Preliminary Report

of

The Hakuhō Maru Cruise KH-71-5

(Phoenix Expedition)

November 18, 1971～March 10, 1972

Eastern North and South Pacific

Ocean Research Institute

University of Tokyo

1973

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By

The Scientific Members of the Expedition

Edited by

Hiroyuki Tsubota

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Page	Line	Misprint	Correct
Contents	9.8	Tin sea water	Tin in sea water
	9.13	Udisequilibrium	U disequilibrium
3	19	wound	wounded
8	15	was good as	was as good as
	18	sam;oes	samples
	22	CHl	HCl
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10	31	potemtial	potential
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42	4	ratioactive	radioactive
43	6	matural	natural
46	the last	were writtn	were written
47	Fig. 35.	Stm.	Stn.
50	Fig. 42.	Stan.	Stn.
52	20	δpCO_2	ΔpCO_2
	21	PCO_2	pCO_2
53	Fig. 45.	145°Wto	145°W to
54	Fig. 48.	St.	Stn.
57	Fig. 49.	St.	Stn.
58	11	µg at/	µg at/l
60	1	a plastic tweezers	a pair of plastic tweezers
62	9	47ϕmm	47ϕ
63	6	seddimen-	sedimen-
64-65	Table 9. 4th Column	Wet weight (mg/m)	Wet weight (mg/m^3)
67	34	slope (B)	slope (β)
68	1	B decreases	β decreases
74	20	particales	particles

Contents

1. Introduction

The principal object of KH-71-5 cruise (Phoenix Expedition) is to study the chemical characteristics of waters in the eastern North and South Pacific. The expedition was first planned by Prof. Y. Horibe as a part of the Pan Pacific Program by chemistry group of the Japanese Oceanographers. The aim of the program is to establish the chemical and isotopic data of the ocean for the better understanding of the large scale circulation and mixing processes and chemical processes in the Pacific. The Phoenix Expedition was proceeded with the last three expeditions, KH-68-4 (the Southern Cross Cruise), KH-70-1, and KH-70-2 (the Great Bear Expedition).

Air-sea interactions, water-sediment interactions, and chemistry of sea water were studied by measuring the chemical species and isotopes in air, sea water, and sediment. Mineralogical, paleontological and cosmophysical studies were also proceeded. Along all the course of the cruise measurements were continued at the stand points of atmospheric physics.

We were much indebted to Prof. Y. Horibe for his advices in planning, to the officers and crew of R.V. Hakuhō Maru for assisting us in doing our research works, also to the business personnels of Ocean Research Institute.

Hiroyuki Tsubota
Chief Scientist

2. Scientists Aboard

TSUBOTA, Hiroyuki	Ocean Res. Inst., Univ. of Tokyo	Chemical Oceanography
SUGIMURA, Yukio	Meteor. Res. Inst.	Nuclear Oceanography
SAITO, Yukimasa	Kobe Yamate Women's Jr. College Formerly, Dept. of Geosciences, Osaka City Univ.	Physical Oceanography
SEKIKAWA, Toshio	Dept. of Phys., Science Univ. of Tokyo	Atmospheric Physics
TAKAGI, Masumi	Res. Inst. Atmospherics, Nagoya Univ.	Atmospheric Physics
TOKURA, Ryoichi	Kyoto Univ. of Education	Biological Geochemistry
NAKAI, Toshisuke	Ocean Res. Inst., Univ. of Tokyo	Physical Oceanography
SAGI, Takeshi	Japan Meteor. Agency	Chemical Oceanography
SHIGEHARA, Koji	Ocean Res. Inst., Univ. of Tokyo	Isotope Oceanography
KODAMA, Yukio	Ocean Res. Inst., Univ. of Tokyo	Analytical Chemistry
KOJIMA, Hiroshi	Dept. of Phys., Science Univ. of Tokyo	Atmospheric Physics
OBA, Tadamichi	Ocean Res. Inst., Univ. of Tokyo	Isotope Geology
ISHIZUKA, Toshio	Ocean Res. Inst., Univ. of Tokyo	Geochemistry
HASUMOTO, Hiroshi	Ocean Res. Inst., Univ. of Tokyo	Biology
TAZAWA, Yuji	Dept. of Phys., Kyoto Univ.	Cosmophysics
TORIYAMA, Noriji	Res. Inst. Atmospherics, Nagoya Univ.	Physics
AOKI, Saburo	Geolog. and Mineralog. Inst., Tokyo Univ. of Education	Mineralogy
SAKAI, Toyosaburo	Inst. Geology nad Paleontology, Tohoku Univ.	Paleontology
SHIMAMURA, Tadashi	Sci. and Eng. Res. Lab., Waseda Univ.	Physics
KATSURA, Tadahiko	Ocean Res. Inst., Univ. of Tokyo	Geology
MITSUDA, Hiroshi	Dept. of Chem., Gakushuin Univ.	Chemistry
TANAKA, Fumio	Dept. of Phys., Science Univ. of Tokyo	Geophysics
UEMURA, Yasuharu	College of Marine Science and Technology, Tokai Univ.	Oceanography
FUKUI, Fukashi	College of Marine Science and Technology, Tokai Univ.	Oceanography
RUPERT, Ralf Alarcon	Linea Aerea Nacinal de Chile	Meteorology
BASTEN, Jorge Claret	Centro Nacional de Datos Oceanograficos de Chile	Oceanography

3. Outline of the Expedition

The expedition consisted of four legs, as is shown in Figure 1. Leg I was from Tokyo to Papeete, Tahiti, Leg II was from Papeete to Valparaiso, Chile via Bellingshausen Sea (65°S, 100°W), Leg III was from Valparaiso to Acapulco, Mexico, and Leg IV was from Acapulco to Tokyo via Honolulu, Hawaii.

Table 1 shows the items of sampling, measurements and observations done in each leg, and all the stations for hydrocast, STD observation, large volume water sampling, piston coring, and dredge are shown in Tables 2, 3, 4, and 5, and 6 and 8, respectively,

Two Chilean scientists participated in Leg II of the expedition, and observed meteorological condition of southern Pacific and collected samples for measuring cesium 137 in surface water.

The last four hydrocast stations along 100°W were completed in Leg IV because our vessel went to Acapulco after Station 52 cutting the remains off to send a wound crew of French vessel, M.V. Cetra Lyra, which had an engine trouble.

Table 1. Observation items

	Leg			
	I	II	III	IV
1. Hydrocasts with 2.7 liter Niskin and 25 liter van Dorn samplers	X	X	X	X
2. Large volume sampling	X	X	X	
3. Measurement with in situ STD system	X		X	
4. Core sampling	X	X	X	X
5. Dredge	X	X		
6. Air sampling and pCO_2 determination	X	X	X	X
7. Measurements for atomospheric physics	X	X	X	X
8. Sounding	X	X	X	X

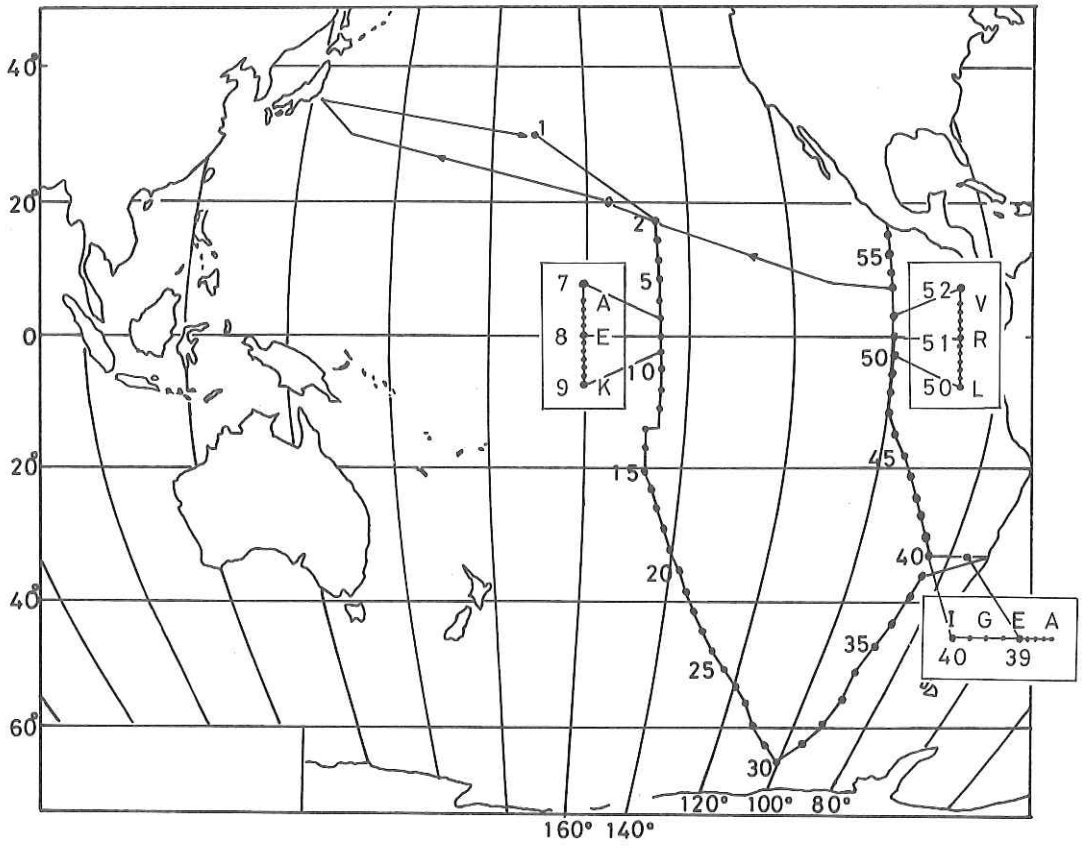

Fig. 1. Hydrographic station.

4. Hydrocast

by

H.Tsubota, Y.Sugimura, Y.Saito, and T.Nakai

Standard hydrocasts from surface to bottom were done at 56 stations which are shown in Table 2. Stations were chosen at an interval of about three degrees latitude, as is shown in Fig. 1. Observations were performed by three five-man rotating groups. They were conducted by Y. Sugimura, Y. Saito, and T. Nakai, respectively.

The hydrocast was carried out by the same way as was described in detail in the Preliminary Report of the "Hakuhō Maru" Cruise KH-68-4[1]. At all stations in Leg I and II, however, observation layers at depths of 3,250 and 3,750 meter were added. Sea water sample from 125 meter depth was also taken at several stations.

The water samplers used for standard layers were 2.7 liter nonmetallic plastic samplers of Niskin type prepared by Ocean Research Institute in the likeness of General Oceanic Nonmetallic Water Sampling Bottles (Model RMS-12) for this expedition, and thermometer frames which reverse with gravity were also made with PVC. Van Dorn Sampler (a pair of 6 liter or 25 liter) or General Oceanic bottle (1.7, 8, or 30 liter) was attached 10 m below or above the 2.7 liter sampler when it was needed.

By means of the sonar pinger attached to the end of the wire, we could obtain the water sample as close as possible to the bottom, beside Station 4.

Before the hydrocast, a bathythermographic observation from surface to 250 meter depth was carried out at each station.

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1) Preliminary Report of the "Hakuhō Maru" Cruise KH-68-4 (Southern Cross Cruise), Ocean Research Institute, University of Tokyo, 1970, Edited by Y. Horibe. Available on request.

Table 2. Stations of standard hydrocast

Station Number	Position		Time			Depth (m)
	Latitude	Longitude	Date		Hour	
1	29°53.9'N	169°57.0'W	Nov.26	1971	0900-1500	5,240
2	16°59.3'N	146°03.2'W	Dec. 1-2	1971	2132-0302	4,860
3	13°54.6'N	146°01.9'W	Dec. 2-3	1971	2130-0307	5.500
4	10°57.3'N	145°59.3'W	Dec. 3	1971	1730-2305	5,150
5	8°02.1'N	145°54.3'W	Dec. 4	1971	1427-1940	5,220
6	5°00.8'N	145°57.2'W	Dec. 5	1971	1035-1518	5,050
7	2°34.2'N	146°00.3'W	Dec. 6	1971	0310-0743	4,550
8	0°04.0'S	146°00.0'W	Dec. 7	1971	1245-1745	4,230
9	2°29.1'S	146°01.0'W	Dec. 8	1971	1400-1825	4,710
10	4°58.1'S	146°03.4'W	Dec. 9	1971	1100-1530	4,960
11	7°59.3'S	146°00.1'W	Dec.10	1971	0500-0925	5,030
12	11°03.5'S	146°03.3'W	Dec.11	1971	1805-2240	4,760
13	14°01.7'S	148°29.8'W	Dec.12-13	1971	2140-0210	4,290
14	17°02.8'S	148°25.0'W	Dec.13	1971	1450-1855	4,140
15	20°24.2'S	147°59.5'W	Dec.19	1971	1500-1908	4,620
16	22°51.8'S	146°48.4'W	Dec.20	1971	0848-1435	4,750
17	25°46.0'S	145°00.7'W	Dec.21	1971	0745-1118	4,010
18	29°05.9'S	143°07.6'W	Dec.22	1971	0500-0840	4,360
19	32°02.8'S	141°06.5'W	Dec.23	1971	0140-0544	4,650
20	35°04.5'S	138°41.5'W	Dec.24	1971	0537-0954	4,800
21	38°05.7'S	136°23.4'W	Dec.25	1971	1110-1515	4,820
22	40°56.7'S	133°42.8'W	Dec.26	1971	0900-1445	5,050
23	43°59.6'S	130°38.4'W	Dec.27	1971	1235-1935	4,940
24	47°01.8'S	126°55.6'W	Dec.28	1971	1700-2053	4,200
25	49°59.5'S	122°53.7'W	Dec.29	1971	1600-1905	3,850
26	53°00.3'S	118°46.9'W	Dec.30	1971	1300-1554	3,050
27	56°05.1'S	115°24.2'W	Dec.31	1971	0806-1107	3,340
28	59°00.7'S	111°24.8'W	Jan. 1	1972	0420-0853	5,220
29	62°09.6'S	106°35.5'W	Jan. 2	1972	0250-0715	5,120
30	64°59.7'S	100°02.9'W	Jan. 3	1972	1423-1900	4,910
31	61°59.4'S	95°45.9'W	Jan. 4	1972	1641-2048	5,100
32	58°56.5'S	92°43.5'W	Jan. 5	1972	1300-1710	4,200
33	55°01.0'S	90°20.0'W	Jan. 7	1972	0738-1200	4,840
34	51°02.9'S	90°08.3'W	Jan. 8	1972	0603-0953	4,835
35	47°00.0'S	87°47.8'W	Jan. 9	1972	0610-1025	4,050
36	42°50.7'S	86°03.9'W	Jan.10	1972	0535-0836	3,300
37	38°57.2'S	84°39.1'W	Jan.11	1972	0720-1115	4,370
38	35°57.5'S	83°47.6'W	Jan.12	1972	0605-0950	4,180
39	32°56.1'S	76°00.0'W	Jan.20-21	1972	2145-0200	4,330
40	32°29.1'S	84°00.0'W	Jan.22	1972	2030-2350	3,790

Table 2. continued

Station	Position		Time			Depth
Number	Latitude	Longitude	Date		Hour	(m)
41	30°00.3'S	86°08.1'W	Jan.23	1972	1627-1942	3,830
42	27°01.2 S	88°36.7'W	Jan.24	1972	1430-1800	3,690
43	24°06.1'S	91°04.9'W	Jan.25	1972	1058-1432	3,810
44	20°50.1'S	93°20.5'W	Jan.26	1972	0825-1236	4,120
45	17°59.5'S	95°40.8'W	Jan.27	1972	0755-1210	4,540
46	15°00.0'S	97°52.3'W	Jan.28	1972	0927-1315	3,483
47	11°58.1'S	100°01.6'W	Jan.29	1972	0557-1010	4,435
48	9°01.8'S	100°00.3'W	Jan.29-30	1972	2335-0310	4,170
49	5°56.3'S	100°00.8'W	Jan.30	1972	1724-2047	3,747
50	2°56.0'S	100°05.5'W	Jan.31	1972	1440-1812	3,470
51	0°01.5'N	100°00.8'W	Feb. 1-2	1972	2150-0145	3,340
52	3°00.0'N	99°59.7'W	Feb. 2	1972	1953-2304	3,504
53	7°00.6'N	100°04.5'W	Feb.12-13	1972	2158-0105	3,388
54	9°00.1'N	99°59.7'W	Feb.12	1972	0905-1238	3,580
55	11°57.8'N	100°06.4'W	Feb.11	1972	1655-2043	3,400
56	14°59.4'N	99°57.2'W	Feb.10-11	1972	2301-0238	3,470

* Time: Ship time
Depth: Uncorrected

4.1. Depth and temperature (Y. Saito and T. Nakai)

Temperature correction was done by using Hidaka's Formula and the accepted depth was determined by depth difference method. Errors of temperature and depth were estimated to be within 0.02°C and 0.5%, respectively.

4.2. Salinity (K. Shigehara, T. Ishizuka, and T. Oba)

An inductive salinometer of Auto Lab Model 601 MK III was used. The lot numbers of the standard sea water used were IAPSO-P56 for stations 1 - 52 and P55 for stations 53 - 56.

4.3. Dissolved oxygen (Y. Kodama and H. Mitsuda)

A modified Winkler's method was used, and the measured values were corrected by H. Tsubota and K. Shigehara using the equation (Horibe,Y., Kodama,Y., and K. Shigehara, 1972)

$$(d.O_2)_{corr.} = (d.O_2)_{meas.} - 0.071 + 0.00048S^*,$$

where S* is the saturation (%) of oxygen estimated by using the solubility C* calculated by the equation (Weiss, R.F., 1970),

$$\ln C^* = -173.4292+249.6339(100/T)+143.3483 \ln(T/100) -21.8492(T/100)+S‰[-0.033096 +0.014259(T/100)-0.0017000(T/100)^2].$$

4.4. pH and total alkalinity (H. Tsubota, F. Fukui, T. Shimamura, and T. Sakai)

Hitachi F-5 pH meter coupled with Metrohm glass electrode was used to determine pH and total alkalinity. Because the reproducibility of pH measurement was good as 0.003, a table was prepared for calculating pH in situ to 3 places of decimals. So that, a difference of 0.005 of pH might be significant when water sam;oes having close temperature would be discussed. Uncertainties of pH values, however, still remained.

Total alkalinity was determined by pH measurements after successive additions of CHl-NaCl solution. The equivalent quantity of HCl was obtained by Gran's plot, relation between 10^{-pH} and $V/(V_o+V)$ where V_o is the volume of the sea water sample and of total alkalinity were estimated to be certain within 0.005 meq/l.

4.5. Reactive silicate (T. Sagi and N. Tokura)

Silicomolybdate yellow method was applied. As to instrumentation a spectrophotometer, Hitachi Model 101, was used coupled with a sequential sampler of 1 cm optical path at a wave length of 380 nm. CSK standard solutions were used for making the calibration curve. The estimated error of the analyses was about 3 %.

4.6. Reactive phosphate (T. Sagi and Y. Tagawa)

The method of Murphy and Riley (1962) was used. For each series of the measurement, solid ascorbic acid was dissolved in distilled water and the mixed solution was prepared for an immediate use. 5 ml of the mixed solution was added to 50 ml unfiltered sea water samples. After 15 minutes the absorbance of the solution was measured in a 5 cm cell at the wave length of 885 nm with a spectrophotometer, Hitachi Model 101. The calibration curve was made by using the CSK solutions. The experimental error did not exceed 3 % of the reported value.

4.7. Nitrite (T. Sagi and H. Hasumoto)

The procedure of nitrite analysis was essentially the same as the method of Bendschneider and Robinson (1952).

4.8. Nitrate (T. Sagi and Y. Uemura)

The analysis of nitrate in sea water was done by the same method as that reported in the earlier report[1], except in some points described below.

To about 100 ml of unfiltered sea water, 1 ml of 7.6 % EDTA-4Na solution was added. The solution was passed through a copperized cadmium column at the flow rate of 6 - 7 ml/min. The first 30 ml of the effluent was discarded and the next 50 ml portion of the effluent was used for the measurement. The absorbance of the solution was determined with a spectrophotometer, Hitachi Perkins-Elmer 139. The calibration was done using a sea water, to which a known amount of nitrate (20 μM) was added, as a reference. Average deviation of the analyses of reference samples was 0.7 % and reducing efficiency was estimated to be 97 %.

4.9. Confirmation of oceanographic data (T. Nakai, Y. Saito, Y. Sugimura and H. Tsubota)

Confirmation of depth, temperature, salinity, and dissolved oxygen, calculation of σ_t, and taking interpolated temperature and salinity were performed by Y. Saito and T. Nakai by using Station Graph (Nakai's data plotting sheet). The other chemical data for routine analyses were verified by drawing cross sections along the course.

4.10. Results

Cross sections of temperature, salinity, σ_t, dissolved oxygen, pH, total alkalinity, reactive silicate, reactive phosphate, and nitrate along the course southward (17°N - 65°S) and northward (65°S - 15°N) are shown in Figures 2 - 19. All the data obtained and interpolated temperature and salinity are tabulated in separate tables (Oceanographic Data of KH-71-5 (Phoenix Expedition) of the Hakuhō Maru, Ocean Research Institute, University of Tokyo, 1973) and can be obtained on request to the Institute. Table of potential temperature at the depth sampled will also be available on request to the editor.

The results of the Southern Cross Cruise showed the existence of thermocline at the depth between 3,000 and 4,000 meter in the western South Pacific. It was seemed an important key to solve the circulation of the Pacific waters to verify whether such the thermocline also exists in the eastern part of the South Pacific. From the results of the observations in this expedition it is concluded that the benthic thermocline found in the western does not exist so clearly in the eastern South Pacific.

Decision of water types and mixing model of waters in the Pacific will be discussed by the authors and their coworkers in elsewhere.

Y. Saito gave Fig. 20 which shows the potemtial temperature-salinity relation and σ_θ-dissolved oxygen curves at all stations along the course.

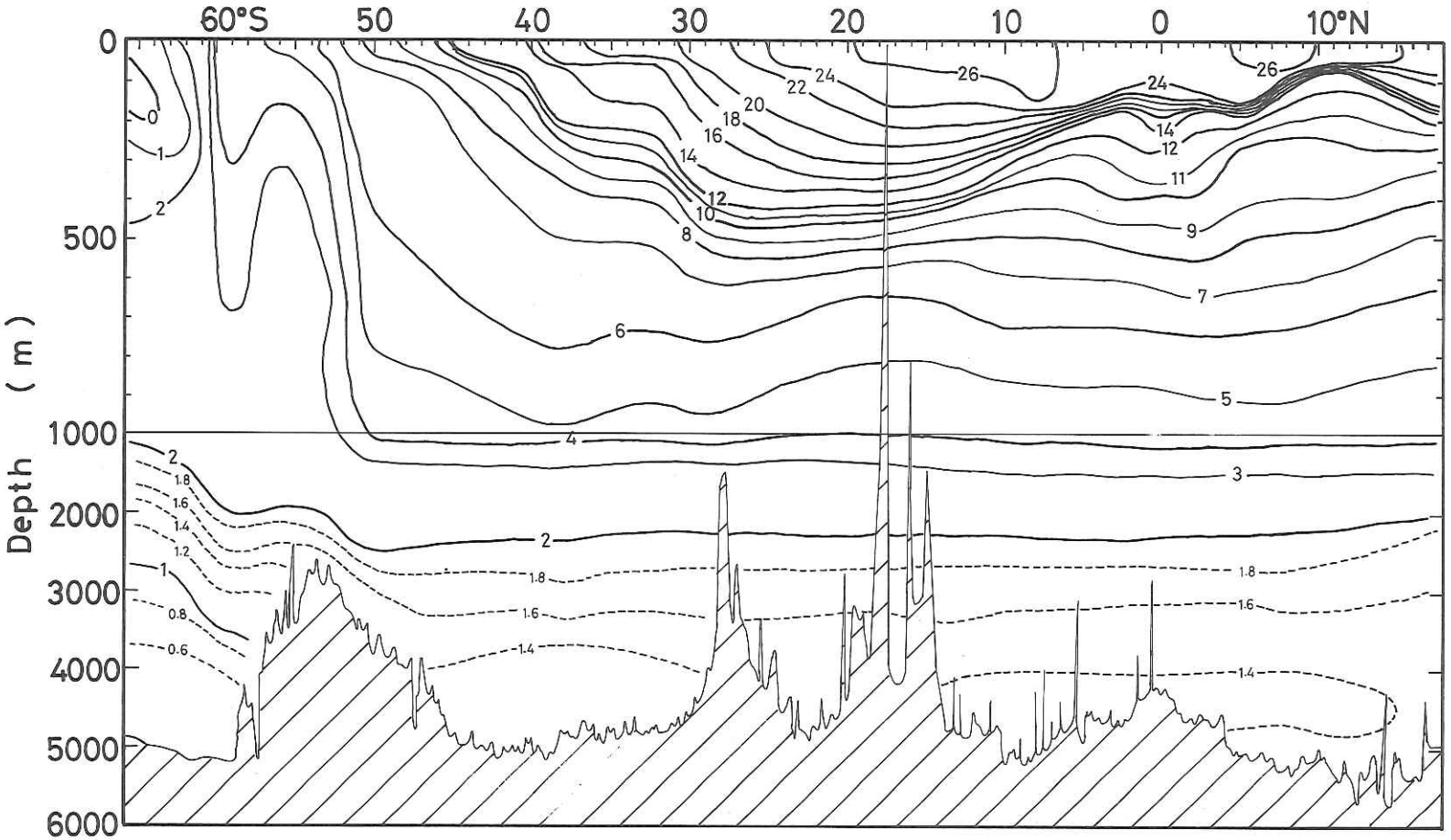


Fig. 2. Temperature profile, southward, 17°N-65°S. (Unit: °C)

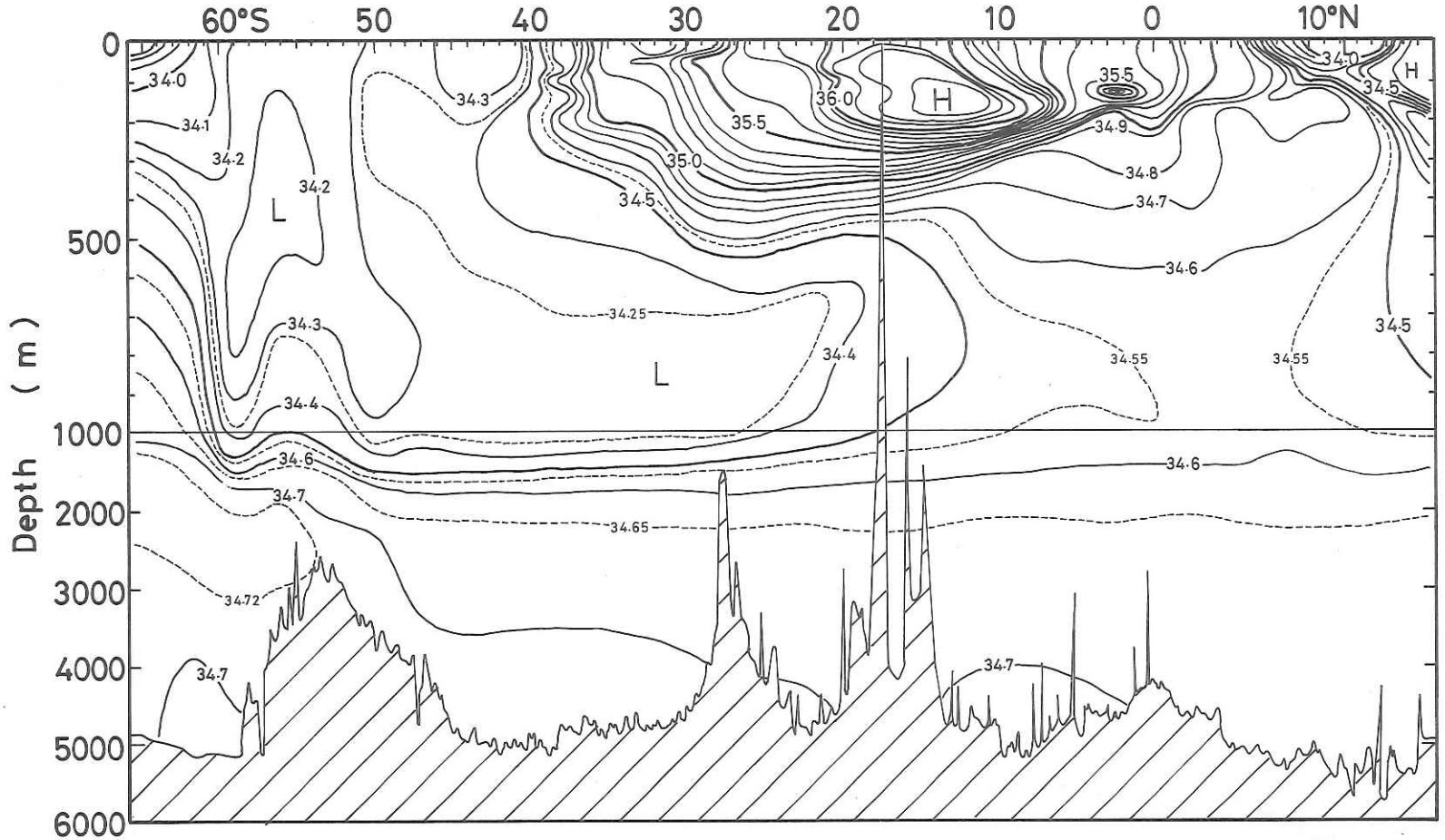


Fig. 3. Salinity profile, southward, 17°N-65°S. (Unit: °/₀₀)

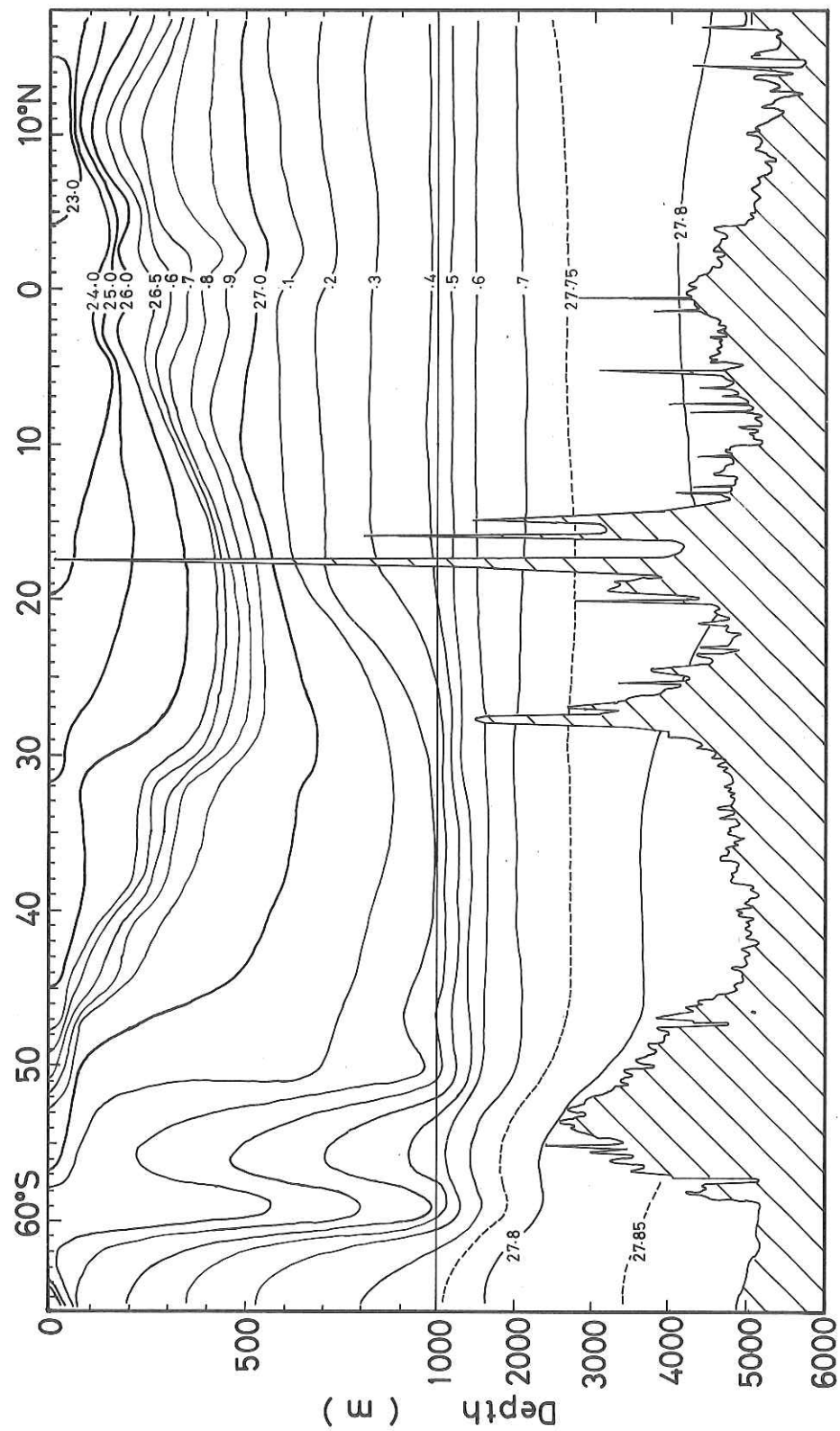


Fig. 4. σt profile, southward, 17°N-65°S.

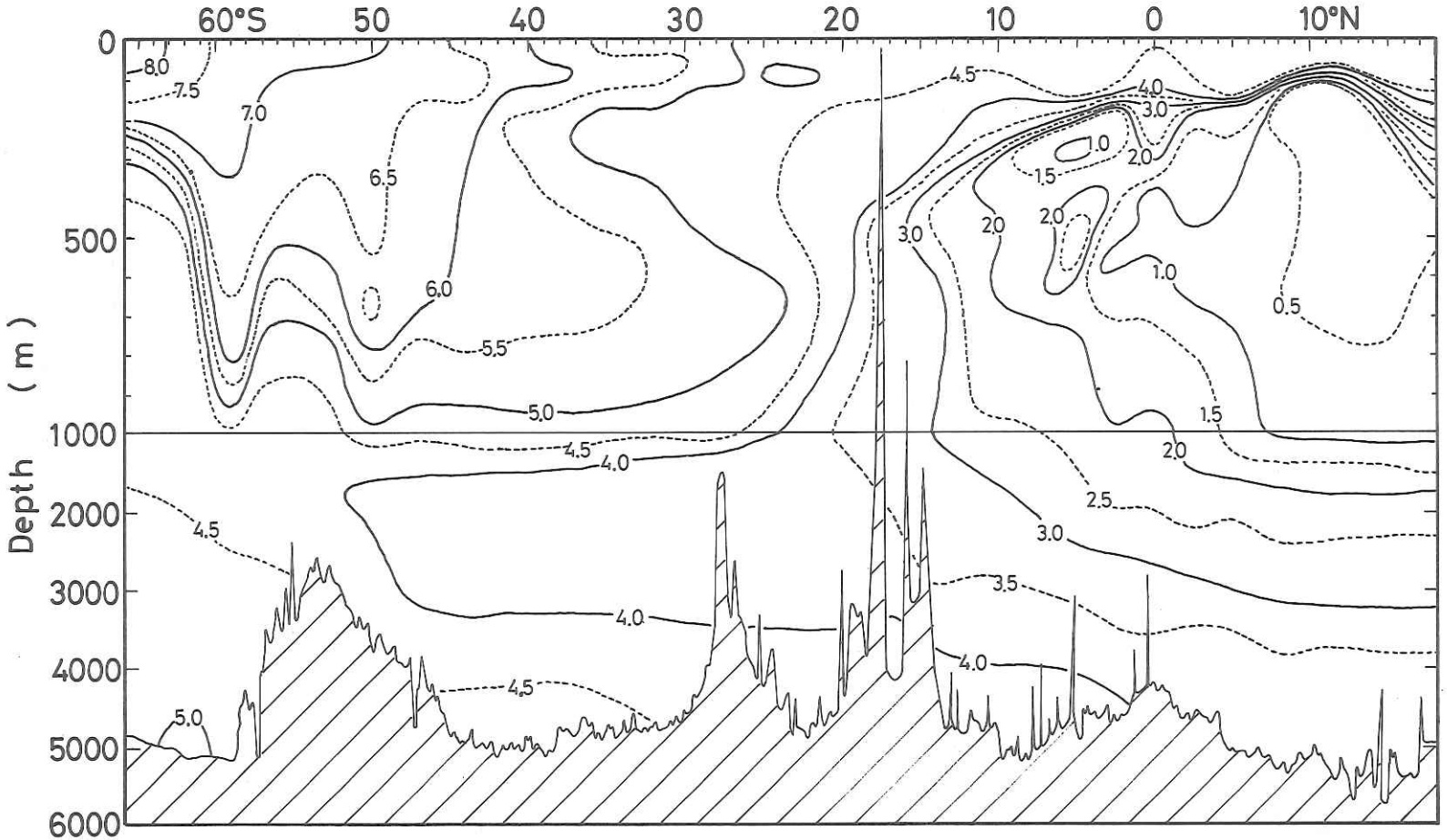


Fig. 5. Dissolved oxygen profile, southward, 17°N-65°S. (Unit: ml/l)

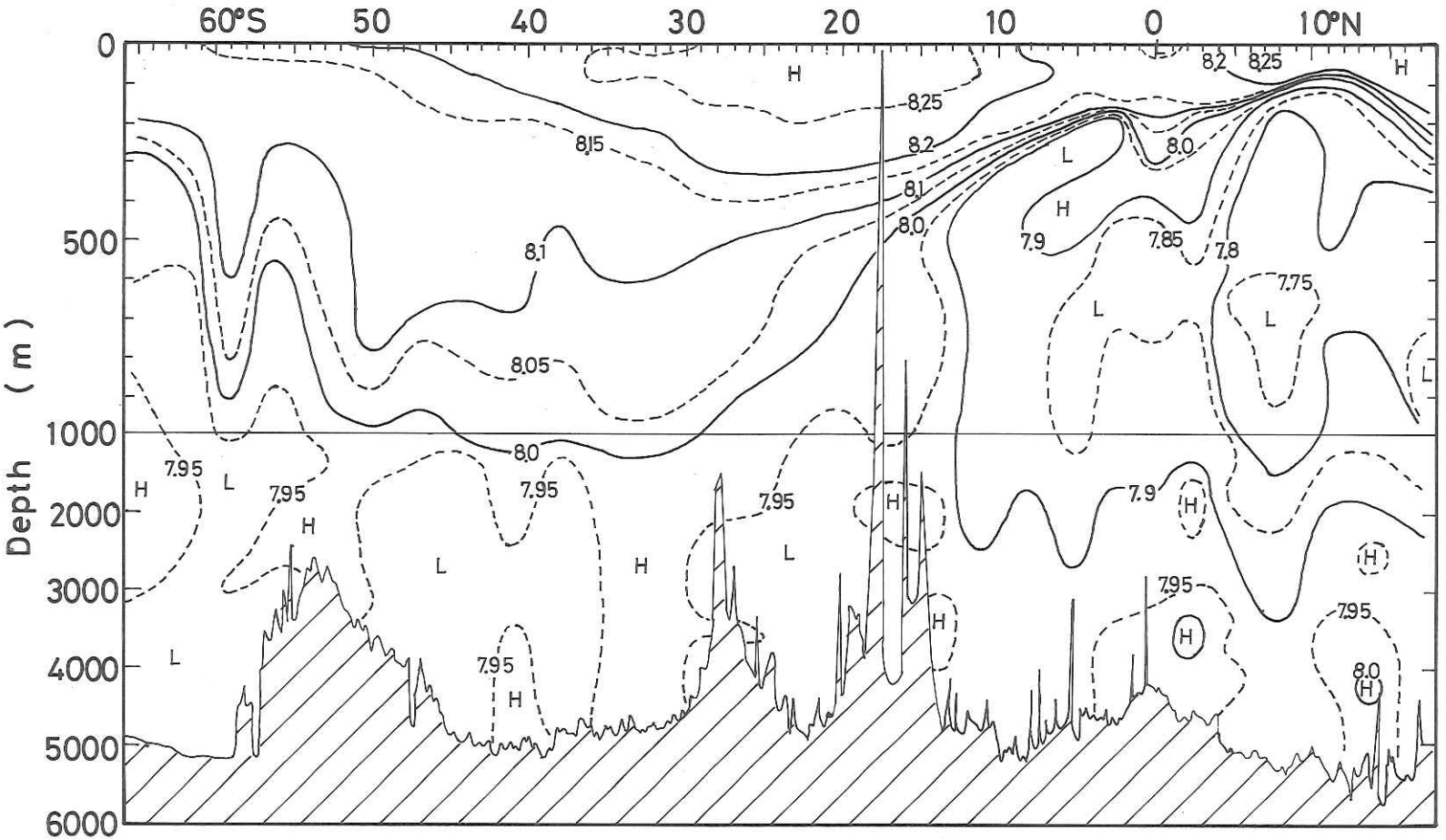


Fig. 6. pH profile, southward, 17°N-65°S.

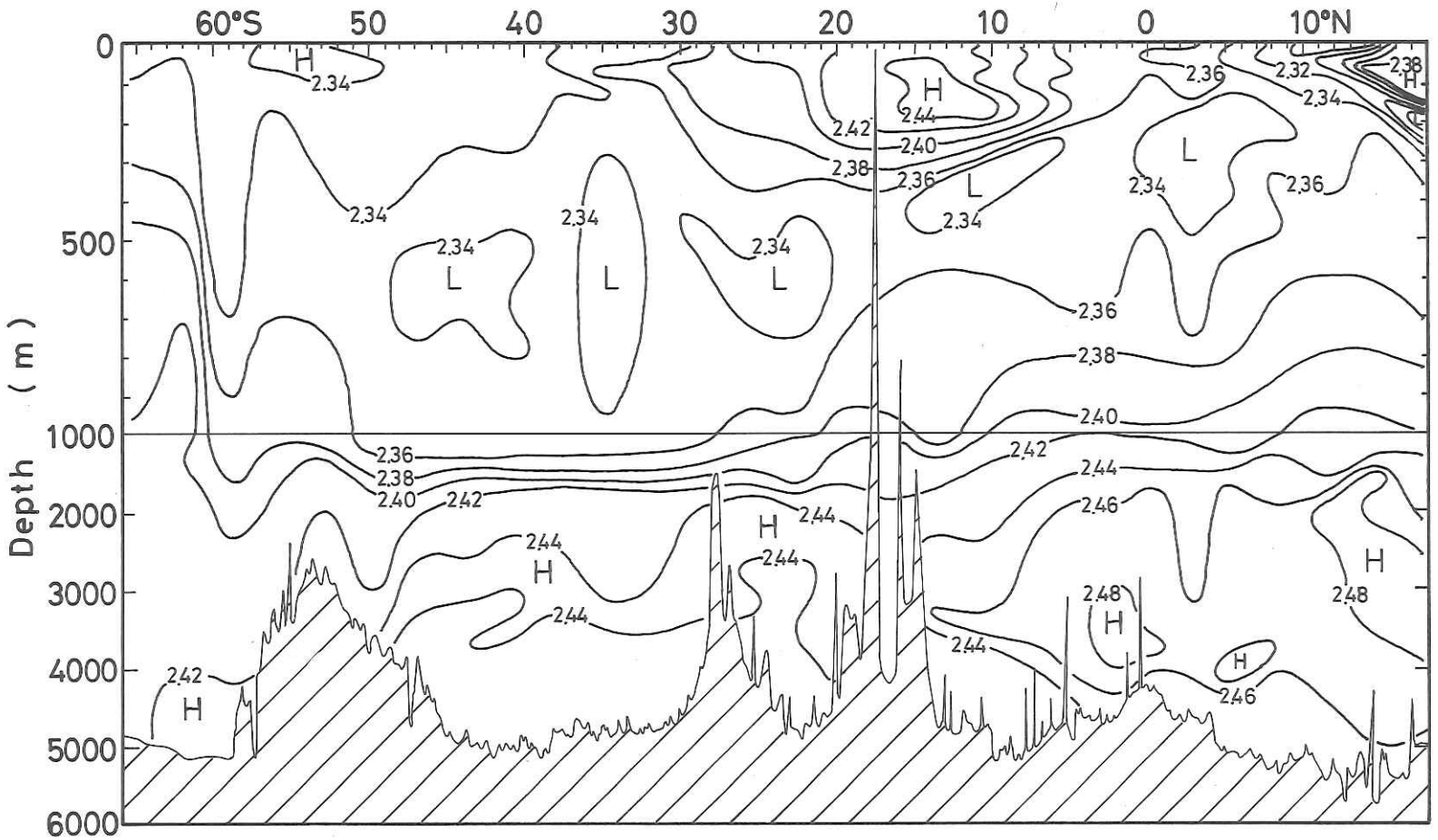


Fig. 7. Total alkalinity profile, southward, 17°N-65°S. (Unit: meq/l)

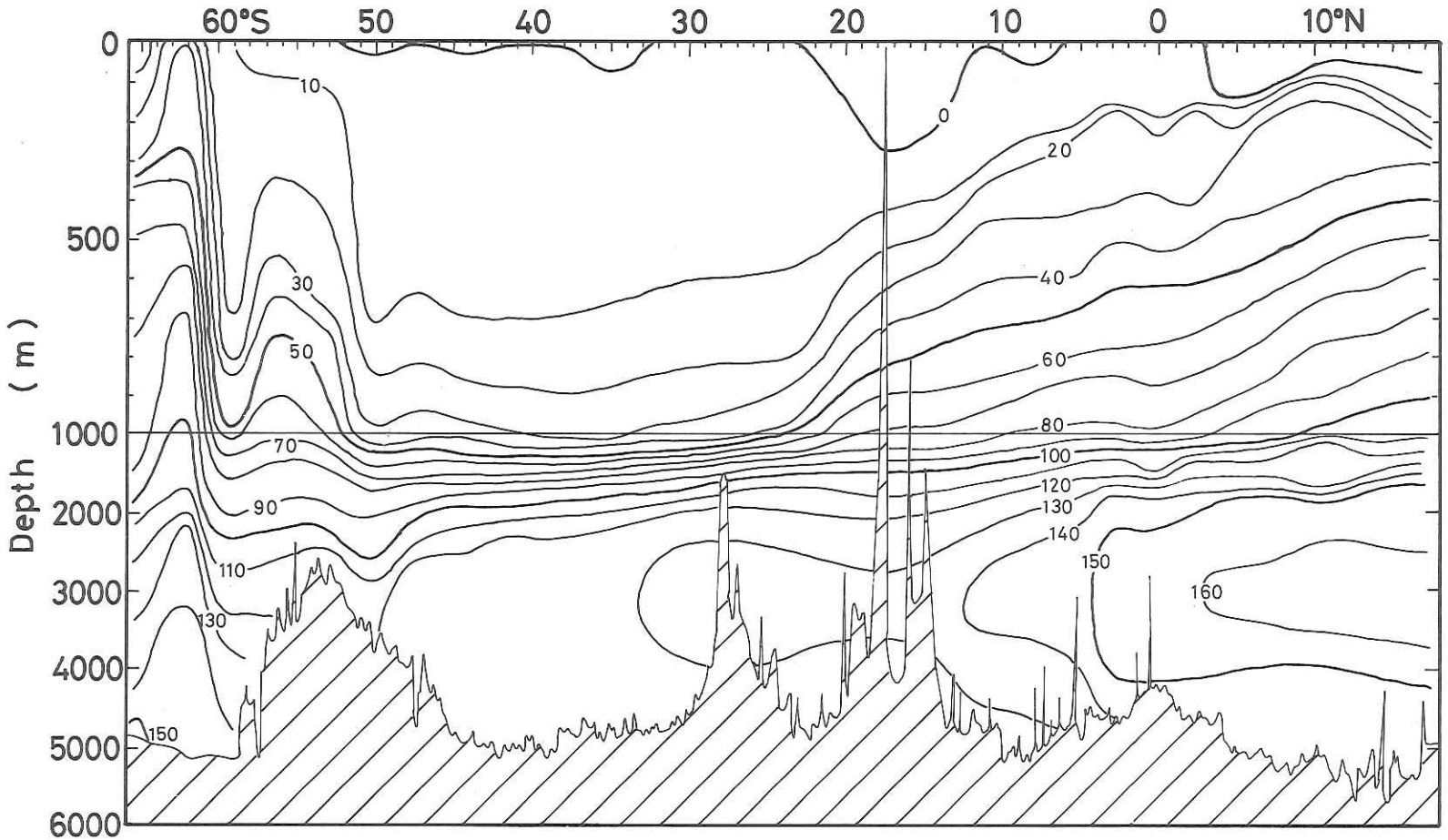


Fig. 8. Reactive silicate profile, southward, 17°N-65°S. (Unit: µg at/l)

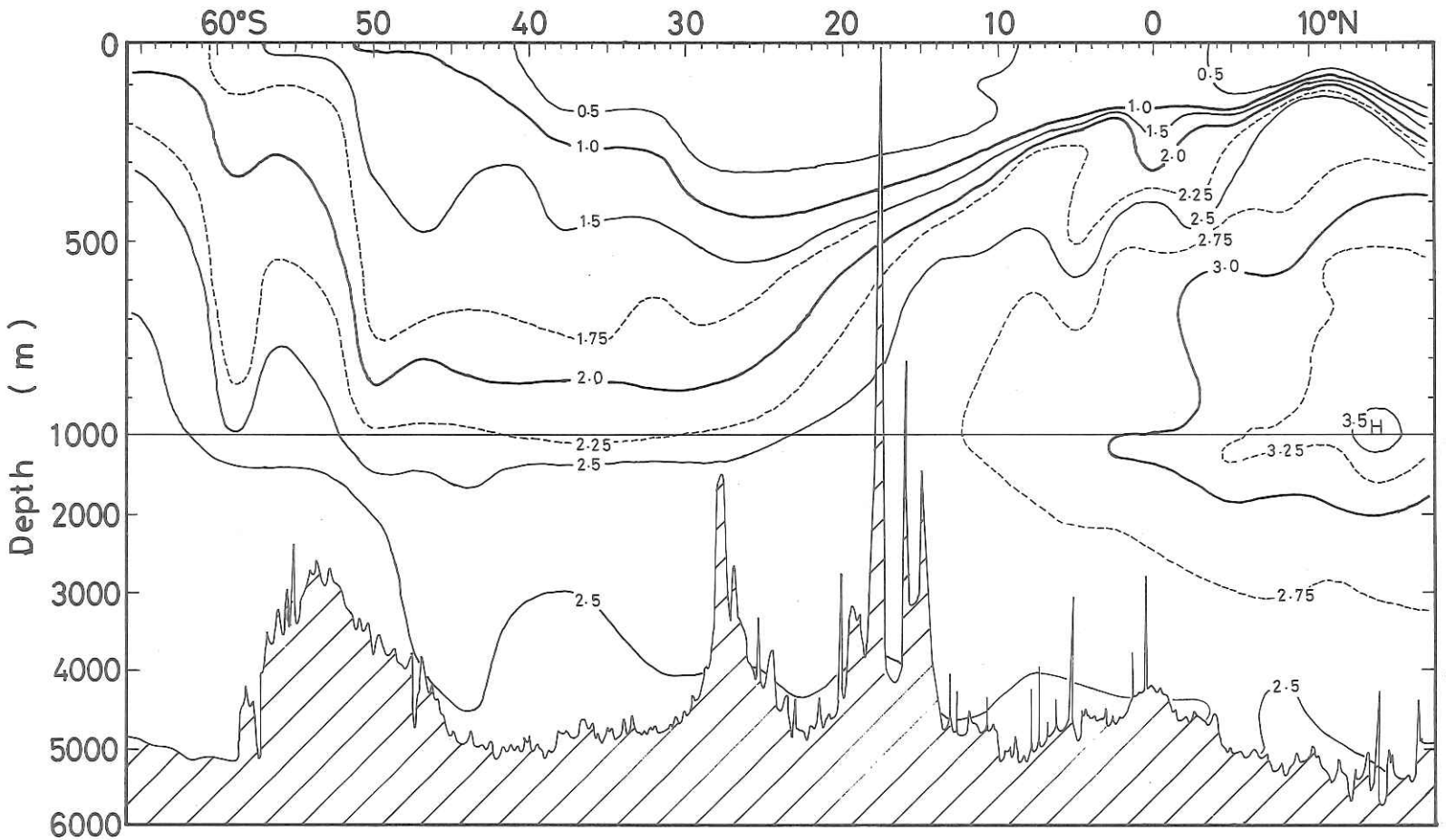


Fig. 9. Reactive phosphate profile, southward, 17°N-65°S. (Unit: µg at/l)

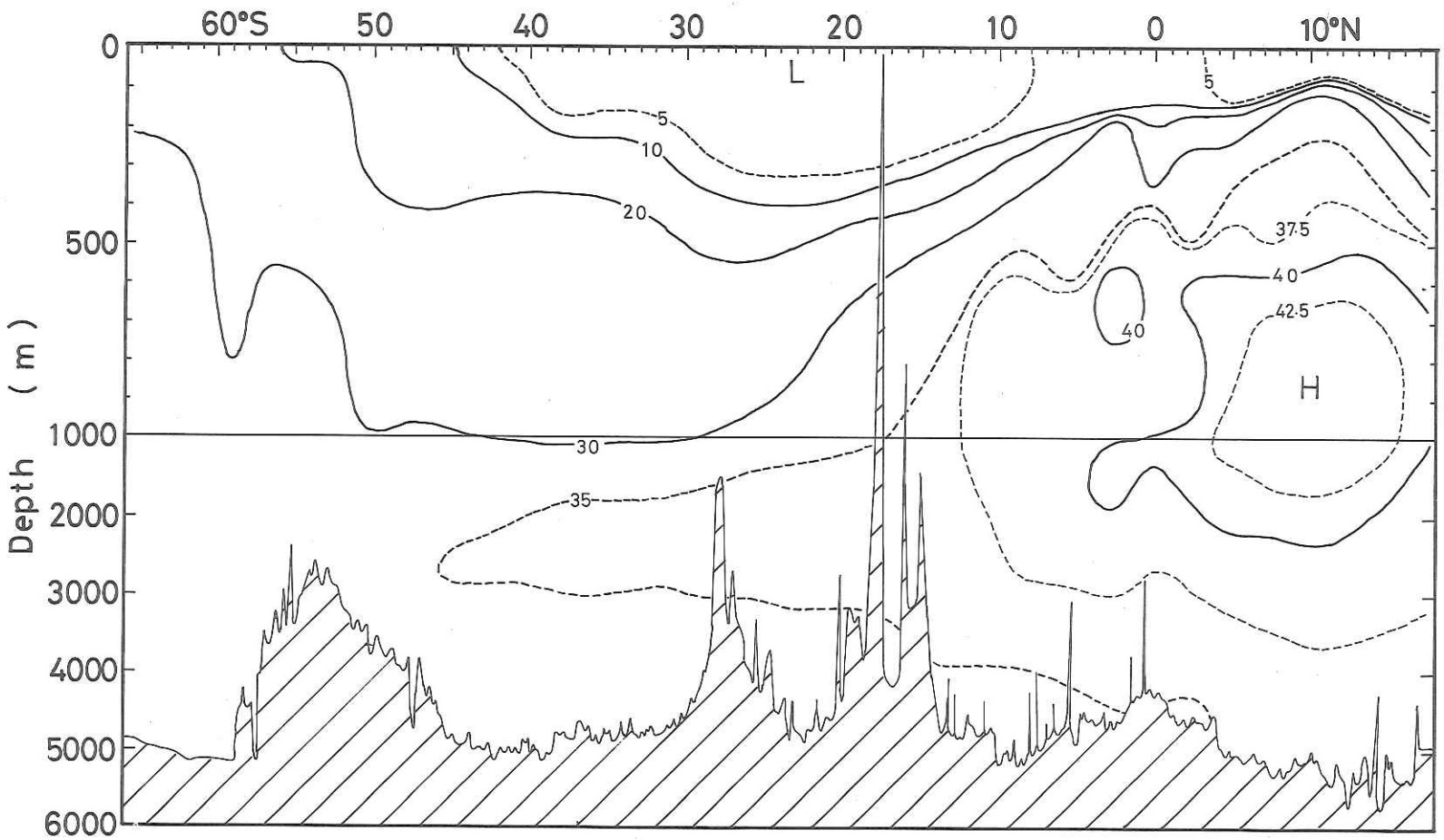


Fig. 10. Nitrate-nitrogen profile, southward, 17°N-65°S. (Unit: μg at/l)

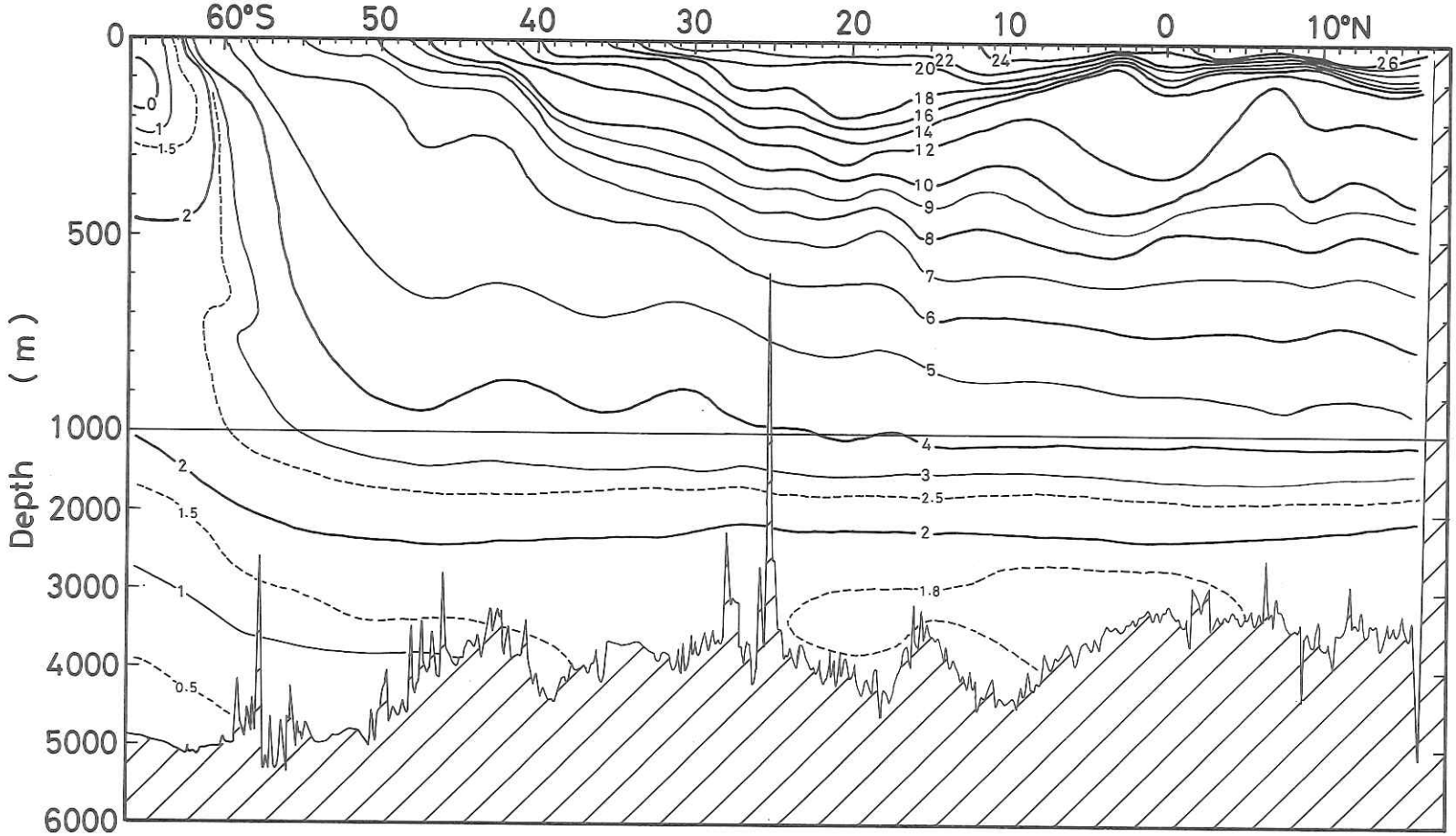


Fig. 11. Temperature profile, northward, 65°S-15°N. (Unit: °C)

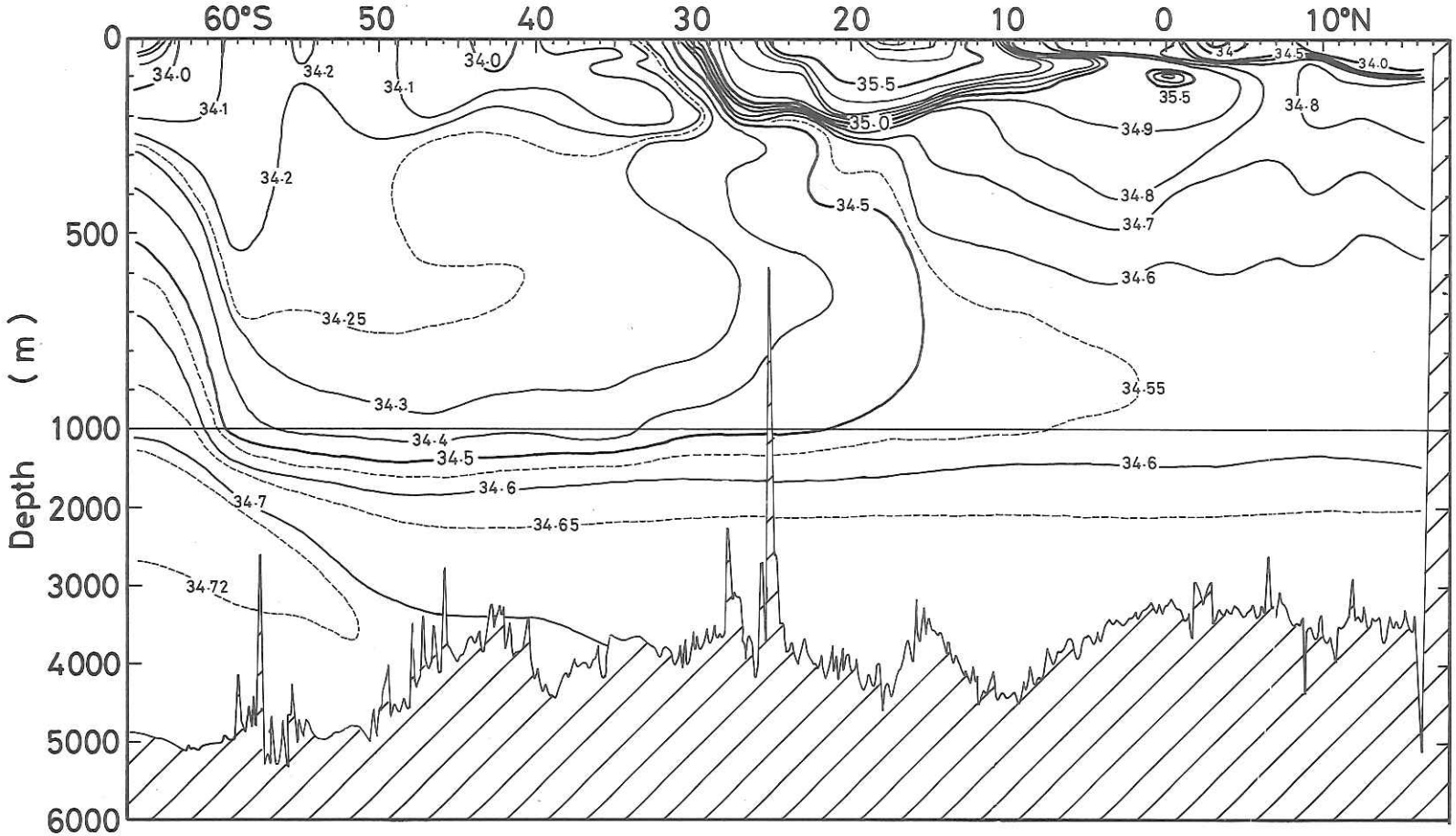


Fig. 12. Salinity profile, northward, 65°S-15°N. (Unit: °/₀₀)

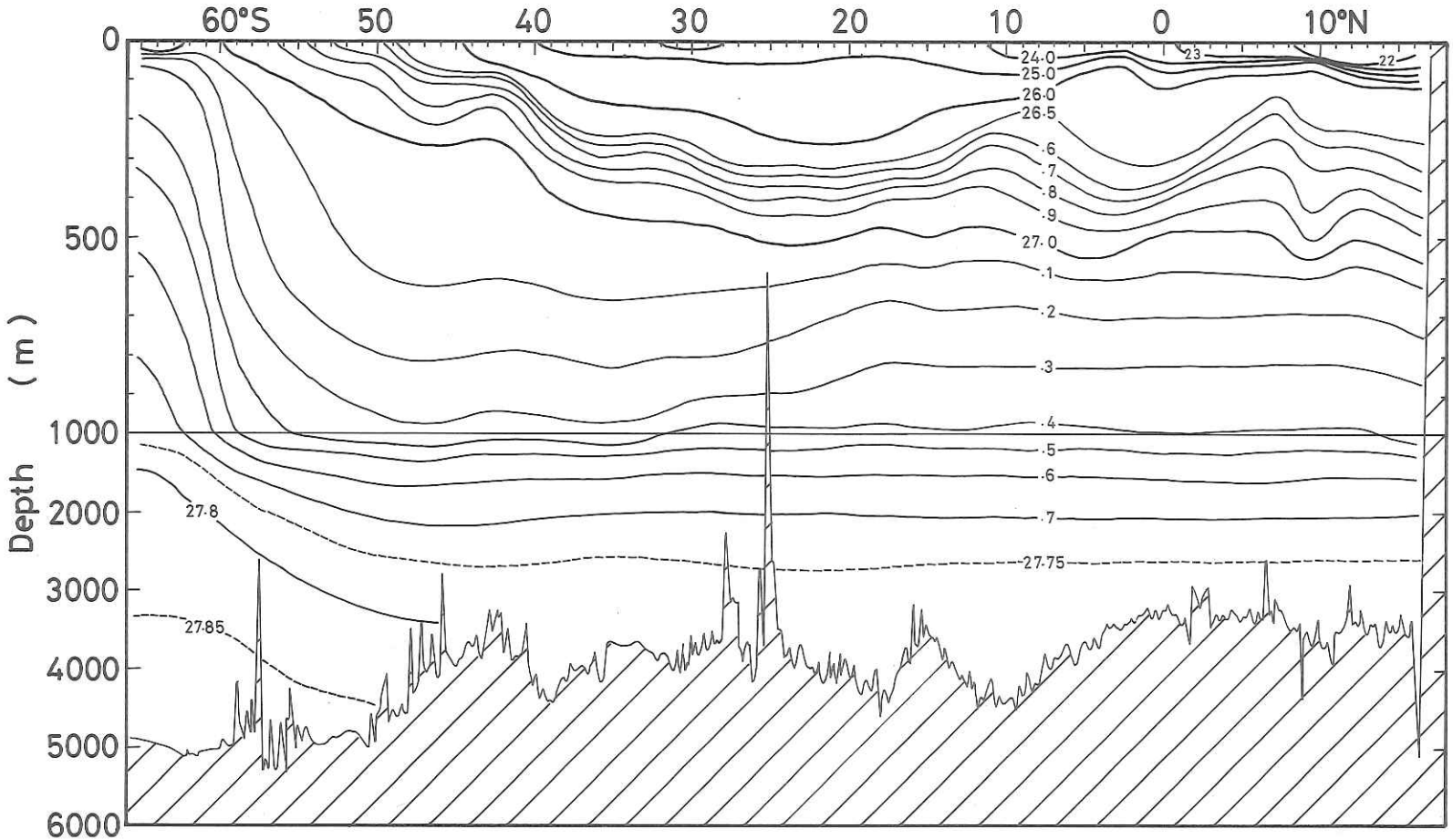


Fig. 13. σt profile, northward, 65°S-15°N.

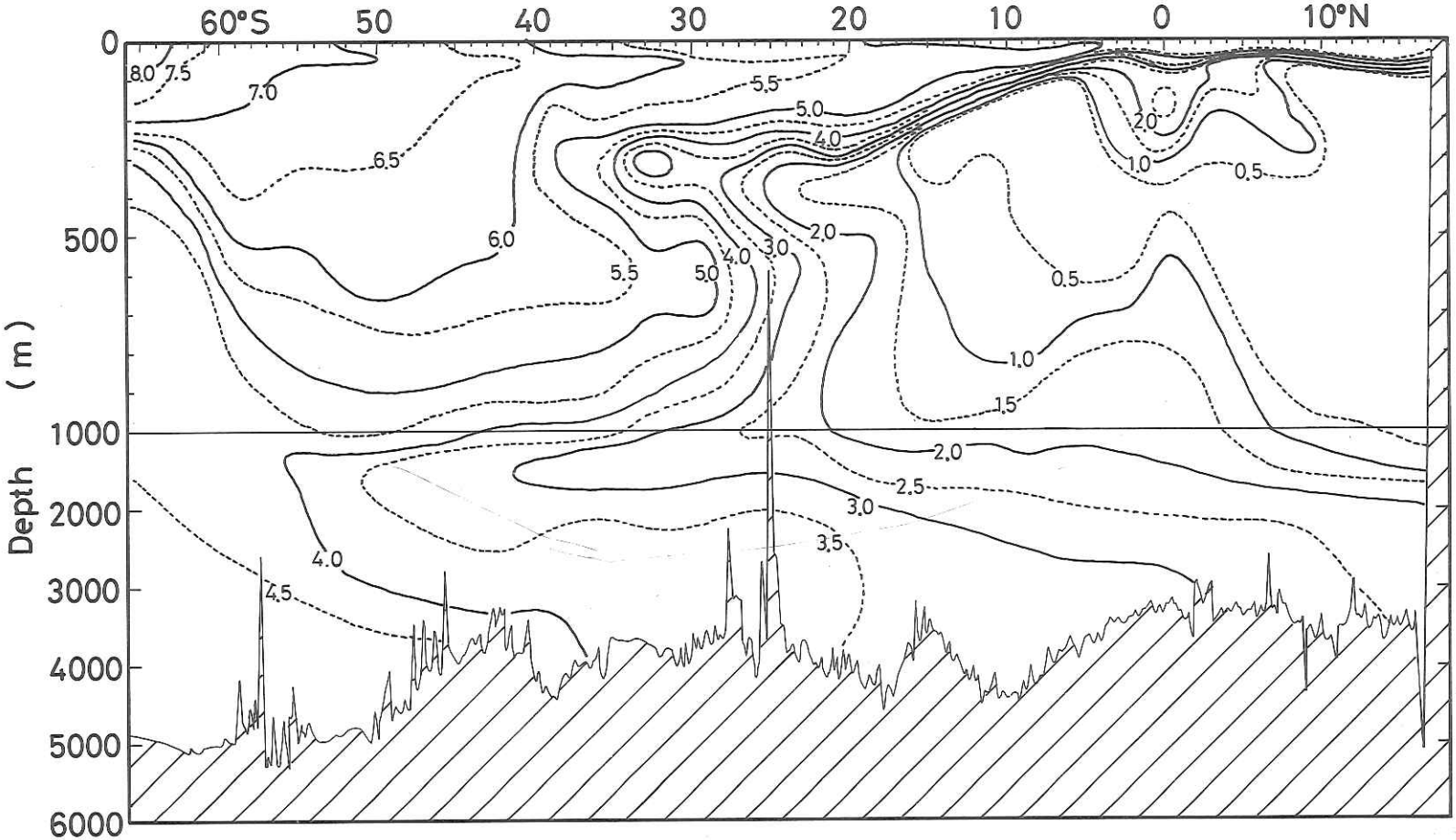


Fig. 14. Dissolved oxygen profile, northward, 65°S-15°N. (Unit: ml/l)

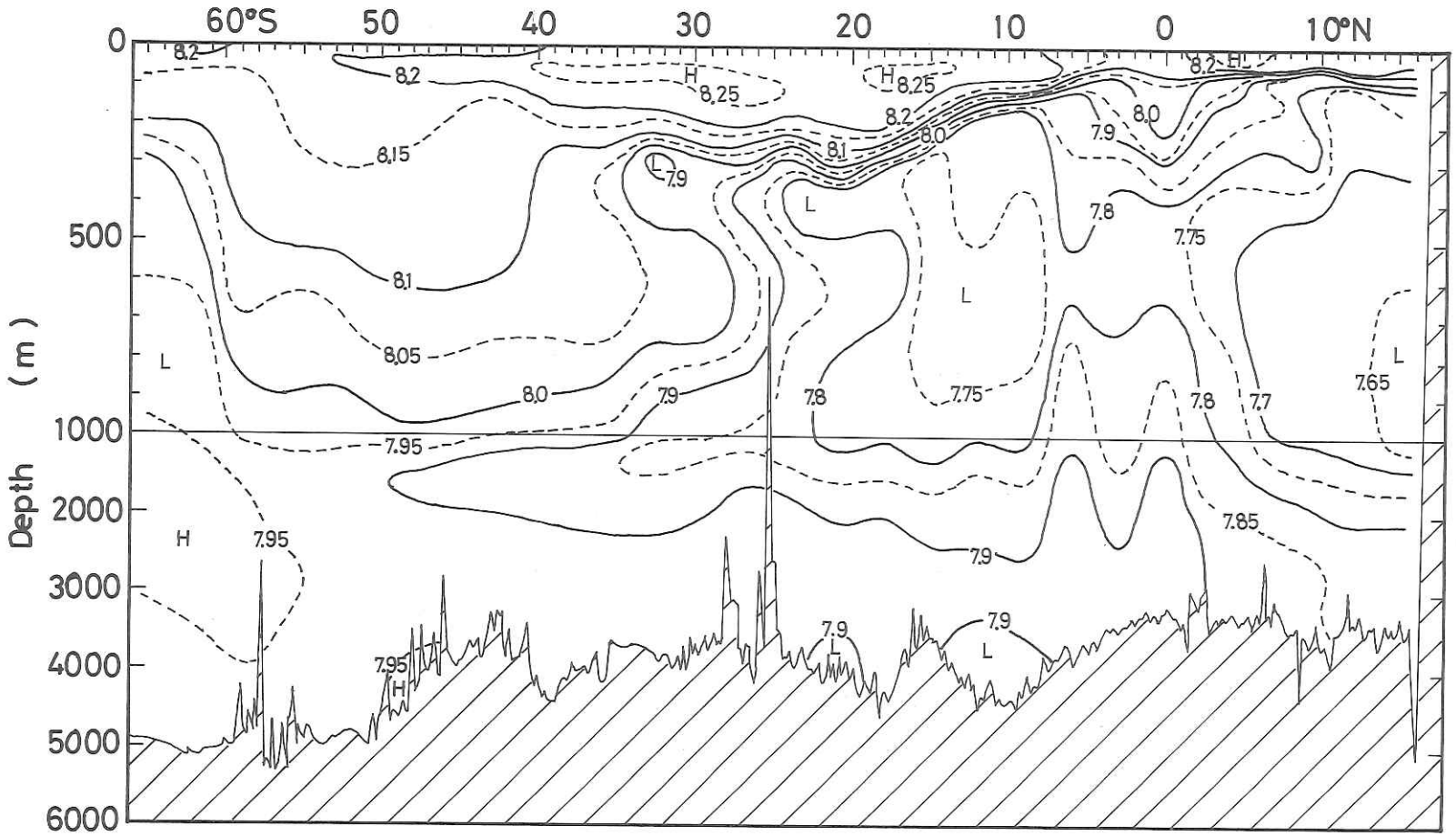


Fig. 15. pH profile, northward, 65°S-15°N.

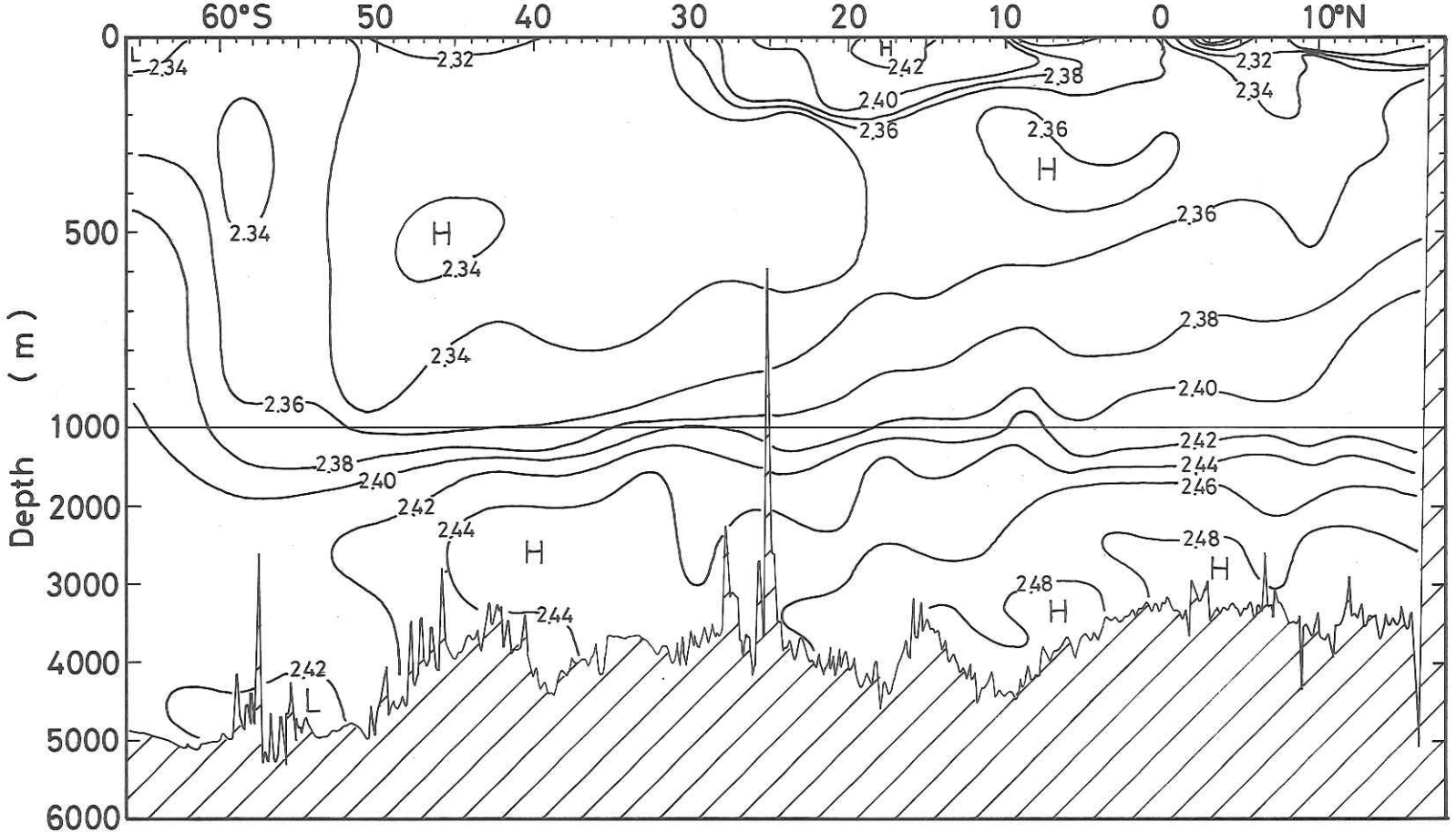


Fig. 16. Total alkalinity profile, northward, 65°S-15°N. (Unit: meq/l)

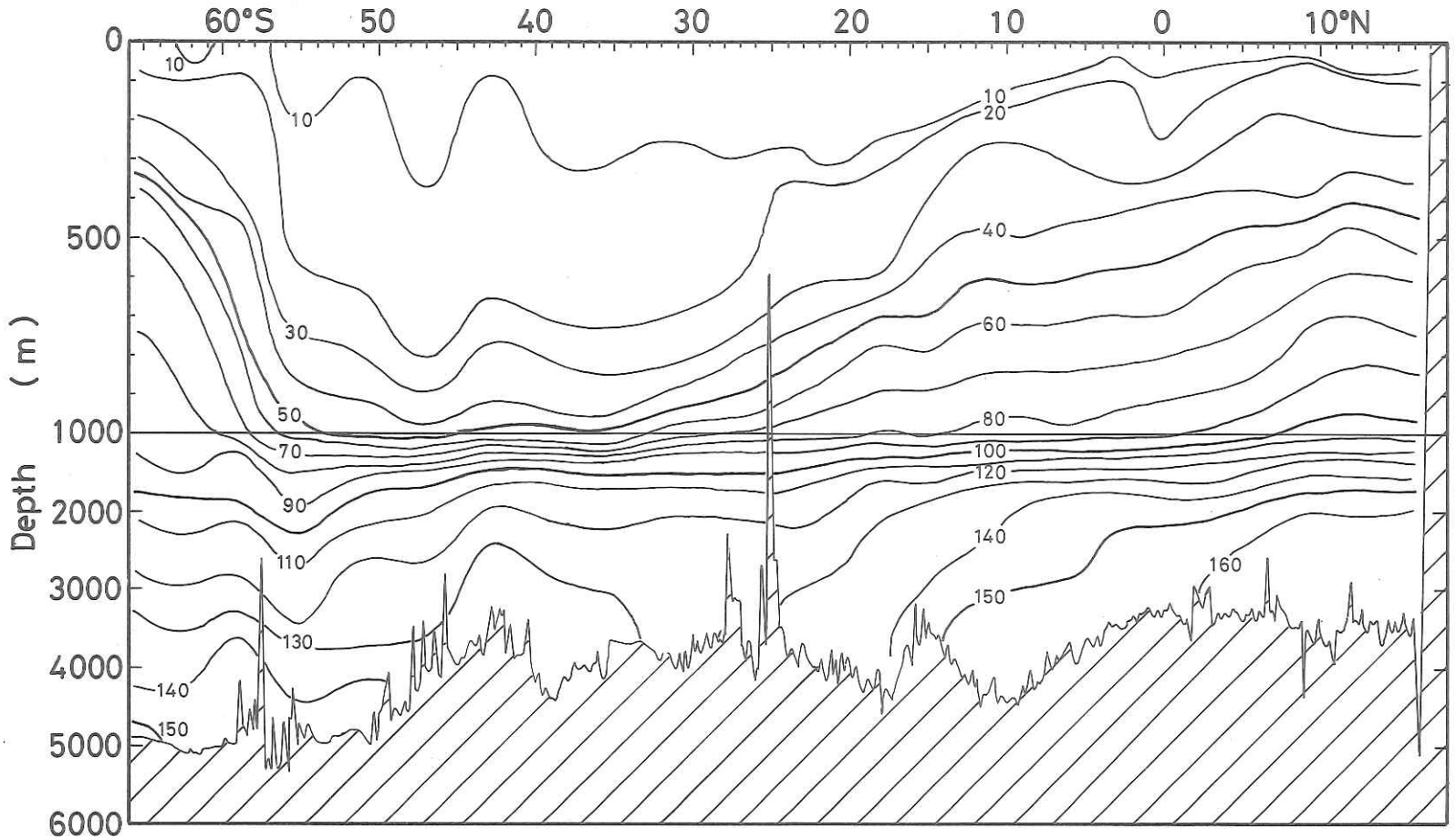


Fig. 17. Reactive silicate profile, northward, 65°S-15°N. (Unit: µg at/l)

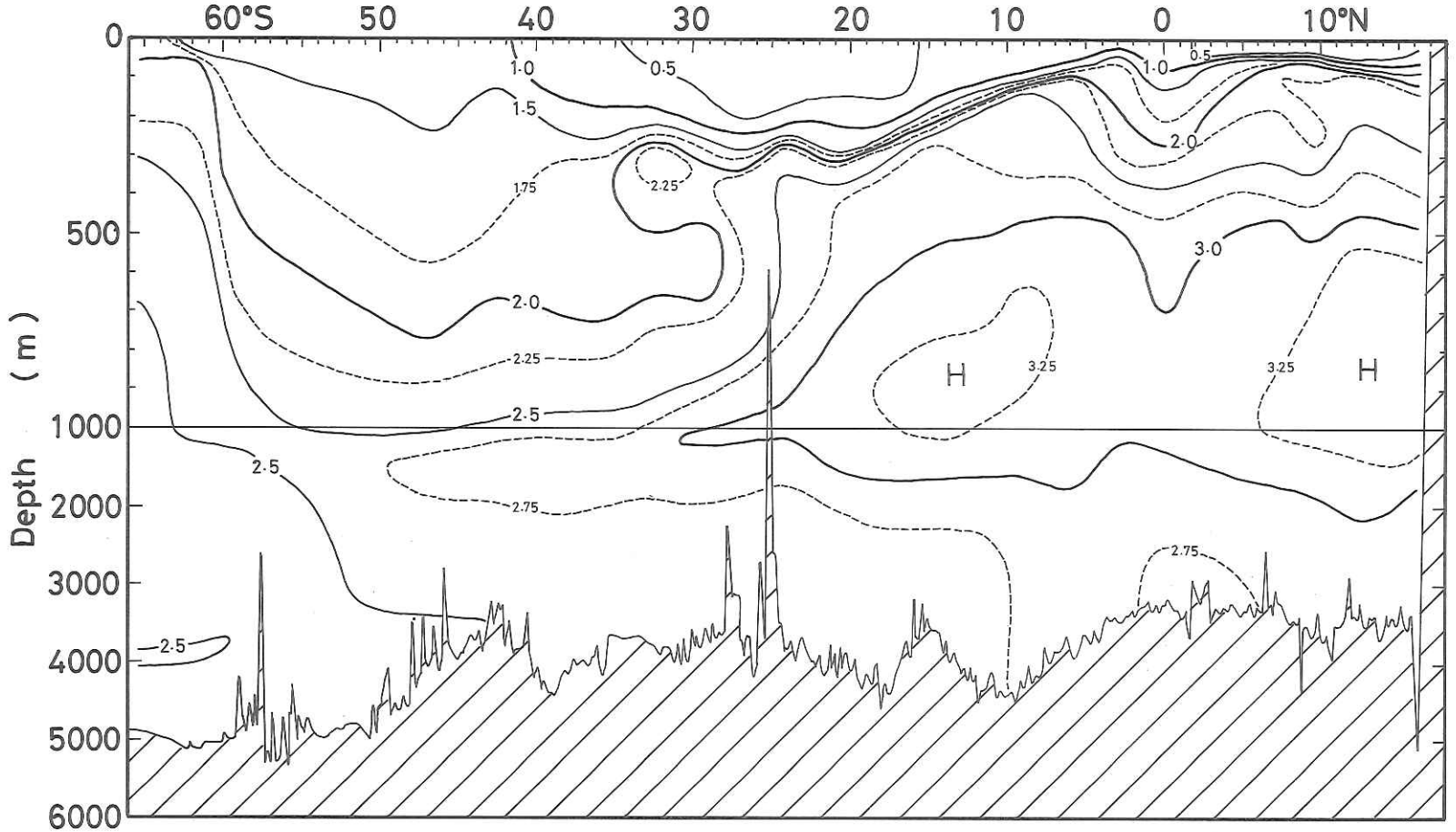


Fig. 18. Reactive phosphate profile, northward, 65°S-15°N. (Unit: µg at/l)

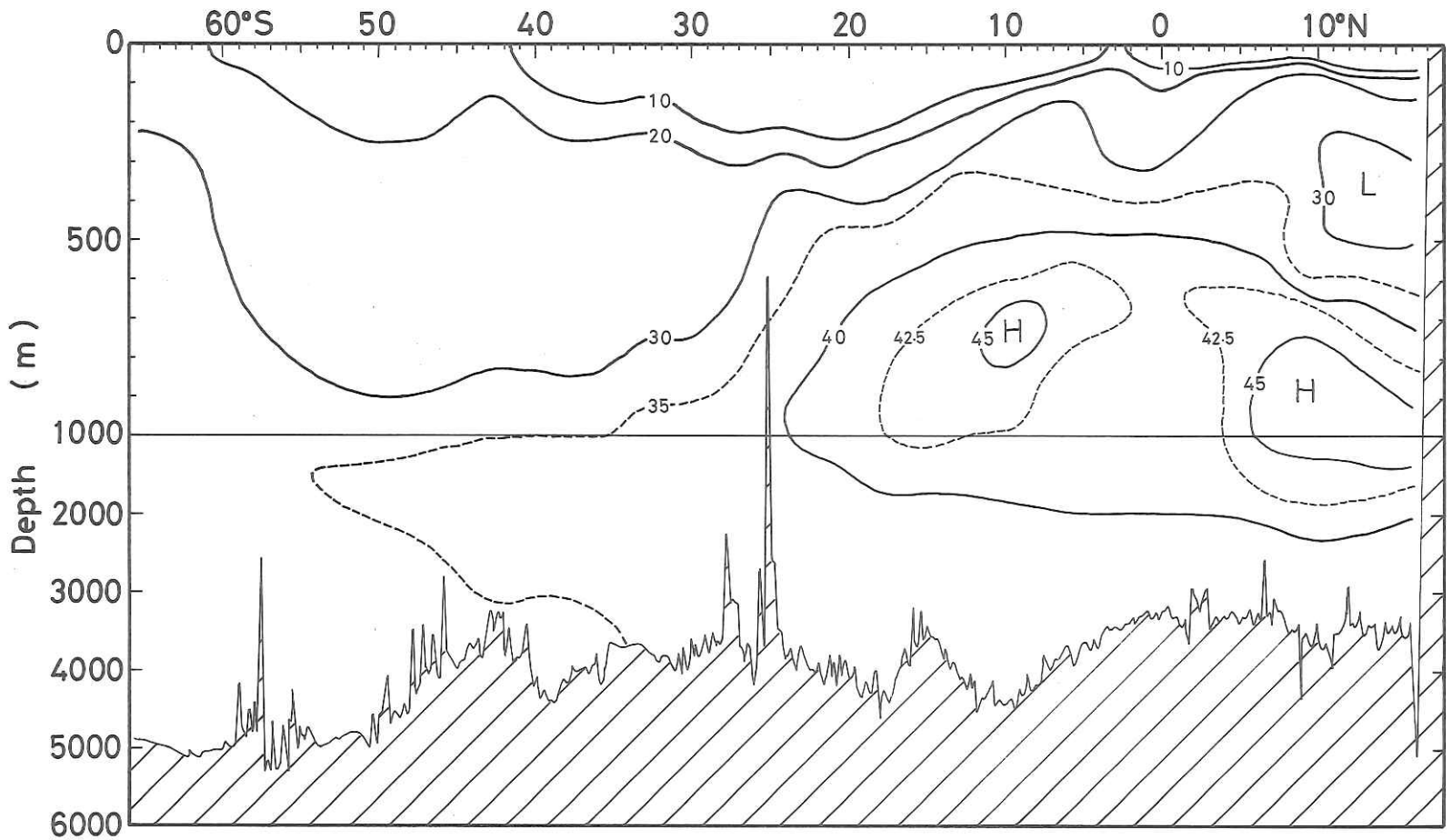
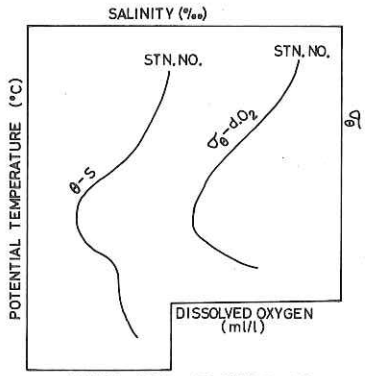
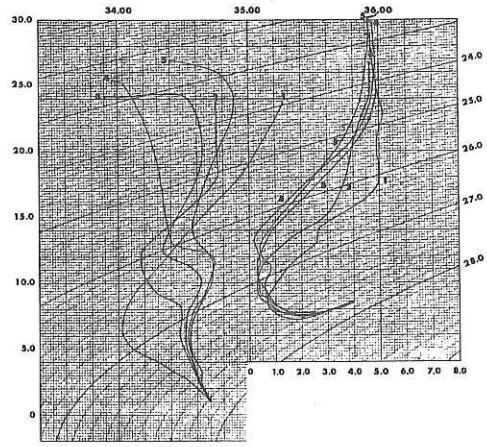
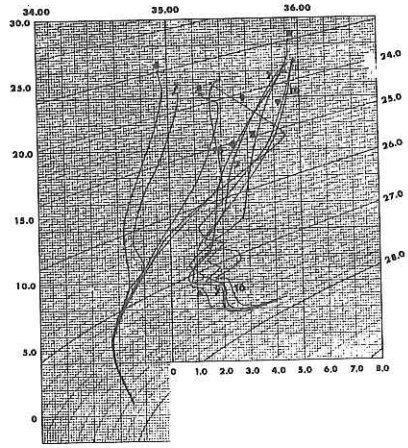


Fig. 19. Nitrate-nitrogen profile, northward, 65°S-15°N. (Unit: µg at/l)



KEYS FOR FIGURE 20





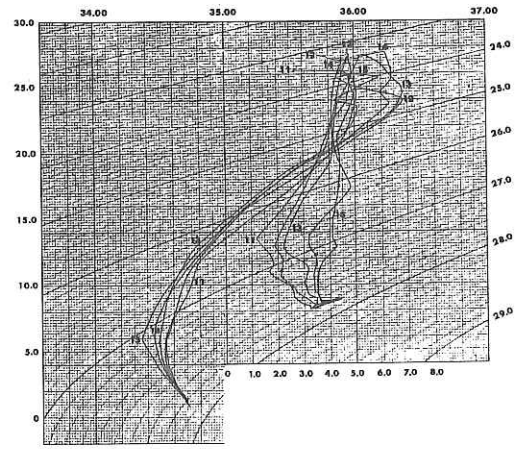
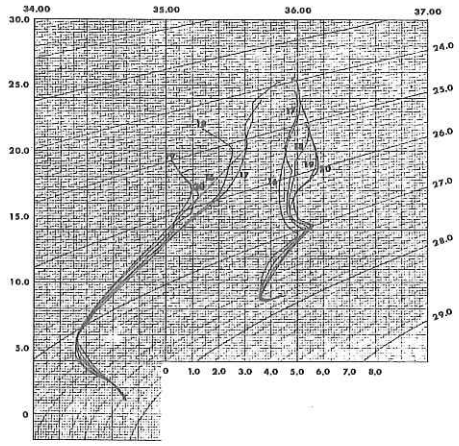
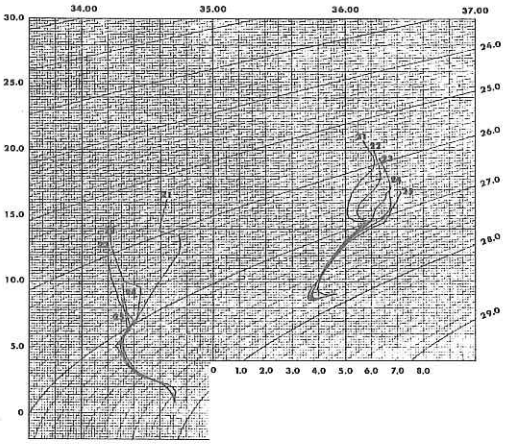
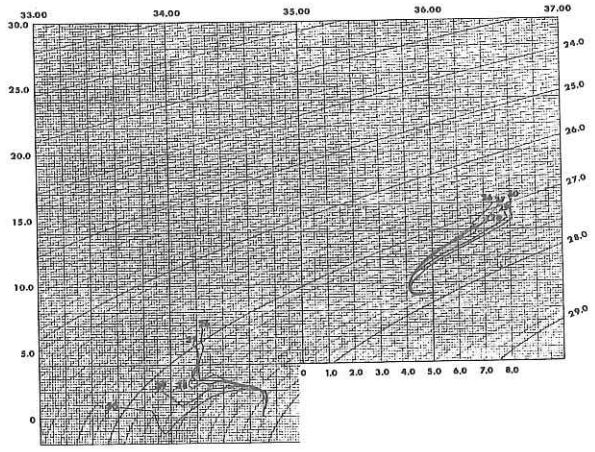


Fig. 20. Potential temperature-salinity and σ_θ-dissolved oxygen relations.







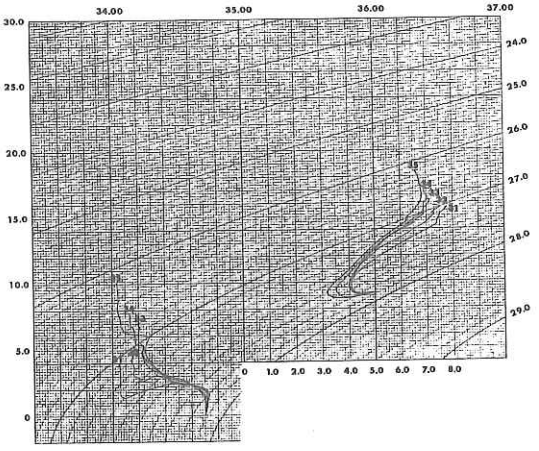


Fig. 20. Continued.

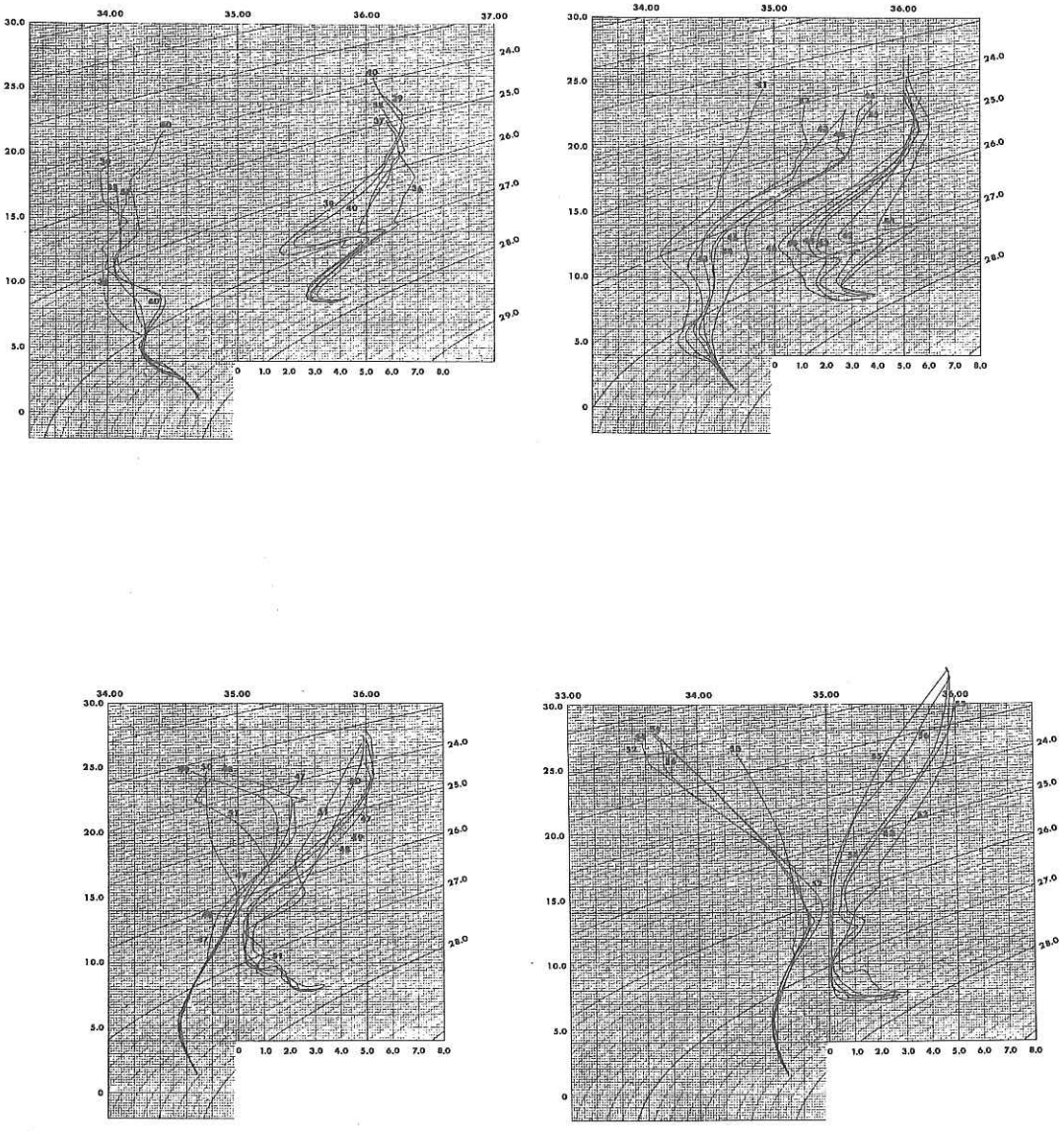


Fig. 20. Continued.

5. Observation with in situ S.T.D. System

by

H.Tsubota, Y.Sugimura, Y.Saito, T. Nakai, and H.Hasumoto

In the Southern Cross Cruise[1)], an in situ S.T.D. system (Bissett-Berman Model 9006) coupled with Rosette Multi Sampler (Model RMS-12) was used for the chemical studies of Equatorial Undercurrent. From the sections obtained it was supposed that the zone where the oxygen isoclines spread out coincides with the zone where surface water of the southern and the northern high-salinity water regions mix together.

In the present expedition, S.T.D.obervations with Rosette Multi Sampler were again carried out in the same latitudes along 146°W (southward) and 100°W (northward) of longitude. The characteristic sections of chemical components were more distinguished along these longitudes rather than along 170°W.

Another S.T.D. observation was made along 33°S of latitude between the coast of Chile and 84°W of longitude. A coastal Peruvian subsurface countercurrent was previously investigated in the STEP-I Expedition (1960) and the Scorpio Expedition (1967). The present observation might produce an additional knowledge for elucidating this subsurface countercurrent, particularly the outward extensions from the strip.

Water samples obtained were used for the determination of salinity (for checking the S.T.D. system), dissolved oxygen, pH, total alkalinity, reactive silicate and phosphate, and nitrite on board, and the remains were brought back to onland laboratories. Stations are shown in Table 3 and 4.

The obervation was carried out by two groups which were led by H. Tsubota and Y. Sugimura, respectively. The chemical analyses and data treatments were made by the same members as was described in the section of Hydrocast. The details of the operation were same as was described earlier[1)], except that a computer was used to read the STD frequencies on line, store their numerical values, punch into tapes and

Table 3. Stations of Equatorial Undercurrent Study

Station Number	Position		Time			Remarks
	Latitude	Longitude	Date		Hour	
Crom-A	2°00.5'N	145°59.8'W	Dec. 6	1971	1115-1225	STD
B	1°30.4'N	145°58.8'W	Dec. 6	1971	1904-2025	STD
C	1°01.3'N	146°01.8'W	Dec. 6-7	1971	2344-0334	STD
D	0°30.0'N	146°00.0'W	Dec. 7	1971	0639-0817	STD
E	0°02.0'S	146°01.7'W	Dec. 7	1971	1103-1235	STD
F	0°33.7'S	145°59.8'W	Dec. 7	1971	2024-2147	STD
G	1°06.3'S	145°59.7'W	Dec. 8	1971	0048-0200	STD
H	1°39.0'S	145°59.8'W	Dec. 8	1971	0449-0607	STD
I	2°13.1'S	145°58.6'W	Dec. 8	1971	0902-1024	STD
J	2°30.2'S	146°00.6'W	Dec. 8	1971	1215-1348	STD
K	2°59.8'S	146°01.0'W	Dec. 8	1971	2120-2247	STD
L	2°57.1'S	100°03.7'W	Jan.31	1972	1317-1430	STD
M	2°29.6'S	99°59.3'W	Jan.31	1972	2052-2206	STD
N	1°57.5'S	99°57.5'W	Feb. 1	1972	0053-0158	STD
O	1°24.8'S	99°57.7'W	Feb. 1	1972	0455-0606	STD
P	1°00.3'S	99°55.4'W	Feb. 1	1972	0827-0936	STD
Q	0°27.9'S	99°57.6'W	Feb. 1	1972	1233-1345	STD
R	0°00.3'N	100°00.2'W	Feb. 1	1972	2020-2135	STD
S	0°30.2'N	99°57.1'W	Feb. 2	1972	0422-0518	HC
T	1°00.0'N	99°58.1'W	Feb. 2	1972	0802-0852	HC
U	1°30.0'N	100°00.7'W	Feb. 2	1972	1110-1200	HC
V	2°00.0'N	100°05.8'W	Feb. 2	1972	1430-1510	HC

STD: Observation with in situ STD system

HC: Hydrocast with 2.7 liter Niskin Samplers

Table 4. Stations of Off-Chilean Current Study

Station Number	Position		Time			Remarks
	Latitude	Longitude	Date		Hour	
Chile-1	32°57.7'S	71°39.4'W	Jan.19	1972	1630-1639	BT
2	32°58.0'S	71°46.8'W	Jan.19	1972	1715-1724	BT
3	32°58.6'S	71°54.4'W	Jan.19	1972	1802-1810	BT
A	32°59.6'S	71°57.9'W	Jan.19	1972	1935-2030*	STD
B	33°00.0'S	73°00.0'W	Jan.20	1972	0156-0339	STD
C	33°03.3'S	73°54.3'W	Jan.20	1972	0855-1046	STD
D	33°02.3'S	75°01.7'W	Jan.20	1972	1541-1715	STD
E	32°55.5'S	76°00.0'W	Jan.21	1972	0220-0349	STD**
F	32°54.0'S	78°01.9'W	Jan.21	1972	1228-1402	STD
G	32°54.2'S	79°59.5'W	Jan.21-22	1972	2135-0049	STD***
H	33°02.0'S	81°57.1'W	Jan.22	1972	0915-1105	STD
I	32°29.1'S	84°00.0'W	Jan.22-23	1972	2356-0122	STD**

STD: Observation with in situ STD system
BT Observation with BT only
* (U-3) → (U-4)
** without Rosette Samplers
*** two runs

print out: Operations of the computer were rescued by the atmospheric physics group because of a lack of hands.

At the station Crom-S, the sensor was broken by an accident and the remaining observations (Crom S, T, U and V) were switched to the layer-by-layer method.

Sections of temperature, salinity, and dissolved oxygen in Equatorial Undercurrent study are shown in Figs. 21-26. Sections of temperature, salinity, dissolved oxygen, pH, total alkalinity, reactive silicate and reactive phosphate for off-Chilean Current are shown in Figs.27-33. The values of these parameters are tabulated in "Oceanographic Data of KH-71-5 (Phoenix Expedition) of the Hakuhō Maru, Ocean Research Institute, Univ. of Tokyo, 1973", and can be obtained on request to the Institute.

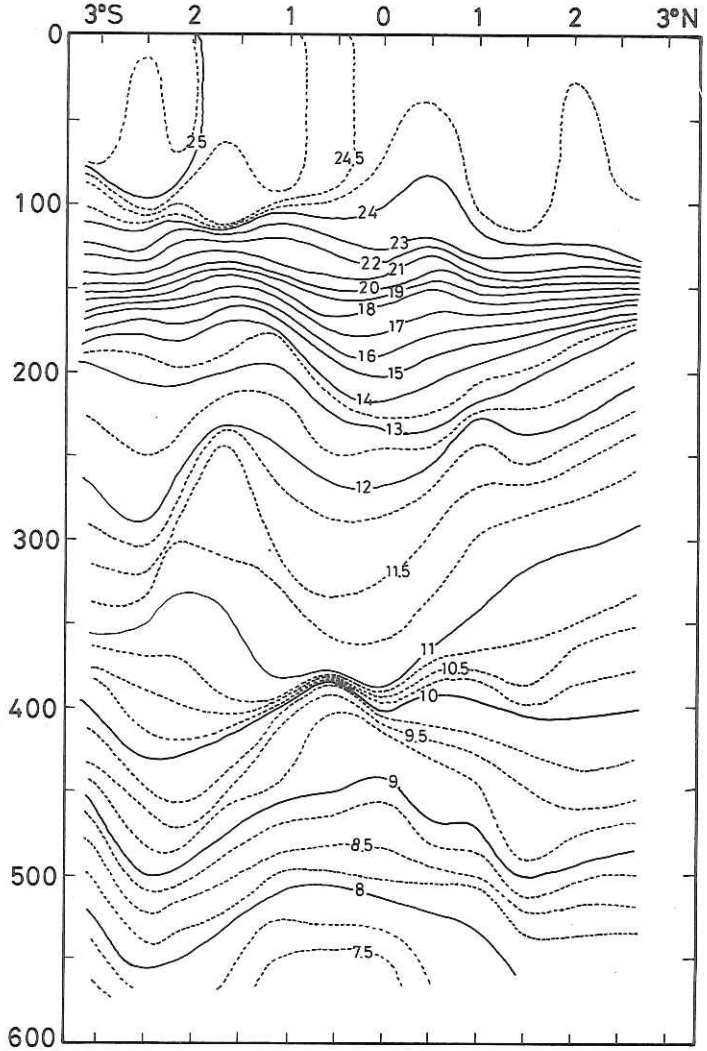


Fig. 21. Temperature profile between 2°N and 3°S along 146°W longitude. (Unit: °C)

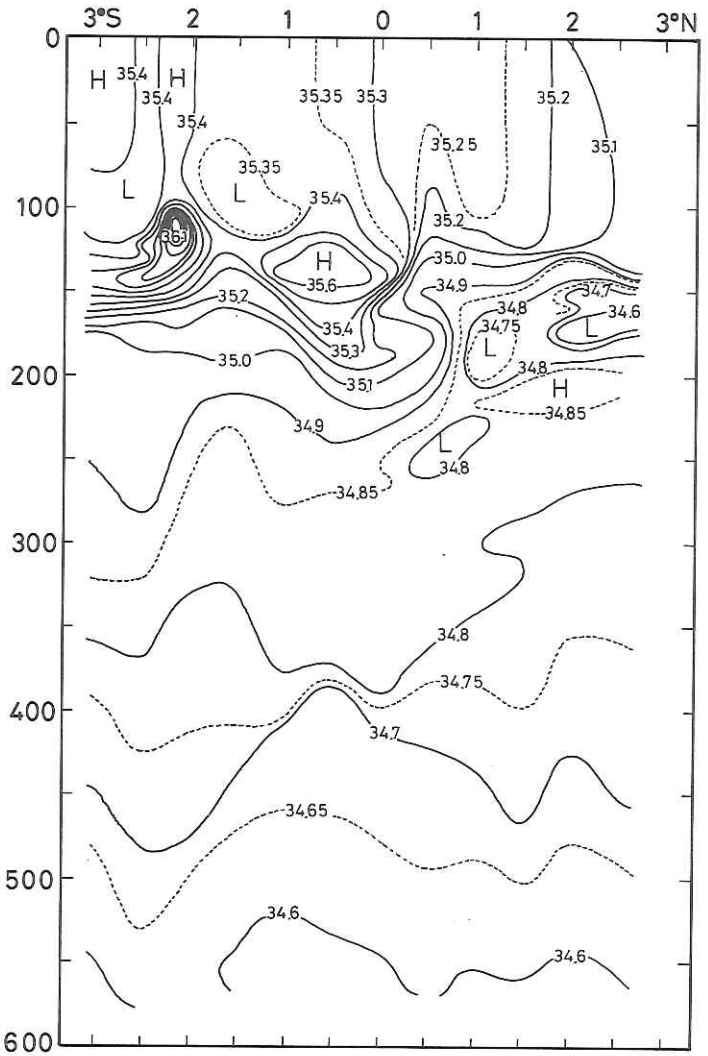


Fig. 22. Salinity profile between 2°N and 3°S along 146°W longitude. (Unit: °/₀₀)

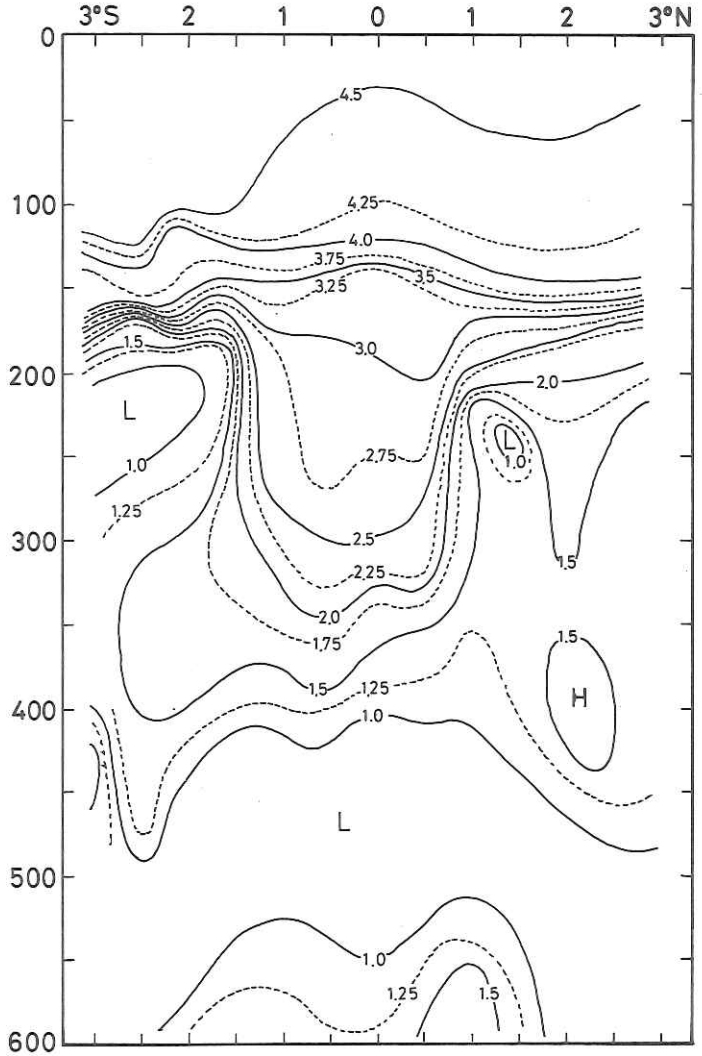


Fig. 23. Dissolved oxygen profile between 2°N and 3°S along 146°W longitude. (Unit: ml/l)

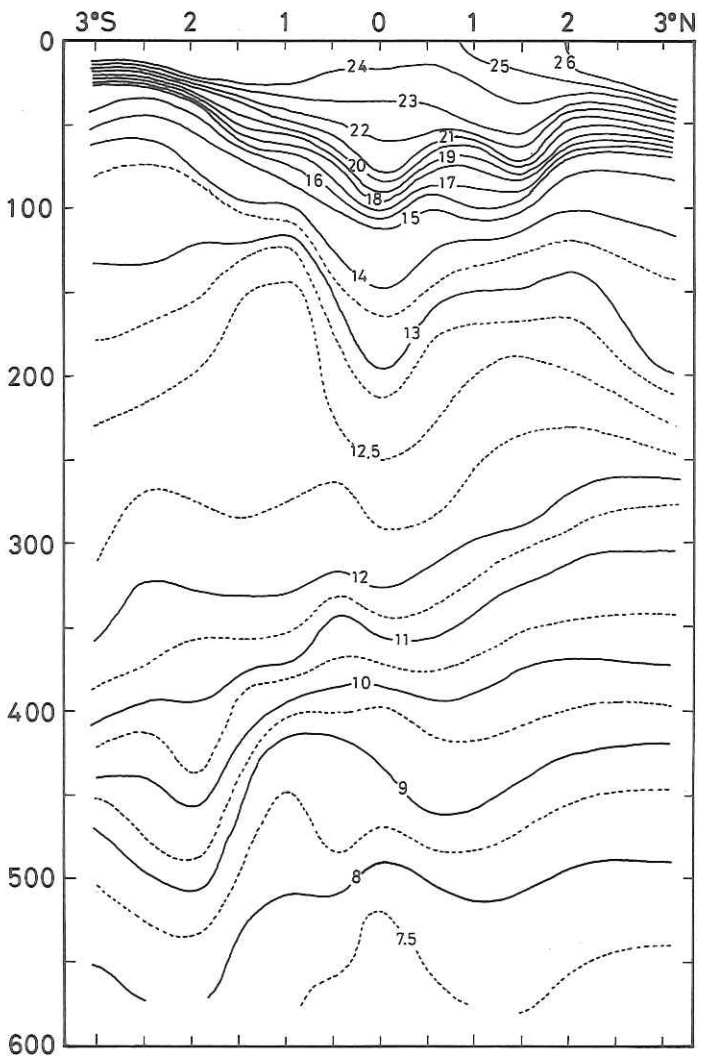


Fig. 24. Temperature profile between 3°S and 2°N along 100°W longitude. (Unit: °C)

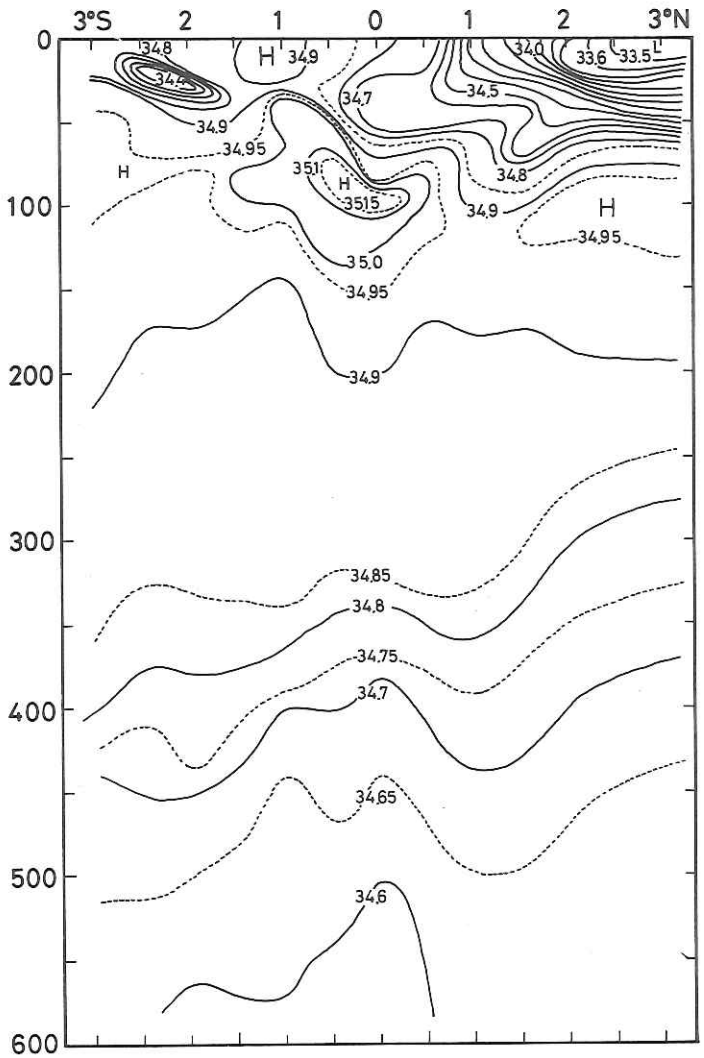


Fig. 25. Salinity profile between 3°S and 2°N along 100°W longitude. (Unit: °/₀₀)

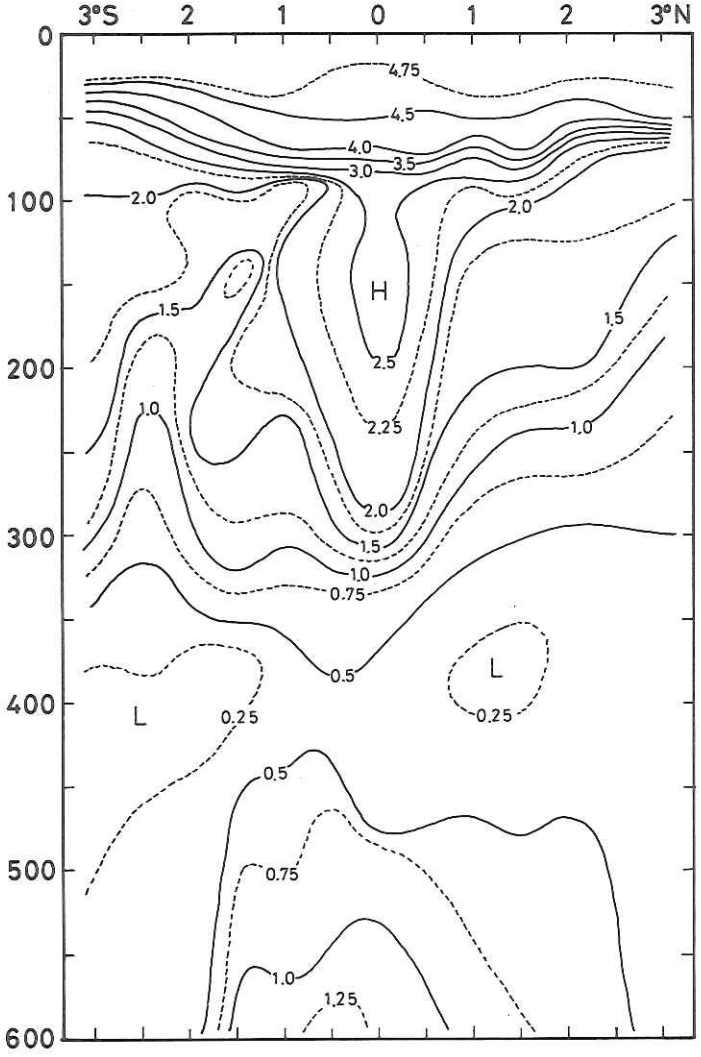


Fig. 26. Dissolved oxygen profile between 3°S and 2°N along 100°W longitude. (Unit: ml/l)

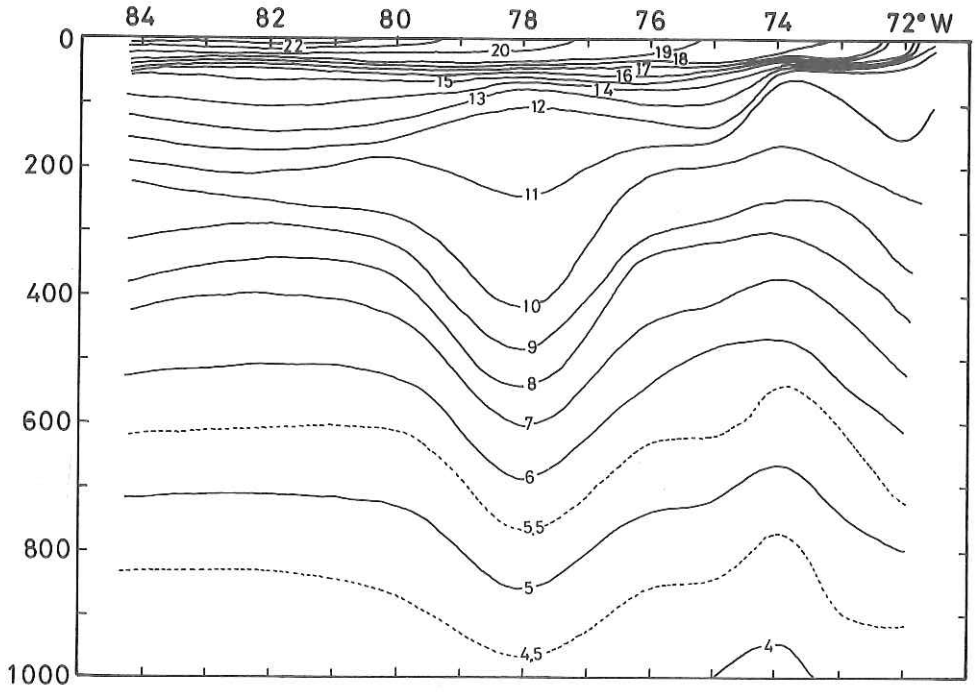


Fig. 27. Temperature profile between the coast of Chile and 84°W along 33°S latitude. (Unit: °C)

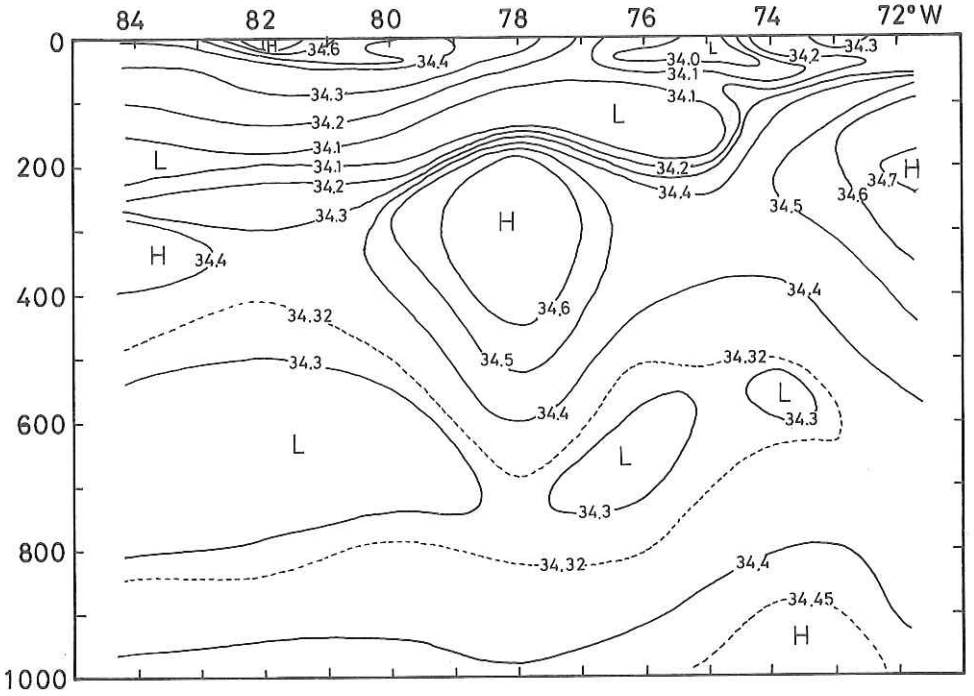


Fig. 28. Salinity profile between the coast of Chile and 84°W along 33°S latitude. (Unit: °/$_{oo}$)

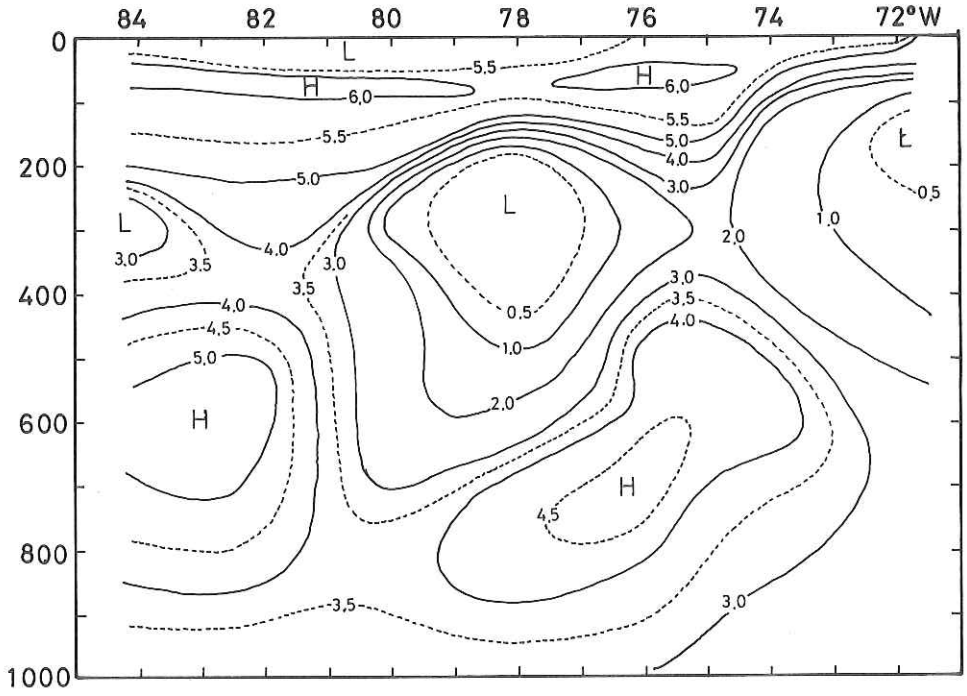


Fig. 29. Dissolved oxygen profile between the coast of Chile and 84°W along 33°S latitude. (Unit: ml/l)

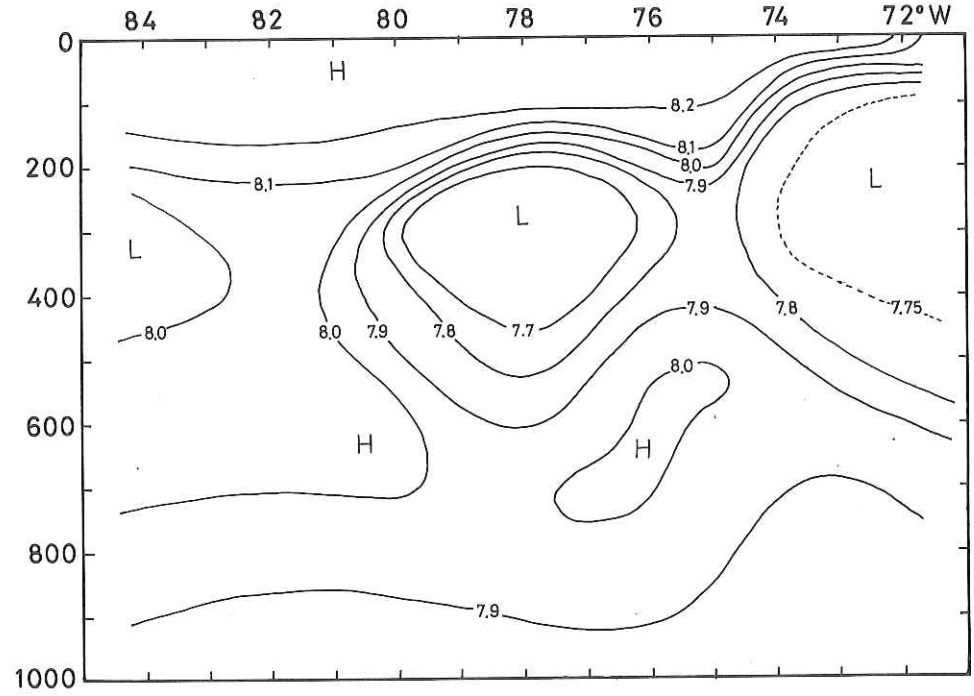


Fig. 30. pH profile between the coast of Chile and 84°W along 33°S latitude.

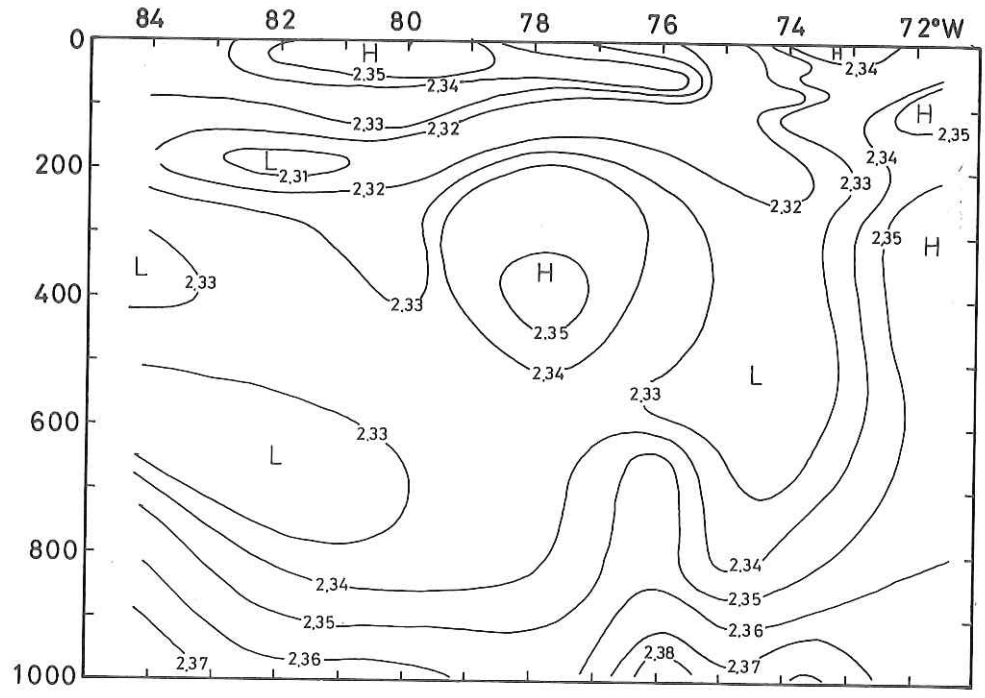


Fig. 31. Total alkalinity profile between the coast of Chile and 84°W along 33°S latitude. (Unit: ml/l) (Unit: meq/l)

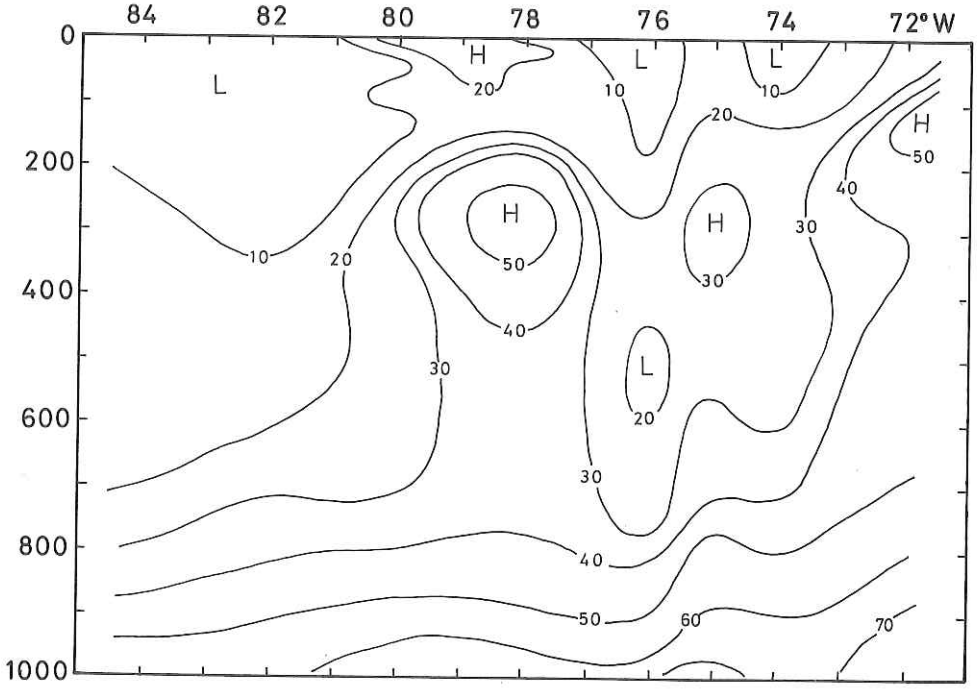


Fig. 32. Reactive silicate profile between the coast of Chile and 84°W along 33°S latitude. (Unit: µg at/l)

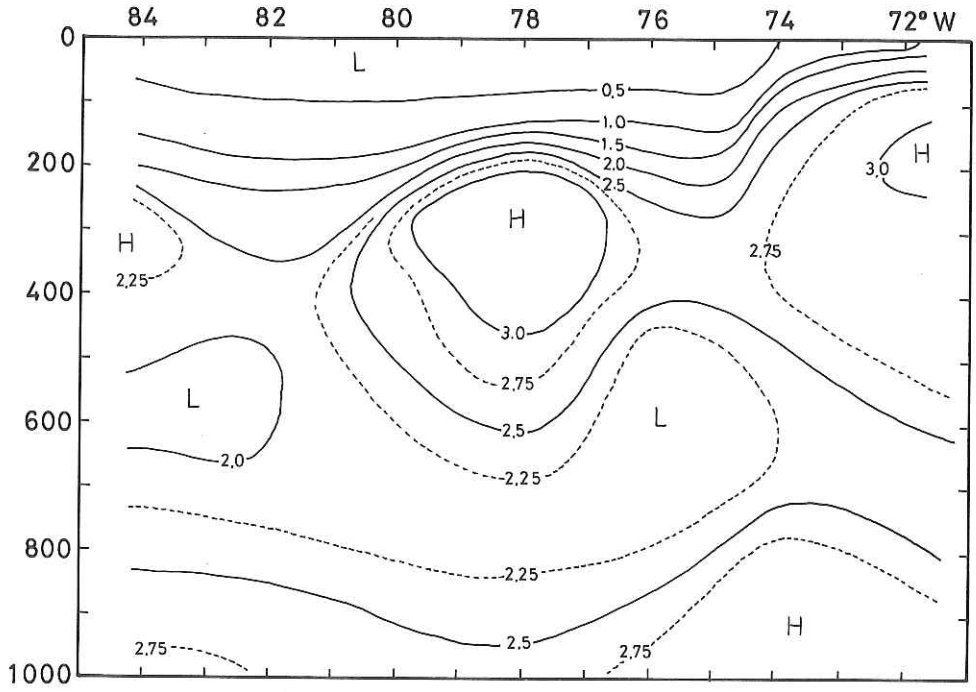


Fig. 33. Reactive phosphate profile between the coast of Chile and 84°W along 33°S latitude. (Unit: µg at/l)

6. Large Volume Water Sampling

by Y. Sugimura

Large volume water samples were obtined at three stations for the studies of ratioactive elements and trace elements. A barrel water sampler of 200 liter was used during the expedition.

Locations and depth of water sampling are shown in Table 5.

Table 5. Stations for large volume water sampling

Station No.	Location		Depth (m)
11-2	8°02.2'S	146°00.8W	0, 100, 500, 1500
19-2	32°04.0'S	141°07.1'W	0, 100, 500, 1500
45-2	17°59.7'S	95°42.7'W	0, 500,1500, 3000

7. Bottom Topography

by T.Katsura and S.Aoki

Contineous sounding during the cruise was carried out by echo sounder. It was suspected that some unknown seamounts were discovered. Table of ship position and echo sounder depth will be available on request to the editor.

8. Sampling of the Bottom Sediments

by T. Oba

Samplings of the bottom sediments were carried out by scientists who need sediments, and the works were directed by Y. Sugimura and H. Tsubota. The samples were red clay for the studies of cosmic dusts, of matural radioactive isotopes, and of sedimentation rate, calcareous and siliceous sediments for paleoclimatology and micropaleontology, and many kinds of sediment for clay mineralogy

8.1. Piston coring

Ocean floor sediments were collected with piston corer at thirteen stations as are shown in Fig.34. Among the thirteen stations, piston coring was successful at eight stations. And other two short cores were obtained by the pilot corer used as the trigger weight on piston corer, besides eight stations just mentioned above. The sediments obtained were red, calcareous, siliceous, and calcareous-siliceous clay, respectively (Table 6).

The piston corer used were the same type of the corer as was described in Preliminary Report of the Hakuhō Maru, Cruise KH-68-3. The length of aluminum pipe were 12 m (inner diameter 68 mm) at five stations, 15 m (inner diameter 68 mm) at four stations, and 6 m (inner diameter 136 mm) at four stations. pipes of 15 m length was used at the station which had been expected to get the long core for the studies of micropaleontology, paleoclimatology, and clay mineralogy. The pipe of large diameter was used to obtain a large amount of red clay for the analyses of natural radioactive isotopes and cosmic dusts. Core catcher was not attached to the cutting edge except station 53-2, but no trouble occurred unless the sediment were too soft and sandy as seen in station 13-2.

Table 6 Stations of coring

Station Number	Position		Depth (m)	Core dia (mm)	Core Length (cm)	Pilot Length (cm)	Remarks
	Latitude	Longitude					
2-2	15°55.0'N	146°10.0'W	5410	68	0	55.5	moderate brown clay
7-2	2°00.8'N	145°59.0'W	4570	68	1024	57	greyish orange calcareous siliceous clay with many mottles, including relative abundant Planktonic Foraminifera
10-2	4°58.5'S	146°03.5'W	4960	68	203	55	moderate brown clay including Planktonic Foraminifera
12-3	11°01.4'S	146°01.5'W	4810	136	326	23	uniform moderate brown clay, Mn nodule at top
15-2	20°22.8'S	148°02.6'W	4615	136	125	27	dark reddish brown clay with ash layers at 30-31 and 53-57 cm from the top
24-2	46°19.3'S	127°46.4'W	4630	68	0	57	very pale orange Globigerina ooze with white pumice between 30 and 57 cm
29-2	62°10.3'S	106°34.1'W	5117	68	1125	0	moderate yellow brown diatom ooze with mottles sporadically
42-2	27°34.8'W	88°03.0'W	3250	68	466	5	uniform dark yellowish orange calcareous clay including relatively abundant Planktonic Foraminifera
44-2	20°50.1'S	93°21.2'W	4157	68	600	45	greyish red clay with granule and pebble at 209-210 and 254-258 cm from the top, including Mn nodules in the pilot core
53-2	8°15.3'N	112°42.1'W	3970	136	575	45	brown clay with many mottles, including relatively abundant Planktonic Foraminifera

Table 8 Stations of dredge

Station Number	Position		Depth (m)	Weight (kg)	Remarks
	Latitude	Longitude			
12-2	11°00.7'S	146°02.6'W	4890-4935	91.5	moderate brown clay, Mn nodules with smooth surface
15-3	20°23.4'S	148°01.2'W	4615-4618	166.8	dark brown red clay, Mn nodules with rough surface
20-3	35°04.5'S	138°39.8'W	4855-4860	89.0	dark brown red clay, Mn nodules with rough surface

Table 7 List of distributed cores for geochemical, mineralogical and paleontological studies

Organization (personnel)	Item of study	Station No. 2	7	10	12	15	24	29	42	44	53
Meteorological Res. Inst. (Y. Sugimura)	Geochronology & natural radio-nuclides	P	M/8	M/8	M/8	M/8	P	M/8	M/8	M/8	M/8
Tokyo Kyoiku Univ. (S. Kuroda)	Clay Mineral	*	M/8	M/8	M/8	M/8	*	M/8	M/8	M/8	M/8
Ocean res. Inst. (T. Oba)	Paleotemperature	P	M/4	M/4	P	P	P	M/4	M/4	M/4	M/4
Tohoku Univ. (T. Sakai)	Paleomagnetism & silicic fossil	*	M/4	M/4	*	*	*	M/4	M/4	M/4	M/4
Ocean Res. Inst. (H. Tsubota)	Interstitial water	*	*	P	P	*	*	*	*	*	*
Ocean Res. Inst.	preserve	*	M/4	M/4	M/4	M/4	*	M/4	M/4	M/4	M/4
Kyoto Univ. (Y. Tazawa) Waseda Univ. (T. Shimamura) Gakushuin Univ. (H. Mitsuda)	Cosmic ray induced nuclides & extra-terrestrial matter	*	*	*	M/2	M/2	*	*	*	*	*

M: Main Core, P: Pilot Core, *: Not distributed.

Cubic sample for paleomagnetic study was sampled from $\frac{M}{4}$ distributed to Tohoku Univ. unless from $\frac{M}{4}$ to preserve in Ocean Res. Inst. for Stn. 12 and 15.

After the corer was recovered on the working deck, sediment was extruded from the pipe using a loose piston. In most cases, the penetration length was nearly equal to the length of main core, therefore in that case, neither compression nor flow-in of sediment in the core barrel was probable. And also in most cases, the sediment of pilot core was very resembled to the top part of the main core as to its color, change of color, and condition. Each core was cut longitudinally into half along the mark which was scored by pin-mark during the extrusion. After taking a photograph by S. Aoki, sediment was described its color and some distinct characters by T. Oba and T. Sakai (Fig.35-Fig.44). The color description was based upon "the Rock-color Chart" distributed by the Geological Society of America, New York, N.Y., reprinted in 1963. Sediment of the core was distributed to scientists for their geochemical and geological studies, as shown in Table 7.

Among the unsuccessful piston coring, one was thought to be caused by bad weather (station 2-2), other two were mainly due to the character of bottom sediment (station 13-2, and 20-2), and the last two were due to cut of their wire between the arm and the piston. The details of piston coring were described in each core log. The corer used at station 53-2 was built on board by engineers of the ship.

8.2 Dredge

Ocean floor sediments were collected at three stations using pipe dredge (inner diameter 40 cm, length 120 cm). Sampling was carried out in the red clay region for geochemical and cosmophysical researches (Fig.34.). As the result, each dredging was successful to get a large amount of red clay and manganese nodules as is shown in Table 8. The details of dredge were writtn in each dredge log.

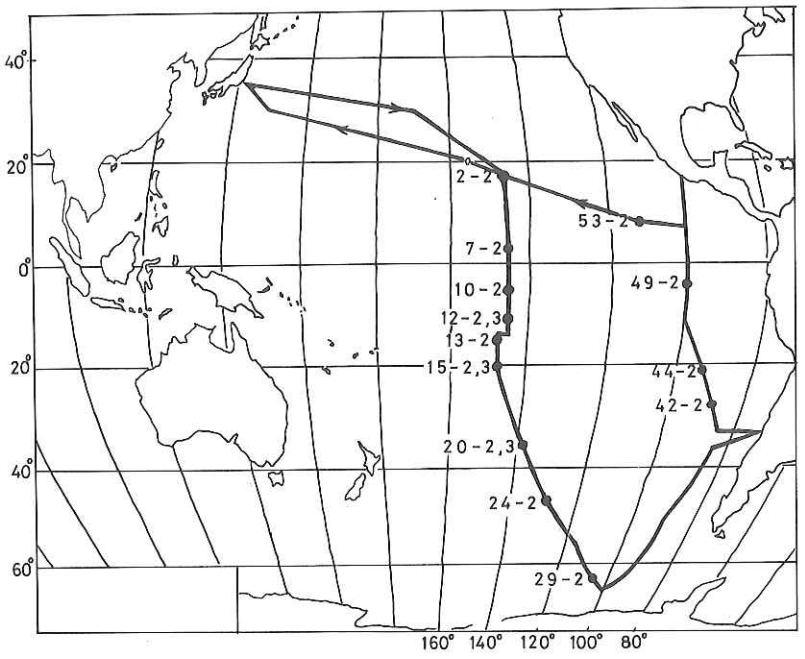


Fig. 34. Bottom sampling station.

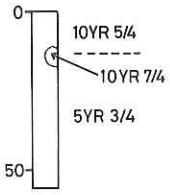


Fig. 35. Core description.
Stm. 2-2-Pilot.

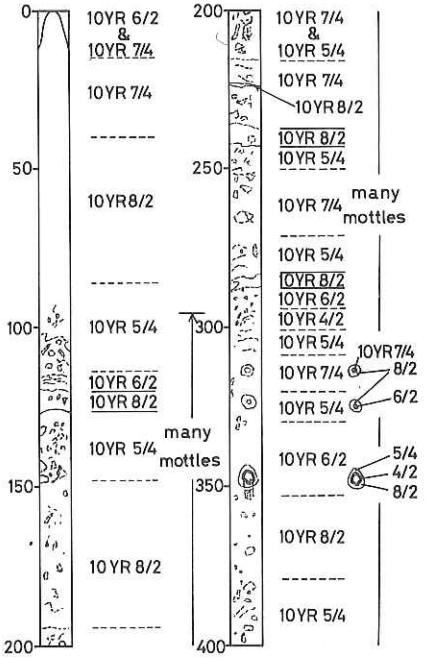


Fig. 36. Core description. Stn. 7-2.

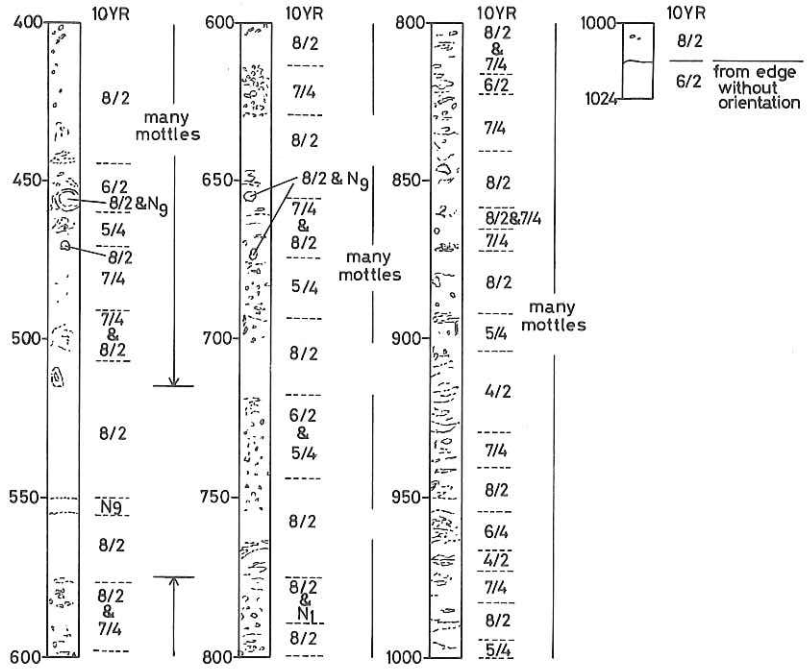


Fig. 36. Core description. (Continued)

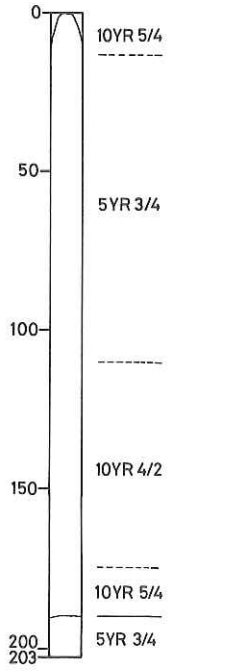


Fig. 37. Core description. Stn. 10-2.

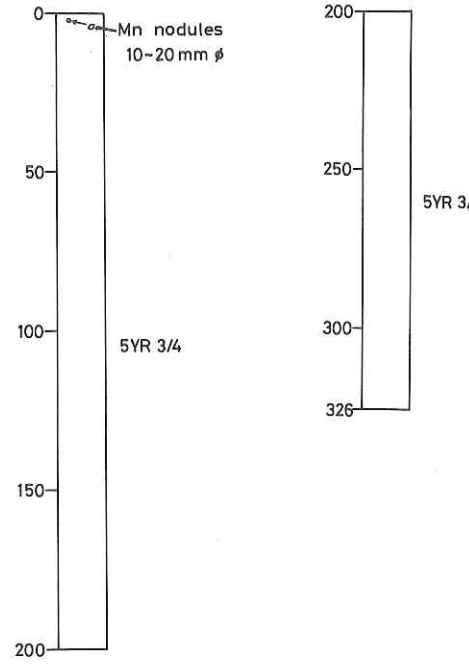


Fig. 38. Core description. Stn. 12-3.

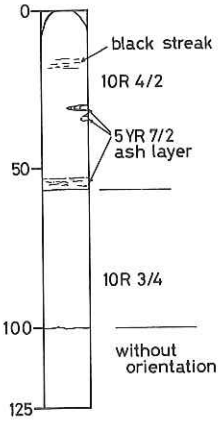


Fig. 39. Core description. Stn. 15-2.

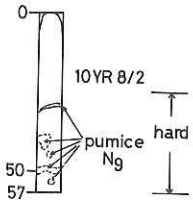


Fig. 40. Core description. Stn. 24-2-Pilot.

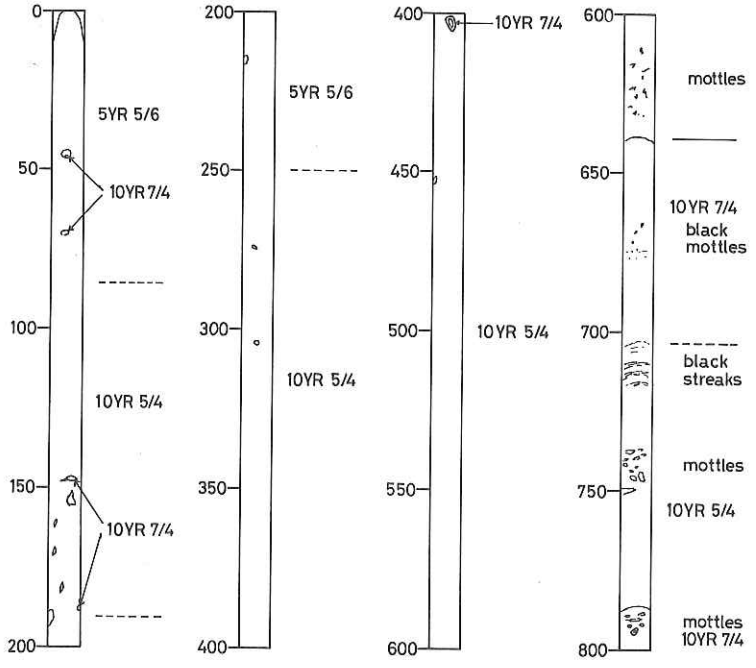


Fig. 41. Core description. Stn. 29-2.

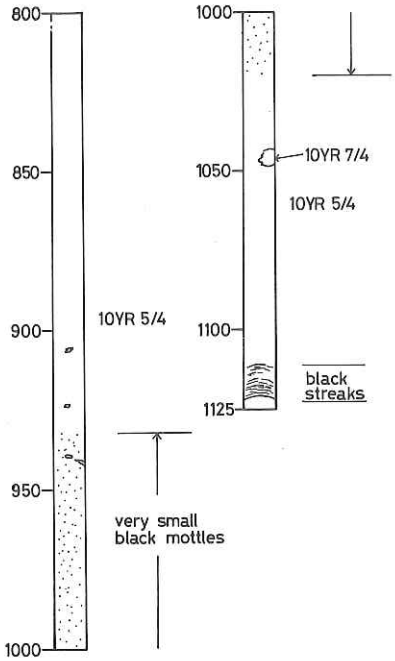


Fig. 41. Core description. (Continued)

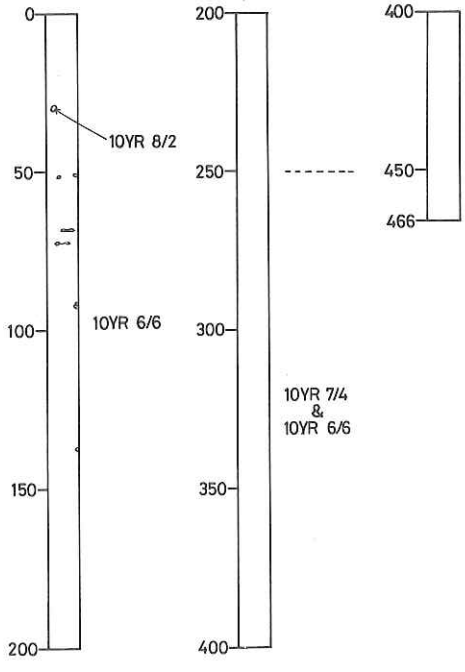


Fig. 42. Core description. Stan. 42-2.

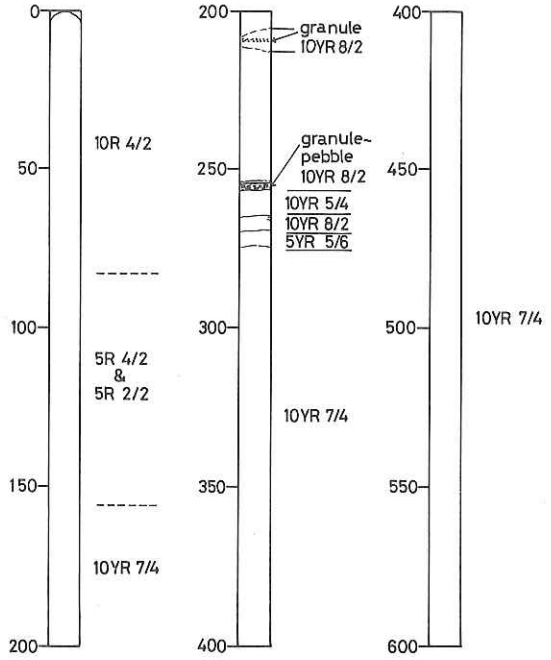


Fig. 43. Core description. Stn. 44-2.

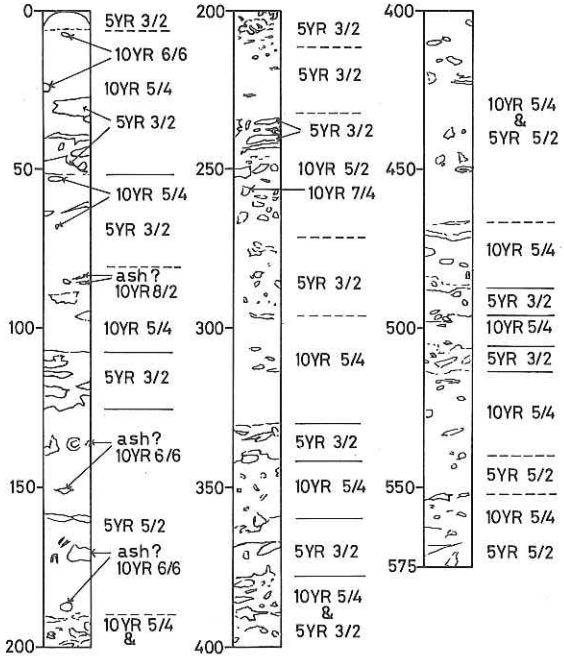


Fig. 44. Core description. Stn. 53-2.

9. Chemical Works

9.1. Carbon dioxide in the atmosphere and in the surface sea water in the Pacific

by

Y.Sugimura

Determination of partial pressure of CO_2 in the surface sea water and in the atmosphere was carried out during the whole cruise. The method employed is followed in general that of our previous cruise of KH-70-2 (Great Bear Expedition, 1970) by means of an infrared gas analyzer coupled with a strip chart recorder and an equilibrator.

During the cruise, the atmospheric CO_2 concentration was almost constant. But it is to be noticed that the CO_2 concentration in the surface sea water was changed from place to place. In the North Pacific, the CO_2 concentration in the surface sea water was generally undersaturated relative to the air. In the eastern part of the South Pacific, the concentration of CO_2 in the surface water was generally supersaturated. In the equatorial region of the Pacific Ocean, wide area of supersaturation was also observed. The distribution of δpCO_2 ($\delta pCO_2 = pCO_{2(sea)} - PCO_{2(air)}$) along the course from 17°N 146°W to the Antarctic Ocean is shown in Fig. 45.

9.2. Sampling for oxygen and hydrogen isotopic analyses

by

K.Shigehara and T.Ishizuka

To solve problems on water circulation in the South Pacific, the studies on isotopes of hydrogen and oxygen in sea water were performed. An aliquot of sea water collected at all hydrographic stations was sealed into a glass ampoule.

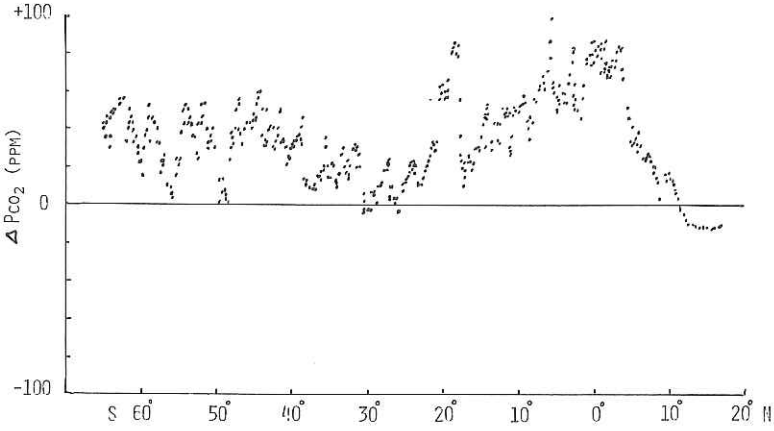


Fig. 45. ΔpCO_2 distribution along the section of 17°N, 145°Wto 65°S, 100°W.

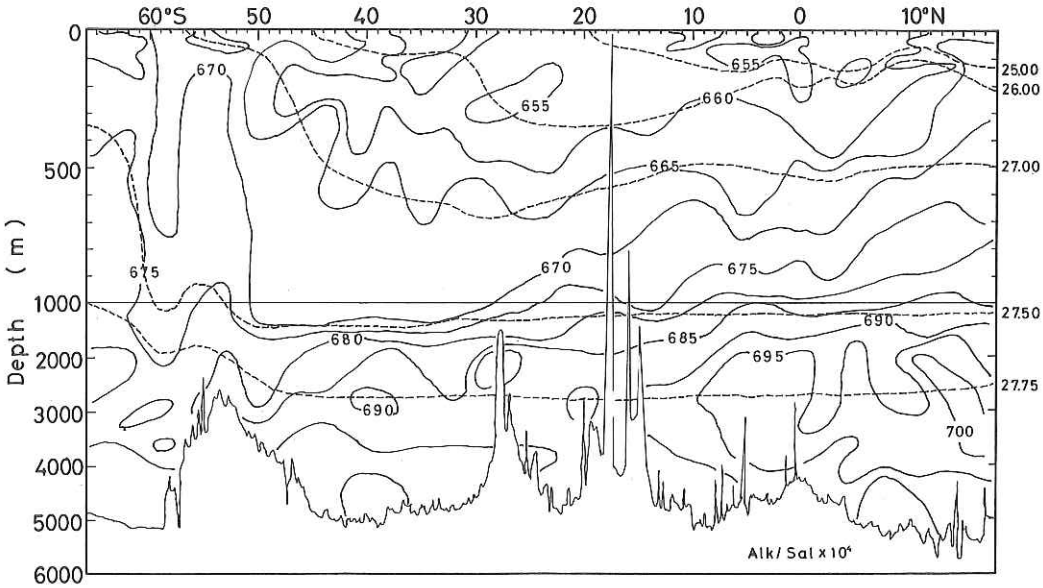


Fig. 46. Specific alkalinity profile, southward, 17°N-65°S.

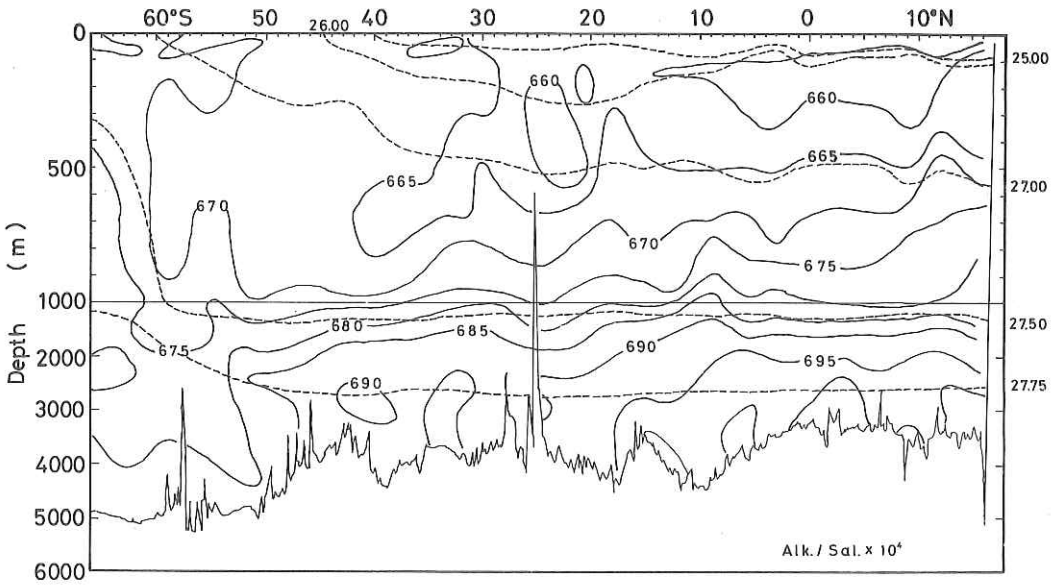


Fig. 47. Specific alkalinity profile, northward, 65°S-15°N.

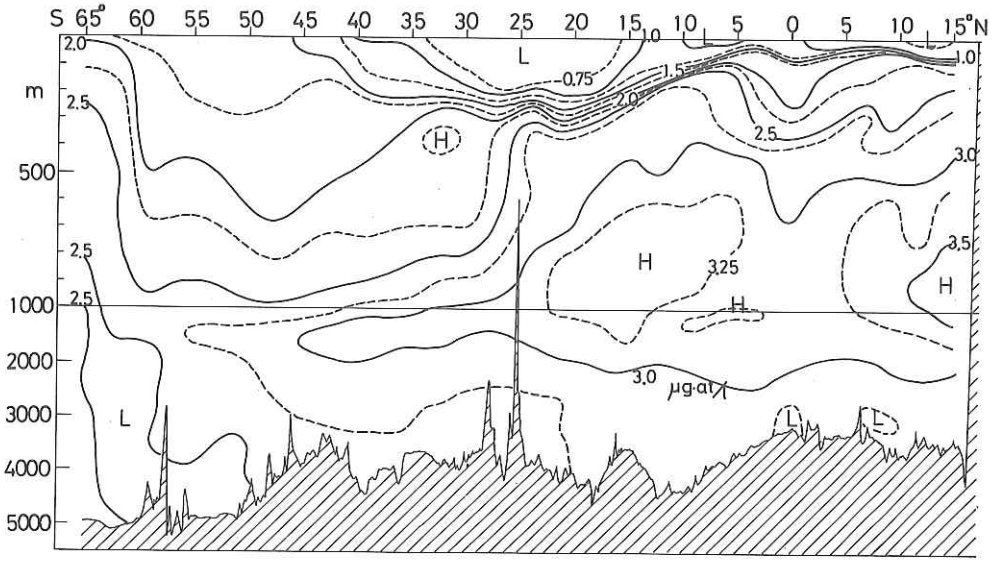


Fig. 48. Vertical section of total phosphorus from St. 30 to St. 56.

Water vapor in the atmosphere was also sampled for the whole course of the cruise at the main deck height to study the air-sea interaction. Horibe's trap was used to collect the vapor. The analyses will be carried out on land laboratory.

9.3. Oxygen-18 of dissolved oxygen

by
K.Shigehara

Dissolved gases were extracted for studying the behavior of dissolved oxygen in sea water by means of measurements of the variation of isotopic ratio.

Samples were taken from various depth at 19 stations (Station 4, 8, 11, 14, 16, 18, 21, 24, 27, 30, 33 (only from Deep water), 37, 39, 42, 44, 47, 51, 54 and 56).

The extraction of dissolved oxygen in sea water was carried out on board just after the water sample was brought up on deck. The method of extraction is essentially the same as given in the Preliminary Report of the Hakuhō Maru Cruise KH 68-4 (Southern Cross Cruise). More than 95% of volume of dissolved gases was extracted to the attached storage glass flask, which was sealed off and brought back to the laboratory for isotope analysis.

The results of isotope analysis will be discussed together with those of former cruises [KT 67-5, KH 67-1, KH 68-3, KH 68-4 (Southern Cross Cruise), KH 70-1 and KH 70-2 (Great Bear Expedition)].

9.4. Alkalinity and calcium in the South Pacific

by
H.Tsubota and F.Fukui

Carbonate alkalinity may be one of keys to solve the oceanic circulation. In the expedition, total alkalinity was carefully

determined by the method developed by H. Tsubota and S. Kanamori[1].

Sea water samples were also collected at all stations and brought back to the laboratory on land for determination of calcium content.

The analytical results will be discussed together with carbonate alkalinity calculated. As the first step of consideration, the sections of specific alkalinity (meq/kg/S°/$_{oo}$) were taken as shown in Figs. 46 and 47.

9.5. Total phosphorus

by

T.Sagi

The distribution of the total phosphorus and of the organic phosphorus may be useful in studying structures of the oceans.

At all stations, the total phosphorus in unfiltered sea water sample was determined on board by a wet digestion method of Menzel (1965).

A section from Stn. 30 to Stn. 56 is shown in Fig. 48.

9.6. Ammonia and organic nitrogen

by

T.Sagi

The distribution of nitrogenous nutrients in sea water has been studied.

At all stations, ammonia content in sea water was determined by the modified indophenol method (T. Sagi, 1966).

A section from Stn. 30 to Stn. 56 is shown in Fig. 49.

In the meridional section along 146°W and 100°W (Fig. 50), the organic nitrogen in unfiltered sea water was determined on board by the following method. 2 ml of 18 N sulfuric acid con-

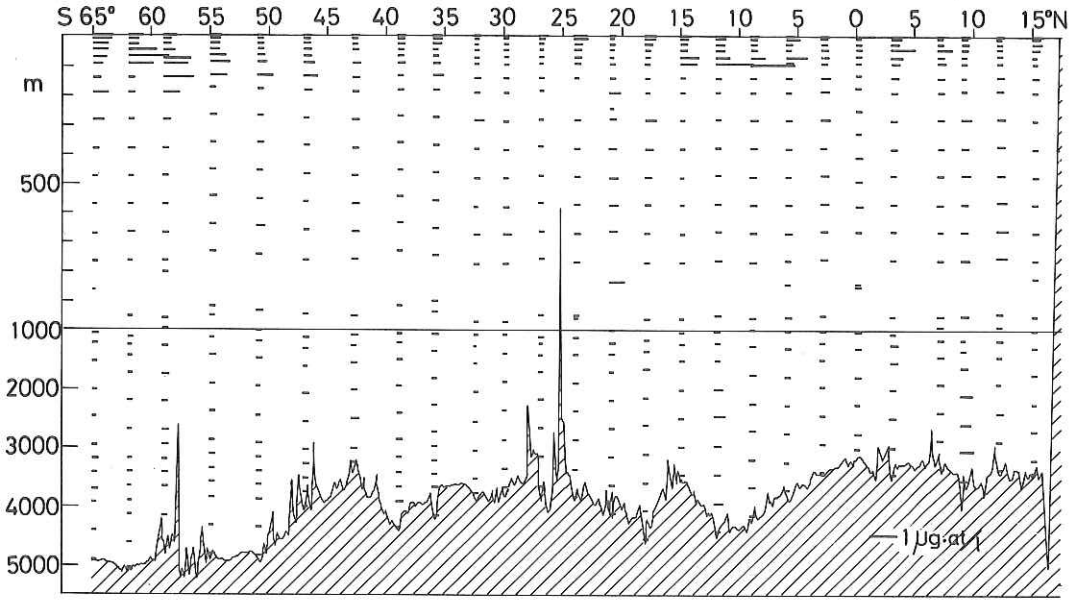


Fig. 49. Vertical section of ammonia from St. 30 to St. 56.

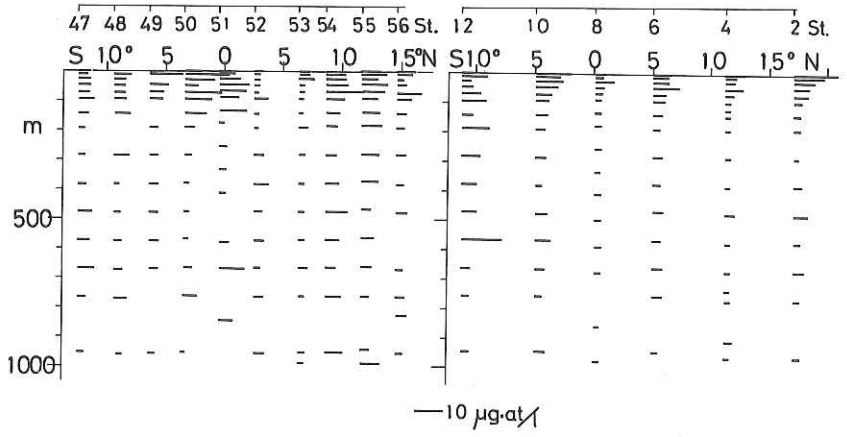


Fig. 50. Vertical section of organic nitrogen along 146°W (right) and 100°W (left).

taining 0.2 mg selenium dioxide was added to 25 ml of sea water. After digestion on a hot plate, the residue was dissolved with about 40 ml of distilled water. pH of the solution was adjusted to 8 with 5 N sodium hydroxide and 0.5 N sodium carbonate, and the solution was diluted to 50 ml with distilled water. The organic nitrogen was determined as the ammonia in the resulting solution by the modified indophenol method. The pH of the solution becomes to nearly 10 after the procedure. Five determinations of the standard solution using by sea water as a dilutant with one batch of reagents gave a standard deviation of about $\pm$0.7 µg at/ at the level of 5 µg at/l and $\pm$0.9 µg at/l at the level of 10 µg at/l.

9.7. Trace metals in sea water

by
H.Tsubota

To study the distribution of trace metals in the South Pacific, 10 l of sea water sampled with van Dorn sampler was taken and passed through a column of chelating ion exchange resin. Reactive metals adsorbed with the resin were eluted with HCl and HNO_3. The effluents were brought back to the laboratory on land for further treatments.

To aid the discussion on lead distribution in ocean, air born dusts were also collected with a high volume air sampler.

9.8. Tin in sea water

by
H.Tsubota and Y.Kodama

Tin is a trace metal lacked in its distribution and behavior in the ocean. Our preliminary work on tin distribution suggested that tin is not so unstable in the ocean as suspectable

based on its chemical character, hydrolysis. The purpose of this study is to obtain the wide distribution of tin in the South Pacific.

Each 500 ml of sea water in Niskin bottle was sampled from various depth at 30 hydrographic stations. The sample was acidified with hydrochloric acid and tin was concentrated with an anion exchange column on board. The further purification and determination will be done at the laboratory on land by the method of Kodama and Tsubota (1971).

9.9. Chemical composition of suspended matter and marine plankton

by
H.Tokura

It has been presumed that the occurrence of minor elements in suspended matter plays an important role in areal distribution of those elements in world oceans. This study is attempted to approach the subject from the comparative viewpoint of biology and geochemistry.

The suspended matters were separated from 500 ml sea water samples with Millipore Filter Type HA. More than 220 sea water samples at various depth were collected at 22 stations. Microscopic examination of suspended matter samples has been carried out on board. The contents of minor elements such as iron and alminium in the same samples will be determined, and the observation of diatoms on the filter with scanning electron microscope will be tried on land laboratory.

Many marine planktons were collected at each station. The plankton sampled were collected by standard nets equipped with XX13 nylon bolting cloth. Several vertical haul with a net (45 cm in dia.) from surface to 150 m depth was conducted at 10 stations. The other net (55 cm in dia.) was applied to sampling under the condition of surface haul at 50 stations. Following planktons of individual species were sorted mecha-

nically with a plastic tweezers from the mixed plankton samples ; many species in Copepoda and Diatom, several species of Euphasia, Peridinium and Ceratium, some species in Gastropoda, Sagittoidea, Polychaeta, Hydrozoa, Radiolaria, Foraminifera and Ciliata were observed. The contents of some minor elements in each species of marine plankton will be determined in Kyoto Kyoiku University.

9.10. Thorium and uranium series disequilibrium in sea water

by
Y.Sugimura and T.Uemura

Thorium isotopes: Each 500 liter of sea water, about 20 samples, was subjected to the analysis. Thorium isotopes in sea water were concentrated by means of chelating ion exchange resin on board. Further purification and determination will be done at onland laboratory.
Uranium content and $^{234}U/^{238}U$ ratio: More than one hundred samples were processed during the cruise for uranium determination. The method of analysis of uranium was described in our previous report (Miyake, Sugimura and Uchida, 1966, 1971).
It is to be noticed that the uranium content in sea water of off Mexico region of the Pacific is remarkably high just below the low oxygen layer as seen in Fig. 51.

9.11. ^{3}H, ^{90}Sr and ^{137}Cs in the South Pacific Ocean

by
Y.Sugimura

^{3}H content: According to our previous observation, the concentration of tritium in the South Pacific was remarkably low comparing with that in the North Pacific. To confirm this point and to obtain further information of vertical distribution of

tritium, this work was conducted. At the stations 3, 6, 9, 13, 16, 20, 24, 28, 35, 43, 47, 50 and 55, the samples of sea water down to 800 m were collected. Determination of tritium content will be done at on land laboratory.

^{90}Sr and ^{137}Cs: More than twenty samples were collected during the cruise. Results of our previous observation showed the concentration of the nuclides are almost same both the North Pacific and the South Pacific. But the knowledge of the eastern side of the South Pacific is little at present. To concentrate ^{90}Sr and ^{137}Cs, carbonate precipitation and ammonium molybdophosphate precipitation methods were used respectively. Purification and radiometry of these nuclides will be done at on land laboratory.

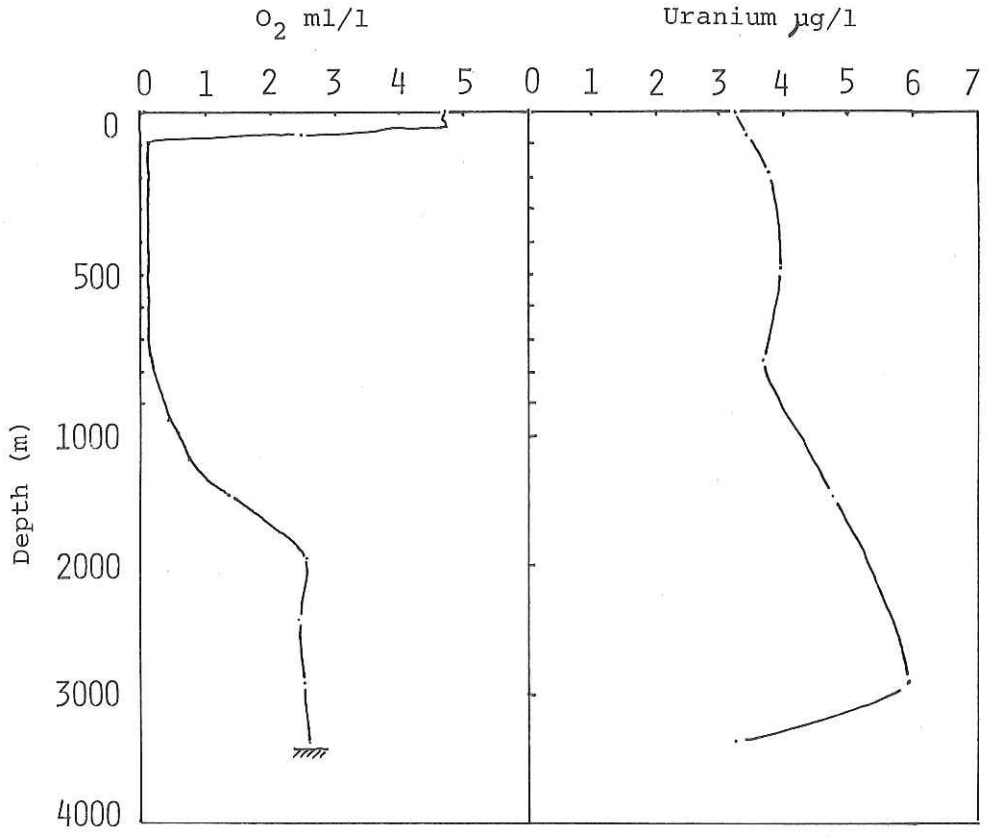


Fig. 51. Distribution of uranium and dissolved oxygen with depth. Stn.55, 11°57.8'N, 100°06.4'W, 3400 m.

9.12. Dust collection in the atmosphere

by

T.Shimamura and Y.Tazawa

Floating dusts in the atmosphere were collected in order to select extraterrestrial origin dusts (so called cosmic dusts) from them. Dusts samplings were carried out on the Pacific Ocean where back ground of artificial or continental origin dusts seemed to be very low.

Millipore Filter (47ϕmm , pore size 8μ) was used for air filtration, and volume of filtrated air was about 80 m^3 per one sheet of filter. Sampling points were 43 points which distributed whole course of this expedition.

Under the microscope, particles on the filter were counted on total number and classified into sizes, shapes and chemical composition.

From these analyses we intend to obtain their size spectra, time variation of their number, and chemical difference, and then to select cosmic dusts statistically.

Preliminary analyses showed that number density of dusts in the atmosphere strongly depends on the direction of wind and the distance from continent.

9.13. Dredged and core samples of brown pelagic clay for studies of extraterrestrial materials and $^{234}U/^{238}U$ disequilibrium

by

H.Mitsuda, T.Shimamura and Y.Tazawa

At Stations 12, 15 and 20, brown clay samples were obtained with a cylindrical dredge and piston corer.

About 250 kg of dredged samples were prepared for the detection of ^{146}Sm and picking up "Cosmic" spherules.

^{146}Sm is an extinct nuclide. It may have been ejected from Super Nova and/or Red Giant. So its existence in deep sea

sediments suggest the accretion of cosmic materials from extra solar system.

About 250 kg of dredged clay samples and large volume of bottom water were also prepared for studies of $^{234}U/^{238}U$ disequilibrium.

Core samples were prepared for the determination of seddimentation rates and the accretion rate of the cosmic materials.

10. Geological Works

10.1. Mineralogy on the sediment samples

by

S.Aoki

Of the core-samples, mineral composition of the surface samples (top-5cm deep) were studied by X-ray diffraction method. The clay fraction less than 2 μ used for present study was collected by the sedimentation method. Clay minerals such as montmorillonite, chlorite, mica (illite) and kaolinite were identified, and non-clay minerals as quartz, feldspar and calcite also confirmed by X-ray analysis. Furthermore, phillipsite belonging to the zeolite group was found at the stations 10-2, 24-2 and 44-2 respectively. However, the mineralogical components seem to be variable from sample to sample. The samples of the station 7-2 and 42-2 are mostly composed of calcite, and clay minerals were not confirmed by X-ray analysis. Geochemical study as well as mineralogical one of the bulk samples and manganese nodules may be made in detail by further work.

11. Biological Works

11.1. Plankton sampling

by

H.Hasumoto and T.Nakai

As a standard method widely employed in C. S. K. (Cooperative Study of the Kuroshio and Adjacent Region) and other projects in Pacific Ocean, 150 - 0 m vertical haul with a Norpac net was made at each hydrocast station (see Table 2).

Two kinds of mesh filtering clothes were used at each station and one of them made of 0.33mm and the other 0.09mm. The serial tows were carried out at 55 stations, in which 42 were in daytime.

The biomass of zooplankton (in wet weight from Station 1 to Station 56) were the most abundant at Station 31 (618 mg/m^3) and the least at Station 17 (2 mg/m^3). Dominant organisums at Station 31 were occupied Diatoms and Copepods.

The samples of phytoplankton are now arranging.

Table 9. Plankton data by standard haul Norpac net

Station No.	Shiptime		Wet weight (mg/m)
	Date	Hour	
1	Nov. 26	12:29-12:35	13.7
2	Dec. 2	00:24-00:34	25.5
3	Dec. 3	00:10-00:18	56.2
4	Dec. 3	19:55-20:05	34.7
5	Dec. 4	17:09-17:18	20.1
6	Dec. 5	12:45-12:55	33.1
7	Dec. 5	05:20-05:28	34.5
8	Dec. 7	15:12-15:20	36.6
9	Dec. 8	16:02-16:10	50.1
10	Dec. 9	13:00-13:10	39.9
11	Dec. 10	06:21-06:30	52.4
12	Dec. 11	19:51-20:00	63.3
13	Dec. 12	23:10-23:19	40.2
14	Dec. 13	16:00-16:10	14.9
15	Dec. 15	16:48-16:56	3.6

Station No.	Shiptime		Wet weight (mg/m)
	Date	Hour	
16	Dec. 20	10:45-10:53	-
17	Dec. 21	09:25-09:33	2.4
18	Dec. 22	06:35-06:43	8.5
19	Dec. 23	03:20-03:40	15.8
20	Dec. 24	08:16-08:24	4.2
21	Dec. 25	12:11-12:19	14.5
22	Dec. 26	10:50-10:58	4.2
23	Dec. 27	15:00-15:08	13.8
24	Dec. 28	18:49-18:57	94.7
25	Dec. 29	17:49-17:58	90.0
26	Dec. 30	13:05-13:13	129.7
27	Dec. 31	10:35-10:42	147.7
28	Jan. 1	04:37-04:44	166.2
29	Jan. 2	05:05-05:13	391.7
30	Jan. 3	16:54-17:00	104.7
31	Jan. 4	17:20-17:27	618.4
32	Jan. 5	15:05-15:25	320.0
33	Jan. 7	10:22-10:29	67.4
34	Jan. 8	08:34-08:41	39.7
35	Jan. 9	08:43-08:50	95.6
36	Jan. 10	07:15-07:11	78.3
37	Jan. 11	10:06-10:13	40.2
38	Jan. 12	09:05-09:12	25.6
40	Jan. 22	22:28-22:35	52.7
41	Jan. 23	18:40-18:46	19.1
42	Jan. 24	16:00-16:07	5.8
43	Jan. 25	12:54-13:03	5.9
44	Jan. 26	10:45-10:53	8.5
45	Jan. 27	10:30-10:37	20.1
46	Jan. 28	11:17-11:25	-
47	Jan. 29	08:14-08:22	66.5
48	Jan. 30	01:53-02:04	62.1
49	Jan. 30	19:01-19:10	42.5
50	Jan. 31	16:21-16:28	37.8
51	Feb. 1	23:30-23:37	180.7
52	Feb. 2	21:38-21:45	62.5
53	Feb. 13	00:18-00:26	164.2
54	Feb. 12	11:10-11:17	213.6
55	Feb. 11	18:48-18:55	119.6
56	Feb. 11	00:25-00:50	367.5

* The towing speed was 1 m/sec. The sample were preserved in 10% formalin seawater solution.

12. Atmospheric Physics Works

12.1. The generation and the disappearance of aerosols particles in the atmosphere over the ocean

by
T.Sekikawa, H.Kojima and F.Tanaka

It has been interested to measure the aerosol concentration over the ocean for watching of air pollution on the global scale. But for reasons of difficulty and of unestablishment of the method for measuring, a useful data is a few. We took an interest in the nature and the origin of background aerosols, and carried out measurements with the object of accumulating the data and estimating the origin of aerosols in the marine atmosphere over the North, South Pacific and the Antarctic.

(1) The attention to an oceanographical survey

Firstly, it is possible that the aerosols are produced by many kinds of processes. We must avoid the influence of pollution from chimneis and exhaust ports on the ship. Beforehand, for estimating the situation of intake of sample air the measurement of the concentration of aerosols with wind direction and velocity were carried out by using a portable particle counter. From these results it was understood that the air passing over the ship is polluted regardless the wind velocity. Accordingly, an intake of sample air was pushed out over the sea and moved the right or left side to the bow with variation of wind direction. Secondly, when the ship is sailing, she shall produce the white-cap herself and some aerosols may be generated by the white-cap effect. Since it is necessary to estimate its effect, the measurement was carried out during both sailing and drifting.

(2) The total concentration of aerosols and size distribution of large particles

To determine the low concentration of aerosol particles, a modified Pollak counter with high sensitivity was prepared. The most different points of the counter to usual Pollak counter is to detect the scattered light instead of the extinction light. The apparatus was operated automatically. To calibrate the instrument, the absolute particle counter was used.

By using the Royco particle counter both the size and the concentration of particles larger than 0.15 μ in radius can be obtained.

Table 10 indicates the total concentration of aerosols obtained in each leg. Fig. 52 represents the frequency distribution of the total concentration in the South and North Hemisphere. The data selected was at midday (local standard time) of fine weather days. Frequency distribution in South Hemisphere shows a median concentration of 300 cm^{-3} and more than 90% is contained from 200 to 400 cm^{-3}. On the other hand, a maximum value in North Hemisphere is same to the former but the distribution shows a broad type such as existing more than 600 cm^{-3}. The variation along the latitude and longitude is not very clear, but mean value in leg 2 containing a storm zone is much than leg 3 where wind velocity was very weak. It is suggested that the total concentration may depend on the wind speed.

Fig. 53 and Fig. 54 represent the size distribution of particles larger than 0.15 μ in radius. In Fig. 53 the mean size distribution classified according to wind force is shown. On the every continent, Junge (1955) has shown that the size distribution of large particle obeys the following formula

$$\frac{dn}{d\log r} = Ar^{-\beta} \qquad \beta = 3$$

where r is particle radius and n is the concentration of aerosols. The formula has been proved by many reseachers theoretically and experimentally. From our observations it is found that the slope (B) of the distribution and the concentration depend on the wind force and that with increasing the wind force,

B decreases. It is to be noticed that a maximum appear in the vicinity of o.4 μ over the range of every wind speed. The phenomenon becomes unclear with approaching to the land (Fig. 54).

(3) The volatility of large particles

It is generally reported that ammonium sulfate and sulfuric mist are the principal chemical elements composing the aerosols in the urban atmosphere. On the other hand, it is known that the aerosols sent out from the ocean surface are composed of sea-salt. Twomey (1968) reported that it is possible to descriminate both kinds of particles by heating the sample air including the particle. Applying the above method, we measured the volatility of particles larger than 0.15 μ in radius above the ocean. By our experiments in the laboratory, it is previously confirmed that the temperature for descriminating both kinds of particles is sufficient at 340°C. Fig. 55 (a) shows the mean values of 4 observations over the South Pacific. As regards larger than 0.4 μ in radius, the fraction of particles remaining (the ratio of the concentration of particles in the heated sample to that in the unheated) is about 95%. Therefore, most particles must be composed of non-volatile materials such as NaCl. But, with the decrease in size, the fraction decrease. At Tokyo the fraction with a given size from 0.2 μ to 1.0 μ are nearly 20%. Fig. 55 (b) is based on the data obtained at 0°S 100°W near North America. At this location the Northeast trade wind brings directly the continental contamination. The fractions less than 0.8 μ decrease with decrease in size and become nearly the same as the value in the urban atmosphere at 0.3 μ.

Table 10. Mean value of total concentration of aerosols

Leg	Region	Total conc., N_o/cm^3	0.2-0.5μ	0.6-10μ
1	Tokyo Equator	410 ± 29	3.2	1.1
2	Honolulu Equator	334 ± 24		
3	Equator Valparaiso	344 ± 10	5.7	1.5
4	Valparaiso equator	293 ± 9	0.97	0.14
5	Acapulco Tokyo	484 ± 28	2.3	0.58

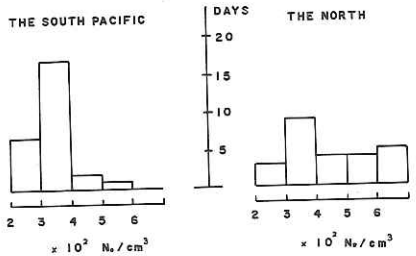


Fig. 52. Frequency distribution of total concentration of aerosols.

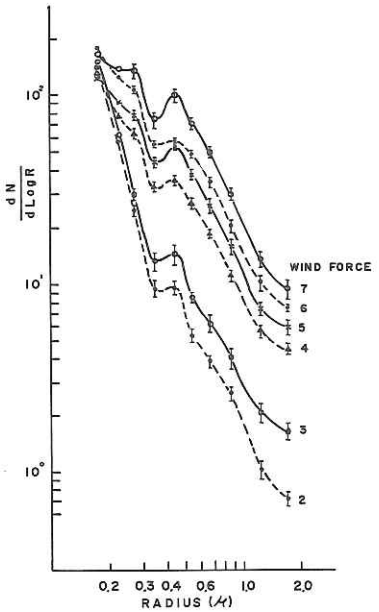


Fig. 53. Mean size distributions of large particle classified according the wind force.

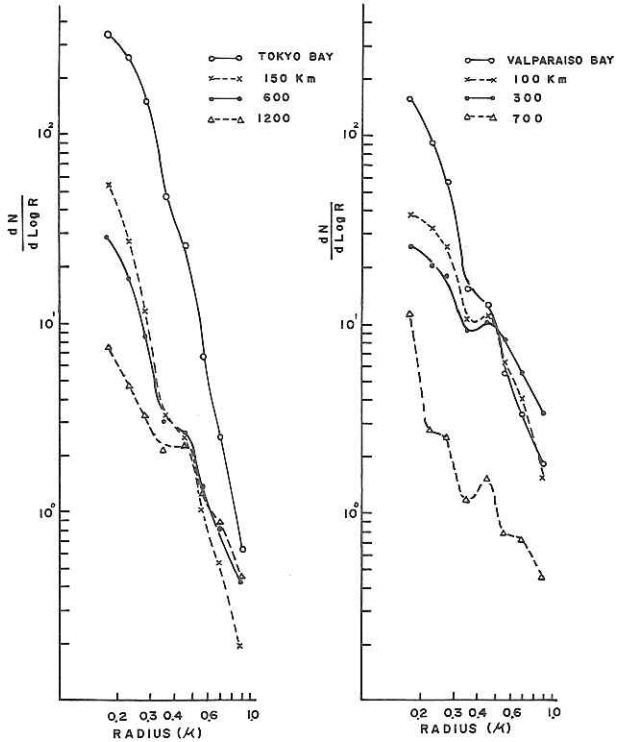


Fig. 54. The size distributions of large particle influenced by the land-air.

Fig. 55 (c) shows the mean values of 6 observations over the North Pacific. The fractions are slightly smaller than that on the South Pacific.

12.2. Measurement of the atmospheric electrical elements

by

M.Takagi and N.Toriyama

The measurement of the atmospheric electrical elements, such as electric field, electrical conductivity, space charge, concentration and average size of condensation nuclei, was carried out through the whole period of the cruise. The measurement mainly aims at the following two points. The first is the problem of atmospheric electrical current system in a global scale. To approach to the solution of this problem the most fundamental is to discriminate between global characteristics and local disturbances. The atmosphere over the ocean, though it may involve a kind of difficulty caused by larger electrode effect or by charge and aerosol generation of sea origin, will present a more natural state of the atmosphere than that over the land, where we have to take care of land pollution much affecting the electrical state in the air. The later half of the cruise, the period from 31 January to 22 February, 1972, was coincided to the Fourth Intensification Interval of Atmospheric Electricity Ten Year Program by the International Commission on Atmospheric Electricity, IAMAP, IUGG. The electric field or the air-earth current density was measured in the period by the use of balloons, airplanes or vessels as well as at land stations at several places over the world. These results are going to be compared and analyzed to solve the problem of so-called global circuit. The second point is the extension of land originating aerosols over the ocean. The inflow of aerosols much lowers electrical conductivity because they adsorb small ions that make the air conduc-

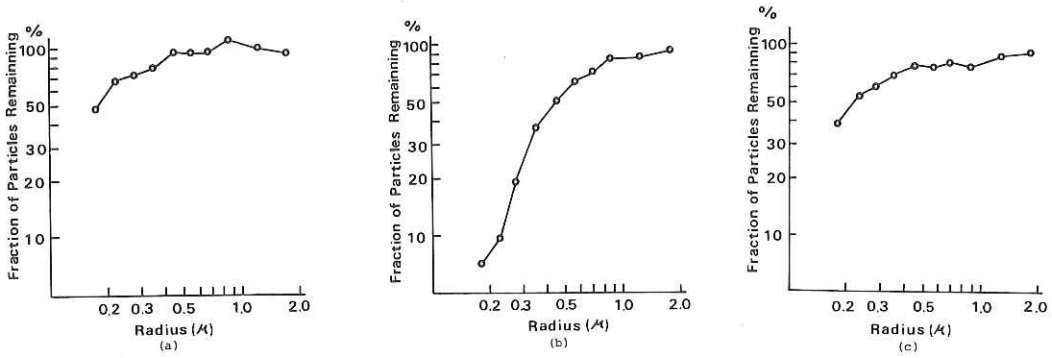


Fig. 55. The fraction of particles remaining of each size over the ocean. (a) The South Pacific
(b) 0°S 100°W
(c) The North Pacific

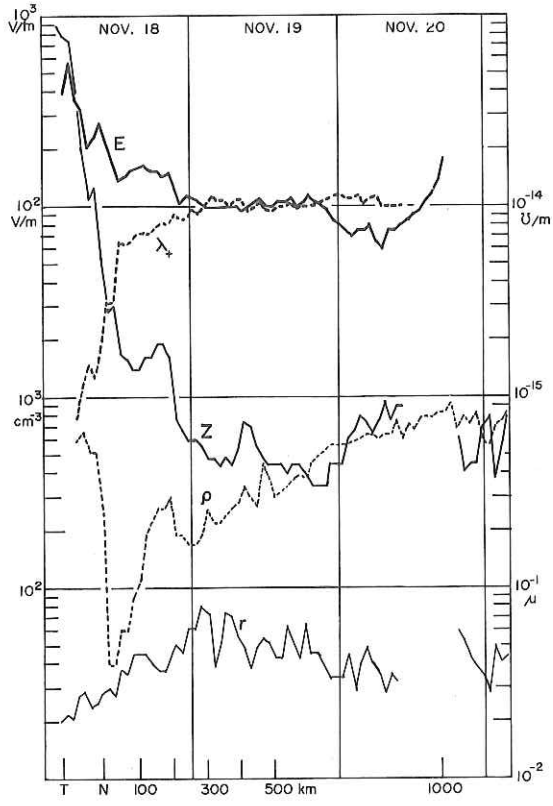


Fig. 57. Variation of E, λ_+, Z, ρ, and r for the distance from Tokyo.

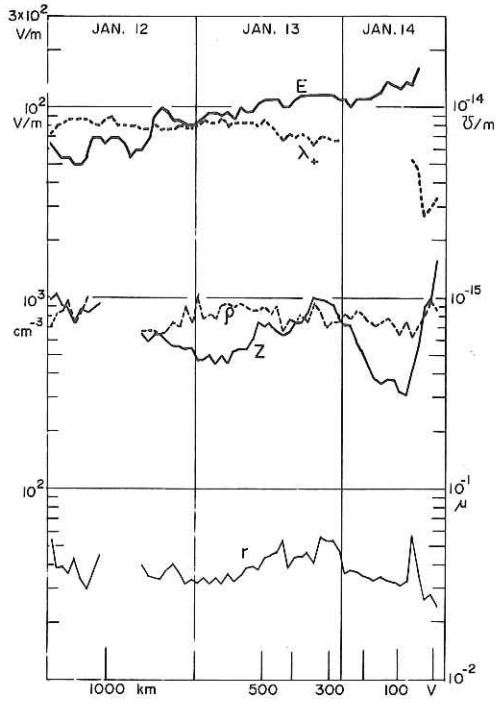


Fig. 58. Variation of E, λ_+, Z, ρ, and r for the distance from Valparaiso.

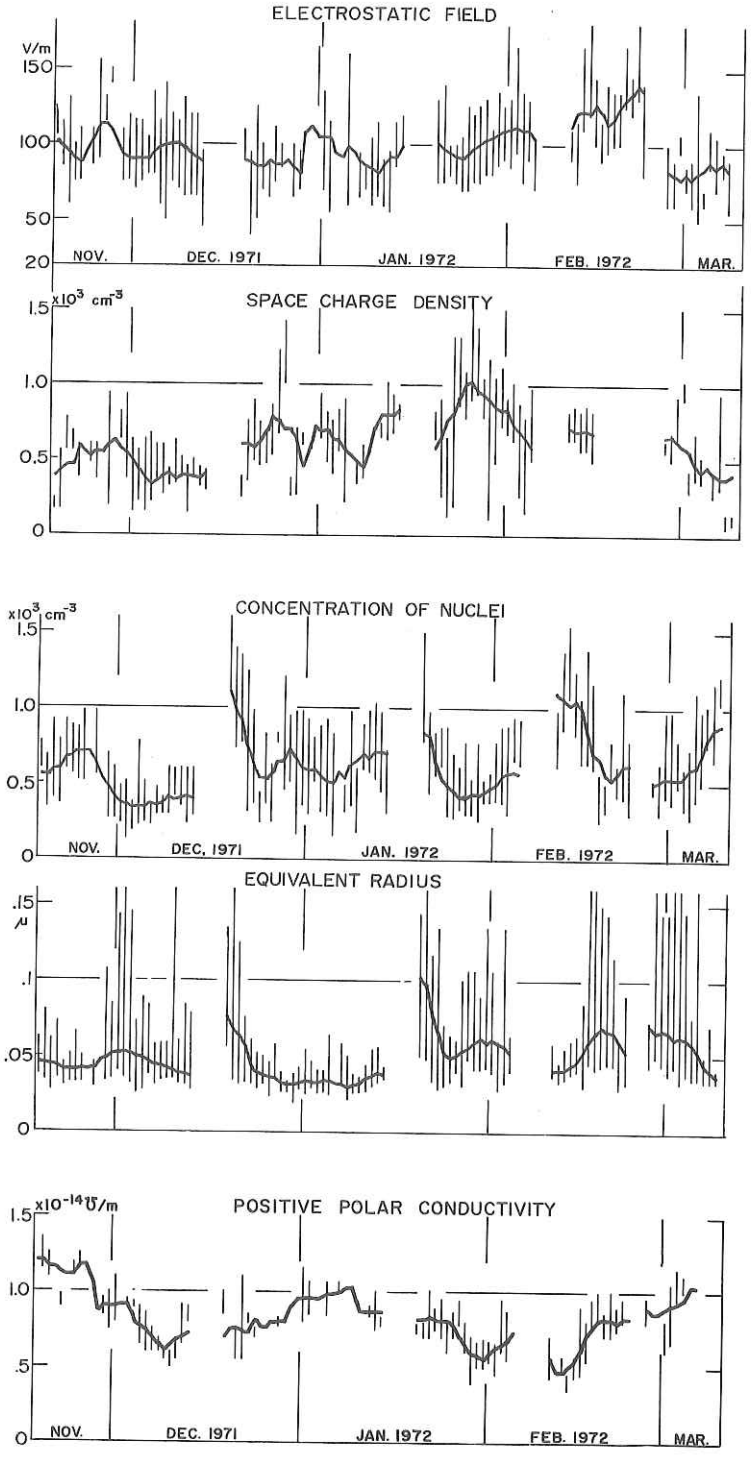


Fig. 56. Variation of atmospheric electrical elements for whole period of the cruise.

tive. It then prepares for irregular space charge distribution and locally high electric field. Our observation in several cruises on the Pacific Ocean near Japan Islands by this time has shown that the process of extension, in which concentration and size distribution of aerosols are changed, is locally and seasonally different to each other according to the circumstance. It would be required to find a general rule forming the process. Generation and disappearance of aerosols over the ocean are also important. Various charge separation taking place at the same time as above makes the electrical state more complicated. These will decide the back ground relating to air pollution due to particles. We would expect to know the present state of back ground pollution and then assess the future of it.

The atmospheric electric field was measured with a mechanical collector type field meter mounted on the uppermost deck, 14 m above the sea surface. The pattern of variation of short period in the field is different from that observed on land, and it superposes considerable fluctuation of the period of several minutes. The space charge density that may be considred as one of causes of the fluctuation is also measured with filter method. Probable correlation between fluctuations in the electric field and that in the space charge density is obvious in some cases, but it is not always said to be generally good. If we notice that the value of space charge represents the nature of sample air while the value of electric field reflects conditions in comparatively wide circumstance, then the comparison of the two elements will need more careful treatment. The effect of exhaust from the vessel seems almost negligible on the averaged value of electric field measured at the setting mentioned above. The averaged diurnal variation of electric field displays a typical course also in this cruise, which has maximum around 18 UT probably reflecting the world wide thunderstorm activity.

A Gerdien-type cylindrical condenser was used for the measurement of electrical conductivity on a side of bridge deck, about 10 m. above the sea level. Under stormy weather the apparatus was often covered by sea splash, and the after effect of this obliged to suspend the measurement for a few days.

When the wind blew from the opposite side of apparatus setting, sample air was more or less affected by ship exhaust and the conductivity gave lower values. But it was not easy for us frequently to move this apparatus setting from a side to another asking for better conditions. Two sets of apparatuses as to be fixed on each side of deck would be needed for more continual measurement.

The concentration of condensation nuclei was measured with a Pollak-type nuclei counter. By using diffusion battery jointly to this, the diffusion coefficient of nuclei which enabled to estimate equivalent size of nuclei was measured at the same time. Intake of sample air to the counter was made with a long hose, which was frequently moved from a side to side according to the wind direction in order to avoid drawing ship exhaust into the counter. The height at the intake is 11 m. above the sea surface. Also, intake to the space charge meter was similarly moved according to the wind direction as that to Pollak counter. The value of space charge was always positive except for the interval disturbed by precipitation. The density as converted into difference of the number of positive charged particales to negative ones in unit volume was several hundred per cubic centimeter if we assume every charged particle carries unit electricity. It is of similar order to the concentration of condensation nuclei obtained with Pollak counter.

An outline of results of these measurements is shown in figures. Fig. 56 shows variation of elements measured for whole undisturbed period of the cruise. From above the atmospheric electric field, space charge density in net number of charged particles assuming single electrification, concentration of condensation nuclei, equivalent radius of condensation nuclei and positive polar conductivity are given on the same time scale. Curves are given by running means for five days, thus general trend of each element seems to be made clear by cancelling day to day fluctuation. Vertical lines are the range of hourly values in the day. Values measured when the vessel is located within 200 km from any coast line are excluded. It seems not easy from the figure to conclude which region in the Pacific

Ocean is less polluted.

Figs. 57 and 58 are shown as representative examples of the aspect with respect to the distance from land. The former is variation at the time departing Tokyo, and the latter is that arriving at Valparaiso, Chile. Dates are given in UT. The distance to the nearest coast from the vessel is also shown under abscissa. T and N in Fig. 57 gives the times of departing Tokyo and passing off the coast Nojimazaki. V in Fig.58 is the time of arriving at Valparaiso. E, λ_+, Z, ρ and r are electric field in V/m, positive polar conductivity in $^{mho}/m$, concentration of condensation nuclei in cm^{-3}, space charge density in the same scale cm^{-3} as Z, and radius of nuclei in μ, respectively. As shown in Fig. 57, E is coming from 500 V/m in Tokyo Bay to about 100 V/m, λ_+ is from 0.08×10^{-14} to 1.1×10^{-14} $^{mho}/m$ and Z is from 9×10^4 to $5 \times 10^2/cm^3$, every element comes to steady value on the ocean at the distance about 300 km. apart from land. In case of arriving at Valparaiso, the effect of land is not so striking as in case of Tokyo. The effect of land will require careful analysis to be clarified, in connection not only with circumstances on the land but also with meteorological and aerological conditions in larger and smaller scales.

Appendix

Core and Dredge Logs

Core Log

Date Dec.2,'71 Ship Hakuhō Maru Cruise KH-71-5 Station 2-2
Latitude 15°55.0'N Longitude 146°10.0'W
Location South East of Hawaii Islands
Weather cloudy, wind ENE 7 Sea 4, swell 5
Bottom saddle of abyssal hill

Length Main Pipe	12 m	Pipe Material	Al(Mg)Alloy
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	445 kg	Trigger Wt.	60 kg
Length Main Line	25 m	Length Trigger Line	25 m
Length Free Fall	12 m		
Time lowered	0805	Uncorr. Water Depth	5410 m
Time hit	1025	Uncorr. Water Depth	5410 m
Wire Angle at Hit	5°	Wire-out at Hit	5500 m
Time surfaced	1140	Winch #1	
Response at Hit	not clear	Response at Pull-out	not clear
Length Main Core	0 cm	Length Trigger Core	55.5 cm

State of Cutting Edge & Pipe Pipe bent at 8 m from the top
Remarks. The trigger may have gone on the way down because of bad weather.

Date Dec.6,'71 Ship Hakuhō Maru Cruise KH-71-5 Station 7-2
Latitude 2°00.8'N Longitude 145°59.0'W
Location central equatorial Pacific
Weather cloudy, wind ESE 6 Sea 3, swell 3
Bottom smooth

Length Main Pipe	15 m	Pipe Material	Al(Mg)Alloy
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	480 kg	Trigger Wt.	60 kg
Length Main Line	23.3 m	Length Trigger Line	23 m
Length Free Fall	7 m		
Time lowered	1304	Uncorr. Water Depth	4570 m
Time hit	1432	Uncorr. Water Depth	4570 m
Wire Angle at Hit	0°	Wire-out at Hit	4604 m
Time surfaced	1540	Winch #1	
Response at Hit	unclear	Response at Pull-out	clear
Length Main Core	1024 cm	Length Trigger Core	57 cm
Length Penetration	1030 cm		

State of Cutting Edge & Pipe good, no damage
Method of Core Extrusion extruding by using piston and bars
Method of Core Storage Lapped by vinyl sheet and contained in 2 m pipes after cutting into halves
No. of Storage Pipes 7
Length of Cores in Pipes 1. 87 cm, 2. 174 cm, 3. 168.5 cm, 4. 168 cm 5. 163 cm, 6. 171 cm, 7. 92.5 cm
No. of Cubic Samples for Paleomagnetism 415(#11003-11417)

Core Log

Date Dec.9,'71 Ship Hakuhō Maru Cruise KH-71-5 Station 10-2
Latitude 4°58.5'S Longitude 146°03.5'W
Location central equatorial Pacific
Weather partly clouky, wind E 6 Sea 3, swell 4
Bottom rough, foot of abyssal hill

Length Main Pipe	15 m	Pipe Material	Al(Mg)Alloy
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	480 kg	Trigger Wt.	60 kg
Length Main Line	23.3 m	Length Trigger Line	23 m
Length Free Fall	7 m		
Time lowered	0812	Uncorr. Water Depth	4950 m
Time hit	0934	Uncorr. Water Depth	4960 m
Wire Angle at Hit	2°	Wire-out at Hit	4999 m
Time surfaced	1030	Winch #1	
Response at Hit	clear	Response at Pull-out	clear
Length Main Core	203 cm	Length Trigger Core	55 cm

Pipe was bent, cutting edge was crushed in one side.
Method of Core Extrusion extruding by using piston and bars
Method of Core Storage lapped by vinyl sheet and contained in 2 m pipes after cutting into halves
No. of Storage Pipes 2
Length of Cores in Pipes 1. 153 cm, 2. 50 cm
No. of Cubic Samples for Paleomagnetism 72(#11418-11489)

Date Dec.11,'71 Ship Hakuhō Maru Cruise KH-71-5 Station 12-2
Latitude 11°01.4'S Longitude 146°01.5'W
Location North of Toamotu Archipelago
Weather squall, wind NE 5 Sea 2, swell 2
Bottom flat

Length Main Pipe	6 m	Pipe Material	Al(Mg)Alloy
I.D. of Pipe	136 mm	Wall Thickness	6 mm
Core Head Wt.	480 kg	Trigger Wt.	60 kg
Length Main Line	15 m	Length Trigger Line	14.8 m
Length Free Fall	8 m		
Time lowered	1400	Uncorr. Water Depth	4835 m
Time hit	1624	Uncorr. Water Depth	4830 m
Wire Angle at Hit	8°	Wire-out at Hit	4896 m
Time surfaced	1740	Winch #1	
Response at Hit	clear	Response at Pull-out	clear
Length Main Core	326 cm	Length Trigger Core	23 cm

State of Cutting Edge & Pipe no damage
Method of Core Extrusion extruding by using piston and bars
Method of Core Storage lapped by vinyl sheet and contained in 2 m pipes after cutting into halves
No. of Storage Pipes 2
Length of Cores in Pipes 1. 184 cm, 2. 142 cm
No. of Cubic Samples for Paleomagnetism 129(#11490-11618)
Remarks. Top 10 cm included Mn nodules.

Core Log

Date Dec.12,'71 Ship Hakuhō Maru Cruise KH-71-5 Station 13-2
Latitude 14°33.0'S Longitude 147°55.3'W
Location Northwest of Tuamotu Archipelago
Weather partly clouky, wind NE 5 Sea 3, swell 2
Bottom Northern slope of Ramgiroa Atoll

Length Main Pipe	12 m	Pipe Material	Al(Mg)Alloy
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	445 kg	Trigger Wt.	60 kg
Length Main Line	23.3 m	Length Trigger Line	23 m
Length Free Fall	10 m		
Time lowered	1606	Uncorr. Water Depth	1830 m
Time hit	1655	Uncorr. Water Depth	1818 m
Wire Angle at Hit	2°	Wire-out at Hit	1817 m
Time surfaced	1735	Winch #1	
Response at Hit	clear	Response at Pull-out	clear
Length Main Core	0 cm	Length Trigger Core	0 cm
Length Penetration	longer than 500 cm		

State of Cutting Edge & Pipe good
Remarks. The main core have been washed away just above the sea surface because of sandy bottom. About 500 g of sandy sediment included Globigerina diatom ooze was obtained

Date Dec.19,'71 Ship Hakuhō Maru Cruise KH-71-5 Station 15-2
Latitude 20°22.8'S Longitude 148°02.6'W
Location Southeast of Tuamotu Archipelago
Weather cloudy, wind NW 4 Sea 3, swell 3
Bottom Foot of abyssal hill

Length Main Pipe	6 m	Pipe Material	Al(Mg)Alloy
I.D. of Pipe	136 mm	Wall Thickness	6 mm
Core Head Wt.	480 kg	Trigger Wt.	60 kg
Length Main Line	15 m	Length Trigger Line	14.8 m
Length Free Fall	8 m		
Time lowered	0835	Uncorr. Water Depth	4620
Time hit	0955	Uncorr. Water Depth	4615
Wire Angle at Hit	0°	Wire-out at Hit	4663 m
Time surfaced	1055	Winch #1	
Response at Hit	not clear	Response at Pull-out	clear
Length Main Core	125 cm	Length Trigger Core	27 cm
Length Penetration	500 cm		

No. of Storage Pipes 1
No. of Cubic Samples for Paleomagnetism 32(#11619-11650)

Core Log

Date Dec.24,'71 Ship Hakuhō Maru Cruise KH-71-5 Station 20-2
Latitude 35°04.8'S Longitude 138°38.9'W
Location central South Pacific
Weather cloudy, wind ENE 5 Sea 3, swell 4
Bottom foot of alyssal hill

Length Main Pipe	6 m	Pipe Material	Al(Mg)Alloy
I.D. of Pipe	136 mm	Wall Thickness	6 mm
Core Head Wt.	480 kg	Trigger Wt.	60 kg
Length Main Line	15 m	Length Trigger Line	14.8 m
Length Free Fall	8 m		
Time lowered	1010	Uncorr. Water Depth	4690 m
Time hit	1129	Uncorr. Water Depth	4650 m
Wire Angle at Hit	0°	Wire-out at Hit	4688 m
Time surfaced	1223	Winch #1	
Response at Hit	not clear	Response at Pull-out	not clear
Length Main Core	0 cm	Length Trigger Core	0 cm

State of Cutting Edge & Pipe no damage with pipe, 9 crushes with edge.
Remarks. 3 Mn nodules were in trigger corer. Mn nodule collided with the edge of main corer may gave prevented from penetrating further.

Date Dec.28,'71 Ship Hakuhō Maru Cruise KH-71-5 Station 24-2
Latitude 46°19.3'S Longitude 127°46.4'W
Location western slope of the East Pacific Rise
Weather cloudy, wind N 5 Sea 3, swell 4
Bottom rugged over 200 m, south flank of a seamount

Length Main Pipe	12 m	Pipe Material	Al(Mg)Alloy
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	445 kg	Trigger Wt.	80 kg
Length Main Line	25.3 m	Length Trigger Line	25 m
Length Free Fall	12 m		
Time lowered	0959	Uncorr. Water Depth	4665 m
Time hit	1113	Uncorr. Water Depth	4630 m
Wire Angle at Hit	4°	Wire-out at Hit	4668 m
Time surfaced	1212	Winch #1	
Response at Hit	clear	Response at Pull-out	not clear
Length Main Core	0 cm	Length Trigger Core	57 cm

Remarks. Main Corer was lost by breaking the wire for free fall.

Core Log

Date Jan.2,'72 Ship Hakuhō Maru Cruise KH-71-5 Station 29-2
Latitude 62°10.3'S Longitude 106°34.1'W
Location Bellingshausen Sea
Weather rain, wind E 4 Sea 2, swell 2
Bottom flat

Length Main Pipe	15 m	Pipe Material	Al(Mg)Alloy
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	480 kg	Trigger Wt.	80 kg
Length Main Line	23.3 m	Length Trigger Line	23 m
Length Free Fall	7 m		
Time lowered	0847	Uncorr. Water Depth	5120 m
Time hit	1024	Uncorr. Water Depth	5117 m
Wire Angle at Hit	0°	Wire-out at Hit	5126 m
Time surfaced	1518	Winch #1	
Response at Hit	not clear	Response at Pull-out	clear
Length Main Core	1125 cm	Length Trigger Core	0 cm

State of Cutting Edge & Pipe no damage with cutting edge and pipe, piston was broken.
Method of Core Extrusion extruding by using piston and bars
Method of Core Storage lapped by vinyl sheet and contained in 2 m pipes after cutting into halves
No. of Storage Pipes 7
Length of Cores in Pipes 1. 146 cm, 2. 182 cm, 3. 179 cm, 4. 180 cm, 5. 181 cm, 6. 184 cm, 7. 73 cm
No. of Cubic Samples for Paleomagnetism 428(#11651-12078)
Remarks. The winch wire kinked at its wire-out of 4848 m when the wire was going up, and 4 hours work for repair. Piston was broken by unknown reason.

Date Jan.24,'72 Ship Hakuhō Maru Cruise KH-71-5 Station 42-2
Latitude 27°34.8'S Longitude 88°03.0'W
Location SW of Nasca Ridge
Weather partly clouky, wind ENE 3 Sea 1, swell 1
Bottom almost flat

Length Main Pipe	12 m	Pipe Material	Al(Mg)Alloy
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	480 kg	Trigger Wt.	80 kg
Length Main Line	23.3 m	Length Trigger Line	23 m
Length Free Fall	10 m		
Time lowered	0828	Uncorr. Water Depth	3250 m
Time hit	0929	Uncorr. Water Depth	3250 m
Wire Angle at Hit	0°	Wire-out at Hit	3241 m
Time surfaced	1030	Winch #1	
Response at Hit	clear	Response at Pull-out	clear
Length Main Core	466 cm	Length Trigger Core	5 cm

State of Cutting Edge & Pipe good
No. of Storage Pipes 3
Length of Cores in Pipes 1. 156 cm, 2. 181 cm, 3. 129 cm
No. of Cubic Samples for Paleomagnetism 208(#12079-12286)

Core Log

Date Jan.26,'72 Ship Hakuhō Maru Cruise KH-71-5 Station 44-2
Latitude 20°50.1'S Longitude 93°21.2'W
Location Peru Basin
Weather partly clouky, wind E 5 Sea 3, swell 1
Bottom almost flat, near flank of a seamount

Length Main Pipe	12 m	Pipe Material	Al(Mg)Alloy
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	480 kg	Trigger Wt.	80 kg
Length Main Line	23.3 m	Length Trigger Line	23 m
Length Free Fall	10 m		
Time lowered	1243	Uncorr. Water Depth	4150 m
Time hit	1425	Uncorr. Water Depth	4157 m
Wire Angle at Hit	2°	Wire-out at Hit	4170 m
Time surfaced	1530	Winch #1	
Response at Hit	clear	Response at Pull-out	clear
Length Main Core	600 cm	Length Trigger Core	45 cm

State of Cutting Edge & Pipe good, no damage
No. of Storage Pipes 4
Length of Cores in Pipes 1. 138 cm, 2. 171 cm, 3. 190 cm, 4. 101 cm
No. of Cubic Samples for Paleomagnetism 179(#12287-12465)

Date Jan.31,'72 Ship Hakuhō Maru Cruise KH-71-5 Station 49-2
Latitude 3°21.5'S Longitude 100°02.3'W
Location East equatorial Pacific
Weather partly cloudy, wind SE 3 Sea 2, swell 2
Bottom very rugged

Length Main Pipe	15 m	Pipe Material	Al(Mg)Alloy
I.D. of Pipe	68 mm	Wall Thickness	6 mm
Core Head Wt.	480 kg	Trigger Wt.	80 kg
Length Main Line	23.3 m	Length Trigger Line	23 m
Time lowered	0820	Uncorr. Water Depth	3475 m
Time hit	0935	Uncorr. Water Depth	3470 m
Wire Angle at Hit	0°	Wire-out at Hit	3551 m
Time surfaced	1030	Winch #1	
Response at Hit	clear	Response at Pull-out	clear
Length Main Core	0 cm	Length Trigger Core	0 cm

Remarks. Both main corer and trigger corer were lost by breaking the wire for free fall and the wire with trigger corer.

Core Log

Date Feb.15,'72 Ship Hakuhō Maru Cruise KH-71-5 Station 53-2
Latitude 8°15.3'N Longitude 112°42.1'W
Location east Central Pacific
Weather cloudy, wind NE 6 Sea 4, swell 4
Bottom a slightly saddle of very rugged hilly area

Length Main Pipe	6 m	Pipe Material	Al(Mg)Alloy
I.D. of Pipe	136 mm	Wall Thickness	6 mm
Core Head Wt.	325 kg	Trigger Wt.	55 kg
Length Main Line	15 m	Length Trigger Line	14.8 m
Length Free Fall	8 m		
Time lowered	0943	Uncorr. Water Depth	3965 m
Time hit	1107	Uncorr. Water Depth	3970 m
Wire Angle at Hit	4°	Wire-out at Hit	3988 m
Time surfaced	1200	Winch #1	
Response at Hit	clear	Response at Pull-out	clear
Length Main Core	575 cm	Length Trigger Core	45 cm

State of Cutting Edge & Pipe good, no damage
No. of Storage Pipes 4
Length of Cores in Pipes 1. 186 cm, 2. 182 cm, 3. 184 cm, 4. 23 cm
No. of Cubic Samples for Paleomagnetism 210(#12466-12675)

Dredge Log

Date Dec.11,'71 Ship Hakuhō Maru Cruise KH-71-5 Station 12-3
Location north of Tuamotu Archipelago
Weather partly cloudy Wind E 5 Sea 2, swell 2
Bottom almost flat, gentle slope

Type of Dredge Pipe(diameter 40 cm, length 120 cm) Add. Wt. 250 kg
Time lowered 0905 Uncorr. Water Depth 4875 m
Initial Time on Bottom 1057 Uncorr. Water Depth 4890 m
Wire Length 4990 m Wire Angle 20°
Ship Position: Lat. 11°00.0'S; Long. 146°01.9'W
Direction of Haul 220° Ship Speed 1 kt
Speed Wire-in 20 m/min Winch #1
Final Time on Bottom 1144 Uncorr. Water Depth 4935 m
Wire Length 5037 m Wire Angle 20°
Ship Position: Lat. 11°01.4'S; Long. 146°03.2'W
Time surfaced 1314

Condition of Haul good

Dredged Materials: Moderate brown clay (91 kg), many Mn nodules with smooth surface, 1 Rock.

Dredge Log

Date Dec.19,'71 Ship Hakuhō Maru Cruise KH-71-5 Station 15-3
Location Southeast of Tuamotu Archipelago
Weather cloudy Wind W 5 Sea 3, swell 3
Bottom almost flat, 2 miles from a hill

Type of Dredge Pipe(diameter 40 cm, length 120 cm) Add. Wt. 250 kg
Time lowere 1128 Uncorr. Water Depth 4610 m
Initial Time on Bottom 1245 Uncorr. Water Depth 4615 m
Wire Length 4650 m Wire Angle 10°
Ship Position: Lat. 20°23.4'S; Long. 148°01.2'W
Direction of Haul 90° Ship Speed 0.5 kt
Speed Wire-in 20m/min Winch #1
Final Time on Bottom 1310 Uncorr. Water Depth 4618 m
Wire Length 4951 m Wire Angle 10°
Ship Position: Lat. 20°23.4'S; Long. 148°01.2'W
Time surfaced 1438

Condition of Haul good

Dredged Materials: Dark brown red clay (160.5 kg), many Mn nodules with rough surface, 1 shark-tooth

Date Dec.24,'71 Ship Hakuhō Maru Cruise KH-71-5 Station 20-3
Location central South Pacific
Weather partly cloudy Wind E 5 Sea 3, swell 4
Bottom almost flat

Type of Dredge Pipe(diameter 40 cm, length 120 cm) Add. Wt. 250 kg
Time lowere 1255 Uncorr. Water Depth 4815 m
Initial Time on Bottom 1401 Uncorr. Water Depth 4850 m
Wire Length Wire Angle 10°
Ship Position: Lat. 35°04.5'S; Long. 138°39.5'W
Direction of Haul 255° Ship Speed 0.2 kt
Speed Wire-in 40 m/min Winch # 1
Final Time on Bottom 1430 Uncorr. Water Depth 4860 m
Wire Length 5200 m Wire Angle 7°
Ship Position: Lat. 35°04.5'S; Long. 138°40.0'W
Time surfaced 1610

Condition of Haul good

Dredged Materials: Dark brown red clay (86.5 kg), many Mn nodules with rough surface.