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Cruise Report of NT03-12 (2003.10.31 – 2003.11.09)

JAMSTEC
Mutsu Institute for Oceanography (MIO)
High Latitude Time Series observatory (HiLaTS)

Feb. 2004

1. Outline of NT03-12

1.1 Cruise Summary

Hajime KAWAKAMI (JAMSTEC, Mutsu Institute for Oceanography)

This cruise was manly carried out in order to study the biogeochemistry in northwestern North Pacific by following institutes and universities.

Mutsu Institute for Oceanography (MIO) of Japan Marin Science Technology Center (JAMSTEC)

National Institute for Environmental Science (NIES)

National Institute of Advanced Industrial Science and technology (AIST)

Hokkaido University

R/V Natsushima left Yokosuka on 31 November. Because the weather of northwestern North Pacific was almost bad in fall, we could observe only one station (St. KONT).

Station KNOT (44N, 155E)

Hydrocast

We deploy water samplers (12L Niskin water sampler with CTD sensor) 3 times (Hydrocast). Water samples taken were or will be used for the following chemical analysis.

• the routine chemical analysis (Sal, SiO_2, PO_4, NO_3, NO_2, TDIC, TALK)

• Th-234, POC, PON, Chl. *a* analysis

In situ pumping

In order to collect suspended particles in the water column, large volume pumping system (LVP) were used. 4 casts of LVP were practiced and 4 LVP were deployed at once for respective casts. The particulate samples from LVP were will be used for Th-234, POC, PON and trace metal analysis.

Station K2 (47N, 160E)

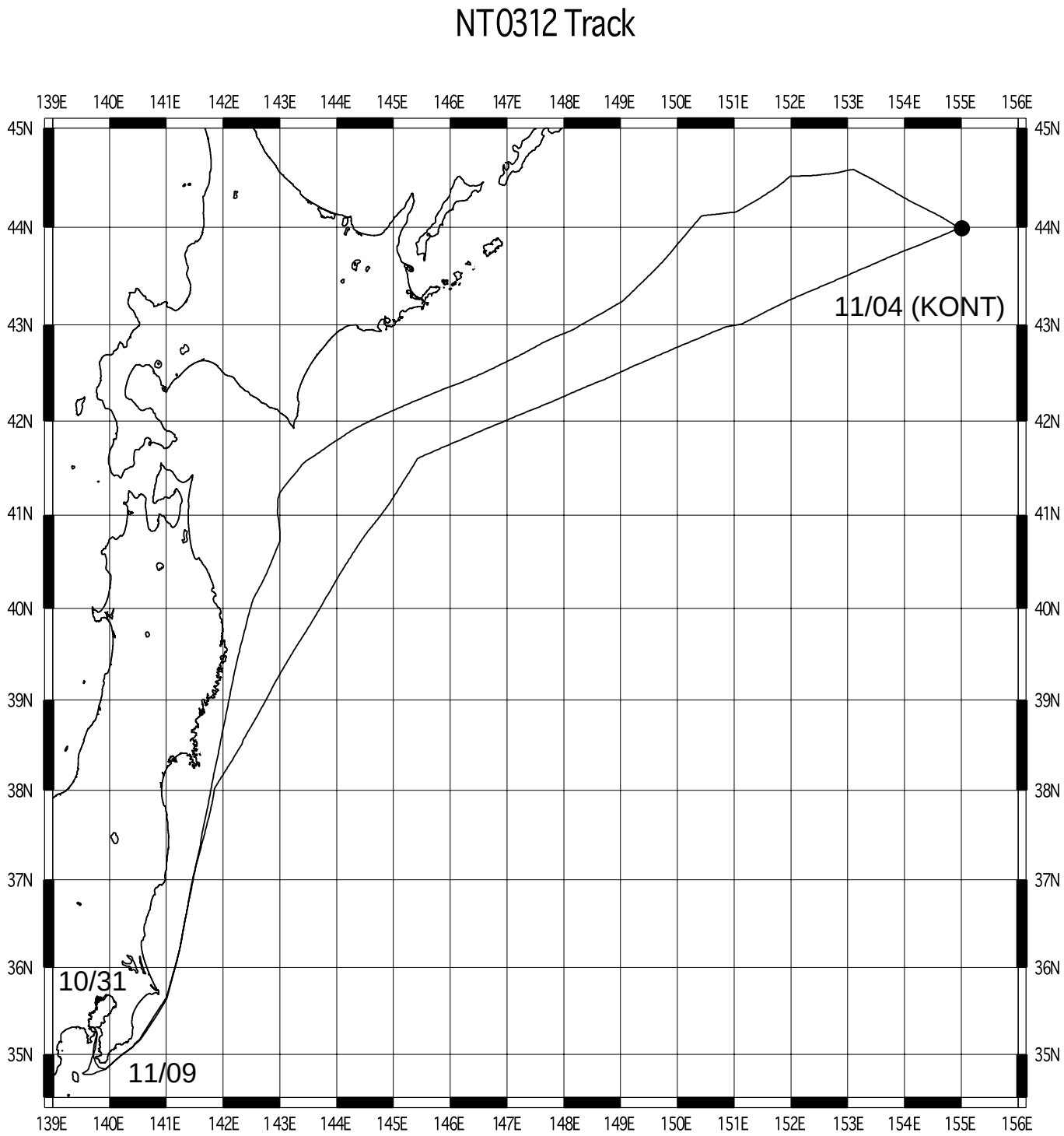
All sampling were canceled because of bad condition.

Station K3 (39, 160E)

All sampling were canceled because of bad condition.

However the cruise of NT03-07 was nearly 100% successful, this cruise was much lower successful because of the bad weather. We need consider the size or type of research vessel in compliance with seasonal weather condition, from now on.

1.2 Cruise track and schedule



JST		Position		Event
Date	Time	Lat.	Long.	
10.31	14:50	35-19N	139-39E	Departure from Yokosuka
11.04	04:50	44-00N	155-00E	Arrival at St. KNOT
11.04	13:00	44-00N	155-00E	Departure from St. KNOT
11:09	07:50	35-19N	139-39E	Arrivai at Yokosuka

1.3 List of Participants

Name	Affiliation	Address	Tel Fax E-mail
Hajime KAWAKAMI	JAMSTEC Mutsu Institute for Oceanography (MIO)		
Kazuhiro HAYASHI	JAMSTEC MIO		
Toru IDAI	JAMSTEC MIO		
Satoru KIMURA	JAMSTEC MIO		

2. Observation

2.1 CTD and Salinity

Toru Idai (JAMSTEC MIO)

On this cruise, multiple rosette (or carousel) water sampling system were not available. Therefore we collected water sample with Niskin bottles and messenger.

(1) Water sampling

12L Niskin bottles (General Oceanics Rosette model 1016) of 11-12 were attached on the hydro wire for each hydrocasting. The hydro wire was extended up to approximately 200m. After few minutes passed since each bottle was located at planned depth, a messenger started to descend. Although this old style water sampling has not been conducted, water samples from 11-12 layers upper 200m were collected without failure. At each station, several hydrocastings were conducted for analysis of routine component (Salinity, nutrients, carbonate and chl-a), radioactive nuclides and primary productivity. Sampling depths were calculated with depth of wire top observed with CTD and distance between each bottle.

(2) CTD

Conductivity, temperature and depth were measured by using self-recording CTD (Sea-Bird SBE 19) at each station. CTD was installed at the top of hydro wire and deployed with Niskin bottles.

CTD data have not been covered hole hydrocast twice at the routine and first radio hydrocast. At the second radio hydrocast, it was sampled successfully. It was caused by start switch of CTD is relatively loose and switched off by the pitch and roll while CTD was at the surface.

Raw data observed were processed with software “SBE Data Processing Win32” and converted to physical values on board.

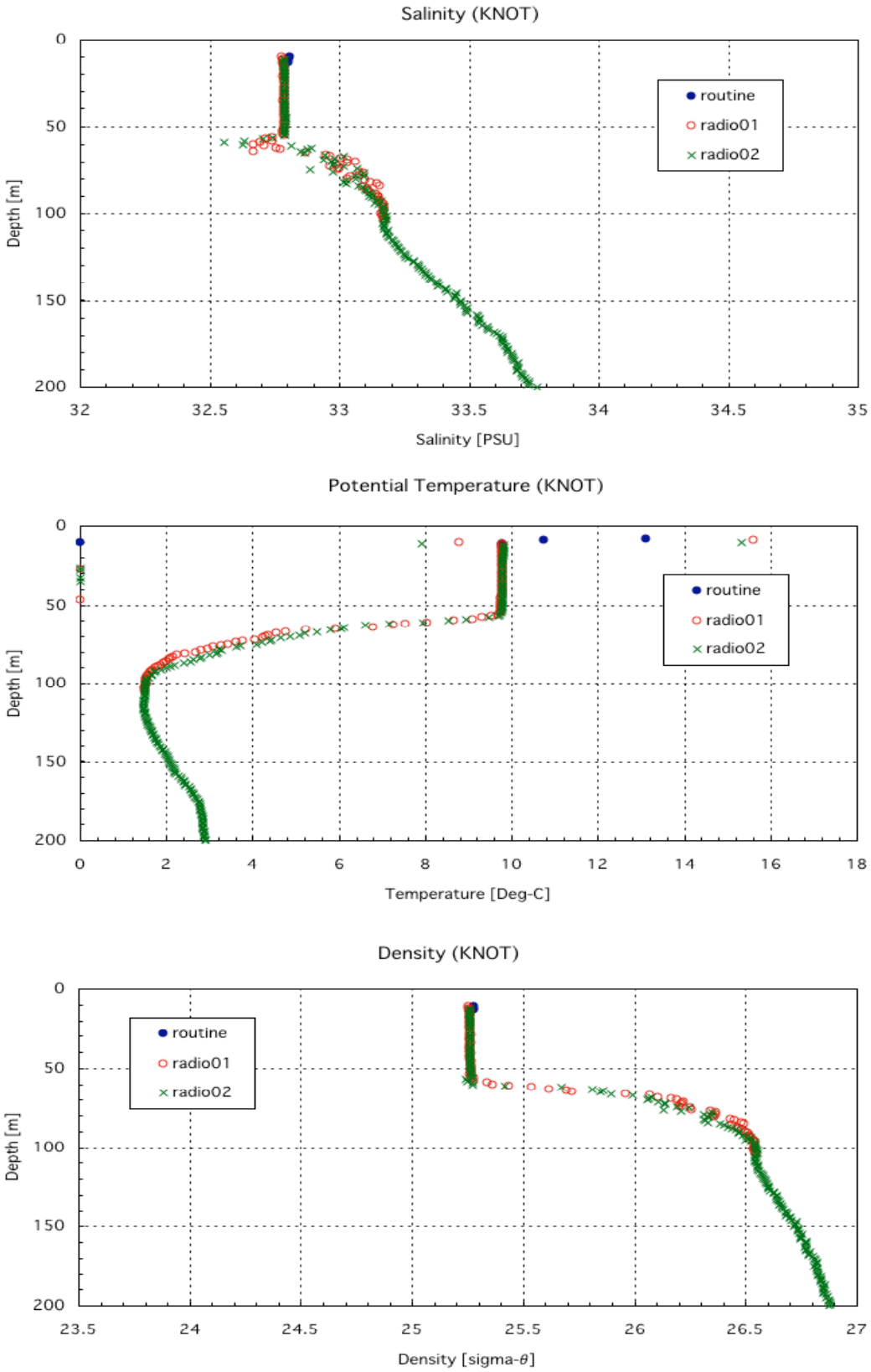


Fig. 2.1 Vertical profile of Salinity, pot-temperature and density (KNOT)

2.2 Hydrocast

2.2.1 Nutrients

Yukihiro NOJIRI (National Institute for Environmental Science)
Kazuhiro HAYASHI (JAMSTEC MIO)
Mario HONDA (JAMSTEC MIO)

(1) Sampling Procedures

Samples were drawn into polypropylene 100 ml small mouth bottles. These were rinsed twice before filling. The samples were quickly stored in a freezer under - 20 °C and kept by the day the nutrients analyses were conducted on land.

(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.

(3) Preliminary results

The results are shown in Appendix.

2.2.2 TCO2 and Alkalinity

Nubuo TSURUSHIMA (National Institute of Advanced Industrial Science and technology)
Kazuhiro HAYASHI (JAMSTEC MIO)
Mario HONDA (JAMSTEC MIO)

(1) Sampling

We collected samples for on board measurements of total carbon dioxide (TC) and total alkalinity (TA). Water samples were collected with CTD rosette systems attached with Niskin bottles of 12 l capacity. Sample waters for TC/TA were drawn from Niskin samplers into 250 (200 ?) ml glass bottles with plastic screw cap (Schott Duran). Sequentially, mercuric chloride solution (3 mg-$HgCl_2$ / 100 g-H_2O) of 0.05 cm^3 was added as preservative. Samples collected on board were kept in refrigerator by the day the analysis was conducted

(2) Analysis

TC and TA in seawater were determined by the methods similar to DOE (1994) with new automatic measurement system (KIMOTO ELECTRIC Co., LTD.). This system contain two devices, device for extraction of carbon dioxide and a device for determination of TA by titration, each in a 50x60x40cm console. This system is coupled to a CO_2 coulometric detector (model 5012, supplied by UIC Coulometrics Inc.), an Autoburette (ABU901, supplied by RADIOMETER Co., LTD.), two cooling units to maintain the sample water at constant temperature, and a personal computer. All procedures except exchange of the samples and rinsing of TA titration cell are operated automatically. Sample water for TC analyses were controlled at constant temperature (10°C). A known volume (about 30 ml) of seawater sample is dispensed into the stripping chamber and acidified with 8.5% reagent grade phosphoric acid, converting all carbonate species to free CO_2. The evolved CO_2 is then extracted from seawater using ultra high purity nitrogen gas (99.9995%) for 10 minutes at a rate of 200 ml/min. The CO_2 gas is absorbed by a coulometer cell solution, containing ethanolamine, dimethylsulfoxide and thymolphthalein indicator, and quantified by coulometric titration. Seawater based reference materials were prepared by Hokkaido University used for calibration. The precision was 0.1%, which was obtaned from 10 replicate determinations on board the ship once a day. TA was determined by potentiometric titration. Sample water for determination of TA was controlled at constant temperature (20°C). A known volume (about 100 ml) of seawater sample is dispensed into closed titration cell containing two glass electrodes, a thermometer and a capillary tube that supplies acid from a burette. Sample seawater was titrated with 0.2 N hydrochloric acid past the carbonic acid endpoint. TA was calculated from titration data by the non-linear least-squares approach (DOE, 1994). The precision was 0.1%, which was obtained from 10 replicate determinations on board the ship once a day.

(3) Results

The results are shown in Appendix.

(4) Reference

DOE (1994): Handbook of methods for the analysis of the various parameters of the carbon dioxide system in seawater; version 2.0, A. G. Dickson and C. Goyet, editors, U. S. Department of Energy CO_2 Science Team Report.

2.2.3 Chlorophyll *a*

Hajime KAWAKAMI (JAMSTEC, Mutsu Institute for Oceanography)

(1) Sampling location

Seawater samples are collected from Station KNOT in this cruise used 12 L Niskin sampling bottles with CTD-RMS. (Th-234 cast)

(2) Experimental procedure

The concentration of chlorophyll *a* in seawater samples is measured by fluorometric determination. The method used here utilizes the Turner fluorometer as suggested by Parsons et al. (1984).

Seawater samples (500 ml) are filtered through a glass fiber filter at 1/2 atmospheric pressure. Filters are used Whatman GF/F glass fiber filters (25 mm diameter).

The filters are extracted by 7 ml of *N, N'* -dimethylformamide between overnight in a dark and cold (-20 ℃) place.

The extracts of the samples are measured the fluorescence by Turner fluorometer (10-AU-005, TURNER DESIGNS) with a 340-500 nm bound excitation filter and a >665 nm bound emission filer, before and after acidification. The acidification is carried out with 2 drops of 1 N HCl and the second measurement made 1 minutes after the acidification.

The amount of chlorophyll *a* is calculated from the following equation;

$$\mu g \text{ chlorophyll } a / L = (fo - fa) / (F_{Ch} - F_{ph}) \quad * \ v/V$$

where fo and fa are the fluorescence before and after the acidification, respectively, F_{Ch} and F_{ph} are the fluorescent factor of chlorophyll *a* and phaeophytine *a*, respectively, v is the volume of *N, N'* -dimethylformamide extract, and V is the volume of seawater.

The method is calibrated against a known concentration of chlorophyll *a* as determined by the spectrophotometric method (Porra et al., 1989).

A precision based on replicate measurements is usually less than 5%.

(3) Preliminary result

The preliminary results were shown in Table 2.2.3 and Figure 2.2.3

(4) References

Parsons Timothy R, Yoshiaki Maita and Carol M Lalli. 1984. "A manual of chemical and biological methods for seawater analysis" (Pergamon Press), pp. 101-112.

Porra R. J., W. A. Thompson and P. E. Kriedemann. 1989. Biochim. Biophys. Acta, 975, 384-394.

Table 2.2.3 The concentrations of Chlorophyll *a* (μg l^{-1}) at NT03-12.

Depth (m)	St. KNOT
0	0.696
10	-
20	0.817
40	0.792
60	0.238
80	0.104
100	0.032
150	0.009
200	0.002

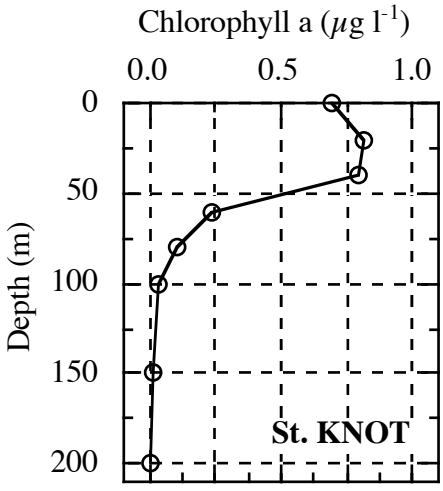


Figure 2.2.3 The vertical distributions of Chlorophyll *a* at NT03-12.

2.2.4 Th-234 and export flux

Hajime KAWAKAMI (JAMSTEC, Mutsu Institute for Oceanography)

(1) Purpose of the study

The fluxes of POC were estimated from Particle-reactive radionuclide (^{234}Th) and their relationship with POC in the northwestern North Pacific Ocean.

(2) Sampling

Seawater sampling for ^{234}Th and POC: 1 station (St. KNOT) and 8 depths (10m, 20m, 40m, 60m, 80m, 100m, 150m and 200m) at each station.

Seawater samples (20–30 L) were taken from Hydrocast at each depth. The seawater samples were filtered with 47mm GF/F filter on board immediately after water sampling.

In situ filtering samples were taken from large volume pump sampler (LVP) at same depths as Hydrocast. The filter samples (150mm GF/F filter) were divided for ^{234}Th, POC and PON.

(3) Chemical analyses

Dissolved ^{234}Th was separated using anion exchange method on board; all Hydrocast samples. Particulate ^{234}Th from LVP samples were separated in land-based laboratory. Separated samples of ^{234}Th were absorbed on 25mm stainless steel disks electrically, and were measured by □-ray counter.

The determinations of POC and PON were used CHN analyzer in land-based laboratory.

(4) Preliminary result

The preliminary results were shown in Figure 2.2.4. This work will help further understanding of particle dynamics at the euphotic layer.

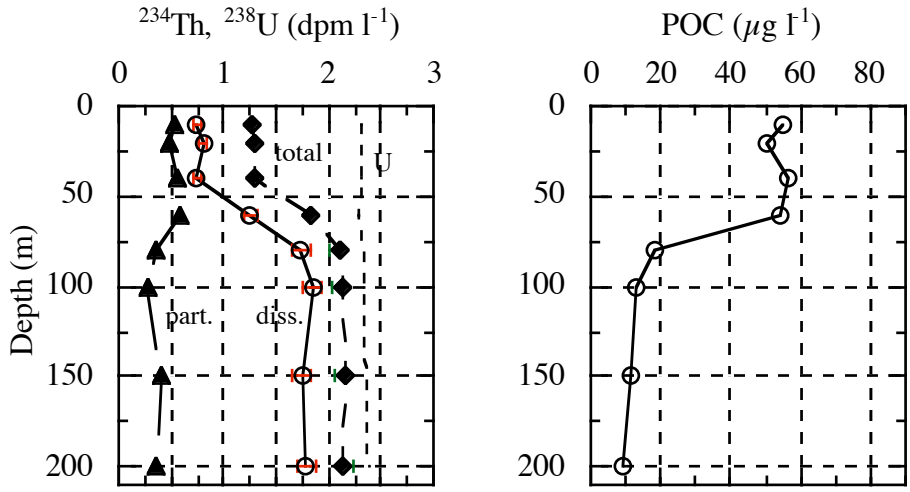


Figure 2.2.4 Vertical destributions of particulate, dissolved and total ^{234}Th, and POC.

2.3 Large Volume Pump (LVP)

Kazuhiro HAYASHI (JAMSTEC MIO) and METS

(1) Instrument overview

Large volume pump (LVP) was developed by Mclane research laboratories Inc., which is designed for large volume, *in-situ* collection of particles and maximum volume 25,000L for 4 L/min pump head with 30Ahr alkalinity battery.

LVP was attached on the 1/4-inch hydro wire. The end of hydro wire was connected with approximately 100kg sinker. The hydro wire was extended up 200m. LVP deployed 4 instruments for each casts, because of it was restricted by winch safety weight limited. We expected to deployment depth from wire length and depth sensor (Sea Bird Inc. SBE39). Depth sensor was attached on the deepest instrument of each cast. Filtering volume was obtained by flow meter (AMCO water metering systems Inc. V100) that is attached on exhaust of pump head.

(2) Sampling results

We was used LVP for suspended particulate matter and radionuclide (^{234} Th) sampling. We did 4 deployments at the station KNOT, and succeeded in obtaining 16 samples. Table 2.3 shows on filtering volume and average depth.

Table 2.3 Filtering volume and calculated depth.

Cast ID		Filtering volume /L	Depth/m	Calculated depth/m	Cast ID		Filtering volume /L	Depth/m	Calculated depth/m
RI #1	LVP 1	189.3	10	9.6	SPOM #1	LVP 1	59.8	20	19.9
	LVP 2	194.9	20	19.2		LVP 2	124.5	60	59.8
	LVP 3	175.6	40	38.4		LVP 3	152.9	100	99.6
	LVP 4	199.5	60	57.6		LVP 4	389.9	150	149.5
RI #2	LVP 5	182.8	80	78.4	SPOM #2	LVP 5	82.5	40	39.5
	LVP 6	187.7	100	98.0		LVP 6	151.4	80	79.1
	LVP 7	199.5	150	147.0		LVP 7	192.3	125	123.6
	LVP 8	203.3	200	196.0		LVP 8	171.8	200	197.7

LVP 4 average depth from sensor **57.63 m**

Normalized value cast RI #1= **0.96**

LVP 8 average depth from sensor **195.96 m**

Normalized value cast RI #2= **0.98**

LVP 4 average depth from sensor **149.47 m**

Normalized value cast SPOM #1= **1.00**

LVP 8 average depth from sensor **197.74 m**

Normalized value cast SPOM #2= **0.99**

2.4 Surface underway observations

2.4.1 Continuous pCO_2 measurement

Yukihiro NOJIRI (National Institute for Environmental Science)
Kazuhiro HAYASHI (JAMSTEC MIO)
Mario HONDA (JAMSTEC MIO)

(1) Introduction

The surface seawater pCO_2 is controlled by the percentage of gaseous carbon dioxide concentration to its solubility in seawater. The four major controlling mechanisms of oceanic pCO_2 are SST (surface seawater temperature), biological activities (photosynthesis and decomposition of organic matter), vertical mixing and gas exchange. The NT03-07 cruise included the subarctic north Pacific with intensive cooling and vertical mixing of surface seawater.

Because the oceanic pCO_2 varies with time and space, the response time of the underway measurement on board a ship should be as short as possible. The popular types of pCO_2 systems are using showerhead type equilibrator. Because it usually has large ratio of air to water in the equilibrator, the system needs circulating pass to achieve the gas-water equilibrium to have enough contact with gas and seawater. This usually makes the response time of the pCO_2 measurement in the order of hour. The oceanic pCO_2 sometime changes very sharply with the rapid change of SST at frontal regions. Sharp spatial change is also observed in the spring bloom season, when the patch of highest productivity is commonly observed in the subarctic and coastal regions.

In this cruise, we used the continuous flow type of equilibrator, which facilitate the rapid response measurement of pCO_2.

(2) Method

The surface seawater taken from the sea chest of R/V Natsushima was supplied to an air-liquid equilibrator having Tandem design, which is a combination of bubbling and mixer equilibrators. Seawater is supplied from the inlet locating the top of the equilibrator and run down. As the inlet diameter is 20 mm, it is never clogged by plankton and nekton. Cylinder air having natural CO_2 concentration is supplied from the bottom of the bubbling equilibrator at 350 ml/min flow rate and ascends in the cylindrical tube. The air is equilibrated to the CO_2 concentration in seawater at the overflow surface of the cylindrical tube. Because of the surface tension in the bubbling air makes the inside pressure of air bubble increase, the resulted pCO_2 of the bubble has slightly lower pCO_2 than the true seawater pCO_2 which is estimated about 0.8% of the total pCO_2 in seawater. The supplied air then passes through the mixer equilibrator with a splasher inside. The air is accurately equilibrated by the second equilibrator and then flows out from the equilibrator. 200 ml/min of the air overflows at a separator, and 150 ml/min of the air is aspirated to a CO_2 measurement system with NDIR.

The NDIR is calibrated with 4 working standard gases have already been critically calibrated against NIES-95 standard gas scale. The calibration was dons at 0 and 12 of GMT. The calibration takes 40 minutes and atmospheric CO_2 was measured after each calibration for 10 minutes. The NDIR output signal was logged with 10 seconds interval for standard gases and with 1minute interval for atmosphere and seawater measurement. Then, we had 2 series of 670 minutes (11 hour and 10 minutes) of continuous pCO_2 measurement of 1 minutes date

logging in a day.

The NDIR mV output are corrected with pressure effect with pressure gage at the outlet of NDIR cell and then calibrated by the standard gas readings.

(3) Result

The distribution of pCO_2 will be determined as soon as possible after this cruise.

2.4.2 Suspended particulate matter (SPM)

Kazuhiro HAYASHI (JAMSTEC MIO)
Katsunori YOSHIDA (JAMSTEC MIO)
Xuedonz XU (JAMSTEC MIO)

(1) Objectives

Suspended particulate matter (SPM) in the sea surface is origin for sinking particle and is mainly formed from biogenic matter and terrigenous matter at the open ocean. Therefore, trace elements in the SPM are influenced by seasonal variation of biological spicies. Understanding the seasonal variation of the sinking particle and process of export flux is important for knowledge of the SPM. The objectives of this investigation are to understand the relationship between chemical tracers and primary production at the northwestern Pacific, and obtain the horizontal and vertical distribution of the trace metals in the SPM and phytoplankton communities in autumn.

Sampling

Samples for horizontal distribution is collected by continuous seawater pump on R/V Natsusima. Underway seawater was passed through temperature and salinity sensor (Themosalinograph model 316SM), and introduced to stainless steel filter holder (SUS 316) for 142mm filters. Particulate matter was collected by Millipore-HA (0.45mm) (Table 2.4.2). Filtered volume was counted by flowmeter. After filtrated, each filter was rinsed 3 times by milli-Q water. The filter moved to acid clean centrifuge tubes and plastic bags, which were stored in the refrigerator. Seawater samples were collected in 100 ml for dissolved nutrients, and were adding 1ml saturated $HgCl_2$ solution. Samples were stored in dark place at room temperature.

Samples for vertical distribution is collected by Mclane Large volume pump (LVP) with 142mm diameter Millipore-HA filter (0.45mm) at the stations KNOT. LVP samples were treated same ways as the underway samples.

(2) Analytical method

The filters are cut by plastic cutter in the clean food. Analysis, the filters are digested by using microwave digestion system (Ethoth: Milestone) with HNO_3 and HF. Dissolved samples are transferred to 50ml centrifuge tube. For ICP-AES samples, uptake of 5ml, add Sc as an internal standard, which take for major elements. These samples will be measured by ICP-AES (Optima 3300DV: Perkin-Elmer). After divided for ICP-AES, almost 45ml sample is added spikes, transferred to Teflon beaker, and evaporated to small drop. Teflon beaker wall is rinsed by conc. HNO_3 3 or 4 times. Sample will be measured by ICP-MS with dessolvator (Aridus: Ceatac Co.) (modified Cullen *et al.*, 2001). Analysis for biogenic Si, $NaCO_3$ extracts filters, and the rest will be analysis for phytoplankton by a scanning electron microscope (SEM). GF/F filter is dried by vacuum freeze drier, and divided in to quaters. One is introduced to CHNS analyzer (NCS 2500: FiniganMAT) for determination of total Carbon and Nitrogen. The other three quarters will be used for determination of inorganic Carbon contents by Coulometer.

Seawater samples are brought out 1ml, added Sc for internal standard, and diluted by 10% HNO_3. Diluted samples will be introduced to ICP-AES and analyze Hg, Ca, Sr and Mg. The rest of seawater samples will be analyzed for dissolved Si, NO_3 and PO_4 by US spectrophotometer (V-550: JASCO Ltd.).

(3) Reference

Cullen *et al*., (2001) Determination of elements in filtered suspended marine particulate material by sector field HR-ICP-MS, J. Anal. At. Spectrom. , 2001, 16, 1307-1312

Table 2.4.2 Underwaysampling log.

ID	Start Date	(UTC)	Lat. (N)	Lon. (E)	Temp.	Salinity (PSU)	Finish Date (UTC)		Lat. (N)	Lon. (E)	Temp.	Salinity (PSU)	Filtering volume /L	Remark
1	11/1/2003	13:12	39.13	142.56	17.903	33.762	11/1/2003	15:43	39.38	143.2	17.72	33.74	114.61	
2	11/1/2003	23:05	40.48	144.31	17.079	33.502	11/2/2003	2:39	41.21	145.09	14.677	32.435	135.37	
3	11/2/2003	4:07	41.34	145.24	12.080	32.567	11/2/2003	5:02	41.39	145.36	12.453	32.556	24.9	
4	11/2/2003	9:01	41.54	146.34	12.703	32.541	11/2/2003	10:00	41.58	146.48	12.58	32.593	35.26	
5	11/2/2003	16:27	42.22	148.25	14.562	33.152	11/2/2003	17:22	42.25	148.38	13.324	32.461	47.37	
6	11/2/2003	23:35	42.49	150.12	12.424	32.527	11/3/2003	1:43	42.57	150.43	12.17	32.59	24.05	
7	11/3/2003	4:02	43.04	151.20	10.955	32.487	11/3/2003	5:08	43.09	151.35	11.546	32.461	45.88	
8	11/3/2003	9:14	43.24	152.32	11.342	32.643	11/3/2003	10:15	43.27	152.46	11.347	32.583	49.42	
9	11/3/2003	22:57	44.00	155.00	11.315	32.543	11/4/2003	1:40	-	-	12.344	32.479	52.58	Station KNOT
10	11/5/2003	9:26	44.04	150.21	11.773	32.532	11/5/2003	9:36	44.04	150.21	-	-	7.72	Pump stoped
11	11/6/2003	6:45	42.31	146.37	12.342	32.526	11/6/2003	7:43	42.23	146.23	12.504	32.513	24.07	
12	11/6/2003	10:30	42.16	145.36	12.943	32.496	11/6/2003	11:45	42.13	145.23	12.725	32.518	16.63	
13	11/7/2003	11:55	40.29	142.50	17.083	33.473	11/7/2003	5:53	40.15	142.39	17.255	33.473	121.36	

3. Appendix

List of Hydrocast

Station: KNOT

	Start	End
Date/Time:	2003.11.4 4:57	
Lat.:	44-00	44-00
Long.:	155-00	155-00
Depth (m):		

Remarks: Cast for Routine
CTDのスイッチに問題があり、ほとんどデータが取れていなかった。

Bottle #	Depth [m]	CTD data Pressure [db]	Pot-Temp. [。C]	Salinity [PSU]	Sigma-□ [kg/m^3]	Sal B/N	Autosal Salinity (psu)	Chemical analysis (uncorrected data) DO umol/kg	TA umol/kg	TDIC umol/kg	NO2 umol/kg	NOx umol/kg	PO4 umol/kg	SiO4 umol/kg
1	200								2279.6	2294.2	0.03	41.20	2.98	92.89
2	150								2256.1	2212.9	0.04	33.74	2.54	71.09
3	125								2247.3	2184.1	0.04	30.63	2.37	59.12
4	100								2216.4	2024.8	0.04	28.05	2.20	50.53
5	80													
6	60								2243.5	2102.7	0.04	25.75	2.06	43.59
7	40								2239.0	2157.9	0.16	20.42	1.72	32.95
8	30								2216.2	2026.7	0.27	8.99	0.96	16.53
9	20								2218.3	2024.9	0.28	9.02	0.96	16.84
10	10	9	9.779	32.807	25.277				2218.5	2022.8	0.28	9.03	0.96	16.83
bucket	0	0							2215.6	2025.4	0.29	9.30	0.96	16.99

Station: KNOT

	Start	End
Date/Time:	2003.11.4 8:37	
Lat.:	44-00	44-00
Long.:	155-00	155-00
Depth (m):		

Remarks: Cast for Th/POC 1 (Kawakami)
CTDのスイッチに問題があり、深い層のデータが取れていなかった。

Bottle #	CTD data Depth [m]	Pressure [db]	Pot-Temp. [。C]	Salinity [PSU]	Sigma-□ [kg/m^3]
1	200				
2	150				
3	100	100	1.512	33.163	26.535
4	80	81	2.424	33.030	26.361
5	60	61	8.036	32.667	25.436
6	40	40	9.768	32.787	25.262
7	20	21	9.771	32.785	25.260
8	10	10	9.781	32.777	25.252

Station: KNOT

	Start	End
Date/Time:	2003.11.4 9:20	
Lat.:	44-00	44-00
Long.:	155-00	155-00
Depth (m):		

Remarks: Cast for Th/POC 2 (Kawakami)

Bottle #	CTD data Depth [m]	Pressure [db]	Pot-Temp. [。C]	Salinity [PSU]	Sigma-□ [kg/m^3]
1	200	203	2.952	33.761	26.899
2	150	152	2.083	33.465	26.735
3	100	101	1.498	33.173	26.544
4	80	81	3.154	33.065	26.326
5	60	60	7.932	32.626	25.419
6	40	40	9.784	32.789	25.261
7	20	21	9.791	32.788	25.260
8	10	9	9.795	32.788	25.259