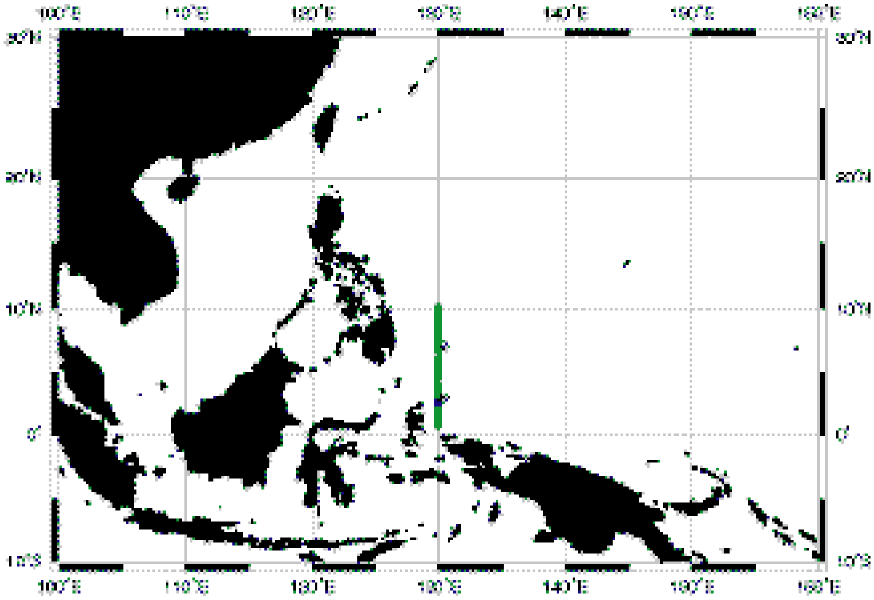
A. Cruise Narrative: P08S



A.1. Highlights

WHP Cruise Summary Information

WOCE section designation	**P08S**
Expedition designation (EXPOCODE)	**49XK9605**
Chief Scientist(s) and their affiliation	**Noriya Yoshioka*; Djoko Hartoyo****
Dates	1996.06.17 - 1996.07.02
Ship	R/V Kaiyo
Ports of call	Yokosuka, Japan-Korol, Palau
Number of stations	27
Geographic boundaries of the stations	10° 0.04' N 129° 56.6' E 130° 5.81' E 45' N
Floats and drifters deployed	none
Moorings deployed or recovered	none
Contributing Authors	Y.Kashino, S.Ishida, N.Yoshioka, H.Yoritaka, H.Yamamoto, M.Hayashi, K.Katayama, S.Kanda, A.Ito, M.Aoki, T.Shiribiki, M.Fujisaki, Y.Nogiwa, K.Nakao, N.Komai, C.Saito, K.Shitashima, D.Tsumune, S.Kraines, N.Harada, R.Key

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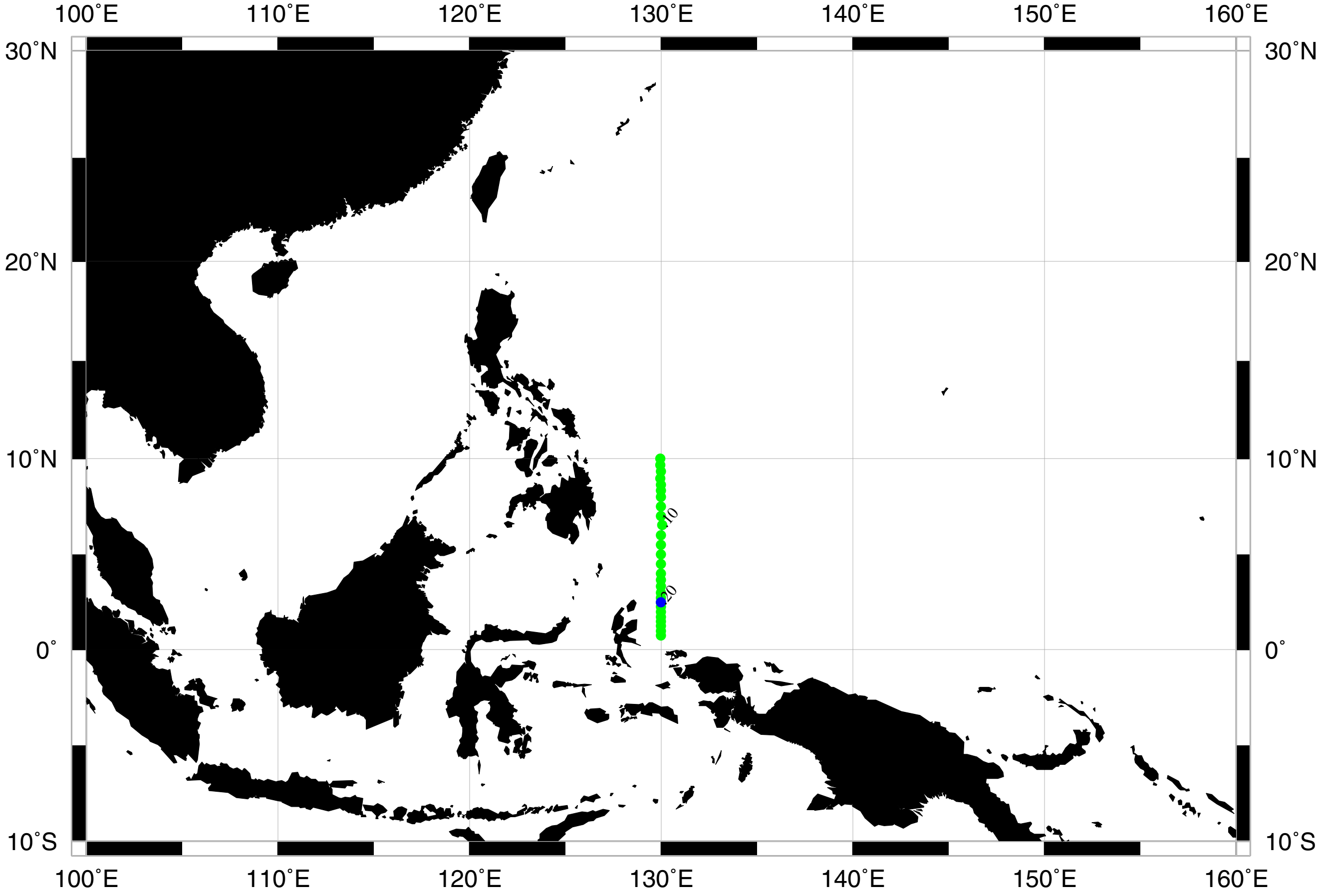
WHP Cruise and Data Information

Instructions: Click on any item to locate primary reference(s) or use navigation tools above.

Cruise Summary Information	**Hydrographic Measurements**
Description of scientific program	CTD - general
	CTD - pressure
Geographic boundaries of the survey	CTD - temperature
Cruise track (figure)	CTD - conductivity/salinity
Description of stations	
Description of parameters sampled	
	Salinity
	Oxygen
	Nutrients
Principal Investigators for all measurements	
Cruise Participants	
	Radiocarbon
Problems and goals not achieved	CO2 system parameters
Underway Data Information	**Acknowledgments**
Navigation	**References**
Bathymetry	
Acoustic Doppler Current Profiler (ADCP)	**DQE Reports**
	14C
Meteorological observations	CO2
	Data Processing Notes

Station locations for P08S



Produced from .sum file by WHPO-SIO

A.2 Cruise Summary Information

A.2.a Geographic boundaries

The 27 CTD stations are located between 10-00N, 130-00E to 00-45N, 130-00E, and distance between two stations are minimum of 15 miles near the Indonesian coast and maximum of 30 miles on the open ocean with smooth bottom topography.

A.2.b Stations occupied

Standard sampling layers are designed as 10, 20, 30, 50, 75, 100, 125, 150, 200, 250, 300, 400, 500, 600, 700, 800, 900, 1000 m and below that level, sampling layers are designed as 250 m interval to the just above the bottom. One casting operation of the Rosette sampler with 36 bottles can satisfy the standard sampling at the area shallower than water depth of 5250 m. At the station deeper than this critical water depth, samplings at the depth of 20, 75 and 125 m were occasionally omitted. At the assistant CTD station on 02-45N, we made CTD observation at layers shallower than 1000 m.

Sampling elements are as follows: Salinity, Dissolved Oxygen, Nutrients (Nitrate, Nitrite, Phosphate and Silicate) were measured at all layers on all stations except the assistant station. Alkalinity, pH and TCO2 were measured at all layers on some stations, and H-3, He-3 and C-14 were sampled at some layers on these stations with a little of exceptions.

A.2.c Floats and drifters deployed

A.2.d Moorings deployed or recovered

A.3 List of Principal Investigators

Table A.3-1: List of parameters to be measured and principal investigators

Parameter/Instr.	Affiliation	Principal Investigator
CTD/Rosette	JAMSTEC	Yuji Kashino (CTD Software)
	JAMSTEC	Hiroyuki Yoritaka (Hardware)
ADCP	JAMSTEC	Yuji Kashino
Salinity	JAMSTEC	Hiroyuki Yoritaka
NO3, NO2, PO4, SiO2	JAMSTEC	Chizuru Saito
DO	NME	Misumi Aoki
C-14, H-3, He-3	JAMSTEC	Chizuru Saito
TCO2, pH, Alkalinity	CRIEPI	Kiminori Shitashima

JAMSTEC:	Japan Marine Science and Technology Center, Japan
NME:	Nippon Marine Enterprise, c/o, Ltd., Japan
CRIEPI:	Central Research Institute Electric Power Industry, Japan

A.4 Scientific Program and Methods

The principal objectives of the cruise were:

- To submit a data set to the WHPO, and contribute the global measurement of the WOCE program.
- To investigate southward intrusion of low salinity water (<34.5 pss-78), which may be advected from the North Pacific ocean to a layer below the high salinity Tropical Pacific water. CTD point at 02-45N, 130-00E was added for this sake.

A.5 Major Problems and Goals not Achieved

At Stn.12 (05-30N,130-00E) on June 26, we encountered a trouble with damage on a fiber of armored-wire of the CTD cable. After this accident, irregular winding of the CTD cable over 5000 m long on the winch wheel was occurred. But there was no influence on the CTD signal, we could carried out all of the originally planned CTD observations on schedule.

A.6 Other Incidents of Note

A.7 List of Cruise Participants

Table A.7-2. Cruise Participants

Name	Affiliation	Parameter
Noriya Yoshioka	JAMSTEC	CTD
Hiroyuki Yoritaka	JAMSTEC	Salinity/CTD Hardware
Yuji Kashino	JAMSTEC	CTD Software /ADCP
Hirofumi Yamamoto	JAMSTEC	CTD
Chizuru Saito	JAMSTEC	Nutrients/C-14/H-3/He-3
Naomi Harada	JAMSTEC	C-14/H-3/He-3
Misumi Aoki	NME	DO
Hiroshi Yamamoto	NME	CTD
Atsuo Ito	NME	Salinity
Mitsuru Hayashi	NME	Salinity
Masayuki Fujisaki	NME	DO
Nobuharu Komai	NME	Nutrients
Takeshi Katayama	NME	CTD
Satoru Kanda	NME	CTD
Takehiko Shiribiki	STM	DO
Yasuko Nogiwa	KEEC	Nutrients
Kiyotaka Nakao	KEEC	Nutrients
Kiminori Shitashima	CRIEPI	TCO2/pH/Alkalinity
Daisuke Tsumune	CRIEPI	TCO2/pH/Alkalinity
Steven B. Kraines	CRIEPI	TCO2/pH/Alkalinity
Djoko Hartoyo	BPPT	CTD
R.Trimanadi	BPPT	CTD
Victoriano C.Buquir	c/o NAMRIA (Philippine)	CTD

JAMSTEC:	Japan Marine Science and Technology Center, Japan
NME:	Nippon Marine Enterprises, c/o Ltd., Japan
STM:	Sanyo Techno Marine, Inc., Japan
KEEC:	Kansai Environmental Engineering Center, c/o Ltd., Japan
CRIEPI:	Central Research Institute of Electric Power Industry, Japan
BPPT:	Badan Pengkajian dan Penerapan Teknologi, Indonesia

B. Underway Measurement

B.1 Navigation and bathymetry (Echosounding)

(Y.Kashino)
19 November 1996

The water depth obtained by the multi-narrow beam echo-sounder (General Instrument) and corrected depth are summarized in Table B.1-1. The corrected depth are derived from CTD depth plus altimeter value. This result shows tendency of decrease of its difference. After Stn.18, the depth measured from echosounding is larger than corrected depth.

Except at few stations, the differences are less than +/- 1.0 %.

Table B.1-1: The differences between corrected water depth and uncorrected echosounding depth. The values of the corrected depths are derived from CTD depth plus altimeter value.

Station Number	Corrected Depth (meter)	Echosounding (uncorrected) (meter)	Diff. (meter)
01	5939	5913	26
02	5751	5761	-10
03	6005	5942	63
04	5924	5865	59
05	5963	5978	-15
06	6002	5827	175
07	5662	5612	50
08	5537	5520	17
09	5549	5520	29
10	5549	5526	23
11	5488	5476	12
12	5466	5450	16
13	5039	5038	1
14	4856	4845	11
15	4693	4709	-16
16	3703	3615	88
17	3885	3886	-1
18	3005	3016	-11
19	----	3032	----
20	4000	4023	-23
21	4308	4317	-9
22	4394	4396	-2
23	3862	3890	-28
24	4121	4113	8
25	----	3299	----
26	3003	3022	-19
27	1451	1514	-53

B.2 Acoustic Doppler Current Profiler (ADCP)

(Y.Kashino)
2 September 1996

a. System

The RD narrow band Acoustic Doppler Current Profiler (ADCP) by RD Instruments was used to observe current structure along the cruise track from Yokosuka to Palau including south of P8 line. This ADCP transmits 75KHz acoustic pluses from the transducer along 4 beams angled of 30 degree.

The ADCP was controlled by the software "TRANSECT" developed by RD Instruments on IBM PS/V model 2408.

b. Data processing

Raw data was acquired every a minute at 51 layers from 30m to 830m every 16m. We report averaged data every 10 km for all layers. Data processing was done as follows:

1) Convert binary data to ASCII processed data outputted every one minute using TRANSECT.
2) Remove noise from processed data. The noise is defined as follows:
   - Data during the period of ship velocity of < 5 knot with 10 minutes before and after.
   - Data with vertical averaged velocity (from 30m depth to the depth where data is available) of > 1.0 m/s, which is probably derived from GPS error.
   - Data with percent good of < 50.
   - Data with its difference from 24 samples average of > 3 sigma.
3) Calculate average velocity every 10 km segment.

The format of averaged data is shown in Table B.2-1. Unit of velocity is (m/sec).

We did not correct the gyrocompass error because it was less than 0.2 degree when we check it in Palau. We did not also correct the error from beam angle setting error because we could not find systematic error when we checked the data obtained during the cruise conducted in January, 1996.

c. Primary result

The meridional and zonal velocity section plot along P8 line and vector plot at 50m and 350m level are shown in Fig. F.1-10, F.1-11, F.2-1 and F.2-7 using averaged data. We can see anticyclonic Halmahera eddy clearly. We can also see the low salinity water from the North Pacific advected by southward flow below the South Pacific Tropical Water comparing meridional velocity section and salinity section along P8 line.

Table B.2-1 Format of averaged data in 10km segments.

Line	Field	Description
Following five lines are header of this file.		
A	1	Expocode and cruise date
B	1	Place where observation was started and ended
C	1	Length of the segment for averaging and the number of segments
D	1	Number, range, and thickness of layer
E	1	Separator
Following are written each 10 km segments. -9.0 is assigned for "bad data" or "no data". The first five lines contain the information of segment (e.g., number of segment, location of center of segments). Starting line 6, information in columns based on the bin depth is written.		
1	1	Serial number of segment.
	2	Number of samples used for averaging location.
2	1	Mean time (UT) - Month
	2	- Day
	3	- Year
	4	- Hour
	5	- Minute
3	1	Location - Latitude
	2	- Longitude
4	1	Name of fields written below line 6
5	1	Unit of fields written below line 6
6	1	Depth (m)
	2	Velocity magnitude (m/sec)
	3	Velocity direction (degree)
	4	East velocity component (m/sec) - east(+)/west(-)
	5	North velocity component (m/sec) - north(+)/south(-)
	6	Number of samples used for averaging value in this layer

B.3 Thermosalinograph and underway dissolved oxygen, fluorometer, etc.

B.4 XBT and XCTD

B.5 Meteorological observations

(S.Ishida, Captain of R/V KAIYO and N.Yoshioka)
September 1996

Routine weather observation with 24 hours intervals are carried out on our cruise. Aneroid barometer (Yanagi INSTRUMENT,TYPE 8A,S/N 6869) at the 13.7 m height from sea surface was used. Wind vane and anemometer (Ogasawara keiki, PR350) is at the height of 27.2 m and wind force is estimated by handy calcurater. Sea water pumped up from the depth of 4.8 m is measured its temperature, and air temperature was measured with a ventilated psychrometer (Ohta keiki,S/N 221705). These instruments were not calibrated except the barometer which was calibrated on July.4,1994.

YYMMDD/HH (UST)	DEG MIN (N)	DEG MIN (E)	DIR	FOR	WEA.	BAR.	AR.T	SST
960623/03	10.06 N	130.03 E	ENE	1	C	1008.6	25.5	29.0
960624/03	08.59 N	129.59 E	CLM	-	BC	1009.8	32.4	29.0
960625/03	07.30 N	130.00 E	SSW	2	BC	1009.3	29.8	29.0
960626/03	06.00 N	130.00 E	NW	2	BC	1012.8	31.8	29.0
960627/03	04.10 N	130.00 E	SSE	2	BC	1010.6	31.2	29.0
960628/03	02.45 N	130.00 E	SE	4	R	1013.8	26.0	29.0
960629/03	01.56 N	130.00 E	ESE	2	BC	1010.5	31.1	28.0
960630/03	01.00 N	130.00 E	NE	4	Q	1011.2	28.0	28.0
960701/03	03.42 N	131.17 E	E	1	C	1011.0	30.5	28.0

B.6 Atmospheric chemistry

C. Hydrographic Measurements - Descriptions, Techniques and Calibrations

C.1 Sampling/measurements equipments

(H.Yoritaka)
September 1996

Small-Volume Sampling	36-place rosettes with 12-liter bottles.
CTD System	SBE-911plus CTD System with altimeter and O2 sensor.
Winch and Cable	Tsurumi Seiki TS-10PVCTD winches having 8000 meters cable of 10.6 mm diameter. The maximum rolling load is 3800 kg x 47 m/minute. ADCP shipboard RD narrow band ADCP at 75 kHz.
Salinometer	Guildline Autosal 8400B with HP 2804A quarts thermometer.
Oxygen Analysis	Carpenter method. Automated potentiometric and photometric titration. Two lags of Metrohm 716 DMS Titrino.
Nutrient Analysis	Bran Luebbe Traacs 800 4 channels systems.
TCO2	UIC Carbon choulometer System 140
pH	RC PHM93 reference pH meter
Alkalinity	RC VIT90 Video Titrator, ABU91 Autoburette and SAM90 Sample Station

C.2 CTD/Rosette hardware

(H.Yoritaka, Y.Kashino, H.Yamamoto, M.Hayashi, K.Katayama and S.Kanda)
September 1996

1. Instruments

SBE9plus CTD for 10,500 meters with the 12-liters 36-positions intelligent GO rosette water sampler (GO1016) was used during the cruise. CTD system was constructed with following sensors ;

Sensor	Model	Primary	Secondary
Temperature	SBE3	S/N 1462	S/N 1465
Conductivity	SBE4	S/N 1045	S/N 1174
Oxygen	SBE13	S/N 0311	
Pressure	Digiquarts	S/N 41223	
Pump	SBE5	S/N 0846	S/N 0847
Altimeter	Bentos 2110-1	DATASONIC	PSA-900A

Temperature and Conductivity sensors were rinsed with fresh water and pure water after each casts, and were rinsed with Triton-X detergent after each two casts.

In each thermometer frames attached on the Niskin bottles for odd number (18 bottles), two SIS digital reversing thermometers and SIS digital reversing pressure meter was fitted. The wire was a single conductor 10.6 mm armored cable manufactured by Rochester Corporation, and the winch was built by Tsurumi Seiki Japan.

2. CTD Sensors Performance

The differences between primary and secondary sensors for temperature and conductivity are shown in Fig.C.2-1. These values are performed with average of differences for 500 db - bottom in raw data at down cast. The differences are within 0.0005 deg.C in temperature. In conductivity, differences are within 0.001 - 0.0015 S/m except for initial drift.

The change of the deck pressure is shown in Fig.C.2-2. While the deck pressure at pre-cast varies within -0.6 - -0.3, it varies within +0.2 - +0.5 at post-cast except for the shallow casts (St.19: 1000db, St. 27: 1500db). The deck pressure had a hysteresis within 0.6 - 1.0 db at the deep casts.

3. CTD Sensor Calibration

The calibrations of the temperature and conductivity sensors were conducted by Northwest Regional Calibration Center, USA on April 1996 (pre-cruise calibration) and on August 1996 (post-cruise calibration). The drift of temperature relative to the pre-cruise calibration during these 4 months was reported to be -1.01 mdeg.C for the primary temperature sensor. This tendency was consistent with previous calibrations. According to this result, the drift for the primary temperature sensor during the cruise was estimated to be -0.5 mdeg.C.

The calibration of the pressure sensor was carried out by ourselves on June 1996 (pre-cruise calibration) and on October 1996 (post-cruise calibration) with dead-weight tester manufactured by Bundenberg Co. Ltd.. Fig.C.2-3 shows difference in pressure between dead-weight tester and CTD calculated with initial coefficients at the factory. Difference between pre-cruise and post- cruise calibration was less than 0.37 db. And hysteresis in each pressure was less than 0.14 db. So the linear coefficient 0.99900 derived from the post- cruise calibration was adopted for correction.

C.3 CTD data processing

Y.Kashino
2 September 1996

Introduction

The CTD data was acquired by SBE 911 plus system with frequency of 24 Hz. This data was processed using SEASOFT Ver 4.207 provided by Sea-Bird Electronics Inc. and some programs developed in JAMSTEC coded in FORTRAN (Microsoft FORTRAN compiler was used).

We report temperature and salinity value from primary sensors, pressure value from pressure sensor in WOCE-CTD-file, although we used twin temperature and conductivity sensors, pressure sensor, and DO sensor. We used the result from secondary sensors to check up one from primary sensors. We don't report the result from DO sensor because we haven't established calibration method of DO-sensor.

We don't also report the data when CTD was near surface (upper than 15 db) because the pump of CTD was not active then.

CTD-file are created using downcast CTD data. We used upcast CTD data for data check and calculation of CTD T/S/P value in WOCE-SEA-file.

Pre-cruise and post-cruise calibration for temperature and conductivity sensors were carried out at NRCC (Northwest Regional Calibration Center) in USA on 23 April 1996 and 31 August 1996. Pre-cruise and Post-cruise calibration for pressure sensor by dead weight tester was carried out at JAMSTEC on 6 June 1996 and 4 October 1996. We check up and calibrated CTD data considering these result.

a. Seagoing computer

We used 3 computer systems for data processing as follows:

(1) System 1 (for data acquisition)
CPU: DECpc 466D2LP (IBM compatible computer, MS-DOS Ver.5)
with 8MB memory, 240MB hard disk and 3.5-inch floppy disk drive.
Optical disk: 3.5-inch and 5-inch optical disk drives.
We used 3.5-inch optical disk during data processing and 5-inch optical disk for backup of raw data from CTD deck unit.
Other: This system is connected with deck unit.

(2) System 2 (for data processing)
CPU: DECpc 466D2LP with 8MB memory, 240Mb hard disk, 3.5-inch floppy disk drive and 5-inch floppy disk drive.
Optical disk: 3.5-inch optical disk drive.
Plotter: Hewlett Packard 7475A Plotter (Paper size is A4)
Hard disk: two 2GB hard disk drives.

(3) System 3 (for data editing)
CPU: NEC PC9821 NA12 (Windows95 with 32MB memory, 1.2GB hard disk, CD-ROM drive and 3.5-inch floppy disk drive.
Optical disk: 3.5-inch optical disk drive.

b. Data processing

(1) General

In order to remove white noise in raw temperature, conductivity and pressure data, we developed software that replaced noise data by running mean. We defined the noise as shown in table C.3-1. Few noises in pressure data over this criteria were detected because of the short period of oscillation (see later).

Shed wakes, which occurred in the case of CTD decent rate being slow or reversal because of the pitch of the ship, were removed using the program developed in JAMSTEC. This program (FDSHDWK) finds shed wakes when CTD decent rate is less than 0.25 m/s and linearly interpolates pressure, temperature and conductivity values in the shed wake using its upper and lower values. If the number of the interpolated values is more than half of the number of observations in some 2db pressure bin, its quality flags of pressure, temperature and salinity should be 6 in CTD file.

After all on-board calibration, uniform pressure CTD profile data was created by same method as one of Millard and Yang (1993).

(2) Temperature

The results of laboratory calibrations for temperature sensors show that CTD temperature sensor tend to drift constantly with time. The difference between twin temperature sensors was almost constant. The result from pre- and post- cruise calibration carried out on 23 April and 31 August shows that the drift of the primary temperature sensor was -0.0010 (deg C). Considering these result, we could estimate that offset correction added to the value of primary temperature sensor was +0.0005 (deg C) during this cruise.

Laboratory calibration carried out on IPTS-68 unit, we converted raw temperature value on IPTS-68 to ITS-90 unit using formula (3) of Millard and Yang (1992) after the offset correction.

(3) Conductivity (salinity) value was corrected as follows:

Step 1. Sensor response correction.

According to Millard and Yang (1993), salinity spikes are caused by sensor response lag between temperature and conductivity. We checked this time lag between T and C sensors for SBE 911 plus system and determined it when total salinity spike area (S) defined as follows was minimum.

$$S = \sum_{i=1}^{N} (PLi - PUi)Hi.$$

N is the number of spike, P is pressure, H is height of spike and suffix U and L mean upper and lower boundary of spike. Fig.C.3-1 is result at the test cast conducted before 8S-01. The results show that time lag should be 0.4 steps, that is, 0.0167 seconds. We used ALIGNCTD of SEASOFT for this correction throughout this cruise.

Even if sensor response correction is done, the salinity spikes still remain. When we find a salinity spike lager than 0.01 PSU in some 2db pressure bin,quality flag of salinity should be 3 in CTD file.

Step 2. Cell thermal mass correction.

Sea-Bird Electronics Inc. recommend that conductivity cell thermal mass effect should be removed. We used CELLTM of SEASOFT to remove this effect.

This utility uses recursive filter described in Lueck (1990).

Step 3. Cell factor correction.

We used Autosal to calibrate CTD conductivity sensor. We determined cell factor by linear regression between CTD conductivity when bottle was fired and conductivity of sampled water measured by Autosal for every casts. CTD conductivity was corrected using the equation as follows:

$$C_{calibrated} = A \text{ x } C_{raw} + B.$$

A and B are slope and offset, respectively.

(4) Pressure

The result of pre-cruise calibration conducted on 4 June by dead weight tester is shown in Fig.C.3-2 . It indicates that the difference between CTD and dead weight tester values was linearly increased. This difference is corrected by regression line with slope and offset of 0.99899 and 5.15870. The error from the approximation using this regression is lower than 0.2 db. The slope and offset shifted to 0.99901 and 4.88735 at 2 October. The estimation of shift of pressure value using these result is 0.3 db between pre-cruise and post-cruise. We do not correct this shift.

The pre- and post-cruise calibration result also showed that hysteresis is 0.1 db. This error is not also corrected.

Raw data from pressure sensor has short period (<0.2 seconds) oscillation. We used FILTER of SEASOFT and filtered this oscillation by low pass filter that time constant was 0.15 seconds.

The variability of deck pressure was shown in Fig.C.3-3. The deck pressure is increased up 0.4 - 1.0 db after cast. CTD pressure value is subtracted by the average of the deck pressure before and after cast.

c. Data flow (See Fig.C.3-4)

(1) SEASAVE (SEASOFT)
Acquires, displays and saves raw data from deck unit to disk.

(2) DATCNV (SEASOFT)
Converts raw, binary data output by SEASAVE to ASCII format data written on physical unit. When water is sampled, this program can output data to .ROS file from that time after a few seconds. (On this cruise, this interval was 10 seconds.)

(3) ROSSUM (SEASOFT)
Edits .ROS file output by DATCNV and writes out a summary file to .BTL file.

(4) BT2FILE (Made in JAMSTEC)
Changes the format of .BTL data to another format for convenience.

(5) SPLDEP (Made in JAMSTEC)
Splits ASCII format data by DATCNV into up- and downcast data, and calculates deck pressure and corrected depth values.

(6) TCCOMP (Made in JAMSTEC)
Compares values of primary and secondary sensors, and plots histograms to check sensor's performance.

(7) NOISE (Made in JAMSTEC)
Finds noise data and replaces it by running mean. This program can remove unnecessary surface data.

(8) ALIGNCTD (SEASOFT)
Corrects time lag between temperature sensor and conductivity sensor for minimizing salinity spiking error.

(9) FILTER (SEASOFT)
Uses low pass filter to remove short period oscillation in pressure data.

(10) CELLTM (SEASOFT)
Corrects conductivity cell thermal effect using a recursive filter.

(11) FDSHDWK (Made in JAMSTEC)
Finds shed wake and interpolates data using the values of its upper and lower boundary.

(12) FSPIKE (Made in JAMSTEC)
Finds salinity spike.

(13) CALBC (Made in JAMSTEC)
Calibrates conductivity data by cell factor correction. This program also corrects the temperature sensor drift and deck pressure of the CTD data reported in WOCE-SEA file.

(14) AVGDAT (Made in JAMSTEC)
Calculates 2db pressure averaged data. After averaging, this program corrects the temperature sensor drift and deck pressure of the CTD data.

(15) MKCTD (Made in JAMSTEC)
Creates WOCE-CTD file.

d. Conclusion

We could acquire high quality CTD data satisfying WOCE requirement except for the bin where salinity spikes and shed wakes were. Estimated accuracy of CTD pressure, temperature and salinity is as follows:

(1) Pressure

Considerable error of CTD pressure value is 1) 0.2 db from regression, 2) 0.3 db from the shift from pre-cruise to post-cruise, 3) 0.1 db from hysteresis, and 4) 0.4 db from deck pressure variability. Therefore, accuracy of CTD pressure value is 1 db during P8S cruise.

(2) Temperature

Accuracy of temperature value should be 0.001 K because the drift of temperature sensor shown by pre- and post-cruise calibration is 0.0010 K, and twin sensor check shows that primary temperature sensor performed satisfactorily.

(3) Salinity

Comparison between CTD salinity and sampled water salinity is shown in Table C.3-2. This result implies that the accuracy of CTD salinity is higher than 0.001 PSU below 500 db.

References

1) Millard,R., and K.Yang: CTD calibration and processing methods used at Woods Hole Oceanographic, Institution, WHOI Tech. Rep. 93-44, 1993.

2) Lueck,R.,: Thermal Inertia of conductivity cell: Theory, J.Atoms.Oceanic Technol., 7, 741-755, 1990.

Table C.3-1. Definition of noise

	Pressure (db)	Temperature (deg C)	Conductivity (S/m)
1. Range	0.5 < or 8000 >	0 < or 32 >	2 < or 8 >
2. Difference from value in a previous step value	1.0 >	0.5 >	0.05 >
3. Difference from running mean			
(a) 0 - 400m	0.5 >	1.0 >	0.1 >
(b) 400 - 1000m	0.5 >	0.2 >	0.02 >
(c) 1000 - 2000m	0.5 >	0.1 >	0.01 >
(d) 2000 - bottom	0.5 >	0.05 >	0.005 >

Table C.3-2. Average, root mean squire and maximum of absolute value of the difference between CTD salinity and Autosal salinity

depth (db)	average (PSU)	RMS (PSU)	maximum (PSU)	No. of sample
0 - 500	-0.00582	0.02771	0.1802	307
500 - 2000	-0.00020	0.00081	0.0046	247
2000 - bottom	0.00014	0.00057	0.0018	325

C.4 Sample water salinity measurements

(H.Yoritaka, A.Ito and M.Hayashi)
September 1996

1. Salinity Sample Collection

The bottles in which the salinity samples are collected and stored are 250ml Phoenix brown glass bottles with screw caps. Each bottles were rinsed three times and filled with sample water. Salinity samples were stored for about 24 hours in the same laboratory as the salinity measurement was made.

2. Instruments and Method

The salinity analysis was carried out by a Guildline Autosal Salinometer model 8400B, which was modified by addition of an Ocean Science International peristaltic-type sample intake pump and Hewlett Packard quartz thermometer model 2804A with two 18111A quartz probes. One probes measured an ambient temperature and another probe measured a bath temperature. The resolution of the quartz thermometer was set to 0.001 deg C. Data of both the salinometer and the thermometer was collected simultaneously by a personal computer. A double conductivity ratio was defined as a median of 31 readings of the salinometer. Data collection was started after 5 seconds and it took about 10 seconds to collect 31 readings by a personal computer.

The salinometer was operated in the airconditioned ship's laboratory at a bath temperature of 27 deg C. An ambient temperature varied from approximately 25 to 26 deg C, while a variation of a bath temperature was almost within +/- 0.004 deg C.

3. Standard Sea Water

Autosal model 8400B was standardized only before sequence of measurements by use of IAPSO Standard Seawater batch P128 whose conductivity ratio was 0.99986. After the standardization, 8400B was monitored by 1-4 SSW ampules before and after the measurements for samples of one station. Total 61 ampules of SSW were measured for monitoring, whose standard deviation was 0.0005 psu. There was slight drift for 8 days (from June 24 to July 1) in monitoring of SSW, so correction was carried out for sample measurements as follows;

- Station 01-15: Corrected Value = Measured Value -0.0000 psu (0 digit)
- Station 16-20: Corrected Value = Measured Value -0.0002 psu (1 digit)
- Station 21-27: Corrected Value = Measured Value -0.0004 psu (2 digits)

After correction, standard deviation for SSW was slightly improved as 0.0004 psu.

4. Duplicate and Replicate Samples

Duplicate samples were drawn from Niskin bottles #1 and #2 which were tripped at the bottom, and also drawn from different Niskin bottles which were tripped at 1000 db in case of shallower water depth than 5000 m. Replicate samples were drawn from Niskin bottles #2. Standard deviation in the measurements of duplicate and replicate samples were as follows ;

Duplicate	Bottom	0.0002 psu	26 pairs
	1000 db	0.0002 psu	4 pairs
Replicate	Bottom	0.0001 psu	25 pairs.

C.5 Dissolved Oxygen determination

(M.Aoki , T.Shiribiki and M.Fujisaki)
19, August, 1996

Methods:

Oxygen samples were collected from Niskin bottles to calibrated dry glass bottles , and sample water were overflowed by three times of the bottle volume. The subsampling bottle consists of the ordinary BOD flask (ca. 200 ml) and glass stopper with long nipple, modified from the nipple presented in Green and Carritt (1966).

Dissolved oxygen in seawater samples were fixed immediately following the water temperature at the time of collection was measured for correction of the sample density. Samples were analyzed about 2 hours later. The end point was determined by the potentiometric method using whole bottle titration. We used 2 sets of Metrohm titrators with automatic burettes and Pt electrode (titrator #1 and #2) for DO. measurements. The average water temperature in the laboratory was 22.8 degC, while room temperature varied in several minutes between 20 to 27 degC.

The standardization was done for each stations and whenever the batch of reagents were changed. An analytical method was fundamentally done according to the WHP Operations and Methods (Culberson,1991). The endpoint was evaluated by the second-derivative curve method with computerization.

Instrument:

Dispenser: Eppendorf Comforpette 4800 / 1000 ul
OPTIFIX / 2 ml
Metrohm Model 725 Multi Dosimat / 20 ml

Titrator: Metrohm Model 716 DMS Titrino / 10ml of titration vessel
Pt Electrode / 6.0403.100 (NC)

Software: Data acquisition / Metrohm, METRODATA / 606013.000
Endpoint evaluation / written by N88BASIC / MS-DOS
(NEC / P9821ne, PC9821na)

Thiosulfate Standardization:

We used 3 batches of KIO3 standard solutions (JM960612, JM960613 and CSK KCP8418: see note below Table C.5-1). Standardization was carried out at each station except for stns. 6, 11, 19 and 26. The results using JM960612 KIO3 solution were that the average of 1.4016 ml (titrator #1) and 1.4038 ml (titrator #2) and standard deviation of 0.0025 ml (#1) and 0.0016 ml (#2) (Fig. C.5-1).

Pure water blanks:

The pure water blanks were determined in deionized water (by Milli-RX12, Millipore). The results of the pure water blanks were that the average of -0.0092 ml (#1) and -0.0093 ml (#2), and standard deviation of 0.0014 ml (#1) and 0.0015 ml (#2) (Fig. C.5-2).

Dissolved Oxygen in the reagents:

DO. in the reagent was reported 0.0017 ml at 25.5 ° C (Murray et. al., 1968). Last cruise, in 1995, we estimated the amount of dissolved oxygen in the reagents that was 0.0027 ml at 21 deg C. In this cruise, we used 0.0027 ml DOrea value for calculation.

Seawater blank:

In this cruise, we analyzed 69 samples for determination of seawater blanks. Most of samples were taken from the layer of 10m, oxygen minimum and bottom at each station. The result shows wide range of blank value and they are not depended on the depth.

Average of seawater blank was 0.08 µmol/Kg and standard deviation (2sigma) was 0.58 µmol/Kg (cf. Fig. C.5-6b). Dissolved oxygen concentrations for the SEA file were not corrected by water blank.

Reproducibility:
In this cruise, 1027 samples were taken for dissolved oxygen measurements. Approximately 14% (148 pairs) of total samples were analyzed as "replicates" taken from same Niskin bottles. And 39 pairs of duplicate samples were analyzed throughout this cruise. Those results are shown in Fig. C.5-3 and Fig. C.5-4.

Replicates sample, 148 pairs, were obtained average of 0.004 umol/kg and standard deviation (2 sigma) of 0.52 µmol/Kg (0.25 % of DO. maximum, 204.1 µmol/Kg, in this cruise). Duplicate sample, 39 pairs, were taken from different Niskin bottles fired at the same depth (26 pairs from the bottom layer, 12 pairs from 1000m and 1 pair from 900m layer). The average difference among them was 0.09 µmol/Kg, and standard deviation (2 sigma) was 0.42 µmol/Kg (0.21% of DO. maximum in this cruise).

Comparison of each standard:
Before the cruise, we compared each standard. The results are shown in Table C.5-1.

Table C.5-1. Comparison of each standard.

KIO3 Lot No.	Normality	average titer	std.	cv %	n	Ratio to CSK Std.
CSK KCP8418	0.0100	1.396 (ml)	0.001	0.05	5	1.0000
JM960612	0.010014	1.397 (ml)	0.001	0.06	5	0.9997
JM960613	0.010014	1.398 (ml)	0.001	0.07	5	1.0005
CSK AMP8047	0.0100	1.396 (ml)	0.000	0.03	5	1.0000

Note: CSK KCP8418 and AMP8047 are the commercially standard solution prepared by Wako pure chemical industries, Ltd. (Guaranteed by Chemical Research Center)

Comparison of standards from other institution:
In this cruise we compared 2 types of standard solution. One is JM which had prepared before this cruise and the other is HDJ (Hydrographic Department, Maritime Safety Agency, Japan) which had been stored since 1994. Standard solution named JM960602 and JM960612 were prepared before this cruise but JM960602 had been weighed in Nov. 1993. The standard solution labeled HDJ02 was stored under the room temperature, but HDJ03 was in a refrigerator either HDJ04 was. Standard HDJ04 was diluted from nominal concentration 0.1 N to 0.01 N before the cruise. We measured these standards on board using the same titration system and reagents. The results are shown in Table C.5-2.

Table C.5-2. Comparison of standards between JAMSTEC and HDJ.

KIO3 Lot No.	Normality	average titer	std.	cv%	n	Ratio to JM960612
JM960602	0.010034	1.402	0.0026	0.19	6	1.0008
HDJ02	0.0100	1.392	0.0009	0.07	5	0.9967
HDJ03	0.0100	1.392	0.0008	0.05	5	0.9970
HDJ04	0.00998	1.405	0.0005	0.04	5	1.0078
JM960612	0.010014	1.398	0.0008	0.06	5	1.0000

Comparison with historical data:

This P8S cruise line and PR1S cruise line which carried out in 1994 were lined along longitude 130E. There were 14 stations in the same latitude on this line. Dispensers, except for the Eppendorf, and electrodes were changed between these 2 cruises.

DO. concentration

Table C.5-3 shows the differences of dissolved oxygen concentration between P8S and PR-1S every 1000m below 3000m. The difference between them are obtained to 0.2 - 0.5% of DO.

Table C.5-3. Comparison of DO. concentration between PR-1S and P8S.

Range	PR-1S,1994		P8S, 1996		Ratio of difference
(m)	µmol/kg	std.	µmol/kg	std.	to DO. in 1994(%)
3000 - 4000	148.3	3.23	147.5	3.40	-0.5
4000 – 5000	151.7	0.87	152.0	0.82	0.2
5000 -	151.7	0.88	152.5	0.40	0.5

Note: DO. concentrations are the average within a range. of Those data are not corrected by seawater blank.

For example, Fig. C.5-5a and C.5-5b show the differences of profile at the same latitude. DO. concentrations above 1000m may show the replace of the water mass.

Seawater blank

We measured seawater blanks from some layers at each station both in 1994 and 1996 cruises. The results are shown in Table C.5-4. In both cruise, the values of seawater blank varied independently of their sampling depth. The methods of analyses were almost the same as for seawater samples but no fixation.

Table C.5-4. Comparison of seawater blank calculated to DO. concentration.

Line name	seawater blank umol/kg	std.	n
PR-1S, 1994	1.09	0.64	55
P8, 1996	0.08	0.29	69

References:

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C.6 Nutrients measurements

(Y.Nogiwa, K.Nakao, N.Komai and C.Saito)
July, 1996

a. Equipment and techniques

The nutrients analyses were performed on BRAN+LUEBBE continuous flow analytical system Model TRAACS 800 (4 channels). The manifolds for the analysis are shown in Fig. C.6-1, -2, -3 and -4 for the nitrate+nitrite, nitrite, silicate and phosphate, respectively. TRAACS 800 was located in the container laboratory on deck the R/V Kaiyo.

The methods used were as follows:

1st channel

Nitrate+Nitrite: Nitrate in seawater is reduced to nitrite when a sample is run through a cadmium tube (1 mm diameter, 10 cm length) inside of which is coated with metallic copper. The nitrite produced is determined by diazitizing with sulfanilamide and coupling with N-1-naphthyl-ethylenediamine (NED) to form a colored azo dye which is measured spectrophotometrically at 550 nm using 3 cm length cell. Nitrite initially present in the sample is corrected. Since the reduction rate was varied from 92 to 97 %.The reduction rate was measured for each analysis and the concentration of nitrate was corrected by reduction rate.

2nd channel

Nitrite: The nitrite is determined by diazitizing with sulfanilamide and coupling with N-1-naphthyl- ethylenediamine (NED) to form a colored azo dye which is measured spectrophotometrically at 550 nm using 5 cm length cell.

3rd channel

Silicate: The standard AAII molybdate-ascorbic acid method with the addition of a 46 deg C heating bath to reduce the reproducibility problems encountered when analyzing samples at different temperatures. The silicomolybdate produced is measured spectrophotometrically at 630 nm using 3 cm length cell.

4th channel

Phosphate: The method of Murphy and Riley (1962) was used, but separate additions of ascorbic acid and mixed molybdate-sulfuric acid-tartrate and addition of a 46 deg C heating bath. The phosphomolybdate produced is measured spectrophotometrically at 880 nm using 5 cm length cell.

The analytical results were corrected for base drift, carry over effect and gain drift. The concentrations of nitrate+nitrite,nitrite, silicate and phosphate were calculated by 2nd order polynomial curve fitting. The temperature of all sample seawater at the analyses was measured and recorded. The temperature of the sample seawater during this cruise ranged from 16 deg C to 26 deg C depending on duration of analysis and ambient temperature.

b. Sampling Procedures

Sampling for nutrients followed that for oxygen. Samples were drawn into polyethylene 100 ml narrow mouth,screw-capped bottles. These were rinsed two to three times before filling. Most of the samples were analyzed within 4 hours after collection. Glass 7 ml sample cups were used .Glass cups were washed in the hot detergents, they were rinsed by deionized water, and kept in deionized water before packing. These were rinsed two times before filling with analyze.

c. Calibration

The calibration of all the volumetric flasks used on the cruise were checked before packing. Calibration of the 3 Eppendorf micropippettes used during the cruise were checked before packing. The temperature during the calibration ranged from 21 to 23 deg C.

d. Nutrient standard

We prepared nutrient standards by following an suggested protocol for continuous flow automated analysis of seawater nutrients by Gordon et.al (1992). Nutrient primary standards of nitrate, nitrite and phosphate were prepared from salts dried in oven/microwave oven and cooled over silica gel in a desiccator before weighing. The dry powder for the primary standard was packed in the nitrogen gas atmosphere. The precision of the weighing was ca. 0.1 %.

Silica standard (one gram of $SiO2$ in plastic ampule, comm No. 4790) prepared by J.T. Baker Chemical Co. was used to prepare the standard solution of silicate analysis during this cruise.

The concentration of A standard are 2500 µM for phosphate, 37500 µM for nitrate and 3800 µM for nitrite, and 33286.6 µM for silicate. The concentration of B standard are 50 µM for phosphate, 750 µM for nitrate and 38 µM for nitrite,and 2662.9 µM for silicate. A and B uniform set of six mixed working standards were prepared in low nutrients sea water (LNSW). Concentrations (umol/l) were: nitrate 45.0, 37.5, 30.0, 15.0, 7.5 and 0 ; nitrite 1.2, 1.0, 0.8, 0.4, 0.2, and 0; silicate 162, 135 ,108, 54, 2.7 and 0 ; phosphate 3.0 ,2.5, 2.0, 1.0, 0.5 and 0 thereafter.

e. The traceability of the standard

Two sets of A standards were prepared at the beginning of the cruise. One of two was used for 15 of working standard during the cruise. The other was stocked as reference A standard to be checked the working standard. The results of this check are shown in Table C6-1.

f. The comparison between working standard solution and CSK standard solution at full scale.

The comparison between working standard solution and CSK standard solution at full scale were made three times before the cruise and once after cruise onborad.

g. Low nutrient sea water

More than 200 liter of surface seawater was collected in JUNE1995 near Palau Is. as low nutrient seawater (LNSW). Collected seawater was stored in the 20 liter container and filtered with 0.45 µm pore size membrane filter (Millipore HA) and subjected to prepare the working standard solution. The concentration of nutrients in each batch of LNSW were determined carefully.

h. Experiment for preparation of Control sample

Control samples were prepared to confirm traceability in the nutrients measurements during the cruise and examined the availability of it.

Method of control samples were:

Sea water (31°N, 133°E, 2500 m) was sterilized heating at 120 deg C for 30 minuets twice after it had been filtered with 0.45µm (Millipore HA) and 0.22µm (MILLIPACK 40) pore size membrane filter. Then the sea water was drawn into sterilized 100ml polypropylene bottles under aseptic condition over filtering with 0.22μm pore size membrane filter again. We confirmed that the control samples condition were free from bacteria and fungi. The 37 control samples were measured. One each analysis,one more bottle control samples were analyzed five times a bottle. The measurement results are in table C.6-4

i. Precision check at each station

On each analysis, one of the deep water sample and one of the shallow water sample were analyzed five times to get the precision, respectively. The precision at full scale at each station were shown in Table C.6-5.

j. Replicate and Duplicate Samples

There were 27 pairs of replicate and duplicate samples drawn. We drawn 2 samples from the Niskin bottles tripped at the bottom for a replicate and 1 sample from another Niskin bottle tripped at the bottom for a duplicate.

The standard deviation of 27 pairs of replicate and duplicate samples were 0.0005 PSU.

Table C.6-1. The concentration ratio of working standard solutions referenced to stocked A standard solution.

Date	Nitrate	Nitrite	Silicate	Phosphate
19 June '96	1.008	1.008	1.006	0.995
1 July '96	0.997	1.017	1.006	1.009

Table C.6-2.The comparison between working standard solution and CSK standard solution at full scale.

Date	Nitrate	Nitrite	Silicate	Phosphate
19 June '96	1.004	0.981	1.025	1.071
21 June '96	1.007	1.004	1.018	1.039
22 June '96	0.994	0.918	1.030	1.027
1 July '96	1.002	0.920	1.018	0.995

The puerility of the nitrite standard solution prepared in this cruise is determined to be 96.6% .

Table C.6-3 The nutrients concentration of LNSW.

Batch No.	Station No.	Nitrate	Nitrite	Silicate	Phosphate (μM/l)
3	1-4	0.000	0.000	1.125	0.004
6	5-9	0.000	0.000	1.151	0.000
4	12,13,	0.000	0.006	1.285	0.018
	18-22				
7	10,11	0.000	0.003	1.133	0.000
	14-17				
8	23-27	0.000	0.008	1.142	0.028

Table C.6-4 Results of control samples measurement.

	Nitrate	Nitrite	Silicate	Phosphate
Mean (μM/Kg)	26.91	0.54	140.63	2.05
STD	0.15	0.01	0.75	0.04
CV(%)	0.55	1.31	0.53	1.81
N	185	185	180	180

Table C.6-5 Precision at full scale at each analysis.

Station No.	Nitrate CV(%)	Silicate CV(%)	Phosphate CV(%)
1	0.28	0.17	0.60
2	0.41	0.10	0.21
3	0.19	0.26	0.26
4	0.18	0.12	0.32
5	0.19	0.27	0.70
6	0.24	0.18	0.29
7	0.07	0.30	0.53
8	0.18	0.18	0.51
9	0.20	0.22	0.45
10	0.11	0.17	0.46
11	0.13	0.23	0.35
12	0.42	0.21	1.22
13	0.08	0.10	0.26
14	0.12	0.50	0.21
15	0.20	0.11	0.40
16	0.32	0.15	0.21
17	0.26	0.16	0.28
18	0.22	0.17	0.71
19	-	-	-
20	0.28	0.27	0.24
21	0.16	0.36	0.96
22	0.18	0.18	0.92
23	0.18	0.19	0.63
24	0.15	0.25	0.38
25	0.21	0.09	0.61
26	0.28	0.34	0.27
27	0.21	0.10	0.49

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C.7 Distribution of oceanic CO_2, pH and TA

(K.Shitashima, D.Tsumune and S.Kraines)
September 1996

1. DESCRIPTION OF METHODS

pH

Sea water samples were collected in 100ml polyethylene bottles with inner caps from Niskin-type water samplers, The sample bottles were capped after an overflow of about 100ml sea water. All samples were stored at room temperature after sampling and analyzed within a few hours. Samples were transferred into a closed and jacketed glass measurement cell with a volume of ~30ml. The cell temperature was maintained at a constant temperature of 25C+/-0.1C. The electric potential and temperature of the sample were measured for 10 minutes with a Ag/AgCl combined electrode (Radiometer

Analytical A/S, GK2401C) and a temperature sensor (Radiometer Analytical A/S, T901) connected to a high precision pH meter (Radiometer Analytical A/S, model PHM93). Tris and 2-Aminopyridine Buffers (Dickson and Goyet, 1994) were employed to calibrate pH electrodes. Calibrations were made at the beginning, middle and end of set of measurements for every station.

Total Alkalinity

Total Alkalinity samples were collected in 250ml polyethylene bottles with inner caps from Niskin-type water samplers, and capped after an overflow of about 150ml of the sea water. All samples were stored at room temperature after sampling and analyzed within a few hours. Samples were transferred into a glass titration cell using a 50ml transfer pipette and titrated at 25C+/-0.1C with 0.1 M HCl containing 0.6M NaCl within 10 min. The electric potential and temperature of the sample were followed with a Ag/AgCl combined electrode (Radiometer Analytical A/S, GK2401C) and a temperature sensor (Radiometer Analytical A/S, T901) connected to a TitraLabTM (Radiometer Analytical A/S) system. The titration was controlled automatically and the titration curve was analyzed with the inflection point titration method by the system. The precision of the method was determined to be 0.0043mmol/kg (n=17) from replicate analysis of the Certified Reference Solutions (CRMs (batch 32) supplied by Dr. Andrew Dickson of Scripps Institution of Oceanography (SIO)). Standardization of the titrant (0.1 M HCl) was accomplished with Na2CO3 (99.99% pure; Asahi Grass) standards.

Total dissolved inorganic carbon (T-CO2)

The T-CO2 concentration in seawater samples were determined by using the coulometric titration system (UIC Inc., Carbon Coulometer model 5011) described by Jhonson et al. (1985) with the modified CO2 extraction system described by Shitashima et al. (1996). A schematic diagram of our system is shown in Fig.C.7-1. Samples for T-CO2 analysis were drawn from the Niskin samplers into 125ml glass vial bottles after an overflow of about 100ml of the sea water. The samples were immediately poisoned with 50ul of 50% saturated HgCl2 in order to restrict biological alteration prior to sealing the bottles. All samples were stored in a refrigerator before measurement, and were analyzed within 12 hours of collection.

Seawater was introduced manually into the thermostated (25C+/-0.1C) measuring pipette with a volume of ~30ml by a pressurized headspace CO2-free air that had been passed through the KOH scrubber. The measured volume was then transferred to the extraction vessel. The seawater sample in the extraction vessel was acidified with 1.5 ml of 3.8% phosphoric acid and the CO2 was extracted from the sample for 10 minutes by bubbling with the CO2-free air. After passing through the Ag2SO4 scrubber and polywool to remove sea salts and water vapor, the evolved CO2 gas was continuously induced to the coulometric titration cell by the stream of the CO2-free air. All reagents were renewed every day.

The T-CO2 concentration in seawater was calculated using a calibration carve constructed by measuring five to six different concentration of dissolved Na2CO3 (99.99% pure; Asahi Grass) used as a standard solution (Dickson and Goyet, 1994). The precision of the T-CO2 measurements was tested by analyzing CRMs (batch 32) at the start of the measurement of samples every day. Fig.C.7-2 shows a comparison between the results of our shipboard measurements of these CRMs during the cruise and certified values provided by Dr. Andrew Dickson. Our shipboard measurements yielded a mean value of 1995.6+/-2.8 umol/kg (n=40), which compares with 1997.6+/-1.4 umol/kg (n=9) certified by SIO. We also prepared and analyzed sub-standards that were bottled into 125ml glass vial bottles from a 201 bottle of filtered and poisoned offshore surface water in order to check the condition of the system and the stability of measurements every day. The resulting standard deviation form replicate analysis of 19 sub-standards was +/-1.8 umol/kg.

2. PRELIMINARY RESULTS

Fig.C.7-3 shows the vertical distributions of pH, Total-Alkalinity and T-CO2 concentration at 1 degree intervals between 10N and 1N along 130E. The fluctuation of the vertical distributions of Total-Alkalinity at some of the stations was caused by electrical problems with the onboard measurement. The T-CO2 maximum layer at each station gradually deepened towards the north. This trend suggests that this layer represents the northward flowing of the Philippine Sea bottom water.

3. REFERENCES

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C.8 Tracers

(C.Saito and N.Harada)
6 September 1996

C-14

All samples were drawn from 12 liter Niskin bottles followed that for oxygen or TCO2. Samples were drawn into glass vials of ca. 200 ml. These were rinsed before filling and overflowed by two to three times of the vial volume. Then 50 mg of saturated HgCl2 solution was added and subsequently rubber cap and aluminum cap were clamped to vials.

Duplicate samples were drawn from the same rosette bottle at all sampling depths. Sampling stations were 1, 4, 7, 9, 11, 13, 15, 18, 22 and 26. The sampling depths of radiocarbon samples shallower than 1000 meters were 30, 50, 100, 200, 300, 400, 500, 800, 1000. Below 1000 meters the sampling interval was 500 meters.

Helium

Samples were transferred the first from Niskin bottle to the copper tube using a gravity feed technique through lengths of plastic tubing. We followed helium sampling procedure by WOCE manual (Jenkins et al., 1991). The seal was made by crimped to form a pressure welded seal. Helium sampling stations were same as radiocarbon sampling site but those layers were very few.

Tritium

Sampling bottles for tritium were baked for a few hours at about 180 C. The inside of this bottle was sealed with argon gas. Sea water sample was introduced into the bottle with a plastic tubing. The bottle was filled within a few centimeters of the top and head space was retained. The cap of ground joint glass bottle was immediately replaced and taped. Tritium sampling stations and depths were same as radiocarbon sampling.

References

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C.9 Weather and sea condition

(S.Ishida, Captain of R/V KAIYO and Nyoshioka)
September 1996

Weather condition was very good through our cruise, as it was covered by the North Pacific high pressure, Any typhoon nor developing low pressure were not appeared around eastern part of the tropical Pacific area on the duration of our cruise. Accordingly, any strong swell nor waves did not disturb our CTD and Rosetta casting operations.

C.10 Problems

(Y.Kashino)
2 December, 1996

As described in A.5, the damage on a fiber of armored-wire of CTD cable occurred during this cruise. Because of this accident, we must slow CTD decent rate at irregular winding after st.12. This effected not only the time schedule but also the quality of CTD data because of increase of shed wakes. The rate of bad data detected changed from 8.8% to 11.1 % before and after this accident.

D. Acknowledgements

(N.Yoshioka)
September 1996

We would like to great acknowledge for contribution of many scientist and technicians, who joined to this cruise from their institution or company. We also would like to greatly thanks for helpful supports by the captain Ishida and the crew on R/V KAIYO. Technics for water sampling, chemical analysis and CTD data processing were totally taken over from previous KAIYO cruises (WOCE-PR1S and PR24 in 1994, PR23 and PR24N in 1995). We would like to great thanks to Mr.Michio Aoyama and Mr.Takeshi Kawano who developed these techniques and constructed the accuracy control system on R/V KAIYO.

The WOCE cruise and publication of this data report were all supported by Tropical Ocean Climate Study (TOCS) conducted by the JAMSTEC, which has been funded by the Science and Technology Agency (STA), JAPAN.

E. References (see each section)

F. Appendices

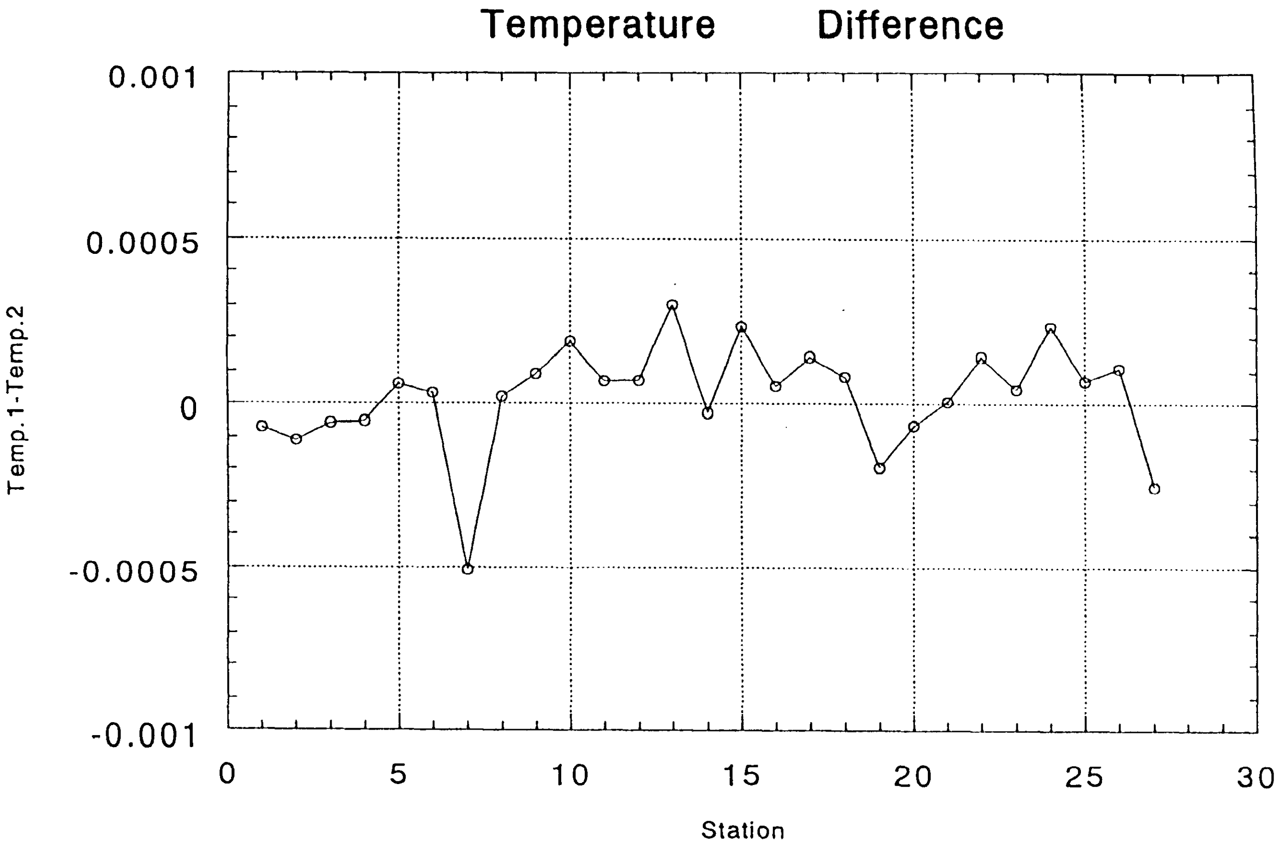


Fig.C.2-1a The differences between primary and secondary sensors for temperature and conductivity. These values are performed with average of differences for 500 db - bottom in raw data at down cast. The differences are within 0.0005 deg.C in temperature. In conductivity, differences are within 0.001 - 0.0015 S/m except for initial drift.

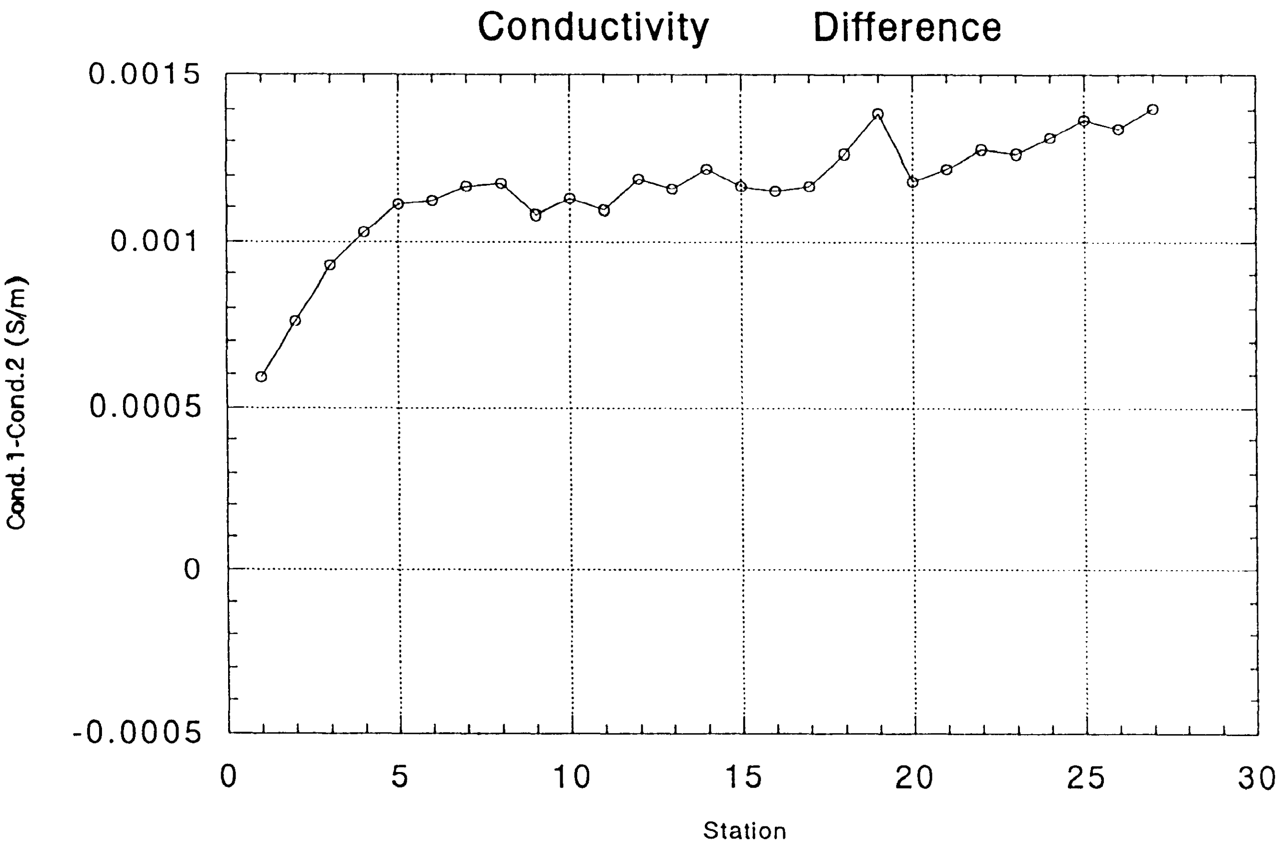


Fig.C.2-1b The differences between primary and secondary sensors for temperature and conductivity. These values are performed with average of differences for 500 db - bottom in raw data at down cast. The differences are within 0.0005 deg.C in temperature. In conductivity, differences are within 0.001 - 0.0015 S/m except for initial drift.

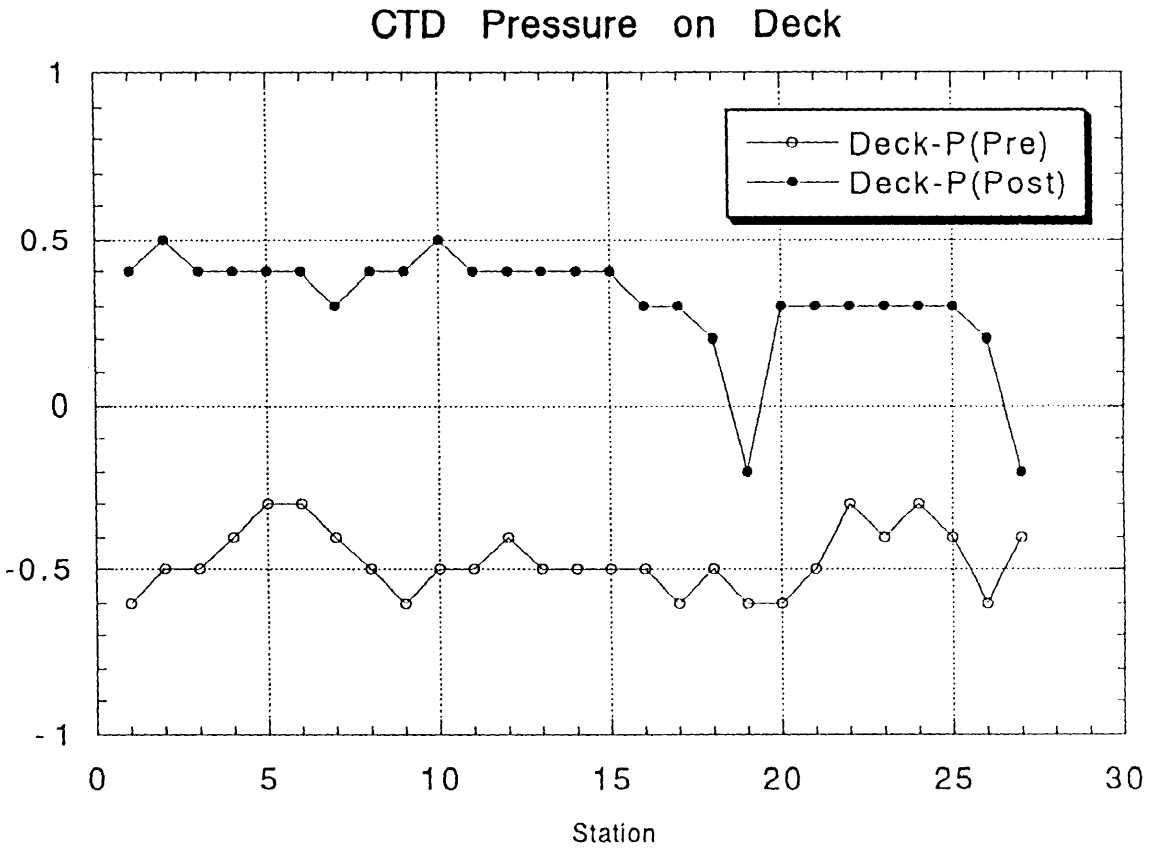


Fig.C.2-2 Change of deck pressure. While the deck pressure at pre-cast varies within -0.6 - -0.3, it varies within +0.2 - +0.5 at post-cast except for the shallow casts (St.19: 1000db, St. 27: 1500db). The deck pressure had a hysteresis within 0.6 - 1.0 db at the deep casts.

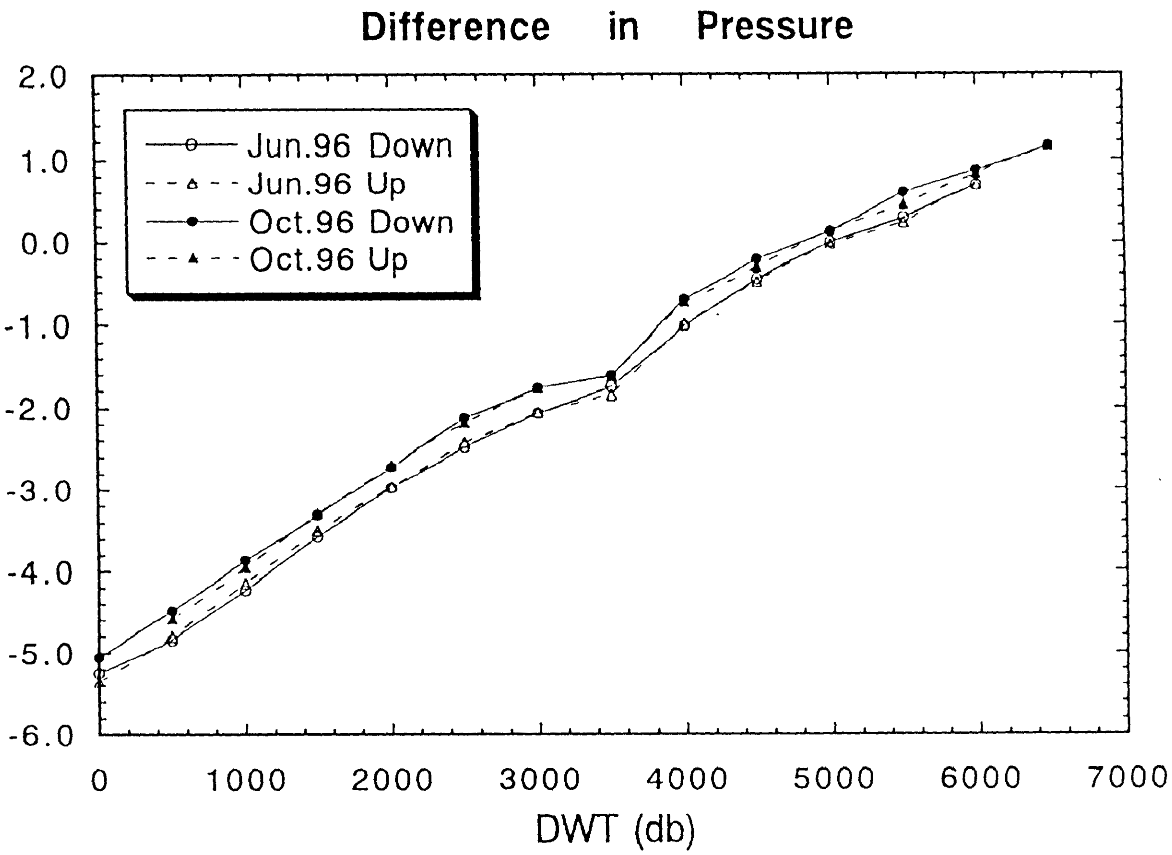


Fig. C.2-3 Laboratory calibration in pressure, at pre-cruise and post-cruise.

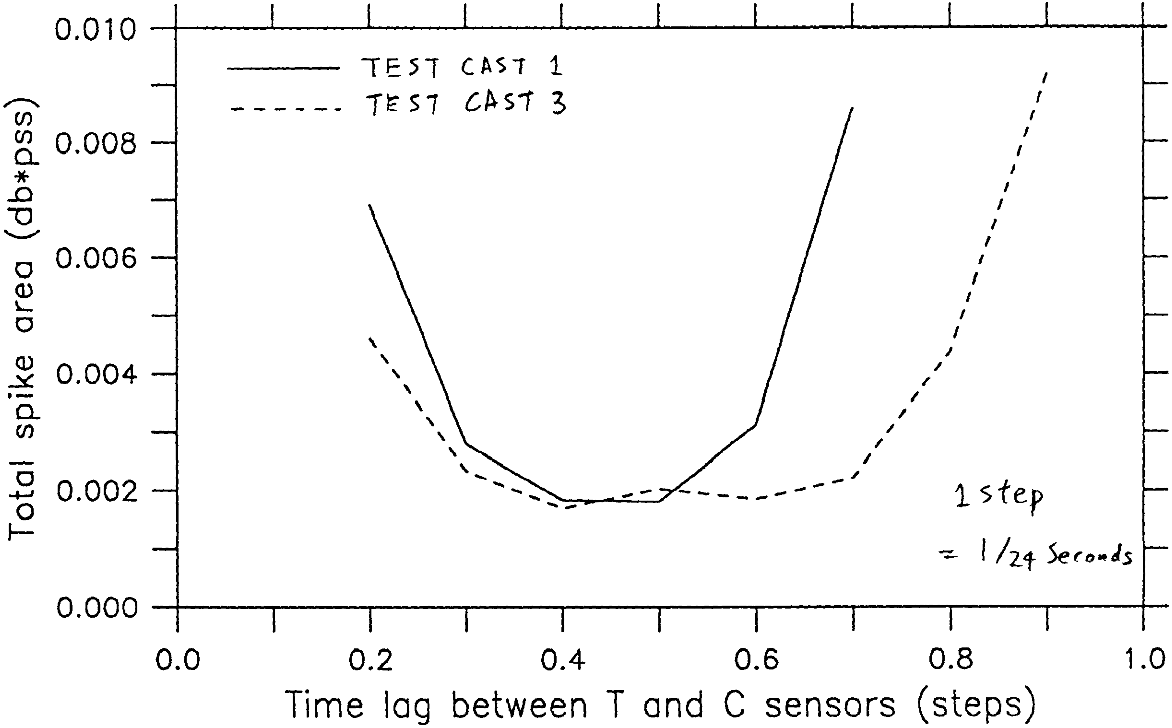


Fig.C.3-1 Total salinity spike area variability for time lag between T and C at the test cast 1 (solid line) and 3 (broken line).

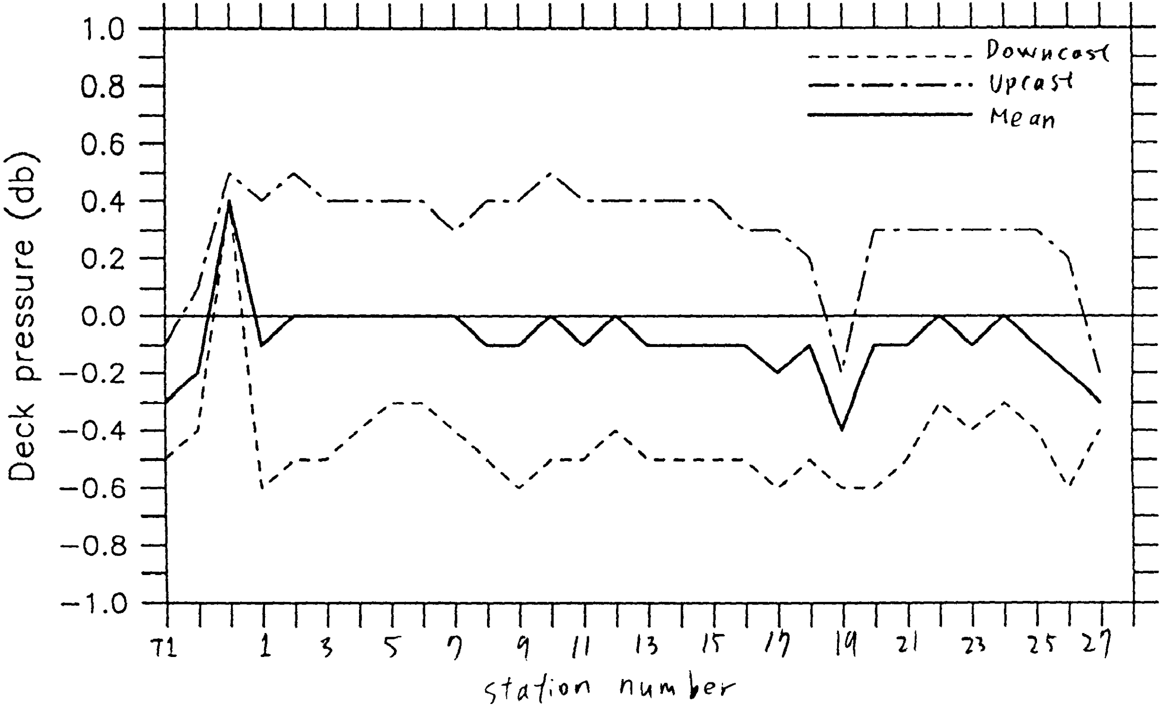


Fig.C.3-2 Deck pressure variability during P8S cruise.

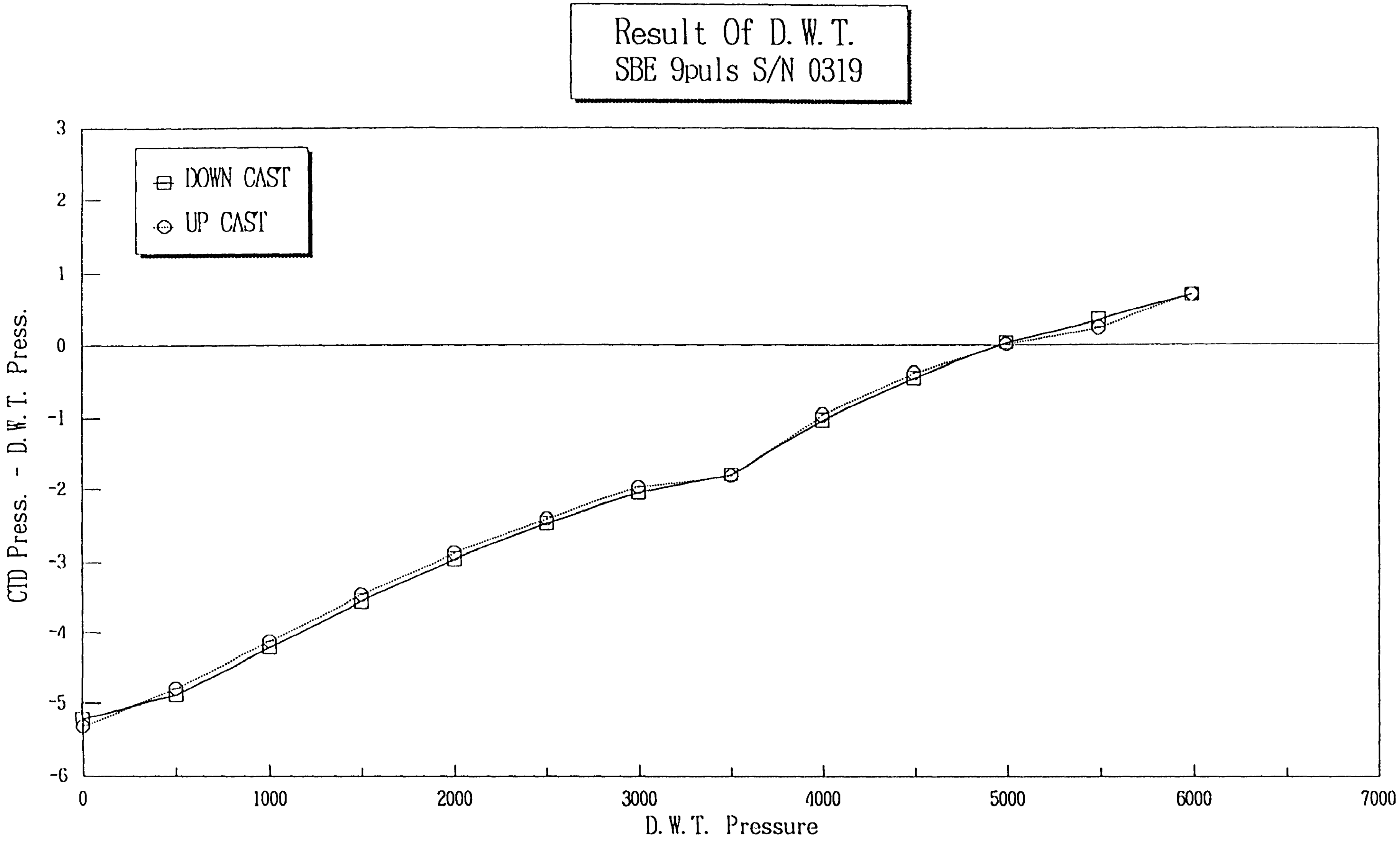
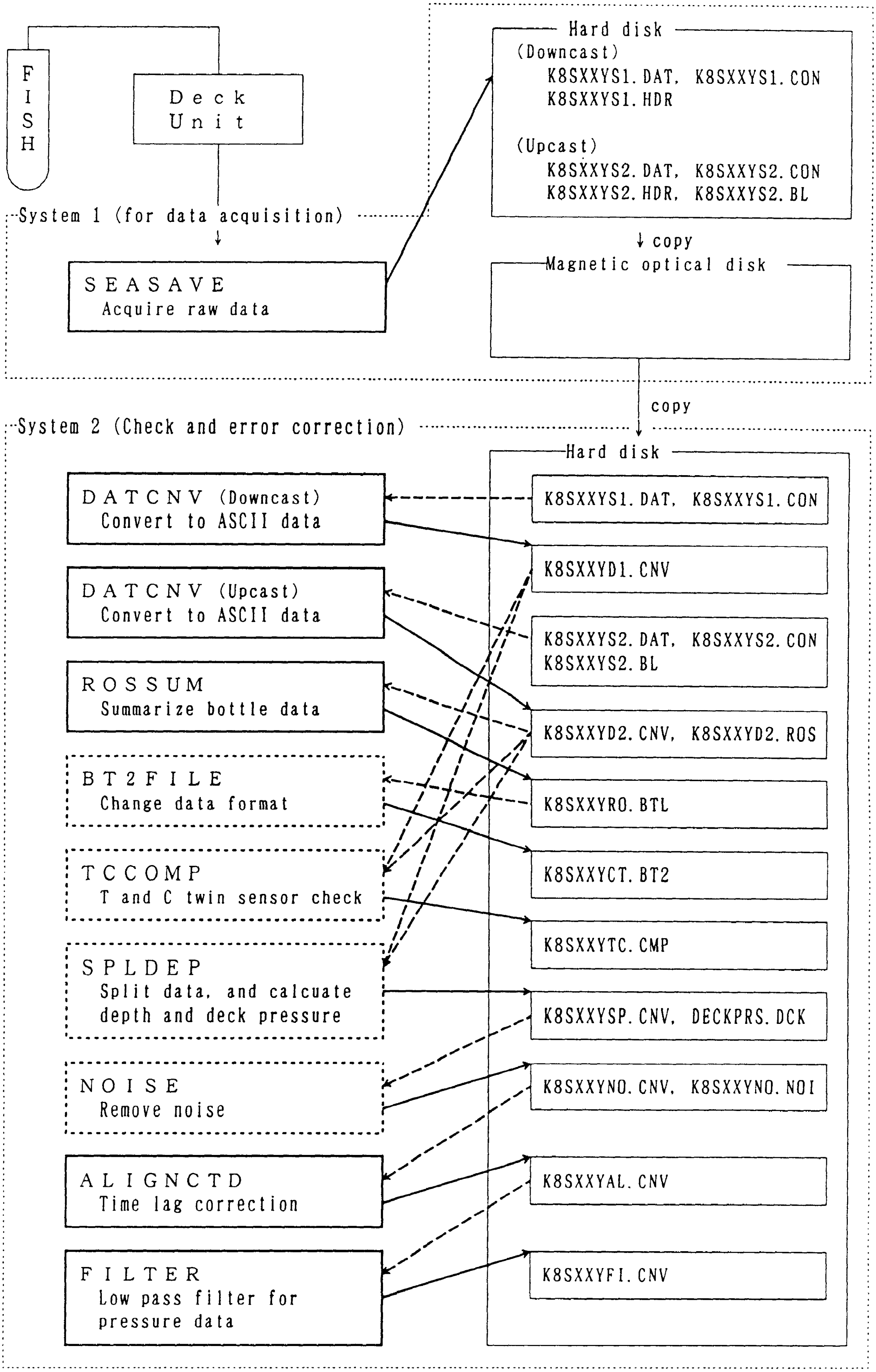
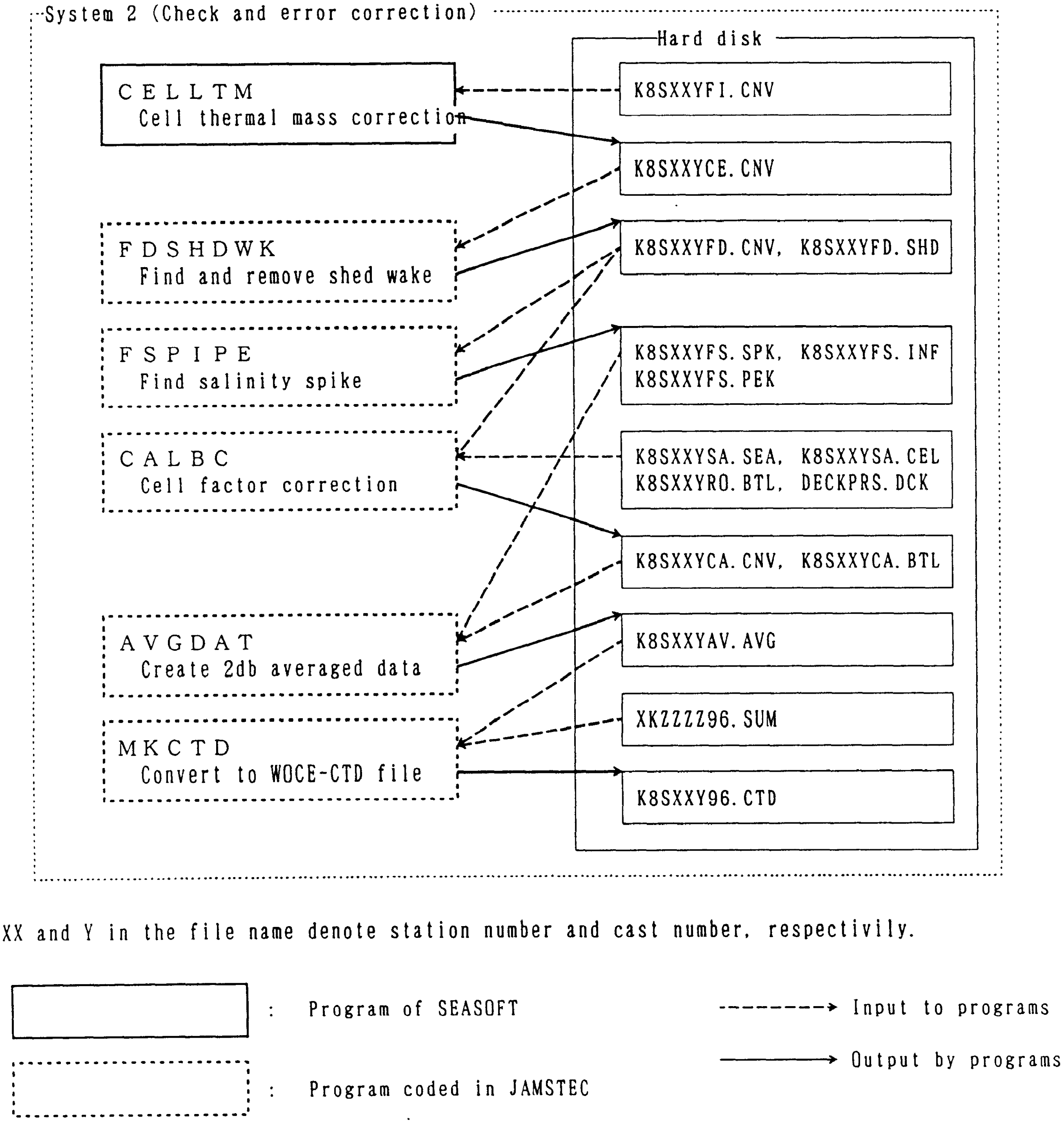


Fig.C.3-3 Result of pressure sensor calibration using a dead weight testor.

Fig.C.3-4 Data flow of CTD data processing.





XX and Y in the file name denote station number and cast number, respectivily.

Fig. C.3-4 Data flow of CTD data processing (continued).

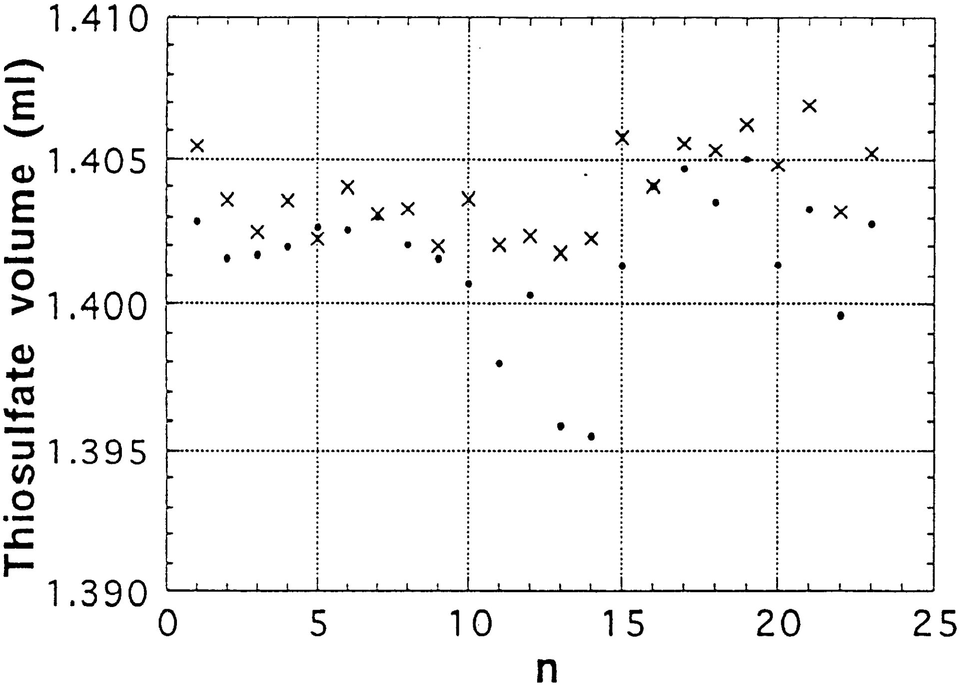


Fig. C.5-1 Results of thiosulfate standardization. Dot shows titrator #1 and cross shows #2.

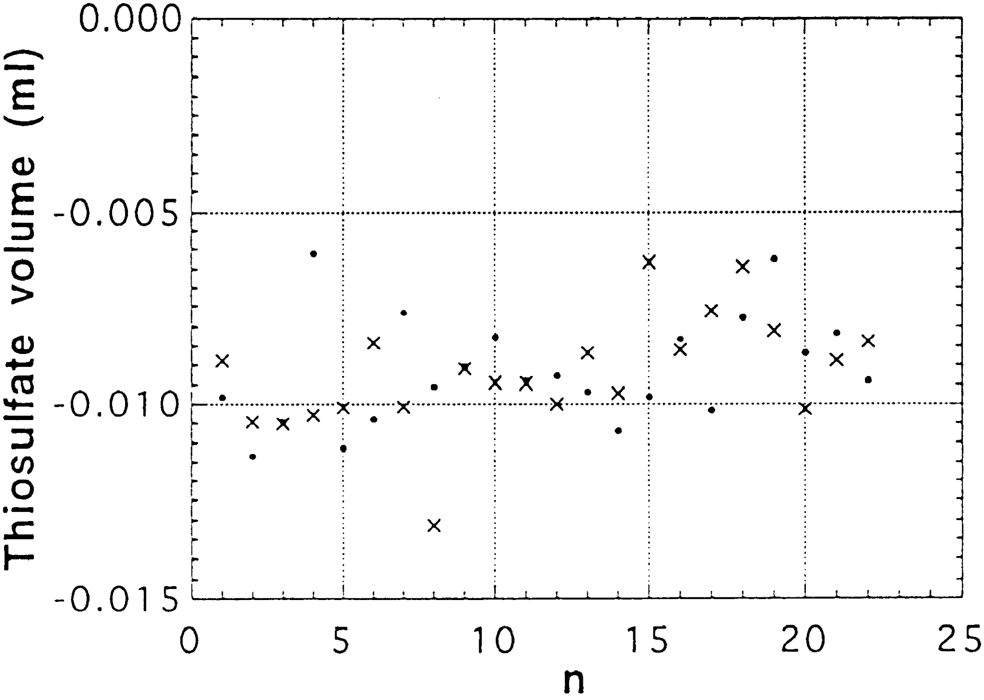


Fig. C.5-2 Results of purewater blank with KIO3 standard solution JM960812. Dot shows titrator #1 and cross shows #2.

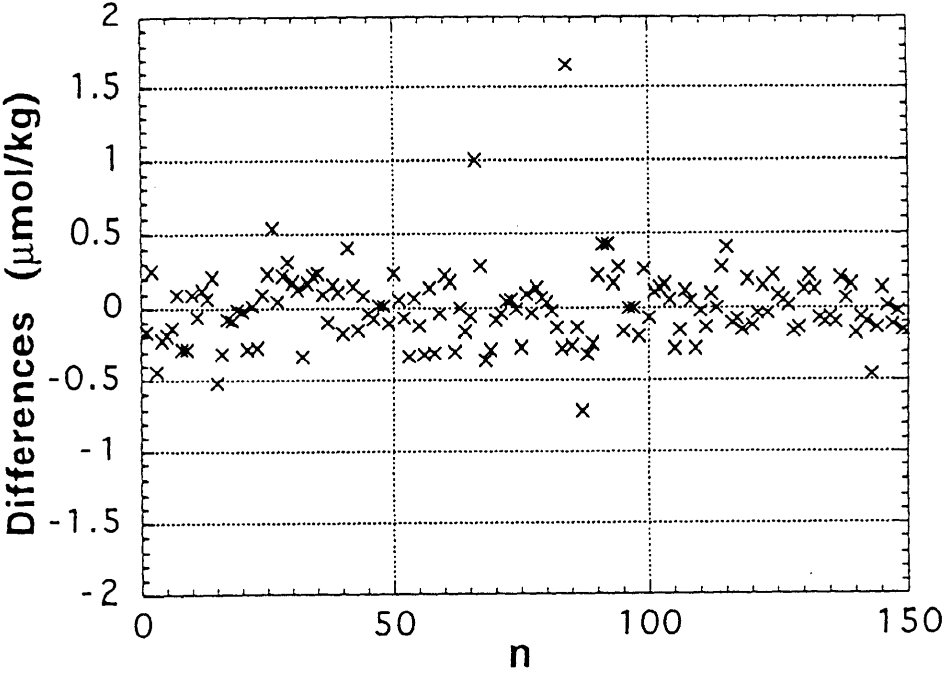


Fig. C.5-3 Differences between "Duplicate" samples.
average = 0.009µmol/kg,
std (2s) = 0.42µmol/kg, 0.21% of D.O. max.

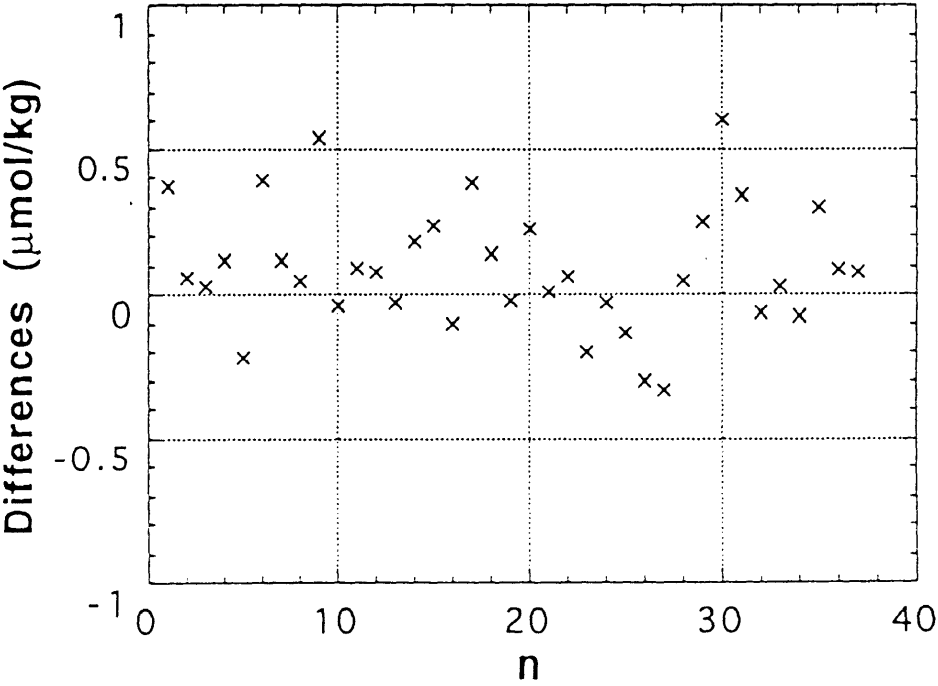


Fig. C.5-4 Differences between "Duplicate" samples.
average = 0.009μmol/kg,
std (2s) = 0.42μmol/kg, 0.21% of D.O. max.

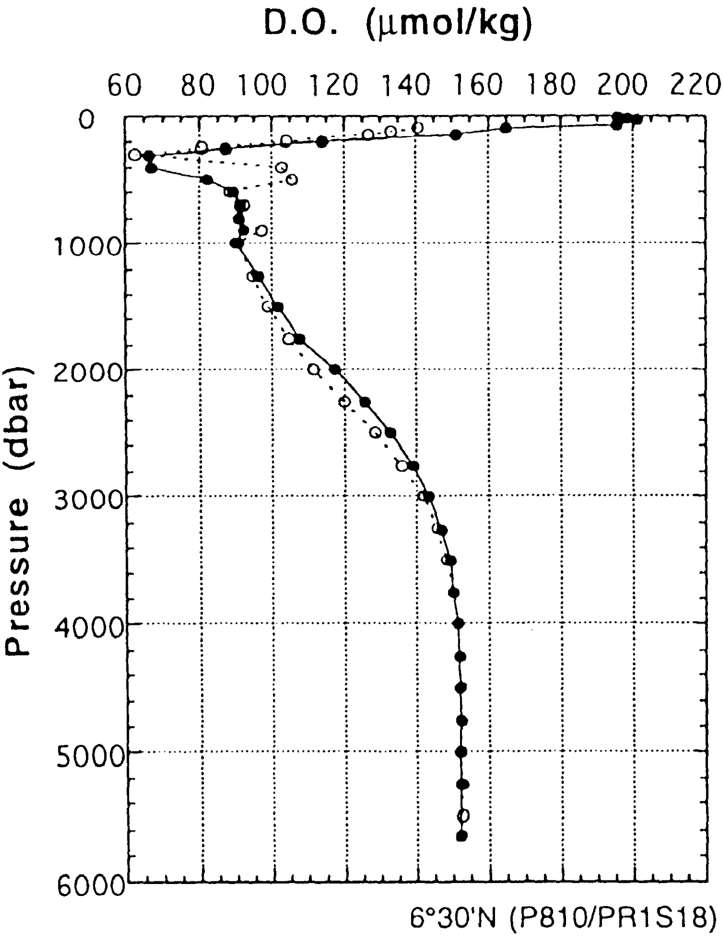


Fig.C.5-5a Profile of D.O. concentrations at 6°30'N. Solid circle shows the results in 1996 and open circles is in 1994.

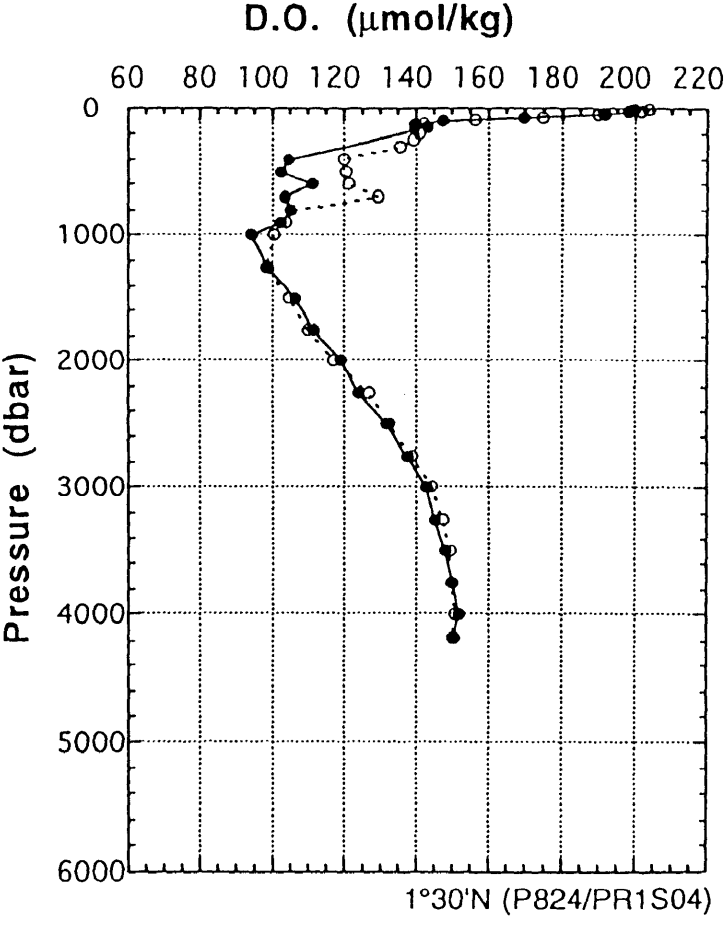


Fig.C5-5b Profile of D.O. concentrations at 1°30’N

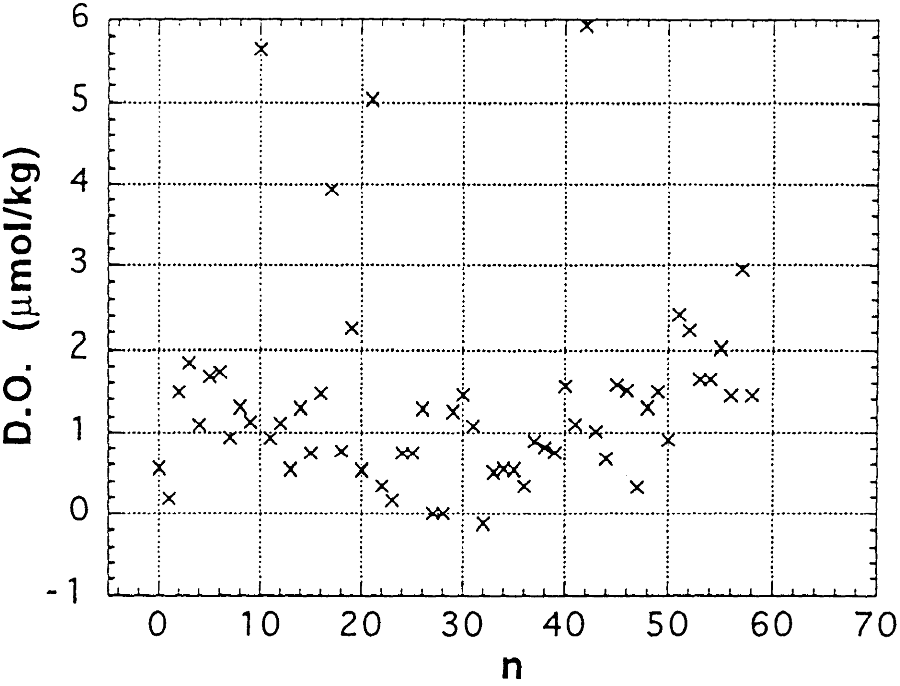


Fig.C.5-6a Seawater blanks in PR-1S, 1994. average = 1.09 μmol/kg, std = 0.0.64 μmol/kg.

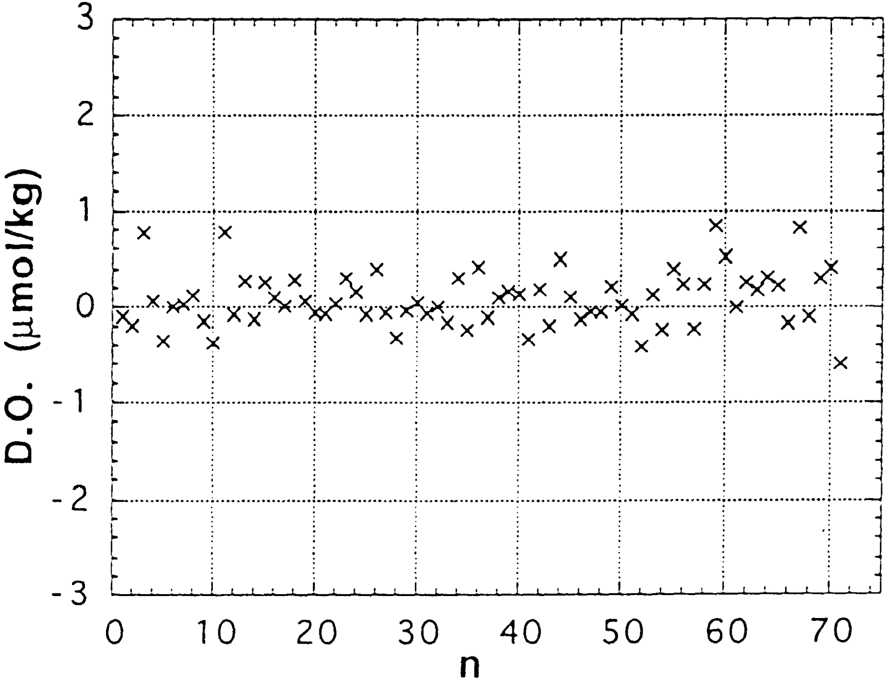


Fig.C.5-6b Seawater blanks in P8S, 1996.
average = 0.08 µmol/kg, std = 0.29 µmol/kg

(ch.1)

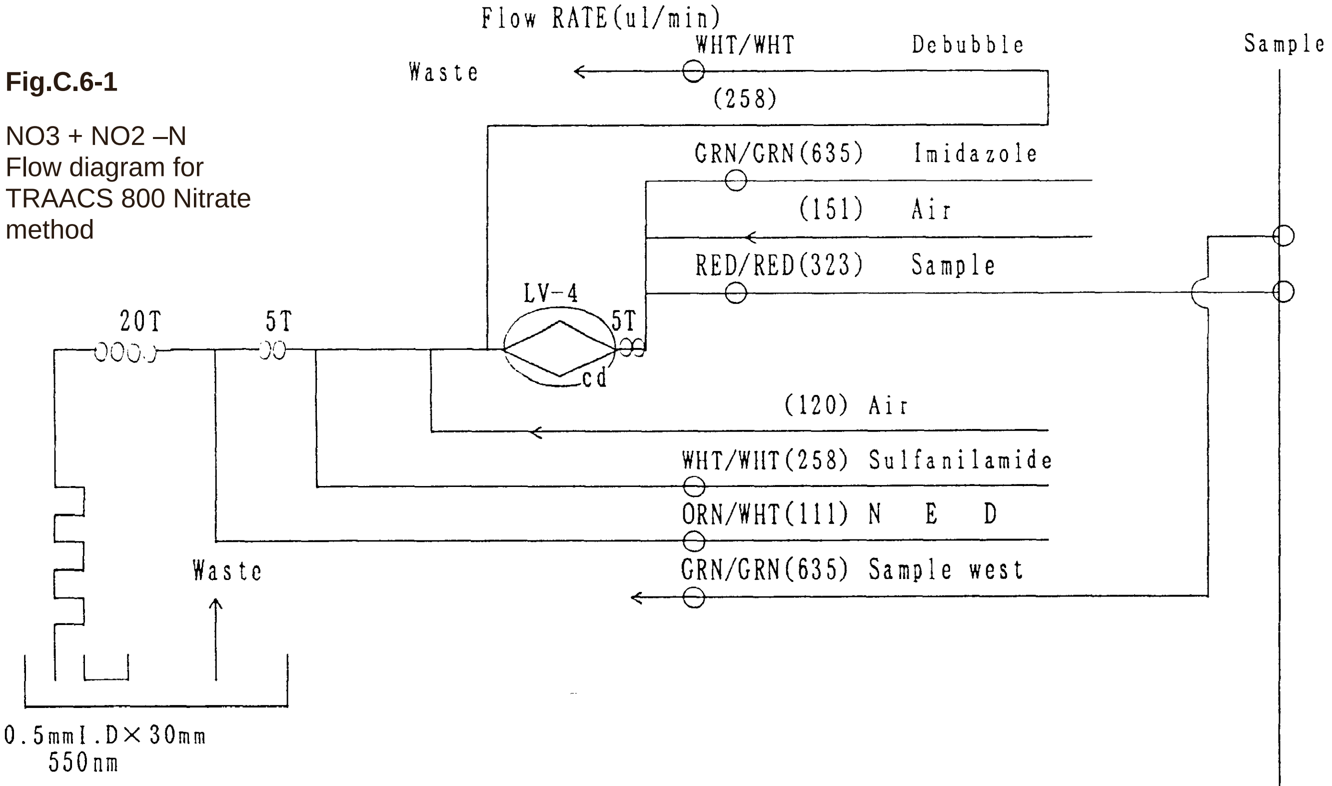


Fig.C.6-1

NO3 + NO2 –N
Flow diagram for
TRAACS 800 Nitrate
method

(ch.2)

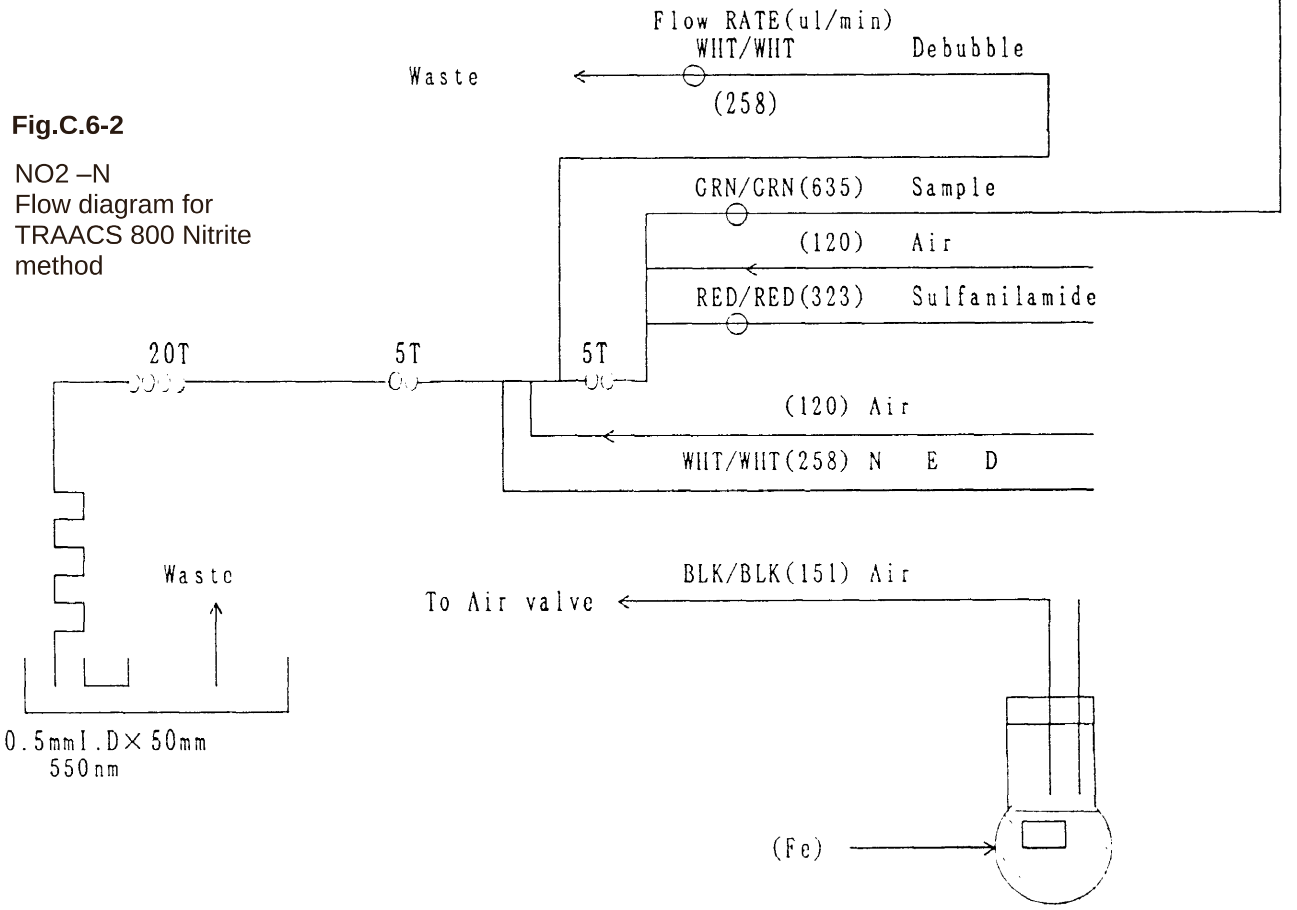


Fig.C.6-2

NO2 –N
Flow diagram for
TRAACS 800 Nitrite
method

Fig.C.6.3

SiO2 –Si
Flow diagram for
TRAACS 800 Silicate
method

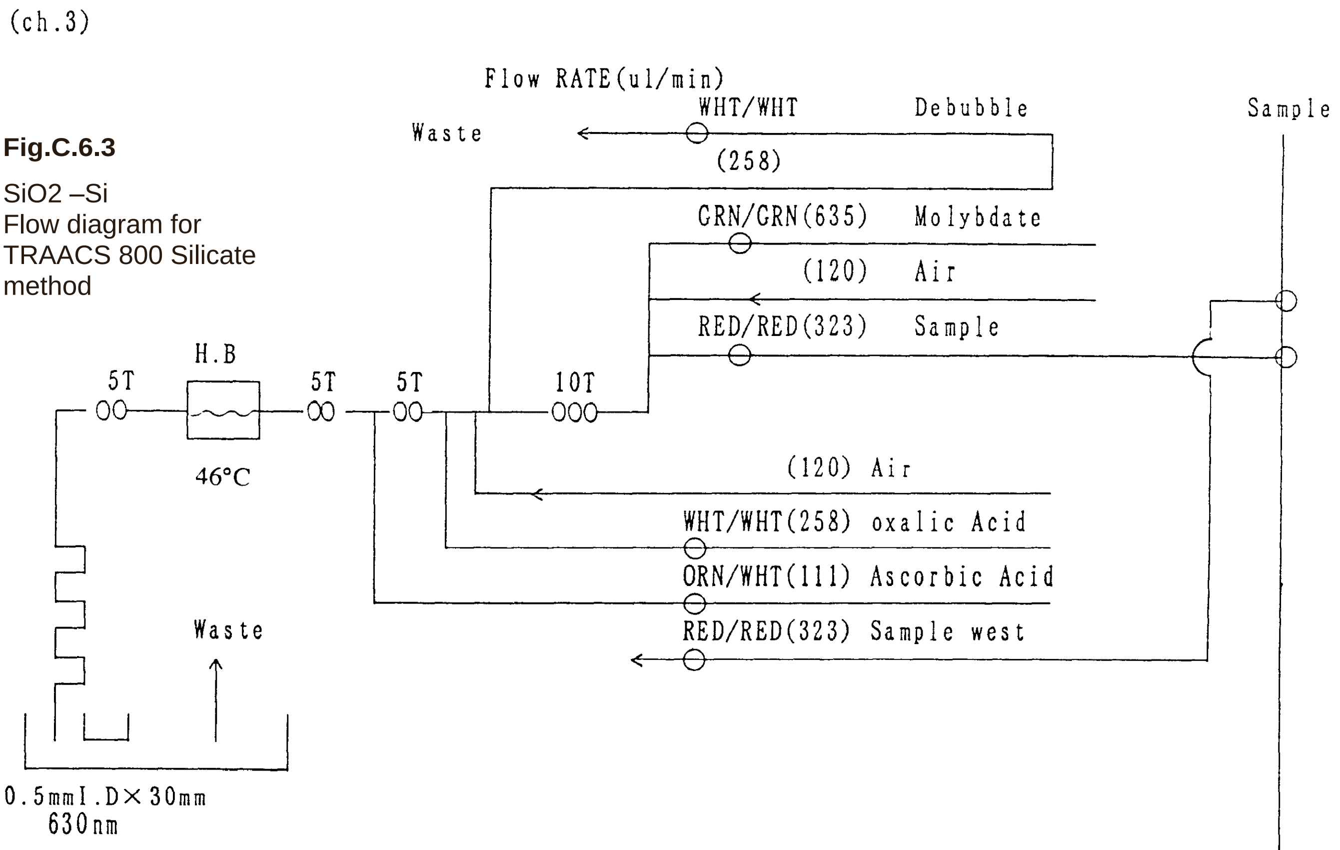
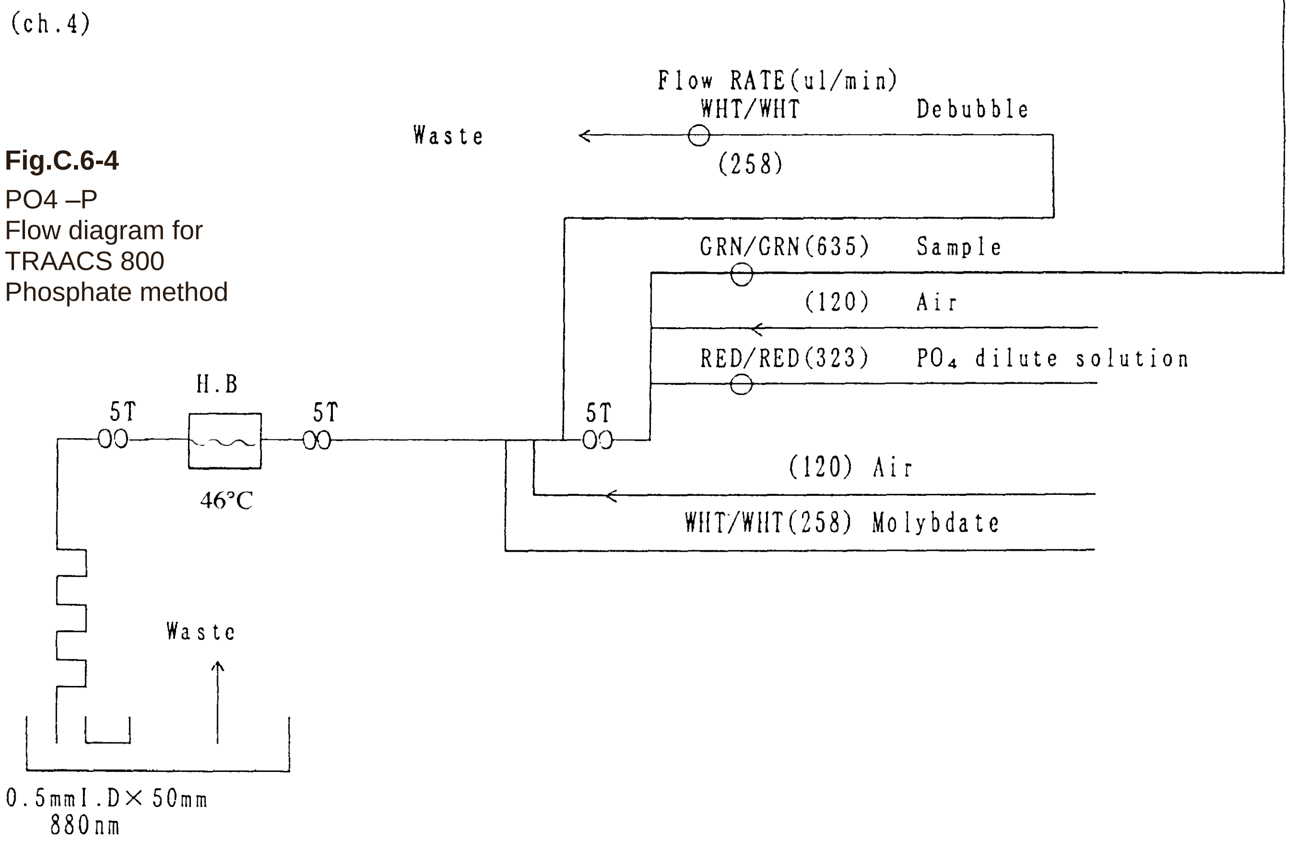


Fig.C.6-4

PO4 –P
Flow diagram for
TRAACS 800
Phosphate method



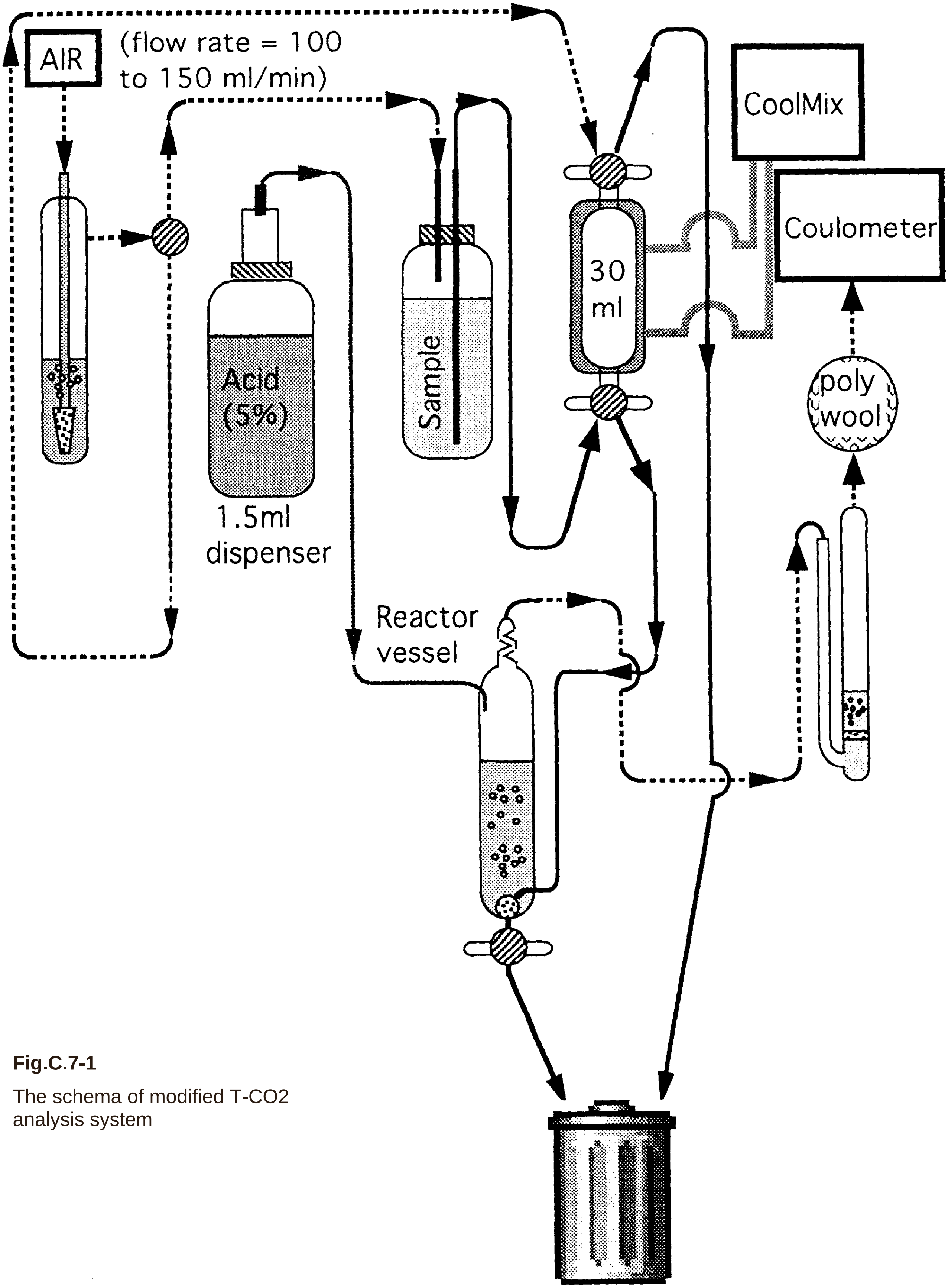


Fig.C.7-1

The schema of modified T-CO2 analysis system

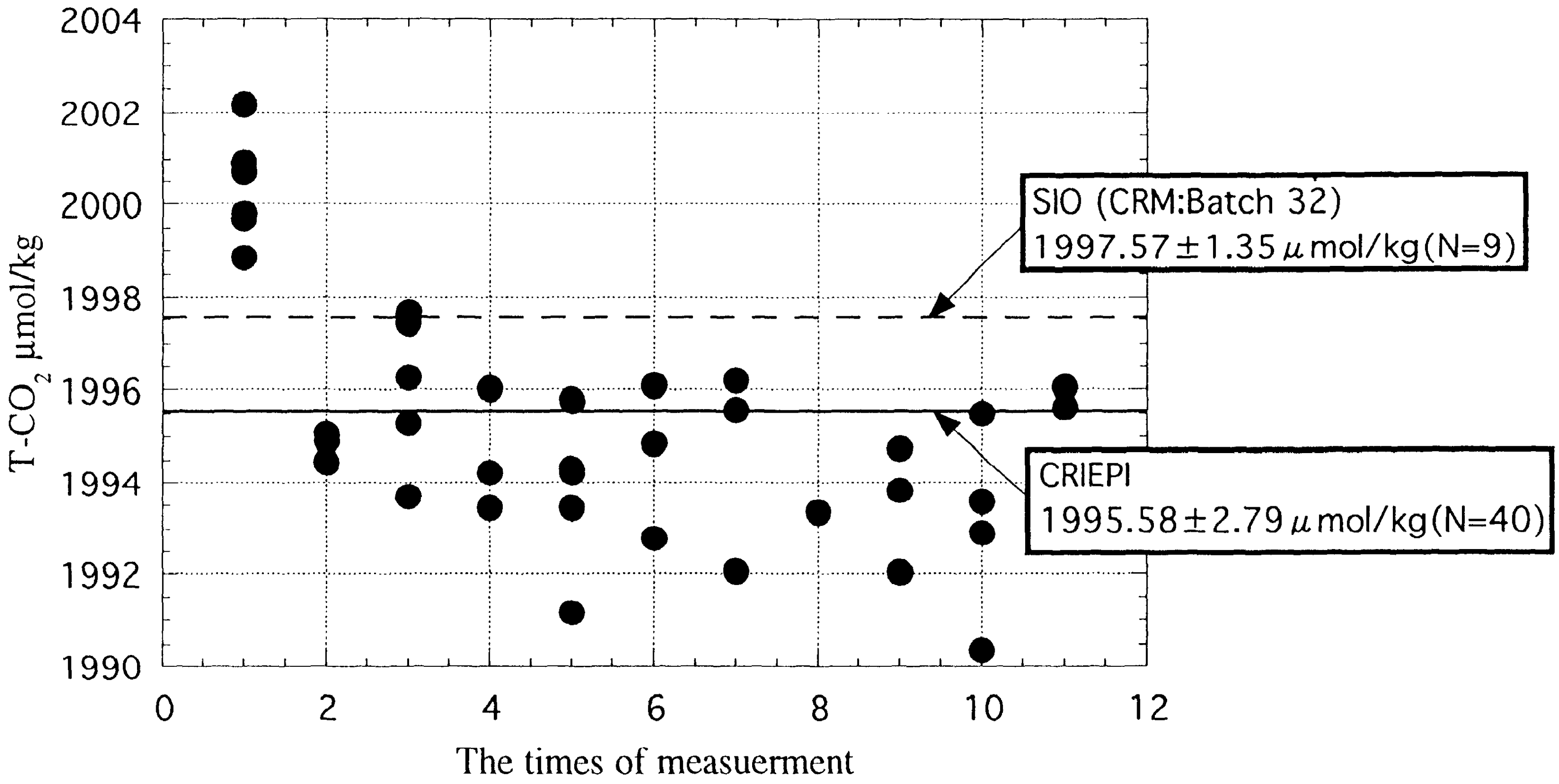
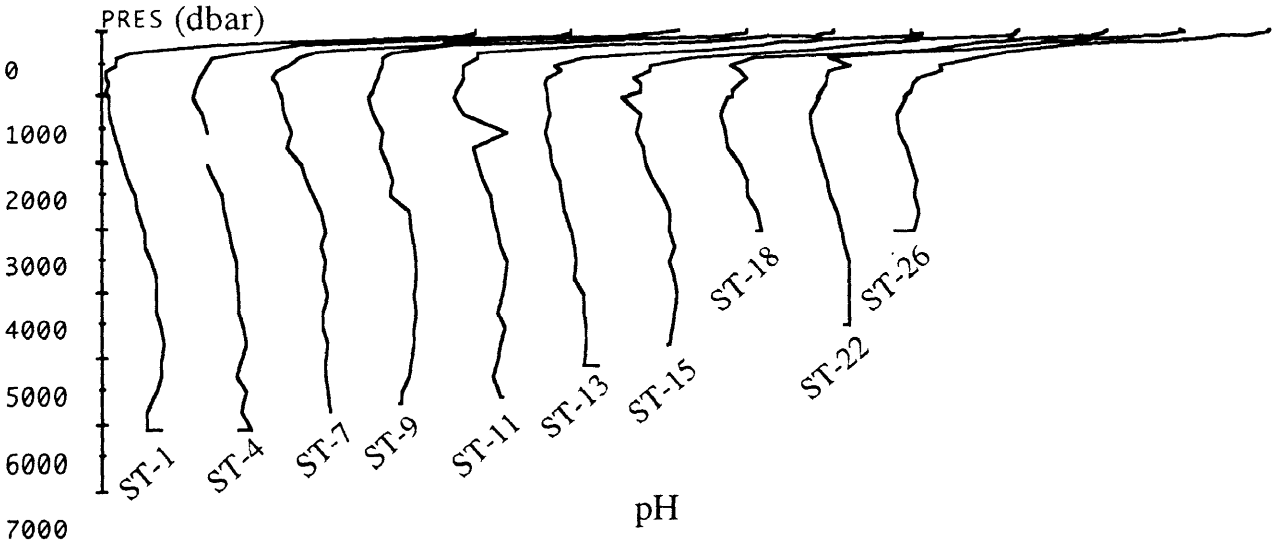
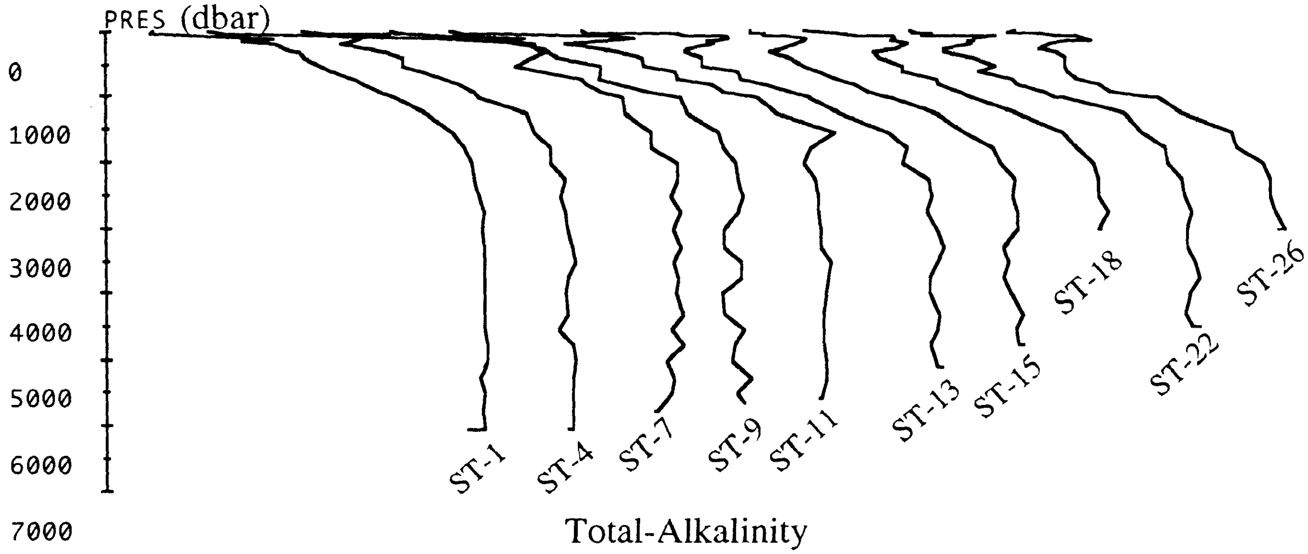


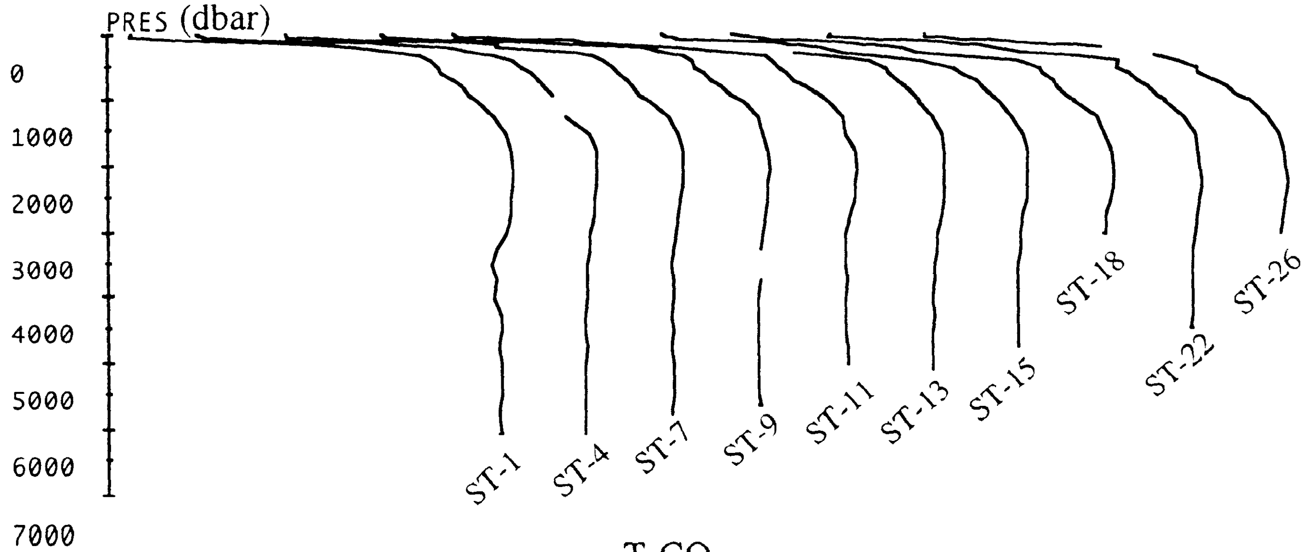
Fig.C.7-2 Comparison between the results of our shipboard measurements of these CRMs during the cruise.



pH



Total-Alkalinity



$T\text{-}CO_2$

Fig.C.7-3 Vertical distributions of pH, Total-Alkalinity (μmol/kg) and T-CO2 (μmol/kg)

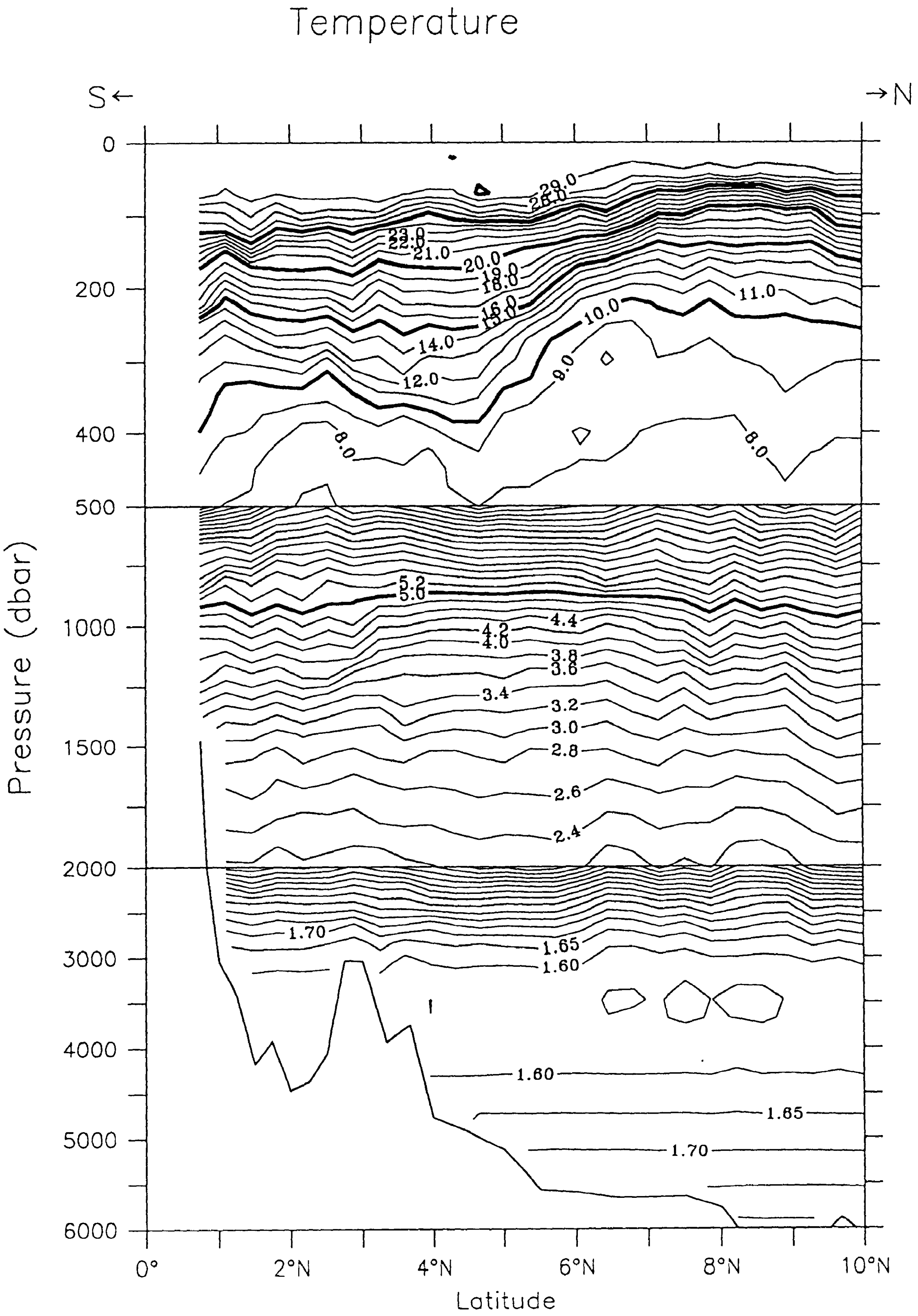


Figure F.1-1 Temperature (CTD)

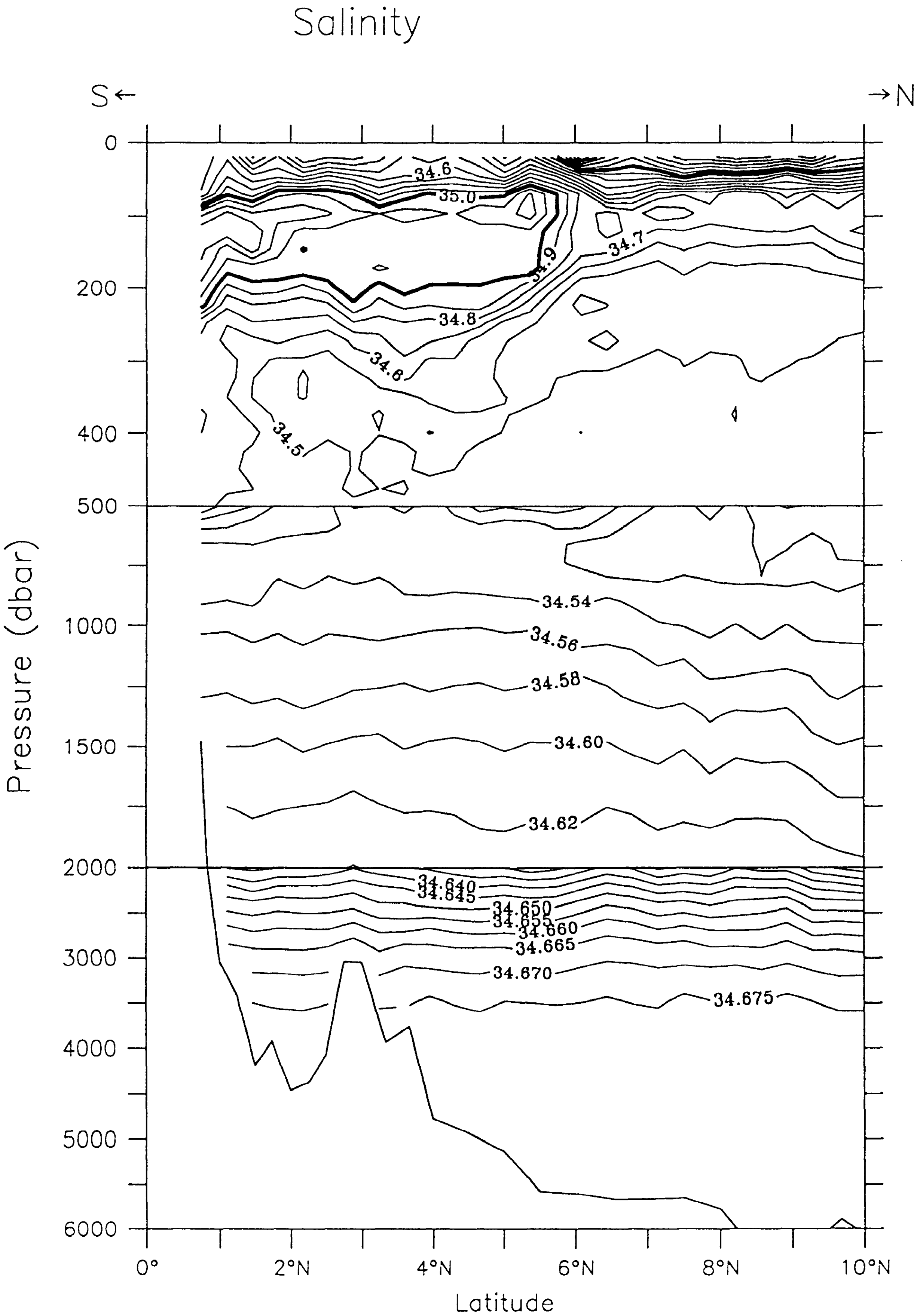


Figure F.1-2 Salinity (CTD)

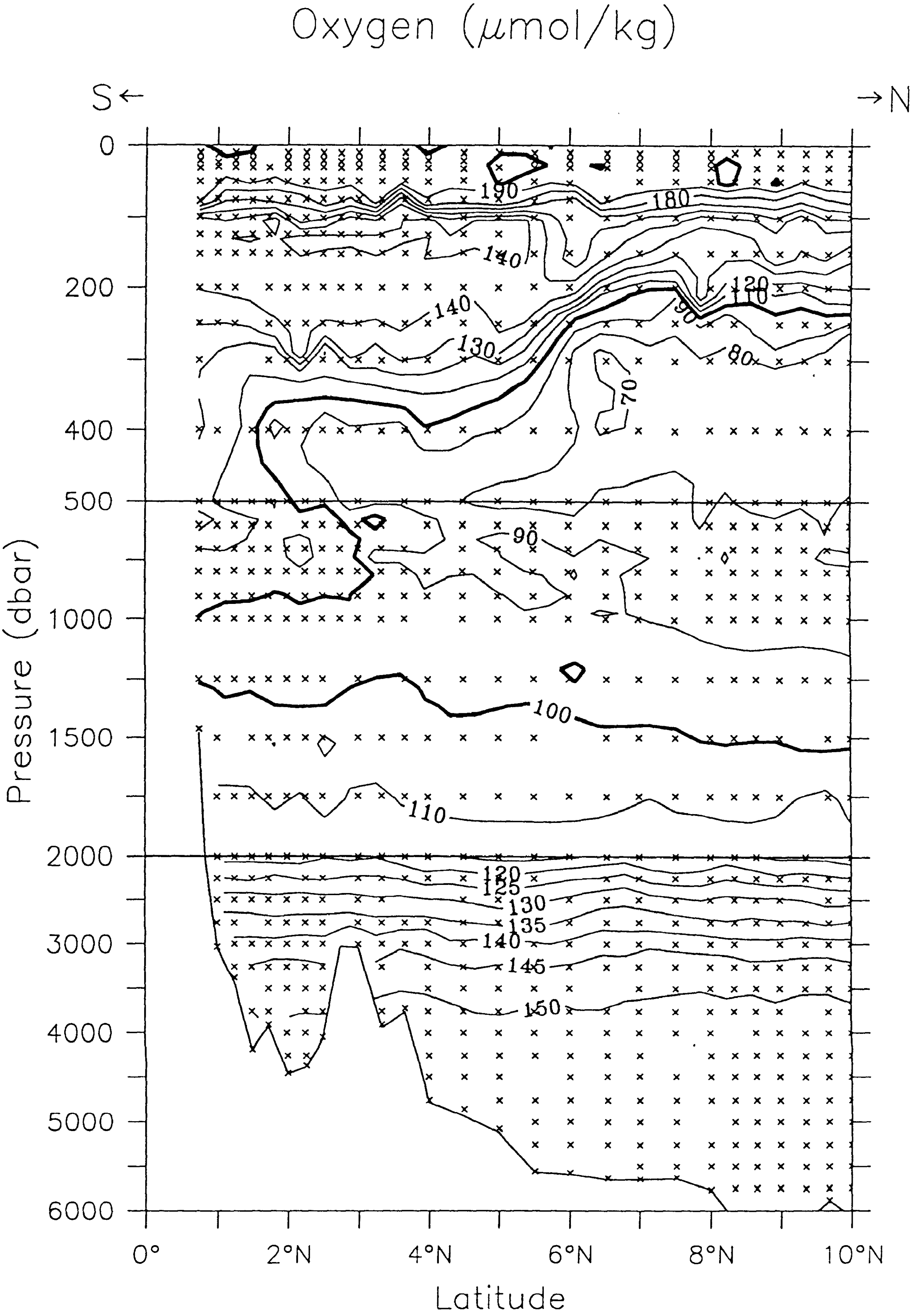


Figure F.1-3 Dissolved oxygen (sampled water)

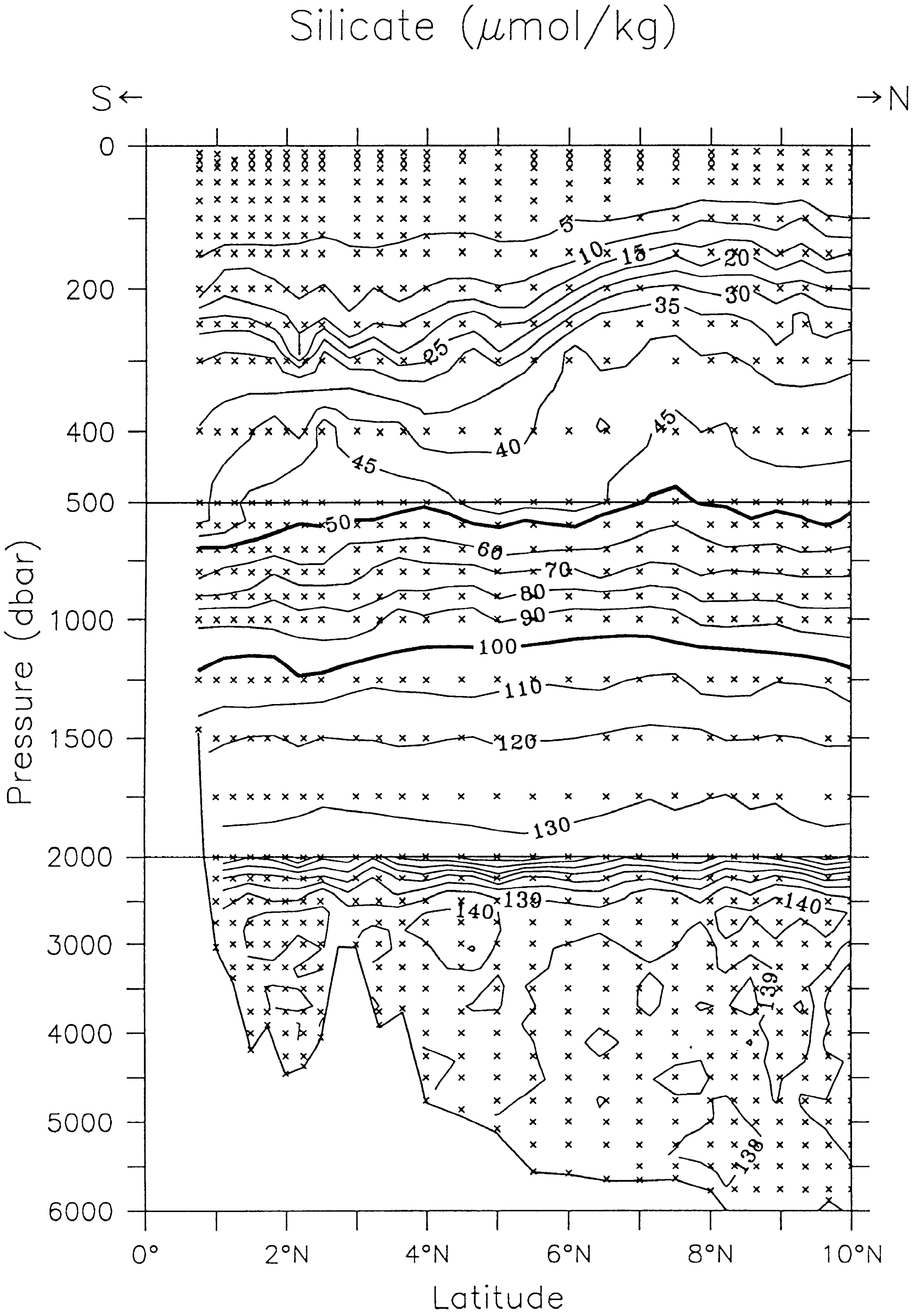


Figure F.1-4 Silicate (sampled water)

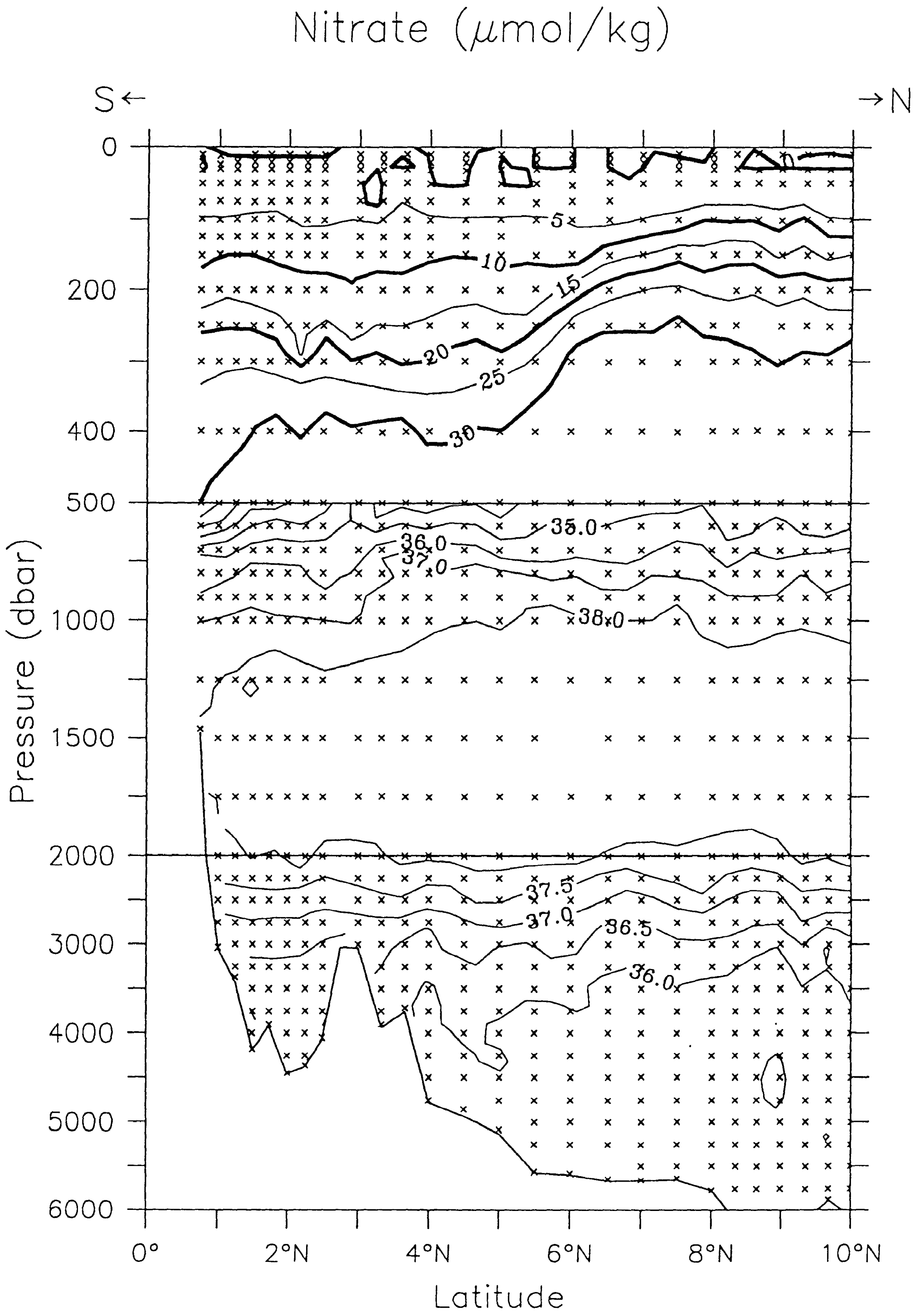


Figure F.1-5 Nitrate (sampled water)

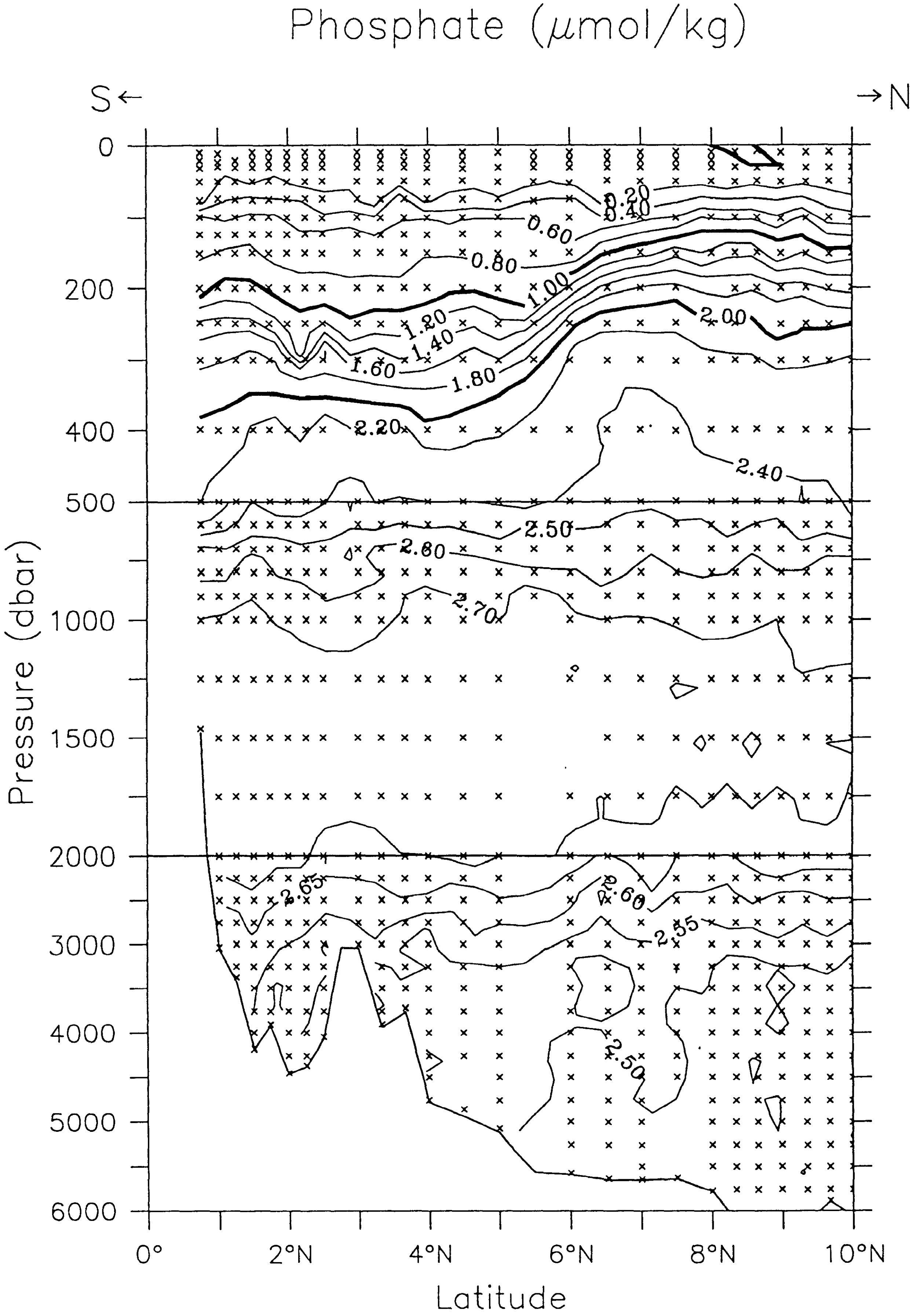


Figure F.1-6 Phosphate (sampled water)

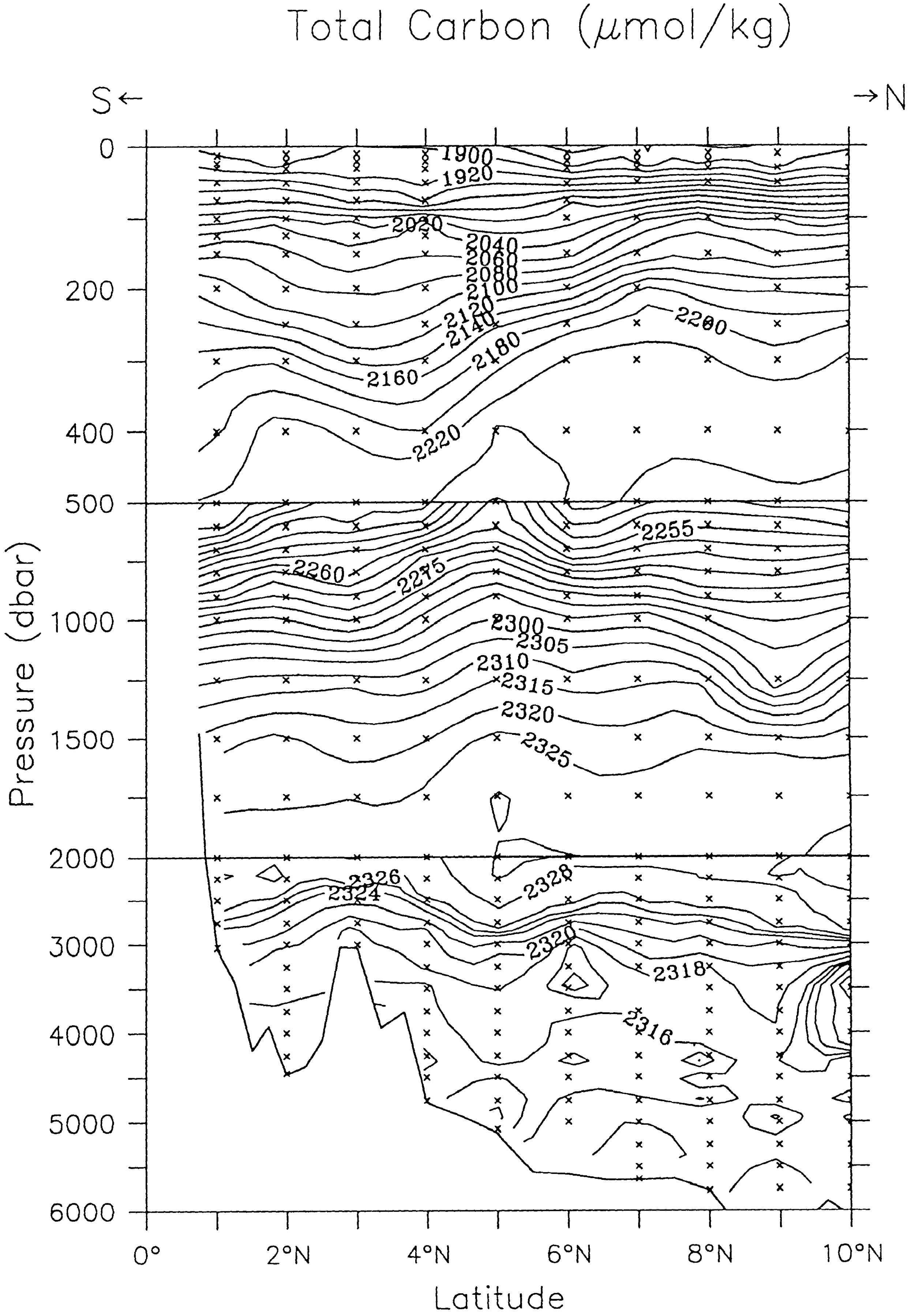


Figure F.1-7 Total Carbon (sampled water)

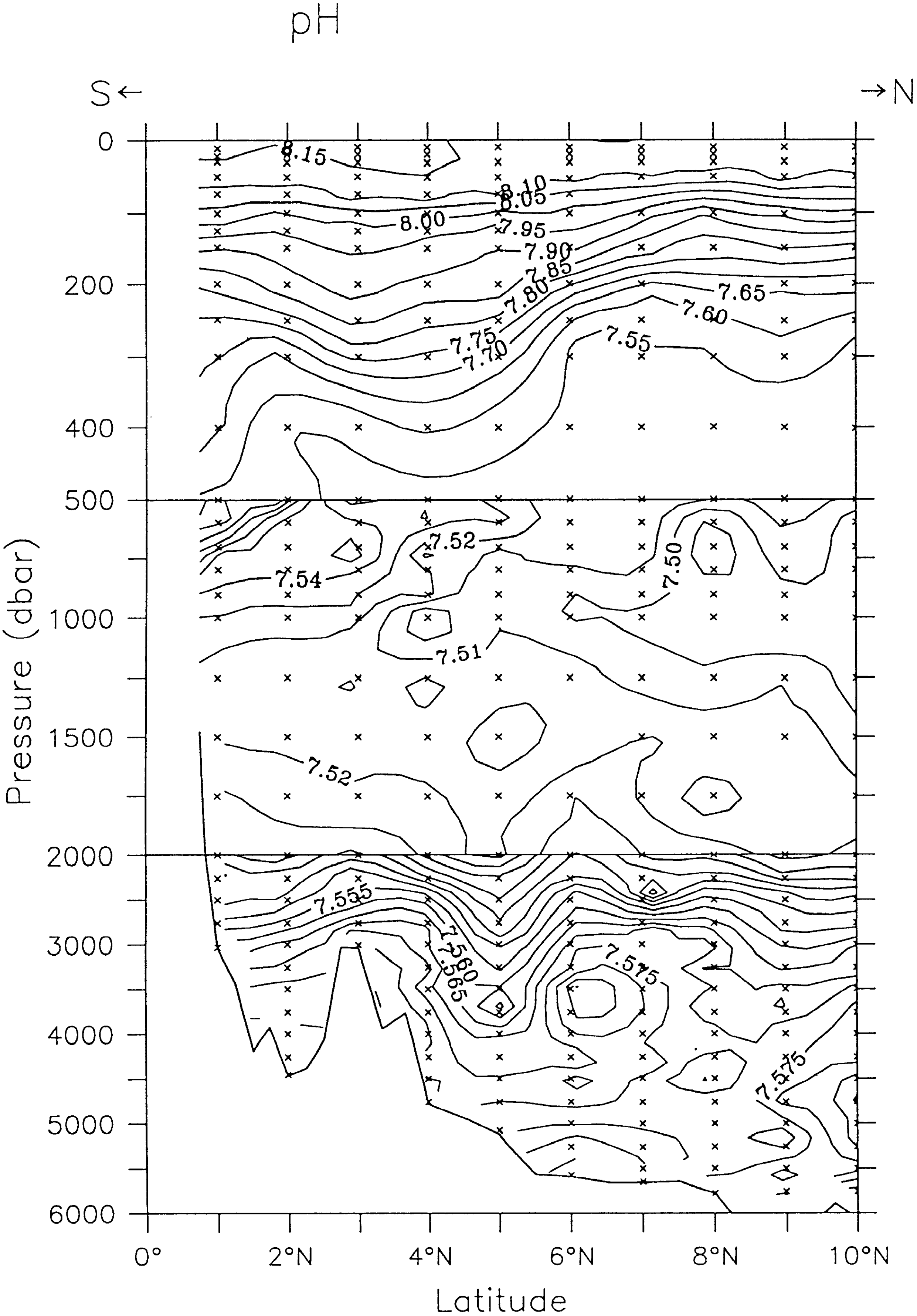


Figure F.1-8 pH (sampled water)

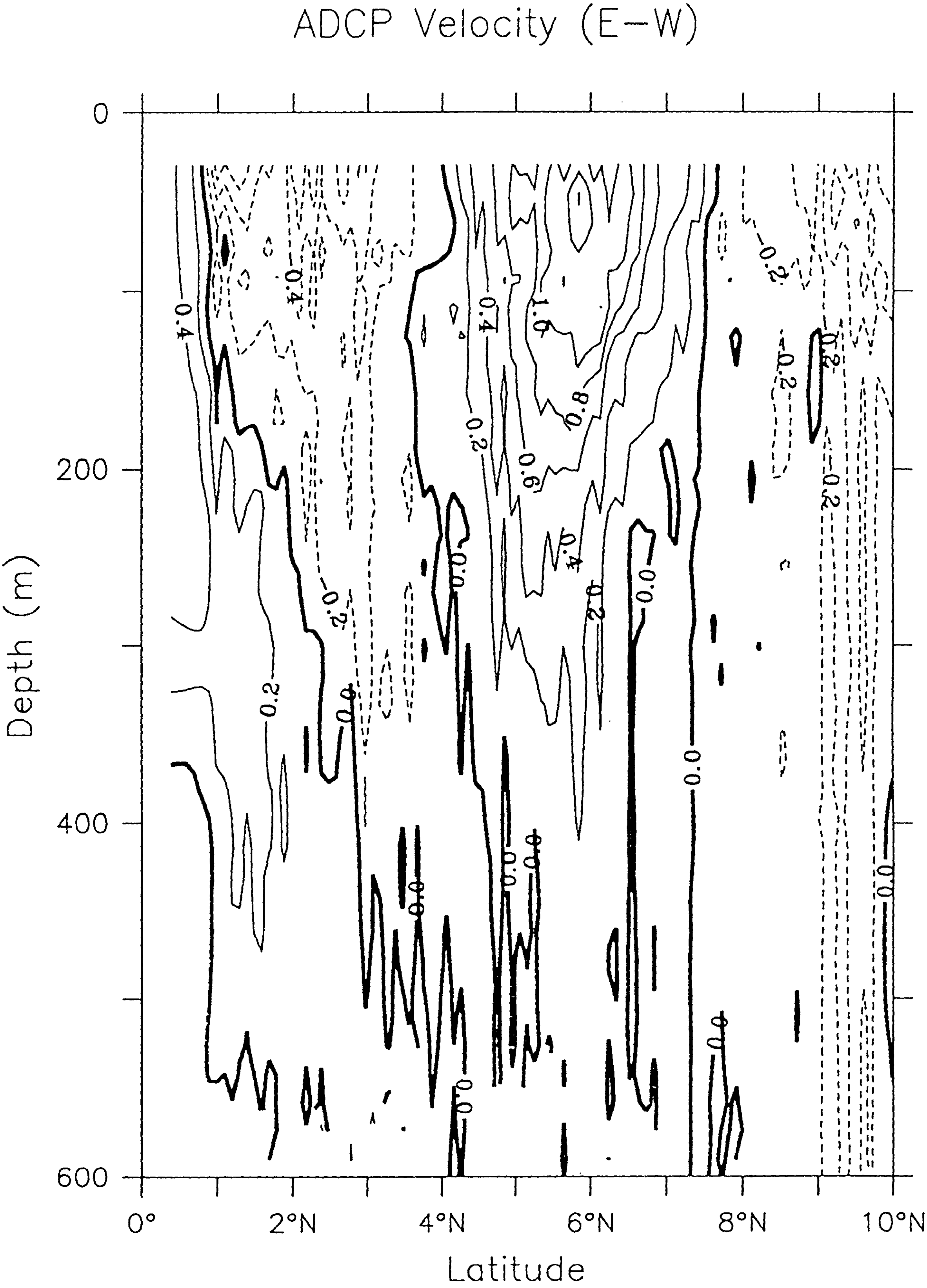


Figure F.1-9 Zonal velocity in m/sec (ADCP). Solid contour denote eastward flow

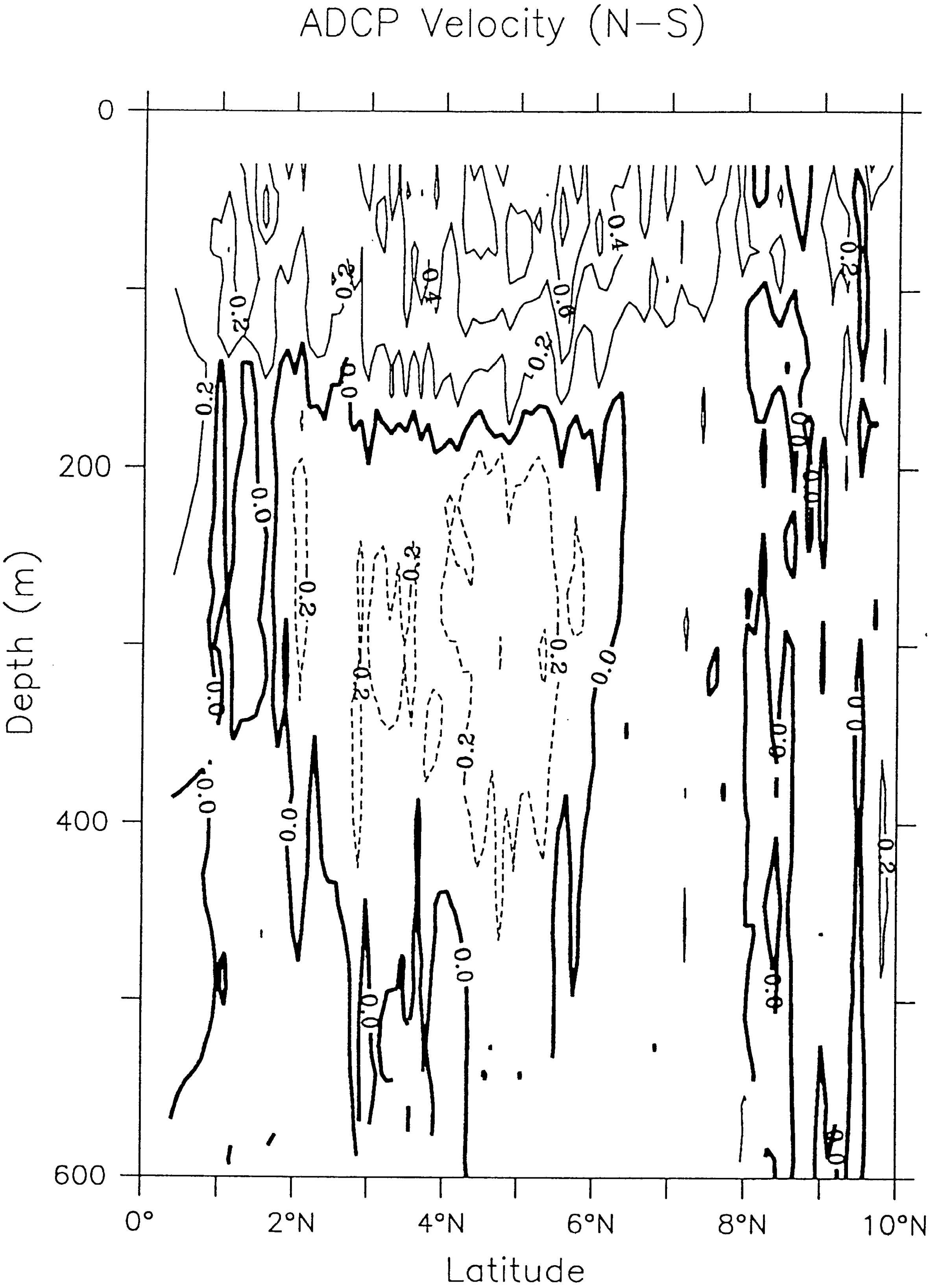
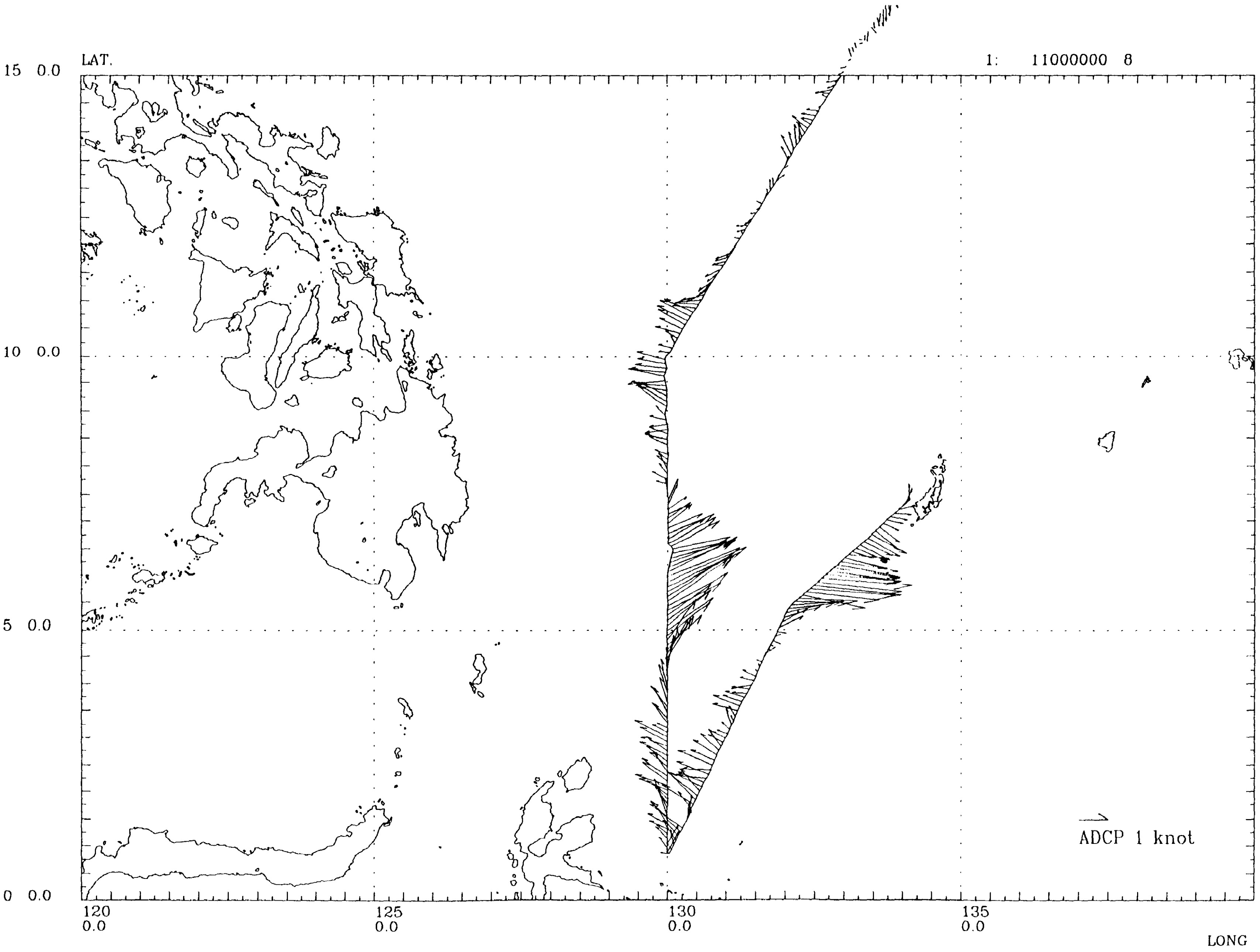


Figure F.1-10 Meridional velocity in m/sec (ADCP). Solid contour denote northward flow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10 0.0
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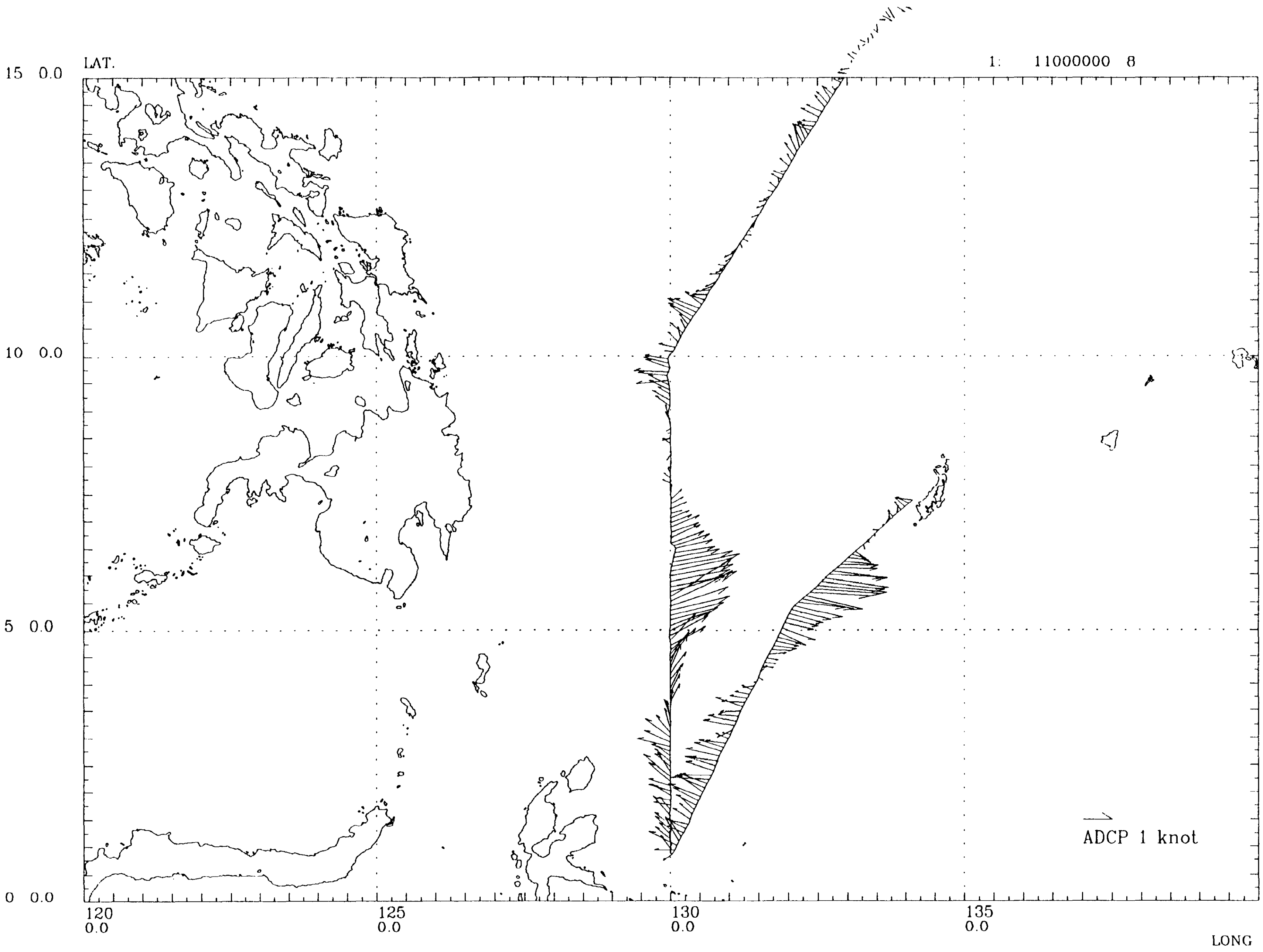
120
0.0
125
0.0
130
0.0
135
0.0
LONG
ADCP 1 knot

Figure F.2-1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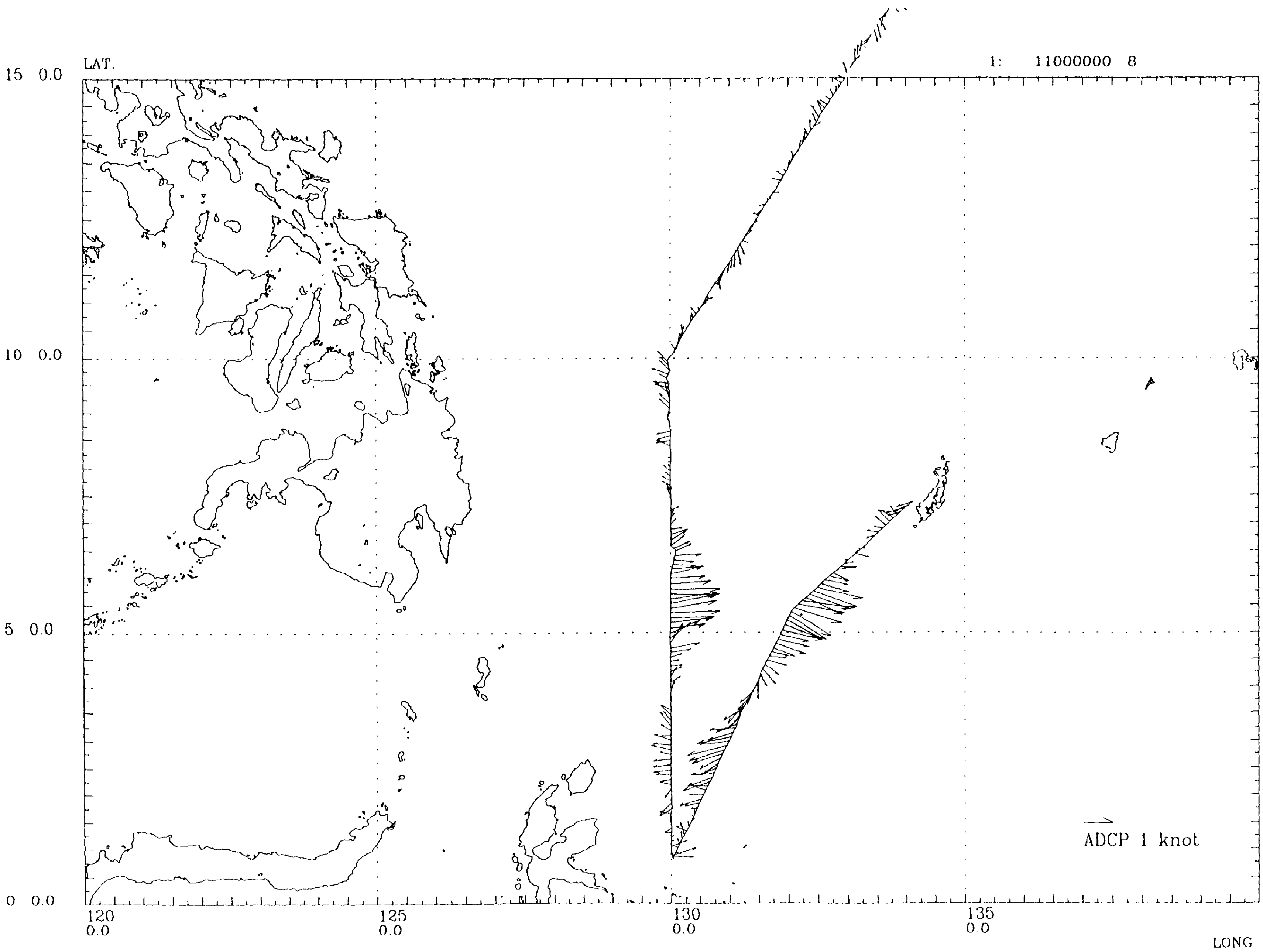
LONG
ADCP 1 knot

Figure F.2-2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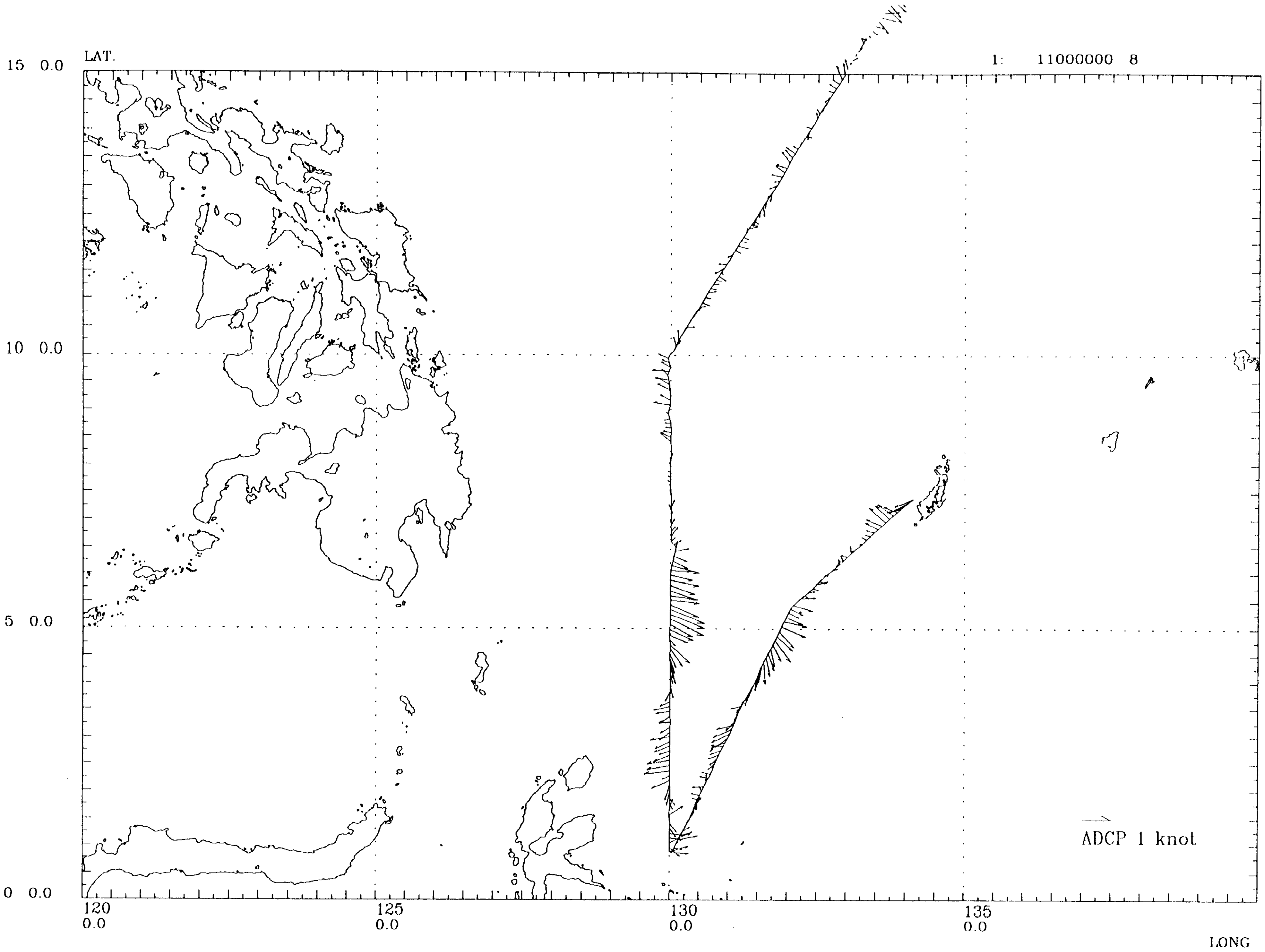
0.0
135
0.0
LONG
ADCP 1 knot

Figure F.2-3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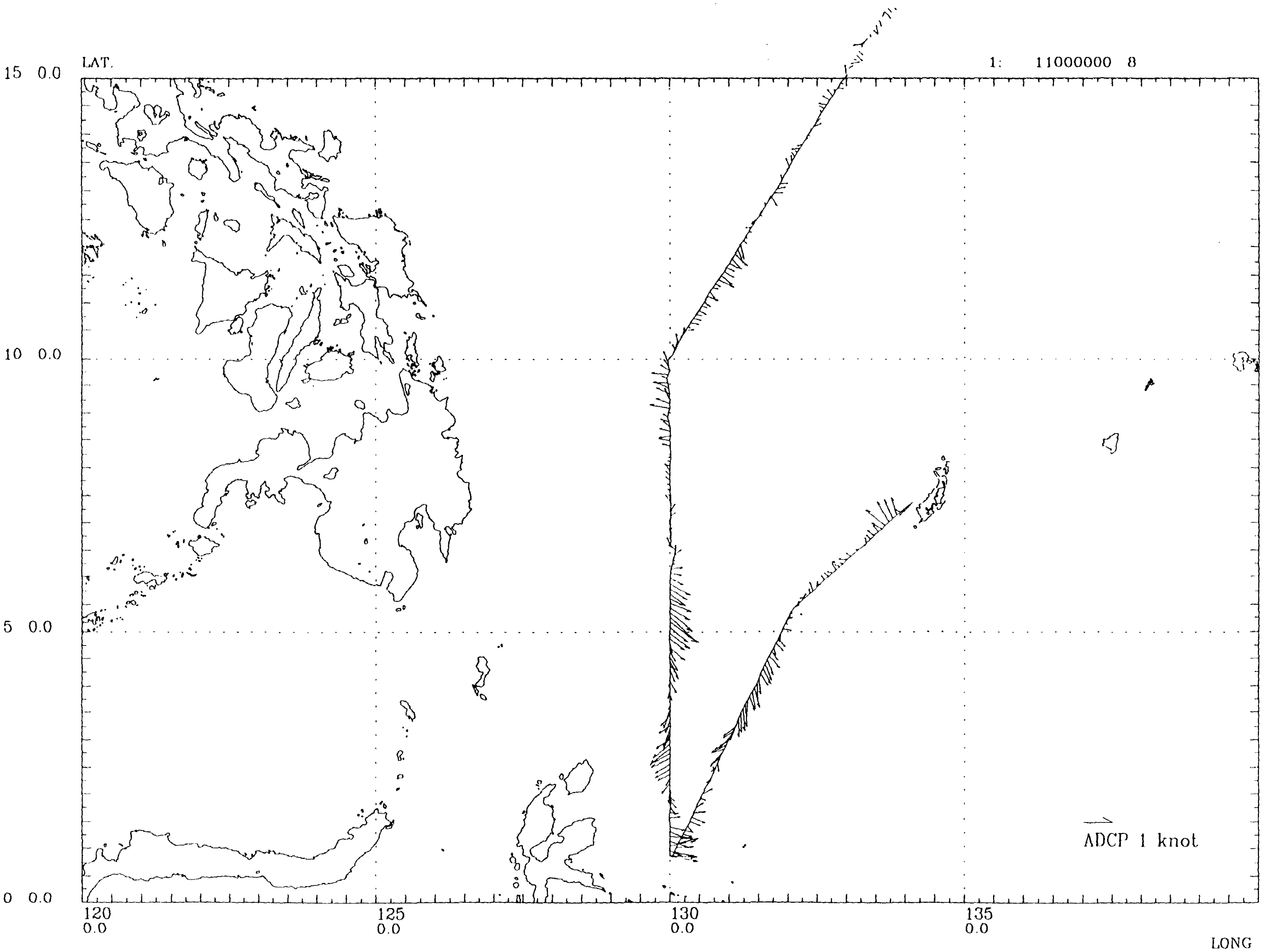
LONG
ADCP 1 knot

Figure F.2-4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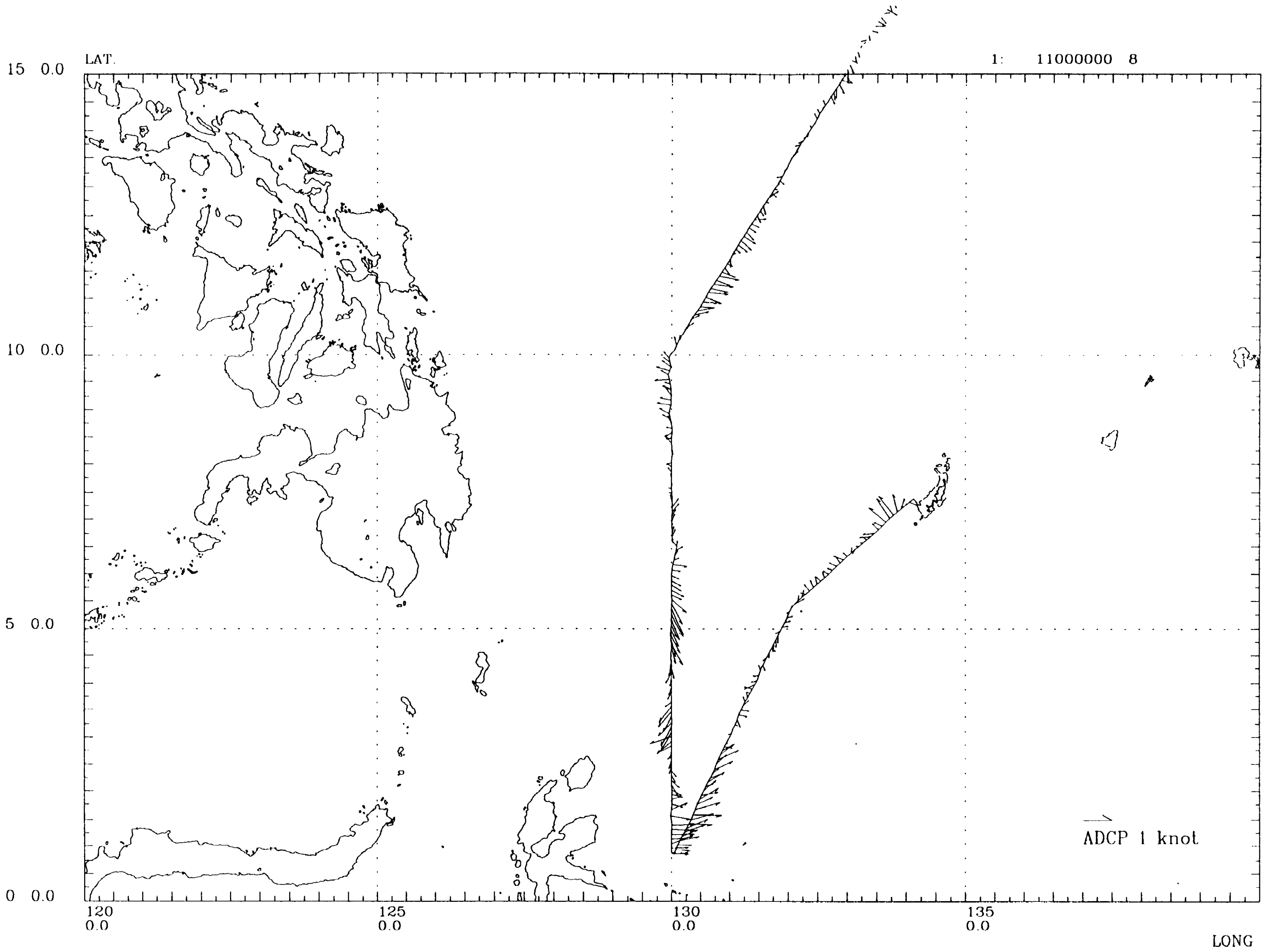
LONG
ADCP 1 knot

Figure F.2-5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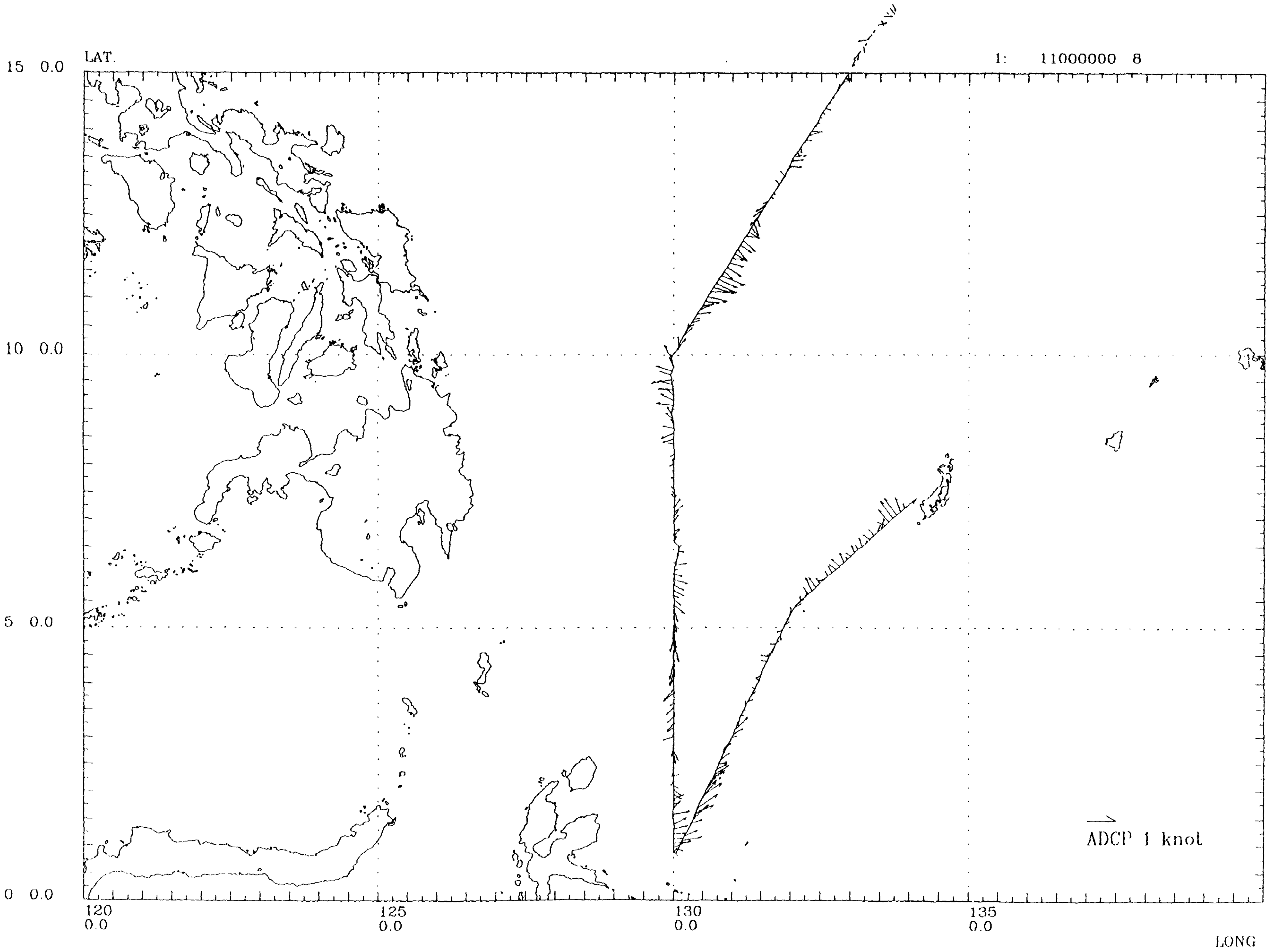
LONG
ADCP 1 knot

Figure F.2-6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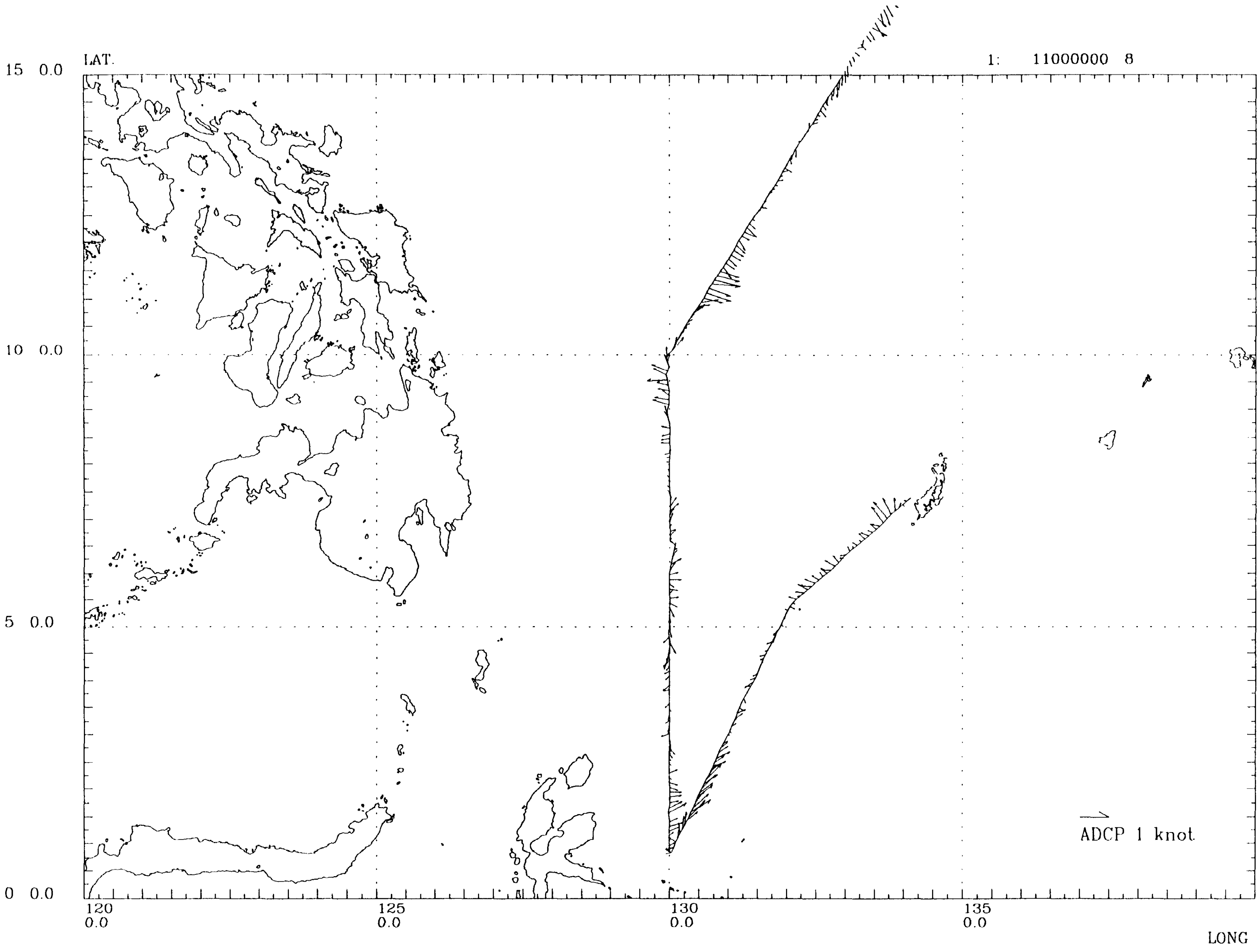
LONG
ADCP 1 knot

Figure F.2-7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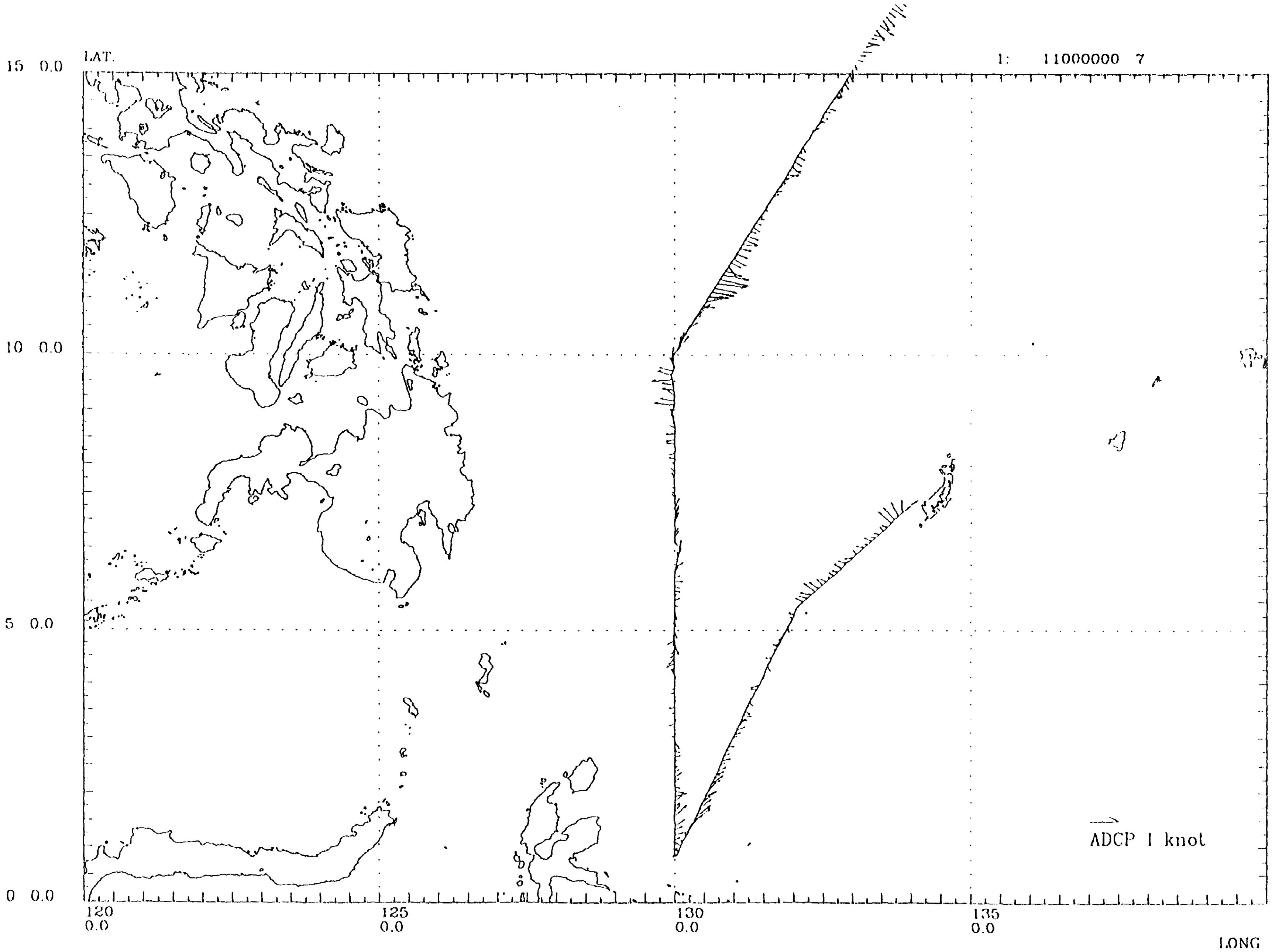
ADCP 1 knot

Figure F.2-8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135
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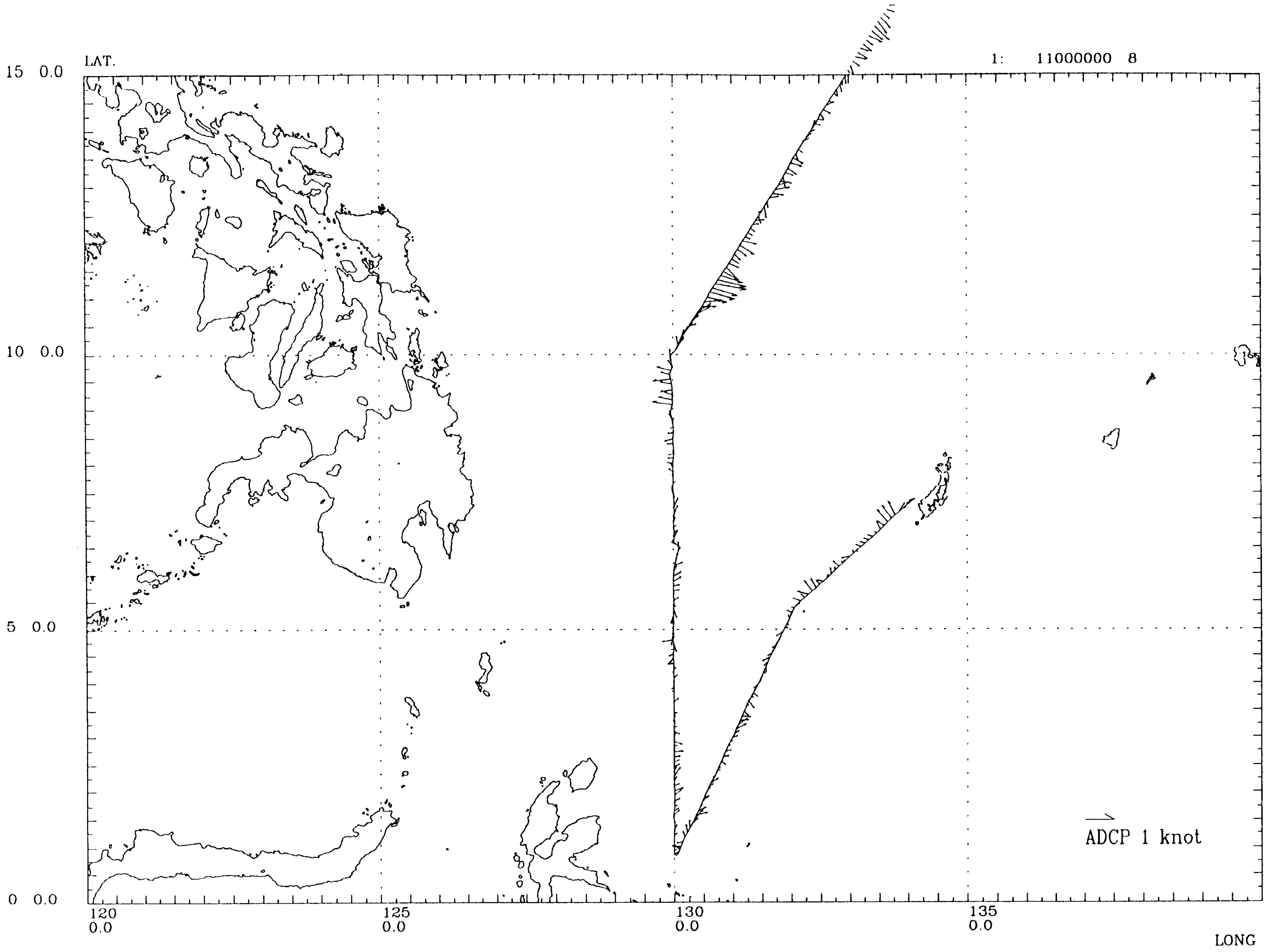
LONG

Figure F.2-9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135
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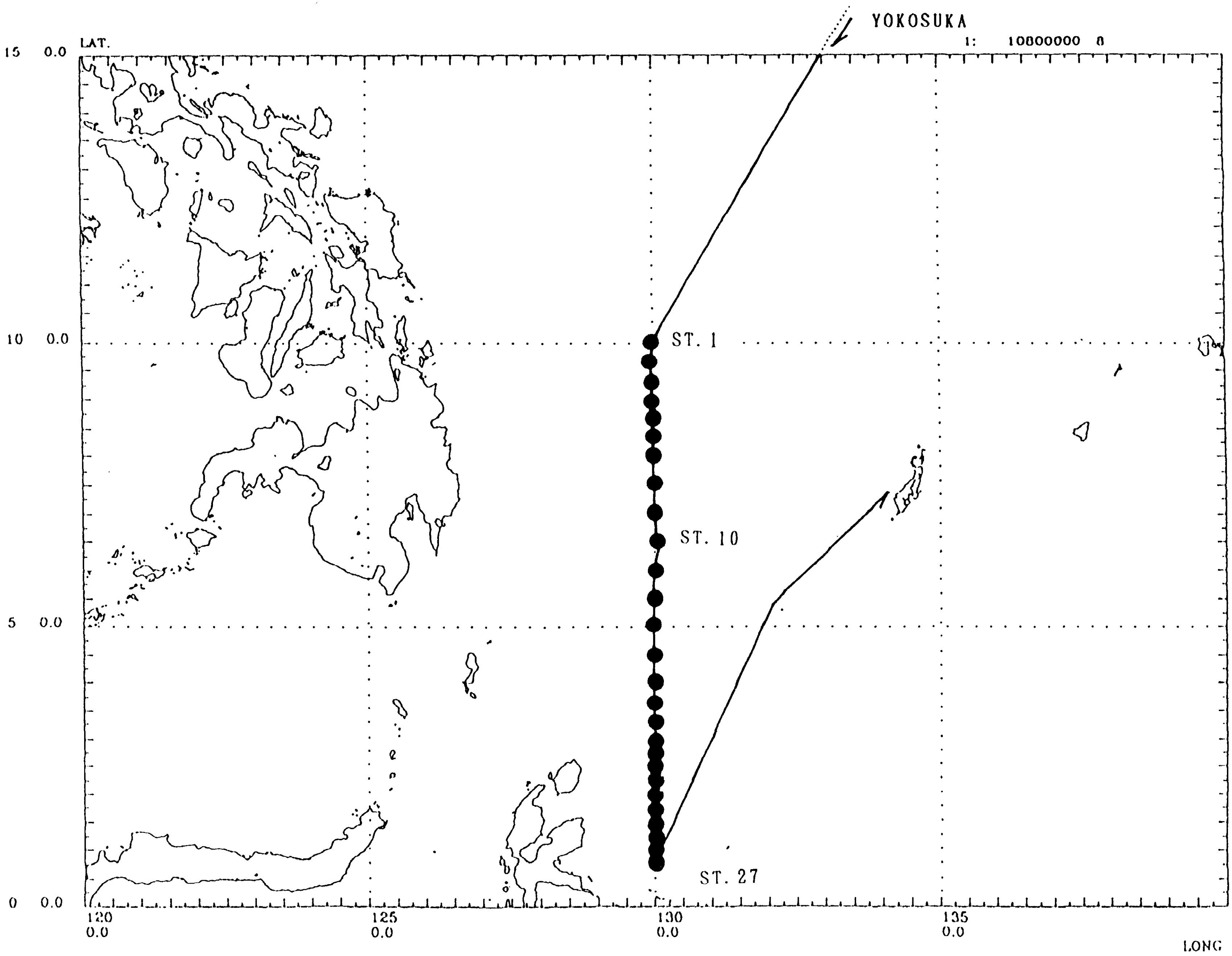
LONG
ADCP 1 knot

Figure F.2-10



WOCE P08S Track Chart

G. Data Quality Evaluation

G.1 Data Quality Evaluation for P08S C14 Data

(Robert Key)
12 Jun 2001

On 4/5/2001 the WOCE Hydrographic Program Office supplied me with a copy of the C-14 results for WOCE P08S which I had agreed to QC check. After merging with the hydrodata and subjecting to my regular checking procedure, I found the data to be of good quality although limited quantity. The quality is significantly better than it was for P9.

Only 2 data points fell outside the "envelop". These data show significantly less scatter than data from neighboring P9 (also Japanese). There appears to be no systematic bias in the data set. I would recommend flagging the following 2 points as questionable (c14f==3):

sta-cast-bottle	comment
4-1-16	lo vs P marked 3
18-1-8	hi vs P marked 3

Both were "off" relative to neighboring samples from this cruise only. I know of no existing C14 data this far west against which a "crossover" analysis could be made. Additionally, the rigor I apply when QCing is dependent upon the overall quality of the entire cruise. That is, the above 2 points would not have been flagged 3 had they been part of P9. With good data smaller deviations can be discerned.

Even if the data is low quality, the c13 values which were used to collect the c14 measurement for fractionation during analysis should be included in the data set. A c13 datum can be "good enough" for this correction without being of sufficient precision for other oceanographic application.

Even though sparse, these are important data since they will allow mapping C-14 further westward in the N. Pacific. My congratulations to the PIs involved.

G.2 Data Quality Evaluation for P08S Carbon Data

(Robert Key)
04 Apr 2001

Based on the final quality control analysis (JGOFS/NOAA grant work) the data quality for this cruise is not the best. Recommended additive adjustments for TCO2 and Alk are +2 and +6 micromoles respectively.

I have attached a copy of the correction table for pacific cruises that included carbon measurements. Most of the time, these recommended corrections are so small that I doubt the change will be visible in graphic sections. The changes might make a small difference in maps on deep surfaces.

Cruise	TCO_2	TA	TAcalc	Nit	Pho	Si	Oxy
cgc91.1	NA	NA	N	NA	NA	NA	NA
p2	-4	+14	N	NA	1.0171	NA	NA
p6	-0.6	NA	Y	NA	0.9813	NA	NA
p8s	+2	+6	N	NA	1.0391	1.0229	NA
p9	+1.1	NA	N	0.9831	NA	NA	NA
p10	NA	NA	N	NA	1.0260	NA	NA
p13n	NA	NA*	N	1.0327#	NA	0.9804#	NA
p14n	NA	NA	Y%	1.0115	1.0174	0.9800	NA
p14s15s	NA	NA	Y%	NA	NA	NA	NA
p15n	NA	NA	N	NA	0.9821	NA	NA
p16s17s	+1.4	NA	Y	NA	0.9803	NA	NA
p16c	NA	NA	N	NA	NA	NA	NA
p16n	+4&	NA	Y	NA	NA	NA	NA
p16a17a	+1.3	NA	Y	NA	NA	NA	NA
p17c	NA	-9	N	1.0195	NA	NA	NA
p17n	-7	-12	N	NA	NA	NA	NA
p17e19s	+1.4	NA	Y	NA	0.9790	0.9814	NA
p18S	NA	NA	Y@	1.0130	0.9722	NA	NA
p18N	NA	NA	Y@	1.0185	NA	NA	NA
p19c	-0.2	NA	Y	NA	0.9767	0.9860	NA
p21E	NA	NA	N	NA	NA	NA	1.0136
p21W	NA	NA	N	NA	NA	NA	0.9703
p31	NA	-6	Y%	1.0150	NA	NA	NA
s4p	-0.9	NA	Y	1.0241	0.9715	0.9810	NA
sr3s4	NA	NA	N	NA	NA	NA	NA
P1	NA	NA	N	NA	NA	NA	NA
EQS92	NA	NA	N	NO3/16	NA	NA	NA
Meteor 11/5$	NA	NA	Y	NA	NA	NA	NA

* alk data adjusted by -23.6 to agree with CRM in individual cruise file
# only adjusted leg 2 (stations >55)
% alk calculated only for bottles that had TCO2 and ph, but no alk
& 3-umol/kg CRM correction already in individual cruise file
@ alk calculated only for bottles that had TCO2 and fco2, but no alk
$ WOCE designation A21 plus parts of S04A and SR02

WHPO Data Processing Notes:

Date	Contact	Data Type	Data Status Summary	
11/06/97	Kashino	CTD/BTL/SUM	Submitted for DQE	
03/10/98	Kashino	HE/TR, C14	Measured but not ready to submit	
03/10/98	Kashino	DOC	Data Update	
08/16/98	Mizuno	CTD/BTL*	Data are Public	(*S/O, NUTs)
01/19/01	Kappa	DOC	Doc Update	txt version updated
01/22/01	Huynh	DOC	Website Updated	Updated txt version online
03/02/01	Saito	He/Tr/C14	Data Update	He/Tr not measured, C14 will be submitted to WHPO. You meant about P8S, I see. In P8S cruise, we took radiocarbon, tritium and helium samples. Radiocarbon data set will be sent to WHPO by Dr.Kumamoto in the near future, but tritium has not yet analyzed cause of the lack of foundation. Besides helium samples were failed to preserve. Then the only radiocarbon data set could be sent the WHPO.
03/06/01	Yuichioro	DELC14	Submitted	Data to be merged into online file.The Bottle File has the following parameters: DELC14, C14ERR; The Bottle File contains: CastNumber StationNumber BottleNumber SampleNumber. KUMAMOTO, YUICHIORO would like the data PUBLIC.

I have just submitted the P8S radiocarbon data through the WHPO ftp data submission site. The file name is "p08shy.txt (ascii file)" including the radiocarbon data, errors, and flags. I should inform you of the replicate measurements of radiocarbon. We have 9 replicates as listed below:

STNNBR	SAMPNO	Number of replicates	(original data +- error)
01	20	2	(-211.4+-6.1, -202.0+-7.2)
07	21	2	(-170.6-+6.2, -163.8+-6.3)
07	34	2	(112.7+-6.0, 107.9+-6.0)
15	01	3	(-221.2+-7.0, -216.2+-5.8, -208.1+-3.7)
15	15	2	(-212.7+-7.1, -206.9+-3.7)
15	20	2	(-151.2+-7.8, -146.3+-3.9)
15	27	2	(74.1+-9.5, 81.1+-4.5)
18	01	2	(-220.5+-3.6, -216.9+-3.6)
18	26	2	(102.0+-6.2, 92.2+-6.2)

03/15/01	Saito	TRITUM	Not Measured	Not measured due to lack of funding. Oh, yes. I meant lack of funding for the tritium. Anyway I heard that Dr. Kumamoto are going to deposit C14 data to WHPO within a few weeks.
04/05/01	Kappa	DELC14	DQE Begun	Sent data to Bob Key to QC For P8S the notes/updates at whp imply that c14 has been run (in Japan) and should be released, but the whp data file contains no C14 data (or C13). This is not one of the cruises which we have included in discussions with NSF regarding "analysis of unfunded samples". If I can get the data, I can certainly do a very quick QC. - Bob Key
06/22/01	Uribe	CTD/BTL	Website Updated	CSV File Added CTD and Bottle files in exchange format have been put online.

10/26/01	Yoritaka	Cruise ID	Data Update	Cruise Info Updated
	Date:	June 17-July 02, 1996		
	PI:	N. Yoshioka and D. Hartoyo (Badan Pengajian Dan Penerapan Teknologi, Indonesia)		
	CTD/S/O2:	Y. Kashino and H. Yoritaka/H. Yoritaka/M. Aoki (Nippon Marine Enterprise, Japan)		
	Nuts:	C. Saito		
	CFC:	no sampling		
	He/Tr,14C:	C. Saito		
	Alk/TCO2:	K. Shitashima (Central Research Institute Electric Power Industry,Japan)		
01/10/02	Kappa	DOC	Cruise Report Updated	
	Compiled PDF cruise report with all figures, C14 and CO2 DQE reports and WHPO Data Processing Notes. Added C14 and CO2 DQE reports and WHPO Data Processing Notes to text version of doc file.			