Preliminary Report
of
The Hakuhō Maru Cruise KH-82-5

22 November 1982 - 24 February 1983

The eastern Pacific Ocean

Ocean Research Institute

University of Tokyo

1984

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By

The Scientific Members of the Expedition

Edited by

Akihiko HATTORI

Yoshibumi TOMODA

1984

Preface

This volume contains the oceanographic data obtained during the Cruise KH-82-5 of the R.V. Hakuho Maru from 22 November 1982 to 24 February 1983. Brief summaries of the research carried out by the scientists aboard are also included.

On behalf of the scientists, we wish to express our gratitude to Captain Ichiro Tadama, the other officers and the crew members of the Hakuho Maru for their cooperation and skillful assistance throughout the cruise. We acknowledge the help of Ms. Masae Ohtsu in compiling and editing this volume.

31 Junuary 1984

Akihiko Hattori
Yoshibumi Tomoda
Chief Scientists

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Outline of the cruise

The cruise consisted of five legs (Fig. 1). The locations of the oceanographic stations are given in Table 1.

Leg 1 was mainly devoted to a seismic study of the Mendocino fracture zone off the west coast of the United States.

During the rest of the cruise (legs 2 to 5), chemical, biochemical and biological processes were investigated with special reference to the cycling of biophilic elements. Information was collected on: (1) distribution of temperature and salinity, (2) distribution of dissolved gases, nutrients, chlorophylls, trace metals and stable and radioactive nuclides, and (3) distribution of phytoplankton and zooplankton. Simultaneous shipboard or in situ experiments on carbon and nitrogen metabolism were carried out using tracer techniques. Settling particles were collected by installing sediment traps at various depths. At selected stations bottom sediment was also collected using a box core sampler or a tripod core sampler. In addition, seismic records were collected near the Clarion fracture zone using an array of ocean bottom seismometers deployed during leg 2 and retrieved during leg 3.

Meteorological variables such as air temperature, wind speed, wind direction, pressure, solar radiation, dew point, and aerosols, and gravity were continuously or intermittently recorded throughout the cruise.

Y. Tomoda served as the director on leg 1, and A. Hattori on leg 2 through leg 5. The names and specialities of the scientists who participated in this cruise are listed in Table 2.

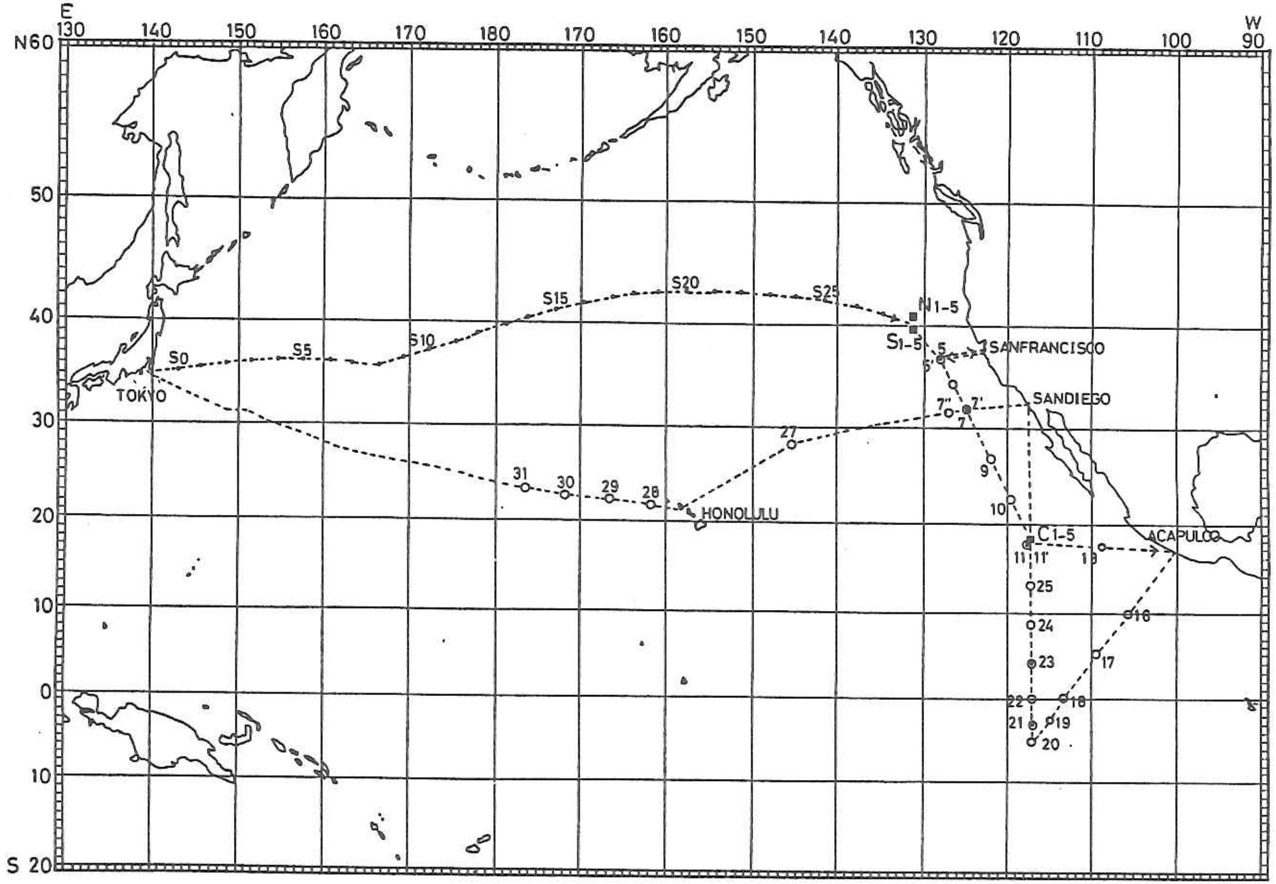

Fig. 1. Track chart of the KH-82-5 cruise of the Hakuho Maru.

Table 1. Location of oceanographic stations and dates

Leg	Station	Latitute	Longitude	Date
1	Leave Tokyo			11/22/82
	N1-N5	40°31.5'-41°02.9'N	130°40.5'-130°39.8'W	12/ 6/82-
	S1-S5	39°29.6'-40°00.0'N	130°40.1'-130°39.6'W	12/ 9/82
	5	36°58.1'-36°59.6'N	127°34.4'-127°33.1'W	12/10/82
	Arrive San Francisco, Alifornia			12/11/82
2	Leave San Francisco, Alifornia			12/15/82
	5'	36°55.5'-36°57.0'N	127°31.5'-127°30.9'W	12/17/82-12/18/82
	6	34°19.8'-34°19.9'N	125°57.1'W	12/18/82
	7	31°39.4'-31°39.6'N	124°22.3'-124°22.1'W	12/19/82-12/20/82
	9	26°50.0'-26°50.1'N	121°47.3'-121°46.6'W	12/21/82
	10	22°11.8'-22°12.5'N	119°22.1'-119°21.3'W	12/22/82
	11	17°26.0'-17°28.0'N	117°00.8'-117°00.5'W	12/23/82-12/24/82
	C1-C5	17°29.4'-17°59.0'N	117°00.6'-116°04.1'W	12/23/82-12/24/82
	13	17°14.5'-17°15.0'N	108°38.9'-108°38.0'W	12/26/82
	Arrive Acapulco, Mexico			12/28/82
3	Leave Acapulco, Mexico			1/ 2/83
	16	9°59.1'-10°00.3'N	105°19.9'-105°19.1'W	1/ 4/83
	17	5°00.5'- 5°00.8'N	109°15.9'-109°15.6'W	1/ 5/83
	18	0°00.5'- 0°01.2'S	113°09.3'-113°08.5'W	1/ 7/83
	19	2°29.2'- 2°29.2'S	115°04.7'-115°03.2'W	1/ 8/83
	20	5°01.0'- 5°01.3'N	117°01.3'-117°00.6'W	1/ 8/83- 1/ 9/83
	21	2°45.3'- 2°47.1'S	117°02.1'-117°01.0'W	1/ 9/83- 1/11/83
	22	0°00.2'N-0.00.4'S	117°00.0'-116°59.9'W	1/12/83
	23	3°57.7'- 4°00.5'N	117°00.2'-116°59.3'W	1/13/83
	24	8°27.6'- 8°28.2'N	117°00.7'-117°00.2'W	1/14/83
	25	12°59.5'-12°59.7'N	117°00.1'W	1/15/83
	11'	17°27.0'-17°27.3'N	116°59.3'-116°58.4'W	1/17/83- 1/18/83
	(C1-C5)	17°29.4'-17°59.0'N	117°00.6'-116°04.1'W	1/16/83- 1/19/83
	Arrive San Diego, California			1/22/83
4	Leave San Diego, California			1/26/83
	7'			1/28/83
	27	26°45.5'-26°50.7'N	146°52.9'-146°46.3'W	2/ 2/83- 2/ 4/83
	Arrive Honolulu, Hawaii			2/ 7/83
5	Leave Honolulu, Hawaii			2/10/83
	28	21°32.2'N	161°00.3'W	2/11/83
	29	22°02.8'N	166°12.8'W	2/12/83
	30	22°34.9'N	171°18.5'W	2/13/83
	31	23°21.9'N	176°15.7'W	2/14/83
	Arrive Tokyo			2/24/83

Table 2. Scientists aboard.

Akihiko HATTORI	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
Yoshibumi TOMODA	Ocean Res. Inst., Univ. of Tokyo	Geophysics
Isao KOIKE	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
Toshisuke NAKAI	Ocean Res. Inst., Univ. of Tokyo	Physical Oceanography
Toshiro SAINO	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
Kinichiro KOIZUMI	Ocean Res. Inst., Univ. of Tokyo	Geophysics
Toshio FURUTA	Ocean Res. Inst., Univ. of Tokyo	Geophysics
Hirotaka OTOBE	Ocean Res. Inst., Univ. of Tokyo	Physical Oceanography
Kazuyasu MIYATA	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
Jota KANDA	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
Hayato SHOJI	Ocean Res. Inst., Univ. of Tokyo	Geophysics
Shinichiro NORIKI	Fac. Fisheries, Hokkaido Univ.	Geochemistry
Ko HARADA	Fac. Fisheries, Hokkaido Univ.	Geochemistry
Norihito ISHIMORI	Fac. Fisheries, Hokkaido Univ.	Geochemistry
Toshitaka SUZUKI	Fac. Fisheries, Hokkaido Univ.	Geochemistry
Tatsuo TANJI	Muroran Inst. Technology	Atmospheric Electricity
Seiji NAKAMURA	Muroran Inst. Technology	Geochemistry
Akira TANIGUCHI	Fac. Agr. Sci., Tohoku Univ.	Biology
Masayuki TAKAHASHI	Inst. Biol. Sci., Univ. Tsukuba	Biological Oceanography
Hajimu KINOSHITA	Fac. Science, Chiba Univ.	Geophysics
Toshio ASANUMA	Fac. Science, Chiba Univ.	Geophysics
Hideki AMEMIYA	Fac. Science, Chiba Univ.	Geophysics
Shozaburo NAGUMO	Earthquake Res. Inst., Univ. of Tokyo	Geophysics
Junzo KASAHARA	Earthquake Res. Inst., Univ. of Tokyo	Geophysics
Sadayuki KORESAWA	Earthquake Res. Inst., Univ. of Tokyo	Geophysics
Nobuhiko HANDA	Water Res. Inst., Nagoya Univ.	Geochemistry
Satoru KANAMORI	Water Res. Inst., Nagoya Univ.	Geochemistry
Takeo HAMA	Water Res. Inst., Nagoya Univ.	Geochemistry
Hidekazu MATSUEDA	Water Res. Inst., Nagoya Univ.	Geochemistry
Takumi HAYASHI	Fac. Science, Kanazawa Univ.	Radio Chemistry
Nobuhiro ISEZAKI	Fac. Science, Kobe Univ.	Geophysics
Masashi KUSAKABE	Dept. Geol. Sci., Univ. South. Calif.	Geochemistry
Kohji ITOH	Dept. Geochem., Calif. Inst. Technol.	Geochemistry

Table 3. Items of observation at each station.

Stations	5	5'	6	7	9	10	11	13	16	17	18	19	20	21	22	23	24	25	11'	7'	27	28	29	30	31
CTD observation		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
Water sampling																									
RMS		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X							
NIS	X	X		X			X							X		X			X	X	X				
PUMP	X													X		X			X	X	X				
GOFLO		X																	X	X	X				
LVFS									X										X		X				
CS				X			X		X					X					X		X				
VD		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Plankton sampling		X		X	X		X	X	X	X	X	X	X	X	X	X	X	X			X				
Sediment sampling									X		X			X					X		X				
Sediment trap	X	X		X			X												X	X					
In situ experiment																					X				
OBSH	X						X												X						

Abbreviations: RMS, rosette multisampler; NIS, Niskin sampler; PUMP, underwater pump
GOFLO, GOFLO sampler; LVFS, large volume underwater filtration system
CS, clean sampler; VD, Van Dorn sampler; OBSH, Ocean Bottom Seismometry

Routine observations of oceanographic variables

Twenty three hydrographic stations were occupied on leg 2 through leg 5 (Fig. 1). At each station, casts of CTD with Rosette samplers or 23-liter Niskin samplers were made to collect information on water temperature, salinity, dissolved oxygen, pH, alkalinity, inorganic nutrients, and chlorophylls. The names of the persons who conducted the measurements are given after each item.

Depth profiles of temperature and salinity were obtained with a Neil Brown Mark III CTD profiler. Calibrations were made based on temperature values obtained at select depths using pairs of protected reversing thermometers (Nakai, Otobe and Hayashi), and salinities determined with discrete water samples using an Auto Lab 601 MK III inductive salinometer (Otobe, Nakamura and Tanji).

Dissolved oxygen was determined by the Winkler method (Noriki and Matsueda), pH was measured with a pH meter, and alkalinity was estimated from the pH shift after the addition of a definite amount of HCl to the seawater samples (Kanamori, Harada and Suzuki). Phosphate, nitrate, nitrite, ammonium and silicic acid were determined using a Technicon type II autoanalyzer (Koike, Miyata and Kanda). The method of Murphy and Riley (1962) was used for reactive phosphate, the Cd-Cu method described by Strickland and Parsons (1972) for nitrate, the method of Bendschneider and Robinson (1952) for nitrite, the method of Head (1971) for ammonium, and the molybdenium blue method described by Strickland and Parsons (1972) for silicic acid. Silicic acid was also determined manually using the molybdenium yellow method described in the Manual of Oceanographic Observations (Oceanographical Society of Japan, 1970). Chlorophyll a and phaeophytin were determined by the fluorometric method as described by Strickland and Parsons (1972) (Saino, Hama and Takahashi).

The data obtained at the hydrographic stations are tabulated in Tables 4-6. Table 7 summarizes the data collected at surface stations (cf. Fig. 1).

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Murphy, J. and J.P. Riley (1962), Anal. Chim. Acta, **27**, 31-36.

Oceanographical Society of Japan (1970), Manual of Oceanographic Observations, Tokyo.

Strickland, J.D.H. and T.R. Parsons (1972), A Practical Handbook of Seawater Analysis, Fisheries Research Board of Canada, Ottawa.

Table 4. Summary of hydrographic data.

Cruise: KH-82-5
Sta.: 5'

Date: 17 Dec.'82
Time: 00:09
05:13

Air temp.: 13.5°C
Latitude: 36°55.6'N
36°57.7'N

Drift: 134°0.6kt
Longitude: 127°30.9'W
127°31.5'W

Wind: WSW 10m/s
Depth: 4740
4760

Depth (m)	Temp. (°C)	Salinity (permil)	Diss.Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	nitrite (μM)	Nitrate (μM)	Ammonium (μM)	Si-manual (μM)	pH	Alkalinity (meq/l)
0	13.50	33.009	5.72	0.67	4.3	0.18	0.9	0.00	0.0	8.098	2.266
10	13.50	32.975	5.75	0.46	3.8	0.10	0.4	0.00	0.0	8.104	2.254
30	13.61	33.118	5.71	0.48	4.3	0.20	1.0	0.00	0.0	8.098	2.262
50	13.40	33.182	5.57	0.59	5.3	0.28	2.3	0.00	0.0	8.080	2.264
75	10.72	33.369	4.41	1.43	15.8	0.10	17.2	0.00	11.4	7.891	2.271
100	10.01	33.542	3.71	1.74	22.2	0.10	22.4	0.00	19.3	7.819	2.280
125	9.33	33.733	3.10	1.98	28.5	0.10	26.2	0.00	24.2	7.764	2.293
150	8.78	33.835	2.89	2.02	31.1	0.11	27.4	0.00	28.2	7.751	2.295
175	8.38	33.909	2.83	2.06	34.1	0.10	28.0	0.00	33.4	7.746	2.300
200	8.10	33.971	2.58	2.15	37.4	0.10	29.6	0.00	50.6	7.738	2.306
300	7.07	34.049	1.82	2.68	51.6	0.11	34.9	0.00	67.9	7.652	2.325
400	6.24	34.116	0.97	2.95	66.7	0.11	39.8	0.00	83.1	7.584	2.345
500	5.52	34.179	0.54	3.20	81.5	0.12	42.6	0.00	111.0	7.549	2.362
750	4.43	34.348	0.23	3.38	109.0	0.12	45.4	0.00	131.0	7.536	2.400
1000	3.71	34.446	0.37	3.38	127.0	0.13	46.2	0.00	144.0	7.550	2.426
1250	3.13	34.512	0.71	3.31	138.0	0.13	45.5	0.00	145.0	7.571	2.445
1251	3.14	34.508	0.74	3.33	141.0	0.13	46.0	0.00	156.0	7.620	2.398
1500	2.69	34.546	1.04	3.24	149.0	0.13	45.1	0.00	170.0	7.605	2.442
1750	2.28	34.585	1.13	3.17	162.0	0.13	44.4	0.00	179.0	7.632	2.459
2000	1.98	34.603	1.39	3.10	171.0	0.13	43.6	0.00	179.0		
2250	1.83	34.631	1.74	3.03	174.0	0.12	42.6	0.00	183.0	7.675	2.478
2500	1.73	34.645	1.93	2.97	175.0	0.12	42.0	0.00	182.0	7.684	2.481
2750	1.64	34.651	2.24	2.90	175.0	0.12	41.5	0.00	183.0	7.701	2.481
3000	1.59	34.658	2.41	2.84	174.0	0.12	41.1	0.00	183.0	7.714	2.485
3250	1.55	34.668	2.56	2.83	174.0	0.11	40.8	0.00	181.0	7.715	2.484
3500	1.52	34.678	2.73	2.77	172.0	0.11	40.3	0.00	180.0	7.731	2.486
3750	1.49	34.684	2.77	2.79	167.0	0.11	40.5	0.00	174.0	7.708	2.464
4000	1.48	34.685	3.17	2.66	166.0	0.11	39.3	0.00	172.0	7.756	2.483

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	13.44	32.934	322.9	0.0000
10	13.44	32.942	322.4	0.0322
0	13.53	33.058	315.6	0.0964
50	13.54	33.151	309.0	0.1587
75	11.09	33.315	252.2	0.2304
100	10.00	33.516	219.5	0.2895
125	9.34	33.683	196.7	0.3420
150	8.91	33.833	179.1	0.3895
175	8.67	33.867	172.9	0.4342
200	8.39	33.950	162.8	0.4769
250	7.64	34.003	148.3	0.5564
300	7.01	34.046	136.7	0.6297
400	6.27	34.109	122.6	0.7644
500	5.71	34.181	110.5	0.8867
600	5.13	34.239	99.5	0.9977
700	4.71	34.296	90.7	1.0994
800	4.38	34.342	83.8	1.1938
1000	3.72	34.432	70.5	1.3633
1250	3.18	34.510	59.7	1.5462
1500	2.68	34.555	51.9	1.7071
1750	2.29	34.589	46.3	1.8511
2000	1.98	34.610	42.3	1.9827
2250	1.82	34.633	39.4	2.1055
2500	1.73	34.649	37.5	2.2231
2750	1.64	34.659	36.1	2.3376
3000	1.59	34.667	35.1	2.4499
3250	1.55	34.673	34.4	2.5613
3500	1.52	34.679	33.7	2.6721
3750	1.49	34.684	33.2	2.7824
4000	1.48	34.688	32.8	2.8930

Table 4. Continued.

Cruise: KH-82-5
Sta.: 6

Date: 18 Dec.'82
Time: 16:58
18:36

Air temp.: 14.3°C
Latitude: 34°19.9'N
34°19.8'N

Drift: 175°0.4kt
Longitude: 125°57.1'W
125°57.1'W

Wind: S 2.0m/s
Depth: 4680

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)	Si-manual (μM)
0	15.80	33.185	5.54	0.36	3.1	0.17	0.1	0.05	0.0
25	15.52	33.161	5.56	0.35	2.8	0.02	0.0	0.00	0.0
50	15.45	33.152	5.57	0.32	2.6	0.01	0.0	0.03	0.0
100	12.11	33.105	5.61	0.47	4.2	0.12	2.1	0.02	0.0
150	10.53	33.253	4.90	0.66	7.2	0.13	7.5	0.06	2.4
250	8.48	33.954	2.57	1.93	34.4	0.25	29.5	0.00	29.3
500	5.40	34.062	1.16	2.69	73.0	0.28	40.8	0.02	68.8
750	4.60	34.326	0.35	3.09	102.0	0.30	44.4	0.00	96.9
1000	3.82	34.446	0.50	3.17	121.0	0.29	45.3	0.00	115.0
1250	3.25	34.503	0.84	3.06	133.0	0.28	44.9	0.11	127.0
1500	2.76	34.555	1.08	3.01	147.0	0.28	44.7	0.00	140.0
1750	2.34	34.586	1.39	2.97	157.0	0.27	43.8	0.06	151.0
2000	2.03	34.612	1.70	2.88	165.0	0.26	43.2	0.04	160.0

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	15.67	33.167	350.9	0.0000
10	15.59	33.156	350.0	0.0350
0	15.52	33.166	347.8	0.1048
50	15.48	33.162	347.2	0.1744
75	15.33	33.128	346.6	0.2615
100	12.41	33.114	290.5	0.3411
125	11.20	33.076	271.8	0.4120
150	10.69	33.198	254.2	0.4784
175	9.81	33.563	213.0	0.5375
200	9.43	33.742	193.8	0.5892
250	8.59	33.943	166.2	0.6811
300	7.93	34.007	151.9	0.7629
400	6.46	34.031	130.7	0.9090
500	5.41	34.074	115.0	1.0366
600	5.24	34.239	100.8	1.1504
700	4.71	34.303	90.2	1.2526
800	4.39	34.373	81.5	1.3455
1000	3.79	34.452	69.6	1.5111
1250	3.23	34.515	59.7	1.6937
1500	2.75	34.555	52.6	1.8557
1750	2.34	34.589	46.6	2.0015
2000	2.04	34.614	42.4	2.1342

Table 4. Continued.

Cruise: KH-82-5
Sta.: 7

Date: 19 Dec.'82
Time: 14:47
19:38

Air temp.: 15.2°C
Latitude: 31°39.4'N
31°39.6'

Drift: 150°0.2kt
Longitude: 124°22.3'W
124°22.1'W

Wind: SSE 14.0m/
Depth: 4380m
4370m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. oxy. (ml/l)	Phosphate (μM)	Silicate (μM)	nitrite (μM)	nitrate (μM)	Ammonium (μM)	Si-manual (μM)	pH	Alkalinity (meq/l)
0	17.10	33.300	5.40	0.38	2.5	0.01	0.3		0.0	8.104	2.272
10	16.60	33.296	5.38	0.34	2.3	0.00	0.1	0.09	0.0	8.117	2.272
30	16.63	33.357	5.38	0.33	2.3	0.00	0.1	0.12	0.0	8.118	2.274
50	16.41	33.307	5.35	0.34	2.3	0.00	0.2	0.10	0.0	8.117	2.271
75	13.94	33.369	5.79	0.37	3.1	0.07	0.4	0.27	0.0	8.084	2.266
100	13.46	33.475	5.55	0.40	4.7	0.17	0.6	0.05	0.0	8.074	2.268
124	11.89	33.388	5.32	0.64	6.8	0.02	4.7	0.12	0.0	8.026	2.262
149	10.55	33.591	4.54	1.10	14.0	0.02	12.9	0.32	5.5	7.934	2.271
174	9.64	33.781	4.04	1.44	21.6	0.02	18.8	0.23	13.1	7.864	2.281
199	8.81	33.887	3.95	1.60	26.7	0.02	22.0	0.52	18.3	7.839	2.288
299	7.62	34.040	2.48	2.38	45.1	0.03	31.2	0.66	35.5	7.709	2.312
399	6.23	34.070	1.42	2.76	65.3	0.03	37.4	0.19	55.3	7.591	2.332
499	5.75	34.179	0.71	3.11	79.7	0.03	41.5	0.12	69.0	7.540	2.352
749	4.62	34.374	0.31	3.34	107.0	0.03	44.5	0.23	95.5	7.522	2.392
999	3.92	34.464	0.54	3.34	124.0	0.03	45.0	0.23	110.0	7.534	2.416
1250	3.29	34.525	0.84	3.21	138.0	0.02	44.5	0.07	124.0	7.561	2.434
1250	3.30	34.521	0.89	3.27	137.0	0.02	44.7	0.22	122.0	7.563	2.430
1500	2.77	34.560	1.14	3.20	150.0	0.02	44.0	0.09	135.0	7.583	2.444
1750	2.40	34.591	1.42	3.11	161.0	0.03	43.3	0.08	144.0	7.608	2.457
2007	2.10	34.619	1.68	3.03	168.0	0.03	42.4	0.00	151.0	7.639	2.468
2260	1.94	34.637	2.00	2.96	171.0	0.03	41.6	0.06	154.0	7.567	2.470
2513	1.81	34.648	2.24	2.89	172.0	0.03	40.7	0.00	156.0	7.673	2.474
2750	1.67	34.661	2.61	2.82	175.0	0.03	40.2	0.16	158.0	7.686	2.476
3000	1.59	34.665	2.61	2.79	177.0	0.03	39.9	0.10	159.0	7.700	2.478
3250	1.54	34.667	2.78	2.80	174.0	0.03	39.8	0.31	157.0	7.710	2.477
3500	1.52	34.679	2.85	2.77	176.0	0.03	39.7	0.17	159.0	7.713	2.479
3750	1.49	34.683	2.99	2.70	172.0	0.03	38.6	0.28	155.0	7.723	2.476
4000	1.49	34.685	3.10	2.73	172.0	0.03	38.5	0.82	155.0	7.719	2.477

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	16.92	33.298	368.6	0.0000
10	16.65	33.289	363.1	0.0366
30	16.62	33.296	362.0	0.1090
50	16.54	33.306	359.6	0.1813
75	15.83	33.284	345.7	0.2704
100	13.78	33.452	291.5	0.3498
125	12.09	33.370	265.8	0.4201
150	10.78	33.494	233.9	0.4833
175	9.76	33.745	198.7	0.5381
200	9.19	33.832	183.3	0.5876
250	8.20	33.980	157.7	0.6738
300	7.53	34.016	145.7	0.7518
400	6.33	34.068	126.3	0.8922
500	5.70	34.180	110.4	1.0159
600	5.22	34.263	98.7	1.1265
700	4.87	34.346	88.6	1.2271
800	4.58	34.409	80.7	1.3190
1000	3.89	34.468	69.4	1.4843
1250	3.28	34.527	59.3	1.6655
1500	2.80	34.561	52.5	1.8277
1750	2.39	34.596	46.5	1.9737
2000	2.10	34.624	42.1	2.1065
2250	1.91	34.643	39.3	2.2305
2500	1.78	34.656	37.3	2.3488
2750	1.66	34.666	35.8	2.4631
3000	1.59	34.672	34.8	2.5748
3250	1.53	34.680	33.8	2.6848
3500	1.52	34.682	33.5	2.7944
3750	1.49	34.687	33.0	2.9043
4000	1.49	34.690	32.7	3.0146

Table 4. Continued.

Cruise: KH-82-5
Sta.: 9

Date: 21 Dec.'82
Time: 08:23
10:00

Air temp.: 18.0°C
Latitude: 26°50.1'N
26°50.0'N

Drift: 143° 0.3kt
Longitude: 121°47.3'W
121°46.6'W

Wind: SSW 4.5m/s
Depth: 4280m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)	Si-manual (μM)
0	17.90	33.581	5.26	0.34	3.2	0.01	0.1	0.05	0.0
25	17.74	33.563	5.28	0.35	3.3	0.02	0.1	0.00	0.0
50	17.70	33.694	5.35	0.33	3.6	0.02	0.1	0.08	0.0
100	16.42	33.668	4.72	0.76	8.1	0.11	6.8	0.03	0.0
150	13.11	33.672	4.74	0.66	7.1	0.10	5.7	0.08	0.0
250	8.77	34.043	2.85	2.02	32.2	0.05	25.8	0.16	23.4
500	5.92	34.266	0.62	3.25	76.4	0.08	40.6	0.27	66.7
750	4.92	34.404	0.32	3.49	98.0	0.10	44.1	0.12	86.8
1000	3.96	34.492	0.62	3.48	118.0	0.11	45.0	0.05	104.0
1250	3.39	34.534	0.86	3.46	131.0	0.11	44.8	0.05	116.0
1500	2.85	34.566	1.17	3.38	144.0	0.11	44.1	0.00	130.0
1750	2.41	34.611	1.52	3.25	149.0	0.11	42.6	0.01	134.0
2000	2.10	34.636	1.91	3.18	160.0	0.09	42.3	0.11	145.0

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	17.76	33.580	367.0	0.0000
10	17.75	33.582	366.6	0.0367
30	17.74	33.585	366.2	0.1100
50	17.84	33.640	364.4	0.1833
75	17.92	33.688	362.9	0.2745
100	16.46	33.701	329.0	0.3616
125	14.51	33.723	286.2	0.4393
150	12.82	33.669	257.2	0.5080
175	10.74	33.704	217.8	0.5682
200	9.79	33.778	196.7	0.6209
250	8.53	34.043	157.9	0.7116
300	7.65	34.049	144.9	0.7895
400	6.59	34.179	121.3	0.9267
500	5.96	34.266	107.0	1.0467
600	5.32	34.321	95.5	1.1543
700	5.00	34.401	85.9	1.2521
800	4.57	34.438	78.6	1.3425
1000	3.95	34.500	67.6	1.5049
1250	3.35	34.541	58.9	1.6841
1500	2.80	34.579	51.2	1.8439
1750	2.39	34.611	45.3	1.9869
2000	2.09	34.636	41.2	2.1171

Table 4. Continued.

Cruise: KH-82-5
Sta.: 10

Date: 22 Dec.'82
Time: 11:58
13:23

Air temp.: 21.0°C
Latitude: 22°12.5'N
22°11.8'N

Drift: 139°0.3kt
Longitude: 119°22.1'W
119°21.3'W

Wind: N 4.5m/s
Depth: 4130m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (mL/L)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)	Si-manual (μM)
0	21.20	34.356	4.95	0.32	2.5	0.01	0.1	0.12	0.0
25	20.73	34.363	4.94						
50	20.70	34.352	4.95	0.23	2.3	0.01	0.0	0.22	0.0
100	17.68	33.983	5.09	0.29	2.7	0.00	0.0	0.11	0.0
150	12.97	33.892	3.91	0.93	10.8	0.09	10.1	0.19	3.8
250	9.32	34.189	1.99	1.16	18.1	0.08	13.5	0.20	6.5
500	7.14	34.430	0.20	3.07	64.8	0.11	37.8	0.00	56.2
750	5.50	34.464	0.20	3.27	87.8	0.13	42.7	0.05	80.9
1000	4.40	34.510	0.35	3.27	109.0	0.11	43.9	0.10	102.0
1250	3.64	34.556	0.62	3.31	126.0	0.12	45.1	0.05	114.0
1500	3.02	34.580	1.08	3.19	139.0	0.13	44.1	0.05	130.0
1750	2.51	34.610	1.45	2.94	148.0	0.22	42.1	0.00	138.0
2000	2.13	34.622	1.79	2.92	153.0	0.22	41.3	0.00	142.0

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	20.82	34.360	385.1	0.0000
10	20.84	34.377	384.3	0.0385
30	20.73	34.365	382.2	0.1152
50	20.71	34.365	381.8	0.1918
75	20.25	34.240	379.1	0.2876
100	17.15	33.954	325.8	0.3754
125	14.50	33.837	277.5	0.4515
150	12.53	33.882	236.1	0.5166
175	11.13	33.901	209.8	0.5732
200	10.32	34.018	187.5	0.6238
250	9.33	34.213	157.3	0.7122
300	8.87	34.306	143.4	0.7898
400	8.13	34.416	124.4	0.9286
500	7.13	34.435	109.1	1.0518
600	6.37	34.444	98.8	1.1635
700	5.75	34.460	90.0	1.2663
800	5.17	34.475	82.2	1.3609
1000	4.37	34.521	70.2	1.5316
1250	3.56	34.563	59.1	1.7167
1500	2.95	34.588	51.7	1.8796
1750	2.49	34.617	45.7	2.0249
2000	2.13	34.640	41.2	2.1564

Table 4. Continued.

Cruise: KH-82-5
Sta.: 11

Date: 23 Dec.'82
Time: 21:51
01:44

Air temp.: 23.4°C
Latitude: 17°28.0'N
17°26.0'

Drift:
Longitude: 117°00.5'W
117°00.8'W

Wind:
Depth: 3900m
3890m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)	Si-manual (μM)	pH	Alkalinity (meq/l)
0	24.80	34.349	4.58	0.21	3.0	0.01	0.1	0.04	0.0	8.221	2.320
10	24.56	34.374	4.55	0.21	2.8	0.01	0.2	0.06	0.0	8.223	2.316
30	23.86	34.571	4.61	0.22	3.0	0.01	0.1	0.07	0.0	8.213	2.338
50	23.77	34.563	4.69	0.23	2.8	0.01	0.1	0.08	0.0	8.215	2.335
75	21.24	34.277	4.99	0.24	3.1	0.01	0.1	0.08	0.0	8.162	2.323
100	17.76	34.059	4.55	0.50	5.4	0.35	1.7	0.07	2.8	8.072	2.306
125	13.65	33.964	3.56	1.07	12.2	0.19	12.1	0.10	9.5	7.929	2.290
150	11.93	34.171	2.07	1.85	17.0	0.26	22.7	0.05	20.1	7.774	2.304
175	12.67	34.742	0.06	2.59	31.4	0.50	28.5	0.09	24.5	7.646	2.344
200	12.34	34.755	0.07	2.62	32.4	1.03	27.7	0.05	27.1	7.643	2.347
300	10.71	34.698	0.08	2.76	40.1	3.05	23.6	0.04	34.0	7.600	2.355
400	9.16	34.605	0.06	2.93	50.6	0.60	29.8	0.03	42.4	7.574	2.358
500	7.90	34.546	0.06	3.09	62.0	0.57	35.0	0.35	41.3	7.558	2.368
750	5.73	34.525	0.07	3.32	87.9	0.65	43.0	0.03	77.8	7.550	2.392
1000	4.41	34.544	0.36	3.36	110.0	0.64	45.8	0.02	101.0	7.550	2.418
1001	4.39	34.542	0.61	3.38	109.0	0.65	45.7	0.03	98.5	7.577	2.408
1250	3.59	34.575	0.88	3.28	124.0	0.62	45.4	0.17	112.0	7.610	2.424
1500	3.01	34.603	1.22	3.14	138.0	0.56	44.4	0.10	125.0	7.614	2.446
1750	2.50	34.626	1.49	3.00	148.0	0.54	43.1	0.14	136.0	7.629	2.449
2000	2.16	34.642	1.98	2.88	155.0	0.55	41.7	0.05	142.0	7.668	2.468
2250	1.95	34.658	2.18	2.80	157.0	0.53	41.4	0.16	144.0	7.682	2.469
2500	1.82	34.668	2.42	2.79	155.0	0.54	41.0	0.07	142.0	7.688	2.474
2750	1.71	34.674	2.61	2.70	162.0	0.50	39.9	0.00	148.0	7.711	2.473
3000	1.62	34.676	2.70	2.66	163.0	0.53	39.4	0.07	149.0	7.706	2.478
3250	1.57	34.680	2.75	2.63	166.0	0.49	39.2	0.34	151.0	7.715	2.476
3500	1.55	34.685	2.55	2.62	166.0	0.49	39.0	0.25	152.0	7.693	2.463
3750	1.55	34.685	2.86	2.60	166.0	0.51	38.7	0.11	151.0	7.731	2.473

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	24.62	34.383	486.6	0.0000
10	24.75	34.347	493.0	0.0490
30	23.82	34.583	449.4	0.1442
50	23.74	34.576	447.7	0.2341
75	20.97	34.253	396.6	0.3425
100	17.45	34.088	322.8	0.4326
125	13.40	33.968	246.2	0.5045
150	12.58	34.399	199.1	0.5609
175	12.78	34.719	179.3	0.6092
200	12.32	34.772	166.7	0.6536
250	11.57	34.761	154.0	0.7364
300	10.72	34.705	143.5	0.8138
400	9.41	34.624	128.0	0.9567
500	7.97	34.547	112.4	1.0845
600	6.78	34.519	98.3	1.1983
700	6.11	34.525	89.5	1.3011
800	5.43	34.527	81.3	1.3957
1000	4.49	34.542	69.8	1.5656
1250	3.67	34.572	59.5	1.7520
1500	3.08	34.600	52.0	1.9162
1750	2.57	34.623	45.9	2.0631
2000	2.18	34.645	41.2	2.1956
2250	1.96	34.659	38.4	2.3182
2500	1.82	34.668	36.8	2.4355
2750	1.72	34.674	35.6	2.5498
3000	1.63	34.679	34.5	2.6620
3250	1.57	34.683	33.9	2.7726
3500	1.55	34.685	33.5	2.8830
3750	1.55	34.687	33.4	2.9943

Table 4. Continued.

Cruise: KH-82-5
Sta.: 13

Date: 26 Dec.'82
Time: 07:06
10:18

Air temp.: 24.2°C
Latitude: 17°14.5'N
17°15.0'N

Drift: 95° 0.6kt
Longitude: 108°38.9'W
108°38.0'W

Wind: NNW 5.0m/s
Depth: 3580m
3640m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)	Si-manual (μM)	pH	Alkakinity (meq/l)
0	26.40	33.755	4.44	0.24	0.9	0.01	0.1	0.00	0.0	8.249	2.287
25	26.75	33.887	4.34	0.18	1.1	0.00	0.0	0.00	0.6	8.247	2.292
50	26.45	34.229	4.47	0.19	1.3	0.00	0.1	0.00	0.8	8.236	2.321
100	16.38	34.567	0.63	2.19	17.7	0.08	26.0	0.00	16.5	7.747	2.335
150	13.42	34.802	0.17	2.50	25.6	0.39	30.5	0.00	23.1	7.669	2.350
250	11.85	34.786	0.15	2.59	30.9	1.96	29.1	0.00	27.9	7.636	2.355
500	8.69	34.617	0.14	3.09	54.9	0.80	29.8	0.03	48.9	7.566	2.374
750	6.19	34.549	0.14	3.38	80.1	0.08	41.9	0.03	71.8	7.541	2.394
1000	4.87	34.536	0.24	3.45	100.0	0.09	46.2	0.10	89.6	7.529	2.416
1250	3.88	34.565	0.60	3.41	118.0	0.09	46.5	0.10	108.0	7.551	2.435
1500	3.18	34.594	1.03	3.27	131.0	0.12	45.4	0.06	121.0	7.583	2.451
1750	2.63	34.618	1.41	3.12	142.0	0.12	43.7	0.04	125.0	7.631	2.459
2000	2.26	34.639	1.86	3.01	150.0	0.12	42.7	0.06	136.0	7.650	2.473

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	26.48	33.832	581.0	0.0000
10	26.63	33.987	574.4	0.0578
30	26.72	34.212	561.0	0.1713
50	26.38	34.267	546.6	0.2826
75	20.86	34.308	389.7	0.3996
100	16.09	34.568	257.7	0.4817
125	14.14	34.754	203.2	0.5401
150	13.35	34.819	182.8	0.5892
175	12.85	34.832	172.3	0.6346
200	12.46	34.821	165.8	0.6780
250	11.88	34.796	157.0	0.7614
300	11.36	34.769	149.8	0.8413
400	9.92	34.681	132.1	0.9900
500	8.50	34.614	115.0	1.1218
600	7.19	34.567	100.2	1.2379
700	6.46	34.550	92.0	1.3434
800	5.83	34.550	84.2	1.4408
1000	4.79	34.544	72.9	1.6177
1250	3.83	34.571	61.1	1.8105
1500	3.18	34.598	53.0	1.9788
1750	2.67	34.624	46.7	2.1289
2000	2.28	34.644	42.0	2.2645
2250	2.00	34.661	38.6	2.3893
2500	1.83	34.670	36.6	2.5070
2750	1.74	34.676	35.6	2.6213
3000	1.70	34.680	34.9	2.7346

Table 4. Continued.

Cruise: KH-82-5
Sta.: 16

Date: 4 Jan. '83
Time: 07:21
08:53

Air temp.: 27.5°C
Latitude: 10°00.3'N
10°59.1'N

Drift: 258° 0.4kt
Longitude: 105°19.1'W
105°19.9'W

Wind: ENE 8.0m/s
Depth: 3240m
3220m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)
0	28.00	33.590	4.35	0.25	1.8	0.04	0.0	0.06
25	28.02	33.597	4.26	0.00	0.0	0.00	0.0	0.00
50	28.02	33.556	4.33	0.21	1.7	0.04	0.0	0.09
100	17.33	34.673	0.75	1.85	16.0	0.30	28.7	0.26
150	13.01	34.805	0.23	2.34	24.8	0.08	34.4	0.10
250	11.26	34.746	0.50	2.33	29.0	0.08	34.9	0.00
500	8.59	34.618	0.11	2.91	49.2	0.09	35.4	0.05
750	5.97	34.556	0.14	3.24	76.0	0.08	45.4	0.00
1000	4.60	34.560	0.48	3.29	97.3	0.08	47.7	0.09
1250	3.73	34.582	0.92	3.19	115.0	0.08	46.3	0.08
1500	3.08	34.605	1.32	3.03	128.0	0.11	44.7	0.00
1750	2.65	34.633	1.67	2.92	137.0	0.11	43.4	0.00
2000	2.24	34.643	1.95	2.85	146.0	0.08	42.4	0.13

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	28.03	33.596	645.4	0.0000
10	28.03	33.597	645.3	0.0645
30	28.04	33.597	645.5	0.1937
50	28.04	33.599	645.5	0.3231
75	26.34	33.932	569.5	0.4825
100	16.79	34.677	265.1	0.5754
125	13.94	34.788	196.8	0.6339
150	13.02	34.813	176.9	0.6814
175	12.45	34.803	167.0	0.7254
200	11.97	34.795	158.8	0.7672
250	11.26	34.763	148.4	0.8466
300	10.75	34.742	141.2	0.9220
400	9.91	34.701	130.3	1.0645
500	8.58	34.626	115.3	1.1960
600	7.48	34.579	103.1	1.3149
700	6.38	34.561	90.1	1.4212
800	5.68	34.557	81.9	1.5164
1000	4.61	34.565	69.3	1.6870
1250	3.74	34.588	59.0	1.8721
1500	3.08	34.610	51.2	2.0351
1750	2.65	34.628	46.3	2.1819
2000	2.24	34.650	41.3	2.3158

Table 4. Continued.

Cruise: KH-85-2
Sta.: 17

Date: 5 Jan. '83
Time: 22:06
23:39

Air temp.: 28.0°C
Latitude: 5°00.5'N
5°00.8'N

Drift: 63° 0.3kt
Longitude: 109°15.9'W
109°15.6'W

Wind: ENE 10.0m/
Depth: 3920m
3920m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)	pH	Alkalinity (meq/l)
0	28.60	34.486	4.28	0.28	2.1	0.05	0.2	0.14	8.235	2.308
25	28.47	34.467	4.24	0.22	2.2	0.03	0.0	0.26	8.252	2.305
50	28.46	34.478	4.28	0.24	2.2	0.03	0.0	0.14	8.253	2.307
100	19.76	34.791	2.94	0.86	7.7	0.20	9.9	0.37	8.036	2.325
150	13.77	34.944	1.83	1.61	17.7	0.07	22.7	0.17	7.845	2.348
250	12.43	34.872	0.71	2.20	24.9	0.03	31.9	0.05	7.707	2.343
500	9.08	34.668	0.77	2.63	38.3	0.04	37.3	0.12	7.642	2.348
750	6.06	34.569	0.50	3.19	70.3	0.05	44.7	0.17	7.566	2.376
1000	4.75	34.564	1.01	3.17	91.3	0.03	44.5	0.10	7.588	2.402
1250	3.75	34.585	1.41	3.12	113.0	0.03	43.6	0.11	7.617	2.425
1500	3.07	34.610	1.70	2.98	129.0	0.03	42.3	0.05	7.633	2.444
1750	2.58	34.628	2.03	2.90	138.0	0.03	41.3	0.07	7.661	2.459
2000	2.27	34.648	2.21	2.84	143.0	0.04	40.9	0.20	7.671	2.463

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	28.46	34.467	596.4	0.0000
10	28.47	34.469	596.5	0.0596
30	28.47	34.473	596.3	0.1790
50	28.45	34.487	594.7	0.2985
75	26.18	34.874	496.9	0.4386
100	20.65	34.749	352.5	0.5473
125	15.04	34.931	208.7	0.6183
150	13.78	34.951	181.6	0.6680
175	13.33	34.934	174.1	0.7135
200	13.09	34.922	170.2	0.7577
250	12.46	34.878	161.5	0.8434
300	11.76	34.829	152.5	0.9252
400	10.41	34.740	135.8	1.0766
500	9.19	34.674	121.1	1.2137
600	7.90	34.618	106.1	1.3369
700	6.60	34.577	91.7	1.4458
800	5.69	34.567	81.4	1.5419
1000	4.70	34.568	70.1	1.7129
1250	3.70	34.590	58.4	1.8988
1500	3.05	34.617	50.4	2.0597
1750	2.58	34.635	45.1	2.2037
2000	2.28	34.649	41.7	2.3364

Table 4. Continued.

Cruise: KH-82-5
Sta.: 18

Date: 7 Jan. '83
Time: 06:37
08:13

Air temp.: 27.1°C
Latitude: 0°00.5'S
0°01.2'S

Drift: 257° 1.0kt
Longitude: 113°08.5'W
113°09.3'W

Wind: E 7.0m/s
Depth: 4020m
4130m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)
0	28.50	34.917	4.24	0.33	2.0	0.24	0.9	0.24
25	28.50	34.917	4.33	0.31	1.9	0.24	0.8	0.04
50	28.50	34.938	4.28	0.27	1.9	0.28	0.9	0.36
100	28.00	35.245	4.00	0.48	2.2	1.67	2.3	0.02
150	16.10	35.142	2.02	1.52	12.6	0.05	17.8	0.11
250	12.69	34.899	1.68	1.79	21.4	0.06	26.1	0.05
500	7.70	34.609	0.95					
750	5.60	34.552	1.64	2.83	69.0	0.06	41.0	0.10
1000	4.44	34.559	1.79	2.90	91.4	0.05	41.4	0.08
1250	3.59	34.586	1.85	2.97	115.0	0.05	42.0	0.13
1500	2.95	34.608	1.98	2.91	132.0	0.06	41.7	0.13
1750	2.59	34.622	2.21	2.84	138.0	0.05	40.7	0.02
2000	2.28	34.641	2.33	2.80	148.0	0.04	40.7	0.00

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	28.49	34.897	566.3	0.0000
10	28.49	34.916	564.9	0.0566
30	28.49	34.921	564.6	0.1696
50	28.51	34.953	562.9	0.2827
75	28.36	35.040	551.8	0.4229
100	27.85	35.225	522.7	0.5584
125	18.78	34.984	289.0	0.6608
150	15.52	35.044	210.5	0.7243
175	14.02	34.981	184.1	0.7747
200	13.38	34.925	175.6	0.8209
250	12.69	34.905	163.8	0.9086
300	12.33	34.885	158.8	0.9927
400	9.05	34.683	118.2	1.1367
500	7.52	34.609	101.5	1.2529
600	6.69	34.579	92.6	1.3589
700	5.93	34.556	85.0	1.4569
800	5.21	34.550	77.0	1.5471
1000	4.43	34.562	67.7	1.7122
1250	3.58	34.589	57.4	1.8924
1500	2.95	34.615	49.7	2.0498
1750	2.59	34.630	45.5	2.1931
2000	2.28	34.647	41.8	2.3266

Table 4. Continued.

Cruise: KH-82-5
Sta.: 19

Date: 8 Jan. '83
Time: 03:20
05:50

Air temp.: 27.4°C
Latitude: 2°29.2'S
2°29.2'S

Drift: 275° 0.9kt
Longitude: 115°03.2'W
115°05.7'W

Wind: SE 11.0m/s
Depth: 4230m
4230m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)
0	28.20	35.033	4.27	0.34	2.2	0.09	1.5	0.21
25	28.19	35.031	4.20	0.34	2.1	0.08	1.3	0.13
50	28.20	35.029	4.29	0.33	1.9	0.09	1.2	0.13
100	27.87	35.352	4.31	0.41	2.0	0.06	2.2	0.44
150	15.26	35.094	1.94	1.62	14.1	0.03	22.0	0.08
250	12.77	34.906	1.19	2.01	22.4	0.02	28.6	0.00
500	8.02	34.634	0.72	2.80	43.6	0.02	40.3	0.05
750	5.85	34.547	1.65	2.85	60.8	0.02	40.6	0.23
1000	4.54	34.548	1.88	2.91	82.4	0.02	41.0	0.06
1250	3.66	34.571	2.03	2.94	103.0	0.01	41.2	0.15
1500	2.97	34.598	2.27	2.87	117.0	0.01	40.4	0.13
1750	2.54	34.626	2.14	2.92	136.0	0.01	41.0	0.11
2000	2.24	34.652	2.29	2.82	139.0	0.01	39.9	0.08

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	28.19	35.009	549.0	0.0000
10	28.20	35.031	547.6	0.0548
30	28.20	35.042	546.8	0.1644
50	28.21	35.048	546.8	0.2740
75	28.22	35.053	546.7	0.4113
100	27.74	35.433	504.3	0.5466
125	23.81	35.398	390.5	0.6569
150	15.57	35.090	208.3	0.7355
175	14.11	35.008	184.0	0.7856
200	13.85	34.994	179.9	0.8323
250	13.03	34.935	168.1	0.9222
300	12.54	34.902	161.3	1.0080
400	10.22	34.764	130.9	1.1667
500	8.23	34.651	108.3	1.2933
600	7.10	34.587	97.5	1.4044
700	6.25	34.562	88.4	1.5066
800	5.49	34.552	80.1	1.6001
1000	4.50	34.557	68.9	1.7676
1250	3.66	34.585	58.4	1.9513
1500	2.97	34.608	50.4	2.1109
1750	2.54	34.636	44.7	2.2539
2000	2.24	34.655	40.8	2.3847

Table 4. Continued.

Cruise: KH-82-5
Sta.: 20

Date: 8 Jan. '83
Time: 23:00
00:37

Air temp.: 27.7°C
Latitude: 5°01.0'S
5°01.3'S

Drift: 269° 0.8kt
Longitude: 117°00.6'W
117°01.3'W

Wind: ESE 10.5m/
Depth: 4300
4350

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)
0	28.20	35.346	4.28	0.38	2.1	0.05	1.4	0.09
25	28.26	35.342	4.34	0.35	1.9	0.05	1.4	0.03
50	28.26	35.342	4.35	0.35	2.0	0.05	1.4	0.05
100	24.77	35.460	3.98	0.82	2.8	0.31	5.7	0.81
150	18.31	35.384	2.95	1.13	3.5	0.08	12.2	0.02
250	12.03	34.883	1.49	2.07	21.3	0.05	28.3	0.00
500	8.71	34.674	0.57	2.80	45.3	0.06	37.2	0.03
750	5.97	34.549	1.45	2.94	57.7	0.02	41.6	0.03
1000	4.46	34.549	2.09	2.89	81.4	0.01	40.3	0.04
1250	3.61	34.578	2.13	2.94	106.0	0.01	40.6	0.00
1500	3.09	34.596	2.18	2.92	118.0	0.02	40.5	0.03
1750	2.62	34.619	2.38	2.85	130.0	0.02	39.9	0.04
2000	2.27	34.646	2.51	2.77	130.0	0.01	38.8	0.03

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	28.25	35.361	525.6	0.0000
10	28.26	35.362	525.7	0.0526
30	28.26	35.362	525.7	0.1578
50	28.27	35.362	525.9	0.2632
75	28.20	35.367	523.6	0.3952
100	25.82	35.467	443.6	0.5165
125	22.54	35.491	348.6	0.6165
150	19.37	35.510	265.2	0.6944
175	15.30	35.074	203.8	0.7543
200	13.29	34.985	169.5	0.8022
250	11.99	34.889	152.3	0.8854
300	11.35	34.843	144.1	0.9627
400	10.03	34.755	128.3	1.1062
500	8.60	34.674	112.0	1.2341
600	7.28	34.606	98.4	1.3490
700	6.37	34.566	89.5	1.4526
800	5.52	34.550	80.6	1.5473
1000	4.45	34.552	68.7	1.7158
1250	3.60	34.583	58.0	1.8974
1500	3.09	34.605	51.7	2.0593
1750	2.61	34.626	46.0	2.2063
2000	2.27	34.647	41.8	2.3404

Table 4. Continued.

Cruise: KH-82-5 | Date: 9 Jan. '83 | Air temp.: 27.2°C | Drift: 261° 1.1kt | Wind: ENE 8.0m/s
Sta.: 21 | Time: 13:50 | Latitude: 2°45.3'S | Longitude: 117°01.0'W | Depth: 4170m
21:04 | 2°47.1'S | 117°02.1'W | 4200m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)	pH	Alkalinity (meq/l)
0	28.40	35.091	4.34	0.34	1.8	0.07	1.3	0.13	8.234	2.349
10	28.39	35.091	4.22	0.33	1.6	0.07	1.0	0.08	8.235	2.359
30	28.37	35.091	4.30	0.37	1.6	0.07	1.1	0.16	8.233	2.355
50	28.37	35.093	4.30	0.33	2.1	0.06	1.4	0.20	8.236	2.354
75	28.35	35.097	4.29	0.33	1.9	0.05	1.3	0.15	8.238	2.361
100	27.23	35.469	4.27	0.48	1.9	0.04	3.0	0.58	8.211	2.385
125	17.55	35.160	1.89	1.65	10.8	1.45	21.8	0.02	7.902	2.358
150	14.68	35.048	1.73	1.73	15.1	0.01	25.3	0.33	7.858	2.367
175	14.36	35.024	1.84	1.75	16.1	0.01	25.0	0.16	7.853	2.365
200	13.54	34.957	1.32	2.09	19.0	0.01	28.2	0.51	7.820	2.363
300	12.28	34.887	0.23	2.47	25.9	0.01	35.6	0.30	7.680	2.361
400	10.12	34.750	0.53	2.71	35.1	0.01	38.7	0.15	7.649	2.359
500	8.22	34.639	1.25	2.75	40.2	0.01	40.7	0.03	7.665	2.365
750	5.67	34.551	1.50	2.98	64.7	0.01	44.0	0.46	7.665	2.390
751	5.63	34.552	1.56	2.94	65.2	0.01	42.7	0.14	7.665	2.392
1001	4.46	34.554	1.93	2.95	84.9	0.01	42.4	0.04	7.685	2.412
1252	3.62	34.582	2.02							
1502	2.87	34.610	2.30	2.84	122.0	0.01	39.7	0.41	7.699	2.456
1753	2.48	34.638	2.17	2.85	140.0	0.01	40.2	0.23	7.709	2.470
2004	2.21	34.648	2.36	2.82	147.0	0.01	39.7	0.24	7.720	2.479
2255	2.06	34.654	2.62	2.78	150.0	0.01	39.5	0.29	7.710	2.480
2506	1.90	34.662	2.81	2.69	145.0	0.01	39.6	0.09	7.729	2.485
2757	1.77	34.667	2.98	2.71	144.0	0.01	39.8	0.14	7.745	2.481
3008	1.66	34.675	3.08	2.65	145.0	0.01	39.5	0.20	7.747	2.484
3259	1.65	34.675	3.23	2.61	145.0	0.00	38.9	0.09	7.757	2.483
3510	1.54	34.683	3.27	2.58	147.0	0.00	38.5	0.18	7.759	2.486
3761	1.46	34.688	3.51	2.53	145.0	0.01	38.0	0.19	7.777	2.487
3964	1.49	34.687	3.53	2.52	144.0	0.01	37.9	0.14	7.795	2.486

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	28.37	35.100	548.0	0.0000
10	28.37	35.100	548.0	0.0548
30	28.33	35.107	546.1	0.1643
50	28.32	35.110	545.8	0.2738
75	28.25	35.184	538.3	0.4106
100	26.54	35.518	461.5	0.5328
125	16.60	35.094	230.3	0.6202
150	14.75	35.065	192.9	0.6741
175	14.39	35.042	187.2	0.7227
200	13.94	34.999	181.2	0.7700
250	13.00	34.929	168.1	0.8602
300	12.36	34.898	158.2	0.9452
400	10.10	34.756	129.3	1.0983
500	8.09	34.634	107.6	1.2242
600	6.87	34.578	95.0	1.3338
700	5.97	34.554	85.6	1.4326
800	5.34	34.548	78.7	1.5238
1000	4.46	34.552	68.8	1.6902
1250	3.63	34.582	58.3	1.8724
1500	2.95	34.606	50.4	2.0315
1750	2.52	34.635	44.6	2.1741
2000	2.23	34.651	41.1	2.3049
2250	2.04	34.656	39.3	2.4294
2500	1.89	34.667	37.3	2.5495
2750	1.75	34.676	35.7	2.6654
3000	1.66	34.679	34.8	2.7784
3250	1.61	34.683	34.0	2.8900
3500	1.52	34.690	32.9	2.9999
3750	1.43	34.697	31.8	3.1069
4000	1.43	34.698	31.7	3.2133

Table 4. Continued.

Cruise: KH-82-5
Sta.: 22

Date: 12 Jan.'83
Time: 01:21
02:49

Air temp.: 28.1°C
Latitude: 0°00.2'N
0°00.4'S

Drift: 267° 1.5kt
Longitude: 116°59.9'W
117°00.0'W

Wind: E 5.5m/s
Depth: 4200m
4170m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)
0	28.60	35.012	4.23	0.37	2.1	0.16	1.0	0.00
25	28.64	35.002	4.33	0.32	1.8	0.16	1.0	0.18
50	28.59	35.008	4.44	0.32	1.7	0.17	0.9	0.29
100	25.94	35.294	3.54	0.69	2.9	0.75	6.7	0.25
150	15.69	35.073	2.03	1.51	13.3	0.06	20.6	0.00
250	12.10	35.874	0.52	2.32	26.3	0.02	33.4	0.02
500	7.38	35.606	1.04	2.87	47.1	0.01	41.3	0.05
750	5.43	35.550	1.71	2.90	67.3	0.02	41.4	0.06
1000	4.44	35.556	1.95	2.92	84.7	0.02	41.3	0.01
1250	3.51	35.583	1.92	3.01	109.0	0.02	42.1	0.05
1500	2.89	35.610	1.99	2.98	123.0	0.01	41.9	0.00
1750	2.54	35.627	2.17	2.94	134.0	0.01	41.6	0.03
2000	2.23	35.644	2.35	2.88	137.0	0.01	40.9	0.04

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	28.66	35.012	563.5	0.0000
10	28.66	35.012	563.6	0.0564
30	28.66	35.010	563.5	0.1692
50	28.61	35.013	562.0	0.2820
75	28.46	35.079	552.4	0.4220
100	25.53	35.274	448.9	0.5471
125	16.75	35.041	237.8	0.6339
150	15.52	35.080	207.8	0.6906
175	13.80	34.972	180.4	0.7402
200	13.15	34.907	172.5	0.7855
250	12.13	34.869	156.2	0.8705
300	11.18	34.815	143.2	0.9485
400	8.57	34.660	112.7	1.0813
500	7.38	34.602	100.1	1.1957
600	6.45	34.564	90.7	1.3000
700	5.82	34.553	83.9	1.3968
800	5.25	34.548	77.6	1.4861
1000	4.46	34.554	68.6	1.6512
1250	3.52	34.585	57.0	1.8320
1500	2.88	34.611	49.5	1.9895
1750	2.54	34.630	45.1	2.1314
2000	2.23	34.646	41.5	2.2634

Table 4. Continued.

Cruise: KH-82-5
Sta.: 23

Date: 13 Jan.'83
Time: 00:41
07:16

Air temp.: 28.4°C
Latitude: 3°58.9'N
4°00.5'N

Drift: 246° 0.8kt
Longitude: 116°59.3'W
117°00.2'W

Wind: E 10.0m/s
Depth: 4180m
4200m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (µM)	Si-Auto (µM)	Nitrite (µM)	Nitrate (µM)	Ammonium (µM)	pH	Alkalinity (meq/l)
0	28.60	34.447	4.29	0.19	1.7	0.01	0.0	0.08	8.256	2.308
10	28.57	34.434	4.26	0.20	1.7	0.00	0.0	0.00	8.257	2.309
30	28.55	34.438	4.23	0.19	1.6	0.00	0.0	0.03	8.250	2.305
50	28.58	34.439	4.24	0.18	1.5	0.00	0.0	0.01	8.262	2.306
75	28.55	34.852	3.29	0.49	3.3	0.68	4.7	0.00	8.152	2.332
99	19.57	34.814	2.87	0.82	8.0	0.04	11.2	0.08	8.030	2.337
124	14.39	34.823	1.67	1.70	19.2	0.00	25.4	0.00	7.826	2.342
149	13.75	34.936	1.19	1.89	19.4	0.00	28.7	0.00	7.783	2.347
174	13.52	34.928	1.19	1.87	19.9	0.00	29.0	0.00	7.794	2.348
199	13.20	34.913	1.11	1.97	21.8	0.00	29.9	0.01	7.788	2.348
298	11.80	34.830	0.71	2.18	26.7	0.01	33.8	0.04	7.716	2.345
397	10.02	34.700	1.08	2.27	32.3	0.01	35.0	0.00	7.701	2.346
496	8.36	34.640	0.26	2.80	47.3	0.00	41.0	0.09	7.607	2.358
744	5.95	34.561	1.01	2.84	65.2	0.00	44.5	0.06	7.622	2.374
998	4.63	34.566	1.22	2.96	89.6	0.00	45.3	0.07	7.638	2.398
1248	3.55	34.592	1.59	2.83	112.0	0.01	43.6	0.03	7.634	2.428
1497	2.88	34.618	1.78	2.84	128.0	0.00	42.3	0.00	7.650	2.450
1747	2.48	34.635	2.07	2.75	136.0	0.00	41.9	0.17	7.681	2.458
1997	2.20	34.654	2.21	2.69	143.0	0.00	41.2	0.06	7.679	2.469
2246	1.95	34.662	2.47	2.61	147.0	0.00	40.8	0.06	7.690	2.476
2496	1.87	34.670	2.56	2.59	150.0	0.00	40.8	0.19	7.706	2.477
2746	1.80	34.675	2.64	2.55	151.0	0.01	40.2	0.19	7.701	2.481
2995	1.76	34.677	2.77	2.54	150.0	0.01	40.1	0.01	7.713	2.480
3244	1.59	34.684	2.83	2.49	152.0	0.00	39.5	0.03	7.715	2.479
3494	1.51	34.688	3.18	2.43	149.0	0.00	38.9	0.03	7.732	2.479
3744	1.47	34.694	3.30	2.40	147.0	0.00	38.4	0.05	7.747	2.472
3993	1.48	34.693	3.28	2.40	145.0	0.01	38.5	0.28	7.750	2.476
4000			2.93							

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	28.54	34.441	600.5	0.0000
10	28.54	34.440	600.6	0.0601
30	28.54	34.440	600.8	0.1803
50	28.55	34.441	601.0	0.3008
75	28.55	34.448	600.6	0.4516
100	22.18	34.740	393.3	0.5763
125	14.99	34.659	227.5	0.6548
150	13.80	34.935	183.2	0.7070
175	13.50	34.931	177.6	0.7532
200	13.19	34.916	172.6	0.7981
250	12.56	34.878	163.4	0.8849
300	11.74	34.826	152.4	0.9672
400	9.94	34.702	130.8	1.1172
500	8.41	34.634	112.1	1.2473
600	7.10	34.583	97.7	1.3603
700	6.26	34.563	88.5	1.4627
800	5.68	34.554	82.2	1.5577
1000	4.63	34.561	69.9	1.7307
1250	3.58	34.586	57.6	1.9151
1500	2.93	34.614	49.6	2.0729
1750	2.50	34.631	44.7	2.2145
2000	2.21	34.647	41.2	2.3454
2250	1.97	34.661	38.4	2.4682
2500	1.84	34.669	36.8	2.5858
2750	1.79	34.673	36.1	2.7014
3000	1.70	34.676	35.2	2.8161
3250	1.59	34.683	33.9	2.9283
3500	1.48	34.690	32.7	3.0373
3750	1.43	34.693	32.1	3.1440
4000	1.43	34.694	32.0	3.2511

Table 4. Continued.

Cruise: KH-82-5
Sta.: 24

Date: 14 Jan.'83
Time: 15:52
17:22

Air temp.: 27.8°C
Latitude: 8°28.2'N
8°27.6'N

Drift: 214° 0.7kt
Longitude: 117°00.2'W
117°00.7'W

Wind: ENE 9.0m/s
Depth: 3910m
3720m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)
0	27.90	33.656	4.38	0.15	2.1	0.02	0.0	0.03
25	27.83	33.662	4.50					
50	27.76	33.674	3.99	0.16	2.0	0.02	0.0	0.04
100	13.48	33.631	1.45	1.96	22.4	0.08	26.3	0.06
150	11.67	33.637	1.33	2.14	28.3	0.03	29.4	0.08
250	10.56	33.712	1.20	2.20	28.7	0.03	31.2	0.02
500	8.64	33.644	0.31	2.89	44.4	0.02	38.9	0.17
750	6.34	33.563	0.27	3.30	70.1	0.01	44.1	0.03
1000	4.77	33.560	0.60	3.34	93.6	0.01	46.1	0.03
1250	3.86	33.579	1.15	3.23	111.0	0.02	44.7	0.00
1500	3.25	33.601	1.42	3.15	125.0	0.02	43.7	0.00
1750	2.73	33.617	1.83	3.05	134.0	0.03	42.3	0.16
2000	2.28	33.639	1.96	2.96	144.0	0.03	41.4	0.00

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	27.88	33.655	636.5	0.0000
10	27.88	33.656	636.6	0.0636
30	27.80	33.667	633.0	0.1907
50	26.95	33.867	592.8	0.3154
75	15.87	34.638	247.7	0.4131
100	13.29	34.642	194.7	0.4680
125	12.39	34.696	173.7	0.5147
150	11.44	34.665	158.9	0.5570
175	11.20	34.705	151.6	0.5967
200	10.64	34.653	146.0	0.6350
250	10.44	34.714	138.2	0.7084
300	10.14	34.715	133.1	0.7791
400	9.36	34.681	123.2	0.9135
500	8.62	34.646	114.5	1.0408
600	7.56	34.594	103.2	1.1598
700	6.63	34.568	92.8	1.2677
800	5.94	34.556	85.1	1.3669
1000	4.72	34.558	71.1	1.5424
1250	3.86	34.579	60.8	1.7326
1500	3.24	34.601	53.4	1.9021
1750	2.72	34.616	47.7	2.0544
2000	2.29	34.640	42.4	2.1919

Table 4. Continued.

Cruise: KH-82-5
Sta.: 25

Date: 15 Jan.'83
Time: 16:44
18:13

Air temp.: 26.6°C
Latitude: 12°59.7'N
12°59.5'N

Drift: 266°0.9kt
Longitude: 117°00.1'W
117°00.1'W

Wind: NE 11.0m/s
Depth: 4140m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)
0	27.20	33.404	4.29	0.18	2.3	0.00	0.0	0.17
25	27.12	33.391	4.31	0.19	2.1	0.00	0.0	0.16
50	27.11	33.394	4.33	0.18	2.1	0.00	0.0	0.14
100	15.53	33.720	0.13	2.42	20.7	0.01	31.5	0.07
150	12.68	33.802	0.14	2.42	25.4	0.03	34.0	0.00
250	11.26	33.757	0.15	2.56	31.1	0.01	34.4	0.03
500	8.32	33.597	0.10	3.02	53.2	0.54	32.0	0.00
750	5.92	33.547	0.13	3.32	77.8	0.01	44.8	0.04
1000	4.76	33.557	0.45	3.36	94.1	0.01	47.0	0.00
1250	3.84	33.574	0.78	3.29	112.0	0.01	46.3	0.03
1500	3.17	33.603	1.14	3.17	127.0	0.00	45.1	0.00
1750	2.66	33.622	1.53	3.01	135.0	0.01	43.2	0.00
2000	2.26	33.639	1.75	2.94	138.0	0.03	42.2	0.00

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	27.14	33.395	632.4	0.0000
10	27.14	33.395	632.5	0.0632
30	27.14	33.396	632.3	0.1898
50	27.11	33.401	631.1	0.3164
75	20.39	34.491	364.5	0.4497
100	15.73	34.702	240.1	0.5253
125	13.31	34.800	183.5	0.5789
150	12.64	34.796	171.0	0.6241
175	12.10	34.795	161.0	0.6666
200	11.84	34.789	156.9	0.7074
250	11.24	34.759	148.4	0.7863
300	10.73	34.725	142.1	0.8619
400	9.52	34.650	127.9	1.0042
500	8.10	34.582	111.6	1.1318
600	6.97	34.550	98.4	1.2455
700	6.22	34.545	89.3	1.3483
800	5.66	34.547	82.5	1.4436
1000	4.71	34.555	71.3	1.6170
1250	3.81	34.575	60.6	1.8070
1500	3.14	34.599	52.7	1.9739
1750	2.63	34.621	46.6	2.1231
2000	2.26	34.639	42.2	2.2584

Table 4. Continued.

Cruise: KH-82-5
Sta.: 11'

Date: 17 Jan.'83
Time: 11:47
18:15

Air temp.: 22.8°C
Latitude: 17°27.0'N
17°27.3'N

Drift: 122° 0.5kt
Longitude: 116°59.0'W
116°58.5'W

Wind: N 10.0m/s
Depth: 3900m

Depth (m)	Temp. (°C)	salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)	pH	Alkalinity (meq/l)
0	24.50	33.984	4.56	0.21	1.4	0.01	0.0	0.09	8.240	2.294
10	24.51	33.963	4.64	0.20	1.4	0.01	0.0	0.04	8.243	2.294
28	24.51	33.964	4.66	0.20	1.3	0.01	0.0	0.05	8.247	2.292
46	23.88	34.253	4.61	0.22	1.4	0.01	0.0	0.00	8.234	2.318
69	22.12	34.391	4.62	0.30	2.2	0.01	0.5	0.06	8.173	2.333
93	18.03	34.169	3.85	0.76	5.7	0.57	4.0	0.05	8.018	2.318
117	14.86	34.267	1.87	1.77	16.7	0.04	18.2	0.09	7.812	2.317
141	14.08	34.416	0.96	2.20	21.7	0.03	23.8	0.04	7.733	2.324
164	13.00	34.719	0.13	2.62	29.3	0.02	27.5	0.00	7.667	2.346
189	12.30	34.754	0.15	2.67	31.9	0.57	26.5	0.05	7.657	2.352
286	10.55	34.655	0.14	2.80	39.3	0.26	25.9	0.00	7.626	2.356
384	9.37	34.615	0.12	2.96	48.1	0.14	28.1	0.00	7.601	2.366
483	7.79	34.551	0.11	3.14	62.1	0.02	33.7	0.00	7.586	2.378
747	5.64	34.522	0.12	3.33	86.6	0.02	42.5	0.00	7.566	2.402
996	4.42	34.537	0.32	3.39	108.0	0.02	45.1	0.04	7.580	2.427
1245	3.62	34.571	0.69	3.30	123.0	0.01	44.7	0.07	7.591	2.437
1494	3.00	34.600	1.19	3.15	136.0	0.01	42.8	0.00	7.610	2.456
1743	2.51	34.620	1.60	3.02	146.0	0.02	42.2	0.02	7.661	2.465
1992	2.18	34.641	1.96	2.91	152.0	0.01	40.9	0.00	7.677	2.473
2242	1.97	34.654	2.21	2.80	156.0	0.02	40.0	0.02	7.699	2.480
2492	1.86	34.662	2.40	2.77	158.0	0.01	39.4	0.04	7.700	2.483
2742	1.74	34.668	2.53	2.73	160.0	0.02	38.7	0.00	7.709	2.483
2992	1.66	34.673	2.71	2.70	162.0	0.01	38.4	0.00	7.718	2.484
3242	1.60	34.676	2.79	2.67	165.0	0.01	38.2	0.04	7.725	2.485
3492	1.59	34.678	2.83	2.66	165.0	0.01	37.9	0.04	7.731	2.481
3742	1.58	34.679	2.91	2.64	165.0	0.01	37.8	0.00	7.735	2.480

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	24.49	33.965	513.0	0.0000
10	24.49	33.966	512.9	0.0513
30	24.19	34.145	491.5	0.1529
50	23.62	34.388	457.9	0.2491
75	20.81	34.285	390.2	0.3565
100	17.58	34.149	321.6	0.4465
125	14.75	34.273	250.8	0.5188
150	14.06	34.423	225.9	0.5793
175	13.08	34.677	188.1	0.6320
200	12.61	34.758	173.2	0.6783
250	11.60	34.719	157.7	0.7637
300	10.74	34.662	147.0	0.8430
400	9.26	34.615	126.5	0.9853
500	7.86	34.548	110.8	1.1120
600	6.88	34.526	99.1	1.2251
700	6.03	34.513	89.4	1.3281
800	5.38	34.519	81.3	1.4226
1000	4.89	34.527	75.2	1.5102
1250	3.62	34.569	59.2	1.7788
1500	3.02	34.596	51.8	1.9423
1750	2.54	34.619	46.0	2.0887
2000	2.17	34.641	41.4	2.2213
2250	1.95	34.654	38.8	2.3444
2500	1.81	34.661	37.2	2.4625
2750	1.72	34.669	35.9	2.5776
3000	1.64	34.673	35.1	2.6909
3250	1.57	34.677	34.3	2.8027
3500	1.56	34.680	34.0	2.9142
3750	1.56	34.681	33.9	3.0268

Table 4. Continued.

Cruise: KH-82-5
Sta.: 27

Date: 2 Feb. '83
Time: 07:15
18:57

Air temp.: 18.3°C
Latitude: 26°50.7'N
26°45.5'N

Drift: 142° 0.4kt
Longitude: 146°52.9'W
146°46.3'W

Wind: NNE 5.0m/s
Depth: 5280m
5140m

Depth (m)	Temp. (°C)	Salinity (permil)	Diss. Oxy. (ml/l)	Phosphate (μM)	Si-Auto (μM)	Nitrite (μM)	Nitrate (μM)	Ammonium (μM)	pH	Alkalinity (meq/l)
0	20.70	35.242	4.71	0.08	2.1	0.01	0.1	0.04	8.202	2.362
10	20.61	35.239	4.87	0.07	2.0	0.01	0.1	0.00	8.206	2.366
29	20.40	35.248	4.87	0.07	2.0	0.00	0.0	0.04	8.207	2.370
48	20.39	35.249	4.88	0.06	1.8	0.00	0.0	0.01	8.203	2.369
72	20.35	35.249	4.87	0.07	1.9	0.00	0.0	0.11	8.205	2.371
96	20.27	35.254	4.87	0.06	1.9	0.00	0.1	0.05	8.201	2.364
120	20.11	35.246	4.85	0.07	2.0	0.02	0.2	0.07	8.195	2.365
145	18.73	35.048	4.48	0.24	3.2	0.04	1.6	0.09	8.131	2.352
169	17.32	34.874	4.70	0.26	4.1	0.03	1.8	0.19	8.122	2.336
193	16.11	34.702	4.69	0.35	5.1	0.02	3.1	0.31	8.093	2.327
290	11.72	34.185	4.46	0.90	12.9	0.00	11.2	0.00	7.975	2.299
388	9.41	34.102	4.25	1.34	23.9	0.00	18.3	0.00	7.899	2.304
486	7.31	34.027	3.23	1.97	43.9	0.00	27.2	0.00	7.784	2.319
733	4.59	34.222	0.50	3.19	101.0	0.00	44.2	0.00	7.550	2.378
980	3.93	34.428	0.70	3.21	119.0	0.01	44.2	0.07	7.607	2.413
1227	3.35	34.520	1.09	3.14	131.0	0.00	44.0	0.06	7.616	2.433
1476	2.80	34.562	1.40	3.08	141.0	0.00	43.4	0.15	7.644	2.447
1725	2.44	34.588	1.78	3.01	141.0	0.00	42.7	0.28	7.656	2.455
1892	2.20	34.610	1.82	3.05	147.0	0.00	43.1	0.06	7.649	2.456
2142	1.94	34.636	1.89	2.93	165.0	0.00	41.7	0.02	7.674	2.475
2392	1.76	34.645	2.18	2.87	169.0	0.00	40.9	0.05	7.697	2.477
2642	1.68	34.660	2.39	2.81	170.0	0.00	40.2	0.09	7.691	2.479
2891	1.60	34.670	2.60	2.75	168.0	0.00	39.5	0.06	7.696	2.480
3141	1.50	34.674	2.82	2.71	166.0	0.00	39.0	0.05	7.719	2.476
3390	1.49	34.677	3.00	2.66	162.0	0.00	39.2	0.01	7.733	2.472
3640	1.50	34.681	3.09	2.64	161.0	0.00	38.9	0.01	7.746	2.476
3890	1.51	34.698	3.22	2.61	158.0	0.00	38.6	0.06	7.760	2.470

CTD

Depth (M)	Temp. (°C)	Sal. (°/..)	δst (cl/ton)	ΔD
0	20.64	35.258	315.3	0.0000
10	20.64	35.259	315.2	0.0315
30	20.63	35.258	315.2	0.0947
50	20.59	35.259	314.0	0.1578
75	20.57	35.257	313.7	0.2368
100	20.43	35.253	310.5	0.3156
125	20.06	35.231	302.7	0.3923
150	19.31	35.125	291.5	0.4686
175	17.86	34.965	268.5	0.5399
200	15.91	34.689	244.9	0.6055
250	13.89	34.429	222.0	0.7253
300	12.45	34.300	203.9	0.8352
400	9.37	34.111	165.5	1.0255
500	7.34	34.025	142.6	1.1863
600	5.56	34.061	117.7	1.3228
700	4.84	34.163	102.1	1.4399
800	4.40	34.275	89.1	1.5425
1000	3.84	34.442	70.9	1.7168
1250	3.25	34.524	59.3	1.9007
1500	2.76	34.565	51.9	2.0612
1750	2.38	34.597	46.4	2.2062
2000	2.12	34.618	42.7	2.3397
2250	1.86	34.640	39.2	2.4640
2500	1.70	34.654	36.9	2.5807
2750	1.60	34.666	35.3	2.6929
3000	1.53	34.675	34.1	2.8022
3250	1.49	34.682	33.3	2.9099
3500	1.46	34.687	32.8	3.0171
3750	1.45	34.689	32.5	3.1245
4000	1.45	34.693	32.2	3.2328

Table 5. Summary of hydrographic data at Stations 28-31.

Sta.28
1983.2.11 08:40-09:06
21 32.2 N, 161 00.3 W

D	T	S	DO
0	24.01	34.778	4.66
10	24.04	34.787	4.60
20	24.05	34.792	4.59
30	24.05	34.794	4.55
40	24.07	34.796	4.60
50	24.07	34.798	4.59
60	24.08	34.799	4.54
70	24.07	34.804	4.57
80	23.90	34.918	4.51
90	23.65	34.919	4.50
100	23.43	34.981	4.68
110	23.32	35.022	4.61
120	23.31	35.081	4.70
130	23.11	35.111	4.69
140	22.93	35.125	4.59
150	22.35	35.150	4.41
160	21.77	35.124	4.30
170	21.23	35.144	4.17
180	20.17	35.079	4.10
190	19.62	35.041	3.92
200	19.29	35.023	3.96
220	18.02	34.874	3.94
240	16.59	34.726	3.87
260	15.36	34.571	3.85
280	14.09	34.466	3.85
300	13.28	34.391	3.77
320	12.23	34.304	3.65
340	11.65	34.272	3.72
360	11.03	34.230	3.75
380	10.26	34.175	3.69
400	9.63	34.163	3.56

Sta.29
1983.2.12 08:41-09:03
22 02.8 N, 166 12.8 W

D	T	S	DO
0	23.21	35.028	4.63
10	23.21	35.050	4.70
20	23.22	35.063	4.60
30	23.22	35.068	4.56
40	23.22	35.071	4.61
50	23.22	35.073	4.60
60	23.22	35.074	4.61
70	23.22	35.074	4.59
80	23.11	35.083	4.61
90	22.77	35.130	4.65
100	22.67	35.148	4.61
110	22.43	35.158	4.57
120	21.88	35.147	4.43
130	21.35	35.148	4.27
140	20.46	35.115	4.18
150	19.26	35.004	3.99
160	18.96	34.986	3.96
170	18.30	34.905	3.91
180	17.75	34.851	3.86
190	17.10	34.770	3.87
200	16.11	34.684	3.91
220	15.45	34.621	3.94
240	14.52	34.524	4.00
260	13.53	34.399	3.98
280	12.77	34.350	3.96
300	12.00	34.292	3.91
320	11.24	34.247	3.99
340	10.52	34.208	3.93
360	9.83	34.169	3.89
380	9.34	34.146	3.82
400	8.93	34.129	3.68

Sta.30
1983.2.13 08:37-09:00
22 34.9 N, 171 18.5 W

D	T	S	DO
0	23.20	35.011	4.55
10	23.20	35.056	4.53
20	23.20	35.083	4.52
30	23.20	35.099	4.59
40	23.20	35.113	4.64
50	23.10	35.153	4.66
60	22.63	35.225	4.60
70	22.48	35.275	4.63
80	22.43	35.316	4.61
90	22.34	35.322	4.61
100	22.26	35.329	4.61
110	22.15	35.316	4.65
120	22.02	35.313	4.59
130	21.91	35.313	4.62
140	21.78	35.301	4.61
150	21.59	35.275	4.54
160	21.03	35.181	4.42
170	19.87	35.080	4.34
180	19.41	35.054	4.07
190	18.65	34.973	4.23
200	17.94	34.911	4.10
220	16.80	34.761	4.06
240	15.28	34.622	4.04
260	14.34	34.534	4.02
280	14.10	34.523	4.06
300	13.42	34.442	4.09
320	12.53	34.353	4.13
340	12.04	34.334	4.24
360	11.63	34.312	4.31
380	11.28	34.299	4.38
400	10.21	34.202	4.23

Sta.31
1983.2.14 08:40-09:04
23 21.9 N, 176 15.7 W

D	T	S	DO
0	23.21	35.048	4.47
10	23.21	35.113	4.51
20	23.22	35.144	4.49
30	23.22	35.159	4.50
40	23.22	35.168	4.48
50	23.22	35.172	4.48
60	23.22	35.174	4.46
70	23.22	35.176	4.52
80	23.11	35.198	4.51
90	22.92	35.247	4.52
100	22.74	35.275	4.46
110	22.62	35.292	4.52
120	22.55	35.299	4.46
130	22.38	35.305	4.55
140	22.04	35.270	4.39
150	21.88	35.296	4.39
160	21.77	35.338	4.50
170	21.31	35.246	4.50
180	20.37	35.122	4.33
190	19.81	35.091	4.13
200	18.78	34.991	4.06
220	17.77	34.882	4.02
240	16.98	34.807	4.07
260	15.58	34.655	4.02
280	14.92	34.581	4.07
300	14.31	34.525	4.09
320	13.60	34.450	4.12
340	12.83	34.381	4.13
360	11.89	34.292	4.06
380	11.28	34.262	4.06
400	10.76	34.229	3.99

Table 6. Summary of chlorophyll-a and phaeophytin data.

Depth	Sta.5' Routine Chl-a	Sta.5' Routine Phaeo.	Sta.5' Van Dorn Chl-a	Sta.5' Van Dorn Phaeo.	Sta.6 Van Dorn Chl-a	Sta.6 Van Dorn Phaeo.	Sta.7 Routine Chl-a	Sta.7 Routine Phaeo.	Sta.7 Van Dorn Chl-a	Sta.7 Van Dorn Phaeo.	Sta.9 Van Dorn Chl-a	Sta.9 Van Dorn Phaeo.	Sta.10 Van Dorn Chl-a	Sta.10 Van Dorn Phaeo.	Depth
0m	0.405	0.193	0.386	0.195	0.116	0.066	0.079	0.030	0.091	0.029	0.079	0.012	0.080	0.014	0m
10	0.430	0.169	0.416	0.182	0.101	0.050	0.085	0.034	0.093	0.028	0.069	0.019	0.079	0.017	10
20	ND	ND	0.584	0.220	0.108	0.057	ND	ND	0.076	0.022	0.066	0.013	0.074	0.013	20
30	0.382	0.204	0.384	0.229	0.113	0.070	0.103	0.045	0.089	0.031	0.067	0.021	0.074	0.016	30
50	0.210	0.159	0.158	0.158	0.120	0.068	0.110	0.056	0.116	0.071	0.083	0.022	0.092	0.020	50
75	0.033	0.064	0.044	0.058	0.216	0.216	0.091	0.192	0.185	0.130	0.114	0.063	0.203	0.227	75
100	0.017	0.038	0.005	0.059	0.051	0.206	0.057	0.192	0.094	0.178	0.172	0.138	0.158	0.078	100
125	0.008	0.032	0.002	0.024	0.024	0.069	0.036	0.064	0.049	0.060	0.123	0.113	0.079	0.155	125
150	0.003	0.026	0.001	0.023	0.010	0.043	0.014	0.031	0.020	0.036	0.056	0.071	0.049	0.060	150
175	0.001	0.023	0.002	0.019	0.004	0.019	0.003	0.017	0.006	0.014	0.014	0.022	0.015	0.032	175
200	0.003	0.017	0.000	0.016	0.002	0.023	0.004	0.008	0.002	0.008	0.009	0.016	0.002	0.017	200
300	0.001	0.026	0.001	0.011	ND	ND	0.002	0.008	ND	ND	ND	ND	ND	ND	300

Depth	Sta.11 Routine Chl-a	Sta.11 Routine Phaeo.	Sta.11 Van Dorn Chl-a	Sta.11 Van Dorn Phaeo.	Sta.13 Van Dorn Chl-a	Sta.13 Van Dorn Phaeo.	Sta.16 Van Dorn Chl-a	Sta.16 Van Dorn Phaeo.	Sta.17 Van Dorn Chl-a	Sta.17 Van Dorn Phaeo.	Sta.18 Van Dorn Chl-a	Sta.18 Van Dorn Phaeo.	Sta.19 Van Dorn Chl-a	Sta.19 Van Dorn Phaeo.	Depth
0m	0.083	0.018	0.096	0.022	0.132	0.042	0.141	0.038	0.106	0.054	0.150	0.061	0.158	0.072	0m
10	0.072	0.019	0.078	0.024	0.117	0.034	0.154	0.046	0.107	0.050	0.145	0.060	0.172	0.059	10
20	ND	ND	0.071	0.022	0.106	0.032	0.141	0.043	0.107	0.056	0.150	0.055	0.167	0.064	20
30	0.044	0.023	0.074	0.017	0.113	0.041	0.154	0.066	0.113	0.058	0.154	0.066	0.181	0.076	30
50	0.064	0.023	0.098	0.034	0.226	0.099	0.176	0.039	0.136	0.053	0.163	0.058	0.176	0.065	50
75	0.122	0.067	0.163	0.073	0.244	0.265	0.303	0.243	0.226	0.241	0.249	0.134	0.154	0.056	75
100	0.217	0.213	0.203	0.221	0.052	0.113	0.117	0.134	0.141	0.164	0.181	0.123	0.154	0.098	100
125	0.081	0.170	0.086	0.171	0.016	0.184	0.024	0.058	0.038	0.067	0.071	0.082	0.099	0.105	125
150	0.017	0.036	0.023	0.070	0.010	0.176	0.010	0.044	0.006	0.026	0.029	0.036	0.057	0.067	150
175	0.001	0.045	0.003	0.042	0.005	0.158	0.004	0.029	0.001	0.020	0.009	0.017	0.022	0.044	175
200	0.002	0.006	0.001	0.091	0.003	0.160	0.003	0.029	0.001	0.021	0.004	0.014	0.007	0.019	200
300	0.001	0.052	ND	ND	0.001	0.083	ND	ND	ND	ND	ND	ND	ND	ND	300

Table 6. Continued.

Depth	Sta.20 Van Dorn Chl-a	Sta.20 Van Dorn Phaeo.	Sta.21 Routine Chl-a	Sta.21 Routine Phaeo.	Sta.21 Van Dorn Chl-a	Sta.21 Van Dorn Phaeo.	Sta.22 Van Dorn Chl-a	Sta.22 Van Dorn Phaeo.	Sta.23 Routinen Chl-a	Sta.23 Routinen Phaeo.	Sta.23 Van Dorn Chl-a	Sta.23 Van Dorn Phaeo.	Sta.24 Van Dorn Chl-a	Sta.24 Van Dorn Phaeo.	Depth
0m	0.104	0.049	0.141	0.059	0.150	0.066	0.158	0.083	0.097	0.046	0.101	0.030	0.083	0.015	0m
10	0.101	0.054	0.114	0.072	0.154	0.056	0.181	0.066	0.100	0.034	0.103	0.041	0.089	0.019	10
20	0.101	0.052	ND	ND	0.154	0.061	0.167	0.064	ND	ND	0.101	0.038	0.092	0.024	20
30	0.106	0.053	0.136	0.048	0.158	0.052	0.185	0.066	0.098	0.043	.108	0.039	0.094	0.023	30
50	0.107	0.055	0.136	0.053	0.154	0.061	0.212	0.092	0.101	0.041	0.109	0.042	0.194	0.052	50
75	0.208	0.149	0.150	0.061	0.167	0.053	0.185	0.114	0.222	0.224	0.244	0.212	0.244	0.359	75
100	0.163	0.189	0.181	0.102	0.158	0.109	0.141	0.085	0.181	0.181	0.158	0.156	0.136	0.200	100
125	0.076	0.134	0.113	0.160	0.113	0.160	0.062	0.066	0.080	0.128	0.087	0.100	0.090	0.177	125
150	0.045	0.064	0.040	0.055	0.045	0.054	0.043	0.046	0.031	0.035	0.030	0.036	0.027	0.049	150
175	0.018	0.030	0.018	0.031	0.017	0.040	0.010	0.018	0.012	0.021	0.008	0.019	0.006	0.035	175
200	0.010	0.011	0.007	0.017	0.006	0.017	0.004	0.012	0.002	0.015	0.001	0.009	0.001	0.039	200
300	ND	ND	0.001	0.013	ND	ND	ND	ND	0.002	0.017	ND	ND	ND	ND	300

Depth	Sta.25 Van Dorn Chl-a	Sta.25 Van Dorn Phaeo.	Sta.11' Routine Chl-a	Sta.11' Routine Phaeo.	Sta.11' Van Dorn Chl-a	Sta.11' Van Dorn Phaeo.	Sta.27 Routine Chl-a	Sta.27 Routine Phaeo.	Sta.27 Van Dorn Chl-a	Sta.27 Van Dorn Phaeo.
0m	0.163	0.068	0.112	0.040	0.100	0.026	0.131	0.047	0.140	0.054
10	0.199	0.048	0.108	0.036	0.101	0.033	0.136	0.048	0.154	0.056
20	0.185	0.051	ND	ND	0.105	0.024	ND	ND	0.145	0.039
30	0.217	0.056	0.111	0.031	0.108	0.050	0.163	0.052	0.154	0.046
50	0.231	0.063	0.149	0.061	0.181	0.134	0.185	0.051	0.181	0.066
75	0.235	0.247	0.288	0.303	0.231	0.241	0.199	0.058	0.185	0.045
100	0.086	0.292	0.212	0.202	0.172	0.159	0.217	0.077	0.249	0.092
125	0.018	0.098	0.075	0.120	0.066	0.094	0.194	0.089	0.090	0.087
150	0.003	0.046	0.047	0.074	0.013	0.059	0.062	0.054	0.063	0.071
175	0.001	0.036	0.003	0.095	0.003	0.035	0.017	0.030	0.016	0.020
200	0.002	0.041	0.002	0.048	0.001	0.030	0.010	0.022	0.012	0.016
300	ND	ND	0.001	0.040	ND	ND	0.001	0.012	ND	ND

Table 6. Continued.

	Sta.27 In Situ Day		Sta.27 In Situ Night		Sta.28 Van Dorn		Sta.29 Van Dorn		Sta.30 Van Dorn		Sta.31 Van Dorn	
Depth	Chl-a	Phaeo.	Chl-a	Phaeo.	Chl-a	Phaeo.	Chl-a	Phaeo.	Chl-a	Phaeo.	Chl-a	Phaeo.
10	0.113	0.039	0.109	0.028	0.096	0.032	0.108	0.036	0.074	0.015	0.093	0.019
20	0.109	0.049	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
30	0.127	0.036	0.113	0.034	ND	ND	ND	ND	ND	ND	ND	ND
50	0.145	0.065	0.136	0.043	ND	ND	ND	ND	ND	ND	ND	ND
60	0.240	0.117	0.145	0.049	ND	ND	ND	ND	ND	ND	ND	ND
70	0.285	0.145	0.194	0.063	ND	ND	ND	ND	ND	ND	ND	ND
100	0.253	0.130	0.330	0.168	0.235	0.095	0.167	0.064	0.098	0.032	0.190	0.067
125	0.185	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 7. Summary of data at surface stations.

Sta.	Date	Time	Lat.	Long.	Temp	Sal.	NO_3^-	NO_2^-	PO_4^{3-}	SiO_2	Chl-a	Phaeo.
S- 0	11/22/82	1900	35°03.8'N	139°43.4'E	20.6	ND	ND	ND	ND	ND	ND	ND
S- 0	11/23/82	0800	35°17.0'N	142°53.0'E	22.3	ND	ND	ND	ND	ND	ND	ND
S- 1	11/23/82	1900	35°31.8'N	145°43.5'E	22.6	34.451	0.28	0.18	0.12	2.6	ND	ND
S- 2	11/24/82	0700	35°55.2'N	148°24.9'E	22.7	34.426	0.12	0.15	0.10	2.3	0.253	0.268
S- 3	11/24/82	1900	36°01.4'N	151°37.6'E	22.3	34.359	0.34	0.14	0.12	2.5	ND	ND
S- 4	11/25/82	0700	36°17.6'N	154°43.5'E	20.4	34.538	0.20	0.08	0.12	2.2	0.190	0.130
S- 5	11/25/82	1900	36°12.0'N	157°49.5'E	18.9	34.182	0.04	0.01	0.11	2.5	ND	ND
S- 6	11/26/82	0700	36°16.0'N	160°56.4'E	21.4	34.365	0.02	0.03	0.11	2.0	ND	ND
S- 7	11/26/82	1900	35°56.8'N	162°39.0'E	18.2	34.339	0.25	0.02	0.14	3.8	ND	ND
S- 8	11/27/82	0700	35°57.4'N	166°47.1'E	18.2	34.306	0.00	0.00	0.11	3.8	ND	ND
S- 9	11/27/82	1900	36°48.2'N	169°30.0'E	17.1	34.374	0.52	0.04	0.17	4.4	ND	ND
S- 10	11/28/82	0700	37°10.2'N	172°21.0'E	17.5	34.487	0.56	0.02	0.16	3.2	0.249	0.129
S- 11	11/28/82	1900	38°01.6'N	175°12.0'E	15.8	34.327	1.71	0.05	0.27	4.6	ND	ND
S- 12	11/29/82	0700	38°53.5'N	178°17.7'E	14.8	33.994	1.31	0.08	0.32	4.6	0.226	0.152
S- 13	11/29/82	1900	39°42.2'N	178°36.2'E	14.0	34.056	2.36	0.07	0.41	5.8	ND	ND
S- 14	11/29/82	0700	40°21.2'N	175°26.5'W	13.8	34.097	2.86	0.04	0.43	5.8	0.303	0.164
S- 15	11/29/82	1900	40°57.4'N	172°39.8'W	12.5	34.814	3.57	0.05	0.56	7.0	ND	ND
S- 16	11/30/82	0700	41°27.3'N	169°09.2'W	12.7	33.788	2.60	0.06	0.46	5.5	0.441	0.202
S- 17	11/30/82	1900	41°52.3'N	166°02.8'W	12.0	33.505	3.42	0.06	0.62	6.4	ND	ND
S- 18	12/ 1/82	0800	42°11.4'N	163°08.3'W	11.9	33.367	2.38	0.07	0.57	4.5	0.285	0.214
S- 19	12/ 1/82	1900	42°22.8'N	160°21.0'W	12.7	33.523	0.94	0.07	0.42	2.6	ND	ND
S- 20	12/ 2/82	0700	42°24.8'N	157°39.6'W	12.6	33.318	1.92	0.12	0.57	3.4	0.280	0.176
S- 21	12/ 2/82	1900	42°18.8'N	154°18.2'W	12.4	33.383	1.94	0.09	0.52	3.3	ND	ND
S- 22	12/ 3/82	0700	42°21.6'N	150°57.4'W	12.7	33.339	1.28	0.03	0.52	2.1	0.221	0.077
S- 23	12/ 3/82	1900	42°16.4'N	147°24.9'W	12.4	33.138	1.76	0.06	0.58	2.5	ND	ND
S- 24	12/ 4/82	0700	42°08.4'N	144°17.7'W	12.5	33.080	1.11	0.06	0.51	2.7	0.280	0.139
S- 25	12/ 4/82	1900	41°51.1'N	140°56.4'W	13.2	33.030	0.21	0.05	0.43	2.5	ND	ND
S- 26	12/ 5/82	0700	41°28.1'N	137°30.3'W	12.9	32.899	0.33	0.05	0.49	2.9	0.289	0.151
S- 27	12/ 5/82	1900	40°58.2'N	134°05.8'W	13.7	33.022	0.19	0.04	0.45	2.3	ND	ND
S- 28	12/ 6/82	0700	40°24.3'N	130°41.8'W	13.4	32.765	0.19	0.05	0.52	2.5	0.185	0.103

Hydrographic characteristics

T. Nakai and A. Hattori

Figures 2-7 show distributions of temperaure, salinity, oxygen, phosphate, nitrate and silicic acid along two transects (Transect 1, Station 5 through Station 11; Transect 2, Station 20 through Station 11'). Transect 1 was set roughly parallel to the coast of the North America Continent, and Transect 2 along 117^{o}W meridian (Fig. 1). The data reproduced in Table 4 were used. Transect 1 was located in the Eastern Boundary Current region of the North Pacific.

1. Temperature

The surface temperature was comparatively cold, about 13^{o}C at Station 5, and became warmer equatorward. Unusually high surface temperatures were observed in the vicinity of the equator. This probably resulted from the appearance of El Nino in the eastern boundary of the Pacific equator. The depth of the thermocline was relatively shallow and the vertical gradient of temperature in the thermocline was large in the low latitude areas.

2. Salinity

At the northern stations (Stations 5-7), the salinity increased monotonously with depth, but between 30^{o}N and 20^{o}N, a weak salinity minimum lay at ca. 175m. In the subsurface layer of the southern stations, there was a complicated interdigitation of salinity minima and maxima. The low salinity water derived from high precipitation in the intertropical convergence zone covered the surface on the north side of the equator. A deep salinity minimum, identified as the Equatorial Intermediate Water, lay at 800m. Just south of the equator, the subsurface saline water with a salinity of >35 permil may originate from the southern hemisphere. T-S diagrams at Station 5 through Station 27 are illustrated in Fig. 8(top).

3. Dissolved oxygen

At stations 5-9, dissolved oxygen decreased gradually with depth and attained a minimum at an intermediate depth of about 800m. A core of oxygen-depleted water with less than 0.25ml O_2/l was found in the intermediate layer (200-800m) at Station 11. This oxygen poor water extended to the boundary between the North Equatorial Current and the North Equatorial Countercurrent. Another oxygen-depleted water lay just south of the equator at about 350m. Its volume was much smaller than the northern one. In the deep layer of the South Pacific, dissolved oxygen concentrations were relatively high owing to the entrainment of the Antarctic Bottom Water rich in oxygen. T-O_2 diagrams at Station 5 through Station 27 are shown in Fig. 8(bottom).

4. Nutrients

Low concentrations of inorganic phosphate were invariably present in the surface water at all stations along the two transects. The lowest concentration of 0.07 μg atom/l was found at Station 27 located in the North Pacific Central Gyre area. Areal variations of surface phosphate were significant (Fig. 5). This probably reflects the divergence and convergence or the vertical circulation of water. High concentrations of >0.5μg atoms/l in the surface water at Stations 5 and 6 resulted from the occurrence of coastal upwelling. Phosphate concentrations increased with depth and attained a maximum, irrespective of location, at a depth of between 800 to 1,000m, where the oxygen minimum was also observed except for the stations in the South Pacific (Fig. 5).

At stations south of 25^{O}N, nitrate was hardly detected in surface waters, suggesting that phytoplankton growth in this area is primarily limited by nitrogen supply. There is no significant correlation between nitrate and phosphate concentrations in the surface waters. Nitrate was maximum found at a depth of ca.1,000m. This depth was deeper than that of the oxygen minimum and the phosphate maximum (Fig. 6), suggesting the occurrence of nitrate reduction and denitrification in the oxygen-depleted intermediate water.

Silicic acid distributions were relatively simple (Fig. 7). In the North Pacific, poleward increase in silicic acid concentrations at the same depth was significant. No regional trend was observed in the surface water.

5. Thermosteric anomaly

The cross section of the thermosteric anomaly (Fig. 9) was similar to the temerature cross section (Fig. 2). Generally, the isopleths extended horizontally without waving. It is suggested that strong currents were not present in this area. The inclination of the isopleths in the subsurface layer of the equatorial region indicates the presence of the Equatorial Current System.

6. Surface currents

Figure 10 shows the direction of the ship's drift estimated on the basis of NNSS (Navy Navigation Satellite System) data. North of 20^{O}N, the equatorward component of the surface current was dominant in offshore areas, reflecting the presence of the California Current. Near the coast of California, the northward counter current was also observed. South of $20^{O}N$, the westward currents generally predominated, but the eastward equatorial countercurrent was present between $5^{O}N$ and $7^{O}N$. The westward currents on the northern and southern sides of the Equatorial Countercurrent can be identified as the North Equatorial Current, and the South Equatorial Current, respectively.

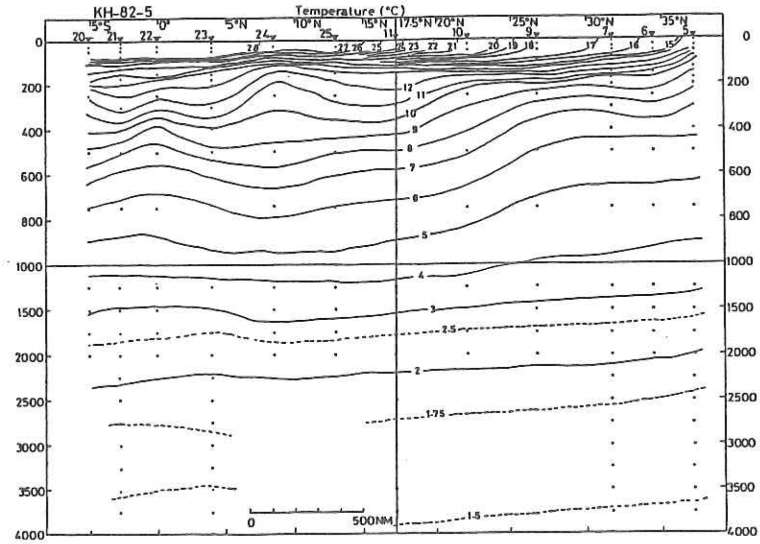


Fig. 2. Distribution of temperature (°C) along the transects 1 and 2.

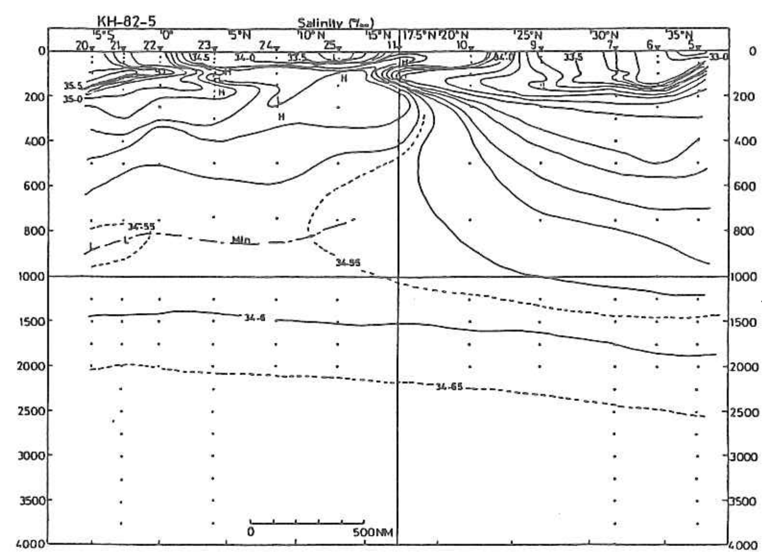


Fig. 3. Distribution of salinity (permil) along the transects 1 and 2.

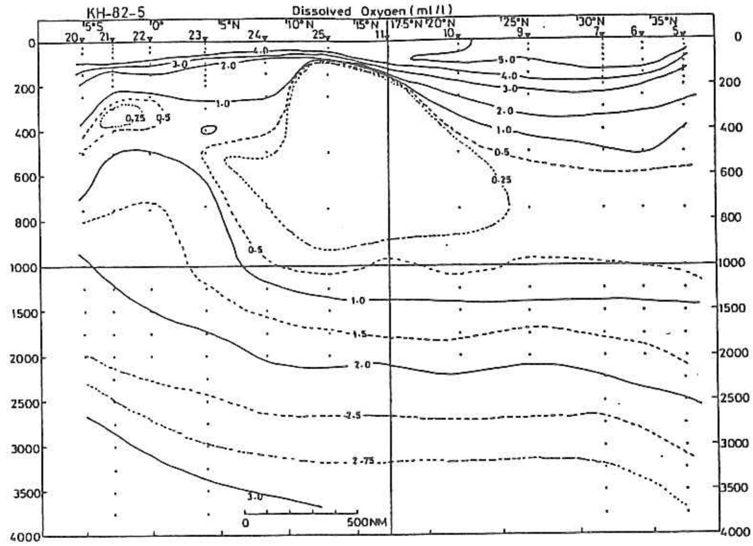


Fig. 4. Distribution of dissoloved oxygen (ml/l) along the transets 1 and 2.

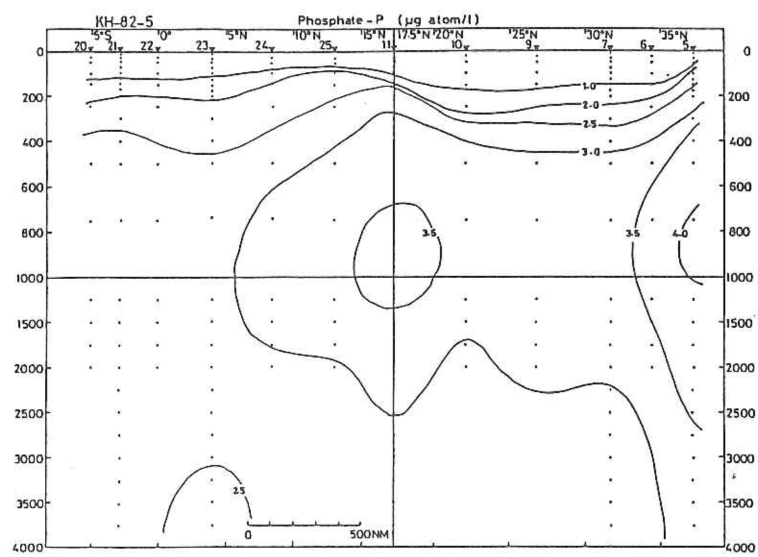


Fig. 5. Distribution of phosphate (μM) along the transets 1 and 2.

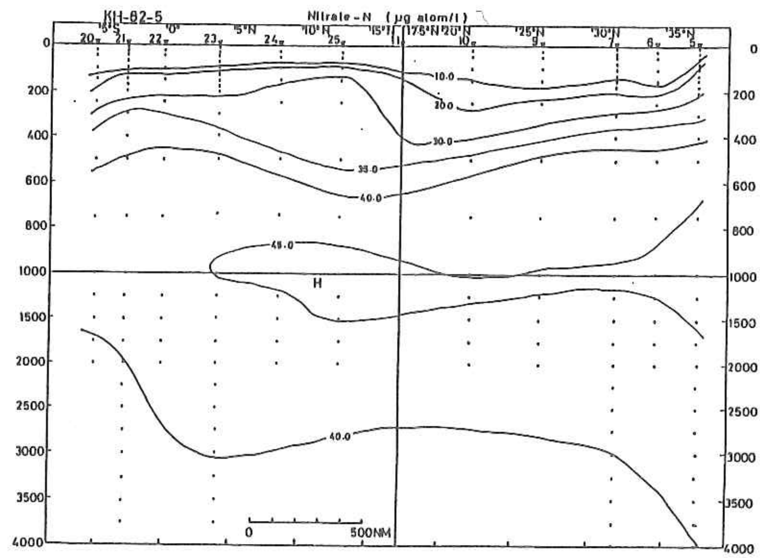


Fig. 6. Distribution of nitrate (μM) along the transets 1 and 2.

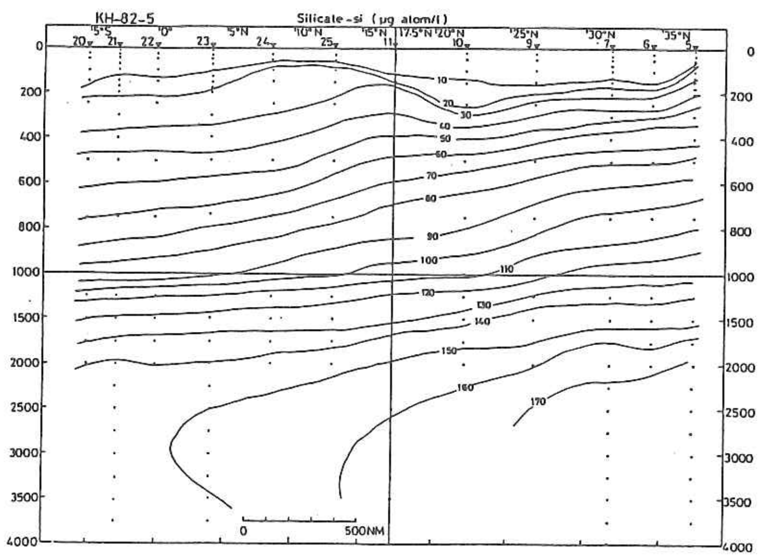


Fig. 7. Distribution of silicic acid (μM) along the transets 1 and 2.

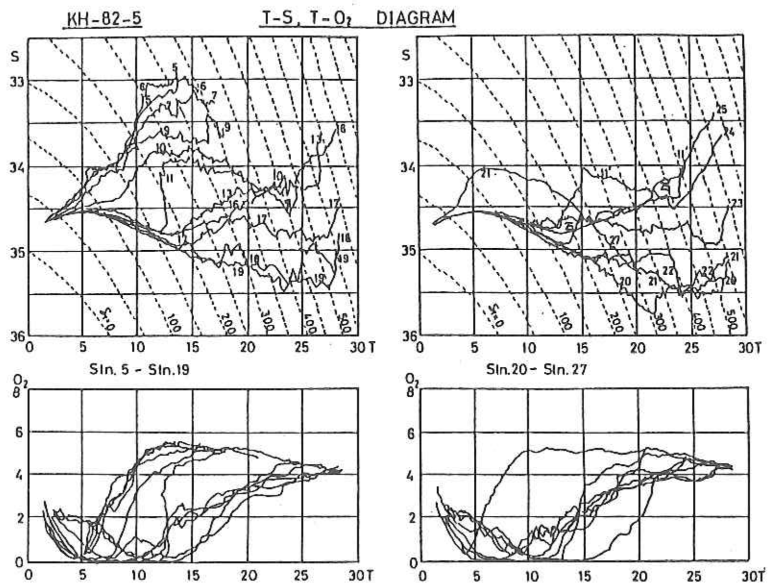


Fig. 8. T-S and T O_2 diagrams at Station 5 through Station 27.

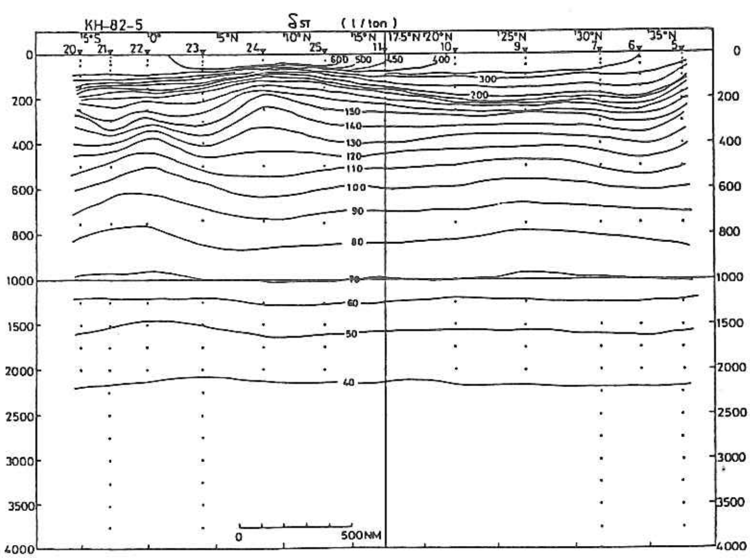


Fig. 9. Distribution of thermosteric anomaly (cl/ton) along the transects 1 and 2.

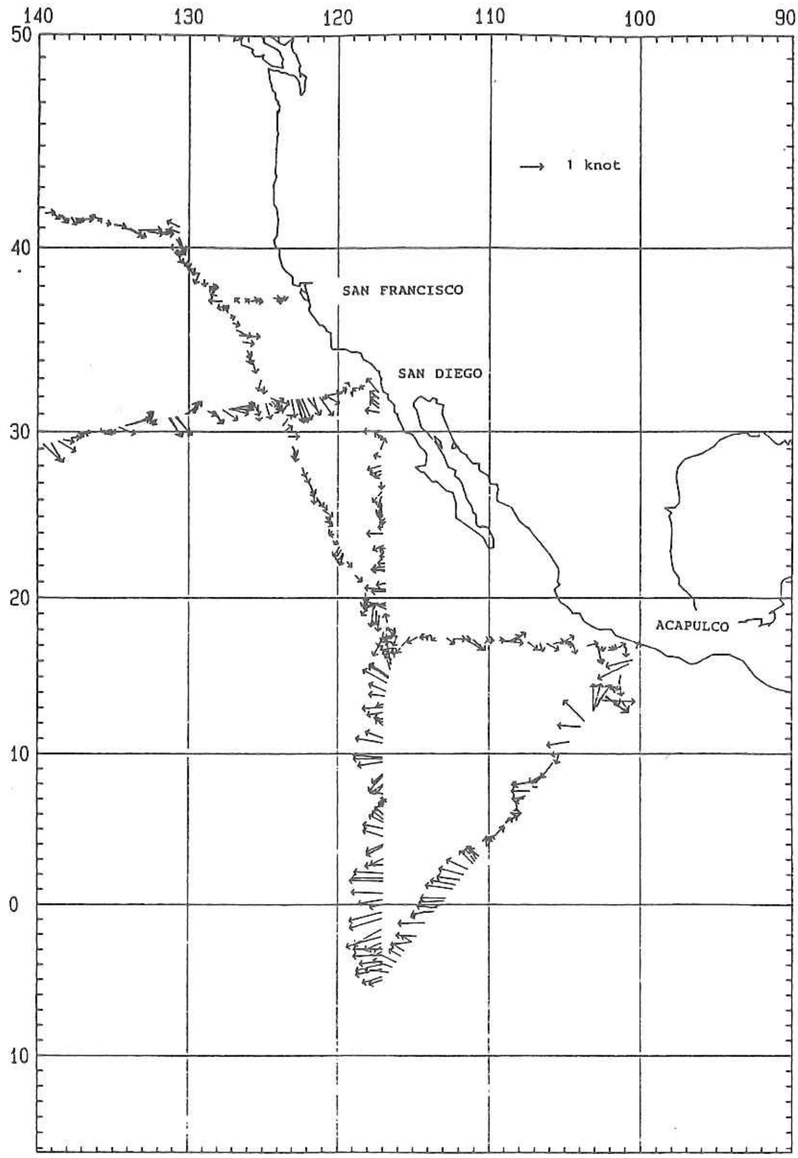


Fig. 10. Surface currents estimated from the ship's drift.

Radiation measurements and estimation of heat exchange across the sea surface in the North Pacific central gyre

H.Otobe and T.Nakai

Downward fluxes of short- and longwave radiations (S, L) were measured directly during the period from 1 to 6 February 1983 in order to estimate the heat exchange across the sea surface in the North Pacific central gyre. A shortwave sensor (Ishikawa Sangyo pyranometer model S-185) and a longwave sensor (Ishikawa Sangyo radiometer model RL-5) mounted on gimbals were installed on the handrail of the anti-rolling tank at the top of the vessel.

The heat exchange across the sea surface(Q) is given by

$$Q = Rn - (lE + H), \qquad (1)$$

and

$$Rn = (1 - r)S - \varepsilon(\sigma T^4 - L), \qquad (2)$$

where Rn is the net radiation flux, lE is the latent heat flux, H is the sensible heat flux, r is the albedo, T is the sea surface temperatue, ε is the emissivity of sea water and σ is the Stefan-Boltzman constant. lE and H were estimated by the aerodynamic bulk method of Kondo (1975), using the routine meteorological data collected at 3-hr intervals. Payne's table (Payne, 1972) was used for the values of r. Temporal variations of the heat budget components at Station 27 in the North Pacific central gyre are reproduced in Fig. 11.

References

Kondo, J. (1975). Boundary-Layer Meteorol., **9**, 91-112.

Payne, R.E. (1972). J. Atmos. Sci., **28**, 959-970.

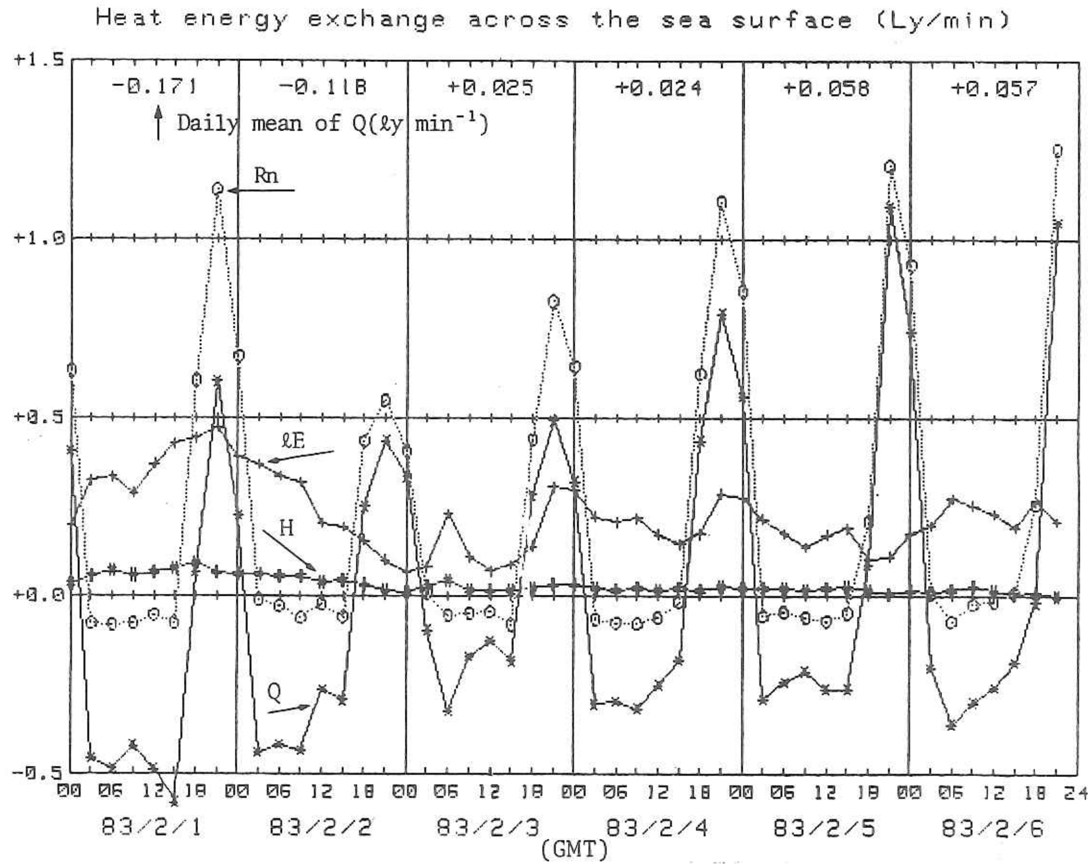


Fig. 11. Temporal variations of the heat budget components at Station 27 plotted at 3-hr intervals.

Measurement of dissolved oxygen by combined use of a CTD system and an oxygen probe

T. Nakai

Vertical distributions of dissolved oxygen were determined with a combination of a Neil Brown Mark III CTD system and a Beckman oxygen electrode at all hydrographic stations. Discrete water samples were collected with Rosette Multi Sampler (Niskin 2.5-literx12) at given 12 depths during upward operation, and their oxygen concentrations determined by the Winkler method were compared with those measured by the oxygen electrode method. The algorithm used for calculation of dissolved oxygen from CTD data is: O_2 = Ox x {(Oi x A + B) x Exp(Ot x Ct + P x Cp)}, where O_2 is CTD oxygen value (ml/l); Ox, the oxygen saturation value after Weiss (1970); Oi, CTD oxygen current (μA); Ot, CTD oxygen prove temperature; P, CTD pressure; A, oxygen current slope correction; B, oxygen current bias correction; Ct, temperature correction factor; and Cp, pressure correction factor. The values for the correction factors, A, B, Ct and Cp were selected so as to give best fit to the Winkler values (Fig. 12). For ininial several runs of the cruise, somewhat different values must be assigned for the correction factors, but we could use the same values for the rest of runs. The winch speed must be very slow when lowering the sensor through the thermocline, because the response of oxygen sensor was relatively slow. The differences between the Winkler values and the oxygen probe values were ca. ±0.1 ml/l in the shallow water above and around the thermocline, and ±0.05 ml/l in the deeper layers.

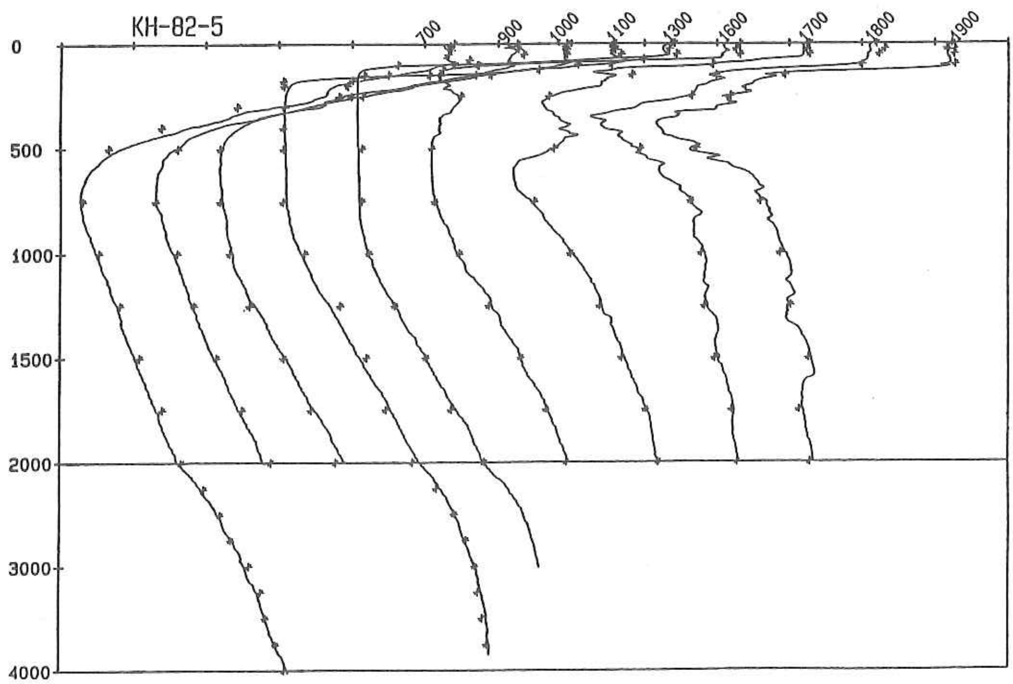


Fig. 12. Depth profile of dissolved oxygen determined with a Neil Brown Mark III CTD system fitted with a Beckman oxygen sensor. Values for DO as determined by the Winkler method are also shown.

Chemical studies of the eastern tropical Pacific

S. Noriki, K. Harada, N. Ishimori and T. Suzuki

1. Chemical composition of particulate matter in seawater

Seawater samples collected from various depths at 7 hydrographic stations and the surface stations (Fig. 1) were filtered through a Nuclepore filter (pore size 0.6 μm). The dry weight of particulate matter was determined, and the concentrations of Ca, Si, Al, and Mn were determined by atomic absorption spectrophotometry and other methods.

2. Aluminum in seawater

The seawater samples (about 1 liter), collected at 5 stations with Niskin bottles or Go-Flo bottles, were acidified. Aluminum was determined by fluorescimetry ashore.

3. Alkalinity and pH in seawater

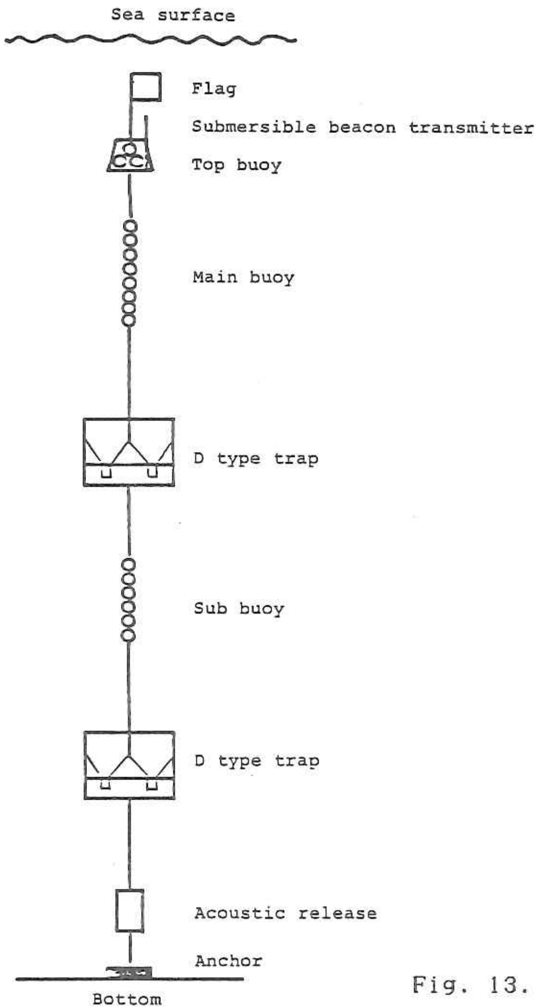
Alkalinity and pH were determined with water samples collected from various depths at all of the hydrographic stations.

4. Sediment trap experiments

NH type traps were deployed at Station 5, 7, 11 and 27, and D type traps at Stations 5, 7, and 11 (Figs. 13, 14). Settling materials were collected at 5 depths by the NH traps and 1 or 2 depths by the D traps. The samples collected were analyzed for major inorganic components, trace metals, stable isotopes of organic carbon and nitrogen, and radionuclides such as ^{234}Th and ^{210}Pb. Particulate flux data are given in Table 8.

5. ^{234}Th, ^{226}Ra, ^{210}Pb and ^{210}Po in seawater

Surface seawater samples (50 liters) were obtained at 47 stations including all the hyrographic stations and the surface



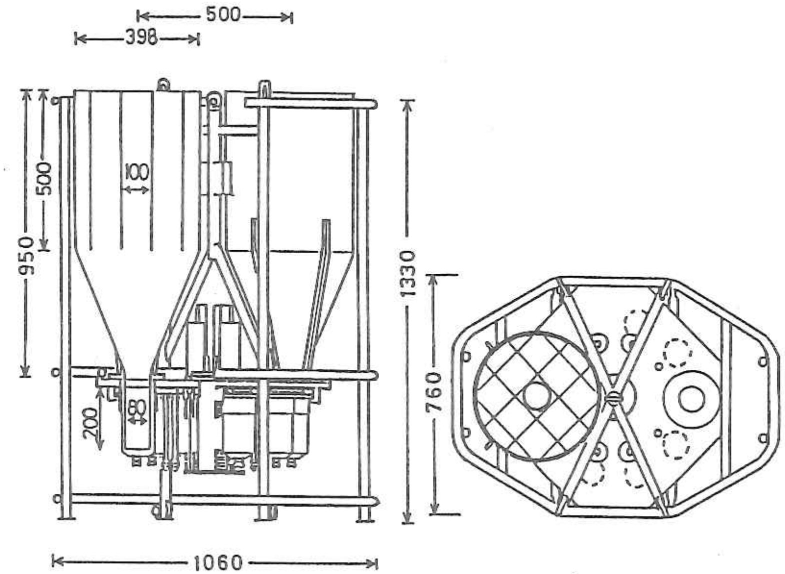


Fig. 14. D type trap.

Fig. 13. Mooring configuration in D type trap experiment.

stations. At Stations 5, 7, 11, 21, 23 and 27, the seawater samples were collected from various depths using a submersible pump or Niskin bottles. Radionuclides, ^{234}Th, ^{226}Ra, ^{210}Pb and ^{210}Po, in seawater were coprecipitated with carbonates and hydroxides, and further fractionated by passing through anion exchange columns. The beta activity from ^{234}Th was counted on board the ship.

6. ^{230}Th in seawater

The large volume water samples (100-200 liters) were collected from various depths at Stations 21 (14 samples) and 11' (13 samples) with Niskin bottles. Thorium isotopes and ^{10}Be were coprecipitated with ferric hydroxide. Thorium was separated from Be by an ion exchange technique. The alpha activity of ^{230}Th was measured with a counter fitted with a Si surface barrier detector and a pulse-hight analyzer. Beryllium-10 was determined by M. Kusakabe, Univrsity of Southern California (Kusakabe, this volume).

7. Chemical studies of sediments and interstitial waters

At Station 11', the sediment sample was obtained with a Box corer. Eleven sub-cores were taken from this box core. Interstitial water samples were obtained by squeezing the subcore samples at near in situ temperatures. Reactive phosphate and silicate, and some metals were determined. Radionuclides such as Th, U, ^{226}Ra, ^{210}Pb and metals such as Fe, Al, and Mn were also determined. These data will be used to study sedimentation rate, interaction between Mn nodules and sediments and other phenomena.

8. Fe, Mn and Al in aerosols and rain over the ocean

Aerosol samples were collected continuously (for one day period) using large volume air sampling systems (flow rate, ca. 1 m^3/min) and Whatman 41 filters (20 x 25 cm). The sampling systems were set on the compass bridge deck about 10 m above the sea surface. The operation of the air sampler was automatically controlled by a wind monitoring system in order to avoid contaminations from the ship exhaust. Thirty five aerosol samples were obtained.

Rain samples were collected in a polyethylene bag when the ship tracked a squall. The rain samples were stored after the addition of HNO_3 so as to make up its 0.6% solution. Seven rain samples were obtained.

9. ^{222}Rn daughters in maritime air

Aerosols in maritime air were collected by filtration through Millipore HA filter (pore size 0.45 μm). The sampler was set on the compass bridge deck. The sampling was conducted for 2-3 hr at a flow rate of 4 l/min and the beta activity emitted from daughters of ^{222}Rn on the filter was counted on board the ship. The concentration of ^{222}Rn in the air was calculated from the beta activity. The results are shown in Table 9.

This work was conducted in collaboration with S. Tsunogai, Y. Watanabe, M. Yamada, N. Masuda, T. Kurata, K. Taguchi, and J. Matsumoto, Laboratory of Analytical Chemistry, Faculty of Fisheries, Hokkaido University.

Table 8. Total particulate flux determined by sediment trap experiments

Station	NH type trap Depth (m)	Deployment period (hours)	Flux (g/m^2yr)	D type trap Depth (m)		Deployment period (hours)	Flux (g/m^2yr)
5	740	141	29.6	4,250	D1	27.5	153.4
	940	141	29.9		D2	30	12.0
	1,440	141	25.4		D3	30	24.0
	3,440	175	19.7		D4	30	52.7
	4,240	175	16.9	4,700	D1	27.5	4.1
					D2	30	9.8
					D3	30	52.4
					D4	30	18.0
7	720	930	6.9	3,700	D1	237	2.1
	920	930	5.6		D2	240	1.3
	1,420	930	5.4		D3	240	1.3
	3,420	930	6.2		D4	240	2.7
	3,820	930	5.9				
11	670	500	9.3	3,820	D1	116	1.1
	870	500	10.0		D2	120	3.2
	1,370	500	8.2		D3	120	2.2
	3,370	500	8.8		D4	120	4.1
	3,670	500	6.7				
27	720	46.5	12.7				
	920	46.5	7.5				
	1,420	46.5	5.1				
	3,420	46.5	4.0				
	4,320	46.5	2.4				

Table 9. Atmospheric concentration of ^{222}Rn

Sample No.	Sampling period	Location	Wind direction	^{222}Rn dpm/m^3
Rn- 2	Jan.28 0453-0800	31°53'N 121°58'W	W	14.5
Rn- 5	Jan.31 0700-0950	30°31'N 133°16'W	S	24.3
Rn- 6	Feb. 1 0828-1122	29°23'N 138°52'W	WNW	17.6
Rn- 7	Feb. 2 0436-0727	28°30'N 143°00'W	W	41.0
Rn- 8	Feb. 2 1003-1300	28°17'N 143°59'W	NW	43.8
Rn- 9	Feb.12 0652-0953	21°35'N 161°50'W	SW	22.0
Rn-10	Feb.12 1005-1320	21°42'N 162°40'W	SSW	25.0
Rn-11	Feb.13 0513-0753	22°05'N 165°32'W	W	52.8
Rn-12	Feb.13 1108-1357	22°12'N 167°44'W	NW	57.7
Rn-13	Feb.14 0632-0856	22°38'N 171°39'W	W	15.1
Rn-14	Feb.14 1201-1458	22°49'N 172°55'W	WSW	62.1
Rn-15	Feb.15 0608-0927	23°26'N 176°34'W	WSW	34.5
Rn-16	Feb.15 1204-1500	23°43'N 177°49'W	W	8.10
Rn-17	Feb.16 0705-0900	24°25'N 178°38'E	N	42.9
Rn-18	Feb.16 1244-1500	24°44'N 177°23'E	N	101
Rn-19	Feb.17 0713-1009	25°36'N 173°14'E	S	76.1
Rn-20	Feb.18 0741-0959	26°42'N 167°47'E	SSE	29.7
Rn-21	Feb.19 0659-1000	27°20'N 162°14'E	SW	44.6
Rn-22	Feb.20 0853-1100	28°58'N 157°24'E	W	37.3
Rn-23	Feb.21 0800-1130	30°25'N 153°26'E	W	65.5

Observation and sample collection of aerosols and radon in the atmosphere near the sea surface of the Pacific Ocean

T. Tanji

To understand the behavior of aerosols and radon(Rn-222) and the composition of aerosols in the atmosphere near the sea surface of the Pacific Ocean, the following experiments were conducted.

1. Atmospheric electric conductivity

Atmospheric electric conductivity was measured continuously throughout the cuise using a Gerdien conductivity apparatus.

2. Mie-particles

Using a light scattering particle counter, the numbers of Mie-particles and their size distribution were determined continuously throughout the cruise.

3. Aitken particles

A photoelectric portable counter was used for determination of numbers of Aitken particles. The measurements were made at 4-hr intervals.

4. Radon daughters

Radon daughters were collected on a filter, for a suitable period, and their radiations were determined with a pulse height analyzer fitted with a silicon semiconductor detector. We set the time length of one measurement to be 4,000 sec. Radon daughters were measured at 8-hr intervals.

5. Aerosol

Aerosol samples were collected using an eight-staged Andersen air sampler. The length for collection of one sample was 10 hr. Forty eight aerosol samplings were made at select areas through the full period of the expedition.

6. Ice crystal nuclei

A four-staged Casella cascade impactor was used for collection of ice crystal nuclei. Sampling was made once a day.

Distribution of heavy metals

S. Kanamori, S. Nakamura and K. Itoh

1. International cross check of clean water sampler

Very low values of heavy metal content in open ocean waters have been reported in these several years and the reason for the previous high values has been mainly attributed to the contamination from water sampler and suspended dust in the atmosphere of laboratory. The advantage and necessity of the use of clean sampler and clean laboratory have been well recognized to be essential for determination of very low content of heavy metals in open ocean water. We have developed a new type of clean water sampler and also constructed a sea-going clean laboratory.

On this cruise, we collected water samples for cross checking of cleanness between our clean sampler and that of Dr. C.C. Patterson, California Institute of Technology, who had developed the first clean water sampler.

The water sampling was made at Stations 16 and 21 and several water samples were taken. The analyses of water samples are now in progress at Dr. M. Murozumi's laboratory in Muroran Institute of Technology and at Dr. C.C. Patterson's laboratory in California Institute of Technology.

2. Distribution of heavy metals in the ocean

Water samplings for study of heavy metal distribution were carried out at Stations 7, 11, 21, 11' and 27, and 20 subsurface water samples were collected. Surface water samples were taken at 18 stations. Analysis of these water samples is in progress at several laboratories for Cu, Zn, Cd, and others.

Distribution of potential carbon dioxide partial pressure

S. Kanamori

The potential carbon dioxide partial pressure is defined as an equilibrium carbon dioxide partial pressure prevailing within a sample water when it is brought to the surface with the same temperature and salinity as observed in situ but corrected for increase in total carbonate content caused by organic matter decomposition and calcium carbonate dissolution. The potential carbon dioxide partial pressure represents the possible carbon dioxide partial pressure of the air which had been in contact with the sample water at the surface before it has been transported to the present depth (S. Kanamori and H. Ikegami, 1982).

Vertical profiles of the potential carbon dioxide partial pressure at Stations 11, 21 and 27 of the eastern North and Equatorial Pacific were determined based on precise measurement of pH and potentiometric titration of total alkalinity (Fig. 15).

The profiles at Stations 11 and 27 show the similar trend found in central North Pacific. The surface value was close to that in equilibrium with the air (330-340 ppm), it decreased with increase in depth, reached to about 250 ppm at 700-800 m and remained nearly constant in the deeper water. However, very high values of more than 400 ppm were observed in the surface layer at Station 21, suggesting the presence of a big inequilibrium between the air and water in the surface layer.

Reference

Kanamori, S. and H. Ikegami (1982) Chikyukagaku, **16**, 99-105.

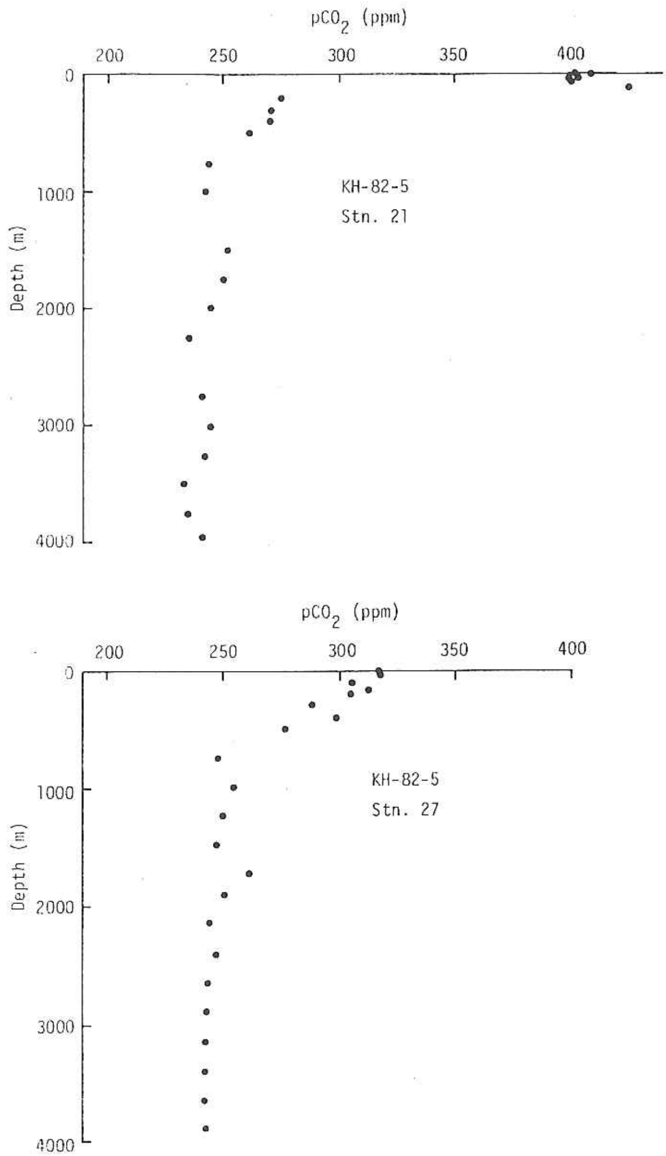


Fig. 15. Vertical distribution of potential CO_2 partial pressure.

Radiochemical study in the Pacific Ocean

M. Sakanoue and T. Hayashi

1. Horizontal distribution of $^{239}Pu + {}^{240}Pu$, ^{238}Pu, ^{241}Am, ^{228}Ra and ^{226}Ra in the surface water

About 1,000 liters of surface seawaters were pumped up at 25 stations. Yield tracers (^{242}Pu and ^{243}Am) and carrier (Fe) were added to the sample waters together with HCl. After standing for several hours to achieve isotopic exchange, NH_4OH was added, and Pu and Am were coprecipitated with $Fe(OH)_3$. Radium was coprecipitate with $BaSO_4$ by the addition of $BaCl_2$. The supernatant was removed by decantation and the precipitates collected with the remaining water (ca.500 ml) were brought back to the laboratory.

2. Vertical variations of isotope ratio (Pu, Ra and Th) in sea water as measured by using MnO_2 acrylic fiber mooring systems

Following the methods of Moore and Reid (1973) and Nozaki (1983), acrylic fibres (TORAY "Toraylon", 3 denier) was soaked in 0.4M $KMnO_4$ at 80°-$85^{\circ}C$ for ca. 1 hr. The black fibre yielded was washed with distilled water, and dried. This MnO_2-coated acrylic fibre (ca.100 g each) was wrapped with untreated acrylic fibre cloth and placed in a nylon net.

Three series of in situ mooring experiments were carried out at Stations 5,7 and 11(Fig.1). The nylon nets with the MnO_2 acrylic fibres were attached to moored sediment traps (cf. Tables 9 and 12) at indicated depths for indicated times (Table 10).

3. Vertical distribution of ^{210}Pb and ^{3}H

Samples were collected with 23-liter Niskin samplers at Stations 5 and 7 (Table 11). About 4 liters of the samples were used for determination of ^{3}H content, and 6 liters for determination of ^{210}Pb content.

4. Radiation measurements in the air

Gamma radiation in air was continuously monitored using a NaI(Tl) scintillation detector (4"ø x 4") fixed on the rear bridge. Gamma energy discrimination was made to investigate the origin of radiation, i.e., radon and its daughters or cosmic ray.

References

Moore, W.S. and D.F. Reid (1973). Extraction of radium from natural waters using manganese-impregnated acrylic fibers. J. Geophys. Res., **78**, 8880-8886.

Nozaki, Y. (1983). Determination of thorium isotopes in seawater by moored MnO_2-fiber method. J. Oceanogr. Soc. Japan, **39**, 129-135.

Table 10. Stations, sampling depths, and times of mooring experiments with MnO_2 fibre.

Sta.	Moored times	Trap	MnO_2 fibre depths (m)				
5	10 Dec.'82-17 Dec.'82	NH-type	4250	3450	1450	950	750
		D-type	4700	4250			
7	19 Dec.'82-28 Jan.'83	NH-type	3840	3440	1440	940	740
		D-type	4150	3700			
11	24 Dec.'82-17 Jan.'83	NH-type	3670	3370	1370	870	670
		D-type	3870				

Table 11. Sampling depths, temperatures and salinities at Stations 5 and 7.

Station 5			Station 7		
Depth(m)	Temp.(^{o}C)	Sal.(ppt)	Depth(m)	Temp.(^{o}C)	Sal.(ppt)
0	13.5	33.01	0	17.1	33.30
457	5.84	34.18	668	5.09	34.34
657	4.87	34.35	862	4.38	34.45
1158	3.33	34.51	1349	3.13	34.54
3150	1.63	34.67	3382	1.54	34.68
3950	1.52	34.68	3781	1.52	34.68
4410	1.56	-	4261	1.55	34.69

Be isotopes in seawater

M. Kusakabe

In the oceanic environment, there are three kinds of Be isotopes (^{7}Be, ^{9}Be and ^{10}Be); two of them (^{7}Be and ^{10}Be) are radioactive and produced by reaction between atmospheric constituents and cosmic ray. Recently the employment of an accelerator to detect ^{10}Be ($t_{1/2}$=1.5 myr) made it possible to measure its concentration in sea water (e.g., Kusakabe et al., 1982). Measures and Edmond (1982) developed a very sensitive method for the determination of ^{9}Be in seawater. So far, however, no one has ever attempted to measure simultaneously ^{9}Be and ^{10}Be in seawater.

In order to clarify the oceanic distribution of Be isotopes, surface waters along the cruise track and closely spaced water column samples were taken. Duplicate samples of at least 250 ml in volume were obtained for ^{9}Be measurement. During legs 2 and 3, 18 surface samples were collected using an all plastic pump. At three stations (Stations 11, 21 and 23), detailed vertical samplings from surface to near bottom were done using Niskin bottles for ^{9}Be. Immediately after the sampling redistilled HCl was added to the samples. Determination of ^{9}Be will be done at University of Southern California and Massachusetts Institute of Technology. Concurrent large volume samplings(100 or 200 liters) for ^{10}Be were done except at Station 23. A submersible pump and Niskin bottles were used to obtain surface waters (<100 m depth) and deeper water, respectively. On board the ship, ^{10}Be was coprecipitated with $Fe(OH)_3$ from the large volume samples and brought back to the USC Geochemical Lab. Accelerator measurement of ^{10}Be will be carried out in collaboration with Prof. D. E. Nelson and his colleagues at Simon Frazer University, Canada. Measurements of ^{210}Pb and ^{210}Po in the samewater are also being carried out.

References

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Geochemical studies of the eastern North Pacific

N. Handa, T. Hama and H. Matsueda

1. Determination of vertical flux of organic matter and organic chemistry of sinking particles

An array of sediment traps was moored at four stations in the eastern North Pacific (Table 12). Particles deposited into the sediment traps were placed in 300 ml PVC bottles, and kept flozen at -20°C until analysis.

After thawing, the samples were centrifuged, and the precipitates were subjected to analyses of dry weight and organic carbon and nitrogen contents. Analysis was also made for lipid materials, amino acids, proteins, and carbohydrates.

Preliminary examination of the sinking particles by scanning electron microscopy showed that coccoliths were dominant in the sinking particles, followed by diatoms and foraminifera.

2. Chemistry of suspended particles

Seawater samples (20 liters) collected with Niskin bottles from the surface to 200 m depth at 18 stations were filtered through Whatman type C glass fibre filter, and suspended particles were collected. Analysis was made for total organic carbon and fatty acids, methyl esters of fatty acids, glyceride and free fatty acids.

Relatively large amounts of suspended particles were collected from 700 and 1,200 m depths at Stations 11 and 27 using an in situ filtration system. At Station 11, 2,251 and 2,357 liters of seawater were passed through the system at 700 and 1,200 m, respectively, for 4 hr of operation and 1,663 and 1,588 liters at

Table 12. Sediment trap experiments conducted in the eastern North Pacific

Ex.	Sta.	Location	Water depth (m)	Sediment trap depth (m)	Mooring period (hr)	Remarks
1	5	36°58.1'N	4,750	740	141	10 Dec.'82-16 Dec.'82
		127°33.1'W		940	141	
				1,440	141	
				3,440	175	
				4,240	175	
2	7	31°41.9'N	4,340	720	930	19 Dec.'82-28 Jan.'83
		124°25.4'W		920	930	
				1,420	930	
				3,420	930	
				3,820	930	
3	11	17°28.5'N	3,870	670	500	24 Dec.'82-17 Jan.'83
		117°02.7'W		870	500	
				1,370	500	
				3,370	500	
				3,670	500	
4	27	26°48.7'N	5,150	720	46.5	2 Feb.'83-4 Feb.'83
		146°49.5'W		920	46.5	
				1,420	46.5	
				3,420	46.5	
				4,320	46.5	

Stations, 27 for 3 hr. More than 30 mgC of organic matter was collected. Aanalysis was made for hydrocarbons, wax esters, glycerides, polycyclic aromatic hydrocarbons, sterols, alcohols and fatty acids.

3. Organic geochemistry of sediment

Sediment sample was collected at Station 11 by a box corer. Stainless steel barrel was directly inserted to the bottom sediment collected by the corer. The core samples obtained were sectioned 1 or 2 cm segments and kept frozen at -20 ^{O}C until analysis.

4. Organic compounds in maritime air

Cascade impactors ranging particle sizes of < 1.1 μ, 1.1-2.0 μ, 2.0-3.3 μ and 3.3-7.0 μ in diamater were used to collect marine aerosol particles onto glass fibre filter (GF/C). Collection of the samples was controlled automatically so as to be conducted only when wind blew from head of the ship. Cumulative values of air passed through the impactors were 2,455, 1,484, 2,890 and 2,411 m^3 on legs 2, 3, 4 and 5, respectively. These samples have been analyzed for hydrocarbons, polycyclic aromatic hydrocarbons, fatty acids and fatty alcohols to estimate long range transport of organic materials through the marine atmosphere.

5. Photosynthetic production of organic matter in the eastern North Pacific

Several types of the experiment for measuring photosynthetic production of organic matter in the surface and subsurface waters of the eastern North Pacific were conducted by the ^{13}C method developed by Hama et al. (1983).

Gross production of organic matter by photosynthesis of phytoplankton was determined at 15 stations on leg 2 through leg 5.

A detailed study of the incorporation of $^{13}C(^{13}CO_2)$ into cellular organic constituents of marine phytoplankton was performed at 8 stations to obtain information on physiological state of natural population of phytoplankton. Cellular organic constituents have been fractionated into lipids, amino acids, proteins and carbohydrates.

In situ measurement of photosythetic incorporation of $^{13}CO_2$ into cellular organic constituents of phytoplankton was also conducted at 12, 60 and 100 m depths of Station 27.

Reference

Hama. T., T. Miyazaki, O. Ogawa, T. Iwakuma, M. Takahashi, A. Otsuki and S. Ichimura (1983), Mar. Biol., **73**, 31-36.

Depth profiles of nitrous oxide in the eastern tropical Pacific Ocean

I. Koike and A. Hattori

Seawater samples, collected from standard hydrocasts of Niskin bottles at Stations 5, 6, 7, 10, 11, 11', 13, 16, 19, 21, and 25, were transferred directly into 17-ml vacuum tight test tubes with rubber stoppers. The sampling procedure was the same as described elsewhere (Koike and Hattori, this volume). In order to terminate biological reactions 0.3 ml of 0.01M $HgCl_2$ was injected through the rubber stopper. Dissolved nitrous oxide was determined by the gas chromatographic method of Cohen (1977).

Reference

Cohen, Y. (1977), Anal. Chem., **49**, 1238-1240.

Natural abundance of ^{15}N in dissolved N_2O

A. Hattori and T. Saino

The importance of the oceanic system in the global cycle of N_2O is being increasingly recognized. As a novel approach to identify biogeochemical processes responsible for the formation and consumption of N_2O in the sea, we attempted to collect information on ^{15}N abundance in dissolved N_2O. We selected the eastern tropical Pacific as the study area because the active occurrence of nitrogen transformations in this area has been suggested.

Water samples (ca. 100 liters each) were collected with Niskin bottles from various depths at 6 stations. Dissolved N_2O was extracted by bubbling with Ar and collected on a molecular sieve 5A column. Atmospheric N_2O was simultaneously collected at the same and other stations. $^{15}N/^{14}N$ ratio of the N_2O was later determined using the method of N. Yoshida and S. Matsuo (Geochem. J., in press) at the laboratory of Dr. Matsuo, Tokyo Institute of Technology.

The ^{15}N data obtained indicate that the subsurface waters act as a source of N_2O and that the extremely oxygen-depleted intermediate waters act as a sink. The details have been presented elsewhere (N. Yoshida, A. Hattori, T. Saino, S. Matsuo and E. Wada, Nature, in press).

Natural abundance of ^{15}N in suspended particulate organic matter

T. Saino and A. Hattori

Variation of the natural abundace of ^{15}N in the suspended particulate organic matter (POM) provides useful information on processes of POM production and decomposition.

Water samples were collected with 23-liter Niskin bottles at Stations. 5, 11, 21, 11', 7' and 27 at depths ranging from the surface to 4,000 m. A time series of water sampling was carried out at Station 27 in the North Pacific central gyre, where the ship chased a surface buoy for ca. 24 hr. The water sample were taken from around the upper thermocline. Emphasis was placed on the short-time variation of the thermocline and its effect on the natural abundance of ^{15}N in suspended POM.

The water samples (90 liters for >300 m, 20 liters for <300 m) were filtered through glass fibre filters (47 mm diameter, pre-combusted at 450 ^{o}C for 4 hr), and POM collected on the filters was dried and kept in a desiccator under vacuum. During this curise, 111 samples were collected.

Diel variation of chemical parameters relating to biological activity in near-surface waters in the North Pacific central gyre

T. Saino, H. Otobe, S. Kanamori, T. Nakai and A. Hattori

This experiment was planned to observe the diel variation of nutrients, dissolved oxygen, and total carbonate in the North Pacific central gyre. A set of surface buoys attached to an underwater reflecting cloth was combined with a buoy fitted with a rope for in situ ^{15}N and ^{13}C uptake experiments, and was deployed and tracked for ca. 24 hr. Water samplings were carried out 4 times, twice during the day and twice at night.

The temperature field was monitored by repeated CTD (Neil Brown), XBT (Tsurumi Seiki Co.) casts, and by two DTR's (digital thermo recorder: Kankyo Keisoku System Co.) moored to the drifting buoy at 60- and 80-m depth. Water samples were taken with twelve 23-liter Niskin bottles placed in the upper thermocline.

Temperature was determined by reversing thermometers, and salinity, dissolved oxygen, phosphate, silicate, nitrate, nitrite, ammonium, chlorophyll-a, pH and alkalinity were measured using portions of the water samples collected at discrete depths. The rests of the water samples were filtered through glass fiber filters for the later analysis of natural abundance of ^{15}N in POM.

Photosynthetic activity of large phytoplankton in the North Pacific central gyre

M. Takahashi

It has been observed that the majority of phytoplankton in subtropical waters of the North Pacific central gyre is in extremely small size, less than 3 μm. However, it has also been known that there is a great variety of phytoplankton species in forms of larger than 10 μm, although their total biomass is small. These large phytoplankton mostly consist of diatoms, dinoflagellates and coccolithophorids.

Photosynthetic activity of these large subtropical phytoplankton was focused on in this study. Water samples were collected at two depths, one near the surface and the other around the subsurface chlorophyll maximum layer of ca. 70 m. One to two hundred liters of water samples were gently passed through a 10 μm Nitex screen, and particles larger than 10 μm were collected and resuspended into 5 liters of Millipore GS (0.22 μm) filtered seawater.

Photosynthetic activity, as dertermined by a ^{14}C tracer technique using the phytoplankton concentrates, remained constant for at least 6 hr. The samples from 10 m depth showed a sunny type in their light-photosynthsis curves (Fig. 16); a maximum photosynthetic rate of 5 to 10 μgC/μgchl.a/hr was attained at a light intensity of ca.500 $\mu E/m^2/sec$. On the other hand, the photosynthesis of the phytoplankton from 70 m was saturated at a lower light intensity of 100 $\mu E/m^2/sec$ (Fig. 16). However, the photoinhibition of the phytoplankton larger than 10 μm from 70 m was not so great as that observed with picophytoplankton (<10 μm) occurring in the same depth (M. Takahashi, unpublished). The high photosynthetic activity of picophytoplankton in the subsurface chlorophyll maximum layer has been reported (Takahashi and Bienfang, 1983). This was not the case with the phytoplankton larger than 10 μm. At low light intensities, where photoshnthetic rates increased almost linearly with increase in light intensity, no significant difference was observed in photosynthetic rate between the surface and subsurface phytoplankton of larger than 10 μm (Fig. 16).

Reference

Takahashi, M. and P.K. Bienfang (1983), Mar. Biol., **76**, 203-211.

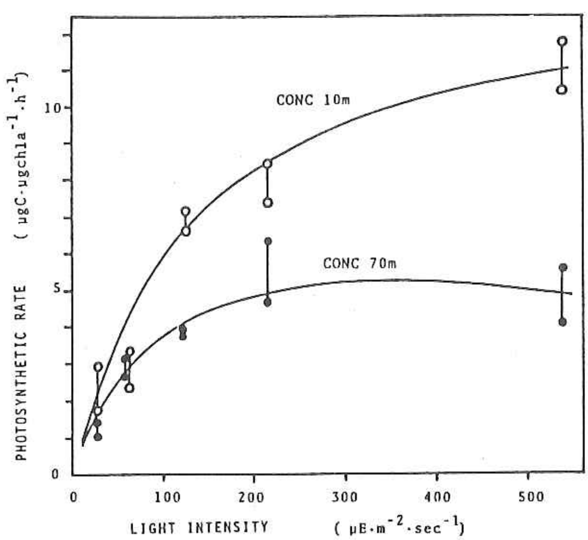

Fig. 16. Light-photosynthesis curves as obtained using phytoplankton populations taken from 10 and 70m at Station 27.

Carbon and nitrogen uptake measurements by the ^{15}N-^{13}C technique

J. Kanda, T. Saino and A. Hattori

Information on nitrogen uptake is useful for understanding regional features of primary productivity. In pelagic ecosystems, primary production is often limited by nitrogenous nutrients and can be characterized by the uptake rates of new and regenerated forms of nitrogen (Dugdale and Goering, 1967; Eppley and Petersen, 1979).

Using a quadrupole mass spectrometer (QMS), ^{13}C and ^{15}N content in organic matter can be measured simultaneously. The application of this technique makes it possible to measure the carbon and nitrogen uptake rates by primary producers in the same sample bottle. The procedure of the uptake measurement is similar to that of standard ^{14}C or ^{15}N tracer techniques. (1) Add the known amount of the tracers (^{13}C sodium carbonate and ^{15}N ammonium, nitrate or urea) to the incubation bottles containing sea water samples. (2) Incubate them for several hours at in situ temperature under natural or artificial light conditions. (3) Collect the particulate organic matter on a glass fibre filter. (4) Measure the amounts of organic carbon and nitrogen and the enrichements of ^{13}C and ^{15}N by QMS.

The following experiments were conducted during the cruise using this ^{15}N-^{13}C technique.

1. Regional characteristics of primary productivity.

Surface sea water samples were collected at 21 stations with plastic buckets or a submersible pump, and uptakes of carbon and nitrogen (ammonium, urea or nitrate) were measured. Sampling was carried out at about 7 o'clock in the morning to avoid the effect of diel variations. Incubation was conducted under illumination from daylight fluorescent lamps at 12,000 lux after an hour of preincubation.

2. Effects of environmental parameters on uptake kinetics

Effects of light intensity, nitrogenous nutrient concentration and incubation period on carbon and nitrogen uptake rates were examined at some stations.

3. Vertical profiles of carbon and nitrogen uptake

In situ or simulated in situ incubations were carried out at some stations.

References

Dugdale, R.C and J.J. Goering (1967), Limnol. Oceanogr., 12,196-206.

Eppley, R.W. and B.J. Peterson (1979), Nature, 282,677-680.

Particulate phosphorus in shallow waters of the Pacific Ocean

K. Miyata and A. Hattori

Chemostat culture experiments have shown that the growth rate of phytoplankton varies depending on the cellular content of the limiting nutrients rather than on their concentrations in ambient seawaters. In other words, chemical composition of phytoplankton provides information on their physiological state. However, the direct applicability of the results obtained in the laboratory experiments to assessment of the physiological state of natural populations of phytoplankton has been questioned, because particulate matter collected from seawater contains, besides living phytoplankton, detrital materials to a varying extent. Fortunately, the detrital portion of the particulate phosphorus is minor and can probably be neglected because of its rapid remineralization. This study, therefore, attempts to collect detailed information on intracellular distribution of phosphorus in natural populations of phytoplankton over extended areas of the eastern and central Pacific.

Water samples were collected from 11 depths (from the surface to 200 m) with van Dorn samplers or a submersible pump at 24 stations. Twenty liters each of the samples was filtered through a Whatman type F glass fibre filter. The filters with residues were kept frozen and brought back to the laboratory for analysis.

Particulate matter on the filters was homogenized, and a portion of the homogenate was used for the determination of total particulate phosphorus. The acid soluble fraction was obtained by extracting twice with 5% trichloroacetic acid or 5% perchloric acid at $0^{o}C$ for 30 or 15 min. This fraction was further divided into orthophosphate, and labile and nonlabile phosphates fractions by acid hydrolysis. Chemical species of the acid soluble phosphates were identified by ^{31}P nuclear magnetic resonance spectroscopy. The lipid fraction was obtained by successively extracting the residue with ethyl alcohol at $0^{o}C$ and twice with ethyl alcohol-ethyl ether (1:1) at $60^{o}C$ for 3 min. The residue was resuspended in ca. 5-10 ml of 0.12 N sulfuric acid containing 0.4% nitric acid, and boiled at $100^{o}C$ for 1 hr. By this treatment, polyphosphates were completely hydrolyzed but nucleic acids were only partially hydrolyzed (ca. 15%). Phosphorus in the residue was referred to as proteinous phosphorus. Phosphorus content in each fraction was determined colorimetrically as orthophosphate, after digestion with potassium persulfate or perchloric acid. The nucleic acids were also determined from light absorbance at 260 nm.

Uptake and regeneration of phosphate in the central North Pacific

K. Miyata, T. Saino and A. Hattori

Nutrient concentration in the euphotic layer of the central North Pacific is very low. However, recent data suggest that the primary productivity in this area is relatively high. Since the entrainment of nutrients from depth is strongly restricted by the presence of the thermocline, nutrients for phytoplankton growth must be supplied by regeneration or mineralization within the euphotic layer. In this study, we attempted to determine uptake and regeneration rates of phosphorus using an isotope dilution technique.

Water samples were collected from the surface with van Dorn samplers at 4 stations west of the Hawaiian Islands. The water samples were placed in 1-liter glass bottles and incubated together with 10 µCi of ^{32}P-phosphate at surface water temperature under the illumination of ca. 10,000 lux. At 4-hr intervals, 50-ml portions of the samples were withdrawn and filtered through a Whatman type F glass fibre filter. The filter was washed three times with 10 ml of filtered seawater. The radioactivity in particulate matter collected on the filter and in the filtrate was measured with a Rack Beta scintillation counter using the Cerenkov counting technique. The ortho-phosphate in the filtrate was converted to blue molibdate-phosphate complex, and the complex was extracted with 2,6-dimethyl-4-heptanone and determined spectrophotometrically. Assuming that the kinetic isotope effect is negligible for phosphate uptake by phytoplankton, and that the

^{32}P taken up is not regenerated during the experiment, uptake and regeneration rates were calculated from the changes in the $^{32}P/(^{32}P+^{31}P)$ ratio and in the concentrations of dissolved phosphate.

Denitrification in the oxygen-depleted layer of the eastern tropical Pacific Ocean

I. Koike and A. Hattori

Denitrification rates in the oxygen-depleted layers of the eastern tropical Pacific Ocean were determined by applying a ^{15}N tracer technique and an acetylene blockage technique. Seawater samples were collected from the oxygen depleted layers (O_2 concentration less than 0.25 ml/l) with 23-liter Niskin bottles at Stations 11, 11', 13, 16, 21 and 25 (Fig. 1). Immediately after sampling, the water samples were transferred, without exposure to air, into 17-ml vacuum-tight test tubes. After allowing ca.100 ml of water to overflow, the tubes were capped with rubber stoppers pierced with a hypodermic needle through which air bubbles were voided. One ml of acetylene was injected through the rubber stopper, then the tube was shaken vigorously, and incubated at near in situ temperature in the dark. At intervals (12-24 hr), 0.3 ml of 0.01 M $HgCl_2$ was introduced to the samples to stop biological reactions. Analysis of N_2O was carried out using a Shimadzu GC-3CMPF gas chromatograph fitted with a ^{63}Ni electron capture detector. The method of Cohen (1977) was used with a slight modification. Denitrification rate was estimated from evolution of N_2O.

Part of the water sample in the Niskin bottle was also placed in 1-liter glass bottles after allowing 2 liters of water to overflow. ^{15}N nitrate (99.6% ^{15}N) was added, and the samples were flushed with a 1:9 mixture of N_2 and Ar for 15 min to reduce partial pressure of N_2. The seawater samples were then gently dispensed into 50-ml vacuum tight flasks with rubber stoppers using a syphon, and incubated under the same conditions as described above. Emphasis was placed on the effects of concentrations of nitrate and electron donors (glucose and pepton) to examine the rate limiting step of in situ denitrification occurring in the oxygen-depleted waters of the eastern tropical Pacific. ^{15}N content was determined by the method of Koike et al. (1978).

References

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Epipelagic net-plankton abundance

A. Taniguchi

A set of paired Norpac nets, 45 cm in diameter and 180 cm long, was hauled vertically from 150 m to the surface. The nettings of XX 13 (0.1 mm in mesh openings) and GG 54 (0.3 mm) were used. Duplicate hauls were carried out at 11 stations and single hauls at 5 stations. Water volume filtered through the nets was determined with flow-meters mounted on mouth rings of the nets. Wet weight and their taxomonic composition determined on board the ship are given in Table 13.

Taxonomic compositions of phytoplankton are expressed as % cell numbers to the total collected with the XX 13 net. Relative dominances of zooplankton taxa, which were analysed with the GG 54 samples, are shown on the basis of numbers and weight of individuals. Portions of the samples were subjected to chemical analysis which was carried out by the colleagues at the Faculty of Fisheries, Hokkaido University.

Table 13. Data on plankton samplings*

Sta.	Date	Time	WO	Angle	Net-XX13 WVF	Net-XX13 WW	Major Constituents	Net-GG54 WVF	Net-GG54 WW	Major Constituents
5'	17 Dec.	0654 0720	150 150	0 0	31.68 32.48	25.25 ND	Thalassiothrix delicatula(40.3).Trichodesmium(35.1) Rhizosolenia hebetata(7.8:most R.hebetata were infected with Richelia intercellularis) Other diatoms(9.1) Dinoflagellata(6.5:dominated with Ceratium spp.) Dictyocha fibula(1.3)	29.57 32.19	7.78 ND	Radiolaria(ccc) Copepoda (cc) Euphausiacea(rr) Polychaeta(rrr)
7	19 Dec.	1939 1958	150 152	4 10	24.14 39.02	24.86 ND	Rh.hebetata(27.3:most were infected with R.intercellularis) Chaetoceros messanensis(27.3) Th'x delicatula(6.6) Chaetoceros seychellarum(4.1) Ch.tetrastichon(4.1) Trichodesmium(3.3) Diatoms(14.9) Dinoflagellata(9.9) Dictyocha(2.5)	24.50 38.71	11.43 ND	Copepoda(cc) Euphausiacea(cc) Chaetognatha(c) Amphipoda(rrr)
9	21 Dec.	1006 1027	154 152	13 9	25.39 20.86	18.91 ND	Rh.hebetata(40.6 most were infected with R.intercellularis) Nitzschia spp.(10.3) Ch.messanensis(9.4) Ch.tetrastichon(6.7) Ceratium extensum(3.1) Ch.peruvianum(2.7) Rh.stolterfothii(2.7) Cer.tenue(2.7) Diatoms(13.4) Dinoflagellata(7.6) Trichodesmium(0.4)	25.59 23.49	2.74 ND	Copepoda(ccc) Chaetogratha(rr)
11	24 Dec.	0149 0201	158 156	18 16	29.25 27.30	30.43 ND	Th'x delicatula(18.0) Cer.inflexum(9.8) Planktoniella sol(9.8) Amphisolenia bidentata(8.2) Ornithocercus splendidus(6.6) Ch. densus(4.9) Cer.extensum(4.9) Pyrocystis fusiformis(4.9) Diatoms (9.8) Dinoflagellata(23.0) No cyanophytes.	29.27 28.59	16.40 ND	Copepoda(ccc) Chaetognatha(c) Polychaeta(c) Euphausiacea(r) Siphonophora(rr)
13	26 Dec.	1024	151	8	23.11	98.66	Ch.coarctatus(21.2) Planktoniella sol(17.0) Pyrocystis noctiluca(10.3) Guinardia flaccida(7.9) Amph.bidentata(4.2) Th'x delicatula(4.2) Cer.macroceros(3.0) Rh.hebetata(3.0) with R.intracellularis Cer.extensum(2.4) Cer.tenue(2.4) Diatoms(5.5) Dinoflagellata(18.8)	25.76	16.30	Copepoda(cccc) Chaetognatha(c) Amphipoda(rr) Decapoda(rr)
16	4 Jan.	0858 0909	152 150	9 2	24.21 24.29	77.24 ND	Ch.coarctatus(15.7) Pyr.noctiluca(12.2) Plank.sol (7.8) Ceratocorys horrida(7.0) Cer.inflexum(5.2) Cer.tenue(5.2) Am.bidentata(3.5) Ch.sychellarum(3.5) Pyr.fusiformis(3.5) Rh.hebetata(3.5) Diatoms(16.5) Dinoflagellata(18.8) No cyanophytes	24.73 24.22	47.31 ND	Copepoda(ccc) Chaetognatha(c) Amphipoda(r)
17	5 Jan.	2342	172	32	36.48	ND	ND	35.71	ND	ND
18	7 Jan.	0828	161	30	58.93	ND	ND	61.07	ND	ND
19	8 Jan.	0500	170	28	30.86	ND	ND	30.90	ND	ND

20	9 Jan.	0040 0059	152 160	9 19	26.16 31.33	66.13 ND	Plank.sol(24.5) Pyr.noctiluca(10.3) Ch.seychellarum (7.4) Th'x delicatula(6.9) Rh.hebetata(5.9: R.intercellularis was hardly found) Rh.styliformis (5.9) Ch.coarctatus(4.9) Cer.palmatum(2.9) G.flaccida (2.9) C'rys horrida(2.5) Rh.robusta(2.5) Diatoms(5.9) Dinoflagellata(17.6)	28.08 31.55	26.71 ND	Copepoda(ccc) Chaetognatha(cc) Euphausiacea(c) Amphipoda(rr)
21	9 Jan.	2111 2122	152 152	10 9	25.61 27.89	60.52 ND	Plank.sol(29.2) Pyr.noctiluca(13.1) Ch.seychellarum (8.5) Ch.coarctatus(6.9) Rh.styliformis(6.2) G.flaccida(3.1) Th'x delicatula(3.1) Cer.macroceros (2.3) Cer.palmatum(2.3) Nitzschia spp.(2.3) Rh.alata (2.3) Diatoms(3.1) Dinofl.(10.0) Dic.fibula(0.5)	26.29 26.85	52.87 ND	Copep.(cc) Chaetog.(c) Amphip.(r)Euph.(r) Siphonophora(rr) Decap.(rrr)
22	12 Jan.	0252 0304	151 168	5 23	23.90 25.35	68.62 ND	Rh.styliformis(22.6) Ch.seychellarum(12.9) Plank.sol(11.3) Rh.hebetata(11.3:R.intercellularis was hardly found) Pyr.noctiluca(4.8) Bacteriastrum elongatum(3.2) Cer.macroceros(3.2) Cer. palmatum (3.2) Trichodesmium(3.2) Diatom(6.5) Dinofl(17.7)	24.99 27.06	40.42 ND	Copep.(cc) Chaetog.(c) Euph.(c) Siphonoph(rr) Amphip(rr) Decap(rr) Fich.larvae(rrrr)
23	13 Jan.	0723 0733	152 155	9 14	27.09 24.49	22.89 ND	Plank.sol(19.8) Ch.coarctatus(15.4) Trichodesmium (9.9) Pyr.noctiluca(8.8) Rh.hebetata(5.5:without R.intercellularis) Bact.elongatum(4.4) Cer.macroceros (3.3) Ch.peruvanum(3.3) Cer.sp.(3.3) Diatoms(11.0) Dinofl.(12.1)	26.40 27.74	15.53 ND	Copep.(ccc) Chaetog.(c) Hydromedusa(r) Euph.(rrr) Fish larvae(rrrr)
24	14 Jan.	1725 1737	155 156	14 16	27.82 27.97	57.51 ND	Plank.sol(36.4) Pyr.noctiluca(21.2) Trichodesmium (13.6) Coscinodiscus rothii(4.5) Asteromphalus hookeri(3.0) Cer.trichoceros(3.0) Pyr.fusiformis(3.0) Diatoms(7.6) Dinoflagellata(7.6)	29.78 30.37	39.62 ND	Copep.(cccc) Chaetog.(rr) Euph(rr) Amphip.(rr) Hydromedusae(rrrr)
25	15 Jan.	1816 1829	151 151	8 6	22.88 21.63	71.24 ND	Plank.sol(17.9) Cos.rothii(9.0) Pyr.noctiluca(7.5) Cer.trichoceros(6.0) Trichodesmium(6.0) Ch.seychellarum(4.5) Rh.hebetata(4.5) Cer.macroceros (3.0) Ch.coarctatus(3.0) Cos.gigas(3.0) Th'x delicatula (3.0) Nitzschia spp.(3.0) Oomithocercus serratus(3.0) Pyr.fusiformis(3.0) Pyr.lunula(3.0) Diatoms(4.5) Dinofl(16.4)	25.73 24.22	51.30 ND	Copep.(ccc) Chaetog(c) Euph.(c) Amphip.(r) Pteropoda(large)(rrr)
27	2 Feb.	1631	150	5	24.53	ND	ND	26.62	ND	ND

* Abbreviations: ND, not determined; WA, wire angle; WO, wire out; WVF, water volume filtered; and WW, wet weight. Relative abundances of phytoplankton are shown in % composition. Relative abundances of zooplankton taxa in number are shown: ccc, highly dominant; cc, dominant; c, common; r, rare; and rr, very rare. First and second abundant taxa in weight are marked full and broken underlines, respectively.

Microzooplankton samplings

A. Taniguchi

One-liter samples of seawater were collected with Niskin or van Dorn bottles from 11 depths shallower than 300 m at 11 stations (see Table 13) and preserved after addition of 10 ml of neutral formalin. After standing for several days, plankton were concentrated ca. 100-fold by gently withdrawing the supernatant with a siphon and then examined under an inverted microscope. Volumes and numbers of the microzooplankton and their taxonomic composition will be investigated.

Mendocino seismic experiment

Y. Tomoda, S. Nagumo, J. Kasahara, S. Koresawa,
H. Kinoshita, T. Asanuma and H. Amemiya

Objectives

The Mendocino fracture zone is the largest fracture zone in the North Pacific, extending from off California-Oregon boarder towards the west to the south of Hess Rise in a distance more than 2,000 nautical miles. The ages of the plates on both sides of the fracture zone are different, about 8 MYBP(Miocene) in the north and about 33 MYBP(Oligocene) in the south at this experimental sites. Gravity anomalies crossing the fracture zone are very large. GEOSAT has recently revealed a large geoid anomaly along the Mendocino fracture zone, suggesting a remarkable lithospheric anomaly beneath the fracture zone.

Seismic refraction studies were conducted in 1960's by Scripps people and revealed differences of the crustal structures between two sides of the fracture zone. Combination of the gravity anomaly and the crustal structure has shown that difference of lithosphere structure exists between the two sides of the fracture zone.

Tomoda had such an idea that, if there exists isostatic anomaly, the fracture zone may convert to subduction zone in future. In order to confirm this unique hypothesis, a geophysical cruise was planned and formed the first leg of the present curise. Emphasis was placed on: (1) to obtain gravity, magnetic, and bathymetric profiles, and (2) to obtain crustal structure profiles crossing the Mendocino fracture zone.

Seismic experiments

Two seismic refraction lines were planned and accomplished, one in the north, the other in the south of the fracture zone (Fig. 17). For each line, four OBSH's (ocean bottom seismometer with hydrophone) were deployed in a linear array, 10 nautical miles apart each other, covering a distance of 30 nautical miles, perpendicularly to the fracture zone.

Large volume airgun shootings (20 liters, 110-130 kg/cm) were run along the OBSH array. The 3.5 kHz profile was taken simultaneously during airgun shootings. Sonobuoys were deployed at the end of the OBSH array.

The station data are listed in Table 14. We spent about 67 hr station time for completing two seismic lines. The weather conditions were very good, and the experiments were successful except one OBSH (Station S3), which remained upon the seafloor in spite of proper response to the acoustic release command. It might be captured by heavy mud due to rough bottom topography.

Results

Recorded sections have been prepared. Some of them are presented in Figs. 18-23. Remarkable features which are seen on the record sections are as follows:

(1) The refractions of P wave from the layer 3 continue to appear up to the distance of about 50 km.

(2) The large amplitudes of refracted P wave at the distance of about 30 km will probably be the reflections from Moho-discontinuity.

(3) The refractions of P to S converted wave are seen up to the distance of about 50 km.

(4) The penetration capability of the large volume airgun is very high.

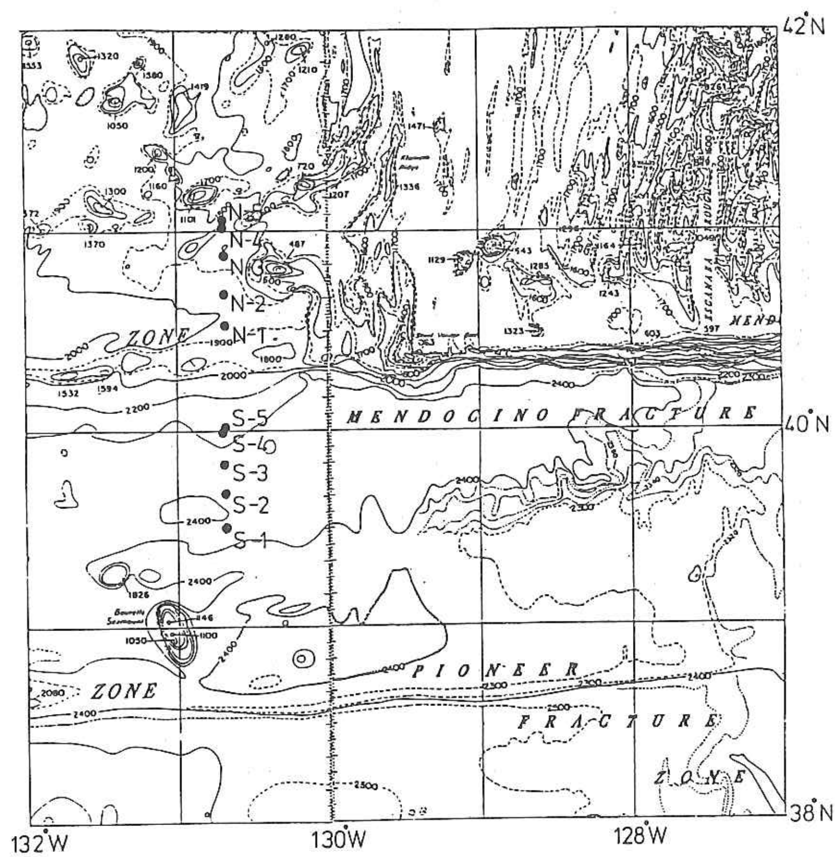


Fig. 17. OBSH(ocean bottom seismometer with hydrophone) and OBH (ocean bottom hydrophone) stations crossing the Mendocino fracture zone.

Table 14. Locations, depths, and times of deployment and retrieval of OBSH in the Mendocino fracture zone.

Station	Deployment					Retrieval					Instruments deployed
	Lat.*	Long.*	Depth	Time***		Lat.**	Long.**	Depth	Time***		
N-1	40 31.9'N	130 39.8'W	3,680m	0146	7/12/82	40 31.5'N	130 39.7'W	3,700m	1905	7/12/82	OBSH(ERI)
N-2	40 41.9	130 40.5	3,720	0301	7/12/82	40 42.0	130 40.3	3,830	2209	7/12/82	OBSH(CU)
N-3	40 53.1	130 39.9	3,600	0418	7/12/82	40 53.0	130 40.2	3,620	0231	8/12/82	OBSH(CU)
N-4	41 01.9	130 40.0	3,300	0522	7/12/82	41 02.0	130 40.1	3,250	0545	8/12/82	OBSH(ERI)
N-5	41 02.9 02.5	130 39.9 40.5	3,260 3,100	0552 0610	7/12/82	41 01.7	130 41.2		0508	8/12/82	SB,OBH
S-1	39 29.9	130 39.8	4,530	1400	8/12/82	39 29.6	130 39.6		0644	9/12/82	OBSH(ERI)
S-2	39 40.1	130 40.1	4,510	1512	8/12/82	39 39.8	130 39.9	4,530	0704	10/12/82	OBSH(CU)
S-3	39 49.9	130 39.7	4,530	1620	8/12/82	continue		4,500			OBSH(CU)
S-4	40 00.0	130 40.1	4,530	1730	8/12/82	39 59.9	130 39.9	4,550	1243	9/12/82	OBSH(ERI)
S-5	40 01.1 00.5	130 40.6 40.8	4,480 4,480	1800 1814	8/12/82 8/12/82	40 00.8	130 40.0	4,500	1046	9/12/82	SB,OBH

* Position determined by Loran C and corrected by NNSS data.

** Surfaced position estimated from the ship position, bearing and range.

*** Japan Standard Time.

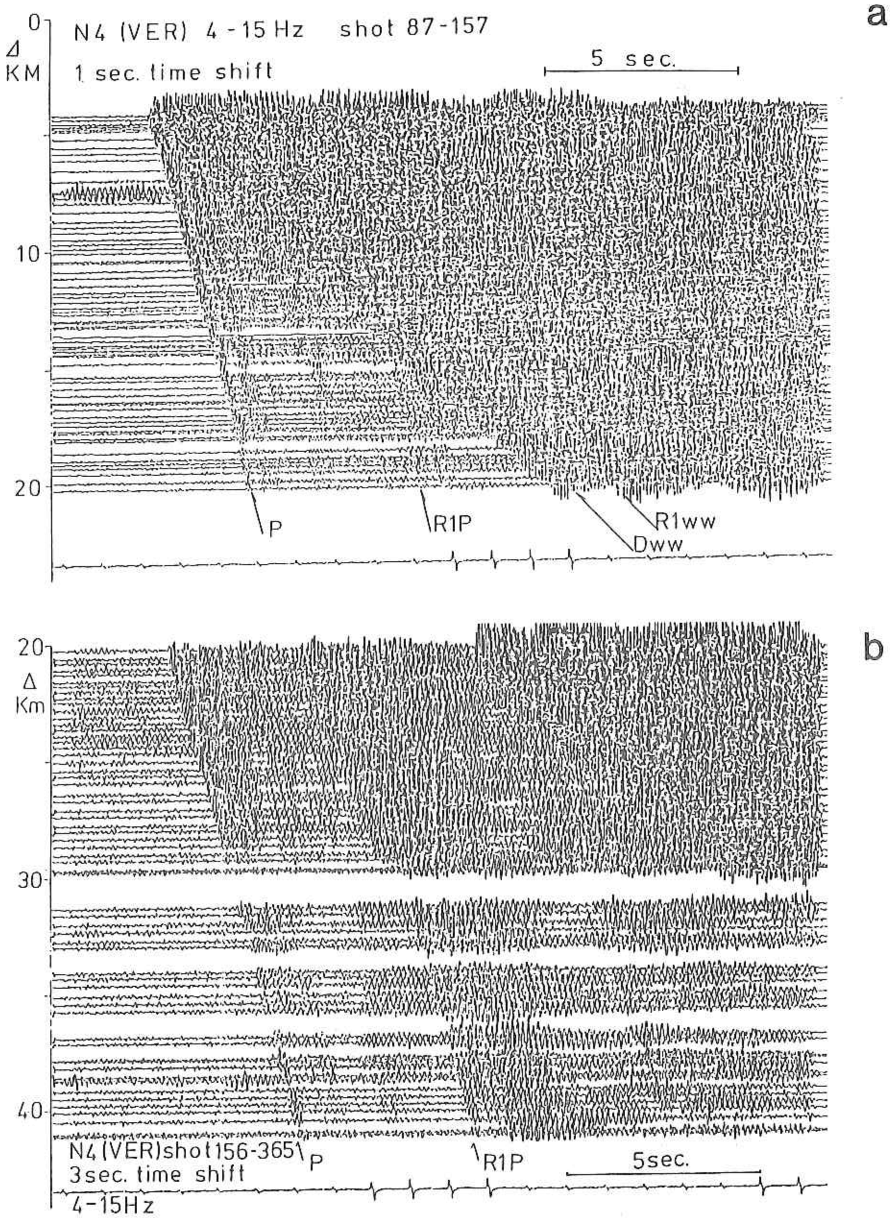


Fig. 18. OBSH distance sections of vertical component at Station N4. P: refracted compressional wave, RIP: refracted compressional wave which was reflected at the sea surface, Dww: direct water wave, and Rlww: reflected water wave.

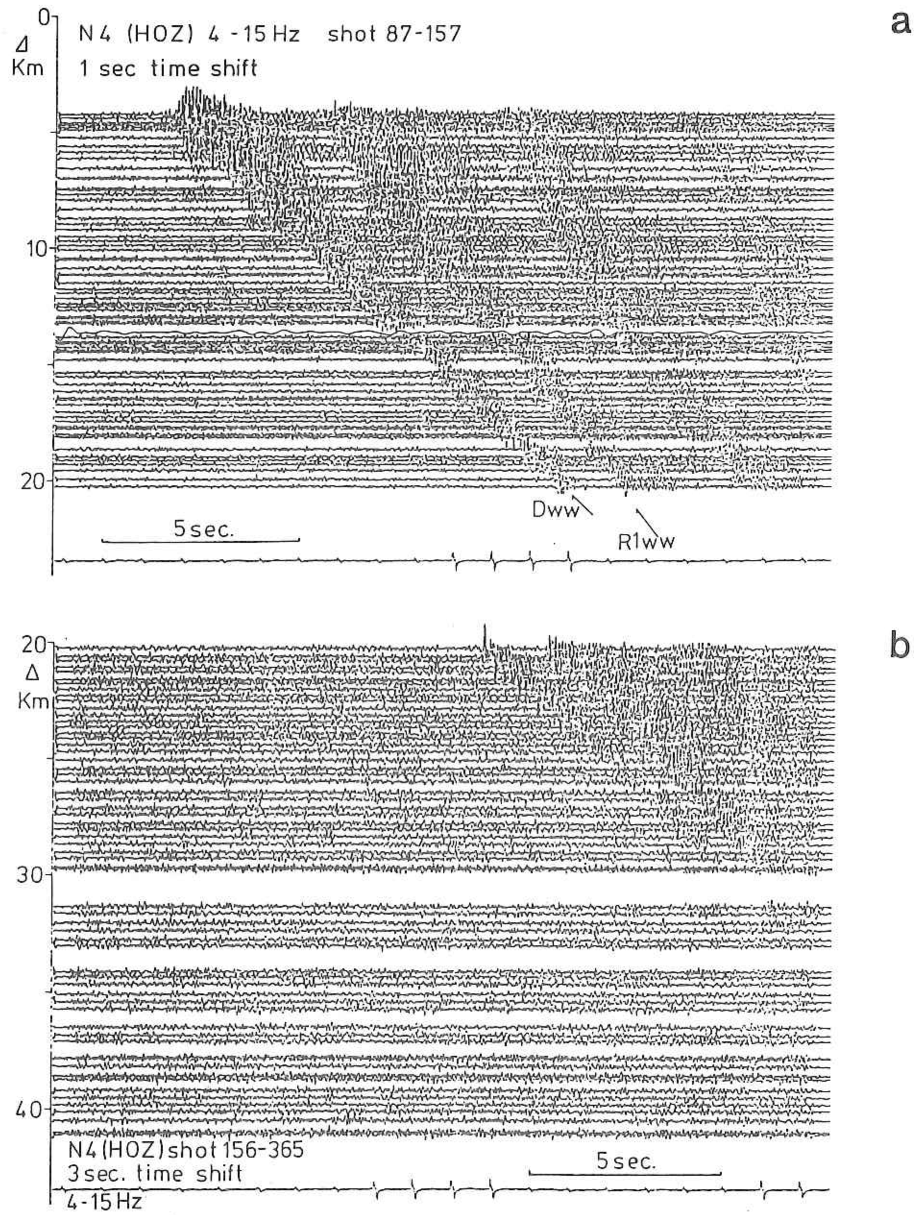
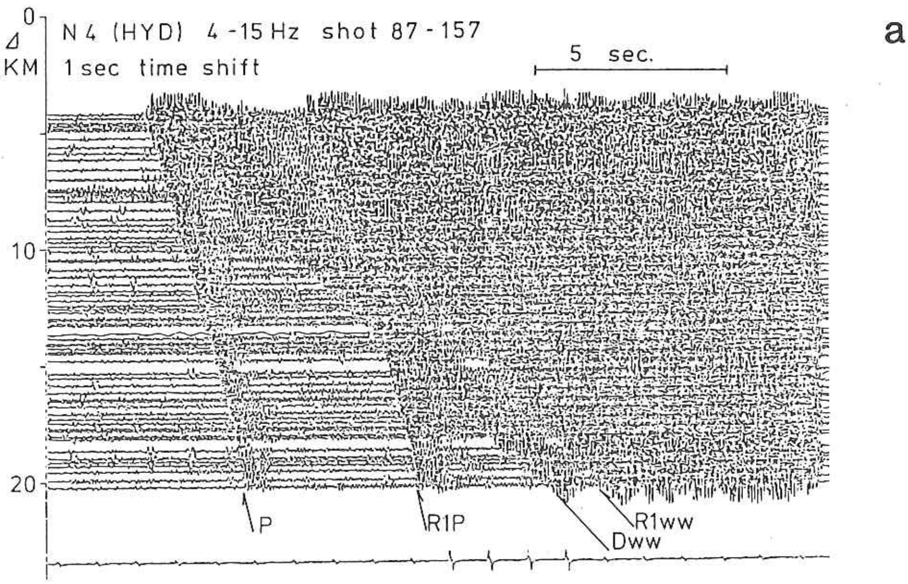


Fig. 19. OBSH distance sections of horizontal component at Station N4. S(shear) wave are faintly seen.



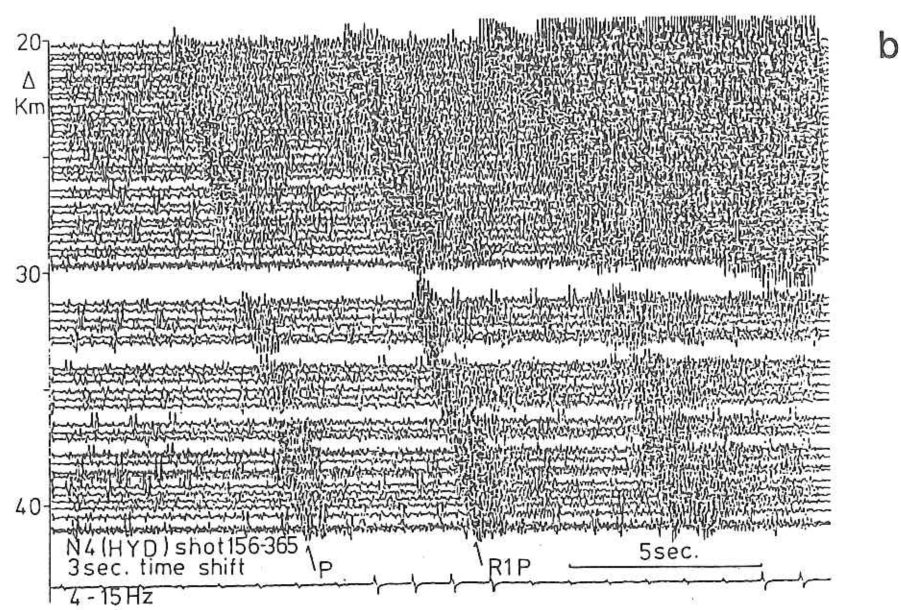


Fig. 20. OBSH distance sections of hydrophone at Station N4. RIP phases are stronger than P phases.

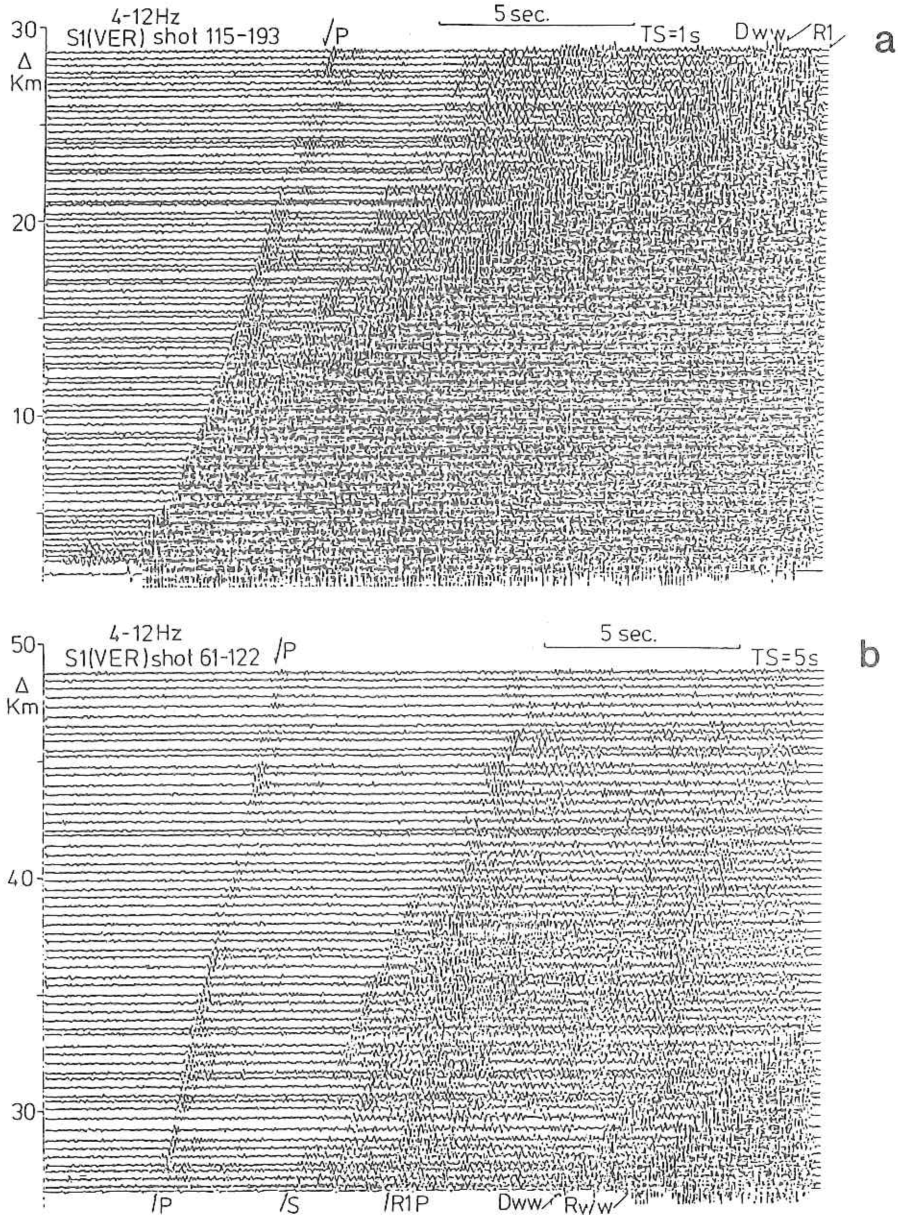


Fig. 21. OBSH distance sections of vertical component at Station S1. P waves are seen even at distance of 48 km. S waves are also seen. Notice the different distance scales between figures a and b also in Figs. 22 and 23.

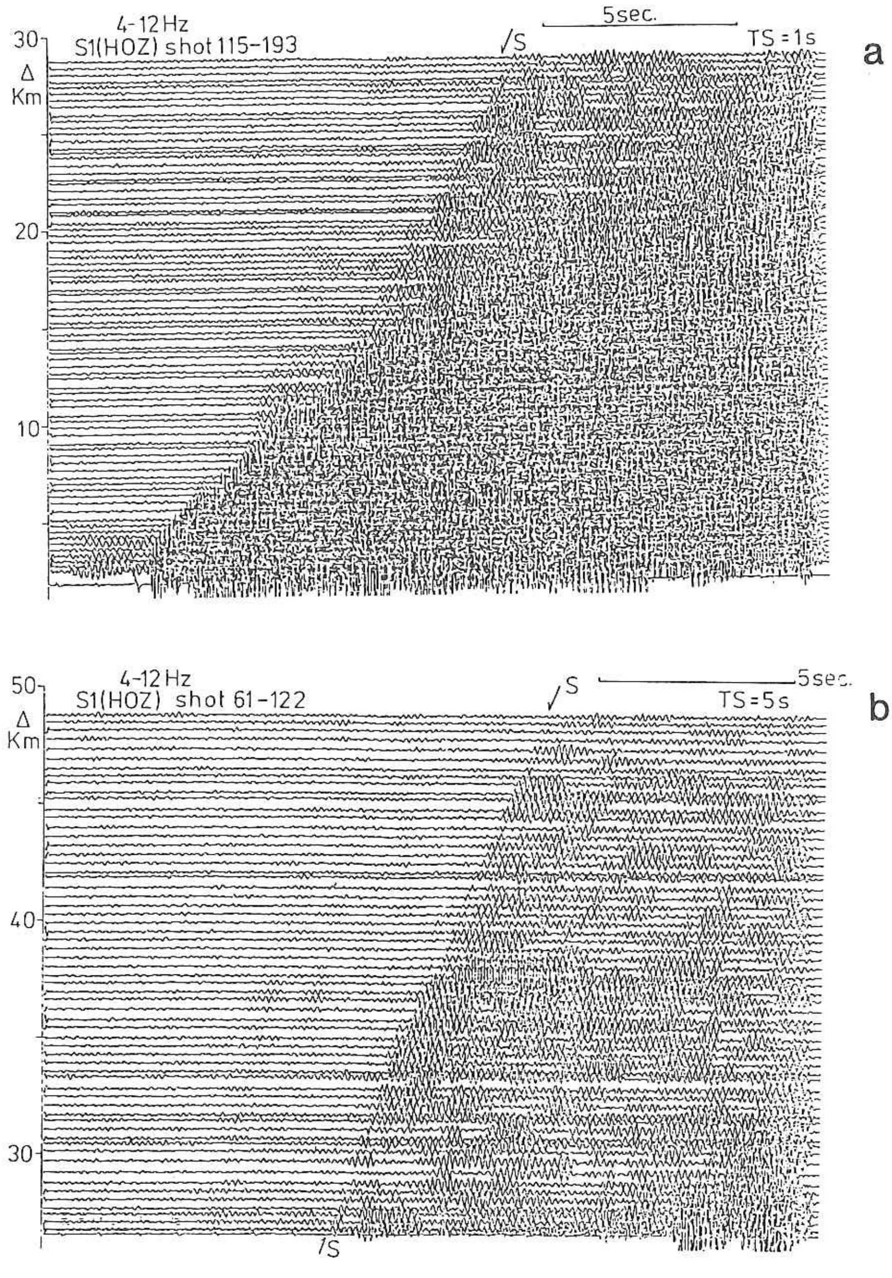


Fig. 22. OBSH distance sections of hydrophone at Station N4. RIP phases are stronger than P phases.

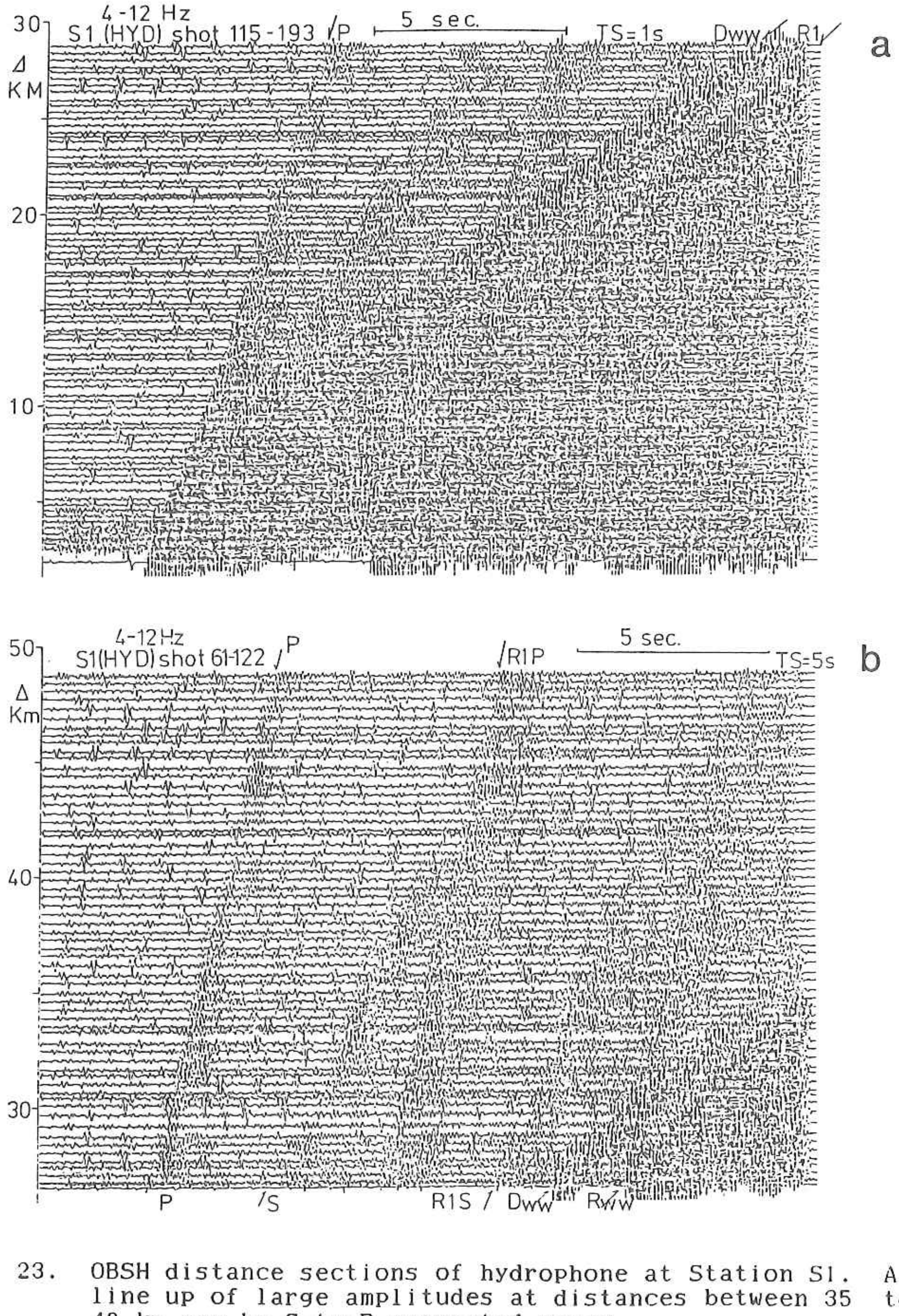


Fig. 23. OBSH distance sections of hydrophone at Station S1. A line up of large amplitudes at distances between 35 to 40 km may be S-to-P converted waves.

Seismic structural study across the Mendocino fracture zone off the west coast of US along 130W longitude by use of a large volume single airgun: collection of basic field data

H. Kinoshita, T. Asanuma and H. Amemiya

Abstract

Some basic data of the seismic structural study are presented. Paste up of the time sections of seismic records after data processing are not completed yet.

Method of survey operations

Four sets of ocean bottom seismic receivers were deployed along each single survey line. Two survey lines are located on both the northern and southern sides of the Mendocino fracture zone which is clearly marked by a large escarpment accompanying a sharp change in the bottom profile (ca. 700 m) within 20 nautical miles along latitude 130°40'W along a longitude 130W. Some field data as to the locations of the deployments and recovery of the instruments are given elsewhere (Tomoda et al., this volume). Of four recording instruments along each single survey track line, a pair of seismometers including a single hydrophone receiver channel are deployed nearer to the end points of shooting and the other pair of hydrophone receivers are located in between the seismometer pair (Tomoda et al, this volume). After placements of four sets of the pop-up type ocean bottom seismometer and hydrophone systems (denoted as OBSH hereafter) the vessel steamed down to one end of the survey track line and slacked the airgun over the board along with a single channel short hydrophone streamer cable which picks up shooting impulses of the airgun. After the shooting and timing devices are all set ready, the vessel is run along the fixed track line with a fixed steaming velocity of 5 knots relative to the sea water. The water depth of the airgun is controlled by a length of stainless steel cable wire connected to a large volume float towed about 50 m after the running vessel.

The basic configuration and characteristics of the shooting system are as follows:

Airgun	
Water depth	25 m (presumed)
Type	Pneumatic trigger
Volume of pneumatic chamber	20 liters
Mean high pressure	100 atmospheric pressures
low (trigger) pressure	14
Mean shooting interval	120 sec
Towing speed	5 knots
Dominant frequency of source	18 Hz
Wave form of shots	Wave packet
Dead weight	900 kg
Hydrophone streamer	
Length	5 m
Sonic elements	Dielectric, 6 pairs
Water depth	(no deeper than 30 m)
Distance from the gun	ca. 30 m (estimated)

The time base used throughout the present survey was the Japan Standard Time which was measured and monitored through the precision clock device (MCXO-019). Shooting instances are picked up through the hydrophone streamer towed after the vessel and recorded by a digital timer-puncher-printer which has been calibrated with the precision clock. JJY and WWVH signals when receivable throughout the present cruise. The shooting sound signal from the hydrophone streamer is reformed compatible to TTL level impulse and the time recording device is triggered by an onset of the impulse. The reforming of the sound signal is aimed to start as soon the shooting sound is received as possible. Addition of the delay in the electronics device (maximum 1/18 Hz * 1/4 period = ca. 0.015 sec) and the delay caused by spacing between the gun and the pick-up (estimated value = 30 m/1500 m/sec = ca. 0.02 sec) gives a rough figure in the time delay of the shooting instances ca. 0.035 sec which is equivalent to 52.5 m shift of the sound source off from the seismic receiver on the sea floor. This estimated delay time is assumed to be constant throughout the duration of the present seismic survey and has to be taken in account in the further data analyses.

Shot instance recorded on the digital timing device can be corrected afterwards based upon JJY time base calibration. However, the long term (3 months) drift of the master clock (MCXO-019) is found to be negligibly small. This allows us to utilize the MCXO-019 as a semistandard absolute clock source for our further data processing of the present structural study.

Water depth along the survey line is recorded both through a 3.5 kHz echo sounder and a 13 kHz precision depth recorder (PDR) as well. Sound velocity of the sea water is assumed to be 1,500 m/sec regardless of water depth and temperature and the delay in the 3.5 kHz sounder is calibrated by opening the receiving circuit gate instantly after ultrasonic shooting. The apparent delay in the 3.5 kHz sounder (75 m) is subtracted from the original depth record after digitizing the water depth record every 2 min and reconstructed by a microcomputer-plotter system.

Basic data

1. Seismic survey track lines (see Tomoda et al., this volume)

2. Water depth along track lines

Of all the depth records (3.5 kHz and 13 kHz), the 3.5 kHz depth records almost all along track lines from N4 to S1 show an abrupt change in water depth across the Mendocino escarpment (see around an attached arrow). No correction to the ship velocity is applied to the time axis (abscissa in Fig. 24).

3. List of shooting instances

List of all the available shooting time are given in Table 15 (northern track) and Table 16 (southern track). From left hand of the list, the original paper tape punched data (shot number, day, hour, minute, second and centisecond) are supplied. On the right hand of the list, the shooting instances are corrected upon precision timer and rearranged so as to be easily legible and to be delay in the present timing device (+0.035 sec) is not applied to the values listed here.

Edition of the field data

All the seismic data recorded are dubbed to open reel type FM magnetic tape recorder cutting off some unnecessary part of the record for the present structural studies. The records are digitized through an analog to digital conversion system (MELCOM 70, Model 30, Earthquake Research Institute, Univ. Tokyo) with an application of high cut anti-aliase filters (over 150 Hz). The sampling rate of the digital output is fixed to 300 samples per second (re 1 sec of Time Signal of the OBSH receiver). AD converted data are dumped to a normal digital magnetic tape with following specifications, i.e.,

Non-Label	
Record form	Variable span
Logical record length	20480
Blocksize	20480
Word length	Half (2 bytes)

and

Word type	Integer (i.e. INTEGER*2).

Examples of the time record section

An examples of time record sections of the seismic signal are shown in Fig. 25. There are some lack of output figure as noticed by seemingly uneven shooting traces. This is caused by an incompleteness of the editor algorism and the debugging procedure have well been accomplished until now (when we are writing this report). The editor programme revised since then is providing data without any leakage of the precious field data.

A more detailed structural analysis along the present track lines is under way and the results will be presented in a later article.

Table 15. Original and MCXO-019 precision master clock device corrected shot instances along the track lines N1 through N5.

DATA SET (SHIKIHI5.DATA) DOES NOT HAVE A LINE NUMBER; NONUM ASSUMED
EDIT
SHOT TIME DATA
(KH82-5, MENDOCINO FRACTURE ZONE, NORTHERN PART)
(SITES N1 THROUGH N5)
**** COEFFICIENTS OF SHOT TIME CORRECTION (JJY)
A = 0.146199D-06 B = -.263214D-04

SHOT NUMBER,ORIGINAL SHOT TIME,CORRECTED TIME

1	7 743 30.04	70743. 30.13
2	7 745 6.13	70745. 6.22
3	7 746 37.52	70746. 37.61
4	7 748 10.16	70748. 10.25
5	7 749 35.39	70749. 35.48
6	7 751 1.11	70751. 1.20
7	7 752 23.09	70752. 23.18
8	7 753 46.10	70753. 46.19
9	7 755 3.46	70755. 3.55
10	7 756 18.32	70756. 18.41
11	7 757 29.09	70757. 29.18
12	7 758 36.21	70758. 36.30
13	7 759 40.20	70759. 40.29
14	7 8 0 43.22	70800. 43.31
15	7 8 1 44.12	70801. 44.21
16	7 8 2 42.53	70802. 42.62
17	7 8 3 39.48	70803. 39.57
18	7 8 4 34.76	70804. 34.85
19	7 8 5 29.46	70805. 29.55
20	7 8 7 15.67	70807. 15.76
21	7 8 8 27.79	70808. 27.88
22	7 8 9 30.80	70809. 30.89
23	7 810 26.52	70810. 26.61
24	7 812 17.31	70812. 17.40
25	7 814 20.18	70814. 20.27
26	7 816 29.11	70816. 29.20
27	7 818 28.54	70818. 28.63
28	7 820 19.87	70820. 19.96
29	7 822 7.70	70822. 7.79
30	7 823 49.31	70823. 49.40
31	7 825 31.53	70825. 31.62
32	7 827 5.95	70827. 6.04
33	7 828 37.43	70828. 37.52
34	7 830 4.96	70830. 5.05
35	7 831 34.12	70831. 34.21
36	7 833 9.57	70833. 9.66
37	7 834 37.93	70834. 38.02
38	7 836 1.08	70836. 1.17
39	7 837 22.74	70837. 22.83
40	7 839 25.05	70839. 25.14
41	7 841 17.96	70841. 18.05
42	7 842 32.43	70842. 32.52
43	7 844 25.22	70844. 25.31
44	7 846 2.66	70846. 2.75
45	7 847 16.81	70847. 16.90
46	7 848 33.09	70848. 33.18
47	7 849 38.93	70849. 39.02
48	7 850 41.13	70850. 41.22
49	7 851 43.05	70851. 43.14
50	7 852 42.30	70852. 42.39
51	7 853 41.25	70853. 41.34
52	7 854 37.52	70854. 37.61
53	7 855 32.45	70855. 32.54
54	7 856 26.29	70856. 26.38
55	7 857 23.24	70857. 23.33
56	7 858 15.64	70858. 15.73
57	7 859 6.26	70859. 6.35
58	7 9 0 43.46	70900. 43.55
59	7 9 1 30.04	70901. 30.13
60	7 9 2 15.52	70902. 15.61
61	7 9 2 59.40	70902. 59.49
62	7 9 3 52.59	70903. 52.68
63	7 9 4 43.00	70904. 43.09
64	7 9 5 30.61	70905. 30.70
65	7 9 6 17.27	70906. 17.36
66	7 9 7 2.48	70907. 2.57
67	7 9 8 30.73	70908. 30.82
68	7 9 9 13.90	70909. 13.99
69	7 9 9 55.41	70909. 55.50
70	7 910 36.41	70910. 36.50
71	7 911 16.70	70911. 16.79
72	7 911 56.16	70911. 56.25
73	7 913 15.78	70913. 15.87
74	7 914 23.02	70914. 23.11
75	7 915 27.45	70915. 27.54
76	7 916 31.86	70916. 31.95
77	7 917 34.06	70917. 34.15
78	7 918 32.86	70918. 32.95
79	7 919 30.69	70919. 30.78
80	7 920 39.99	70920. 40.08
81	7 921 46.63	70921. 46.72
82	7 922 49.43	70922. 49.52
83	7 923 50.69	70923. 50.78
84	7 924 48.85	70924. 48.94
85	7 925 53.79	70925. 53.88
86	7 927 4.34	70927. 4.43
87	7 928 34.93	70928. 35.02
88	7 930 15.63	70930. 15.72
89	7 931 48.02	70931. 48.11
90	7 933 18.13	70933. 18.22
91	7 935 11.52	70935. 11.61
92	7 937 32.62	70937. 32.71
93	7 939 42.76	70939. 42.85
94	7 941 40.70	70941. 40.79
95	7 943 34.65	70943. 34.74
96	7 945 28.33	70945. 28.42
97	7 947 11.43	70947. 11.52
98	7 948 47.87	70948. 47.96
99	7 950 20.15	70950. 20.24
100	7 951 49.57	70951. 49.66
101	7 953 15.23	70953. 15.32
102	7 955 15.43	70955. 15.52
103	7 957 2.18	70957. 2.27
104	7 958 44.03	70958. 44.12
105	710 0 17.59	71000. 17.68
106	710 1 51.82	71001. 51.91
107	710 2 57.45	71002. 57.54
108	710 4 32.07	71004. 32.16
109	710 5 57.90	71005. 57.99
110	710 7 22.68	71007. 22.77
111	710 8 42.22	71008. 42.31
112	71010 1.04	71010. 1.13
113	71011 22.48	71011. 22.57
114	71013 59.96	71013. 0.05
115	71014 26.90	71014. 26.99
116	71015 44.98	71015. 45.07
117	71017 3.77	71017. 3.86
118	71018 17.02	71018. 17.11
119	71019 27.55	71019. 27.64
120	71020 35.14	71020. 35.23
121	71021 41.76	71021. 41.85
122	71022 45.92	71022. 46.01
123	71023 48.12	71023. 48.21
124	71024 48.47	71024. 48.56
125	71025 49.12	71025. 49.21
126	71026 52.90	71026. 52.99
127	71028 5.27	71028. 5.36
128	71029 15.02	71029. 15.11
129	71030 21.88	71030. 21.97
130	71031 27.49	71031. 27.58
131	71033 36.69	71033. 36.78
132	71035 19.67	71035. 19.76
133	71036 55.51	71036. 55.60
134	71038 39.46	71038. 39.55
135	71040 15.93	71040. 16.02
136	71041 48.58	71041. 48.67
137	71043 16.24	71043. 16.33
138	71044 41.94	71044. 42.03
139	71046 3.30	71046. 3.39
140	71047 21.59	71047. 21.68
141	71048 39.25	71048. 39.34
142	71050 2.42	71050. 2.51

Table 15. Continued.

143	71051 13.87	71051. 13.96
144	71052 23.71	71052. 23.80
145	71053 30.70	71053. 30.79
146	71055 16.47	71055. 16.56
147	71057 12.53	71057. 12.62
148	71058 58.47	71058. 58.56
149	711 0 38.02	71100. 38.11
150	711 2 12.51	71102. 12.60
151	711 3 43.94	71103. 44.03
152	711 5 18.49	71105. 18.58
153	711 6 48.84	71106. 48.93
154	711 8 46.86	71108. 46.95
155	71110 29.74	71110. 29.83
156	71112 8.45	71112. 8.54
157	71113 42.52	71113. 42.61
158	71115 12.65	71115. 12.74
159	71116 40.94	71116. 41.03
160	71118 4.82	71118. 4.91
161	71119 26.64	71119. 26.73
162	71121 23.95	71121. 24.04
163	71123 19.18	71123. 19.27
164	71125 10.34	71125. 10.43
165	71126 51.20	71126. 51.29
166	71128 28.15	71128. 28.24
167	71130 0.56	71130. 0.65
168	71131 30.82	71131. 30.91
169	71132 57.24	71132. 57.33
170	71135 5.70	71135. 5.79
171	71137 13.10	71137. 13.19
172	71139 15.01	71139. 15.10
173	71141 12.76	71141. 12.85
174	71143 19.16	71143. 19.25
175	71145 19.59	71145. 19.68
176	71147 19.31	71147. 19.40
177	71149 18.44	71149. 18.53
178	71151 17.56	71151. 17.65
179	71153 23.90	71153. 23.99
180	71155 24.35	71155. 24.44
181	71157 23.03	71157. 23.12
182	71159 28.92	71159. 29.01
183	712 1 30.68	71201. 30.77
184	712 3 29.91	71203. 30.00
185	712 5 30.74	71205. 30.83
186	712 7 30.99	71207. 31.08
187	71215 46.73	71215. 46.82
188	71217 52.74	71217. 52.83
189	71219 56.37	71219. 56.46
190	71222 59.95	71222. 0.04
191	71224 2.58	71224. 2.67
192	71226 13.52	71226. 13.61
193	71232 24.68	71232. 24.77
194	71234 35.98	71234. 36.07
195	71236 41.32	71236. 41.41
196	71238 47.73	71238. 47.82
197	71240 52.21	71240. 52.30
198	71243 2.25	71243. 2.34
199	71247 12.03	71247. 12.12
200	71249 19.45	71249. 19.54
201	71251 22.68	71251. 22.77
202	71253 32.10	71253. 32.19
203	71255 39.71	71255. 39.80
204	71257 51.38	71257. 51.47
205	71259 57.40	71259. 57.49
206	713 2 3.30	71302. 3.39
207	713 4 12.69	71304. 12.78
208	713 6 20.68	71306. 20.77
209	713 8 28.38	71308. 28.47
210	71310 42.49	71310. 42.58
211	71312 50.18	71312. 50.27
212	71315 8.19	71315. 8.28
213	71317 14.53	71317. 14.62
214	71317 46.56	71317. 46.65
215	71319 17.83	71319. 17.92
216	71321 29.35	71321. 29.44
217	71323 35.61	71323. 35.70
218	71325 43.57	71325. 43.66
219	71327 58.92	71327. 59.01
220	71330 14.88	71330. 14.97
221	71332 23.44	71332. 23.53
222	71334 35.19	71334. 35.28
223	71336 46.38	71336. 46.47
224	71338 55.00	71338. 55.09
225	71341 6.06	71341. 6.15
226	71343 14.90	71343. 14.99
227	71345 27.82	71345. 27.91
228	71347 45.78	71347. 45.87
229	71349 57.26	71349. 57.35
230	71352 11.47	71352. 11.56
231	71354 22.34	71354. 22.43
232	71356 32.04	71356. 32.13
233	71358 42.39	71358. 42.48
234	714 0 55.71	71400. 55.80
235	714 3 18.65	71403. 18.74
236	714 5 32.35	71405. 32.44
237	714 7 44.06	71407. 44.15
238	71410 0.87	71410. 0.96
239	71412 15.07	71412. 15.16
240	71414 27.33	71414. 27.42
241	71416 41.74	71416. 41.83
242	71419 4.52	71419. 4.61
243	71421 24.83	71421. 24.92
244	71423 38.72	71423. 38.81
245	71425 52.45	71425. 52.54
246	71428 6.79	71428. 6.88
247	71430 24.54	71430. 24.63
248	71432 37.50	71432. 37.59
249	71434 56.88	71434. 56.97
250	71437 23.54	71437. 23.63
251	71439 39.81	71439. 39.90
252	71444 12.26	71444. 12.35
253	71446 26.64	71446. 26.73
254	71448 47.62	71448. 47.71
255	71451 10.59	71451. 10.68
256	71453 29.82	71453. 29.91
257	71455 51.71	71455. 51.80
258	71458 9.50	71458. 9.59
259	715 0 24.86	71500. 24.95
260	715 2 42.13	71502. 42.22
261	715 5 3.64	71505. 3.73
262	715 7 26.97	71507. 27.06
263	715 9 45.09	71509. 45.18
264	71512 12.09	71512. 12.18
265	71514 30.24	71514. 30.33
266	71516 47.17	71516. 47.26
267	71519 8.34	71519. 8.43
268	71521 31.51	71521. 31.60
269	71523 59.06	71523. 59.15
270	71526 20.08	71526. 20.17
271	71528 44.45	71528. 44.54
272	71531 9.73	71531. 9.82
273	71533 29.15	71533. 29.24
274	71535 51.80	71535. 51.89
275	71538 21.84	71538. 21.93
276	71540 42.50	71540. 42.59

END OF DATA

Table 16. Original and MCXO-019 precision master clock device corrected shot instances along the track lines S1 through S5.

DATA SET (SHIKIS15.DATA) DOES NOT HAVE A LINE NUMBER; NONUM ASSUMED
EDIT

SHOT TIME DATA
(KH82-5, MENDOCINO FRACTURE ZONE, SOUTHERN PART)
(SITES · S1 THROUGH S5)
**** COEFFICIENTS OF SHOT TIME CORRECTION (JJY)
A = 0.1461990-06 B = -.2632140-04

SHOT NO.	ORIGINAL SHOT TIME	CORRECTED TIME
1	81937 55.86	81937. 55.97
2	81940 32.96	81940. 33.07
3	81943 8.30	81943. 8.41
4	81945 36.49	81945. 36.60
5	81948 1.43	81948. 1.54
6	81950 32.24	81950. 32.35
7	81953 4.94	81953. 5.05
8	81955 33.86	81955. 33.97
9	81958 0.55	81958. 0.66
10	820 0 31.43	82000. 31.54
11	820 2 52.49	82002. 52.60
12	820 5 20.80	82005. 20.91
13	820 7 53.80	82007. 53.91
14	82010 23.02	82010. 23.13
15	82012 50.27	82012. 50.38
16	82015 19.47	82015. 19.58
17	82017 45.69	82017. 45.80
18	82019 49.60	82019. 49.71
19	82021 57.06	82021. 57.17
20	82024 9.16	82024. 9.27
21	82026 19.32	82026. 19.43
22	82028 26.34	82028. 26.45
23	82030 35.19	82030. 35.30
24	82032 45.62	82032. 45.73
25	82033 59.54	82033. 59.65
26	82034 13.81	82034. 13.92
27	82034 26.24	82034. 26.35
28	82034 27.62	82034. 27.73
29	82034 28.75	82034. 28.86
30	82034 43.55	82034. 43.66
31	82034 59.74	82034. 59.85
32	82037 8.69	82037. 8.80
33	82039 28.05	82039. 28.16
34	82041 37.34	82041. 37.45
35	82043 49.59	82043. 49.70
36	82046 3.17	82046. 3.28
37	82048 16.20	82048. 16.31
38	82050 36.25	82050. 36.36
39	82053 1.88	82053. 1.99
40	82055 26.30	82055. 26.41
41	82057 45.75	82057. 45.86
42	821 0 8.95	82100. 9.06

43	821 2 28.94	82102. 29.05
44	821 4 45.53	82104. 45.64
45	821 7 0.90	82107. 1.01
46	821 9 25.17	82109. 25.28
47	82111 52.45	82111. 52.56
48	82114 10.35	82114. 10.46
49	82116 27.57	82116. 27.68
50	82118 42.00	82118. 42.11
51	82121 0.43	82121. 0.54
52	82123 18.45	82123. 18.56
53	82125 34.67	82125. 34.78
54	82128 1.50	82128. 1.61
55	82130 20.73	82130. 20.84
56	82132 42.15	82132. 42.26
57	82135 4.93	82135. 5.04
58	82137 28.96	82137. 29.07
59	82139 52.49	82139. 52.60
60	82142 11.04	82142. 11.15
61	82144 39.64	82144. 39.75
62	82146 55.78	82146. 55.89
63	82149 9.86	82149. 9.97
64	82151 24.51	82151. 24.62
65	82153 44.72	82153. 44.83
66	82156 2.92	82156. 3.03
67	82158 18.82	82158. 18.93
68	822 0 43.87	82200. 43.98
69	822 3 10.37	82203. 10.48
70	822 5 27.81	82205. 27.92
71	822 7 42.20	82207. 42.31
72	82210 0.13	82210. 0.24
73	82212 15.83	82212. 15.94
74	82214 33.91	82214. 34.02
75	82216 56.05	82216. 56.16
76	82219 16.85	82219. 16.96
77	82221 38.88	82221. 38.99
78	82223 57.09	82223. 57.20
79	82226 16.01	82226. 16.12
80	82228 34.05	82228. 34.16
81	82230 51.53	82230. 51.64
82	82233 16.34	82233. 16.45
83	82235 34.74	82235. 34.85
84	82237 58.45	82237. 58.56
85	82240 10.41	82240. 10.52
86	82242 36.56	82242. 36.67
87	82244 54.77	82244. 54.88
88	82247 16.59	82247. 16.70
89	82249 42.40	82249. 42.51
90	82252 0.50	82252. 0.61
91	82254 17.84	82254. 17.95
92	82256 42.47	82256. 42.58

93	82259 0.62	82259. 0.73
94	823 1 21.26	82301. 21.37
95	823 3 49.56	82303. 49.67
96	823 6 8.55	82306. 8.66
97	823 8 24.77	82308. 24.88
98	82310 47.29	82310. 47.40
99	82313 9.96	82313. 10.07
100	82315 20.81	82315. 20.92
101	82317 50.50	82317. 50.61
102	82320 15.52	82320. 15.63
103	82322 36.76	82322. 36.87
104	82324 52.92	82324. 53.03
105	82327 13.80	82327. 13.91
106	82329 34.32	82329. 34.43
107	82331 56.93	82331. 57.04
108	82334 20.71	82334. 20.82
109	82336 44.99	82336. 45.10
110	82339 3.94	82339. 4.05
111	82341 20.75	82341. 20.86
112	82343 41.33	82343. 41.44
113	82345 58.31	82345. 58.42
114	82348 21.43	82348. 21.54
115	82350 37.97	82350. 38.08
116	82353 5.39	82353. 5.50
117	82355 24.67	82355. 24.78
118	82357 42.88	82357. 42.99
119	9 0 0 3.18	90000. 3.29
120	9 0 2 20.13	90002. 20.24
121	9 0 4 39.22	90004. 39.33
122	9 0 6 58.68	90006. 58.79
123	9 0 9 20.81	90009. 20.92
124	9 011 37.72	90011. 37.83
125	9 013 51.43	90013. 51.54
126	9 016 6.55	90016. 6.66
127	9 018 24.70	90018. 24.81
128	9 020 39.68	90020. 39.79
129	9 023 2.20	90023. 2.31
130	9 025 27.38	90025. 27.49
131	9 027 44.63	90027. 44.74
132	9 030 0.90	90030. 1.01
133	9 032 16.81	90032. 16.92
134	9 034 38.96	90034. 39.07
135	9 037 1.38	90037. 1.49
136	9 039 22.87	90039. 22.98
137	9 041 53.66	90041. 53.77
138	9 044 12.75	90044. 12.86
139	9 046 32.26	90046. 32.37
140	9 048 51.37	90048. 51.48
141	9 051 11.63	90051. 11.74
142	9 053 34.93	90053. 35.04

Table 16. Continued.

143	9 056 1.96	90056. 2.07
144	9 058 26.55	90058. 26.66
145	9 1 0 44.94	90100. 45.05
146	9 1 3 6.45	90103. 6.56
147	9 1 5 32.16	90105. 32.27
148	9 1 7 52.97	90107. 53.08
149	9 110 14.90	90110. 15.01
150	9 112 45.24	90112. 45.35
151	9 115 11.78	90115. 11.89
152	9 117 30.30	90117. 30.41
153	9 119 48.29	90119. 48.40
154	9 122 10.95	90122. 11.06
155	9 124 29.48	90124. 29.59
156	9 126 50.43	90126. 50.54
157	9 129 16.74	90129. 16.85
158	9 131 35.89	90131. 36.00
159	9 134 4.06	90134. 4.17
160	9 136 29.61	90136. 29.72
161	9 138 50.71	90138. 50.82
162	9 141 12.83	90141. 12.94
163	9 143 35.45	90143. 35.56
164	9 146 2.43	90146. 2.54
165	9 148 21.61	90148. 21.72
166	9 150 49.35	90150. 49.46
167	9 153 10.27	90153. 10.38
168	9 155 32.97	90155. 33.08
169	9 157 55.50	90157. 55.61
170	9 2 0 20.34	90200. 20.45
171	9 2 2 40.95	90202. 41.06
172	9 2 5 4.17	90205. 4.28
173	9 2 7 30.92	90207. 31.03
174	9 2 9 54.15	90209. 54.26
175	9 212 19.65	90212. 19.76
176	9 214 40.91	90214. 41.02
177	9 217 8.92	90217. 9.03
178	9 219 30.80	90219. 30.91
179	9 221 53.13	90221. 53.24
180	9 224 13.10	90224. 13.21
181	9 226 40.27	90226. 40.38
182	9 228 59.63	90228. 59.74
183	9 231 17.29	90231. 17.40
184	9 233 45.67	90233. 45.78
185	9 236 11.70	90236. 11.81
186	9 238 33.65	90238. 33.76
187	9 240 57.41	90240. 57.52
188	9 243 26.77	90243. 26.88
189	9 245 47.07	90245. 47.18
190	9 248 15.61	90248. 15.72
191	9 250 35.49	90250. 35.60
192	9 252 53.85	90252. 53.96
193	9 255 13.67	90255. 13.78
194	9 257 31.66	90257. 31.77
195	9 259 49.09	90259. 49.20
196	9 3 2 20.92	90302. 21.03
197	9 3 4 54.17	90304. 54.28
198	9 3 7 18.03	90307. 18.14
199	9 3 9 40.74	90309. 40.85
200	9 312 6.94	90312. 7.05
201	9 314 28.53	90314. 28.64
202	9 316 53.43	90316. 53.54
203	9 319 22.71	90319. 22.82
204	9 321 49.48	90321. 49.59
205	9 324 12.47	90324. 12.58
206	9 326 33.62	90326. 33.73
207	9 328 54.91	90328. 55.02
208	9 331 13.73	90331. 13.84
209	9 332 35.27	90332. 35.38
210	9 332 36.91	90332. 37.02
211	9 332 39.13	90332. 39.24

END OF DATA

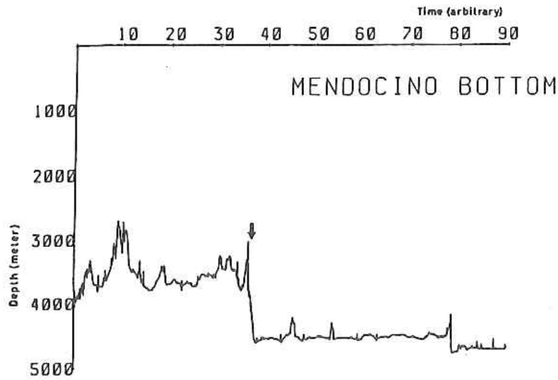


Fig. 24. PDR record throughout the seismic survey track lines. No corrections to the ship tracking traces are applied.

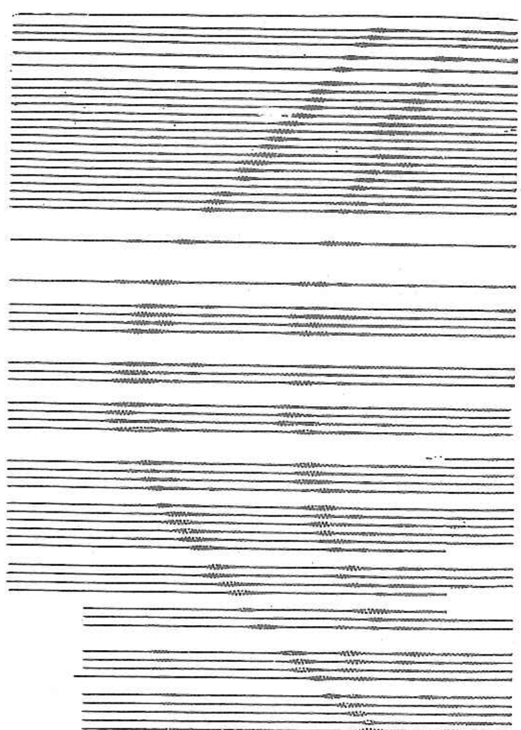


Fig. 25. An example of the paste up of time record sections of the sound wave arrivals in the close range of OBSH.

Clarion ocean bottom seismometer (OBS) array

S. Nagumo, J. Kasahara, S. Koresawa and H. Amemiya

Objectives

The objectives of the Clarion OBS array are to observe natural earthquakes. It has an expeditional nature because the seismicity hitherto reported in this region is none.

The array was deployed at about 2 x 10^3 km away to the west from the Middle-America trench, which is an active zone along the coast of Mexico, and is about 1 x 10^3 km away to the west from the Orozco fracture zone where seismicity is active. The OBS array is located in the west frank of the East Pacific Rise near the junction of the Clarion fracture zone and the Mathematician seamounts, the latter are the abandoned spreading center of the Pacific-Cocos plate boundary in 19 MYBP (Mammerickx) while the former is one of the large fracture zones in the East Pacific Rise off Mexico and the Middle-America trench.

One major interest of this observation is the attenuation characteristics of seismic waves under the East Pacific Rise, where an anomalous low velocity zone in the upper mantle has been reported by surface wave studies. The other interest is whether the region is really aseismic with respect to the micro-earthquakes which are generally not detected by land stations.

Field operation

Five OBS's were deployed as shown in Fig. 26 forming an array. They were deployed in 23-24 December 1982, and were successfully retrieved in 16-18 January 1983. The period of observation upon the seafloor was 24-27 days. The station data are given in Table

17.

The bottom topography was very rough. The 3.5 kHz profile was taken during deployment cruising. The deployment of OBS was done exactly at the update time of NNSS. This operation gave us high accuracy of OBS position. This region is not covered by Loran C.

The operation was very smooth both in deployment and retrieval. The surfacing speed of OBS was from 31 to 37 m/min. It surfaced at distances of about 400-1,000 m from the ship. Such navigation was achieved by re-occuping the position of the deployment at the time of the predicted surfacing.

Results

Remarkable results so far obtained are as follows:

(1) The local seismicity was extremely low. Only two earthquakes were detected during one month observation period. However, the existence of a few local earthquakes is significant. Because it will indicate that the region is neither completely aseismic nor tectonically stable.

(2) During the observation period one earthquake of M=4.4 occurred off the coast of Mexico (29 December 1982, 21H35M UTC) at a distance of about 1,300 km from the station. However, neither P nor S phase of this earthquake was detected on the OBS records. The only phases recorded were T-phases. This means that the attenuation of body waves under the East Pacific Rise is very large.

(3) Many T-phases were recorded. During the observation period, an earthquake swarm activity took place near Miyake-jima island, south off Honshu, Japan, starting from 28 December 1982 to the

middle of January 1983. The T-phases from many of these earthquakes were recorded by this OBS array. The lowest magnitude of the eathquake whose T-phase was detected was 4.0. Since the epicentral distance is more than 1×10^3 km, this means that the transmission efficiency crossing the North Pacific is very excellent. Two predominant frequencies were observed in T-phases; they were 6-7 Hz and 2-3 Hz. The duration of these T-phases were 1-2 min.

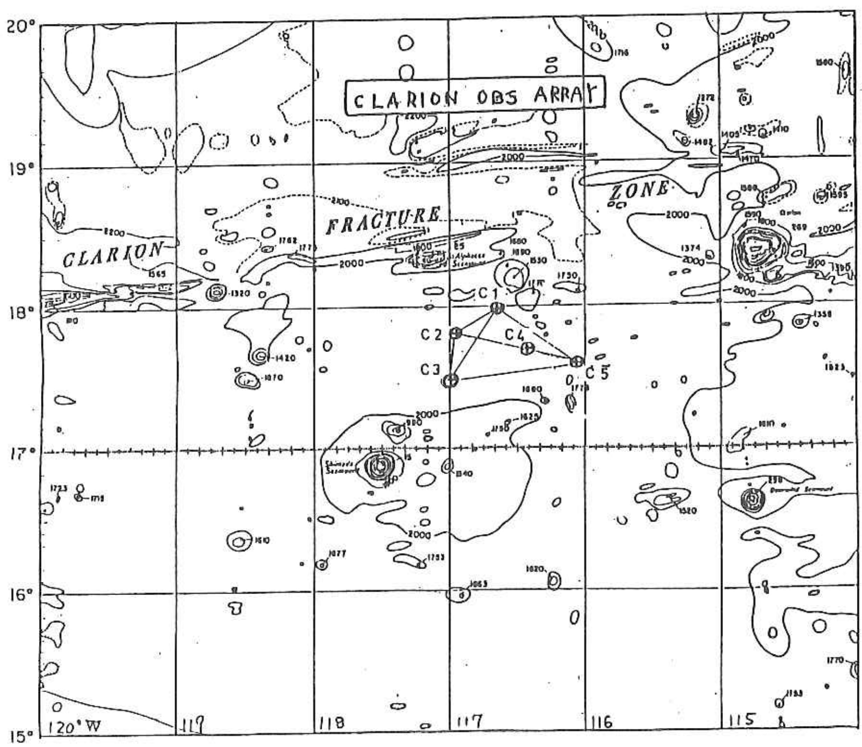


Fig. 26. Location of the Clarion OBS array.

Table 17. Location, depths and dates of deployment and retrieval of OBS near the Clarion fructure zone.

Station	Deployment				Retrieval				Instruments deployed
	Lat.*	Long.*	Depth	Time***	Lat.**	Long.**	Depth	Time***	
C-1	17 59.0	116 39.4	3,900	0720 24/12/82	17 59.0	116 39.5	3,870	2202 19/ 1/83	OBS
C-2	17 49.14	116 57.09	4,020	0923 24/12/82	17 49.2	116 57.0	3,980	1748 19/ 1/83	OBS
C-3	17 29.42	117 00.55	4,020	1122 24/12/82	17 29.3	117 00.7	3,920	2310 17/ 1/83	OBS
C-4	17 41.55	116 26.29	3,930	1057 25/12/82	17 41.6	116 26.1	3,840	1803 17/ 1/83	OBS
C-5	17 35.78	116 04.07	3,820	1337 25/12/82	17 36.9	116 03.8	3,800	1407 17/ 1/83	OBS

* Position determined by NNSS.

** Surfaced position estimated from the ship position, bearing and range.

*** Japan Standard Time.

Shipboard measurement of the three components of the geomagnetic field by STCM along the Mendocino fracture zone

N. Isezaki

During the KH-82-5 cruise, the three components of the geomagnetic field were measured by a shipboard three component magnetometer (STCM). Since the final data of the sea depths and the ship positions were not available, tentative analysis was made based on the ship positions estimated from Loran C data. Interesting features of the three component anomalies observed north of the Mendocino fracture zone are reported here.

The observed field was corrected for magnetic field produced by a ship body. However, estimate of the latter was not precise because of large pitching and rolling. Therefore, the three components may include error as large as 50 nT. The accuracy of measurement can be seen in comparing the calculated total intensity, T $(=\sqrt{X^2 + Y^2 + Z^2})$, with the total intensity, P, measured by a proton magnetometer. Here, X, Y and Z are the northward, eastward, and downward intensities of the magnetic field, respectively.

Results

1. Track A-B

The track A-B is located north of the Mendocino fracture zone and east of the Surveyor fracture zone (Fig. 27). The almost whole part of A-B is in the Cretaceous magnetic quiet zone. At the eastern edge of the track near B, the magnetic anomaly lineations (anomaly no. 32B) begin toward the east.

Figure 28 shows X, Y, Z, T and P along the track (the abscissa is marked every 2 hr). X component decreases from A (24XXX nT) to B, while the other components increase. P is plotted with the shift of 200 nT below T for the comparison with T. If T is completely parallel to P, measurement is thouht to be perfect. The difference between them should be the error in measurement. The parallelism of T and P is good enough for the analysis of the marine magnetic anomalies at the present time.

The magnetic quiet zone is defined by the zone where the total intensity is very smooth. As shown in Fig. 28, T and P are very smooth in the quiet zone. X and Z are also very smooth. However, Y is significantly not smooth. Y is usually so small compared with X and Z that the change in Y does not have any large effect on T as do X and Z. This finding indicates that the magnetic quiet zone is actually not quiet.

2. Track C-D

The track C-D runs between the Surveyor and Mendocino fracture zones and between the anomaly no. 23 and no. 13 (Fig. 27).

Figure 29 shows X, Y, Z, T and P along the track C-D. P is not shifted like in Fig. 28. In this figure, we can see the important characteristics of the magnetic anomaly lineations as follows: (1) X is smooth compared with other components, and (2) Y and Z change almost out of phase. If the two dimensional magnetic source lies north to south, it is easily proved mathematically that there is no anomaly in X, and that the anomalies in Y and Z are out of phase. Figure 29 shows this phenomena almost completely.

However, there are significant small anomalies in X from which we could refine the structure of the magnetic source beneath the ocean floor.

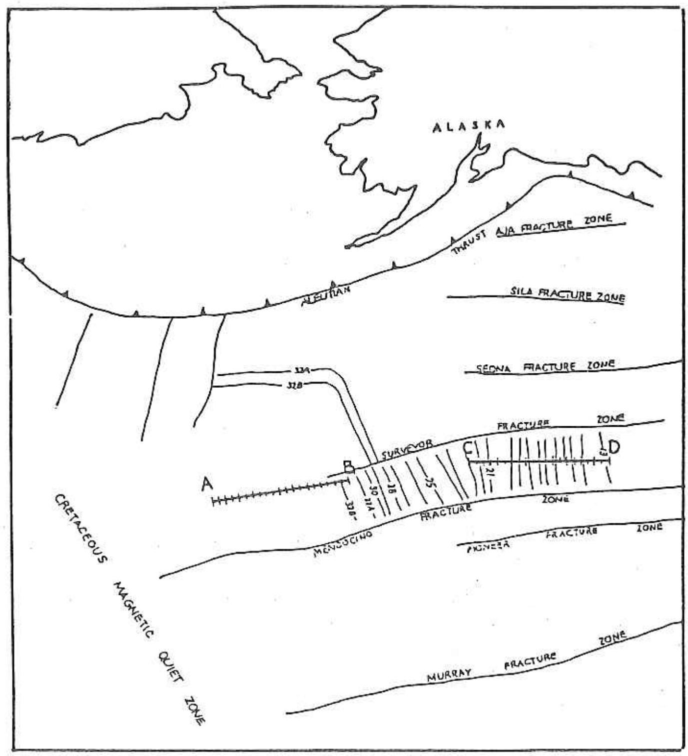


Fig. 27. The ship track during the STCM observation.

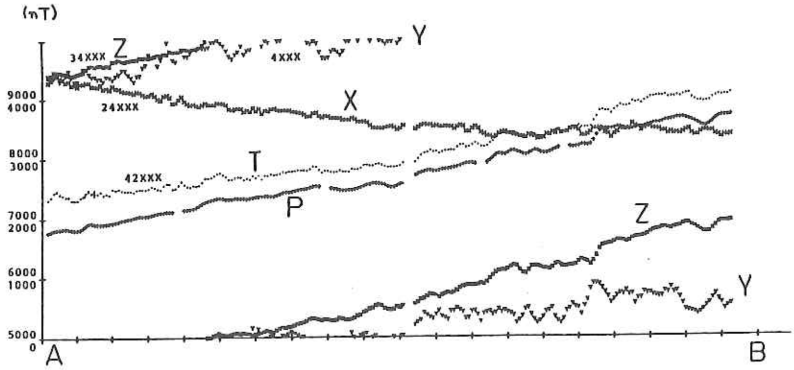


Fig. 28. Variations of the three components (X.Y.Z) of geomagnetic field, and calculated and measured total intensities (T and P) along the track A-B.

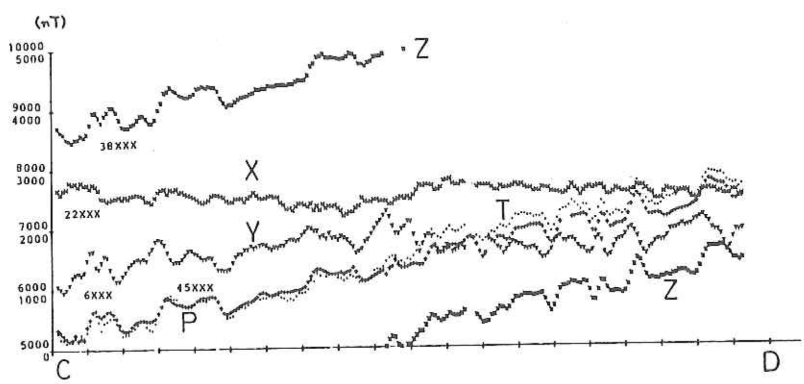


Fig. 29. Variations of the three components (X.Y.Z) of geomagnetic field, and calculated and measured total intensities (T and P) along the track C-D.