Berichte

aus dem

Institut für Meereskunde

an der

Christian-Albrechts-Universität Kiel

Nr. 51

ESACAN - Data report

by

C. Brockmann, E. Fahrbach and W. Urquizo

ISSN 0341 - 8561

1978

Berichte aus dem

Institut für Meereskunde

an der

Christian-Albrechts-Universität Kiel

Nr. 51

ESACAN - Data report

by

C. Brockmann, E. Fahrbach and W. Urquizo

Copies of this report may be obtained on request

from:

C. Brockmann and E. Fahrbach
Institut für Meereskunde
an der Universität Kiel
Düsternbrooker Weg 20
D-2300 K I E L 1

A Spanish version may be obtained on request from:

W. Urquizo
Instituto del Mar del Peru
Casilla 3734 - Lima - Peru

ISSN 0341 - 8561

Table of contents

Summary

From March to May 1977 the joint German-Peruvian investigation of the northern Peruvian upwelling area ESACAN ("Estudio del Sistema de Afloramiento Costero en el Area Norte") took place. Three current meter moorings were laid on a section along 5°S at depths of 104 m, 1360 m and 3820 m. On board the Peruvian research vessel "BAP Unanue" hydrographic casts, STD-measurements and current profiling measurements were carried out. Meteorological data were collected from five land stations and two buoys. Data are available from two further land stations: at one the sea-level was recorded; at the other the sea-surface temperature. The data obtained are presented in this paper.

Zusammenfassung

Von März bis Mai 1977 fand das deutsch-peruanische Gemeinschaftsprojekt ESACAN ("Estudio del Sistema de Afloramiento Costero en el Area Norte") zur Untersuchung der nördlichen Auftriebsregion vor der peruanischen Küste statt. Drei Strommesserverankerungen werden auf einem Schnitt entlang 5°S in 104 m, 1360 m und 3820 m Tiefe ausgelegt. An Bord des peruanischen Forschungsschiffes "BAP Unanue" wurde eine hydrographische Serienausrüstung, eine STD-Sonde und ein profilierender Strömungsmesser eingesetzt. Meteorologische Daten werden an 5 Landstationen und 2 Bojen gewonnen. Die Wasserstandsaufzeichnungen und Oberflächentemperaturmessungen von je einer Landstation stehen zur Verfügung. Das gesammelte Datenmaterial wird in diesem Band vorgelegt.

1. Introduction

One of the most important upwelling areas is situated off the Peruvian coast. Four regions are especially prominent. They are situated at 4° - 6° S, 7° - 8° S, 11° - 12° S and 14° - 15° S. The most intense upwelling is encountered in the last area. In addition to the spatial change, there is a time variation with a pronounced annual period. The maximum upwelling is found in the southern hemispheric winter.

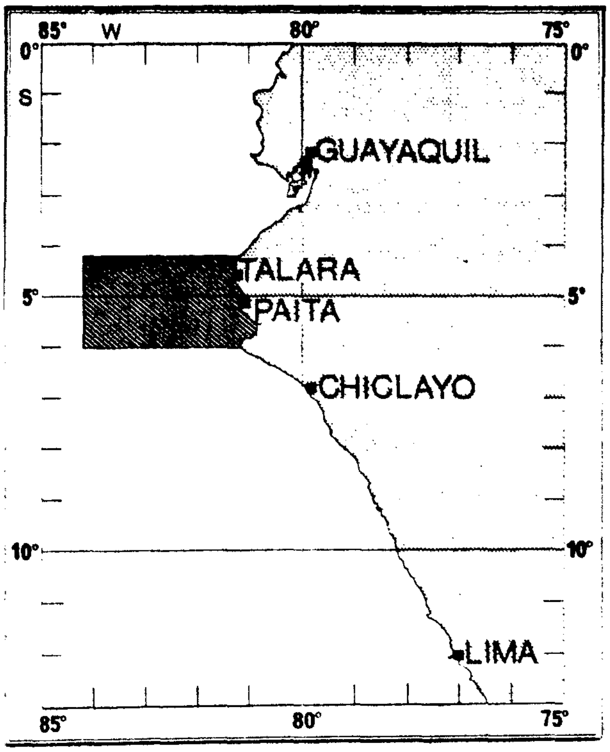


Figure 1
The location of ESACAN area

Between March and May 1977 two programmes for the investigation of these phenomena were undertaken: The US-investigation Joint II MAM 77 within the scope of the "Coastal Upwelling Ecosystem Analysis" (CUEA) programme in the southern area and the Westgerman-Peruvian "Estudio del Sistema de Afloramiento Costero en el Area Norte" (ESACAN) in the north. The location of the ESACAN area is depicted in Figure 1.

The northern upwelling area is of special interest because there coastal upwelling may interact with features typical of the equatorial region, for example the equatorial front and the equatorial undercurrent. Special conditions may be generated by the fact that the Peru current leaves the coast in this region.

A dramatic change in the whole system occurs when the "El Nino" phenomenon takes place. The equatorial front advances far to the south and coastal upwelling is suppressed.

2. Measurements

In the period from March 27 to May 22 1977 stratification measurements were made from the Peruvian research vessel "BAP Unanue" in the northern upwelling area. These measurements were supplemented by current meter measurements from a moored array.

2.1. Navigation and bathymetry

On board "BAP Unanue" terrestrial and astronomical navigation were practised. The terrestrial navigation was carried out by radar and gave reasonable results (accuracy $\pm$ 1 nm) within a distance of 15 nm of the coast. Astromical navigation could only yield very crude results, because of the restricted visibility. Further than 15 nm from the coast the position error may be as large as $\pm$ 5 nm; the accuracy depends mainly on the number of stations made without terrestrial navigation. However, the mooring positions, even those for which no radar fix was possible are exact to within 1 nm. Only the gross features of the bottom topography of the area under investigation are known (Fig. 2). A more detailed two-dimensional bathymetric survey did not seem justified during this cruise because of the limited navigational accuracy. However, to get some additional information to that given by existing charts, three bathymetric sections were carried out along 4° 15'S, 5° 00' S and 6° 00' S

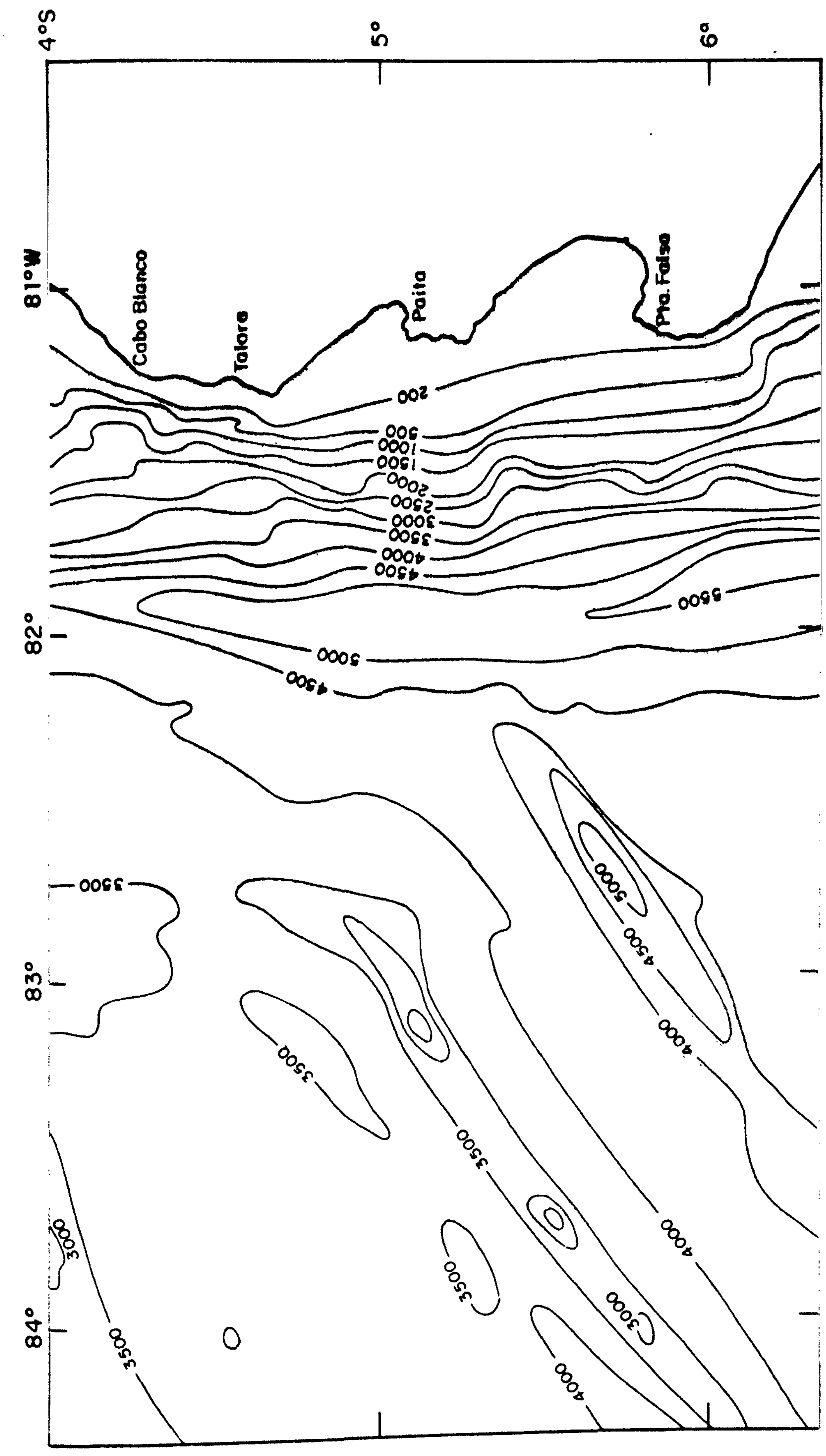


Figure 2. Bathymetric chart from Scripps Institution of Oceanography (depth in meters).

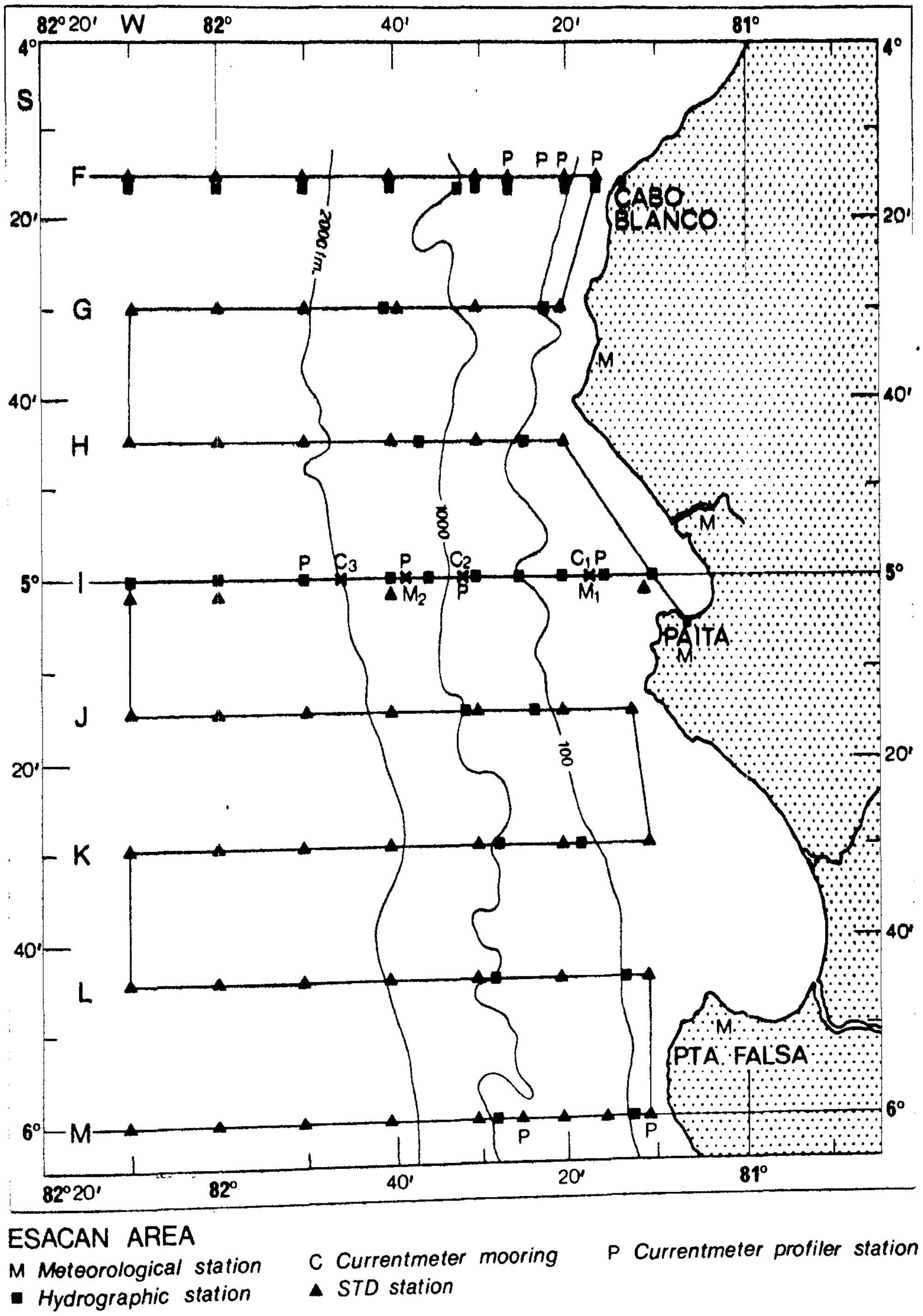


Figure 3. Location of measurements in the ESACAN area.

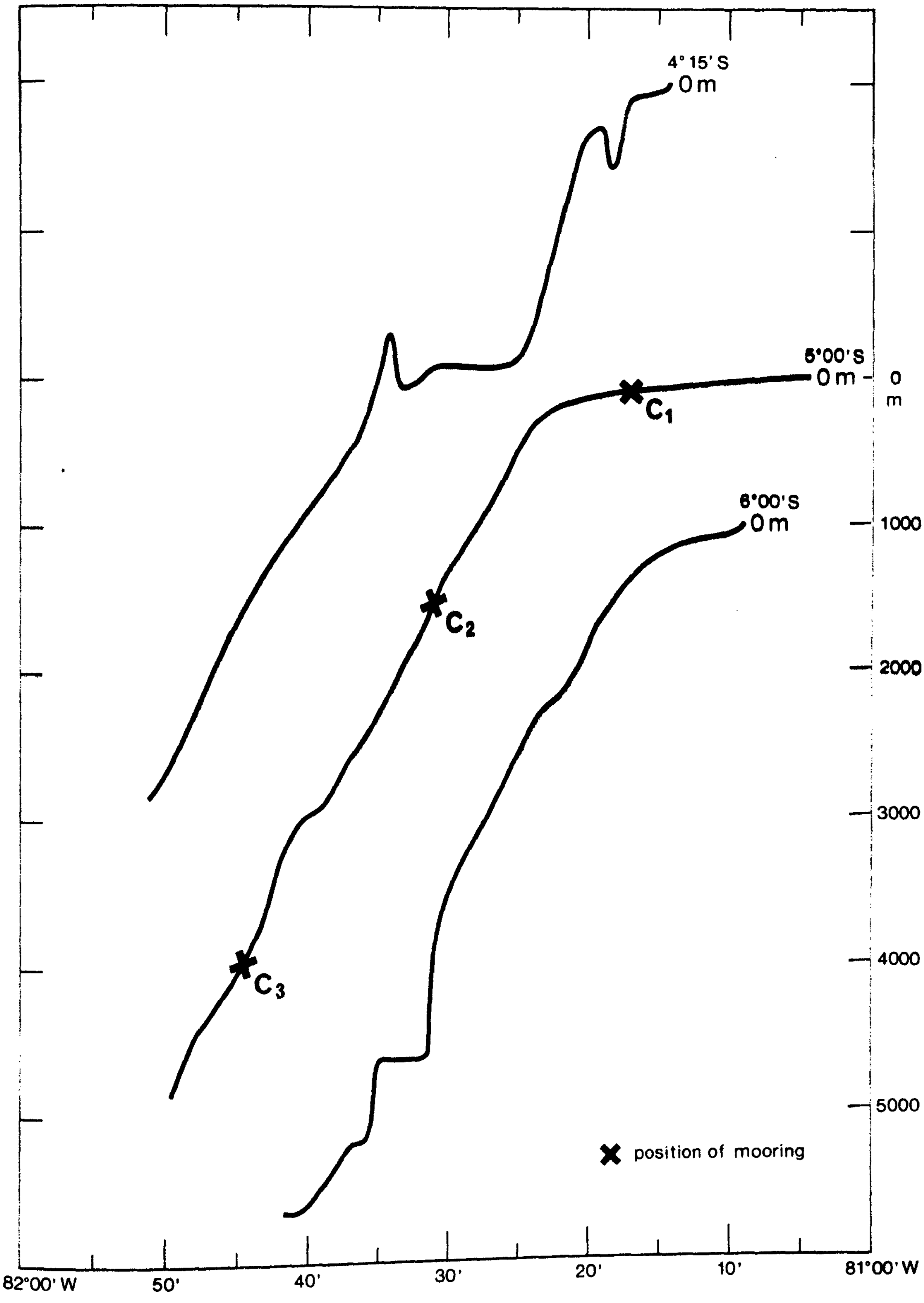


Figure 4. Bathymetric sections along $4^{o}15$'S, $5^{o}00$'S and $6^{o}00$'S.

(Fig. 4).

The measurements of the echosounder were corrected to agree with the depth values obtained from the readings of the pressure gauges in the moorings combined with the known cable length. Sound velocity corrections have not been applied because they are much smaller than the errors caused by instrumental problems.

2.2. Moored instrument measurements

Three subsurface moorings with 16 Aanderaa RCM-4 current meters were located at the positions given in Figure 3 and 4. The moorings were maintained for about 50 days. The sampling interval was 10 minutes for all instruments. As an example a schematic representation of the mooring C2 is given in Figure 5.

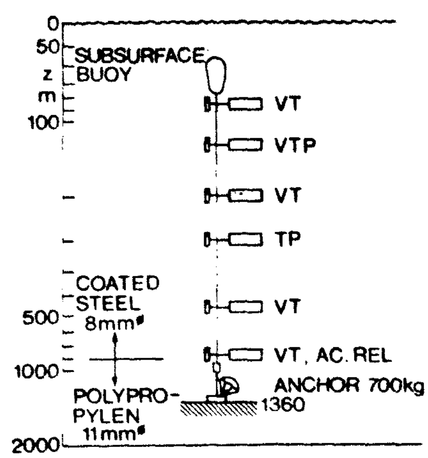


Figure 5

Schematic representation of mooring C2

V = velocity sensor
T = temperature sensor
P = pressure sensor
AC.REL = acoustic release

Unfortunately not all of the instruments worked without problems The time series obtained are summarized in Table 1.

Because the aim of the experiment was to study upwelling phenomena with low frequency variations the time series of the hourly means have been filtered by a Lanczos low pass filter with a half power point of 35 hours and 60 weights (Fig. 6).

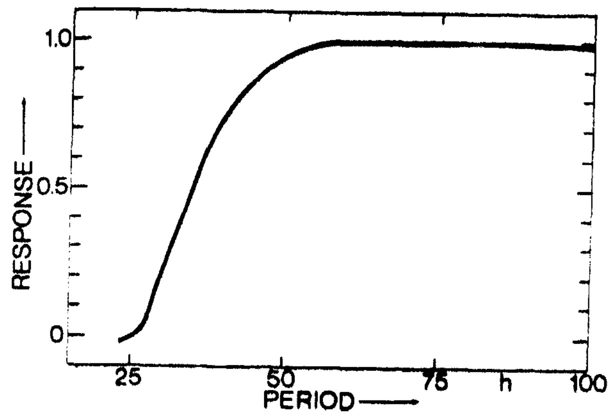


Figure 6

Response of the applied Lanczos low pass filter (60 weights).

The results of the current measurements are presented in Figures 7 - 10. Current measurements are presented in two ways: as progressive vector diagrams (Fig. 7 and 8) and stick-plot diagrams (Fig. 9 and 10). The progressive vector diagrams consist of hourly values. The overall mean currents are presented in Figure 11. The instrumental accuracy of the Aanderaa current meters is given as $\pm$ 2 % of the measured speed and as $\pm$ 5 degrees for the direction. In Figure 12 the pressure traces are shown. Quite strong movements of the moorings are indicated in the records. The velocity generated by the movement of the mooring has been calculated for the deepening of C2 on April 30 as 0.16 cm s^{-1}, which is negligible in comparison with the recorded velocities of 15 cm s^{-1}. The high velocities shown in th record of mooring C2 in 560 m depth seem rather doubtful. But even the most painstaking inquiry did not reveal an instrumental or data processing error which could explain the surprising feature.

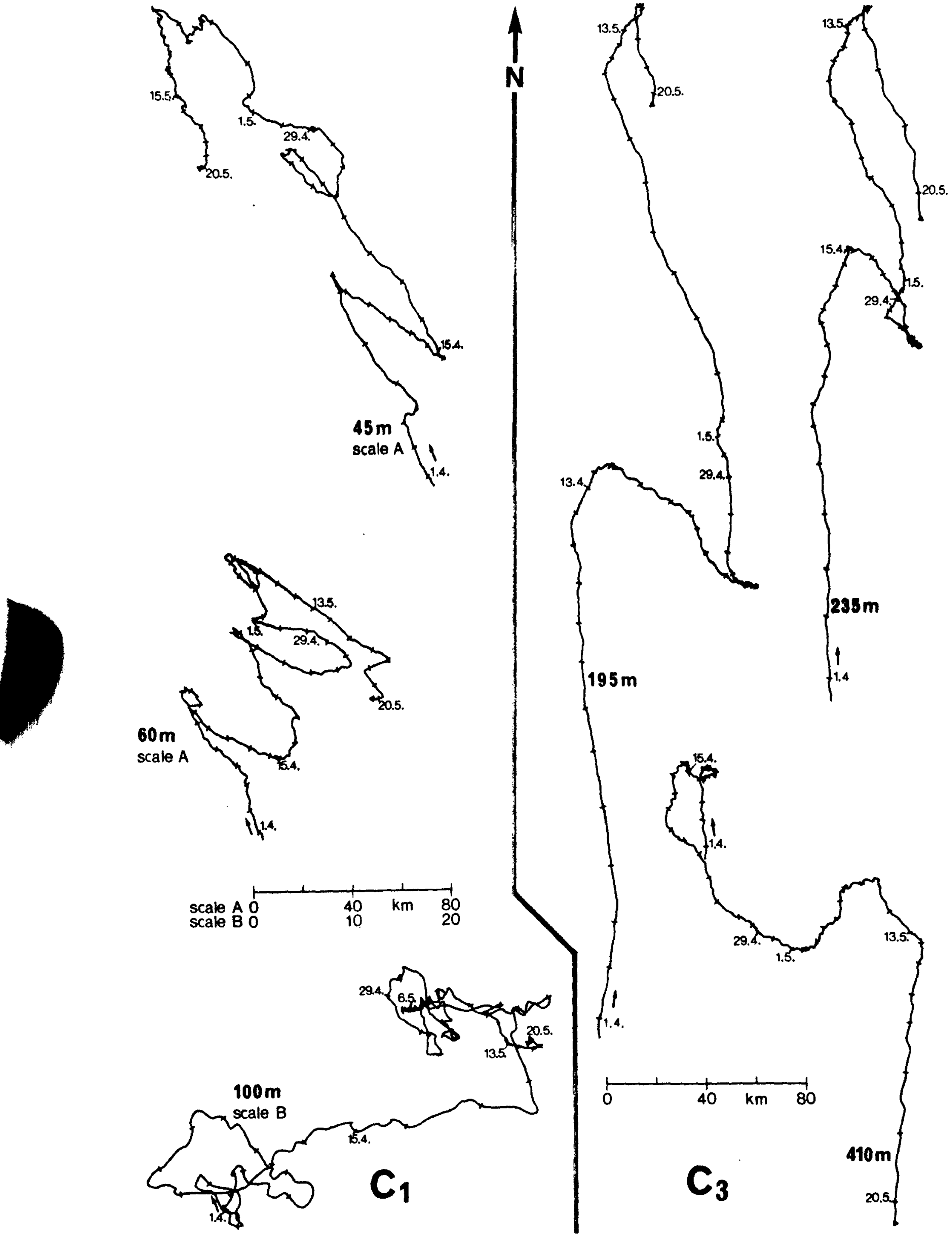


Figure 7. Progressive vector diagrams derived from the current meter time series at moorings C_1 and C_3. The deepest current meter of C_1 gave erroneous values at the end of the observation period because the

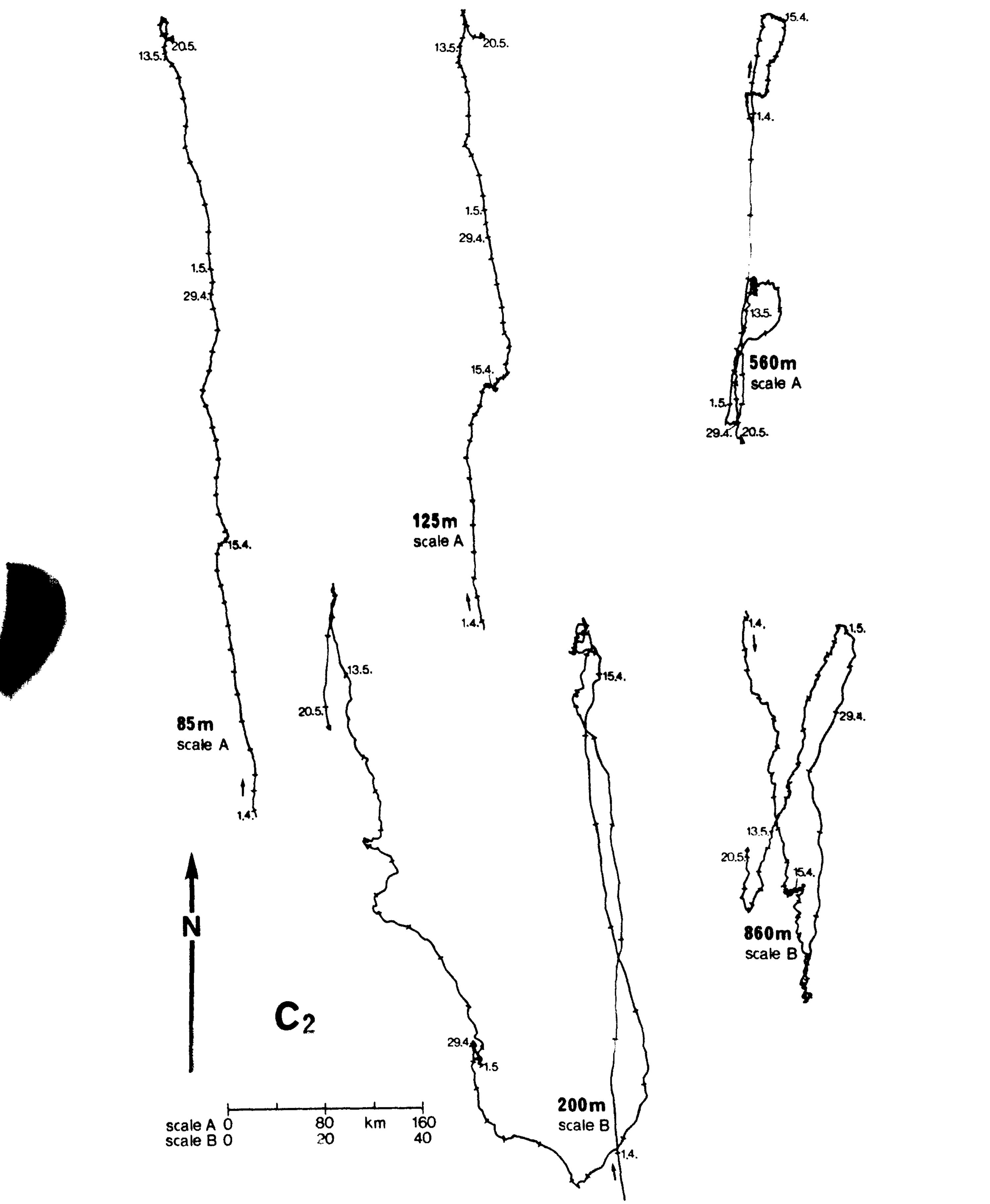


Figure 8. Progressive vector diagrams derived from the current meter time series at mooring C_2 (hourly mean values).

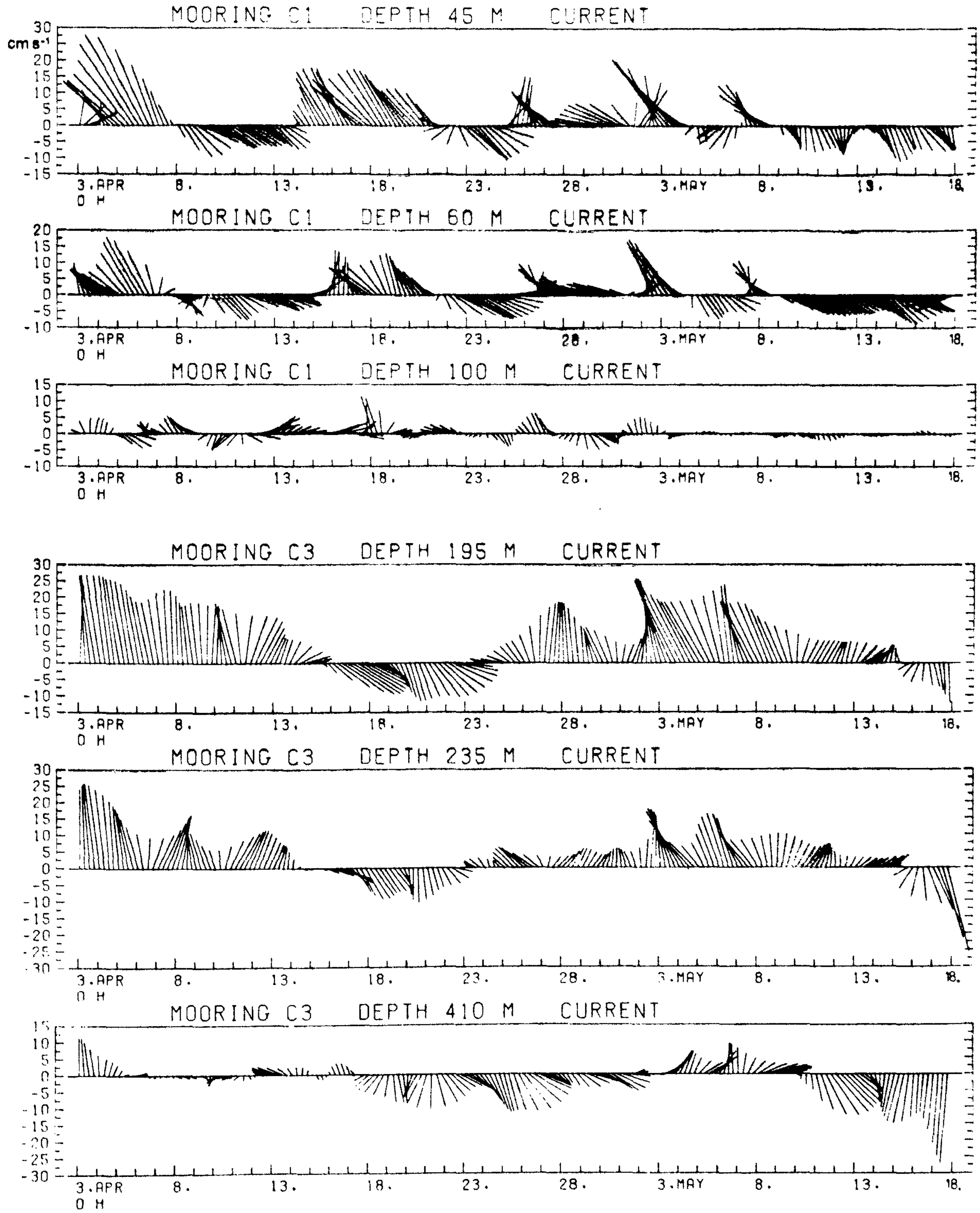


Figure 9. Stick-plot diagrams derived from the current meter time series at moorings C_1 and C_3. For the deepest current meter of C_1 see caption of Figure 7 (low passed values at 6 hour interval). North is upwards.

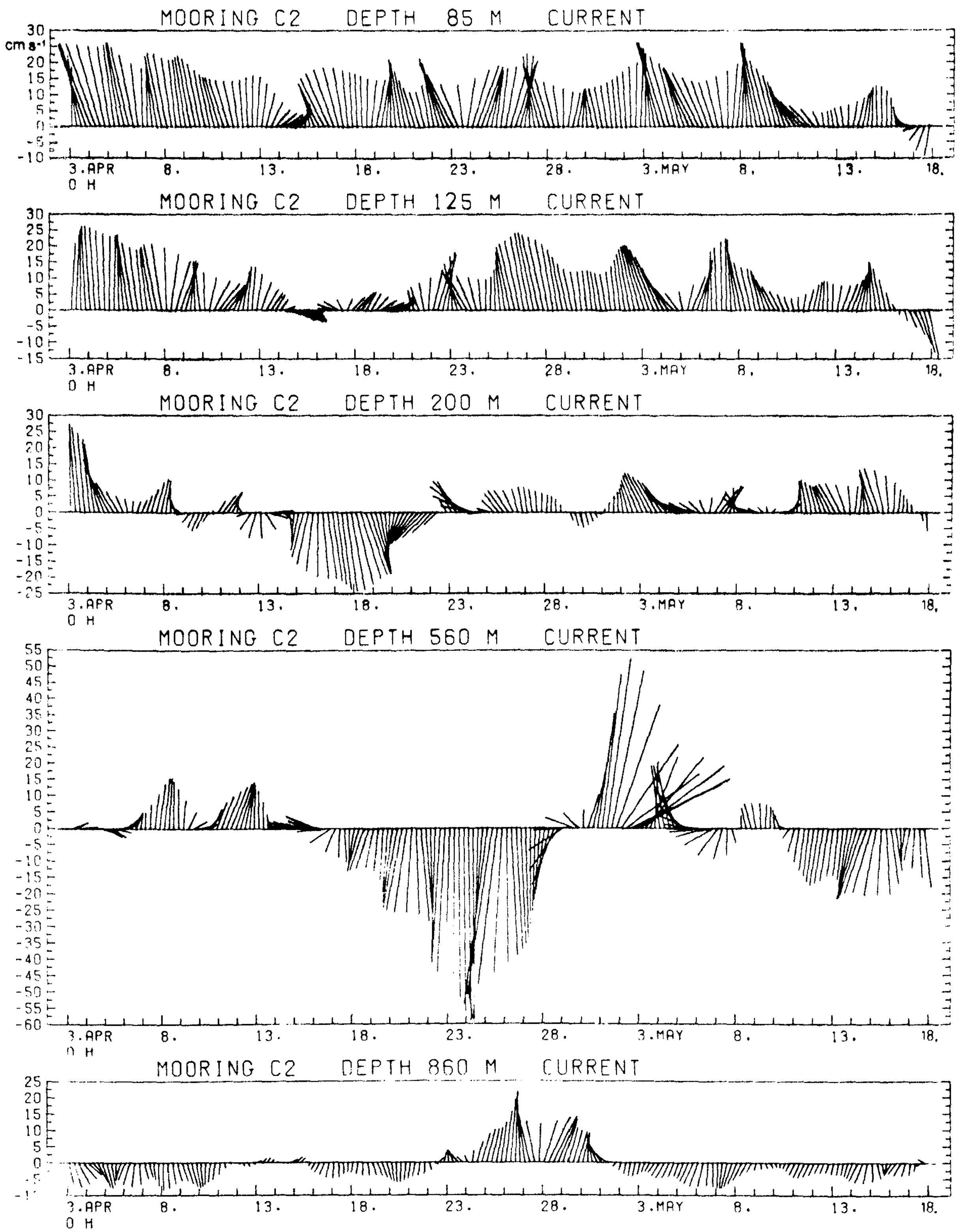


Figure 10. Stick-plot diagrams derived from the current meter time series at mooring C_2 (low passed values at 6 hour intervals). North is upwards.

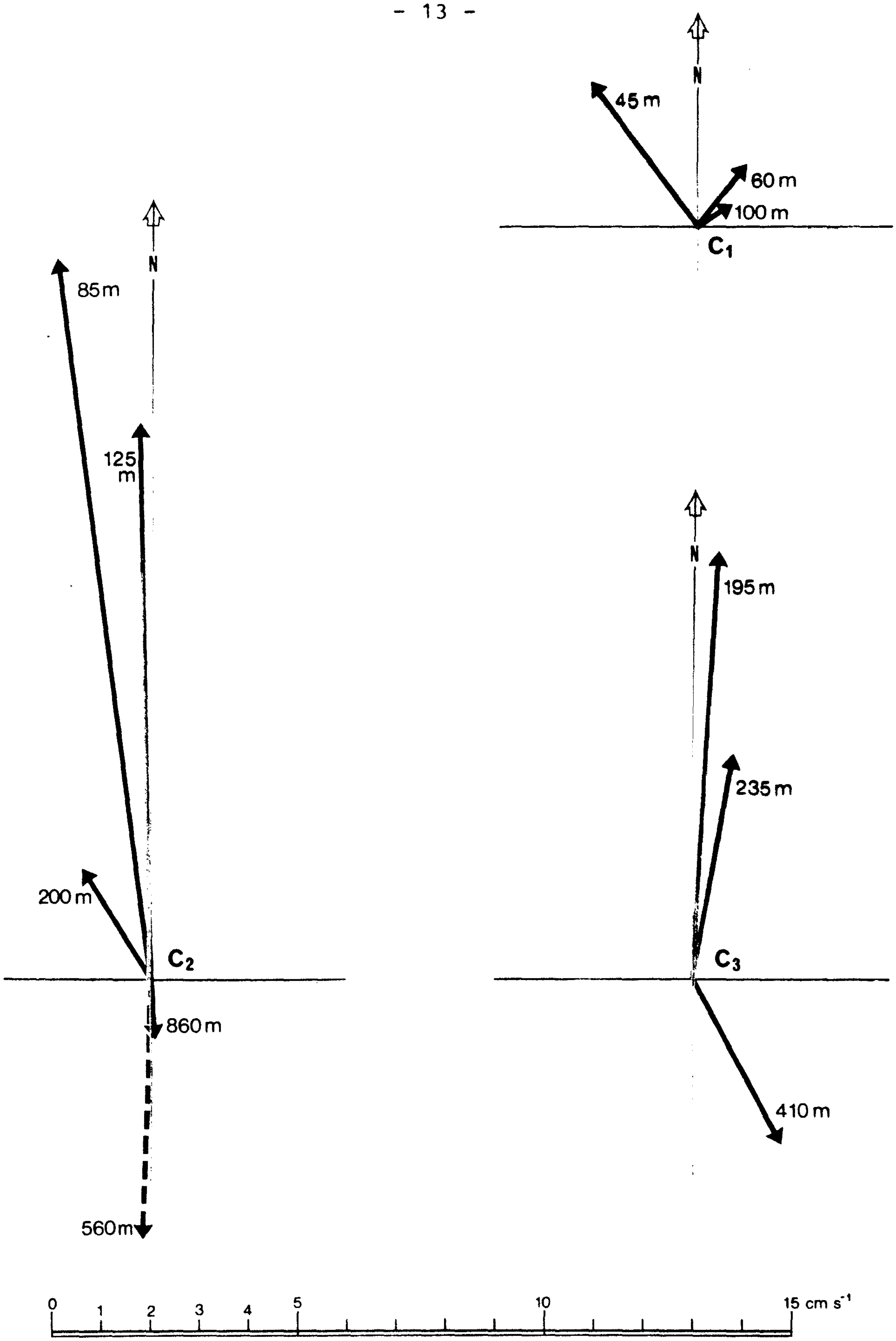


Figure 11. Mean current over the whole observation period (51 days). The record of the instrument at 560 m on C_2 seems doubtful, however, no instrumental or processing error could be found. For the deepest instrument of C_1 see caption of Figure 7.

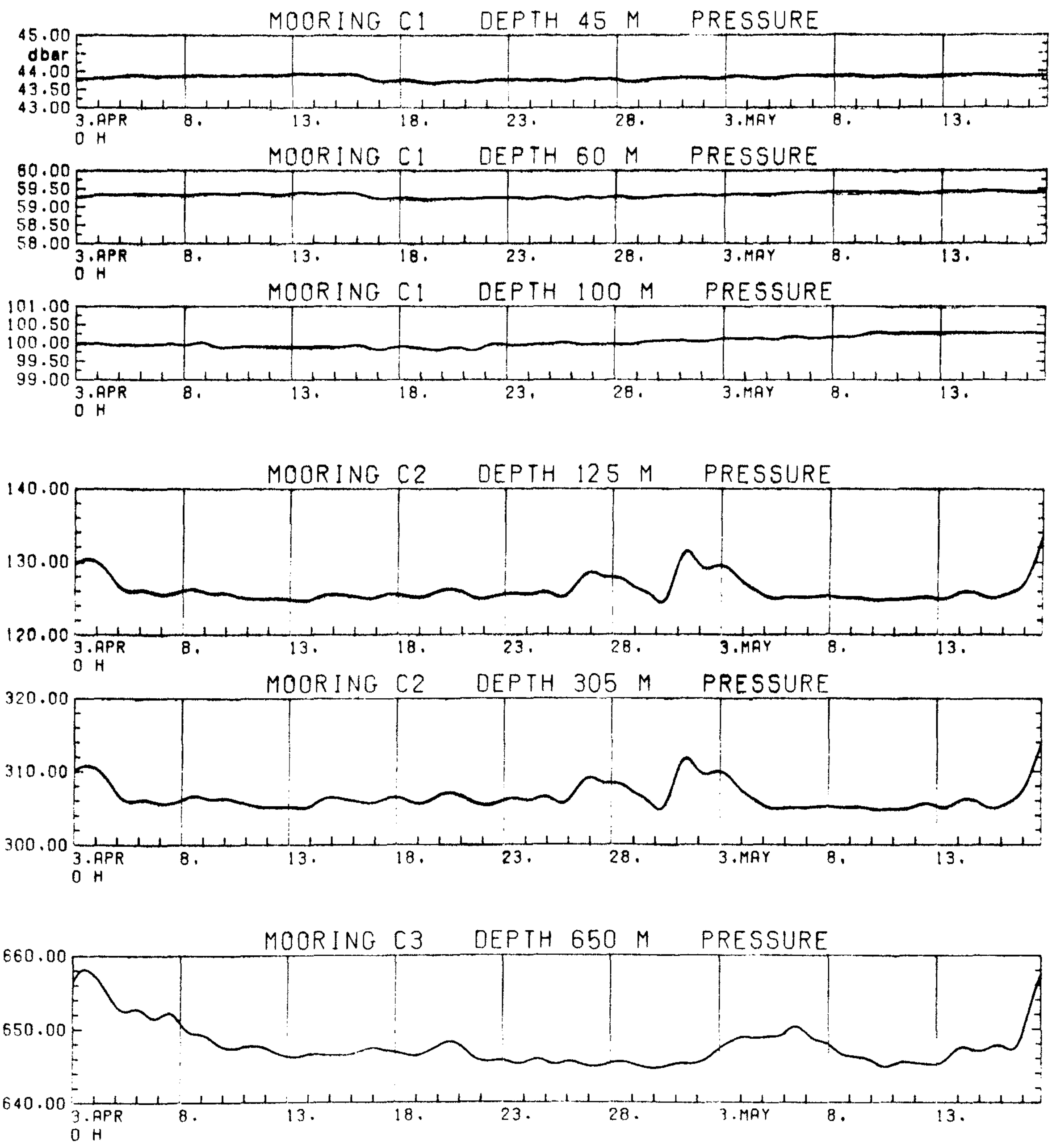


Figure 12. Pressure gauge records
(low passed values at 1 hour intervals).

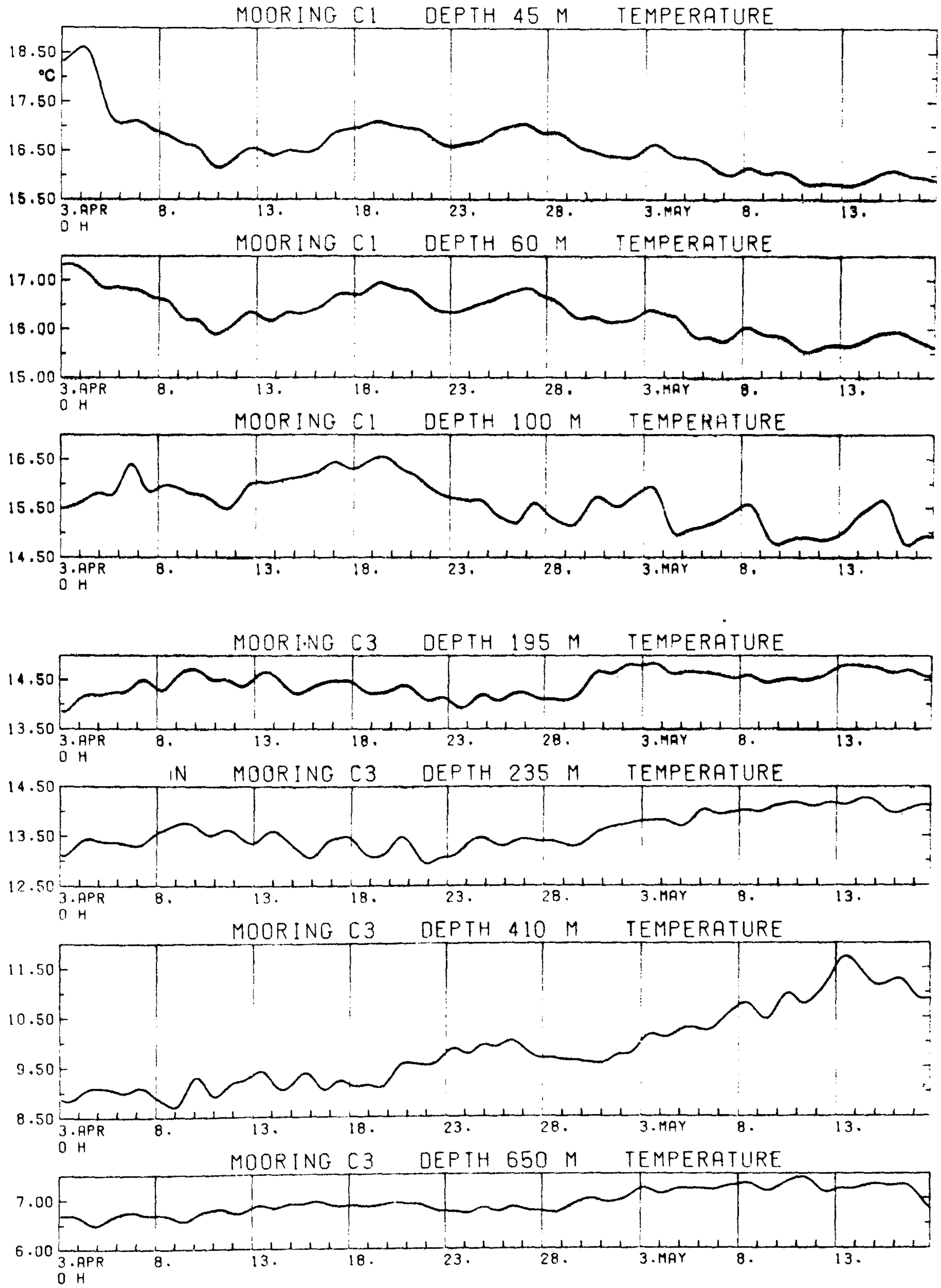


Figure 13. Temperature records derived from moorings C_1 and C_3 (low passed values at 1 hour intervals).

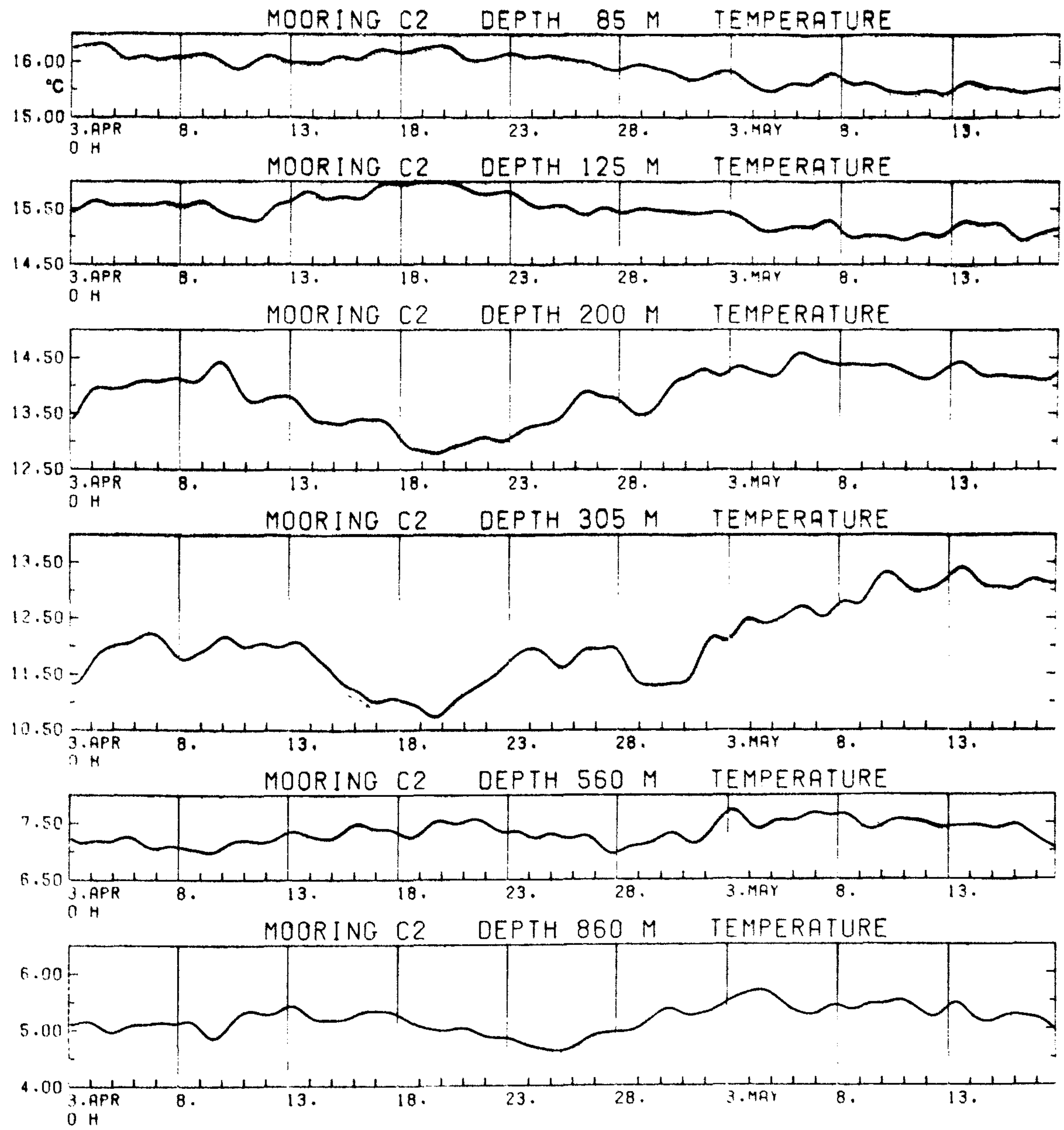


Figure 14. Temperature records derived from mooring C_2 (low passed values at 1 hour intervals).

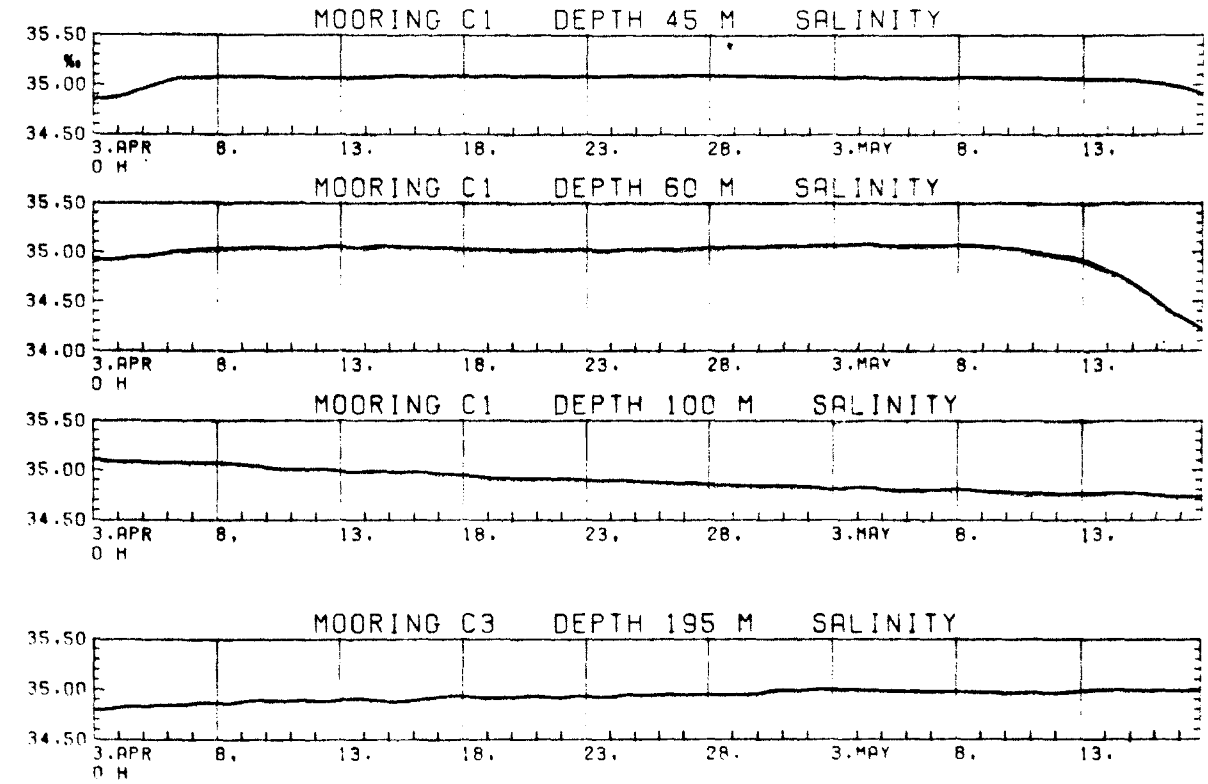


Figure 15. Salinity records
(low passed values at 1 hour intervals).

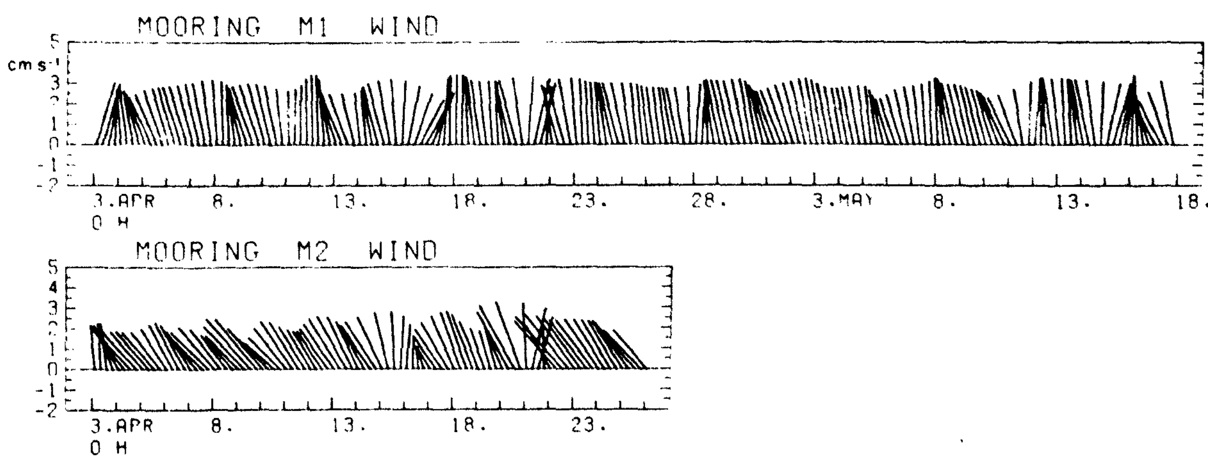


Figure 16. Stick-plot diagrams derived from the wind records at M_1 and M_2
(low passed values at 6 hour intervals).
For M_1 a constant speed of 3.5 m s^{-1} is assumed.
For M_2 a constant speed of 3.5 m s^{-1} is assumed
[illegible] at April 20, 22.30 h

Figures 13 - 15 show the filtered temperature and salinity records. The errors in the temperature measurements amount to ± 0.1°C. The salinity time series has been adjusted to agree with the hydrographic casts, taking in account the well known problems with Aanderaa conductivity cells (H. Peters, personal communication). The striking decrease of salinity at C1 is due to strong overgroth of the conductivity cells.

The wind speed sensors only functioned for a part of the observation period. To use as much of the data as possible, the time series of M_2 was completed with the mean speed obtained from the intact record of 22 days. The speed sensor on M_1 worked only for 3 days. The mean speed was calculated from this record and used for the whole time series. The filtered wind records are shown as stick-plot diagrams in Figure 16.

2.3. Shipborne measurements

During the whole experiment the Peruvian research vessel "BAP Unanue" was in the area. Hydrographic casts, STD- and profiling current measurements were carried out. A quasi-synoptic survey from April 30 to May 3 was used to produce surface maps.

2.3.1. Hydrographic casts

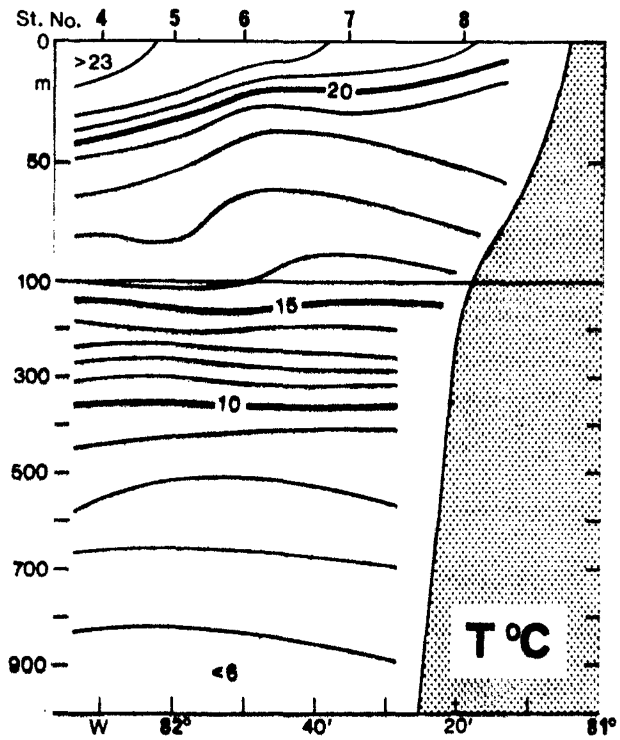
Hydrographic casts were carried out with 13 Niskin bottles. Two reversing thermometers were mounted on each bottle. The hydrographic winch was equipped with 1000 m of wire.

Unfortunately the salinometer broke down two weeks before the end of the cruise. It may be possible that even a part of the salinities determined earlier are affected by a slowly increasing error, although there is no evidence of this. For this reason no estimate can be given of the salinity error.

The reversing thermometers appear to be less accurate than may be generally expected because there was no possibility in Peru to recalibrate them. By intercomparison the best ones were selected for near-surface use (accuracy $\pm$ 0.03°C) and the poor ones for greater depth (accuracy $\pm$ 0.1°C). The results are presented in temperature and salinity sections (Fig. 17 - 24). The location of the sections is given in Figure 3.

2.3.2. STD-Sonde

A Plessey STD with a 1500 m depth range was on bord. As the instrument did not work reliably only one STD section has been processed (Fig. 25). The accuracy of the STD- measurements is $\pm$ 0.1°C in temperature and $\pm$ 0.05 ‰ in salinity. At each STD-station three Niskin bottles were deployed on the same wire as the STD. The temperature measurements of the STD were corrected to agree with values measured by the reversing thermometers. The salinity of these samples was determined by L. Codispoti on board the US research vessel "Melville". The corrected salinity measurements of the STD agree well with the salinities determined earlier on board the "BAP Ununue".



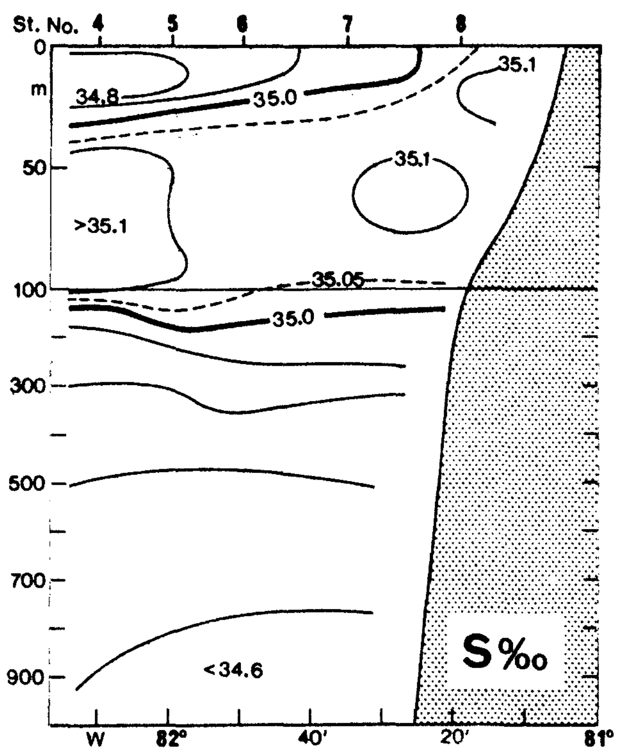


Figure 17. Temperature and salinity sections along 5°00'S from hydrographic casts carried out from March 30 to 31 1977

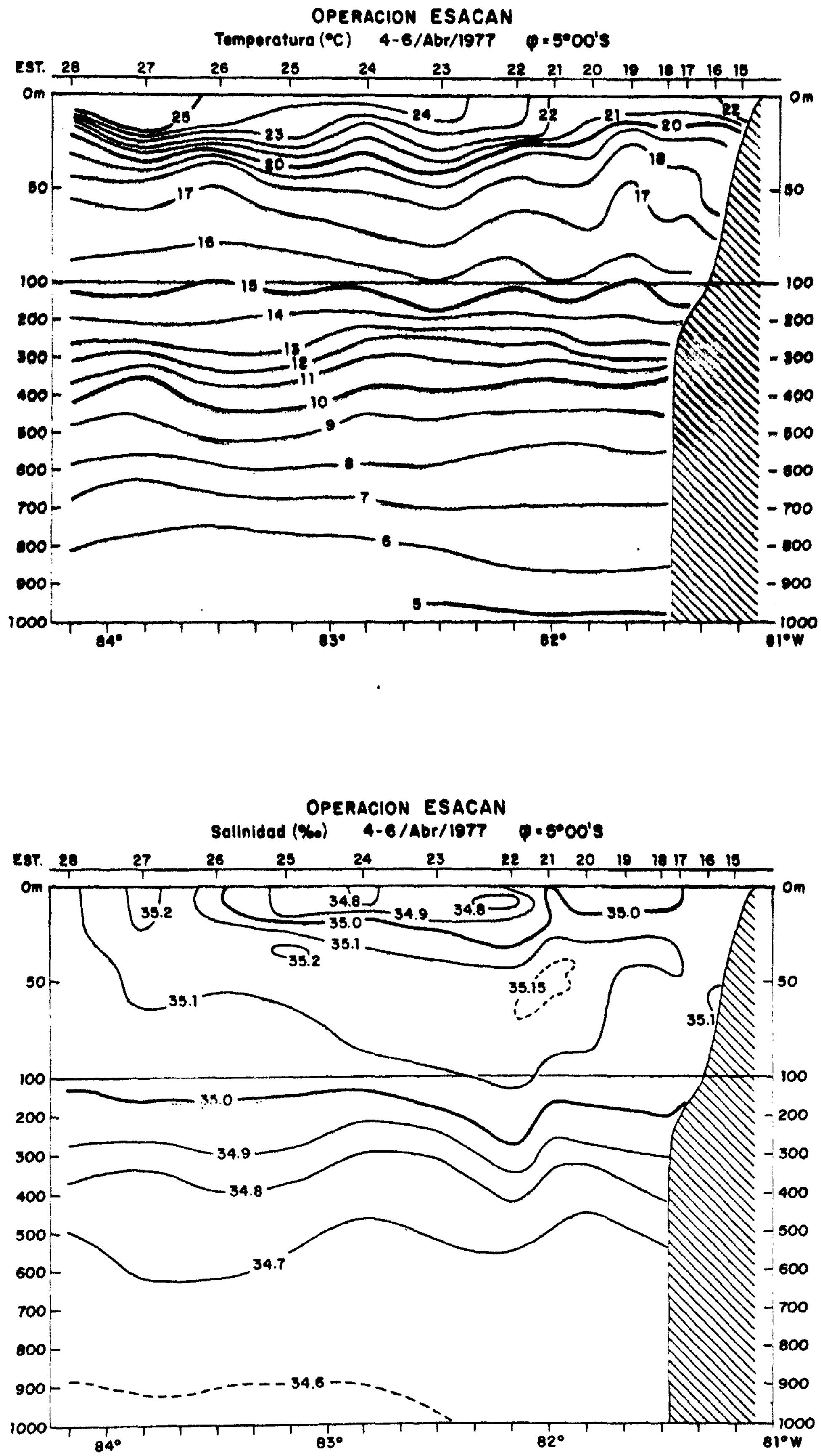


Figure 18. Temperature and salinity sections from hydrographic casts.

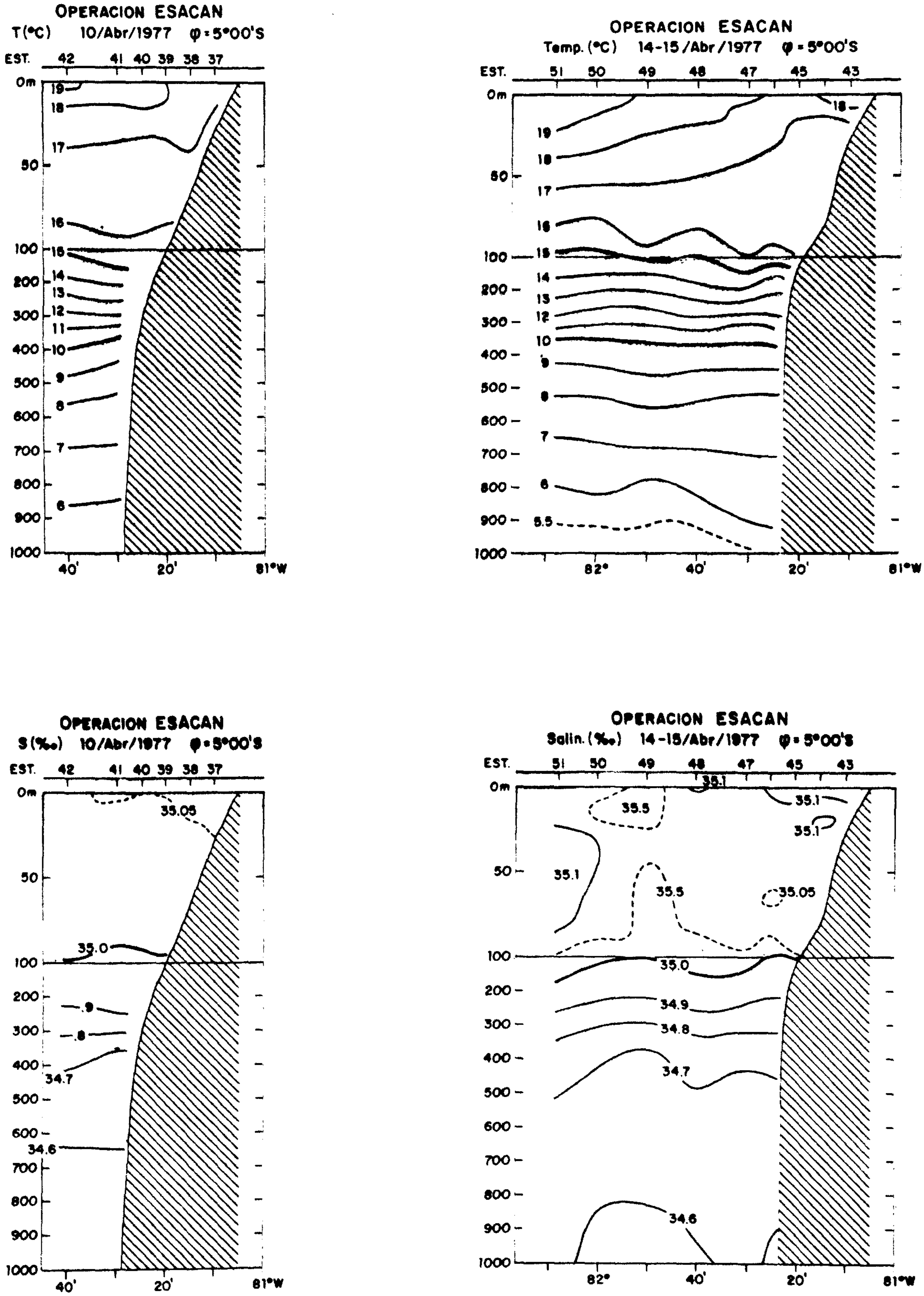
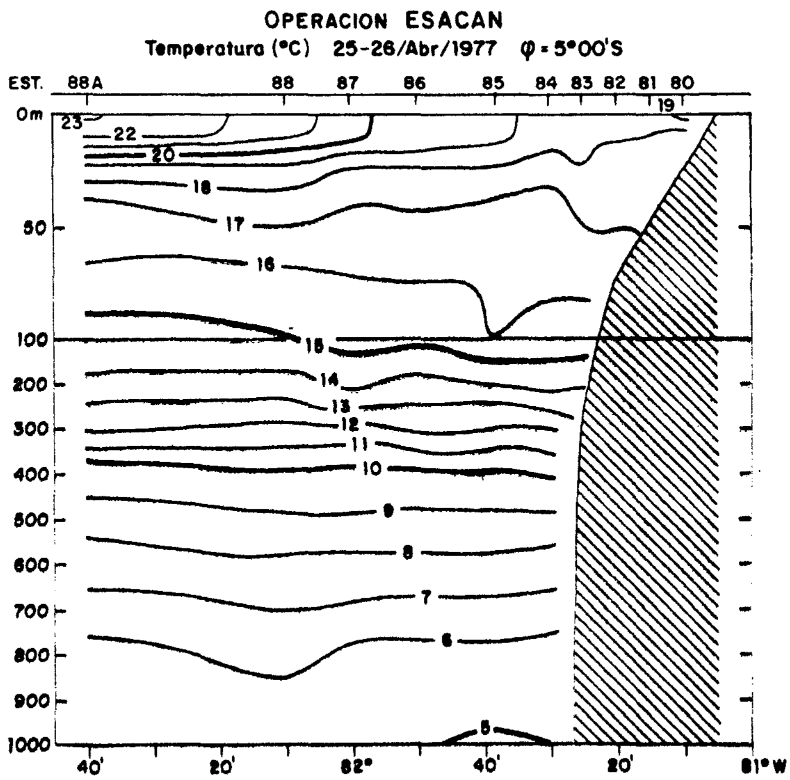


Figure 19. Temperature and salinity sections from hydrographic casts.



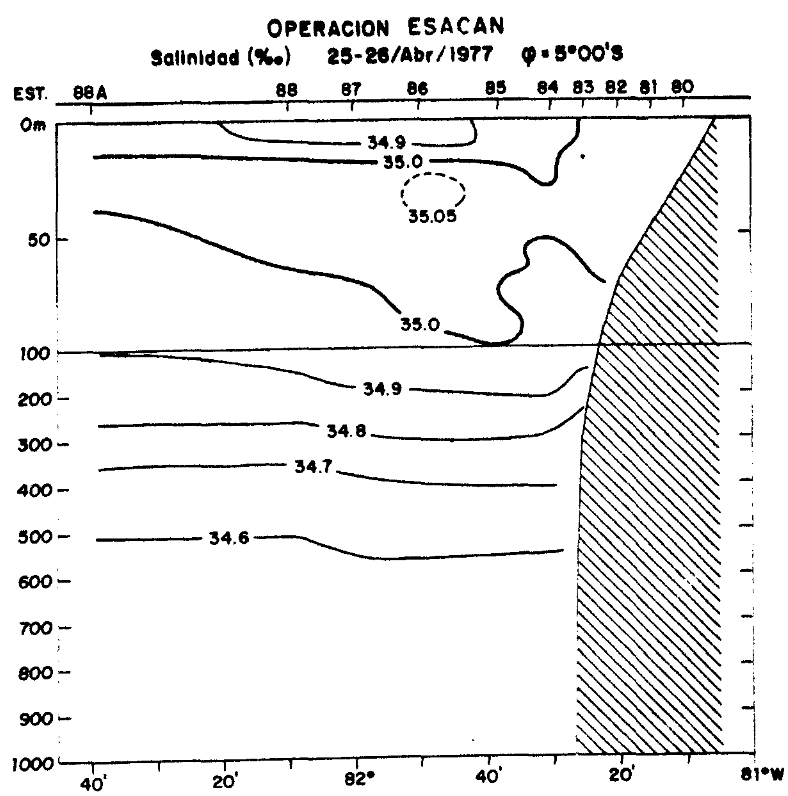


Figure 20. Temperature and salinity sections from hydrographic casts.

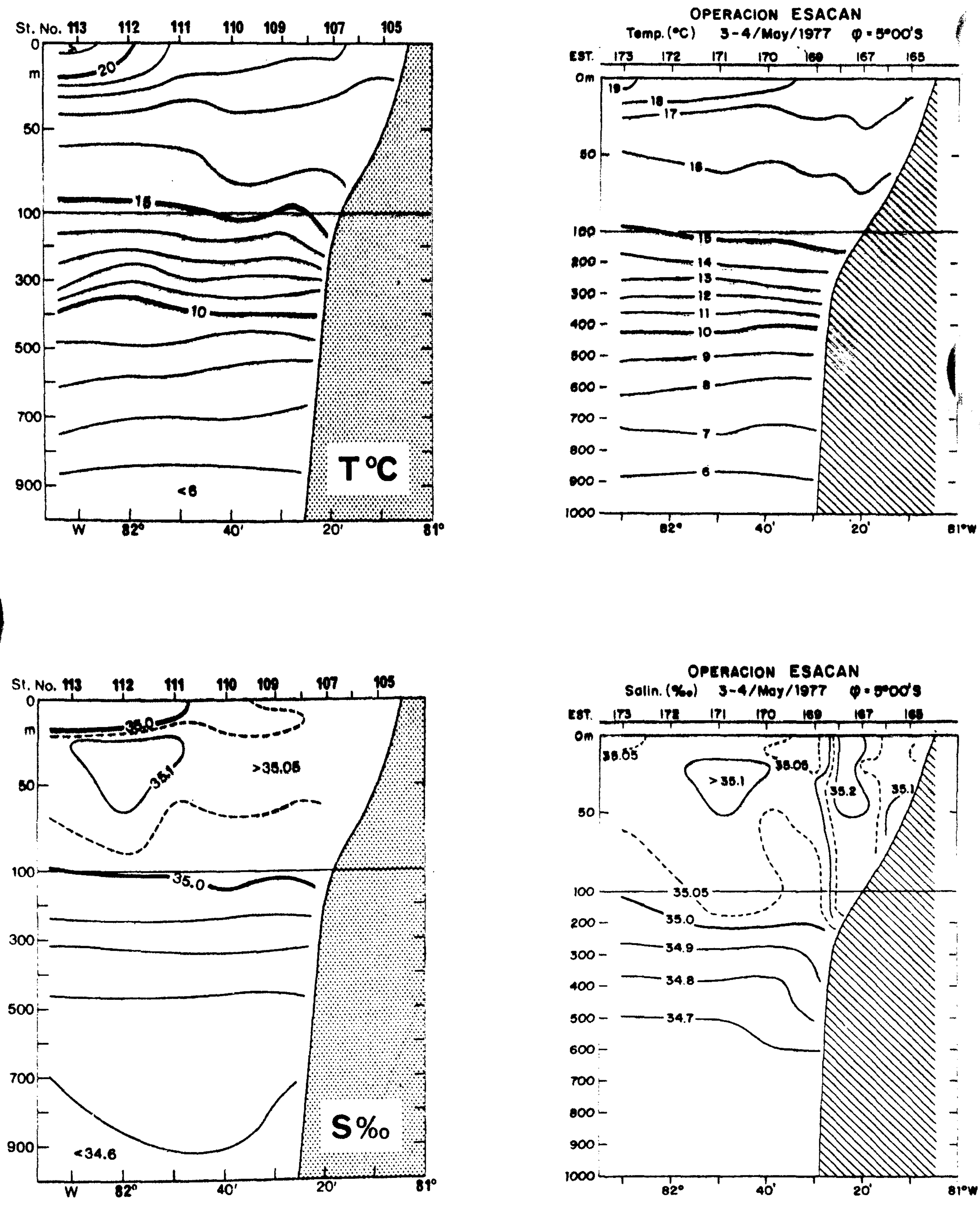


Figure 21. Temperature and salinity sections from hydrographic casts along 5°00'S carried out at April 29 and from May 3 to 4 1977.

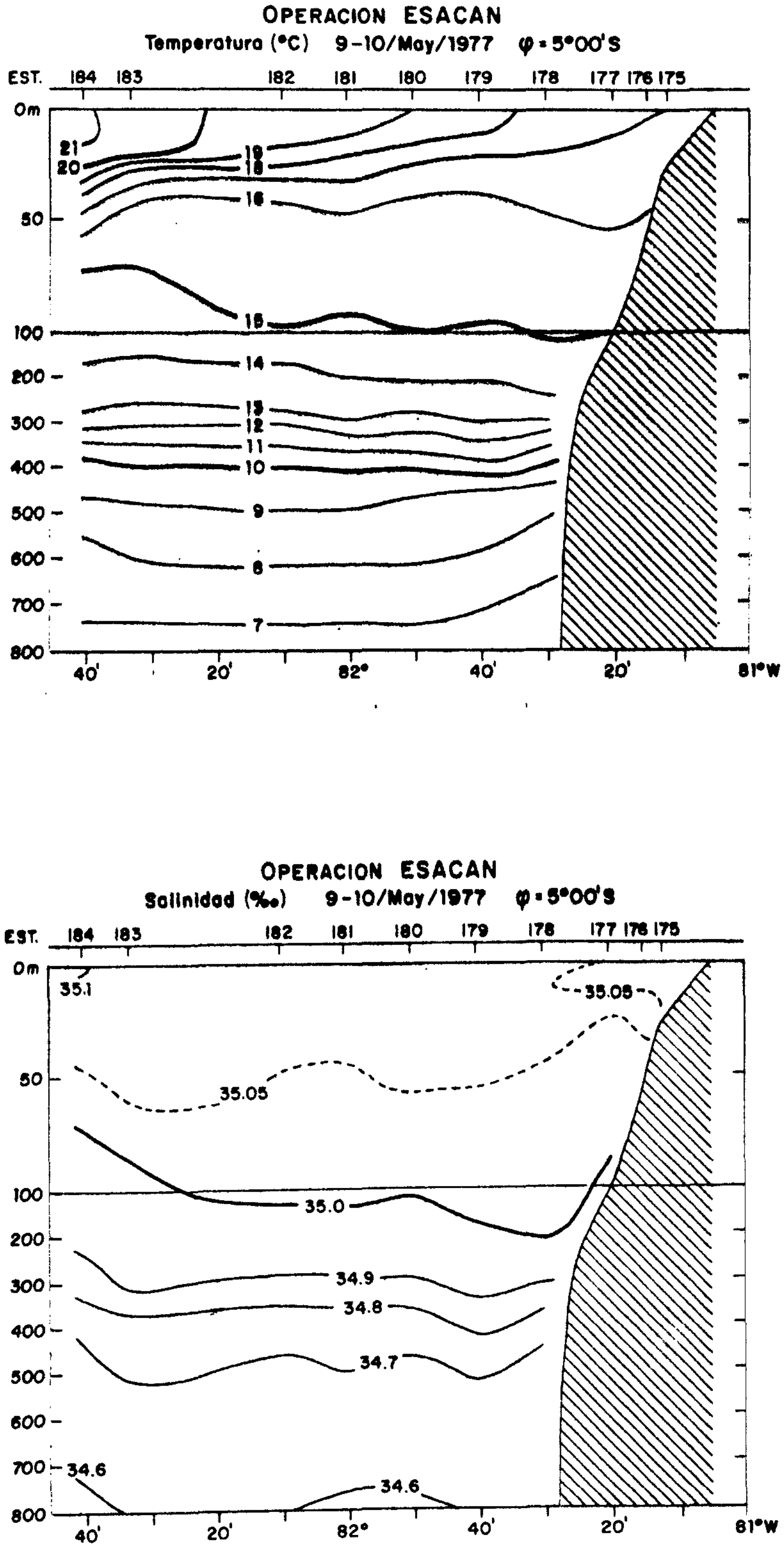


Figure 22. Temperature and salinity sections from hydrographic casts.

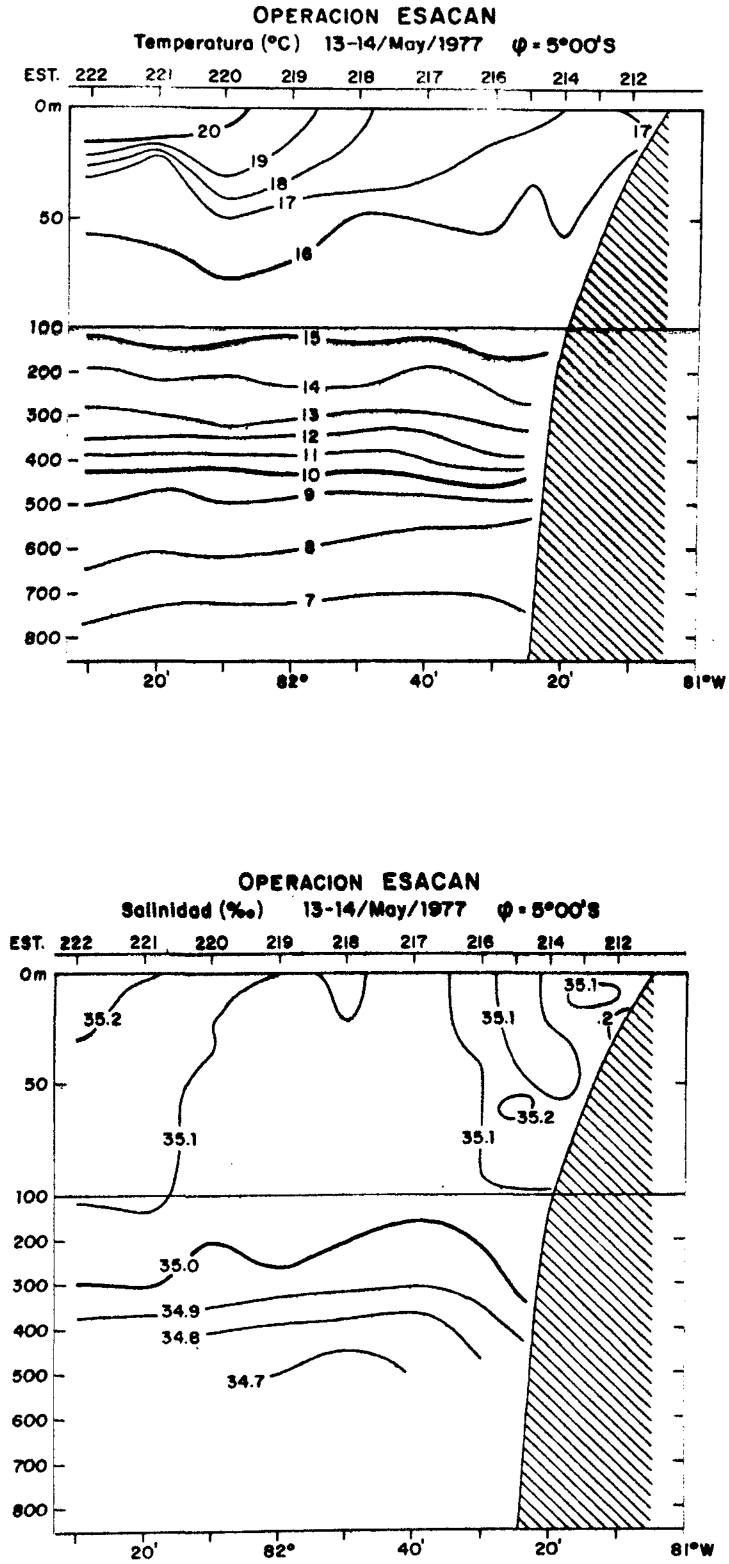
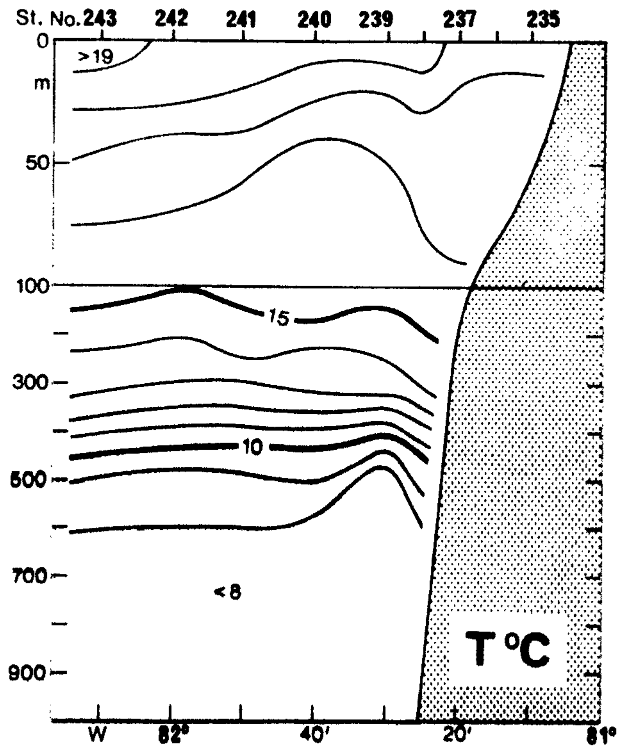


Figure 23. Temperature and salinity sections from hydrographic casts.



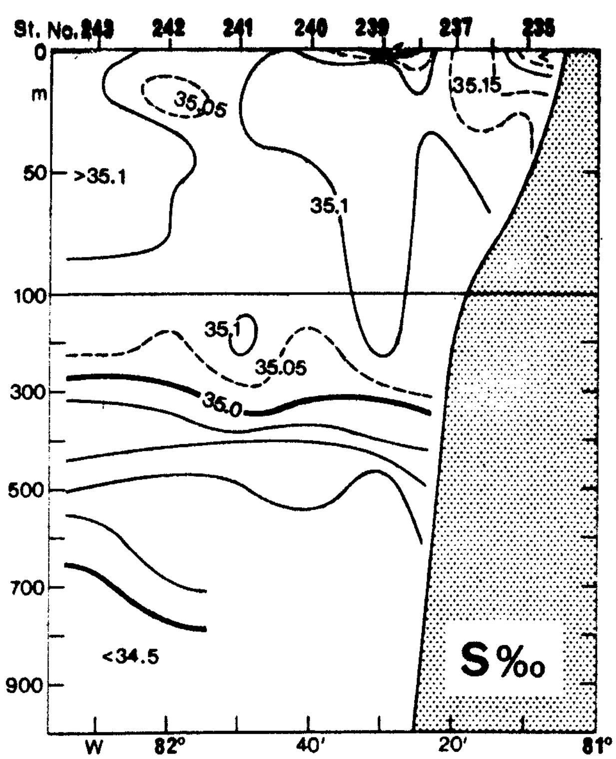


Figure 24. Temperature and salinity sections along 5°00'S vom hydrographic casts carried out from May 21 to 22 1977.

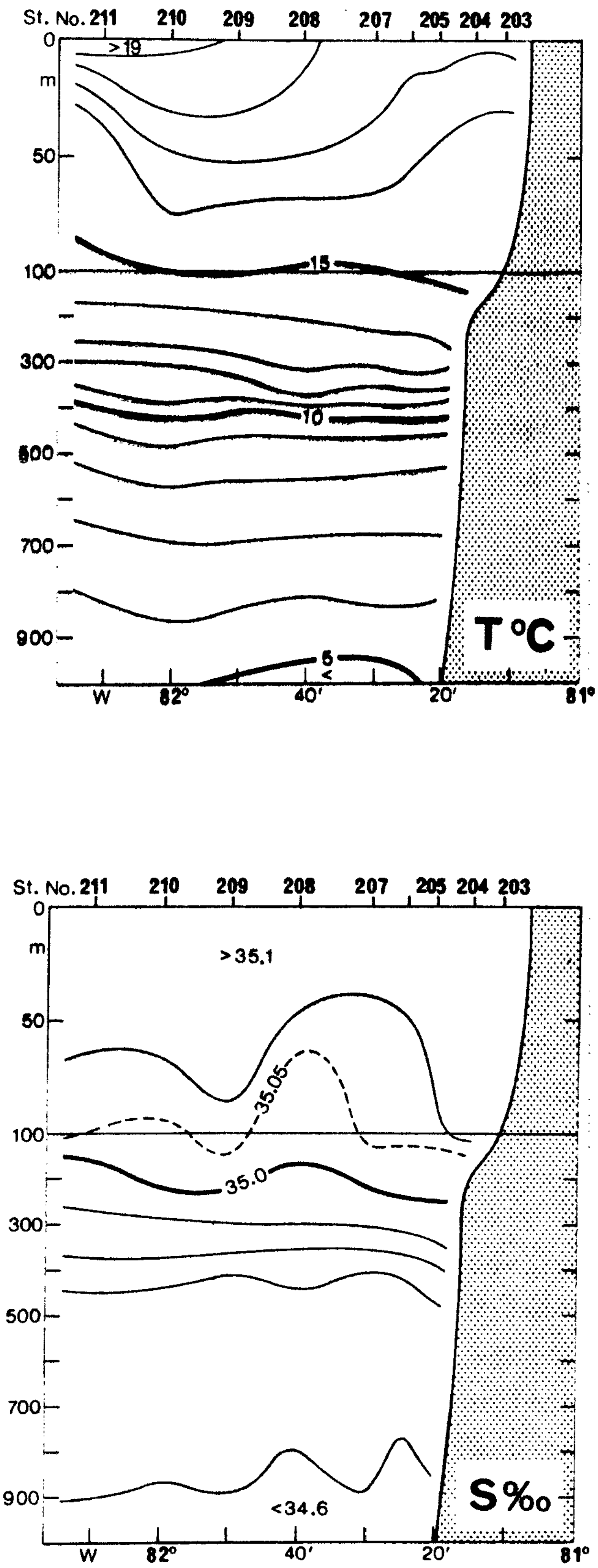


Figure 25. Temperature and salinity sections along 6°00'S from STD measurements carried out from May 12 - 13 1977.

2.3.3. Profiling current meter measurements

At 14 locations profiling current measurements were carried out with a RCM-4 Aanderaa current meter. At some locations the profiles were repeated several times. For detailed information see table 2. The locations of the measurements are shown in Figure 3.

The current meter sank along the hydrographic wire from a freely drifting ship (Fig. 26).

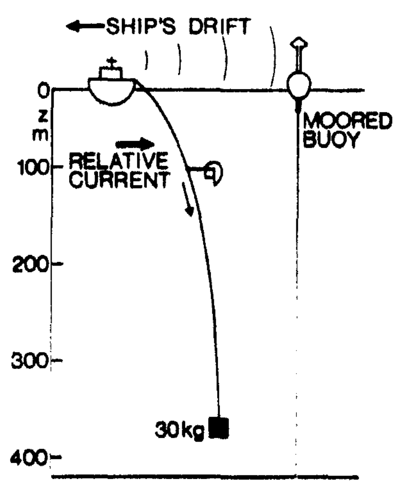


Figure 26

Schematic representation of a profiling current measurement. The ship's drift is determined relative to a moored buoy.

The drift of the ship was determined every 5 minutes with reference to a specially laid buoy, a meteorological buoy or an oil rig. From the instantaneous drift fixes during each profile a mean drift was determined which was added to the velocity measured by the instrument. The mean drift at each location during several profiles is presented in Figure 27. Table 3 gives the statistics of the values presented. Because in general the drift velocity was significantly higher (in the order of 50 cm s^{-1} than the corrected current velocities (in the order of 20 cm s^{-1}) the accuracy is very limited. Assuming an error in the drift of $\pm$ 10 cm s^{-1} in speed and $\pm$ 5^{o} in direction, one obtains an error in the velocity components in the order of $\pm$ 10 cm s^{-1}. Taking into account this error which is of the same order as the observed currents, the current profiles agree with the measurements of moored current meter. However, if there is only the relative current needed, as far calculations of current shear the accuaracy amounts to that one, normally given by Aanderaa.

On the current meter there was a temperature and salinity sensor. The salinity records are adjusted to agree with the hydrographic casts.

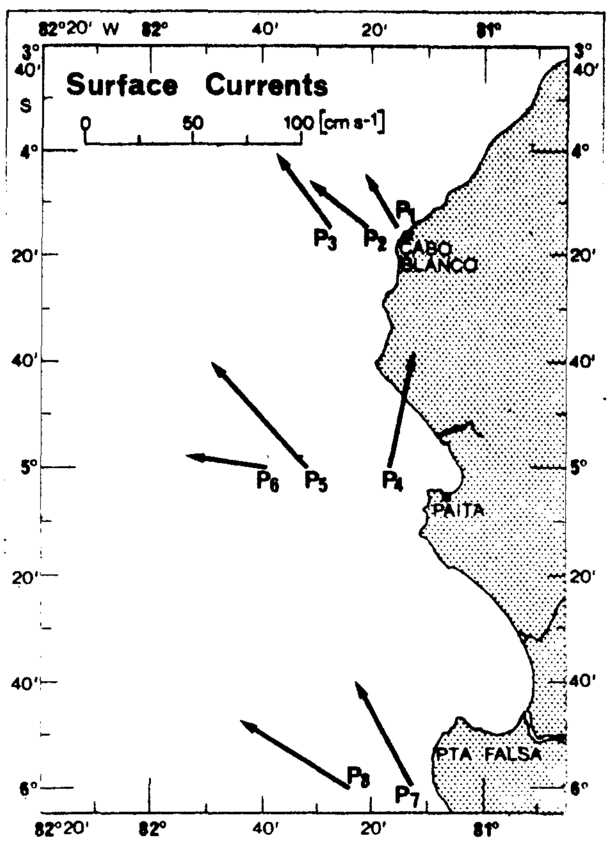


Figure 27

Surface currents determined from ship's drift measurements. For more detailed information on time and location see Table 3 and station list.

The results of the two components, temperature and salinity are shown in figures 28 - 31.

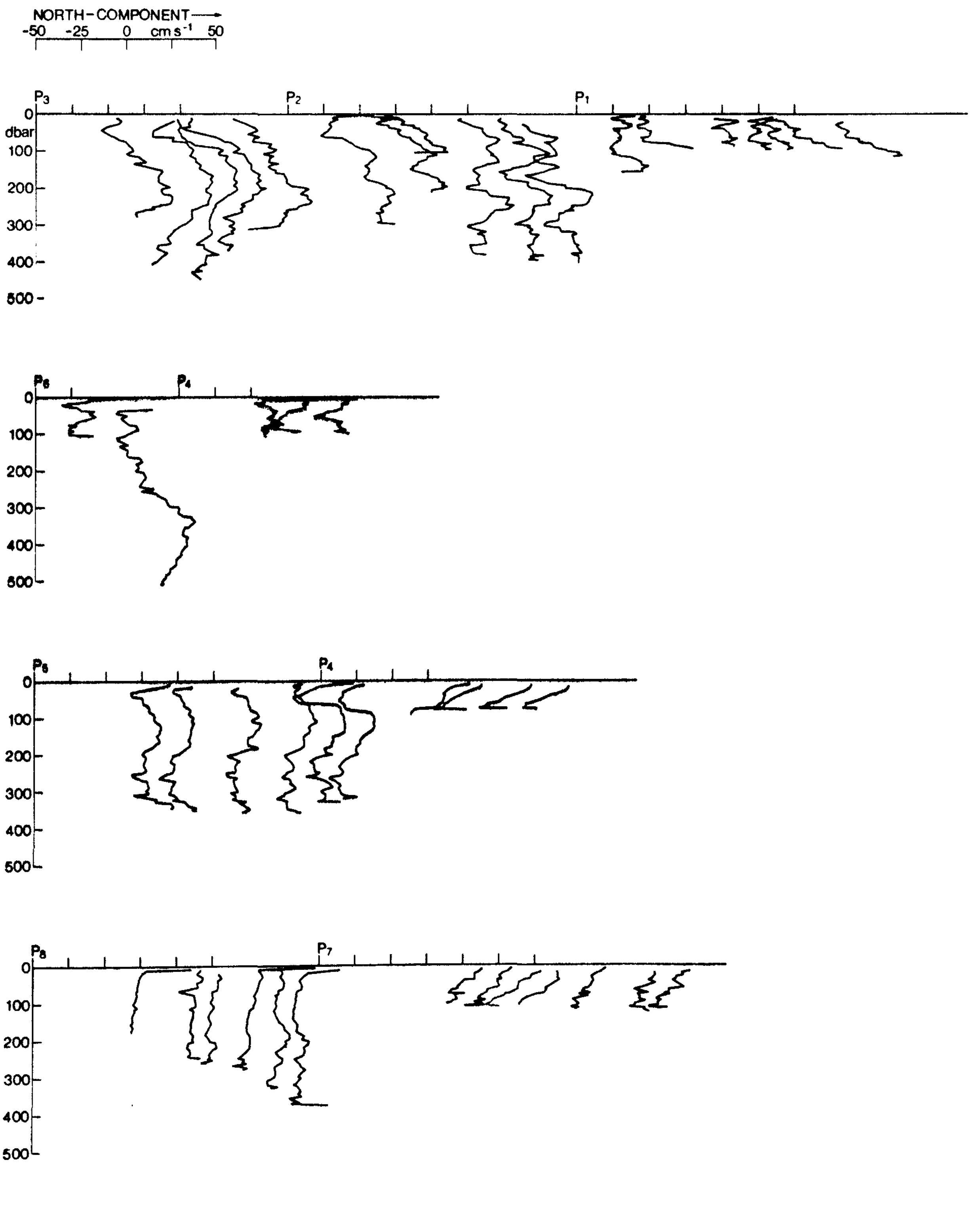


Figure 28. V (northward) velocity component derived from the profiling current measurements at positions shown on Figure 27.

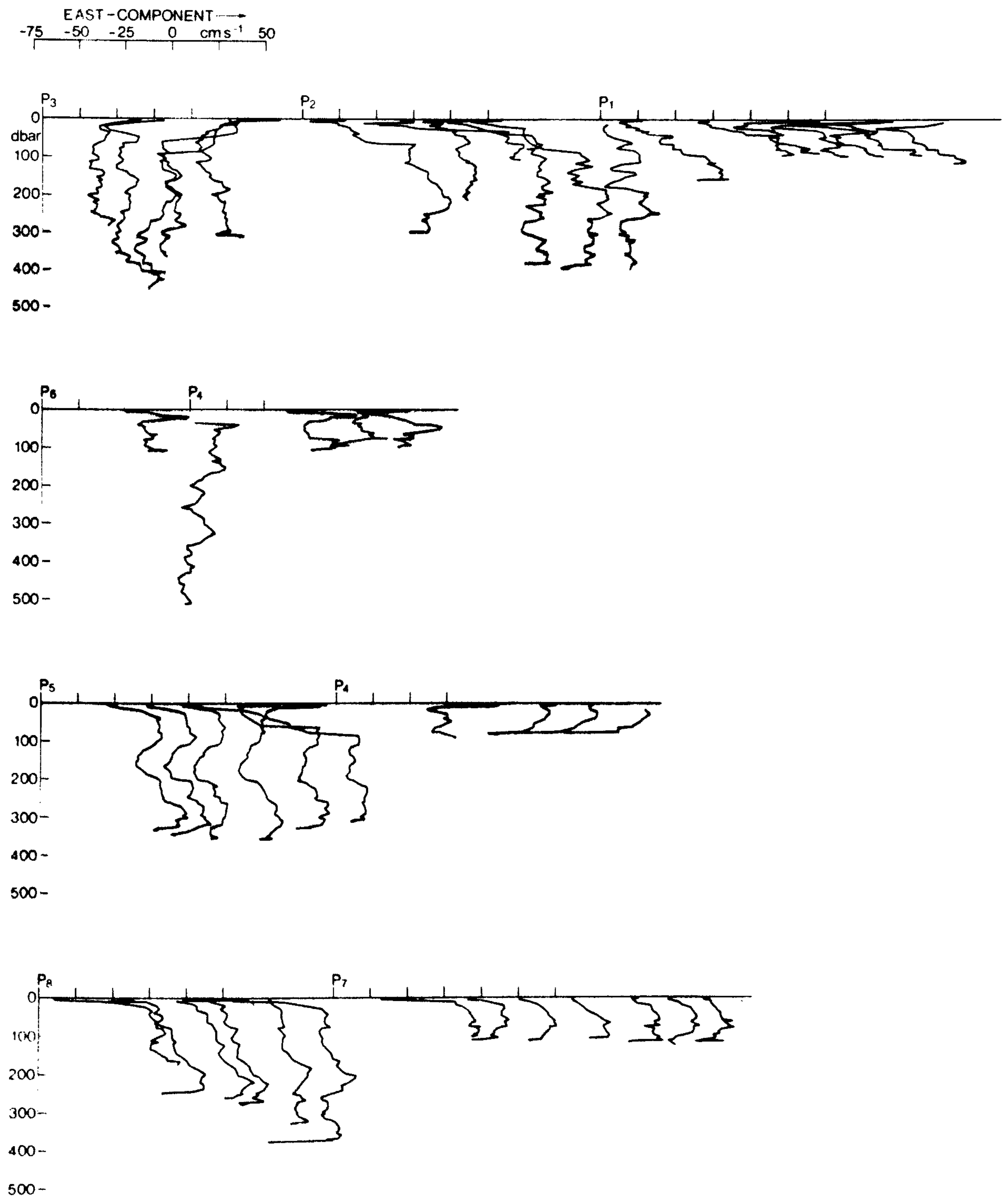


Figure 29. U (eastward) velocity component derived from the profiling current measurements at positions shown on Figure 27.

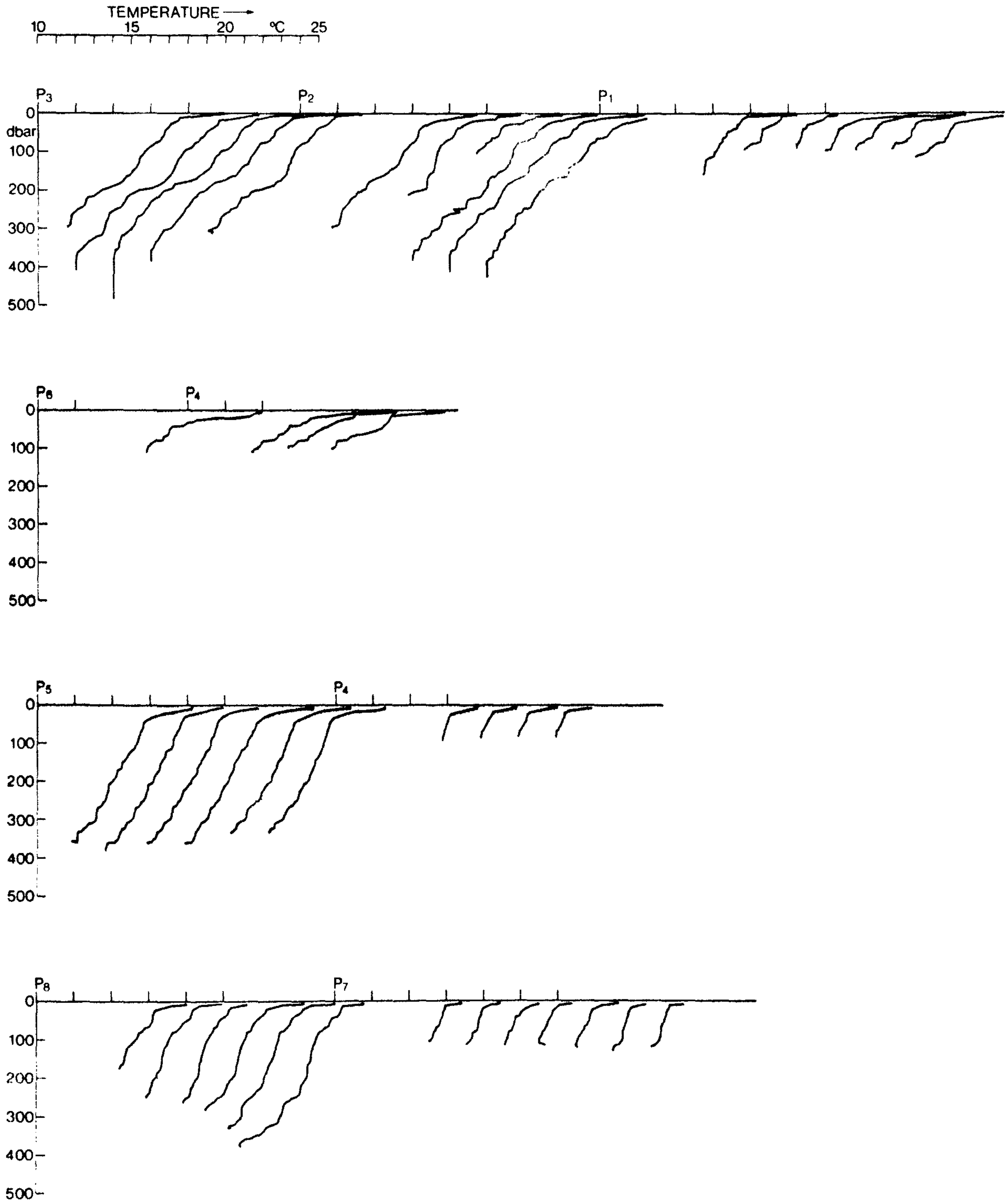


Figure 30. Temperature profiles at positions shown on Figure 27.

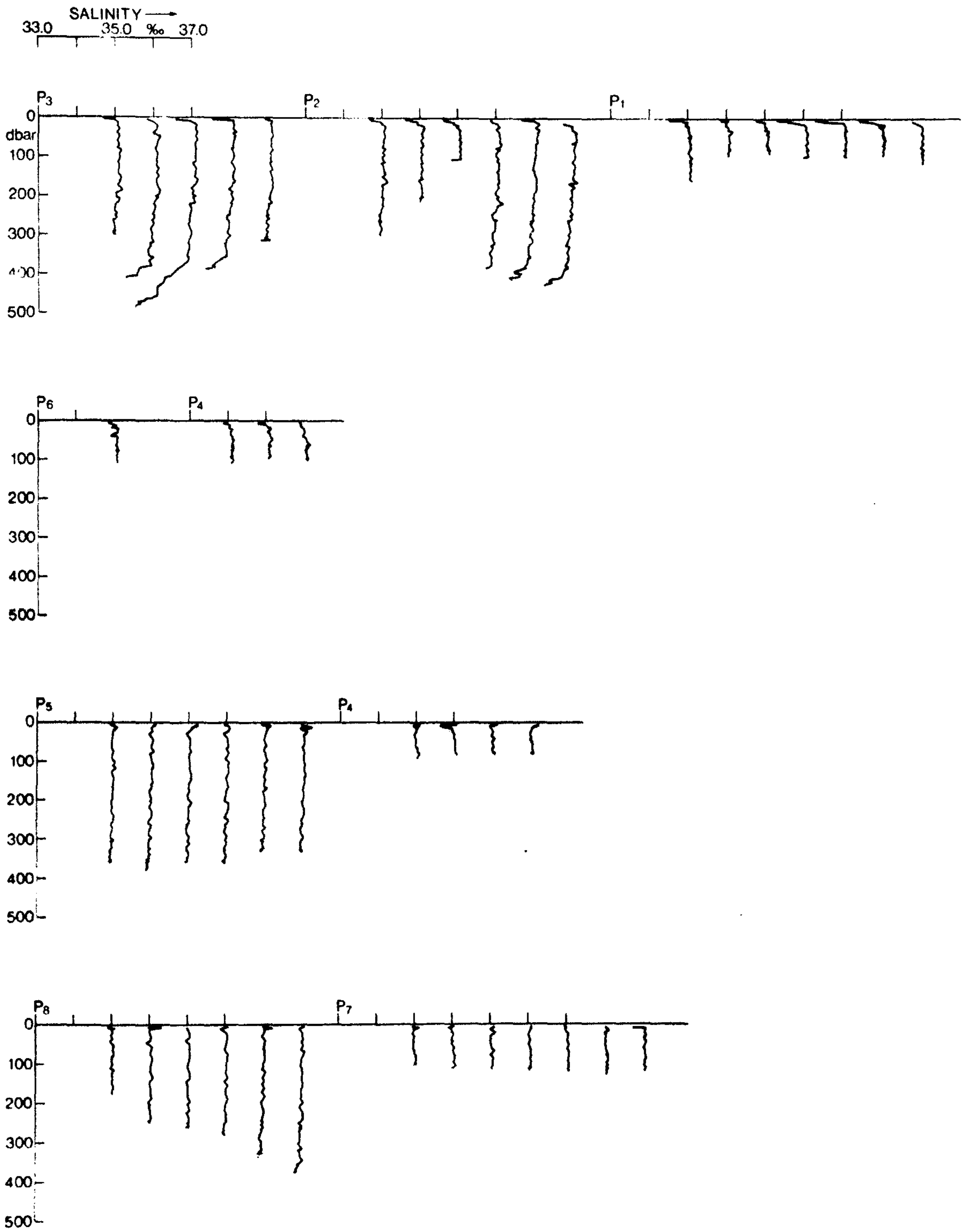
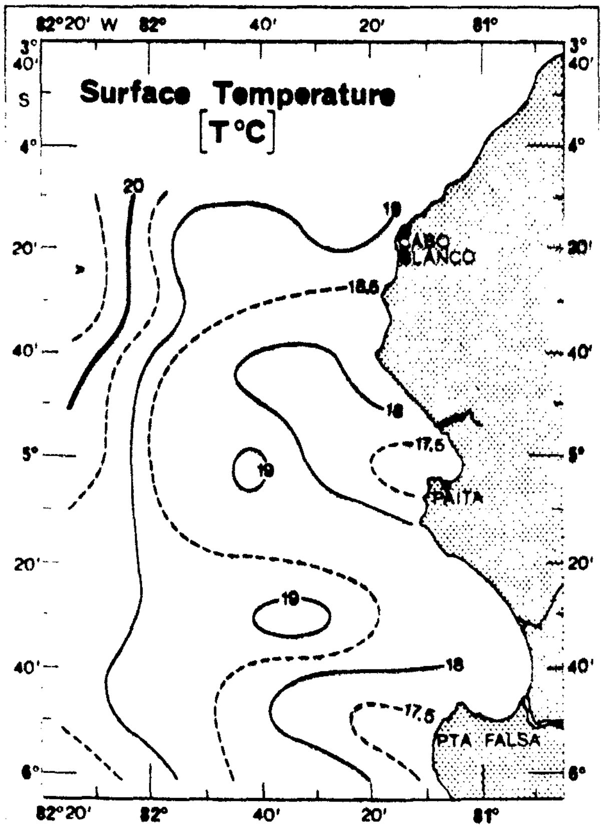
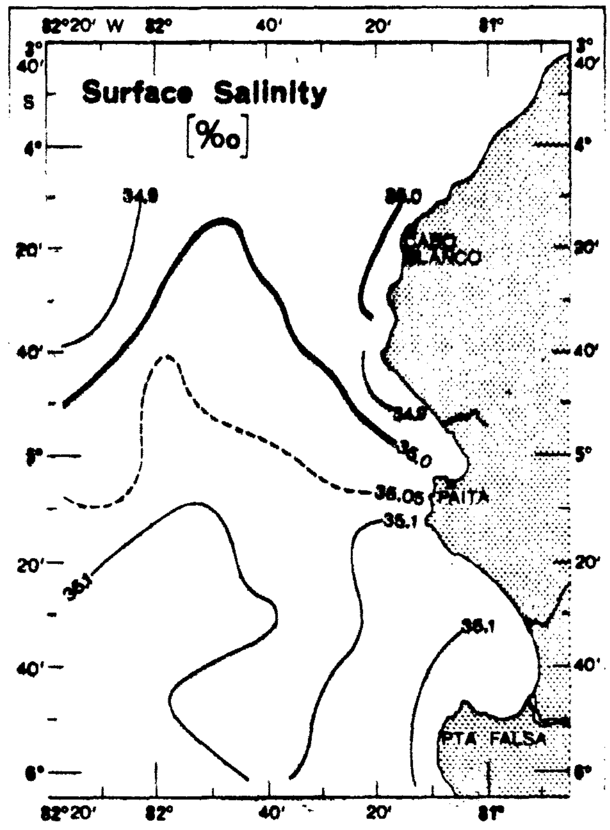


Figure 31. Salinity profiles at position shown on Figure 27.

2.3.4. Surface mapping

From April 30 to May 3 1977 sequential surface measurements were carried out over the whole area at the positions shown in Figure 3. The results are presented as pseudo-synoptic maps of the sea-surface temperature, salinity and wind at 5 m above the sea-surface (Fig. 32).





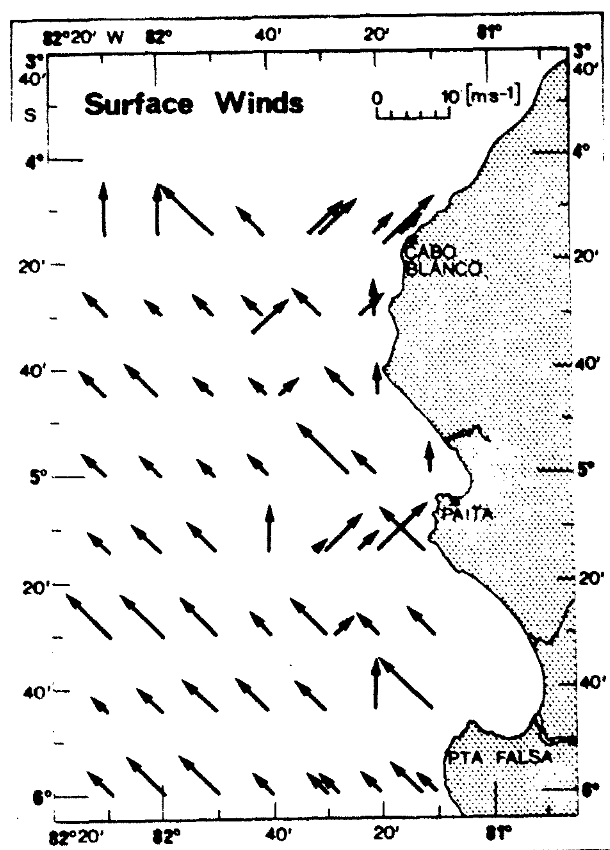


Figure 32

Sea-surface temperature, salinity and winds at 5 m above the sea-surface during the survey from April 30 to May 3 1977.

3. Data from land stations

To facilitate a complete analysis all available informations from surrounding land stations were collected.A list of time series collected is given in Table 4. The quality of the data from various stations was not uniform. There are stations at which the wind direction was given as an angle and at others as a point of the compass. At some stations there were no observation at night. To provide complete time series the data were interpolated which may be acceptable for low frequency studies. The atmospheric pressure of all stations is reduced to the pressure on sea-level. The pressure records from Paita show a evident systematical deviation of about 50 mb which may be explained as instrumental error. Therefor they are corrected to agree with values interpolated from those at Talara and Chiclayo. The corrected and interpolated time series were filtered in the same way as the moored instruments records. The results are presented in Figures 33 and 34. Data were obtained from two further land stations. The tide gauge at Talara provided hourly sea-level records. The values are given relative to the tide gauge zero which is 1.43 m below the mean sea-level. The thermograph records at Paita is digitized at hourly intervals. Both records were treated like the moored instruments time series (Fig. 35 and 36).

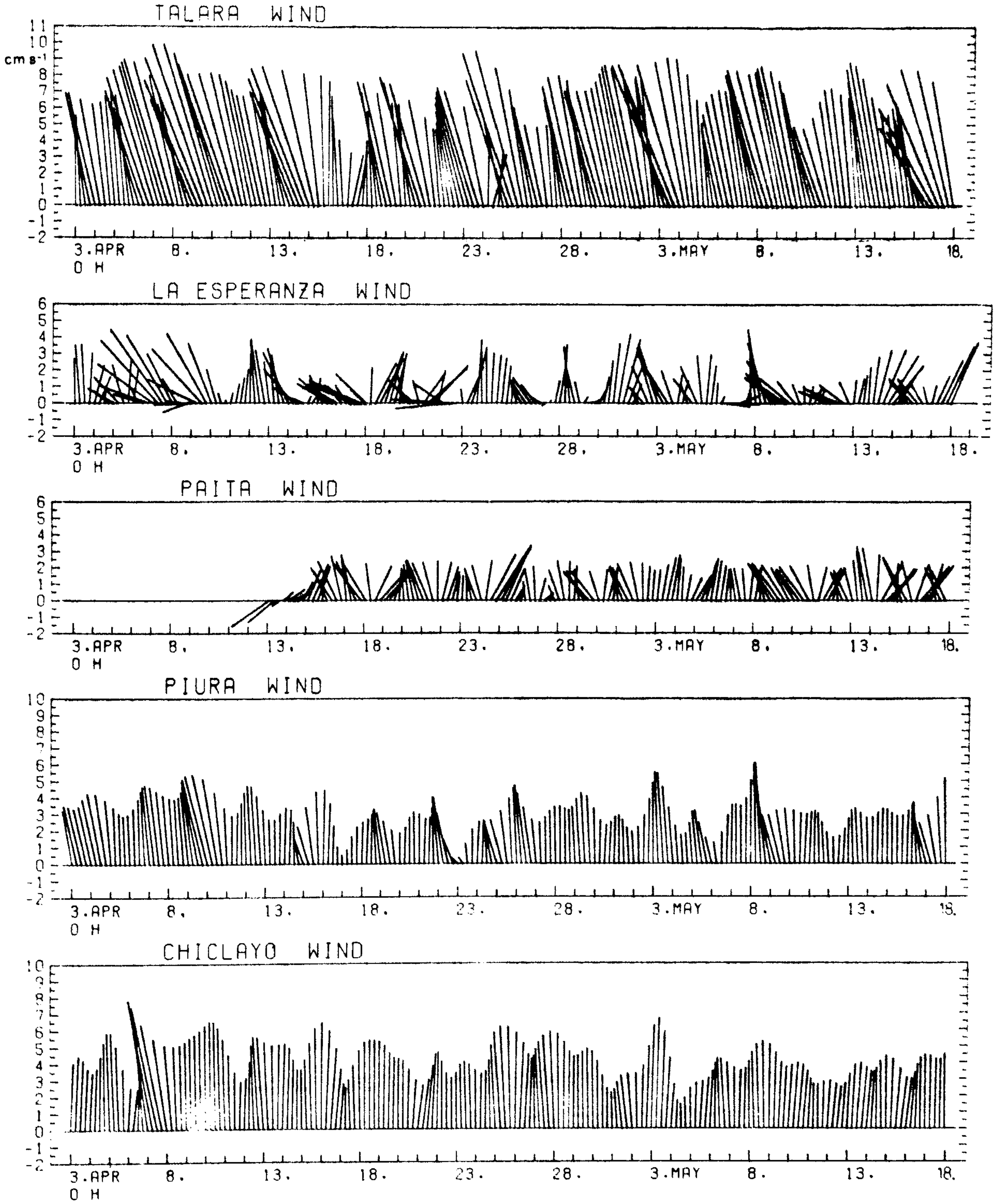


Figure 33. Wind at the airport stations of Talara, Piura and Chiclayo (at Piura the night time values are interpolated), and at Paita and La Esperanza (at both stations the night time wind values are interpolated), low passed values at 6 hour intervals.

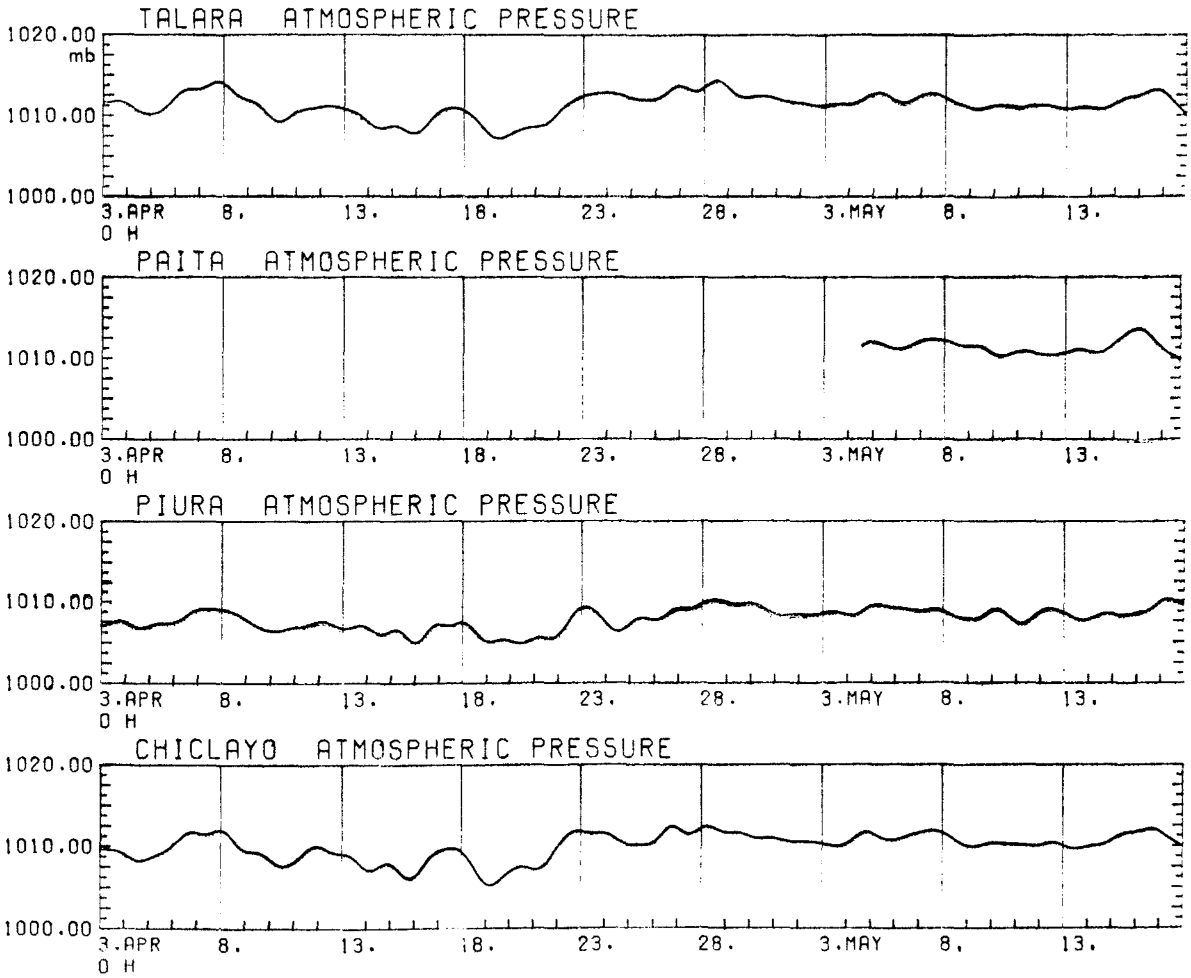


Figure 34. Atmospheric pressure at the airport stations of Talara, Piura and Chiclayo (at Piura the night time values are interpolated) and at Paita, low passed values at 6 hour intervals.

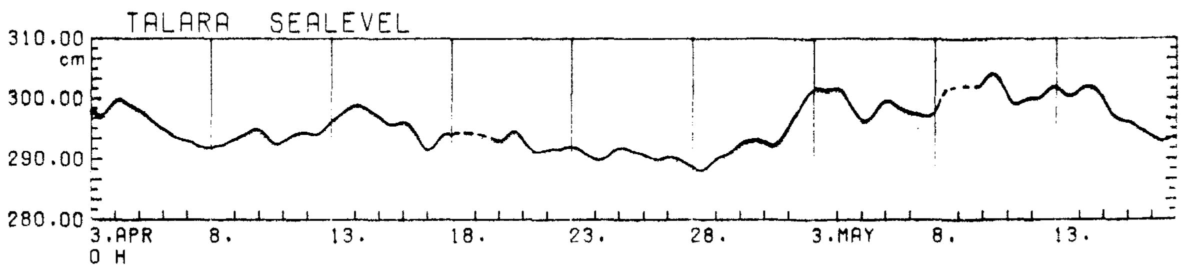


Figure 35. Sea-level record from Talara. During periods in which no data is available the curve is completed by a dashed straight line (low passed values at 6 hour intervals.

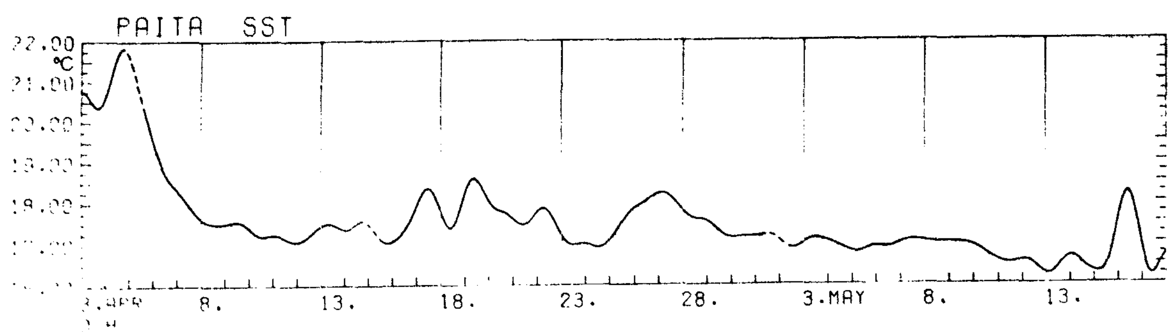


Figure 36. Sea-surface temperature at Paita. During periods in which no data is available the curve is completed by a dashed straight line (low passed values at 6 hour intervals).

Acknowledgements

This experiment could only be performed successfully with the valuable help of numerous persons and organizations.

We thank:

M. Tomczak and S. Zuta for having initiated the experiment.

Vice-Almirante A. Indacochea Q. and J. Meincke
for having supported the experiment during various critical phases.

D. Carlsen, H.J. Langhof and U. Hünninghaus for
having prepared the moorings.

N. Márresi B., Captain of "BAP Unanue",and his
crew.

All members of IMARPE participating in the experiment.

U. Kinder and M. v. Spreckelsen for having carried out a large part of the data processing.

Mrs. Petersen for preparing a large part of the graphs.

E. Gerkes M.,Habour-master of Paita,giving us powerful support on land and sea.

D. Enfield for allowing us to benefit from the CUEA facilities.

L. Codispoti for providing us with a salinity standard.

G. Belevan of CORPAC
Sr. Moralez of SENAMIH
J. Vargas of HIDRONAV
C. Vega of the Chira-Piura Project
for placing at our disposal meteorological and sea-level data.

The Deutsche Forschungsgemeinschaft for having provided the funds for the German participation.

Name	IFM Code	Position	Water depth (m)	Sensor depth (m)	Sensors	Observation period
	187101			45	VTPC	
C_1	102	$5^{o}01.3'S\ 81^{o}17.0'W$	104	60	VTPC	
	104			100	VTPC	
	186101			85	VT	
	102			125	VTP	
C_2	103	$5^{o}01.3'S\ 81^{o}31.0'W$	1360	200	VT	
	104			305	TP	31.3.77 1440 h -
	105			560	VT	20.5.77 0730 h
	106			860	VT	
	185101			195	VTC	
	102	$5^{o}00.5'S\ 81^{o}44.5'W$	3820	235	VT	GMT + 5
C_3	104			410	VT	
	105			650	TP	
M_1	188	$5^{o}01.3'S\ 81^{o}17,0'W$	104	0	WD	
M_2	196	$5^{o}01.5'S\ 81^{o}39.5'W$	2580	0	WSD	31.3.77 1440 h - 28.4.77 1810 h

Sensors: V current speed and direction, T Temperature, P Pressure, C Conductivity
WSD meteorological buoy (wind speed and direction)
WD meteorological buoy (wind direction)

Table 1: Moored instruments

Position	Date	Water depth (m)	Number of Profiles	Observation period	Wire length (m)
5°00.0'S 81°49.0'W	01.04.77	3910	1	2 h	100
5°01.0'S 81°39.5'W	01.04.77	2580	1	1 h	100
5°03.0'S 81°27.2'W	01.04.77	930	1	1 h	100
5°01.5'S 81°17.0'W	01.04.77	97	1	1 h	100
5°01.1'S 81°17.0'W	04.04.77	94	1	1 h	100
5°01.5'S 81°39.5'W	07.04.77	2580	1	3 h	500
4°15.0'S 81°16.0'W	18.04.77	90	7	12 h	100
4°15,5'S 81°19.5'W	20.04.77	240	4	4 h	200
4°15.0'S 81°22.0'W	20.04.77	1170	3	6 h	400
4°15.0'S 81°28.0'W	19.04.77	1870	5	10 h	400
5°59.0'S 81°13.0'W	11.05.77	135	7	11 h	100
6°02.0'S 81°24.5'W	12.05.77	1475	6	11 h	400
5°01.0'S 81°17.0'W	15.05.77	90	4	3 h	90
5°01.0'S 81°33.0'W	17.05.77	1960	6	11 h	400

Table 2: Profiling current measurements

No	Mean position (S)	(W)	Number of samples	time
P_1	4°15'	81°16'	7	18.4.77
P_2	4°15'	81°21'	6	20.4.77
P_3	4°15'	81°27'	5	19.4.77
P_4	5°01'	81°17'	6	1.4./4.4./15.5.77
P_5	5°01'	81°33'	6	17.5.77
P_6	5°01'	81°39'	2	1.4./7.4.77
P_7	5°59'	81°13'	7	11.5.77
P_8	6°02'	81°24'	6	12.5.77

All measurements were carried out within a distance of 2nm of the given position

Table 3: Statistics of the surface current measurements at profiler stations

Name	Position	Data	Sampling interval (h)	Interpolated values	Providing source
Talara	04°34.0'S 81°15.0'W	Sea-level	1	-	HIDRONAV
		Wind (A)	1	-	CORPAC
		Atmospheric pressure	1	-	CORPAC
La Esperanza	04°55.0'S 81°03.5'W	Wind (P)	6	1 per day	DEPECP
Paita	05°05.0'S 81°07.0'W	Wind (P)	6	1 per day	SENAMHI
		Atmospheric pressure	1	-	SENAMHI
		Sea-surface temperature	1	-	IMARPE
Piura	05°11.0'S 80°36.0'W	Wind (A)	1	8 per day	CORPAC
		Atmospheric pressure	1	8 per day	CORPAC
Chiclayo	06°47.0'S 79°50.0'W	Wind (A)	1	-	CORPAC
		Atmospheric pressure	1	-	CORPAC

HIDRONAV Direccion de Hidrografia y Navegacion de la Marina
CORPAC Corporacion Peruana de Aerolineas Commerciales
DEPECP Direccion Ejecutiva del Proyecto Especial CHIRA-PIURA
SENAMHI Servicio Nacional de Meteorologia y Hidrologia
IMARPE Instituto del Mar del Peru
Wind (A) Wind direction measured as angle
Wind (P) Wind direction measured as point of the compass

Table 4: Available data from land stations

List of stations

H	Hydrographic cast (H3 cast with 3 bottles only)
BT	Bathythermograph
STD	Salinity, Temperature, Depth-Sonde
Prof	Profiling current meter
MB	Microbiological samples
PP	Phytoplankton samples
ZP	Zooplankton samples
OM	Organic matter samples
( )	Instrument failed

The depth values are uncorrected.

Station N°.	Time		φ (S)	λ (W)	Depth (m)	Operations performed
1	28-III	09^{00}-16^{00}	05°01.5'	81°39.5'	2580	mooring M2 laid
2	29-III	09^{20}-13^{15}	05°01.3'	81°31.0'	1300	mooring C2 laid
3	30-III	08^{40}-13^{30}	05°00.5'	81°44.5'	3660	mooring C3 laid
4		15^{55}-22^{30}	05°00.0'	82°10.0'	5500	H, BT, ZP
5		23^{40}-31-III 03^{00}	05°00.0'	82°00.0'	4370	H
6	31-III	03^{58}-05^{53}	05°00.0'	81°50.0'	4200	H
7		08^{10}-10^{10}	05.01.0'	81°35.5'	1950	H
8		11^{45}-12^{45}	05°03.0'	81°19.7'	140	H
9		13^{45}-15^{15}	05°01.3'	81°17.0'	97	mooring C1 M1 laid
10	01-IV	07^{30}-09^{05}	05°00.0'	81°49.0'	4200	Prof, (STD)
11		10^{20}-11^{45}	05°01.0'	81°39.5'	2580	Prof, (STD)
12		12^{40}-12^{50}	05°01.0'	81°31.0'	1300	mooring C2 checked
13		13^{35}-15^{10}	05°03.0'	81°28.2'	1000	Prof, (STD)
14		16^{40}-17^{30}	05°01.5'	81°17.0'	100	Prof, STD
15	04-IV	13^{15}-13^{35}	05°00.0'	81°10.0'	25	H
16		14^{50}-17^{50}	05°01.1'	81°17.0'	96	H, Prof, (STD), BT
17		18^{40}-19^{55}	05°01.0'	81°24.6'	196	H, STD
18		20^{27}-22^{25}	05°00.0'	81°30.0'	1500	H
19		23^{55}-05-IV 01^{25}	05°01.5'	81°39.5'	2700	H
20	05-IV	02^{13}-03^{55}	05°00.0'	81°50.0'	4950	H
21		04^{55}-07^{40}	05°00.0'	82°00.0'	-	H
22		08^{55}-10^{45}	05°00.0'	82°10.0'	-	H, ZP
23		12^{30}-14^{20}	05°00.0'	82°30.0'	-	H
24		16^{03}-18^{15}	05°03.0'	82°50.0'	-	H, ZP
25		20^{20}-22^{40}	05°00.0'	83°11.0'	-	H
26	06-IV	00^{30}-02^{40}	05°00.0'	83°30.0'	-	H, ZP
27		04^{31}-06^{25}	05°00.0'	83°50.0'	-	H
28		08^{30}-11^{05}	05°00.0'	84°10.0'	-	H, ZP
29		21^{25}-22^{00}	05°05.0'	82°40.0'	4220	BT
30		23^{00}-23^{17}	05°05.0'	82°30.0'	-	BT
31	07-IV	00^{13}-00^{40}	05°05.0'	82°23.0'	4600	BT
32		01^{12}-01^{30}	05°05.0'	82°20.0'	4600	BT
33		02^{03}-02^{25}	05°05.0'	82°17.0'	-	BT
34		02^{57}-03^{18}	05°05.0'	82°14.0'	-	BT
35		03^{52}-04^{13}	05°05.0'	82°05.0'	-	BT
36		08^{40}-14^{35}	05°01.5'	81°39.5'	2580	BT, STD,H, ZP, Prof

Station N°.	Time		φ (S)	λ (W)	Depth (m)	Operations performed
37	10-IV	$09^{09}-09^{35}$	$05^{\circ}00.0'$	$81^{\circ}10.0'$	25	H
38		$09^{56}-10^{38}$	$05^{\circ}00.0'$	$81^{\circ}15.0'$	-	H
39		$10^{56}-11^{32}$	$05^{\circ}00.0'$	$81^{\circ}20.0'$	105	H
40		$12^{00}-12^{40}$	$05^{\circ}00.0'$	$81^{\circ}25.0'$	-	H
41		$13^{09}-15^{15}$	$05^{\circ}00.0'$	$81^{\circ}30.0'$	1500	H
42		$17^{05}-19^{20}$	$05^{\circ}00.0'$	$81^{\circ}40.0'$	2800	H
43	14-IV	$07^{11}-07^{47}$	$05^{\circ}00.0'$	$81^{\circ}10.0'$	25	H, MB
44		$08^{06}-09^{04}$	$05^{\circ}00.0'$	$81^{\circ}15.0'$	-	H, PP, ZP
45		$09^{37}-10^{43}$	$05^{\circ}00.0'$	$81^{\circ}20.0'$	105	H, PP, ZP, MB
46		$10^{56}-12^{37}$	$05^{\circ}00.0'$	$81^{\circ}25.0'$	1200	H
47		$13^{04}-14^{55}$	$05^{\circ}00.0'$	$81^{\circ}30.0'$	1900	H, PP, ZP, MB
48		$16^{00}-18^{14}$	$05^{\circ}00.0'$	$81^{\circ}40.0'$	2900	H
49		$20^{30}-22^{35}$	$05^{\circ}00.0'$	$81^{\circ}50.0'$	-	H, PP, ZP, MB
50	14-IV	23^{15}-15-IV 01^{08}	$05^{\circ}00.0'$	$82^{\circ}00.0'$	-	H
51		$02^{08}-04^{22}$	$05^{\circ}00.0'$	$82^{\circ}08.0'$	4800	H, PP, ZP, MB
52	18-IV	$06^{30}-08^{30}$	$04^{\circ}13.0'$	$81^{\circ}17.5'$	150	Prof
53		$09^{00}-10^{50}$	$04^{\circ}13.0'$	$81^{\circ}15.0'$	110	Prof, H, PP, ZP
54		$11^{05}-12^{35}$	$04^{\circ}15.0'$	$81^{\circ}16.0'$	90	Prof, H, STD
55		$12^{52}-14^{31}$	$04^{\circ}15.0'$	$81^{\circ}16.0'$	90	Prof, H, STD
56		14^{4}[illegible]-16^{23}	$04^{\circ}15.0'$	$81^{\circ}16.0'$	90	Prof, H, STD
57		$16^{40}-18^{20}$	$04^{\circ}15.0'$	$81^{\circ}16.0'$	90	Prof, H, STD, PP
58		$18^{30}-20^{42}$	$04^{\circ}15.0'$	$81^{\circ}16.0'$	90	Prof, H, ZP
59	19-IV	$02^{27}-09^{15}$	$04^{\circ}15.0'$	$81^{\circ}28.0'$	2050	H, Prof, STD, ZP, PP
60		$09^{25}-11^{25}$	$04^{\circ}15.0'$	$81^{\circ}27.0'$	2000	Prof
61		$11^{40}-13^{45}$	$04^{\circ}15.0'$	$81^{\circ}27.0'$	2000	Prof
62		$13^{58}-15^{30}$	$04^{\circ}15.0'$	$81^{\circ}27.0'$	2000	Prof
63		$17^{15}-18^{15}$	$04^{\circ}14.0'$	$81^{\circ}28.0'$	1950	Prof
64		$19^{00}-23^{05}$	$04^{\circ}15.0'$	$81^{\circ}28.0'$	2100	H, STD, ZP, PP
65	20-IV	$05^{15}-07^{25}$	$04^{\circ}15.0'$	$81^{\circ}18.5'$	650	H, STD
66		$07^{48}-09^{15}$	$04^{\circ}15.2'$	$81^{\circ}19.0'$	320	Prof
67		$09^{30}-10^{34}$	$04^{\circ}15.2'$	$81^{\circ}19.8'$	208	Prof
68		$10^{50}-11^{41}$	$04^{\circ}15.7'$	$81^{\circ}19.2'$	262	Prof
69		$12^{00}-14^{10}$	$04^{\circ}14.8'$	$81^{\circ}21.7'$	1200	Prof
70		$14^{30}-16^{24}$	$04^{\circ}14.8'$	$81^{\circ}21.7'$	1200	Prof

Station N°.	Time		φ (S)	λ (W)	Depth (m)	Operations performed
71		$16^{40}-18^{18}$	04°15.0'	81°23.0'	1300	Prof
72		$19^{05}-20^{22}$	04°15.0'	81°16.0'	115	H, STD, PP, ZP, MB
73		$20^{40}-23^{27}$	04°15.0'	81°20.0'	720	H, STD, PP, ZP, MB
74		$23^{40}-03^{05}$	04°14.0'	81°25.5'	1840	H, (STD)
75	21-IV	$03^{25}-06^{50}$	04°15.0'	81°30.0'	2640	H, (STD), PP, ZP, MB
76		$07^{35}-09^{45}$	04°15.0'	81°40.0'	3300	H, (STD)
77		$10^{34}-13^{45}$	04°15.2'	81°50.0'	5000	H, STD, PP, ZP, MB
78		$14^{35}-17^{10}$	04°15.0'	82°00.0'	5600	H, STD
79		$18^{00}-22^{00}$	04°15.0'	82°10.0'	-	H, STD, PP, ZP, MB
80	25-IV	$16^{21}-16^{50}$	05°00.0'	82°10.0'	25	H, MB
81		$17^{15}-17^{50}$	05°00.0'	81°15.0'	46	H, ZP
82		$18^{00}-18^{58}$	05°00.0'	81°20.0'	75	H, MB
83		$19^{30}-20^{42}$	05°00.0'	81°25.0'	300	H
84		$21^{14}-23^{12}$	05°00.0'	81°30.0'	1400	H, MB
85	26-IV	$00^{10}-02^{10}$	05°00.0'	81°38.0'	2000	H
86		$03^{10}-05^{36}$	05°00.0'	81°50.0'	2400	H, MB
87		$06^{30}-08^{40}$	05°00.0'	82°00.0'	-	H
88		$09^{35}-11^{35}$	05°00.0'	82°10.0'	4900	H, MB
88A		$14^{05}-15^{50}$	05°00.0'	81°39.8'	-	H, MB
89	27-IV	$00^{45}-02^{13}$	04°17.0'	81°17.0'	192	H, MB
90		$03^{50}-05^{04}$	04°30.0'	81°22.0'	180	H, MB
91		$06^{35}-07^{35}$	04°45.0'	81°25.0'	170	H, MB
92		$08^{58}-10^{05}$	05°00.0'	81°28.0'	230	H, MB
93		$11^{25}-12^{26}$	05°15.0'	81°25.0'	400	H, MB
94		$14^{25}-15^{01}$	05°30.0'	81°20.0'	200	H, MB
95		$17^{20}-18^{39}$	05°45.0'	81°14.0'	180	H, MB
96		$19^{40}-20^{30}$	06°00.0'	81°13.0'	175	H, MB
97		$21^{50}-23^{47}$	06°00.0'	81°28.0'	2750	H, MB
98	28-IV	$01^{02}-02^{55}$	05°45.0'	81°29.0'	1800	H, MB
99		$03^{55}-05^{50}$	05°30.0'	81°29.0'	2000	H, MB
100		$07^{02}-08^{42}$	05°15.0'	81°32.0'	1900	H, MB
101		$09^{55}-11^{35}$	05°00.0'	81°38.0'	-	H, MB
102		$12^{55}-14^{20}$	04°45.0'	81°38.0'	2000	H, MB
103		$16^{00}-18^{10}$	04°34.0'	81°42.0'	2500	H, MB
104		$19^{37}-21^{00}$	04°15.0'	81°32.0'	2100	H, MB

Station N^{o}.	Time		ϕ (S)	λ (W)	Depth (m)	Operations performed
105	29-IV	$01^{10}-01^{40}$	05°00.0'	81°10.0'	60	H, MB
106		$02^{12}-02^{45}$	05°00.0'	81°15.0'	70	H, MB, OM
107		$03^{12}-04^{10}$	05°00.0'	81°20.0'	230	H, MB, OM
108		$04^{37}-06^{10}$	05°00.0'	81°25.0'	750	H, MB
109		$06^{25}-08^{10}$	05°00.0'	81°30.0'	3290	H, MB, OM
110		$09^{00}-10^{28}$	05°00.0'	81°40.0'	3600	H, MB
111		$11^{15}-12^{47}$	05°00.0'	81°50.0'	4570	H, MB, OM
112		$13^{37}-15^{15}$	05°00.0'	82°00.0'	4500	H, MB
113		$16^{05}-17^{50}$	05°00.0'	82°10.0'	4500	H, MB, OM
114	30-IV	$01^{15}-01^{30}$	04°15.0'	81°15.0'	74	STD, OM
115		$01^{50}-02^{15}$	04°15.0'	81°20.0'	450	STD
116		$03^{10}-03^{52}$	04°15.0'	81°30.0'	2000	STD, OM
117		$04^{45}-06^{13}$	04°15.0'	81°40.0'	3200	STD
118		$07^{00}-07^{55}$	04°15.0'	81°50.0'	-	STD, OM
119		$08^{40}-09^{25}$	04°15.0'	82°00.0'	4400	STD
120		$10^{20}-11^{01}$	04°15.0'	82°10.0'	4000	STD, OM
121		$12^{30}-13^{11}$	04°30.0'	82°10.0'	-	STD, OM
122		$14^{15}-14^{48}$	04°30.0'	82°00.0'	3600	STD
123		$15^{50}-16^{41}$	04°30.0'	81°50.0'	-	STD, OM
124		$17^{50}-18^{45}$	04°30.0'	81°40.0'	-	STD
125		$19^{30}-20^{13}$	04°30.0'	81°30.0'	2800	STD, OM
126		$21^{30}-21^{45}$	04°30.0'	81°20.0'	120	STD, MB, OM
127		$23^{06}-23^{18}$	04°45.0'	81°20.0'	30	OM
128	01-V	$00^{05}-00^{46}$	04°45.0'	81°30.0'	1000	STD
129		$01^{36}-02^{15}$	04°45.0'	81°40.0'	3600	STD, OM
130		$02^{58}-03^{48}$	04°45.0'	81°50.0'	4400	STD
131		$04^{37}-05^{37}$	04°45.0'	82°00.0'	5200	STD, OM
132		$06^{17}-07^{01}$	04°45.0'	82°10.0'	3000	STD, OM
133		$08^{25}-09^{50}$	05°00.0'	82°10.0'	5100	STD, OM
134		$11^{35}-12^{05}$	05°00.0'	82°00.0'	-	STD, MB, OM
135		$13^{38}-14^{20}$	05°00.0'	81°40.0'	2400	STD, MB, OM
136		$16^{50}-16^{55}$	05°00.0'	81°25.0'	45	OM
137		$19^{42}-20^{02}$	05°15.0'	81°12.0'	50	STD, OM
138		$20^{40}-20^{55}$	05°15.0'	81°20.0'	160	STD
139		$21^{46}-22^{35}$	05°15.0'	81°30.0'	1500	STD, OM

Station N^{o}.	Time		ϕ (S)	λ (W)	Depth (m)	Operations performed
140		$23^{30}-00^{10}$	$05^{\circ}15.0'$	$81^{\circ}40.0'$	3100	STD
141	02-V	$01^{06}-01^{37}$	$05^{\circ}15.0'$	$81^{\circ}50.0'$	3700	STD
142		$02^{20}-03^{00}$	$05^{\circ}15.0'$	$82^{\circ}00.0'$	5600	STD
143		$03^{42}-04^{38}$	$05^{\circ}15.0'$	$82^{\circ}10.0'$	-	STD
144		$05^{55}-06^{55}$	$05^{\circ}30.0'$	$82^{\circ}10.0'$	-	STD, OM
145		$07^{40}-08^{30}$	$05^{\circ}30.0'$	$82^{\circ}00.0'$	-	STD
146		$09^{15}-10^{00}$	$05^{\circ}30.0'$	$81^{\circ}50.0'$	-	STD, OM
147		$10^{45}-11^{40}$	$05^{\circ}30.0'$	$81^{\circ}40.0'$	5000	STD
148		$12^{25}-13^{14}$	$05^{\circ}30.0'$	$81^{\circ}30.0'$	4300	STD, OM
149		$14^{08}-14^{45}$	$05^{\circ}30.0'$	$81^{\circ}20.0'$	2200	STD
150		$16^{15}-16^{50}$	$05^{\circ}30.0'$	$81^{\circ}10.0'$	250	STD, OM
151		$17^{40}-18^{05}$	$05^{\circ}45.0'$	$81^{\circ}10.0'$	80	STD, OM
152		$18^{40}-19^{15}$	$05^{\circ}45.0'$	$81^{\circ}20.0'$	600	STD
153		$19^{40}-20^{50}$	$05^{\circ}45.0'$	$81^{\circ}30.0'$	2400	STD, OM
154		$21^{30}-22^{25}$	$05^{\circ}45.0'$	$81^{\circ}40.0'$	4700	STD
155		$23^{10}-00^{05}$	$05^{\circ}45.0'$	$81^{\circ}50.0'$	4800	STD
156	03-V	$00^{50}-01^{30}$	$05^{\circ}45.0'$	$82^{\circ}00.0'$	-	STD
157		$02^{07}-02^{46}$	$05^{\circ}45.0'$	$82^{\circ}10.0'$	-	STD
158		$03^{50}-04^{58}$	$06^{\circ}00.0'$	$82^{\circ}10.0'$	-	STD, OM
159		$05^{45}-06^{54}$	$06^{\circ}00.0'$	$82^{\circ}00.0'$	-	STD
160		$07^{35}-08^{20}$	$06^{\circ}00.0'$	$81^{\circ}50.0'$	-	STD, OM
161		$09^{10}-09^{55}$	$06^{\circ}00.0'$	$81^{\circ}40.0'$	-	STD
162		$10^{50}-11^{37}$	$06^{\circ}00.0'$	$81^{\circ}30.0'$	-	STD, OM
163		$12^{35}-13^{15}$	$06^{\circ}00.0'$	$81^{\circ}20.0'$	2100	STD
164		$14^{15}-14^{30}$	$06^{\circ}00.0'$	$81^{\circ}10.0'$	250	STD, MB
165		$19^{05}-19^{43}$	$05^{\circ}00.0'$	$81^{\circ}10.0'$	45	H
166		$19^{50}-20^{18}$	$05^{\circ}00.0'$	$81^{\circ}15.0'$	75	H
167		$20^{35}-21^{20}$	$05^{\circ}00.0'$	$81^{\circ}20.0'$	120	H
168		$21^{40}-22^{22}$	$05^{\circ}00.0'$	$81^{\circ}25.0'$	220	H
169		$22^{44}-01^{06}$	$05^{\circ}00.0'$	$81^{\circ}30.0'$	1200	H, MB
170	04-V	$01^{35}-03^{25}$	$05^{\circ}00.0'$	$81^{\circ}40.0'$	2500	H
171		$04^{07}-07^{00}$	$05^{\circ}00.0'$	$81^{\circ}50.0'$	4050	H, MB
172		$07^{56}-08^{05}$	$05^{\circ}00.0'$	$82^{\circ}00.0'$	-	(H)
173		$09^{00}-10^{20}$	$05^{\circ}00.0'$	$82^{\circ}10.0'$	-	H, MB
174		$14^{50}-14^{55}$	$05^{\circ}01.3'$	$81^{\circ}17.0'$	85	MB

Station N°.	Time		φ (S)	λ (W)	Depth (m)	Operations performed
175	09-V	15^{53}-16^{20}	05°00.0'	81°12.0'	25	H
176		17^{05}-17^{36}	05°00.0'	81°15.0'	55	H
177		18^{00}-18^{46}	05°00.0'	81°20.0'	110	H
178		19^{40}-21^{53}	05°00.0'	81°30.0'	1600	H
179		22^{45}-00^{52}	05°00.0'	81°40.0'	3800	H
180	10-V	01^{43}-03^{31}	05°00.0'	81°50.0'	3950	H
181		04^{24}-06^{33}	05°00.0'	82°00.0'	-	H
182		07^{17}-09^{18}	05°00.0'	82°10.0'	-	H
183		10^{12}-12^{03}	05°00.0'	82°33.0'	-	H
184		13^{42}-15^{02}	05°00.0'	82°40.0'	-	H
185	11-V	02^{00}-02^{45}	06°00.0'	81°12.0'	110	H
186		04^{00}-04^{45}	06°00.0'	81°12.0'	110	H
187		06^{20}-07^{50}	05°59.0'	81°12.0'	110	Prof, H
188		08^{00}-09^{34}	05°59.0'	81°13.0'	150	Prof, H
189		09^{45}-11^{10}	05°59.0'	81°13.0'	146	Prof, H
190		11^{57}-13^{38}	05°59.0'	81°13.0'	110	Prof, H
191		14^{00}-15^{38}	05°59.0'	81°13.0'	152	Prof, H
192		15^{50}-17^{05}	06°00.0'	81°13.0'	115	Prof, H
193		17^{18}-19^{45}	05°59.0'	81°12.0'	115	Prof, H
194		20^{00}-21^{40}	06°00.0'	81°13.0'	140	H
195		22^{00}-23^{40}	05°59.0'	81°14.0'	190	H
196	12-V	00^{35}-01^{20}	06°00.0'	81°13.0'	116	H
197		06^{30}-07^{55}	06°02.0'	81°24.5'	1580	Prof
198		08^{15}-09^{35}	06°02.0'	81°24.5'	1580	Prof
199		09^{50}-11^{35}	06°02.0'	81°24.5'	1540	Prof
200		11^{55}-13^{35}	06°00.0'	81°25.0'	1560	Prof
201		14^{00}-15^{35}	06°00.0'	81°25.0'	1600	Prof
202		15^{50}-17^{25}	06°02.0'	81°24.0'	1540	Prof
203		19^{00}-19^{45}	06°00.0'	81°11.0'	120	STD, H3
204		20^{05}-21^{03}	06°00.0'	81°15.0'	200	STD, H3
205		21^{30}-22^{05}	06°00.0'	81°20.0'	1100	STD, H3
206		23^{30}-00^{56}	06°00.0'	81°25.0'	2140	STD, H3
207	13-V	01^{35}-02^{36}	06°00.0'	81°30.0'	2400	STD, H3
208		03^{27}-04^{48}	06°00.0'	81°40.0'	-	STD, H3
209		05^{45}-07^{15}	06°00.0'	81°50.0'	-	STD, H3
210		08^{08}-10^{08}	06°00.0'	82°00.0'	-	STD, H3
211		10^{50}-12^{25}	06°00.0'	82°10.0'	-	STD, H3
212		20^{23}-21^{00}	05°00.0'	81°10.0'	25	H

Station N^{o}.	Time		ϕ (S)	λ (W)	Depth (m)	Operations performed
213		$21^{25}-22^{06}$	05°00.0'	81°15.0'	65	H
214		$22^{30}-23^{18}$	05°00.0'	81°20.0'	130	H
215		$23^{43}-01^{14}$	05°00.0'	81°25.0'	950	H
216	14-V	$01^{35}-02^{51}$	05°00.0'	81°30.0'	1440	H
217		$03^{28}-05^{03}$	05°00.0'	81°40.0'	2900	H
218		$05^{48}-07^{45}$	05°00.0'	81°50.0'	4200	H
219		$08^{28}-10^{25}$	05°00.0'	82°00.0'	-	H
220		$11^{10}-12^{57}$	05°00.0'	82°10.0'	-	H
221		$13^{26}-14^{58}$	05°00.0'	82°20.0'	-	H
222		$15^{37}-17^{05}$	05°00.0'	82°30.0'	-	H
223	15-V	$07^{00}-11^{00}$	05°01.5'	81°39.5'	2580	mooring M2 recovered
223A		$13^{40}-14^{11}$	05°01.35'	81°17.0'	91	Prof
224		$14^{28}-14^{58}$	05°01.35'	81°17.0'	90	Prof
225		$15^{10}-15^{57}$	05°01.35'	81°17.0'	90	Prof
226		$15^{50}-16^{40}$	05°01.35'	81°17.0'	90	Prof
227	17-V	$07^{07}-08^{38}$	05°01.0'	81°32.8'	2100	Prof
228		$08^{59}-10^{39}$	05°01.0'	81°32.8'	2100	Prof
229		$10^{57}-12^{38}$	05°01.0'	81°32.8'	2100	Prof
230		$12^{46}-14^{25}$	05°01.0'	81°32.8'	2100	Prof
231		$14^{46}-16^{23}$	05°01.0'	81°32.8'	2100	Prof
232		$16^{52}-18^{30}$	05°01.0'	81°32.8'	2100	Prof
233	20-V	$08^{05}-11^{16}$	05°00.5'	81°44.5'	3660	mooring C3 recovered
234		$12^{30}-16^{20}$	05°01.3'	81°31.0'	1300	mooring C2 recovered
235	21-V	$09^{35}-10^{05}$	05°00.0'	81°10.0'	55	H
236		$10^{30}-11^{02}$	05°00.0'	81°15.0'	82	H
237		$11^{27}-12^{10}$	05°00.0'	81°20.0'	170	H
238		$12^{36}-14^{16}$	05°00.0'	81°25.0'	1000	H
239		$14^{40}-16^{29}$	05°00.0'	81°30.0'	1500	H
240		$17^{15}-18^{45}$	05°00.0'	81°40.0'	3400	H
241		$19^{25}-21^{01}$	05°00.0'	81°50.0'	-	H
242		$21^{45}-23^{42}$	05°00.0'	82°00.0'	-	H
243	22-V	$00^{20}-02^{04}$	05°00.0'	82°10.0'	-	H
244		$07^{50}-13^{30}$	05°01.3'	81°17.0'	97	mooring C1 M1 recovered