Date: May 16, 1994

To:

Chayes, D.	L-DEO
Cox, L.	L-DEO
Hayes, D.	L-DEO
Mutter, J.	L-DEO
MARSCICO,	L-DEO
Stennett, J.	L-DEO
Robinson, W.	L-DEO
Science Officer	EWING
Captain	EWING
Chief Engineer	EWING

RESEARCH CRUISE REPORT

R/V MAURICE EWING, LEG 93-09

"CITHER 2" WOCE Hydrographic Section A-17. escription and definition of the western boundary of the South and Equatorial Atylantic Ocean: watermasses and dynamics"

P.I. Dr. Laurent Mémery, LODYC, Paris, France
Dates: 4 Jan to 21 March 1994
Ports: Montevideo, Uruguay to Cayenne, France

Michael Rawson
Marine Department

May 17, 1994

PRELIMINARY CRUISE REPORT

SHIP NAME :
Maurice Ewing

DATES :
4 Jan. - 21 March 1994

CHIEF SCIENTIST :
Laurent Mémery
LODYC (France)

PARTICIPANTS :
Brazil, France, Spain, USA

OPERATING INSTITUTION :
LDGO

PROJECT TITLE :
CITHER 2

CLEARANCE COUNTRIES :
Brazil, U.K., France
Observer : B. - Josue A. Fontainha ; U. K., F : no

PORT CALLS :
Montevideo (Uruguay), Salvador de Bahia (Brazil), Cayenne (France), Fort de France (France)

DESCRIPTION OF SCIENTIFIC PROGRAM :
Part of the WOCE program (World Ocean Circulation Experiment) : hydrographic section A17. Description and definition of the western boundary of the South and Equatorial Atlantic Ocean : watermasses and dynamics.

DATA OBSERVATIONS AND SAMPLES COLLECTED :
235 hydrographic stations with $CTDO_2$ profiles and tracer measurements with a 32 bottles rosette.
$CTDO_2$: Laboratoire de Physique des Océans - Brest (France).
Salinity, Oxygen : Laboratoire de Physique des Océans - Brest (France).
Nutrients, pH, alkalinity, Phytoplankton, Dissolved organic carbon : Instituto de Investigaciones Mariñas - Vigo (Spain).
Total CO_2 : Marine Science Laboratory - Sequim, Wahington (USA).
Freons : Laboratoire d'Océanographie DYnamique et de Climatologie - Paris (France).
Tritium - Helium : Laboratoire de Modélisation du Climat et de l'Environnement - Gif/Yvette (France).
SF_6 : Woods Hole (Mass., USA)

During transit,
ADCP (currents) : LPO - Brest (France) ; LODYC - Paris (France).

INFORMATION ADDRESS :
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4 Place Jussieu
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FRANCE

SCHEDULE OF DELIVERY FOR ALL DATA RESULTS AND REPORTS :

Data collected	Delivery to Host Countries
CTD, ADCP	Data : Sep. 95
Tracers : salinity, oxygen, nutrients, carbon, freons	Data : Sep. 95
Tritium, Helium	Data : Sep. 96
Final Report	Sep. 95

See note on the back page.

CITHER 2 CRUISE
Jan 4 - March 21, 1994
(Woce Hydrographic Section A17)
(EW9401-9402)

Laurent Mémery
Laboratoire d'Océanographie Dynamique et de Climatologie (LODYC)
Université Pierre et Marie Curie
Paris, France

1) General presentation of the program.

The major goals of the international program WOCE (World Ocean Circulation Experiment) consist in describing the oceanic circulation on a global scale, with the associated transports of heat, salt and tracers. In that general framework, the French component is more focalized on the South Atlantic Ocean (CITHER - CIrculation THERmohaline). After CITHER 1 (February - March 1992), which has covered the Equatorial Atlantic Ocean (northern boundary of the basin), CITHER 2 aims at describing the water masses, from 50°S to 10°N, following the South American continent, and at defining the western boundary conditions of the South Atlantic Ocean (Falklands Islands - Salvador de Bahia - Cayenne). Those cruises will be completed later by meridional sections in the eastern basin, in order to cover the whole South Atlantic Ocean (CITHER 3 : 1995).

CITHER 2 is mainly built upon hydrological sections, including measurements of chemical tracers, both classical (oxygen, nutrients) and transient (CFCs and Tritium). Moreover, all the major components of the inorganic dissolved carbon system are measured.
That project is based on a fruitful collaboration between different laboratories and countries :
- CTD, Salinity, Oxygen : LPO (Brest, France) - LODYC (Paris, France).
- Nutrients, pH, Alkalinity : IIM (Vigo, Spain).
- Total Carbon : MSL (Sequim, Washington, USA).
- CFCs : LODYC (Paris, France).
- Tritium : LMCE (Gif/Yvette, France).

The track has been elaborated taking into account several basic principles :
- optimal description of all the water masses and of their meridional evolution between 50°S and 10°N.
- definition of the western boundary conditions of the South Atlantic Ocean.
- resolution of the western boundary currents and definition of closed "boxes", in order to be abble to use conservation constrains.

- horizontal (30 nautic miles) and vertical (32 bottles) coverages in agreement with the WOCE recommendations, with increased horizontal resolution (down to several nm) on the western boundary sections.

Figures 1a and 1b show the track of the two legs of the cruise and tables 1a, 1b the position of the stations (see text for more explanations). During that cruise, 235 hydrographic stations with complete CTDO_2 profiles using a rosette of 32 bottles (8 liters) have been performed. Measurements of salinity, oxygen, nutrients, pH and CFCs have been made at every station. Alkalinity and total carbon have been measured one every third station along the main section and one every other station for the 4 western boundary sections. At every station, on the surface bottle, alkalinity has been measured, and a sample of phytoplankton has been taken. The dataset has been completed by 10 stations sampled in Dissolved Organic Carbon (DOC) on the main section from the Malvinas Islands to 10°N. Finally, 30 stations have been sampled in tritium, with 20 stations in Helium 3 as well, with a strong emphasis on the western boundaries. Moreover, deep SF6 samples on 7 stations have been taken in the Brazil basin and sent to Woods Hole. These samples will give the background level of SF6 before a tracer (SF6) release experiment is done in 1995 in the framework of Deep Basin Experiment : that experiment aims at quantifying the vertical mixing in the deep ocean, which has major implications in large scale ocean circulation and climate (heat and tracer transports). During most of the cruise, the Hydrosweep central beam has been used to get the bottom depth, and direct current profiles have been obtained with the ADCP.

2) The cruise.

2a) First leg (fig. 1a).

- Jan, 4 : departure from Montevideo (point A) towards East - South East to get 50 liters of nutrient free surface waters needed for nutrient measurements, before going South (where there is no such nutrient free waters).
- Jan, 5 : direction Argentina basin towards bottom depths larger than 6000m to test and wind the wire. Two tests stations in between.
- Jan, 8 : direction Falklands Islands for the beginning of the main section.
- Jan, 10 : beginning of the main South - North section by a "western" boundary sub section between the Falklands plateau (point B) and the abyssal plain of the Argentina basin. Closed station (down to 5nm) according to the topography.
- Jan, 12 : end the Falklands western boundary section and beginning of the "regular" section (spacing between stations = 30 nm).
- Jan, 14 -15 : strong depression arriving during station 23. Work stopped during a day.
- Jan, 21 : after station 41 (point C), direction towards Brazil (North West : point D).

- Jan, 23 : beginning of the Porto Alegre western boundary section towards East, with closed stations according to the bathymetry (line D-C).
- Jan, 26 : end of the western boundary section (station 59) and new very strong depression. After major problems with the wire and the rosette, nothing done during almost two days.
- Jan, 31 : station 72 at the Vema channel, between the Argentina basin and the Brazil basin. Because of the delay due to the two depressions, spacing between stations not decreased and kept at 30nm.
- Feb, 5 - 6 : several "closed" stations (20 nm) near the Martin Vaz islands (very variable topography : point E).
- Feb, 10 : station 115 (point F), last point before transit to Salvador de Bahia. Test stations 116 (at 3000 m for CFCs blanks) and 117 at the same position.
- Feb, 13 : arrival at Salvador de Bahia (point G). End of the first leg.

2b) Second leg (fig. 1b).

- Feb, 17 : departure from Salvador de Bahia (after 4 days of Carnaval !) and beginning of the Salvador western boundary section, with very closed stations (line H-I).
- Feb, 21 : after many problems with the rosette, end of the western boundary section two days late on the schedule (point F). Because of the problems, decision to stop in Recife (point J) to pick up a colleague coming from France.
- Feb, 24 : last station (149) before transit to Recife.
- Feb, 26 : back to station 150 to continue the main North South section.
- Feb, 28 : at sta. 153, the first 500 m of the wire are cut, because of a bad reception of the CTD signal, which is getting worst and worst. After that operation, no more problems until the end of the cruise.
- March, 14 : end of the main North - South section at station 210 (point K).
- March, 15 : beginning of the last section between the Mid Atlantic Ridge and Cayenne (line L-K-M-N).
- March, 20 : last station in front of Cayenne (station 235 : point N).
- March, 21 : end of the CITHER 2 cruise ; beginning of the transit towards Fort de France (Martinique).

3) Problems encountered and some suggestions.

During that three months cruise, we have dealt with different types of problems. During the first leg, two very strong depressions have obliged us to stop working during several days. During the second leg, we have waisted a lot of time trying to solve our own problems with the electrical alimentation of the engines of the rosette. Besides these two major, but straightforward points, several other points deserve more comments. The bad weather has emphasized two important shortcomings concerning the CTD winch and the CTD lab.

First of all, the compensator of swell was not operational : it might even have had negative consequences on the wire, as many times the compensation effect was in opposition of phase with the swell. We have been obliged several times to cut the wire because of bends done during the station (and we nearly have lost the rosette in the first leg during the second depression). In our opinion, for a good behaviour of the wire during station, that compensator of swell should be changed or modified. That problem was certainly enhanced by the quality of the wire, which has nearly never been used until that cruise. During the second leg, the transmission of the CTD signal was so bad that we were obliged to cut 500 meters. Obviously, for coming hydrographic cruises, the wire should be replaced.

As the ship is very low above the water, when the sea is rough, it is nearly impossible to sample the bottles on the C deck (even if we would prefer to stay outside, because of possible CFCs contamination). It is the reason why during the first leg, in the South, from times to times, we were obliged to put the rosette into the CTD lab (considering the size of the rosette, that has required some work before the cruise in order to make that operation possible, as the door was a little to small : that necessary work has not been easy to do, but it has been extremely helpful for the cruise). To do that, a wheeling cart has been built, which was supposed to bear the weight of the rosette and to carry it from the deck to the lab : this cart did not work very well. Obvioulsy, the weight of the rosette was too great and the system to drive the cart not adequate. For WOCE type rosettes (32-36 bottles of 5-8 liters), all that system should be reconsidered.

4) Some prelimary results.

The figures shown in this report come from the very first results obtained on board. The data have not been validated, and for some of them even calibrated yet : they can be considered only qualitatively. They are shown only to give a general idea of the information obtained during the cruise.

Figures 2 show the North South main section from the Malvinas Islands to 10N (line B-C-E-F-K) in temperature (2a), salinity (2b), silicate (2c) and alkalinity (2d). South of 35S, in the upper part of the ocean, one can see many structures of several tens of miles, which represent rings and meanders of the Confluence between the Malvinas current (cold and fresh) and the Brazil current (warm and salty). More North, centered at around 20S, the upper ocean is characterized by the salty and nutrient free Central Waters of the subtropical gyre. Below, a tongue defined by a strong minimum in salinity which can be followed to 10N at around 800 m defines the AntArctic Intermediate Waters (AAIW). This minimum is just above a relative maximum of silicate and alkalinity. Between 2000 m and 3000 m, the North Atlantic Deep Water (NADW - maximum in salinity, and minimum in silicate

and alkalinity) is little by little mixed with surrounding waters (Circumpolar Deep Water - CDW) during its transit towards the South. As it can be seen on the figures, the termination of this watermass in the South, at around 40°S, is rather intricate and the mixing processes with the CDW are very strong. The bottom of the ocean is lined by the AntArctic Bottom Water (AABW), very cold, rather fresh, rich in nutrients, more specifically in silicate, and with high alkalinity. The distribution of this watermass is mostly driven by topography, and mixing with overlying waters (CDW) can dilute it very efficiently at the level of topographic accidents. That can be seen with salinity and more easily with silicate, at the transition between the Argentina Basin and the Brazil Basin, at 32°S (Vema Channel), as well as at the northern limit of the Brazil Basin, close to the Equator.

Figure 3a, b, c and d represent the same tracers along the western boundary section in front of Salvador de Bahia (line H-I-F). The same watermasses can be seen, with a decrease of the signals towards the East. More specifically, the AAIW are characterized by their minimum in salinity and maximum in alkalinity at 700-800 m and the NADW by a maximum in salinity, and minimum in alkalinity and silicate between 1500 and 2000 m. Moreover, in spite of mixing during its transport towards the North, the signature of the AABW is still very strong at the bottom of the ocean, most specifically in silicate.

Figure 4a and 4b show two CFC (F11) sections based on raw data not converted into pmol/l yet. Contrary to more classical tracers, freons are transient : their distribution are not in steady state, they are entirely manmade, and they are invading the ocean. Furthermore, they are conservative in sea water. That means that water parcel which is freon free has not been in contact with the atmosphere during the last 50 years. On contrary, a water parcel which is already polluted has been ventilated after 1930 and is less than 50 years old. Fig. 4a represents part of the meridional section from 13°S (in front of Salvador de Bahia) to 10°N (line F-K). In the Brazil Basin, the bottom is enriched with F11 : this maximum shows the ventilation of the deep ocean from the South (Weddell Sea). In the South part of this subsection, above the AABW, the ocean is nearly freon free on a great depth : at these latitudes, the NADW and the CDW have not yet been polluted by CFCs ; these watermasses are more than 50 years old. Going Northward, the vertical patterns of the F11 distribution becomes more intricate, with successive extrema. At around 4000m, from station 162, the signature of the Lower NADW, coming from the Greenland Sea, can be easely seen, with a large signal at the Equator (around station 170) and at the northern limit of the section. Another clear maximum exists at 1700 m : it represents the Upper NADW, coming mostly from the Labrador Sea. Those two extrema are separated by older water, much less ventilated. The F11 concentrations are of course maximum at the surface of the ocean. The upper thermocline and the UNADW are separated by a narrow,

but very well defined, minimum : at around 1000m, the ocean is nearly freon free and very badly ventilated. Fig. 4b shows the western boundary section off shore of Cayenne (line N-M-L). At that latitude (5°N), there is no more signal of AABW at the bottom. On contrary, the maxima associated with the UNADW (1700m) and the LNADW (4000m) are increased, mainly along the coast : they reflect the strong deep western boundry currents which feed the Atlantic Ocean from the Nordic Seas.

5) Aknowledgements.

Despite the problems encountered during that cruise and presented above, CITHER 2 has been a total success. All the objectives of the program have been reached in terms of spatial coverage, types of measurements and data quality. Obviously, those results should have not been obtained without the very efficient help and the disponibility of every member of the crew. The work has always been done in a very constructive and nice atmosphere. Moreover, some work on the ship was needed before the beginning of the cruise (concerning the CTD lab or the electrical alimentation). Everything was done when we arrived at Montevideo, and without those modifications, the cruise would have been much more difficult : we thank the technical team who has done that very useful work. For most of us, it was the first time that we were on an american ship, and that experience has been very rich and positive (only wine was missing to make it perfect for poor french scientists lost in the middle of the ocean during three months !!). More specifically, during the first leg, the role of the captain Ian Young and of the first mate Louis Mello were crucial. Moreover, the science officer Bruce Francis (and his team) must be more specifically thanked. He has made a fantastic job during the whole cruise : with kindness and efficiency, he has always been present to help us as soon as we were facing a problem. Finally, that program could not have been possible without Michael Rawson, who has received us when the "Maurice Ewing" was in Forida to understand our needs and make the modifications needed on the ship, and who has been obliged to deal with extremely difficult administrative problems.

CITHER 2 CRUISE
SCIENTISTS

NAME	FUNCTION	AFFILIATION
	First and Second Leg	
J. ALVAREZ SALGADO	Nutrients	IIM, Vigo, Spain
L. ARLEN	TCO_2	NOAA/NMFS, Highlands, NJ, USA
L. BINGLER	TCO_2	Battelle, Sequim, Wash., USA
S. CHIHAOUI	CFCs	LODYC, Paris, France
A. FERNANDEZ RIOS	Alk, pH	IIM, Vigo, Spain
J. A. FONTAINHA	Brazilian Obs.	Rio, Brazil
C. GONZALES	Nutrients	IIM, Vigo, Spain
J. P. GOUILLOU	CTD	LPO, Brest, France
L. MEMERY	Ch. Sci., CFCs	LODYC, Paris, France
M. J. MESSIAS	CFCs	LODYC, Paris, France
G. ROSON PORTO	Alk, pH	IIM, Vigo, Spain
	First Leg	
M. ARHAN	CTD	LPO, Brest, France
J. BALLE	CTD	LODYC, Paris, France
P. BRANELLEC	S, O_2	LPO, Brest, France
P. CHANTRY	CTD	LODYC, Paris, France
E. CHARTIER	O_2	LPO, Brest, France
N. DANIAULT	CTD	LPO, Brest, France
J. C. DUTAY	Tritium, S	LMCE, Gif/Yvette, France
M. FICHAUT	CTD	IFREMER, Brest, France
C. HEMON	CTD	LPO, Brest, France
P. LE BOT	S	LPO, Brest, France
H. LOUKOS	CTD	LODYC, Paris, France
G. MADEC	CTD	LODYC, Paris, France
	Second Leg	
A. BILLANT	S, O_2	LPO, Brest, France
E. BRAGA	O_2	USP, São Paulo, Brazil
S. DELEVILLE	CTD	LODYC, Paris, France
J. P. GIRARDOT	CTD	LPO, Brest, France
Y. GOURIOU	CTD	ORSTOM, Brest, France
A. LAZAR	CTD	LODYC, Paris, France
C. LEVY	CTD	LODYC, Paris, France
M. LEVY	CTD, CFCs	LODYC, Paris, France
O. MARTI	Tritium, S	LMCE, Gif/Yvette, France
G. MAUDIRE	CTD	IFREMER, Brest, France
H. MERCIER	CTD	LPO, Brest, France
O. PEDEN	CTD	LPO, Brest, France
J. PEDREIRA	S	LPO, Brest, France

94/03/20
17:53:17

Table 1a

CITHER II - LEG 1 - Toutes stations

Resume_Stations

No station	date	heure(GMT)	latitude	longitude	profondeur	nb bouteilles
001	08/01/1994	19:58:08	S 46 49	W 053 42	6041	32
002	09/01/1994	16:16:50	S 49 35	W 056 10	0702	32
003	10/01/1994	00:43:42	S 50 42	W 057 13	0235	32
004	10/01/1994	04:38:40	S 50 17	W 056 47	0449	32
005	10/01/1994	08:58:16	S 49 51	W 056 21	0589	12
006	10/01/1994	13:06:53	S 49 26	W 055 56	0770	32
007	10/01/1994	17:19:19	S 49 01	W 055 31	1082	16
008	10/01/1994	21:00:51	S 48 40	W 055 11	1737	18
009	11/01/1994	00:19:29	S 48 30	W 055 02	2883	24
010	11/01/1994	05:01:44	S 48 27	W 054 58	4205	29
011	11/01/1994	11:14:15	S 48 15	W 054 47	5007	31
012	11/01/1994	17:16:49	S 48 06	W 054 38	5575	32
013	12/01/1994	00:04:31	S 47 41	W 054 14	5817	32
014	12/01/1994	07:24:25	S 47 16	W 053 52	6014	32
015	12/01/1994	14:14:51	S 46 51	W 053 32	6068	32
016	12/01/1994	21:34:31	S 46 25	W 053 09	6088	32
017	13/01/1994	04:41:45	S 46 00	W 052 48	6072	32
018	13/01/1994	12:03:56	S 45 35	W 052 27	6031	32
019	13/01/1994	19:39:26	S 45 10	W 052 05	6012	32
020	14/01/1994	03:11:31	S 44 46	W 051 45	5889	32
021	14/01/1994	11:24:06	S 44 20	W 051 21	5752	32
022	14/01/1994	19:08:38	S 43 55	W 051 00	5568	32
023	15/01/1994	23:08:13	S 43 29	W 050 39	5397	32
024	16/01/1994	07:35:05	S 43 05	W 050 18	5525	32
025	16/01/1994	14:07:34	S 42 40	W 049 57	5683	32
026	16/01/1994	20:58:05	S 42 16	W 049 35	5809	32
027	17/01/1994	04:05:00	S 41 50	W 049 14	5749	32
028	17/01/1994	11:07:40	S 41 25	W 048 53	5574	32
029	17/01/1994	18:15:42	S 41 00	W 048 31	5443	32
030	18/01/1994	01:17:30	S 40 35	W 048 10	5340	32
031	18/01/1994	07:55:21	S 40 10	W 047 48	5293	32
032	18/01/1994	14:13:56	S 39 45	W 047 27	5269	32
033	18/01/1994	20:50:28	S 39 20	W 047 06	5238	32
034	19/01/1994	03:31:44	S 38 55	W 046 44	5207	32
035	19/01/1994	10:36:07	S 38 30	W 046 22	5190	32
036	19/01/1994	17:34:04	S 38 05	W 046 01	5172	32
037	20/01/1994	00:14:40	S 37 40	W 045 39	5156	32
038	20/01/1994	07:14:08	S 37 15	W 045 19	5114	32
039	20/01/1994	13:44:14	S 36 50	W 044 57	5057	32
040	20/01/1994	19:54:57	S 36 25	W 044 36	4984	32
041	21/01/1994	02:00:01	S 36 00	W 044 15	4905	32
042	21/01/1994	10:04:10	S 35 30	W 045 03	4841	32
043	22/01/1994	17:13:50	S 32 21	W 050 13	0234	09
044	22/01/1994	18:38:32	S 32 25	W 050 06	0972	16
045	22/01/1994	21:43:16	S 32 36	W 049 46	1505	18
046	23/01/1994	01:07:21	S 32 48	W 049 27	1748	19
047	23/01/1994	04:52:06	S 33 00	W 049 07	2570	23
048	23/01/1994	09:00:58	S 33 12	W 048 48	3023	27
049	23/01/1994	13:02:18	S 33 24	W 048 28	3204	27
050	23/01/1994	17:57:48	S 33 36	W 048 09	3358	27
051	23/01/1994	22:20:34	S 33 48	W 047 51	3779	30
052	24/01/1994	03:50:28	S 34 04	W 047 23	4210	32
053	24/01/1994	10:22:58	S 34 21	W 046 56	4500	32
054	24/01/1994	18:59:24	S 34 37	W 046 29	4651	32
055	25/01/1994	00:46:47	S 34 53	W 046 02	4742	32
056	25/01/1994	06:44:13	S 35 10	W 045 35	4797	32
057	25/01/1994	12:52:45	S 35 26	W 045 08	4862	32
058	25/01/1994	19:25:29	S 35 43	W 044 42	4838	32
059	26/01/1994	14:14:16	S 36 00	W 044 14	4886	32
060	27/01/1994	23:05:27	S 35 35	W 043 53	4893	32
061	28/01/1994	05:29:16	S 35 12	W 043 33	4878	32
062	28/01/1994	11:55:11	S 34 49	W 043 12	4791	32
063	28/01/1994	18:04:30	S 34 25	W 042 51	4651	32
064	28/01/1994	23:52:54	S 34 01	W 042 30	4535	32
065	29/01/1994	05:47:46	S 33 37	W 042 09	4529	32
066	29/01/1994	11:33:33	S 33 14	W 041 48	4570	30
067	29/01/1994	18:06:06	S 32 50	W 041 27	4510	31
068	29/01/1994	23:55:25	S 32 27	W 041 06	4422	31
069	30/01/1994	06:13:28	S 32 03	W 040 46	4112	28
070	30/01/1994	12:03:37	S 31 40	W 040 25	3753	29
071	30/01/1994	17:41:14	S 31 16	W 040 04	3628	27
072	30/01/1994	23:03:25	S 30 53	W 039 44	4414	31
073	31/01/1994	05:06:23	S 30 29	W 039 22	4150	29
074	31/01/1994	10:24:56	S 30 05	W 039 02	4220	30
075	31/01/1994	15:51:03	S 29 42	W 038 41	4293	30
076	31/01/1994	21:14:56	S 29 18	W 038 20	4315	30
077	01/02/1994	03:06:15	S 28 54	W 037 59	4407	31
078	01/02/1994	08:57:27	S 28 31	W 037 38	4450	31
079	01/02/1994	14:40:43	S 28 07	W 037 18	4529	32
080	01/02/1994	20:15:02	S 27 44	W 036 57	4678	32
081	02/02/1994	01:58:07	S 27 21	W 036 36	5022	32
082	02/02/1994	07:52:06	S 26 58	W 036 16	4605	32
083	02/02/1994	13:55:17	S 26 34	W 035 55	4484	32
084	02/02/1994	19:49:22	S 26 11	W 035 34	4253	31
085	03/02/1994	01:26:41	S 25 47	W 035 14	4278	31
086	03/02/1994	07:18:26	S 25 24	W 034 53	4401	32
087	03/02/1994	13:02:39	S 25 01	W 034 32	4545	32
088	03/02/1994	18:51:40	S 24 37	W 034 11	4625	32
089	04/02/1994	00:40:19	S 24 14	W 033 51	4583	32
090	04/02/1994	06:32:12	S 23 50	W 033 30	4627	32
091	04/02/1994	12:20:20	S 23 27	W 033 10	4754	32
092	04/02/1994	18:24:38	S 23 04	W 032 49	4783	32
093	05/02/1994	00:14:23	S 22 40	W 032 28	4598	32
094	05/02/1994	05:57:09	S 22 17	W 032 08	4559	32
095	05/02/1994	16:35:29	S 21 54	W 031 47	4550	32
096	05/02/1994	22:35:39	S 21 31	W 031 27	4614	32
097	06/02/1994	03:36:59	S 21 15	W 031 13	4632	32
098	06/02/1994	08:34:02	S 21 00	W 030 59	4651	32
099	06/02/1994	13:40:30	S 20 39	W 030 58	4545	32
100	06/02/1994	18:38:59	S 20 20	W 030 57	4499	32
101	06/02/1994	23:34:17	S 20 00	W 030 56	4552	32
102	07/02/1994	04:38:51	S 19 39	W 030 55	4548	32
103	07/02/1994	09:30:40	S 19 20	W 030 54	4530	32
104	07/02/1994	15:23:03	S 18 50	W 030 52	4507	32
105	07/02/1994	21:13:59	S 18 21	W 030 51	4582	32
106	08/02/1994	03:10:42	S 17 51	W 030 49	4763	32
107	08/02/1994	09:13:28	S 17 22	W 030 48	4874	32
108	08/02/1994	15:17:44	S 16 52	W 030 46	4933	32
109	08/02/1994	21:19:35	S 16 23	W 030 44	4930	32
110	09/02/1994	03:55:33	S 15 53	W 030 43	4927	32
111	09/02/1994	09:59:44	S 15 24	W 030 41	4825	32
112	09/02/1994	16:16:42	S 14 54	W 030 40	4871	32
113	09/02/1994	22:20:54	S 14 25	W 030 38	4904	32
114	10/02/1994	04:26:11	S 13 55	W 030 36	5312	32
115	10/02/1994	10:29:00	S 13 26	W 030 35	5199	32
116	10/02/1994	18:40:06	S 13 26	W 030 35	5205	32
117	11/02/1994	00:19:47	S 13 26	W 030 35	5205	32

94/03/20
17:51:43

Table 1b

CITHER II - LEG 2 - Toutes stations

Resume_Stations

No station	date	heure(GMT)	latitude	longitude	profondeur	nb bouteilles
118	17/02/1994	23:24:32	S 12 21	W 037 37	0319	16
119	18/02/1994	01:54:33	S 12 23	W 037 35	1025	16
120	18/02/1994	04:49:47	S 12 24	W 037 34	1568	16
121	~~25/02/1994 17:46:58~~		S 12 25	W 037 32	1996	32
122	18/02/1994	12:21:48	S 12 29	W 037 27	2503	32
123	18/02/1994	18:17:37	S 12 34	W 037 20	3017	32
124	19/02/1994	00:15:56	S 12 42	W 037 07	3519	32
125	19/02/1994	05:40:49	S 12 57	W 036 47	3869	32
126	19/02/1994	11:47:13	S 13 12	W 036 27	4196	32
127	19/02/1994	17:49:25	S 13 13	W 035 57	4339	32
128	20/02/1994	00:02:01	S 13 14	W 035 28	4406	32
129	20/02/1994	07:20:50	S 13 15	W 034 59	4433	32
130	20/02/1994	14:17:39	S 13 16	W 034 30	4519	32
131	20/02/1994	18:35:47	S 13 16	W 034 29	4516	32
132	20/02/1994	23:17:00	S 13 18	W 034 00	3751	32
133	21/02/1994	04:57:18	S 13 19	W 033 31	4587	32
134	21/02/1994	10:24:42	S 13 19	W 033 31	4588	16
135	21/02/1994	14:35:01	S 13 20	W 033 01	4561	32
136	21/02/1994	20:47:39	S 13 21	W 032 32	4645	32
137	22/02/1994	01:08:58	S 13 21	W 032 32	4645	16
138	22/02/1994	05:40:41	S 13 22	W 032 03	4842	32
139	22/02/1994	10:30:05	S 13 22	W 032 03	4838	16
140	22/02/1994	16:38:32	S 13 24	W 031 34	4985	32
141	22/02/1994	23:08:08	S 13 25	W 031 04	5043	32
142	23/02/1994	05:42:40	S 13 26	W 030 35	5165	32
143	23/02/1994	12:10:25	S 12 56	W 030 33	5138	32
144	23/02/1994	18:29:53	S 12 26	W 030 32	5334	32
145	24/02/1994	01:04:00	S 11 56	W 030 30	5397	32
146	24/02/1994	07:37:49	S 11 26	W 030 29	5360	32
147	24/02/1994	14:06:14	S 10 57	W 030 27	5331	32
148	24/02/1994	20:40:34	S 10 27	W 030 25	5313	32
149	25/02/1994	03:35:19	S 09 57	W 030 24	5298	32
150	25/02/1994	10:04:25	S 09 27	W 030 22	5306	32
151	27/02/1994	22:33:50	S 08 57	W 030 21	5242	32
152	28/02/1994	04:46:52	S 08 28	W 030 19	5366	32
153	28/02/1994	10:58:54	S 07 58	W 030 17	5388	32
154	28/02/1994	17:58:10	S 07 28	W 030 16	5387	32
155	01/03/1994	00:25:03	S 06 58	W 030 14	5369	32
156	01/03/1994	06:44:06	S 06 28	W 030 13	5209	32
157	01/03/1994	12:56:25	S 05 59	W 030 11	5179	32
158	01/03/1994	19:18:22	S 05 29	W 030 09	5106	32
159	02/03/1994	01:34:05	S 04 59	W 030 08	4972	32
160	02/03/1994	08:00:12	S 04 29	W 030 06	4680	32
161	02/03/1994	13:58:31	S 03 59	W 030 05	4883	32
162	02/03/1994	20:08:30	S 03 30	W 030 03	4828	32
163	03/03/1994	02:06:26	S 03 00	W 030 01	4888	32
164	03/03/1994	08:17:24	S 02 29	W 030 00	4878	32
165	03/03/1994	13:19:39	S 02 12	W 029 59	4883	32
166	03/03/1994	18:21:34	S 01 54	W 030 00	4914	32
167	03/03/1994	23:26:36	S 01 35	W 030 00	4964	32
168	04/03/1994	04:25:59	S 01 18	W 029 59	4224	32
169	04/03/1994	09:13:20	S 00 59	W 030 00	3858	32
170	04/03/1994	14:30:27	S 00 44	W 030 25	4492	32
171	04/03/1994	18:37:09	S 00 45	W 030 25	4496	32
172	04/03/1994	22:35:48	S 00 30	W 030 51	4107	32
173	05/03/1994	04:07:01	S 00 14	W 031 17	4289	32
174	05/03/1994	09:39:18	N 00 00	W 031 43	4224	32
175	05/03/1994	15:33:30	N 00 14	W 032 09	4555	32
176	05/03/1994	21:18:43	N 00 29	W 032 34	4566	32
177	06/03/1994	03:03:58	N 00 44	W 033 00	3524	32
178	06/03/1994	08:26:52	N 00 59	W 033 26	3717	32
179	06/03/1994	14:20:42	N 01 17	W 033 56	4028	32
180	06/03/1994	20:23:07	N 01 35	W 034 26	3904	32
181	07/03/1994	02:11:13	N 01 52	W 034 56	4000	32
182	07/03/1994	08:09:39	N 02 10	W 035 26	4303	32
183	07/03/1994	14:19:26	N 02 27	W 035 56	3690	32
184	07/03/1994	20:02:29	N 02 45	W 036 27	4324	32
185	08/03/1994	02:11:20	N 03 02	W 036 57	4146	32
186	08/03/1994	08:17:02	N 03 19	W 037 27	4546	32
187	08/03/1994	14:30:54	N 03 37	W 037 57	4372	32
188	08/03/1994	20:43:36	N 03 54	W 038 27	4349	32
189	09/03/1994	02:51:52	N 04 12	W 038 57	4593	32
190	09/03/1994	09:01:46	N 04 29	W 039 27	4433	32
191	09/03/1994	15:03:53	N 04 47	W 039 58	4466	32
192	09/03/1994	21:14:23	N 05 04	W 040 28	4666	32
193	10/03/1994	03:35:49	N 05 22	W 040 58	4663	32
194	10/03/1994	08:09:15	N 05 22	W 040 58	4655	32
195	10/03/1994	12:40:59	N 05 39	W 041 28	4696	32
196	10/03/1994	18:55:03	N 05 57	W 041 59	4707	32
197	11/03/1994	01:11:43	N 06 15	W 042 29	4707	32
198	11/03/1994	07:20:13	N 06 32	W 042 59	4633	32
199	11/03/1994	13:32:25	N 06 49	W 043 29	4661	32
200	11/03/1994	19:47:28	N 07 07	W 044 00	4656	32
201	12/03/1994	02:03:21	N 07 24	W 044 30	4566	32
202	12/03/1994	08:20:58	N 07 42	W 045 00	4542	32
203	12/03/1994	15:01:06	N 08 00	W 045 31	4537	32
204	12/03/1994	21:18:10	N 08 17	W 046 01	4571	32
205	13/03/1994	03:58:14	N 08 35	W 046 31	4602	32
206	13/03/1994	10:21:06	N 08 52	W 047 02	4654	32
207	13/03/1994	16:33:32	N 09 09	W 047 33	4691	32
208	13/03/1994	22:36:27	N 09 27	W 048 03	4741	32
209	14/03/1994	04:48:07	N 09 45	W 048 34	4780	32
210	14/03/1994	10:51:06	N 10 02	W 049 04	4851	32
211	15/03/1994	11:19:10	N 13 12	W 047 13	4285	32
212	15/03/1994	16:37:03	N 13 39	W 046 57	3843	32
213	15/03/1994	22:09:02	N 13 12	W 047 13	4191	32
214	16/03/1994	03:59:18	N 12 45	W 047 29	4133	32
215	16/03/1994	09:35:39	N 12 18	W 047 45	4519	32
216	16/03/1994	15:28:10	N 11 51	W 048 01	4640	32
217	16/03/1994	21:13:10	N 11 24	W 048 17	4935	32
218	17/03/1994	03:25:31	N 10 56	W 048 32	4914	32
219	17/03/1994	09:25:15	N 10 29	W 048 49	4891	32
220	17/03/1994	15:16:02	N 10 02	W 049 04	4847	32
221	17/03/1994	21:10:29	N 09 36	W 049 19	4768	32
222	18/03/1994	03:06:39	N 09 10	W 049 35	4679	32
223	18/03/1994	08:58:30	N 08 44	W 049 50	4580	32
224	18/03/1994	14:35:21	N 08 18	W 050 05	4471	32
225	18/03/1994	20:24:50	N 07 52	W 050 20	4387	32
226	19/03/1994	02:40:02	N 07 26	W 050 34	4278	32
227	19/03/1994	08:37:21	N 07 00	W 050 50	4069	32
228	19/03/1994	14:31:41	N 06 34	W 051 05	3529	32
229	19/03/1994	18:54:35	N 06 19	W 051 14	2991	32
230	19/03/1994	23:22:48	N 06 09	W 051 21	2773	32
231	20/03/1994	04:03:04	N 06 01	W 051 24	2149	32
232	20/03/1994	07:21:47	N 05 57	W 051 26	1529	32
233	20/03/1994	10:16:53	N 05 55	W 051 28	0992	32
234	20/03/1994	12:42:36	N 05 53	W 051 28	0494	32
235	20/03/1994	16:13:03	N 05 53	W 051 30	0243	32

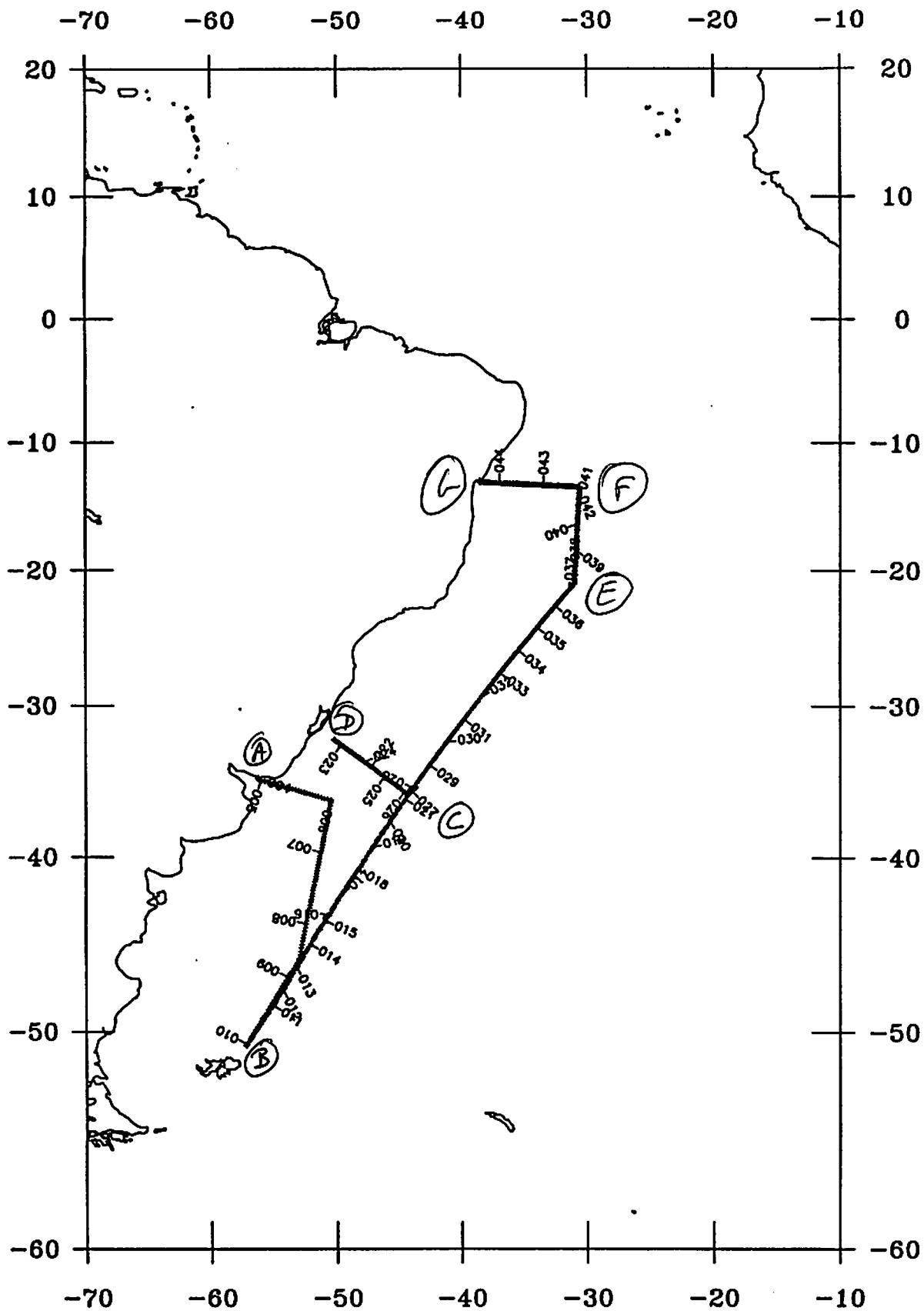

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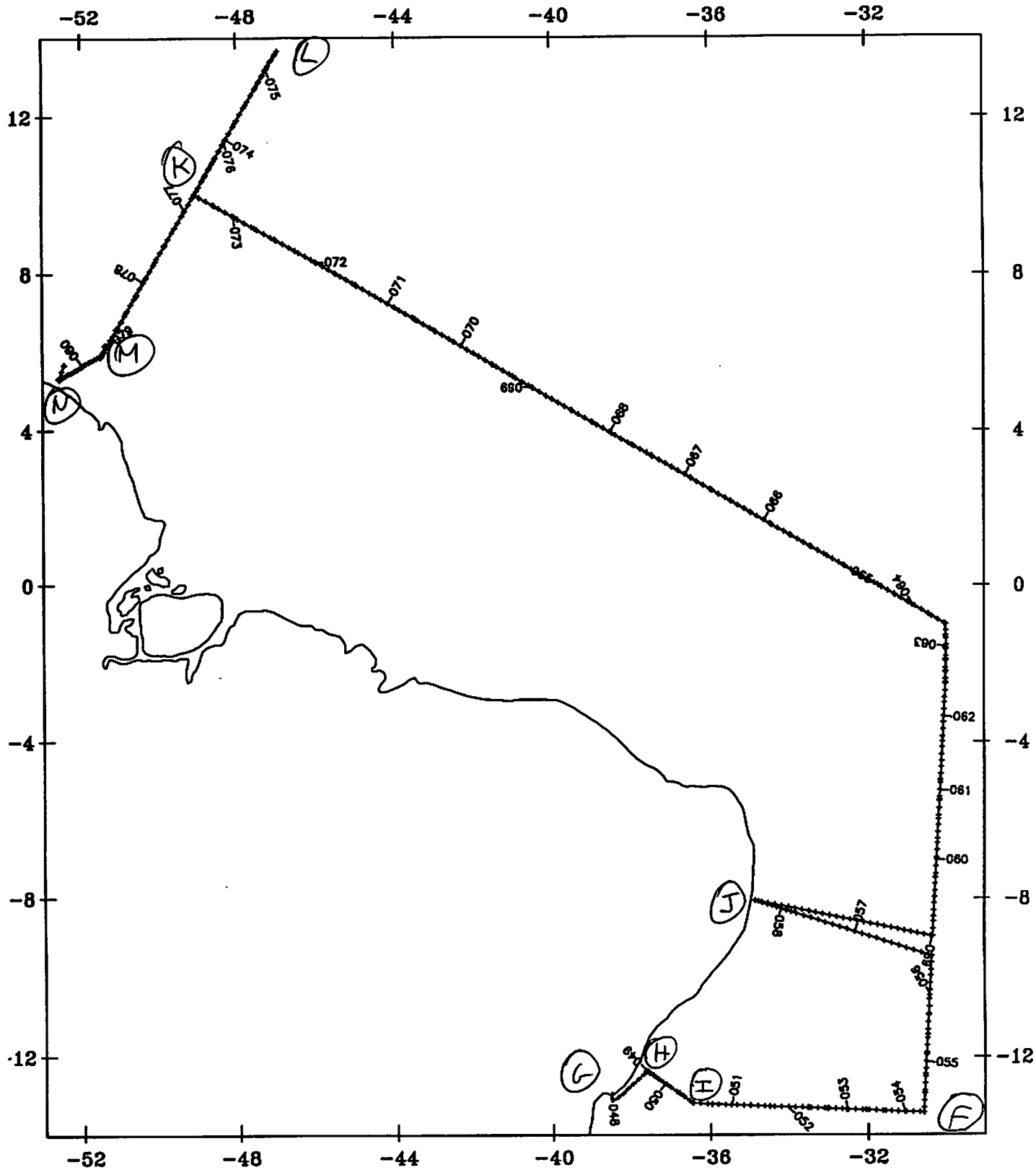
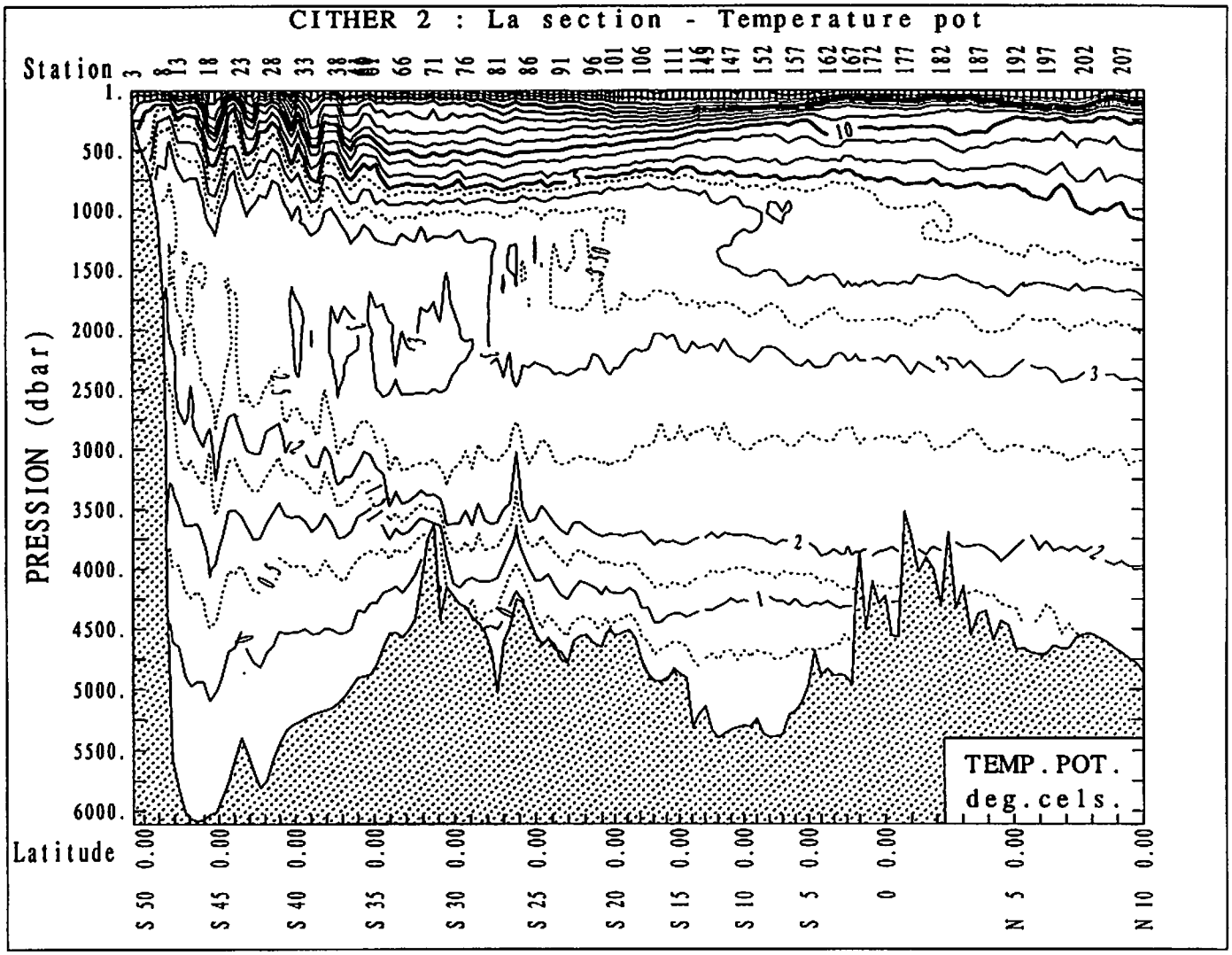
Fig. 1a



EW-9402 NAVIGATION TRACK LINE ; SCALE = 0.3 inch/deg.

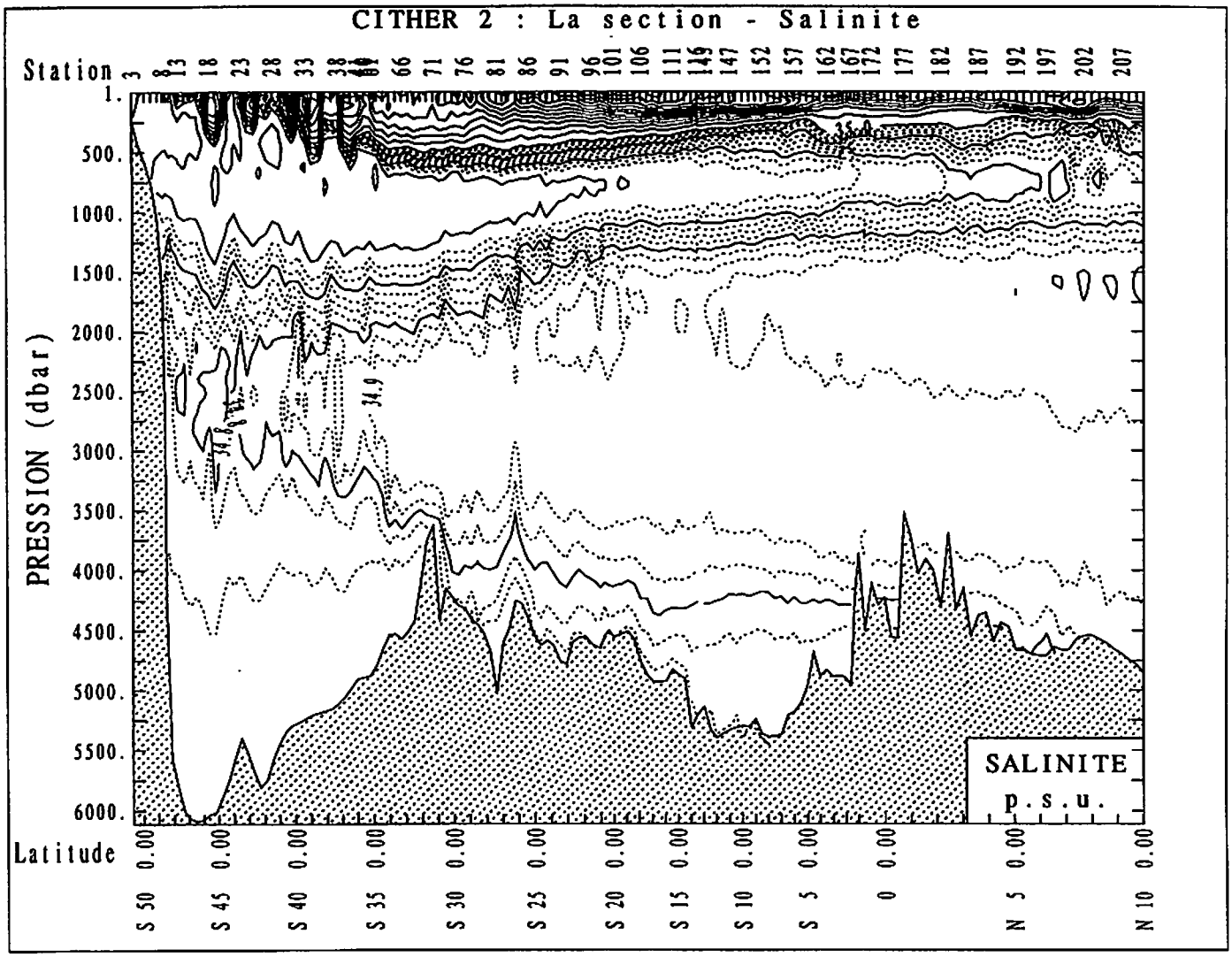
Fig. 1b

Fig. 2a



cith2.mlt cith2-mlt.cat tet1.par	HYDROLOGIE TRASEC 15/03/94 IFREMER

Fig. 2b



cith2.mlt cith2-mlt.cat sal.par	HYDROLOGIE TRASEC 15/03/94 IFREMER

Fig. 2c

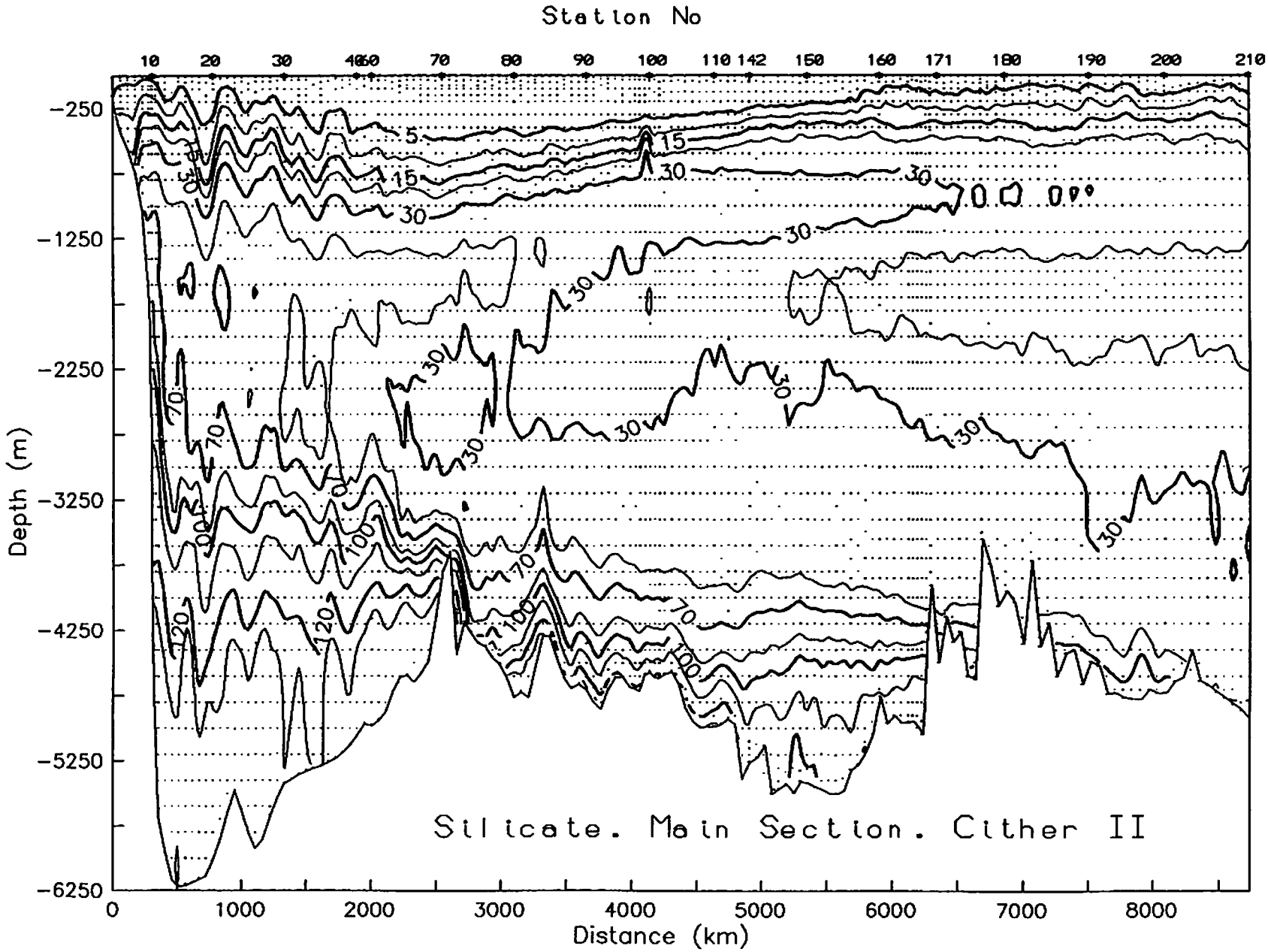

Station No
10 20 30 40 50 70 80 90 100 110 142 150 160 171 180 190 200 210
-250
-1250
-2250
-3250
-4250
-5250
-6250
Depth (m)
0 1000 2000 3000 4000 5000 6000 7000 8000
Distance (km)
Silicate. Main Section. Cither II

Fig. 2d

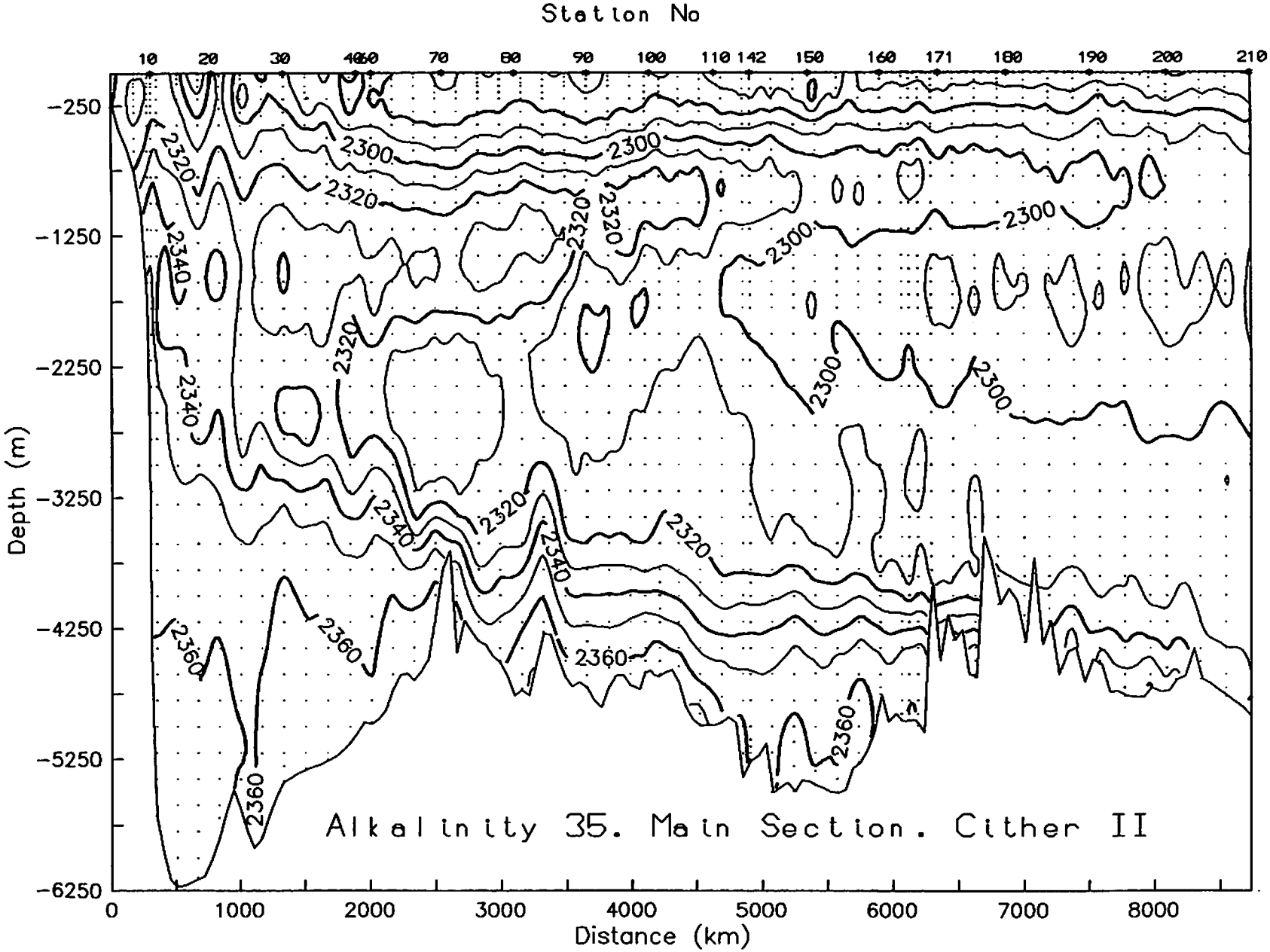
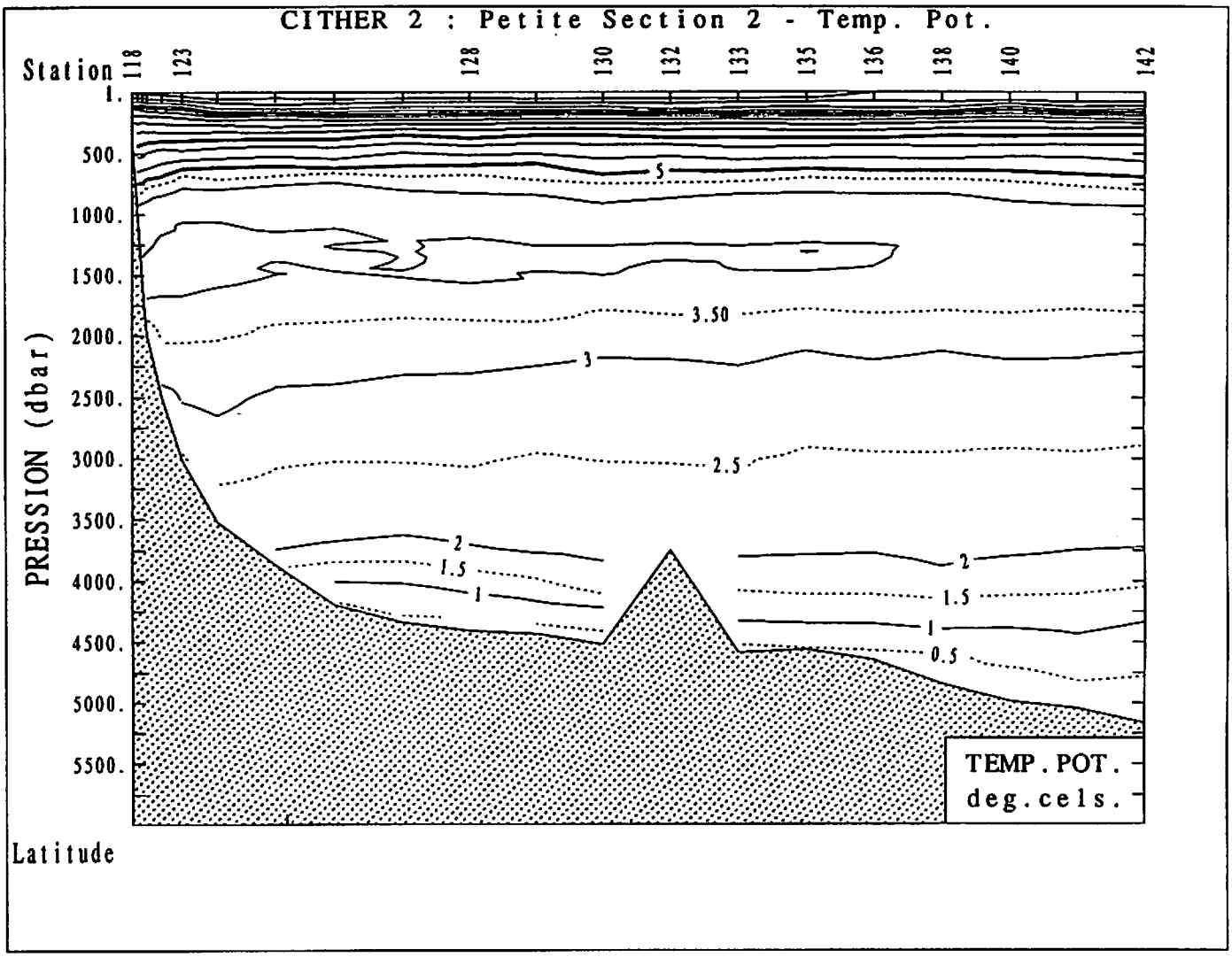
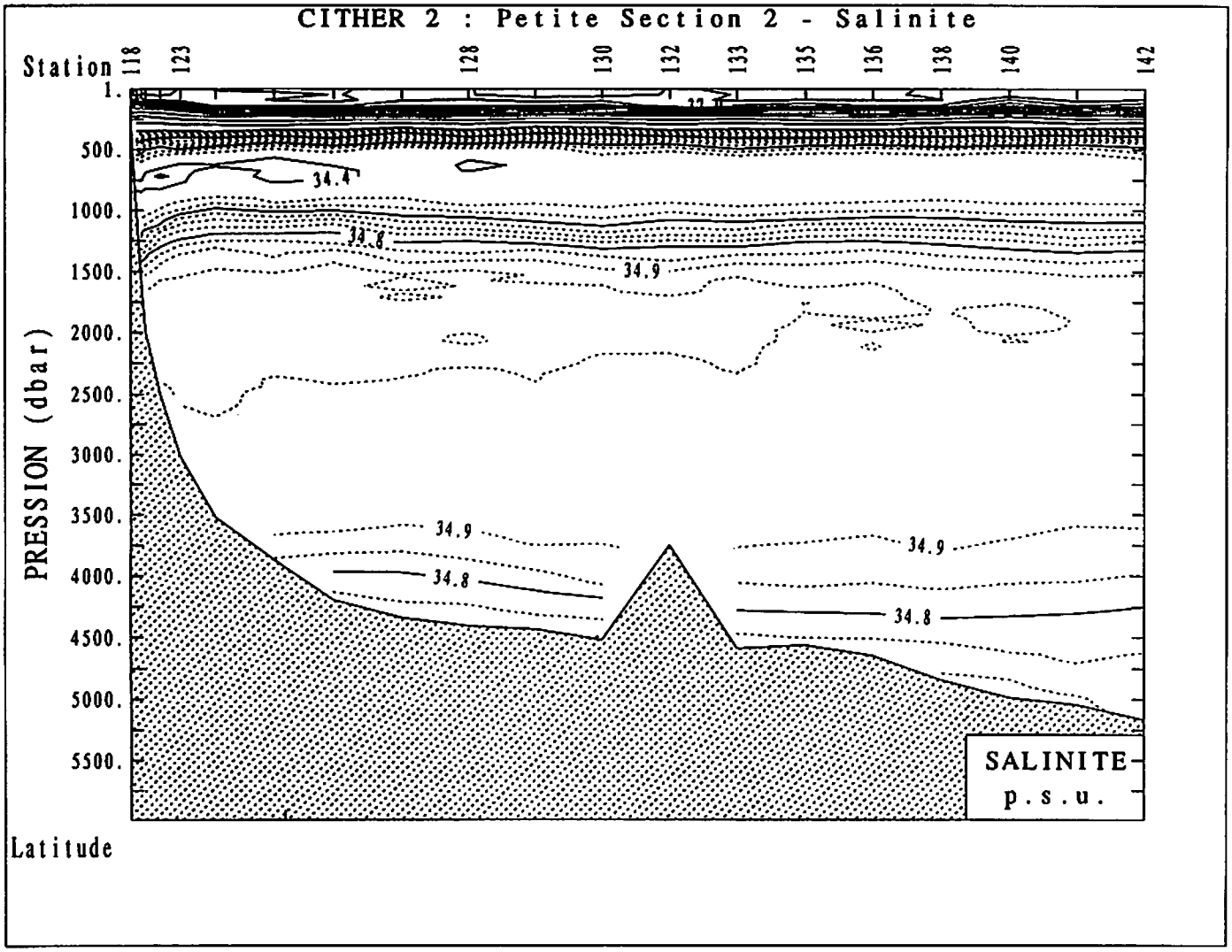

Station No
10 20 30 40 50 70 80 90 100 110 142 150 160 171 180 190 200 210
-250
-1250
-2250
-3250
-4250
-5250
-6250
Depth (m)
0 1000 2000 3000 4000 5000 6000 7000 8000
Distance (km)
2300
2320
2340
2360
Alkalinity 35. Main Section. Cither II

Fig. 3a



cith2.mlt cith2-mlt.cat tet1.par	HYDROLOGIE TRASEC 20/03/94 IFREMER

Fig. 36



cith2.mlt cith2-mlt.cat sal.par	HYDROLOGIE TRASEC 20/03/94 IFREMER

Fig. 3c

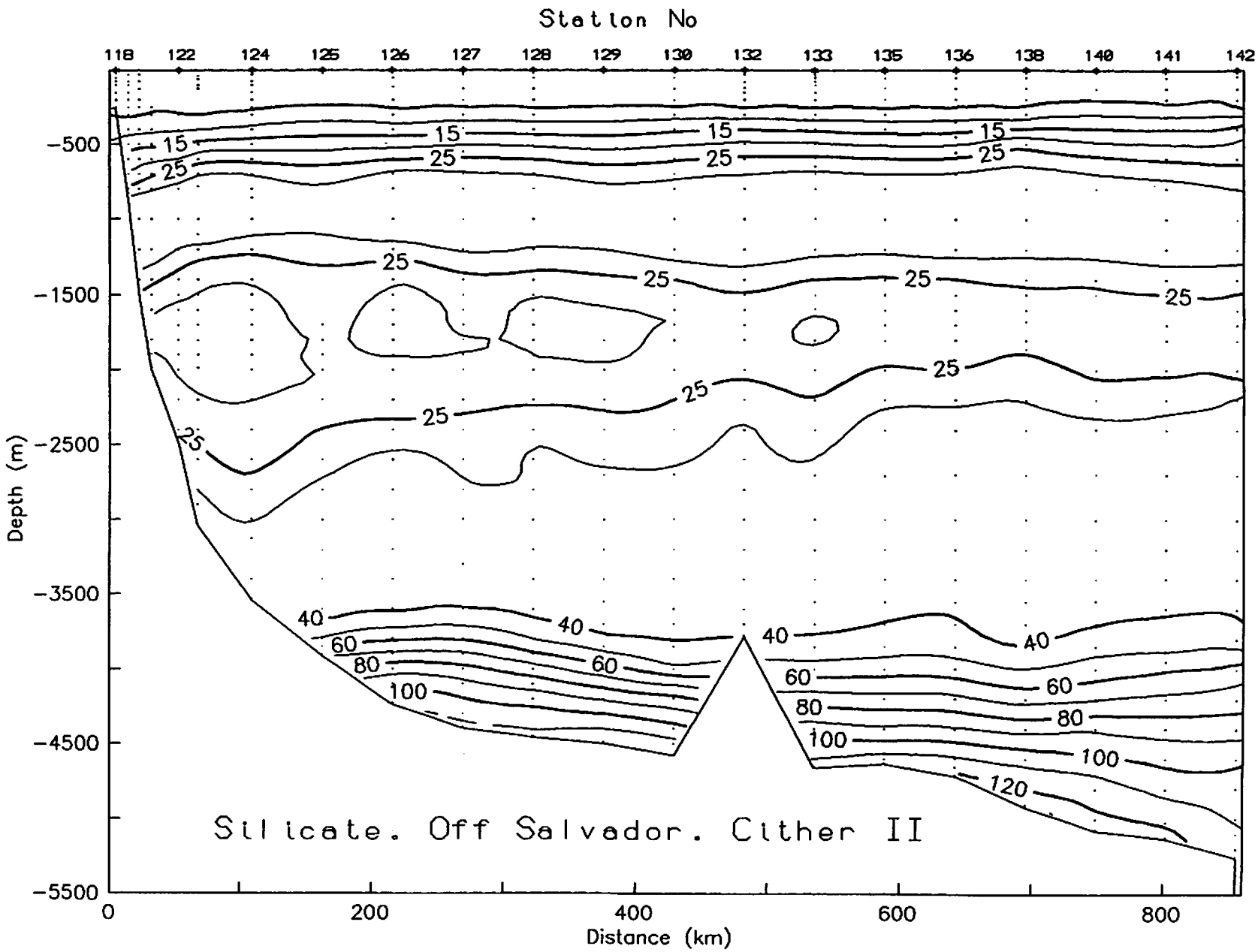
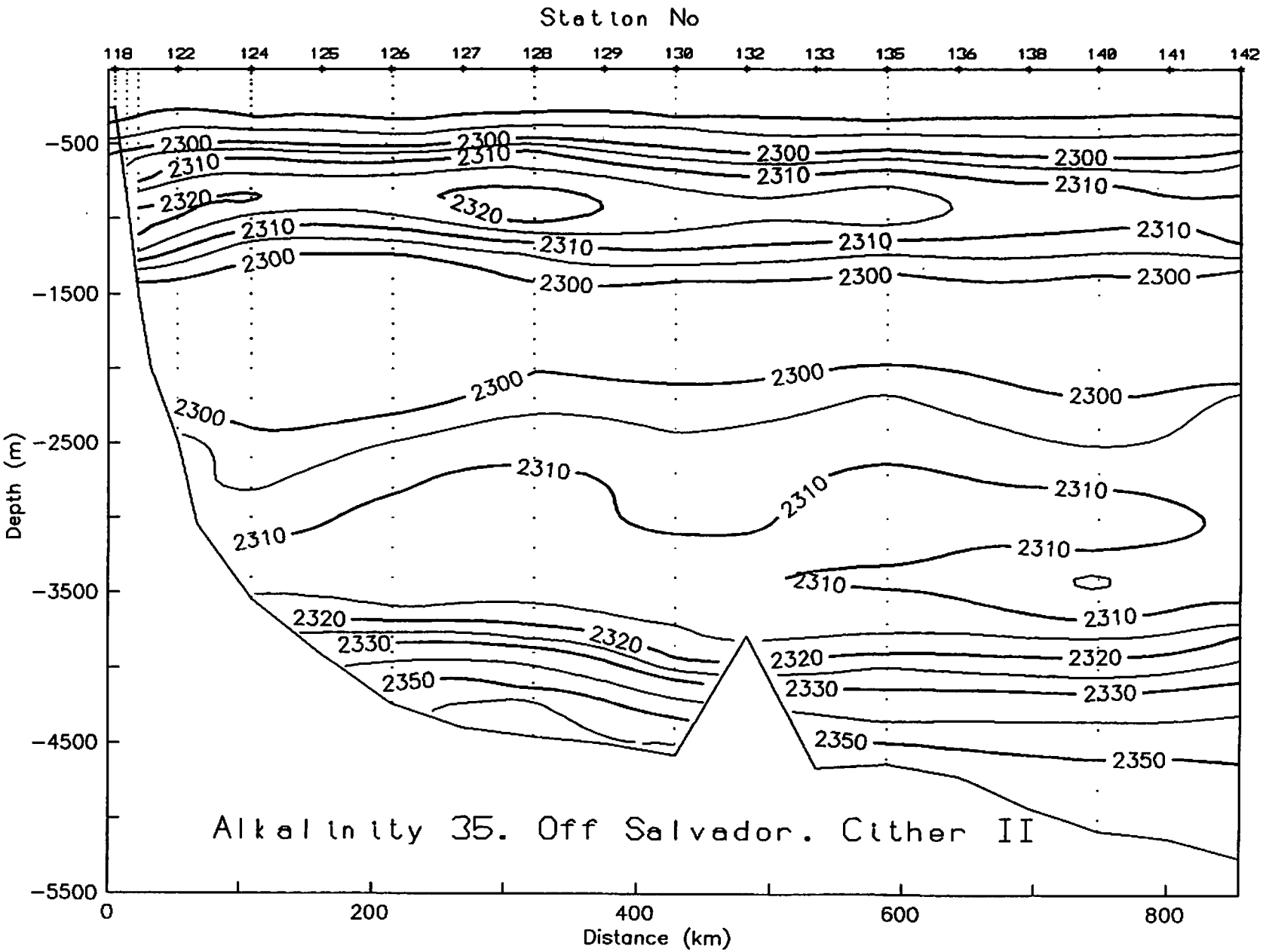

Station No
118 122 124 125 126 127 128 129 130 132 133 135 136 138 140 141 142
Depth (m)
-500
-1500
-2500
-3500
-4500
-5500
15
25
40
60
80
100
120
Silicate. Off Salvador. Cither II
0 200 400 600 800
Distance (km)

Fig. 3d


Station No
118
122
124
125
126
127
128
129
130
132
133
135
136
138
140
141
142
Depth (m)
-500
-1500
-2500
-3500
-4500
-5500
2300
2310
2320
2330
2350
0
200
400
600
800
Distance (km)
Alkalinity 35. Off Salvador. Cither II

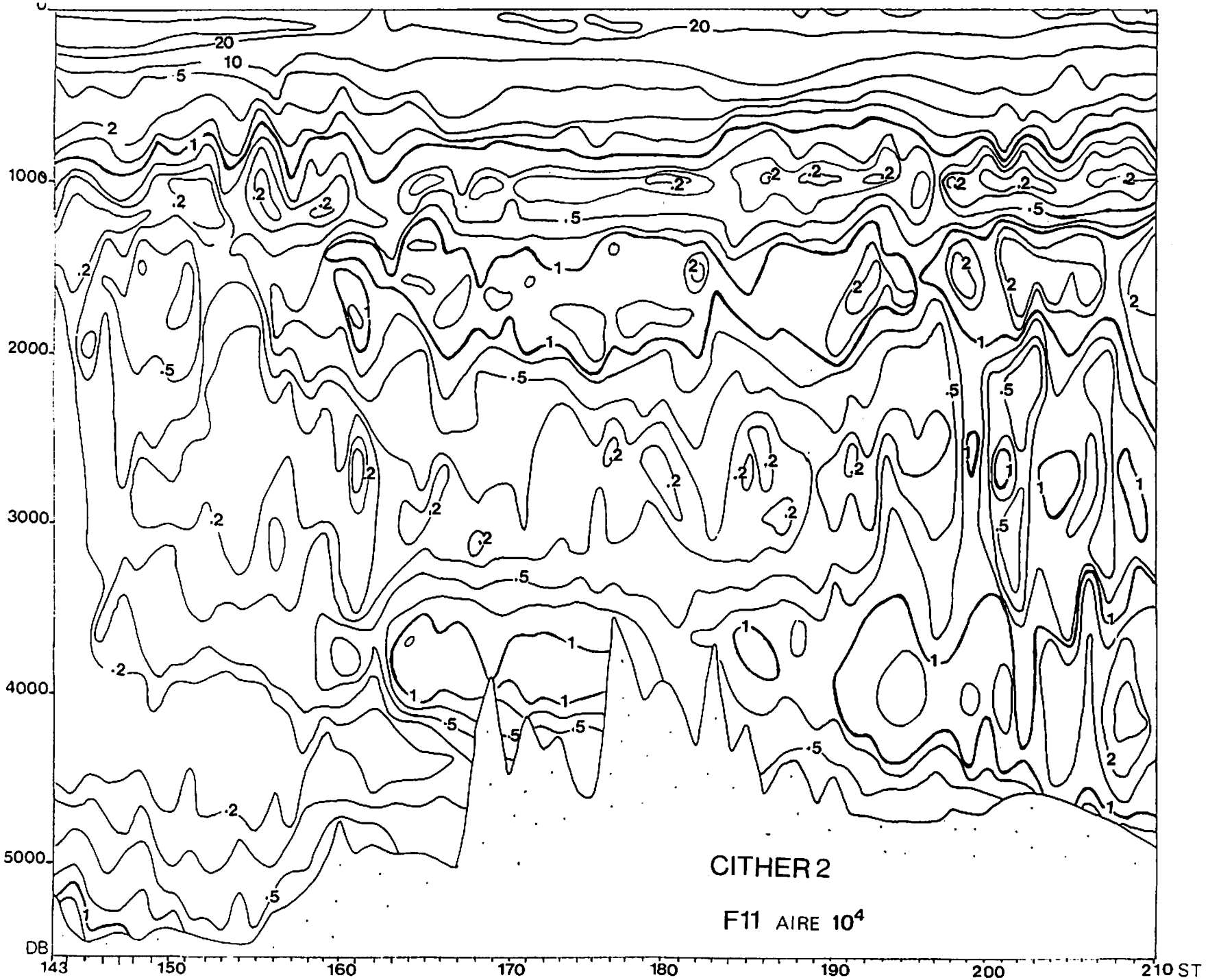
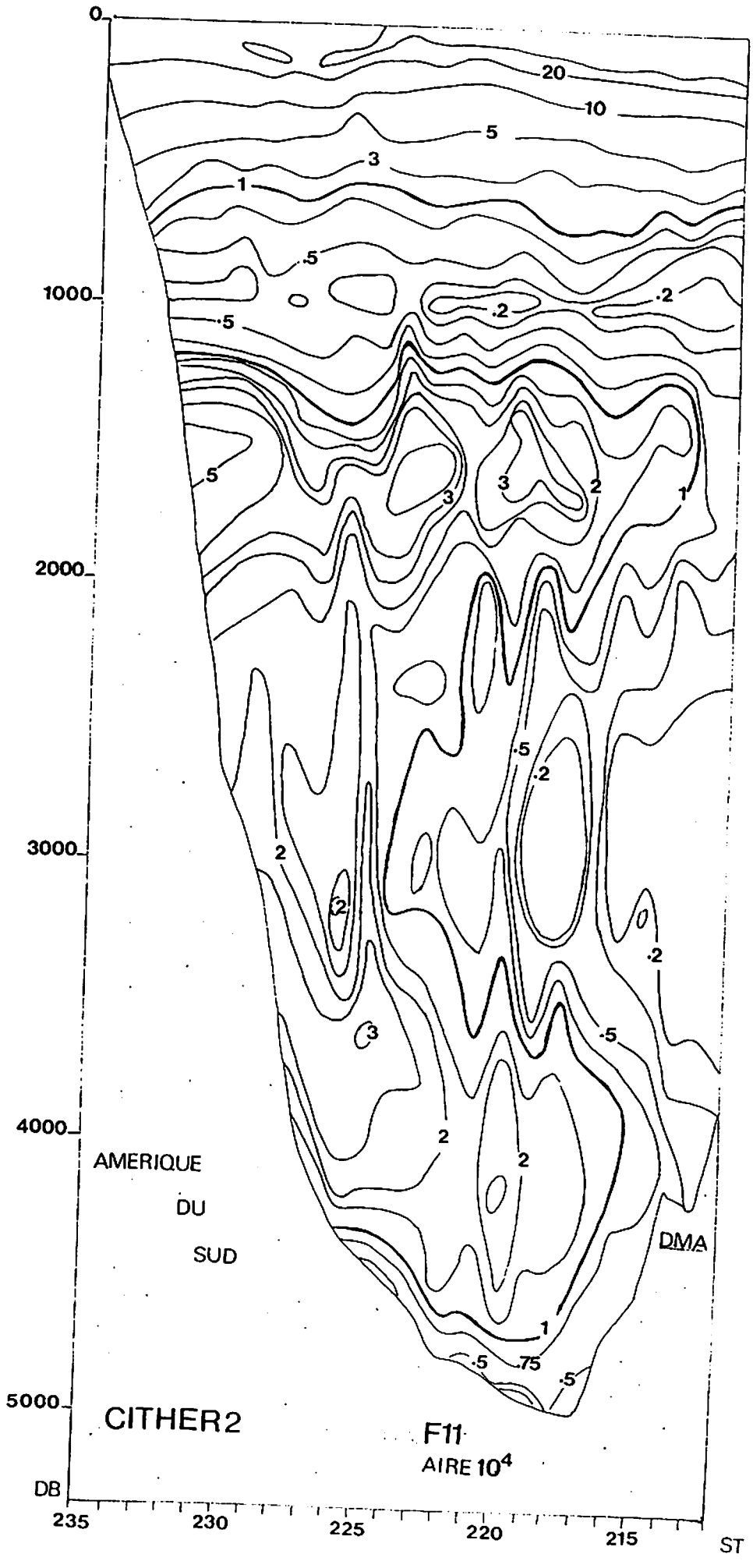

0
1000
2000
3000
4000
5000
DB
143
150
160
170
180
190
200
210 ST
CITHER 2
F11 AIRE 10^4

Fig. 4a

Fig. 4b


0
1000
2000
3000
4000
5000
DB
235
230
225
220
215
ST
AMERIQUE
DU
SUD
DMA
CITHER2
F11
AIRE 10^4