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MR99-K02

Preliminary Cruise Report

June 1999

Japan Marine Science and Technology Center

MR99-K02 Preliminary Cruise Report

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1. Preface

Makio Honda (Principle Investigator)

R/V MIRAI left her mother port Sekinehama on 8 May, 1999 for MR99-K02 cruise. The principle objective of this cruise was the study of biogeochemistry under the "spring bloom" condition expected to occur in the northwestern North Pacific in this season. We visited three main stations and conducted the comprehensive observations including hydrocasts, sea floor sediment coring, moored and drifting sediment trap experiment, plankton net, and aerosol sampling. Every work was carried out smoothly and successfully. Especially it was the first time to deploy and recover the drifting sediment trap mooring system with primary production incubation bottles at the mid night. The enthusiastic work by crew members enabled us to conduct this work.

On the other hand, it was tough to meet the spring bloom. Although we expected that the spring bloom would occur at the main stations, we could not meet this phenomena. We carried out time consuming sea surface monitoring around stn. KNOT to find it. Even if we found that, the water mass in which the spring bloom might take place moved away and we could not return the same water mass. We felt the importance of real time ocean color data by satellite which was not available this cruise. Although there was the above difficulty, we succeeded to carry out the comprehensive observation under the spring bloom condition: color of sea water was brown, sea water pCO2 was significantly low (< 220 ppm) and concentrations of proxy for biological activity such as fluorescence was high. According to the preliminary report, settling particles collected by drifting sediment traps or some chemical substances such as halocarbon was significantly higher under the spring bloom condition.

I thank all of participants for the cooperative research. I hope that the result of observation will be helpful for our science. I acknowledge marine technicians from Marine Works Japan Inc. and Global Ocean Development Inc. Without their assist and techniques in chemical analysis, deck works and sea-beam topography survey and so on, any works were not possible. Finally, I appreciate captain Akamine, chief engineer Watanabe, chief officer Kurihara, and crew members. Although we participants might force them to work for 24 hours and drive the MIRAI along the transect which was not planned and we decided suddenly on board, they worked devotedly and satisfied our request.

2. Outline of MR99-K02

2.1 Cruise summary

Makio Honda (Principle Investigator)
(Japan Marine Science and Technology Center)

The main objective of MR99-K02 cruise (from 8 May to 1 June, 1999) by R/V "MIRAI" was the study of material cycle under the "spring bloom" condition in the northwestern North Pacific. We visited three stations with emphesis on the observation at stn. KNOT, which is the Japanese time series station for the biogeochemical study. We visited stn. KNOT twice at the begining and late of cruise in order to observe the change in marine chemistry and biology during the "spring bloom" and conducted the comprehensive observations as follows:

(1) Underway observation of pCO2, TCO2, nutrients, DO, fluorescence
(2) Hydrocasting for Sal., DO, nutrients, pH, pCO2, TCO2, TALK, carbon isotopes, chl-a, halocarbon, POC, and radionuclide
(3) Sea floor sediment sampling by multiple corer
(4) Drifting sediment trap experiment
(5) Primary productivity measurement by *in-situ* and *quasi in-situ* method (on deck incuvation)
(6) Plankton sampling
(7) Recover and re-deployment of moored sediment trap system

When we visited stn. KNOT, the " spring bloom" had not taken place yet. Stn. KNOT was located at the "sub-arctic boundary" and was unusually covered with the "Kuroshio " related water judging from high temperature (> 7 °C) and salinity (> 33 psu). Collected materials by the moored sediment traps which recovered at stn. KNOT also showed that the spring bloom has not taken place yet. Although we investigated the "spring bloom" around stn. KNOT, we could not find the "spring bloom" event. We conducted the comprehensive observation under the above condition at stn. KNOT.

However, on the way to stn. 50N, approximately 40 nautical miles northeastward from stn. KNOT, we met the water mass where sea-water pCO2 was about 200 ppm and concentration of fluorescene was 4 times higher than that at stn. KNOT and color of sea water was brown. We quickly changed our schedule and conducted the comprehensive observation at this position named "stn. HP1". It is noteworthy that the properties of water was changable and it was hard to say that we could conduct all observations in the same water mass perfectly.

Unfortunately, we did not meet the "spring bloom" at the second visit to stn KNOT either. After we conducted the basic observation at stn. KNOT , we made a big effort to find the "spring bloom" around stn. HP1. However we did not find the "spring bloom" event which we met before. Instead of the "spring bloom" area, we conducted the observation in the area, named stn. HP2, where sea water pCO2 was relatively lower (approximately 250 ppm) and fluorescene was higher than stn. KNOT.

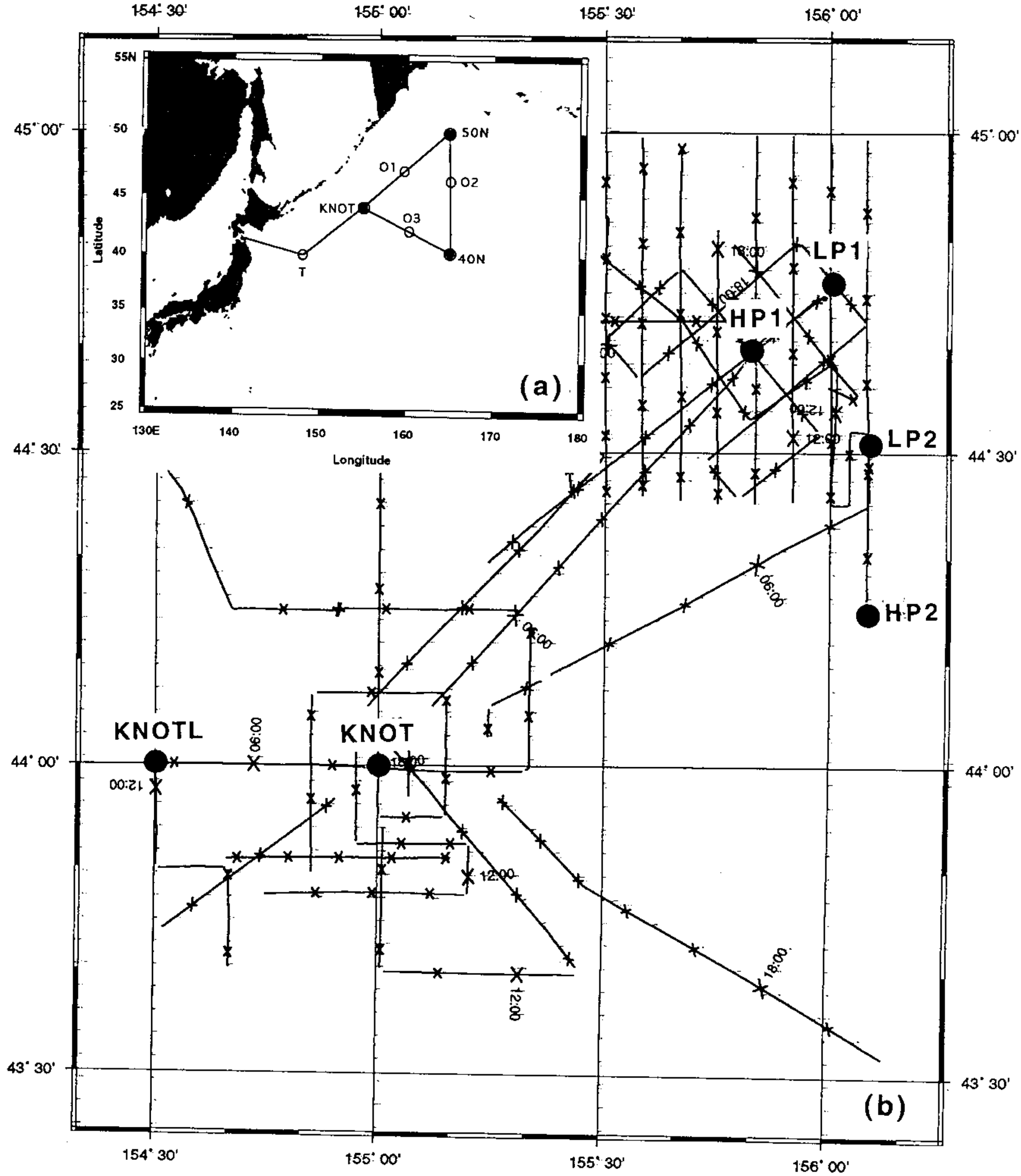
Most of results of the above observations should be waited until the analysis on land is completed. However the following interesting things has been reported on board:

(a) Qualitatively speaking, settling particles collected by floating sediment trap were largely higher at stn. HP1 and HP2 than stn. KNOT and other stations.

(b) Concentrations of halocarbon and DMS which suspected to be produced by phytoplankton was two times higher at stn. HP.

(c) Nutrients were relatively consumed up.

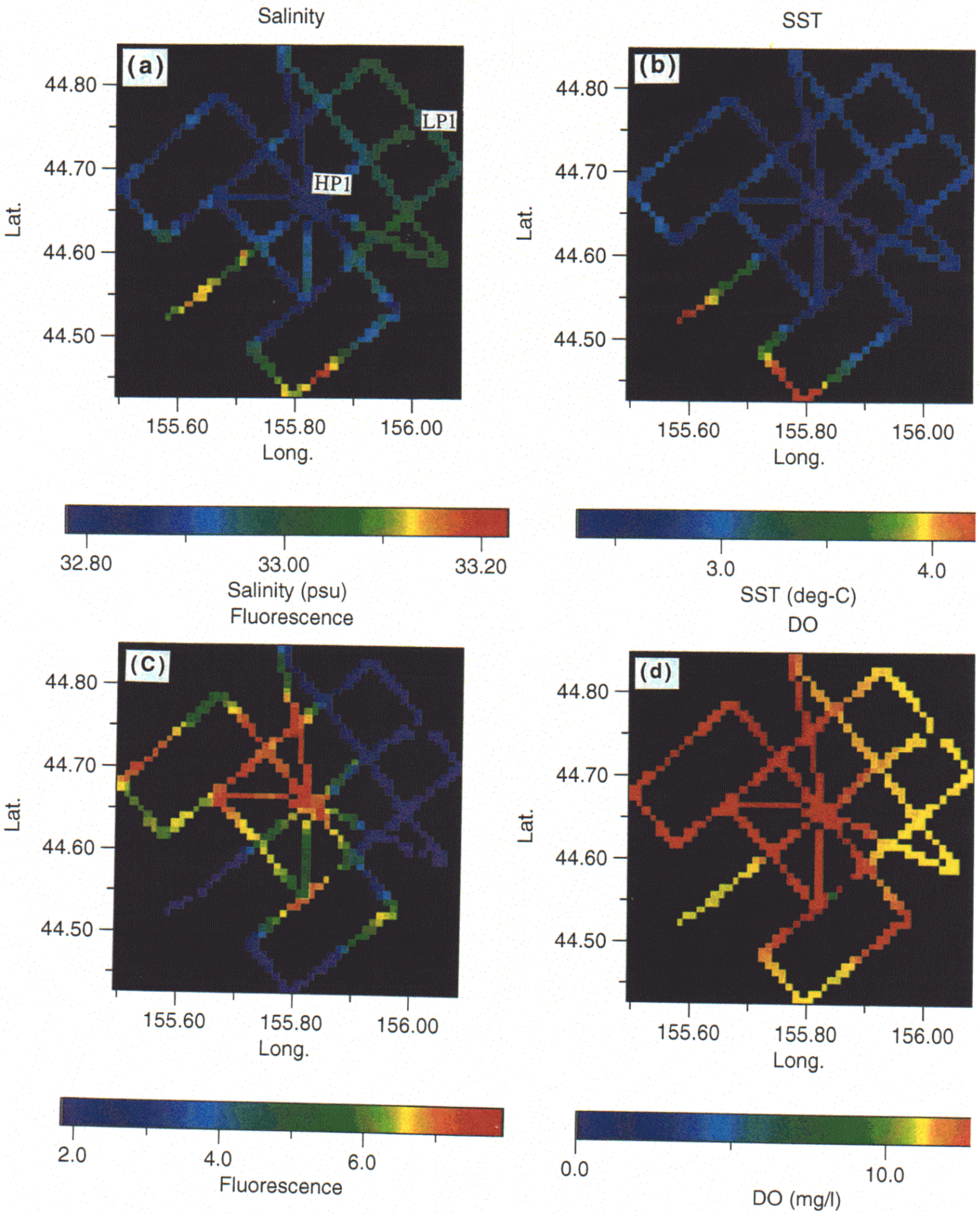
Beside the above bloom study, we also carried out the observation at stn. 50N and 40N. As same as stn. KNOT, we did not observe any phenomena attributed to the "spring bloom". At both stations, moored sediment trap systems which deployed last July, 1998, were recoverd successufully. High flux of settling particles could be seen in the middle of the last April, 1999, at stn. 50N. However it was difficult to define this high flux as the "spring bloom" because sea water pCO2 was still equal to or slightly higher than atmospheric pCO2. It is likely that the real "spring bloom" which lowers sea water pCO2 is comming after our cruise.



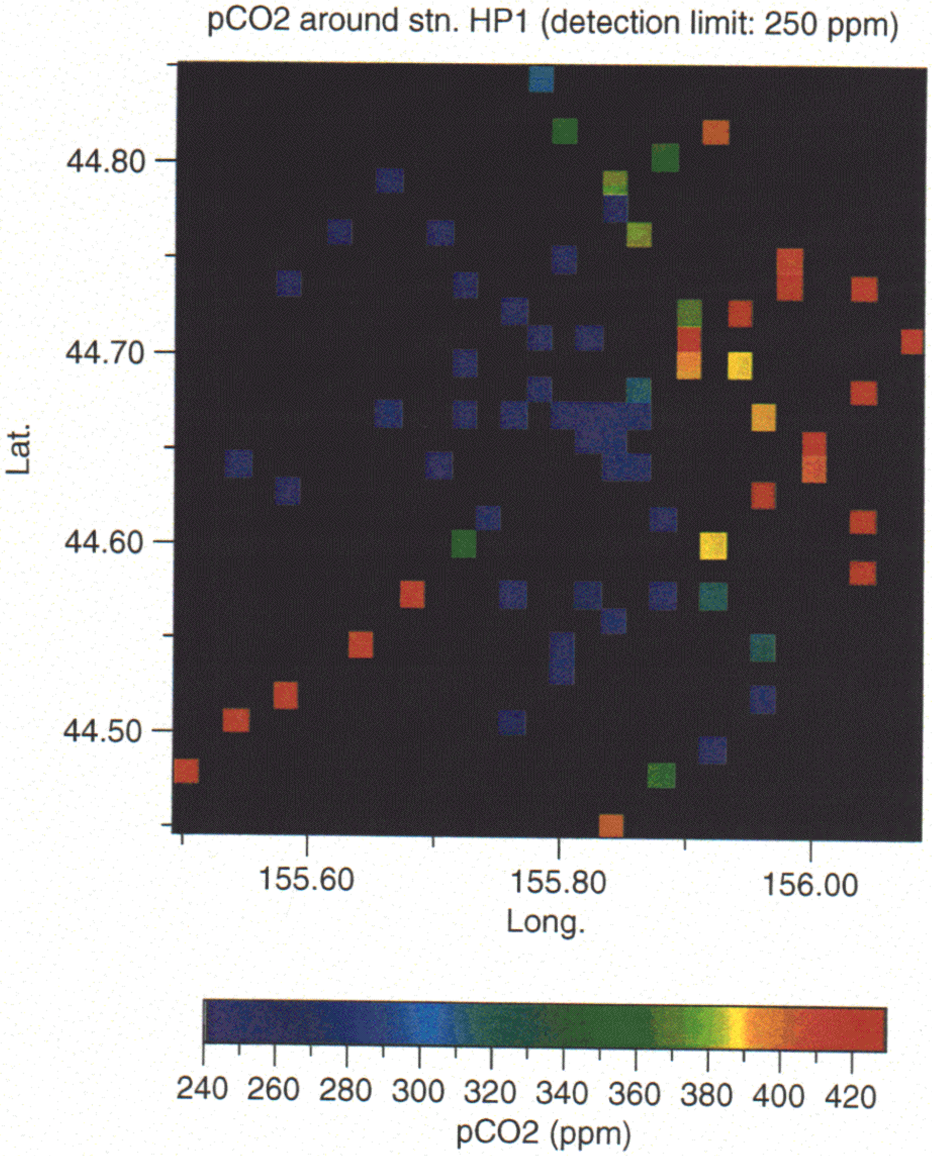
Cruise track during MR99-K02

(a) all cruise track

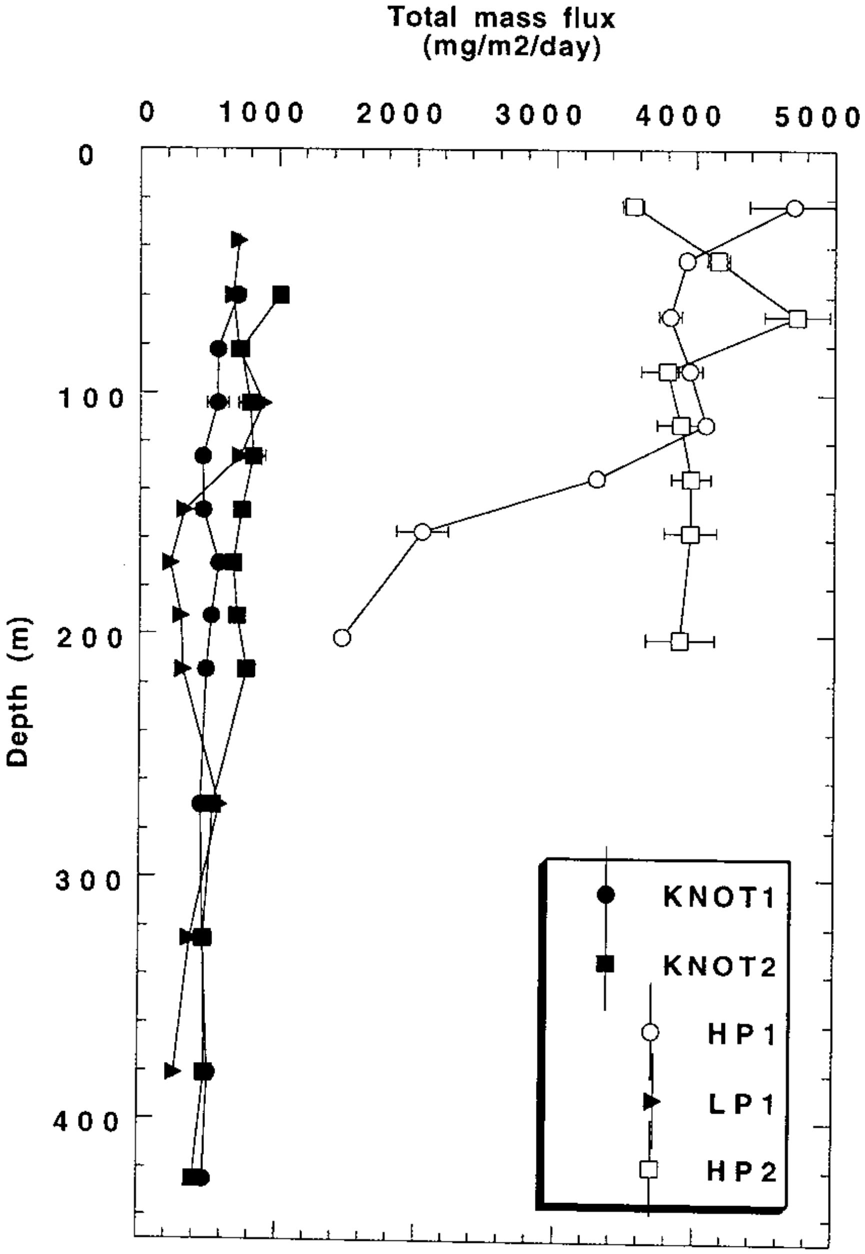
(b) cruise track around station KNOT. HP and LP indicate stations under spring bloom condition (high productivity ?) and nomal condition (low productivity ?), respectively



Horizontal distributions for (a) salinity, (b) sea surface temperature, (c) fluorescence, and (d) dissolved oxygen along cruise track around HP1 (center position with low salinity, SST and with high fluorescence, DO) and LP1.



Horizontal distribution for pCO_2. Detection limit was 250 ppm and the real values were largely smaller than 250 ppm (*ca.* 180 ppm was observed by another pCO_2 sensor)

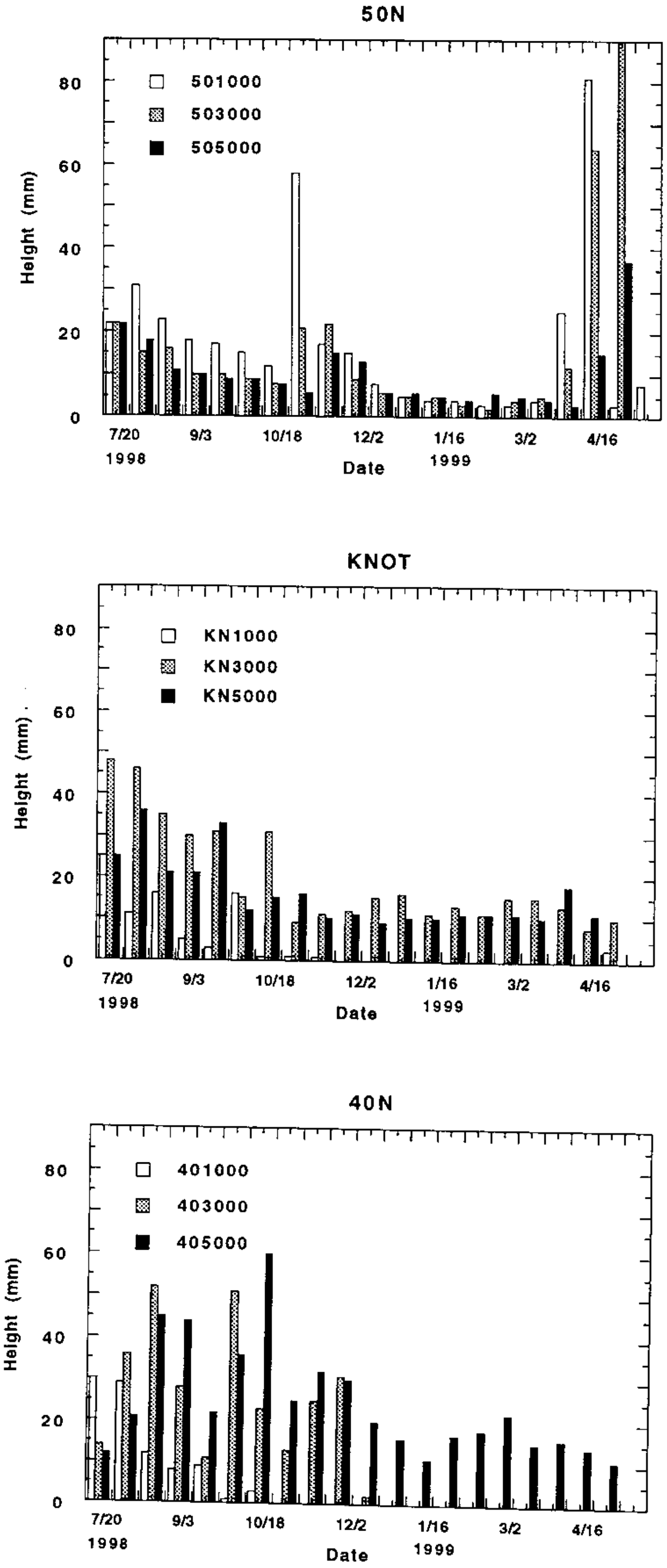


Total mass fluxes of settling particles observed by drifting sediment trap experiment

Stations summary

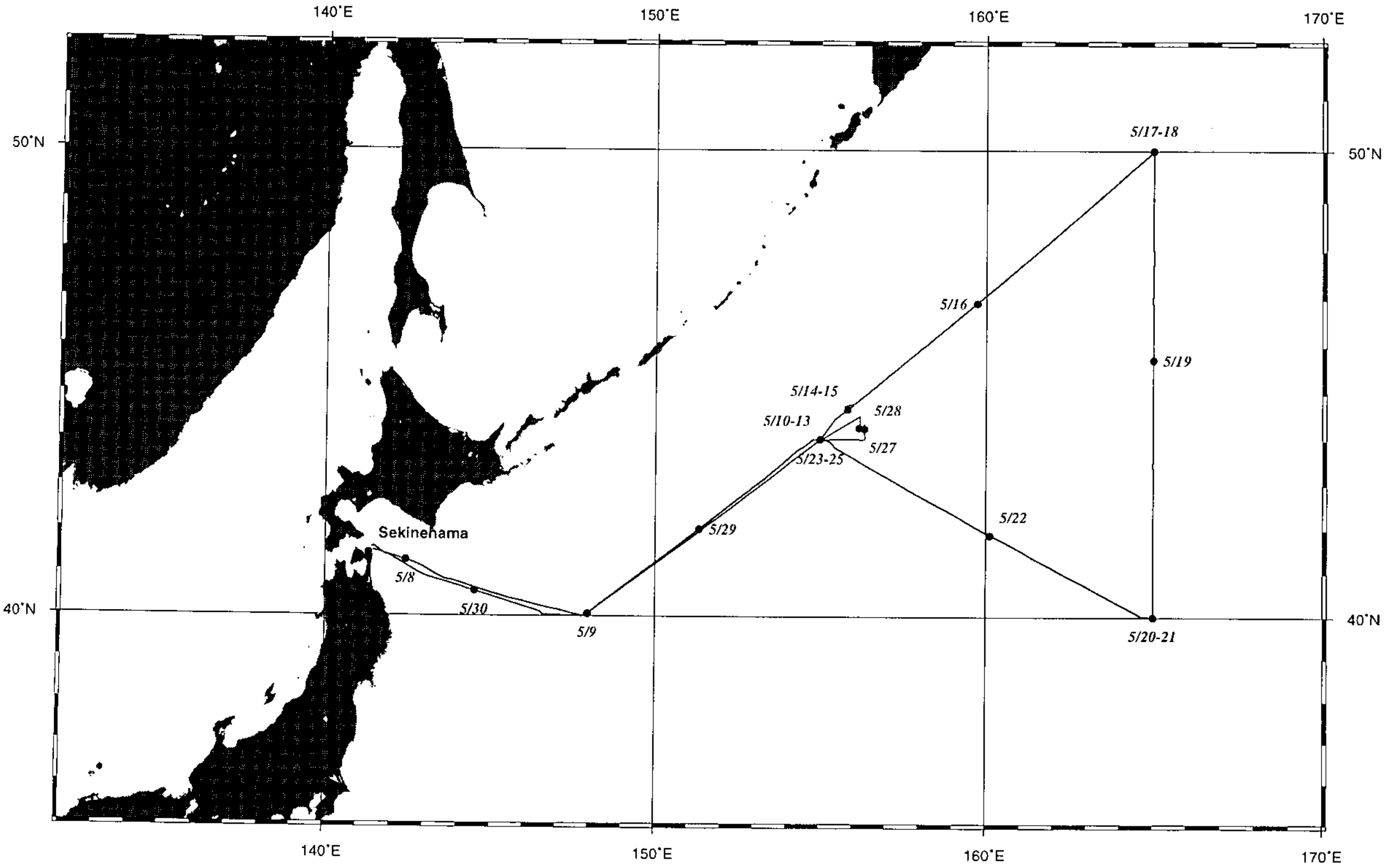
Station	Position	Date	Sal (psu)	Temp (deg-C)	DO (mg/l)	Fluorescence	pCO2 (ppm)
TEST	40-00N, 147-50E	9, May, 1999	33.12	5.4	12.9	2.3	250-260
KNOT1	44-00N, 155-00E	10-12	33.62	7.7	10.5	1.5	370
KNOTL	44-00N, 154-30E	12	32.97	4.5	11.4	1.8	390
HP1	44-39N, 155-49E	14-15	32.83	2.7	14.3	7.4	180-220
LP1	44-46N, 156-01E	14-15	32.98	3.0	11.3	1.9	390-400
O1	46-55N, 159-44E	16	33.01	2.1	11.4	1.5	410-420
50N	50-00N, 165-00E	17-18	33.08	2.6	11.2	1.3	430-440
O2	45-51N, 165-01E	19	33.09	4.2	11.0	1.6	370-380
40N	40-00N, 165-00E	20-21	34.32	13	9.3	1.1	330
O3	41-53N, 160-07E	22	33.41	7.1	10.4	1.7	360
KNOT2	44-00N, 155-00E	23-25	33.16	5.7	10.8	1.8	380
HP2	44-16N, 156-09E	27-28	32.87	2.9	12.1	2.4	240-260
LP2	44-31N, 156-12E	27	32.96	3.5	11.3	2.4	380

SEDIMENT TRAP EXPERIMENT
(from July, 1998 to May, 1999)



Seasonal variability in fluxes of settling particles at stn. 50N, KNOT, and 40N during July, 1998 and May, 1999. Fluxes are estimated by heights of samples in collecting cups.

2.2 Cruise track and cruise log



Ship Track (MR99-K02)

Cruise Log

Date	Time	Station	Position		Events
			Lat.	Long.	
5/8					Departure from Sekinehama
5/9	03:30	TEST	40-00.00N	147-50.00E	Arrival at Sta. TEST
	08:00	TEST	40-00.14N	147-50.05E	Small CTD/RMS cast
	08:41	TEST	40-00.26N	147-50.53E	Plankton net
	09:22	TEST	40-00.44N	147-51.11E	Bio-optical measurement
	09:49	TEST	40-00.66N	147-51.63E	FRR measurement
	10:47	TEST	40-00.75N	147-52.20E	Surface water sampling
	10:21	TEST	40-00.82N	147-51.99E	Large CTD/RMS cast
	11:56	TEST	40-03.05N	147-56.30E	XBT probe cast
	12:00				Departure from stn. TEST
5/10	12:00	KNOT	44-00.00N	155-00.00E	Arrival at stn. KNOT
	13:15	KONT	44-00.02N	155-00.06E	JAMSTEC drifting sediment trap deployment
	14:00	KNOT	43-59.39N	155-00.03E	Large CTD/RMS cast
	17:31	KNOT	43-58.74N	155-00.00E	Small CTD/RMS cast
	20:30	KNOT	43-58.98N	155-00.07E	Large CTD/RMS cast
	20:45	KNOT	43-59.02N	155-00.00E	Surface water sampling
	21:55	KNOT	43-59.02N	155-00.09E	Large CTD/RMS cast
	22:26	KNOT	43-58.93N	155-00.05E	Surface water sampling
	23:24	KNOT	43-53.96N	155-00.43E	Small CTD/RMS cast
	23:37	KNOT	43-58.92N	155-00.46E	Surface water sampling
5/11	03:32	KNOT	43-58.19N	155-03.02E	CREST drifting sediment trap deployment
	07:30	KNOT	43-59.00N	155-01.77E	Time series sediment trap recovery
	09:55	KNOT	43-59.91N	154-58.99E	Bio-optical measurement
	10:06	KNOT	44-00.12N	154-58.99E	FRR measurement
	11:21	KNOT	43-59.64N	155-00.09E	Large CTD/RMS cast
	11:41	KNOT	43-59.75N	155-00.32E	Surface water sampling
	12:36	KNOT	44-00.00N	155-00.94E	Small CTD/RMS cast
	12:38	KNOT	44-00.00N	155-00.94E	Surface water sampling
	13:16	KNOT	44-00.42N	155-00.44E	Bio-optical measurement
	13:29	KNOT	44-00.65N	155-00.24E	FRR measurement
	13:57	KNOT	44-00.92N	155-00.19E	Plankton net
	15:51	KNOT	44-02.31N	155-00.54E	Surface water sampling
	15:55	KNOT	44-02.47N	155-00.53E	Plankton net
	18:35 to 23:20	*Around* *Stn.* *KNOT*			Phytoplankton blooming area search
	23:58	KNOT	44-02.73N	154-57.41E	Water sampling for P.P.
5/12	02:47	KNOT			Drifting sediment trap recovery and deployment to attach in situ PP bottles
	10:04	KNOT	44-14.95N	154-54.63E	Bio-optical measurement
	10:15	KNOT	44-14.95N	154-54.55E	FRR measurement
	10:16	KNOT	44-14.94N	154-54.53E	Surface water sampling
	12:57	KNOT	43-59-65N	155-19.71E	Bio-optical measurement
	16:15	KNOT	44-00.24N	154-29.59E	Large CTD/RMS cast
	16:37	KNOT	44-00.13N	154-29.27E	Surface water sampling
	17:22	KNOT	44-00.04N	154-28.92E	Small CTD/RMS cast
	17:32	KNOT	44-00.05N	154-28.84E	Surface water sampling
	17:51	KNOT	44-00.28N	154-28.84E	Plankton net
	19:29	KNOT	44-00.82N	154-28.03E	Large CTD/RMS cast

Date	Time	Station	Position		Events
			Lat.	Long.	
5/13	02:07	KNOT	40-07.55N	154-59.45E	CREST drifting sediment trap recovery
	09:12	KNOT	43-58.29N	155-02.92E	Time series sediment trap cast
	09:57	KNOT	43-57.99N	155-02.09E	Bio-optical measurement
	09:59	KNOT	43-58.00N	155-02.08E	Surface water sampling
	12:58	KNOT	43-58.57N	155-02.12E	Bio-optical measurement
	14:28	KNOT	44-12.62N	155-02.15E	JAMSTEC drifting sediment trap recovery
	15:30				Departure from stn. KNOT
	18:20				Discovery of phytoplankton blooming area,
	to				and continue searching...
5/14	06:15				
	08:25	HP1	44-40.15N	155-51.37E	Large CTD/RMS cast
	08:40	HP1	44-40.16N	155-51.49E	Surface water sampling
	09:45	HP1	44-39.50N	155-49.62E	Small CTD/RMS cast
	09:47	HP1	44-39.48N	155-49.64E	Surface water sampling
	10:13	HP1	44-39.49N	155-49.62E	Bio-optical measurement
	10:24	HP1	44-39.48N	155-49.64E	FRR measurement
	10:55	HP1	44-39.49N	155-49.65E	Large CTD/RMS cast
	11:19	HP1	44-39.49N	155-49.63E	Surface water sampling
	13:30	HP1	44-39.77N	155-49.77E	CREST drifting sediment trap deployment
	15:45	LP1	44-46.75N	156-01.55E	JAMSTEC drifting sediment trap deployed
	18:53	LP1	44-39.48N	155-49.65E	Water sampling for P.P.
	19:13	LP1	44-39.37N	155-50.53E	Plankton net
5/15	08:45	HP1	44-46.71N	156-01.53E	Large CTD/RMS cast
	09:04	HP1	44-46.78N	156-01.58E	Surface water sampling
	08:14	HP1	44-46.76N	156-01.56E	Large CTD/RMS cast
	09:40	HP1	44-46.80N	156-01.56E	Small CTD/RMS cast
	09:41	HP1	44-46.80N	156-01.56E	Surface water sampling
	10:07	HP1	44-46.77N	156-01.56E	Bio-optical measurement
	10:17	HP1	44-46.74N	156-01.57E	FRR measurement
	10:55	HP1	44-46.72N	156-01.57E	Large CTD/RMS cast
	11:21	HP1	44-46.77N	156-01.57E	Surface water sampling
	14:05	HP1	44-37.08N	156-00.16E	CREST drifting sediment trap recovery
	16:30	LP1	44-45.44N	156-04.61E	JAMSTEC drifting sediment trap recovery
	18:53	LP1	44-46.72N	156-01.55E	Water sampling for P.P.
	19:23	LP1	44-46.08N	156-01.54E	Plankton net
	20:30				Departure for stn. 50N
5/16	10:00	01	46-55.74N	159-43.81E	Bio-optical measurement
	10:34	01	46-55.47N	159-43.70E	Large CTD/RMS cast
	10:54	01	46-55.35N	159-43.63E	Surface water sampling
	11:42	01	46-55.12N	159-43.41E	Plankton net
	12:51	01	46-55.03N	159-43.54E	Bio-optical measurement
5/17	07:30	50N	50-00.00N	165-00.00E	Arrival at stn. 50N
	10:15	50N	50-00.72N	165-02.89E	Time series sediment trap recovery
	11:40	50N	49-59.99N	164-59.87E	Large CTD/RMS cast
	11:48	50N	50-00.00N	164-59.96E	Surface water sampling
	12:53	50N	49-59.99N	165-00.03E	Bio-optical measurement
	13:02	50N	49-59.97N	165-00.03E	FRR measurement

Date	Time	Station	Position		Events
			Lat.	Long.	
5/17	13:31	50N	49-59.90N	165-00.05E	Small CTD/RMS cast
	13:34	50N	49-59.89N	165-00.04E	Surface water sampling
	14:12	50N	49-59.93N	164-59.93E	Large CTD/RMS cast
	14:37	50N	49-59.98N	164-59.85E	Surface water sampling
	15:26	50N	50-00.12N	164-59.86E	Small CTD/RMS cast
	18:25	50N	49-5957N	164-59.30E	Large CTD/RMS cast
	22:11	50N	49-59.87N	164-59.15E	Plankton net
	23:21	50N	49-59.91N	164-59.36E	Water sampling for P.P.
	23:45	50N	49-59.93N	164-59.35E	Plankton net
5/18	02:20	50N	50-00.12N	165-00.08E	Multiple corer sampling
	10:04	50N	50-00.02N	164-59.93E	FRR measurement
	10:35	50N	49-59.92N	165-00.07E	Bio-optical measurement
	12:51	50N	49-58.30N	165-00.97E	Bio-optical measurement
	13:01	50N	49-58.31N	165-01.04E	FRR measurement
	13:30	50N	50-00.42N	165-00.96E	Time series sediment trap cast
	18:00				Departure from stn. 50N
5/19	10:05	02	45-50.71N	165-00.21E	Bio-optical measurement
	10:31	02	45-50.66N	165-00.49E	Large CTD/RMS cast
	10:36	02	45-50.69N	165-00.46E	Surface water sampling
	12:55	02	45-38.74N	165-01.35E	Bio-optical measurement
	13:00				Departure from stn. 02
5/20	10:30	40N	40-00.0N	165-00.00E	Arrival at stn. 40N
	10:44	40N	40-00.01N	165-00.21N	Bio-optical measurement
	13:40	40N	40-00.93N	165-00.50E	Time series sediment trap recovery
	13:50	40N	40-00.17N	165-00.25E	Plankton net
	15:08	40N	40-00.25N	165-00.81E	Large CTD/RMS cast
	18:28	40N	39-59.46N	165-00.24E	Small CTD/RMS cast
	20:47	40N	39-59.98N	165-00.20E	Large CTD/RMS cast
	20:54	40N	40-00.02N	165-00.17E	Surface water sampling
	21:51	40N	40-00.08N	165-00.14E	Large CTD/RMS cast
	22:25	40N	40-00.05N	164-59.96E	Surface water sampling
	23:24	40N	40-00.28N	164-59.94E	Small CTD/RMS cast
5/21	00:35	40N	40-01.56N	164-59.81E	Water sampling for P.P.
	09:57	40N	39-59.31N	165-01.18E	Bio-optical measurement
	10:08	40N	39-59.25N	165-01.26E	FRR measurement
	12:55	40N	40-00.10N	165-03.30E	Bio-optical measurement
	13:07	40N	40-00.03N	165-03.44E	FRR measurement
	13:30	40N	40-00.14N	165-00.32E	Time series sediment trap cast
	18:00				Departure from stn. 40N
5/22	10:01	03	41-53.16N	160-06.90E	Bio-optical measurement
	10:26	03	41-53.27N	160-07.04E	Large CTD/RMS cast
	10:35	03	41-53.31N	160-06.98E	Surface water sampling
	11:11	03	41-53.44N	160-06.81E	Plankton net
	12:52	03	41-55.70N	159-59.89E	Bio-optical measurement
	13:00				Departure from stn. 03
5/23	07:00	KNOT	44-00.00N	155-00.00E	Arrival at stn. KNOT
	08:35	KNOT	43-59.90N	155-00.44E	JAMSTEC drifting sediment trap deployment
	09:06	KNOT	44-00.08N	155-00.08E	Large CTD/RMS cast
	09:21	KNOT	44-00.08N	155-59.96E	Surface water sampling

Date	Time	Station	Position		Events
			Lat.	Long.	
5/23	10:00	KNOT	43-59.85N	154-59.84E	Bio-optical measurement
	10:10	KNOT	43-59.77N	154-59.91E	FRR measurement
	11:15	KNOT	43-59.68N	154-59.12E	CREST drifting sediment trap deployment
	12:51	KNOT	44-00.32N	154-58.71E	Bio-optical measurement
	13:03	KNOT	44-00.24N	154-58.69E	FRR measurement
	13:34	KNOT	44-00.11N	154-58.73E	Small CTD/RMS cast
	13:38	KNOT	44-00.14N	154-58.69E	Surface water sampling
	14:15	KNOT	44-00.56N	154-58.68E	Large CTD/RMS cast
	14:37	KNOT	44-00.96N	154-58.85E	Surface water sampling
	15:30	KNOT	44-01.62N	154-59.15E	Small CTD/RMS cast
	18:03	KNOT	44-02.06N	154-59.63E	Large CTD/RMS cast
	23:53	KNOT	44-01.72N	155-04.56E	Water sampling for P.P.
5/24	01:39	KNOT	43-59.78N	155-03.38E	CREST drifting sediment trap attached in situ PP bottles deployment
	01:58	KNOT	43-59.54N	155-02.93E	Plankton net
	05:55	KNOT	44-00.01N	155-00.00E	Multiple corer sampling
	09:57	KNOT	44-00.01N	155-00.01E	Bio-optical measurement
	10:08	KNOT	44-00.02N	155-00.03E	FRR measurement
	12:54	KNOT	44-00.23N	155-00.11E	Bio-optical measurement
	13:04	KNOT	44-00.28N	155-00.31E	FRR measurement
	13:25 to 23:00				Grid survey (I)
5/25	01:32	KNOT	43-59.48N	155-11.07E	CREST trap with in situ PP bottles recovery
	08:40	KNOT	44-00.15N	155-13.69E	JAMSTEC drifting sediment trap recovery
	09:21	KNOT	44-00.60N	155-14.59E	Large CTD/RMS cast
	10:24	KNOT	44-00.78N	155-15.71E	Bio-optical measurement
	10:01	KNOT	44-00.82N	155-15.40E	FRR measurement
	11:35	KNOT	44-00.38N	155-14.31E	CREST drifting sediment trap recovery
	11:40				Grid survey (II) start
	12:54		44-08.12N	155-21.99E	Bio-optical measurement
	13:04		44-08.14N	155-22.19E	FRR measurement
	13:30				Resumed grid survey (II) resumed
5/26	09:55		44-52.19N	155-30.22E	Bio-optical measurement
5/27	08:20				Grid survey end
	08:30	LP2	44-15.54N	156-08.84E	Large CTD/RMS cast
	08:50	LP2	44-15.50N	156-10.00E	Surface water sampling
	09:30	LP2	44-15.37N	156-09.23E	Small CTD/RMS cast
	09:33	LP2	44-15.34N	156-09.24E	Surface water sampling
	10:00	LP2	44-15.13N	156-09.30E	Bio-optical measurement
	10:16	LP2	44-14.99N	158-09.49E	FRR measurement
	10:49	LP2	44-14.93N	156-69.41E	Large CTD/RMS cast
	10:55	LP2	44-14.92N	156-09.51E	Surface water sampling
	12:08	LP2	44-15.52N	156-10.38E	Large CTD/RMS cast
	12:30	LP2	44-15.66N	156-10.68E	Surface water sampling
	13:11	LP2	44-15.55N	156-11.04E	Bio-optical measurement
	13:21	LP2	44-15.44N	156-11.21E	FRR measurement
	14:27	LP2	44-15.06N	156-12.03E	CREST drifting sediment trap deployment

Date	Time	Station	Position		Events
			Lat.	Long.	
5/27	16:37	LP2	44-30.99N	156-12.29E	Bio-optical measurement
	16:48	LP2	44-30.92N	156-12.30E	FRR measurement
	17:57	LP2	44-30.90N	156-12.24E	Plankton net
	19:01	LP2	44-30.80N	156-12.07E	Water sampling for P.P.
	19:27	LP2	44-30.95N	156-12.07E	Large CTD/RMS cast
	19:45	LP2	44-30.97N	156-12.09E	Surface water sampling
	20:14	LP2	44-31.03N	156-12.18E	Small CTD/RMS cast
	20:17	LP2	44-31.03N	156-12.15E	Surface water sampling
	20:51	LP2	44-30.99N	156-12.22E	Large CTD/RMS cast
	21:08	LP2	44-30.99N	156-12.24E	Surface water sampling
	21:40				To high productivity area
	23:00	HP2	44-13.35N	156-13.20E	Plankton net
	23:54	HP2	44-13.33N	156-13.45E	Water sampling for P.P.
5/28	00:52	HP2	44-13.37N	156-14.06E	Large CTD/RMS cast
	02:04	HP2	44-13.54N	156-14.77E	Small CTD/RMS cast
	02:07	HP2	44-13.56N	156-14.81E	Surface water sampling
	14:07	HP2	44-06.89N	156-20.77E	Drifting sediment trap recovery
	14:30				Departure for Sekinehama
5/31	7:00				Arrival at Sekinehama

2.3 List of Participants

Name	Affiliation	Address	Tel Fax E-mail
Makio HONDA	Japan Marine Science & Technology Center (JAMSTEC)	2-15 Natsushima-cho Yokosuka 237-0061, Japan	
Akihiko MURATA	JAMSTEC	2-15 Natsushima-cho Yokosuka 237-0061, Japan	
Shigeto NAKABAYASHI	JAMSTEC	2-15 Natsushima-cho Yokosuka 237-0061, Japan	
Chizuru SAITO	JAMSTEC	690 Kitasekine Sekine Mutsu 035-0022, Japan	
Yuichiro KUMAMOTO	JAMSTEC	2-15 Natsushima-cho Yokosuka 237-0061, Japan	
Hazime KAWAKAMI	JAMSTEC	2-15 Natsushima-cho Yokosuka 237-0061, Japan	
Andrey ANDREEV	JAMSTEC	2-15 Natsushima-cho Yokosuka 237-0061, Japan	
Koh HARADA	National Institute for Resources and Environment (NIRE)	16-3 Onogawa Tsukuba Ibaraki 305-8659, Japan	
Yoko SHIBAMOTO	NIRE	16-3 Onogawa Tsukuba Ibaraki 305-8659, Japan	
Hisashi NARITA	Hokkaido University	N10, W5 Kita-ku Sapporo 060-0810, Japan	
Masahiro NARUKAWA	Hokkaido University	N19, W8 Kita-ku Sapporo 060-0819, Japan	
Kousei SASAOKA	Hokkaido University	3-1-1 Minato-cho Hakodate 041-8611, Japan	
Yuichiro YAMADA	Hokkaido University	3-1-1 Minato-cho Hakodate 041-8611, Japan	
Shinya HASHIMOTO	Tokyo University of Fisheries	4-5-7 Konan Minato-ku Tokyo 108-8477, Japan	
Tsutomu MIKAMI	Tokyo University of Fisheries	4-5-7 Konan Minato-ku Tokyo 108-8477, Japan	
Yoshitaka YAMAGUCHI	Kinki University	3-4-1 Kowakae Higashiosaka Osaka, Japan	

2.3 List of Participants

Name	Affiliation	Address	Tel Fax E-mail
Kiyoshi MATSUMOTO	University of Tokyo	1-15-1 Minamidai Nakano-ku Tokyo 164-8639, Japan	
Keiri IMAI	Japan Sciense and Technology corporation (JST)	3-1-1 Minato-cho Hakodate 041-8611, Japan (Hokkaido University)	
Takeshi EGASHIRA	JST	16-2 Onogawa Tsukuba Ibaraki 305-0053, Japan (National Institute for Environmental Studies)	
Nobuharu KOMAI	Marine Works Japan Ltd. (MWJ)	Live Pier Kanazawahakkei 3F 1-1-7 Mutsuura Kanagawa-ku Yokohama 236-0031, Japan	
Toshikatsu SUGAWARA	MWJ	Live Pier Kanazawahakkei 3F 1-1-7 Mutsuura Kanagawa-ku Yokohama 236-0031, Japan	
Hirokatsu UNO	MWJ	Live Pier Kanazawahakkei 3F 1-1-7 Mutsuura Kanagawa-ku Yokohama 236-0031, Japan	
Kazuhiro HAYASHI	MWJ	Live Pier Kanazawahakkei 3F 1-1-7 Mutsuura Kanagawa-ku Yokohama 236-0031, Japan	
Fuyuki SHIBATA	MWJ	Live Pier Kanazawahakkei 3F 1-1-7 Mutsuura Kanagawa-ku Yokohama 236-0031, Japan	
Katsunori SAGISHIMA	MWJ	Live Pier Kanazawahakkei 3F 1-1-7 Mutsuura Kanagawa-ku Yokohama 236-0031, Japan	
Mizue HIRANO	MWJ	Live Pier Kanazawahakkei 3F 1-1-7 Mutsuura Kanagawa-ku Yokohama 236-0031, Japan	
Hiroaki MURAKI	MWJ	Live Pier Kanazawahakkei 3F 1-1-7 Mutsuura Kanagawa-ku Yokohama 236-0031, Japan	
Aya KATO	MWJ	Live Pier Kanazawahakkei 3F 1-1-7 Mutsuura Kanagawa-ku Yokohama 236-0031, Japan	
Mikio KITADA	MWJ	Live Pier Kanazawahakkei 3F 1-1-7 Mutsuura Kanagawa-ku Yokohama 236-0031, Japan	
Fujio KOBAYASHI	MWJ	Live Pier Kanazawahakkei 3F 1-1-7 Mutsuura Kanagawa-ku Yokohama 236-0031, Japan	
Kenichiro SATO	MWJ	Live Pier Kanazawahakkei 3F 1-1-7 Mutsuura Kanagawa-ku Yokohama 236-0031, Japan	
Toshio FURUTA	Global Ocean Development, Inc. (GODI)	3-65 Oppamahigashi-cho Yokosuka 237-0063, Japan	
Satoshi OKUMURA	GODI	3-65 Oppamahigashi-cho Yokosuka 237-0063, Japan	

3. Observation

3.1 Meteorological measurement

Satoshi Okumura
(Global Ocean Development Inc.)

(1) Introduction

Some surface meteorological parameters were observed throughout R/V Mirai MR99-K02 Cruise from the departure of Sekinehama on May 8 to the return to Sekinehama on May 31, 1999. Parameters of these observations are as follows:

Press.: Atmospheric pressure adjusted to the sea surface level [hPa]
Dry Air Temp.: Atmospheric dry temperature [deg-C]
Wet Air Temp.: Atmospheric wet temperature [deg -C]
Dew P.T.: Dew point temperature [deg-C]
RH: Relative humidity [%]
Rain: Previous 1 hour precipitation [mm]
W.D.: 10 minutes averaged wind direction [deg]
W.S.: 10 minutes averaged wind speed [m/s]
SST: Sea surface temperature [deg-C]
Wv.Ht: Significant wave height measured first 20 minutes at every 3 hours (0200, 0500, 0800, 1100, 1400, 1700, 2000, 2300UTC) [m]
Wv.PD: Period of Wv.Ht [sec]
Radiation: Short and long wave radiation from solar upward looking radiometer [MJ/m^2]
Weather: Weather

(2) Methods

Surface meteorological data were collected and processed by KOAC-7800 weather data processor and some sensors assembled by Koshin Denki, Japan. The R/V Mirai onboard sensors for meteorological measurements are listed below.

Table3.1.1

Sensors	Type	Maker	Location(Altitude from baseline)
Anemometer:	KE-500	Koshin Denki, Japan	Foremast (30.16m)
Thermometer:	FT	Koshin Denki, Japan	Compass Deck (24.85m)
Dew point meter:	DW-1	Koshin Denki, Japan	Compass Deck (24.85m)
Barometer:	F-451	Yokogawa, Japan	Weather observation room Captain Deck (19.50m)
Rain gauge:	50202	Young, U.S.A.	Compass Deck (25.35m)
Optical Rain gauge:	ORG-115DR	SCTI, U.S.A.	Compass Deck (24.70m)
Radiometer:	MS-801(short wave) MS-200 (long wave)	Eiko Seiki, Japan Eiko Seiki, Japan	Radar mast (34.70m)
Wave height meter:	MW-2	Tsurumi-seiki, Japan	Bow (16.00m)

(3) Preliminary Result

Table 3.1.2 show data of these observations.

It must be noted that position data often showed irregular value because of differential GPS error.

(4) Data archive

Surface meteorological data will be submitted to the DMO (Data Management Office), JAMSTEC and will be under their control. Every 6 seconds data files, every 10 minutes data files and every 1hour data files are contained in the 3.5" MO disk.

Table 3.1.2

Time		Position		W.D.	W.S.	Weather	Press.	Dry Temp.	Dew P.T.	RH	Sea W.T.	Rain	Wv. Ht.	Wv. PD.
UTC	Ship's T.	Lat.	Log.	(deg)	(m/s)		(hPa)	(DEG-C)	(DEG-C)	(%)	(DEG-C)	(mm/h)	(m)	(sec)
08/00	08/09	N40-00	E147-50	120	7.7	bc	1015.8	8.4	6.3	87	5.5	0.0	1.2	8
03	12	N41-16	E142-26	270	5.0	bc	1012.4	10.8	5.1	68	11.9	0.0	1.2	9
06	15	N40-54	E143-23	310	6.4	bc	1012.7	11.2	6.0	70	11.7	0.0	1.2	8
09	18	N40-39	E144-28	220	4.2	bc	1014.0	11.4	6.1	70	12.1	0.0	1.5	9
12	21	N40-24	E145-33	180	7.5	bc	1015.5	7.7	6.3	91	5.5	0.0	1.6	8
15	09/00	N40-12	E146-35	160	4.0	bc	1015.8	8.4	5.6	83	7.0	0.0	1.4	6
18	3	N40-01	E147-38	70	5.2	bc	1015.7	5.8	3.6	86	5.8	0.0	1.5	7
21	6	N40-00	E147-49	100	6.2	bc	1016.3	6.1	4.5	90	5.1	0.0	1.4	7
09/00	9	N40-00	E147-50	210	7.5	bc	1013.0	6.3	6.1	99	4.3	0.0	1.2	9
3	12	N40-03	E147-56	140	7.9	f	1014.1	9.0	8.3	95	5.6	0.0	1.5	8

Time		Position		W.D.	W.S.	Weather	Press.	Dry Temp.	Dew P.T.	RH	Sea W.T.	Rain	Wv. Ht.	Wv. PD.
UTC	Ship's T.	Lat.	Log.	(deg)	(m/s)		(hPa)	(DEG-C)	(DEG-C)	(%)	(DEG-C)	(mm/h)	(m)	(sec)
6	15	N40-31	E148-46	150	9.6	f	1013.1	9.1	9.4	100	6.3	15.2	1.3	10
9	18	N41-01	E149-39	200	7.5	f	1013.4	10.8	10.6	99	10.0	0.0	1.4	10
12	21	N41-31	E150-33	210	6.5	f	1014.3	8.2	8.0	99	5.9	0.0	1.3	10
15	10/00	N42-00	E151-26	200	8.9	f	1013.2	7.0	6.9	100	5.4	0.0	1.3	11
18	3	N42-30	E152-19	220	6.6	f	1013.5	6.6	6.9	100	5.3	0.0	1.3	11
21	6	N43-00	E153-13	220	6.9	f	1013.5	6.5	6.9	100	5.3	0.0	1.3	11
10/00	9	N43-59	E154-59	90	5.2	f	1010.8	6.4	5.4	93	7.5	0.0	1.1	6
3	12	N43-59	E154-59	200	9.2	f	1011.4	8.3	87.8	97	7.4	0.0	1.4	10
6	15	N43-59	E155-00	210	11.2	f	1010.0	9.2	9.0	99	7.6	0.0	1.2	7
9	18	N43-58	E155-00	210	12.7	f	1010.3	8.8	8.9	100	7.6	0.8	1.4	7
12	21	N43-59	E154-59	240	8.8	f	1010.7	6.9	7.0	100	7.6	0.4	1.4	7
15	11/00	N43-58	E155-00	270	5.7	f	1010.9	5.2	5.1	99	7.6	2.5	1.4	6
18	3	N43-59	E155-00	30	4.0	f	1011.3	4.9	4.1	95	7.6	0.0	1.5	6
21	6	N43-58	E155-02	70	5.5	f	1011.9	5.1	4.5	96	7.5	0.0	1.3	6
11/00	9	N44-17	E154-38	330	11.8	o	1008.4	1.9	2.2	100	4.3	0.0	2.1	18
3	12	N43-59	E155-00	40	6.3	o	1009.1	6.5	4.9	89	8.0	0.0	1.0	6
6	15	N44-01	E155-00	60	7.6	r	1007.7	5.0	4.4	96	7.8	3.0	0.9	7
9	18	N44-03	E155-00	50	4.9	o	1006.9	5.9	5.5	97	7.6	0.1	1.0	6
12	21	N43-39	E155-18	50	5.9	o	1004.4	6.7	5.8	94	7.8	0.7	1.0	7
15	12/00	N44-02	E154-57	40	9.9	r	1003.0	3.6	3.1	97	7.4	1.1	1.1	6
18	3	N44-05	E154-57	20	13.1	r	1001.8	3.5	2.4	93	7.5	2.8	1.3	5
21	6	N44-29	E155-15	350	15.6	r	1004.4	2.1	1.7	97	4.1	2.3	2.0	13
12/00	9	N43-58	E155-03	280	9.0	o	1008.1	4.9	4.8	99	7.6	0.0	1.1	5
3	12	N44-12	E155-20	330	12.3	c	1008.2	2.2	0.3	88	5.1	0.0	21.9	9
6	15	N43-59	E154-43	320	8.4	o	1011.3	1.9	0.0	87	5.6	0.0	2.2	13

Time		Position		W.D.	W.S.	Weather	Press.	Dry Temp.	Dew P.T.	RH	Sea W.T.	Rain	Wv. Ht.	Wv. PD.
UTC	Ship's T.	Lat.	Log.	(deg)	(m/s)		(hPa)	(DEG-C)	(DEG-C)	(%)	(DEG-C)	(mm/h)	(m)	(sec)
9	18	N44-00	E154-28	270	9.5	o	1013.2	2.2	0.8	90	4.4	0.0	1.5	6
12	21	N43-57	E154-30	250	6..5	o	1012.6	2.7	1.6	92	4.5	0.0	1.8	8
15	13/00	N43-58	E154-44	230	10.2	o	1012.1	3.7	2.6	92	6.1	0.0	1.2	6
18	3	N44-07	E154-59	200	7.4	o	1008.8	6.3	5.0	92	8.1	0.0	1.1	7
21	6	N44-00	E155-05	230	11.3	r	1007.6	7.3	6.7	96	7.6	3.9	1.1	6
13/00	9	N44-40	E155-51	140	11.3	o	1004.3	2.5	1.6	94	2.6	1.6	1.0	6
03	12	N43-58	E155-03	240	7.3	bc	1009.0	7.1	3.3	77	7.8	0.0	1.3	6
06	15	N44-13	E155-03	290	7.7	bc	1009.4	6.7	2.4	74	7.3	0.0	1.3	6
09	18	N44-41	E155-53	280	5.6	bc	1009.2	3.2	0.4	82	2.6	0.0	1.6	20
12	21	N44-40	E155-30	310	5.5	bc	1010.1	3.5	1.4	86	2.9	0.0	1.0	4
15	14/00	N44-33	E155-50	180	4.3	bc	1009.7	2.7	0.9	88	2.6	0.0	1.0	4
18	3	N44-47	E155-50	120	6.7	o	1007.6	2.6	0.8	88	2.9	0.0	1.0	9
21	6	N44-36	E155-49	100	8.0	r	1006.9	3.3	1.6	89	2.5	1.7	1.1	11
14/00	9	N44-46	E156-01	10	6.5	o	1006.0	1.9	0.3	89	2.8	0.0	2.2	7
3	12	N44-39	E155-49	110	10.7	r	1000.2	2.8	2.0	95	2.7	0.3	1.4	6
6	15	N44-45	E155-59	100	7.1	o	998.0	2.9	2.2	96	2.7	1.5	1.5	7
9	18	N44-39	E155-49	290	14.3	r	999.1	2.1	1.6	97	2.7	0.2	1.7	6
12	21	N44-45	E155-58	350	7.9	o	1001.0	0.8	0.2	93	2.4	0.2	3.0	13
15	15/00	N44-45	E156-00	340	4.5	r	1002.3	0.9	0.0	93	2.8	0.0	2.2	7
18	3	N44-46	E155-59	20	4.1	o	1003.0	1.0	0.1	94	2.8	0.2	2.5	7
21	6	N44-46	E155-59	40	5.7	r	1004.6	1.0	0.3	95	2.8	0.2	2.4	8
15/00	9	N46-47	E159-29	260	13.7	o	1000.1	1.8	-1.3	80	2.4	0.0	3.5	16
3	12	N44-45	E155-59	360	9.4	c	1006.3	2.3	-1.2	78	3.0	0.0	2.2	9
6	15	N44-42	E156-03	330	10.9	c	1007.2	2.1	-3.0	69	2.8	0.0	2.2	8
9	18	N44-46	E156-02	300	10.4	c	1008.1	1.7	-2.6	73	3.0	0.0	2.3	8
12	21	N44-51	E156-10	280	12.5	c	1007.0	1.7	-1.3	81	2.9	0.0	2.4	10

Time		Position		W.D.	W.S.	Weather	Press.	Dry Temp.	Dew P.T.	RH	Sea W.T.	Rain	Wv. Ht.	Wv. PD.
UTC	Ship's T.	Lat.	Log.	(deg)	(m/s)		(hPa)	(DEG-C)	(DEG-C)	(%)	(DEG-C)	(mm/h)	(m)	(sec)
15	16/00	N45-20	E156-59	280	15.4	o	1004.3	1.1	-1.2	85	2.6	0.0	3.2	12
18	3	N45-48	E157-48	280	11.8	o	1001.9	0.6	-1.1	88	2.7	0.1	3.3	12
21	6	N46-17	E158-38	280	13.3	o	1001.1	1.2	-2.9	74	2.1	0.0	3.5	12
16/00	9	N50-00	E165-02	250	5.5	o	1000.1	2.9	1.0	87	2.7	0.0	2.2	8
3	12	N46-55	E159-43	270	11.5	c	1000.6	1.9	-1.9	76	2.0	0.0	2.9	8
6	15	N47-13	E160-13	270	11.7	c	1000.2	2.1	-2.3	73	2.1	0.0	3.1	12
9	18	N47-43	E161-05	270	12.6	o	1000.0	1.3	-1.1	84	2.4	0.0	3.2	11
12	21	N48-13	E161-56	270	12.5	r	999.4	1.6	-0.1	89	2.7	0.1	3.2	13
15	17/00	N48-43	E162-48	280	12.7	r	998.1	1.1	-0.7	88	2.3	0.0	2.9	13
18	3	N49-14	E163-41	280	11.1	o	998.2	1.1	-0.3	90	2.5	0.0	3.3	15
21	6	N49-44	E164-33	290	5.9	o	999.2	2.0	1.3	95	2.6	0.1	2.9	15
17/00	9	N49-59	E165-00	110	0.3	bc	1003.4	2.2	0.8	90	2.8	0.0	1.6	7
3	12	N49-59	E165-00	260	7.9	o	1001.8	2.4	0.1	85	2.7	0.0	2.0	7
6	15	N50-00	E164-59	260	8.1	o	1003.2	2.3	-1.7	75	2.8	0.0	1.9	7
9	18	N49-59	E164-59	250	7.0	o	1004.9	2.2	0.2	87	2.7	0.0	2.0	7
12	21	N49-59	E164-58	240	6.2	o	1005.7	1.7	0.0	88	2.7	0.0	1.7	7
15	18/00	N49-59	E164-59	240	6.2	o	1006.0	2.0	0.0	87	2.7	0.0	1.5	7
18	3	N50-00	E165-00	210	5.7	o	1005.1	1.0	-0.5	90	2.7	0.0	1.6	7
21	6	N49-59	E164-59	220	4.9	o	1004.7	1.5	0.3	92	2.7	0.0	1.6	7
18/00	9	N46-04	E164-59	290	11.3	o	1014.6	3.5	-0.8	74	3.8	0.0	2.3	12
3	12	N49-59	E165-00	30	4.0	c	1001.7	2.4	-0.7	80	3.2	0.0	1.5	7
6	15	N50-00	E165-01	340	7.6	o	1001.0	2.1	-1.6	77	3.1	0.0	1.3	7
9	18	N50-00	E165-00	340	7.7	o	1002.1	2.3	-0.9	79	2.9	0.0	1.3	7
12	21	N49-13	E165-00	310	10.5	o	1003.7	1.6	-0.9	84	2.8	0.0	1.9	14
15	19/00	N48-26	E164-59	290	12.7	o	1005.4	1.5	-0.9	84	2.6	0.0	2.2	15
18	3	N47-38	E165-00	290	12.8	o	1008.7	1.9	-0.4	85	2.9	0.0	2.5	15

Time		Position		W.D.	W.S.	Wea-ther	Press.	Dry Temp.	Dew P.T.	RH	Sea W.T.	Rain	Wv. Ht.	Wv. PD.
UTC	Ship's T.	Lat.	Log.	(deg)	(m/s)		(hPa)	(DEG-C)	(DEG-C)	(%)	(DEG-C)	(mm/h)	(m)	(sec)
21	6	N46-51	E164-59	280	9.4	c	1012.1	2.2	0.1	86	2.9	0.0	2.4	13
19/00	9	N40-25	E165-00	110	0.7	c	1027.9	7.6	4.4	81	10.1	0.0	1.3	11
3	12	N45-44	E165-00	300	12.4	o	1017.1	3.1	0.7	84	4.6	0.0	2.5	8
6	15	N45-13	E165-00	300	13.9	o	1018.8	3.7	0.8	81	4.8	0.0	2.5	12
9	18	N44-26	E165-00	300	11.7	o	1022.8	4.6	1.1	78	5.5	0.0	2.9	12
12	21	N43-37	E164-59	300	9.1	o	1025.4	4.3	1.3	81	5.8	0.0	2.7	14
15	20/00	N42-48	E164-59	320	4.2	bc	1026.2	4.7	2.4	85	5.3	0.0	2.1	12
18	3	N42-00	E165-00	310	2.7	o	1027.2	6.1	3.4	83	7.1	0.0	2.1	16
21	6	N41-12	E165-00	130	2.1	o	1027.8	7.0	3.3	78	7.6	0.0	2.2	16
20/00	9	N39-59	E165-00	260	8.3	r	1011.7	13.6	13.8	100	13.0	0.0	2.1	7
3	12	N40-00	E165-00	140	8.3	r	1026.5	9.0	6.4	84	12.8	0.2	1.4	7
6	15	S40-00	E165-00	140	9.3	r	1023.8	8.7	6.0	83	12.9	0.4	1.2	7
9	18	S39-59	E165-00	140	11.9	r	1023.0	8.7	6.9	89	12.9	1.4	1.3	6
12	21	S40-00	E165-00	130	16.0	r	1020.4	9.7	8.5	93	12.9	1.9	1.7	6
15	21/00	N40-00	E165-00	140	16.9	r	1015.7	10.7	9.8	95	12.9	2.2	2.5	6
18	3	N40-03	E164-57	150	13.8	r	1011.5	12.1	11.7	97	12.8	1.8	2.6	8
21	6	N40-08	E164-56	230	12.9	r	1010.8	13.4	13.5	100	12.9	0.6	2.5	7
21/00	9	N41-47	E160-22	260	8.6	o	1012.7	10.0	8.1	88	8.6	0.0	1.8	12
3	12	N39-59	E165-02	250	13.0	o	1011.8	14.2	12.8	91	13.0	0.0	1.7	8
6	15	N40-00	E165-00	280	13.0	f	1012.8	13.0	13.1	100	13.0	0.4	2.0	7
9	18	N40-00	E164-56	290	13.0	o	1013.6	11.8	11.7	99	13.0	0.2	2.1	7
12	21	N40-17	E164-00	280	9.1	o	1013.6	10.0	9.7	98	9.1	0.0	1.7	9
15	22/00	N40-39	E163-05	180	10.6	o	1012.6	10.5	10.0	97	10.6	0.0	1.6	8
18	3	N41-01	E162-12	160	2.7	o	1012.1	10.4	9.5	95	9.7	0.0	1.8	13
21	6	N41-23	E161-17	280	5.0	f	1013.0	9.0	9.2	100	8.6	0.6	2.1	14
22/00	9	N44-00	E155-00	300	6.1	bc	1012.6	5.0	0.8	75	5.1	0.0	1.7	6

Time		Position		W.D.	W.S.	Weather	Press.	Dry Temp.	Dew P.T.	RH	Sea W.T.	Rain	Wv. Ht.	Wv. PD.
UTC	Ship's T.	Lat.	Log.	(deg)	(m/s)		(hPa)	(DEG-C)	(DEG-C)	(%)	(DEG-C)	(mm/h)	(m)	(sec)
3	12	N41-54	E160-04	240	8.5	bc	1012.7	9.4	7.1	85	7.3	0.0	1.7	7
6	15	N42-09	E159-27	240	10.0	bc	1012.0	9.9	7.9	87	9.0	0.0	1.8	11
9	18	N42-31	E158-34	260	12.0	c	1010.5	9.9	7.1	83	8.1	0.0	1.8	9
12	21	N42-52	E157-41	270	10.0	o	1009.8	8.6	6.2	85	9.5	0.0	1.8	7
15	23/00	N43-15	E156-46	270	8.1	c	1009.8	6.3	4.6	89	6.9	0.0	2.0	8
18	3	N43-38	E155-51	300	7.7	c	1009.9	6.4	2.9	78	6.3	0.0	1.6	8
21	6	N43-58	E155-11	320	8.5	o	1011.6	4.5	1.7	83	4.9	0.0	1.7	7
23/00	9	N44-00	E154-59	120	4.3	o	1009.6	5.0	3.5	90	5.8	0.0	1.7	8
3	12	N44-00	E154-59	310	5.7	o	1013.2	5.0	1.2	77	5.2	0.0	1.7	6
6	15	N44-01	E154-59	350	6.4	c	1013.3	3.3	-0.1	78	5.2	0.0	1.7	7
9	18	N44-02	E154-59	360	1.6	o	1014.1	2.5	0.6	87	5.1	0.0	1.7	6
12	21	N44-01	E155-00	350	1.7	o	1014.8	2.8	0.4	84	5.3	0.0	1.8	7
15	24/00	N44-01	E155-04	20	2.1	o	1012.8	2.9	0.5	84	5.2	0.0	1.4	7
18	3	N43-59	E155-03	120	5.4	o	1012.2	3.5	0.7	82	5.4	0.0	1.5	7
21	6	N44-00	E154-59	130	5.7	o	1010.7	4.3	2.0	85	5.7	0.0	1.9	8
24/00	9	N44-00	E155-14	50	5.3	o	1007.8	3.3	1.8	90	5.3	0.0	1.3	6
3	12	N44-01	E154-59	140	5.9	o	1006.3	6.1	4.2	88	5.9	0.0	1.5	8
6	15	N44-14	E155-18	140	4.7	f	1003.2	5.2	4.6	96	4.7	0.3	1.4	8
9	18	N44-42	E155-52	60	3.3	f	1002.5	3.5	3.1	98	3.3	1.9	1.4	9
12	21	N44-33	E155-00	320	3.0	f	1003.1	2.9	2.7	99	3.0	0.4	1.5	13
15	25/00	N43-58	E155-11	330	5.3	o	1004.9	3.4	2.9	97	5.3	0.0	1.5	7
18	3	N43-57	E155-12	350	4.6	o	1005.9	2.6	2.2	97	5.3	0.0	1.3	6
21	6	N43-54	E155-14	340	4.0	o	1007.7	2.1	1.6	97	5.5	0.0	1.3	6
25/00	9	N45-00	E155-31	50	16.0	o	1001.0	2.6	1.7	94	3.0	15.0	2.4	7
3	12	N44-03	E155-14	120	4.2	o	1008.1	4.0	1.3	83	5.5	0.0	1.1	6
6	15	N44-19	E155-50	100	4.8	o	1008.3	3.1	1.0	86	4.8	0.0	1.0	9

Time		Position		W.D.	W.S.	Weather	Press.	Dry Temp.	Dew P.T.	RH	Sea W.T.	Rain	Wv. Ht.	Wv. PD.
UTC	Ship's T.	Lat.	Log.	(deg)	(m/s)		(hPa)	(DEG-C)	(DEG-C)	(%)	(DEG-C)	(mm/h)	(m)	(sec)
9	18	N45-00	E156-03	80	8.5	o	1008.3	2.3	0.7	90	3.5	0.0	1.0	10
12	21	N44-31	E155-55	100	11.6	r	1006.8	2.9	1.9	93	3.2	2.1	1.0	9
15	26/00	N44-44	E155-49	90	14.8	r	1004.2	2.5	1.3	92	3.3	0.4	1.3	9
18	3	N44-49	E155-44	90	17.0	r	1001.0	2.8	2.0	95	3.3	0.3	1.7	8
21	6	N44-27	E155-40	70	17.4	r	997.4	3.6	2.5	93	4.3	1.8	2.6	10
26/00	9	N44-15	E156-09	340	5.7	r	1019.0	4.1	1.9	86	3.0	0.0	2.2	8
3	12	N44-31	E155-30	40	16.7	o	999.7	3.2	1.6	89	2.9	0.0	4.3	11
6	15	N44-39	E155-25	30	12.6	o	1004.0	3.1	1.7	91	2.9	0.0	3.4	8
9	18	N44-55	E155-20	20	11.4	o	1009.0	2.5	0.9	90	3.1	0.0	3.8	13
12	21	N44-33	E155-00	360	10.3	o	1011.5	3.1	1.9	92	3.2	0.0	2.7	10
15	27/00	N44-13	E156-05	360	10.0	o	1013.4	2.7	1.0	88	4.1	0.0	2.8	7
18	3	N44-12	E156-05	360	10.3	o	1015.1	3.3	1.0	85	4.2	0.0	2.9	8
21	6	N44-11	E156-05	10	10.7	o	1016.4	3.3	1.8	90	4.3	0.0	2.4	8
27/00	9	N44-16	E156-20	100	10.3	o	1006.9	3.8	3.3	97	3.2	0.0	1.5	6
3	12	N44-15	E156-10	10	5.7	o	1017.9	4.3	1.5	82	3.1	0.0	2.1	7
6	15	N44-20	E156-12	30	6.0	o	1017.8	2.3	0.6	89	3.3	0.0	1.8	8
9	18	N44-30	E155-12	70	4.4	f	1017.3	1.9	1.2	96	3.5	0.0	1.8	7
12	21	N43-30	E156-12	110	6.8	f	1014.8	1.7	1.3	98	3.4	0.0	1.7	7
15	28/00	N44-13	E156-13	140	5.2	r	1015.1	2.3	1.9	98	3.1	0.9	1.6	7
18	3	N44-13	E156-15	100	10.2	r	1010.0	2.2	1.6	95	3.1	1.2	1.6	7
21	6	N44-14	E156-18	130	13.2	o	1007.5	3.2	2.8	98	3.0	0.1	1.4	6
28/00	9	N42-20	E151-54	180	7.6	o	1005.8	7.3	6.7	96	5.3	2.1	2.1	9
3	12	N44-13	E156-19	100	12.0	o	1004.3	3.9	3.3	96	3.1	2.5	1.9	10
6	15	N43-59	E156-14	120	12.8	o	1003.2	5.7	5.2	96	4.9	5.5	2.4	13
9	18	N44-00	E155-11	200	5.3	f	1001.9	5.1	4.6	97	6.6	0.4	3.2	15
12	21	N43-43	E154-14	240	9.1	o	1003.2	3.9	3.5	97	6.4	0.1	2.6	9

Time		Position		W.D.	W.S.	Weather	Press.	Dry Temp.	Dew P.T.	RH	Sea W.T.	Rain	Wv. Ht.	Wv. PD.
UTC	Ship's T.	Lat.	Log.	(deg)	(m/s)		(hPa)	(DEG-C)	(DEG-C)	(%)	(DEG-C)	(mm/h)	(m)	(sec)
15	29/00	N43-19	E153-36	260	8.2	o	1004.1	3.6	3.1	97	4.5	0.8	2.9	9
18	3	N43-00	E153-04	280	7.2	o	1005.3	3.9	3.1	95	4.3	0.0	2.3	8
21	6	N42-40	E152-29	180	5.8	o	1006.0	4.4	3.5	94	4.3	0.0	2.4	8
29/00	9	N40-20	E145-26	220	7.3	f	1013.3	14.1	9.7	75	12.8	0.0	1.1	11
3	12	N42-00	E151-19	280	6.8	o	1007.5	7.9	6.6	91	6.6	0.0	2.0	9
6	15	N41-39	E150-42	280	4.2	c	1008.5	8.5	6.4	87	6.6	0.0	1.4	8
9	18	N41-10	E149-53	200	3.1	c	1009.7	11.3	8.3	82	12.1	0.0	1.3	8
12	21	N40-42	E149-03	220	6.1	c	1011.4	9.0	7.4	90	9.4	0.0	1.3	7
15	30/00	N40-13	E148-14	200	5.0	o	1011.8	9.5	8.2	92	7.3	0.0	1.0	6
18	3	S00-05	E156-01			c								
21	6	S00-05	E156-01			c								
30/00	9	S00-04	E156-00											
3	12	S00-04	E155-59											
6	15	S00-03	E156-02											
9	18	S00-03	E155-58											
12	21	S00-04	E156-00											
15	31/00	S00-04	E156-04											
18	3	N00-00	E155-59											
21	6	N00-00	E156-09											
31/00	9	S00-34	E156-00											

3. 2 Temperature and Salinity measurement / Water sampling by CTD / RMS

Hirokatsu UNO, Fujio KOBAYASHI, Mizue HIRANO
(Marine Works Japan Ltd.)
Chizuru SAITO, Makio HONDA
(Japan Marine Science and Technology Center)

(1) Introduction

As a basic property of the water mass in the study area, temperature and salinity were measured by CTD, and sea water sampling was conducted by RMS in order to obtain the samples for chemical analysis. In this section, we describe as for the CTD/RMS observations in MR99-K02 cruise conducted from 8 May 1999 to 31 May 1999 by R/V MIRAI.

(2) Measured Items

Temperature and Salinity were measured from sea surface through 5,300m in maximum (Large system) or 3,500m in maximum (Small system), and sea waters were sampled at stations KNOT, 50N, 40N and other stations by using CTD(conductivity-temperature-depth profiler) / RMS (Rosette Multi-bottle array water sampling Systems). CTD/RMS water-sampling casts of 2-14 times were conducted at every station (51 casts in total) for the chemical analysis of general water properties, carbon, trace metals, radio isotope, etc. .

(3) Observation Methods

(a) CTD/RMS systems

Two CTD/Rosette Multi-bottle Array Systems (CTD/RMS) were used during this cruise. One was the 30-liters 24-positions intelligent General Oceanic RMS (GO 1016) water sampler with Sea-Bird Electronics, Inc. CTD (SBE911plus) for 10,500 meters, nicknamed Large-CTD/RMS. Another one was the same CTD and RMS as Large CTD/RMS, but with 12-liters 12-positions water sampler, nicknamed Small-CTD/RMS.

30-liters and 12-liters Niskin bottles were attached on each Rosette system, 12 bottles of which were especially cleaned for the trace metal analysis. The sensors attached on each CTD were temperature sensor, conductivity sensor, pressure sensor and altimeter. In addition, Large-CTD/RMS was also with DO sensor and Fluorometer (Fluorometer . The calibration of these sensors were conducted by SBE in May 1994. Specification of the sensors were listed below.

CTD/RMS	Sensor	Model	Serial No.
Large-CTD/RMS			
	Temperature	SBE3-04/F	Primary S/N031524
	Conductivity	SBE4-04/O	Primary S/N041203
	Pressure		S/N 42410
	Oxygen	SBE13-04	S/N130338
	Altimeter	Benthos2110-1	S/N 0206
	Fluormeter		S/N 2148
Small-CTD/RMS			
	Temperature	SBE3-04/F	Primary S/N031359
	Conductivity	SBE4-04/O	Primary S/N041202
	Pressure		S/N 42423
	Altimeter	Benthos2110-1	S/N 0205

(b) Operation during Observation

Large-CTD/RMS was deployed and recovered from the stern of R/V MIRAI using the A-frame, and another small frame installed on starboard side, named as the Gallows, was used for Small-CTD/RMS. The CTD raw data was acquired on real time by using a SEASAVE utility of a software SEASOFT (Ver. 4.232) provided by Sea-Bird Electronics, Inc. and stored on the hard disk of a personal computer set in After Wheel-house. Water samplings were made during up cast by sending a fire command from the computer. Detail information during a cast such as date/time, station/cast/file names, location at the start/bottom/end of observation, water sampling layers and events were recorded in a CTD cast log sheet. These were summarized in CTD Cast List or CTD Bottle List shown in Appendix.

After a cast, the Large-CTD/RMS was lifted down from upper deck to the Water Drawing Room on 2nd deck and sea water was drawn from the bottles.

(c) CTD data processing

The CTD raw data was processed by using SEASOFT (Ver. 4.232) on another computer (IBM PS/V). Procedure of the data processing and used utilities of SEASOFT were as following.

DATCNV: Converts the binary raw data to output on physical units. Output items are depth, pressure, potential temperature, salinity, density(sigma-theta), oxygen, fluorescence. Simultaneously, this utility selects the CTD data when bottles closed to output on another file.
WILDEDIT: Marks wild points by setting their values to the bad value specified in the input .CNV header. The first pass of WILDEDIT is used to obtain an accurate estimate of the true standard deviation of the data. The second pass is used to mark the values good or bad.

SPLIT: Splits the data made by DATCNV into up and down cast data.

BINAVG: Calculates the averaged data in every 1 meter.

ASCIIOUT: Converts the binary averaged data into ASCII format data.

ROSSUM: Edits the data of sampled water to output a summary file. These data were shown in tables in Appendix CTD Bottle List.

SEAPLOT: Display the vertical profiles of averaged potential temperature, salinity, sigma-theta, oxygen ,and fluorescence data on CRT and print out. Plotted profiles for every station are shown in Figures in appendix.

(4) Management of the CTD data

A file name of each cast consist of the cruise identification, station name, CTD/RMS type and cast number, e.g., 99K2K1L1. After SPLIT utility was used, up/down identification was added. As a result of above on-board processing, 12 files were made for 1 cast, such as .DAT, .CON, .HDR, .BL, .ROS, .BTL, d*.CNV, u*.CNV, d*.ASC, u*.ASC, d*.HDR, u*.HDR files. All of raw and processed CTD data files were copied into a 3.5 inch magnetic optical disk (MO disk).

3. 3 Dissolved oxygen, nutrients and salinity

3 . 3 . 1 Dissolved oxygen

Nobuharu Komai, Katsunori Sagishima
(Marine Works Japan Ltd.)
Chizuru Saito
(Japan Marine Science and Technology Center)

(1) Introduction

Dissolved oxygen is a major parameter for deciding the seawater characteristic on oceanography. In this cruise, the methods of dissolved oxygen determination is based on WHP Operations and Methods manual (Culberson, 1991, Dickson, 1994).

(2) Methods

(a) Instruments and Apparatus

Glass bottle : Glass bottle for D.O. measurements consist of the ordinary BOD flask (ca.180ml) and glass stopper with long nipple, modified from the nipple presented in Green and Carritt (1966).
Dispenser : Eppendorf Comforpette 4800 / 1000µl
OPTIFIX / 2 ml (for $MnCl_2$ & NaOH/NaI aq.)
Metrohm Model 725 Multi Dosimat/20 ml (for KIO_3)
Titrator : Metrom Model 716 DMS Titrino/10 ml of titration vessel
Metrom Pt Electrode / 6.0403.100 (NC)
Software : Data acquisition and endpoint evaluation / Metrohm, METRODATA / 606013.000

(b) Methods

Sampling and analytical methods were based on to the WHP Operations and Methods (Culberson, 1991, Dickson, 1994) .

(b-1) Sampling

Seawater samples for dissolved oxygen measurement were collected from 30 L Niskin bottles to calibrated dry glass bottles. During each sampling, 3 bottle volumes of seawater sample were overflowed to minimize contamination with atmospheric oxygen and the seawater temperature at the time of collection was measured for correction of the sample volume.

After the sampling, $MnCl_2$ (aq.) 1ml and NaOH/NaI (aq.) 1ml were added into the glass bottle, and then shook the bottle well. After the precipitation has settled, we shook the bottle vigorously to disperse the precipitate.

(b-2) D.O. analysis

The samples were analyzed by 2 sets of Metrohm titrators with 10 ml piston buret and Pt Electrode using whole bottle titration. Titration was determined by the potentiometric methods and the endpoint for titration was evaluated by the software of Metrohm, METRODATA (606013.000).

Concentration of D.O. was calculated by equation (8) and (9) of WHP Operations and Methods (Culberson, 1991). Salinity value of the equation (9) was used from the value of salinity of CTD. The amount of D.O. in the reagents was reported 0.0017 ml at 25.5 deg-C (Murray et al., 1968). However in this cruise, we used the value (= 0.0027 ml at 21 deg-C) measured at 1995 WOCE cruise of R/V Kaiyo. D.O. concentrations we calculated were not corrected by seawater blank.

We prepared and used one batch of 5 liter of 0.07N thiosulfate solutions and 5 liter of 0.0100N standard K I O3 solutions (JM981130). The standardizations and blank determination have been performed every day before the sample analysis. The value of thiosulfate standardization of titrator #A was significantly changed at 20-May-99, so we didnít use a titrator #A since that day.

(3) Preliminary Result

(3-1) Comparison of our K I O3 standards to CSK standard solution.

After this cruise, we compared our standards with CSK standard solution (Lot. DLG8365) which is the commercially available standard solution prepared by Wako Pure Chemical Industries, Ltd. The results are shown in table 3.3.1-1. Normality of our standard may be different 0.02% from nominal normality.

Table 3.3.1-1. Comparison of each standards

K I O3 Lot No.	Nominal Normality	Average Titer (ml)	Standard Deviation	n	Ratio to DLG8365 (CSK)
DLG 8365	0.0100	1.3826	0.0005	10	
JM981016	0.010019	1.3950	0.0007	10	0.9998

(3-2) Titration blanks

The titration blank were determined in deionized water by Milli-RX12, Millipore. The blank results from the presence of redox species apart from oxygen in the reagents which can behave equivalently to oxygen in the analysis. The results were shown in Fig.3.3.1-1. The average of titiration blank was -0.010 ml (Titrator #A) and -0.009 ml (Titrator #B), respectively.

(3-3) Thiosulfate Standardization

The results of standardization were shown in Fig.3.3.1-2. The average of molarity of thiosulfate solution was 0.07219 mol (Titrator #A) and 0.07197 mol (Titrator #B) with standard deviation was 0.00019 mol and 0.00008 mol, respectively. Molarity of titrator #A was high since 20-May-99 when the room temperature was high (ca.28 deg-C).

(3-4) Reproducibility

In this cruise, 324 samples for D.O. samples were collected. 50 pairs (15%) of total samples were analyzed as "duplicates" which were collected from same Niskin bottle. These results were shown in Fig. 3.3.1-3 and 3.3-1-4. At Fig. 3.3.1-3, absolute difference of the samples whose sequence number 19 to 26 was high. These samples were collected at Stn. 50, so the precision of the collected samples at Stn. 50N seemed to be not good.

From duplicate analyses, the precision of this analysis was evaluated to be 0.44 µmol/kg (one sigma). This is corresponded to 0.11% of D.O. maximum concentration 411.86 µmol/kg observed in this cruise.

(4) References :

Culberson, C.H. (1991) Dissolved Oxygen, in WHP Operations and Methods, Woods Hole., pp1-15

Culberson, C.H., G.Knapp, R.T.Williams and F.Zemlyak (1991) A comparison of methods for the determination of dissolved oxygen in seawater. (WHPO 91-2)

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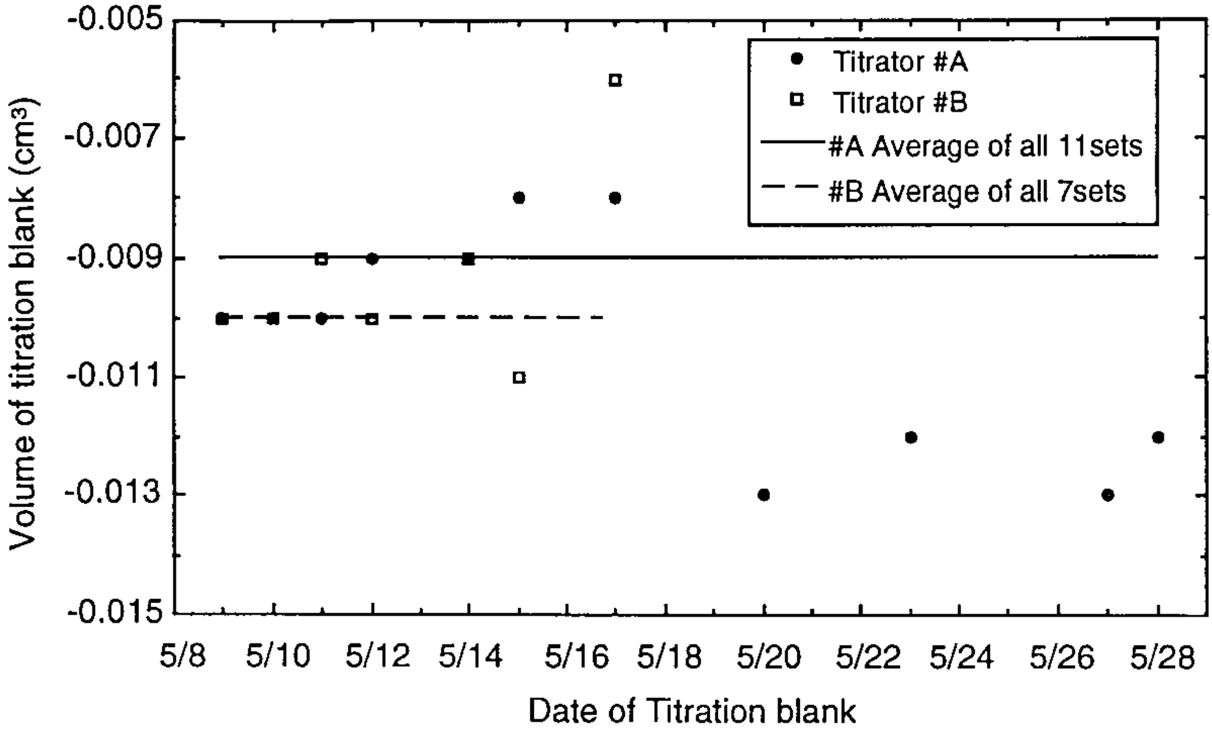

Fig. 3.3.1-1 Results of pure water blank at MR99-K02 cruise.

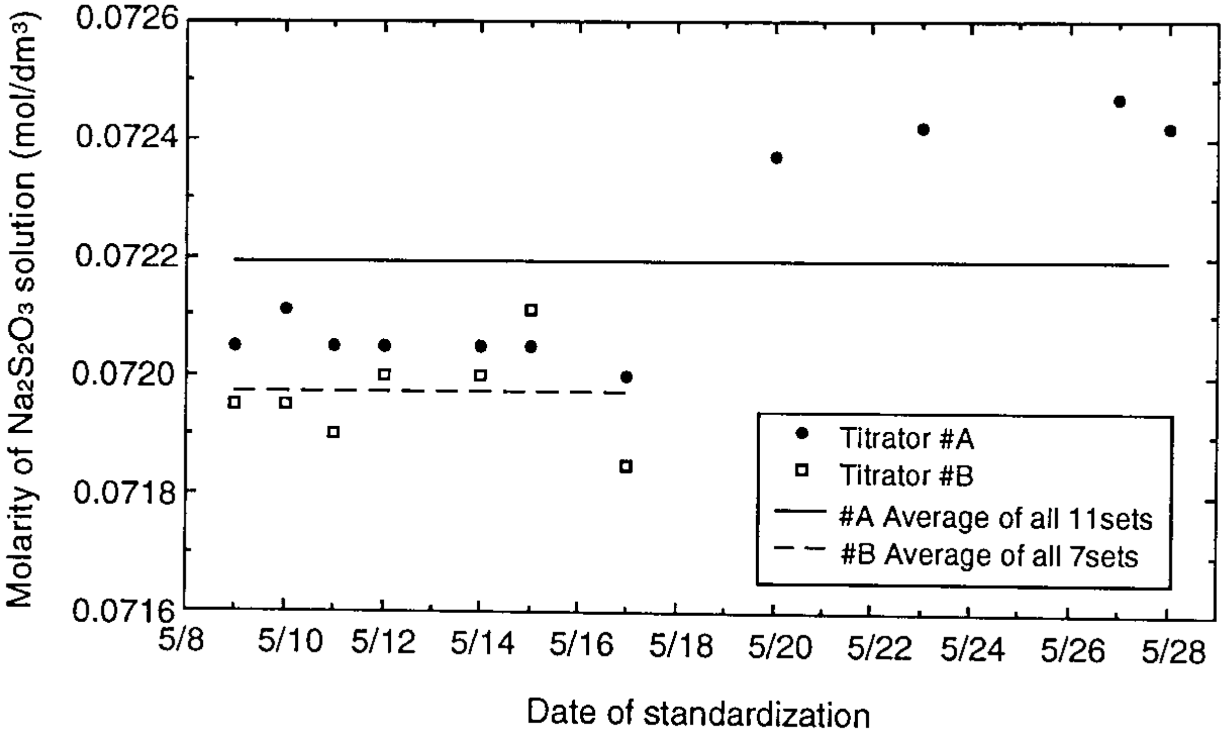

Fig. 3.3.1-2 Results of standardization at MR99-K02 cruise.

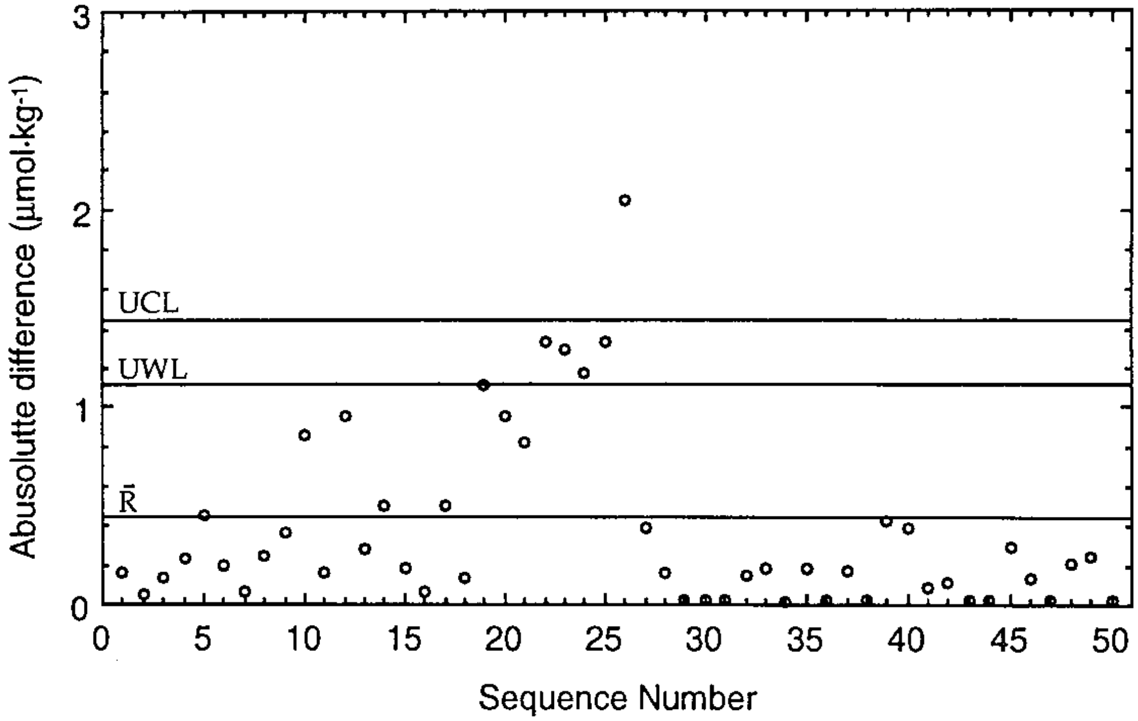

Fig. 3.3.1-3 Abusolute differences between duplicates at MR99-K02 cruise.

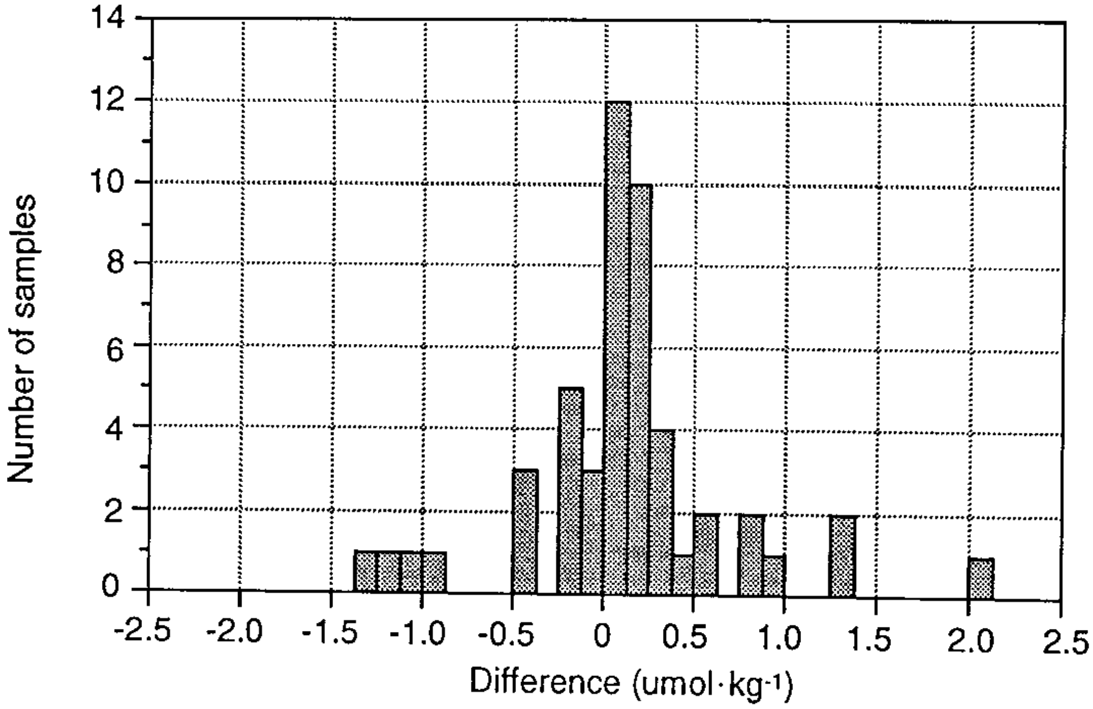

Fig. 3.3.1-4 Distribution of duplicates (first titration minus second) at MR99-K02 cruise.

3.3.2 Nutrients measurements of sea water sample

Kenichiro SATO (MWJ)
Chizuru SAITO (JAMSTEC)

(1) Objective

The vertical and horizontal distributions of the nutrients are one of the most important factors on the primary production. During this cruise nutrients measurements will give us the important information on the mechanism of the primary production or seawater upwelling.

(2) Instruments and Methods

The nutrients analyses were performed on BRAN+LUEBBE continuous flow analytical system Model TRAACS 800 (4 channels). The laboratory temperature was maintained between 20-25 deg C.

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

Nitrate: Nitrate in seawater is reduced to nitrite, which is determined by the method described above. Nitrite initially present in the sample is corrected.

Silicate: The standard AAII molybdate-ascorbic acid method was used. Tempreture of the sample was maintained at 45-50 deg C using a water bath to reduce the reproducibility problems encountered when the samples were analyzing at different temperatures. The silicomolybdate produced is measured spectrophotometrically at 630 nm using a 3 cm length cell.

Phosphate: The method by Murphy and Riley (1962) was used with separate additions of ascorbic acid and mixed molybdate-sulfuric acid-tartrate. Tempreture of the samples were adjusted to be 45-50 deg C using a water bath. The phospho- molybdate produced is measured at 880 nm using a 5 cm length cell.

a. Sampling Procedures

Samples were drawn into polypropylene 100 ml small mouth bottles. These were rinsed twice before filling. The samples were analyzed as soon as possible. Five ml sample cups were used for analysis.

b. Low Nutrients Sea water (LNSW)

Ten containers (20L) of low nutrients sea water were collected in early 1998 at equatorial Pacific and filtered with 0.45mm pore size membrane filter (Millipore HA). They are used as preparing the working standard solution.

(3) Preliminary results

a. Precision of the analysis

We have made the repeat analysis of two layers' (about 100 m and 500 m depths) samples at each station. At those repeat analysis range of CV (concentration average to standard deviation) were 0.03 to 2.6 % in upper layer and 0.07 to 1.9 % in bottom layer except nitrite.

b.Distribution of nutrients

The results are shown in Appendix.

In this expedition we made a hit of spring blooming spot. Surface nutrient concentrations were extremrely low compared with other season. On the other hand, the highest concentrations were observed upper 1000 m layer in stn. 50N. Anyway we are looking forward to analyzing the blooming season's data.

These data are stored in MO disk in Ocean Research Department in JAMSTEC.

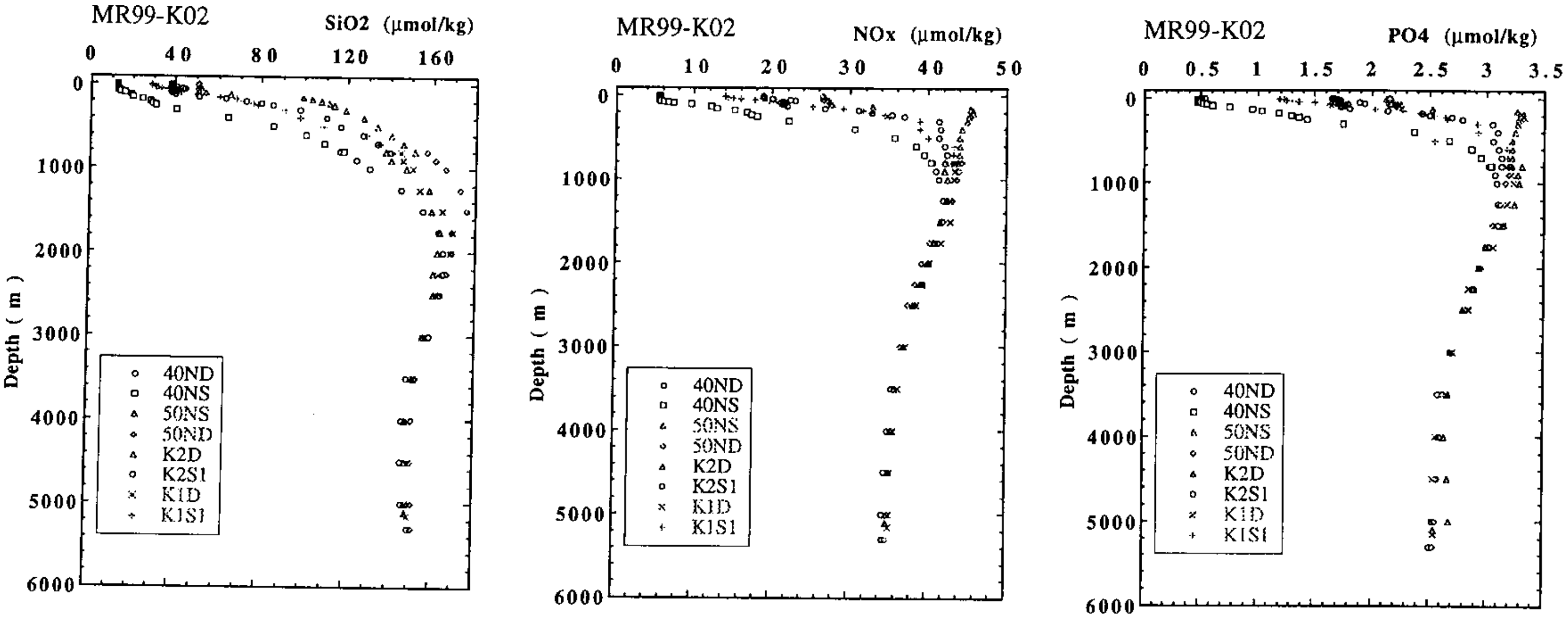

Fig. 3.3.2.1 Vertical profiles for SiO_2, NO_x and PO_4.

3. 3. 3 Salinitiy measurements

Hirokatsu UNO, Fujio KOBAYASHI, Mizue HIRANO
(Marine Works Japan Ltd.)
Chizuru SAITO
(Japan Marine Science and Technology Center)

(1) Instrument and Method

Salinity was measured by a Guildline Autosal salinometer model 8400B, which was modified by addition of an Ocean Science International peristalitic-type sample intake pump and Hewlett Packard quartz thermometer model 2804A with two 18111A quartz probes. One probes measured at room temperature and the other probe measure at a bath temperature. The resolution of the quartz thermometer was set to 0.001 °C. Data of both the salinometer and the thermometer was collected simultaneously by a personal computer. A double conductivtiy ratio was defined as median of 31 times readings of the salinometer. Data collection started after 5 seconds and it took about 10 seconds to collect 31 reading by a personal computer.

The salinometer was operated in the air-conditioned ship's laboratory at bath temperature of 24°C. Room temperature varied from approximately 24°C to 26°C, while a variation of bath temperature was

1. Salinity Sample Bottles

The bottles in which the salinity samples are collected and stored are 250 ml brown glass bottles with screw caps.

2. Salinity Sample Collection and Temperature Equilibration

Each bottles was rinsed twice with sample water and was filled to the shoulder of the bottle. Its cap was also thoroughly rinsed. Salinity samples were stored more than 24 hours in same laboratory were the salinity measurement was made.

3. Standardization

Autosal model 8400B was standardized before and after sequence of measurements by use of IAPSO Standard Seawater batch P134 whose conductivity ratios were 0.99989.

4. Sub-Standard Seawater

We also used sub-standard seawater which was deep-sea water filtered by pore size of 0.45 micrometer and stored in a 20 liter container made of polyethylene for at least 24 hours before measuring. It was measured every 10 samples in older to check and correct the trend.

(2)Result

The result obtained are shown in CTD/RMS bottle lists in Appendix. These salinity data are stored in Ocean Research Department, JAMSTEC.

3.4 Carbonate chemistry

3.4.1. pH measurements

Andray Andreev (JAMSTEC)

(1) Introduction

The pH (-log [H^+]) of the seawater has used to be considered as a key factor which determine the form of existence and migration of chemical elements in the seawater. Also the change of the carbonate parameters of the world ocean due to increase of the antropogenic CO2 concentration in the atmosphere demands the precise measurements of the pH in the seawater.

During last 30 years in the routine expedition work the most popular became the potentiometric method of the determination of the pH in the seawater by cell with liquid junction or ' salt bridge' (saturated solution of KCl)

Ag, AgCl | solution of KCL || test solution | H^+ - glass - electrode (A).

In such measurements as electrode pair the H^+-glass electrode and silver/silver chloride or mercury/mercury chloride as reference electrode are used to apply.

The calibration of the electrodes of the cell (A) can be done by using phosphate buffer solution (Na2HPO4 and KH2PO4 in the distilled water) (NBS scale) and in the total hydrogen scale (T) by TRIS and AMP in the synthetic seawater (Dickson and Goyet, 1996).

And then the pH of the seawater can be determined by following equation

$$pH= pH(standard)+ F(Es - Et)/RT\bullet \ln(10) \qquad (1)$$

, where (Es - Et) is the difference in EMF of standard and test solutions, RT(ln (10)/F is Nernst constant (59. 16 mv/pH unit at the temperature 25 degree C).

The main problem of the measurement by cell (A) it is problem of the residual liquid junction potential (LJP) which arise on the interface of ' salt bridge' and test solution (additional term in the equation 1). The value of LJP is different in the buffer and test solution and it also depends on the sample mixing speed in the cell and the level of the KCl solution in the reference electrode.

The difference in the LJP in the standard and test solution can be as high as several mV that leads to the error in the pH about 0.1 pH unit if use for the pH measurements in the seawater as standard NBS buffer solutions based on distilled water.

Another problem is that the EMF of the cell (A) is determined by activity of hydrogen ion than concentration. The coefficient between activity and concentration (coefficient of activity) depends on salinity. As far salinity of the test solutions from the salinity of the standard solution (for the buffer solutions in the Total hydrogen scale or SeaWater scale (SWS) it is 35 psu) than higher error in the determination of pH.

To avoid the problem of liquid junction potential (and drift in EMF related with the change of the level of KCL solution in the reference electrode) two cells can be applied

Ag, AgCl | solution of KCL || test solution | H^+ -glass-electrode (B1),
Ag, AgCl | solution of KCL || est solution | Na^+ -glass-electrode (B2)
with common reference Ag, AgCl electrode.

The difference in EMF between cell (B1) and cell (B2) is determined by cell without transfer
Na+ -glass-electrode | test solution | H+ -glass-electrode (C).
The pH of the test solution can be calculated from the measured EMF of the cell (C) by the equation

$$pH= pH(standard)+ F(Es - Et)/RT\bullet\ln(10) + \log[(mNa)s/(mNa)t] + \log[(\gamma H)s/(\gamma H)t + \log[(\gamma Na)s/(\gamma Na)t] \qquad (2)$$

, where (mNa) and (γNa) are molality and activity coefficient of the sodium ion in the standard (s) and test (t) solutions, (γH)s and (γH)t are the coefficient of activity of the hydrogen ion in the standard and test solutions.
In the measurements of the pH of the seawater by cell (A) it used to be assumed that log[(γH)s/(γH)t is equal to 0.
The (mNa) and (γNa) in the seawater can be determined from salinity (S) by equations:

$$mNa= 13.872(S/(1000-1.00511\bullet S) \qquad (3)$$

and

$$\ln(\gamma Na)= A\bullet I^{0.5} + B\bullet I+ C\bullet I^{1.5}+ D\bullet I^{2}+ E\bullet I^{2.5} \qquad (4)$$

, where ionic strength of seawater (I) is determined by expression
$I= 19.9273(S/(1000- 1.00511\bullet S)$.
At temperature 25 degree C A= -1.1613, B= 1.4272, C= -1.2976, D= 0.7468 and E= -0.1842 (Tishchenko, 1994).
In (Tishchenko et al., 1999) it was proposed conduct calculation of the pH in the seawater based on EMF measurements of the cell (C) in the conventional scale (pHC)

$$pHC= -\log[aH]$$

, where aH is the activity of the hydrogen ion.
The value of (paH (-log [H] -log[γH]) + log[γNa]) (equation 2) in the solution of 0.025 M Na_2HPO_4+ 0.025 M NaH_2PO_4 + 0.5 m NaCl at the temperature 25 degree C is equal to 6.334 (Tishchenko, 1999).

At the temperature 25 degree C

$$pHCt = 6.334 + F(Es - Et)/RT\bullet\ln(10) + \log[(mNa)s/(mNa)t] - \log(\gamma Na)t \qquad (5)$$

, where Es is EMF of the solution (0.025 M Na2HPO4+ 0.025 M NaH2PO4 + 0.5 m NaCl), (mNa)t and (γNa)t in the seawater samples can be calculated by equations (3) and (4).

(2) Instruments and standards

The measurements of the pH of the seawater were carried out by potentiometric method in the closed cells at the temperature 25 degree C (pH25).
The two types of the electrode cells were applied (A) and (B1)+(B2).
The measurement of EMF of the cell (A) was conducted by pH/Ion meter (model PHM95), pH and Ag/AgCl reference electrode of the ' Radiometer ' company. The temperature of the test solution was monitored by temperature sensor (Radiometer) within 0.1 degree C.
For the measurement by cell (B1)+(B2) the pH/ISE meter (model 920A), pH (model 91- 01), sodium - glass (model 84-11) and Ag/AgCl (model 90-01) of the ' Orion' company were applied.
The four different buffer solutions were used as standards. As primary standard the TRIS (0.04 m TRIS + 0.04 m TRISHCL) in synthetic seawater (S=35 psu) (Total hydrogen scale) (pHT=8.089 pH unit at the t=25 degree C, Dickson and Goyet, 1996) and phosphate (0.025 M Na2HPO4+ 0.025 M KH2PO4) in the distilled water (NBS scale, pH=6.865 at t= 25 degree C) only for measurement in the cell (A)) were used for the electrodes calibration. As secondary standard the phosphate (0.025 M Na2HPO4+ 0.025 M KH2PO4 in the solution of 0.5 m NaCl and AMP* in the synthetic seawater were applied. The use the latter buffer solution (AMP*) as secondary standard was due to some deviation in the preparation of the buffer solution from the prescribed in (Dickson and Goyet, 1996).
Recently a new value of pH25T for the TRIS buffer was adopted (8.0936 pH unit) and we used this value in our calculation. To do comparison with the historical data it should be take into account the difference between ' old ' (Dickson and Goyet, 1996) and ' new ' (DelValls and Dickson, 1998) pH25T value of the TRIS buffer.

(3) Results and Discussion.

Standard deviation or repeatibility (Dickson and Goyet, 1996) of the pH measurements (S) in the seawater samples by the cell (A), estimated by following expression $S=((\Sigma di^2/2k)$ (where di is the difference between the dublicate measurements and k is amount of the dublicate measurements), was equal to ± 0.064 mv or ± 0.001 pH unit (k=50). The repeatibility of the measurements in the buffer solutions was about twice higher than standard deviation of the measurements in the water samples.
The drift in the EMF values of cell B1 and B2 was as much as 2-3 mv for the period 2-3 hours as result of high outflow rate and hence the change of the level of the KCL saturated solution in the Ag/AgCl

reference electrode of the ' Orion ' company.

The reference electrode of the ' Radiometer ' company was more stable with almost zero drift in EMF during several hours measurement period.

Fig.3.4.1.1 shows the vertical distribution of the pH25T, pH25C and (pH25C - pH25T) at the deep stations (station KNOT1.1 (44 N, 155 E), 50N165E, 40N165E and KNOT2.1 (44 N, 155 E) (pH25T)).

In the bottom water layer (depth 4000 - 5500 meters) the distribution of the pH25C at the study stations was quite uniform (Fig.3.4.1.1). The pH25T was higher at the station 40N165E and it higher at the station 50N165E.

The average difference between pH25C and pH25T was equal to -0.188 pH unit, excluding 800-500 meter water layer at the station KNOT1.1. where it was -0.17 pH unit. The low absolute values of the (pH25C - pH25T) at the shallow hydrocast of the station KNOT1.1 was due to the not proper work of sodium electrode at the beginning measurements in the cruise.

At the Fig. 3.4.1.2.A there are shown vertical profiles of the pH25T in the upper 250 meter water layer at the stations KNOT1.1- 1.5, KNOT2.1- 2.4, 50N165E and 40N165E.

The pH of the seawater in the upper water layer can be expressed as some initial value pH^0 plus pHexcess (the decrease of the pH due to the increase of the concentration of the CO2 in the atmosphere) and plus ΔpHbiol. (the change of the pH due to biological activity: inorganic carbon and nutrients assimilation, organic matter decomposition and calcification)

$$pH25 = pH25^0 + pHexcess + \Delta pHbiol. \qquad (6).$$

The $pH25^0$ is changing with seawater temperature due to the change in pre-form (initial) concentration of total alkalinity and total alkalinity (Chen et al. 1979).

We estimated that the temperature coefficient of the $pH25^0$ in the Northwestern Pacific surface water in the temperature interval 4- 12 degree C is equal to 0.025 pH unit/degree C (unpublished results of the expedition MR98K02). Thus the change of the pH due to the biological activity can be determined by following equation

$$\Delta pHbiol.= pH25- pH25^0- pHexcess = pH25- 0.025 \cdot T(^0C)- pHexcess- a$$

, where a is constant.

Fig.3.4.1.2.B shows the distribution of the pH25T-0.025•T (where T is the temperature of the seawater) in the upper 250 meters water layer at the study stations.

Based on the results of our calculation the increase of the partial pressure of the CO2 in the atmosphere from the pre-industrial value (about 280 (atm) to the 360 (atm (the averaged measured value of the pCO2 in the atmosphere of the Northwestern Pacific during cruise) should result in the decrease of the pH25 at 0.10- 0.11 pH unit in the upper surface layer. Thus absolute value of the pHexcess is equal to 0.10-

0.11 pH unit in the surface water and it decreasing with depth. The variations in the pHexcess value in the upper 250 meters could not be considerable, hence, the change of the (pH25- 0.025(T) with depth (Fig.3.4.1.2. B) shows mainly the change of the pH25 due to the biological activity.

There is linear correlation between Apparent Oxygen Utilization (AOU) values, calculated from dissolved oxygen, measured by oxygen sensor, and ((pH25- 0.025•T) values (Fig. 3.4.1.3.A).

Using Redfield's model (Redfield et al., 1963) the ratio between the decrease of the pH25 and dissolved oxygen concentration can be estimated. The decomposition of the organic matter results in the increase of total inorganic carbon concentration due to the organic carbon oxidation and the decrease of total alkalinity due to the protonation (Brewer et al., 1979)

ΔTCO2org.dec. + ΔTAorg.dec.   0.83•AOU.

In according to our calculations the increase of the total inorganic carbon at 1 (μmol/kg) (when total alkalinity is constant) and decrease of total alkalinity at 1 (μmol/kg) (when total inorganic carbon is constant) leads to the decrease of the pH25 at about 0.0025 pH unit. Thus between the AOU and (pH25biol.activ. the linear relation should exist

ΔpH25org.dec.   - 0.0028•AOU.

The absolute value of coefficient between change of the (pHT25- 0.025• T) values and AOU in the 250 meter upper water layer at the study stations was lower than 0.0028 probably due to applying uncorrected dissolved oxygen data, measured by oxygen sensor.

The high values of the (pHT25- 0.025•T) in the surface water layer at the stations KNOT1-4, KNOT2-2, KNOT2-3 and KNOT2-4 are coincide with low values of the pCO2 of the seawater and are the result of the considerable assimilation of the inorganic carbon concentration during photosynthesis.

In the 50 - 250 meter layer the pH25 of the seawater is decreasing with depth as the result of the organic matter decomposition. The location of the maximum vertical gradient in the pH25 values is coincide with position of the main pycnocline (halocline) (the depth about 125 meter).

The exchange of matter between deep and surface water layers in the study area is limited by exchange through the main pycnocline. Thus the vertical flux of the dissolved oxygen and dissolved inorganic carbon is determined by the vertical stability. Fig. Fig.3.4.1.3.B show the linear correlation between value of the vertical gradient of pH25 and vertical gradient of the density (Fig.3.4.1.3.B) in the 85 - 225 meter water layer.

(4) Proposals

The measurements of the pH in the sea water are planning conduct by the cell without transfer

Cl-ion reference elctrode | test (standard) solution | H+ -glass-electrode (D) .

To take into account the change with salinity the coefficient activity of the chloride ion the equation (4) with different coefficient can be applied.

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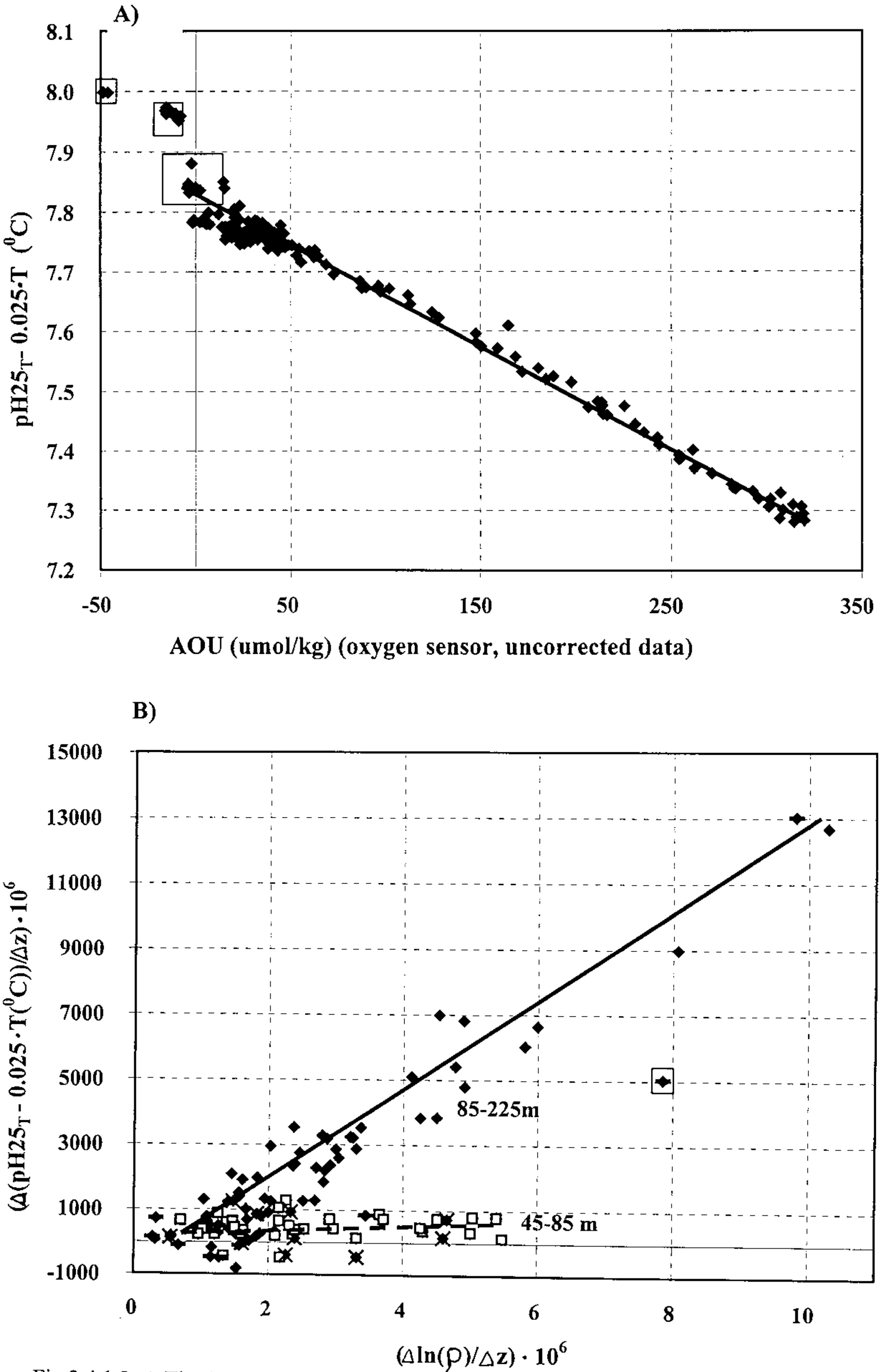

Fig.3.4.1.3. A.The ($pH25_T$-0.025·T) versus AOU(μmol/kg) in the upper 250 meters water layer. Stations KNOT1.1-1.5,2.1-2.4, 50N165E and 40N165E.

B. The Δ($pH25_T$-0.025·T)/Δz versus (Δln ρ/Δz) . ■ - 85-225 meters depth interval, □ -45- 85 meters depth interval. ✱- station 40N165E.

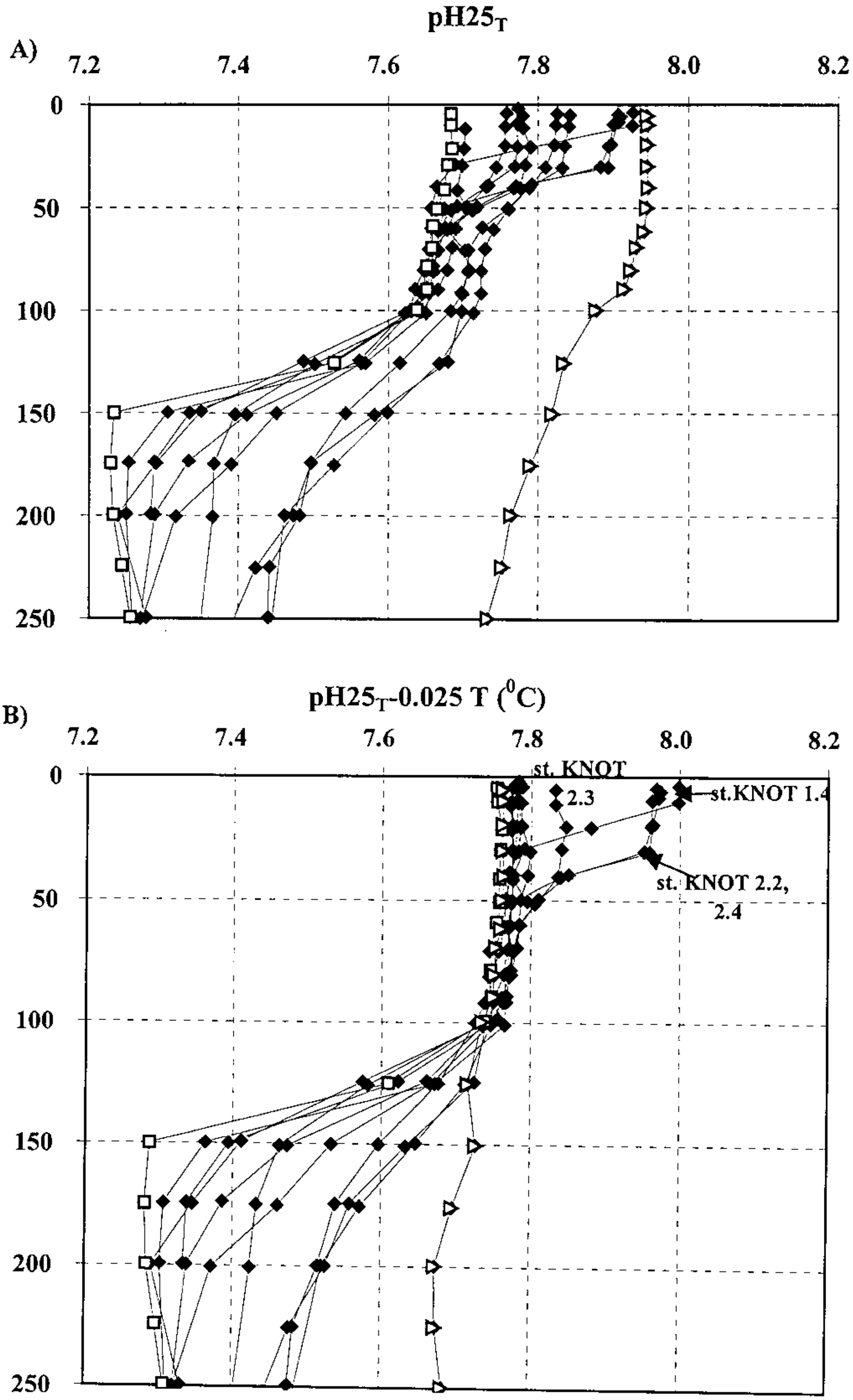

Fig. 3.4.1.2. The vertical distribution of the pH25$_T$ (A) and (pH25$_T$ - 0.025 T(^{0}C)) (B) in the upper 250 meters water layer at the stations KNOT1.1-1.5, 2.1- 2.4 (■), 50N165E (□) and 40N165E(▷).

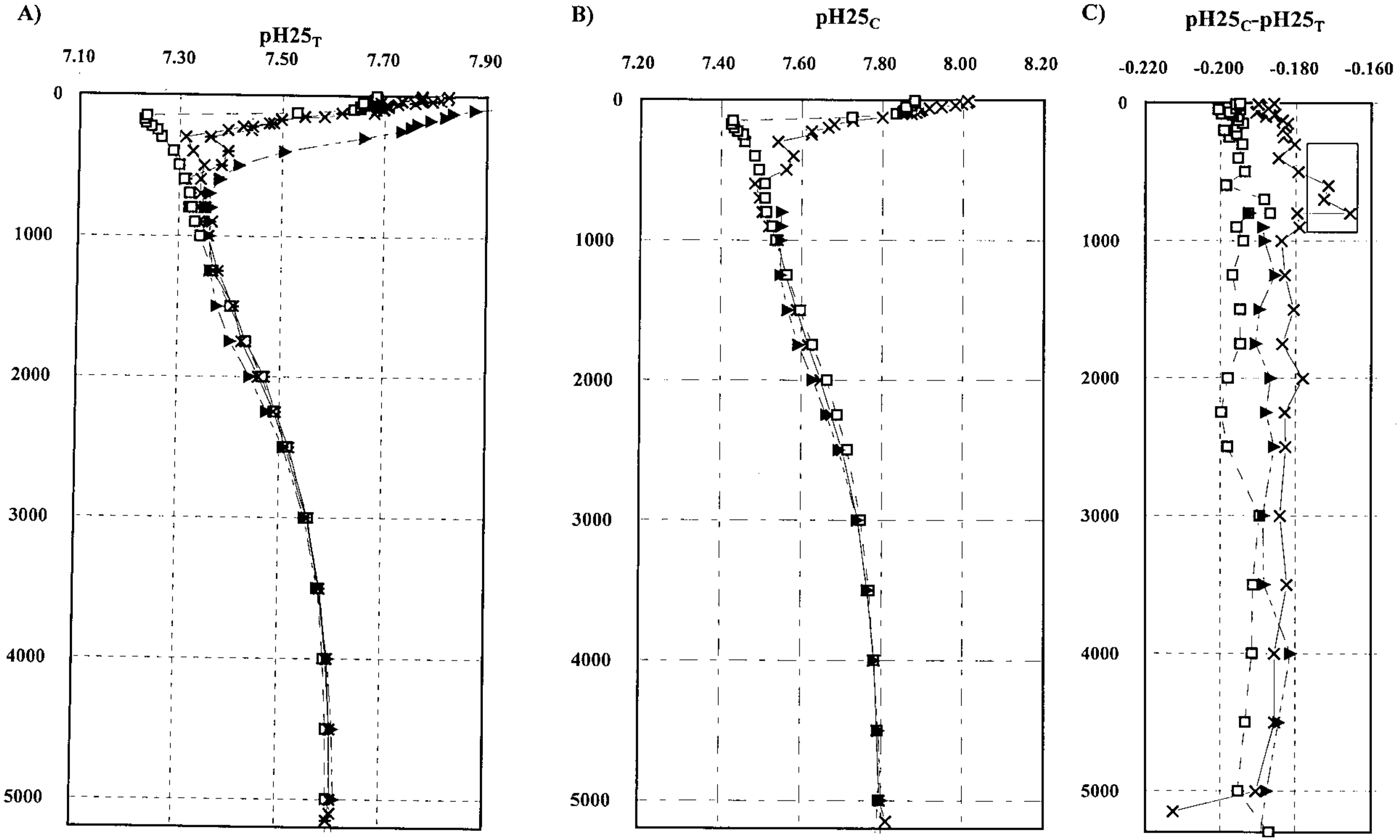

Fig.3.4.1.1. The vertical distribution of pH25$_T$ (A), pH25$_C$ (B) and (pH25$_C$ - pH25$_T$) (C)at the station KNOT1.1 (44 N,165 E) (×), 50N165E (□), 40N165E (▶) and KNOT2.1 (44 N,165 E) (✳).

3.4.2 Total dissolved inorganic carbon

Yuichiro Kumamoto, Akihiko Murata (JAMSTEC)
Kazuhiro Hayashi (MWJ)

Global warming caused by green house gas such as CO2 has become much attention all over the world. In order to verify carbon cycle in the northwestern North pacific, total dissolved inorganic carbon (TDIC) was measured with analytical instruments installed on R/V MIRAI.

3.4.2.1 Bottle sampling

Concentration of TDIC in seawater collected at the stations KNOT, 50N, and 40N from surface to bottom was measured by a coulometer (Carbon Dioxide Coulometer Model 5012, UIC Inc.). A volume of seawater (35 cm^3) was taken into a receptacle and 2 cm^3 of 10 percents (v/v) phosphoric acid was added. The CO2 gas evolved was purged by CO2 free nitrogen gas for 12 minutes at the flow rate of 110 cm^3 $min.^{-1}$ and absorbed into an electrolyte solution. Acids formed by reacting with the absorbed CO2 in the solution were titrated with hydrogen ions using the coulometer. Calibration of the coulometer was carried out using sodium carbonate solutions (0-2.5mM). The coefficient of variation of 3 replicate determinations was approximately less than 0.1 percents for 1 sigma. All the data were referenced to the Dickson's CRM and shown in the Appendix.

3.4.2.2 Continuous surface seawater sampling

Concentration of TDIC in surface seawater water collected by a pump from 4 m depth was continuously measured every 40 minutes by a coulometer (Carbon Dioxide Coulometer Model 5012, UIC Inc.). A volume of seawater (35 cm^3) was taken into a receptacle and 2 cm^3 of 10 percents (v/v) phosphoric acid was added. The CO2 gas evolved was purged by CO2 free nitrogen gas for 12 minutes at the flow rate of 110 cm^3 $min.^{-1}$ and absorbed into an electrolyte solution. Acids formed by reacting with the absorbed CO2 in the solution were titrated with hydrogen ions using the coulometer. Calibration of the coulometer was carried out using sodium carbonate solutions (0-2.5mM). The coefficient of variation of 3 replicate determinations was approximately less than 0.1 percents for 1 sigma. All the data were referenced to the Dickson's CRM. Figure 1 shows a relation between Normalized TDIC (NTDIC, S=35 per mil) and sea surface temperature in the surface seawater.

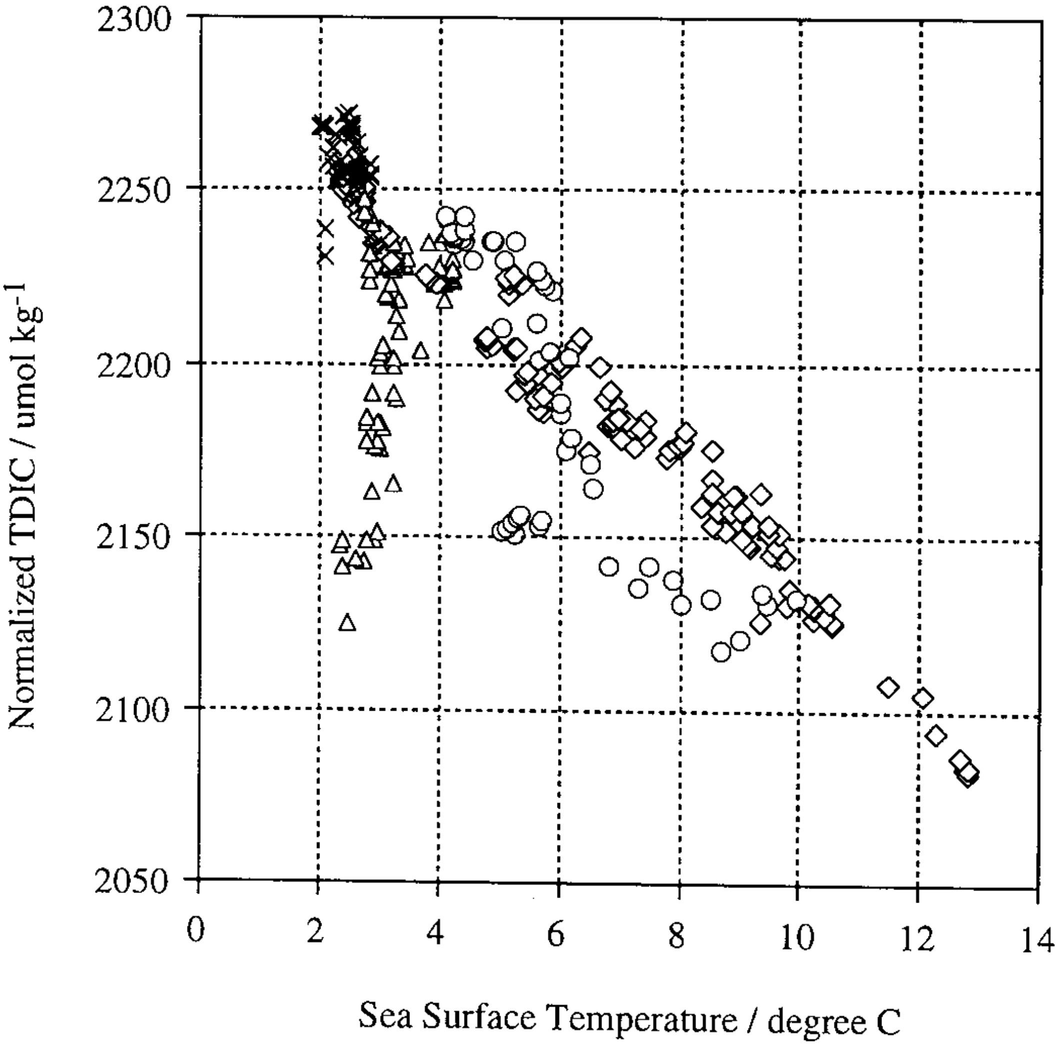

Figure 3.4.2.2.1: Relation between normalized TDIC (NTDIC, S=35 per mil) and sea surface temperature during the MR99-K02 cruise. Circles, crosses, and diamonds show data observed from Mutsu City to St. KNOT, from St. KNOT to St. 50N, and from St. 50N to St. KNOT, respectively. Triangles show data observed during the survey cruises around St. KNOT (see Cruise Summary).

3.4.3 Total Alkalinity

Akihiko Murata (JAMSTEC)
Fuyuki Shibata and Mikio Kitada (MWJ)

Samples were drawn from 12 L drawn from 12 L NiskinTM bottles into 250 ml polyethylene bottles. Bottles were rinsed twice and filled from the bottom, overflowing a volume while taking care not to entrain any bubbles. The bottles were then sealed by a screw cap with an inner cap and stored at room temperature for maximum of 24 hours prior to analysis.

The total alkalinity titration system consists of a titrator (Radiometer, TitraLabTM, TIM900) and an autoburette (Radiometer, ABU901). The titration was made by adding HCl (0.1N) to seawater past the carbonic acid point. Glass (Radiometer, REF201) and reference (Radiometer REF201) electrodes were used to measure emf. The repeatability of measured total alkalinity was 0.15 % on average. All the values reported are set to the Dickson's CRM.

3.4.4 Carbon isotopes

Yuichiro Kumamoto, Makio Honda (JAMSTEC)
Kazuhiro Hayashi (MWJ)

In order to study the role of surface water and intermediate water in carbon cycle in the western North pacific, seawater for radio and stable carbon isotopes of TDIC was collected by the hydrocast at the stations KNOT, 50N, and 40N and the underway (continuous) surface seawater sampling. Seawater was collected in a 250 ml glass bottle. Then a head-space of 2 % of the bottle volume was left by removing seawater sample with a plastic pipette. Saturated mercuric chloride (HgCl2) of 0.05 cm^3 was added as preservative. Finally, the bottle was sealed using a greased ground glass and a clip was secured. We collected 240 seawater samples during this cruise. All the samples were stored in a laboratory of JAMSTEC Mutsu Branch in Mutsu City. In the laboratory, TDIC will be extracted as CO2 and converted to graphite for measurements of stable and radio carbon isotopes, respectively.

3.4.5 Study of carbon system at the station KNOT

Takeshi Egashira
(Japan Science and Technology Corporation)

(1) Introduction

A new ocean time series station has been established in the western sub arctic Pacific. This is one of the activities of JGOFS-Japan and JGOFS-NPTT (North Pacific Task Team). This station was named "KNOT" (Kyodo Northwest Pacific Ocean Time series; Kyodo is Japanese word meaning collaborative) and located at 44°N, 155°E. The station KNOT is in the southwestern part of western subarctic gyre and the area is characterized by high biological production in spring/summer and deepening of surface mixed layer in winter season by surface cooling. The purpose of this study is to understand the seasonal variation of carbon system in the area around the KNOT.

(2) Methods

(Sampling)

We collected samples for on measurement of total carbon dioxide (TC) and total alkalinity (TA), carbon dioxide isotope (^{13}CO2), methane (CH4), methane isotope (^{13}CH4), halocarbons and nutrients. Water samples were collected with CTD rosette systems attached with Niskin bottles of 30L capacity. Sample waters were drawn from Niskin samplers into individually numbered, clean bottles.

(Sample storage)

TC and TA samples (250ml) were poisoned with 0.05ml of saturated HgCl2 solution and stored in glass bottles at room temperature. ^{13}CO2 (100ml), CH4(100ml), ^{13}CH4 (30ml or 100ml), and halocarbons (50ml) samples were poisoned with 0.5ml of saturated HgCl2 solution and stored in glass bottles at at are refrigerator (5°C). Nutrients samples (100ml) were stored in polypropylene bottles at a freezer (-20°C).

(3) Future plan

These samples will be analyzed in laboratory on land.

3.4. 6 Dissolved organic carbon

Y. Yamaguchi, Y. Nakaguchi and K. Hiraki
(Department of Chemistry, Faculty of Science and Technology, Kinki University)

(1) Introduction

Dissolved organic matter (DOM) in sea water is one of the largest reservoirs of organic carbon in the global carbon cycle. It is important to understand the process by which the behavior of oceanic DOM could affect atmospheric carbon dioxide concentration. On the other hand, DOM plays an important role in the metal solvilization and scavenging and biogeochemical process in the aquatic environments. So the investigation of DOM is significant, and it has been done in the world. However the origin of DOM is poorly understood because the production, decomposition processes and the most of part of chemical composition has been still unknown. The purpose of this study is to know the seasonal variation of DOM and to estimate the effect by biological activity. Then, dissolved organic carbon (DOC) was measured by high temperature catalytic oxidation (HTCO) method at the Stn. KNOT, Stn. HP (High productivity) and Stn. LP (Low productivity).

(2) Sampling

Sea water samples for determination of DOC were collected from 27 depth at the Stn. KNOT and 14 depth at the Stn. HP and LP with CTD rosette system equipped with 30 litter Niskin bottles. Samples were taken from the cast following gas sampling using the in-line filtration system with pre-combusted Whatman GF/F glass fiber filter. Immediately after collection, the samples were poured into the pre-combusted 5 ml ampouls in the lab. Then, in order to remove the inorganic carbon, the samples were acidified by addition of 50 µl 6 N-HCl and bubbling with high purity nitrogen gas. After these treatments, ampouls in sea water samples were closed up and stored in refrigerator.

(3) Analysis

DOC is assayed by HTCO method using a Shimadzu TOC-5000 analyzer. The frozen samples were thawed below 5°C, quickly. After thawing of frozen samples, small volumes (100µl) were sampled and injected in a quartz combustion tube in an electric furnace at 680℃ and filled with a platinum-aluminum catalyst. Then, organic matter was oxidized to carbon dioxide in combustion tube. Concentration of DOC is measured as carbon dioxide by Non-dispersive Infra-Red (NDIR) analyser.

3.4.7 Water sampling for analysis of long-chain unsaturated alkenones

Naomi Harada (JAMSTEC)

(1) Objectives

Long-chain unsaturated alkenones contained in sediment have for long, been investigated as a robust proxy of past thermometer (e.g. Chapman et al., 1996). These compounds are notably biosynthesized by a group of haptophyte algae, in particular the coccolithophorid Emiliania huxleyi (E. *huxleyi*). The alkenone thermometer which has been used to calculate sea surface temperature (SST) is based on the unsaturation ratios of the C37 alkenones, primarily UK‘37 index. The UK‘37 index is defined as the ratio of (C37:2) / (C37:2 + C37:3), where C37:2 and C37:3 are methyl ketones with two and three double bonds, respectively.

In order to estimate the past alkenone temperature using sediment core, a calibration equation is necessary. Most precise calibration is an empirical equation introduced by a relationship between UK37 index and SST in the modern field where the sediment core was collected.

In this study, therefore, to obtain a calibration from a relationship between the UK37 index and sea water temperatures at some depths where the alkenone producersnlive in of the northwestern North Pacific, sea water samples (ca. 5 litters each) were collected at three stations (St. KNOT, St. 40°N and St. 50°N) during MR99-K02 cruise. method for trace metal.

(2) Sampling procedure on board

At every station, sea water samples were collected in plastic bottles at six water depths: 10m, 50m, 100m, 150m, 200m and Chl. maximum layer (*ca.* 40m) using a compact CTD rosette system equipped on the right side of MIRAI (Table 3.4.8.1). Niskin bottles were cleaned by a method for trace metal before the observation. Every water sample in the plastic bottle was stored under -20°C in MIRAI.

(3) Analytical procedure on shore

E. *huxleyi* and G. *oceanica* which are alkenone producers, are concentrated on GF/F filter by aspiratory filtration. These GF/F filters are treated by organic solvent extraction, and then every extracted alkenone in the solvent is derivatized. The derivatized alkenone sample is introduced into a gas chromatography equipped with a FID detector and a capillary column. Integrated area (indicated as voltage) of each alkenone compound is used to calculate the UK37 value.

(4) Future analysis

There are only a few investigations which detail the seasonal variation of the relationship between alkenone fluxes and alkenone temperatures using sinking material and the relationship between the alkenone temperatures and the species composition of alkenone producers. The investigation on the seasonal variation of alkenone fluxes and alkenone temperatures in particular, has not been reported for the northwestern North Pacific. Yet, it is recognized that the seasonal variation of the alkenone flux and temperature in the upper layer could provide valuable information for understanding the past change of the alkenone recorded in the deep sediment. In future, therefore, in order to obtain the new knowledge about alkenones in the modern northwestern North Pacific, we would like to present a data set of alkenone fluxes and alkenone temperatures within time series sediment trap samples. In addition, we would like to compare the alkenone temperature range with the distribution of alkenone producers and actual temperature. Investigations concerning these modern alkenone data might contribute to the alkenone to be more robust proxy as a thermometer.

Table 3.4.8.1 Sampling summary of sea water for coccolith

Station	Sampling depth (m)	Volume of sample (litter)
KNOT 1	10	4.85
	40 (Chl max.)	5.0
	50	5.375
	100	5.22
	150	5.315
	200	5.27
KNOT 2	10	5.47
	40 (Chl max.)	5.38
	50	5.33
	100	5.34
	150	5.39
	200	5.34
KNOT 1-3	10	5.305
	40 (Chl max.)	5.28
	50	5.12
	100	5.10
	150	5.36
	200	5.41
40°N	10	5.31
	40 (Chl max.)	5.31
	50	5.27
	100	5.485
	150	5.52
	200	5.5
50°N	10	5.4
	40 (Chl max.)	5.55
	50	5.13
	100	5.22
	150	5.29
	200	5.375

3.5 Particle organic carbon (POC)

Keiri Imai and Takeshi Egashira
(Core Research for Evolutional Science and Technology)

The stock of particle organic carbon (POC) in euphotic layer is related to the consequences of biogeochemical processes. Therefore In this cruise it is very important to estimate vertical distribution of POC. The sample collection and storage is conducted as following.

Water samples were collected with 24L rosette samplers from 13 layers (10, 20, 30, 40, 50, 60, 80, 100, 150, 200, 250, 300 and 500m) at the stations of KNOT1, KNOT2, HP1, HP2, LP1 and LP2. Surface water samples were collected with clean plastic bucket at above each stations.

Particle matter of subsamples was filtered onto precombusted (450°C, 4h) grass fiber filter (Whatman GF/F). A filter after fileration was rinsed with particle free salt water and stored frozen (-20 °C) untile analysis.

3.6 Phytoplankton pigment

3.6.1 Phytoplankton Pigment measurements in the subarctic North Pacific

Kosei Sasaoka
(Faculty of Fisheries, Hokkaido University)

(1) Objectives

Subarctic North Pacific Ocean is one of the highest biological productivity regions in the world. The quantitative assessment of phytoplankton production in this region is very important to estimate global primary production. The recent development of satellite ocean color remote sensing and its application to the observation of the temporal and spatial variability of chlorophyll distribution over broad area with synoptic scales has provided us with a unique tool to study these features. However, there is some problems of in-water algorithms in this region. The solar incoming radiation in the subarctic North Pacific shows large seasonal variability by sky conditions. These radiant environment could effect the photosynthetic characteristics of phytoplankton in the waters. The bio-optical algorithms in the high latitude regions were different from the general algorithms (Mitchell, 1992). Then, the new bio-optical algorithms for the high latitude regions need to be developed as soon as possible. Especially in the winter season, there is a few bio-optical data sets in this region.

Primary objective of this study is to validate and to develop bio-optical algorithm for new series ocean color sensors, such as Sea-viewing Wide Field-of-view Sensor (SeaWiFS) and Global Imager (GLI) in the subarctic North Pacific Ocean. Therefore, we measured *in situ* bio-optical parameters, including upwelled spectral radiance, downwelled spectral irradiance, phytoplankton pigment concentrations (fluorometric method), and particle absorption coefficient. Temporal and spatial valiability of chlorophyll a were examined using SeaWiFS data which has been received on board.

(2) Water samples for chlorophyll a and absorption coefficient

Water samples for chlorophyll a (Chl-a), pheopigment and absorption coefficient determinations were collected using Niskin bottles attached to a rosette on the CTD. Chlorophyll samples were collected at all stations by shallow casts from surface to 200m depth and absorption coefficient samples were gathered at the stations from surface to 50 m depth, which were carried optical measurements (described 3.14).

Chlorophyll samples were collected in 250 ml bottles and filtered through a Whatman GF/F filter on board. Filtering Volume was 200 ml. Filtered samples were extracted in 6 ml of N,N-dimethylformamide, under cold and dark conditions for later analysis. Chl-a and phaeophytin were determined by the fluorometric method (Parsons *et al*., 1984) with a Turner Designs Fluorometer (Model:10-AU). Chl-a obtained by the CTD casts, summarized in Table. 1, and vertical profiles of chl-a concentration are shown

in Fig. 1. We will compare of these chlorophyll data sets and SeaWiFS data sets in future study.
The absorption coefficients samples were collected in 4000 ml bottles and between 1000 and 3000 ml filtered on to a 25 mm Watman GF/F glass-fiber filters under low vacuum pressure (<100 mmHg) on board.

We will measure the absorption coefficients of phytoplankton (aph) and detritus (ad) using the modified glass fiber technique with methanol treatment (Kishino et al., 1985), and then we will calculate a chlorophyll normalized specific absorption spectra, a*ph to divide aph by Chl-a concentration. In future study, we are going to use these chlorophyll a and absorption coefficients for the model parameter to estimate primary production from satellite ocean color data.

Table 1. Chlorophyll a (chl-a) (mg/m^3) obtained by CTD casts.

CTD Cast	Bottle No.	Depth	Chl-a
5/9		0	3.128
TEST	14	10	3.742
Large CTD/RMS	13	20	3.564
(shallow)	12	30	4.198
TESTL	11	40	4.712
	10	50	3.980
	9	75	0.562
	7	100	0.230
	19	125	0.253
	5	150	0.071
	3	200	0.113
5/10		0	0.725
KNOT	22	10	0.759
Large CTD/RMS	21	20	0.571
(shallow)	20	30	0.692
99k2k1L3	18	50	0.367
	16	70	0.154
	13	100	0.045
	12	125	0.036
	11	150	0.020
	9	200	0.024
5/11		0	0.941
KNOT	16	10	0.826
Large CTD/RMS	15	20	0.778
(shallow2)	14	30	0.642
99k2k2L1	12	50	0.329
	10	70	0.123
	7	100	0.066
	6	125	0.046
	5	150	0.020
	3	200	0.031
5/12		0	0.665
KNOTL	16	10	0.642
Large CTD/RMS	15	20	0.859
(shallow2)	14	30	0.980
99k2k3L1	12	50	0.396
	10	70	0.125
	7	100	0.064
	6	125	0.020
	5	150	0.064
	3	200	0.009
5/12	24	10	0.741
KNOTL	22	20	0.655
Large CTD/RMS	20	30	1.032
Radionuclide	18	40	0.754
(JAMSTEC)	16	50	0.359
99k2k3L2	14	60	0.304
	12	80	0.201
	10	100	0.154
	8	150	0.020
	6	200	0.008
	4	250	0.011
	2	300	0.034
5/14		0	9.900
HP1	16	10	13.187
Large CTD/RMS	15	20	3.623
(shallow2)	14	30	1.026
99k2k4L2	12	50	0.281
	10	70	0.234
	7	100	0.111
	6	125	0.037
	5	150	0.039
	3	200	0.019
5/15		0	0.923
LP1	16	10	0.895
Large CTD/RMS	15	20	0.665
(shallow2)	14	30	0.523
99k2k5L2	12	50	1.206
	10	70	1.190
	7	100	0.942
	6	125	0.190
	5	150	0.661
	3	200	0.814
5/16		0	0.566
stO1	10	10	0.499
Large CTD/RMS	9	20	0.530
(shallow)	8	30	0.468
99k2o1L1	6	50	0.333
	5	75	0.222
	4	100	0.105
	3	125	0.293
	2	150	0.027
	1	200	0.016
5/17		0	0.349
50N	24	10	0.367
Large CTD/RMS	22	20	0.341
Radionuclide	20	30	0.406
(JAMSTEC)	18	40	0.382
99k250L1	16	50	0.363
	14	60	0.254
	12	80	0.259
	10	100	0.104
	8	150	0.030
	6	200	0.010
	4	250	0.007
	2	300	0.014
5/19		0	0.677
O2	10	10	0.780
Large CTD/RMS	9	20	0.877
(shallow)	8	30	0.723
99k2o2L1	7	40	0.820
	6	50	0.700
	5	75	0.158
	4	100	0.048
	3	125	0.023
	2	150	0.010
	1	200	0.008

Table 1. (Continued)

CTD Cast	Bottle No.	Depth	Chl-a
5/20		0	0.415
40N	24	10	0.521
Large CTD/RMS	22	20	0.532
Radionuclide	20	30	0.497
(JAMSTEC)	18	40	0.488
99k240L2	16	50	0.499
	14	60	0.398
	12	80	0.164
	10	100	0.062
	8	150	0.014
	6	200	0.009
	4	250	0.006
	2	300	0.009
5/22		0	0.519
O3	10	10	0.715
Large CTD/RMS	9	20	0.842
(shallow)	8	30	0.893
99k2o3L1	7	40	0.976
	6	50	0.958
	5	75	0.187
	4	100	0.082
	3	125	0.050
	2	150	0.030
	1	200	0.019
5/23		0	1.032
KNOT2	22	10	1.103
Large CTD/RMS	21	20	1.170
(shallow1)	20	30	1.063
KN21DL2	19	40	0.640
	18	50	0.322
	16	75	0.177
	13	100	0.054
	12	125	0.036
	11	150	0.021
	9	200	0.016
5/25	24	10	1.073
KNOT2	22	20	1.251
Large CTD/RMS	20	30	1.091
Radionuclide	18	40	1.032
(JAMSTEC)	16	50	0.784
KN23DL1	14	60	0.283
	12	80	0.181
	10	100	0.071
	8	150	0.027
	6	200	0.015
	4	250	0.009
	2	300	0.013
5/27		0	4.000
HP2	24	10	4.099
Large CTD/RMS	22	20	3.663
Radionuclide	20	30	5.188
(JAMSTEC)	18	40	2.237
99K2HPL2	16	50	1.822
	14	60	0.717
	12	80	0.614
	10	100	0.312
	8	150	0.257
	6	200	0.215
	4	250	0.099
	2	300	0.090
5/27		0	1.742
LP2	16	10	1.703
Large CTD/RMS	15	20	1.901
(shallow)	14	30	2.554
99K2LPL2	12	50	0.939
	10	70	0.232
	7	100	0.160
	6	125	0.127
	5	150	0.080
	3	200	0.402
5/27	18	3	3.307
HP2	16	10	3.821
Large CTD/RMS	15	20	3.881
(shallow2)	14	30	4.000
99K2HPL4	13	40	2.732
	12	50	0.980
	11	60	0.548
	9	80	0.640
	7	100	0.583
	6	125	0.443
	5	150	0.236
	3	200	0.213

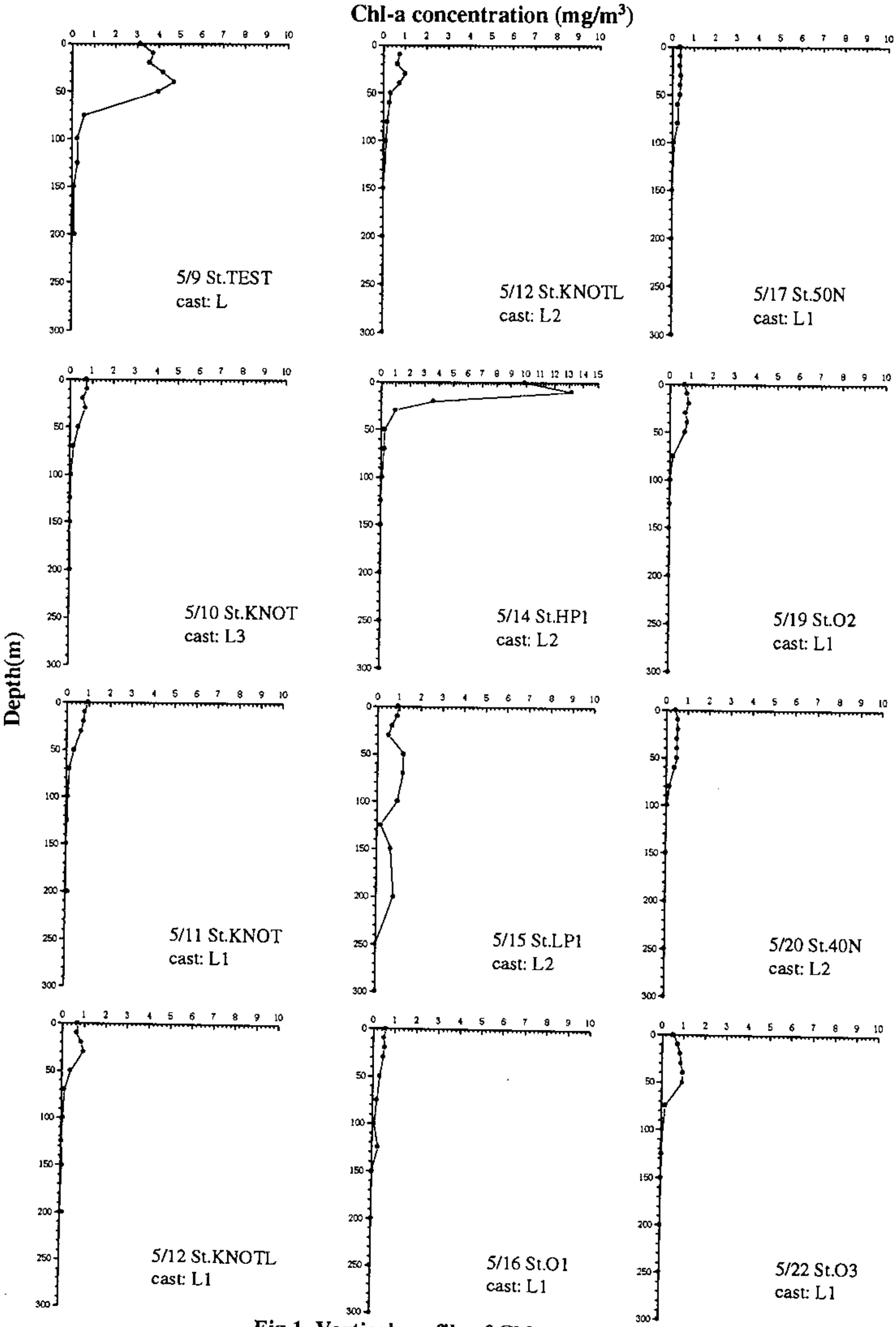

Fig 1. Vertical profile of Chl-a concentration.

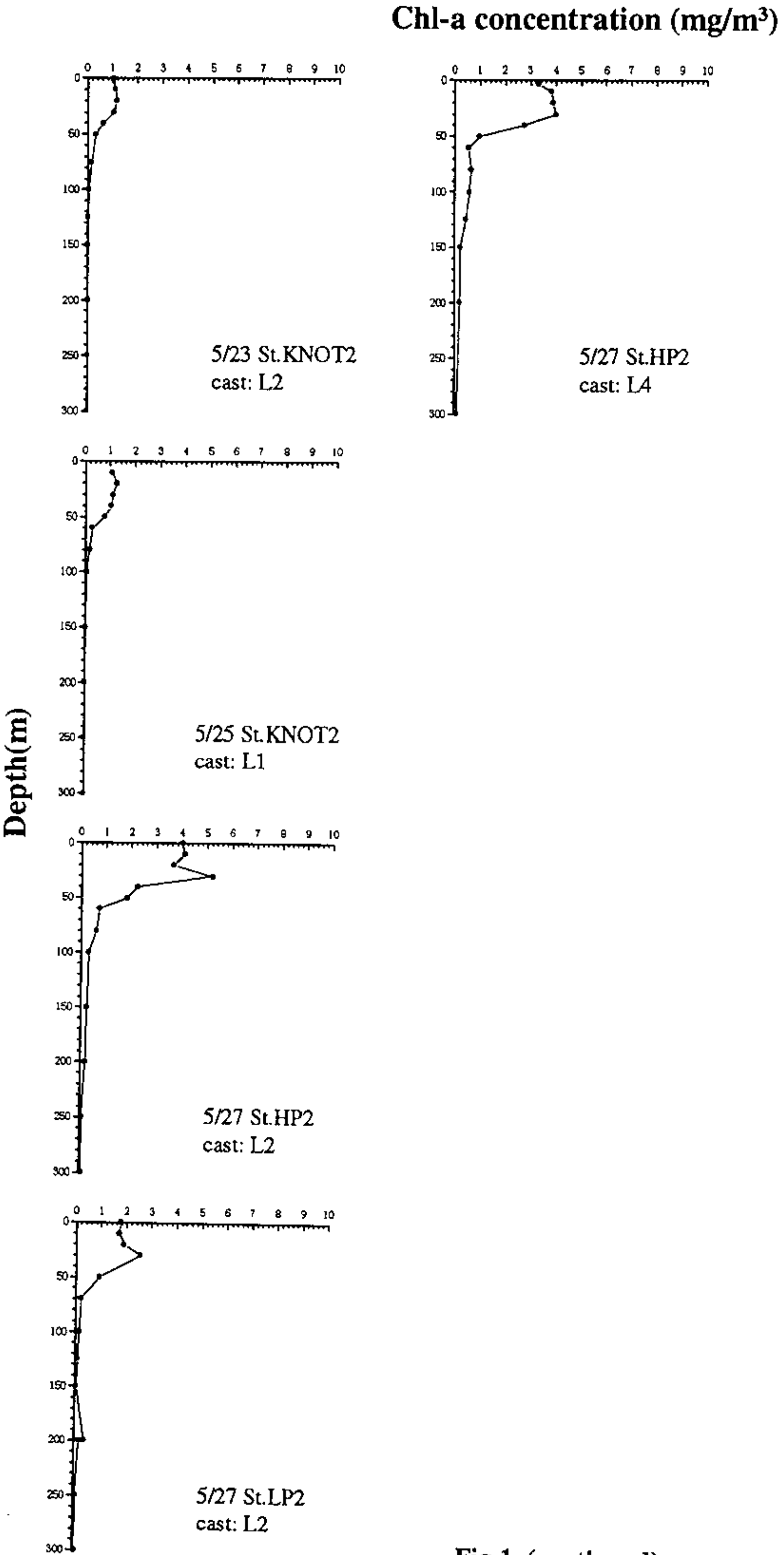

Fig 1. (continued)

3.6.2 Phytoplankton pigments

Keiri Imai and Takeshi Egashira
(Core Research for Evolutional Science and Technology)

Chorophyll *a* and pigments separated by HPLC are measured for comparison with phytoplankton species and number. The seawater subsamples for Phytoplankton pigiments collected from 12 layer(0, 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 200m) by niskin sampler attached to CTD-RMS at same stations as primary production experiments. Chorophyll *a* samples were carried out size fraction with nuclepore filter(pore size 10, 2um) and grass fiber filter (Whatman GF/F). In Grid Survey to curry out spring bloom patch study (HP2), surface seawater were collected with seawater pump of EPCS system. And Chorophyll *a* samples were made with grass fiber filter (Whatman GF/F). These Chorophyll *a* samples will be measured with Turnuer.

3.7 Trace metal

- Behavior of iron in the Northwestern North Pacific Ocean.-

Shigeto Nakabayashi
(Japan Marine Science and Technology Center)

(1) Introduction

Fe is one of the major elements in the earth's crust. However, its concentration in seawater is extremely low. This low concentration is attributed to the fact that solubility of thermodynamically stable Fe(III) is very low. In other wards, Fe in seawater readily hydrolyzes to form insoluble colloidal hydrous ferric oxides, settling down to the bottom. Because of this high reactivity, its residence time in the ocean is one of the shortest, which is on the order of few hundreds years in deep water and several weeks in surface water.

Usually an element with a long residence time does not respond to the sudden change of input or output. However, an element with a short residence time like Fe changes its concentration in the seawater according to the change of input or output, so that it is a very good tracer for short term phenomenon.

Fe is supplied from river and atmosphere to the ocean surface. However, because of its rapid removal from seawater, riverine dissolved Fe is readily removed within estuary, so that influence of riverine input to the open ocean surface may not be recognized. Therefore the airborne dust has been proposed as a major source of dissolved Fe to the open ocean surface. On the other hand, in deep waters other sources of dissolved Fe have been proposed as the partial release of Fe from resuspended sediment particles including colloid, and the diffusion from the pore water in the sediment.

Fe has been also known as an essential micro-nutrient for the phytoplankton growth in the ocean. Due to its extremely low solubility, however, the concentration becomes so low that phytoplankton growth is subdued where its supply is limited. Thus, the fate of Fe in seawater is closely related to the biological activity. It is very important to know the behavior of Fe in the ocean for the study of the global biogeochemical cycles of carbon and its related elements.

The Northwestern North Pacific Ocean is characterized by upwelling of deep water, high nutrients, high primary production and complicated water mass structure (i.e. intermediate water), among others. And also large aeolian input of terrigeneous material to the area is expected. Generally, in the North Pacific the dominant source of the terrigeneous material is Asian dust. Because they can supply Fe over the surface water, they have significant impact on the phytoplankton growth. In addition, seasonal and geographical changes of these features are drastic. This complexity has prevented us from knowing exactly to what extent it plays a role in the global material cycles, which is a main goal of this project. One of the objectives of this study is to clarify the role of Fe in the phytoplankton growth in the Northwestern North Pacific. The other objective is to evaluate the transport and transformation processes of terrigeneous material and intermediate water in these regions using Fe as a tracer.

(2)Methods

Water samples were collected vertically at 11 stations using acid-cleaned new type 12 l Niskin-X sampling bottles (General Oceanics) attached to CTD-RMS. As mentioned above, Fe in the seawater is extremely low, so we have to take special care before, while and after taking water samples. Sampling bottles with internal closing mechanism may also be prone to contamination, however this new type sampling bottle has its stainless steel spring closures mounted externally. This method of mounting the springs is ideal for applications such as trace metal analysis where the inside of the sampling bottle must be totally free of contaminants. In addition, inside the sampling bottles were coated with Teflon to avoid contamination. Teflon stopped cock, Teflon air vent screw cock and biton o-ring were also used for the bottles. Moreover the steel hydrowire was sheathed in plastic heat-shrink tubing for 10 m above the rosette as an effort to minimize contamination from the hydrowire. CTD parameters were measured on the down and up casts, and water samples taken on the up cast. Surface seawater samples were collected in acid-cleaned low density polyethylene bottles directly hanging on a nylon rope. Sampling stations are listed in Table 1.

Sample bottles were of acid-cleaned low density polyethylene and were handled and stored in polyethylene bags. Water samples for total Fe (100 ml) were kept in a freezer (-20 C) immediately after sampling.

Samples for dissolved Fe(III) were filtered in-line using a peristaltic pump system through the acid-washed 25 mm diameter, 0.2 µm Nuclepore polycarbonate filters held in Teflon filter sandwiches. The filtrates (100 ml) were adjusted to pH 3.2 with formic acid-ammonium format buffer solution and then were kept in a refrigerator (4 C) until the measurements. This peristaltic pump system comprised a Masterflex L/S multi-pump head peristaltic pump (Cole-Palmer model PA-41B) with a Masterflex L/S Standard pump head (Cole-Palmer model 07016-21) containing a short length of PharMed tubing (Norton size 1.59 mm i.d., 3.18 mm o.d.) connected to a Teflon tubing (PFA size 1.59 mm i.d., 3.18 mm o.d.) and Teflon filter sandwiches (SAVILEX 2-25-2T).

Samples for colloidal Fe(III) (100 ml) were adjusted to pH 3.2 with same buffer solution without filtration and were kept in a refrigerator (4 C). Samples for calibration (only 0 and 10 m, 250 ml) and other dissolved trace metals (250 ml) were also filtered using same procedure and were kept in a freezer (-20 C). All procedures were done in a class 100 laminar flow cabinet to avoid contamination. Treatment of samples are listed in Table 2.

(3)Future plane

Fe(III) will be measured by automated analytical method using a combination of selective column extraction and luminol-hydrogen peroxide chemiluminescence detection method. It will be clarify the behavior of iron in the Northwestern North Pacific during this cruise. Fe has been known as an essential micro-nutrient for the phytoplankton growth in the ocean. Due to its extremely low solubility, however, the concentration becomes so low that plankton growth is subdued where its supply is limited. Thus, the fate of Fe in seawater is closely related to the biological activity. It is very important to know the behavior of Fe in the ocean for the study of the global biogeochemical cycles of carbon and its related elements. One of the objectives of this study is to clarify the role of Fe in the phytoplankton growth in this region during a spring bloom, especially.

Table 3.7.1. Sampling locations for Fe study.

Date	Station	Depth, m
5/10	KNOT 1-1	0, 10, 25, 40, 50, 75, 100, 125, 150, 175, 200, 300, 400, 500, 600, 700, 800, 1000, 1250, 1500, 1750, 2000, 2500, 3000, 3500
5/11	KNOT 1-2	0, 10, 20, 30, 40, 50, 75, 100, 125, 150,175, 200, 250
5/12	KNOT L	0, 10, 20, 30, 40, 50, 75, 100, 125, 150,175, 200, 250
5/14	HP 1	0, 10, 20, 30, 40, 50, 75, 100, 125, 150,175, 200, 250
5/15	LP 1	0, 10, 20, 30, 40, 50, 75, 100, 125, 150,175, 200, 250
5/17	St. 50 N	0, 10, 20, 30, 40, 50, 75, 100, 125, 150, 175, 200, 250, 300, 400, 500, 600, 800, 1000, 1250, 1500, 2000, 2500, 3000, 3500
5/20	St. 40 N	0, 10, 20, 30, 40, 50, 75, 100, 125, 150, 175, 200, 250, 300, 400, 500, 600, 800, 1000, 1250, 1500, 2000, 2500, 3000, 3500
5/23	KNOT 2-1	0, 10, 20, 30, 40, 50, 75, 100, 125, 150, 175, 200, 250, 300, 400, 500, 600, 800, 1000, 1250, 1500, 2000, 2500, 3000, 3500
5/27	HP 2-1	0, 10, 20, 30, 40, 50, 75, 100, 125, 150,175, 200, 250
5/27	LP 2	0, 10, 20, 30, 40, 50, 75, 100, 125, 150,175, 200, 250
5/28	HP 2-2	0, 10, 20, 30, 40, 50, 75, 100, 125, 150,175, 200, 250

Table 3.7.2. Treatment of samples.

Volume	Measurement	Treatment
100 ml	Dissolved Fe(III)	filtration (0.2 µm) and pH adjustment (pH 3.2), refrigerated (4 C)
100 ml	Colloidal Fe(III)	no filtration and pH adjustment (pH 3.2), refrigerated (4 C)
100 ml	Total Fe(III)	no treatment, frozen (-20 C)
250 ml	Calibration	filtration (0.2 µm) (only 0 and 10 m), frozen (-20 C)
250 ml	Other metals	filtration (0.2 µm), frozen (-20 C)

3.8 Gas

3.8.1 Halocarbon

Shinya Hashimoto and Tsutomu Mikami
(Tokyo university of fisheries)

(1) Introduction

The measurement of halocarbons in seawater sample was carried out in the North Pacific Ocean, an area that exhibits relatively high plant productivity in the water column. The research was carried out during the cruise conducted on board the research vessel Mirai during May, 1999. The sampling sites were 12 stations. The maximum depths of sampling stations were from 5000 m at Stn. 40N and 50N. Water samples were collected from several depths at each station with a CTD-rosette sampler fitted with 24 Niskin sample bottles of 30 l volume (General Oceanics).

(2) Methods

The water sample was collected in 40 ml brown colored glass bottle (I-CHEM Certified 200, Nalge Company) for the measurement of halocarbon. After overflow of more than 100 ml of water, 0.5 ml of HgCl2 was added to inhibit microbial activity, and the sample bottle was immediately sealed with a septa (PTFE/silicone) with care to exclude air bubbles, and stored in the box (in the dark) and kept at 4 C in refrigerator. Samples containing air bubbles were discarded. The final concentration of HgCl2 in sample bottles was about 350 mg/l.

(3) Preliminary results

Distribution of halocarbon concentrations in the North Pacific Ocean was examined to evaluate this oceanic area, with relatively high plant productivity in the water column, as a natural halocarbon source in this season. Relatively high concentrations of halocarbons in surface water were detected in the area of low concentration of pCO2. Both distributions of halocarbons and correlations among halocarbons showed that there was some sources of halocarbons in seawater in this area.

3.8.2 Measurement of halogenated volatile organic confounds

Sachiko Nomura, Masahiro Narukawa and Kimitaka Kawamura
(Institute of low temperature science, Hokkaido University)

(1) Introduction

The ocean is the main reservoir of chlorine, bromine, and iodine on the earth. Various types of macroalgae and phytoplankton are capable of producing halogenated hydrocarbons. Halocarbons formed in the algal cells are transferred to the seawater across the cell walls.

Volatile halocarbons are emitted from the ocean to the atmosphere, and where they are photodissociated to result in the release of halogen atoms. Because the halogen atoms are highly reactive, they have an influence on the oxidation of many organic and inorganic species in the troposphere. Therefore, measurements of the halocarbons in the ocean and atmosphere should provide information on atmospheric chemistry.

In order to understand the global distribution of these halocarbons, more observations are needed in more locations. In this investigation, we measured the natural halocarbons both the seawater and air samples in the western North Pacific.

(2) Sampling and Methods

Seawater samples (50ml, 100ml) were collected at 7 stations (St. T, St. KNOT, St. O1, St. 50N, St. O2, St. 40N and St. O3) during a cruise of MR99-K02 in the western North Pacific. The samples were transported to the lab in Sapporo. Halocarbons will be measured using a purge and trap system with a gas chromatograph/mass spectrometer (GC/MS). The water samples are purged by nitrogen and concentrated with the carbon trap. The concentrated gases are transferred to GC/MS.

(3) Future Plan

Seawater sample will be analyzed for halocarbons by purge and trap system with GC/MS. Using large volume of seawater, we will detect polyhalocarbons, which is organic carbon with many halogen atoms. Using a chlorophyll-a data, we will discuss in the detail on the production of halocarbons during the spring bloom.

3.9 Water collection for TFA

Nobuyoshi Yamashita (National Institute for Resources and Environment)
Kurunthachalam Kannan (Michigan State University)

(1) Introduction

The initial concern over TFA was the possible atmospheric conversion of freon replacements (HFCs). They were expected to increase to 200 ng/L in precipitation by 2010. For some samples which have already have exceeded that level. Preliminary results show (5-day back trajectories) that air masses passing over industrial areas contain high concentrations of the HAAs, including TFA. As TFA was in archived cloud water samples which analyzed, freon replacements are not the sole source of this compound. It may be guess the major question is how fast is this material accumulating in the environment and to what final levels?

It is very interesting in obtaining Pacific Ocean samples and compare them to previous results. Previously we had analyzed samples from profiles collected from the Canada Basin, Eastern Arctic and the Atlantic Ocean. In general, these samples contained TFA at concentrations greater than 120 ng/L. Below 900 m in the Canada Basin the water is believed to be greater than 300 years old. This implies that the TFA is present not as a result of man's latest activities, such derived from freon replacements. In fresh water systems, adjacent to little or no industrial activity, the concentrations of TFA is less than 10 ng/L. This finding implies that the TFA found in the oceans is naturally occurring or resulting from some human activity from long ago.

(2) Methods

Sample were taken at pre-determined depths with Go-Flo sampler. Sample volume is about 2 liter.

Blanks: 6L of ultraclean water. Sample bottles were rinsed 1 x with about 50 ml of blank water.
Samples were to be stored at 4°C or equivalent (frozen is better) refrigerator temperature HSSs are relatively stable at low temps in water.

(3) Sample list

May 10, 1999 Stn. KNOT
duplicate collection
depth (m), 3, Chl-a max, 10, 20, 30, 40, 50, 75, 100, 125, 150, 175

May 22, 1999 Stn. O3
duplicate collection
depth (m), 3, Chl-a max, 10, 20, 30, 40, 50, 75, 100, 125, 150, 200

(4) Future plan

Same kind of water collection are planned in the KH99-3 (Hakuho maru) and other research cruise with full support in future.

3.10 Radionuclides

3.10.1 ^{234}Th by JAMSTEC

Hazime Kawakami (JAMSTEC)

(1) Purpose of the study

Particle-reactive radionuclide (^{234}Th) and their relationship with POC and PON in the northwestern North Pacific Ocean.

(2) Sampling

Seawater sampling for ^{234}Th : 5 stations (Stn. KNOTL, 50N, 40N, KNOT2, HP2). 12 depths (10m, 20m, 30m, 40m, 50m, 60m, 75m, 100m, 150m, 200m, 250m, 300m) at each station and 20 liters for each depth.

Seawater samples were filtered with 47mm GF/F filter on board immediately after water sampling.

(3) Chemical analyses

Separations of U and Th were used by anion exchange method on board; Dissolved and particulate samples of Stn. KNOTL, 50N, 40N and KNOT2. The rest of samples were separated from U in land-based laboratory.

Separated samples of Th were absorbed on 25mm stainless steel disks electrically, and were measured by β-ray counter.

(4) Preliminary result

The distributions of dissolved and particulate ^{234}Th will be determined as soon as possible after this cruise. This work will help further understanding of particle dynamics in the water column.

3.10. 2 Time-series observation of ^{234}Th, ^{210}Po and ^{210}Pb at KNOT station

Koh Harada (National Institute for Resources and Environment)
Yoko Shibamoto (National Institute for Resources and Environment)
Hisashi Narita (Graduate School of Hokkaido University)
Masashi Kusakabe (Japan Marine Science and Technology Center)

(1) Introduction

Since export flux from surface layer to deeper layer is strongly related with biological production in the surface layer, it is predicted to have a large seasonal variation. To understand seasonal change of export flux from the surface layer, the time-series observations of particulate flux by drifting sediment traps and short lived natural radio nuclides have been conducted from June 1998. The flux observed by the drifting sediment traps should be corrected because of non-quantitative collecting efficiency due to shape of the trap and complicated hydrodynamics in the surface water. The short lived radio nuclides are good tracers for particulate materials. Therefore the vertical profiles of the nuclides are planned to use for correction of the export flux by the drifting traps as well as independent estimation of the flux from the nuclides profiles.

In this cruise, a water mass with low pCO2 and high chlorophyll was discovered. To clarify the deference between the water mass and one with almost same water temperature but high pCO2 and low chlorophyll, samples from Stn. HPs and LPs were also analyzed.

(2) Methods

About 20-l each of seawater samples were collected at 6 stations from several layers as follows:

Stn. KNOT-1 0, 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 200, 300 m
Stn. HP1 0, 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 200, 300, 500 m
Stn. LP1 0, 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 200, 300, 500 m
Stn. KNOT-2 0, 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 200, 300, 500 m
Stn. HP1 0, 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 200, 300 m
Stn. HP2 0, 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 200, 300 m

Immediately after the sampling, the seawater samples were filtered through GF/F filters, acidified and spiked. After standing for 3 to 6 hours, the samples were neutralized by adding ammonia water and hydroxide precipitates were formed. The precipitates were collected on cartridge filters. After some purification and separation treatments using ion exchange and extraction techniques, Po was plated onto a silver disc, Th was collected in scintillation solution and Pb fraction was kept in a plastic bottle. Radio-activities in each fraction are going to be counted in a land laboratory in NIRE.

3.11 Primary production

Keiri Imai and Takeshi Egashira
(Core Research for Evolutional Science and Technology)

In western region of North Pacific Ocean time series survey was started since June 1998. In this region it is very important to estimate primary production by phytoplankton in spring. Therefore the mission of this cruise is to measure primary production of spring bloom by phytoplankton.

In this cruise, using ^{13}C as a tracer for inorganic ^{13}C uptake by phytoplankton photosynthesis, incubation experiments carried out in two types procedures(in-site and –vivo). Water samples were collected with lever action niskin bottles attached Kevler wire from the 6 layers corresponding to 100, 34, 17, 8.5, 4, 0.9% of surface irradiance and drained into 250ml polycarbonate bottles. After addition of ^{13}C-NaHCO3 those bottles were incubated for 24h. And particle matter was filtered onto precombusted (450°C, 4h) grass fiber filter (Whatman GF/F) after incubation. Primary production will be calculated with concentration and ^{13}C atom % of particle organic carbon (POC) determined by tracer. Incubation data and station and sampling depth are as follows.

Table 3.11.1 Incubation data and station and sampling depth

Date	Station	Sampling Depth (m)
12-13 May	KNOT1	0, 5, 10, 20, 30, 50
14-15 May	HP1	0, 1, 3, 5, 6, 10
15-16 May	LP1	0, 9, 18, 28, 37, 60
17-18 May	50N	0, 5, 10, 20, 50
20-21 May	40N	0, 8, 16, 25, 58
23-24 May	KNOT2	0, 5, 15, 20, 30, 45
27-28 May	LP2	0, 4, 10, 17, 24, 42
23-24 May	HP2	0, 3, 5, 9, 12, 20

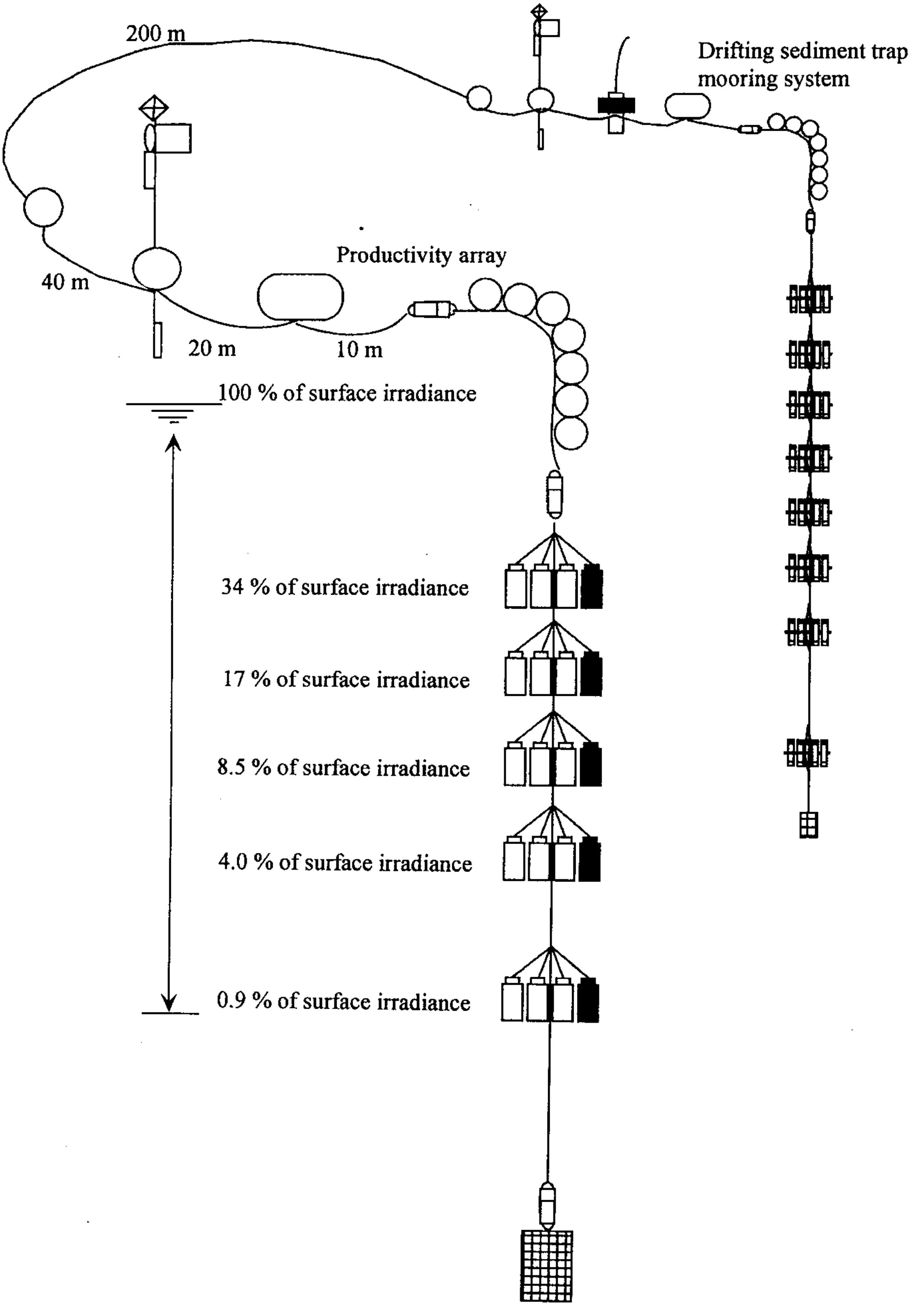

Fig. 3.11.1 Mooring system for *in situ* primary production measurement

3.12 Drifting sediment trap experiment

Makio Honda (Japan Marine Science and Technology Center)
Hisashi Narita (Hokkaido University)
Keiri Imai (National Institute of Environmental Science)
Koh Harada (National Institute of Resource and Environment)
Sediment trap working group

(1) Introduction

As one of tactics to verify the role of oceanic biological pump in the control of global environment, time-series sediment trap experiments have been carried out all over the world ocean. However, time-series sediment traps have been usually deployed in the deep sea (> 1000 m) because of complication of hydrodynamics, swimmer, and vandalism in the shallower water. Therefore these sediment traps have not given us enough information about the mechanism of biological pump in the layer between photic zone and deep sea. In addition, collecting efficiency of moored sediment traps are significantly affected by hydrodynamics. In order to solve these problem, drifting sediment trap experiments have been also conducted to collect settling particles in the shallower depth although experimental period is limited.

For the better understanding of biological pump in spring in the Northwestern North Pacific, we conducted short-termed drifting sediment trap experiment four times at and around stn. KNOT in this cruise.

(2) Methods

1) Instrumentation

Sediment trap array consisted of eight individual transparent policarbonate cylinders with baffle (collection area, *ca*. 0.0038 m^2: aspect ratio, 620 mm length / 75 mm width = 8.27), which were modified from Knauer et *al*. (1979) and were deployed from *ca*. 20 m to 400 m. In order to compare the result and conduct multi purpose study, two mooring systems were used. Figures 3.11.1 (a) and (b) show mooring systems by CREST group and JAMSTEC, respectively. Before deployment, each piece of sediment trap was filled with filtered surface sea water, which salinity was adjusted to *ca*. 39 PSU by addition of NaCl. Thermometer and depth sensor were attached on CREST sediment trap array. These sediment traps were lowered from surface floating package including surface floating buoy, GPS buoy, radar reflector, and flash light.

2) Experiments

Experiments were conducted four times in this cruise (Table 3.11.1). Two mooring systems were deployed and drifted twice at stn. KNOT at the beginning and the late of this cruise. Judging from sea water pCO2, DO, and fluorescence observed with underway monitoring system, the spring bloom has not occurred yet during both period. Other two experiments were conducted in the area where the spring bloom took place around stn. KNOT (stn. HP1, 2 and LP1). During these experiments, one mooring system was deployed in this high productivity area and another one was deployed in the outside of this area where the spring bloom could not be seen.

3) Drifting track

These mooring system drifted during *ca.* 23 ~ 73 hours at and around stn. KNOT (Table 3.11.1). During the experiment, the position of mooring system was monitored on board by GPS tracking system. Fig. 3.11.2 (a), (b), (c), and (d) show tracks of two drifting sediment trap mooring systems during four experiments. As can be seen in figures, two sediment trap mooring systems drifted drawing spiral pattern and changed these directions simaltaneously, which is indicative of that these drifting patterns were controled by the small eddy.

4) Variability in depth and water temperature during experiments

Several depth sensors and thermometers were installed on mooring system.

Fig. 3.11.3 (a), (b), (c), (d) show the variability in depths of depth sensors, which installed at 10 m and 190 m on CREST mooring system for each experiments. Depth of 10 m depth sensor increased from 12 m to 14 m at the beginning of experiment (I), which was attributed to the extension of mooring rope (Fig. 3.11.3 (a)). After this period, depth of depth sensor was stable with small amplitude of 0.3 m ~ 1.0 m, which might synchronized with surface waves. Depth of 190 m depth sensor increased slightly during the experiment. Internal current might raise the mooring system. During experiment (III), depths of 10 m and 190 m depth sensors decreased around 2:00 of 24 May. It was caused by the installation of the primary production mooring system at the top of drifting sediment trap mooring system.

Fig. 3.11.4 (a), (b), (c), and (d) show the change in temperature of each depth during experiments.

Fig. 3.11.4 (a) show that SST during experiment (I) was approximately 7.5 °C, which was warmer than the typical water of sub-Arctic water overlying stn. KNOT in spring. Temperature at 40 m increased around 12:00 of 11 May and 3:00 of 12 May. During this period, the surface mixed layer became thick. It is notable that temperature at 180 m temporally became higher than that at 120 m.

During experiment (II), temperature at 20 m and 40 m decreased significantly between 21:00 on 14 May and 3:00 of 15 May. This time was coincident with the turning point of track of mooring system (Fig. 3.11.2 (b)). Temperature at 40 m was lower than that at 60 m (Fig. 3.11.4 (b)). These data also show that surface water was the sub-Arctic related water and mixed layer was relatively thick during this time. Temperature of 80 m was the lowest during the experiment (II). Although temperature at 180 m was relatively stable, temperature at 120 m was changeable significantly with the minimum at 0:00 of 15 May. This figure shows that the drifting sediment trap mooring system passed through different water mass during experiment. These figures show that, in the high production area (Experiments (II) and (IV)), surface water temperature was approximately 3 °C and sub-surface water temperature (40 m - 110 m) was lower than 1 °C.

4) Sample treatment

After recovery, sediment trap samples were treated according to procedures in Fig. 3.11.5 (a) and (b). Some samples were water sieved through a 1 mm nylon screen to remove "swimmer" such as zooplankton and small fish. Samples less than 1 mm were sequentially filtered with GF/F filter or Nuclepore filter rinsing with small amount high pure water on board, and filter papers with settling particles were frozen in the refrigerator. Remains of sediment trap samples were freezed or stored in the refrigerator with preservative (formaline) for the future analysis.

(3) Future analysis

On board, any results were not obtained before the analysis on samples. These samples will be distributed to participants for the following various analysis.

1. Dry weight
2. Org-C, inorganic carbon, Total-N
3. Carbonate, Opal
4. Stable isotopes
5. Trace elements
6. Radionuclides
7. Microscopic analysis

Table 3.11.1 Drifting sediment trap experiment

Station	Deployment position	Deployment time	Recovery position	Recovery time (period)
Experiment (I)				
KNOT (44N, 155E) (JAMSTEC)	44-00.02N 155-00.06E	99/05/10 13:15	44-12.62N 155-02.15E	99/05/13 14:28 (*ca* . 73 hr.)
KNOT (44N, 155E) (CREST)	43-58.19N 155-03.02E	99/05/11 3:32 (05/12 attached in situ PP bottles)	40-07.55N 154-59.452E	99/05/13 2:07 (*ca* . 22.5 hr.)
Experiment (II)				
HP1 (CREST)	44-39.63N 155-50.26E	99/05/14 13:30	44-37.48N 156-00.03E	99/05/15 13:30 (ca. 24 hr.)
LP1 (JAMSTEC)	44-46.75N 156-01.55E	99/05/14 15:45	44-45.44N 156-04.61E	99/05/15 15:30 (ca. 24 hr.)
Experiment (III)				
KNOT (44N, 155E) (JAMSTEC)	43-59.90N 155-00.44E	99/05/23 8:35	44-59.56N 155-13.78E	99/05/25 08:30 (*ca* . 48 hr.)
KNOT (44N, 155E) (CREST)	43-59.68N 154-59.12E	99/05/23 11:15 (05/24 attached in situ PP bottles)	43-59.98N 155-14.02E	99/05/25 11:20 (*ca* . 48 hr.)
Experiment (IV)				
HP2 (CREST)	44-15.08N 156-12.83E	99/05/27 14:26	44-06.89 156-20.77	99/05/28 13:45 (*ca* . 23 hr)

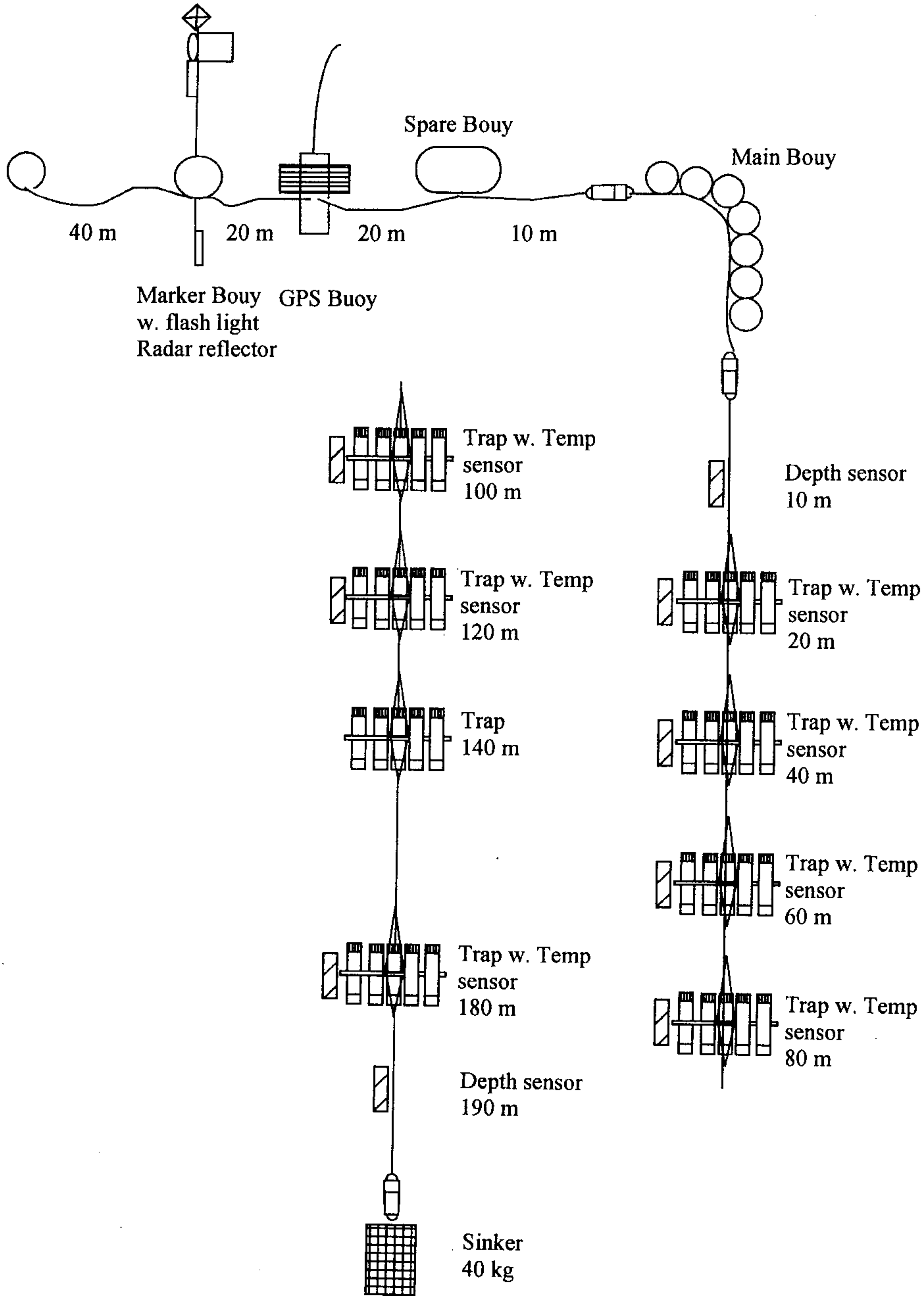

Fig. 3.11.1 (a) Drifting sediment trap mooring system by CREST

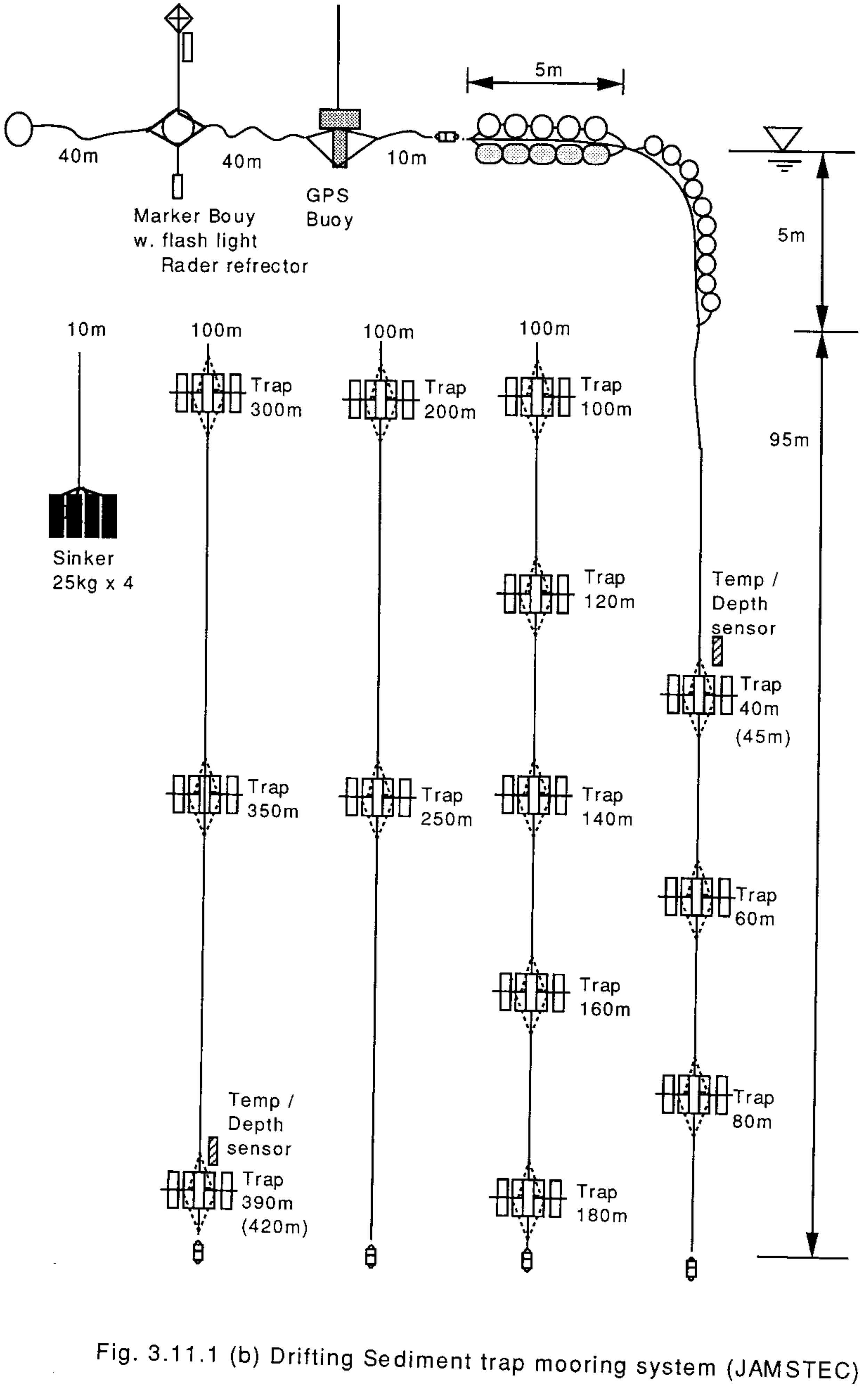

Fig. 3.11.1 (b) Drifting Sediment trap mooring system (JAMSTEC)

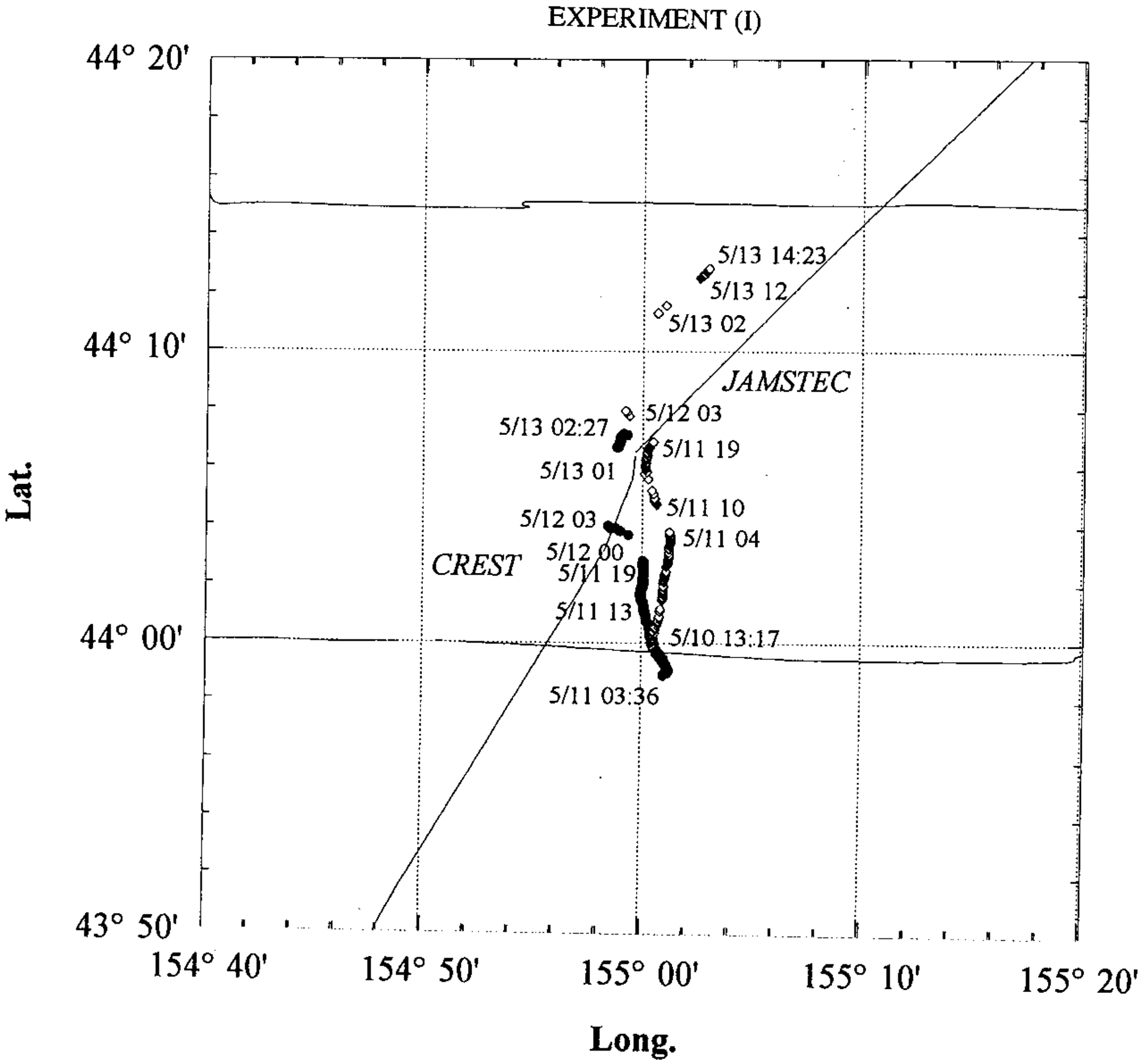

Fig. 3.11.2 (a) Track of drifting sediment trap (CREST) during experiment (I) at stn. KNOT1

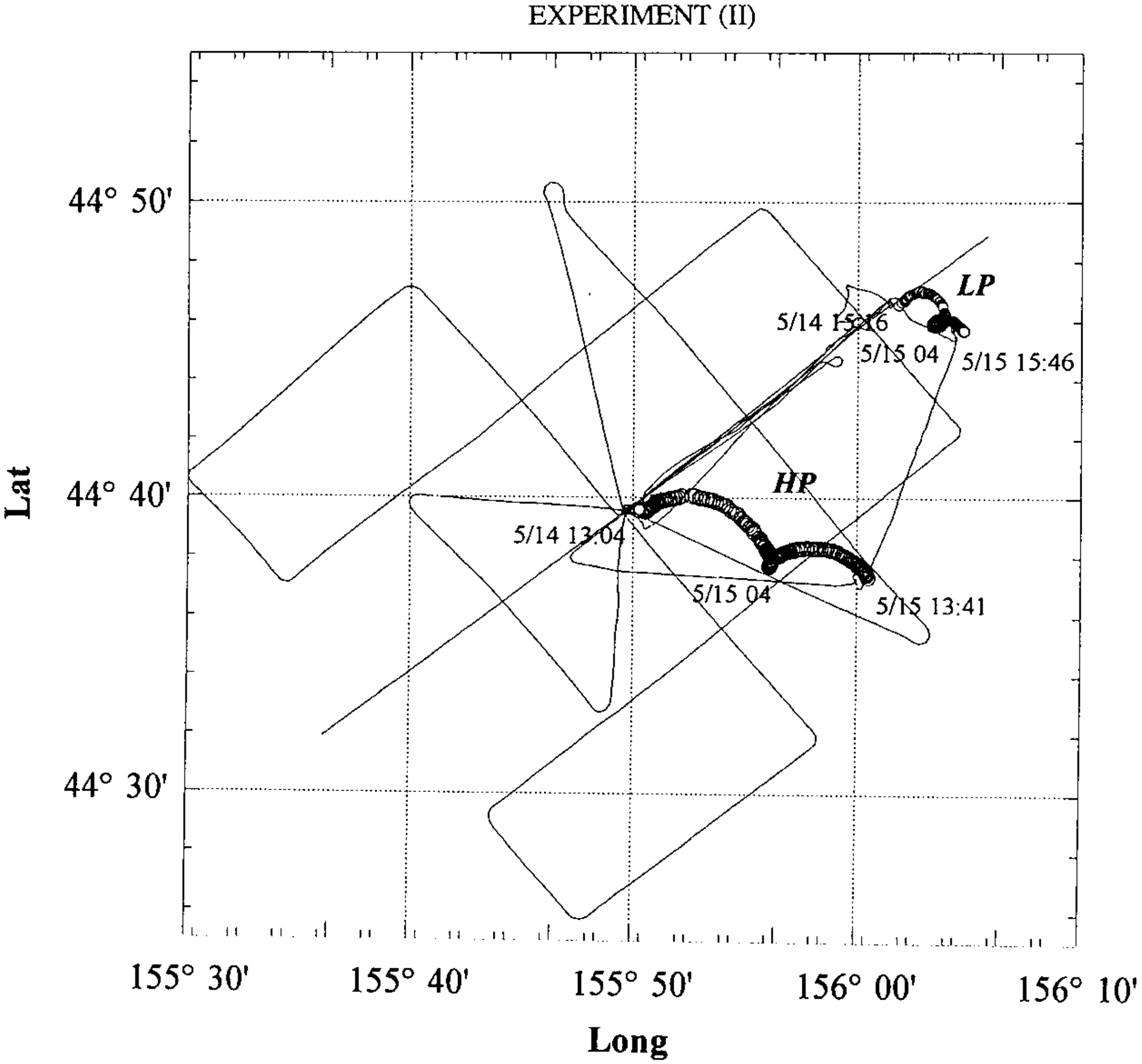

Fig. 3.11.2 (b) Tracks of drifting sediment traps (CREST and JAMSTEC) during experiment (II) at stns. HP1 and LP1

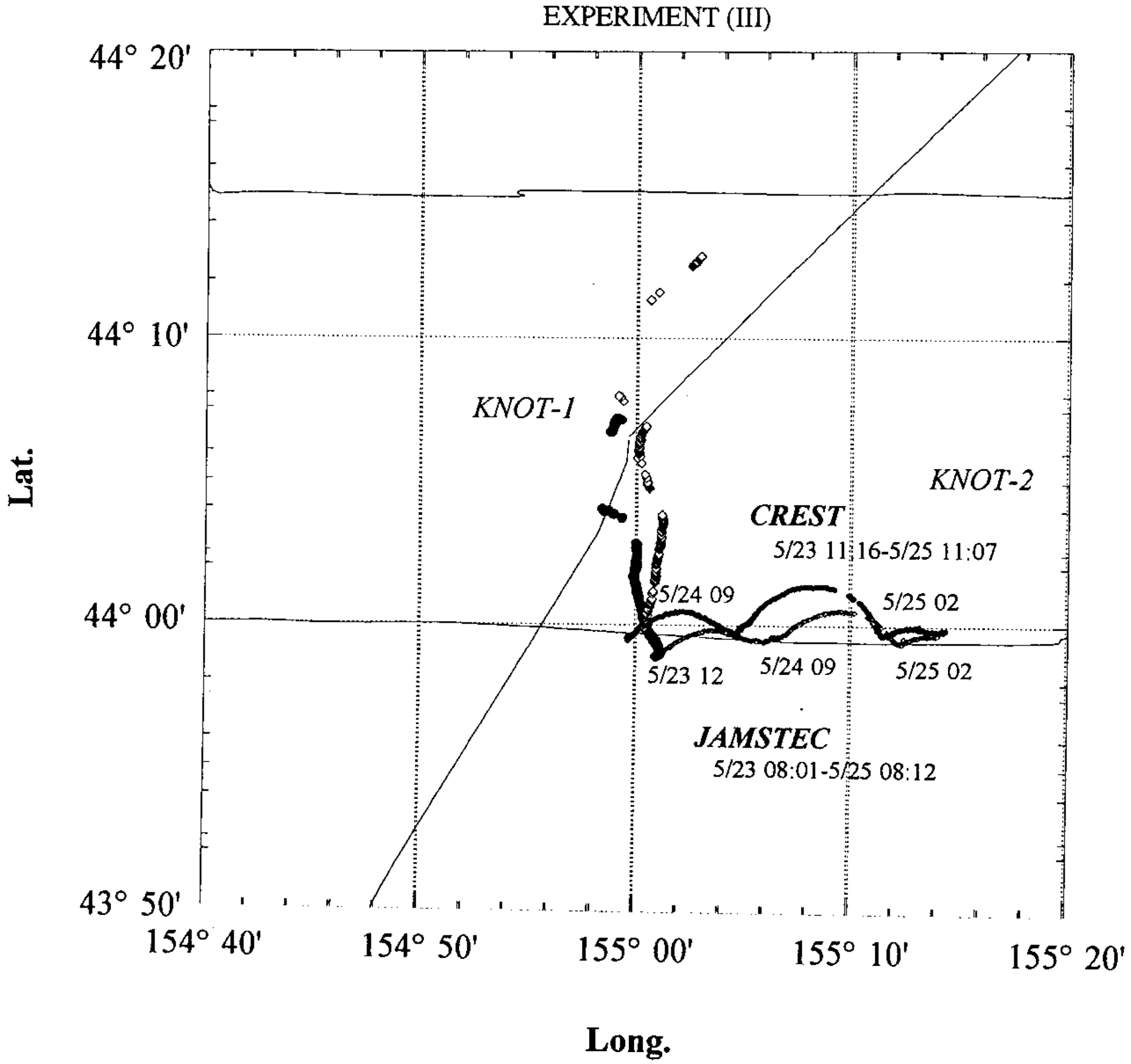

Fig. 3.11.2 (c) Tracks of drifting sediment traps (CREST and JAMSTEC) during experiment (III) at stn. KNOT2

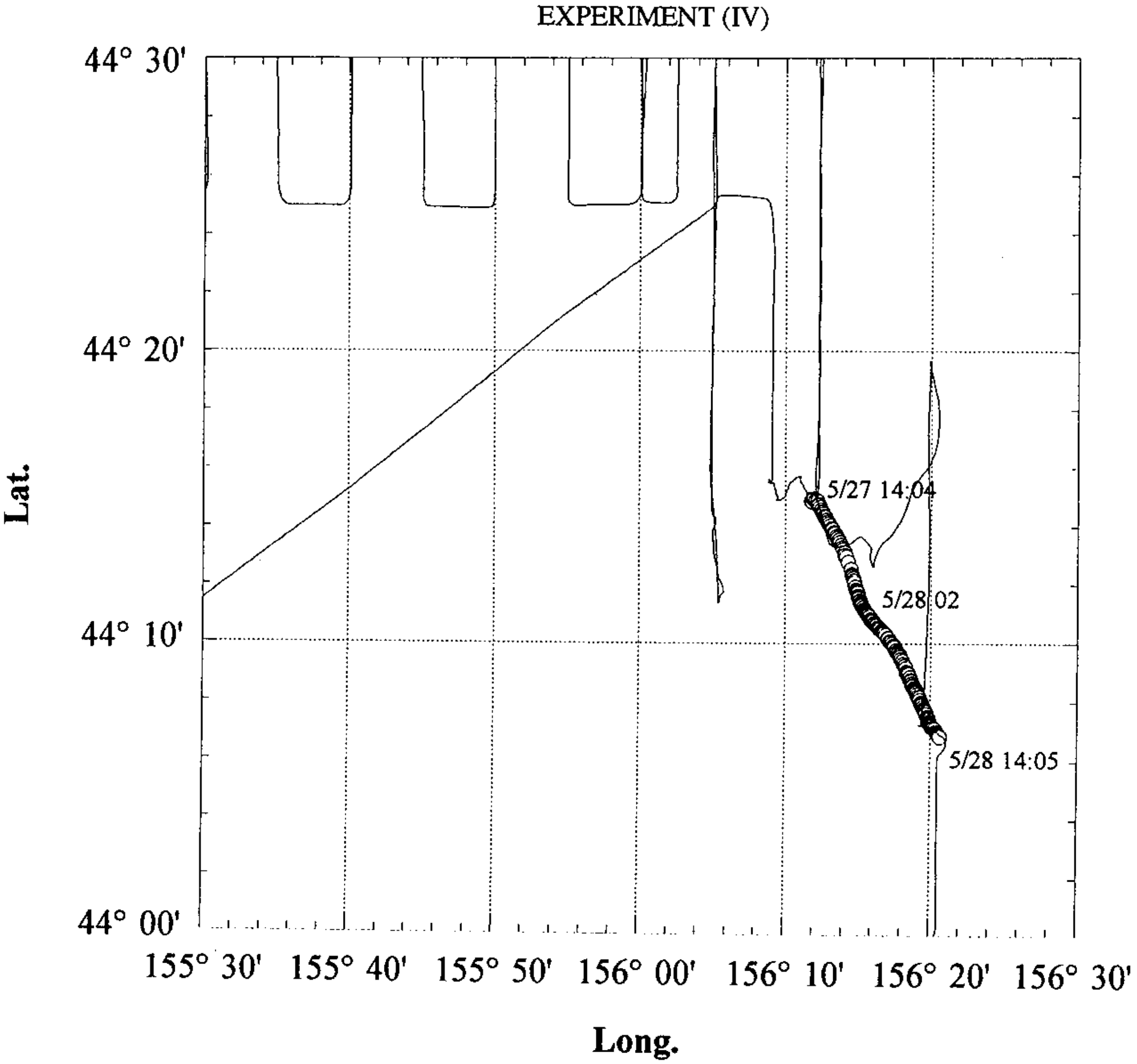

Fig. 3.11.2 (d) Tracks of drifting sediment trap (CREST)
during experiment (IV) at stn. HP2

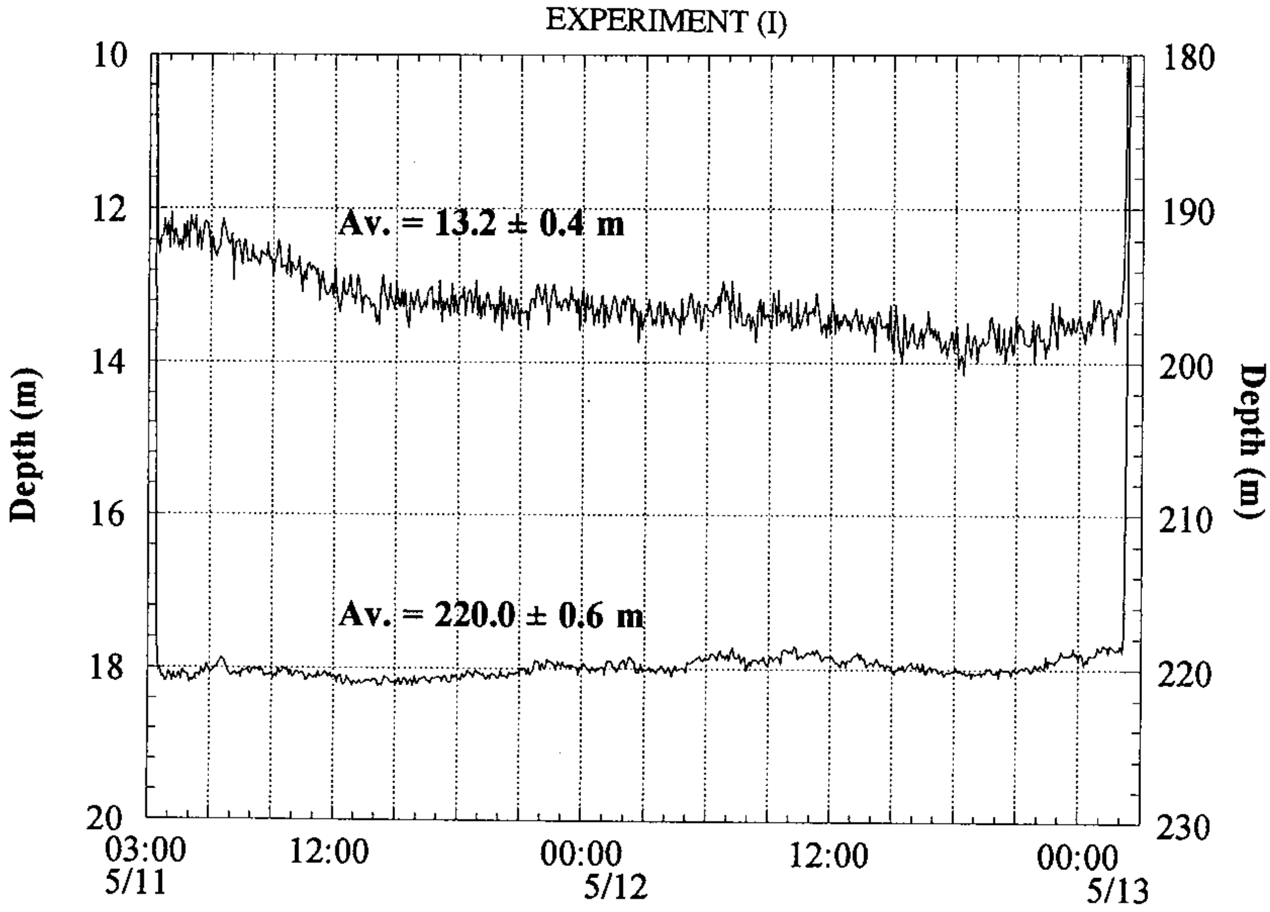

Fig. 3.11.3 (a) Variability in water depth of depth sensors attached on CREST sediment trap array at 10 m and 190 m during experiment (I) at stn. KNOT1

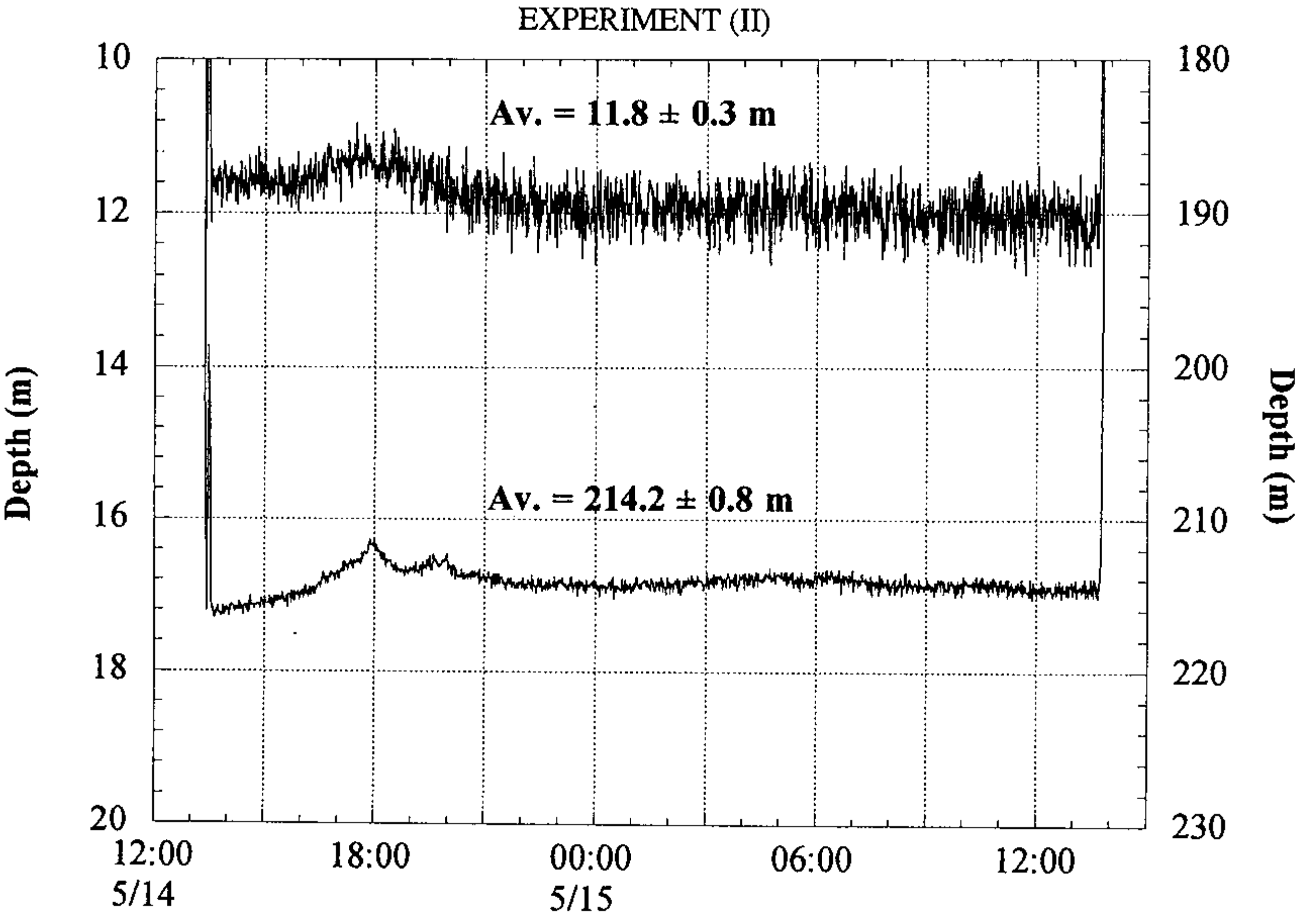

Fig. 3.11.3 (b) Variability in water depth of depth sensors attached on CREST sediment trap array at 10 m and 190 m during experiment (II) at stns. HP1

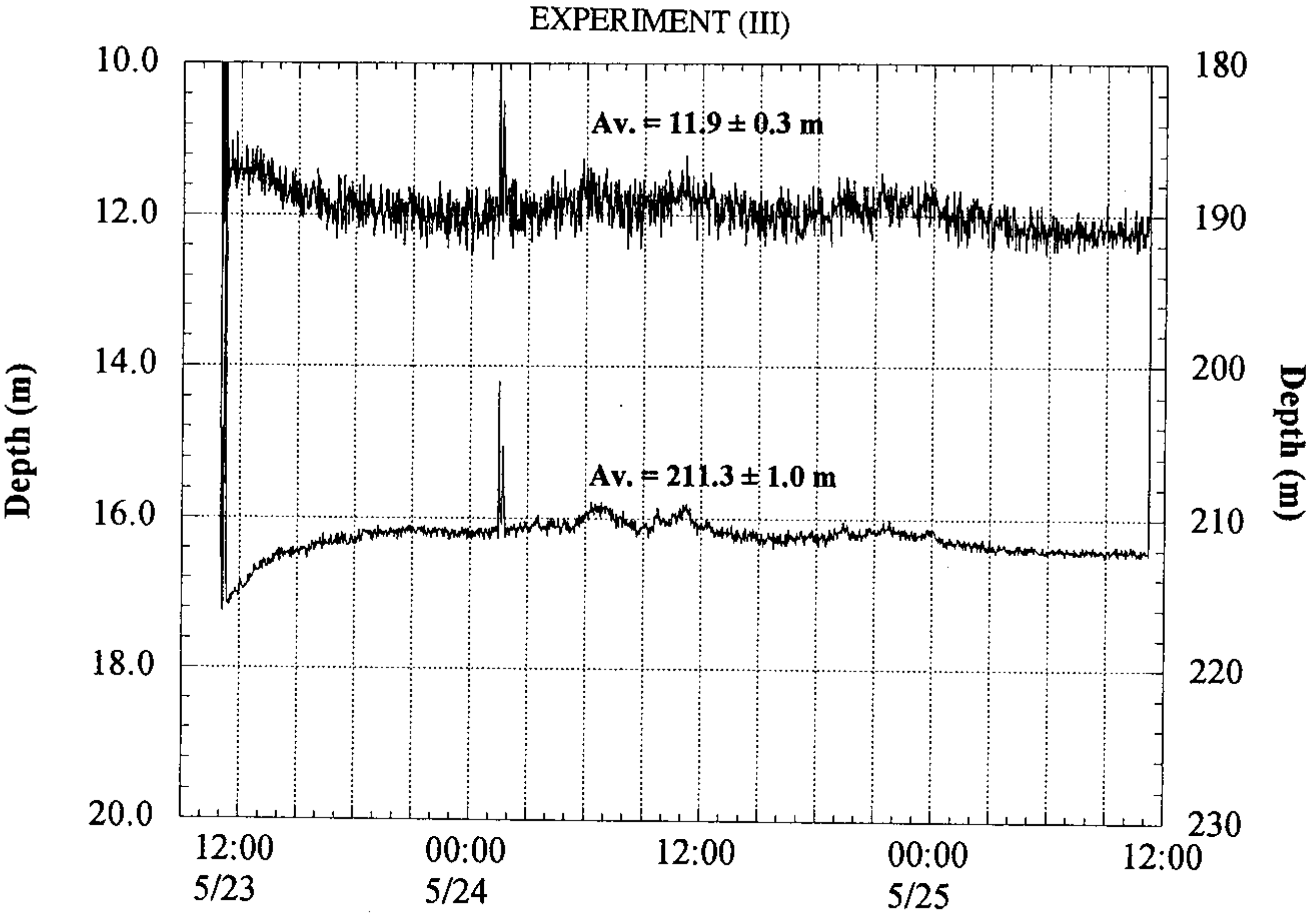

Fig. 3.11.3 (c) Variability in water depth of depth sensors attached on CREST sediment trap array at 10 m and 190 m during experiment (III) at stn. KNOT2

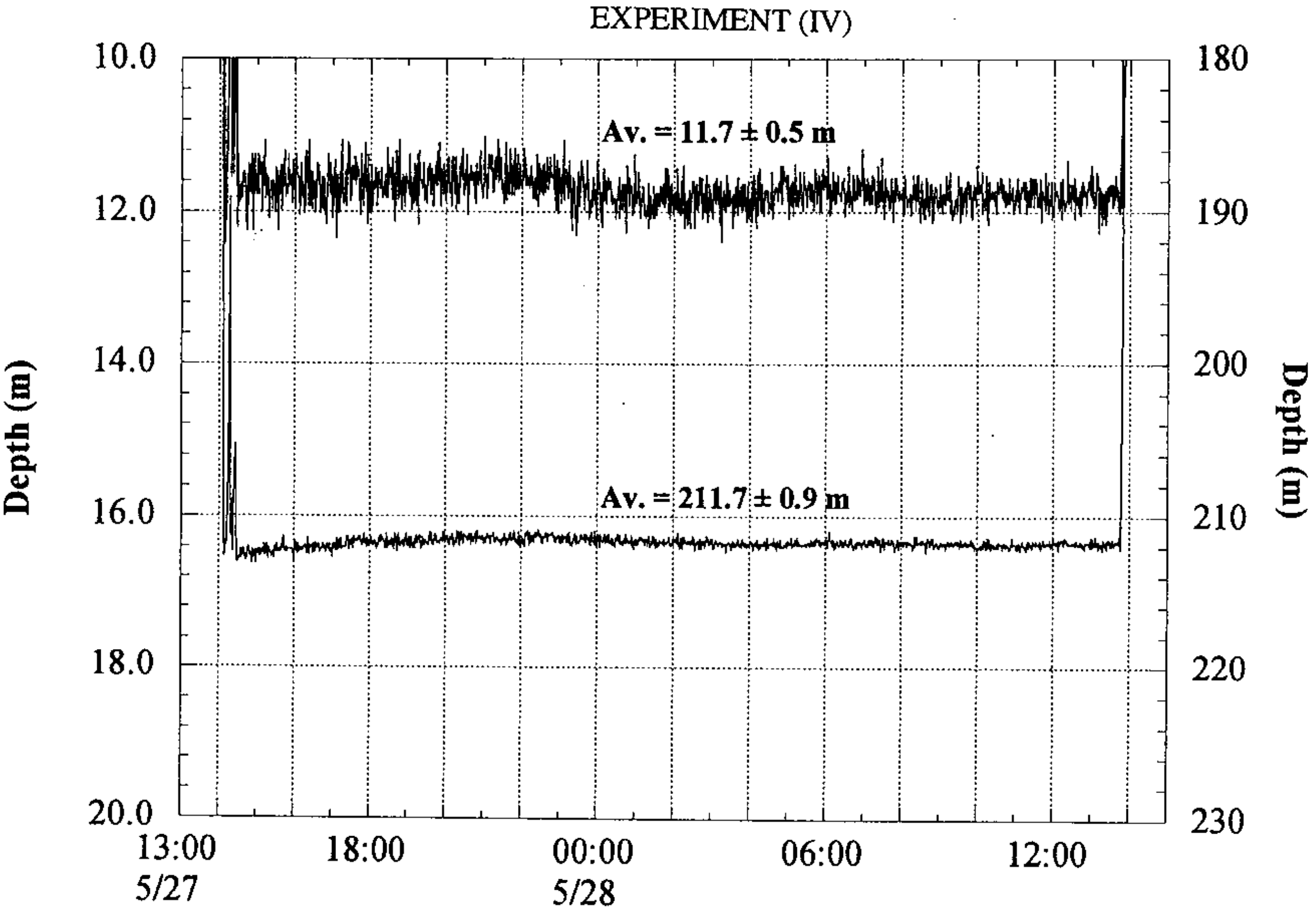

Fig. 3.11.3 (d) Variability in water depth of depth sensors attached on CREST sediment trap depths during experiment (IV) at stn. HP2

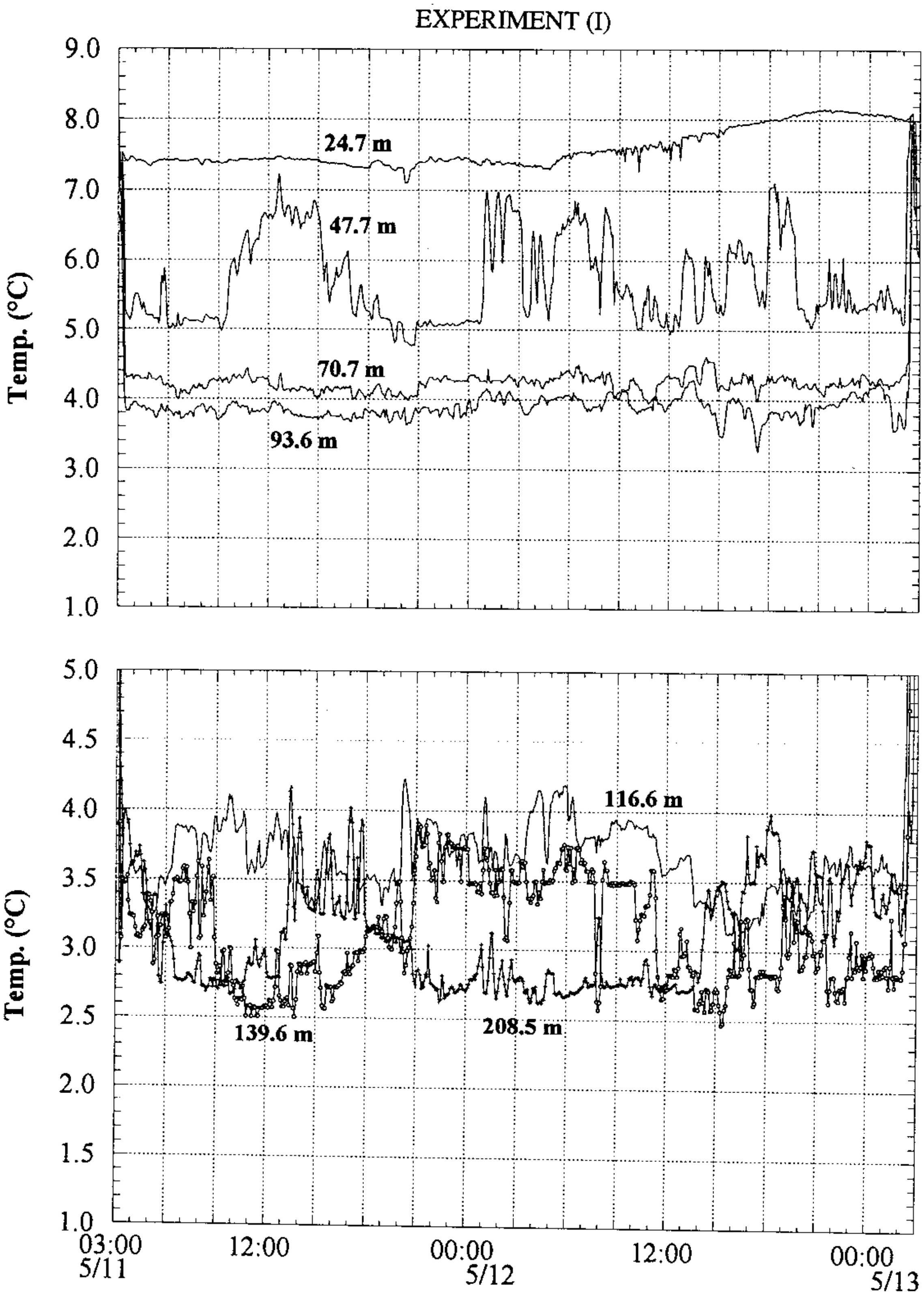

Fig. 3.11.4 (a) Variability in water temperature at each depths of CREST sediment trap array during experiment (I) at stn. KNOT1

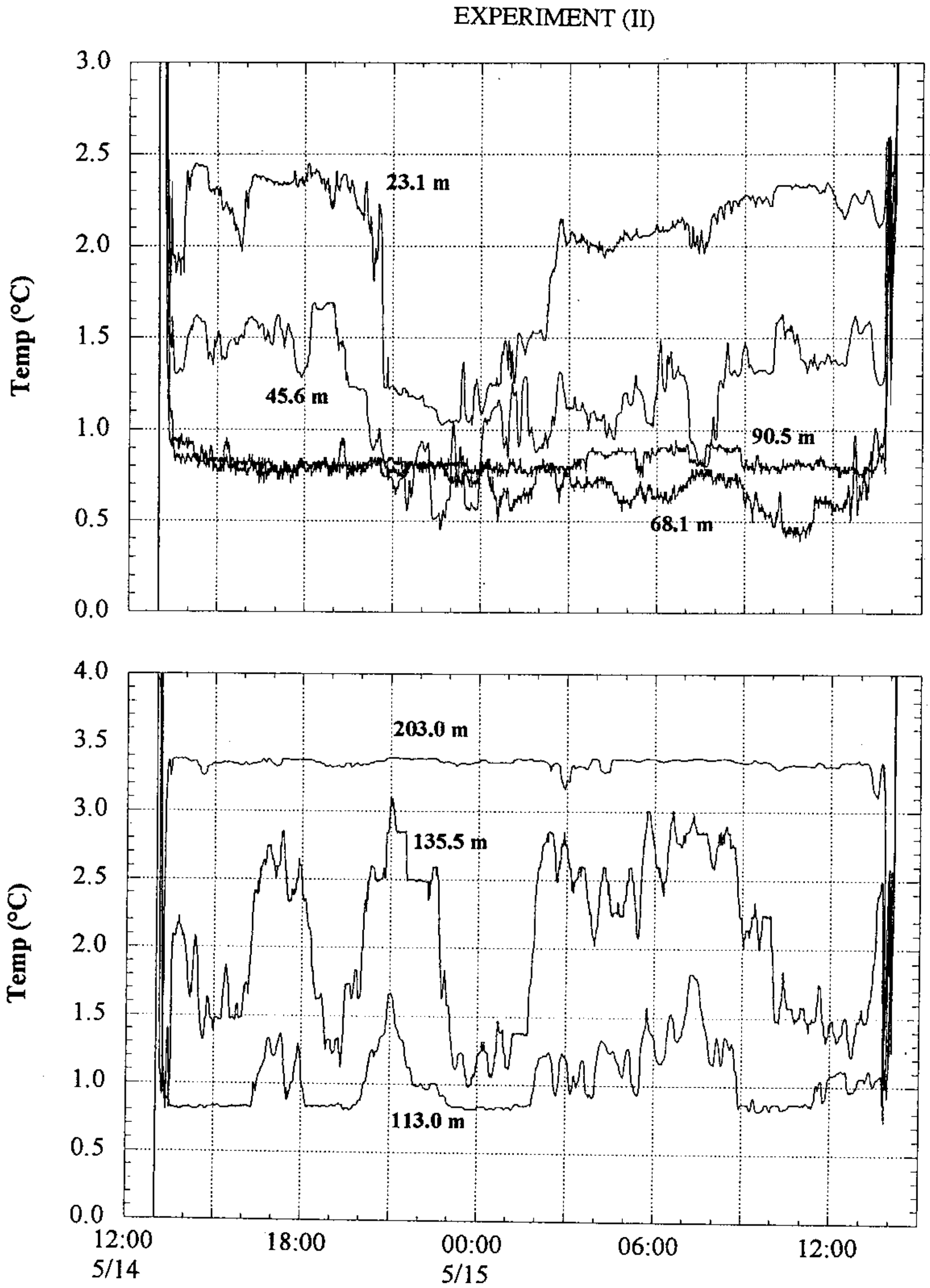

Fig. 3.11.4 (b) Variability in water temperature at each depths of CREST sediment trap array during experiment (II) at stns. HP1

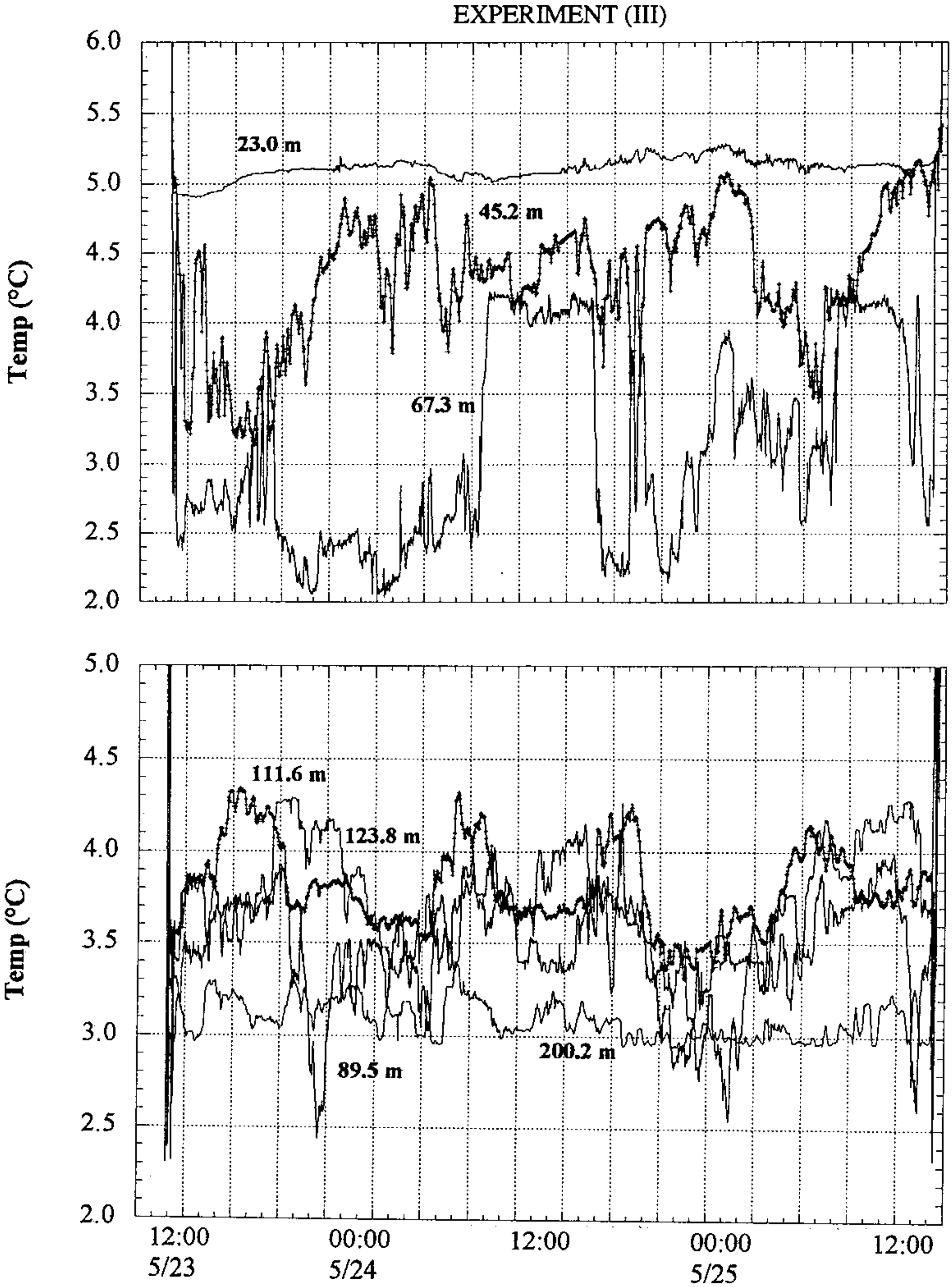

Fig. 3.11.4 (c) Variability in water temperature at each depths of CREST sediment trap array during experiment (III) at stn. KNOT2

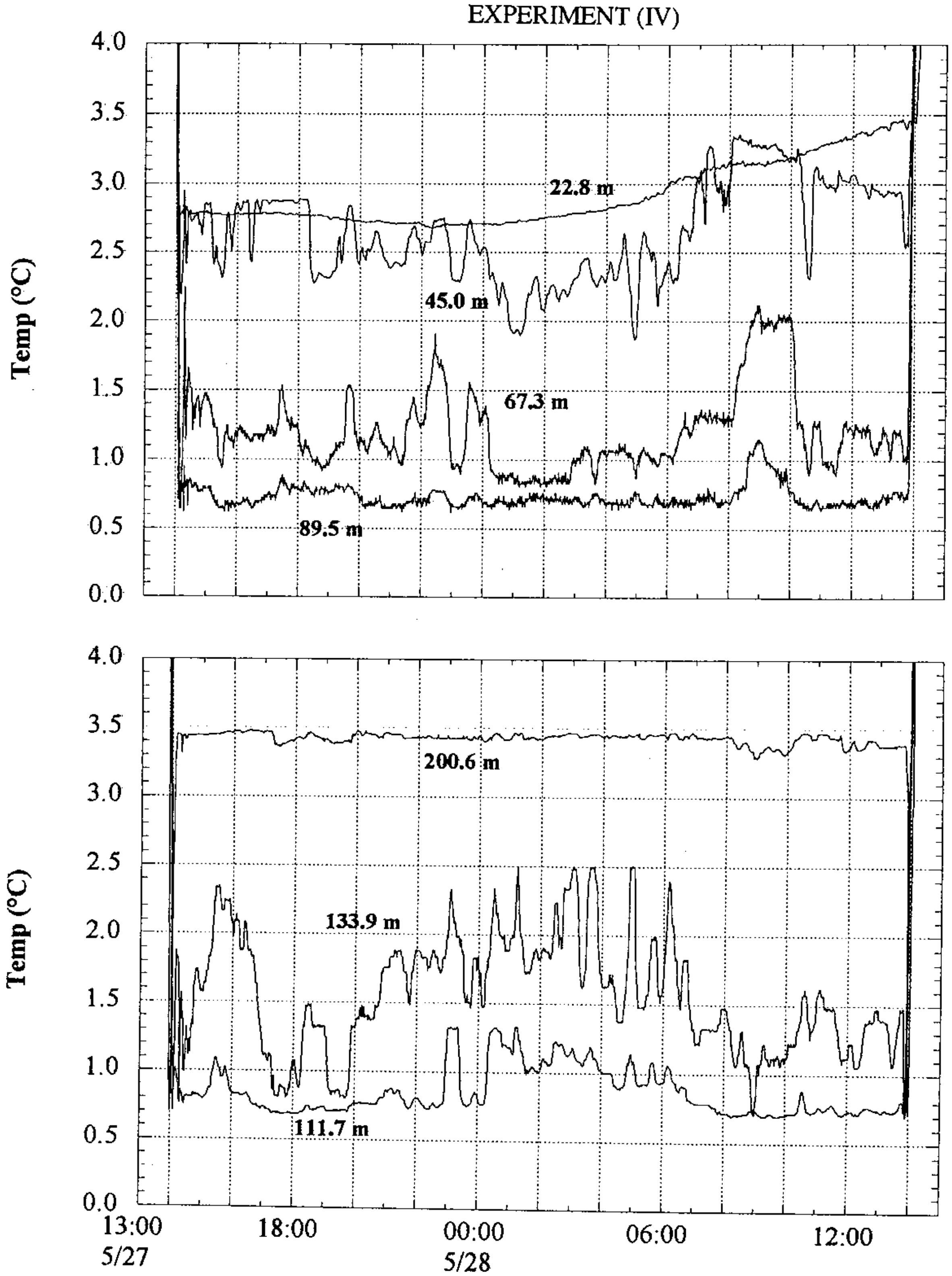

Fig. 3.11.4 (d) Variability in water temperature at each depths of CREST sediment trap array during experiment (IV) at stn. HP2

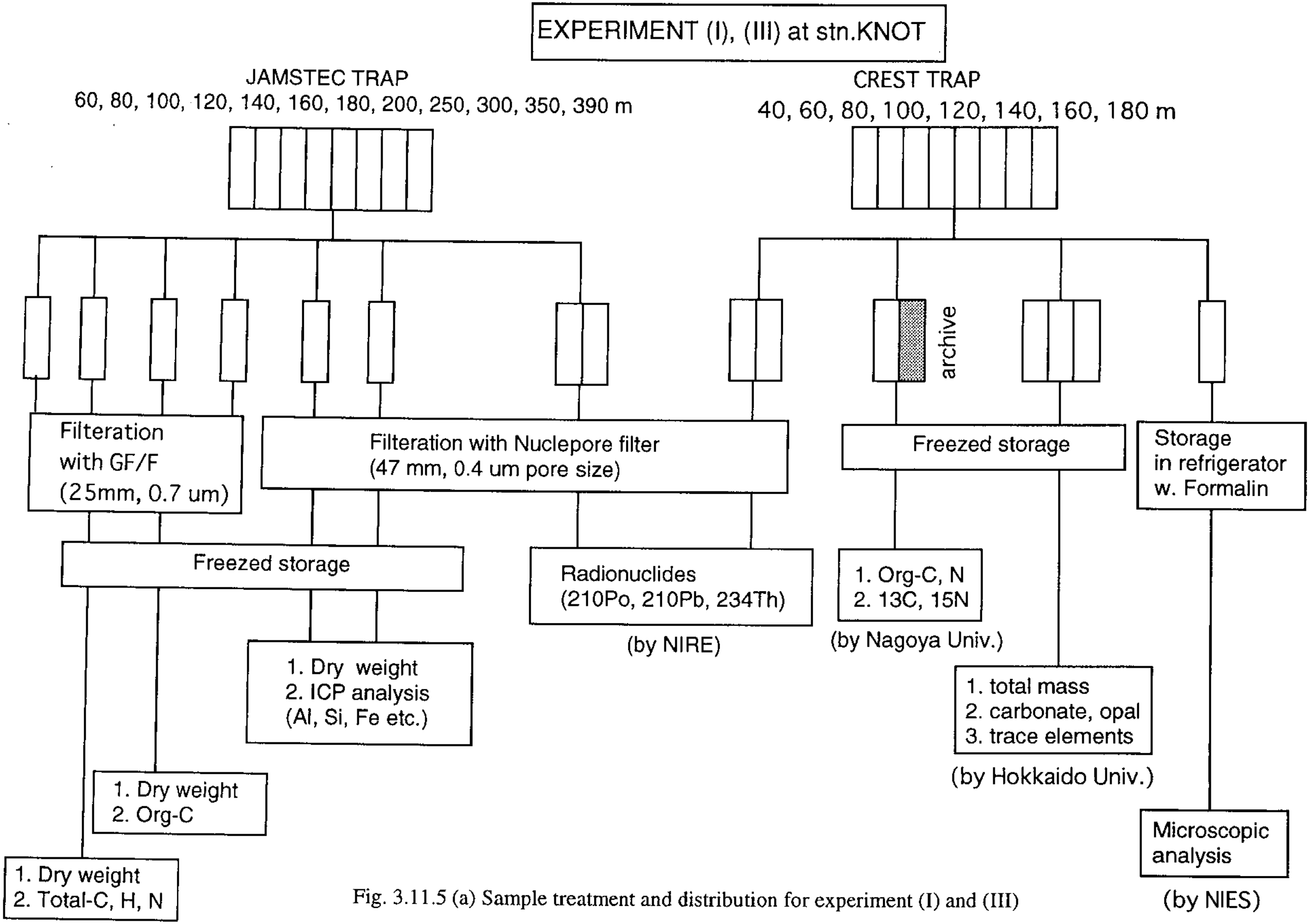

Fig. 3.11.5 (a) Sample treatment and distribution for experiment (I) and (III)

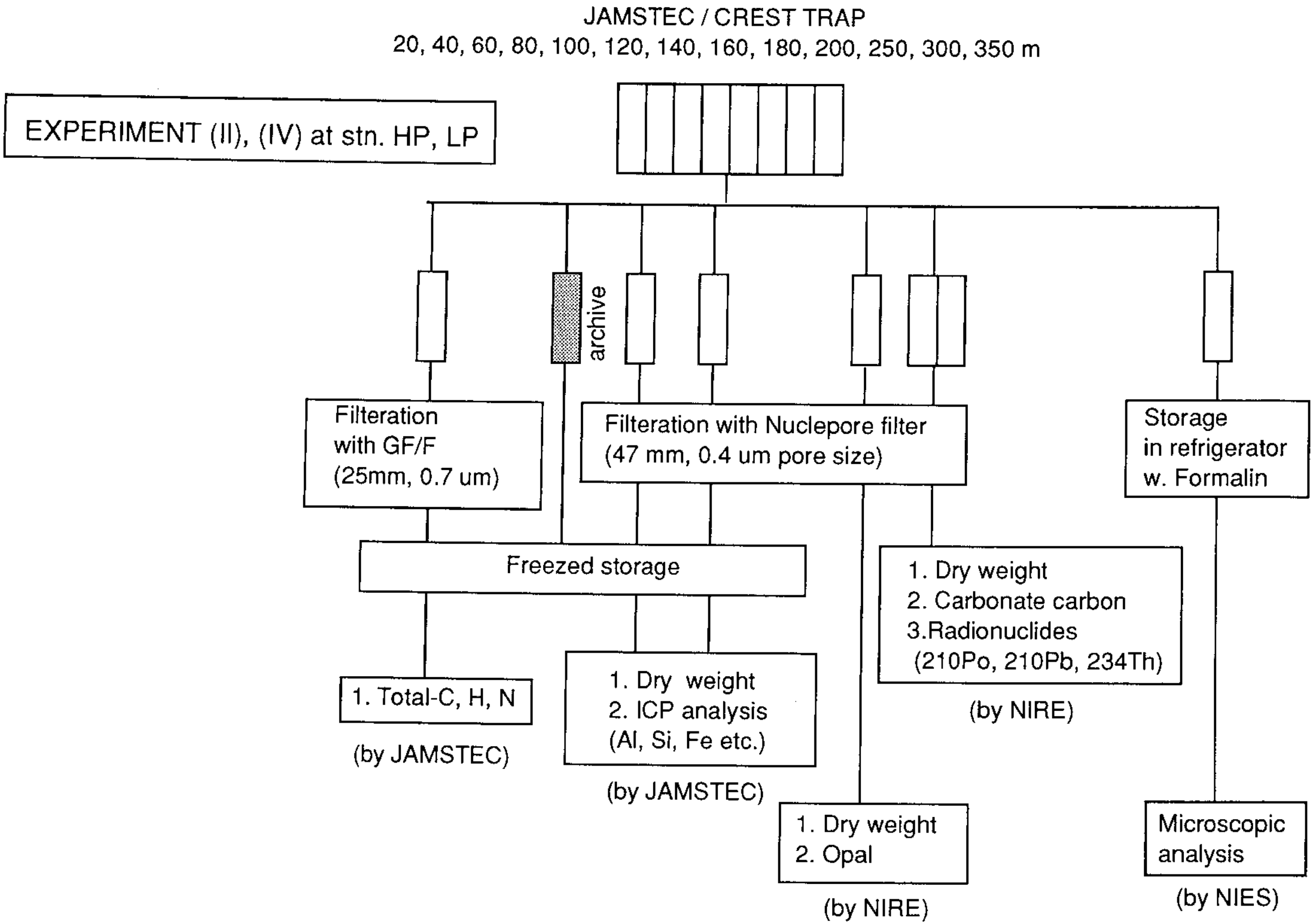

Fig. 3.11.5 (b) Sample treatment and distribution for experiment (II) and (IV)

3.13 Time-series sediment trap experiment

Makio Honda
(Japan Marine Science and Technology center)
Toshikatsu Sugawara, Hiroaki Muraki, Aya Kato
(Marine Works Japan Ltd.)

(1) Introduction

One of characteristics in the northwestern North Pacific is strong seasonal variability in the biological activity and its related marine chemistry. In order to study seasonal variability in biological pump and its role in materials cycle with the emphasis on the carbon cycle, time-series sediment trap experiment has been conducted since December, 1997 at three stations (stn. KNOT : Japanese biogeochemical time-series station, Stn. 50N: western Subarctic gyre, and Stn. 40N: Subarctic front). The following sediment trap mooring systems were recovered and re-deployed in July, 1998 during MR98-05 cruise by R/V MIRAI.

(2) Methods

1) Mooring system

The mooring system consists of three sediment traps with 21 collecting cups (McLane mark 7G-21 or Mark 78-21), glass floatation, wire / nylon ropes, and acoustic release (Benthos 865A). Sediment traps were deployed at approximately 1000 m, 3000 m, and 5000 m depths at respective stations. Before deployment, collecting cups were filled with sea water based 5 % buffered formalin to preserve collected settling particles. Each cup was scheduled to rotate every 15 days and started in July, 1998. Outlines of mooring systems are shown in Fig. 3.13.1.

2) Recovery

Unlike we expected, we needed not to suffer from the dense fog or rough weather during MR99-K02. Thanks to the enthusiastic assistance by captain Akamine, chief officer Kurihara and crew members, these sediment trap mooring systems were recovered successfully during this cruise. All collecting cups (approximately 186) rotated on schedule and valuable samples were collected.

(3) Preliminary results

1) Seasonality in fluxes

On board, heights of total mass flux in collecting cups were measured as the first observation (Table 3.13.1, Fig. 3.13.2).

Samples from stn. KNOT (44N, 155E) show that settling particles collected at 3000 m and 5000 m were relatively higher in volume in summer and the early autumn, and lower in winter. Judging from lower flux in the spring (April, 1999), the spring bloom has not begun yet at stn. KNOT.

Settling particles collected at 1000 m was smaller in volume than 3000m and 5000 m and little sample were collected after October, 1998. We found that big shrimp was trapped in the collecting cup of the early October. Therefore it is likely that the existence of this "swimmer" affected the collecting efficiency and the large fluff particles clogged the mouth of collecting cups in the late September as we have observed in the previous sediment trap experiments.

At stn. 50N, higher flux were observed in the late autumn and the early spring. These materials showed different appearance and high flux in the early spring seems more fluffy. It seems a group of diatom species. However it is too early to define that this is the spring bloom because sea water pCO2 value (approximately 390 ppm) were still higher than atmospheric pCO2 value (approximately 360 ppm) when we visited stn. 50N to recover the mooring system. Another bloom might occur from now on and might lower sea water pCO2 by the lower value than atmospheric pCO2. It is of interest that the highest flux observed in the early spring at each depth shows the time lag, in other words, the highest flux at 3000 m and 5000 m appeared one collecting period (15 days) after highest flux appeared at 1000 m and 3000 m, respectively. Assuming this time lag is attributed to the settling velocity, settling velocity of particles at stn. KNOT can be estimated to be approximately 133 m per day, which is coincident with that reported previously.

Fluxes increased from the late summer to the middle autumn in 1998 at stn. 40N. Fluxes at 5000 m also increased slightly in March. Unfortunately, little fluxes were collected after August and December at 1000 m and 3000 m, respectively. As observed at 1000 m at stn KNOT, this should be the artifact and it is also likely that the collecting efficiency was lowered by the large fluxes.

2) Future plan

These samples will be transported to laboratory being kept in refrigerator. At laboratory, chemical components such as carbon, nitrogen, carbonate, opal and trace elements will be measured. These analysis will reveal property of biological pump in the northwestern North Pacific.

3) Redeployment

The above mooring systems were re-deployed at same positions after sample collection, data acquisition, and exchange of battery and preservative. Each cup was scheduled to rotate every 17.38 days and start in May, 1999. Specification of above sediment trap mooring system are shown in Table 3.13.3. These mooring systems are planned to be recovered next year by R/V MIRAI.

3.13.1 (a) Sediment trap sample records (stn. KNOT)

stn. depth(m) S/N	**KNOT** **915** open day	**(43-58.1691N)** **(155-03.0506E)** sample hights (mm)	Note	**KNOT** **2949** open day	sample hights (mm)	Note	**KNOT** **4982** open day	sample hights (mm)	Note
1	1998/7/20	25		1998/7/20	48		1998/7/20	25	
2	1998/8/4	11	Jelly fish	1998/8/4	46		1998/8/4	36	
3	1998/8/19	16		1998/8/19	35		1998/8/19	21	
4	1998/9/3	5		1998/9/3	30		1998/9/3	21	
5	1998/9/18	3		1998/9/18	31		1998/9/18	33	
6	1998/10/3	16	Big shrimp	1998/10/3	15		1998/10/3	12	
7	1998/10/18	1	Clogg ?	1998/10/18	31		1998/10/18	15	
8	1998/11/2	1		1998/11/2	9		1998/11/2	16	
9	1998/11/17	1		1998/11/17	11		1998/11/17	10	
10	1998/12/2	-		1998/12/2	12		1998/12/2	11	
11	1998/12/17	-		1998/12/17	15		1998/12/17	9	
12	1999/1/1	-		1999/1/1	16		1999/1/1	10	
13	1999/1/16	-		1999/1/16	11		1999/1/16	10	
14	1999/1/31	-		1999/1/31	13		1999/1/31	11	
15	1999/2/15	-		1999/2/15	11		1999/2/15	11	
16	1999/3/2	-		1999/3/2	15		1999/3/2	11	
17	1999/3/17	-		1999/3/17	15		1999/3/17	10	
18	1999/4/1	-		1999/4/1	13		1999/4/1	18	
19	1999/4/16	-		1999/4/16	8		1999/4/16	11	
20	1999/5/1	3	5/11 recovery	1999/5/1	10	5/11 recovery	1999/5/1	-	5/11 recovery
21	1999/5/16	-		1999/5/16	-		1999/5/16	-	

3.13.1 (b) Sediment trap sample records (stn. 50N)

stn.	**50N**	**(50-00.7843N)**		**50N**			**50N**		
depth(m)	**1195**	**(165-01.3665E)**		**3229**			**5059**		
S/N	open day	sample hights (mm)	Note	open day	sample hights (mm)	Note	open day	sample hights (mm)	Note
1	1998/7/20	22		1998/7/20	22		1998/7/20	22	
2	1998/8/4	31	Jelly fish	1998/8/4	15		1998/8/4	18	
3	1998/8/19	23		1998/8/19	16		1998/8/19	11	
4	1998/9/3	18		1998/9/3	10		1998/9/3	10	
5	1998/9/18	17		1998/9/18	10		1998/9/18	9	
6	1998/10/3	15		1998/10/3	9		1998/10/3	9	
7	1998/10/18	12		1998/10/18	8		1998/10/18	8	
8	1998/11/2	58		1998/11/2	21		1998/11/2	6	
9	1998/11/17	17		1998/11/17	22		1998/11/17	15	
10	1998/12/2	15		1998/12/2	9		1998/12/2	13	
11	1998/12/17	8		1998/12/17	6		1998/12/17	6	
12	1999/1/1	5		1999/1/1	5	Jelly fish	1999/1/1	6	
13	1999/1/16	4		1999/1/16	5		1999/1/16	5	
14	1999/1/31	4		1999/1/31	3		1999/1/31	4	
15	1999/2/15	3		1999/2/15	2		1999/2/15	6	
16	1999/3/2	3		1999/3/2	4		1999/3/2	5	
17	1999/3/17	4		1999/3/17	5		1999/3/17	4	
18	1999/4/1	25	Increase of diatom	1999/4/1	12		1999/4/1	3	
19	1999/4/16	81	Diatom bloom ?	1999/4/16	64	Increase of diatom	1999/4/16	15	
20	1999/5/1	3	Clogg ?	1999/5/1	90	Diatom bloom ?	1999/5/1	37	Increase of diatom
21	1999/5/16	8	5/18 recovery	1999/5/16	-	5/18 recovery	1999/5/16	-	5/18 recovery

3.13.1 (c) Sediment trap sample records (stn. 40N)

stn.	40N	(40-00.0941N)		40N			40N		
depth(m)	932	(165-00.3559E)		2965			4996		
S/N	open day	sample hights (mm)	Note	open day	sample hights (mm)	Note	open day	sample hights (mm)	Note
1	1998/7/20	30		1998/7/20	14		1998/7/20	12	
2	1998/8/4	29		1998/8/4	36		1998/8/4	21	
3	1998/8/19	12		1998/8/19	52		1998/8/19	45	
4	1998/9/3	8		1998/9/3	28		1998/9/3	44	
5	1998/9/18	9		1998/9/18	11		1998/9/18	22	
6	1998/10/3	1	Clogg ?	1998/10/3	51		1998/10/3	36	
7	1998/10/18	3		1998/10/18	23		1998/10/18	60	
8	1998/11/2	-		1998/11/2	13		1998/11/2	25	
9	1998/11/17	-		1998/11/17	25		1998/11/17	32	
10	1998/12/2	-		1998/12/2	31		1998/12/2	30	
11	1998/12/17	-		1998/12/17	2		1998/12/17	20	
12	1999/1/1	-		1999/1/1	-		1999/1/1	16	
13	1999/1/16	-		1999/1/16	-		1999/1/16	11	
14	1999/1/31	-		1999/1/31	-		1999/1/31	17	
15	1999/2/15	-		1999/2/15	-		1999/2/15	18	
16	1999/3/2	-		1999/3/2	-		1999/3/2	22	
17	1999/3/17	-		1999/3/17	-		1999/3/17	15	
18	1999/4/1	-		1999/4/1	-		1999/4/1	16	
19	1999/4/16	-		1999/4/16	-		1999/4/16	14	
20	1999/5/1	-		1999/5/1	-		1999/5/1	11	
21	1999/5/16	-	5/20 recovery	1999/5/16	-	5/20 recovery	1999/5/16	-	5/20 recovery

Table 3.13.2 Specification of Sediment Trap Mooring system in 1999

Stn.		**KNOT**	**50N**	**40N**
Date of deploy		1999/05/13	1999/05/18	1999/05/21
Position	sinker drop	43-57.95N	50-00.87N	40-00.11N
		155-02.09E	165-01.05E	164-59.99E
		5373m	5533m	5476m
	calibrated	43-58.29N	50-00.42N	40-00.14N
		155-02.92E	165-00.96E	165-00.32E
		5375	5546m	5476m
Sediment trap	depth and S/N			
(McLane	shallow	ca. 1000m (S/N: 4095)*	1000m (S/N: 0256)*	1000m (S/N: 6854)*
Mark7G-21	intermediate	3000m (S/N: 877)	3000m (S/N: 989)	3000m (S/N: 1386)
* Mark78-21)	deep	5000m (S/N: 1387)	5000m (S/N: 878)	5000m (S/N: 1388)
w.depth/tilt sensor	start	1999/05/14 00:00:00	1999/05/19 00:00:00	1997/12/01 00:00:00
	interval	17.38 day	17.375 day	17.375 day
	end	2000/05/14 00:00:00	2000/05/19 00:00:00	2000/05/22 00:00:00
	preservative	5% buffered formalin (sea water base)	5% buffered formalin (sea water base)	5% buffered formalin (sea water base)
Current meter	type			InterOcean S4D
	S/N			08782014
	depth			1000m
	Start			1999/05/21 00:00:00
	Burst			(cycle duration) 6 hr.
	Mode			(channel) 12356
	Interval			0.5sec
	Sampling			(average count)120 sec
Acoustic Release	S/N	782	673	624
(Benthos 865A)	Receive	10.5 kHz	14.0 kHz	11.5 kHz
NOTE:	Trans	12.0 kHz	12.0 kHz	12.0 kHz
Re/Tr reverse	ENABLE	A	A	4A
for Deck Unit	RELEASE	B	B	4B

Note

* In order to avoid problem of "Y2K", this year "1999" was converted to "1989" on computer.

* Sinker arrived at the sea floor about 1 hour after siker dropped.

* Positions are on the scale of WGS-84.

3.13.3 (a) Sediment trap mooring system (stn. KNOT)

Mooring ID	NEW	JAST01HL (KNOT)		Water Depth		5375m		1999 May	
Description		Weight (lb/ea)	Item Quantity (#)	Item Length (m)	Item Weight (lbs)	Mooring Length (m)	Mooring Weight (lbs)	Above Bottom (m)	Below Surface (m)
Start of Mooring		0	0	0	0	0	0	4492.1	882.9
Beacon Float		-64	1	0.3	-64	0.3	-64	4492.1	882.9
Nylon rope 3/4"		1	1	20	1	20.3	-63	4491.8	883.2
FLOTATION MODULE		-64	6	1.8	-384	22.1	-447	4471.8	903.2
Chain 3/8"		4.49	1	1	4.49	23.1	-442.51	4470	905.0
FLOTATION MODULE		-64	6	1.8	-384	24.9	-826.51	4469	906.0
Chain 3/8"		4.49	1	1	4.49	25.9	-822.02	4467.2	907.8
FLOTATION MODULE		-64	6	1.8	-384	27.7	-1206	4466.2	908.8
Nylon rope 3/4"		1	1	20	1	47.7	-1205	4464.4	910.6
Chain 3/8"		8.98	1	2	8.98	49.7	-1196	4444.4	930.6
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	50.7	-1187	4442.4	932.6
SEDIMENT TRAP MK7-21	S/N 4095	121	1	1.52	121	52.22	-1066	4441.4	933.6
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	53.22	-1056.9	4439.8	935.2
Chain 3/8"		8.98	1	2	8.98	55.22	-1047.9	4438.8	936.2
Sievel		10	1	0.3	10	55.52	-1037.9	4436.8	938.2
wire rope 3/16"		75	1	500	75	555.52	-962.94	4436.5	938.5
wire rope 3/16"		75	1	500	75	1055.5	-887.94	3936.5	1438.5
wire rope 3/16"		75	1	500	75	1555.5	-812.94	3436.5	1938.5
wire rope 3/16"		75	1	500	75	2055.5	-737.94	2936.5	2438.5
FLOTATION MODULE		-64	9	2.7	-576	2058.2	-1313.9	2436.5	2938.5
Nylon rope 3/4"		1	1	20	1	2078.2	-1312.9	2433.8	2941.2
Chain 3/8"		8.98	1	2	8.98	2080.2	-1304	2413.8	2961.2
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	2081.2	-1294.9	2411.8	2963.2
SEDIMENT TRAP MK7-21	S/N 877	121	1	1.52	121	2082.7	-1173.9	2410.8	2964.2
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	2083.7	-1164.8	2409.3	2965.7
Chain 3/8"		8.98	1	2	8.98	2085.7	-1155.9	2408.3	2966.7
Sievel		10	1	0.3	10	2086	-1145.9	2406.3	2968.7
wire rope 3/16"		75	1	500	75	2586	-1070.9	2406	2969.0
wire rope 3/16"		75	1	500	75	3086	-995.86	1906	3469.0
wire rope 3/16"		75	1	500	75	3586	-920.86	1406	3969.0
wire rope 3/16"		75	1	500	75	4086	-845.86	906.02	4469.0
FLOTATION MODULE		-64	9	2.7	-576	4088.7	-1421.9	406.02	4969.0
Nylon rope 3/4"		1	1	20	1	4108.7	-1420.9	403.32	4971.7
Chain 3/8"		8.98	1	2	8.98	4110.7	-1411.9	383.32	4991.7
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	4111.7	-1402.8	381.32	4993.7
SEDIMENT TRAP MK7-21	S/N 1387	121	1	1.52	121	4113.3	-1281.8	380.32	4994.7
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	4114.3	-1272.8	378.8	4996.2
Chain 3/8"		8.98	1	2	8.98	4116.3	-1263.8	377.8	4997.2
Sievel		10	1	0.3	10	4116.6	-1253.8	375.8	4999.2
wire rope 3/16"		45	1	300	45	4416.6	-1208.8	375.5	4999.5
Chain 3/8"		4.49	1	1	4.49	4417.6	-1204.3	75.5	5299.5
ACOUSTIC RELEASE		55	1	1	55	4418.6	-1149.3	74.5	5300.5
Chain 3/8"		4.49	1	1	4.49	4419.6	-1144.8	73.5	5301.5
wire rope 3/16"		4.5	1	50	4.5	4469.6	-1140.3	72.5	5302.5
Nylon rope 3/4"		1	1	20	1	4489.6	-1139.3	22.5	5352.5
Chain 3/8"		8.98	1	2	8.98	4491.6	-1130.3	2.5	5372.5
ANCHOR		2800	1	0.5	2800	4492.1	1669.7	0.5	5374.5

3.13.3 (b) Sediment trap mooring system (stn. 50N)

Mooring ID NEW JAST02HL (50,165) Water Depth 5546m 1999 May

Description		Weight (lb/ea)	Item Quantity (#)	Item Length (m)	Item Weight (lbs)	Mooring Length (m)	Mooring Weight (lbs)	Above Bottom (m)	Below Surface (m)
Start of Mooring		0	0	0	0	0	0	4392.1	1153.9
Beacon Float		-64	1	0.3	-64	0.3	-64	4392.1	1153.9
Nylon rope 3/4"		1	1	20	1	20.3	-63	4391.8	1154.2
FLOTATION MODULE		-64	6	1.8	-384	22.1	-447	4371.8	1174.2
Chain 3/8"		4.49	1	1	4.49	23.1	-442.51	4370	1176
FLOTATION MODULE		-64	6	1.8	-384	24.9	-826.51	4369	1177
Chain 3/8"		4.49	1	1	4.49	25.9	-822.02	4367.2	1178.8
FLOTATION MODULE		-64	6	1.8	-384	27.7	-1206	4366.2	1179.8
Nylon rope 3/4"		1	1	20	1	47.7	-1205	4364.4	1181.6
Chain 3/8"		8.98	1	2	8.98	49.7	-1196	4344.4	1201.6
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	50.7	-1187	4342.4	1203.6
SEDIMENT TRAP MK7-21	S/N 0256	121	1	1.52	121	52.22	-1066	4341.4	1204.6
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	53.22	-1056.9	4339.8	1206.2
Chain 3/8"		8.98	1	2	8.98	55.22	-1047.9	4338.8	1207.2
Sievel		10	1	0.3	10	55.52	-1037.9	4336.8	1209.2
wire rope 3/16"		75	1	500	75	555.52	-962.94	4336.5	1209.5
wire rope 3/16"		75	1	500	75	1055.5	-887.94	3836.5	1709.5
wire rope 3/16"		75	1	500	75	1555.5	-812.94	3336.5	2209.5
wire rope 3/16"		75	1	500	75	2055.5	-737.94	2836.5	2709.5
FLOTATION MODULE		-64	9	2.7	-576	2058.2	-1313.9	2336.5	3209.5
Nylon rope 3/4"		1	1	20	1	2078.2	-1312.9	2333.8	3212.2
Chain 3/8"		8.98	1	2	8.98	2080.2	-1304	2313.8	3232.2
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	2081.2	-1294.9	2311.8	3234.2
SEDIMENT TRAP MK7-21	S/N 989	121	1	1.52	121	2082.7	-1173.9	2310.8	3235.2
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	2083.7	-1164.8	2309.3	3236.7
Chain 3/8"		8.98	1	2	8.98	2085.7	-1155.9	2308.3	3237.7
Sievel		10	1	0.3	10	2086	-1145.9	2306.3	3239.7
wire rope 3/16"		75	1	500	75	2586	-1070.9	2306	3240
wire rope 3/16"		75	1	500	75	3086	-995.86	1806	3740
wire rope 3/16"		75	1	500	75	3586	-920.86	1306	4240
wire rope 3/16"		15	1	100	15	3686	-905.86	806.02	4740
wire rope 3/16"		15	1	100	15	3786	-890.86	706.02	4840
wire rope 3/16"		15	1	100	15	3886	-875.86	606.02	4940
FLOTATION MODULE		-64	9	2.7	-576	3888.7	-1451.9	506.02	5040
Nylon rope 3/4"		1	1	20	1	3908.7	-1450.9	503.32	5042.7
Chain 3/8"		8.98	1	2	8.98	3910.7	-1441.9	483.32	5062.7
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	3911.7	-1432.8	481.32	5064.7
SEDIMENT TRAP MK7-21	S/N 878	121	1	1.52	121	3913.3	-1311.8	480.32	5065.7
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	3914.3	-1302.8	478.8	5067.2
Chain 3/8"		8.98	1	2	8.98	3916.3	-1293.8	477.8	5068.2
Sievel		10	1	0.3	10	3916.6	-1283.8	475.8	5070.2
wire rope 3/16"		45	1	300	45	4216.6	-1238.8	475.5	5070.5
wire rope 3/16"		15	1	100	15	4316.6	-1223.8	175.5	5370.5
Chain 3/8"		4.49	1	1	4.49	4317.6	-1219.3	75.5	5470.5
ACOUSTIC RELEASE		55	1	1	55	4318.6	-1164.3	74.5	5471.5
Chain 3/8"		4.49	1	1	4.49	4319.6	-1159.8	73.5	5472.5
wire rope 3/16"		4.5	1	50	4.5	4369.6	-1155.3	72.5	5473.5
Nylon rope 3/4"		1	1	20	1	4389.6	-1154.3	22.5	5523.5
Chain 3/8"		8.98	1	2	8.98	4391.6	-1145.3	2.5	5543.5
ANCHOR		2800	1	0.5	2800	4392.1	1654.7	0.5	5545.5

3.13.3 (c) Sediment trap mooring system (stn. 40N)

Mooring ID NEW JAST03HL (40,165) Water Depth 5476m 1999 May.

Description		Weight (lb/ea)	Item Quantity (#)	Item Length (m)	Item Weight (lbs)	Mooring Length (m)	Mooring Weight (lbs)	Above Bottom (m)	Below Surface (m)
Start of Mooring		0	0	0	0	0	0	4595.1	880.94
Beacon Float		-64	1	0.3	-64	0.3	-64	4595.1	880.94
Nylon rope 3/4"		1	1	20	1	20.3	-63	4594.8	881.24
FLOTATION MODULE		-64	6	1.8	-384	22.1	-447	4574.8	901.24
Chain 3/8"		4.49	1	1	4.49	23.1	-442.51	4573	903.04
FLOTATION MODULE		-64	6	1.8	-384	24.9	-826.51	4572	904.04
Chain 3/8"		4.49	1	1	4.49	25.9	-822.02	4570.2	905.84
FLOTATION MODULE		-64	6	1.8	-384	27.7	-1206	4569.2	906.84
Nylon rope 3/4"		1	1	20	1	47.7	-1205	4567.4	908.64
Chain 3/8"		8.98	1	2	8.98	49.7	-1196	4547.4	928.64
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	50.7	-1187	4545.4	930.64
SEDIMENT TRAP MK7-21	S/N 6854	121	1	1.52	121	52.22	-1066	4544.4	931.64
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	53.22	-1056.9	4542.8	933.16
Chain 3/8"		8.98	1	2	8.98	55.22	-1047.9	4541.8	934.16
Sievel		10	1	0.3	10	55.52	-1037.9	4539.8	936.16
Chain 3/8"		4.49	1	1	4.49	56.52	-1033.5	4539.5	936.46
CURRENT METER	Inter Oc.	10	1	1	10	57.52	-1023.5	4538.5	937.46
Chain 3/8"		4.49	1	1	4.49	58.52	-1019	4537.5	938.46
wire rope 3/16"		75	1	500	75	558.52	-943.96	4536.5	939.46
wire rope 3/16"		75	1	500	75	1058.5	-868.96	4036.5	1439.5
wire rope 3/16"		75	1	500	75	1558.5	-793.96	3536.5	1939.5
wire rope 3/16"		75	1	500	75	2058.5	-718.96	3036.5	2439.5
FLOTATION MODULE		-64	9	2.7	-576	2061.2	-1295	2536.5	2939.5
Nylon rope 3/4"		1	1	20	1	2081.2	-1294	2533.8	2942.2
Chain 3/8"		8.98	1	2	8.98	2083.2	-1285	2513.8	2962.2
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	2084.2	-1275.9	2511.8	2964.2
SEDIMENT TRAP MK7-21	S/N 1386	121	1	1.52	121	2085.7	-1154.9	2510.8	2965.2
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	2086.7	-1145.9	2509.3	2966.7
Chain 3/8"		8.98	1	2	8.98	2088.7	-1136.9	2508.3	2967.7
Sievel		10	1	0.3	10	2089	-1126.9	2506.3	2969.7
wire rope 3/16"		75	1	500	75	2589	-1051.9	2506	2970
wire rope 3/16"		75	1	500	75	3089	-976.88	2006	3470
wire rope 3/16"		75	1	500	75	3589	-901.88	1506	3970
wire rope 3/16"		75	1	500	75	4089	-826.88	1006	4470
FLOTATION MODULE		-64	9	2.7	-576	4091.7	-1402.9	506.02	4970
Nylon rope 3/4"		1	1	20	1	4111.7	-1401.9	503.32	4972.7
Chain 3/8"		8.98	1	2	8.98	4113.7	-1392.9	483.32	4992.7
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	4114.7	-1383.8	481.32	4994.7
SEDIMENT TRAP MK7-21	S/N 1388	121	1	1.52	121	4116.3	-1262.8	480.32	4995.7
Bridle (1m x 3 wire rope)		9.06	1	1	9.06	4117.3	-1253.8	478.8	4997.2
Chain 3/8"		8.98	1	2	8.98	4119.3	-1244.8	477.8	4998.2
Sievel		10	1	0.3	10	4119.6	-1234.8	475.8	5000.2
wire rope 3/16"		45	1	300	45	4419.6	-1189.8	475.5	5000.5
wire rope 3/16"		15	1	100	15	4519.6	-1174.8	175.5	5300.5
Chain 3/8"		4.49	1	1	4.49	4520.6	-1170.3	75.5	5400.5
ACOUSTIC RELEASE		55	1	1	55	4521.6	-1115.3	74.5	5401.5
Chain 3/8"		4.49	1	1	4.49	4522.6	-1110.8	73.5	5402.5
wire rope 3/16"		4.5	1	50	4.5	4572.6	-1106.3	72.5	5403.5
Nylon rope 3/4"		1	1	20	1	4592.6	-1105.3	22.5	5453.5
Chain 3/8"		8.98	1	2	8.98	4594.6	-1096.3	2.5	5473.5
ANCHOR		2800	1	0.5	2800	4595.1	1703.7	0.5	5475.5

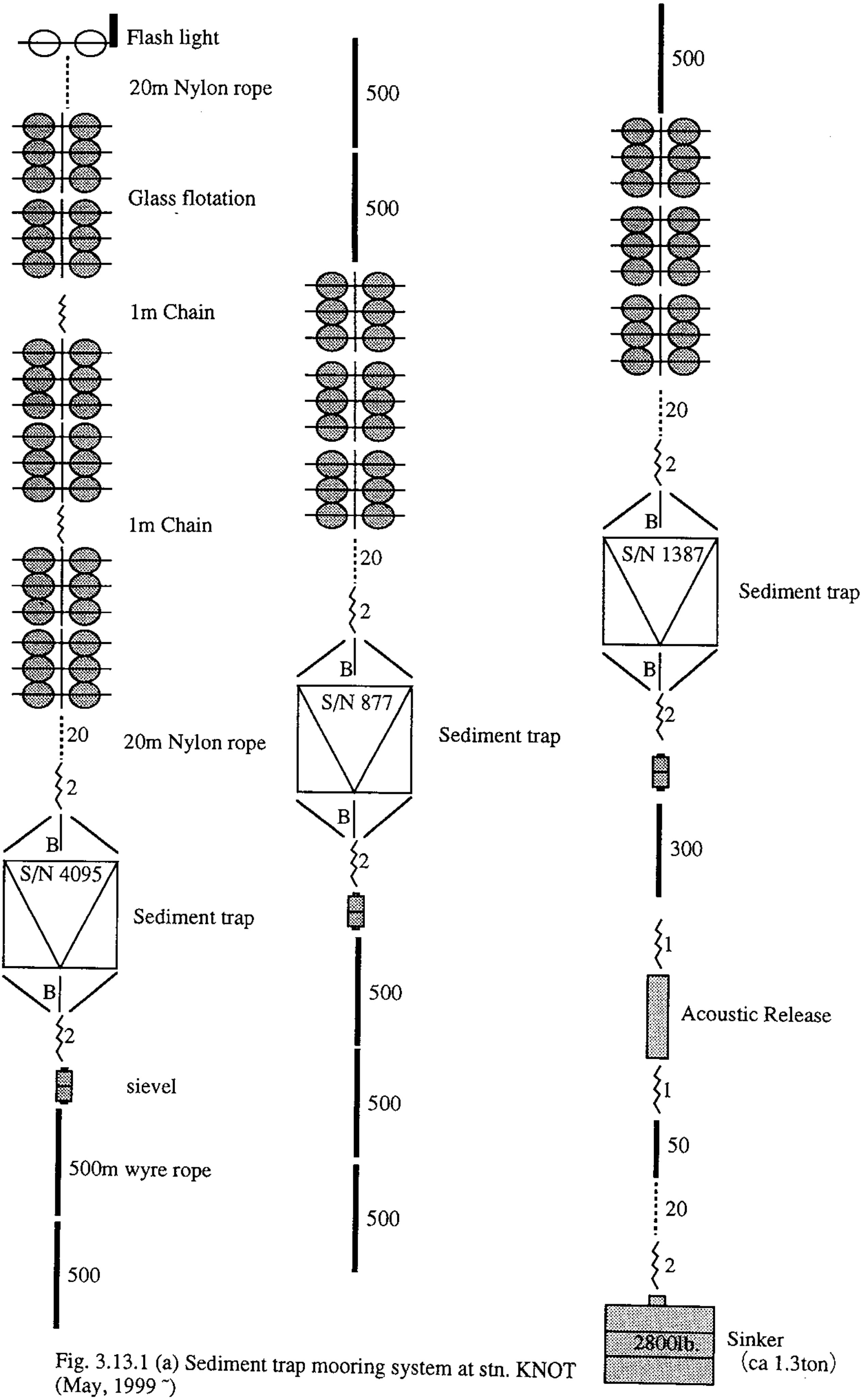

Fig. 3.13.1 (a) Sediment trap mooring system at stn. KNOT (May, 1999 ~)

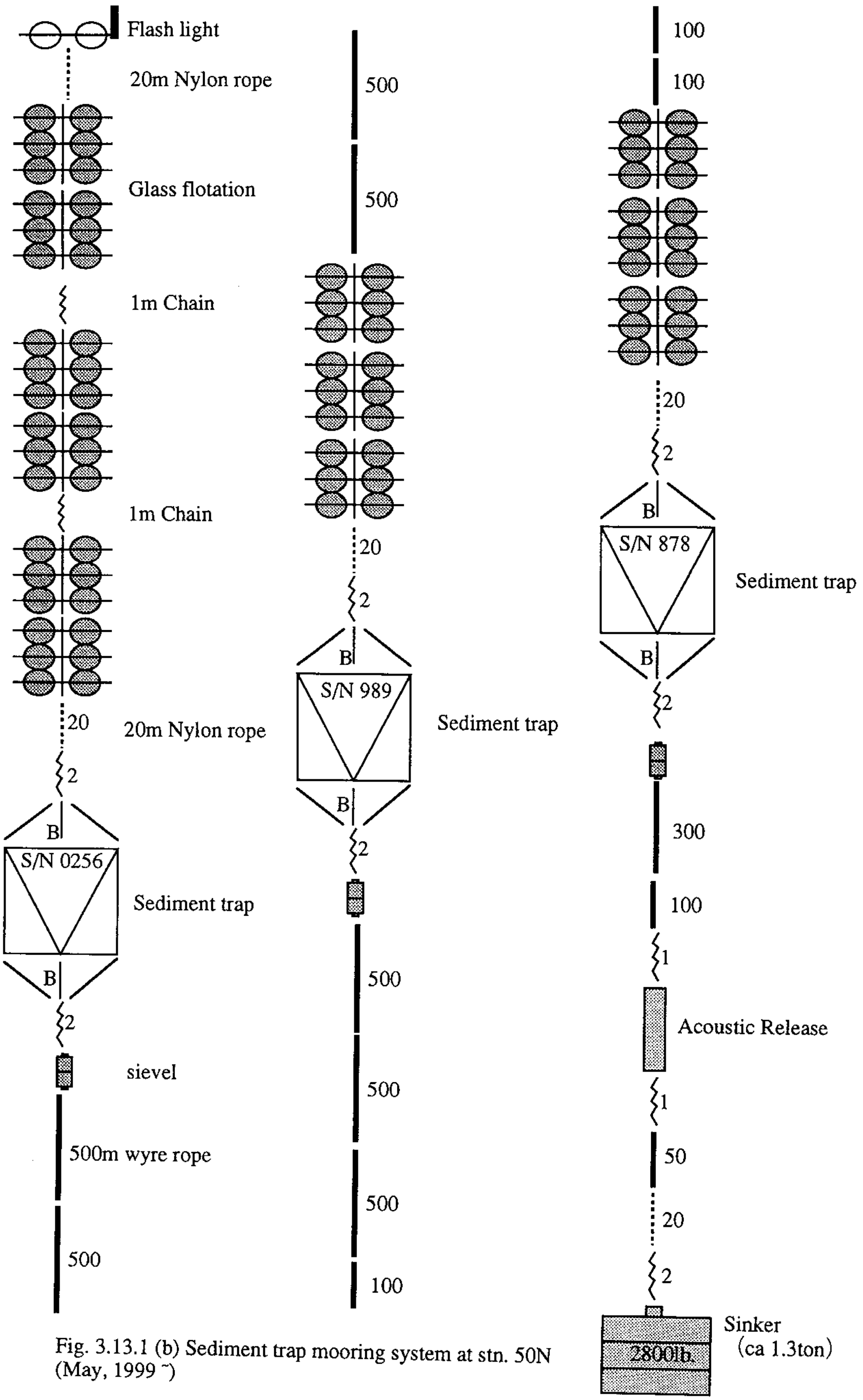

Fig. 3.13.1 (b) Sediment trap mooring system at stn. 50N (May, 1999 ~)

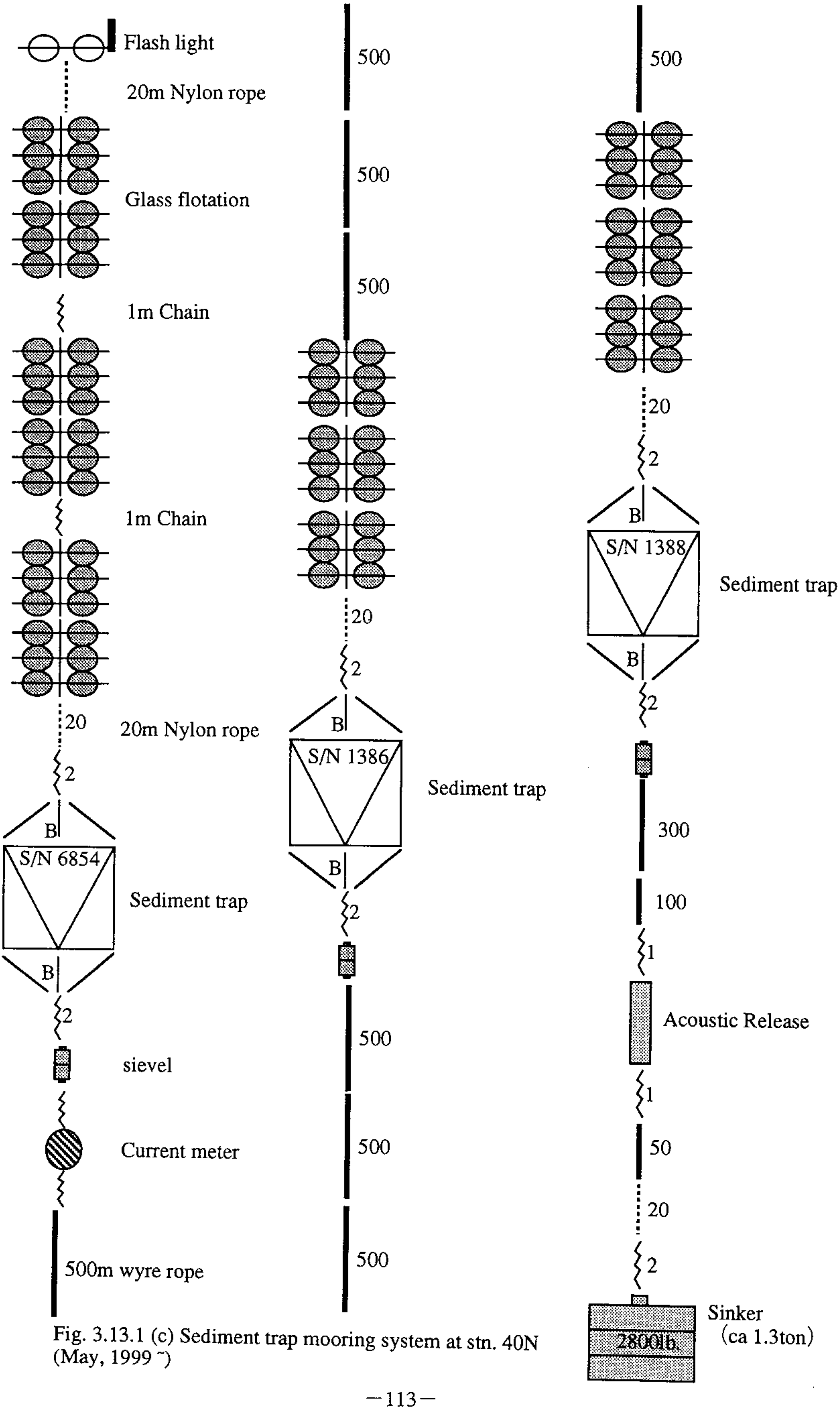

Fig. 3.13.1 (c) Sediment trap mooring system at stn. 40N (May, 1999 ~)

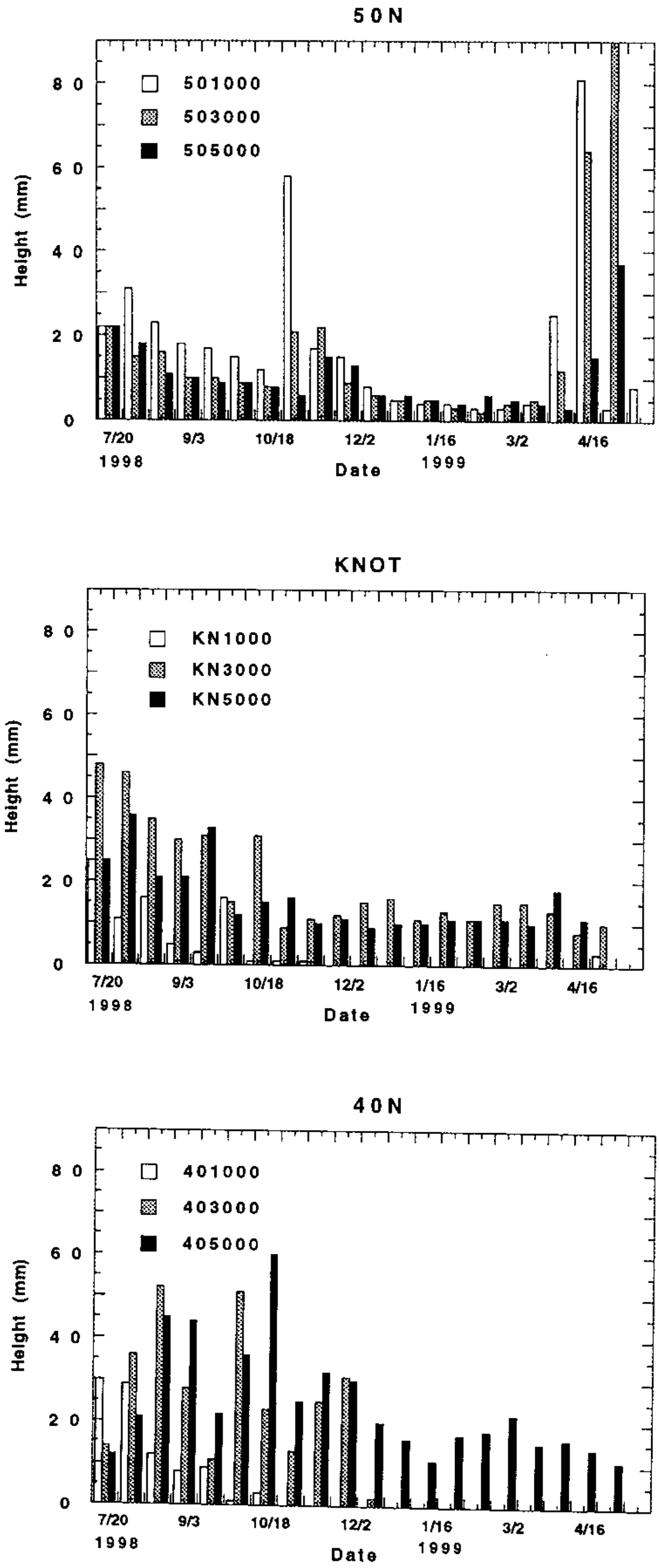

Figure 3.13.2 Total volume fluxes

3.14 Bio-optical measurements in the subarctic North Pacific Ocean for ocean color remote sensing

Kosei Sasaoka
(Faculty of Fisheries, Hokkaido University)

The underwater spectral downward irradiance and upward radiance were measured using the underwater unit, MER-2040 (Biospherical Instrument Inc.). The measurements were carried out from the sea surface down to depth 100m depending on the water turbidity. The incident solar spectral irradiance was measured using the deck unit, MER-2041 (Biospherical Instrument Inc.). The measurements were carried out two times a day near the satellite overpassing time (about 10:00 A.M. and 13:00 P.M.) at Stns. Knot, O1, 50N, 40N, KNOT2 and HP2. At other stations (St.TEST, HP1, LP1, O2, O3, LP2 and special stations (19 May, between St.O2 and St.40N and 22 May, between St.O3 and St.KNOT2)) were made once a day near the satellite overpassing time (about 10:00 A.M. or 13:00 P.M.). The list of MER-2040/2041 measurement in this cruise summarized Table 1. The spectral channels of MER-2040 / 2041 covered the wavelength of 412, 443, 465, 490, 510, 520, 555, 565, 625, 665, 670, 683 nm and PAR (710 nm for upward radiance). These channels were selected for compatible satellite ocean color sensor, Sea-viewing Wide Field-of-view Sensor(SeaWiFS) and Global Imager(GLI).

Upward and downward PAR (Photosynthetically available radiation) was determined optical depth for the in-situ primary production measurement (CREST group).

In future study, we will calculate normalized water leaving radiance (Lwn) using these bio-optical parameters and examine the relationship between in situ measured chl-a values and estimated chl-a values using the several bio-optical algorithm developed by NASA, NASDA and other researchers. We will develop the new bio-optical algorithms for the high latitude regions and make high accuracy chl-a images in this region in future study.

Table 1. The list of MER2040/2041 measurement in this cruise

No.	St.	Date	Time(JST)	Latitude	Longitude
1	Test	9 May, 1999	9:58	40-00.7	147-51.8
2	KNOT	11 May, 1999	9:55	43-59.9	154-59.0
3	KNOT	11 May, 1999	13:16	44-00.4	155-00.4
4	KNOT	12 May, 1999	10:04	44-15.0	154-54.6
5	KNOT	12 May, 1999	12:58	43-59.6	155-19.7
6	KNOT	13 May, 1999	9:59	43-58.0	155-02.1
7	KNOT	13 May, 1999	12:56	43-58.6	155-02.2
8	HP1	14 May, 1999	10:12	44-39.5	155-49.6
9	LP1	15 May, 1999	10:06	44-46.8	156-01.6
10	O1	16 May, 1999	10:00	46-55.7	159-43.8
11	O1	16 May, 1999	12:52	46-55.0	159-43.5
12	50N	17 May, 1999	12:53	50-00.0	165-00.0
13	50N	18 May, 1999	9:52	50-00.0	165-00.0
14	50N	18 May, 1999	10:24	50-00.0	165-00.0
15	50N	18 May, 1999	12:51	49-58.3	165-01.1
16	O2	19 May, 1999	10:04	45-50.7	165-00.2
17	special	19 May, 1999	12:55	45-38.7	165-01.4
18	40N	20 May, 1999	10:43	40-00.0	165-00.2
19	40N	21 May, 1999	9:56	39-59.3	165-01.2
20	40N	21 May, 1999	12:55	40-00.1	165-03.3
21	O3	22 May, 1999	10:00	41-53.2	160-07.0
22	special	22 May, 1999	12:52	41-55.7	159-59.9
23	KNOT2	23 May, 1999	10:01	43-59.8	154-59.9
24	KNOT2	23 May, 1999	12:51	44-00.3	154-58.7
25	KNOT2	24 May, 1999	9:56	44-00.0	155-00.1
26	KNOT2	24 May, 1999	12:53	44-00.2	155-00.1
27	Grid Survey	25 May, 1999	10:23	44-00.8	155-15.7
28	Grid Survey	25 May, 1999	12:53	44-08.1	155-22.0
29	Grid Survey	26 May, 1999	9:55	44-52.2	155-30.2
30	HP2	27 May, 1999	10:00	44-15.0	156-11.0
31	HP2	27 May, 1999	13:10	44-15.6	156-11.3
32	LP2	27 May, 1999	16:36	44-31.0	156-12.3

3.15 Plankton

Yuichiro Yamada
(Biological Oceanography Laboratory, Faculty of Fisheries, Hokkaido University)
Keiri Imai
(Core Research for Evolutional Science and Technology)

(1) Net zooplankton

This samplings aims to reveal the biomass, horizontal and vertical distribution, and species composition of net zooplankton in northwestern subarctic Pacific. Net zooplankton were collected using three types nets. Palumbo-Chun-Petersen (PCP) type closing net (45cm mouth diameter, 0.06mm mesh) designed by Kawamura (1989) were made at stn. KNOT 1, 50N and KNOT 2. Sampling depth strata were 0-50, 50-250, 250-500, 500-1000 and 100-1800m at stn. KNOT 1, 0-100, 100-250, 250-500, 500-1000 and 1000-1500m at stn. 50N, and 0-50, 50-250, 250-500, 500-1000 and 1000-1500m at stn. KNOT 2. Twin-type (0.33mm mesh) or single type (0.2mm mesh) NORPAC nets (45cm mouth diameter, Motoda 1957) were towed vertically. Volumes of water filtered through the net were estimated from readings of a Rigosha flowmeter mounted in the mouth of each net. All net samples were immediately preserved in 5% buffered formalin-seawater solution. Field sampling data for net zooplankton are summarized in Table 3.15.1.

(2) Phytoplankton and microzooplankton

The subject of this study is to reveal the species succession of phytoplankton and microzooplankton in northwestern subarctic Pacific. Water samples for taxonomic analysis and counting for phytoplankton (1l) and microzooplankton (2l) were collected using Niskin bottles at 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 200 and 250m depth and surface. Surface water samples were collected with a plastic bucket. All water samples were preserved with 1% buffered formalin (phytoplankton) or 3% Lugol’s solution (microzooplankton). Field sampling data for water samples are summarized in Table 3.15.2. Collected samples will be used for identifying the species of phytoplankton and microzooplankton.

References

Kawamura, A. 1989. Fast sinking mouth ring for closing Norpac net. Nippon Suisan Gakkaishi 55: 1121

Motoda, S. 1157 North Pacific standard plankton net. Inf. Bull. Planktol. Jpn 4: 13-15

Table 3.15.1. Summary of field sampling data for net zooplankton (PCP: Palumbo-Chun-Petersen type closing net, TN: twin-type NORPAC net, SN: single-type NORPAC net)

stn.	position	date	time (LST)	net	depth (m)	Wire angle
KNOT1	44°N	11 May	14:43-15:20	TN	0-500, 0-150	2~5°
	155°E		15:22-15:32	SN	0-200	5°
			15:45-18:30	PCP	0-1800	2~15°
KNOT L	44°N	12 May	17:51-18:26	TN	0-500, 0-150	1~4°
	154°29'E		18:31-18:41	SN	0-200	6°
HP 1	44°40'N	14 May	19:13-19:47	TN	0-500, 0-100	2~10°
	155°50'E		19:55-19:59	SN	0-100	4°
LP 1	44°47'N	15 May	19:23-19:57	TN	0-500, 0-100	3~4°
	156°02'E		20:04-20:16	SN	0-100, 0-50	0~1°
50N	50°N	17 May	21:55-22:32	TN	0-500, 0-150	4~5°
	165°E		22:37-22:45	SN	0-200	0°
		17-18 May	23:45-01:58	PCP	0-1500	0~16°
40N	40°N	20 May	13:50-14:20	TN	0-500, 0-150	0~2°
	165°E		14:25-14:32	SN	0-200	5°
KNOT 2	44°N	24 May	01:58-03:58	PCP	0-1500	3~20°
	155°E		04:25-04:55	TN	0-500, 0-150	16~22°
			04:59-05:08	SN	0-200	10°
LP2	44°31'N	27 May	17:56-18:27	TN	0-500, 0-100	3~14°
	156°12'E		18:31-18:35	SN	0-100	2°
HP 2	44°14'N	27 May	23:01-23:40	TN	0-500, 0-100	3~5°
	156°15'E		23:45-23:49	SN	0-100	3°

Table 3.15. 2. Summary of field sampling data for water samples.

stn.	position	date	time (LST)	depth (m)
KNOT1	44°N 155°E	10 May	22:11	0-250 (phytoplankton) 0-200 (microzooplankton)
		11 May	11:32	0-250 (phytoplankton) 0-200 (microzooplankton)
KNOT L	44°N 154°29'E	12 May	16:27	0-250 (phytoplankton) 0-200 (microzooplankton)
HP1	44°40'N 155°50'E	14 May	11:10	0-100
LP1	44°47'N 156°02'E	15 May	11:10	0-100
50 N	50°N 165°E	17 May	14:29	0-250 (phytoplankton) 0-200 (microzooplankton)
40 N	40°N 165°E	20 May	22:11	0-250 (phytoplankton) 0-200 (microzooplankton)
KNOT2	44°N 155°E	23 May	14:33	0-250 (phytoplankton) 0-200 (microzooplankton)
HP2	44°14'N 156°15'E	27 May	12:21	0-100
LP2	44°31'N 15612E	27 May	21:03	0-100
HP2	44°14'N 156°15'E	28-May	01:07	0-100

3.16 Atmospheric observation

3.16.1 Atmospheric input of iron over the Northwestern North Pacific Ocean.

Shigeto Nakabayashi
(Japan Marine Science and Technology Center)

(1) Introduction

Fe is one of the major elements in the earth's crust. However, its concentration in seawater is extremely low. This low concentration is attributed to the fact that solubility of thermodynamically stable Fe(III) is very low. In other wards, Fe in seawater readily hydrolyzes to form insoluble colloidal hydrous ferric oxides, settling down to the bottom. Because of this high reactivity, its residence time in the ocean is one of the shortest, which is on the order of few hundreds years in deep water and several weeks in surface water.

Fe has been also known as an essential micro-nutrient for the phytoplankton growth in the ocean. Due to its extremely low solubility, however, the concentration becomes so low that phytoplankton growth is subdued where its supply is limited. Thus, the fate of Fe in seawater is closely related to the biological activity. It is very important to know the behavior of Fe in the ocean for the study of the global biogeochemical cycles of carbon and its related elements.

Fe is supplied from river and atmosphere to the ocean surface. However, because of its rapid removal from seawater, riverine dissolved Fe is readily removed within estuary, so that influence of riverine input to the open ocean surface may not be recognized. Therefore the airborne dust has been proposed as a major source of dissolved Fe to the open ocean surface.

The Northwestern North Pacific Ocean is characterized by upwelling of deep water, high nutrients, high primary production and complicated water mass structure (i.e. intermediate water), among others. And also large aeolian input of terrigeneous material to the area is expected. Generally, in the North Pacific the dominant source of the terrigeneous material is Asian dust. Because they can supply Fe over the surface water, they have significant impact on the phytoplankton growth. In addition, seasonal and geographical changes of these features are drastic. This complexity has prevented us from knowing exactly to what extent it plays a role in the global material cycles.

This study is focused on the impact of aeolian input to Fe distribution at the surface water and phytoplankton growth in the Northwestern North Pacific Ocean.

(2) Methods

Atmospheric dust samples were collected for 24 hr. periods using a high volume air sampler Model HVC-1000N (Shibata co.). The sampler was set up on the compass deck with a wind sector control and filtered the air at the rate of about 1000 l min.$^{-1}$. 21 atmospheric dust samples were collected on the 0.6 µm pore size Nuclepore polycarbonate filters (203 x 253 mm) while the ship was steaming or at the stations. After the collection of dust samples, the filters were kept in a freezer until its analysis on the land-based laboratory. Samples collected in this cruise are listed in Table 1.

(3) Future plane

Atmospheric dust filter samples will be analyzed for iron and other metals by ICP-AES or GFAAS after acid digestion. And also dissolution rate and solubility of atmospheric Fe in seawater will be measured. Large aeolian input of terrigeneous material (Asian dust) to the Northwestern North Pacific is expected. Because they can supply Fe over the surface water, they have significant impact on the phytoplankton growth. This study will be focused on the impact of aeolian input to Fe distribution at the surface water and phytoplankton growth in this region.

Table 3.16.1.1. The list of samples.

	Start					End					Volume
No	Date	Time	Station	Lat. (N)	Long. (E)	Date	Time	Station	Lat. (N)	Long. (E)	m^3
1	5/9	13:40	St. T	40-20.6	148-26.5			steaming			491.1
2	5/10	14:13	KNOT 1-1	43-59.2	154-60.0	5/10	14:34	KNOT 1-1	43-59.2	154-60.0	20.3
3	5/11	13:58	KNOT 1-2	44-00.9	155-00.2	5/11	16:03	KNOT 1-2	44-00.9	155-00.2	126.5
4	5/12	16:34	KNOT L	44-00.1	154-28.9	5/13	15:23		44-16.3	155-09.1	974.3
5	5/13	15:29		44-16.3	155-09.1	5/14	15:33		44-46.8	156-01.9	1113.6
6	5/14	15:39		44-46.8	156-01.9	5/15	15:40		44-45.7	156-04.4	1376.9
7	5/15	15:45		44-45.7	156-04.4	5/16	13:00	St. O1	46-55.1	159-43.5	716.9
8	5/16	13:05	St. O1	46-55.1	159-43.5	5/17	11:30	St. 50 N	50-00.0	165-00.0	810.7
9	5/17	11:38	St. 50 N	50-00.0	165-00.0	5/18	13:28	St. 50 N	49-58.5	165-00.9	1200.9
10	5/18	13:34	St. 50 N	49-58.5	165-00.9	5/19	13:15	St. O2	45-38.0	165-00.1	1005.5
11	5/19	13:21	St. O2	45-38.0	165-00.1	5/20	14:30	St. 40 N	40-00.3	165-00.8	1167.5
12	5/20	14:48	St. 40 N	40-00.3	165-00.8	5/21	15:24	St. 40 N	40-00.1	165-00.0	906.6
13	5/21	15:29	St. 40 N	40-00.1	165-00.0	5/22	12:57	St. O3	41-55.6	160-00.0	1193.4
14	5/22	13:02	St. O3	41-55.6	160-00.0	5/23	12:47	KNOT 2-1	44-00.2	154-58.7	403.1
15	5/23	13:50	KNOT 2-1	44-00.2	154-58.7	5/24	16:08	grid survey	44-25.8	155.32.2	853.7
16	5/24	16:13	grid survey	44-25.8	155.32.2	5/25	12:58	grid survey	44-08.1	155-22.2	1168.6
17	5/25	13:02	grid survey	44-08.1	155-22.2	5/26	13:03	grid survey	44-25.8	155-25.5	1163.0
18	5/26	13:07	grid survey	44-25.8	155-25.5	5/27	13:48	HP 2-1	44-15.1	156-11.5	1025.3
19	5/27	13:53	HP 2-1	44-15.1	156-11.5	5/28	13:24		44-07.2	156-20.0	1228.5
20	5/28	13:29		44-07.2	156-20.0	5/29	13:09	steaming	41-52.2	151-04.7	1035.3
21	5/29	13:13	steaming	41-52.2	151-04.7	5/30	13:10	steaming	40-34.8	144-26.9	1147.9

3.16.2 Atmospheric aerosol and ozone in the marine boundary layer

Kiyoshi Matsumoto and Mitsuo Uematsu
(Ocean Research Institute, The University of Tokyo)

(1) Introduction

Tropospheric aerosols are important in the global radiation budget through reflection and absorption of solar radiation (direct forcing), and through the modification of optical properties and the lifetime of clouds (indirect forcing). Global geographical and seasonal distributions of tropspheric aerosols have attracted considerable attention during the past several decades. Especially, the importance of the western North Pacific region has been recognized in the recent studies, due to the long-range transport of anthropogenic and terrestrial aerosols from East Asia to the remote ocean.

In order to investigate the chemical and physical properties of marine aerosols over the western North Pacific Ocean, the measurements of atmospheric aerosols have been carried out during this cruise. Simultaneously, the concentration of ozone, which is a good indicator of air masses in marine boundary layer, has been measured.

(2) Experimental

The measurements of carbonaceous aerosols were conducted for every 2 hours by using an ambient carbon particulate monitor (Rupprecht & Patashnick Co. Inc., Model 5400). The instrument can measure both the organic and elemental carbon in aerosols by a thermal analysis technique. Organic carbon were measured by the combustion at 340°C, and then total carbon were measured at 750°C. The difference of the amounts of the total and organic carbon gives the amount of elemental carbon.

Particle number concentrations were measured by using two particle counters (RION, Model KC-18 and Model KC-01). The number concentrations of relatively small particles were measured by the KC-18 counter with 5 size ranges (0.10, 0.15, 0.20, 0.30, 0.50µm <d) for every 10 min. On the other hand, those of relatively large particles were measured by the KC-01 counter with 5 size ranges (0.30, 0.50, 1.0, 3.0, 5.0µm <d) for every 20 min.

In this study, atmospheric aerosols only with diameter < 2.5µm were injected into the carbon particulate monitor and the KC-18 counter by using PM2.5 cyclone (50% cutoff efficiency for 2.5µm particle).

Ozone concentrations were measured at 12 seconds interval by an ozone analyzer (Dylec, Model 1150).

The inlets of air for the carbon particulate monitor, the ozone analyzer and the particle counters were located on the compass deck (about 17m above the sea surface).

Bulk aerosol samples were collected for about 12 hour periods on cellulose acetate filters (Whatman 41) by using a cassette high-volume aerosol sampler (Kimoto Co. Inc.), which is equipped with automatic filter exchange system, and on cellulose acetate filters (Whatman 41) by a high-volume aerosol sampler (Kimoto Co. Inc.). After collections, the samples were stored at ambient temperature prior to analysis. Size-fractionated aerosols samples were collected for about 5 day periods on quartz fiber filters (Pallflex 2500QAT-UP) by using an Andersen low pressure impactor (Tokyo Dylec, LP-20), which can be segregated into 13 size fractions (50% effective cutoff diameter of each impactor stages are 0.06, 0.13, 0.21, 0.31, 0.51, 0.71, 1.2, 2.2, 3.6, 5.3, 8.0, 11μm.). Before sampling, quartz fiber filters have been heated at 500°C for 4 hour. After collections, the samples were stored at -20°C prior to analysis. In order to avoid contamination from the ship exhaust, aerosol samplers were automatically controlled by a wind sector to start sampling only when the relative wind direction was within ± 90°C of the bow and the relative wind speed was higher than 1.0m/s.

Rainwater samples were collected by using a rain sampler (Shibata Co., W-102) with in-situ filtration by each rain event basis. After collections, the value of pH and electrical conductivity were measured immediately, and then the samples were stored in polypropylene bottles at 4°C.

The collections of aerosol and rainwater were carried out on the compass deck.

(3) Preliminary Results

Ozone

The concentrations of ozone during the cruise are shown in Figure 3.16.2.1. Relatively high concentrations were detected throughout the cruise, since the present research area is higher latitudinal oceanic region. Due to the anthropogenic effects, the concentrations increased near the Japan Islands. During 21-22 May, drastic decrease of ozone concentrations were detected, probably due to the invasion of subtropical air mass, of which ozone concentrations generally show lower values, accompany with movement of the low pressure system to the north.

Carbonaceous aerosols

The concentrations of particulate organic and elemental carbon are shown in Figure 3.16.2.2 Both revealed lower concentrations over the remote oceanic region, whereas enhanced concentrations of both can be seen near the Japan Island, showing anthropogenic effects.

(3) Future Plan

Bulk aerosol samples and rainwater samples will be analyzed for major inorganic ions. Size-fractionated aerosol samples will be analyzed for organic compounds. After the determination of data quality, the separation of air masses will be attempted by the meteorological data observed on the ship. It may be possible to discuss the geographical characteristics of the chemical properties of atmospheric aerosols and the influence of air mass history and meteorological conditions to the aerosol chemistry over the western North Pacific Ocean.

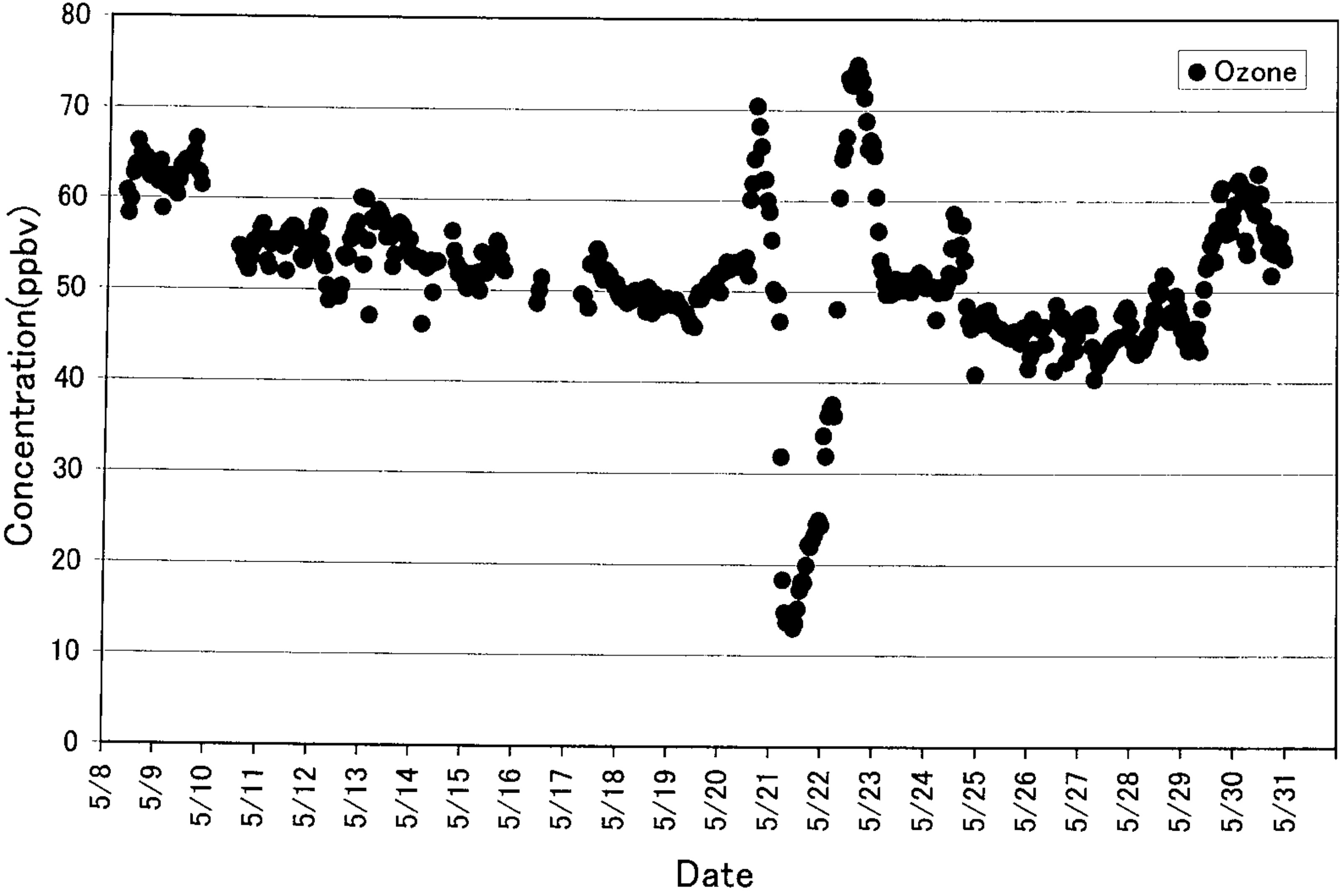

Figure 3.16.2.1 Temporal variation of ozone concentrations.

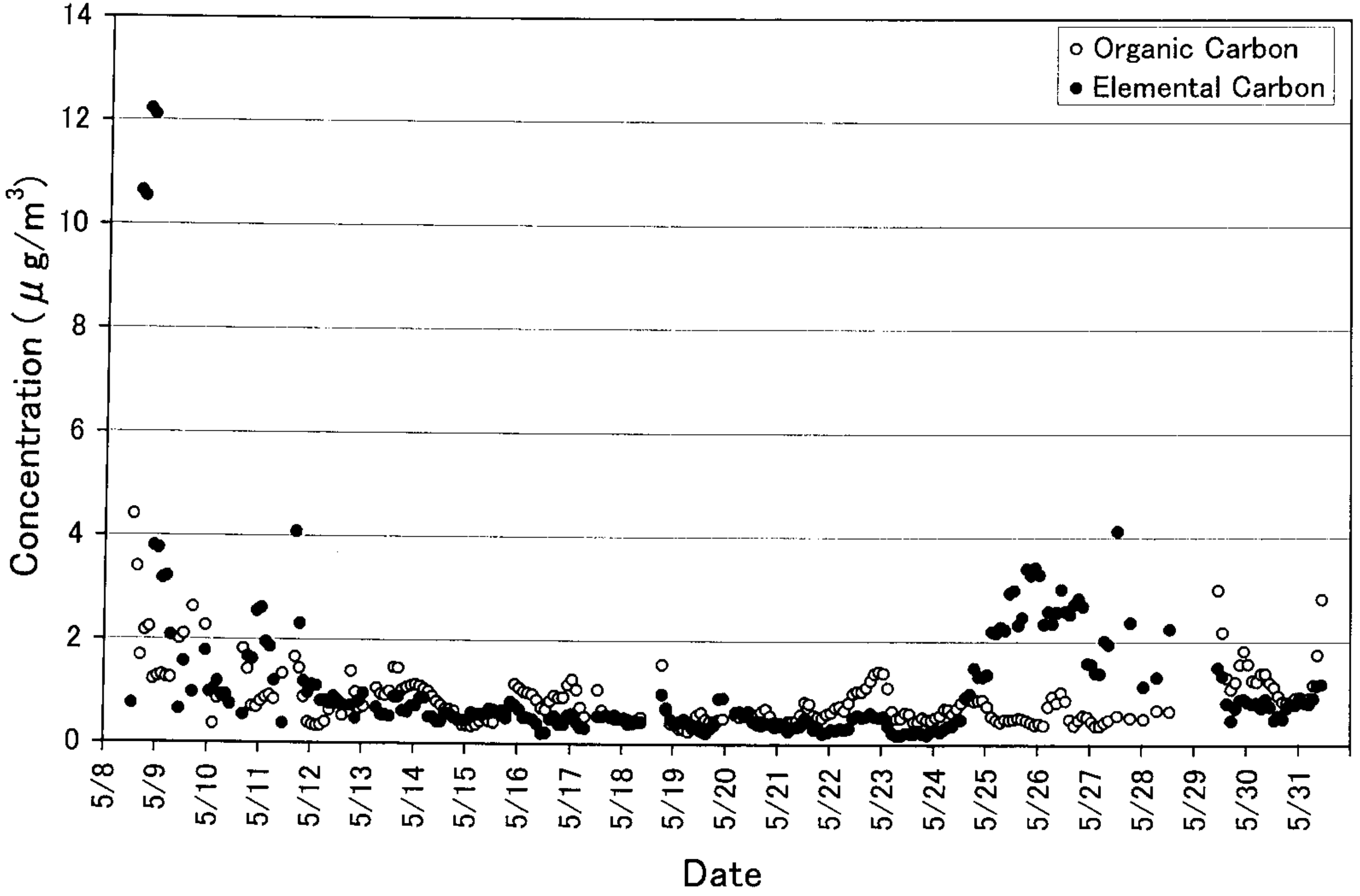

Figure 3.16.2.2 Temporal variation of carbonaceous aerosol concentrations.

3.16.3 Nonmethane hydrocarbons and ozone measurements over the western North Pacific

Takuya Saito, Masahiro Narukawa and Kimitaka Kawamura
(Institute of Low Temperature Science, Hokkaido University)

(1) Introduction

Recently, it has been discussed that halogen atoms may be of considerable importance for the tropospheric chemistry. They may affect the oxidizing capacity of the atmosphere, especially, the atmospheric removal rate of nonmethane hydrocarbons (NMHCs) and ozone. However, presently there is no method which allow the direct measurement of halogen atoms. Consequently, the evidence for the existence of relevant levels of halogen atoms is only indirect. Logarithmic plots of the ratios of hydrocarbon concentrations are such an indirect method to gain insight into their reactions with halogen atoms, especially, chlorine atoms.

For a few atmospheric trace gases, concentration measurements have been complemented by determinations of their isotopic composition. Such information has provided additional constraints on budgets and removal mechanism. Although very few measurements of isotopic composition are available for NMHCs, the isotopic composition ($\delta^{13}C$) of NMHCs may be a very valuable tracer for better understanding of chlorine atom chemistry in the troposphere.

(2) Methods

Air samples (n=45) were collected on the compass deck of R/V Mirai by pressurizing the stainless canisters with metal bellows pump to about 1.5 atm. Tropospheric ozone was measured every 12 seconds by an ozone monitor (Dylec, 1150). The air was drawn through a Teflon line (1/4' OD) using a pump. The air intake was located on compass deck.

(3) Future plan

The sample analysis will be made in the laboratory for NMHCs. NMHCs in the canister will be concentrated using a preconcentration unit and measured using a GC equipped with a flame ionization detector. Measurements of $\delta^{13}C$ of NMHCs will be made by isotope ratio mass spectrometer (IRMS) interfaced to a capillary gas chromatograph and on-line combustion system. After the determination of data quality, these data will be used to investigate the possible impact of chlorine atom on the removal processes of NMHCs over the western North Pacific.

3.16.4 Organic aerosols over the western North Pacific

Masahiro Narukawa and Kimitaka Kawamura
(Institute of Low Temperature Science, Hokkaido University)

(1) Introduction

For marine organic aerosol study, western North Pacific is an interesting oceanic region. During spring season, transport of anthropogenic and terrestrial materials from East Asian continent is intensified and the spring blooms of phytoplankton occur in this region. An intensified transport of organic compounds to the marine environments as well as sea-to-air flux of volatile and particulate materials from the ocean change the composition of marine aerosols, and may have an influence on the optical and microphysical properties of clouds in the western North Pacific.

Previous studies on the marine organic aerosols have shown that water-soluble organic acids including low molecular weight dicarboxylic acids are abundant in the marine aerosols (Kawamura and Usukura, 1993). They comprise up to 18% of the total aerosol carbon in the Pacific atmosphere and their latitudinal distribution suggested that the low molecular weight diacids are produced in the marine atmosphere by photochemical oxidation of various organic compounds, mostly light hydrocarbons and oxygen-containing organic compounds (Kawamura and Sakaguchi, 1999). Further, water-soluble organics alter hygroscopic behavior of atmospheric particles, suggesting that water-soluble organic compounds play an important role in controlling cloud albedo by acting as CCN. The cloud activity may compensate the potential global warming caused by the increased concentrations of greenhouse gases such as carbon dioxide.

Properties of aerosols depend on the size distribution as well as chemical composition. The aim of our studies in this expedition is to clarify the size distribution of low molecular weight dicarboxylic acids and their spatial distributions.

(2) Samples

Marine aerosol samples were collected on compass deck of R/V Mirai using a pre-combusted (450°C, 3hours) quartz fiber filter (Pallflex, 2500QAT-UP) and high volume air sampler (Kimoto, 120F) or high volume air sampler with Andersen type 5-stage impactor (Shibata, HVC-1000N). Filter samples were stored in a pre-cleaned glass jar with a Teflon-lined screw cap at 20°C prior to analysis. Rainwater samples were also collected using a stainless steel rain collector. The rain samples were stored in a brown-colored glass bottle with a Teflon-lined screw cap, to which small amount of HgCl2 was added as bactericide.

(3) Future Plan

Aerosol samples will be analyzed for low molecular weight diacids. Aliquots of aerosol filter samples will be extracted with pure water for the isolation of dicarboxylic acids. The extracts will be concentrated and then esterified with 14% borontrifluoride in n-butanol to derive dicarboxylic acid dibutyl esters. The esters will be determined using a GC and GC/mass spectrometer.

Based on the size distribution of diacids, we will estimate relative contribution of the continental and marine source inputs to diacids in the marine aerosols. Comparison of this study with the previous study also may characterize the aerosols in this region during spring season.

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Kawamura, K. and K. Usukura, Distribution of low molecular weight dicarboxylic acids in the North Pacific aerosol samples, J. Oceanogr., 49, 271-283, 1993.

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3.17 Underway observation

3.17.1 Partial pressure of CO2 (pCO2) in the atmosphere and sea surface

Akihiko Murata (JAMSTEC)
Mikio Kitada (MWJ)

Concentrations of CO2 in the atmosphere and the sea surface were measured continuously during the entire cruise by the automated system with a non-dispersive infrared (NDIR) analyzer (BINOSTM). It runs on half hour or two hours cycle during which four standards, an ambient air sample, and a head space sample from the equilibrator were analyzed.

The ambient air sample taken from the bow is introduced into the NDIR through a mass flow controller which controls the air flow rate at about 0.5L/min, a cooling unit, a perma pure dryer, and a desiccant holder (Mg(ClO4)2).

The equilibrator has shower head space in the top through which surface water is forced at a rate of 5-8L/min. Air in the head space is circulated with an air pump at 0.5-0.8L/min in a closed loop through two cooling units, a perma pure dryer, and the desiccant holder.

For calibration, compressed gas standards with nominal mixing ratios of 270, 330, 360, 410, ppmv (parts per million by volume) were used.

In this cruise, measurement of discrete pCO2 was also tested. From this test, it was found that ratio of air to seawater in an equilibrator should be changed for more efficient equilibration.

3.17.2 Measurement of CO2 in the atmosphere and in surface seawater

Takeshi Egashira
(Japan Science and Technology Corporation)

(1) Introduction

Concentrations of the partial pressure of CO2 (pCO2) in surface seawater were measured continuously during the cruise. There were three primary objectives of the cruise. First was to assess pCO2 at the station KNOT. Second was to measure pCO2 during the cruise. Third was to discover occuring bloom.

(2) Methods

Surface seawater is pumped up to a Tandem-style equilibrator (Kimoto Electric Co., Ltd.) and the gases were equilibrated with a headspace of the equilibrator. After equilibration the headspace gas was dried and analyzed using a standardized infra-red analyzer. The pCO2 in surface seawater was measured using the infra-red analyzer with an estimated precision of approximately 0.05 ppm.

(3) Future plan

We have three plans for pCO2 data. First is to add GPS, atmospheric pressure, seawater temperature, and salinity data. Second is to correct data with salinity, pressure, and warming. Third is to extract and assess data around station KNOT.

3.17.3 Salinity, temperature, DO, and fluorescence

Nobuharu Komai, Katsunori Sagishima
(Marine Works Japan Ltd.)
Hajime Kawakami
(Japan Marine Science and Technology Center)

(1) Introduction

To monitor continuously the physical, chemical and biological characteristic of sea surface water and to find the bloom during this cruise.

(2) Methods

The Continuous Sea Surface Water Monitoring System is located in the "sea surface monitoring laboratory" on R/V Mirai. It can automatically measure temperature, salinity, dissolved oxygen, fluorescence and particle size of plankton in the surface water every one minute. Measured data are saved every one minute together with time and the position of ship, and displayed in the data management PC machine. This system is connected to shipboard LAN-system and provides the acquired data for pCO2 measurement system, etc.

Sea surface water was continuously pumped up from the seachest of the ship at 4 meters depth to the laboratory and then flowed into the Continuous Sea Surface Water Monitoring System and pCO2 measurement system etc. through a steel pipe. The flow rate of surface water for the Continuous Sea Surface Water Monitoring System was controlled by some valves and passed through some sensors i.e. temperature, salinity and dissolved oxygen etc. through vinyl-chloride pipes. At this cruise, the picture of PC machine were showed to TV monitor of the ship. Mr. Furuta of GODI did it for us.

This system have six kinds of sensor, specification and calibration date of the each sensors are listed below.

a-1) Temperature and salinity sensors

SEACAT THERMOSALINOGRAPH

Model:	SBE-21, SEA-BIRD ELECTRONICS, INC.
Serial number:	2113117-2088
Measurement range:	Temperature -5 to +35 deg-C, Salinity 0 to 6.5 S/m
Accuracy:	Temperature 0.01 deg-C/6month, Salinity 0.001 S/m/month
Resolution:	Temperature 0.001 deg-C, Salinity 0.0001 S/m
Calibration date:	09-Jan-99 (mounted on 5-May-99 in this system)

a-2) Ship bottom oceanographic thermometer (mounted at the back of the pump for surface water)

Model: SBE 3S, SEA-BIRD ELECTRONICS, INC.
Serial number: 032175
Measurement range: -5 to +35 deg-C
Initial Accuracy: 0.001 deg-C per year typical
Stability: 0.002 deg-C per year typical
Calibration date: 30-Dec-98 (mounted on 23-Apr-99 in this system)

b) Dissolved oxygen sensor

Model: 2127, Oubisufair Laboratories Japan INC.
Serial number: 31757
Measurement range: 0 to 14 ppm
Accuracy: ±1% at 5 deg-C of correction range
Stability: 1% per month
Calibration date: 7-May-99

c) Fluorometer

Model: 10-AU-005, TURNER DESIGNS
Serial number: 5562 FRXX
Detection limit: 5 ppt or less for chlorophyll a
Stability: 0.5% per month of full scale

d) Particle size sensor

Model: P-05, Nippon Kaiyo LTD.
Serial number: P5024
Accuracy: ±10% of range
Measurement range: 0.02681mm to 6.666mm
Reproducibility: ±5%
Stability: 5% per week

e) Flowmeter

Model: EMARG2W, Aichi Watch Electronics LTD.
Serial number: 8672
Measurement range: 0 to 30 L/min
Accuracy: ±1%
Stability: ±1% per day

(3) Preliminary Result

In order to calibrate the data from this system, seawater samples were collected from the system. For salinity validation we sampled once a day from the system during this cruise (except with the 18-May-99). All salinity samples were analyzed by an Autosal salinometer (see section 3.3.3) and the results were shown in table 3.17.3-1.

We compared salinity values of the water samples and those from SBE21 sensor of the system (Fig. 3.17.3-1). There was not a constant trend of difference during this cruise. We calculated the Root Mean Squares (R.M.S.) of difference of salinity value for 19 samples and it was 0.0178 (one sigma) except with the data which difference was ca.1PSU.

D.O. sensor of this system was calibrated just before this cruise. To estimate of accuracy of the sensor, we collected the 10 samples from the course of the system and analyzed by Winkler method (see section 3.3.1). The results were shown in table 3.17.3-2 and Fig. 3.17.3-2. Calculated R.M.S. of differences of D.O. value was 0.255 ml/l (one sigma).

Preliminary data every 10 minutes from Sekinehama to Stn. KNOT, Stn. KNOT to Stn. 50N, Stn. 50N to Stn. 40N, Stn. 40N to Stn. KNOT2, Stn. KNOT2 to sekinehama were shown in Fig. 3.17.3-3 ~ Fig. 3.17.3-7, respectively. They showed the respective trend of temperature, salinity, D.O. and fluorescence distributions on the ship's track.

(4) Other remarks

The data from the particle size sensor were not reliable, because the setting of the sensorwas not good. We cleaned the flow cell of fluorometer at Sekinehama just before this cruise.

(5) Data archive

All the files of raw data, Microsoft excel files of raw data, excel files divided into each 10minutes data were stored on a magnetic optical disk. All the data will be submitted to the DMO at JAMSTEC.

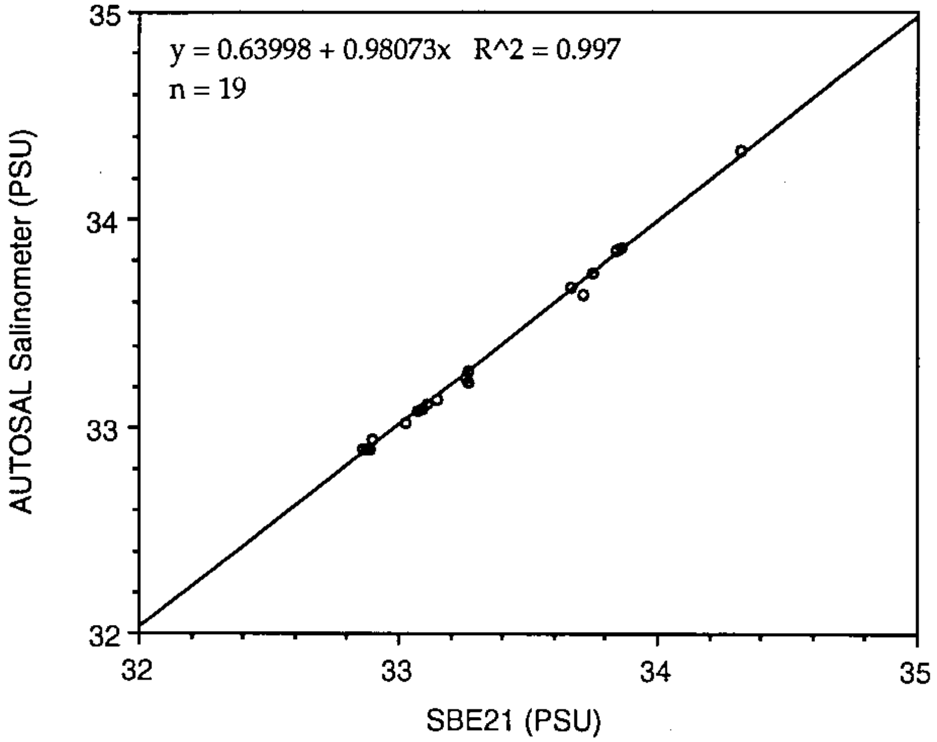


Fig. 3.17.3-1 Comparison between the salinity values measured by SBE21 of the Sea Suraface Monitoring System and by Autosal salinometer for 19 samples obtained during MR98-K02 cruise.

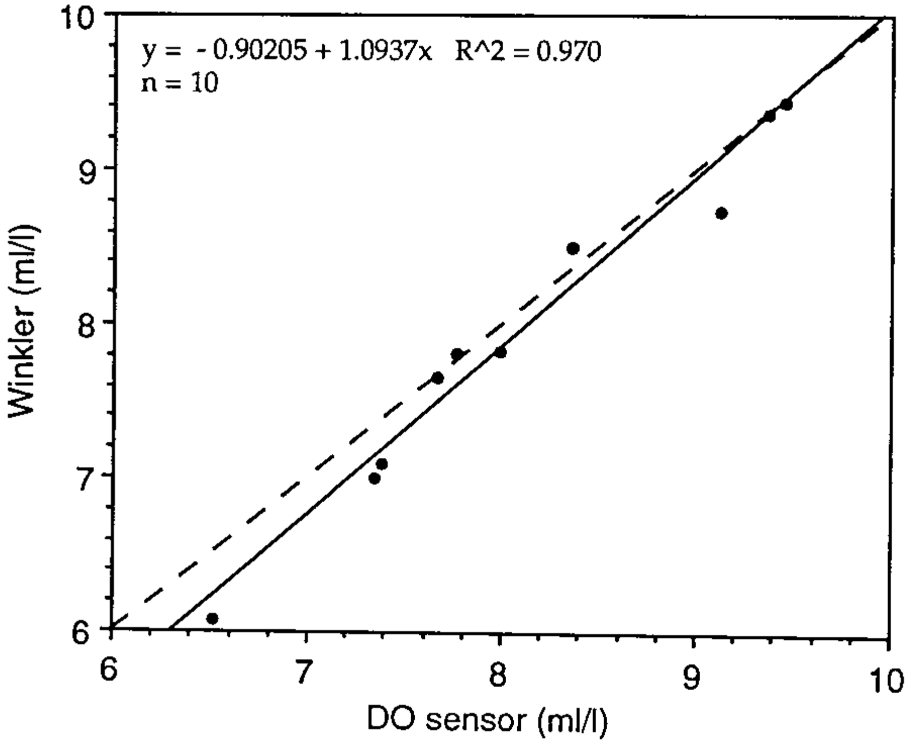


Fig. 3.17.3-2 Comparison between the D.O. value measured by D.O. sensor of the Sea Suraface Monitoring System and by Winkler method for 10 samples obtained during MR99-K02 cruise.

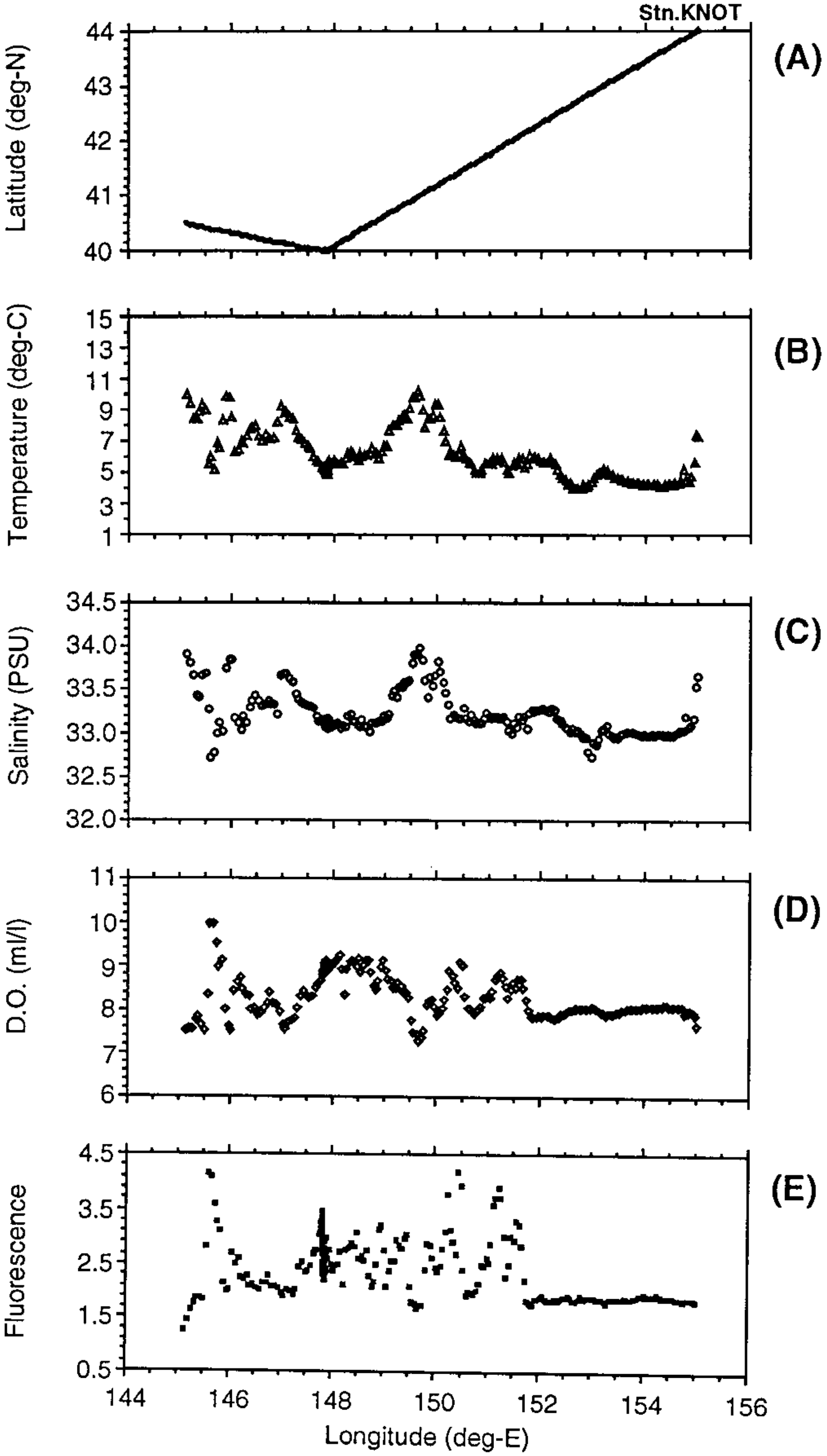


Fig 3.17.3-3 Ship's track (A), temperature (B), salinity (C), D.O. (D) and fluorescence (E) of suface water from Sekinehama to Stn. KNOT. Note: Salinity and D.O. in this figure is not corrected.

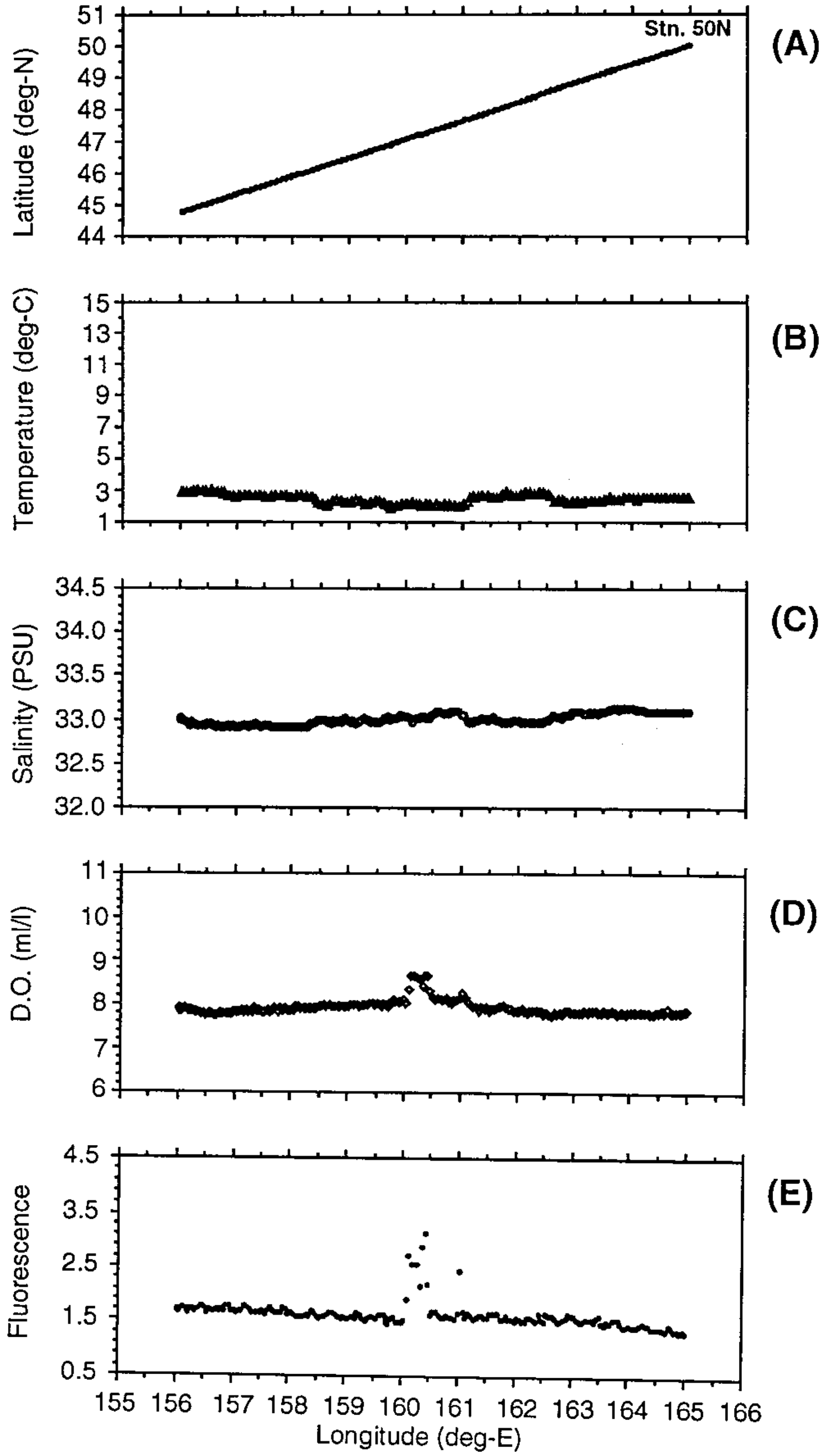


Fig 3.17.3-4 Ship's track (A), temperature (B), salinity (C), D.O. (D) and fluorescence (E) of suface water from Stn. KNOT to Stn. 50N.
Note: Salinity and D.O. in this figure is not corrected.

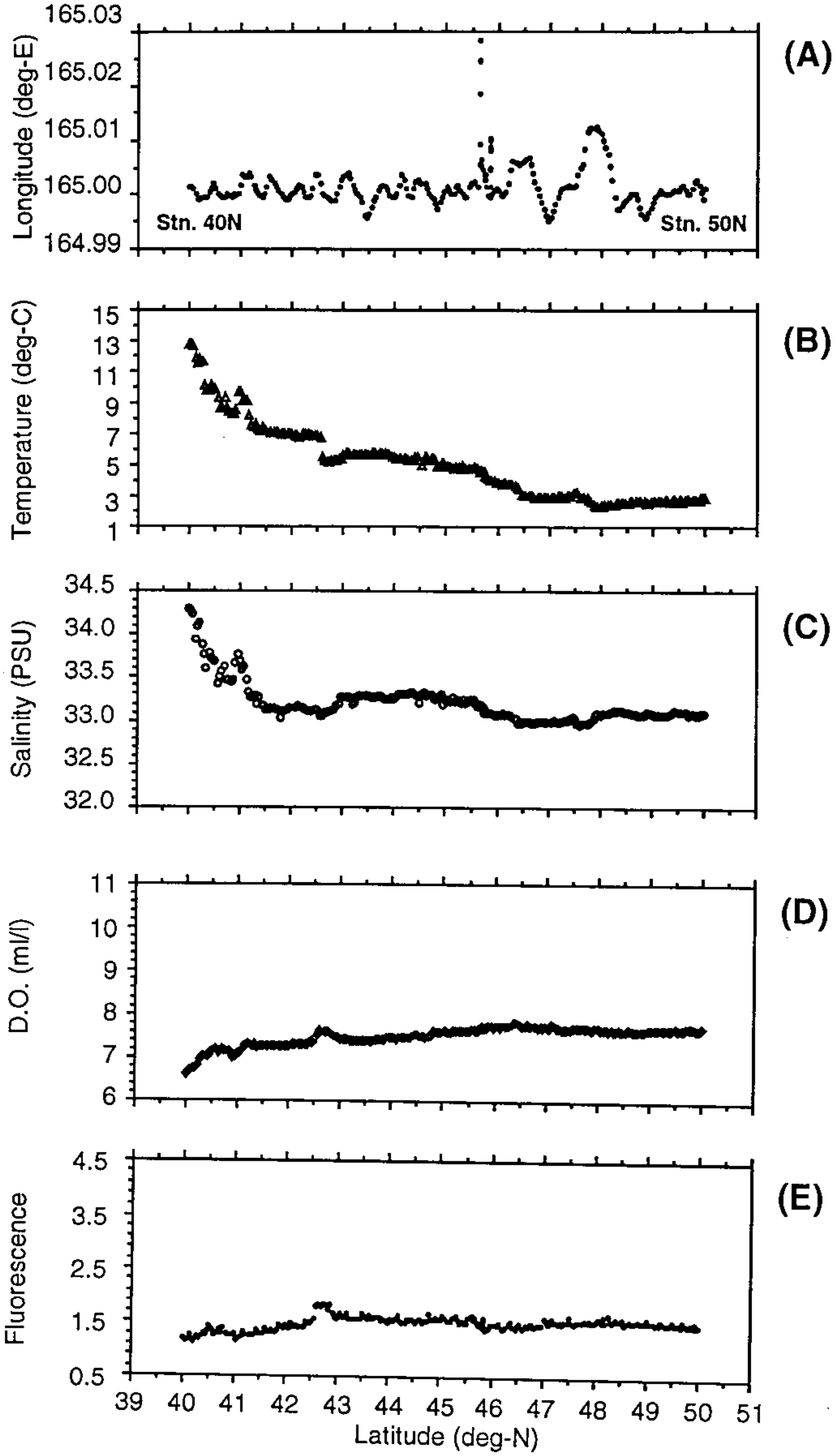


Fig 3.17.3-5 Ship's track (A), temperature (B), salinity (C), D.O. (D) and fluorescence (E) of suface water from Stn. 50N to Stn. 40N.
Note: Salinity and D.O. in this figure is not corrected.

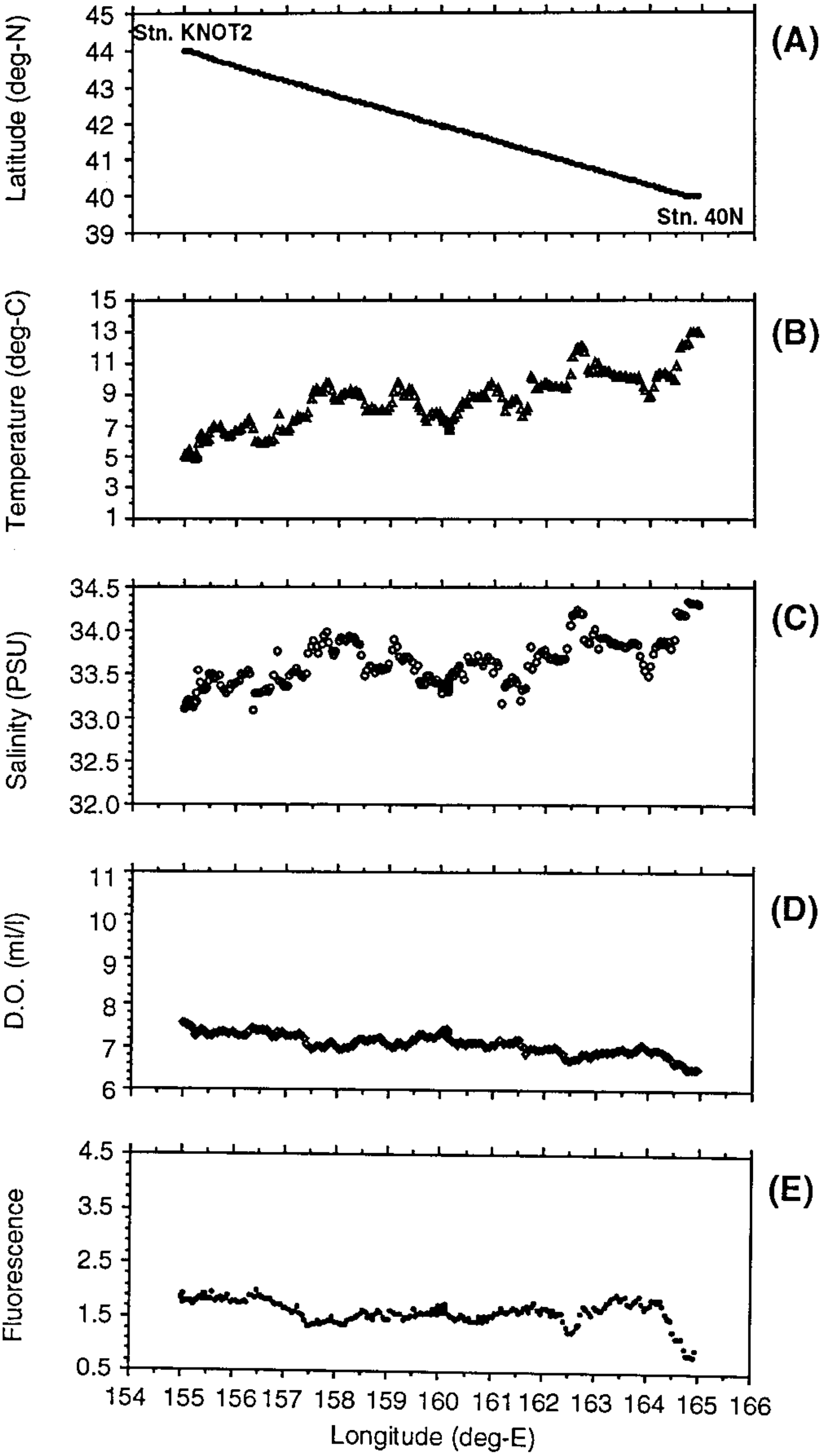


Fig 3.17.3-6 Ship's track (A), temperature (B), salinity (C), D.O. (D) and fluorescence (E) of suface water from Stn. 40N to Stn. KNOT2.
Note: Salinity and D.O. in this figure is not corrected.

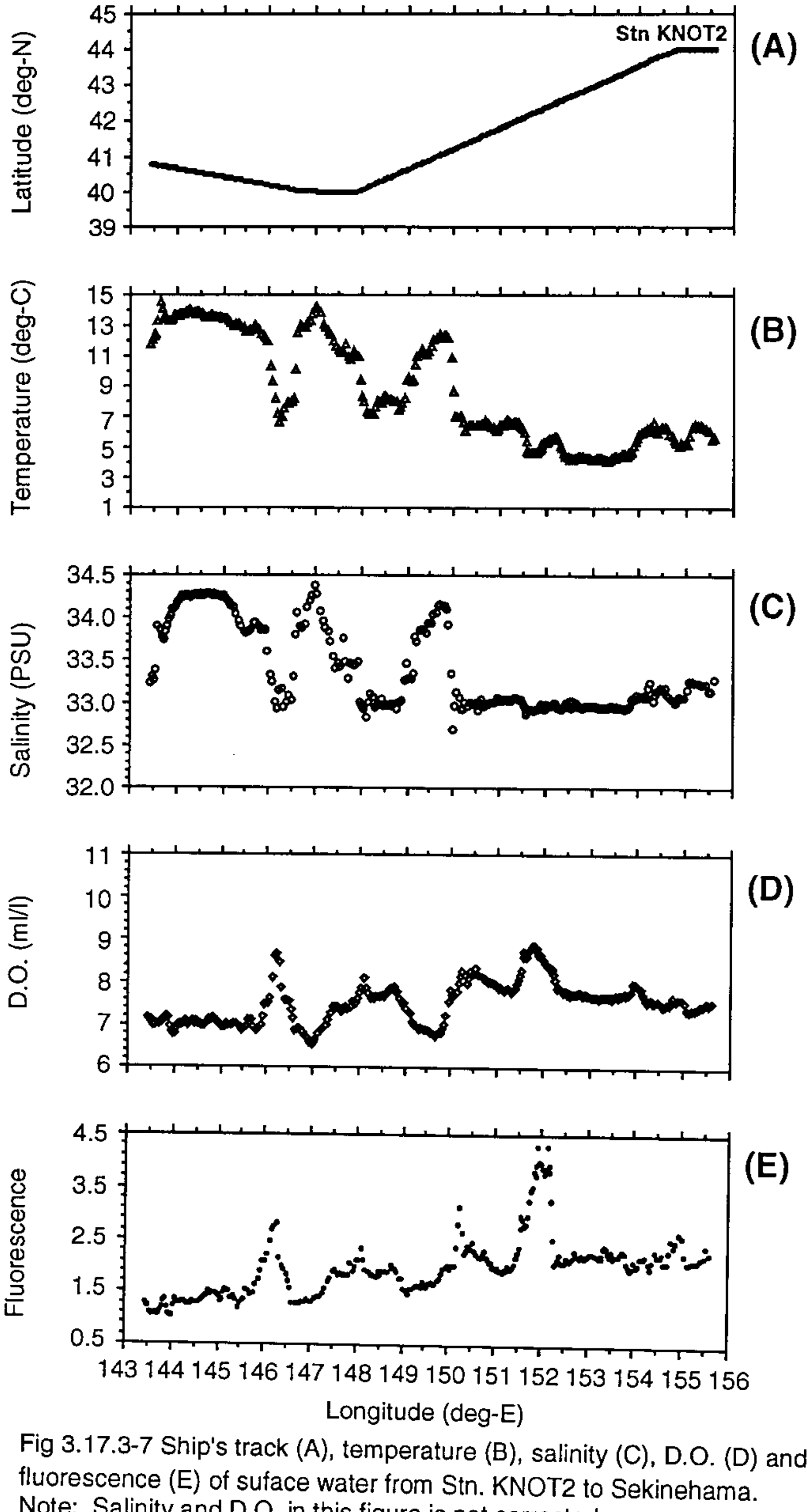


Fig 3.17.3-7 Ship's track (A), temperature (B), salinity (C), D.O. (D) and fluorescence (E) of suface water from Stn. KNOT2 to Sekinehama. Note: Salinity and D.O. in this figure is not corrected.

Table 3.17.3-1 Comparison between the salinity values based on water samples using an Autosal salinometer and SBE21sensor of the Sea Surface Monitoring System.

Sampling (UTC)		Latitude	Longitude	Temp	Salinity (PSU)		Difference (PSU)
Date	Time			(deg-C)	SBE21	Salinometer	SBE21-Salinometer
5/9/99	4:37	40-18.622N	148-23.003E	6.0833	33.1444	33.1345	0.0099
5/10/99	9:32	43-59.006N	155-00.508E	7.5322	33.6673	33.6737	-0.0064
5/11/99	4:25	44-00.455N	155-00.386E	7.9367	33.7501	33.7453	0.0048
5/12/99	2:10	44-15.045N	155-04.570E	4.8229	33.2648	33.2204	0.0444
5/13/99	9:40	44-43.140N	155-56.006E	2.8527	33.0270	33.0239	0.0031
5/14/99	4:20	44-39.738N	155-50.127E	2.6209	32.8796	32.8919	-0.0123
5/15/99	4:24	44-37.153N	155-59.699E	2.7773	32.8864	32.8941	-0.0077
5/16/99	7:41	47-30.057N	160-42.301E	2.0801	33.0784	33.0797	-0.0013
5/17/99	8:09	49-59.570N	164-59.528E	2.6643	33.0933	33.0879	0.0054
5/19/99	6:20	45-08.013N	165-00.014E	4.8264	33.2622	33.2452	0.0170
5/20/99	14:58	40-00.494N	165-00.316E	12.8457	34.3264	34.3268	-0.0004
5/21/99	14:10	40-33.183N	163-21.139E	10.2475	33.8471	33.8517	-0.0046
5/22/99	14:54	43-14.851N	156-48.692E	7.4814	33.7131	33.6348	0.0783
5/23/99	7:27	44-02.041N	154-59.062E	5.1382	33.1087	33.1143	-0.0056
5/24/99	13:26	44-10.044N	154-59.996E	4.3823	33.0247	32.0319	0.9928
5/25/99	14:05	44-58.765N	155-50.119E	3.4509	32.8939	32.9384	-0.0445
5/26/99	14:03	44-19.377N	156-04.937E	2.9032	32.8589	32.8914	-0.0325
5/27/99	5:05	44-15.171N	156-11.630E	3.0616	32.8863	32.8865	-0.0002
5/28/99	9:02	44-00.007N	155-10.470E	6.5380	33.2681	33.2770	-0.0089
5/29/99	10:24	40-57.725N	149-30.184E	11.7012	33.8587	33.8633	-0.0046

Table 3.17.3-2 Comparison of D.O. values between a D.O. sensor of Sea Surface Monitoring System and water samples from the system using Winkler method.

Sampling (UTC)		Latitude	Longitude	Salinity (PSU)	Tempature (deg-C)	D.O. Sensor (ml/L)	Winkler (ml/L)	Difference (ml/L) (Sensor - Winkler)
Date	Time							
1999/5/9	4:34	40-18.140N	148-22.187E	33.158	6.132	9.122	8.741	0.381
1999/5/10	9:30	43-59.002N	155-00.505E	33.668	7.532	7.379	7.099	0.280
1999/5/10	15:23	43-59.054N	155-00.299E	33.684	7.551	7.344	7.004	0.340
1999/5/12	9:38	44-00.501N	154-28.328E	32.960	4.305	7.989	7.824	0.165
1999/5/14	4:24	44-39.724N	155-50.186E	32.886	2.603	9.456	9.443	0.013
1999/5/15	4:30	44-37.229N	156-00.087E	32.890	2.765	9.371	9.367	0.004
1999/5/17	8:06	49-59.570N	164-59.553E	33.091	2.698	7.765	7.815	-0.050
1999/5/20	15:03	40-00.584N	165-00.321E	34.321	12.850	6.522	6.073	0.449
1999/5/23	7:32	44-02.072N	154-59.066E	33.116	5.128	7.662	7.657	0.005
1999/5/27	13:50	44-14.224N	156-12.554E	32.880	3.070	8.354	8.507	-0.153

3.17.4 Nutrients monitoring in sea water

Kenichiro SATO (MWJ)
Chizuru SAITO (JAMSTEC)

(1) Sea surface nutrients measurement

The distributions of nutrients of sea surface water are important to investigate the primary production. The nutrients were measured colorimetrically by BRAN + LUEBBE nutrients monitoring system. This system was located in the sea surface water monitoring laboratory on R/V Mirai. Sea surface water pumped up to laboratory, and drawn into this monitoring system continuously.

(2) Preliminary results

We have not corrected surface nutrient data yet, but when the blooming occurred we got the trend of nutrient concentration sharply decreased (see figure 3.17.4.1). In the latter half of this cruise, base line for silicate measurement became unstable, because it might be a contamination of silicate line or so, but other 3 elements (nitrate + nitrite, nitric and phosphate) were almost coincident with routinely surface nutrient concentrations.

These data are stored in MO disk in Ocean Research Department in JAMSTEC.

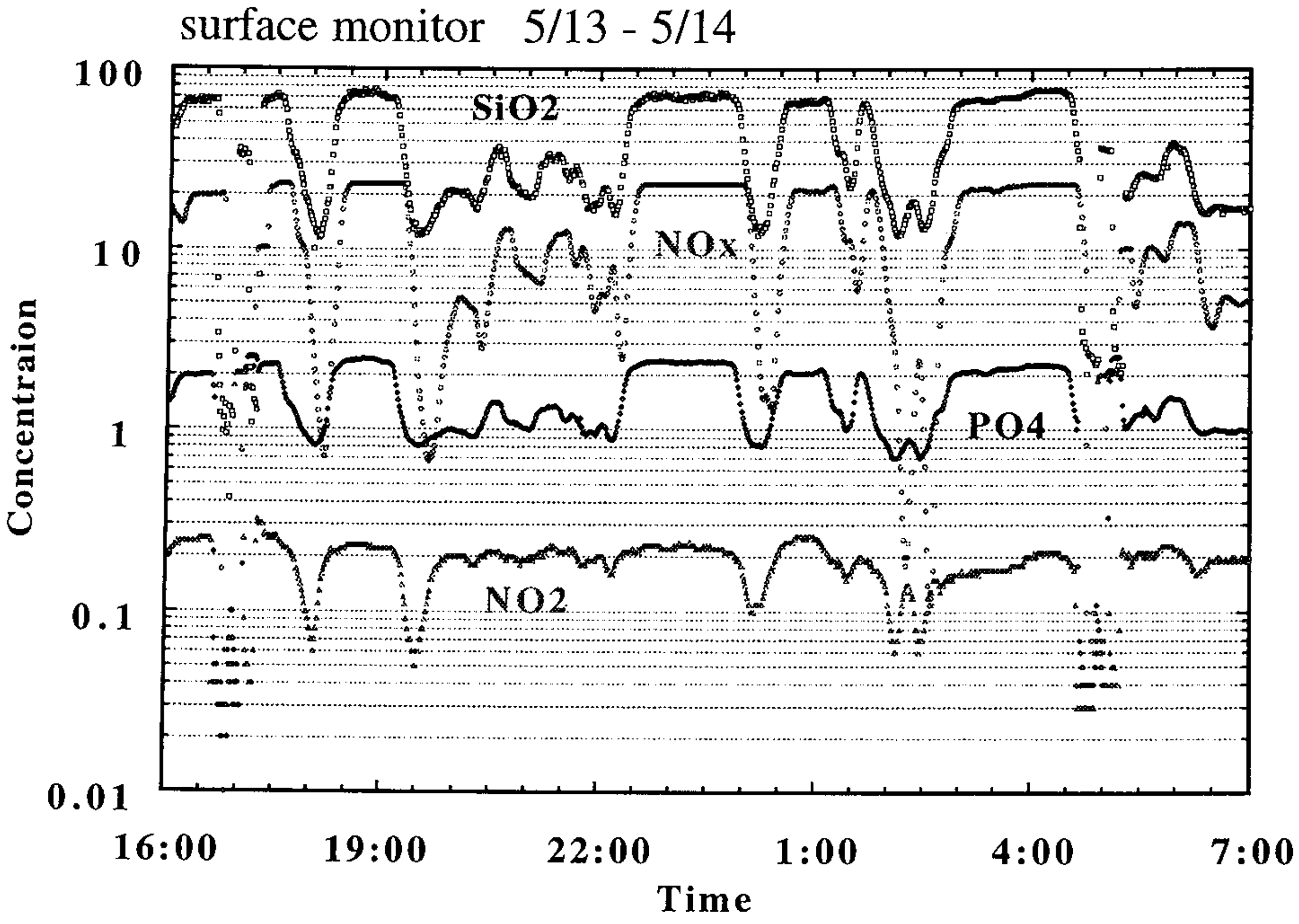


Fig. 3.17.4 Change in nutrients measured by nutrients monitoring system along the cruise track (13 - 14, May) . Note that concentrations have not been corrected yet.

3.18 Sea floor sediment sampling and study on geochemical cycle on sea floor

Koh Harada (National Institute for Resources and Environment)
Yoko Shibamoto (National Institute for Resources and Environment)
Toshikatsu Sugawara (Marine Works Japan Ltd.)

(1) Introduction

Water-sediment boundary is a place where biogeochemical processes actively occur. To clarify regeneration process of nutrients, balances of the nutrients at the boundary are investigated by measuring the nutrient concentration in pore water.

Sediment particles near the boundary are well mixed by organisms at sea floor. To clarify the space and seasonal variation of the bioturbation, shot lived radio-nuclides are also investigated.

(2) Methods and preliminary result

Sediment core sampling were conducted at two stations, STN 50N and STN KNOT-2 using with a Multiple Corer. The coring logs are shown in Table 3.18.1. Eight non-disturbed cores of which length was about 30 cm were successively collected at both stations. Immediately after recovering the corer on the deck, four of the eight cores from each station were sliced in about 3.5 mm thick each for topmost ten sub-samples, about 7 mm thick each for the next ten sub-samples and about 14 mm thick each for other sub-samples down to the bottom. Pore water samples were squeezed by centrifugation at 2^{o}C from sub-samples of the two cores. Concentrations of silicate, phosphate, nitrate and nitrite were determined by an Auto Analyzer.

Sub-samples from the another three cores at STN 50N and two cores at STN KNOT-2 were kept in a freezer and brought to the land laboratory in NIRE. Concentrations of ^{234}Th, ^{210}Pb and ^{210}Po will be determined. For general information of the geochemical properties, water content, concentration of CaCO3, biogenic silica and sedimentation rate by ^{230}Th method will be also investigated. The vertical profiles of the water content were shown in Fig. 3.18.1.

Core description was drawn from one non-sliced core. X-ray photographs were also taken from the same core. The core descriptions were shown in Fig. 3.18.2.

Other cores were distributed as follows:

STN 50

Determination of artificial chemicals (Tokyo University of Fisheries)

Determination of ^{14}C (JAMSTEC)

STN KNOT-2

Determination of artificial chemicals (Tokyo University of Fisheries)

Determination of ^{14}C (JAMSTEC)

Determination of metals by ICP-MS (Hokkaido University).

Table 3.18.1 Multiple coring log

Station: 50N
Date: May/18/1999
Number of pipes: 8

Time(LST)	Wire-out	Latitude*	Longitude*	Depth	Tension	Remarks
2:15						Started
2:20	0m	50_00.1229N	165_00.0757E	5514m	0.6ton	Surfaced
2:55	1000m				1.3ton	
3:12	2000m				2.1ton	
3:28	3000m				2.5ton	
3:45	4000m				3.8ton	
4:01	5000m				4.8ton	
4:11	5450m				5.2ton	Stopped wire-out
4:15	5450m					Started wire-out slowly
4:18	5505m	49_59.9651N	164_59.9643E	5510m	4.7ton	Hit bottom
4:19	5530m					Stopped wire-out
4:26	5505m				5.4ton	Left bottom
4:36	5000m				5.2ton	
4:50	4000m				4.4ton	
5:04	3000m				3.5ton	
5:18	2000m				2.6ton	
5:32	1000m				1.6ton	
5:48	0m				0.6ton	Surfaced
5:50						Recovered a corer

*GPS: WGS84

Station: KNOT
Date: May/24/1999
Number of pipes: 8

Time(LST)	Wire-out	Latitude*	Longitude*	Depth	Tension	Remarks
5:54						Started
5:55	0m	44_00.0132N	154_59.9847E	5315m	0.4ton	Surfaced
6:17	1000m				1.2ton	
6:33	2000m				2.1ton	
6:49	3000m				3.0ton	
7:06	4000m				3.8ton	
7:22	5000m				4.7ton	
7:27	5250m				5.1ton	Stopped wire-out
7:30	5250m					Started wire-out slowly
7:33	5305m	44_00.0307N	154_59.9622E	5315m	4.7ton	Hit bottom
7:34	5325m					Stopped wire-out
7:39	5305m				5.2ton	Left bottom
7:49	5000m				5.2ton	
8:03	4000m				4.4ton	
8:16	3000m				3.6ton	
8:30	2000m				2.6ton	
8:44	1000m				1.6ton	
9:01	0m				0.5ton	Surfaced
9:02						Recovered a corer

*GPS: WGS84

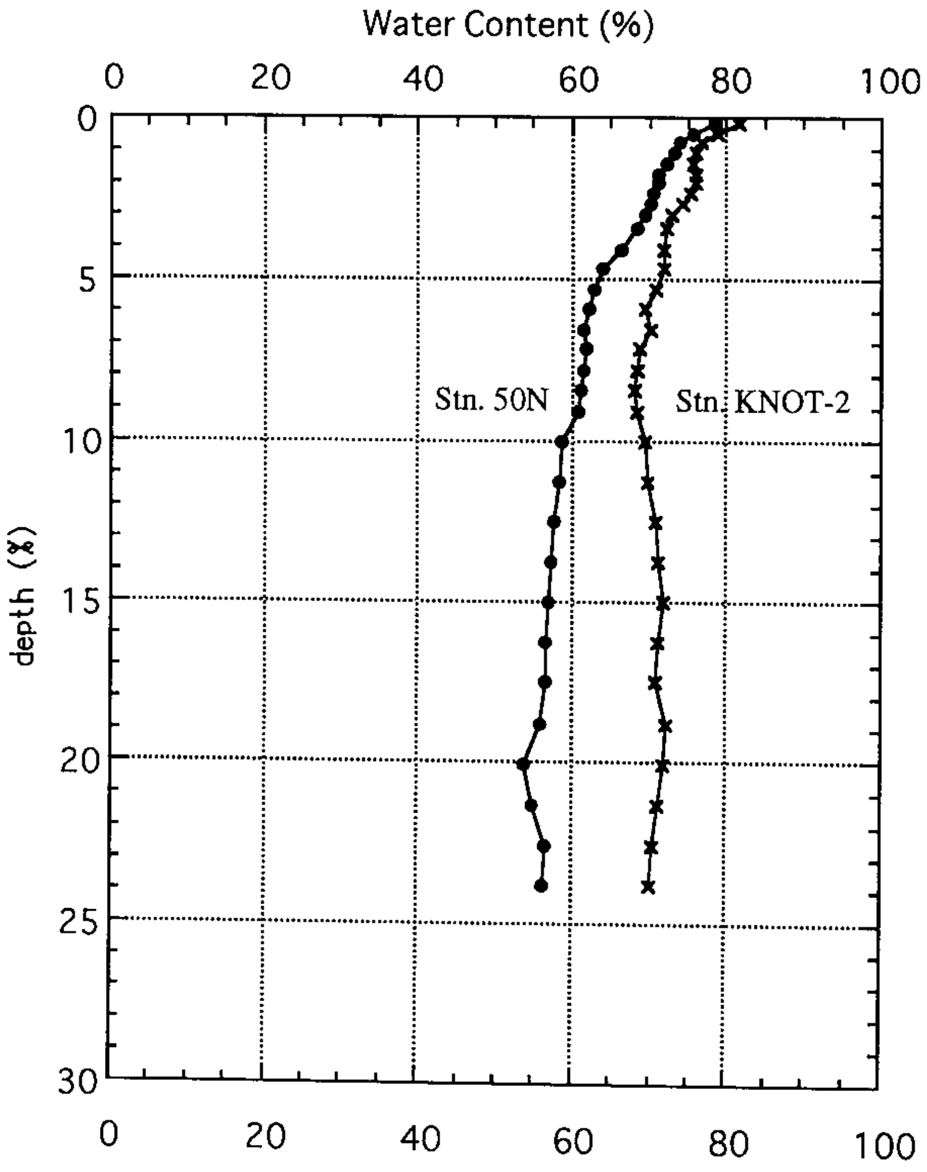


Fig. 3.18.1 Vertical profile of the water content at stn. 50N and stn. KNOT2

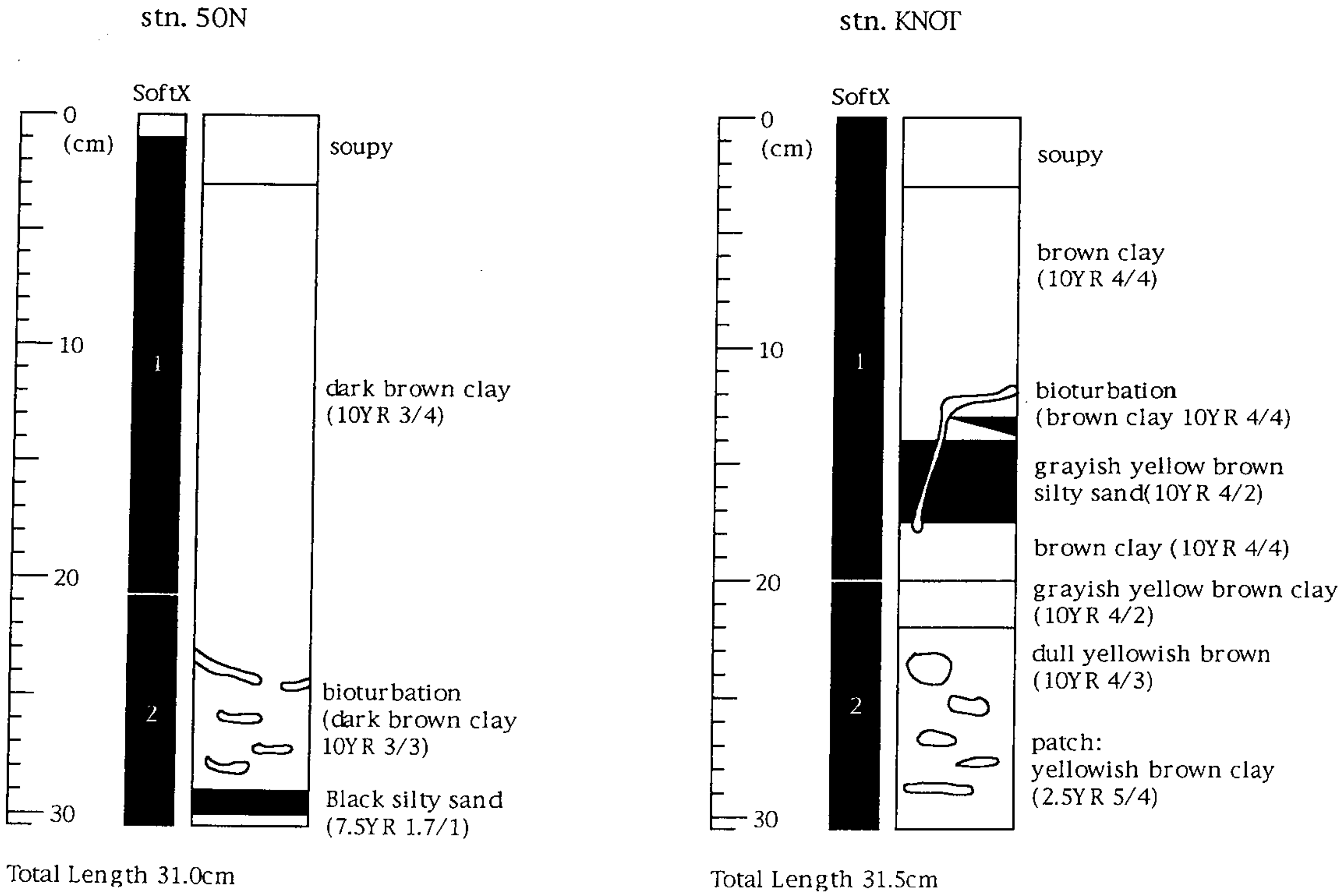


Fig. 3.18.2 Core description

3.19 ADCP

Satoshi Okumura
(Global Ocean Development Inc.)

(1) Introduction

Continuous measurement of current profiles in water column were performed throughout MR99-K02 cruise from the departure of Sekinehama, Japan on 8 May 1999 to the return to Sekinehama on 31 May 1999.

(2) Methods

The current profile data were measured by VM-75 shipboard ADCP (Acoustic Doppler Current Profiler) system arranged by RD Instruments, Inc. U.S.A..

Major parameters for the measurement configuration are as follows:

Frequency : 75kHz
Average : every 300 sec
Depth cell length : 1600 cm
No. of depth cells : 40
First depth cell position : 30.9 m
Last depth cell position : 654.9 m
ADCP ensemble time : 32.4 sec
Ping per ADCP raw data : 8

(2-1) N-S (North-South) and E-W (East-West) velocity components of each depth cell [cm/s]
(2-2) Echo intensity of each depth cell [dB]

(3) Preliminary results

Two-hourly current vectors of 2-hour running mean averaged data are plotted for 30.8m-layer (Fig.3.19.1), 206.8m-layer (Fig.3.19.2) respectively.. We could not plot whole cruise data in one sheet because of the software limitation.

(4) Remarks

Because of MO disk drive error sometimes occurred, some ADCP data was not recorded from May 12 to 26.

(5) Data archives

ADCP data obtained in this cruise will be submitted to the DMO (Data Management Office), JAMSTEC and will be under their control.

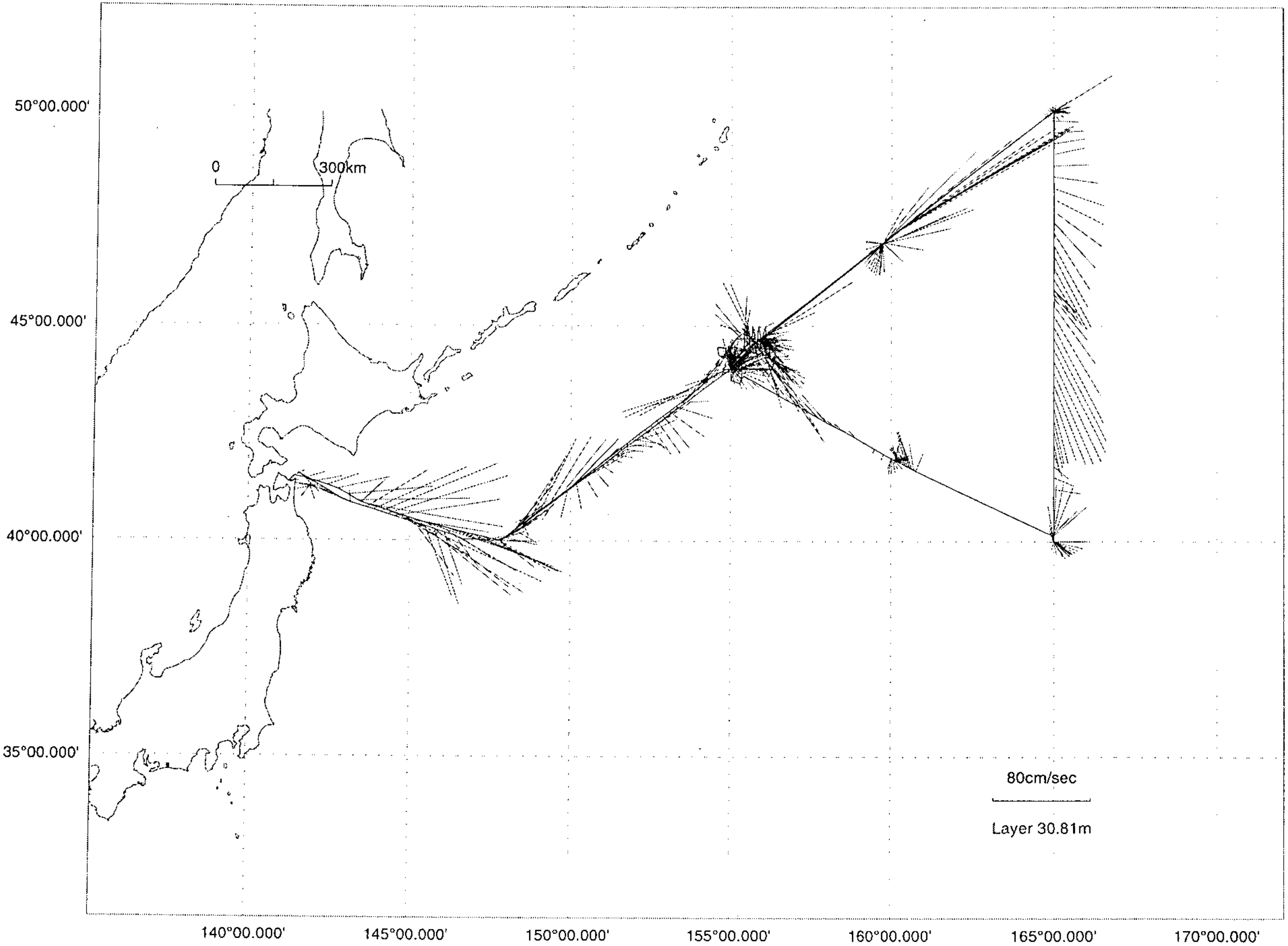

50°00.000'
45°00.000'
40°00.000'
35°00.000'
140°00.000'
145°00.000'
150°00.000'
155°00.000'
160°00.000'
165°00.000'
170°00.000'
0
300km
80cm/sec
Layer 30.81m

Figure 3.19.1

3:52:31 5/6/1999

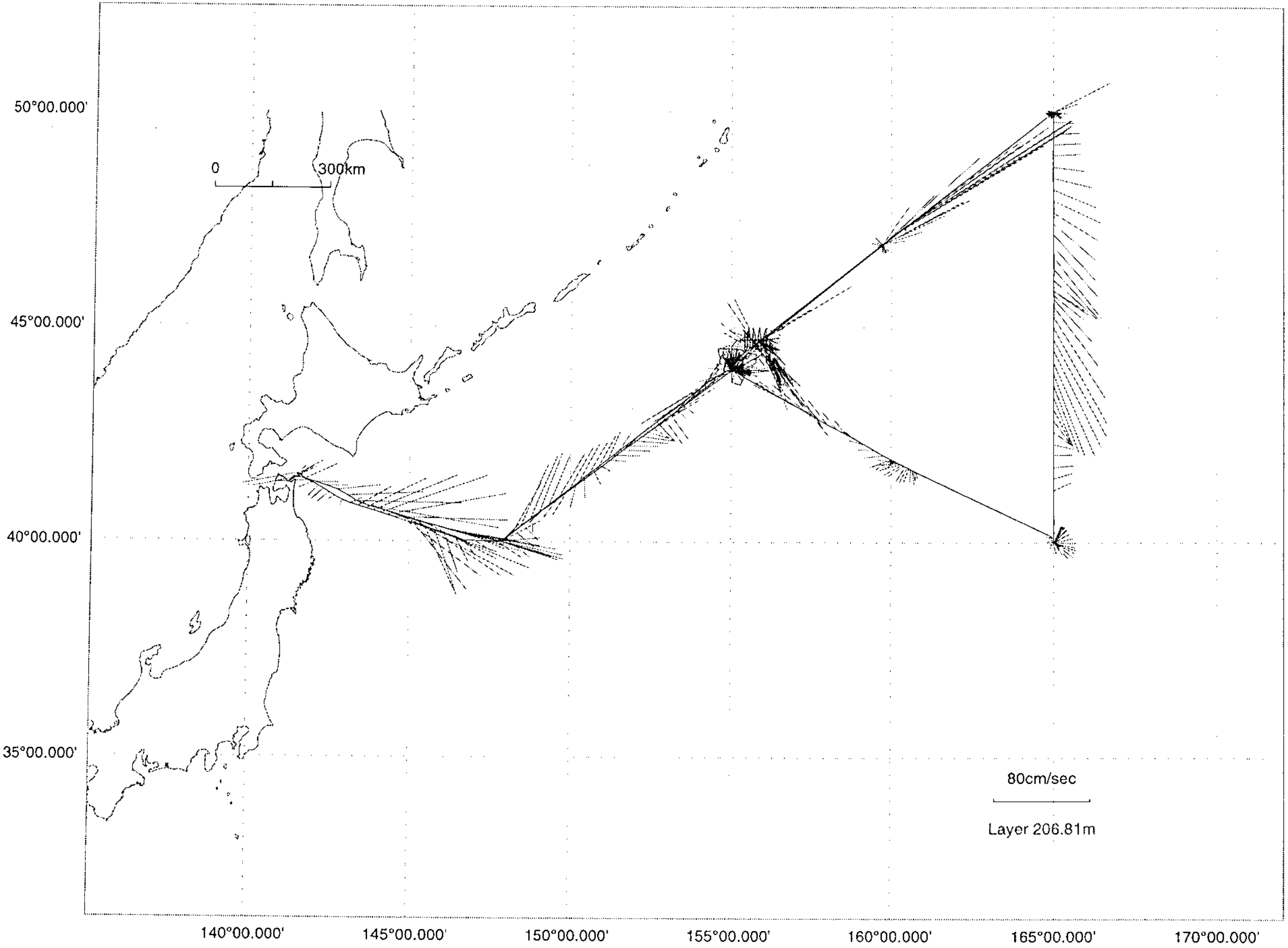
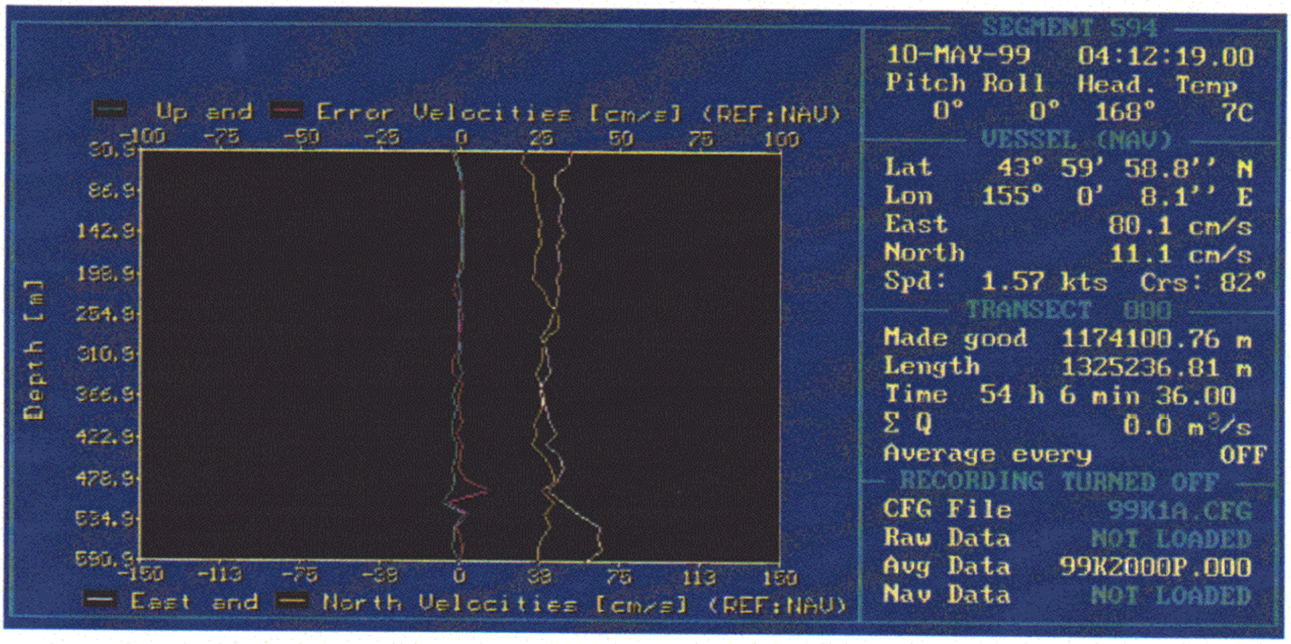
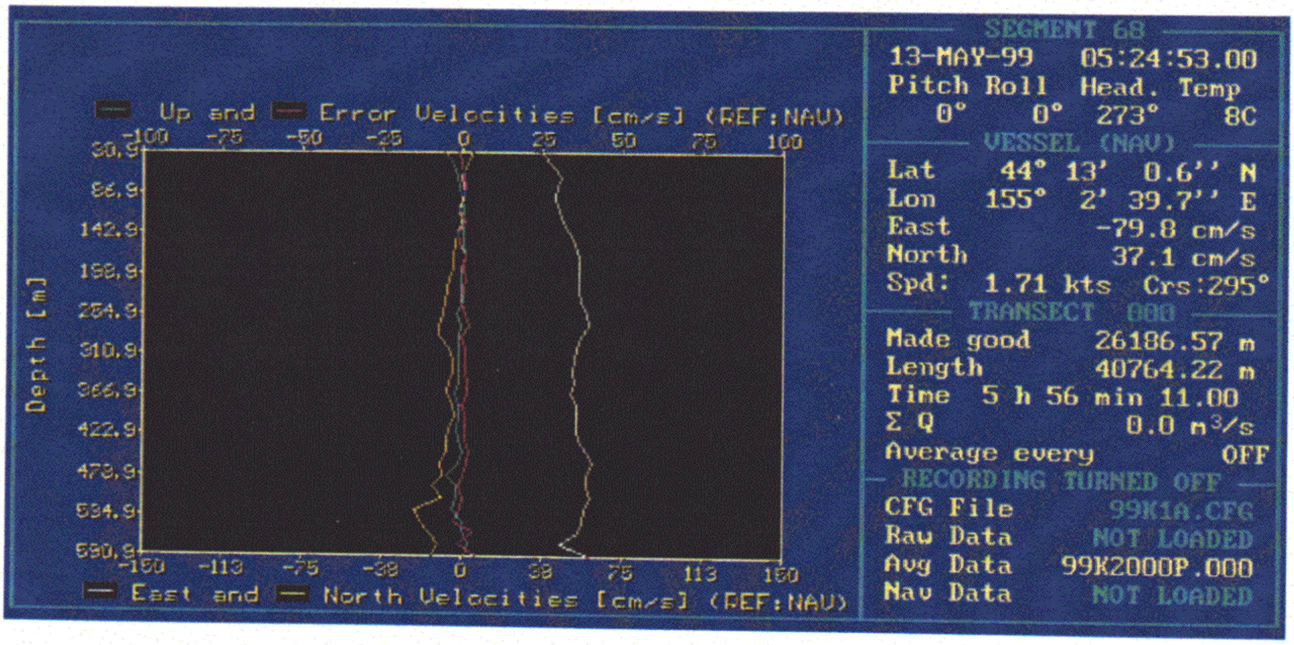


Figure 3.19.2



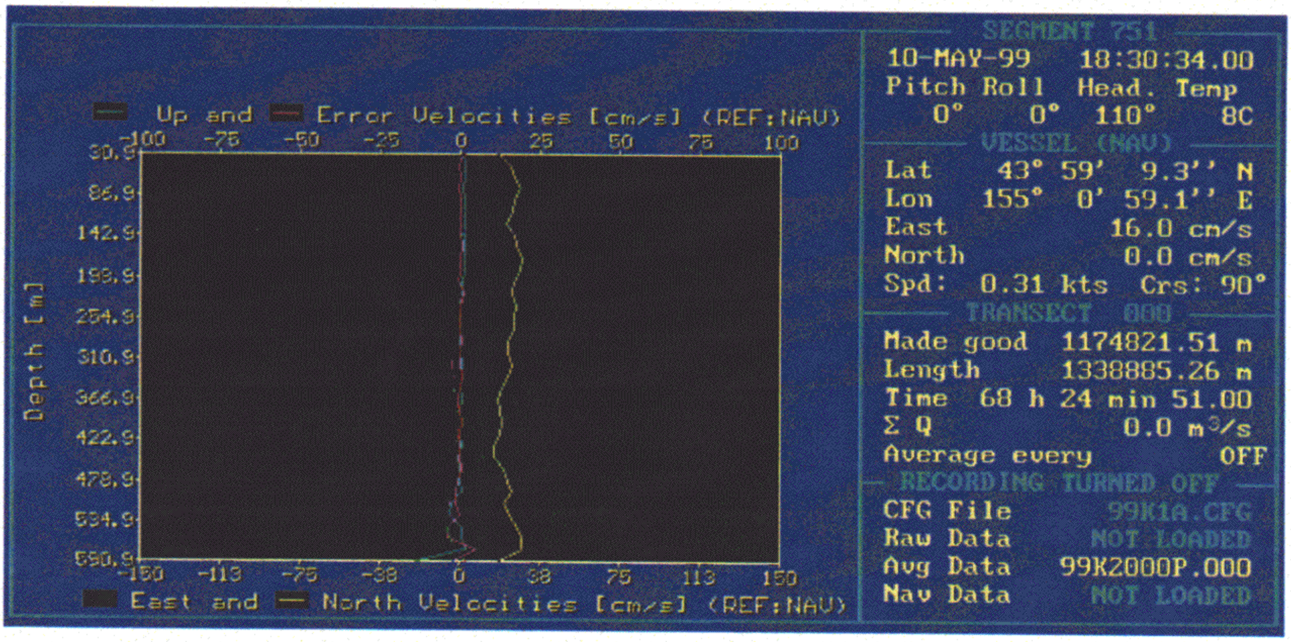
```
SEGMENT 594
10-MAY-99     04:12:19.00
Pitch Roll   Head.  Temp
  0°    0°   168°     7C
VESSEL (NAV)
Lat     43° 59' 58.8'' N
Lon    155°  0'  8.1'' E
East            80.1 cm/s
North           11.1 cm/s
Spd:  1.57 kts   Crs: 82°
TRANSECT 000
Made good   1174100.76 m
Length      1325236.81 m
Time   54 h 6 min 36.00
Σ Q               0.0 m³/s
Average every          OFF
RECORDING TURNED OFF
CFG File         99K1A.CFG
Raw Data        NOT LOADED
Avg Data      99K2000P.000
Nav Data        NOT LOADED
```

KNOT1(JAMSTEC) Deployment



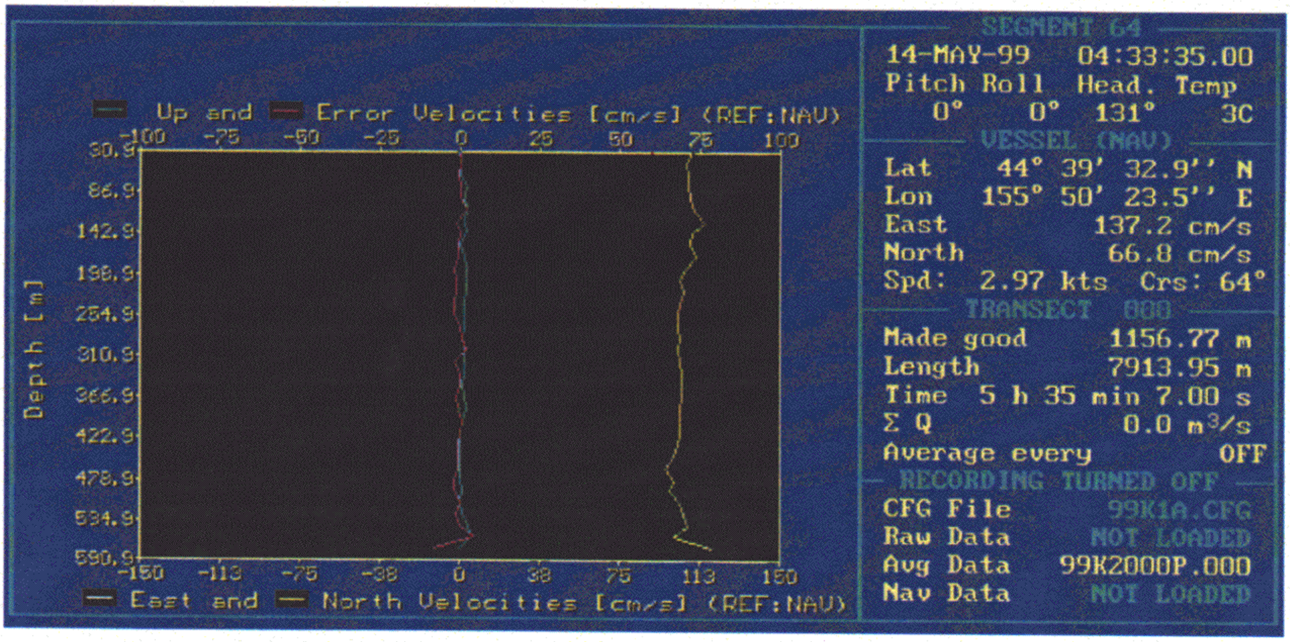
```
SEGMENT 68
13-MAY-99     05:24:53.00
Pitch Roll   Head.  Temp
  0°    0°   273°     8C
VESSEL (NAV)
Lat     44° 13'  0.6'' N
Lon    155°  2' 39.7'' E
East           -79.8 cm/s
North           37.1 cm/s
Spd:  1.71 kts  Crs:295°
TRANSECT 000
Made good     26186.57 m
Length        40764.22 m
Time    5 h 56 min 11.00
Σ Q               0.0 m³/s
Average every          OFF
RECORDING TURNED OFF
CFG File         99K1A.CFG
Raw Data        NOT LOADED
Avg Data      99K2000P.000
Nav Data        NOT LOADED
```

KNOT1(JAMSTEC) Recovery



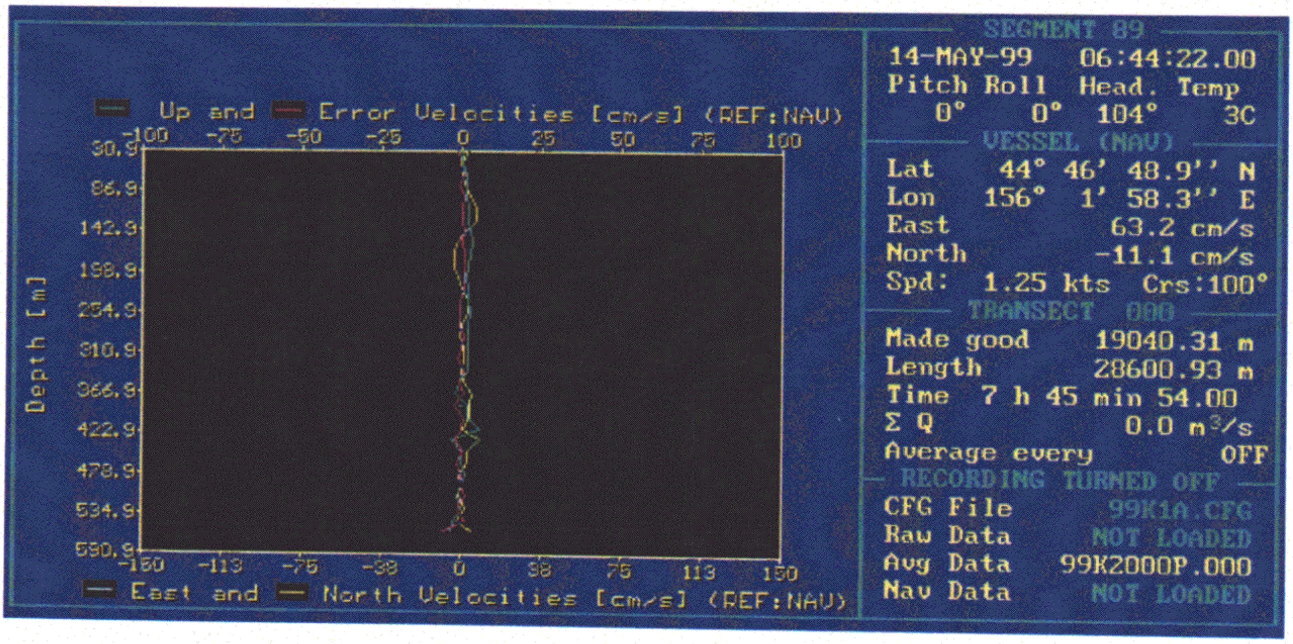
```
         SEGMENT 751
10-MAY-99    18:30:34.00
Pitch Roll  Head. Temp
   0°    0°  110°    8C
        VESSEL (NAV)
Lat     43° 59'  9.3'' N
Lon    155°  0' 59.1'' E
East              16.0 cm/s
North              0.0 cm/s
Spd:  0.31 kts   Crs: 90°
        TRANSECT  000
Made good   1174821.51 m
Length      1338885.26 m
Time  68 h 24 min 51.00
Σ Q                0.0 m³/s
Average every          OFF
   RECORDING TURNED OFF
CFG File         99K1A.CFG
Raw Data        NOT LOADED
Avg Data      99K2000P.000
Nav Data        NOT LOADED
```

KNOT1(CREST) Deployment



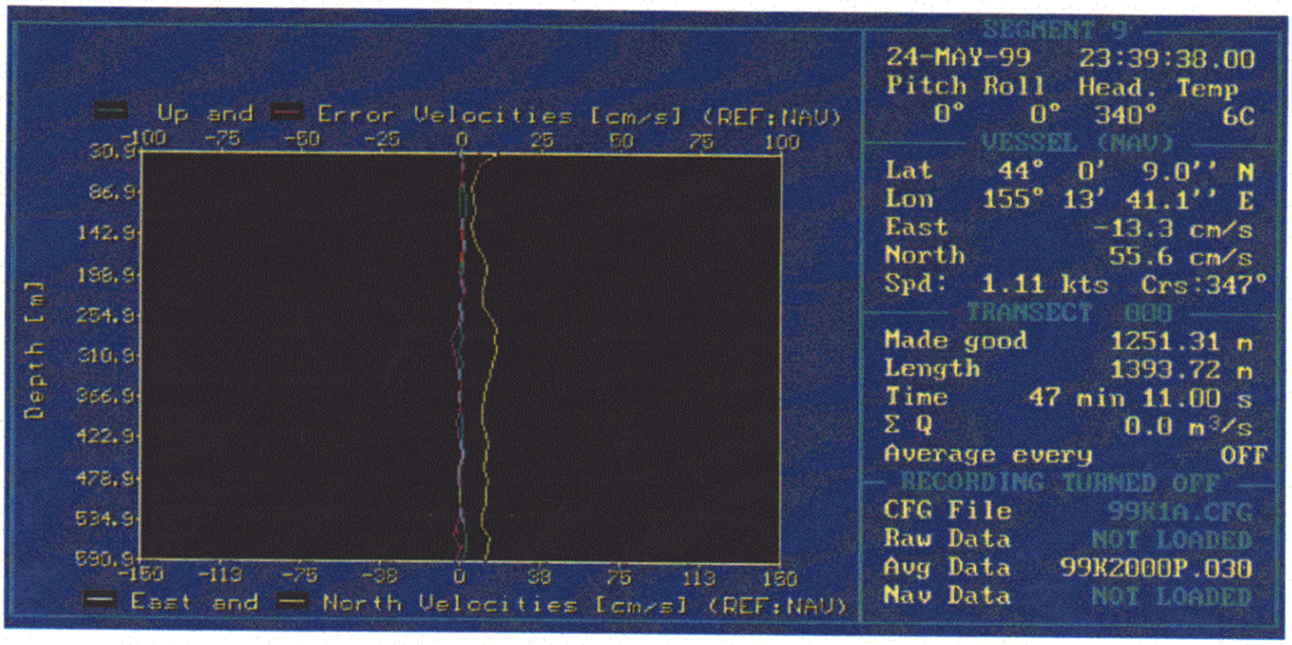
```
      SEGMENT 64
14-MAY-99     04:33:35.00
Pitch Roll   Head.  Temp
  0°     0°   131°    3C
     VESSEL (NAV)
Lat      44° 39' 32.9'' N
Lon     155° 50' 23.5'' E
East              137.2 cm/s
North              66.8 cm/s
Spd:  2.97 kts   Crs: 64°
      TRANSECT  000
Made good        1156.77 m
Length           7913.95 m
Time   5 h 35 min 7.00 s
Σ Q                0.0 m³/s
Average every          OFF
   RECORDING TURNED OFF
CFG File         99K1A.CFG
Raw Data        NOT LOADED
Avg Data      99K2000P.000
Nav Data        NOT LOADED
```

HP1(CREST) Deployment



```
      SEGMENT 89
14-MAY-99     06:44:22.00
Pitch Roll   Head.  Temp
  0°     0°   104°    3C
     VESSEL (NAV)
Lat      44° 46' 48.9'' N
Lon     156°  1' 58.3'' E
East               63.2 cm/s
North             -11.1 cm/s
Spd:  1.25 kts   Crs:100°
      TRANSECT  000
Made good       19040.31 m
Length          28600.93 m
Time   7 h 45 min 54.00
Σ Q                0.0 m³/s
Average every          OFF
   RECORDING TURNED OFF
CFG File         99K1A.CFG
Raw Data        NOT LOADED
Avg Data      99K2000P.000
Nav Data        NOT LOADED
```

LP1(JAMSTEC) Deployment



```
            SEGMENT 9
24-MAY-99    23:39:38.00
Pitch Roll  Head. Temp
   0°    0°  340°     6C
           VESSEL (NAV)
Lat    44°  0'  9.0'' N
Lon   155° 13' 41.1'' E
East           -13.3 cm/s
North           55.6 cm/s
Spd:  1.11 kts  Crs:347°
          TRANSECT  000
Made good       1251.31 m
Length          1393.72 m
Time       47 min 11.00 s
Σ Q               0.0 m³/s
Average every          OFF
     RECORDING TURNED OFF
CFG File         99K1A.CFG
Raw Data        NOT LOADED
Avg Data      99K2000P.030
Nav Data        NOT LOADED
```

KNOT2 (JAMSTEC) Recovery

3.20 Underway Geophysics

3.20.1 Multi-Narrow Beam Echo Sounding System

Toshio Furuta and Satoshi Okumura (GODI)

(1) Introduction

R/V Mirai has installed a multi narrow beam echo sounding system manufactured by SeaBeam Inc., SeaBeam 2100 system. This system utilized bathymetry mapping and subbottom profiler. The newest one can measure more than 120 degrees wider swath and available all depth of the world ocean floor.

(2) System configuration

The system consists of mainly four segments; under hull unit, controller electronic circuits, real time display unit, and post processing unit. Under hull unit has two projector alleys, one is for 12kHz and another for 4kHz with one hydrophone alley. The hydrophone alley can receive both returning acoustic signals of 12kHz and 4kHz, interleavingly. Main electronic circuits of 12kHz bathymetry and 4kHz subbottom profiler have the individual consoles in which the cpus and dsp boards process receiving signals. The real time display unit consists of three Indy workstations (W/S), two of them are for 12kHz terminal and real time display, and one for subbottom profiling controller. The system has also output devices such as graphic recorders, color printer and color plotter.

(3) Method

Gridding survey in this cruise was carried out on the three sites at 44° N, 155E° (KNOT site), 50° N and 40°N along 165°E. Each area is approximately 60 n.m. square or less, and depth from 5800m to 3000m. The gridding survey interval being one and half or twice of depth is different depending on their depths. After the gridding survey, the bathymetric data were fed to post processing W/S by ftp command. The post processing system furnished on this MNBES has two high performance W/S Indigo2 which have "mb-system" software on the basis of the Genetic Mapping Tool (GMT) called SeaView. Consequently, measured data can easily be edited on W/S by automatically or manually to provide gridding data and map images.

The bathymetry data gridding on the basis of netCDF format can be sent to the network server of Mirai to overprint on the navigation track display.

(4) Results

It is, of course, required to keep high accuracy that precise correction of sound speed of the target area can be performed based on the temperature profiles of water column. During this cruise, CTD casts have done at the target sites or very close to the sites, we could obtain the sound velocity profile derived from the CTD data. The newest system has continuously measured the surface water sound velocity in real time, because sound velocity at the hydrophone alley is a very important factor to determine the angle of acoustic ray path which affects the outer beam of wider swath.

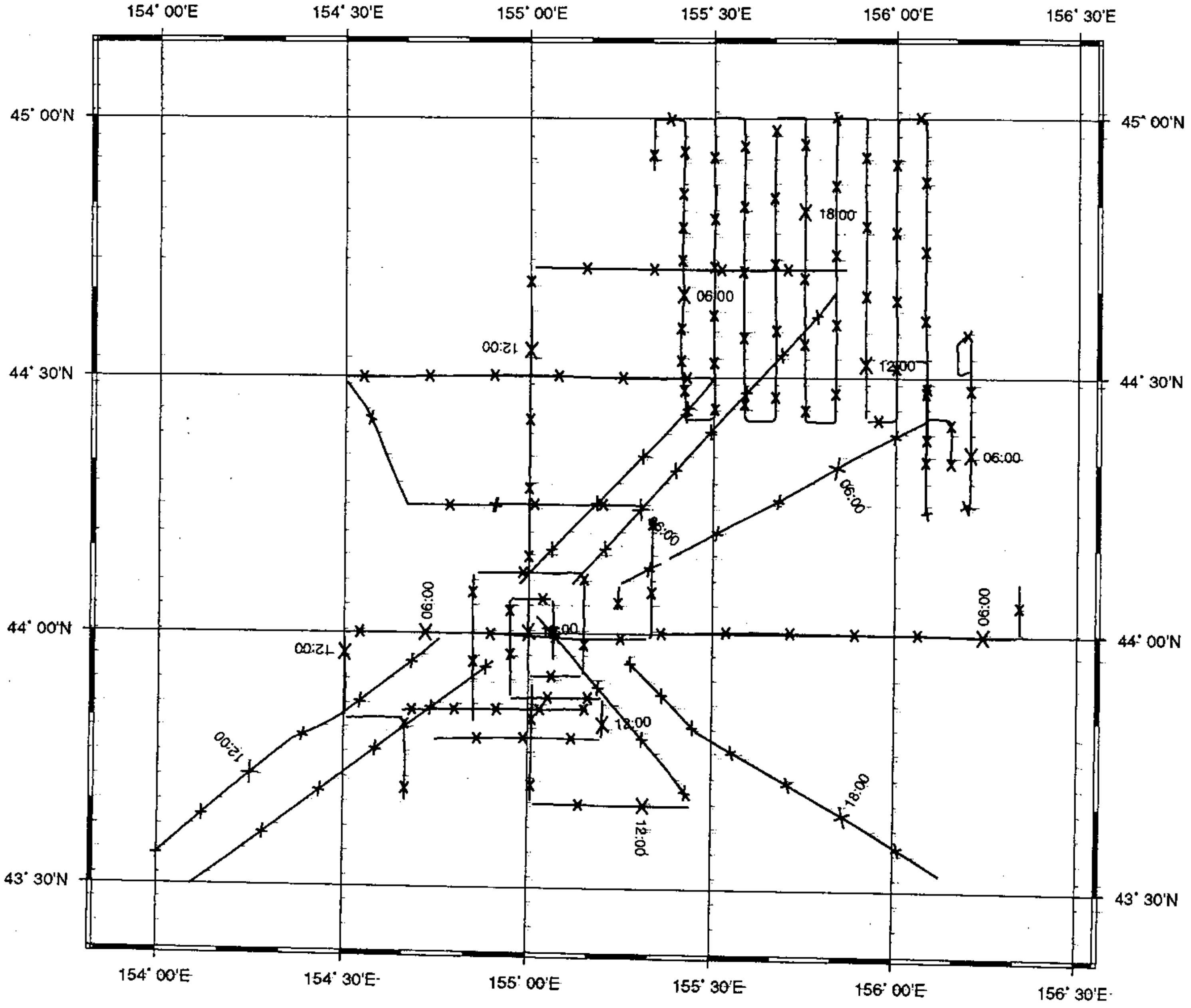
Figures 3.20.3-1 to 3.20.3-3 show the bathymetric topographies of survey areas, these are drown in addition to the previous data which were measured MR98-K01 or older scientific cruises.

(5) Data storage

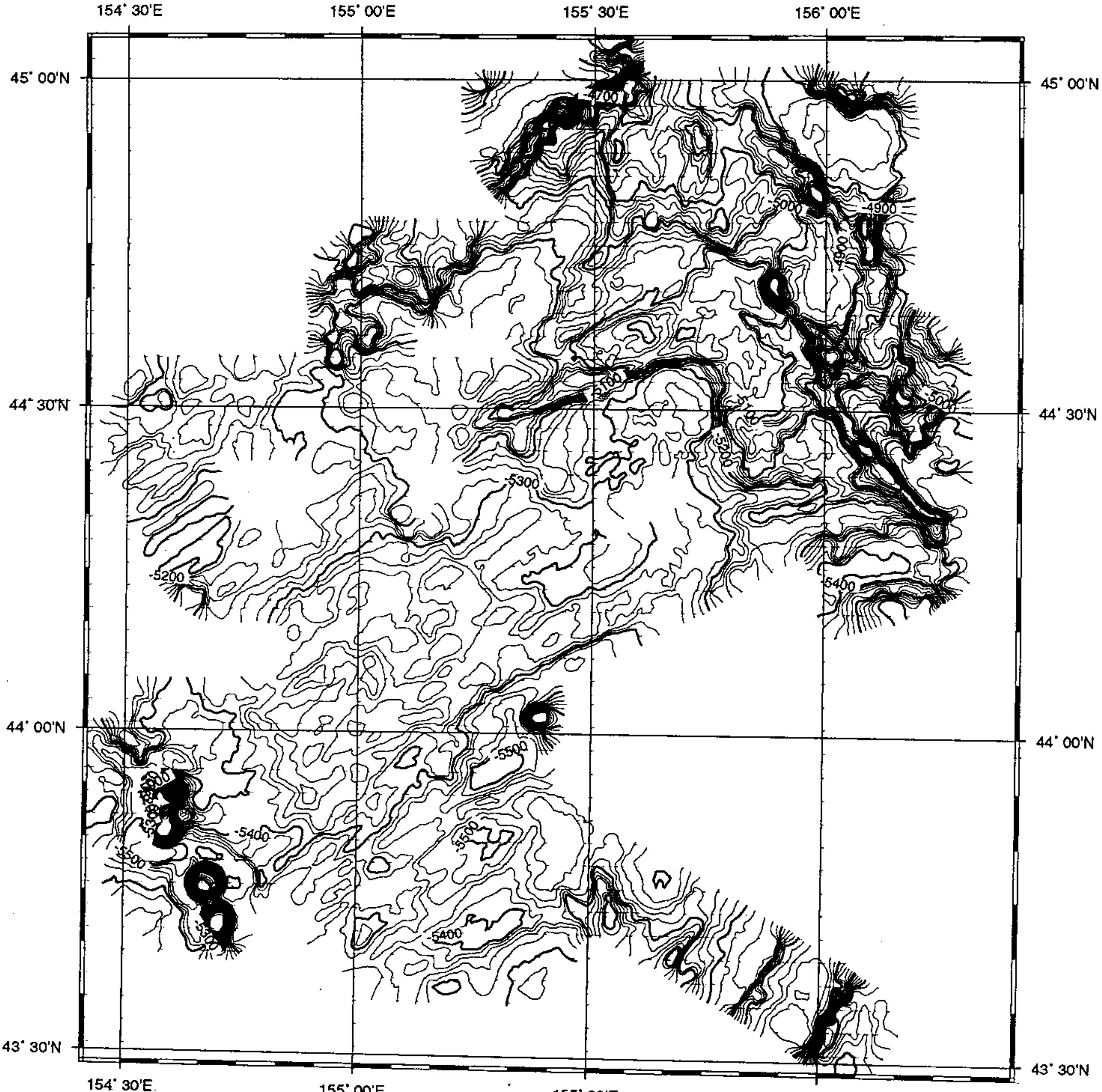
Media; Exabyte tape

Place: JAMSTEC Data Management Office and JODC of Japan Marine Safety Agency

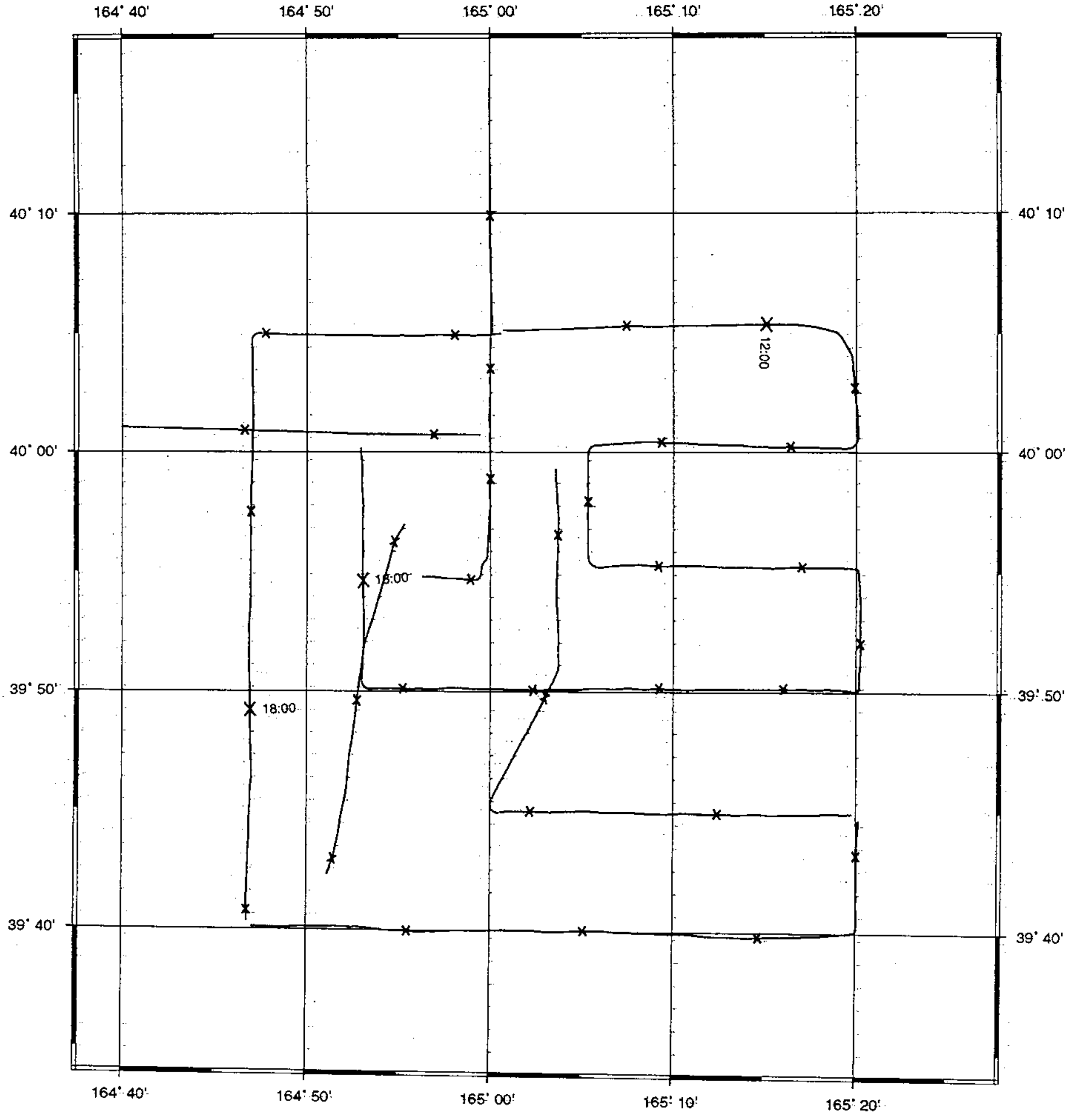
KNOT and Adjacent Area



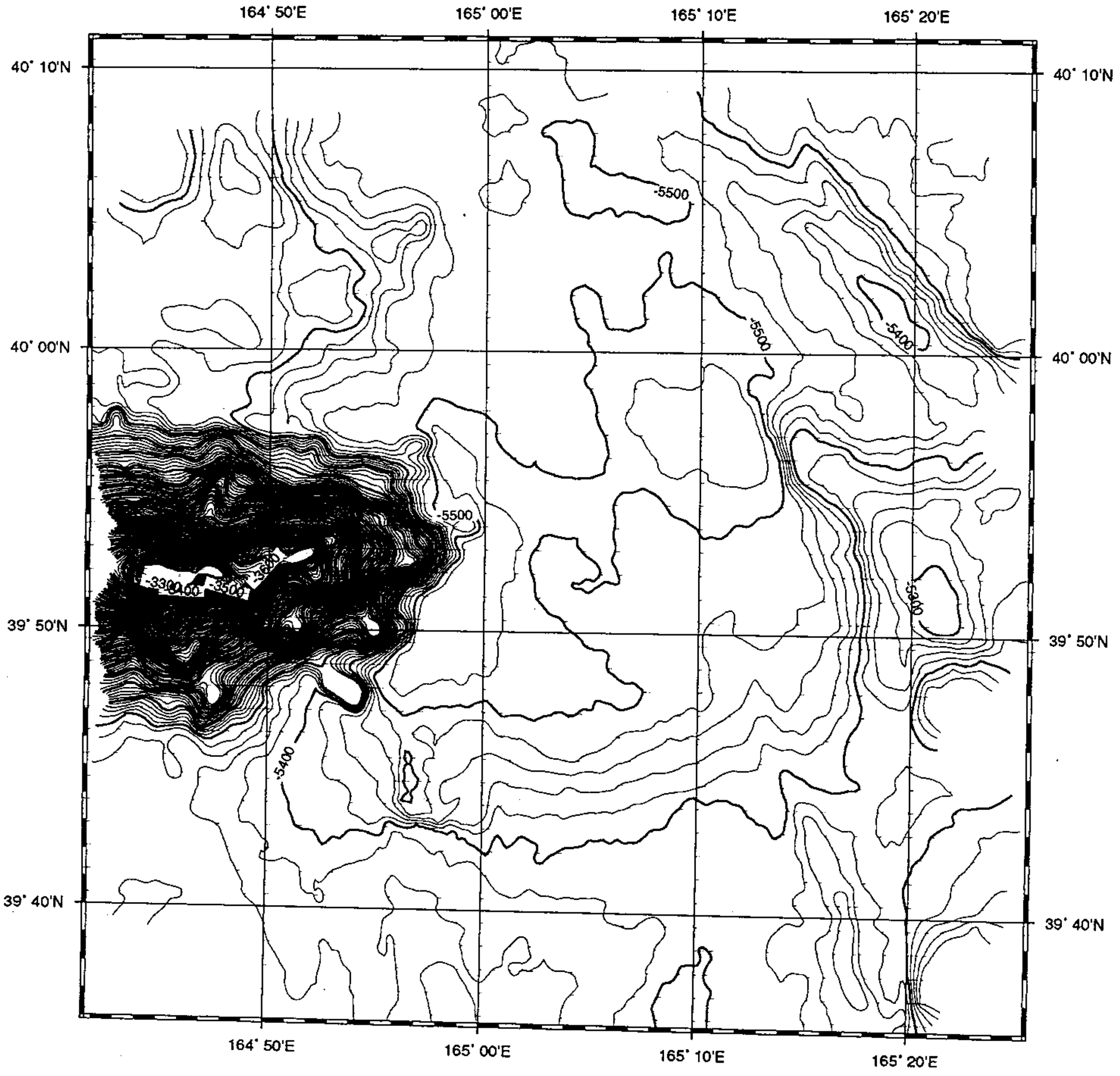
KNOT and Adjacent Area



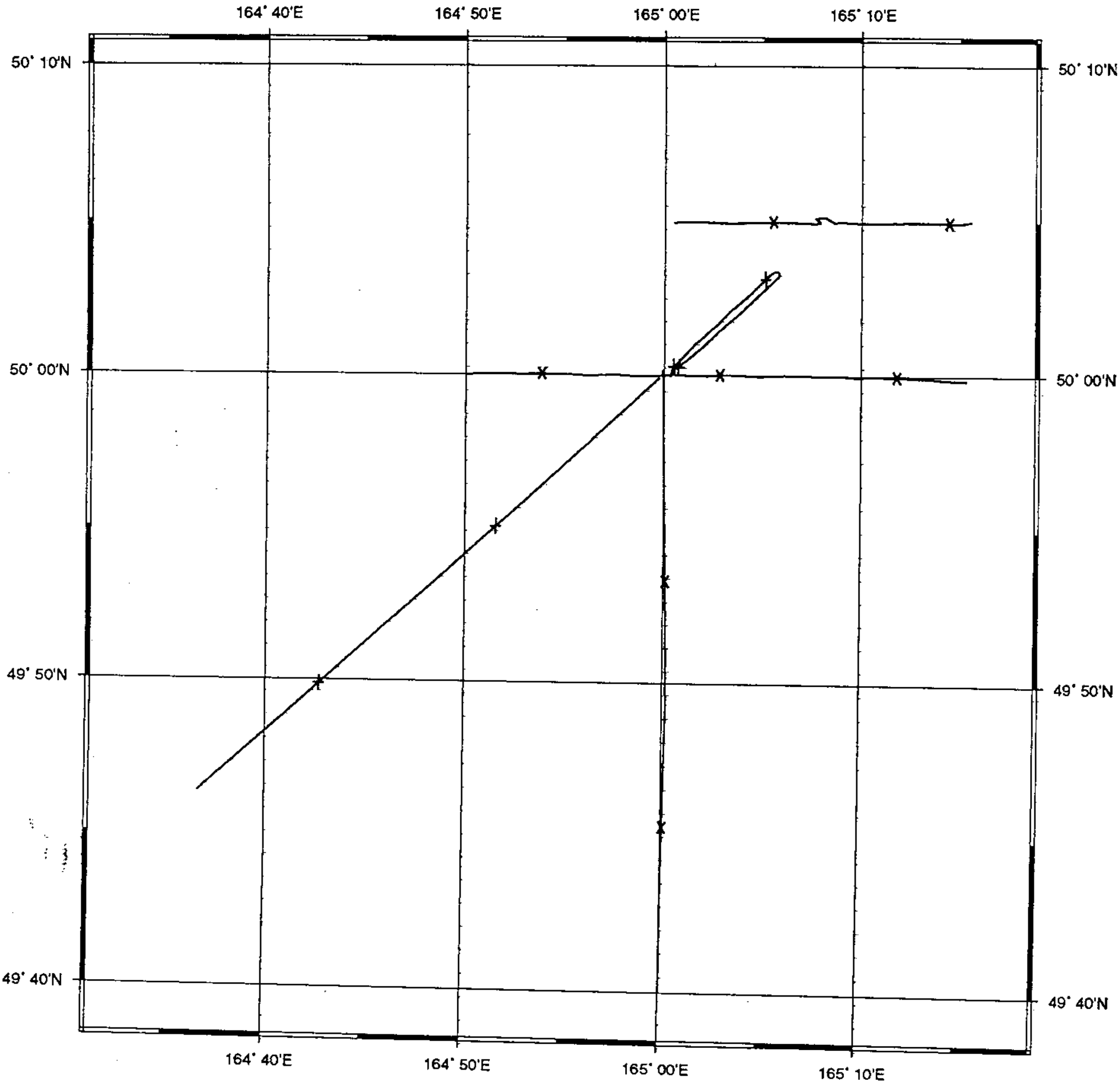
Station 40N


164° 40'
164° 50'
165° 00'
165° 10'
165° 20'
40° 10'
40° 00'
39° 50'
39° 40'
12:00
15:00
18:00

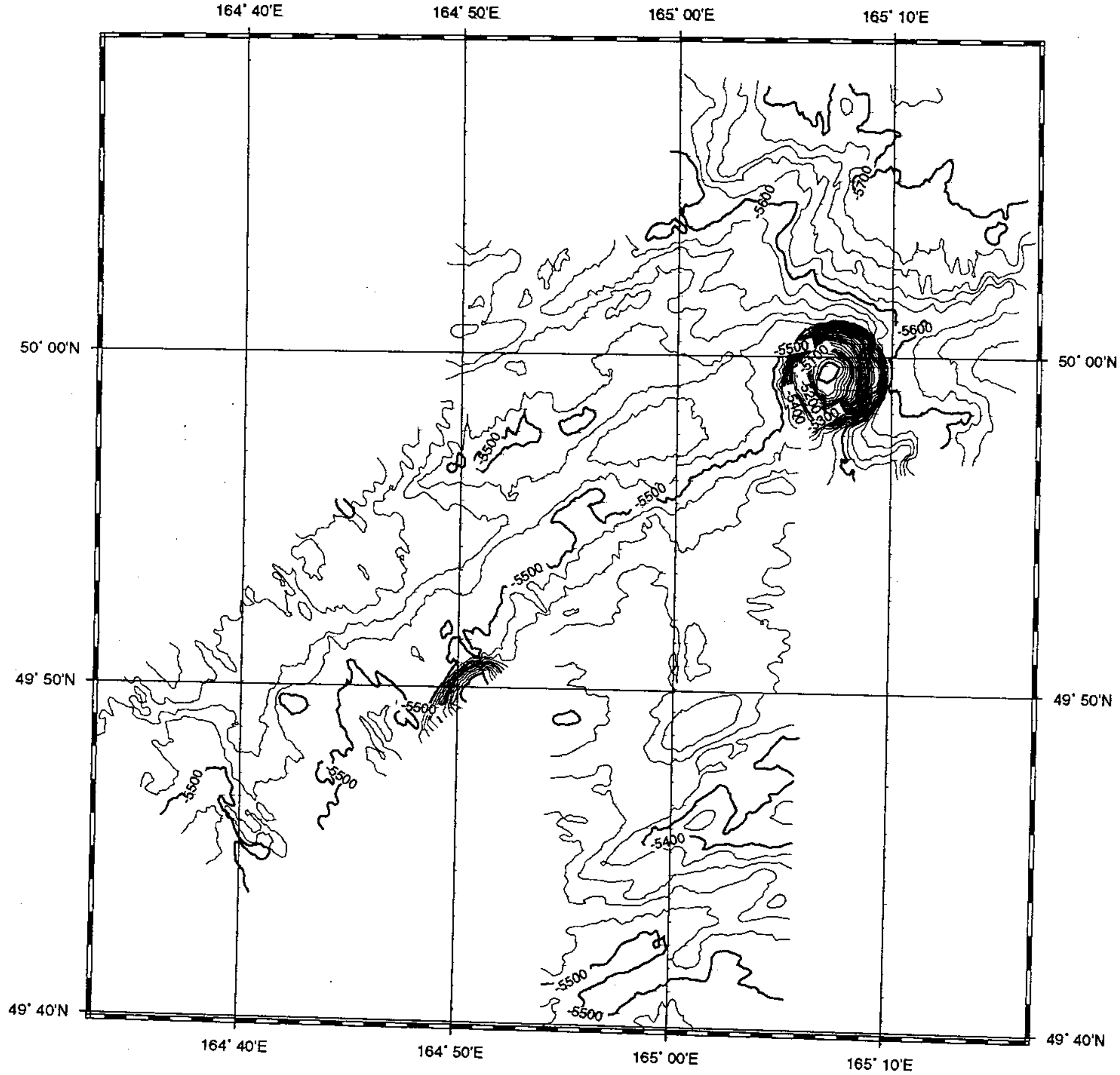
Station North 40



Station 50N



Station North 50 (MR9805_stn3)



3.20.2. Sea Surface Gravity

Toshio Furuta and Satoshi Okumura (GODI)

(1) Introduction

Sea Surface gravity measurement during MR99-K02 cruise using a LaCoste-Romberg gravity meter S-116 installed on the R/V Mirai among port call of Sekinehama.

(2) System configuration

The system consists of three components, first is a sensor platform with horizontally stabilized mechanism(two axes of gyros and torque motors), second is a digital control system, and third is a cataloging PC which can record data in 3.5" optical magnetic disk (MO) at every ten second in addition with common navigation information. Data is also sent to the Mirai network server through ethernet LAN system via terminal server.

(3)Method

As system can measure only the relative variation of gravity values, the value were correlated by the absolute or known gravity values at each port (from start to finish of one cruise or leg). Moreover, measured values are corrected based on the bathymetry(free-air) and ship movement(etoveth). Consequently, the corrected gravity data should involve the information of crustal and upper mantle structures how they compensate the discrepancy from isostatic balance.

(4) Data storage:

Media; 3.5" magnetic optical disk (230MB MO)

Place; JAMSTEC Data Management Office

Annex shows the observed values at Sekinehama gravity base measured by a Scintrex gravity meter CG-3M, these values were used for correction of sea surface gravity meter at the ports.

3.20.3. Surface three component magnetometer

Toshio Furuta and Satoshi Okumura (GODI)

(1)Introduction

In order to continuously obtain the geomagnetic field vectors on the sea surface, a three component magnetometer is a very useful equipment. The magnetic force on the sea is affected by induction of magnetized body beneath the subbottom in addition to the earth dipole magnetic field. The magnetic measurement on the sea is, therefore, one of utilities for geophysical reconstruction of crustal structure and so on. The geomagnetic field can be divided into three components, i.e., two horizontal (x & y)and one vertical (z) moments. Three-component observation instead of total force includes much information of magnetic structure of magnetized bodies.

(2) System configuration

The system is mainly divided into three segments; sensor unit, control and datalogging unit, and gyro and vertical reference unit (VRU). The sensor unit is installed on the top of foremast, the control and datalogging unit in the dry laboratory, and the VRU also in dry lab. The gyro(ship heading) using this system is as same as navigation gyrocompass. A ring laser gyro in the Doppler Radar Meteorology system can be used to measure the ship attituide, instead of normal VRU, because of high precision

(3) Method

The sensor is a three axes fluxgate magnetometer and sampling period is 8Hz. The timing of sampling is controlled by the 1pps standard clock of GPS signal. Every one second data set which consists of 310 bytes; navigation information, 8 Hz three component of magnetic forces and ship's attitude data were recorded in the external hard disk. The data set is simultaneously fed to the Mirai network server through ethernet LAN system.

(4) Results

During MR99-K02 cruise, the magnetic force is continuously measured among port call of Sekinehama. Data obtained on the sea will be analyzed in near future.

The procedure of quality control of the measured data is mainly to eliminate the effect of ship's magnetized vector condition.

(5) Data storage:

Media; 3.5" optical magnetic disk(230MB MO)
Place; JAMSTEC Data Management Office