Preliminary Report
of
The Hakuho Maru Cruise KH-86-3

June 3 - August 1, 1986
The Bering Sea and
the northern North Pacific

Ocean Research Institute
University of Tokyo
1986

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By
The Scientic Members of the Expeditions
Edited by
Akihiko HATTORI
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Preface

This volume compiles the oceanographic data obtained during the KH-86-3 cruise of the R/V Hakuho Maru from 3 June to 1 August 1986. Included also are summaries of the individual research work carried out by the scientists aboard.

During the last decade, several cooperative oceanographic research efforts have been made in the Bering Sea and the northern North Pacific aimed at the advancement of our understanding of physical, chemical and biological processes, and of their interaction in the most productive sea area in the world. Within the framework of this cooperative research, two Hakuho Maru cruises were conducted in 1975 and 1978. The present cruise formed the third phase of this integrated research program, and had close connections with the ISHTAR program sponsored by the Office of Polar Program, the National Science Foundation, USA. The data obtained in the earlier cruises appear in the reports of the Hakuho Maru Cruises KH-75-4 and KH-78-3, Ocean Research Institute, University of Tokyo, 1977 and 1979.

On behalf of the scientists aboard, I wish to express my sincere gratitude to Captain I. Tadama, the other officers and the crew members of the Hakuho Maru for their cooperation throughout the cruise, and to Mr. Toshisuke Nakai and Ms. Masae Otsu for editorial assistance.

1 December 1986

Akihiko Hattori
Chief Scientist
Ocean Research Institute
University of Tokyo

Contents

Outline of the cruise

The cruise consisted of three legs: leg 1, from Tokyo to Kodiak, Alaska; leg 2, from Kodiak to Vancouver, British Columbia; and from Vancouver to Tokyo (Fig. 1). The location of the oceanographic stations and the dates are given in Table 1.

Emphasis was placed on chemical, biochemical and biological aspects with special reference to cycling of biophilic elements. Detailed information was collected for : (1) distribution of temperature and salinity, (2) distribution of dissolved gases, nutrients, chlorophylls, trace metals, dissolved and particulate organic matter, and stable and radioactive nuclides, (3) distribution of phytoplankton, zooplankton and micronekton, and (4) underwater irradiance and tubidity. Simultaneous shipboard experiments on carbon and nitrogen metabolism were carried out.

At selected stations, bottom sediment samples were collected with a box corer, and settling materials by installing sediment traps at various depths. Gases and aerosols in maritime air were also collected over the extended areas of the northern North Pacific throughout the cruise.

The names and institutions of the scientists who participated in this cruise are listed in Table 2, and observation items at each station in Table 3.

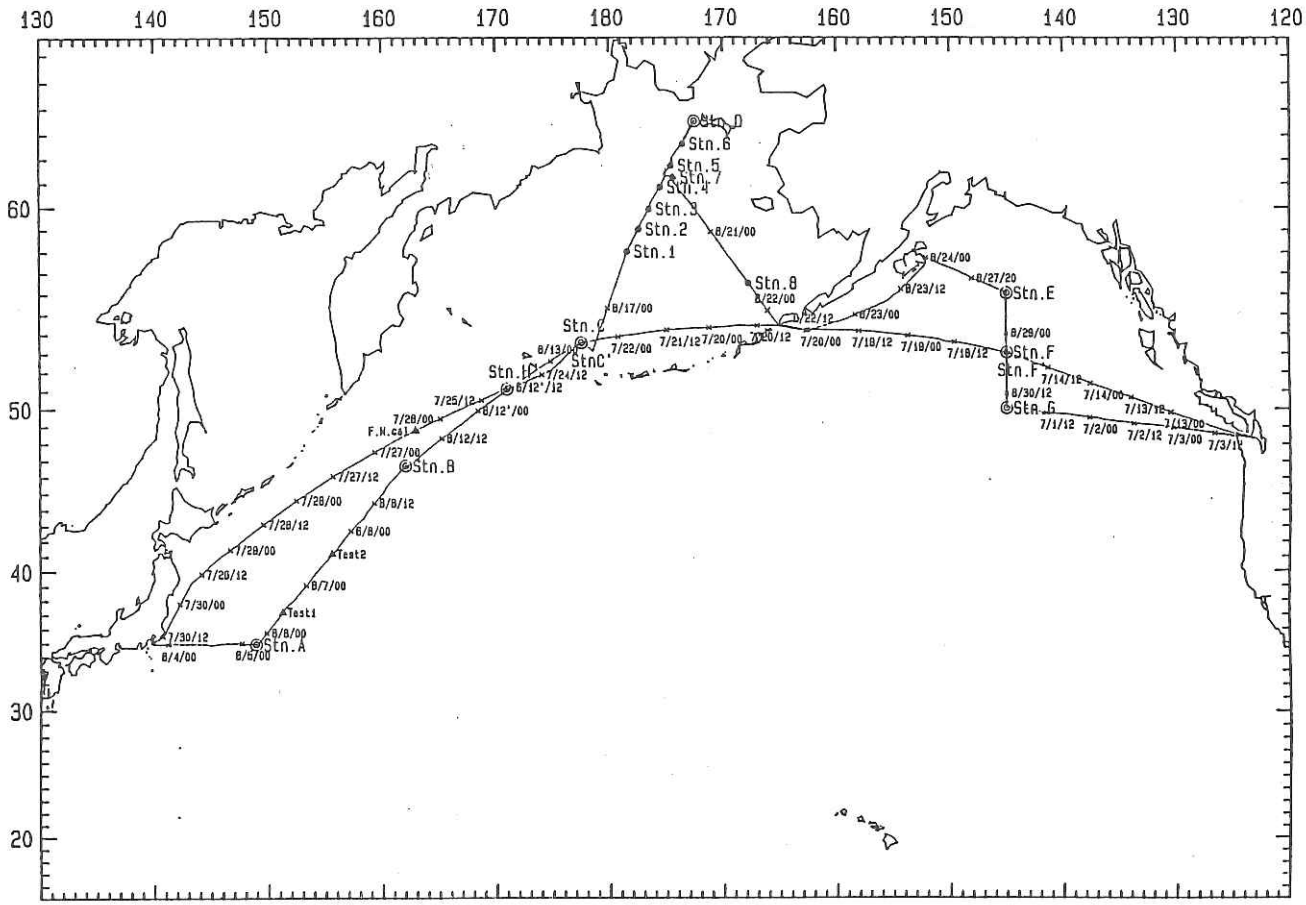

Fig. 1. Track chart of the KH-86-3 cruise of the Hakuho Maru.

Table 1. Location of oceanographic stations and dates

Leg	Station	Latitude	Longitude	Date
Leave Tokyo				6/ 3/86
1	A	34°48.9'N-34°57.3'N	148°50.7'E-148°57.7'E	6/ 5/86
	B	46°38.0'N-46°44.2'N	160°01.5'E-160°30.4'E	6/ 9/86-6/12/86
	C	52°58.0'N-53°32.3'N	177°30.2'E-178°33.7'E	6/13/86-6/16/86
	1	57°58.9'N-57°59.9'N	178°24.8'W-178°27.8'W	6/17/86
	2	58°59.5'N-59°00.0'N	177°24.2'W-177°28.1'W	6/18/86
	3	59°53.9'N-59°55.0'N	176°28.8'W-176°31.5'W	6/18/86
	4	60°48.7'N-60°49.3'N	175°29.6'W-175°30.2'W	6/18/86
	5	61°42.5'N-61°42.8'N	174°32.1'W-174°32.2'W	6/18/86-6/19/86
	6	62°35.8'N-62°35.9'N	173°31.9'W-173°32.4'W	6/19/86
	D	63°30.0'N-63°31.1'N	172°29.3'W-172°30.0'W	6/19/86
	7-1	61°12.7'N-61°13.0'N	174°19.8'W-174°20.4'W	6/20/86
	7-2	61°10.9'N	174°19.3'W	6/20/86
	7-3	61°08.6'N	174°18.6'W	6/20/86
	7-4	61°05.0'N	174°27.0'W-174°27.1'W	6/20/86
	8	56°30.2'N-56°30.7'N	167°44.9'W-167°47.2'W	6/21/86
Arrive Kodiak, Alaska				6/24/86
Leave Kokiak, Alaska				6/27/86
2	E	55°59.9'N-56°01.3'N	145°00.4'W-145°03.6'W	6/28/86
	F	52°59.4'N-53°03.9'N	144°57.1'W-145°00.3'W	6/29/86-6/30/86
	G	49°59.8'N-50°03.8'N	144°56.7'W-144°59.9'W	6/30/86-7/ 1/86
Arrive Vancouver, British Columbia				7/ 4/86
Leave Vancouver, British Columbia				7/11/86
3	F'	52°55.7'N-53°01.3'N	144°38.6'W-144°59.3'W	7/14/86-7/17/86
	C'	53°29.1'N-53°30.7'N	177°28.5'E-177°32.3'E	7/22/86
	H	51°01.2'N-51°05.4'N	170°56.4'E-170°59.6'E	7/24/86-7/25/86
Arrive Tokyo				8/ 1/86

Table 2. Scientists aboard

Akihiko HATTORI	Ocean Research Insititute, University of Tokyo
Isao KOIKE	Ocean Research Insititute, University of Tokyo
Makoto TERAZAKI	Ocean Research Insititute, University of Tokyo
Toshisuke NAKAI	Ocean Research Insititute, University of Tokyo
Toshiro SAINO	Ocean Research Insititute, University of Tokyo
Ken FURUYA	Ocean Research Insititute, University of Tokyo
Hirotaka OTOBE	Ocean Research Insititute, University of Tokyo
Masae OTSU	Ocean Research Insititute, University of Tokyo
Hae-Lip SUH	Ocean Research Insititute, University of Tokyo
Luis TUPAS	Ocean Research Insititute, University of Tokyo
Shizuo TSUNOGAI	Faculty of Fisheries, Hokkaido University
Koh HARADA	Faculty of Fisheries, Hokkaido University
Kazunori TAGUCHI	Faculty of Fisheries, Hokkaido University
Seiya NAGAO	Faculty of Fisheries, Hokkaido University
Kouji DEMURA	Faculty of Fisheries, Hokkaido University
Kuninao TADA	Faculty of Fisheries, Hokkaido University
Tsuneo ODATE	Faculty of Fisheries, Hokkaido University
Satoru KANAMORI	Water Research Institute, Nagoya University
Masahiko YAMATO	Water Research Institute, Nagoya University
Akio HASHIMOTO	Water Research Institute, Nagoya University
Eiichiro TANOUE	Environmental Science, the Graduate School of Science and Technology, Kobe Univesity
Shigemitsu HARA	Environmental Science, the Graduate School of Science and Technology, Kobe Univesity
Hiroshi SASAKI	Faculty of Agriculture, Tohoku University
Haruto ISHII	Faculty of Agriculture, Tohoku University
Nobuyuki KADOYA	Faculty of Marine Science and Technology, Tokai University
Tatsuo AONO	Faculty of Science and Technology, Kinki University
Masashi KUSAKABE	Department of Geological Science, University of Southern California
Tadashi YOSHINARI	New York State Department of Health

Table 3. Observation Items at each station

Station		A	B	C	1	2	3	4	5	6	D	7				8	E	F	G	F'	C'	H
												1	2	3	4							
CTD (+RMSx24) observation			x	x	x												x	x	x	x	x	x
OCTOPUS (+RMSx12) observation			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Water sampling	Niskin		x	x	x							x					x	x	x	x	x	x
	Large Volume		x	x																x		
	Clean		x	x	x						x	x						x		x		
	Van Dorn		x	x	x	x	x	x	x	x	x	x				x	x	x	x			
Sediment sampling	Box Corer		x	x			x									x				x		
	OKEAN																					x
Plankton sampling	NORPAC		x	x	x	x	x	x	x	x	x	x					x	x	x	x	x	
	ORI			x														x		x		
	MTD			x	x	x	x														x	
	ORI-MPS		x																	x		
Sediment trap	Anchored	x	x	x														x		x	x	
	Floating		x	x																		x

Routine observations of oceanographic variables

At each station, casts of CTD fitted with an oxygen electrode and twenty four 5-liter rosette water samplers were made to collect information on water temperature, salinity, dissolved oxygen, phosphate, silicic acid, nitrate, nitrite, ammonium, pH, alkalinity, chlorophylls, and particulate matter. Additional water samples were collected with 23-liter Niskin bottles or 20-liter van Dorn bottles from the upper 200 m layer. Casts of OCTOPUS (Ishimaru et al., 1984) were also conducted in the shallow layer (< 200 m), and data on underwater irradiance, in situ chlorophyll fluorescence, and turbidity were simultaneously collected. Saino was responsible for the operation of CTD and OCTOPUS. The names of the persons who carried out the measurements are given after each item.

Water temperature was measured using a pair of protected reversing thermometers (Nakai), and salinity with a Guildline Autosal 8400A salinometer (Otobe, Kusakabe, Tada and Odate). Dissolved oxygen was determined by the Winkler method adopting a Hirama photometric end-point detector (Tsunogai and Saino). The obtained values for temperature, salinity and oxygen were used for calibration of CTD sensors (Nakai).

Silicic acid, nitrate, nitrite and ammonium were determined using a Technicon autoanalyzer AAII (Hattori, Otsu and Saino). The methods described in Strickland and Parsons (1972) were used with modifications for autoanalyzer measurements. Phosphate was determined manually by the method of Murphy and Riley (Harada, Taguchi and Nagao). The pH was determined with a precision of 0.003 pH unit using a specially designed pH meter at 25 °C, and the alkalinity from the pH shift after the addition of a definite amount of HCl to the seawater samples (Kanamori, Hashimoto, Kadoya and Aono, cf. page 72). Total dissolved nitrogen was measured using a Yanako TN-7 total nitrogen analyzer (Koike and Tupas, cf. page 71).

Particulate matter was collected on a Whatman type F glass fiber filter, and chlorophyll *a* and phaeophytin were determined fluorometrically by the method described in Strickland and Parsons (1972) (Furuya, Tanoue and Hara). Numbers and volumes of particulate matter were determined with an Elzone 80XY particle counter (Sasaki and Ishii).

The data available at present are summarized in Tables 4-37, and Figs. 2-10.

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Ishimaru, T., H. Otobe, T. Saino, H. Hasumoto and T. Nakai (1984). OCTOPUS, an octo parameter underwater sensor, for use in biological oceanography studies. J. Oceanogr. Soc. Japan, 40, 207-212.

Murphy, J. and J.P. Riley (1962). A modified single solution method for the determination of phosphate in natural waters. Anal. Chim. Acta, 27, 31-36.

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 at Station B

Station	B		Date	June 9, 1986				Lat.	46 - 39.9 N				Air T.	5.9 C		Weather	Fog		Sea	2	
Depth	5630 m		TIME	02 : 40 - 05 : 46				Long.	162 - 01.9 E				Barro.	1005.6 mb		Wind	NE-2.0 m/s		Swell	3	
AMS or HYDROCAST																CTDO data					
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Pot-T	Sig-t	%-DO	AOU	D	T	S	D.O.	Dst	Del-D
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM	C		%	ml/l	m	C		ml/l	cl/t	
0	0	4.11	33.013	7.65	7.863	2.311	39.8	1.90	22.6	0.21	0.39	4.110	26.19	104.2	-0.31	0	4.107	33.022	7.74	180.5	0.0000
50	50	2.96	33.053	7.72	7.839	2.309	40.9	1.98	23.7	0.21	0.46	2.957	26.33	102.3	-0.17	10	4.109	33.021	7.77	180.5	0.0189
100	101	1.24	33.166	7.48	7.776	2.323	45.4	2.02	27.1	0.40	0.72	1.235	26.56	94.9	0.40	20	3.837	33.020	7.77	178.1	0.0364
200	200	2.96	33.795	1.76	7.410	2.397	92.9	3.10	43.9	0.02	0.98	2.948	26.93	23.4	5.75	30	3.741	33.019	7.79	177.3	0.0540
300	300	3.33	33.993	0.77	7.366	2.388	106	3.28	45.3	0.00	0.14	3.310	27.05	10.4	6.66	50	3.543	33.030	7.76	174.7	0.0895
400	400	3.40	34.132	0.49	7.376	2.401	118	3.27	46.3	0.00	0.36	3.373	27.16	6.6	6.92	75	1.729	33.126	7.53	153.2	0.1304
500	500	3.25	34.218	0.48	7.389	2.439	127	3.28	45.7	0.00	0.25	3.216	27.24	6.5	6.96	100	1.360	33.159	7.29	148.2	0.1690
600	601	3.10	34.280	0.48	7.399	2.429	131	3.23	46.0	0.00	0.40	3.060	27.30	6.4	6.98	150	2.582	33.622	3.67	121.7	0.2365
700	701	2.94	34.327	0.50	7.407	2.466	141	3.25	45.7	0.00	0.26	2.893	27.35	6.7	6.99	200	2.971	33.816	2.13	110.2	0.2945
800	800	2.80	34.361	0.54	7.417	2.453	144	3.21	45.7	0.00	0.11	2.747	27.39	7.2	6.97	300	3.168	34.003	0.99	97.8	0.3998
900	901	2.67	34.394	0.58	7.424	2.447	152	3.19	44.6	0.00	0.10	2.610	27.43	7.7	6.96	400	3.411	34.139	0.51	89.6	0.4961
1000	1001	2.54	34.427	0.70	7.435	2.455	155	3.17	45.0	0.00	0.17	2.474	27.47	9.3	6.86	500	3.262	34.224	0.51	81.9	0.5851
1250	1249	2.26	34.496	0.97	7.462	2.453	162	3.11	44.4	0.00	0.22	2.197	27.55	12.8	6.64	600	3.099	34.290	0.47	75.5	0.6676
1500	1500	2.08	34.546	1.27	7.495	2.472	166	3.09	43.7	0.00	0.19	1.980	27.60	16.6	6.37	700	2.942	34.339	0.51	70.4	0.7450
1750	1750	1.92	34.584	1.54	7.526	2.482	167	3.02	43.1	0.00	0.19	1.802	27.64	20.1	6.13	800	2.792	34.377	0.55	66.3	0.8175
2000	1999	1.80	34.613	1.91	7.555	2.467	167	2.92	42.0	0.00	0.18	1.663	27.68	24.8	5.78	1000	2.497	34.449	0.66	58.4	0.9525
2250	2250	1.69	34.635	2.30	7.590	2.475	162	2.86	40.3	0.00	0.11	1.533	27.70	29.8	5.41	1250	2.257	34.511	0.92	51.8	1.1046
2500	2500	1.60	34.653	2.60	7.615	2.477	160	2.77	39.9	0.00	0.06	1.422	27.72	33.6	5.13	1500	2.067	34.559	1.17	46.7	1.2439
2750	2750	1.55	34.664	2.85	7.638	2.479	158	2.64	39.4	0.00	0.18	1.350	27.74	36.8	4.89	1750	1.907	34.597	1.49	42.6	1.3730
3000	3000	1.51	34.672	3.06	7.655	2.488	155	2.66	38.1	0.00	0.08	1.286	27.75	39.5	4.69	2000	1.784	34.625	1.88	39.6	1.4942
3250	3250	1.48	34.677	3.22	7.670	2.485	153	2.61	36.4	0.00	0.06	1.232	27.75	41.5	4.53	2250	1.681	34.646	2.28	37.3	1.6102
3500	3499	1.46	34.683	3.28	7.677	2.476	152	2.60	36.1	0.00	0.22	1.186	27.76	42.3	4.48	2500	1.602	34.661	2.57	35.5	1.7219
3750	3751	1.45	34.685	3.49	7.685	2.470	150	2.47	37.1	0.00	0.16	1.149	27.76	45.0	4.27	2750	1.552	34.672	2.83	34.4	1.8309
4000	4000	1.45	34.689	3.56	7.695	2.464	148	2.54	37.3	0.00	0.38	1.121	27.76	45.9	4.20	3000	1.509	34.680	3.07	33.4	1.9391
4500	4353	1.49	34.686	3.65	----	----	145	----	36.6	0.00	0.03	1.119	27.76	47.1	4.10	3250	1.479	34.687	3.24	32.7	2.0457
5000	4843	1.53	34.690	3.70	----	----	145	----	37.2	0.00	0.12	1.097	27.76	47.8	4.04	3500	1.463	34.692	3.40	32.3	2.1527
5500	5322	1.58	34.690	3.76	----	----	145	----	36.6	0.00	0.05	1.083	27.76	48.6	3.97	4000	1.448	34.698	3.64	31.7	2.3681

Table 5. Summary of hydrographic data at Station C

Station	C		Date	June 13, 1986				Lat.	53 - 30.5 N				Air T.	5.5 C		Weather	Cloudy		Sea	3	
Depth	3720 m		TIME	13 : 58 - 17 : 05				Long.	177 - 38.6 E				Barro.	1006.3 mb		Wind	W - 7.5 m/s		Swell	1	
BMS or HYDROCAST																CTDO data					
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Pot-T	Sig-t	%-DO	AOU	D	T	S	D.O.	Dst	Del-D
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM	C		%	ml/l	m	C		ml/l	cl/t	
0	0	5.14	33.113	7.67	7.892	2.308	31.2	1.79	20.5	0.17	0.50	5.140	26.16	107.2	-0.52	0	5.142	33.122	7.25	183.5	0.0000
50	50	4.41	33.156	7.60	7.864	2.311	34.1	1.86	21.5	0.20	0.93	4.406	26.28	104.4	-0.32	10	5.044	33.110	7.17	183.3	0.0196
100	100	3.53	33.268	6.00	7.739	2.305	48.9	2.14	29.1	0.20	0.20	3.523	26.45	80.7	1.43	20	4.858	33.122	7.20	180.4	0.0379
200	200	3.72	33.509	4.37	7.618	2.316	65.9	2.53	34.6	0.00	0.15	3.706	26.63	59.2	3.02	30	4.567	33.140	7.17	176.1	0.0552
300	300	3.83	33.796	2.42	7.494	2.336	81.8	2.87	38.9	0.00	0.09	3.809	26.85	32.9	4.93	50	4.334	33.138	7.13	173.9	0.0905
400	400	3.66	33.936	1.35	7.422	2.354	96.6	3.07	43.9	0.00	0.09	3.632	26.97	18.3	6.03	75	3.713	33.217	6.85	162.0	0.1324
500	500	3.54	34.041	0.96	7.402	2.382	109	3.15	45.2	0.00	0.05	3.505	27.07	13.0	6.43	100	3.458	33.319	6.05	152.0	0.1720
600	600	3.47	34.108	0.85	7.401	2.383	114	3.18	43.9	0.00	0.10	3.428	27.13	11.5	6.55	150	3.417	33.427	5.39	143.6	0.2466
700	701	3.36	34.170	0.84	7.403	2.385	122	3.19	44.5	0.00	0.10	3.311	27.19	11.3	6.58	200	3.770	33.561	4.16	136.6	0.3165
800	801	3.24	34.230	0.84	7.409	2.402	129	3.13	45.7	0.00	0.08	3.184	27.25	8.6	6.80	300	3.835	33.790	2.56	119.9	0.4471
900	901	3.11	34.279	0.62	7.412	2.407	138	3.18	45.4	0.00	0.04	3.047	27.30	8.3	6.84	400	3.719	33.919	1.63	109.1	0.5642
1000	1001	3.00	34.317	0.61	7.416	2.407	140	3.18	45.7	0.00	0.00	2.930	27.34	8.2	6.87	500	3.568	34.027	1.07	99.6	0.6719
1250	1251	2.70	34.463	0.79	7.429	2.437	152	3.17	45.7	0.00	0.00	2.613	27.48	10.5	6.74	600	3.483	34.114	0.78	92.2	0.7716
1500	1500	2.39	34.477	0.87	7.449	2.445	168	3.14	44.7	0.00	0.13	2.286	27.52	11.5	6.72	700	3.352	34.188	0.64	85.4	0.8652
1750	1751	2.12	34.539	1.07	7.475	2.462	177	3.11	43.1	0.00	0.10	1.999	27.59	14.0	6.57	800	3.236	34.244	0.56	80.2	0.9531
2000	2001	1.92	34.583	1.36	7.563	2.468	194	3.04	43.1	0.00	0.06	1.781	27.64	17.7	6.31	1000	2.996	34.330	0.51	71.5	1.1166
2250	2251	1.78	34.613	1.62	7.533	2.470	200	3.03	40.4	0.00	0.03	1.621	27.68	21.0	6.08	1250	2.684	34.419	0.55	62.2	1.3008
2500	2501	1.70	34.634	1.90	7.555	2.473	205	2.97	40.9	0.00	0.01	1.520	27.70	24.6	5.81	1500	2.369	34.493	0.70	54.0	1.4650
2750	2751	1.64	34.649	2.03	7.573	2.472	210	2.83	40.1	0.00	0.03	1.438	27.72	26.3	5.69	1750	2.118	34.551	0.98	47.7	1.6114
3000	3001	1.61	34.659	2.20	7.587	2.472	210	2.86	39.5	0.00	0.08	1.384	27.73	28.5	5.53	2000	1.936	34.590	1.23	43.3	1.7456
3250	3250	1.59	34.667	2.28	7.598	2.473	211	2.86	39.1	0.00	0.08	1.339	27.74	29.5	5.45	2250	1.785	34.624	1.53	39.7	1.8704
3500	3500	1.58	34.674	2.55	7.611	2.492	209	2.83	38.9	0.00	0.08	1.303	27.74	33.0	5.18	2500	1.702	34.644	1.79	37.5	1.9890
3750	3749	1.57	34.678	2.64	7.624	2.476	205	2.77	38.1	0.00	0.09	1.266	27.75	34.1	5.10	2750	1.638	34.659	2.02	35.9	2.1039
																3000	1.601	34.670	2.20	34.9	2.2168
																3250	1.583	34.677	2.35	34.2	2.3289
																3500	1.575	34.683	2.50	33.7	2.4415
																3750	1.449	34.696	3.52	31.8	2.5515

Table 6. Summary of hydrographic data at Station 1

Station	1		Date	June 17, 1986			Lat.	57 - 59.5 N					Air T.	6.4 C		Weather	Fog		Sea	3	
Depth	3640 m		TIME	15 : 16 - 16 : 21			Long.	178 - 26.5 W					Barro.	999.0 mb		Wind	ENE- 8.5 m/s		Swell	2	
RMS or HYDROCAST																CTDO data					
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Pot-T	Sig-t	%-DO	AOU	D	T	S	D.O.	Dst	Del-D
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM	C		%	ml/l	m	C		ml/l	cl/t	
0	0	6.10	33.086	7.72	7.999	2.291	62.3	1.44	14.8	0.15	0.30	6.100	26.03	110.4	-0.73	0	6.200	32.854	7.69	215.6	0.0000
10	10	4.46	33.150	7.69	7.929	2.291	41.8	1.73	18.8	0.19	0.61	4.459	26.27	105.8	-0.42	10	5.936	33.092	7.62	194.7	0.0207
20	20	3.60	33.236	7.73	7.872	2.293	42.1	1.98	22.7	0.19	0.17	3.599	26.42	104.2	-0.31	20	3.856	33.191	7.65	165.4	0.0387
30	30	3.34	33.279	7.71	7.856	2.288	42.9	2.06	23.3	0.22	0.24	3.338	26.48	103.3	-0.24	30	3.508	33.239	7.37	158.6	0.0552
40	40	3.20	33.229	7.62	7.843	2.297	43.9	2.07	23.7	0.24	0.37	3.198	26.45	101.7	-0.12	50	3.260	33.252	7.18	155.4	0.0868
50	49	2.92	33.233	7.56	7.828	2.303	45.8	2.16	24.4	0.27	0.38	2.917	26.48	100.2	-0.01	75	2.785	33.274	6.51	149.8	0.1251
75	76	2.24	33.248	7.34	7.791	2.300	48.0	2.21	25.6	0.33	0.22	2.236	26.55	95.6	0.34	100	2.182	33.260	6.83	146.9	0.1627
100	100	2.13	33.239	7.47	7.798	2.297	48.0	2.19	25.5	0.41	0.15	2.125	26.55	97.0	0.23	150	2.203	33.277	6.68	145.0	0.2349
200	200	3.71	33.587	3.63	7.569	2.322	76.0	2.63	34.1	0.00	0.03	3.696	26.69	49.2	3.75	200	3.692	33.595	4.20	133.3	0.3058
300	300	3.71	33.818	1.87	7.455	2.341	93.3	2.96	39.1	0.00	0.04	3.689	26.87	25.4	5.50	300	3.706	33.840	2.00	114.9	0.4311
500	500	3.44	34.082	0.72	7.399	2.377	115	3.22	42.0	0.00	0.01	3.406	27.11	9.7	6.69	400	3.569	33.982	1.18	103.0	0.5426
750	750	3.09	34.266	0.44	7.386	2.409	136	3.22	42.5	0.00	0.02	3.039	27.29	5.9	7.02	500	3.437	34.091	0.78	93.5	0.6447
1000	1000	2.77	34.379	0.45	7.417	2.433	150	3.20	42.1	0.00	0.03	2.702	27.41	6.0	7.07	600	3.274	34.188	0.60	84.7	0.7375
																700	3.153	34.248	0.50	79.1	0.8235
																800	3.026	34.298	0.48	74.3	0.9055
																1000	3.005	34.327	0.52	71.9	1.0591

Table 7. Summary of hydrographic data at Station E

Station	E		Date	June 28, 1986		Lat.	56 - 01.3 N						Air T.	8.4 C		Weather	Drizzle		Sea	4	
Depth	3910 m		TIME	06 : 06 - 08 : 52		Long.	145 - 01.5 W						Barro.	1015.1 mb		Wind	SE - 8.0 m/s		Swell	4	
AMS or HYDROCAST																CTDO data					
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Pot-T	Sig-t	%-DO	AOU	D	T	S	D.O.	Dst	Del-D
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM	C		%	ml/l	m	C		ml/l	cl/t	
0	0	8.40	32.600	7.08	7.964	----	16.7	1.14	11.8	0.12	0.15	8.400	25.33	106.5	-0.43	0	8.239	32.586	7.30	262.0	0.0000
50	50	6.39	32.661	7.26	7.943	----	20.0	1.23	13.4	0.14	0.26	6.386	25.66	104.3	-0.30	10	8.217	32.612	7.61	259.8	0.0266
100	100	4.35	33.030	5.86	7.780	----	34.4	1.89	23.3	0.05	0.01	4.343	26.18	80.3	1.43	20	8.158	32.608	7.68	259.3	0.0523
200	200	3.78	33.913	0.73	7.370	----	90.0	3.22	45.2	0.00	0.01	3.766	26.94	9.9	6.62	30	6.973	32.625	7.75	242.2	0.0772
300	300	3.72	34.032	0.50	7.375	----	102	3.26	45.5	0.00	0.01	3.699	27.04	6.8	6.66	50	6.284	32.624	7.52	233.9	0.1258
400	400	3.62	34.115	0.45	7.392	----	113	3.18	45.5	0.00	0.02	3.592	27.12	6.1	6.92	75	4.974	32.678	7.28	215.1	0.1824
500	500	3.50	34.177	0.39	7.402	----	120	3.20	45.0	0.00	0.01	3.465	27.18	5.3	7.00	100	4.176	33.269	5.50	162.5	0.2295
600	600	3.38	34.241	0.53	7.411	----	126	3.23	44.8	0.00	0.00	3.338	27.24	7.2	6.88	150	3.820	33.826	2.09	117.1	0.2998
700	700	3.22	34.295	0.40	7.415	----	136	3.23	45.2	0.00	0.02	3.172	27.30	5.4	7.04	200	3.787	33.925	1.13	109.3	0.3572
800	800	3.07	34.334	0.43	7.420	----	140	3.02	44.9	0.00	0.01	3.015	27.35	5.8	7.03	300	3.725	34.037	0.66	100.3	0.4638
900	900	2.92	34.369	0.37	7.426	----	144	3.19	44.8	0.00	0.02	2.858	27.39	4.9	7.12	400	3.598	34.134	0.58	91.7	0.5626
1000	1000	2.78	34.406	0.47	7.431	----	152	3.19	45.0	0.00	0.01	2.712	27.43	6.3	7.05	500	3.440	34.214	0.54	84.2	0.6540
1250	1249	2.46	34.475	0.59	7.447	----	162	3.13	44.6	0.00	0.01	2.376	27.51	7.8	6.98	600	3.300	34.276	0.50	78.3	0.7393
1500	1499	2.21	34.532	0.84	7.473	----	168	3.08	44.0	0.00	0.01	2.109	27.58	11.0	6.78	700	3.164	34.319	0.51	73.8	0.8200
1750	1750	2.05	34.568	1.16	7.496	----	174	3.11	43.6	0.00	0.01	1.930	27.62	15.2	6.48	800	3.009	34.359	0.52	69.5	0.8964
2000	2000	1.87	34.604	1.52	7.532	----	177	2.93	42.1	0.00	0.02	1.732	27.66	19.8	6.16	1000	2.749	34.426	0.52	62.2	1.0395
2250	2249	1.75	34.630	1.82	7.562	----	177	2.88	41.4	0.00	0.01	1.592	27.69	23.6	5.88	1250	2.446	34.491	0.66	54.8	1.2015
2500	2500	1.68	34.645	2.07	7.587	----	178	2.89	41.0	0.00	0.01	1.501	27.71	26.8	5.65	1500	2.197	34.547	0.88	48.6	1.3480
2750	2750	1.61	34.658	2.35	7.608	----	178	2.85	40.4	0.00	0.02	1.408	27.73	30.4	5.38	1750	2.054	34.579	1.13	45.0	1.4835
3000	2999	1.55	34.670	2.63	7.632	----	177	2.70	39.3	0.00	0.02	1.325	27.74	34.0	5.11	2000	1.869	34.617	1.52	40.8	1.6110
3250	3249	1.50	34.681	2.87	7.653	----	175	2.63	38.8	0.00	0.02	1.251	27.75	37.0	4.88	2250	1.754	34.640	1.86	38.2	1.7303
3500	3500	1.46	34.690	3.15	7.674	----	171	2.65	37.9	0.00	0.02	1.186	27.76	40.6	4.61	2500	1.676	34.657	2.14	36.4	1.8450
3750	3750	1.45	34.696	3.25	7.689	----	168	2.64	37.1	0.00	0.02	1.149	27.77	41.9	4.51	2750	1.609	34.671	2.43	34.9	1.9570
																3000	1.549	34.683	2.71	33.5	2.0663
																3250	1.497	34.693	3.01	32.4	2.1737
																3500	1.460	34.702	3.24	31.5	2.2794
																3750	1.446	34.707	3.44	31.0	2.3846

Table 8. Summary of hydrographic data at Station F

Station	F		Date	June 29, 1986				Lat.	53 - 02.5 N				Air T.	8.3 C		Weather	Fog		Sea	3	
Depth	4110 m		TIME	10 : 48 - 14 : 04				Long.	145 - 00.0 W				Barro.	1008.1 mb		Wind	SE - 7.0 m/s		Swell	4	
AMS or HYDROCAST																CTDO data					
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Pot-T	Sig-t	%-DO	AOU	D	T	S	D.O.	Dst	Del-D
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM	C		%	ml/l	m	C		ml/l	cl/t	
0	0	7.98	32.400	7.21	7.952	2.246	14.4	1.15	11.2	0.15	0.13	7.980	25.24	107.3	-0.49	0	7.981	32.294	5.47	280.3	0.0000
50	50	6.13	32.543	7.38	7.935	2.257	16.6	1.23	11.6	0.16	0.21	6.126	25.60	105.3	-0.37	10	7.888	32.488	5.42	264.5	0.0281
100	100	4.24	32.901	6.60	7.830	2.249	27.1	1.65	19.7	0.20	0.03	4.233	26.09	90.2	0.72	20	7.752	32.497	5.52	262.0	0.0548
200	200	3.65	33.845	1.46	7.408	2.334	84.1	3.02	42.9	0.00	0.02	3.636	26.90	19.8	5.92	30	6.813	32.531	5.63	247.3	0.0803
300	299	3.68	33.980	0.69	7.370	2.339	98.5	3.19	44.8	0.00	0.03	3.659	27.01	9.4	6.68	50	6.290	32.548	5.58	239.6	0.1285
400	399	3.62	34.091	0.67	7.400	2.353	111	3.12	45.0	0.00	0.04	3.592	27.10	9.1	6.70	75	5.569	32.549	5.52	231.2	0.1875
500	500	3.53	34.164	0.62	7.409	2.366	118	3.11	45.0	0.00	0.03	3.495	27.17	8.4	6.77	100	4.085	33.128	4.76	172.3	0.2393
600	600	3.40	34.233	0.59	7.420	2.388	126	----	44.6	0.00	0.01	3.358	27.24	8.0	6.82	150	3.599	33.719	2.32	123.1	0.3127
700	701	3.25	34.292	0.55	7.423	2.388	134	3.13	44.6	0.00	0.02	3.201	27.30	7.4	6.88	200	3.620	33.870	1.38	111.9	0.3725
800	799	3.09	34.337	0.51	7.426	2.404	139	3.17	44.8	0.00	0.03	3.035	27.35	6.8	6.95	300	3.679	34.009	0.65	101.9	0.4815
900	900	2.93	34.375	0.52	7.429	2.405	144	3.16	44.5	0.00	0.02	2.868	27.39	6.9	6.97	400	3.616	34.104	0.60	94.1	0.5815
1000	1000	2.79	34.407	0.47	7.431	2.412	152	3.15	45.2	0.00	0.04	2.722	27.43	6.3	7.04	500	3.502	34.187	0.60	86.8	0.6754
1250	1250	2.49	34.472	0.60	7.444	2.426	163	3.15	45.0	0.00	0.02	2.405	27.51	7.9	6.97	600	3.376	34.257	0.64	80.4	0.7634
1500	1500	2.26	34.524	0.81	7.465	2.441	167	3.09	43.6	0.00	0.01	2.158	27.57	10.6	6.80	700	3.251	34.306	0.69	75.6	0.8461
1750	1750	2.07	34.565	1.12	7.492	2.443	174	3.01	43.9	0.00	0.01	1.950	27.62	14.7	6.52	800	3.071	34.356	0.58	70.3	0.9241
2000	2000	1.94	34.596	1.44	7.519	2.454	175	2.96	43.2	0.00	0.01	1.801	27.65	18.8	6.23	1000	2.784	34.421	0.52	62.9	1.0689
2250	2249	1.81	34.621	1.75	7.547	2.454	176	2.91	41.6	0.00	0.01	1.651	27.68	22.8	5.94	1250	2.483	34.486	0.57	55.5	1.2328
2500	2499	1.71	34.640	2.06	7.575	2.458	177	2.84	41.3	0.00	0.01	1.530	27.71	26.7	5.65	1500	2.240	34.539	0.76	49.5	1.3815
2750	2750	1.63	34.658	2.37	7.601	2.466	176	2.78	40.6	0.00	0.01	1.428	27.73	30.7	5.36	1750	2.067	34.578	1.04	45.2	1.5188
3000	3001	1.57	34.670	2.64	7.626	2.472	174	2.71	38.9	0.00	0.00	1.345	27.74	34.1	5.10	2000	1.921	34.610	1.33	41.7	1.6475
3250	3251	1.52	34.680	2.89	7.646	2.458	174	2.67	38.4	0.00	0.01	1.271	27.75	37.3	4.86	2250	1.803	34.634	1.63	39.0	1.7696
3500	3500	1.49	34.688	3.10	7.664	2.468	173	2.61	38.4	0.00	0.01	1.215	27.76	40.0	4.65	2500	1.707	34.654	1.95	36.9	1.8866
3750	3750	1.47	34.694	3.30	7.676	2.461	169	2.53	37.0	0.00	0.12	1.169	27.77	42.6	4.46	2750	1.630	34.669	2.25	35.2	1.9999
4000	4000	1.47	34.698	3.38	7.683	2.467	170	2.55	37.5	0.00	0.03	1.141	27.77	43.6	4.38	3000	1.571	34.681	2.52	33.8	2.1105
																3250	1.525	34.691	2.80	32.7	2.2189
																3500	1.488	34.699	3.03	31.8	2.3259
																4000	1.473	34.709	3.36	31.0	2.5403

Table 9. Summary of hydrographic data at Station G

Station	G		Date	June 30, 1986			Lat.	50 - 00.5 N					Air T.	7.7 C		Weather	Overcast		Sea	3	
Depth	4260 m		TIME	16 : 28 - 19 : 44			Long.	144 - 59.2 W					Barro.	998.9 mb		Wind	SE -10.0 m/s		Swell	3	
AMS or HYDROCAST																CTDO data					
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Pot-T	Sig-t	%-DO	AOU	D	T	S	D.O.	Dst	Del-D
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM	C		%	ml/l	m	C		ml/l	cl/t	
0	0	9.13	32.532	7.08	7.980	-----	9.5	1.03	8.80	0.09	0.10	9.130	25.17	108.2	-0.54	0	9.125	32.550	6.57	277.6	0.0000
50	50	7.81	32.576	7.23	7.969	-----	10.0	1.10	9.90	0.10	0.10	7.805	25.40	107.3	-0.49	10	9.123	32.540	6.59	278.3	0.0279
100	99	6.23	32.749	6.89	7.922	-----	12.8	1.25	12.7	0.34	0.10	6.221	25.75	98.6	0.09	20	9.096	32.539	6.64	277.9	0.0574
200	200	4.86	33.821	3.27	7.603	-----	55.2	2.40	33.2	0.00	0.06	4.844	26.76	45.6	3.90	30	9.048	32.543	6.65	276.9	0.0843
300	300	4.42	33.972	1.84	7.485	-----	75.9	2.81	39.0	0.00	0.02	4.397	26.92	25.4	5.40	50	8.217	32.578	6.82	262.4	0.1384
400	400	4.09	34.020	1.28	7.447	-----	91.5	3.01	42.0	0.00	0.02	4.061	27.00	17.6	6.01	75	7.596	32.574	6.69	254.2	0.2044
500	500	3.87	34.108	0.94	7.435	-----	104	3.07	41.8	0.00	0.02	3.834	27.09	12.8	6.39	100	6.251	32.669	6.60	230.1	0.2646
600	600	3.66	34.183	0.79	7.431	-----	115	3.09	43.4	0.00	0.01	3.617	27.17	10.7	6.57	150	5.137	33.695	4.23	140.3	0.3571
700	700	3.49	34.241	0.67	7.425	-----	124	3.12	43.9	0.00	0.02	3.440	27.23	9.1	6.72	200	4.812	33.846	3.05	125.5	0.4252
800	802	3.30	34.293	0.50	7.422	-----	130	3.18	44.1	0.00	0.01	3.243	27.29	6.7	6.92	300	4.330	33.952	1.85	112.5	0.5462
900	900	3.12	34.336	0.47	7.422	-----	141	3.19	44.7	0.00	0.00	3.057	27.34	6.3	6.99	400	4.049	34.052	1.34	102.2	0.6571
1000	999	2.94	34.376	0.45	7.424	-----	147	3.19	45.2	0.00	0.00	2.871	27.39	6.0	7.04	500	3.843	34.128	1.19	94.5	0.7584
1250	1250	2.61	34.450	0.46	7.433	-----	154	3.19	43.8	0.00	0.00	2.524	27.48	6.1	7.09	600	3.674	34.197	0.84	87.7	0.8542
1500	1500	2.35	34.504	0.72	7.453	-----	165	3.14	44.7	0.00	0.00	2.247	27.55	9.5	6.87	700	3.479	34.258	0.70	81.3	0.9437
1750	1749	2.13	34.555	1.07	7.483	-----	172	3.07	43.8	0.00	0.00	2.009	27.60	14.0	6.56	800	3.274	34.312	0.60	75.4	1.0276
2000	2000	1.97	34.589	1.34	7.512	-----	176	2.98	42.9	0.00	0.00	1.830	27.64	17.5	6.32	1000	2.961	34.387	0.49	66.9	1.1820
2250	2243	1.84	34.616	1.66	7.540	-----	176	2.91	42.0	0.00	0.00	1.681	27.68	21.6	6.03	1250	2.603	34.465	0.50	58.0	1.3546
2500	2500	1.73	34.637	2.04	7.571	-----	176	2.82	41.3	0.00	0.00	1.550	27.70	26.5	5.67	1500	2.330	34.522	0.71	51.5	1.5101
2750	2749	1.65	34.653	2.32	7.598	-----	174	2.77	39.7	0.00	0.00	1.448	27.72	30.0	5.40	1750	2.106	34.571	1.01	46.1	1.6515
3000	3000	1.58	34.667	2.63	7.622	-----	174	2.71	39.5	0.00	0.00	1.355	27.74	34.0	5.11	2000	1.951	34.603	1.36	42.5	1.7825
3250	3251	1.53	34.679	2.88	7.643	-----	173	2.66	38.8	0.00	0.00	1.280	27.75	37.2	4.86	2250	1.829	34.629	1.67	39.6	1.9068
3500	3500	1.50	34.686	3.06	7.659	-----	171	2.61	38.4	0.00	0.00	1.225	27.76	39.5	4.69	2500	1.714	34.651	2.03	37.1	2.0250
3750	3749	1.49	34.691	3.23	7.672	-----	171	2.60	37.9	0.00	0.00	1.188	27.76	41.7	4.52	2750	1.640	34.666	2.34	35.4	2.1387
4000	4000	1.49	34.696	3.32	7.683	-----	171	2.55	37.2	0.00	0.00	1.160	27.77	42.8	4.43	3000	1.580	34.678	2.63	34.1	2.2499
																3250	1.532	34.689	2.92	33.0	2.3594
																3500	1.502	34.697	3.15	32.1	2.4672
																3750	1.486	34.703	3.34	31.6	2.5747

Table 10. Summary of hydrographic data at Station F'

Station	F'		Date	July 14/15, 1986				Lat.	52 - 59.9 N				Air T.	8.7 C		Weather	Rain		Sea	3	
Depth	4090 m		TIME	22 : 27 - 01 : 56				Long.	144 - 55.9 W				Barro.	1028.4 mb		Wind	S - 5.5 m/s		Swell	3	
RMS or	HYDROCAST															CTDO data					
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Pot-T	Sig-t	%-DO	ADU	D	T	S	D.O.	Dst	Del-D
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM	C		%	ml/l	m	C		ml/l	cl/t	
0	0	8.73	32.446	7.05	7.961	2.247	13.9	1.11	10.1	0.07	0.26	8.730	25.16	106.7	-0.44	0	8.729	32.455	6.75	278.8	0.0000
50	50	6.33	32.529	7.49	7.934	2.265	15.0	1.17	10.9	0.06	0.18	6.326	25.56	107.3	-0.51	10	8.737	32.455	6.83	278.9	0.0300
100	100	4.75	32.803	6.68	7.831	2.266	25.5	1.61	18.8	0.07	0.08	4.743	25.96	92.3	0.55	20	8.635	32.455	6.84	277.4	0.0564
200	200	3.61	33.838	1.48	7.405	2.336	82.2	3.10	41.9	0.00	0.04	3.597	26.90	20.0	5.91	30	8.540	32.452	6.81	276.3	0.0847
300	300	3.69	33.984	0.68	7.363	2.365	97.2	3.27	45.2	0.00	0.04	3.669	27.01	9.2	6.69	50	6.174	32.531	6.99	239.5	0.1356
400	401	3.62	34.084	0.61	7.388	2.372	108	3.24	44.7	0.00	0.07	3.592	27.10	8.3	6.77	75	5.031	32.605	6.82	221.2	0.1933
500	500	3.49	34.167	0.61	7.400	2.386	117	3.18	44.3	0.00	0.04	3.455	27.17	8.2	6.78	100	4.360	32.809	6.35	199.0	0.2464
600	599	3.33	34.236	0.53	7.410	2.402	125	3.17	44.4	0.00	0.03	3.289	27.24	7.1	6.89	150	3.657	33.719	2.70	123.6	0.3273
700	700	3.17	34.289	0.59	7.419	2.405	131	3.18	44.3	0.00	0.01	3.122	27.30	7.9	6.86	200	3.594	33.865	1.54	112.0	0.3868
800	800	3.02	34.334	0.53	7.423	2.414	138	3.16	44.3	0.00	0.01	2.965	27.35	7.1	6.94	300	3.666	34.026	0.65	100.5	0.4953
900	900	2.89	34.373	0.61	7.439	2.427	142	3.19	44.5	0.00	0.00	2.829	27.39	8.1	6.89	400	3.588	34.126	0.64	92.3	0.5939
1000	1001	2.78	34.401	0.49	7.432	2.418	146	3.17	44.6	0.00	0.03	2.712	27.43	6.5	7.03	500	3.449	34.198	0.60	85.5	0.6865
1250	1250	2.50	34.467	0.59	7.439	2.455	156	3.17	44.5	0.00	0.01	2.415	27.50	7.8	6.98	600	3.294	34.260	0.58	79.5	0.7732
1500	1500	2.29	34.513	0.77	7.460	2.453	163	3.15	44.4	0.00	0.01	2.188	27.56	10.1	6.83	700	3.145	34.308	0.60	74.5	0.8549
1750	1749	2.09	34.558	1.15	7.487	2.459	168	3.09	43.8	0.00	0.05	1.970	27.61	15.1	6.49	800	3.023	34.345	0.59	70.7	0.9323
2000	2000	1.93	34.590	1.42	7.523	2.466	170	2.98	42.3	0.00	0.03	1.791	27.65	18.5	6.25	1000	2.767	34.417	0.55	63.0	1.0772
2250	2250	1.81	34.617	1.73	7.548	2.468	171	2.89	41.9	0.00	0.04	1.651	27.68	22.5	5.96	1250	2.512	34.476	0.58	56.5	1.2424
2500	2500	1.71	34.637	2.11	7.575	2.481	173	2.81	41.1	0.00	0.04	1.530	27.70	27.4	5.60	1500	2.288	34.526	0.78	50.9	1.3945
2750	2750	1.63	34.653	2.41	7.601	2.480	171	2.81	40.0	0.00	0.04	1.428	27.72	31.2	5.32	1750	2.092	34.569	1.07	46.1	1.5351
3000	2999	1.57	34.666	2.71	7.625	2.480	170	2.70	39.5	0.00	0.03	1.345	27.74	35.0	5.03	2000	1.930	34.604	1.42	42.3	1.6658
3250	3250	1.52	34.676	2.92	7.647	2.475	169	2.66	38.8	0.00	0.04	1.271	27.75	37.7	4.83	2250	1.796	34.631	1.78	39.2	1.7887
3500	3499	1.49	34.683	3.08	7.661	2.478	167	2.63	38.0	0.00	0.03	1.215	27.76	39.7	4.67	2500	1.699	34.650	2.10	37.0	1.9061
3750	3750	1.47	34.688	3.33	7.677	2.471	166	2.57	37.8	0.00	0.24	1.169	27.76	42.9	4.43	2750	1.632	34.664	2.40	35.5	2.0199
4000	4000	1.47	34.688	3.42	7.693	2.482	164	2.62	37.2	0.00	0.04	1.141	27.76	44.1	4.34	3000	1.565	34.677	2.73	34.1	2.1310
																3250	1.517	34.687	3.00	33.0	2.2402
																3500	1.490	34.694	3.23	32.2	2.3479
																4000	1.470	34.704	3.59	31.3	2.5636

Table 11. Summary of hydrographic data at Station C'

Station	C'		Date	July 22, 1986				Lat.	53 - 30.5 N				Air T.	7.5 C		Weather	Rain		Sea	2	
Depth	3930 m		TIME	12 : 21 - 15 : 11				Long.	177 - 31.7 E				Barro.	1018.8 mb		Wind	E -5.0 m/s		Swell	1	
AMS or HYDROCAST																CTDO data					
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Pot-T	Sig-t	%-DO	AOU	D	T	S	D.O.	Dst	Del-D
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM	C		%	ml/l	m	C		ml/l	cl/t	
0	0	7.55	32.722	7.11	7.910	2.286	17.6	1.57	15.8	0.19	0.46	7.550	25.55	105.0	-0.34	0	7.553	32.741	7.07	241.1	0.0000
50	50	6.00	33.023	7.14	7.881	2.297	20.1	1.64	17.4	0.26	0.56	5.996	25.99	101.9	-0.13	10	7.528	32.802	6.58	236.2	0.0244
100	100	3.30	33.207	6.84	7.775	2.293	42.7	2.08	26.0	0.24	0.07	3.294	26.43	91.5	0.64	20	7.354	32.859	6.76	229.7	0.0476
200	200	3.84	33.667	2.85	7.497	2.324	72.9	2.79	37.6	0.00	0.06	3.826	26.74	38.7	4.51	30	7.176	32.901	6.84	224.2	0.0708
300	301	3.80	33.911	1.35	7.402	2.353	90.5	3.07	42.1	0.00	0.04	3.779	26.94	18.4	6.00	50	6.218	32.994	6.78	205.3	0.1142
400	400	3.65	34.019	0.86	7.381	2.370	104	3.16	44.6	0.00	0.04	3.622	27.04	11.7	6.51	75	3.837	33.117	6.73	170.8	0.1619
500	500	3.52	34.117	0.65	7.382	2.381	116	3.16	45.2	0.00	0.04	3.485	27.13	8.8	6.74	100	3.339	33.183	6.17	161.3	0.2023
600	600	3.42	34.176	0.63	7.390	2.389	123	3.21	45.1	0.00	0.04	3.378	27.19	8.5	6.78	150	3.523	33.446	4.46	143.0	0.2799
700	699	3.29	34.227	0.55	7.394	2.402	129	3.17	45.3	0.00	0.03	3.241	27.24	7.4	6.88	200	3.820	33.721	2.80	125.0	0.3472
800	800	3.15	34.274	0.51	7.397	2.406	134	3.14	45.3	0.00	0.03	3.095	27.29	6.8	6.94	300	3.778	33.932	1.37	108.7	0.4654
900	900	3.03	34.311	0.49	7.400	2.415	142	3.18	45.4	0.00	0.04	2.968	27.33	6.6	6.98	400	3.648	34.042	0.93	99.2	0.5726
1000	1000	2.90	34.350	0.52	7.405	2.417	147	3.18	45.4	0.00	0.04	2.831	27.38	6.9	6.98	500	3.537	34.125	0.73	91.9	0.6715
1250	1250	2.56	34.440	0.56	7.424	2.425	161	3.17	45.1	0.00	0.03	2.475	27.48	7.4	7.00	600	3.443	34.182	0.64	86.7	0.7643
1500	1500	2.28	34.508	0.76	7.443	2.449	175	3.12	44.6	0.00	0.04	2.178	27.55	10.0	6.85	700	3.301	34.237	0.57	81.3	0.8532
1750	1750	2.05	34.560	1.03	7.473	2.456	187	3.09	43.2	0.00	0.03	1.930	27.62	13.5	6.62	800	3.145	34.290	0.52	75.9	0.9369
2000	2001	1.86	34.600	1.35	7.502	2.467	199	3.02	41.8	0.00	0.01	1.722	27.66	17.6	6.33	1000	2.880	34.370	0.49	67.5	1.0918
2250	2250	1.76	34.624	1.59	7.526	2.465	204	2.94	40.9	0.00	0.01	1.602	27.69	20.6	6.11	1250	2.568	34.452	0.57	58.7	1.2659
2500	2500	1.68	34.644	1.82	7.547	2.467	209	2.90	40.2	0.00	0.03	1.501	27.71	23.6	5.90	1500	2.279	34.520	0.76	51.3	1.4213
2750	2750	1.63	34.657	2.02	7.564	2.469	212	2.92	39.5	0.00	0.01	1.428	27.73	26.1	5.71	1750	2.055	34.571	1.01	45.7	1.5617
3000	3000	1.59	34.666	2.17	7.580	2.470	214	2.82	38.6	0.00	0.03	1.364	27.74	28.1	5.56	2000	1.874	34.610	1.33	41.4	1.6902
3250	3250	1.58	34.674	2.32	7.592	2.477	215	2.84	39.0	0.00	0.03	1.329	27.74	30.0	5.41	2250	1.774	34.633	1.60	38.9	1.8112
3500	3500	1.57	34.679	2.36	7.605	2.477	216	2.82	38.8	0.00	0.00	1.293	27.75	30.5	5.38	2500	1.692	34.653	1.83	36.8	1.9278
3750	3750	1.57	34.684	2.53	7.616	2.482	211	2.72	38.7	0.00	0.04	1.266	27.75	32.7	5.21	2750	1.636	34.667	2.06	35.4	2.0412
3850	3879	1.57	34.686	2.60	7.627	2.480	206	2.76	37.4	0.00	0.04	1.251	27.75	33.6	5.14	3000	1.597	34.678	2.24	34.2	2.1527
																3250	1.581	34.685	2.42	33.6	2.2633
																3500	1.575	34.690	2.54	33.1	2.3745
																3750	1.575	34.694	2.70	32.9	2.4864

Table 12. Summary of hydrographic data at Station H

Station	H		Date	July 25, 1986				Lat.	51 - 03.6 N				Air T.	9.6 C		Weather	Rain		Sea	3	
Depth	4760 m		TIME	00 : 22 - 03 : 32				Long.	170 - 58.1 E				Barro.	1011.4 mb		Wind	W -7.0 m/s		Swell	1	
AWS or HYDROCAST																CTDO data					
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Pot-T	Sig-t	%-DO	AOU	D	T	S	D.O.	Dst	Del-D
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM	C		%	ml/l	m	C		ml/l	cl/t	
0	0	9.00	32.589	7.01	7.991	2.263	16.5	1.12	11.3	0.11	0.25	9.000	25.23	106.9	-0.45	0	9.001	32.597	4.36	272.2	0.0000
50	49	3.82	32.950	7.11	7.853	2.283	27.1	1.72	20.2	0.50	0.52	3.817	26.17	96.2	0.28	10	8.996	32.599	4.23	272.0	0.0279
100	100	3.91	33.350	5.23	7.695	2.306	50.7	2.21	29.5	0.00	0.11	3.903	26.48	71.1	2.13	20	8.220	32.718	4.28	252.0	0.0545
200	200	3.79	33.740	2.51	7.498	2.338	79.0	2.80	39.0	0.00	0.23	3.776	26.81	34.1	4.85	30	7.394	32.688	4.34	243.0	0.0787
300	300	3.72	33.923	1.38	7.426	2.350	96.7	3.03	43.1	0.00	0.08	3.699	26.96	18.7	5.98	50	4.092	32.892	4.24	190.1	0.1226
400	400	3.57	34.045	1.00	7.413	2.369	110	3.11	44.0	0.00	0.15	3.542	27.07	13.5	6.39	75	3.736	33.061	3.91	174.1	0.1687
500	500	3.46	34.131	0.82	7.410	2.376	119	3.15	44.5	0.00	0.05	3.425	27.15	11.1	6.58	100	3.838	33.316	3.33	155.7	0.2091
600	600	3.37	34.199	0.67	7.411	2.386	126	3.16	44.8	0.00	0.38	3.328	27.21	9.0	6.75	150	4.042	33.593	2.34	136.8	0.2837
700	700	3.22	34.261	0.52	7.415	2.391	134	3.17	45.0	0.00	0.05	3.172	27.27	7.0	6.92	200	3.886	33.753	1.75	123.2	0.3491
800	801	3.07	34.307	0.56	7.419	2.402	142	3.19	45.0	0.00	0.08	3.015	27.33	7.5	6.91	300	3.718	33.940	0.98	107.5	0.4669
900	899	2.96	34.344	0.58	7.424	2.416	146	3.18	45.0	0.00	0.17	2.898	27.37	7.7	6.90	400	3.548	34.060	0.70	96.9	0.5709
1000	1000	2.80	34.383	0.59	7.430	2.428	152	3.16	45.0	0.00	0.05	2.732	27.41	7.9	6.92	500	3.451	34.153	0.57	88.9	0.6672
1250	1250	2.44	34.472	0.70	7.450	2.439	163	3.11	44.8	0.00	0.03	2.356	27.51	9.2	6.88	600	3.336	34.222	0.52	82.7	0.7573
1500	1500	2.21	34.526	0.97	7.475	2.447	169	3.08	43.8	0.00	0.02	2.109	27.58	12.7	6.65	700	3.205	34.280	0.46	77.2	0.8418
1750	1750	2.03	34.566	1.31	7.506	2.453	171	2.98	43.3	0.00	0.00	1.910	27.62	17.1	6.34	800	3.061	34.325	0.45	72.4	0.9218
2000	2000	1.89	34.599	1.55	7.532	2.478	177	2.91	42.4	0.00	0.05	1.751	27.66	20.2	6.13	1000	2.801	34.395	0.47	65.0	1.0703
2250	2249	1.76	34.626	1.89	7.563	2.484	178	2.89	41.2	0.00	0.02	1.602	27.69	24.5	5.81	1250	2.462	34.479	0.58	55.8	1.2372
2500	2500	1.68	34.644	2.25	7.591	2.485	176	2.82	40.5	0.00	0.02	1.501	27.71	29.2	5.47	1500	2.200	34.541	0.81	49.1	1.3853
2750	2750	1.62	34.660	2.55	7.616	2.487	171	2.74	39.8	0.00	0.02	1.418	27.73	33.0	5.18	1750	2.020	34.581	1.08	44.6	1.5210
3000	3000	1.55	34.672	2.86	7.643	2.482	167	2.65	38.3	0.00	0.05	1.325	27.74	36.9	4.88	2000	1.884	34.611	1.32	41.4	1.6481
3250	3250	1.52	34.681	3.01	7.658	2.487	163	2.64	38.3	0.00	0.05	1.271	27.75	38.9	4.74	2250	1.762	34.638	1.59	38.4	1.7689
3500	3500	1.49	34.686	3.20	7.673	2.485	159	2.57	37.9	0.00	0.00	1.215	27.76	41.3	4.55	2500	1.678	34.657	1.90	36.4	1.8840
3750	3749	1.46	34.693	3.39	7.684	2.483	157	2.53	37.6	0.00	0.03	1.159	27.77	43.7	4.37	2750	1.612	34.671	2.15	34.9	1.9960
4000	3999	1.45	34.696	3.48	7.693	2.481	153	2.53	36.9	0.00	----	1.121	27.77	44.8	4.28	3000	1.552	34.682	2.38	33.6	2.1056
																3250	1.518	34.690	2.56	32.7	2.2135
																3500	1.482	34.697	2.76	32.0	2.3206
																4000	1.450	34.706	3.07	31.1	2.5345

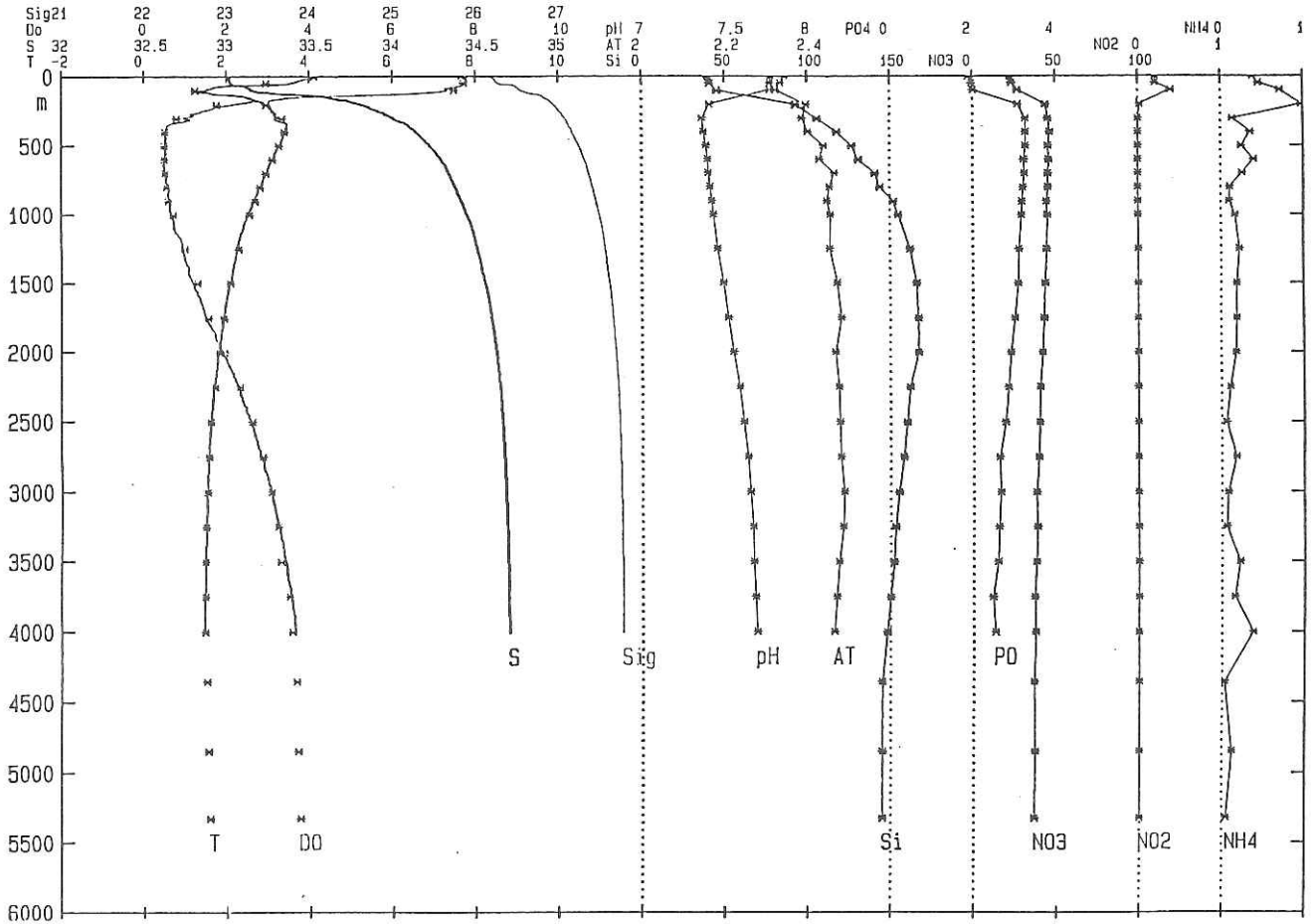


Fig. 2. Vertical profiles of temperature, salinity, sigma-t, dissolved oxygen, pH, alkalinity, silicic acid, phosphate, nitrate, nitrite and ammonium at Station B.

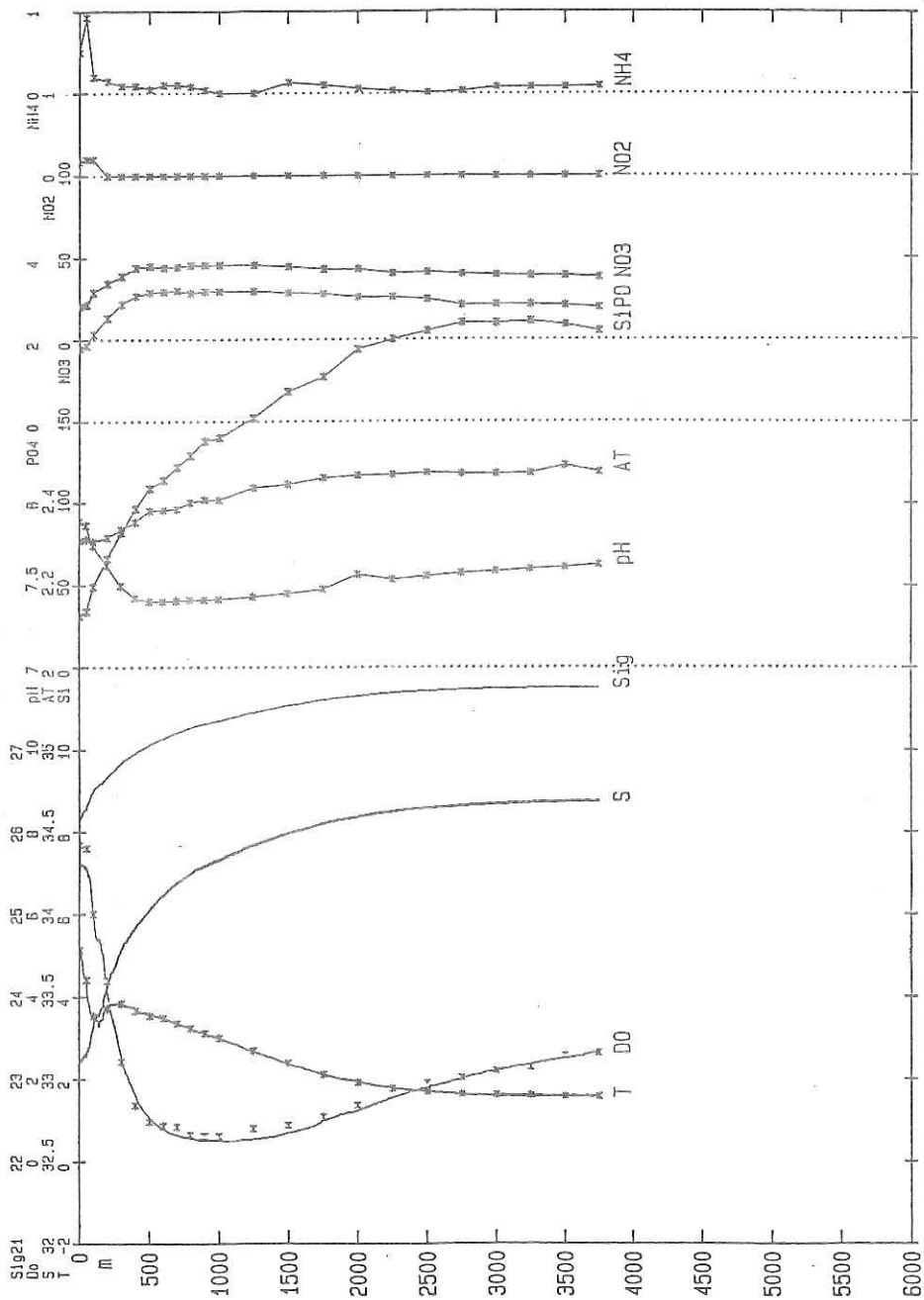


Fig. 3. Vertical profiles of temperature, salinity, sigma-t, dissolved oxygen, pH, alkalinity, silicic acid, phosphate, nitrate, nitrite and ammonium at Station C.

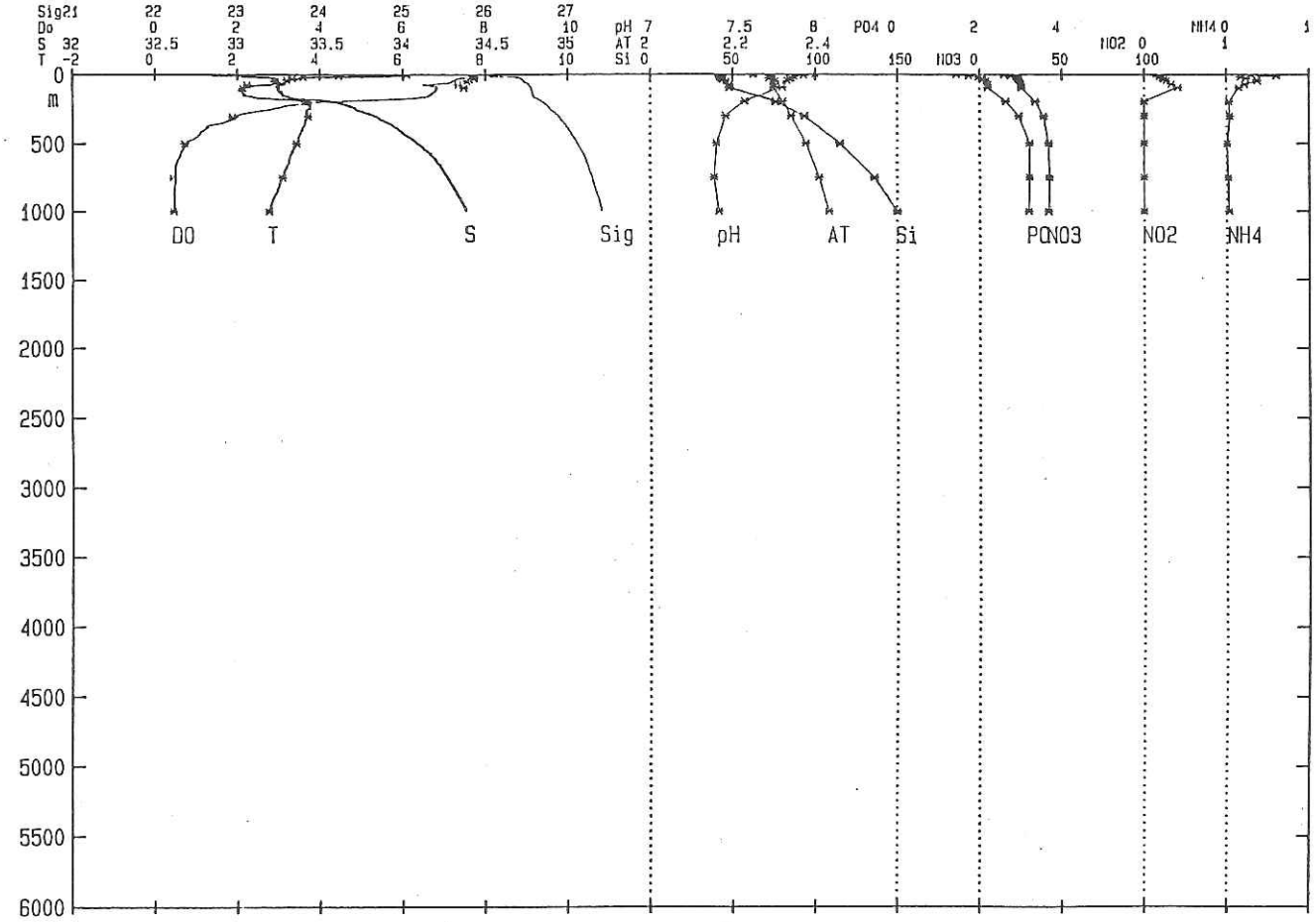


Fig. 4. Vertical profiles of temperature, salinity, sigma-t, dissolved oxygen, pH, alkalinity, silicic acid, phosphate, nitrate, nitrite and ammonium at Station 1.

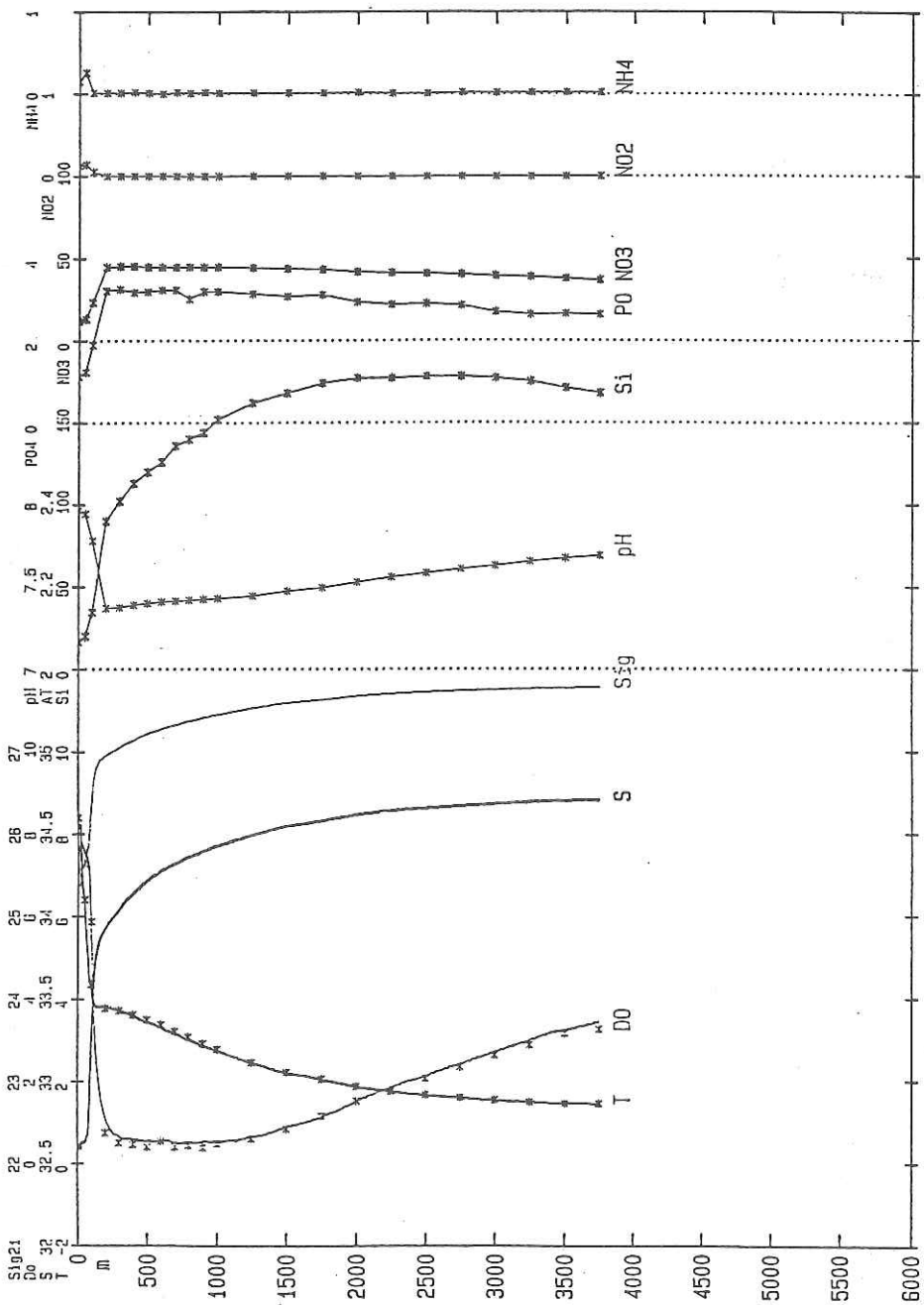


Fig. 5. Vertical profiles of temperature, salinity, sigma-t, dissolved oxygen, pH, alkalinity, silicic acid, phosphate, nitrate, nitrite and ammonium at Station E.

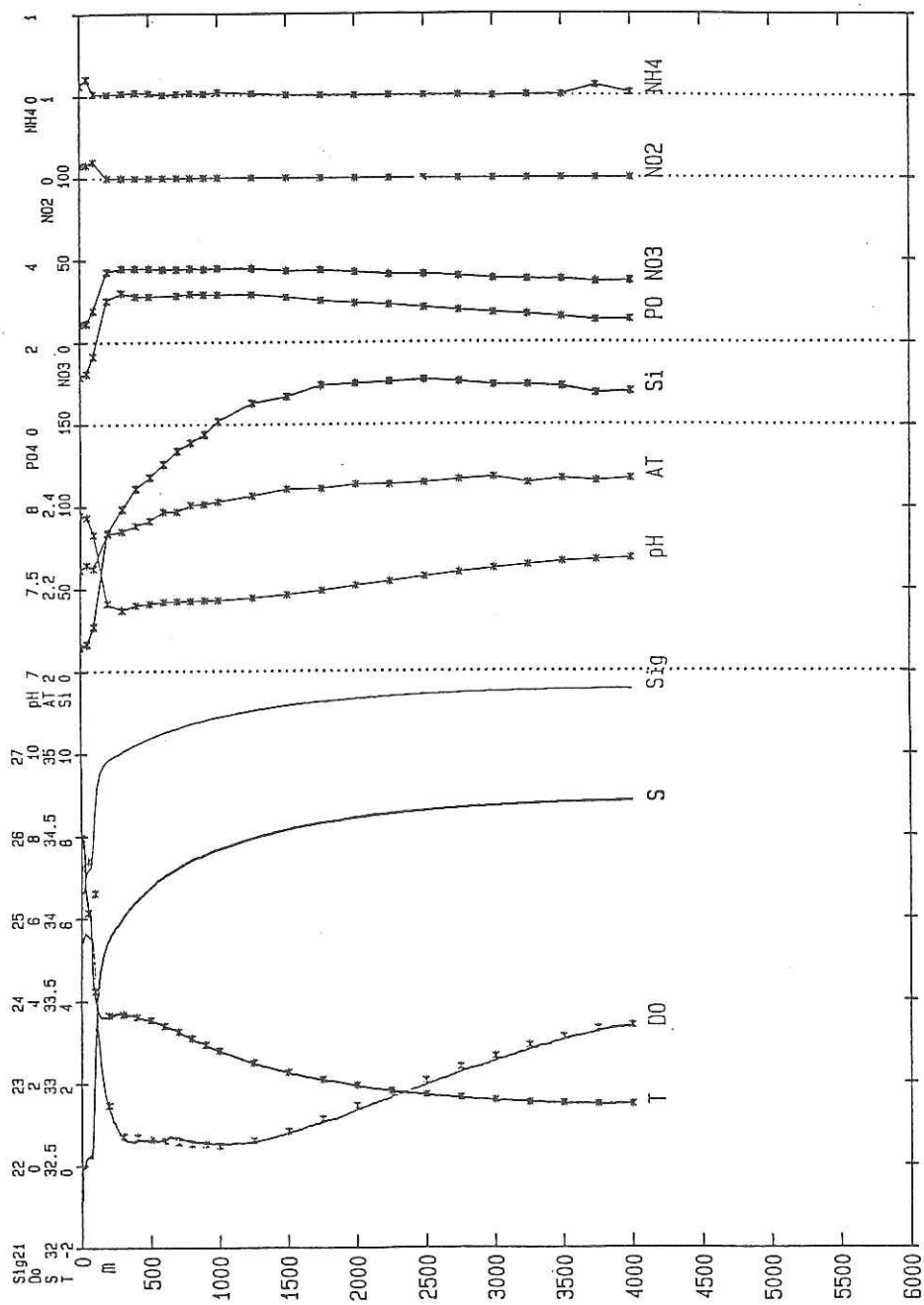


Fig. 6. Vertical profiles of temperature, salinity, sigma-t, dissolved oxygen, pH, alkalinity, silicic acid, phosphate, nitrate, nitrite and ammonium at Station F.

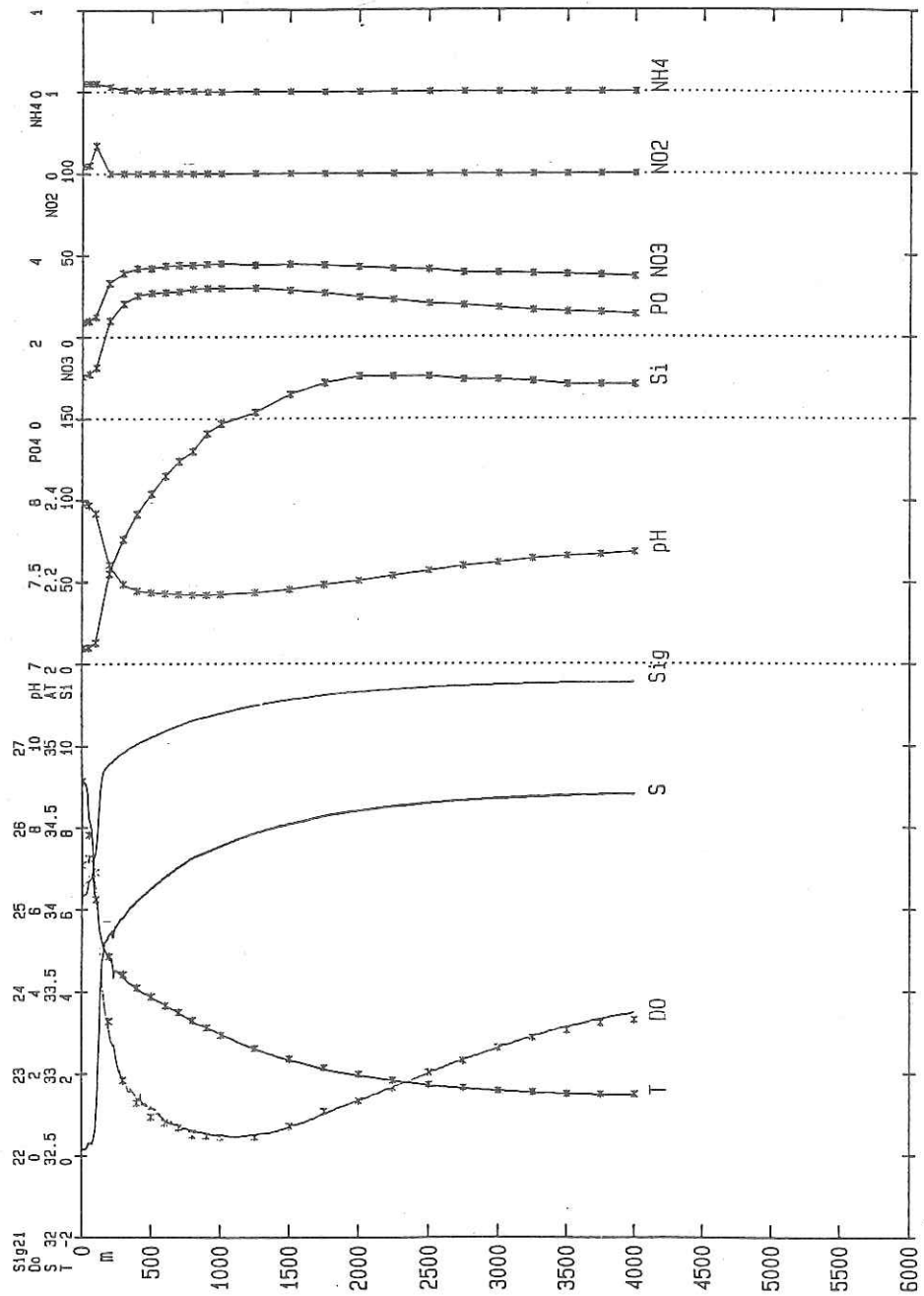


Fig. 7. Vertical profiles of temperature, salinity, sigma-t, dissolved oxygen, pH, alkalinity, silicic acid, phosphate, nitrate, nitrite and ammonium at Station G.

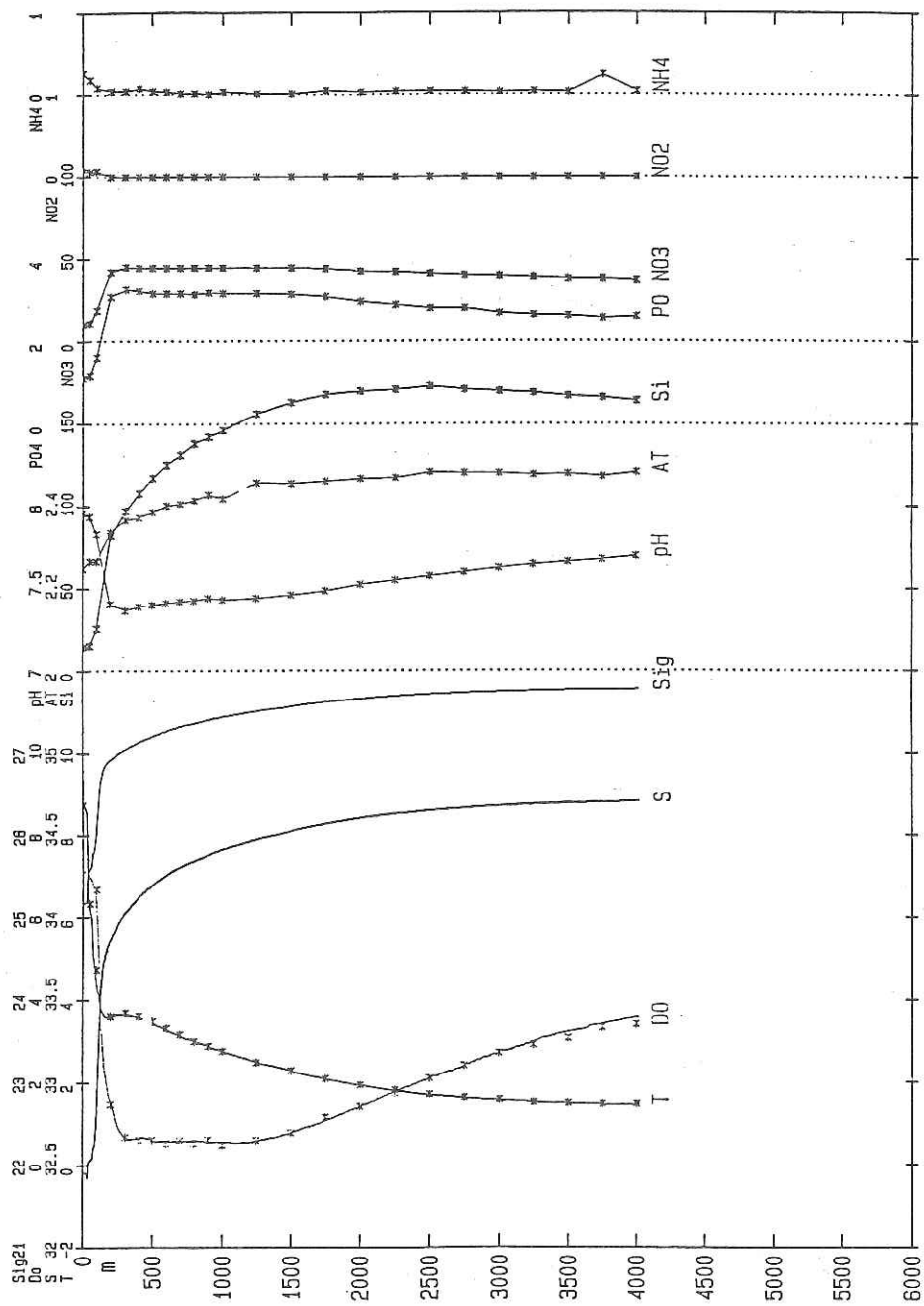


Fig. 8. Vertical profiles of temperature, salinity, sigma-t, dissolved oxygen, pH, alkalinity, silicic acid, phosphate, nitrate, nitrite and ammonium at Station F'.

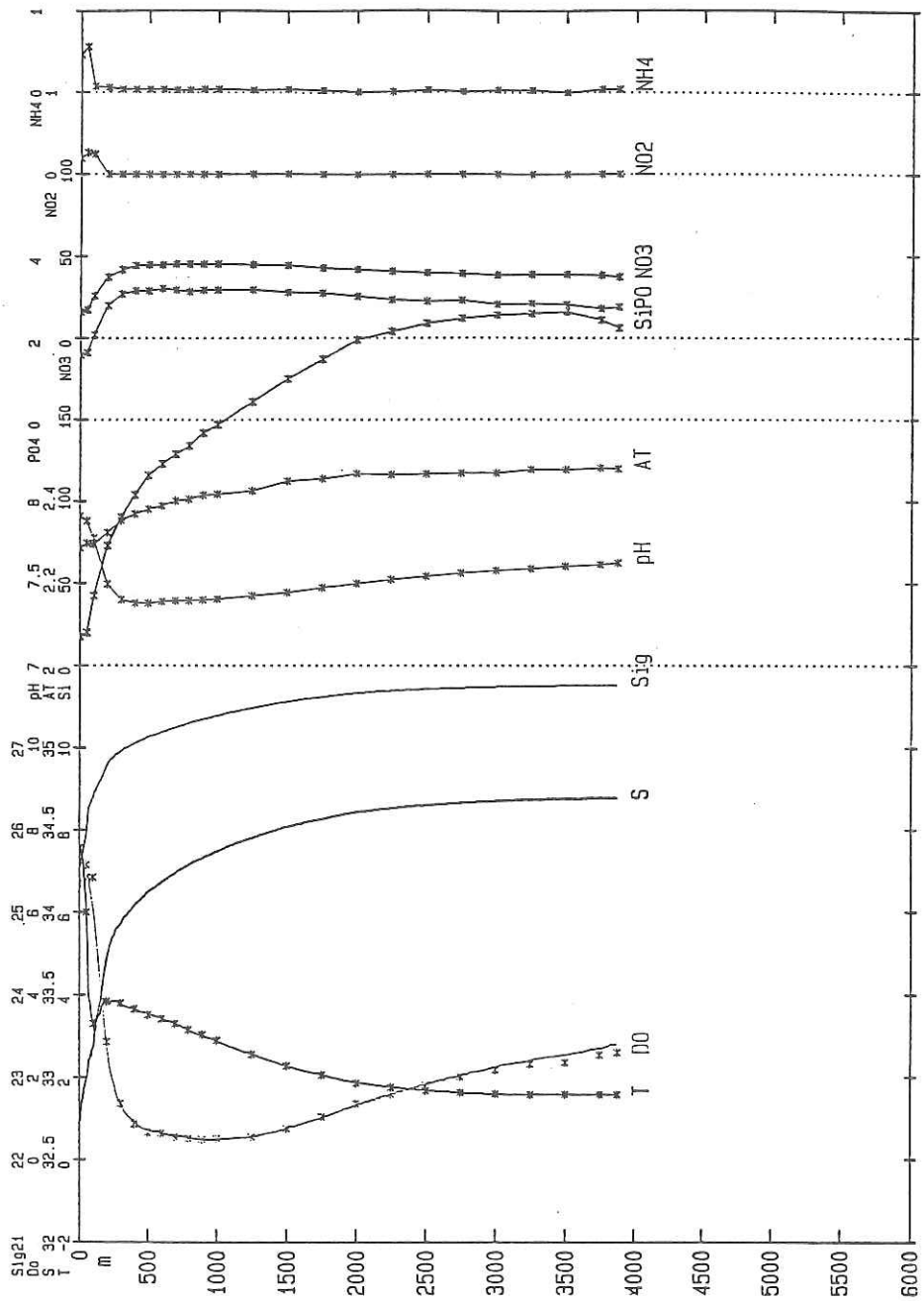


Fig. 9. Vertical profiles of temperature, salinity, sigma-t, dissolved oxygen, pH, alkalinity, silicic acid, phosphate, nitrate, nitrite and ammonium at Station C'.

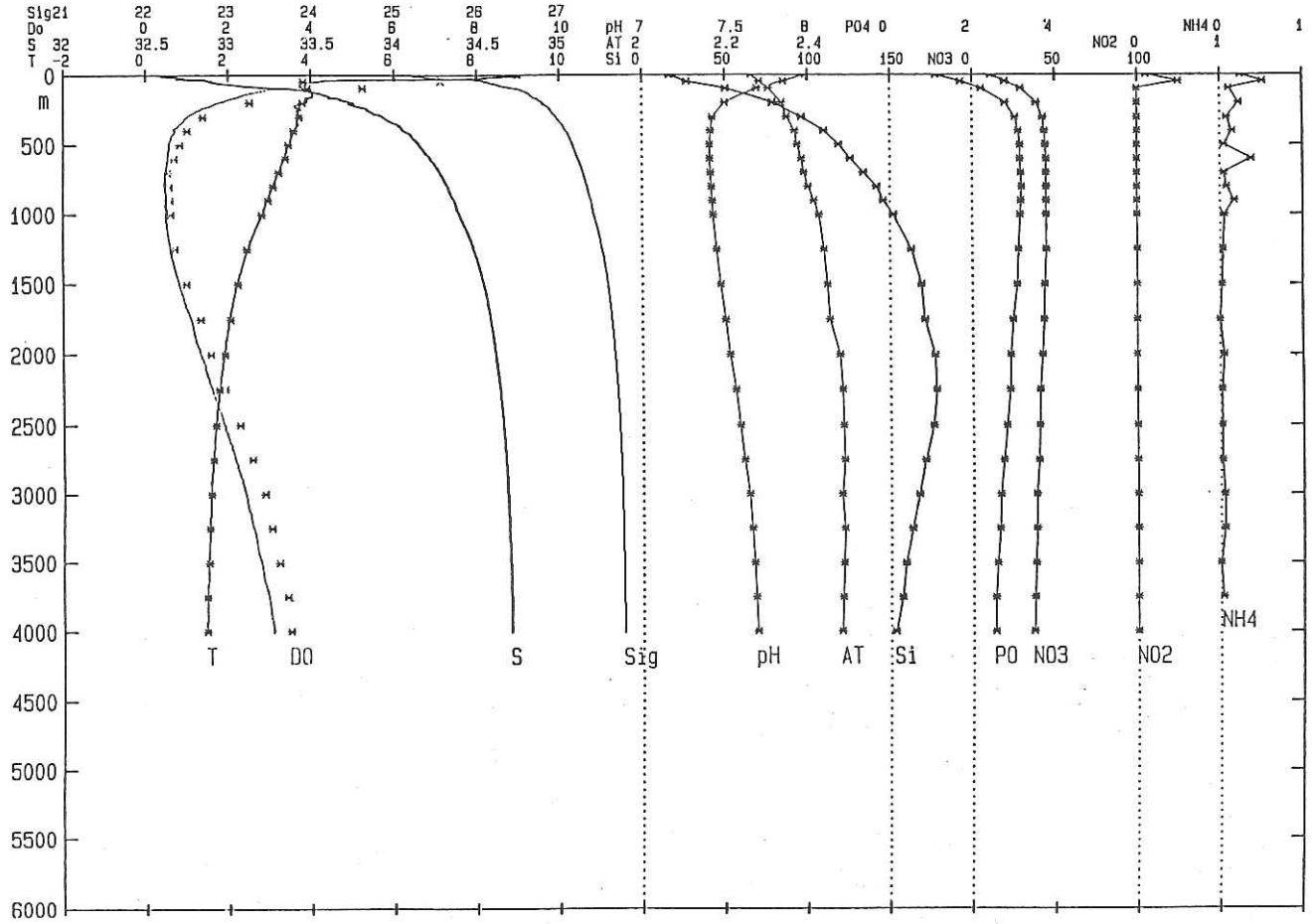


Fig. 10. Vertical profiles of temperature, salinity, sigma-t, dissolved oxygen, pH, alkalinity, silicic acid, phosphate, nitrate, nitrite and ammonium at Station H.

Table 13. Summary of hydrographic data in shallow depths at Station B

Station	B-NIS		Depth	5630 m		Date	June 9, 1986		TIME	05 : 53 - 06 : 45		Lat.	46 - 40.4 N		Long.	162 - 01.6 E			
NISKIN																			
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Pot-t	Sig-t	D-st	Sat-O	%-DO	AOU	Chl-a	Pheo.	Ptc-n	Ptc-v
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM	C		cl/t	ml/l	%	ml/l	mg/l	mg/l	1/ml	V/ml
0	0	4.20	32.996	7.81	7.867	2.335	39.6	1.82	22.1	0.29	0.26	4.200	26.17	183.3	7.32	106.6	-0.49	0.717	0.171	1783	547
15	15	3.84	32.999	7.77	7.869	2.326	39.2	1.89	22.1	0.29	0.32	3.839	26.21	179.7	7.39	105.2	-0.38	0.799	0.127	1980	1366
20	20	3.84	33.004	7.83	7.869	2.302	39.8	1.87	22.4	0.29	0.43	3.839	26.21	179.3	7.39	106.0	-0.44	0.816	0.272	1951	634
25	24	3.79	33.007	7.74	7.866	2.330	39.8	1.91	22.4	0.29	0.46	3.788	26.22	178.6	7.40	104.6	-0.34	0.868	0.296	1816	492
30	29	3.58	33.013	7.71	7.860	2.312	40.3	1.92	22.6	0.29	0.47	3.578	26.25	176.3	7.44	103.7	-0.27	0.861	0.358	1304	531
40	39	3.42	33.052	7.62	7.853	2.303	40.9	1.93	23.4	0.29	0.44	3.418	26.29	171.9	7.46	102.1	-0.16	0.781	0.368	712	138
50	49	3.28	33.087	7.78	7.821	2.302	42.0	1.93	24.5	0.29	0.48	3.277	26.33	168.0	7.49	103.9	-0.29	0.352	0.326	473	196
60	59	1.74	33.117	7.72	7.808	2.299	43.2	2.03	25.1	0.32	0.45	1.737	26.48	153.9	7.78	99.2	0.06	0.236	0.201	441	218
80	78	1.47	33.133	7.72	7.799	2.302	43.8	2.09	25.8	0.40	0.44	1.466	26.51	150.9	7.84	98.5	0.12	0.159	0.179	332	34
100	98	1.43	33.191	7.19	7.761	2.321	48.3	2.22	27.2	0.47	0.38	1.425	26.56	146.2	7.84	91.7	0.65	0.087	0.137	492	281
150	146	2.86	33.656	2.61	7.465	2.342	80.7	2.92	40.2	0.06	0.09	2.851	26.82	121.4	7.54	34.6	4.93	0.015	0.054	397	94
200	195	3.34	33.858	1.11	7.375	2.407	94.3	3.23	44.8	0.06	0.08	3.327	26.94	110.2	7.44	14.9	6.33	0.016	0.024	103	10

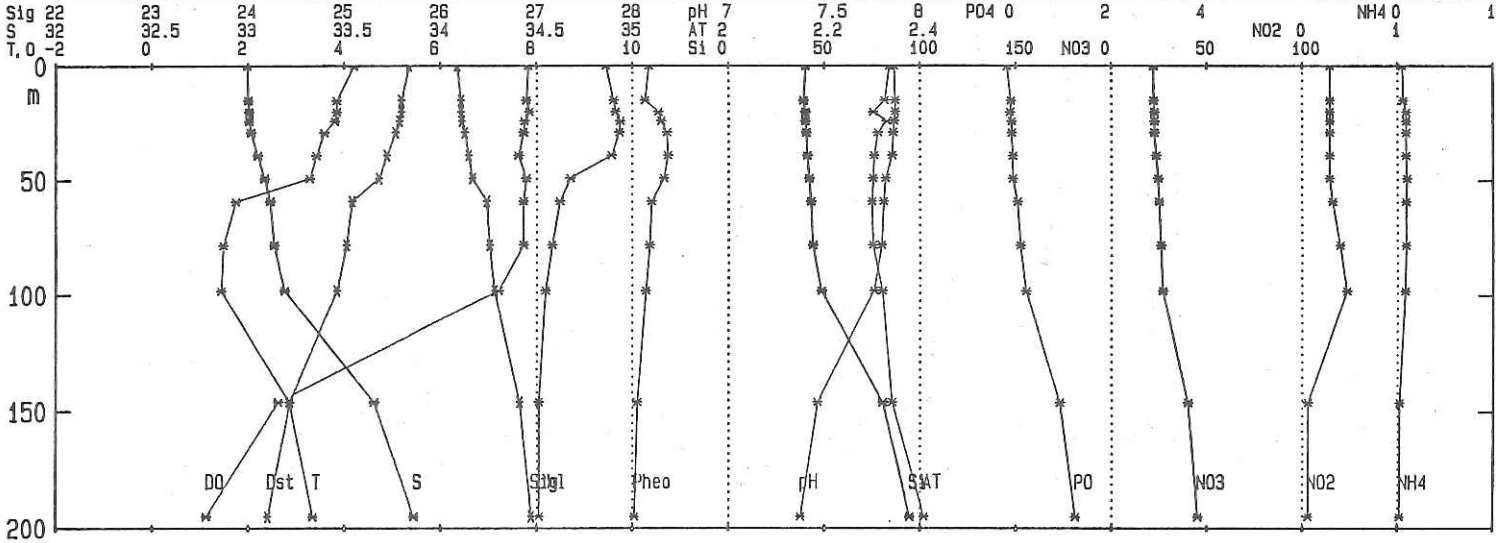


Table 14. Summary of hydrographic data in shallow depths at Station C

Station	C-NIS		Depth	3720 m		Date	June 13, 1986			TIME	17:20 - 18:01			Lat.	53 - 31.2 N			Long.	177 - 41.0 E		
NISKIN																					
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Pot-t	Sig-t	D-st	Sat-O	%-DO	AOU	Chl-a	Pheo.	Ptc-n	Ptc-v
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM	C		cl/t	ml/l	%	ml/l	mg/l	mg/l	i/ml	V/ml
0	0	5.20	33.113	7.51	7.889	2.324	31.8	1.63	19.9	0.17	0.48	5.200	26.16	184.8	7.14	105.2	-0.37	0.868	0.150	1725	459
15	15	5.19	33.113	7.56	7.887	2.322	31.8	1.75	19.9	0.17	0.50	5.189	26.16	184.7	7.14	105.8	-0.42	0.880	0.181	2085	430
20	20	5.04	33.113	7.57	7.893	2.305	31.8	1.78	19.8	0.16	0.43	5.038	26.18	183.1	7.17	105.6	-0.40	0.967	0.196	2310	396
25	25	4.76	33.124	7.56	7.885	2.314	32.4	1.82	20.2	0.17	0.48	4.758	26.21	179.3	7.22	104.7	-0.34	1.029	0.309	1507	237
30	30	4.70	33.130	7.50	7.883	2.308	33.0	1.80	20.5	0.17	0.51	4.698	26.23	178.2	7.23	103.8	-0.27	1.190	0.322	1212	339
40	40	4.51	33.141	7.35	7.868	2.315	34.1	1.88	21.0	0.17	0.76	4.507	26.26	175.5	7.26	101.2	-0.09	0.682	0.336	572	60
50	50	4.41	33.129	7.33	7.865	2.297	34.7	1.87	21.4	0.17	0.87	4.406	26.26	175.4	7.28	100.7	-0.05	0.446	0.226	719	97
60	59	4.18	33.165	7.35	7.849	2.314	38.6	1.97	21.8	0.20	1.01	4.176	26.31	170.4	7.32	100.4	-0.03	0.322	0.259	520	119
80	79	3.70	33.220	6.67	7.782	2.297	45.5	2.08	25.3	0.22	0.62	3.695	26.40	161.7	7.40	90.1	0.73	0.104	0.163	446	195
100	99	3.55	33.310	5.79	7.714	2.308	51.1	2.23	28.7	0.00	0.08	3.544	26.49	153.5	7.43	78.0	1.64	0.047	0.177	435	75
150	149	3.52	33.417	5.14	7.662	2.318	60.2	2.43	31.3	0.00	0.07	3.510	26.57	145.2	7.43	69.2	2.29	0.026	0.135	398	103
200	198	3.76	33.552	4.21	7.609	2.332	65.9	2.48	33.4	0.00	0.00	3.746	26.66	137.2	7.38	57.1	3.17	0.025	0.113	491	52

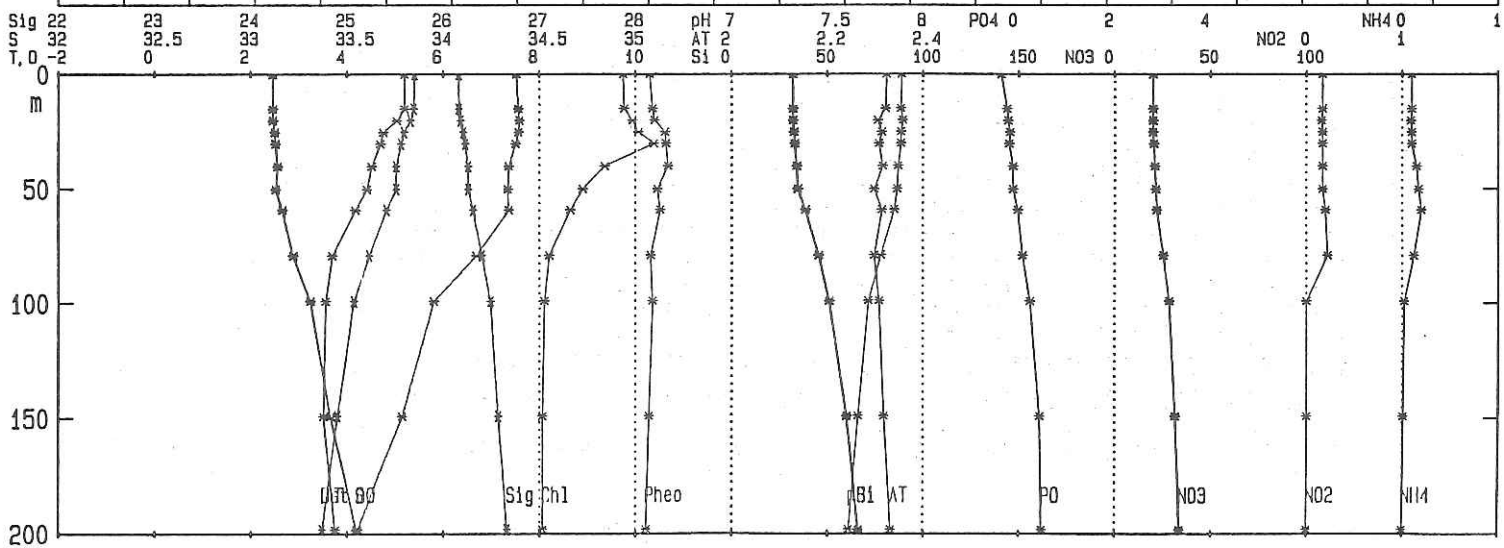


Table 15. Summary of hydrographic data in shallow depths at Station E

Station	E-NIS	Depth	3910 m	Date	June 28, 1986	TIME	09:01 - 09:48	Lat.	56 - 00.9 N	Long.	145 - 01.6 W

NISKIN

Sample No.	D m	T C	S	D.O. ml/l	pH	AT meq/l	SiO2 uM	PO4 uM	NO3 uM	NO2 uM	NH4 uM	Pot-t C	Sig-t	D-st cl/t	Sat-O ml/l	%-DO %	AOU ml/l	Chl-a mg/l	Pheo. mg/l	Ptc-n 1/ml	Ptc-v V/ml
0	0	8.40	32.600	7.08	7.961	-----	15.6	1.19	11.7	0.12	0.11	8.400	25.33	263.3	6.65	106.5	-0.43	0.645	0.097	1027	353
10	10	8.27	32.603	7.16	7.963	-----	15.6	1.19	11.7	0.12	0.12	8.269	25.35	261.2	6.67	107.4	-0.49	0.422	0.102	1121	702
20	19	8.15	32.599	7.19	7.961	-----	15.0	1.21	11.5	0.12	0.10	8.148	25.37	259.8	6.69	107.5	-0.50	0.558	0.126	1128	731
25	24	7.46	32.607	7.44	7.966	-----	15.0	1.19	11.7	0.12	0.17	7.458	25.47	249.9	6.79	109.5	-0.65	0.645	0.170	1181	451
30	29	7.16	32.616	7.44	7.959	-----	15.6	1.22	11.9	0.12	0.10	7.157	25.52	245.3	6.84	108.8	-0.60	0.732	0.243	1355	621
40	39	6.60	32.621	7.38	7.943	-----	16.7	1.34	12.6	0.12	0.07	6.597	25.60	237.9	6.93	106.5	-0.45	0.508	0.233	783	298
50	49	6.26	32.615	7.24	7.928	-----	17.9	1.31	13.8	0.12	0.26	6.256	25.64	234.2	6.99	103.6	-0.25	0.409	0.304	650	748
60	58	5.65	32.632	7.25	7.914	-----	18.4	1.37	14.3	0.14	0.39	5.645	25.72	225.9	7.09	102.3	-0.16	0.310	0.213	539	188
80	78	4.96	32.754	7.06	7.882	-----	20.1	1.51	15.7	0.25	0.54	4.954	25.90	209.2	7.20	98.1	0.14	0.179	0.111	420	541
100	97	4.44	33.259	5.92	7.791	-----	31.2	1.77	22.7	0.05	0.00	4.433	26.36	165.9	7.27	81.5	1.35	0.078	0.057	350	105
150	146	3.82	33.816	1.62	7.429	-----	77.0	3.00	42.6	0.00	0.00	3.810	26.86	117.8	7.35	22.0	5.73	0.018	0.025	195	77
200	194	3.81	33.916	0.75	7.323	-----	88.2	3.24	45.8	0.00	0.00	3.797	26.94	110.2	7.35	10.2	8.60	0.017	0.027	124	118

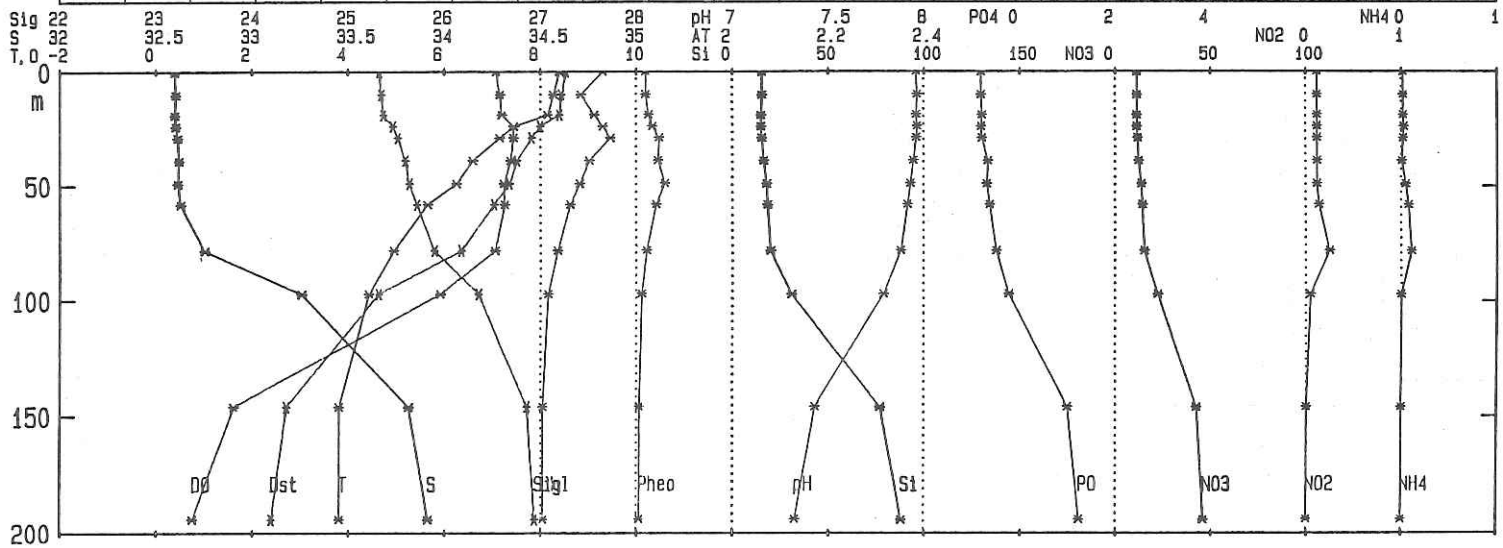


Table 16. Summary of hydrographic data in shallow depths at Station F

Station	F-NIS		Depth	4100 m		Date	June 29, 1986			TIME	14:07 - 14:37			Lat.	53 - 02.9 N		Long.	144 - 59.6 W			
NISKIN Sample No.	D m	T C	S	D.O. ml/l	pH	AT meq/l	SiO2 uM	PO4 uM	NO3 uM	NO2 uM	NH4 uM	Pot-t C	Sig-t	D-st cl/t	Sat-O ml/l	%-DO %	AOU ml/l	Chl-a mg/l	Pheo. mg/l	Ptc-n 1/ml	Ptc-v V/ml
0	0	8.40	32.454	7.19	7.949	2.241	14.9	1.14	10.7	0.15	0.12	8.400	25.22	274.2	6.65	108.0	-0.54	0.199	0.055	926	98
10	10	8.06	32.457	7.17	7.953	2.240	14.9	1.16	11.2	0.15	0.14	8.059	25.27	269.2	6.71	106.9	-0.46	0.197	0.046	871	83
20	20	7.34	32.504	7.32	7.951	2.236	15.5	1.16	11.2	0.15	0.13	7.338	25.41	256.0	6.82	107.4	-0.50	0.249	0.079	755	95
25	24	6.33	32.520	7.39	7.949	2.236	15.5	1.18	11.2	0.15	0.12	6.328	25.55	242.2	6.98	105.9	-0.41	0.252	0.106	648	314
30	29	6.74	32.522	7.40	7.949	2.240	15.5	1.17	11.3	0.15	0.12	6.737	25.50	247.0	6.91	107.1	-0.49	0.247	0.114	514	66
40	39	6.52	32.526	7.42	7.942	2.251	15.5	1.18	11.6	0.15	0.16	6.517	25.53	244.0	6.95	106.8	-0.47	0.267	0.144	538	154
50	49	6.35	32.524	7.39	7.939	2.252	15.5	1.23	11.6	0.15	0.16	6.346	25.55	242.1	6.98	105.9	-0.41	0.280	0.181	410	339
60	59	6.21	32.531	7.35	7.936	2.255	16.0	1.22	12.1	0.16	0.19	6.205	25.58	239.9	7.00	105.0	-0.35	0.307	0.213	345	84
80	78	5.74	32.548	7.34	7.922	2.243	16.6	1.28	12.8	0.18	0.50	5.734	25.65	233.2	7.08	103.7	-0.26	0.199	0.188	262	146
100	98	4.64	32.636	7.18	7.879	2.267	20.5	1.44	15.2	0.34	0.37	4.633	25.84	214.8	7.26	98.9	0.08	0.164	0.144	190	94
150	146	3.73	33.580	3.12	7.533	2.310	65.3	2.68	37.3	0.00	0.03	3.720	26.68	134.8	7.38	42.3	4.26	0.020	0.042	219	23
200	195	3.67	33.611	1.57	7.419	2.332	82.4	3.03	43.4	0.00	0.03	3.657	26.87	116.8	7.38	21.3	5.81	0.011	0.022	117	8

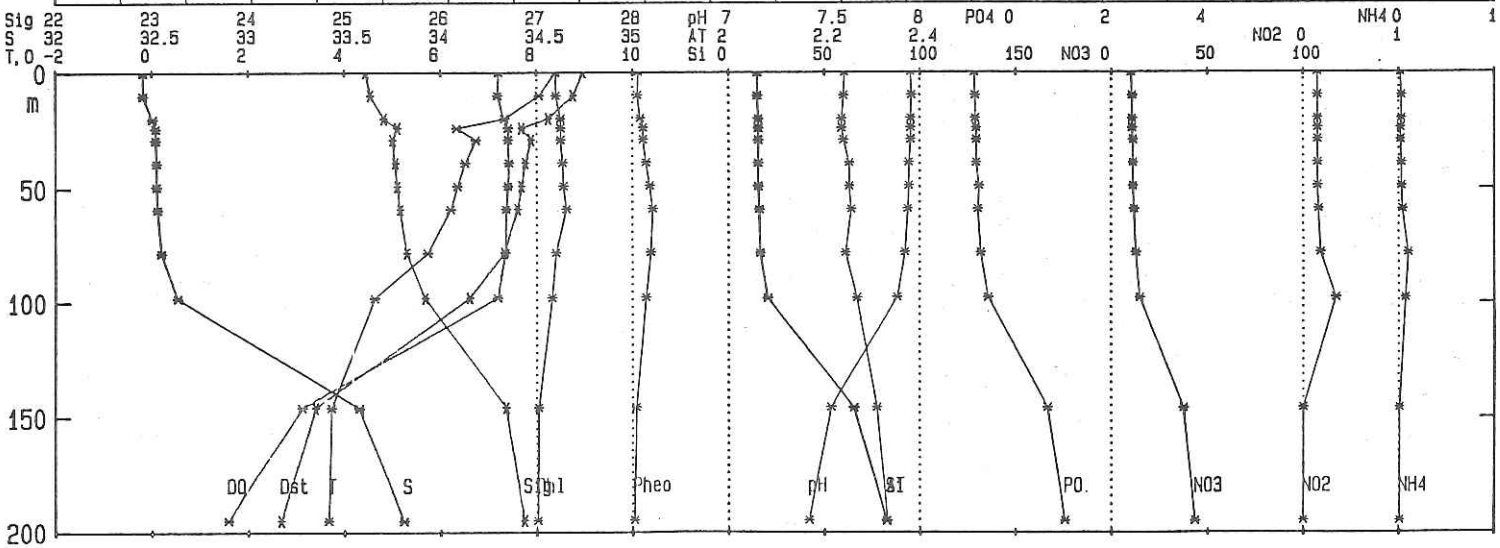


Table 17. Summary of hydrographic data in shallow depths at Station G

Station	G-NIS		Depth	4260 m		Date	June 30, 1986			TIME	19 : 48 - 20 : 22			Lat.	50 - 01.5 N			Long.	144 - 57.9 W		
NISKIN																					
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Pot-t	Sig-t	D-st	Sat-O	%-DO	AOU	Chl-a	Pheo.	Ptc-n	Ptc-v
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM	C		cl/t	ml/l	%	ml/l	mg/l	mg/l	1/ml	V/ml
0	0	9.10	32.522	7.01	7.976	-----	9.5	1.04	9.30	0.10	0.14	9.100	25.16	279.3	6.55	107.1	-0.46	0.407	0.059	1501	999
10	10	9.02	32.517	7.07	7.980	-----	9.5	1.03	9.30	0.10	0.10	9.019	25.17	278.4	6.56	107.8	-0.51	0.345	0.071	1393	148
20	19	9.00	32.518	7.06	7.980	-----	9.5	1.03	9.10	0.10	0.10	8.998	25.18	278.1	6.56	107.6	-0.50	0.340	0.068	1251	131
25	24	9.00	32.518	7.08	7.983	-----	9.5	1.04	9.00	0.10	0.11	8.997	25.18	278.1	6.56	107.9	-0.52	0.355	0.061	1371	412
30	29	8.70	32.539	7.17	7.982	-----	9.5	1.04	9.00	0.10	0.10	8.697	25.24	272.1	6.61	108.5	-0.56	0.536	0.139	1838	871
40	38	8.18	32.545	7.30	7.975	-----	9.5	1.08	9.40	0.10	0.10	8.176	25.32	264.3	6.68	109.2	-0.62	0.645	0.170	1783	275
50	48	7.89	32.561	7.20	7.969	-----	10.0	1.08	9.50	0.10	0.10	7.885	25.37	259.1	6.73	107.0	-0.47	0.625	0.190	1575	692
60	58	7.50	32.557	7.24	7.958	-----	11.7	1.13	10.4	0.17	0.17	7.494	25.43	254.2	6.78	106.6	-0.45	0.498	0.194	693	180
80	77	6.42	32.604	7.25	7.945	-----	10.6	1.20	10.9	0.38	0.38	6.413	25.61	237.0	6.96	104.2	-0.29	0.242	0.145	386	351
100	96	6.27	32.723	6.93	7.924	-----	12.3	1.26	12.4	0.10	0.10	6.262	25.72	226.3	6.98	99.3	0.05	0.126	0.084	177	139
150	144	5.14	33.543	4.88	7.738	-----	34.6	1.95	25.8	0.02	0.02	5.129	26.50	151.8	7.13	68.4	2.25	0.017	0.023	171	148
200	192	4.76	33.784	3.46	7.616	-----	54.1	2.39	32.8	0.02	0.02	4.745	26.74	129.6	7.19	48.1	3.73	0.006	0.027	237	998

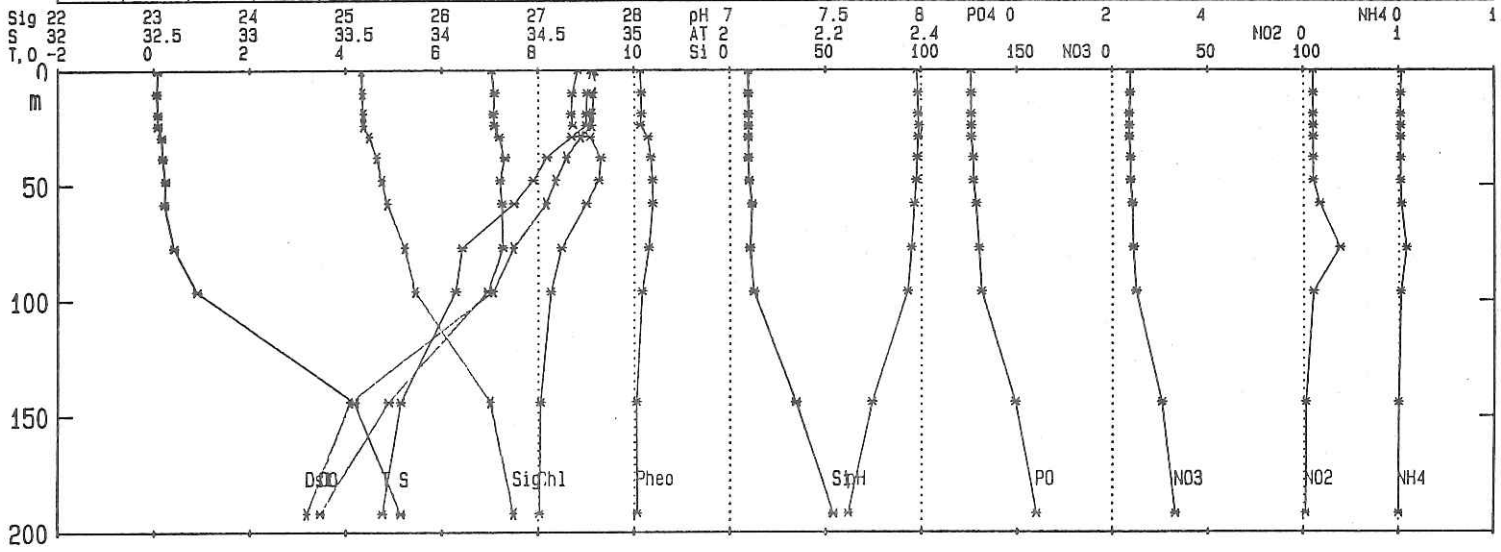


Table 18. Summary of hydrographic data in shallow depths at Station F'

Station	F'-NIS	Depth	4100 m	Date	July 15, 1986	TIME	02 : 06 - 02 : 46	Lat.	53 - 01.0 N	Long.	144 - 56.2 W

NISKIN

Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Pot-t	Sig-t	D-st	Sat-D	%-DO	AOU	Chl-a	Pheo.	Ptc-n	Ptc-v
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM	C		cl/t	ml/l	%	ml/l	mg/l	mg/l	l/ml	V/ml
0	0	8.90	32.439	7.05	7.961	2.241	13.9	1.12	10.0	0.07	0.27	8.900	25.13	282.5	6.58	107.1	-0.47	0.434	0.061	1643	197
10	10	8.77	32.437	7.11	7.960	2.251	13.9	1.13	10.0	0.07	0.23	8.769	25.15	280.7	6.60	107.7	-0.51	0.360	0.051	1513	610
20	20	8.71	32.446	7.12	7.958	2.251	13.9	1.15	10.2	0.08	0.23	8.708	25.16	279.2	6.61	107.7	-0.51	0.355	0.047	1204	362
25	25	8.66	32.441	7.13	7.958	2.249	13.9	1.17	10.2	0.08	0.26	8.657	25.14	281.8	6.59	108.3	-0.54	0.353	0.040	1055	220
30	30	8.64	32.443	7.10	7.959	2.249	13.9	1.17	10.0	0.07	0.24	8.637	25.17	278.4	6.62	107.3	-0.48	0.355	0.070	1309	691
40	39	8.58	32.443	7.12	7.957	2.254	13.9	1.16	10.2	0.07	0.22	8.576	25.18	277.6	6.63	107.4	-0.49	0.409	0.114	1295	168
50	49	6.95	32.507	7.42	7.944	2.250	15.6	1.21	10.7	0.07	0.26	6.946	25.46	250.8	6.88	107.9	-0.54	0.372	0.108	1221	385
60	59	6.28	32.516	7.48	7.930	2.253	15.0	1.12	11.4	0.09	0.18	6.275	25.56	241.9	6.99	107.1	-0.49	0.360	0.164	772	558
80	79	5.41	32.558	7.37	7.910	2.258	16.2	1.34	12.7	0.18	0.50	5.404	25.69	226.8	7.13	103.3	-0.24	0.302	0.200	428	124
100	99	4.43	32.763	6.65	7.830	2.270	24.9	1.61	18.6	0.06	0.10	4.423	25.96	203.2	7.29	91.2	0.64	0.151	0.121	277	44
150	148	3.71	33.641	2.65	7.490	2.327	66.0	2.83	37.6	0.00	0.10	3.700	26.73	130.0	7.38	35.9	4.73	0.017	0.037	301	22
200	197	3.60	33.825	1.54	7.411	2.346	81.6	3.08	42.6	0.00	0.07	3.587	26.89	115.1	7.39	20.8	5.85	0.010	0.026	217	128

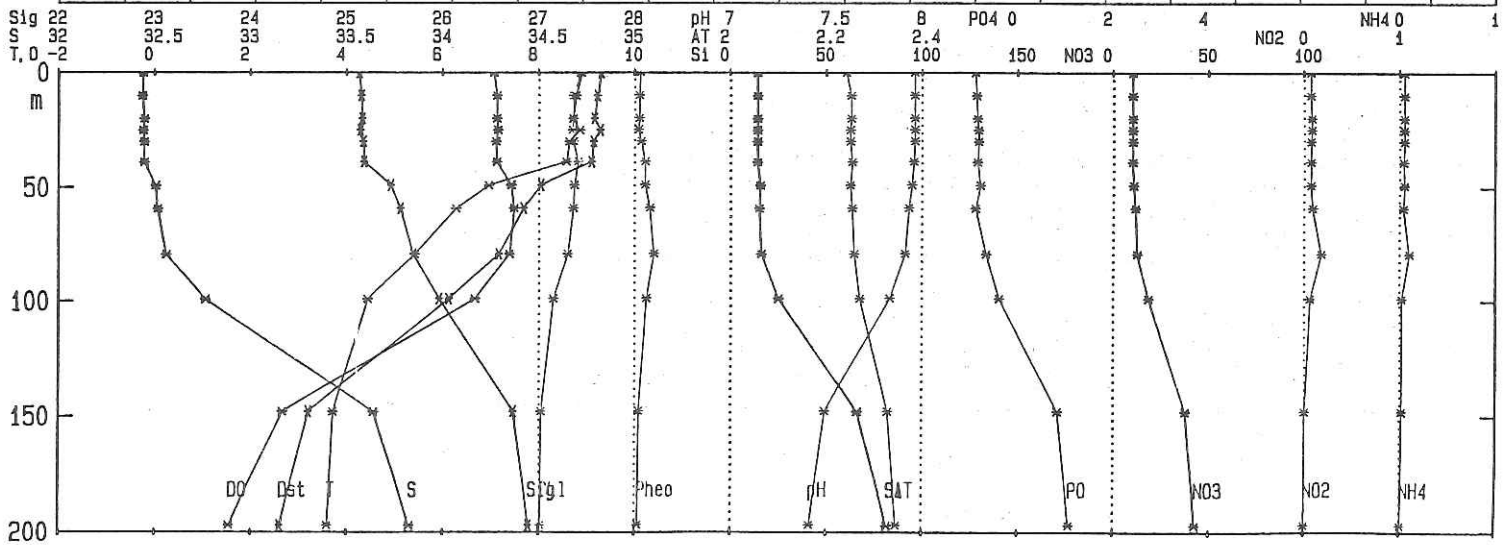


Table 19. Summary of hydrographic data in shallow depths at Station C'

Station	C'-NIS	Depth	3930 m	Date	July 22, 1986	TIME	15 : 16 - 16 : 00	Lat.	53 - 30.5 N	Long.	177 - 32.1 E

NISKIN

Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Pot-t	Sig-t	D-st	Sat-O	%-DO	AOU	Chl-a	Pheo.	Ptc-n	Ptc-v
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM	C		cl/t	ml/l	%	ml/l	mg/l	mg/l	i/ml	V/ml
0	0	7.55	32.906	7.14	7.904	2.286	16.3	1.12	15.7	0.18	0.47	7.550	25.69	228.7	6.77	105.5	-0.37	0.533	0.150	2499	1093
10	10	7.42	32.910	7.14	7.906	2.290	16.3	1.13	15.7	0.18	0.44	7.419	25.72	226.7	6.79	105.2	-0.35	0.533	0.165	2519	1091
20	20	7.26	32.917	7.14	7.906	2.274	16.3	1.51	15.8	0.18	0.49	7.258	25.74	224.1	6.81	104.8	-0.33	0.608	0.163	2165	522
25	24	7.15	32.930	7.18	7.908	2.282	16.3	1.51	15.8	0.18	0.56	7.148	25.77	221.7	6.83	105.2	-0.35	0.595	0.205	2227	957
30	29	7.04	32.951	7.17	7.909	2.294	17.6	1.49	16.0	0.17	0.67	7.037	25.80	218.7	6.84	104.8	-0.33	0.570	0.230	2122	709
40	39	6.55	32.976	7.13	7.889	2.296	18.8	1.58	16.6	0.22	0.56	6.547	25.88	210.7	6.92	103.0	-0.21	0.843	0.335	1976	725
50	49	5.93	33.004	7.15	7.874	2.290	20.1	1.65	18.1	0.27	0.64	5.926	25.98	201.2	7.02	101.8	-0.13	0.744	0.361	1579	226
60	59	5.32	33.049	7.39	7.868	2.303	23.9	1.76	19.1	0.28	0.76	5.315	26.09	190.9	7.12	103.7	-0.27	0.570	0.273	1239	283
80	78	3.75	33.125	7.09	7.793	2.284	33.9	2.00	23.1	0.27	0.40	3.745	26.32	169.3	7.40	95.8	0.31	0.434	0.337	1127	557
100	98	3.32	33.179	6.79	7.759	2.297	40.2	2.14	26.8	0.03	0.04	3.314	26.40	161.4	7.48	90.8	0.69	0.113	0.147	447	190
150	146	3.50	33.299	6.70	7.721	2.302	52.8	2.29	29.8	0.00	0.07	3.490	26.48	153.9	7.44	90.1	0.74	0.023	0.063	410	82
200	195	3.85	33.664	2.83	7.492	2.318	71.6	2.76	38.4	0.00	0.09	3.837	26.74	129.6	7.35	38.5	4.52	0.011	0.085	1132	115

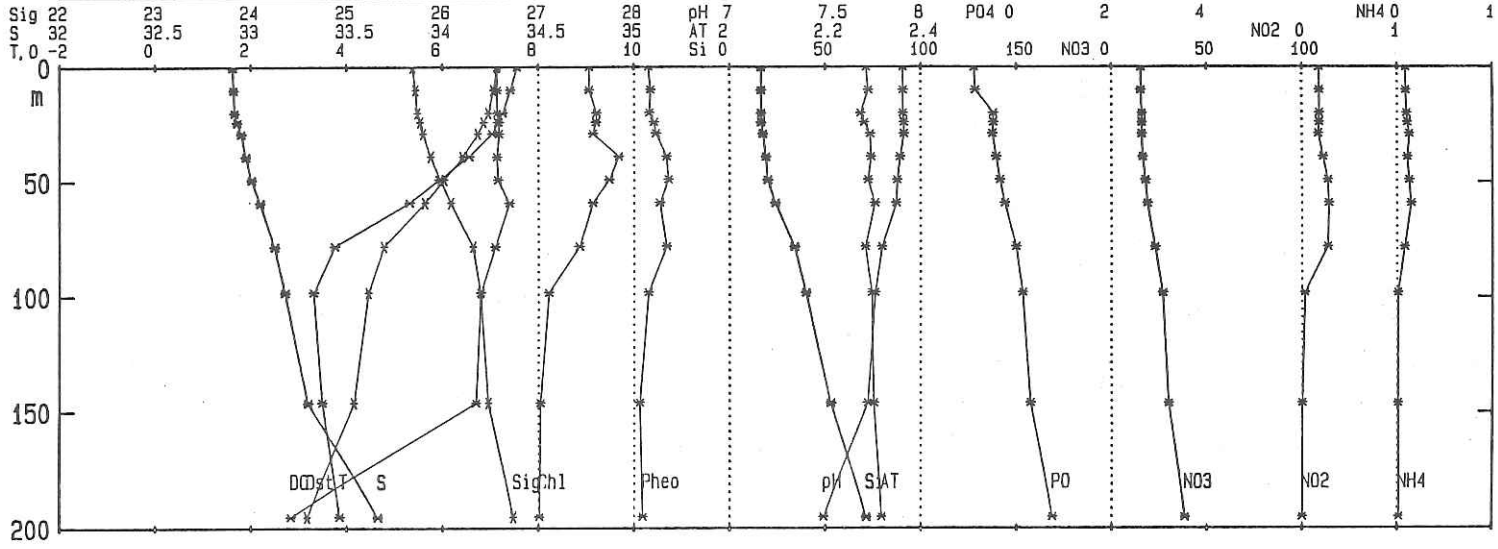


Table 20. Summary of hydrographic data in shallow depths at Station H

Station	H-NIS	Depth	4820 m	Date	July 25, 1986	TIME	03 : 37 - 04 : 13	Lat.	51 - 05.0 N	Long.	170 - 56.8 E

NISKIN

Sample No.	D m	T C	S	D.O. ml/l	pH	AT meq/l	SiO2 uM	PO4 uM	NO3 uM	NO2 uM	NH4 uM	Pot-t C	Sig-t	D-st cl/t	Sat-O ml/l	%-DO %	AOU ml/l	Chl-a mg/l	Pheo. mg/l	Ptc-n 1/ml	Ptc-v V/ml
0	0	9.00	32.595	7.01	7.991	2.263	16.5	1.12	11.1	0.11	0.28	9.000	25.24	272.3	6.56	106.9	-0.45	1.017	0.176	3686	1472
10	10	8.25	32.689	7.14	7.988	2.272	17.7	1.13	11.6	0.11	0.26	8.249	25.42	254.5	6.67	107.1	-0.47	1.012	0.304	3972	1502
20	19	7.69	32.757	7.17	7.976	2.275	18.9	1.25	12.3	0.12	0.38	7.688	25.56	241.8	6.75	106.2	-0.42	0.990	0.533	3068	556
25	24	6.45	32.860	7.32	7.938	2.274	22.4	1.42	14.8	0.17	0.48	6.448	25.81	218.2	6.94	105.4	-0.38	1.078	0.522	2821	562
30	29	5.58	32.893	7.26	7.905	2.279	23.6	1.52	16.4	0.24	1.00	5.578	25.94	205.5	7.09	102.4	-0.17	0.990	0.558	1971	523
40	38	4.50	32.876	7.25	7.881	2.282	23.6	1.62	17.6	0.45	1.04	4.497	26.05	195.3	7.28	99.7	0.03	0.521	0.305	836	363
50	48	4.09	32.886	7.18	7.866	2.284	24.8	1.70	18.9	0.59	1.40	4.087	26.10	190.6	7.35	97.7	0.17	0.270	0.174	741	4356
60	58	3.81	32.925	7.01	7.840	2.285	29.5	1.76	21.4	0.29	0.12	3.806	26.15	185.0	7.40	94.8	0.39	0.139	0.145	614	62
80	79	3.78	33.094	6.11	7.767	2.293	38.9	2.01	25.5	0.00	0.14	3.775	26.29	172.0	7.39	82.6	1.28	0.056	0.091	522	369
100	96	3.84	33.268	5.26	7.700	2.308	48.3	2.18	29.3	0.00	0.14	3.834	26.42	159.4	7.38	71.3	2.12	0.052	0.076	409	141
150	144	4.08	33.535	3.95	7.605	2.327	66.0	2.50	34.0	0.00	0.12	4.070	26.61	141.5	7.32	54.0	3.37	0.011	0.080	494	50
200	192	3.82	33.714	2.63	7.506	2.332	75.5	2.62	38.6	0.00	0.17	3.807	26.78	125.5	7.36	35.7	4.73	0.005	0.069	856	131

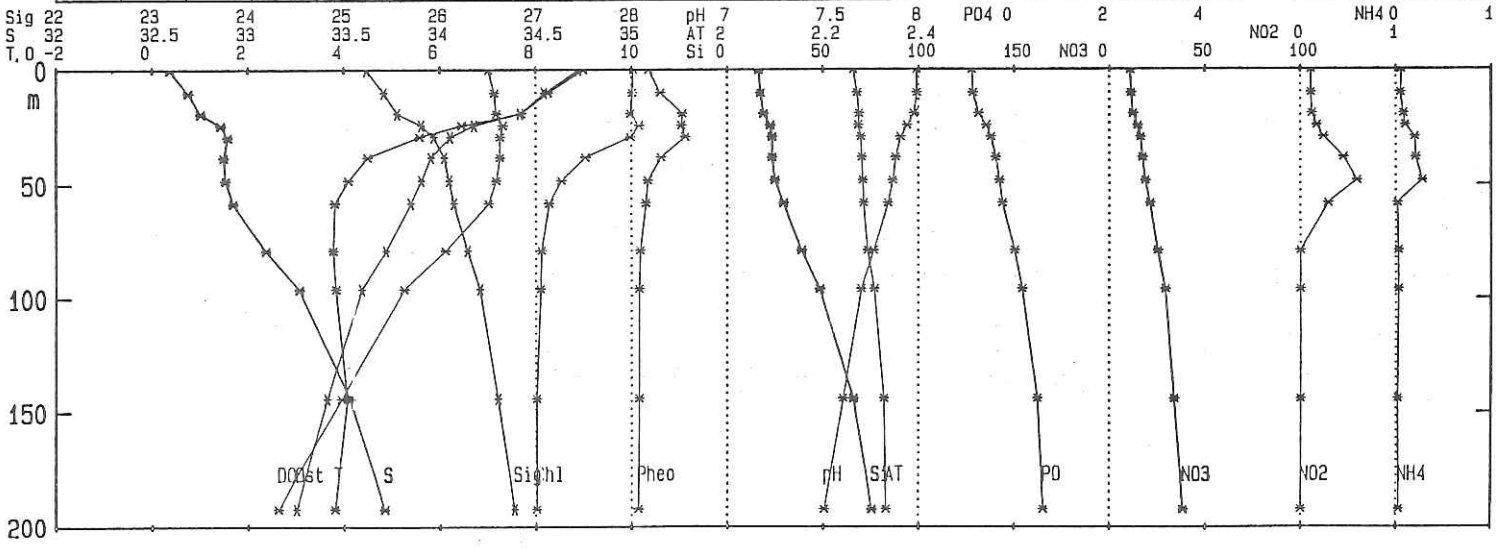


Table 21. Summary of OCTOPUS data at Station C

Station	C/DN	Depth	3520 m	Date	June 16, 1986	TIME	09 : 42 - 10 : 00	Lat.	52 - 58.8 N	Long.	178 - 27.0 E

				BMS										OCTOPUS					VanDorn		
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Sig-t	%-DO	AOU	Aqua	XMS	Q-s	Q-a	D(vd)	Chl-a	Pheo.
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM		%	ml/l	mv	mv	mv	mv	m	mg/l	mg/l
0	0	5.40	33.117	7.41	----	----	30.6	----	19.1	0.18	0.37	26.14	104.3	-0.30	0.491	2.203	1.333	1.189	0	0.818	0.127
10	10	5.35	33.115	7.38	----	----	31.1	----	19.4	0.17	0.25	26.14	103.7	-0.26	0.977	2.056	1.265	1.175	10	0.893	0.154
20	20	5.10	33.107	7.40	----	----	30.6	----	19.4	0.17	0.21	26.16	103.4	-0.24	1.222	2.034	1.136	1.104	20	0.769	0.162
30	30	4.85	33.110	7.45	----	----	30.0	----	19.6	0.21	0.19	26.19	103.4	-0.25	2.302	2.114	1.015	1.114	30	1.042	0.297
40	40	4.61	33.110	7.36	----	----	30.0	----	20.1	0.21	0.37	26.22	101.6	-0.12	2.382	2.166	0.885	1.064	40	1.004	0.421
50	50	4.46	33.123	7.31	----	----	32.7	----	20.5	0.22	0.51	26.25	100.5	-0.04	1.875	2.438	0.747	1.043	50	0.694	0.367
60	60	4.23	33.143	7.29	----	----	34.3	----	21.3	0.22	0.61	26.29	99.7	0.02	1.149	2.668	0.643	1.112	75	0.292	0.266
75	75	3.69	33.167	7.12	----	----	38.1	----	22.9	0.27	0.66	26.36	96.1	0.29	0.044	2.834	0.494	0.934	100	0.071	0.178
100	100	3.49	33.303	5.92	----	----	51.0	----	27.9	0.14	0.08	26.49	79.6	1.52	0.111	2.888	0.250	0.863	150	0.071	0.166
125	124	3.35	33.387	----	----	----	----	----	----	----	----	26.57	----	----	0.032	2.815	0.001	0.879	200	0.025	0.158
150	150	3.51	33.427	4.84	----	----	59.0	----	30.9	0.08	0.03	26.58	65.2	2.59	0.028	2.823	0.002	0.922			
175	175	3.82	33.517	4.18	----	----	65.5	----	32.6	0.10	0.01	26.62	56.7	3.19	0.028	2.219	0.002	0.891			
200	203	3.83	33.616	3.49	----	----	69.7	----	34.4	0.00	0.00	26.70	47.4	3.87	0.028	2.838	0.001	0.372			

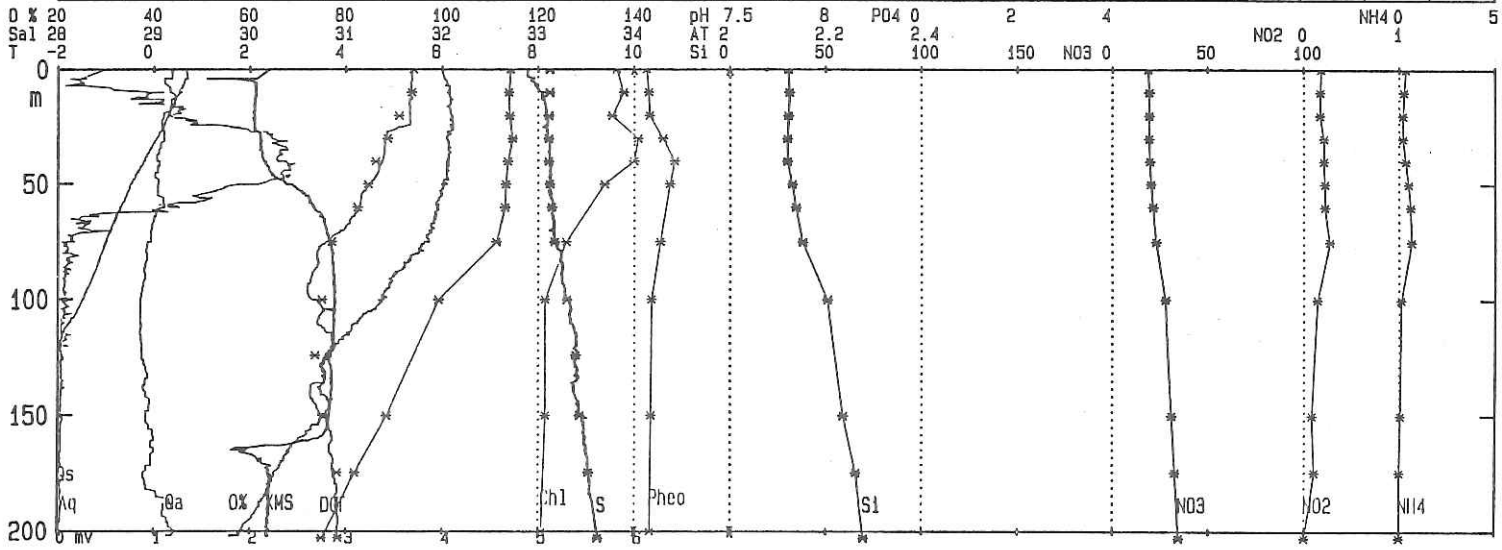


Table 22. Summary of OCTOPUS data at Station 1

Station	1/DN	Depth	3640 m	Date	June 17, 1986	TIME	14 : 45 - 15 : 05	Lat.	57 - 59.6 N	Long.	178 - 26.3 W

															OCTOPUS				VanDorn		
BMS Sample No.	D m	T C	S	D.O. ml/l	pH	AT meq/l	SiO2 uM	PO4 uM	NO3 uM	NO2 uM	NH4 uM	Sig-t	%-DO %	AOU ml/l	Aqua mv	XMS mv	Q-s mv	Q-a mv	O (vd) m	Chl-a mg/l	Pheo. mg/l
0	0	6.00	32.985	7.69	----	----	32.3	----	14.6	0.15	0.18	25.96	109.7	-0.68	0.026	2.037	1.356	0.251	0	0.934	0.066
10	10	5.88	32.972	7.81	----	----	32.3	2.04	14.9	0.15	0.15	25.97	111.1	-0.78	2.423	1.758	1.063	0.307	10	1.001	0.138
20	20	3.75	33.172	7.78	----	----	42.0	1.96	23.2	0.21	0.15	26.36	105.2	-0.38	2.802	2.021	0.908	0.324	20	0.986	0.367
30	30	3.52	33.221	7.77	----	----	43.1	2.11	24.3	0.23	0.20	26.42	104.5	-0.33	1.907	2.478	0.781	0.327	30	0.640	0.268
40	40	3.25	33.212	7.60	----	----	44.7	2.11	24.8	0.24	0.33	26.44	101.5	-0.11	0.945	2.649	0.672	0.324	40	0.406	0.293
50	50	3.30	33.228	7.63	----	----	44.7	2.16	24.8	0.26	0.53	26.44	102.1	-0.15	0.990	2.703	0.573	0.312	50	0.401	0.225
60	60	2.96	33.279	7.28	----	----	47.4	2.19	26.9	0.33	0.23	26.51	96.6	0.26	0.342	2.764	0.478	0.303	75	0.215	0.206
70	70	2.65	33.292	7.08	----	----	49.6	----	27.6	0.30	0.18	26.55	93.2	0.52	0.157	2.769	0.382	0.303	100	0.125	0.199
80	80	2.41	33.282	7.43	----	----	47.4	2.21	26.8	0.34	0.18	26.56	97.2	0.21	0.120	2.809	0.283	0.310	150	0.042	0.184
90	91	2.15	33.284	7.50	----	----	46.3	2.19	26.5	0.45	0.20	26.59	97.5	0.19	0.134	2.855	0.180	0.338	200	0.031	0.139
100	100	2.07	33.289	7.54	----	----	46.3	2.19	26.7	0.50	0.07	26.60	97.8	0.17	0.038	2.871	0.052	0.365			
150	150	2.28	33.312	7.18	----	----	49.0	2.24	28.1	0.03	0.07	26.60	93.6	0.49	0.029	2.800	0.003	0.323			
200	201	3.58	33.601	3.45	----	----	75.4	2.72	36.5	0.00	0.00	26.71	46.6	3.96	0.023	2.080	0.001	0.318			

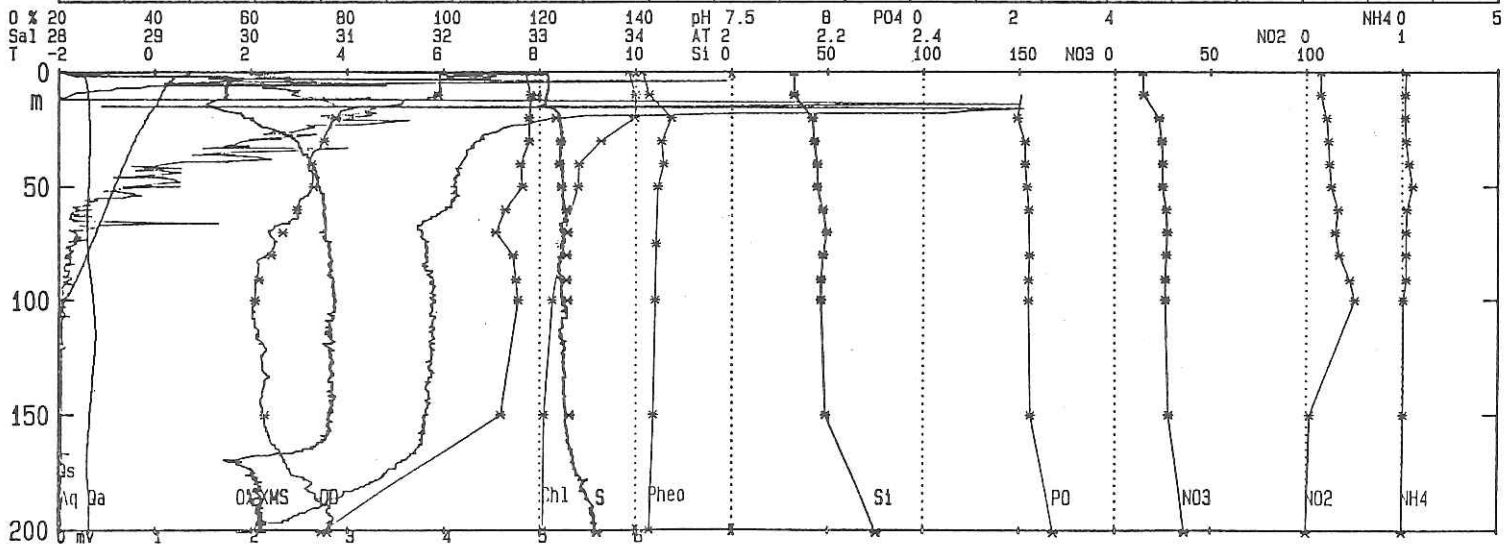


Table 23. Summary of OCTOPUS data at Station 2

Station	2/DN	Depth	136 m	Date	June 18, 1986	TIME	01:49 - 02:05	Lat.	58 - 59.9 N	Long.	177 - 26.6 W

RMS														OCTOPUS				VanDorn		
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Sig-t	%-DO	AOU	Aqua	XMS	Q-s	Q-a	D(vd)	Chl-a	Pheo.
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM		%	ml/l	mv	mv	mv	mv	m	mg/l	mg/l
0	0	5.10	32.760	7.95	8.056	-----	17.1	1.11	9.00	0.12	0.21	25.89	110.8	-0.77	0.021	1.802	0.575	0-.004	0	1.228	0.227
10	12	5.05	32.730	7.97	8.063	-----	14.8	1.08	8.90	0.12	0.21	25.87	110.9	-0.78	2.975	1.780	0.001	0-.004	10	1.203	0.237
20	22	5.04	32.736	7.96	8.055	-----	14.8	1.11	9.20	0.12	0.29	25.88	110.8	-0.77	3.121	1.764	0.001	0-.004	20	1.054	0.182
30	32	4.26	32.782	7.74	8.002	-----	17.1	1.29	11.3	0.16	1.20	26.00	105.7	-0.42	2.061	2.098	0.002	0-.004	30	0.605	0.553
40	42	3.63	32.894	7.49	7.924	-----	22.8	1.65	15.5	0.19	1.95	26.15	100.8	-0.06	0.636	2.422	0.002	0-.004	40	0.365	0.677
50	52	3.13	32.972	7.27	7.848	-----	30.8	1.95	19.1	0.21	2.33	26.26	96.7	0.25	0.183	2.581	0.002	0-.004	50	0.280	0.802
60	63	3.21	33.107	6.92	7.818	-----	36.8	2.13	22.9	0.21	1.63	26.36	92.3	0.58	0.022	2.677	0.002	0-.004	75	0.087	1.019
70	72	3.02	33.151	6.45	7.741	-----	47.9	2.23	26.6	0.16	0.55	26.41	85.6	1.08	0.042	2.679	0.002	0-.004	100	0.136	0.649
80	83	2.88	33.151	6.52	7.729	-----	52.5	2.27	27.0	0.16	0.15	26.42	86.2	1.04	0.024	2.601	0.003	0-.004	130	0.144	0.560
90	93	2.89	33.176	6.34	7.721	-----	53.7	2.32	27.3	0.14	0.38	26.44	83.9	1.22	0.023	2.218	0.003	0-.004			
100	103	2.71	33.208	6.59	7.725	-----	53.7	2.28	27.5	0.12	0.06	26.46	86.8	01.00	0.020	1.805	0-.000	0-.004			
110	111	2.76	33.232	6.30	7.708	-----	57.1	2.35	27.7	0.11	0.31	26.49	83.1	1.28	0.020	1.742	0-.000	0-.004			
125	125	2.79	33.219	6.28	7.714	-----	57.1	2.43	27.7	0.11	0.32	26.48	82.9	1.29	0.018	1.742	0.001	0-.004			

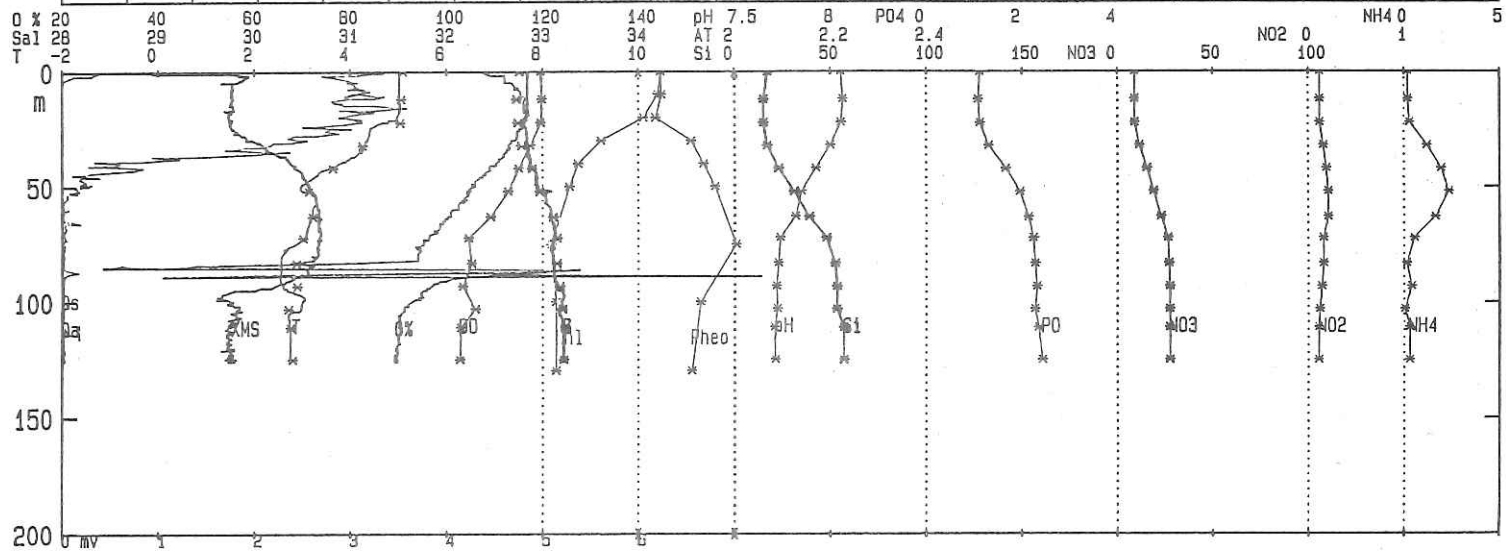


Table 24. Summary of OCTOPUS data at Station 3

Station	3/DN	Depth	145 m	Date	June 18, 1986	TIME	08:34 - 08:48	Lat.	59 - 53.9 N	Long.	176 - 28.8 W

															OCTOPUS				VanDorn		
BMS Sample No.	D m	T C	S	D.O. ml/l	pH	AT meq/l	SiO2 uM	PO4 uM	NO3 uM	NO2 uM	NH4 uM	Sig-t	%-DO %	AOU ml/l	Aqua mv	XMS mv	Q-s mv	Q-a mv	D (vd) m	Chl-a mg/l	Pheo. mg/l
0	0	4.00	32.295	8.51	8.232	----	0.0	0.41	0.0	0.00	0.01	25.63	115.1	-1.12	0.127	2.275	1.425	0.448	0	0.980	0.257
10	10	3.97	32.322	8.60	8.238	----	0.0	0.41	0.0	0.00	0.01	25.66	116.3	-1.20	2.167	1.744	1.082	0.438	10	1.079	0.288
20	19	3.90	32.327	8.59	8.236	----	0.0	0.43	0.0	0.00	0.01	25.67	115.9	-1.18	3.057	1.729	0.928	0.437	20	1.029	0.353
30	30	1.59	32.599	8.19	8.079	----	5.2	----	4.80	0.03	1.33	26.08	104.4	-0.35	4.346	0.737	0.705	0.440	30	4.973	1.508
40	40	1.26	32.737	7.19	7.794	----	32.8	2.02	19.8	0.11	2.21	26.21	91.0	0.71	3.586	1.365	0.363	0.443	40	4.310	1.523
60	60	1.32	32.808	7.02	7.745	----	41.5	2.15	23.2	0.09	0.72	26.26	89.0	0.87	1.266	2.278	0.001	0.450	50	1.628	1.520
80	79	1.44	32.894	6.99	7.737	----	43.8	2.18	23.6	0.06	0.56	26.32	89.0	0.87	0.029	2.444	0.002	0.464	75	0.880	0.668
100	100	1.49	32.986	6.83	7.723	----	49.5	2.28	24.7	0.04	0.38	26.39	87.1	1.01	0.027	1.222	0-.001	0.471	100	0.222	0.222
120	120	1.49	33.001	6.72	7.697	----	53.0	2.33	24.7	0.04	0.62	26.41	85.7	1.12	0.028	0.906	0.001	0.456	130	0.121	0.411
140	137	1.51	33.007	6.70	7.707	----	53.0	2.33	24.6	0.04	0.55	26.41	85.5	1.14	0.028	0.613	0.001	0.435			

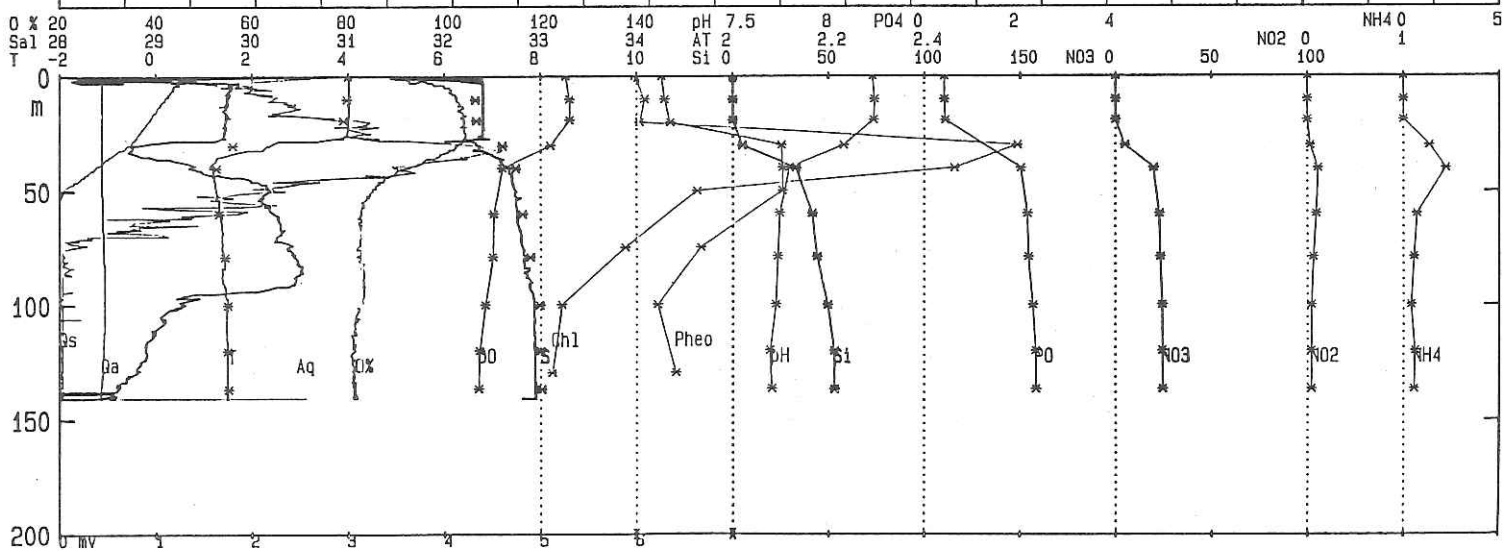


Table 25. Summary of OCTOPUS data at Station 4

Station	4/DN	Depth	110 m	Date	June 18, 1986	TIME	16:50 - 17:08	Lat.	60 - 48.7 N	Long.	175 - 30.2 W

RMS														OCTOPUS					VanDorn		
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Sig-t	%-DO	ADU	Aqua	XMS	G-s	G-a	D(vd)	Chl-a	Pheo.
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM		%	ml/l	mv	mv	mv	mv	m	mg/l	mg/l
0	0	3.20	31.200	8.05	7.990	-----	0.0	0.39	0.0	0.00	0.01	24.84	106.0	-0.45	1.534	2.338	1.494	0.720	0	0.229	0.060
5	6	3.24	31.216	8.12	7.995	-----	0.0	0.41	0.0	0.00	0.00	24.85	107.0	-0.53	0.044	2.424	1.275	0.703	10	0.234	0.058
15	15	2.05	31.482	8.22	8.009	-----	0.0	0.39	0.0	0.00	0.00	25.15	105.3	-0.41	0.044	2.281	1.171	0.706	20	0.247	0.069
25	25	1.89	31.448	8.32	8.016	-----	0.0	0.39	0.0	0.00	0.00	25.13	106.1	-0.48	0.099	2.302	1.077	0.738	30	0.368	0.096
35	35	-0.65	31.682	9.76	8.051	-----	0.0	0.49	0.0	0.00	0.00	25.45	116.6	-1.39	1.482	1.547	0.973	0.806	40	1.203	0.310
45	45	-1.49	31.873	9.23	----	-----	2.3	----	2.00	0.05	0.08	25.63	107.9	-0.68	2.350	1.818	0.793	0.878	50	0.521	0.221
55	55	-1.36	32.046	8.44	7.877	-----	17.8	1.19	9.00	0.13	0.82	25.77	99.1	0.07	0.409	2.633	0.626	0.795	75	0.496	0.319
65	65	-0.73	32.258	7.68	7.799	-----	27.5	1.64	14.8	0.10	2.27	25.92	91.9	0.68	0.043	2.786	0.515	0.774	100	0.066	0.289
75	75	0.13	32.425	6.60	7.724	-----	33.8	1.96	17.9	0.15	2.28	26.02	80.9	1.56	0.042	2.467	0.409	0.776			
85	85	0.54	32.505	6.35	7.663	-----	41.9	----	20.1	0.14	2.38	26.07	78.7	1.71	0.043	2.004	0.275	0.740			
95	95	0.56	32.504	6.28	7.659	-----	42.4	2.19	20.1	0.14	2.54	26.06	77.9	1.78	0.042	1.957	0.024	0.717			
105	106	0.56	32.501	6.26	7.659	-----	42.4	2.15	20.0	0.14	2.50	26.06	77.7	1.80	0.072	2.670	0.071	0.358			

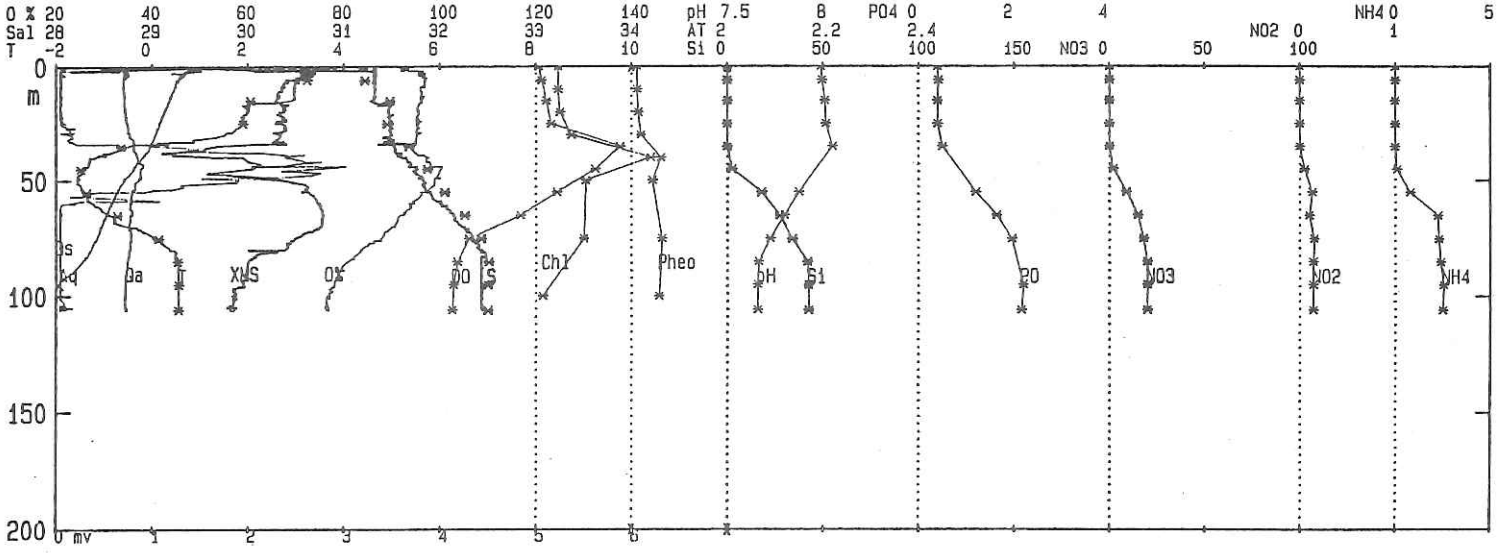


Table 26. Summary of OCTOPUS data at Station 5

Station	5/DN		Depth	79 m		Date	June 18-19, 1986			TIME	23:58 - 00:13			Lat.	61 - 42.5 N			Long.	174 - 32.1 W		
BMS															OCTOPUS				VanDorn		
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Sig-t	%-DO	AOU	Aqua	XMS	Q-s	Q-a	D (vd)	Chl-a	Pheo.
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM		%	ml/l	mv	mv	mv	mv	m	mg/l	mg/l
0	0	3.10	30.479	8.34	8.055	-----	0.0	0.53	0.0	0.00	0.10	24.27	109.0	-0.69	0.021	2.738	0.267	0-.003	0	0.204	0.032
5	5	3.22	30.507	8.35	8.055	-----	0.0	0.51	0.0	0.00	0.07	24.28	109.5	-0.72	0.018	2.592	0.137	0-.003	10	0.156	0.045
10	10	1.99	30.850	9.34	8.116	-----	0.0	0.56	0.0	0.00	0.05	24.65	118.9	-1.49	0.020	2.570	0.003	0-.003	20	0.593	0.094
15	15	0.60	31.389	9.66	-----	-----	0.0	0.57	0.0	0.00	0.38	25.16	119.1	-1.55	0.018	2.472	0.000	0-.003	30	1.628	0.591
20	20	0.44	31.671	9.96	8.116	-----	0.0	0.56	0.0	0.00	0.02	25.40	122.5	-1.83	0.015	2.449	0.001	0-.003	40	1.032	0.213
25	25	-0.99	31.965	10.52	8.078	-----	0.5	0.63	0.0	0.00	0.00	25.69	124.7	-2.09	0.865	1.993	0.001	0-.003	50	1.086	0.258
30	30	-1.45	32.057	10.07	7.872	-----	1.6	0.76	0.0	0.00	0.14	25.78	118.0	-1.54	2.393	1.772	0.001	0-.003	75	1.386	0.627
35	35	-1.62	32.158	8.64	-----	-----	4.7	1.30	8.40	0.14	0.97	25.87	100.8	-0.07	3.221	1.743	0.001	0-.003			
40	40	-1.66	32.205	8.25	7.832	-----	12.7	1.45	9.70	0.16	1.49	25.91	96.2	0.33	0.077	2.140	0.001	0-.003			
45	45	-1.70	32.247	7.83	7.786	-----	25.3	1.64	11.0	0.17	1.63	25.94	91.2	0.75	0.641	1.650	0.002	0-.003			
50	50	-1.70	32.266	7.83	-----	-----	24.3	1.67	11.1	0.16	1.67	25.96	91.2	0.75	0.017	1.378	0.002	0-.003			
60	60	-1.70	32.288	7.73	7.784	-----	25.3	1.73	11.4	0.16	1.77	25.97	90.1	0.85	0.016	0.546	0-.000	0-.003			
75	75	-1.69	32.359	7.21	7.702	-----	26.4	1.75	9.20	0.13	1.79	26.03	84.1	1.36	0.353	0.283	0-.001	0-.003			

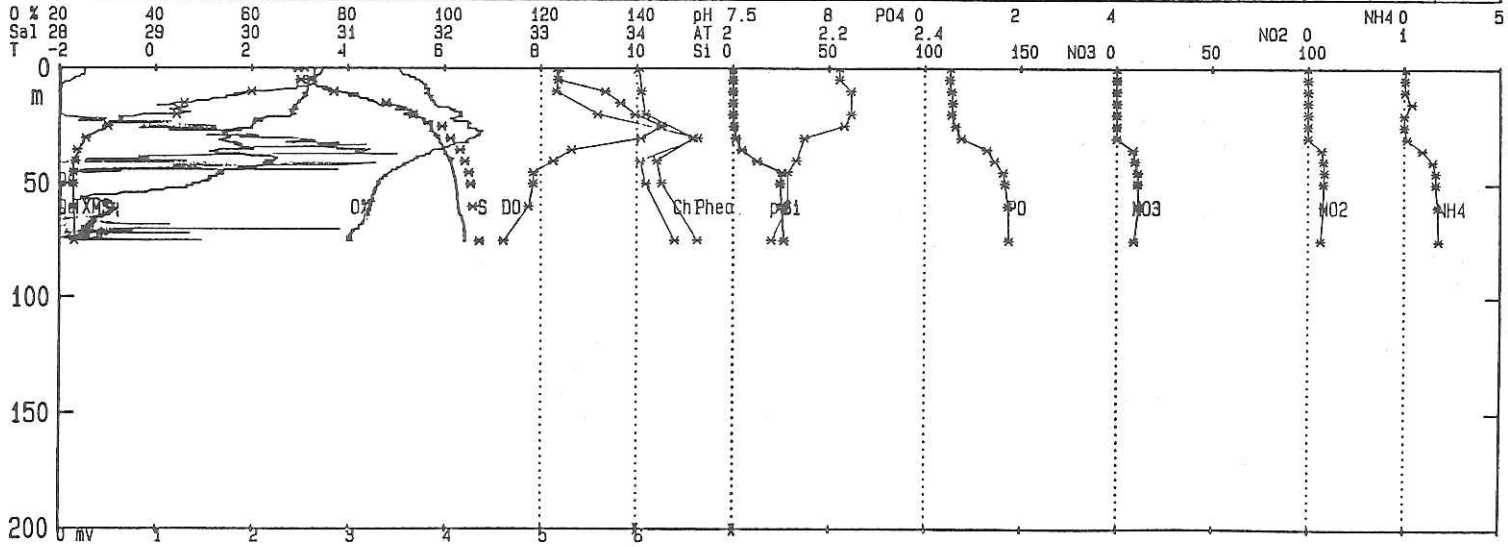


Table 27. Summary of OCTOPUS data at Station 6

Station	6/DN	Depth	68 m	Date	June 19, 1986	TIME	06:34 - 06:51	Lat.	62 - 35.8 N	Long.	173 - 32.4 W

															OCTOPUS				YanDorn		
BMS Sample No.	D m	T C	S	D.O. ml/l	pH	AT meq/l	SiO2 uM	PO4 uM	NO3 uM	NO2 uM	NH4 uM	Sig-t	%-DO %	AOU ml/l	Aqua mv	XMS mv	Q-s mv	Q-a mv	D(vd) m	Chl-a mg/l	Pheo. mg/l
0	0	3.80	31.785	8.11	8.035	----	0.0	0.58	0.0	0.00	0.05	25.25	108.8	-0.65	0.021	2.476	1.148	0.173	0	0.277	0.063
5	5	3.79	31.773	8.11	8.038	----	0.0	0.58	0.0	0.00	0.09	25.24	108.7	-0.65	0.021	2.323	1.089	0.174	10	0.242	0.068
10	10	3.58	31.840	8.21	8.040	----	0.0	0.59	0.0	0.00	0.10	25.31	109.6	-0.72	0.022	2.258	1.019	0.174	20	0.377	0.141
15	15	1.93	32.013	----	----	----	0.0	0.58	0.0	0.00	0.48	25.58	----	----	0.022	2.134	0.959	0.175	30	0.781	0.528
20	20	1.48	32.044	8.86	8.064	----	0.0	0.61	0.0	0.00	0.06	25.64	112.2	-0.97	0.458	1.896	0.891	0.176	40	1.276	0.659
25	25	0.82	32.059	9.12	8.069	----	0.0	0.64	0.0	0.00	0.06	25.69	113.6	-1.09	1.079	1.820	0.802	0.177	50	0.806	0.489
30	30	0.45	32.178	----	----	----	1.0	0.76	0.10	0.00	0.31	25.81	----	----	1.542	1.855	0.715	0.178	65	1.936	0.954
35	35	-1.22	32.300	7.88	7.802	----	13.0	1.31	5.10	0.07	1.25	25.97	93.1	0.59	0.394	1.958	0.611	0.179			
40	40	-1.55	32.350	7.33	7.711	----	18.7	1.58	6.30	0.09	1.90	26.02	85.8	1.21	0.070	1.031	0.509	0.181			
45	45	-1.55	32.329	7.24	7.696	----	20.2	1.62	6.30	0.09	2.10	26.00	84.8	1.30	0.022	0.691	0.377	0.184			
50	50	-1.56	32.339	----	7.686	----	20.7	1.65	6.30	0.09	2.22	26.01	----	----	0.200	0.516	0.143	0.186			
60	60	-1.48	32.371	7.11	----	----	----	1.72	----	----	----	26.04	83.4	1.41	0.239	0.123	0.000	0.194			
65	65	-1.47	32.379	7.15	7.695	----	21.3	1.77	5.90	0.09	2.81	26.04	83.9	1.37	0.431	0-.021	0.002	0.204			

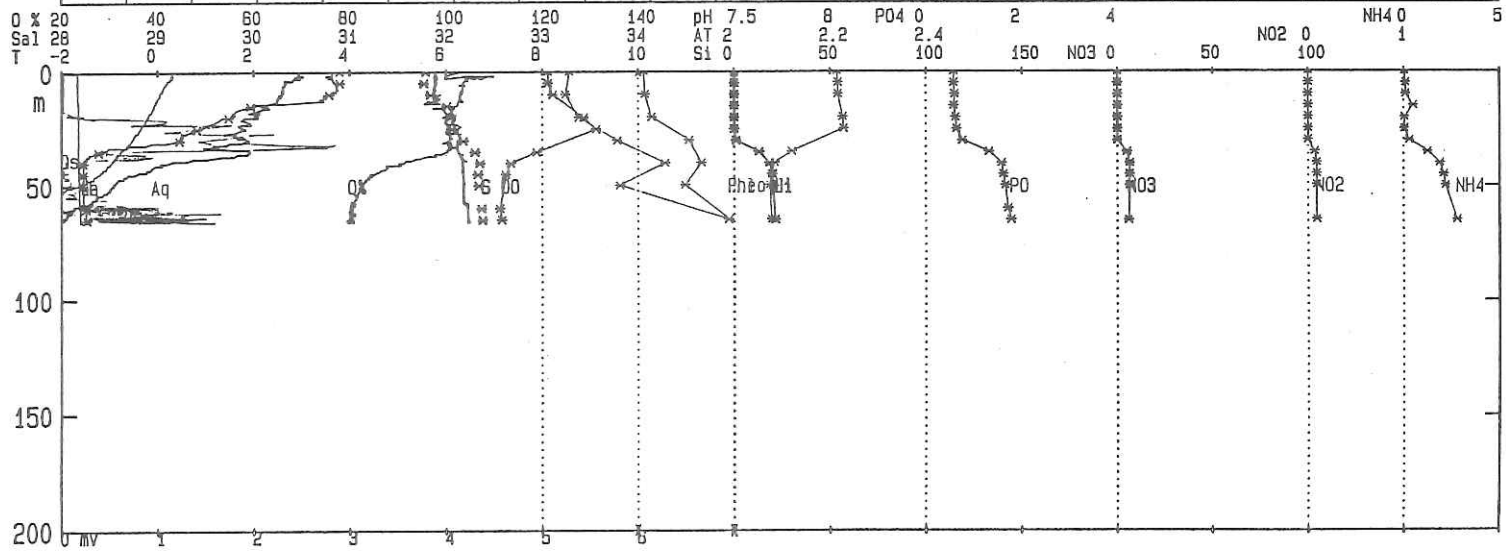


Table 28. Summary of OCTOPUS data at Station D

Station	D/DN	Depth	52 m	Date	June 19, 1986	TIME	12 : 32 - 12 : 42	Lat.	63 - 30.0 N	Long.	172 - 30.0 W

															OCTOPUS				VanDorn		
BMS Sample No.	D m	T C	S	D.O. ml/l	pH	AT meq/l	SiO2 uM	PO4 uM	NO3 uM	NO2 uM	NH4 uM	Sig-t	%-DO %	AOU ml/l	Aqua mv	XMS mv	Q-s mv	Q-a mv	D (vd) m	Chl-a mg/l	Pheo. mg/l
0	0	3.40	32.155	8.53	8.092	2.251	0.0	0.53	0.0	0.00	0.04	25.58	113.6	-1.02	0.026	2.422	1.479	0.593	0	0.244	0.113
5	5	3.28	32.163	8.55	8.102	2.246	0.0	0.54	0.0	0.00	0.02	25.60	113.5	-1.02	0.028	2.314	1.243	0.586	10	0.290	0.112
10	10	3.14	32.158	8.70	8.104	2.247	0.0	0.54	0.0	0.00	0.04	25.60	115.1	-1.14	0.026	2.168	1.173	0.594	20	0.588	0.265
15	15	2.60	32.189	----	8.105	2.248	0.0	0.51	0.0	0.00	0.02	25.67	----	----	0.060	2.207	1.112	0.601	30	8.840	1.918
20	20	2.55	32.194	9.65	8.108	2.255	0.0	0.56	0.0	0.00	0.04	25.68	125.8	-1.98	0.497	2.050	1.061	0.608	40	2.807	1.859
25	25	-0.92	32.446	10.26	8.054	2.257	2.1	0.79	2.00	0.01	0.58	26.08	122.3	-1.87	1.471	1.909	0.989	0.615	50	1.144	2.108
30	30	-1.22	32.549	9.72	8.028	2.260	2.1	0.88	1.90	0.04	0.92	26.17	115.0	-1.27	3.752	1.228	0.870	0.621			
35	35	-1.20	32.620	----	8.027	2.269	6.7	1.01	3.40	0.07	1.95	26.23	----	----	1.563	2.328	0.705	0.625			
40	41	-1.35	32.806	7.24	7.717	2.282	25.9	1.92	9.00	0.13	4.34	26.39	85.5	1.23	1.437	0.695	0.624	0.624			
45	45	-1.35	32.806	7.10	7.707	2.280	25.9	1.93	9.30	0.13	4.35	26.39	83.9	1.37	1.614	0.319	0.499	0.622			

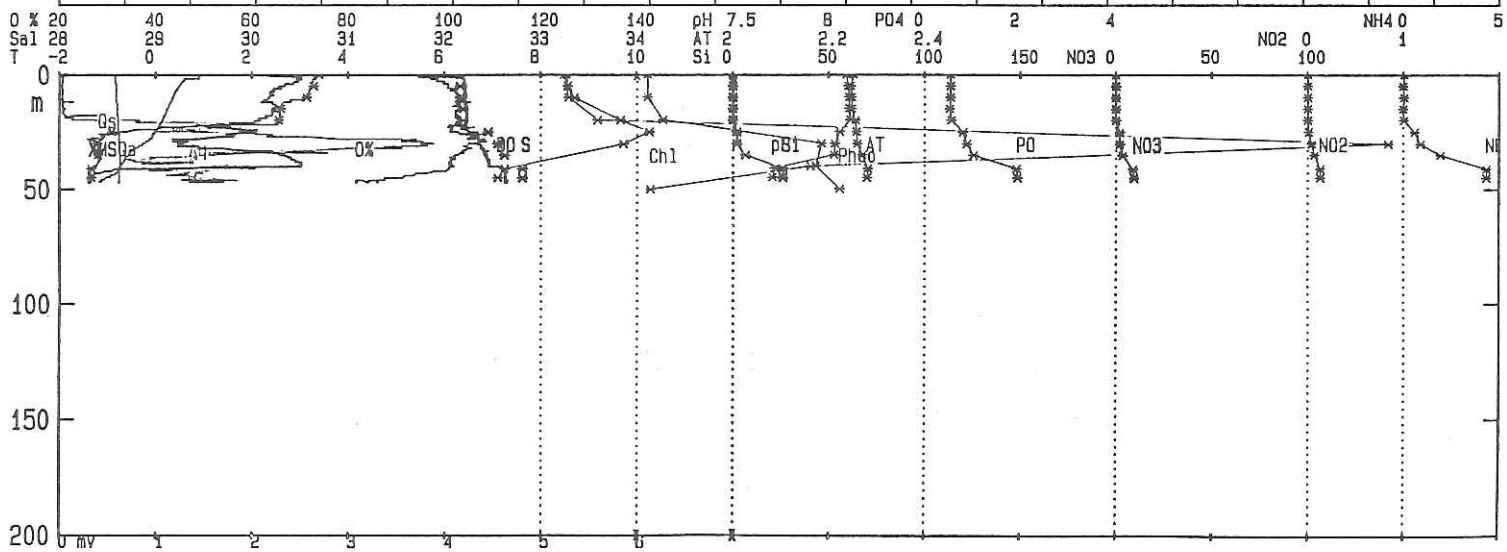


Table 29. Summary of OCTOPUS data at Station 7-1

Station	7-1/DN		Depth	83 m		Date	June 20, 1986			TIME	07 : 04 - 07 : 24		Lat.	61 - 12.7 N			Long.	174 - 20.4 W		
RMS														OCTOPUS				RMS		
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Sig-t	%-DO	AOU	Aqua	XMS	Q-s	Q-a	D (vd)	Chl-a	Pheo.
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM		%	ml/l	mv	mv	mv	mv	m	mg/l	mg/l
0	0	-0.50	27.735	9.07	8.023	1.964	0.0	0.45	0.0	0.00	0.40	22.26	105.9	-0.50	0.018	2.390	1.315	0.171	0	0.744	0.071
5	5	0.14	28.973	7.60	8.035	2.052	0.0	0.45	0.0	0.00	0.26	23.24	91.0	0.75	0.021	1.881	1.085	0.171	5	0.744	0.027
10	10	-0.09	29.962	7.61	----	----	----	----	----	----	----	24.04	91.2	0.73	0.021	2.189	1.007	0.170	10	----	----
15	15	-0.07	30.907	7.76	----	----	0.0	0.40	0.0	0.00	0.20	24.81	93.7	0.52	0.021	2.015	0.947	0.170	15	0.968	0.090
20	20	-0.74	31.394	8.04	8.106	2.188	0.0	0.46	0.0	0.00	0.29	25.22	95.6	0.37	0.021	2.174	0.882	0.170	20	0.902	0.053
25	25	-1.43	31.879	8.46	7.972	2.224	4.6	0.78	2.90	0.08	0.40	25.64	99.0	0.08	0.033	2.216	0.819	0.169	25	2.244	0.311
30	30	-1.51	31.968	8.62	----	----	9.8	1.05	6.20	0.14	0.69	25.71	100.8	-0.07	1.595	2.350	0.739	0.169	30	1.452	0.483
35	35	-1.31	32.098	8.44	7.781	2.241	19.5	1.55	10.6	0.19	1.99	25.81	99.3	0.06	0.959	2.279	0.641	0.168	35	1.518	0.366
40	40	-1.50	32.125	7.60	7.762	2.233	21.6	1.70	10.5	0.17	2.91	25.84	89.0	0.94	0.029	2.109	0.566	0.167	40	1.298	0.276
45	45	-1.56	32.191	7.17	7.768	2.240	22.1	1.76	11.0	0.18	2.91	25.89	83.8	1.39	0.018	1.989	0.491	0.167	45	0.638	0.136
50	50	-1.57	32.185	7.00	----	----	23.1	1.74	10.8	0.17	2.91	25.89	81.8	1.56	0.018	1.949	0.407	0.166	50	0.462	0.132
60	60	-1.70	32.259	7.02	7.753	2.242	25.7	1.73	10.5	0.18	2.20	25.95	81.8	1.57	0.018	1.473	0.191	0.165	60	1.210	0.338
75	76	-1.70	32.252	7.51	7.754	2.255	25.7	1.71	10.5	0.18	2.23	25.94	87.5	1.07	0.029	2.837	0.001	0.384	76	2.002	0.424

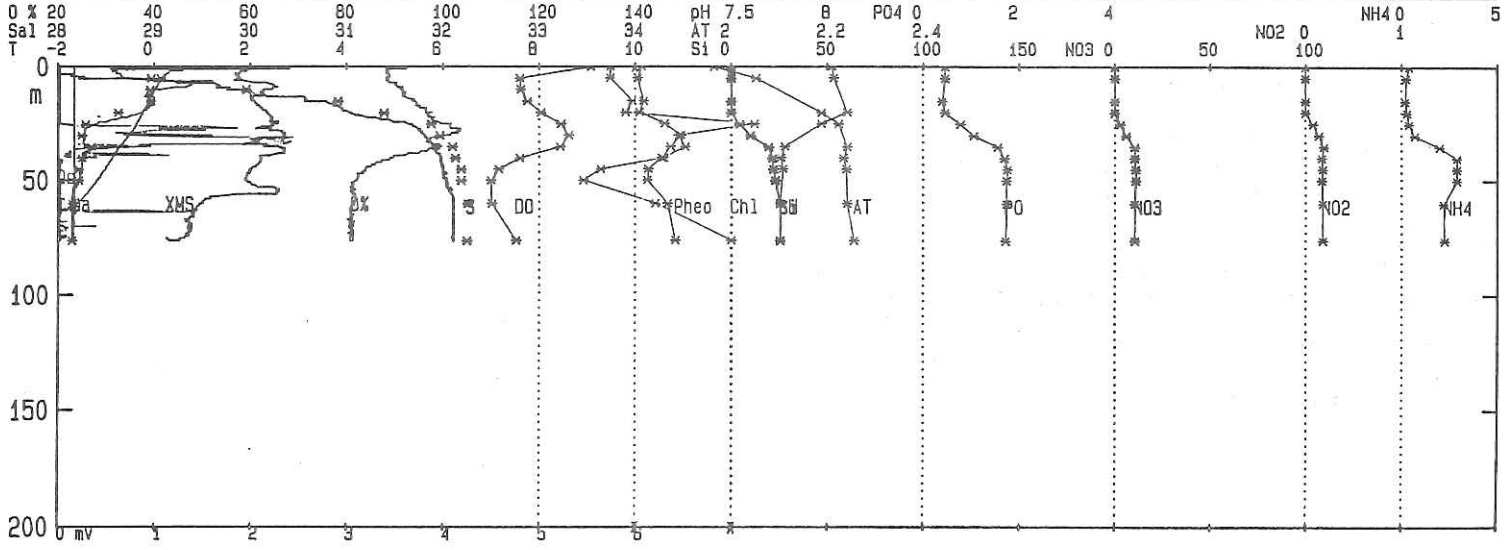


Table 30. Summary of OCTOPUS data at Station 7-2

Station	7-2/DN	Depth	82 m	Date	June 20, 1986	TIME	09 : 30 - 09 : 39	Lat.	61 - 10.9 N	Long.	174 - 19.3 W

RMS															OCTOPUS				RMS		
Sample No.	D m	T C	S	D.O. ml/l	pH	AT meq/l	SiO2 uM	PO4 uM	NO3 uM	NO2 uM	NH4 uM	Sig-t	%-DO %	AOU ml/l	Aqua mv	XMS mv	Q-s mv	Q-a mv	D (vd) m	Chl-a mg/l	Pheo. mg/l
0	0	-0.10	28.335	8.19	-----	-----	0.5	0.36	0.0	0.00	0.39	22.73	97.1	0.25	0.018	2.289	1.384	0.309	0	0.726	0.100
5	5	-0.08	28.320	7.25	-----	-----	0.5	0.37	0.0	0.00	0.28	23.53	86.6	1.12	0.020	1.829	1.158	0.306	5	0.856	0.075
10	10	-0.09	28.965	7.32	-----	-----	0.0	0.35	0.0	0.00	0.19	24.05	87.8	1.02	0.021	1.897	1.081	0.306	10	1.091	0.160
15	15	-0.06	31.014	7.39	-----	-----	0.5	0.34	0.0	0.00	0.16	24.89	89.3	0.89	0.022	1.871	1.018	0.305	15	0.992	0.172
20	20	-0.80	31.485	7.58	-----	-----	4.1	0.67	1.90	0.07	0.32	25.30	90.1	0.84	0.020	2.278	0.952	0.304	20	2.596	0.501
25	25	-1.44	31.873	8.07	-----	-----	4.1	0.64	1.30	0.06	0.29	25.63	94.5	0.47	2.102	1.873	0.885	0.304	25	3.256	0.383
30	30	-1.46	31.956	8.21	-----	-----	9.2	0.95	5.50	0.13	0.53	25.70	96.0	0.34	1.223	2.345	0.781	0.303	30	3.080	0.791
35	35	-1.44	32.022	7.79	-----	-----	8.2	0.96	5.60	0.12	0.57	25.75	91.3	0.74	1.644	2.267	0.704	0.303	35	2.508	0.589
40	40	-1.58	32.090	7.77	-----	-----	----	----	----	----	----	25.81	90.7	0.80	2.495	1.628	0.589	0.302	40	3.212	1.046
45	44	-1.49	32.244	8.22	-----	-----	15.3	1.37	10.0	0.18	1.70	25.93	96.3	0.32	2.438	1.876	0.452	0.302	44	5.415	1.714
50	50	-1.61	32.225	7.70	-----	-----	24.0	1.64	10.5	0.18	2.74	25.92	90.0	0.86	0.021	1.968	0.326	0.302	50	1.342	0.310
60	60	-1.68	32.277	6.94	-----	-----	25.0	1.59	10.0	0.19	2.52	25.96	80.9	1.64	0.020	1.619	0.033	0.300	60	1.628	0.333
75	74	-1.69	32.280	6.72	-----	-----	25.5	1.57	10.1	0.19	2.52	25.97	78.3	1.86	0.027	1.448	0.001	0.299	74	5.304	1.177

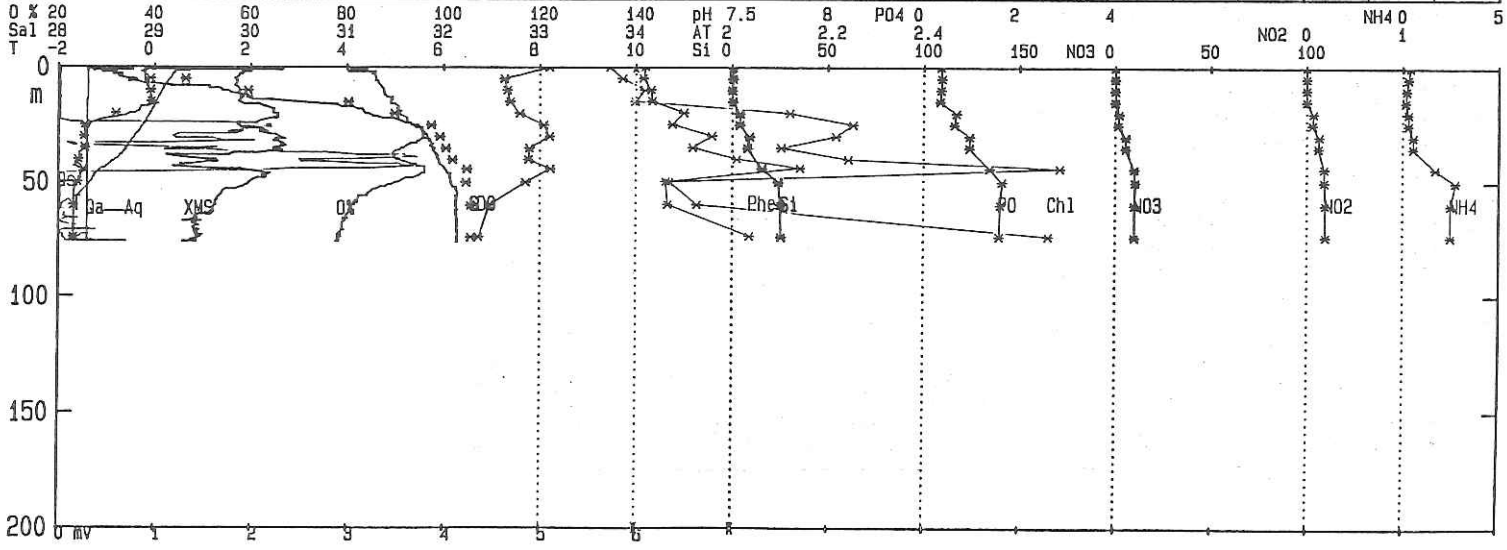


Table 31. Summary of OCTOPUS data at Station 7-3

Station	7-3/DN	Depth	83 m	Date	June 20, 1986	TIME	10 : 05 - 10 . 17	Lat.	61 - 08.6 N	Long.	174 - 18.6 W

RMS														OCTOPUS					RMS		
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Sig-t	%-DO	AOU	Aqua	XMS	G-s	G-a	D(vd)	Chl-a	Pheo.
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM		%	ml/l	mv	mv	mv	mv	m	mg/l	mg/l
0	0	0.90	28.295	8.01	-----	-----	0.0	0.36	0.0	0.00	0.32	22.66	97.4	0.21	0.042	0.553	1.455	0.544	0	0.657	0.041
5	5	0.56	28.435	7.16	-----	-----	0.0	0.35	0.0	0.02	0.41	22.79	86.4	1.13	0.028	1.792	1.209	0.534	5	1.091	0.087
10	10	0.38	29.946	7.42	-----	-----	0.0	0.36	0.0	0.00	0.15	24.01	90.0	0.82	0.051	1.547	1.138	0.529	10	0.756	0.116
15	15	0.06	30.525	7.64	-----	-----	0.0	0.38	0.0	0.00	0.15	24.49	92.2	0.64	0.028	1.818	1.063	0.523	15	0.868	0.092
20	20	-0.43	31.181	7.87	-----	-----	0.0	0.31	0.0	0.00	0.13	25.04	94.2	0.49	0.028	2.290	0.998	0.519	20	0.657	0.085
25	25	-0.85	31.555	8.30	-----	-----	0.0	0.43	0.0	0.00	0.12	25.36	98.5	0.12	0.028	2.266	0.935	0.519	25	0.694	0.149
30	30	-1.34	31.952	8.65	-----	-----	1.0	0.44	0.0	0.00	0.12	25.69	101.6	-0.13	0.598	2.235	0.871	0.519	30	1.042	0.122
35	35	-1.54	32.067	8.94	-----	-----	0.0	0.41	0.20	0.02	0.15	25.79	104.5	-0.38	1.791	1.915	0.793	0.519	35	1.892	0.482
40	40	-1.66	32.146	8.52	-----	-----	3.1	0.99	8.50	0.13	0.53	25.86	99.4	0.06	4.089	0.820	0.642	0.518	40	11.319	4.397
45	45	-1.67	32.165	7.86	-----	-----	13.3	1.35	9.80	0.18	1.93	25.87	91.6	0.72	2.023	2.113	0.440	0.519	45	2.794	0.767
50	48	-1.62	32.242	7.41	-----	-----	16.3	1.36	10.2	0.18	2.01	25.93	86.6	1.15	0.228	2.239	0.388	0.519	48	1.540	0.524
60	60	-1.70	32.274	6.80	-----	-----	18.9	1.64	10.6	0.19	2.23	25.96	79.3	1.78	0.027	1.798	0.134	0.521	60	1.122	0.401
75	76	-1.70	32.278	7.48	-----	-----	24.5	1.54	10.2	0.19	2.26	25.97	87.2	1.10	0.024	2.831	0.002	0.368	76	3.080	0.301

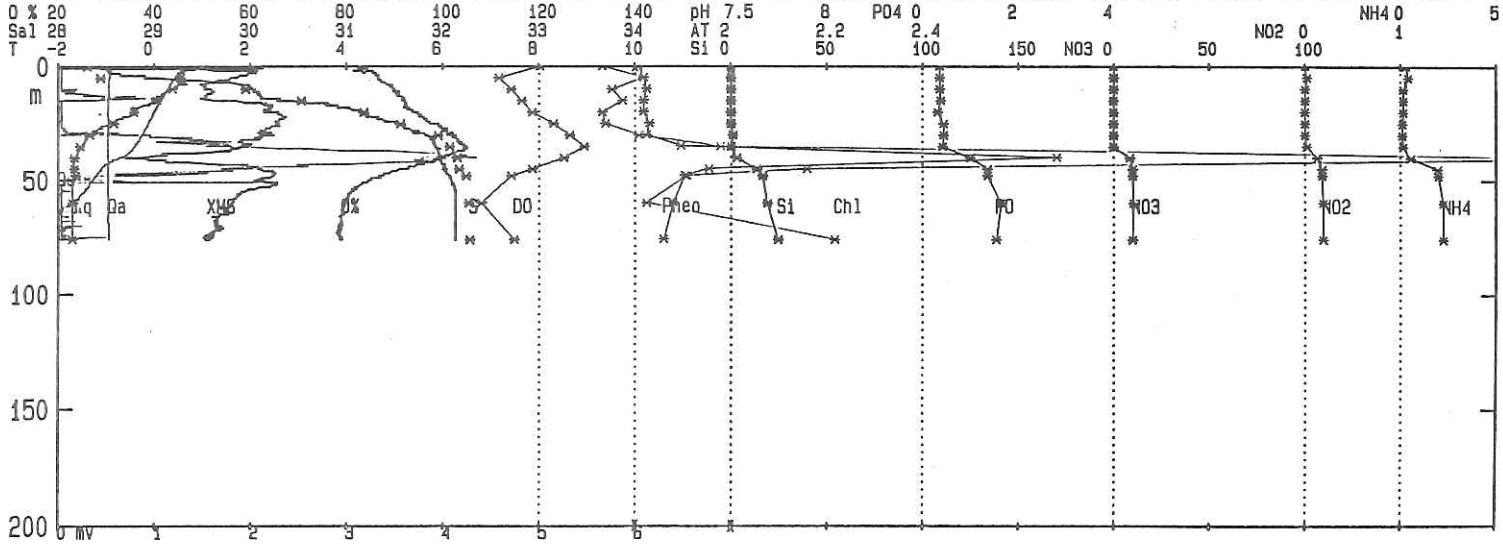


Table 32 Summary of OCTOPUS data at Station 7-4

Station	7-4/DN	Depth	86 m	Date	June 20, 1986	TIME	10 : 52 - 11 : 04	Lat.	61 - 05.0 N	Long.	174 - 27.0 W

RMS															OCTOPUS					RMS		
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Sig-t	%-DO	AOU	Aqua	XMS	Q-s	Q-a	D (vd)	Chl-a	Pheo.
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM		%	ml/l	mv	mv	mv	mv	m	mg/l	mg/l
0	0	2.20	28.485	7.08	8.015	2.004	0.5	0.30	0.0	0.00	0.29	22.74	89.2	0.86	0.032	0.863	1.453	0.531	0	0.645	0.082
5	5	0.85	29.290	6.79	8.028	2.066	0.0	0.31	0.0	0.00	0.24	23.46	83.1	1.38	0.035	1.881	1.233	0.537	5	0.967	0.109
10	10	1.00	29.954	7.05	8.019	2.099	0.0	0.30	0.0	0.00	0.21	23.99	87.0	1.06	0.035	1.608	1.162	0.539	10	1.203	0.150
15	15	0.02	30.917	7.16	-----	-----	0.0	0.33	0.0	0.00	0.20	24.81	86.6	1.10	0.245	1.312	1.094	0.542	15	1.606	0.278
20	20	-0.14	31.355	7.27	8.044	2.177	0.0	0.29	0.0	0.00	0.16	25.17	87.9	1.01	1.318	1.732	1.015	0.546	20	1.012	0.175
25	25	-0.36	31.568	7.57	8.056	2.208	1.5	0.35	0.0	0.00	0.12	25.35	91.1	0.74	0.094	2.361	0.940	0.549	25	0.836	0.248
30	30	-1.30	31.710	7.76	-----	-----	2.1	0.35	0.0	0.00	0.12	25.50	91.1	0.76	0.090	2.655	0.879	0.554	30	0.792	0.240
35	35	-1.44	31.852	7.84	8.061	2.216	2.6	0.34	0.0	0.00	0.13	25.61	91.8	0.70	1.055	2.566	0.818	0.558	35	1.342	0.464
40	40	-1.56	31.972	8.08	7.982	2.224	8.7	0.61	3.80	0.08	0.25	25.71	94.4	0.48	2.410	2.322	0.755	0.563	40	1.540	0.783
45	45	-1.29	32.049	7.66	7.805	2.231	24.2	1.32	11.3	0.18	1.94	25.77	90.2	0.83	0.232	2.521	0.676	0.568	45	0.660	0.372
50	50	-1.19	32.162	7.14	-----	-----	23.7	1.20	11.0	0.19	1.52	25.86	84.4	1.32	0.031	2.648	0.616	0.573	50	0.248	0.217
60	60	-1.65	32.271	6.67	7.768	2.240	24.7	1.43	11.4	0.15	2.65	25.96	77.9	1.89	0.032	2.302	0.505	0.583	60	0.781	0.397
75	75	-1.69	32.319	6.72	7.766	2.250	24.7	1.47	11.5	0.15	2.67	26.00	78.3	1.86	0.035	2.169	0.248	0.604	75	1.870	0.324

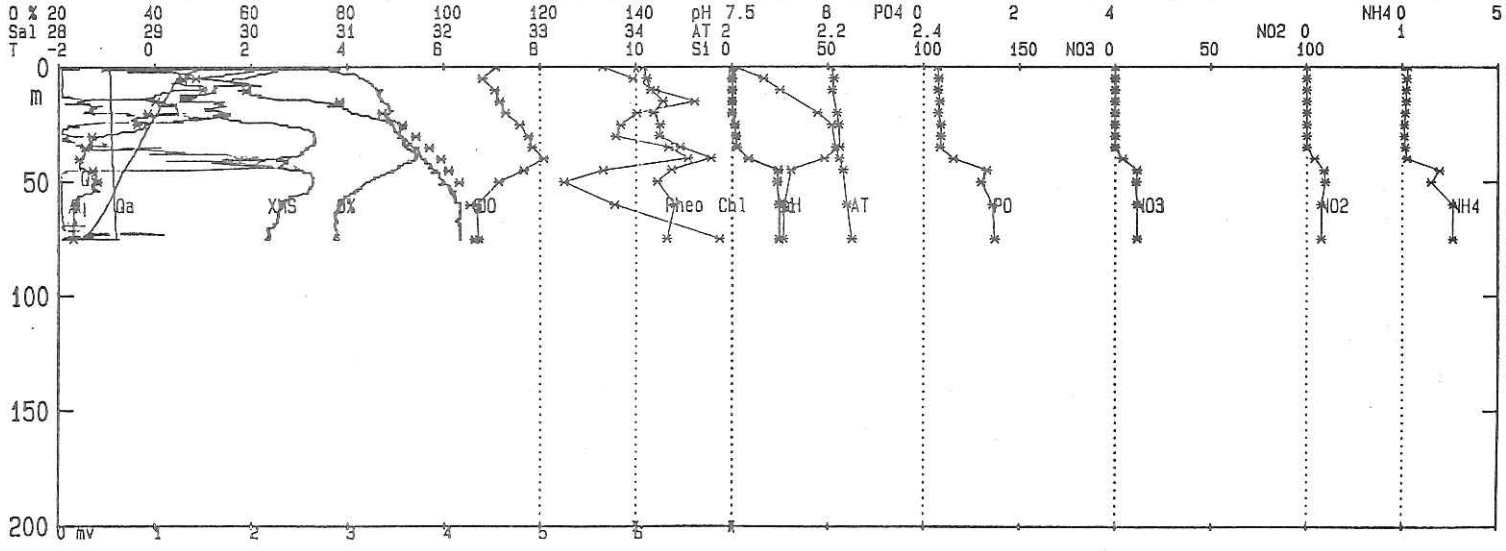


Table 33. Summary of OCTOPUS data at Station 8

Station	8/DN	Depth	110 m	Date	June 21, 1986	TIME	15:55 - 16:07	Lat.	56 - 30.7 N	Long.	167 - 47.2 W

BWS															OCTOPUS					VanDorn		
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Sig-t	%-DO	AOU	Aqua	XMS	Q-s	Q-a	D(vd)	Chl-a	Pheo.
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM		%	ml/l	mv	mv	mv	mv	m	mg/l	mg/l
0	0	5.86	31.720	7.45	8.130	2.228	0.0	0.31	0.0	0.00	0.28	24.98	105.0	-0.36	0.037	1.305	1.356	0.354	0	0.486	0.052
5	5	5.84	31.732	6.17	----	----	0.0	0.30	0.0	0.00	0.21	24.99	86.9	0.93	0.046	2.164	1.142	0.372	10	0.432	0.092
15	15	5.82	31.724	6.21	8.132	2.226	0.0	0.32	0.0	0.00	0.23	24.99	87.5	0.89	0.045	2.120	1.004	0.365	20	0.407	0.105
25	25	5.70	31.748	6.26	8.132	2.228	0.0	0.32	0.0	0.00	0.33	25.02	88.1	0.84	0.055	2.080	0.859	0.352	30	0.548	0.144
35	34	4.41	31.846	6.42	8.119	2.233	0.0	0.48	0.0	0.00	1.55	25.24	87.4	0.92	0.043	2.178	0.766	0.350	40	0.194	0.099
45	45	3.36	31.895	6.41	----	----	11.8	0.96	3.00	0.06	4.55	25.38	85.0	1.13	0.151	2.262	0.638	0.358	50	0.116	0.126
55	55	2.45	31.948	6.27	7.983	2.224	9.7	1.01	4.20	0.08	4.94	25.49	81.4	1.43	0.051	2.297	0.535	0.381	75	0.123	0.264
65	65	3.30	32.150	6.25	7.980	2.232	21.0	1.13	5.10	0.10	5.88	25.58	83.1	1.28	0.045	2.343	0.434	0.392	100	0.118	0.544
75	75	3.14	32.475	5.46	7.700	2.231	38.9	2.05	22.2	0.16	2.15	25.66	72.4	2.08	0.046	1.501	0.324	0.391			
85	84	3.19	32.486	4.95	----	----	45.6	2.22	24.5	0.18	2.20	25.66	65.7	2.58	0.044	1.350	0.140	0.391			
95	95	3.21	32.497	4.77	7.642	2.239	46.1	2.23	24.5	0.18	2.43	25.67	63.3	2.76	0.045	1.071	0.000	0.390			
105	106	3.23	32.501	4.66	7.638	2.242	46.1	2.31	23.0	0.18	2.13	25.67	61.9	2.86	0.043	0.605	0-.000	0.423			

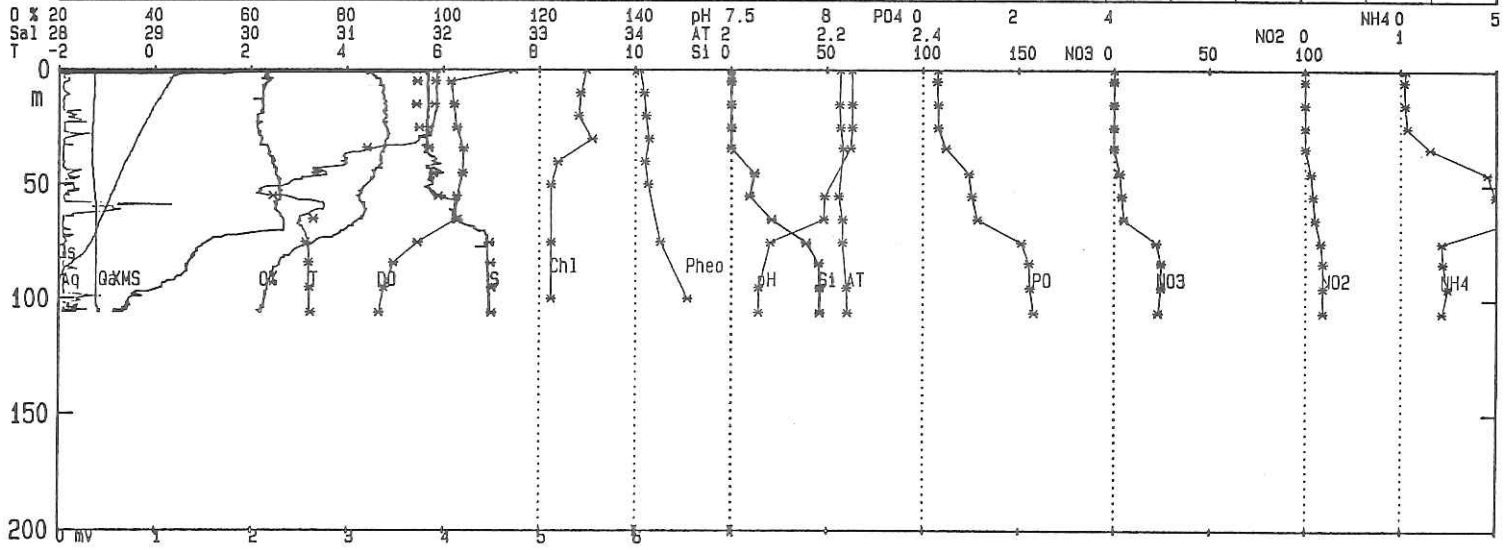


Table 34. Summary of OCTOPUS data at Station F'

Station	F'/DN	Depth	4105 m	Date	July 15, 1986	TIME	10 : 48 - 11 : 10	Lat.	53 - 00.2 N	Long.	144 - 59.2 W

RMS															OCTOPUS				RMS		
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Sig-t	%-DO	AOU	Aqua	XMS	G-s	G-a	D	Chl-a	Pheo.
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM		%	ml/l	mv	mv	mv	mv	m	mg/l	mg/l
0	0	8.86	32.206	7.37	----	----	13.3	1.12	10.0	0.07	0.27	24.95	111.7	-0.77	2.548	0.842	1.512	0.890	0	0.434	0.049
15	15	8.79	32.221	6.08	----	----	13.4	0.58	10.1	0.13	0.22	24.98	92.1	0.52	2.117	2.336	1.218	0.914	15	0.368	0.049
30	30	8.58	32.224	6.25	----	----	----	----	----	----	----	25.01	94.2	0.39	2.434	2.283	1.091	0.932	30	----	----
40	41	6.37	32.387	6.48	----	----	15.2	1.22	11.7	0.14	0.24	25.44	92.9	0.50	2.343	2.421	0.975	0.936	41	0.372	0.152
50	49	6.25	32.396	6.47	----	----	15.9	1.24	12.2	0.16	0.15	25.46	92.4	0.53	2.355	2.418	0.894	0.925	49	0.340	0.178
60	60	5.90	32.433	6.37	----	----	15.9	1.29	12.3	0.16	0.35	25.54	90.4	0.68	2.261	2.565	0.765	0.912	60	0.292	0.187
70	70	4.98	32.529	6.39	----	----	17.1	1.40	13.9	0.34	0.41	25.72	88.7	0.81	2.054	2.651	0.702	0.902	70	0.287	0.195
80	79	4.62	32.625	6.29	----	----	20.7	1.52	16.9	0.18	0.03	25.83	86.6	0.98	1.840	2.715	0.633	0.891	79	0.194	0.119
90	90	4.39	32.798	6.05	----	----	26.2	1.63	20.0	0.03	0.05	26.00	82.9	1.24	1.603	2.699	0.555	0.884	90	0.154	0.109
100	99	4.17	33.101	5.64	----	----	37.8	2.02	25.8	0.00	0.05	26.26	77.0	1.68	1.401	2.748	0.487	0.880	99	0.098	0.060
110	110	4.04	33.331	4.98	----	----	46.3	2.27	30.4	0.01	0.08	26.45	67.9	2.35	1.385	2.794	0.407	0.879	110	0.043	0.049
125	120	3.89	33.529	4.39	----	----	56.7	2.55	34.7	0.00	0.05	26.63	59.8	2.96	1.304	2.795	0.325	0.875	120	0.018	0.036
130	130	3.78	33.654	3.82	----	----	63.4	2.66	37.1	0.00	0.05	26.74	51.9	3.54	1.404	2.743	0.222	0.871	130	0.027	0.209

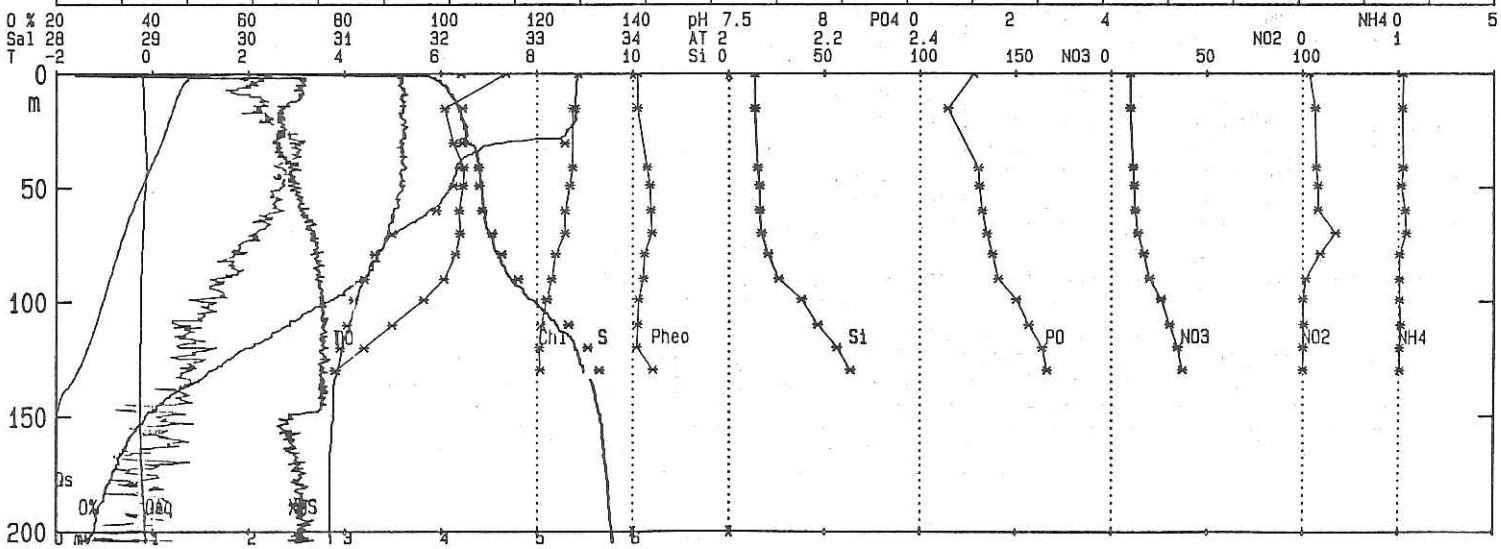


Table 35. Summary of OCTOPUS data at Station C'

Station	C'/DN	Depth	3920 m	Date	July 22, 1986	TIME	11 : 47 - 12 : 10	Lat.	53 - 30.3 N	Long.	177 - 31.2 E

															OCTOPUS				Niskin		
Sample	D	T	S	D.O.	pH	AT	SiO2	PO4	NO3	NO2	NH4	Sig-t	%-DO	AOU	Aqua	XMS	Q-s	Q-a	D	Chl-a	Pheo.
No.	m	C		ml/l		meq/l	uM	uM	uM	uM	uM		%	ml/l	mv	mv	mv	mv	m	mg/l	mg/l
0	0	7.61	32.680	7.42	----	-----	18.5	1.12	15.9	0.18	0.38	25.51	109.6	-0.65	0.636	0.913	1.409	0.425	0	0.533	0.150
10	10	7.48	32.755	6.04	----	-----	17.9	1.13	16.1	0.18	0.52	25.59	89.1	0.74	1.876	1.428	1.129	0.430	10	0.533	0.165
20	20	7.41	32.755	6.04	----	-----	17.9	1.34	16.1	0.18	0.59	25.59	89.0	0.75	2.162	1.416	1.025	0.438	20	0.608	0.163
30	30	6.92	32.851	6.07	----	-----	18.5	1.32	16.1	0.18	0.53	25.74	88.4	0.80	2.418	1.460	0.914	0.447	24	0.595	0.205
40	40	6.71	32.851	6.17	----	-----	19.7	1.20	16.7	0.20	0.53	25.76	89.3	0.74	2.383	1.602	0.787	0.456	29	0.570	0.230
50	50	6.02	32.904	6.15	----	-----	21.5	1.44	17.7	0.24	0.80	25.89	87.7	0.86	2.262	1.692	0.666	0.457	39	0.843	0.335
60	60	4.74	33.050	6.32	----	-----	25.7	1.60	19.8	0.29	0.66	26.16	87.4	0.91	2.068	1.809	0.553	0.455	49	0.744	0.361
70	70	3.97	33.089	6.27	----	-----	33.5	1.72	23.3	0.50	0.37	26.27	85.1	1.10	1.616	1.918	0.441	0.452	59	0.570	0.273
80	80	3.77	33.121	6.13	----	-----	36.5	1.78	24.8	0.21	0.37	26.31	82.9	1.26	0.737	2.039	0.338	0.446	78	0.434	0.337
90	90	3.50	33.159	5.97	----	-----	38.3	1.89	25.7	0.05	0.03	26.37	80.3	1.47	0.493	2.081	0.223	0.437	98	0.113	0.147
100	100	3.34	33.166	5.87	----	-----	40.7	1.91	26.8	0.01	0.18	26.39	78.6	1.60	0.217	2.081	0.088	0.419	146	0.023	0.063
150	150	3.62	33.437	4.58	----	-----	59.2	2.18	33.2	0.01	0.11	26.58	61.8	2.83	0.055	1.902	0.001	0.444	195	0.011	0.085
200	200	3.91	33.715	3.17	----	-----	74.8	2.56	38.7	0.02	0.15	26.77	43.2	4.17	0.104	1.895	0.001	0.398			

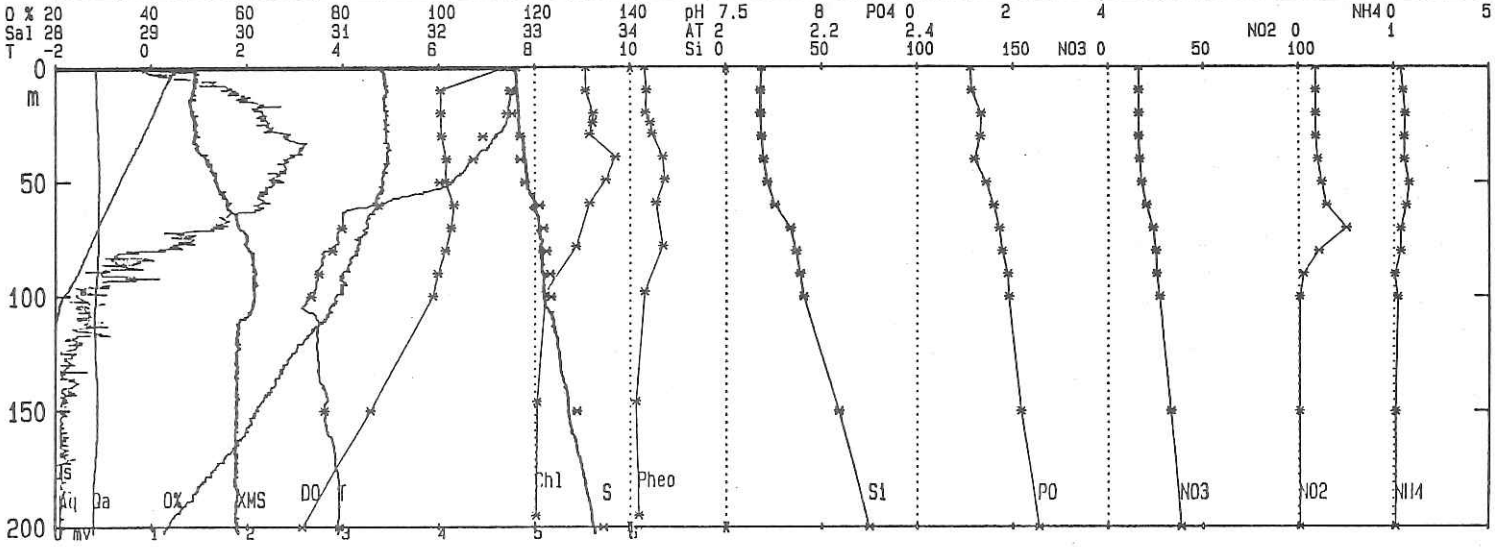


Table 36. Vertical distribution of total dissolved nitrogen (μg atoms N/l)

Sta.B		Sta.C		Sta.1		Sta.3		Sta.D		Sta.8		Sta.E		Sta.F		Sta.G		Sta.F'		Sta.C'		Sta.H	
m		m		m		m		m		m		m		m		m		m		m		m	
0	34.9	0	27.9			0	7.8	0	7.2	0	10.3	0	21.3	0	21.0	0	19.4	0	22.3	0	23.5	0	23.6
15	34.8	15	26.6			10	6.7	5	7.5	15	9.4	10	22.2	10	24.3	10	20.3	10	21.7	10	24.2	10	23.8
20	33.7	20	26.2			20	8.6	10	8.1	15	8.3	20	23.3	20	23.5	20	20.6	20	20.9	20	24.6	20	25.1
25	34.9	25	29.2			40	28.1	15	9.5	25	7.3	25	22.9	25	22.9	25	18.3	25	20.1	25	24.9	25	27.4
30	37.4	30	29.7			60	30.3	20	9.5	35	8.7	30	26.6	30	23.5	30	17.5	30	21.1	30	25.5	30	30.6
40	35.9	40	32.3			80	30.1	25	11.3	45	16.6	40	27.2	40	21.5	40	17.7	40	19.3	40	26.4	40	31.5
50	35.7	50	32.3			120	31.0	30	12.3	55	15.6	50	26.5	50	21.5	50	19.5	50	20.2	50	26.7	50	33.6
60	35.7	60	34.0			140	33.0	35	13.3	65	18.8	60	29.5	60	23.3	60	18.8	60	19.6	60	28.9	60	35.3
80	36.0	80	33.8					40	23.5	75	31.6	80	28.7	80	24.1	80	19.5	80	21.5	80	32.7	80	35.7
100	37.1	100	38.4					45	24.0	85	32.9	100	34.0	100	25.1	100	21.5	100	26.0	100	33.8	100	38.6
150	50.3	150	39.5							95	33.1	150	50.2	150	47.7	150	33.0	150	44.9	150	39.2	150	41.9
200	56.1	200	44.2							105	32.1	200	51.9	200	50.5	200	40.3	200	48.6	200	45.6	200	46.5
0	34.0	0	27.8	0	21.4							0	21.3	0	20.7	0	19.3	0	20.2	0	23.9	0	–
50	33.5	50	32.2	10	26.5							50	24.2	50	21.0	50	20.3	50	19.3	50	26.3	50	34.3
100	35.7	100	28.3	20	30.8							100	33.9	100	26.9	100	23.1	100	24.3	100	34.9	100	39.4
200	55.4	200	44.3	30	31.7							200	52.0	200	50.2	200	41.4	200	48.0	200	45.6	200	46.7
300	54.6	300	48.5	40	32.9							300	53.3	300	52.3	300	46.5	300	51.0	300	50.6	300	50.6
400	54.3	400	51.6	50	32.5							400	52.1	400	50.9	400	50.0	400	50.9	400	52.5	400	52.3
500	55.0	500	51.1	75	35.1							500	52.0	500	50.7	500	50.2	500	52.0	500	51.8	500	51.8
600	56.1	600	50.3	100	34.7							600	51.5	600	50.5	600	49.1	600	52.2	600	51.3	600	53.3
700	54.6	700	51.8	200	43.0							700	53.0	700	51.2	700	49.5	700	51.9	700	50.4	700	51.4
800	55.4	800	52.1	300	48.4							800	51.8	800	52.2	800	51.5	800	51.5	800	50.1	800	52.1
900	55.9	900	50.8	500	51.3							900	53.2	900	52.9	900	49.4	900	51.7	900	52.3	900	52.6
1000	54.2	1000	51.3	750	51.4							1000	53.5	1000	51.8	1000	51.3	1000	54.4	1000	52.0	1000	52.3
1250	55.4	1250	50.8	1000	51.0							1250	53.3	1250	50.4	1250	49.7	1250	50.7	1250	51.0	1250	51.9
1500	55.4	1500	50.8									1500	52.5	1500	48.6	1500	50.8	1500	50.3	1500	52.5	1500	53.7
1750	52.1	1750	51.1									1750	51.9	1750	48.4	1750	49.3	1750	49.8	1750	50.5	1750	50.7
2000	50.7	2000	47.8									2000	52.1	2000	47.9	2000	49.3	2000	49.0	2000	50.6	2000	50.5
2250	48.8	2250	47.0									2250	49.0	2250	47.4	2250	48.6	2250	47.5	2250	46.4	2250	50.7
2500	47.7	2500	45.6									2500	50.0	2500	48.1	2500	47.3	2500	47.0	2500	47.7	2500	50.6
2750	47.1	2750	44.7									2750	49.4	2750	47.7	2750	48.6	2750	47.0	2750	46.6	2750	49.8
3000	48.8	3000	44.8									3000	48.8	3000	45.0	3000	48.0	3000	45.2	3000	44.6	3000	48.5
3250	48.4	3250	43.9									3250	49.1	3250	47.0	3250	47.5	3250	44.8	3250	44.6	3250	48.9
3500	45.2	3500	42.5									3500	46.6	3500	45.1	3500	47.1	3500	42.8	3500	45.0	3500	48.5
3750	45.9	3750	43.4									3750	45.7	3750	43.5	3750	46.7	3750	42.8	3750	44.6	3750	48.4
4000	45.4													4000	44.3	4000	45.4	4000	43.7	3870	44.2	4000	48.7

* Water samples collected by Niskin bottle casts (Stas. C, F, G, F', C' and H) or OCTPUS casts (Stas. 3, D and 8) from shallow depths (upper portion of the table) and by CTD casts from a whole water column (lower portion of the talble) were used.

Table 37. Vertical distribution of particle number (per ml) and particle volume (μm^3/ml x 1000)

Depth m	PN	PV
Sta.B (Nis)*		
0	1783	547
15	1980	1366
20	1951	834
25	1616	492
30	1304	531
40	712	138
50	473	196
60	441	218
80	332	34
100	492	282
150	397	94
200	103	10

Depth m	PN	PV
Sta.C (Nis)		
0	1725	459
15	2085	430
20	2310	396
25	1507	237
30	1212	339
40	572	60
50	719	97
60	520	119
80	446	195
100	435	75
150	398	103
200	491	52

Depth m	PN	PV
Sta.1 (Nis)		
0	3241	1003
10	1761	998
20	1664	981
30	737	972
40	609	120
50	490	88
75	424	118
100	336	82
200	303	217

Depth m	PN	PV
Sta.2 (OCT)		
0	1820	398
10	2373	934
20	2403	689
40	504	340
50	434	323
70	331	122
80	415	49
90	392	56
110	577	88
125	1107	24

Depth m	PN	PV
Sta.3 (VD)		
0	2772	974
10	1806	851
20	3780	707
30	11836	2395
40	8420	1160
50	3317	194
75	2231	428
100	1091	220
140	3894	659

Depth m	PN	PV
Sta.4 (Nis)		
0	3344	1502
Sta.5		
0	1587	278
Sta.6		
0	1387	990

Depth m	PN	PV
Sta.D (VD)		
0	865	864
10	1330	2051
20	1207	4906
30	1695	1591
40	9301	4667

Depth m	PN	PV
Sta.7-4 (VD)		
0	7832	784
5	7231	771
10	5967	734
20	5561	2438
30	4238	566
50	1874	325
70	3401	1320
80	4746	548

Depth m	PN	PV
Sta.8 (VD)		
0	967	141
10	1157	884
20	1026	587
30	1031	475
40	1247	432
50	1701	594
75	1937	498
100	3740	1412

Depth m	PN	PV
Sta.E (VD)		
0	1027	353
10	1121	702
20	1128	731
25	1181	451
30	1355	622
40	783	298
50	650	748
60	539	188
80	420	541
100	350	105
150	195	77
200	124	118

Depth m	PN	PV
Sta.F (Nis)		
0	926	98
10	871	83
20	755	95
25	648	314
30	514	66
40	538	154
50	410	339
60	345	84
80	262	146
100	190	94
150	219	23
200	117	8

Depth m	PN	PV
Sta.G (Nis)		
0	1501	999
10	1393	148
20	1251	131
25	1371	413
30	1838	871
40	1783	275
50	1575	692
60	893	180
80	386	351
100	177	139
150	171	149
200	237	998

Depth m	PN	PV
Sta.F' (Nis)		
0	1643	197
10	1513	610
20	1204	362
25	1055	220
30	1309	691
40	1295	168
50	1221	385
60	772	558
80	428	124
100	277	44
150	301	22
200	217	128

Depth m	PN	PV
Sta.C' (Nis)		
0	2499	1093
10	2519	1091
20	2165	522
25	2227	957
30	2122	709
40	1976	725
50	1579	226
60	1239	282
80	1127	557
100	447	190
150	410	82
200	1132	115

Depth m	PN	PV
Sta.H (Nis)		
0	3686	1472
10	3972	1502
20	3068	556
25	2821	562
30	1971	523
40	836	363
50	741	4356
60	614	62
80	522	369
100	409	141
150	494	50
200	856	131

* Water samples collected by Niskin (Nis), Van Dorn (VD) or OCTOPUS (OCT) casts were used.

Hydrographic characteristics

T. Nakai, H. Otobe and A. Hattori

1. The northwestern North Pacific and the deep Bering Sea (Stations B, H, C and 1)

On the western side of the Emperor Sea Mounts in the northwestern North Pacific (Station B), a cold watermass with a temperature less than 2.5 °C lay between 60 and 150m, and formed a dichothermal layer below where a strong halocline was found. Mesothermal water was located at a depth of about 350m. These patterns are typical of the Western Subarctic Water (Fig. 11, see also Fig. 18).

On the eastern side of the Emperor Sea Mounts, south of the Near Islands (Station H), the distribution of temperature and salinity differed either from those at Station B or those at Station C located in the Bower's Basin of the Bering Sea. The dichothermal layer was hardly identifiable (Fig. 17) and mesothermal water higher than 4 °C was seen at ca. 150m. The influence of the Alaskan Stream Water is apparent in this area.

At Station C in the Bower's Basin, the dichothermal layer was thick. This watermass probably originates from mode water with a temperature of approximately 2.2 °C, salinity of 33.25 ppt and dissolved oxygen of 6.8 ml/l; the mode water was clearly seen at a depth between 100 and 150 m at Station 1 (Fig. 18). The inflow of the Bering Slope Current along the continental slope is suggested to be the possible source.

The concentration of dissolved silicic acid in the bottom layer of Station C was very high (> 200 μM) (Fig. 13), as observed in the other areas of the deep Bering Sea.

2. Northwestern Bering Sea shelf region (Stations 2-6 and D)

In the northwestern shelf region, the water structure was complex (Fig. 11), because of the seasonal cooling and heating, the vertical and horizontal water mixing by the tidal current and the wind, the freezing and melting of ice and runoff from large rivers. The temperature was very low. We encountered large floating ices at the vicinity of Station 4 on July 18-20. The surface salinity was very low (about 31.0 ppt), and cold water less than -1 °C was commonly found near the bottom of the continental shelf area north of Station 4. The maximum oxygen content

exceeding 9 ml/l existed at about 30 m (Fig. 12). Silicic acid and nitrate in the surface layer were completely depleted (Figs. 13 and 14). Maximum concentration of chlorophyll *a* was found in the subsurface layer (30-40m), and the concentration of ammonium was very high in the bottom layer. It is suggested that the spring bloom of phytoplankton occurred before we made the observations.

3. The Gulf of Alaska (Stations E, F and G, Figs. 15 and 16)

Three stations 300 nautical miles apart (E, F and G) were occupied along 145°W meridian. The contours of sigma-t generally inclined toward the south, suggesting the occurrence of eastward geostrophic flow. The surface geostrophic velocity relative to 3000 db and the volume transport were calculated to be 1.1 cm/sec and 3.2 x 10^6 m^3/sec between Stations E and F, respectively, and 3.6 cm/sec and 6.8 x 10^6 m^3/sec between Stations F and G, respectively.

At Station F, the thermocline was at about 50 m. The dichothermal water was relatively warm and was hardly distinguishable from the mesothermal water (Fig. 17, *top*). The halocline and oxycline were located between 100 and 150 m (Fig. 17, *middle* and *bottom*). Judging from these profiles, the watermass at Station F can be identified as the Eastern Subarctic Water.

4. Water circulation in the studied area

The Alaskan Stream which originates from the Eastern Subarctic Water flows westward on the southern side of the Aleutian Islands. A great part of the stream enters into the Bering Sea through the Near Strait and the other part passes around the Near Islands together with a small part of the Western Subarctic water. The surface water flows eastward on the northern side of the Aleutian Islands, turns northwest in a direction near the shelf break area (the Bering Slope Current), and produces a cyclonic circulation over the deep Bering Sea basin. A part of the circulating water flows along the Kamchatka Peninsula (the East Kamchatka Current) and serves as the source of the Western Subarctic Water. A part of the East Kamchatka Current is drifted eastward by the westerly wind (the Subarctic Current), while the other part contributes to the formation of the Oyashio Current. The T-S and T-O_2 diagrams illustrated on the basis of the CTDO data collected in this cruise (Fig. 18) are consistent with this general pattern of water circulation. The

data on surface currents estimated from the ship's drift (Fig. 19) also generally support this view, but some discrepancy can be noted. This may be attributed to the temporal variations of the flow pattern and the presence of vortex currents.

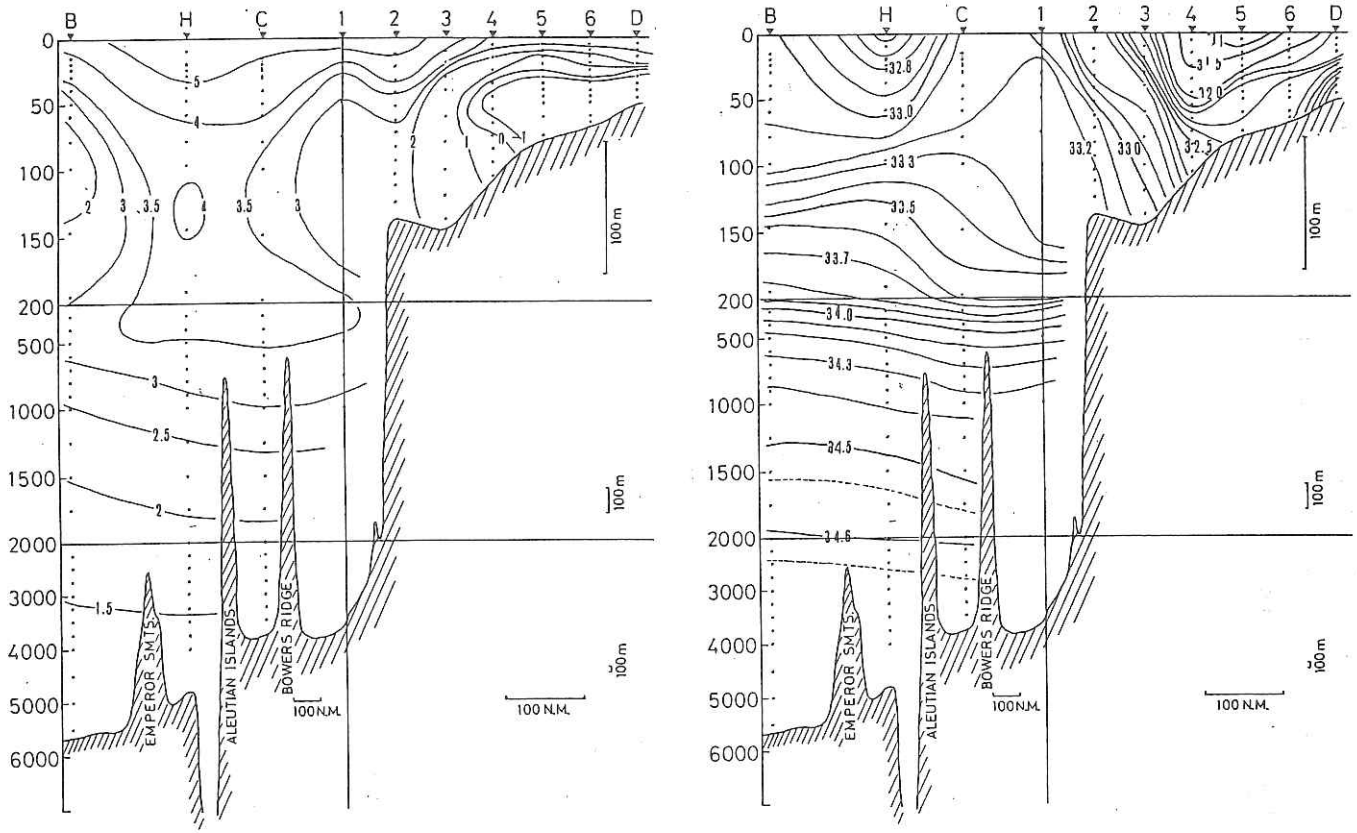


Fig. 11. Cross sections of temperature (C) and salinity (ppt) along a transect between Station B and D.

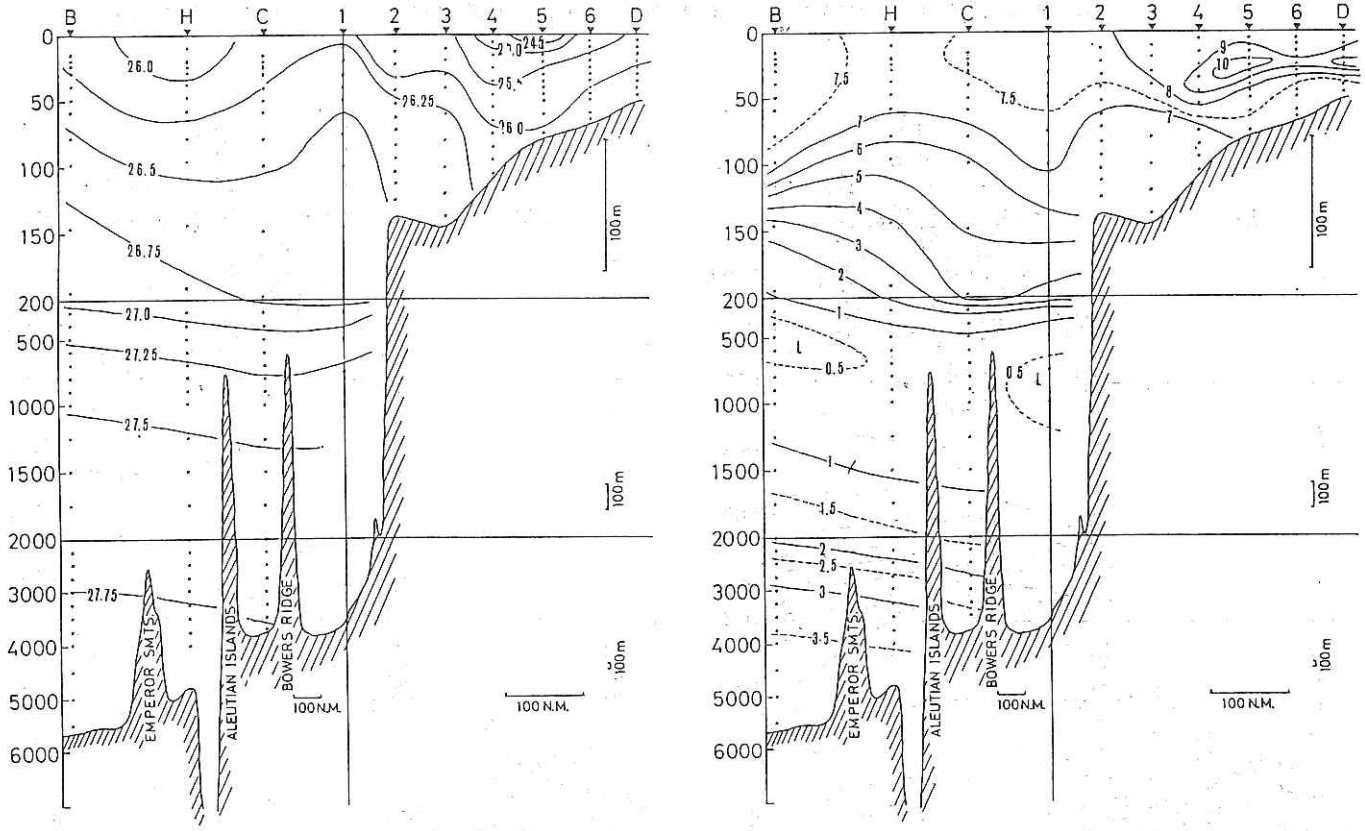


Fig. 12. Cross sections of sigma-t and dissolved oxygen (ml/l) along a transect between Stations B and D.

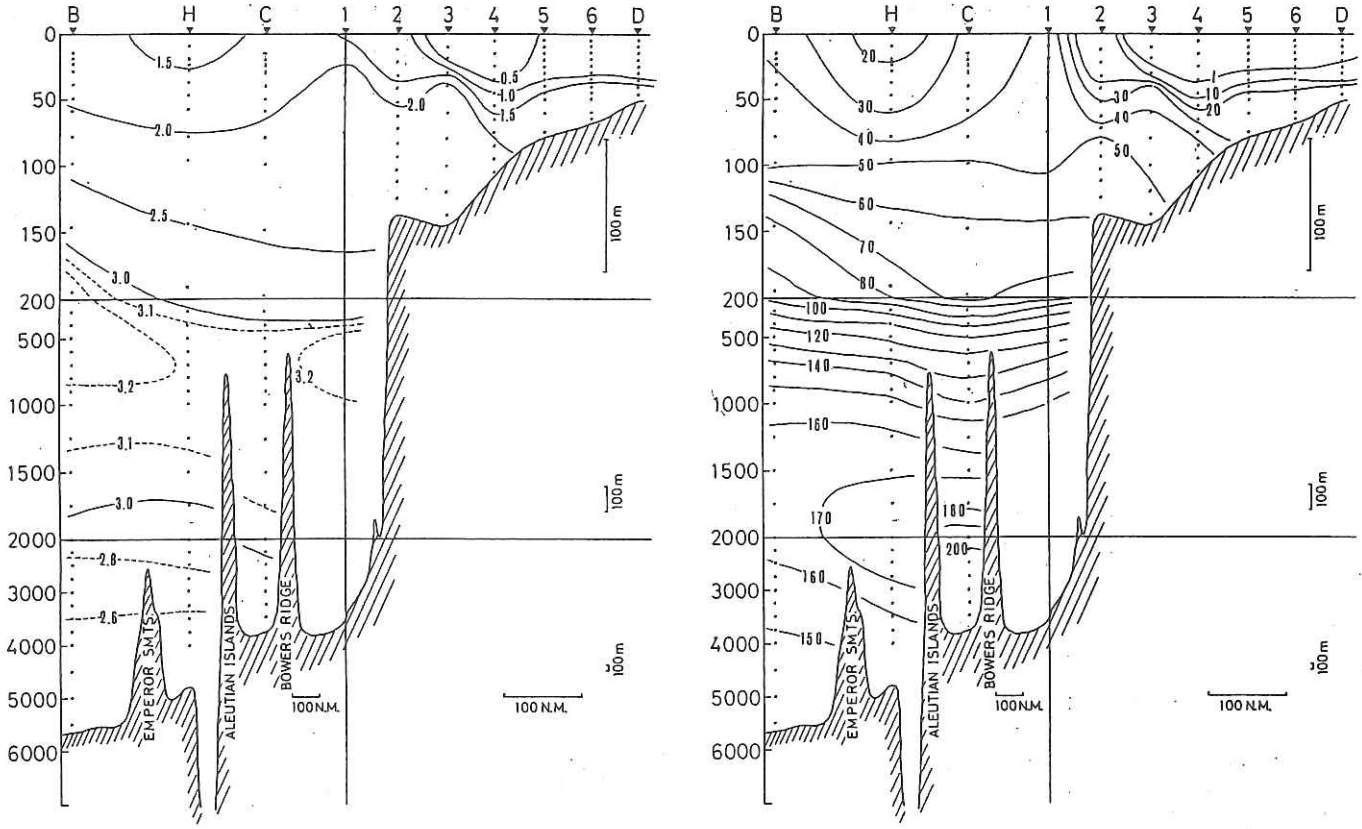


Fig. 13. Cross sections of phosphate (µg atoms P/l) and silicic acid (µg atoms Si/l) along a transect between Stations B and D.

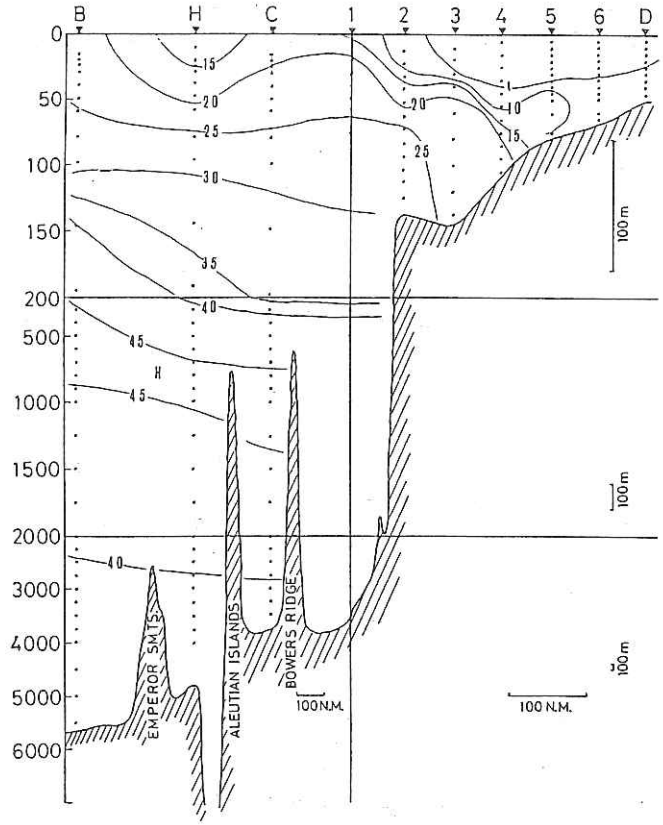


Fig. 14. Cross sections of nitrate (µg atoms N/l) along a transect between Stations B and D.

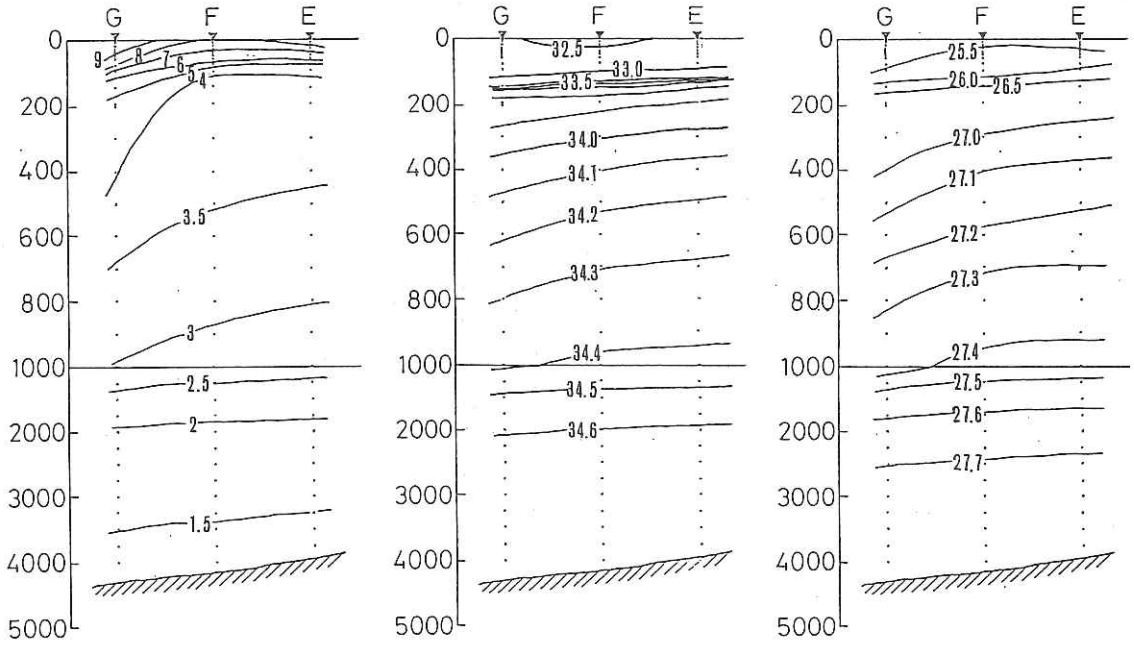


Fig. 15. Cross sections of temperature (C), salinity (ppt) and sigma-t along a north-south transect in the Gulf of Alaska.

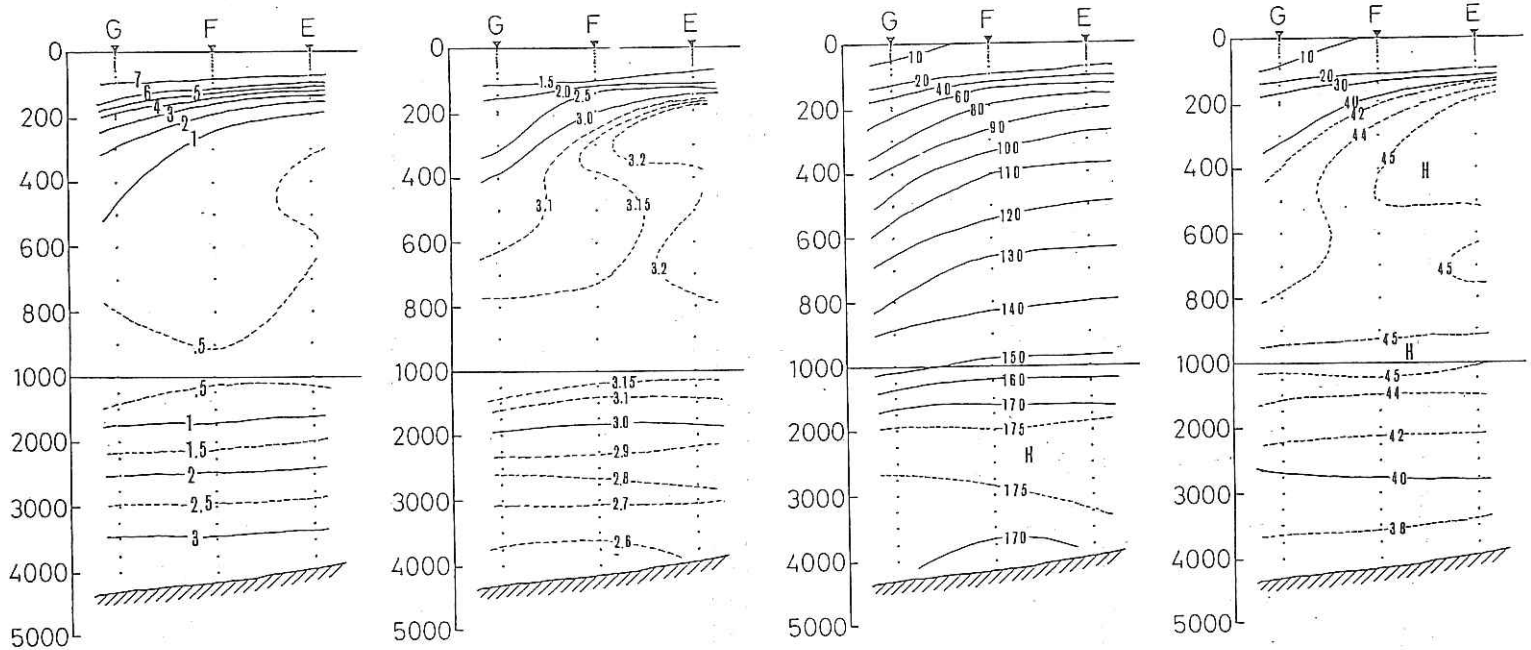


Fig. 16. Cross sections of dissolved oxygen (ml/l), phosphate (μg atoms P/l), silicic acid (μg atoms Si/l) and nitrate (μg atoms N/l) along a north-south transect in the Gulf of Alaska.

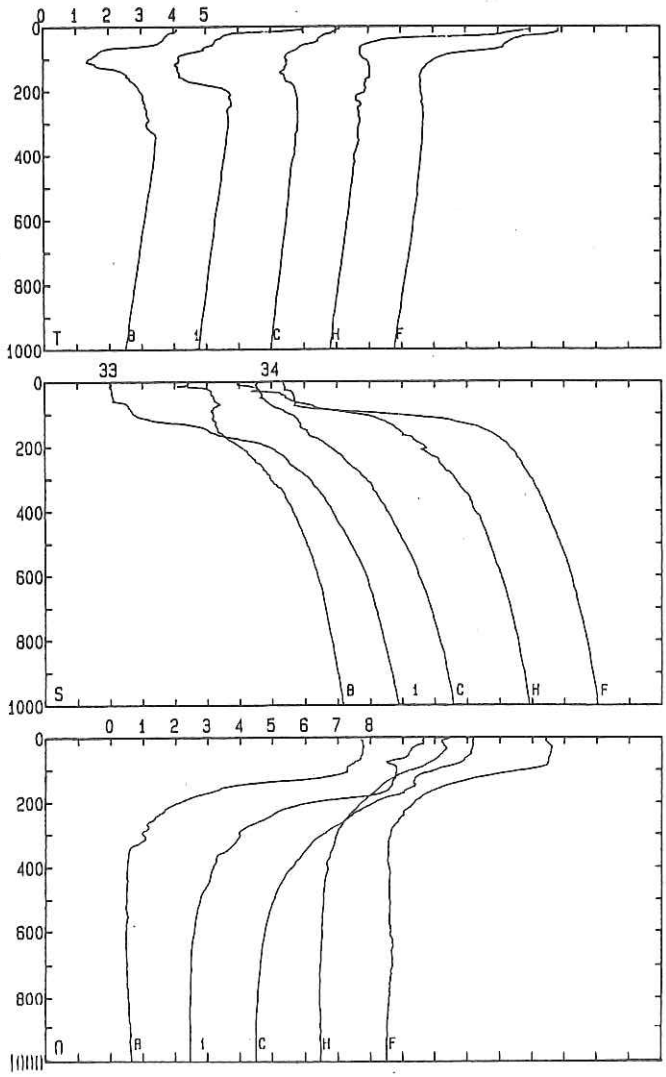


Fig. 17. CTDO profiles of temperature (C, *top*), salinity (ppt, *middle*) and dissolved oxygen (ml/l, *bottom*) at Station B, 1, C, H and F. For illustration, origins of abscissa scale for the individual station data were successively shifted toward the right by two units.

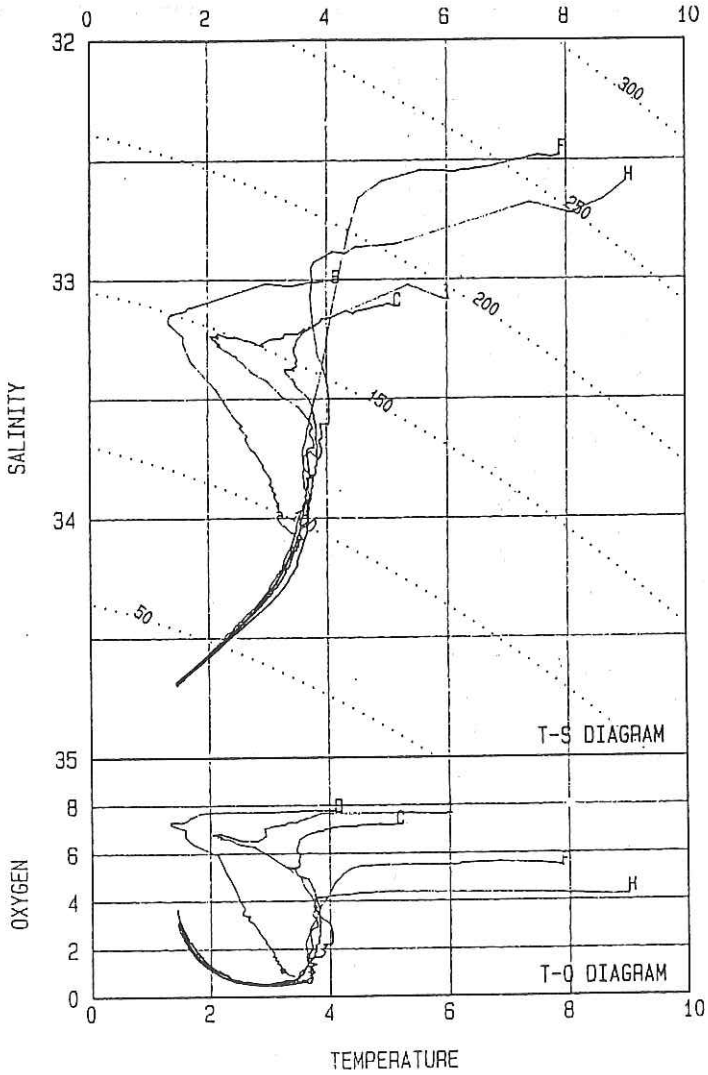


Fig. 18. T-S and T-O_2 diagrams at Stations B, 1, C, H and F. Data collected by CTDO casts were used.

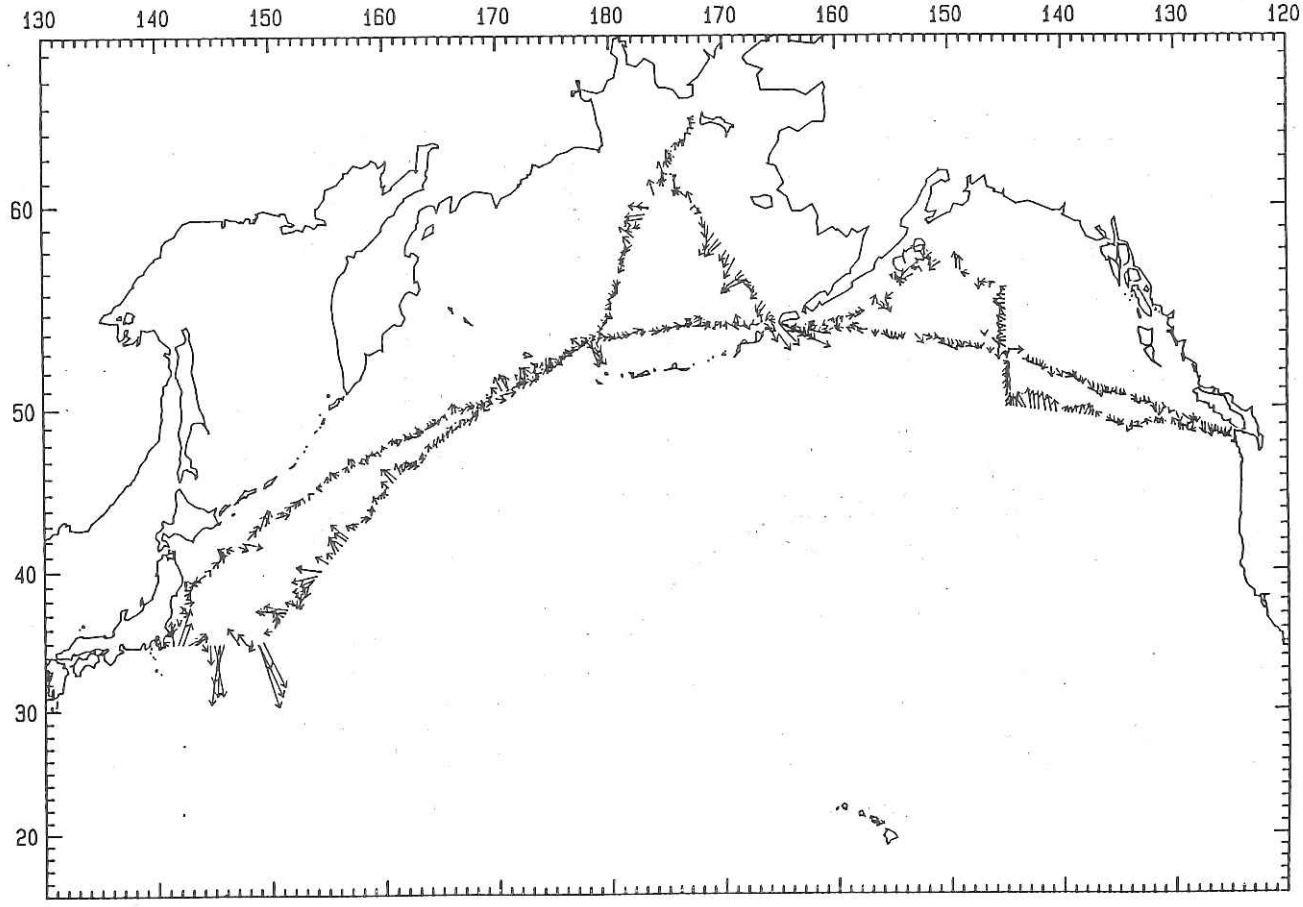


Fig. 19. Surface currents estimated from the ship's drift.

Water temperature observation in the upper ocean

H. Otobe, T. Saino, K. Harada and H. Sasaki

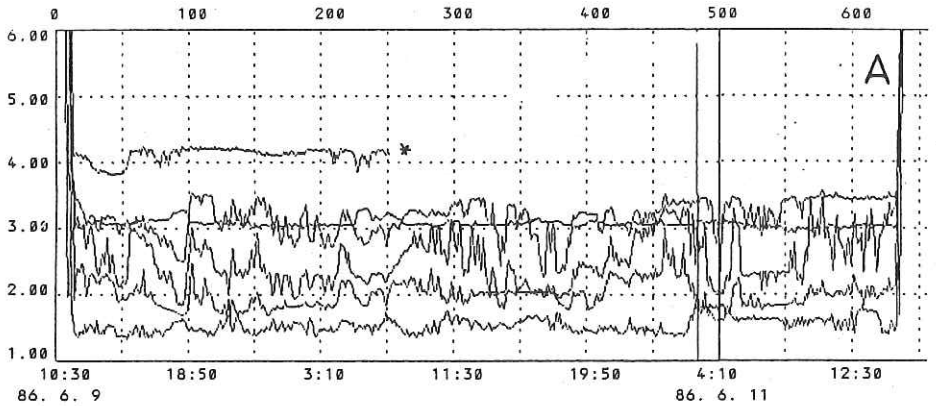
In order to obtain information on the advective water movement, water temperature in the upper layer was continously monitored in the Bering Sea and the Gulf of Alaska. Six self-contained digital therometers (Model RMT water thermometer, Rigosha & Co., LTD, Tokyo) with an accuracy of ±0.05°C and resolving power of 0.02°C were attached to a sediment trap buoy system of the Ocean Research Institute, University of Tokyo and 2 thermometers to that of Hokkaido University (Table 38).

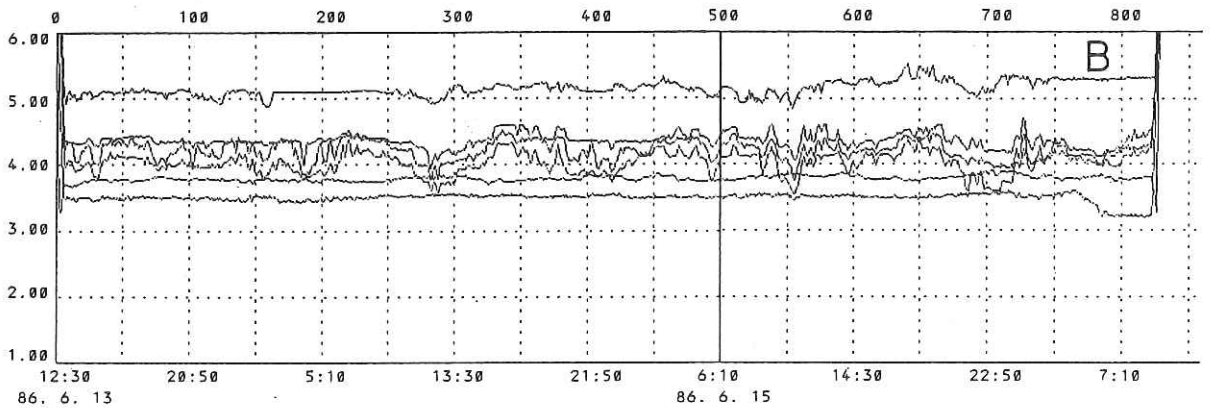
The data stored in a memory unit of each thermometer (4096) were read out on a personal computer through a RC-232C serial interface and transferred to mini floppy disks.

The records are reproduced in Fig. 20.

Table 38. Summary of water temperature observations

Station	Observation period	Sampling interval	Observation depth intended	Buoy system used
		min	m	
B	1100 9 Jun-1530 11 Jun	5	10,40,50,60,100,200	ORI
C	1300 13 Jun-0900 16 Jun		10,40,50,60,100,200	(floating)
F'	1150 15 Jul-1530 17 Jul		15,30,40,60,100	
C	1200 13 Jun-0900 22 Jul	15	100,250	Hokkaido Univ.
F	0800 29 Jun-0900 15 Jul	10	260,600	(anchored)


0
100
200
300
400
500
600
6.00
5.00
4.00
3.00
2.00
1.00
A
10:30
18:50
3:10
11:30
19:50
4:10
12:30
86. 6. 9
86. 6. 11


0
100
200
300
400
500
600
700
800
6.00
5.00
4.00
3.00
2.00
1.00
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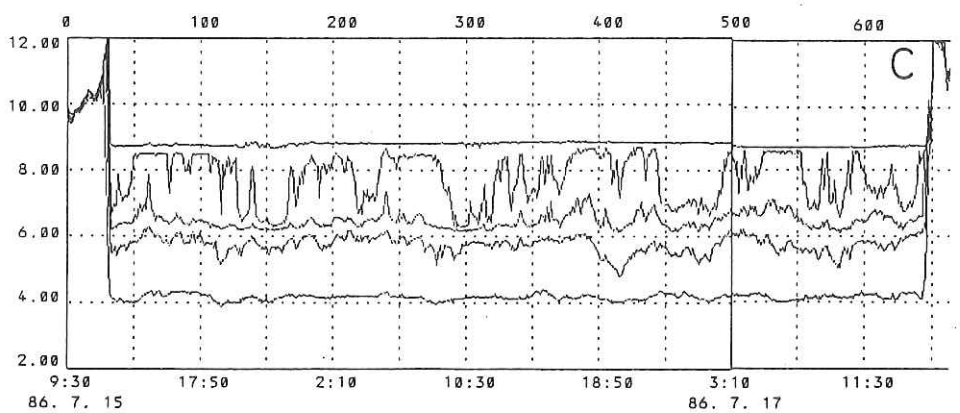
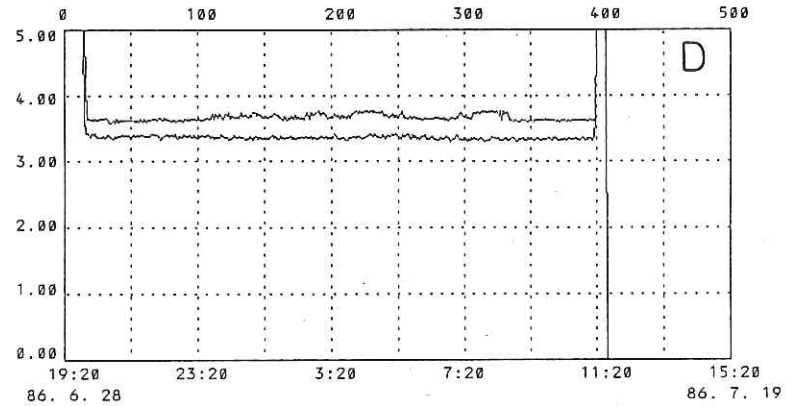
5:10
13:30
21:50
6:10
14:30
22:50
7:10
86. 6. 13
86. 6. 15


0
100
200
300
400
500
600
12.00
10.00
8.00
6.00
4.00
2.00
C
9:30
17:50
2:10
10:30
18:50
3:10
11:30
86. 7. 15
86. 7. 17



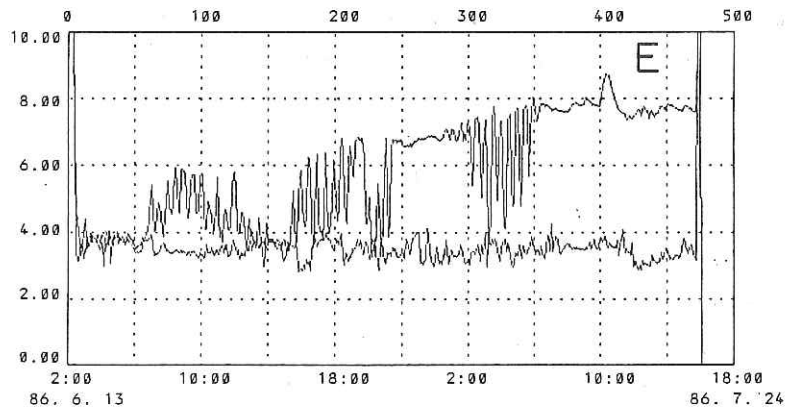


Fig. 20. Water temperature records at 10, 40, 50, 60, 100 and 200 m (from top to bottom) at Station B during the period from 1100 LST 09 June to 1530 LST 11 June 1986 (A), at Station C during the period from 1300 LST 13 June to 0900 LST 16 June 1986 (B), at 15, 30, 40, 60 and 100 m at Station F' during the period from 1150 LST 15 July to 1530 LST 17 July 1986 (C), at ca. 100 and 250 m at Station B during the period during 1200 LST 13 June and 0900 LST 22 July 1986 (D), and at depths of 10-60 m and 350-400 m at Station F during the period from 0800 LST 29 June to 0900 LST 15 July 1986 (E).

Chemical and radiochemical studies of the northern North Pacific and the Bering Sea

S. Tsunogai, K. Harada, K. Taguchi, S. Nagao and K. Demura

1. Sediment trap experiments

We collected settling particles with two types of sediment traps (D and NH types) at three stations and studied the spatial, temporal and vertical variations of particulate fluxes with special reference to the high biological productivity in this region. Emphasis was placed on fluxes of chemical and radiochemical components. One of the three arrays of time-series sediment traps (D type) which had been deployed at Station B on 11 August 1985 during the KH-85-4 cruise was retrieved on 9 June 1986, and the other two arrays of sediment traps were installed from 13 June to 22 July 1986 at Station C in the Bering Sea Basin and from 29 June to 15 July 1986 at Station F in the Gulf of Alaska, respectively (Fig. 21). The particle samples were collected on Nuclepore filters (pore size, 0.6 μm) and freeze-dried. Total mass fluxes are listed in Table 39. Major chemical components, trace metals and natural radionuclides in these samples will be determined.

2. Radionuclides in seawater

In order to study the removal processes of reactive chemical elements from the ocean, the following natural radionuclides in seawater were determined: ^{234}Th, ^{232}Th, ^{230}Th, ^{228}Th, ^{231}Pa, ^{210}Po, ^{210}Bi and ^{210}Pb.

The samples for ^{234}Th, ^{210}Pb, ^{210}Bi and ^{210}Po analysis (20-50 l each) were collected from 10 depths in the upper 100 m layer at Stations C and F' with a submersible pump and also collected from 11 depths in the bottom 500 m layer at Station B, C and F' with Niskin bottles. On the basis of the results obtained, the effects of biological activity and the bottom interface on the removal of these nuclides from seawater will be investigated.

The samples for the determination of long lived radionuclides, ^{232}Th, ^{230}Th, ^{228}Th and ^{231}Pa (180-200 l each), were collected from 16 and 17 depths at Stations C and F', respectively, with large volume water samplers and a submersible pump. Surface samples (about 200 l each) were also collected at 26 stations, and ^{228}Th content was determined. The results will give information for understanding the slow removal

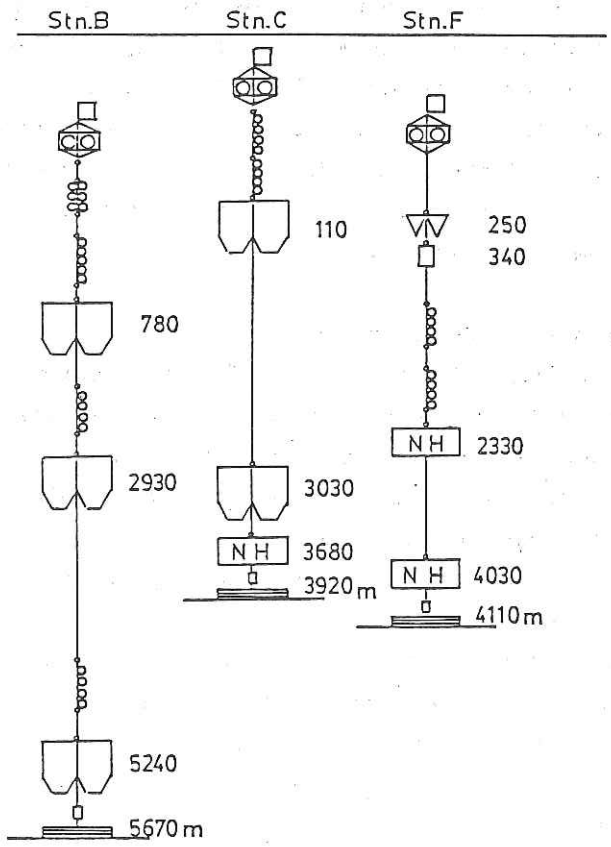


Fig. 21. Arrays of sediment traps used at Stations B, C and F.

processes of these elements in the ocean.

3. Uranium and some heavy metals in marine sediments

Sediment samples were obtained with a large box corer at Stations B, C and 3 and with an Okean grab sampler at Station F'. The core samples were cut into 5 cm segments, and interstitial water was separated using a squeezer made of polyvinylchloride under mechanical pressure. The interstitial water samples (about 500 ml each) will be analyzed for uranium and other heavy metals. The solid fractions of the sediment samples will be also analyzed for uranium and other metals after water and organic matter contents are determined. The data can be used to elucidate the behavior of uranium and heavy metals during the early diagenesis of marine sediments.

4. Dimethylsulfide in the ocean water

The distribution of dimethylsulfide (DMS) in seawater was studied in order to estimate the emission rate of DMS from the ocean to the atmosphere. The samples for the DMS measurements (about 50 ml each) were taken from the surface 200 m layer at 17 stations with Niskin bottles and analyzed for DMS and other reduced sulfur compounds on board the vessel within 12 hours by FPD-gas chromatography. Some of the results are given in Table 40.

At Stations C and F', we obtained 18 bottom water samples to disclose a sink term of DMS in the ocean. The results given in Table 41 show that the concentrations of DMS near the sea-floor are negligibly small.

5. ^{210}Pb in maritime aerosols

Aerosols in maritime air were collected by filtration through a Whatman 41 filter (20 x 25 cm) using a large volume air sampler(Fuji VFC 304P, flow rate 1 m^3/min). The air sampler was set on the compass bridge deck of the vessel and a sector controller was used to avoid contamination from the ship exhaust.

Twenty one samples were obtained during the cruise. The atmospheric concentrations of ^{210}Pb were determined by digesting the filter samples with hot nitric acid and by using a radiochemical technique devised by Tsunogai and Kondo (1982). The beta activity of ^{210}Pb was counted with a low back-ground gas flow type GM counter.

Table 39. Total particulate fluxes observed with sediment traps

Type of trap	Depth m	Period			Total mass flux mg/m^2•day	
	Station B (46 49'N, 162 07'E, water depth 5670 m)					
D	780	11 Aug '85-24 Oct '85	74 days		309	634*[1]
		24 Oct '85- 6 Jan '86	74		105	194*[1]
		6 Jan '85-21 Mar '86	74		65	107*[1]
		21 Mar '85- 3 Jun '86	74		111	229*[1]
D	2930	11 Aug '85- 9 Jun '86	302		170	179*[1]
D	5240	11 Aug '85-24 Oct '85	74		258	329*[1]
		24 Oct '85- 6 Jan '86	74		51	91*[1]
		6 Jan '85-21 Mar '85	74		33	47*[1]
		21 Mar '85- 3 Jun '85	74		55	102*[1]
	Station C (53 30'N, 177 31'E, water depth 3920 m)					
D	110	13 Jun '86-22 Jun '86	9		21	142*[2]
		22 Jun '86- 1 Jul '86	9		26	137*[2]
		1 Jul '86-10 Jul '85	9		24	40*[2]
		10 Jul '86-19 Jul '85	9		24	126*[2]
D	3030	13 Jun '86-22 Jun '86	9		10	3*[2]
		22 Jun '86- 1 Jul '86	9		295	912*[2]
		1 Jul '86-10 Jul '86	9		120	86*[2]
		10 Jul '86-19 Jul '86	9		97	84*[2]
NH	3680	13 Jun '86-22 Jul '86	39		478 ± 63 (n=6)	
	Station F (53 00'N, 145 00'W, water depth 4110 m)					
S*[3]	250	29 Jun '86-15 Jul '86	16		73	
O*[4]	340	29 Jun '86-15 Jul '86	16		66	
NH	2330	29 Jun '86-15 Jul '86	16		127 ± 36 (n=5)	
NH	4030	29 Jun '86-15 Jul '86	16		121 ± 43 (n=5)	

*[1] Formaldehyde was used as a preservative.
*[2] Sodium azide was used as a preservative.
*[3] A funnel-shaped trap with buffles and without a lid (ORI-UT).
*[4] A cylinder-shaped trap without a lid (Tohoku Univ).

Table 40. Dimethylsulfide concentrations in seawater near the surface

Station B		Station C		Station D		Station F	
Depth (m)	DMS (ng/l)	Depth (m)	DMS (ng/l)	Depth (m)	DMS (ng/l)	Depth (m)	DMS (ng/l)
0	95	0	31	0	6	0	2.0
15	56	15	20	5	15	10	4.2
20	74	20	40	10	20	20	5.4
24	135	30	47	20	22	24	5.7
29	197	40	37	25	20	29	2.6
39	80	50	54	30	16	39	8.9
59	23	59	19	41	8.4	49	7.9
78	21	79	23	45	16	59	4.2
98	6.9	99	10			78	10
195	5.8					98	3.4
						146	6.7
						195	0.6

Table 41. Dimethylsulfide concentrations in the bottom waters*

Station C (water depth 3920 m)		Station F' (water depth 4070 m)	
Depth (m)	DMS (ng/l)	Depth (m)	DMS (ng/l)
3620	1.8	3849	0
3720	0.8	3784	0
3821	0.8	3875	0
3846	0.5	3923	0
3870	0.5	3971	0
3890	0.5	4019	0
3899	0	4048	0
3909	0	4057	0
3914	0	4061	0

* Detection limit is 0.2 ng DMS/l.

Vertical distribution of total dissolved nitrogen in the northern North Pacific Ocean and the Bering Sea

I. Koike and L. Tupas

The vertical distribution of total dissolved nitrogen was determined for stations B, C, E, F, and G in the northern North Pacific Ocean and for stations 1, 3, D, and 8 in the Bering Sea. Water samples from shallow depths (surface to 200 m) were collected with 23-liter Niskin bottles, while deep water samples were collected with a rosette multisampler.

Water samples were first filtered through Whatman GF/F filters, stored at 4°C and were analyzed on board within 10 hours after collection. Total dissolved nitrogen was determined with a Yanaco Total Nitrogen Analyzer (Model TN-7). Forty µl of sea water was injected manually into the reaction column of the machine and 4 to 6 trials per water sample were performed. Water samples were preserved after analysis with mercury chloride.

Preliminary results (Table 36) show that waters of the northern North Pacific Ocean contain between 17.5 to 56.1 µg atoms N/l of dissolved total nitrogen while waters of the Bering Sea contain between 21.4 to 51.4 µg atoms N/l at the deep basin (maximum depth sampled at 1000 m) and between 7.2 to 33.1 µg atoms N/l at the shallower area (maximum depth sampled at 105 m).

CO_2 exchange between the air and sea

S. Kanamori, T. Aono, N. Kadoya and A. Hashimoto

The high productivity of the Bering Sea has been considered to be supported by active input of the deep water rich in nutrients from the Pacific. We can expect a close relation between carbonate and nutrient concentrations. Therefore, we investigated the dynamics of carbonate and nutrients in association with production and decomposition of organic matter, and CO_2 exchange between air and sea in this productive area.

The total dissolved carbonate and individual carbonate species were calculated from pH and titration alkalinity. The pH was measured, within a few hours after sampling with an air-tight pH cell system at 25.0 $\pm$ 0.1° C on the NBS standard buffer scale. The precision of the measurement was $\pm$ 0.003 pH unit and the reproducibility within $\pm$ 0.001 pH unit.

The titration of alkalinity was carried out by a computer processed automatic potentiometric titration system with an accuracy of $\pm$ 0.1 % error.

The measurements of pH was carried out at all stations and those of alkalinity at Stations B, C, 1, F, F', C', H (Tables 4-12).

Distribution of arsenic

S. Kanamori and A. Hashimoto

Arsenic is present in two oxidation states in seawater, arsenate and arsenite. The thermodynamically stable form is arsenate. Arsenite is probably produced by biological reduction of arsenate. The occurrence of organic derivatives of arsenic in natural waters has been reported. It is suggested that the dissolved states of arsenic in seawater are affected or controlled by biological activity. We investigated the distribution and dissolved states of arsenic species in the Bering Sea and the northern North Pacific where the primary productivity and other biological activities are known to be very high.

Seawater samples were collected at Stations B, C, D, E and F. One liter of sample water was filtered through a Nuclepore filter (0.4 μm) within a few hours after the sampling. One hundred ml of the filtrate was kept frozen and the remaining filtrate was acidified with HCl. Chemical analysis will be made at Nagoya University.

Heavy metals in marine aerosols

S. Kanamori

Aerosol samples were collected for the study of the aerial and size distribution of heavy metal aerosols (Cu, Zn, Cd, Fe, Al, and Mn) in the maritime air over the northern North Pacific and the Bering Sea. Aerosol particles greater than 0.4 μm were separated into 8 size fractions and the remaining smaller fraction was caught on a back-up filter (Nuclepore Filter, 0.4 μm) by the use of an Andersen low volume sampler.

Ten sets of aerosol samples were collected during this cruise. Chemical analysis will be made at Nagoya University.

"Clean" water sampling and heavy metal study

S. Kanamori, T. Aono, N. Kadoya and A. Hashimoto

The distribution and dissolved states of several heavy metal elements (Cu, Zn, Cd, Fe, Al and Mn) were investigated. Emphasis was placed upon the organic-metal association and the nutrients-dissolved metal relation.

New "clean" water samplers, one for surface water and the other for subsurface water, were designed and constructed at the metal workshop of Nagoya University and used in this cruise for the first time. Because of their complex structure, the clean water samplers reported previously were inconvenient in operating on board and often failed to function properly. Our samplers were designed to eliminate these defects. A special device was made to avoid any contamination from the sampler itself, the steel wire, and the ambient water during operation. One set for surface water and four sets for subsurface water were operated at a time.

Seventeen casts were carried out during the cruise and "clean" seawater samples were taken from 62 layers covering from the surface to 5500 m depth. Although a few samplers did not work well in the early phase of trial, the reliability of water sampling was increased by improved handling. There was no mal-functioning in the last 5 casts.

Setting of the "clean" water sampler and processing of the sample water were done in a clean room (class 100) on board the ship. The capacity of the samplers was 1.8 l. The suspended particulate matter was separated by centrifugation (10,000 rpm for 1 hr.) or by filtration through a Nuclepore filter (0.4 μm). The sample waters were then processed through a column of reversed phase absorption resin, and a majority of metal-organic compounds was separated. The chemical analysis will be made at Nagoya University.

Distribution of vanadium and molybdenum in seawater

N. Kadoya

Vanadium and molybdenum are biologically active metals and their distributions in the oceans may reflect the mode and extent of biological activity. We have found that vanadium is depleted in the surface water of the Southern Sea where the biological production is very high. This study attempts to collect information on the distributions of vanadium and molybdenum in the highly productive Bering Sea and northern North Pacific where available data are extremely limited.

Sea water samples were collected at all stations. Vanadium was determined with an autoanalyzer on board the ship within several hours after sampling by the catalytic oxidation method of Bindschedler using 4,4'-bis(dimethylamino) diphenylamine and potassium bromate. The concentration of vanadium tended to increase with depth: 20 to 30 nmol/l in the surface layer and 35 to 40 nmol/l in deep water. One hundred ml water sample was saved for molybdenum analysis in the shore laboratory.

Study on the distribution of Se species, Se(IV), Se(VI) and organic Se, in seawater and on the presence in gaseous state of Se and some other bio-essential elements in maritime air over the Bering Sea and the northern North Pacific

T. Aono, Y. Nakaguchi and K. Hiraki

The main purpose of the present study is to improve our understanding of the mechanisms which control the chemical state of Se in seawater.

The concurrent occurrence of Se (IV), Se (VI) and organic Se in natural waters has been reported. The chemical state of Se is regulated by the oxidation and reduction potential of ambient seawater and sediment and also by the action of microorganisms. The present cruise covers the Bering Sea and the northern North Pacific where biological activity is known to be very high. We determined three Se species in seawater from these areas to obtain information how the distribution of Se species reflects the biological activity.

Our previous studies upon trace bio-essential elements in dust, mist and fume in the atmosphere have shown that a substantial portion of these elements exists in gaseous state. By applying a cold-trap method using liquid nitrogen, we collected gaseous substances in maritime air over the Bering Sea and the northern North Pacific, and Se and some other bio-essential elements were determined. Information on the distribution of these elements in gaseous state and its spatial and temporal variation is crucial for understanding the geochemical cycle of the trace bioelements.

Air sampling for the study of increasing atmospheric methane

T. Yoshinari

The concentration of atmospheric methane is increasing at about 2 % per year. This rate of increase is approximately correlated with that of the human population on the earth. While major sources of methane have been identified, their relative source strengths are yet to be clarified.

We intend to establish a data base for the abundance of ^{13}C, ^{14}C and ^{2}H in methane of air samples from various parts of the surface of the earth. Based on the information and the data of the isotope ratio for major sources we hope to establish the source strengths of major sources on the earth.

Six air samples have been collected during the trans-Pacific cruise between Vancouver, Canada and Tokyo, Japan. Each sample was contained in an aluminum cylinder in which about 2.5 m^3 air was filled by using a compressor. These will be used for analyses of the abundance of ^{13}C, ^{14}C and ^{2}H in methane as well as the concentrations of H_2, CO and CH_4 in air.

Depth profiles of nitrous oxide in the northern North Pacific Ocean and Bering Sea

A. Hattori and I. Koike

Seawater samples, collected from standard hydrocasts of 23-l Niskin bottles (above 200 m depth) and 5-l Niskin bottles (below 200 m depth) at Stations B, C, F, and H, were transferred directly into 100 ml serum bottles using a siphon. After allowing ca. 200 ml of water to overflow, the bottles were capped with rubber stoppers pierced with a hypodermic needles to avoid air bubbles. In order to terminate the biological reaction, 0.2 ml of 0.1 M $HgCl_2$ was injected through the rubber stopper. Dissolved nitrous oxide was determined by the gas chromatographic method of Cohen (1977).

Reference

Cohen, Y. (1977), Shipboard measurement of dissolved nitrous oxide in seawater by electron capture gas chromatography. Anal. Chem., 49, 1238-1240.

A study of maritime aerosol over the northern North Pacific Ocean and Bering Sea

A. Ono and M. Yamato

The importance of a deeper understanding as to how and to what extent man's activities influence chemical processes in the atmosphere has become apparent. Remote oceanic areas are suitable fields for studying the transformation of aerosol particles in the atmosphere and the transport processes of pollutants from the continents to the atmosphere because there are no local sources of pollutants. Our main concern in this study is to clarify the molecular state of submicron sulfate particles over the oceans.

Samplings of gases and aerosol particles in maritime air were undertaken over extended areas of the northern North Pacific and Bering Sea. To avoid contamination by ship exhaust, aerosol samplers were placed on the upwind side of the stack of ship, about 13 m above the sea surface. The samplers were automatically controlled so as to operate only when the wind speed exceeded 3.6 m/sec and when the wind direction was within 60 degrees from the forward direction of the ship. For chemical analysis of bulk components, aerosol particles were collected with a large volume Andersen sampler. For electron microscopic examination, aerosol particles were collected on electron microscope grids coated with a thin film of carbon, calcium, nitron and barium chloride by the combined use of a two-stage impactor and an electrostatic aerosol sampler. Sulfur dioxide, a precursor of sulfate in aerosol, was collected on a filter paper soaked in Na_2CO_3 solution after the removal of aerosol particles by passing through a fluoropore filter. The concentration of total aerosol particles was determined using an expansion-type portable nuclei counter.

Sulfate and nitrate particles were identified by the method of Bigg et al. (1974), and the method of Isawa and Ono (1977), respectively. The sulfuric acid component in the aerosol particles was examined by the calcium thin film technique of Ono et el. (1983). A preliminary examination suggests that sulfuric acid particles predominate in remote oceanic areas. Over the Bering Sea almost all particles reacted completely with the calcium thin film.

References

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Geochemical study of beryllium isotopes

M. Kusakabe

The ratio of cosmogenic nuclides ^{7}Be (half life 53.6 days) to ^{10}Be (half life 1.5 million years) can be used as a geochronometer for phenomena in air and surface water. In addition, the $^{10}Be/^{9}Be$ ratio (^{9}Be is stable) has been used recently in geochronology with a time scale of several million years or more. However, the behavior of the nuclides on the earth surface is not well understood due to the difficulty in measurement.

In order to clarify the behavior of the Be isotopes, the following experiments have been done.

1. Distribution of Be isotopes in surface water

About 200 l of surface water samples were collected approximately every 24 hours while the ship was steaming. Preconcentration and purification of Be were carried out partially on board the ship in collaboration with the Hokkaido University group who are interested in U-Th series nuclides. After extraction of U-Th series nuclides, the samples were brought back to the laboratory. The activities of ^{7}Be have been counted by using gamma ray spectrometry. The samples will be further purified and analysed for ^{10}Be by an accelerator.

Measurement of ^{9}Be using gas chromatography will be done on 500 ml surface water samples which were taken at the same locations as above.

2. Vertical distributions of Be isotopes

At three stations (Stations B, C and F), vertical profiles were taken for Be isotopes. Seawater samples (40-50 l) were collected at Station B for ^{7}Be and ^{10}Be from 12 depths with Niskin bottles. More detailed profiles were available with large amount of water (170-200 l) at Stations C and F' by using a submersible pump and a large volume water sampler. The activities of ^{7}Be have been counted for surface water samples 200 m and above. ^{10}Be will be measured for every sample. The waters for ^{9}Be (~500 ml) were taken from the routine hydrocasts.

3. Be isotopes in settling particulates

Sediment trap samples from three locations (Stations B, C and F) were

available for ^{7}Be measurement (see Tsunogai et al. in this volume for details of the traps). The activity of ^{7}Be was detected in the sample from 1100 m depth at Station B. Weak but significant amounts of ^{7}Be activity were also found in the samples which had been collected with the traps deployed at 120 m at Station C and at 250 m at Station F. The evaluation of total flux of ^{7}Be can be done with the knowledge of the total flux of particulates which is not available yet. ^{9}Be and ^{10}Be will be measured for all samples obtained including the samples from deep waters.

4. Be isotopes in aerosol

Eighteen aerosol samples were taken along the cruise track by passing more than 1500 m^3 of air through Whatman #541 filter paper. It took at least 1 day to get enough volume depending on weather conditions. The filter papers were brought back to USC and have been analysed for ^{7}Be by gamma ray spectrometry. Concentrations of ^{10}Be and ^{26}Al will be measured by an accelerator.

Study on biochemical constitutents of particulate matter in deep water

E. Tanoue

Biochemical components of particulate matter, phytoplankton, zooplankton and deep-sea sediments were examined. Emphasis was placed on the clarification of the origin and fate of particulate organic matter in deep water.

Approximately 40 l of seawater was collected with Niskin bottles from the surface to 3000 m depth at Stations B, C, E, G, F' and H. Particulate matter was collected by filtering ca. 20 l of seawater through a precombusted Whatman GF/F (47 mm in diameter) glass fiber filter. Four hundred to six hundred liters of seawater was collected from 8 water layers from the surface to 2000 m depth at Stations B, C and F'. Two hundred liters of the seawater samples was filtered through a Whatmann GF/F (150 mm in diameter) glass fiber filter under a hydraulic pressure of ca.200 mmHg. Ten liters of the filtrate was adjusted to pH 2.0 with HCl and heneicosanoic acid was added as an inner standard. Dissolved lipids were extracted three times with chloroform.

Plankton samples were collected by a NORPAC twin net or an ORI net at Stations B, C, E and D, and sediment samples by a box corer at Stations B, C and 3. All the samples were stored frozen (-30° C) until later chemical analyses in the land laboratory.

Organic C and N were determined using a CHN analyzer. Total carbohydrate, amino acid and lipid were determined by colorimetric, fluorometric and wet oxidation methods, respectively. Lipid materials were separated into simple lipid, glycolipid and phospholipid fractions. Simple lipid fraction was further separated into hydrocarbon, free fatty acid and mono-, di- and triglyceride fractions by silica gel chromatography. Lipid fractions were quantified as fatty acid contents by gas liquid chromatography. Proteins were solubilized with sodium dodecylsulfate (SDS), and molecular weight distributions of proteins and their subunits were determined by a SDS-polyacrylaminde gel electrophoresis. Carbohydrate was hydrolized and monosaccharide components were determined by gas liquid chromatography. Chemical form of carbohydrate was further characterized by combined use of staining with a specific fluorescing dye and enzymatic digestion.

Natural abundance of ^{15}N and ^{13}C in suspended and settling particulate organic matter

T. Saino and A. Hattori

Data on the natural abundances of ^{15}N and ^{13}C in the particulate organic matter (POM) provides useful information for understanding the processes of POM production and decomposition. During this cruise, we collected settling materials by using sediment traps and the suspended particulate materials with Niskin bottles, and determined their isotopic ratios to obtain insight into the particle dynamics in the oceanic waters.

Water samples were collected with 23-liter Niskin bottles at Stations B, C, F, F', C' at depths from 0 to 4000 m. Closely spaced water samplings were also carried out in the shallow layer (<200 m) at those stations. Surface water samples were obtained with a bucket at each station and once a day from 18 July to 29 July while steaming.

Sediment trap experiments (Table 42) were conducted at Stations B, C and F'. Sediment traps were hung at 10, 20, 30, 40, 50, 60, 70, 80, 100, 125, 150, and 200 m at Stations B and C, and at 15, 30, 40, 50, 60, 70, 80, 100, 125, 150 m at Station F'. The water samples (ca. 60 liters for >300 m, ca. 20 liters for <200 m) and the sediment trap samples were filtered through glass fiber filters (Whatman GF/F, 47 mm diameter, precombusted at 450 C for 4 hr), and POM collected on the filters was kept frozen for later mass spectroscopic analysis.

Table 42. Summary of the sediment trap experiments

Station		Date	Location	
B	Initial:	11:37 9 June	46 40.3'N	162 01.9'E
	Final:	15:09 11 June	46 42.5'N	162 27.6'E
C	Initial:	12:30 13 June	53 29.8'N	177 35.7'E
	Final:	09:00 16 June	52 59.4'N	178 26.3'E
F'	Initial:	12:13 15 July	52 59.6'N	144 56.1'W
	Final:	15:09 17 July	52 56.0'N	144 41.9'W

Diel variations of downward particulate flux at a 60 m depth observed in a time-series sediment trap experiment

H. Sasaki and S. Nishizawa

The temporal variation of downward particulate flux within a day in the coastal water was documented by Welschmeyer et al. (1984). The variation indicates the occurrence of the diel change of zooplankton grazing activity in the upper water column. In the open ocean, an observation has been made in the western North Pacific by Oyama et al. (in press) using sediment traps which were repeatedly deployed and retrieved at 6-hour intervals. They showed a marked diel variation of particulate flux in a 60 m layer, 20 m beneath the subsurface chlorophyll maximum layer. The maximum flux was observed sometime in the evening.

During the Cruise of KH-86-3, diel variations of downward fluxes were determined using a newly designed time-series sediment trap (0.196 cm^2 in mouth area) which can collect 12 consecutive samples of sinking particles. A surface-floating array consisted of a main buoy, a rader buoy, a radio buoy and a 200 m suspension rope (cf. page 84) onto which the trap was fastened at a 60 m depth.

The experiments were conducted at Stations B, C and F'. Unfortunately, we failed to retrieve the sediment trap at Station C. Location of sampling sites, suspension periods and collecting intervals are shown in Table 43.

References

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Welschmeyer, N. A., A. E. Copping, M. Vernet and C. J. Lorenzen (1984). Diel fluctuation in zooplankton grazing rate as determined from the downward vertical flux of pheopigments. Mar. Biol. 83, 263-270.

Table 43. Location of sampling sites, suspension periods of the trap array, and collecting intervals

Station	Location	Date	Suspension	Collecting
B	46 39.9'N 162 01.9'E	9-11 June 1986	48 hr	4 hr
F'	52 59.9'N 144 55.9'W	15-17 July 1986	48 hr	6 hr

Carbon and nitrogen uptake by natural populations of phytoplankton, and regeneration and oxidation of ammonium in shallow oceanic waters

A. Hattori and M. Otsu

Uptake rates of carbon dioxide, ammonium and nitrate by natural populations of phytoplankton in shallow waters of the northern North Pacific and the Bering Sea were measured by a ^{13}C-^{15}N dual tracer technique. Water samples were collected with 23-liter Niskin bottles from depths of 100, 25 and 3.6 % light penetration, and from depths of the ammonium maximum and nitrite maximum (cf. Tables 20-35). Subsamples (2 liters) were transferred to polycarbonate bottles after passing through a 200 μm mesh screen to remove a majority of zooplankton, and incubated with 0.2 μM of $NaH^{13}CO_3$ (90 atom %) and 1-2 μM of $K^{15}NO_3$ (99 atom %) or 0.1-0.5 μM of $(^{15}NH_4)_2SO_4$ (99 atom %) under constant illumination from a bank of daylight fluorescent lamps at a light intensity of 270 μEinst per $m^2 \cdot sec$. For the subsurface samples, light intensities were reduced to simulate natural light conditions using metal screens. After 5 and 10 hours of incubation, the samples were filtered through Whatman glass fiber filters (type F, precumbusted at 450° C for 4-5 hours), and the filters and filtrates were saved for later analysis of ^{13}C and ^{15}N.

Using the filter samples, amounts of particulate organic carbon and nitrogen and ^{13}C and ^{15}N contents were determined with a Nichiden-Anelva TE-360 quadrupole mass spectrometer. The uptake rates were calculated from increase of ^{13}C and ^{15}N enrichments in particulate matter with time and initial ^{13}C enrichment in carbonate and ^{15}N enrichment in ammonium or nitrate.

Ammonium in the filtrates was separated by steam-distillation in the presence of excess MgO. Nitrate was reduced to nitrite by passing through a copper-cadmium column, and treated successively with aniline and β-naphthol. The azo-dye produced was extracted with n-hexane. The amounts of ^{15}N in the ammonium and azo-dye were determined, and the rates of ammonium regeneration and of ammonium oxidation were estimated from change of ^{15}N in ammonium and nitrate with time.

The mass spectrometric analysis has not yet been completed. The data available at present are entered in Table 44.

Table 44. Carbon and nitrogen uptake by natural populations of phytoplankton

Station	Depth m	Amb. conc. (µg atoms N or C/l)						Specific rate (1/hr)				Uptake rate(ng atoms/l·hr)			
		NH_4	NO_3	NO_2	ΣCO_2	PON	POC	Vamm		Vnit	Vc	ρamm		ρnit	ρc
B	0	0.31	20.3	0.25	2220	2.01	14.6	2.68*	3.65**	1.94*	5.79*	5.4*	7.3**	3.9*	84*
	9	0.55	20.0	0.25	2230	2.07	15.0	4.03	5.56	1.90	6.37	8.4	11.5	3.9	96
	22	0.36	21.4	0.22	2240	2.08	14.1	2.55	2.35	1.09	3.24	5.3	4.9	2.3	46
	50	0.98	22.4	0.23	2260	1.65	12.4	0.18	0.13	0.12	0.02	0.3	0.2	0.2	0
	100	0.57	28.7	0.27	2270	0.52	6.3	0.26	0.65	0.69	-0.16	0.1	-0.3	0.4	-1
C	0	0.37	19.3	0.17	2220	2.39	17.4	4.22	3.39	1.60	7.97	10.1	8.1	3.8	139
	8	0.37	19.6	0.17	2220	2.52	18.1	3.69	3.34	1.91	8.89	9.3	8.4	4.8	161
	34	0.49	20.6	0.17	2220	1.72	14.8	3.64	3.57	0.81	4.83	6.2	6.1	1.4	72
	60	0.99	22.7	0.21	2230	0.85	10.4	0.12	0.23	-0.12	-0.32	0.1	0.2	-0.1	-3
	80	0.66	24.7	0.24	2260	0.53	9.4	0.23	0.51	-0.03	0.00	0.1	0.3	0.0	0
1	0	0.06	13.8	0.11	2170	4.32	28.3	1.33	0.98	2.19	5.87	5.7	4.2	9.4	166
	7	0.06	13.9	0.12	2180	4.29	28.5	1.31	1.07	2.65	5.89	5.6	4.6	11.4	168
	25	0.43	22.5	0.23	2210	2.13	19.8	1.71	1.54	0.20	2.17	3.6	3.3	0.4	43
	50	0.20	24.1	0.27	2250	0.83	10.2	0.23	0.15	-0.16	0.05	0.2	0.1	-0.1	0
	100	0.02	25.9	0.37	2250	0.53	8.4	0.25	0.25	0.00	0.02	0.1	0.1	0.0	0
D	0	0.01	0.0	0.01	2080	1.79	17.0	2.47	2.38	1.70	1.99	4.4	4.3	3.0	34
	5	0.00	0.0	0.01	2090	1.83	16.9	2.39	2.51	2.38	1.77	4.4	4.6	4.4	30
	21	0.00	0.0	0.02	2110	2.33	18.3	2.60	2.39	2.48	1.18	6.0	5.6	5.8	22
	45	4.45	9.4	0.13	2260	2.55	18.4	0.42	0.87	0.47	0.10	1.1	2.2	1.2	2

* Rate estimated from ^{15}N or ^{13}C enrichments at 0 and 5 hr.
** Rate estimated from ^{15}N enrichments at 5 and 10 hr.

Distribution of planktonic protista

S. Hara and E. Tanoue

The composition, standing stock and distribution of phototrophic and heterotrophic members of protista and monera in seawater were examined.

Seawater samples (1 liter each) were collected from the surface to 200 m with Niskin bottles at Stations B, C, E, F, G, F', C' and H. Samples were also collected from the surface and down to near the bottom with Van Dorn samplers at shallow stations. Deep water samples were collected with Niskin bottles at Stations B, C, E, F' and H.

Phototrophic and heterotrophic protista and phototrophic monera (blue green algae) were fixed with glutaraldehyde (1% final concentration). These organisms were collected on a Gelman membrane filter (25 mm in diameter and 0.2 μm in pore size). The filter was mounted on a slide glass with glycerine jelly, stored at -20°C and examined by epifluorescent microscopy. Heterotrophic monera (bacteria), fixed with glutaraldehyde (1%), were stained with a fluorescing dye (DAPI), collected on a Nuclepore filter (25 mm in diameter and 0.2 μm in pore size), stored at 4°C and examined by an epifluorescesce technique. The community structure of planktonic protista and monera at each station will be investigated. The other part of the seawater samples was divided and treated with glutaraldehyde (1 %), Lugol's solution (5 %) or formalin (5 %). Morphology and morphometry of phototrophic and heterotrophic protista will be examined by light and electron microscopies.

Studies on the processes of production at low trophic levels and the organic substances in the northern Pacific Ocean and the Bering Sea

K. Tada and T. Odate

1. Regional variations of zooplankton and phytoplankton with special reference to size distribution

Net plankton samples were collected at 14 stations by a NORPAC twin net (XX13 and GG54) tow from 200 m to the surface. Water samples were taken with Van Dorn samplers from several depths between 0 and 200 m. Phytoplankton in the water samples were fixed with Lugol's solution. Microzooplankton were concentrated by filtering 10 or 20 liters of seawater samples through a NXXX25 screen (40 μm mesh). Species and cell numbers of phytoplankters and microzooplankters will be determined later. Nutrient concentrations in ambient seawater were determined on board the ship. An aliquot of seawater was filtered through a Nuclepore filter (10 or 2 μm) or a Whatman GF/F filter, and chlorophyll *a* and phaeopigment were determined.

During sailing, 102 surface seawater samples were collected at about four-hour intervals from 4 m depth. The samples obtained were treated in the same way as described above. [T. Odate]

2. Studies on the behavior of organic matter in seawater and the processes of production and decomposition of organic substances

Seawater samples were collected from the surface to 5000 m at Stations B, C, D and F with Niskin bottles. The samples were filtered through a Whatman GF/F filter. The filtrates, to which 10^{-4}M of $HgCl_2$ was added were saved for later determinations of dissolved free amino acids and dissolved combined amino acids. Particulate samples collected on the filters were stored frozen at -20°C. Concentrations of ATP in the upper 200 m layer at Stations 1, 2, 3 and 5 of the Bering Sea were determined by the method described by Parsons et al. (1984) using 250 ml of water samples collected with Van Dorn bottles. Experiments were conducted at Station F to obtain information on the rate of zooplankton decomposition. Zooplankton samples were freeze-dried immediately after sampling, placed in a glass bottle containing 5 l of surface seawater, and incubated in the dark in a deck tank containing running surface

seawater. After 1.5, 5.5, 15, 30, and 50 hours, aliquots were taken out and filtered through a whatman GF/F filter. The amount and composition of amino acids in the filtrate will be examined later.

The analyses will be carried out in the shore laboratory after the cruise. [K. Tada]

A part of this research program was planned by Prof. Y. Maita, Faculty of Fisheries, Hokkaido University.

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Fluorocytometry of oceanic particulate matter

T. Saino, K. Furuya and A. Hattori

Oceanic particulate materials were analysed with a JASCO FCS-1 cell sorter. For each particle in seawater (<40 μm), a 488 nm Ar-ion laser beam (500 mW) was irradiated, and the forward scattered light, right angle scattered light, and green and red fluorescence were monitored simultaneously.

Two fluorescent spherical latex beads (2 and 5 μm diameter) were used as standards for test of machine stability and as measure of each signal. A part of each water sample was saved for later image analysis by fluorescence microscopy (K. Furuya).

Data were obtained from shallow depths (<200 m) at Stations C, 1, 2, 3, 4, 5, 6, D, 7, 8, E, F, G, C' and H.

Estimate of cellular carbon in natural populations of phytoplankton

K. Furuya and T. Saino

The relationship between cellular carbon content and cell volume of natural populations of phytoplankton was investigated. Phytoplankton cells from the surface seawater were sorted using a JASKO FCS-1 cell sorter. Forward scattered light and red fluorescence were selected as indices. The sorted phytoplankton samples were kept frozen for later analysis of the carbon centent with an CHN analyzer coupled to a quadrupole mass spectrometer. Care was taken to reduce a carbon blank.

Aliquots of the sorted samples were fixed with glutaraldehyde and processed following the procedure of Tsuji and Yanagita (1981). The cell volume of the phytoplankton and possible contamination of the other detrital particles were examined by epifluorescence microscopy.

Reference

Tsuji, T. and T. Yanagita (1981). Improved fluorescence microscopy for measuring the standing stock of phytoplankton including fragile components. Mar. Biol., 64, 207-211.

Composition and biomass of phytoplankton

K. Furuya

Size distribution of phytoplankton was investigated following the method of Tsuji and Yanagita (1981). Water samples collected from various depths shallower than 200 m were fixed with 1 % glutaraldehyde, and filtered through Gelman GA6 membrane filters. The phytoplankton collected on the filters were examined by fluorescence microscopy. Cell numbers and size distribution were determined with an image analyzer system fitted with an epifluorescence microscope (excitation: 420-490 nm). Using the data obtained, total cell volumes of various size groups of phytoplankton were calculated (Furuya 1982). Numbers of phycoerythrin-containing cells were separately counted by exciting the phytoplankton specimens with a green light of 520-550 nm. Biomasses of the individual size groups of phytoplankton in terms of C were estimated from the cell volumes using reported values for the volume-carbon conversion factor. Classification at a class level was also conducted based on observations under an ordinary microscope.

Phytoplankton species will be identified based on the information obtained by observation under an inverted microscope and by scanning electron microscopy.

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Furuya, K. (1982). Measurement of phytoplankton standing stock using an image analyzer system. Bull. Plankton Soc. Japan, 29, 131-132.

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Vertical distribution of submicron particles

I. Koike

Vertical distributions of submicron particles in the Bering Sea and northern North Pacific Ocean were determined. Discrete water samples were collected with a rosette sampler (5 l) or with 23-l Niskin bottles. At Stations C and F, bottom waters were also collected with the aid of a Pinger system.

An Elzone particle counter (80XY, Particle Data, Inc. Illinois, U.S.A.) fitted with a 12 μm orifice tube and a 10 μl volumetric tube was used. Nucleopore (0.2 μm) filtered 3.5 % NaCl solution served as a control. When necessary, the sample seawater was diluted with the same NaCl solution. Using 120 channels of the machine, particle counting can be made over the size range from 0.34 to 7.85 μm. However, we adopted values only in the size range from 0.38 to 2.02 μm (60 channels) because of high blank values in the range smaller than 0.38 μm and large fluctuation of signals in the range larger than 2.0 μm. The measurements were repeated at least three times and averaged to express numbers of particles in each size fraction. Total volume of the particles in each size fraction was calculated by using the particle numbers and assumed particle diameter.

Growth and carbon conversion efficiency of bacterial populations in the euphotic layer of the northern North Pacific

I. Koike and L. Tupas

Bacterial growth in seawater was estimated from increase in particle number or volume in given size fractions during incubation. Sample seawater collected from the euphotic layer of the northern North Pacific was filtered through a Whatman GF/F filter (pore size ca. 0.6 μm) to eliminate the bacterial grazers. The filtrate (250 ml) was placed in a 500 ml glass bottle and incubated at in situ temperature in the dark. At 10-30 hr intervals, 30 ml portions were taken out, and introduced in a test tube (10 ml, for particle counting) and a plastic bottle (20 ml, for nutrient analysis).

The subsamples for particle counting were treated with Gelman disk (0.45 μm) filtered formalin (2 % final concentration). The change in the size distribution of the particles was monitored with an Elzone particle counter for 2 weeks. The subsamples for nutrients and other organic nitrogen and carbon measurements were stored frozen for later analyses.

Excreta from zooplankton were obtained by incubating copepods or sagitta in GF/F filtered surface seawater for 20 hrs. After the incubation, zooplankton were removed by gentle filtration through a 100 μm net. The filtrate was further incubated as described above.

About 5 l of GF/F filtered seawater with or without added zooplankton was prepared. The water sample was transferred, by using a siphon, into a 500 ml glass bottle. After allowing ca.500 ml to overflow, the bottle was capped carefully and incubated at in situ temperature in darkness. Four glass bottles were prepared for one experiment. At 10-30 hour intervals, the bottles were sacrified, one by one, for the determinations of oxygen, particle numbers and nutrients. The Winkler titration method using a 100 ml oxygen bottle was used for oxygen analysis. Carbon conversion efficiency during bacterial growth was calculated from the increase in particle volume and oxygen consumption by assuming appropriate conversion factors for cell carbon/volume and respiratory quotient.

Excretion of organic and inorganic compounds by macrozooplankton and the utilization of excreta by heterotrophic marine bacteria

L. Tupas and I. Koike

Experiments were performed on board to determine the dissolved organic and inorganic compounds excreted by the different macrozooplankton collected from stations in the northern North Pacific Ocean and the Bering Sea and also to study the utilization of these excreted dissolved compounds by heterotrophic marine bacteria.

Live zooplankton were collected with a 0.493 µm mesh size net with a mouth diameter of 0.5 m and fitted with a large cod end (2 liters capacity). Samples were collected from a depth of 200 m and the animals placed in a large container for sorting. Animals used for experiments were from the Amphipoda, Euphausiacea, Copepoda, Chaetognatha, Ctenophora, Schypohmedusae, and Thaliacea. Live animals were picked up one by one by gentle suction using an automatic pipet with a modified tip and transferred to 1 liter polycarbonate bottles containing 500 ml of either filtered sea water or synthetic sea water (0.45 µm Millipore HA). Incubation bottles contained from 5 to 50 animals depending on the size of the animals being incubated (the larger the animal, the less number incubated). The bottles were covered with aluminum foil and incubated in the dark at in situ temperature (4-6°C) for 24 hours. Forty ml of water was collected at 6-hour intervals and frozen for chemical analysis. Samples were collected with a siphon covered with a 100 µm net at the end.

To determine the utilization of excreta, animals were collected and treated as above and kept in the incubation bottles. After 24 hours the incubation water was transferred into another clean bottle using a siphon covered with a 100 µm mesh size net at the end to prevent the animals from being transferred into the new bottle and incubated further for 6 days under the conditions mentioned above. Forty ml of water (10 ml for microbial and particle counting; 30 ml for chemical analysis) was collected at 2-day intervals.

Feeding behavior of *Calanus plumchrus* and *Calanus cristatus*

H. Ishii and S. Nishizawa

The gut fluorescence method of Mackas and Bohrer (1976) is becoming popular in estimating the ingestion rate of herbivorous zooplankton under field conditions (Dagg and Grill, 1980). Gut clearance time is needed in calculation of the ingestion rate, but the effects of the particle concentration and feeding prehistory on the gut clearance time have not been considered in most previous studies. We tried to estimate the ingestion rates of freshly caught copepods, *Calanus plumchrus* and *C. cristatus*, which are the dominant species in the Bering Sea and the Oyashio Water, using the gut fluorescence method. We also aimed to clarify the effects of feeding prehistory on ingestion rate, the relation between diel vertical migration and feeding behavior, and the daily energy requirement of these copepods.

1. Zooplankton sampling

Zooplankton were collected from three depth zones, 0-50, 50-100, and 100-200 m, by divided vertical tows of a closing net (56 cm diameter, 493 μm mesh) with a 2-1 cod-end. A portion of the samples was preserved for later analysis, and the remainder was used for immediate sorting of zooplankton. Copepodite V specimens of *C. plumchrus* and *C. cristatus* were picked up. These were ground in a 90 % acetone solution, and chlorophylls and phaeopigments were measured with a Turner Designs fluorometer. The residuals were frozen for later elemental analysis.

2. Feeding experiment

The zooplankton collected were reared in seawater at surface seawater temperature and acclimated. Starved specimens were prepared by leaving the zooplankton in GF/C filtered seawater for 1.5 days. The zooplankton samples with different feeding prehistory were prepared by rearing zooplankton in seawater with various particle concentrations for 1 day. The starved zoo-plankton (2 to 4 individuals for *C. plumchrus* and 1 for *C. cristatus*) were transferred to 100 ml glass bottles containing seawater with different particle concentrations. The other groups were transferred to 100 ml glass bottles filled with natural seawater containing the same particle concentrations as those used for the acclima-

tion. The experimental bottles were placed on a wheel rotator and incubated for 3 hours at 4.5°C in the dark. Initial and final particle concentrations were determined with an Elzone electronic particle counter of Particle Data Inc. using a 120 μm orifice. The ingestion and filtering rates were calculated using the equation of Frost (1972). After the experiments, the gut fluorescence was measured, and the gut clearance time was calculated. The rates of respiration and ammonia excretion were estimated from the differences in oxygen and ammonia concentrations before and after 24 hours incubation.

References

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Ecological study of zooplankton and micronekton

M. Terazaki and H. L. Suh

1. Collection of zooplankton and micronekton

A NORPAC-twin net consisting of 0.10 mm and 0.33 mm-mesh nets was towed vertically from a depth of 150 m to the surface at each station. The tows were carried out mostly at night to collect epipelagic zooplankton.

A Motoda horizontal net (MTD net) was towed at 3-4 hour intervals in 5 different strata between 200 m and the surface at Station C. The net tows were also made at Stations 1 (0-200 m), 2 (0-80 m) and 3 (0-80 m).

Large zooplankton and micronekton were collected by an oblique tow of an ORI net (0.69 mm-mesh) in the layer between 1470 m and the surface at Stations B, C and F.

An ORI type Multiple Plankton Sampler (ORI-MPS) with 0.33 mm-mesh nets was towed vertically at 6-hour intervals in 4 different strata between 1500 m and the surface at Station B. Large zooplankton, especially chaetognaths and copepods were collected. The ORI-MPS was also towed, day and night, in 3 different strata between 2000 m and the surface at Station F'.

2. Study of diurnal migration of zooplankton

Diurnal migration of amphipods (*Parathemisto japonica* and *P. pacifica*), euphausiids (*Euphausia pacifica* and *Thysanoessa longipes*) and chaetognaths (*Sagitta elegans* and *Eukrhonia hamata*) was investigated using the specimens collected with MTD nets. Spatial and temporal variations of the distribution of meso- and bathypelagic zooplankton were examined using the samples collected with the ORI-MPS.

3. Feeding habits of amphipods and euphausiids

The food items and feeding rhythm of amphipods (*P. japonica* and *P. pacifica*) and euphausiids (*T.longipes*, *T.inermis*, *T.raschi*, *T. spinifera* and *E.pacifica*) were analyzed using the samples collected with MTD nets. Pigment analysis of stomach contents was also conducted.