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MIRAI Cruise Report

MR08-06

Legs. 2 and 3

Studies on geophysics and paleoceanography in the South Pacific: Evolution of climate changes and biogeochemical cycles in the Chilean continental marginal area

Leg 2: 14th March – 30th March

(Valparaiso – Punta Arenas)

Leg 3: 2nd April – 8th April

(Punta Arenas – Valparaiso)

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Contents

Notice on using
This cruise report is a preliminary documentation as of the end of the cruise. It may not be corrected even if changes on content (i.e. taxonomic classifications) are found after publication. It may also be changed without notice. Data on the cruise report may be raw or not processed. Please ask the Chief Scientist for the latest information before using.

1. Preface

This volume includes the simply notes instruments, methods, and preliminary results obtained on-board of the MR08-06 legs. 2 and 3 cruises carried out by R/V MIRAI in the Chilean coastal area including the fjord in 2009. The cruise is divided in two legs of which research area are mouth of the Guafo, Baker Channel and fjord, Magellan mouth in the Pacific side, Drake passage and near Agnes Island (from Valparaiso to Punta Arenas; leg. 2) and inside fjords (from Punta Arenas to Valparaiso; leg. 3). However, we had no observation during the leg.3.

Main purpose of this cruise is to understanding of glacial and inter-glacial climate changes and abrupt changes in the above area, especially changes in the biological pump, which transports carbon from the surface to the deep ocean, sea-surface water temperatures, and the ventilation rate of the intermediate water. Understanding circulation, water masses and large-scale processes and the effect of their variability on present biological productivity and biogeochemical cycling in the eastern South Pacific off Southern Chile including the fjords system, also constitutes our primary motivation for this cruise.

The main observations are site survey by using Seabeam and sub-bottom profiler system, sediment coring by piston corer, and multiple corer, conductivity, temperature, depth observation and water collection at several the water depths by CTD/Niskin bottle sampler and its physical and chemical properties of temperature, salinity, dissolved oxygen, total carbonate, alkalinity, pCO_2, pH, nutrients and Chl *a*, and plankton collection in the surface and sub-surface water by Norpac net. We also successfully observed under way of geological, geophysical, meteorological, biogeochemical (Chl *a*, and pCO_2), physical property (temperature and salinity) investigations, shipboard ADCP, satellite, and collected aerosol, rain, water vapor and volatile organic gases related with global warming.

The cruise successfully finished and we could collect data and samples according to the plan. On behalf of the scientists on-board, I thank all Japanese, and Chilean authorities; the Ministry of Education, Culture, Sports, Science, and Technology of Japan, the Ministries of Foreign Affair of Japan, Chile, Servicio Hidrografico y Oceanografico de la Amada de Chile, for allowing us to work inner and territorial water and the exclusive economic zone of Chile. I really appreciate Captain, Dr. Akamine, Chief officer, Mr. Inoue, and crew members for their hard works on board the ship. Finally, I would like to thank Chilean national observer Miss. Lucia Alejandra Villlar Munoz for her supports and Magellan pilots, Mr. Jorge Garavito Soto and Mr. Rene Arriagada Parra for their best advices about roots for safety navigation in the fjords.

MR08-06 Chief Scientist
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Research Institute for Global Change (RIGC)
Paleoceanography Research Team

2. Introduction

2.1 Background and purposes

The southern region of the eastern South Pacific (ESP) has several important components to be considered: a) the West Wind Drift current that splits into an equatorward Chile-Peru Current and a poleward Cape Horn Current; b) strong poleward winds; c) heavy precipitation during frequent storms which result in large surface buoyancy fluxes; d) input of freshwater by river input, ice melting and rainfall origin greatly enhance the supply of terrigenous sediment; e) enhancement of the vertical stratification by continental fresh water runoff; f) formation of Subantarctic Mode Water (the precursor of Antarctic Intermediate Water, AAIW) offshore southern Chile. Here, subduction and spreading contribute to the ventilation of the main thermocline and of the oxygen minimum zone (OMZ) along the ESP, and to the removal of atmospheric CO_2 and of temperature anomalies. The coastal area south of 42º S, characterized by a complex system of fjords and channels, is particularly vulnerable to climate change and human influence. At present, ice sheet and glaciers that are retreating at an alarming rate constitute one of the main factors affecting some of the major Patagonian ecosystems. In the past, changes in the Patagonian ice fields have had a large impact on circulation and climate. Understanding circulation, water masses and large-scale processes and the effect of their variability on present and past biological productivity and biogeochemical cycling in the ESP off Southern Chile including the fjords system, constitutes our primary motivation for this cruise.

The MR08-06 leg.2, R/V MIRAI cruise has two main objectives: 1) to identify and calibrate biogeochemical proxies (biomarkers, Mg/Ca, Sr/Ca ratio in foraminifera, stable isotope ratio of carbon and nitrogen in foraminifera, zoo- and phytoplankton assemblages, etc.) in the modern ocean (water column and the most recent sediments), and 2) to investigate past changes in the biological pump, which transports carbon from the surface to the deep ocean, sea-surface water temperatures, and the ventilation rate of the intermediate water.

2-2 Relationship with other proposals and collaborative researches regarding MR08-06

The cruise includes sampling in inland waters, only in the Baker Channel and the mouth of the Guafo. Other coastal stations are included south of the Taitao peninsula. The strategic sampling in these areas is directly related to the objectives of the COPAS Sur-Austral Development Plan (Base Financing Program of the CONICYT (http://www.conicyt.cl/573/article-28139.html). Participants in this Development Plan are the COPAS Center of the University of Concepción, the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA), and the Center for Research on Patagonian

Ecosystems (CIEP). The upcoming MIRAI cruise is part of the Development Plan.

Collaboration between the COPAS Center of the University of Concepción and JAMSTEC (http://www.jamstec.go.jp) dates back to the Beagle 2003 expedition dedicated to the study of the impact of global climate change on the AAIW. Collaborations started during that cruise extended later to the training of UdeC graduate students in Japan, joint publications, presentations at congresses, etc. This interaction strengthens the agreement between Institute of Observational Research for Global Change (IORGC, JAMSTEC) Agreement and COPAS (UdeC) signed by the respective authorities in 2007, and facilitates the operation of the oceanographic platform for access to the southern zone.

3. Cruise summary

3.1 Ship

R/V MIRAI

L x B x D	128.58m x 19m x 6.9m
Gross Tonnage	8,687 tons
Call Sign	JNSR

3.2 Cruise Code

MR08-06

3.3 Title of the cruise

Studies on geophysics and paleoceanography in the South Pacific: Evolution of climate changes and biogeochemical cycles in the Chilean continental marginal area.

3.4 Institute

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

2-15 Natsushima-cho, Yokosuka 237-0061, Japan

3.5 Chief Scientist

Naomi Harada (JAMSTEC)

3.6 Cruise periods and ports of call

Leg.2: 14th March, 2009 (Valparaiso, Chile) to 30th March, 2009 (Punta Arenas, Chile)

Leg.3: 2nd April, 2009 (Punta Arenas, Chile) to 8th April, 2009 (Valparaiso, Chile)

3.7 Observation summary

Piston coring	5 casts
Multiple coring	12 casts (5 casts were failure)
Plankton net	38 tows
CTD/water sampling	15 casts
Drifting sediment trap	7 casts
Bottom Boundary Layer water sampling	7 casts
Sub bottom profiling	9 stations
Meteorological water sampling	Continuous data
Aerosol sampling	Continuous data
Surface Meteorology	Continuous data
Cloud observation with lidar	Continuous data
Eddy flux measurement	Continuous data
Aerosol observation with sky radio meter	Continuous data
Sea surface water monitoring	Continuous data
Sea surface Gravity	Continuous data

Shipboard ADCP	Continuous data
Sea bottom topography	Continuous data
Surface Tree Component	Continuous data
Magnetic Field Measurement	Continuous data

3.8 Data Policy

All data collected during this cruise are under the control of the Data Integration and Analysis Group (DIAG) of JAMSTEC.

3.9 Overview

3.9.1 Leg.2: 14th March, 2009 (Valparaiso) – 30th March, 2009 (Punta Arenas)

Piston cores, PC01, 02, 03 and 04 were collected during the leg.1. Total 5 piston cores were collected at five stations in this leg.2. The first piston core, PC05 was collected at the St.38 (47-14'S, 74-50'W, water depth 192m) with a multiple core at Taitao. The sediment core length was 624cm. The grain components are silty clay with some pellets, and major lithology is kaolinite, illite, quarts, and pellets. Radiolarians and diatoms are a few, but other fossils such as foraminifera are rare. The PC06 was collected at St.40, Baker fjord (47-42'S, 74-44'W, water depth 259m). The sediment core length was 1,411cm. The major lithology is clayey silt with nanno fossils and some pellets. The grain components are kaolinite, illite, and quarts. Radiolarians and nanno plankton fossils existed, but foraminifera and diatoms were few. In the inner area of Baker fjord, even though the multiple core could not been collected, because the coring was failure due to too soft bottom sediment containing much amount of pore water such as a liquid. For PC07 at St.43 Oceanic site of Baker Bay (47-49'S, 75-52'W, water depth 1,388m), the sediment of 495.7cm was collected. The major grain components are sandy clay with nanno fossils. The quarts content was the highest in the clay with rock fragments, mica, and accessory minerals. Foraminifers were also contained. The PC08 was collected at same position of the PC03 in the Magellan mouth during the MR03-K04 MIRAI cruise in 2003 (52-52'S, 74-05'W, water depth 558m). Because we could not access the first planed position in the Pacific side of Magellan due to rough condition. The sediment core length was 749.7cm. The major lithology was calcareous clayey sand and major grain components are nanno fossils, foraminifera, bioclasts, pellets, radiolarians with minerals and quarts. The PC09 was collected at St.44 in Drake Passage (55-43'S, 66-08'W, water depth 684m). The core length was 997.2cm. The major lithology was foraminiferal sand and major grain components are foraminiferal fossils and bioclasts. The minerals and quarts contents were relatively small.

In addition, 12 casts of multiple coring (including 5 failure casts), 15 casts of CTD/hydrocasts, 38 tows of plankton net, 7 casts of drifting sediment trap casts, 7 casts of benthic boundary layer water sampling were done. The SeaBeam, sub bottom profiler, aerosols collection, and pCO_2, were continuously observed according to the cruise track.

3.9.2 Leg.3: 2nd April, 2009 (Punta Arenas) – 8th April, 2009 (Valparaiso)

We had no observation during the leg.3, because Chilean national observer disembarked at Punta Arenas after the leg.2.

4. List of Instruments on MIRAI

4.1 Multi Narrow Beam Echo Sounding System

① SeaBeam 2112.004, (SeaBeam Instruments Inc., USA)

② Sub-bottom profiler: SeaBeam 2112.004, (SeaBeam Instruments Inc. USA)

4.2 Sediment coring systems

① Multiple corer: 620 kg lead weight with 8 sub-corers (RIGO Co. Ltd., Japan)

② Piston corer: 1.3 ton stainless and lead weight with maximum 20m core tube (RIGO Co. Ltd., Japan)

4.3 Physical properties measurement of sediment

① Multi-sensor core logger: MSCL-S with detectors of gamma-ray attenuation, P-wave velocity and magnetic susceptibility (Bartington Instruments, UK) (GEOTEK Ltd., UK)

② Core color reflectance: CM-2002 (Konica Minolta Holdings Inc., Japan)

③ Core photograph: digital camera, Nikon D1x / Lens: Nikon AF Zoom-Nikkor 24-50mm (Nikon Corporation, Japan)

④ Soft-X ray photograph: SOFTEX PRO-TEST 150 (Softex Corporation, Japan)

4.4 Ship board magnet system

① Gravity Meter: S-116 (LaCoste-Romberg. Inc., USA)

② Magnet Meter: Three component magnetometer, SFG-1214 (Tierra Tecnica Ltd., USA)

4.5 Surface meteorological observation system

① Anemometer: KE-500 (Koshin Denki, Japan)

② Thermometer (SST): RFN1-0 (Koshin Denki, Japan)

③ Tair/RH: HMP45A (VAISARA, Finland) with 43408 Gill aspirated radiation shield (R.M. Young, USA)

④ Barometer: AP370 (Koshin Denki, Japan)

⑤ Rain gauge: 50202 (R.M. Young, USA)

⑥ Optical rain gauge: ORG-115DR (Osi, USA)

⑦ Radiometer: MS-801 (short wave), MS-202 (long wave) (Eiko Seiki, Japan)

⑧ Wave height meter: MW-2 (Tsurumi-seiki, Japan)

4.6 SOAR insolation-radiation observation system

① Anemometer: 05106 (R.M. Young, USA)

② Tair/RH: HMP45A (VAISARA, Finland) with 43408 Gill aspirated radiation shield (R.M. Young, USA)

③ Barometer: 61201 with 61002 Gill pressure port (R.M. Young, USA)

④ Rain gauge: 50202 (R.M. Young, USA)

⑤ Optical rain gauge: ORG-115DA (Osi, USA)

⑥ Radiometer: PSP (short wave), PIR (long wave) (Eppley labs, USA)

4.7 Ceilometer

① CT-25K (VAISARA, Finland)

4.8 Current profiler

① Broadband Acoustic Doppler Current Profiler, VM-75 (Teledyne RD Instruments Inc., USA)

4.9 CTD/ Carousel water sampling system

① Carousel Water Sampler: SBE32 (Sea-Bird Electronics Inc., USA)

② Conductivity/Temperature/Depth Profiler: SBE 04-02/O, SBE9plus, SBE03plus, (Sea-Bird Electronics Inc., USA)

③ Dissolved oxygen sensor: SBE43 (Sea-Bird Electronics Inc., USA)

④ Fluorescence sensor (Seapoint sensors, Inc., USA)

⑤ Transmission sensor (WET labs, Inc., USA)

⑥ Altimeter: PSA-916T (BENTHOS Inc., USA)

⑦ Pump: SBE 5T (Sea-Bird Electronics Inc., USA)

⑧ Deck unit: SBE 11plus (Sea-Bird Electronics Inc., USA)

⑨ Niskin Water sampler: 12-litre Niskin-X, 12-litre clean Niskin-X (General Oceanics Inc., USA)

4.10 Partial pressure CO_2 (pCO_2) measurement system

① Non-dispersive infrared analyzer: MLT3T-IR (BINOS, Inc., USA)

4.11 Bottle salinity measurement

① Salinometer: Model 8400B “AUTOSAL”, (Guildline Instruments Ltd., Canada)

Thermometer: Model 9504 Digital Platinum Resistance Thermometer, (Guildline Instruments Ltd., Canada)

4.12 Nutrients measurement

① Nutrients analyzer: Continuous Flow Analytical System, Model TRAACS 800 (4 channels), (Bran+Luebbe, Germany)

4.13 Total dissolved inorganic carbon (TCO_2) measurement

① TCO_2 analyzer: systems C (Nippon ANS Inc., Japan)

② Sea water dispensing, extraction and a coulometer: systems N2 (Nippon ANS Inc., Japan)

4.14 Total alkalinity

① Spectrophotometer: TA analytical system (Nippon ANS Inc., Japan)

4.15 Total hydrogen ion concentration scale (pH)

① pH/ion meter: PHM240 (Radiometer Analytical SAS, France)

4.16 Dissolved oxygen measurement

① Automatic photometric titrator: DOT-01 (Kimoto Electronic Co. Ltd, Japan)

② Burette for sodium thiosulfate and potassium iodate: APB-510 (Kyoto Electronic Co. Ltd., Japan)

4.17 Surface sea water monitoring

① Continuous Sea Surface Water Monitoring System (Nippon Kaiyo Co. Ltd., Japan)

② Temperature and conductivity sensor: SBE-21 (Sea-Bird Electronics Inc., USA)

③ Bottom of ship thermometer: SBE 3S (Sea-Bird Electronics Inc., USA)

④ Dissolved Oxygen Sensor: 2127A (Hach Ultara Analytics Japan, Inc., Japan)

⑤ Fluorometer: 10-AU-005 (Turner Designs, Inc., USA)

⑥ Flow meter: EMARG2W (Aichi Watch Electronics Ltd., Japan)

4.18 Chlorophyll a

① Fluorometer: 10-AU-005 (Turner Designs, Inc., USA)

5. Cruise track and cruise log

5.1 Cruise track

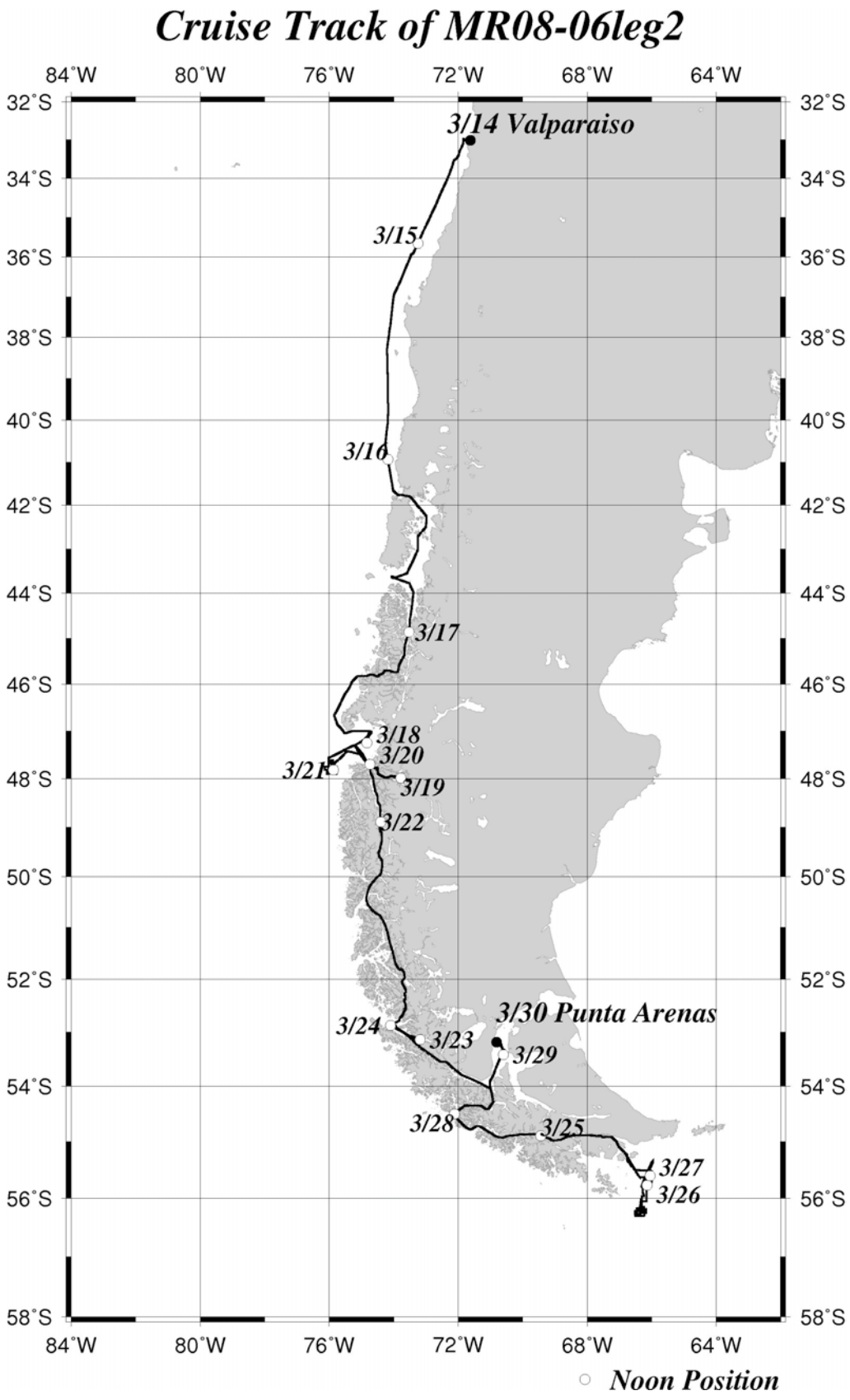

Fig. 5.1-1 Cruise track of MR08-06 leg.2

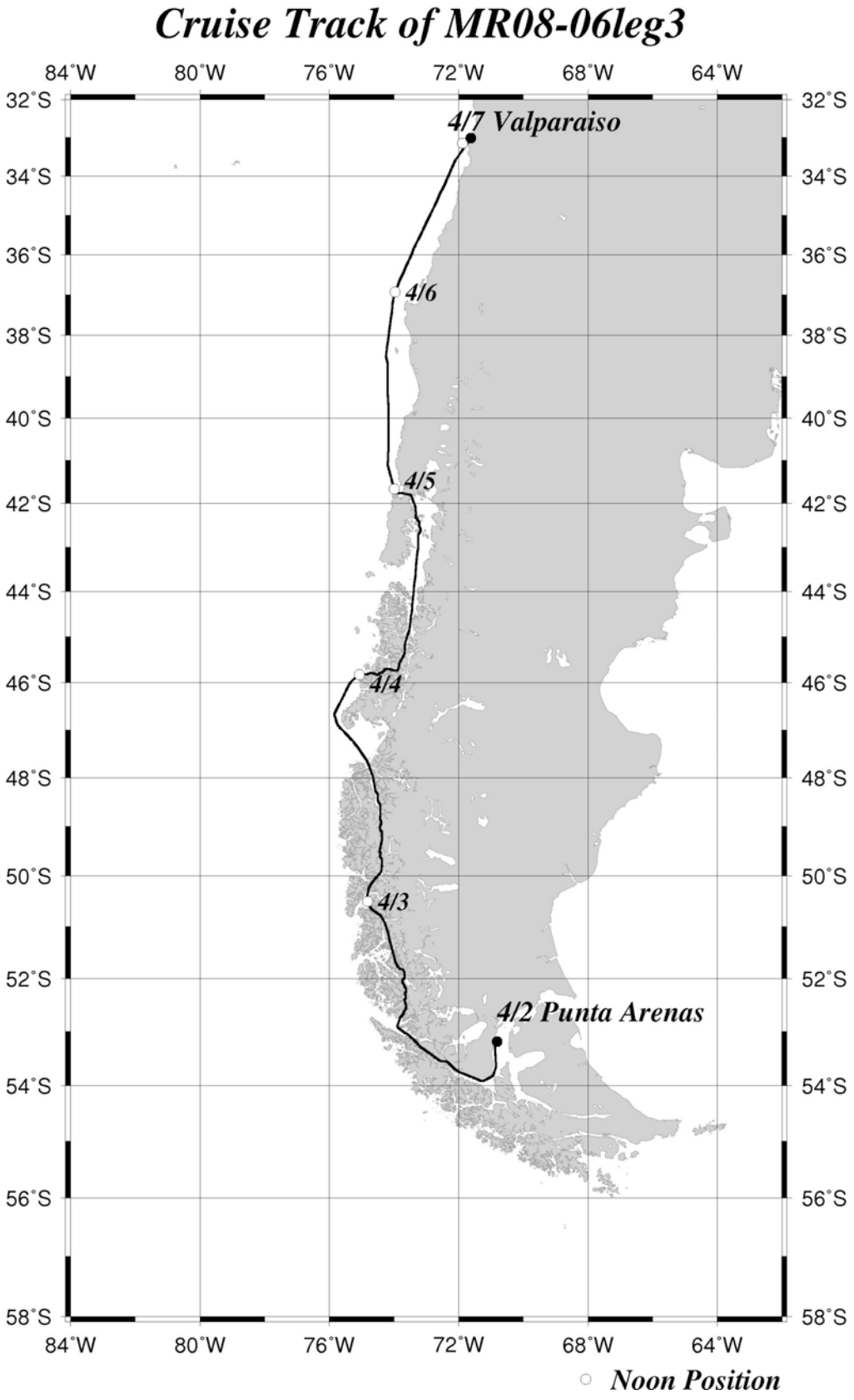

Fig.5.1-2 Cruise track of MR08-06

5.2 Cruise log

MR08-06Leg2

U.T.C.		S.M.T.		Position		Events
Date	Time	Date	Time	Long.	Lat.	
3/14	22:10	3/14	19:10	71_37.67W	33_02.15S	MR08-06 Leg2 cruise Start (Departure from Valparaiso)
3/15	01:00		22:00	-	-	Time adjustment -1 hours (SMT=UTC-4h)
	15:33		11:33	-	-	Continuous monitoring of sea surface water Start
3/17	07:24	3/17	03:24	-	-	Arrival at St.37
	07:30		03:30	74_03.72W	43_37.09S	CTD/Hydrocast (#1, 185m)
	08:13		04:13	74_03.50W	43_37.28S	Plankton Net (#1)
	09:12		05:12	74_03.10W	43_37.15S	Multiple Core (#1) Start
	09:23		05:23	74_03.13W	43_37.14S	Multiple Corer Penetrate (MC37, Water depth: 199m)
	09:36		05:36	-	-	Departure from St.37
3/18	09:22	3/18	05:22	-	-	Site Survey (0.5 hours)
	10:48		06:48	-	-	Arrival at St.38
	10:58		06:58	74_45.01W	46_59.97S	CTD/Hydrocast (#2, 75m)
	11:33		07:33	74_44.98W	46_59.96S	Plankton Net (#2)
	12:03		08:03	74_44.99W	47_00.03S	Bottom Boundary Layer water sampling (BBL) (#1)
	12:37		08:37	74_45.12W	47_00.10S	Drifting Sediment Trap (#1) Deployment
	14:36		10:36	-	-	Site Survey (2.5 hours)
	17:05		13:05	74_50.37W	47_14.15S	Multiple Core (#2) Start
	17:21		13:21	74_50.37W	47_14.14S	Multiple Corer Penetrate (MC38, Water depth: 187m)
	17:58		13:58	74_50.37W	47_14.14S	Piston Core (#1) Start
	18:38		14:38	74_50.38W	47_14.15S	Piston Corer Penetrate (PC05, Water depth: 192m)
	21:07		17:07	74_40.75W	47_01.59S	Drifting Sediment Trap (#1) Recovery
	21:12		17:12	-	-	Departure from St.38
3/19	10:18	3/19	06:18	-	-	Arrival at St.42
	10:20		06:20	73_47.26W	47_59.40S	CTD/Hydrocast (#3, 50m)
	10:55		06:55	73_47.27W	47_59.37S	Multiple Core (#3) Start
	11:26		07:26	73_47.30W	47_59.31S	Multiple Corer Penetrate (MC42, Water depth: 1,063m)
	11:56		07:56	73_47.28W	47_59.33S	CTD/Hydrocast (#4, 1049m)
	13:22		09:22	73_47.14W	47_59.32S	Drifting Sediment Trap (#2) Dep.
	13:45		09:45	73_47.40W	47_59.38S	Plankton Net (#3)
	14:37		10:37	73_47.39W	47_59.53S	BBL (#2)
	17:12		13:12	73_47.27W	47_59.27S	Multiple Core (#4) Start
	17:36		13:36	73_47.28W	47_59.27S	Multiple Corer Penetrate (MC42B, Water depth: 1071m, failure)
	18:10		14:10	-	-	Site Survey (1.5 hours)
	20:05		16:05	73_45.01W	48_10.03S	Drifting Sediment Trap (#2) Rec.
	20:30		16:30	-	-	Departure from St.42
	22:36		18:36	-	-	Arrival at St.41
	22:42		18:42	74_15.48W	47_58.81S	CTD/Hydrocast (#5, 716m)

U.T.C.		S.M.T.		Position		Events
Date	Time	Date	Time	Long.	Lat.	
3/19	23:52	3/19	19:52	74_15.55W	47_58.80S	Multiple Core (#5) Start
3/20	00:13	3/19	20:13	74_15.62W	47_58.79S	Multiple Corer Penetrate (MC41, Water depth: 737m, failure)
	00:43		20:43	74_15.61W	47_58.79S	Plankton Net (#4)
	01:27		21:27	74_15.55W	47_58.79S	BBL (#3)
	02:05		22:05	74_15.54W	47_58.80S	Multiple Core (#6, Ashura type MC)
						Multiple Core Penetrate (MC41B, water depth: 735m, failure)
	02:48		22:48	-	-	Departure from St.41
	02:48		22:48	-	-	Site Survey (8.0 hours)
	10:48	3/20	06:48	-	-	Arrival at St.40
	10:51		06:51	74_44.43W	47_42.46S	CTD/Hydrocast (#6, 50m)
	11:26		07:26	74_44.37W	47_42.40S	Multiple Core (#7) Start
	11:39		07:39	74_44.38W	47_42.40S	Multiple Corer Penetrate (MC40, water depth: 260m, failure)
	12:03		08:03	74_44.41W	47_42.38S	CTD/Hydrocast (#7, 244m)
	12:58		08:58	74_44.53W	47_42.79S	Drifting Sediment Trap (#3) Dep.
	13:13		09:13	74_44.54W	47_42.66S	Plankton Net (#5)
	14:49		10:49	74_44.48W	47_43.25S	Drifting Sediment Trap (#3) Rec.
	15:04		11:04	74_44.41W	47_43.28S	BBL (#4)
	15:36		11:36	74_44.41W	47_42.56S	Multiple Core (#8) Start
	15:47		11:47	74_44.37W	47_42.37S	Multiple Corer Penetrate (MC40B, water depth: 258m, failure)
	17:10		13:10	74_44.38W	47_42.39S	Piston Core (#2) Start
	17:54		13:54	74_44.38W	47_42.39S	Piston Corer Penetrate (PC06, Water depth: 258m)
	18:51		14:51	74_44.37W	47_42.36S	Drifting Sediment Trap (#4) Dep.
	22:50		18:50	74_45.50W	47_44.00S	Drifting Sediment Trap (#4) Rec.
	23:12		19:12	-	-	Departure from St.40
3/21	04:12	3/21	00:12	-	-	Arrival at St.43
	04:12		00:12	-	-	Site Survey (5.5 hours)
	10:00		06:00	75_51.67W	47_48.80S	CTD/Hydrocast (#8, 100m)
	10:36		06:36	75_51.70W	47_48.75S	Multiple Core (#9) Start
	11:11		07:11	75_51.67W	47_48.71S	Multiple Corer Penetrate (MC43, Water depth: 1,389m)
	12:04		08:04	75_51.64W	47_48.82S	Drifting Sediment Trap (#5) Dep.
	12:35		08:35	75_51.66W	47_48.75S	Piston Core (#3) Start
	13:31		09:31	75_51.68W	47_48.71S	Piston Corer Penetrate (PC07, Water depth: 1,388m)
	14:43		10:43	75_52.36W	47_49.30S	CTD/Hydrocast(#9, 1,385m)
	17:09		13:09	75_50.52W	47_50.00S	Plankton Net (#6)
	19:04		15:04	75_50.21W	47_50.87S	Drifting Sediment Trap (#5) Rec.
	19:30		15:30	-	-	Site Survey (7.0 hours)
3/22	02:30		22:30	-	-	Departure from St.43
3/23	15:00	3/23	11:00	-	-	Arrival at St.46
	15:12		11:12	73_10.79W	53_08.59S	CTD/Hydrocast (#10, 50m)
3/24	02:00		22:00	-	-	Departure from St.46
	09:12	3/24	05:12	-	-	Arrival at St.46

U.T.C.		S.M.T.		Position		Events
Date	Time	Date	Time	Long.	Lat.	
3/24	09:57	3/24	05:57	74_05.08W	52_52.00S	CTD/Hydrocast (#11, 50m)
	10:36		06:36	74_05.04W	52_51.99S	Multiple Core (#10) Start
	10:55		06:55	74_05.02W	52_51.97S	Multiple Corer Penetrate (MC46, water depth: 558m)
	11:26		07:26	74_04.98W	52_51.99S	Drifting Sediment Trap (#6) Dep.
	11:43		07:43	74_05.06W	52_52.00S	CTD/Hydrocast (#12, 548m)
	13:03		09:03	74_06.14W	52_52.10S	BBL (#5)
	13:37		09:37	74_05.02W	52_52.02S	Piston Core (#4) Start
	14:27		10:27	74_05.00W	52_52.00S	Piston Corer Penetrate (PC08, water depth: 558m)
	17:08		13:08	74_06.09W	52_53.75S	Plankton Net (#7)
	19:35		15:35	74_06.58W	52_53.44S	Drifting Sediment Trap (#6) Rec.
	19:42		15:42	-	-	Departure from St.46b
3/26	01:30	3/25	21:30	-	-	Arrival at St.44
	01:30		21:30	-	-	Site Survey (10.5 hours)
	12:32	3/26	08:32	66.20.63W	56_03.16S	CTD/Hydrocast (#13, 100m)
3/26	13:30	3/26	09:30	-	-	Site Survey (20.0 hours)
3/27	09:58	3/27	05:58	66_08.01W	55_42.51S	CTD Hydrocast (#14, 50m)
	10:33		06:33	66_08.03W	55_42.55S	Multiple Core (#11) Start
	10:54		06:54	66_08.02W	52_42.59S	Multiple Corer Penetrate (MC44, water depth: 685m)
	11:25		07:25	66_08.60W	55_42.67S	Drifting Sediment Trap (#7) Dep.
	11:39		07:39	66_07.70W	55_42.51S	CTD/Hydrocast (#15, 661m)
	11:51		07:51	66_08.01W	55_42.55S	Sea Surface Transparency Observation (#1)
	12:57		08:57	66_07.99W	55_42.55S	Piston Core (#5) Start
	13:42		09:42	66_08.06W	55_42.58S	Piston Corer Penetrate (PC05, Water depth: 684m)
	14:26		10:40	66_07.96W	55_42.67S	BBL (#6)
	17:03		13:03	66_02.92W	55_34.71S	Plankton Net (#8)
	17:57		13:57	66_03.63W	55_31.73S	8 figure running for magnetometer calibration
	18:56		14:56	66_00.58W	55_32.13S	Drifting Sediment Trap (#7) Rec.
	19:24		15:24	-	-	Departure from St.44
3/28	12:30	3/28	08:30	-	-	Arrival at St.45
	12:30		08:30	-	-	Site Survey (0.5 hours)
	13:27		09:27	72_06.28W	54_31.11S	CTD/Hydrocast (#16, 50m)
	13:59		09:59	72_06.39W	54_31.07S	Multiple Core (#12) Start
	14:15		09:15	72_06.36W	54_31.07S	Multiple Corer Penetrate (MC45, Water depth: 487m)
	14:45		10:45	72_06.44W	54_31.97S	Drifting Sediment Trap (#8) Dep.
	14:58		10:58	72_06.44W	54_30.76S	CTD/Hydrocast (#17, 443m)
	15:15		11:15	72_06.47W	54_30.75S	Sea Surface Transparency Observation (#2)
	17:03		13:03	72_07.32W	54_30.77S	BBL (#7)
	17:28		13:28	72_07.48W	54_30.84S	Plankton Net (#9)
	20:46		16:46	72_08.92W	54_32.17S	Drifting Sediment Trap (#8) Rec.
	20:48		16:48	-	-	Departure from St.45
3/29	17:00	3/29	13:00	-	-	Continuous monitoring of sea surface water End
3/30	13:50	3/30	09:50	70_54.38W	53_10.19S	MR08-06 Leg.2 end (Arrival at Punta Arenas)

MR08-06Leg3

U.T.C.		S.M.T.		Position		Events
Date	Time	Date	Time	Long.	Lat.	
4/2	17:00		13:00	70_54.38W	53_10.19S	MR08-06 Leg3 cruise Start (Departure from Punta Arenas)
4/7	19:30		15:30	71_37.67W	33_02.15S	MR08-06 Leg3 cruise End (Arrival at Valparaiso)

6. List of Participants

Explanatory notes

* Leg.2 (Valparaiso-Punta Arenas)

† Leg.3 (Punta Arenas-Valparaiso)

*† Legs.2 and 3 (Valparaiso-Valparaiso)

6.1 Chief Scientist

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6.2 Scientists and Research staffs

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Keiji Horikawa*†	Nagoya University/JAMSTEC, IORGC, PPG
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Silvio Pantoja*	UdeC/COPAS
Wolfgang Schneider*	UdeC/COPAS
Karol Patricia Espejo Sepúlveda*	UdeC/COPAS
Alejandro J. Avila Santis*	UdeC/COPAS
Giovanni Daneri Hermosilla*	Centro de Investigación en Ecosistemas de la Patagonia/ Universidad Austral de Chile
Jose Luis Iriarte Machuca*	Universidad Austral de Chile
Eduardo Menschel Aguilar*	COPAS/ Universidad Austral de Chile
Ryo Anma*†	University of Tsukuba
Isao Motoyama*†	University of Tsukuba
Kiichiro Kawamura*†	Fukada Geological Institute
Hiroshi Furutani*†	The University of Tokyo

6.3 Marine technicians

Satoshi Okumura*	Global Ocean Development Inc. (GODI)
Harumi Ota*†	GODI
Takashi Kawamura*†	GODI
Yusuke Sato*†	Marine Works Japan (MWJ)
Kazuhiro Yoshida*†	MWJ
Takami Mori*†	MWJ

Ei Hatakeyama*†	MWJ
Junji Matsushita*†	MWJ
Yasuhiro Arii*†	MWJ
Tomonori Watai*†	MWJ
Yohei Taketomo*	MWJ
Satoshi Ozawa*	MWJ
Shinsuke Toyoda*	MWJ
Tatsuya Tanaka*	MWJ
Kenichiro Sato*	MWJ
Minoru Kamata*	MWJ
Masanori Enoki*	MWJ
Misato Kuwahara*	MWJ
Hideki Yamamoto†	MWJ
Shinichiro Yokogawa†	MWJ
Katsunori Sagishima†	MWJ
Yuichi Sonoyama†	MWJ
Ayaka Hatsuyama†	MWJ
Shunsuke Tanaka†	MWJ

6.4 Students

Atsushi Kurasawa*†	Hokkaido University/JAMSTEC, IFREE, Research Program for Paleoenvironment and Earth system evolution
Kazuyo Shiroya*†	The University of Tokyo/JAMSTEC, IORGC, PPG
Yasumi Yamada*†	University of Tsukuba
Jinyoung Jung*†	The University of Tokyo

6.5 Chilean National Observer

Lucia Alejandra Villar Munoz*	Hydrographic and Oceanographic Service of the Chilean Navy

6.6 Magellan Pilots

Rene Arriagada Parra*

Jorge Gravito Soto*

7. Observations

7.1 Meteorological observations

7.1.1 Surface Meteorological Observation

(1) *Personnel*

Kunio Yoneyama*	JAMSTEC	: Principal Investigator
Satoshi Okumura	GODI	: Operation Leader
Harumi Ota	GODI	
Takashi Kawamura	GODI	

* : Not on-board

(2) *Objectives*

Surface meteorological parameters were observed to accumulate the basic meteorological dataset. These parameters bring us the information about the temporal variation of the meteorological condition surrounding the ship.

(3) *Parameters and Methods*

Surface meteorological parameters were observed throughout the MR08-06 Leg.2 cruise. During this cruise, we used two systems for the observation.

i. MIRAI Surface meteorological observation (SMET) system

Instruments of SMET system are listed in Table 7.1.1-1 and measured parameters are listed in Table 7.1.1-2 Data were collected and processed by KOAC-7800 weather data processor made by Koshin-Denki, Japan. The data set consists of 6-second averaged data.

ii. Shipboard oceanographic and atmospheric radiation (SOAR) system

The SOAR system designed by BNL (Brookhaven National Laboratory, USA) consists of major three parts.

a) Portable Radiation Package (PRP) designed by BNL – short and long wave downward radiation.
b) Zeno meteorological (Zeno/Met) system designed by BNL – wind, air temperature, relative humidity, pressure, and rainfall measurement.
c) Scientific computer system (SCS) designed by NOAA (National Oceanic and Atmospheric Administration, USA) – centralized data acquisition and logging of all data sets.

The SCS recorded PRP data and Zeno/Met data every 6 and 10 seconds, respectively. Instruments and their locations are listed in Table 7.1.1-3 and measured parameters are listed in Table 7.1.1-4.

We have checked the following sensors, before and after the cruise for the quality control as post processing.

i. Young Rain gauge (SMET and SOAR)

The linearity of output value from the rain gauge sensor was inspected by changing input value adding fixed quantity of test water.

ii. Barometer (SMET and SOAR)

Comparison with the portable barometer value, PTB220CASE, (VAISALA, Finland).

iii.Thermometer (air temperature and relative humidity) (SMET and SOAR)

Comparison with the portable thermometer value, HMP41/45 (VAISALA, Finland).

(4) *Preliminary results*

The Table 7.1.1-5 shows the weather log every three hours of the following parameter.

Wind direction and speed (SMET)
Pressure (SMET)
Air temperature and dewpoint temperature (SMET)
Relative humidity (SMET)
Sea surface temperature (SST) (SMET)
Precipitation (SMET, Optical rain gauge)
Significant wave height and period (SMET)

The Fig. 7.1.1-1 shows the time series of the following parameters;

Wind (SOAR)
Air temperature (SOAR)
Relative humidity (SOAR)
Precipitation (SOAR, Optical rain gauge)
Short/long wave radiation (SOAR)
Pressure (SOAR)
Sea surface temperature (SMET)
Significant wave height (SMET)

(5) *Data archives*

These meteorological data were submitted to the Data Integration and Analysis Group (DIAG) of JAMSTEC just after the cruise. The corrected data set will be provided by K. Yoneyama, JAMSTEC.

(6) *Remarks*

The SST data from 22:50 (UTC) 14th March 2009 to 19:30 (UTC) 29th March 2009 collected by SMET is available.

Table 7.1.1-1 Instruments and installations of MIRAI SMET system

Sensors	Type	Manufacturer	Location (altitude from surface)
Anemometer	KE-500	Koshin Denki, Japan	foremast (24m)
Tair/RH	HMP45A	VAISALA, Finland	
with 43408 Gill aspirated radiation shield		R.M. Young, USA	compass deck (21m)
			starboard side and port side
Thermometer: SST	RFN1-0	Koshin Denki, Japan	4th deck (-1m, inlet -5m)
Barometer	AP370	Koshin Denki, Japan	captain deck (13m)
			weather observation room
Rain gauge	50202	R. M. Young, USA	compass deck (19m)
Optical rain gauge	ORG-115DR	Osi, USA	compass deck (19m)
Radiometer (short wave)	MS-801	Eiko Seiki, Japan	radar mast (28m)
Radiometer (long wave)	MS-202	Eiko Seiki, Japan	radar mast (28m)
Wave height meter	MW-2	Tsurumi-seiki, Japan	bow (10m)

Table 7.1.1-2 Parameters of MIRAI SMET system

Parameter	Units	Remarks
1 Latitude	degree	
2 Longitude	degree	
3 Ship's speed	knot	Mirai log, DS-30 Furuno
4 Ship's heading	degree	Mirai gyro, TG-6000, Tokimec
5 Relative wind speed	m/s	6sec./10min. averaged
6 Relative wind direction	degree	6sec./10min. averaged
7 True wind speed	m/s	6sec./10min. averaged
8 True wind direction	degree	6sec./10min. averaged
9 Barometric pressure	hPa	adjusted to sea surface level
		6sec. averaged
10 Air temperature (starboard side)	degC	6sec. averaged
11 Air temperature (port side)	degC	6sec. averaged
12 Dewpoint temperature (starboard side)	degC	6sec. averaged
13 Dewpoint temperature (port side)	degC	6sec. averaged
14 Relative humidity (starboard side)	%	6sec. averaged
15 Relative humidity (port side)	%	6sec. averaged
16 Sea surface temperature	degC	6sec. averaged
17 Rain rate (optical rain gauge)	mm/hr	hourly accumulation
18 Rain rate (capacitive rain gauge)	mm/hr	hourly accumulation
19 Down welling shortwave radiation	W/m^2	6sec. averaged
20 Down welling infra-red radiation	W/m^2	6sec. averaged
21 Significant wave height (bow)	m	hourly
22 Significant wave height (aft)	m	hourly
23 Significant wave period (bow)	second	hourly
24 Significant wave period (aft)	second	hourly

Table 7.1.1-3 Instruments and installation locations of SOAR system

Sensors (Zeno/Met)	Type	Manufacturer	Location (altitude from surface)
Anemometer	05106	R.M. Young, USA	foremast (25m)
Tair/RH	HMP45A	VAISALA, Finland	
with 43408 Gill aspirated radiation shield		R.M. Young, USA	foremast (23m)
Barometer	61201	R.M. Young, USA	
with 61002 Gill pressure port		R.M. Young, USA	foremast (22m)
Rain gauge	50202	R.M. Young, USA	foremast (24m)
Optical rain gauge	ORG-115DA	Osi, USA	foremast (24m)

Sensors (PRP)	Type	Manufacturer	Location (altitude from surface)
Radiometer (short wave)	PSP	Epply Labs, USA	foremast (24m)
Radiometer (long wave)	PIR	Epply Labs, USA	foremast (24m)
Fast rotating shadowband radiometer		Yankee, USA	foremast (24m)

Table 7.1.1-4 Parameters of SOAR system

Parameter	Units	Remarks
1 Latitude	degree	
2 Longitude	degree	
3 SOG	knot	
4 COG	degree	
5 Relative wind speed	m/s	
6 Relative wind direction	degree	
7 Barometric pressure	hPa	
8 Air temperature	degC	
9 Relative humidity	%	
10 Rain rate (optical rain gauge)	mm/hr	
11 Precipitation (capacitive rain gauge)	mm	reset at 50mm
12 Down welling shortwave radiation	W/m^2	
13 Down welling infra-red radiation	W/m^2	
14 Defuse irradiance	W/m^2	

Table 7.1.1-5 Weather log
MR08-06 Leg.2

Time		Position		W.D.	W.S.	Weather	Press.	Dry Temp	Dew P.T.	RH	SST	Rain	Wv. Ht.	Wv. Pd.
UTC		Lat S	Lon W	(deg)	(m/s)		(hPa)	(DEG-C)	(DEG-C)	(%)	(DEG-C)	(mm/h)	(m)	(sec)
3/15	0:00	32_58	71_50	188	14.1	bc	1013.1	15.5	12.1	80	14.4	0	2.5	7.8
3/15	3:00	33_30	72_04	204	14.5	bc	1013.0	15.1	12.1	82	13.4	0	2.4	6.5
3/15	6:00	33_59	72_19	192	8.9	b	1014.1	14.8	12.3	85	13.2	0	2.3	6.7
3/15	9:00	34_29	72_35	197	10.7	bc	1014.1	14.6	11.7	83	15.3	0	2.3	6.5
3/15	12:00	34_59	72_52	196	10	bc	1015.3	13.6	11.5	87	15.0	0	1.9	6.1
3/15	15:00	35_30	73_10	211	10.8	bc	1015.9	13.7	11.1	84	13.2	0	1.7	5.5
3/15	18:00	35_56	73_27	215	11.1	bc	1015.6	14.3	11.6	84	13.6	0	1.7	7.0
3/15	21:00	36_34	73_46	220	11.2	bc	1016.1	14.7	12.7	88	12.9	0	1.4	5.2
3/16	0:00	37_14	74_02	182	5.1	bc	1017.3	15.9	13.6	86	16.6	0	1.3	5.7
3/16	3:00	37_56	74_09	359	6	bc	1016.5	15.6	14.1	91	14.7	0.3	1.0	6.7
3/16	6:00	38_39	74_11	212	7.8	bc	1017.7	16.0	13.1	83	14.0	0	1.0	6.5
3/16	9:00	39_20	74_11	192	7.1	bc	1018.2	14.8	11.4	80	15.7	0	1.5	5.9
3/16	12:00	40_02	74_11	218	6.2	bc	1019.3	14.6	10.4	76	14.7	0	2.0	7.4
3/16	15:00	40_43	74_14	200	8.1	o	1021.8	13.6	11.0	84	14.6	0	2.8	9.1
3/16	18:00	41_22	74_05	214	8.1	p	1022.4	12.3	10.0	86	14.1	0	2.9	10.4
3/16	21:00	41_47	73_33	298	7.7	c	1021.8	13.1	10.4	84	11.8	0	0.4	14.7
3/17	0:00	42_22	72_59	35	3.5	c	1023.5	12.6	10.7	88	12.6	0	0.3	11.7
3/17	3:00	43_04	73_17	330	5.3	o	1024.2	11.6	10.9	95	11.0	0	0.7	8.3
3/17	6:00	43_36	73_48	320	6.4	o	1022.6	12.5	11.6	94	11.9	0	2.2	7.8
3/17	9:00	43_37	74_03	305	3.8	c	1022.7	12.4	11.7	96	11.7	0.1	2.0	8.4
3/17	12:00	43_52	73_27	3	9.3	d	1022.8	11.5	11.5	100	11.9	0	1.2	16.5
3/17	15:00	44_37	73_30	6	7.9	o	1022.1	12.4	12.4	100	12.4	0.1	1.0	21.3
3/17	18:00	45_21	73_40	41	4	r	1020.9	12.6	12.2	98	11.8	0.3	0.3	11.0
3/17	21:00	45_45	74_19	50	2.3	o	1019.6	13.9	12.8	93	12.3	0.1	0.3	10.9
3/18	0:00	45_54	75_14	286	4.2	o	1019.7	12.9	12.5	98	13.2	0.1	2.2	7.8
3/18	3:00	46_22	75_37	292	7.7	o	1018.7	12.8	12.3	97	13.2	0	2.3	8.1
3/18	6:00	46_52	75_45	315	6.4	d	1018.0	12.5	12.1	98	13.2	0	2.1	10.7
3/18	9:00	46_60	75_07	10	3.1	o	1016.6	12.9	12.0	95	13.3	0	2.1	13.5
3/18	12:00	47_00	74_45	17	5.2	o	1015.8	13.1	11.4	90	12.9	0	1.9	9.4
3/18	15:00	47_04	74_47	14	4.8	o	1015.7	13.4	11.6	89	12.9	0	1.8	9.2
3/18	18:00	47_14	74_50	19	6.7	o	1014.2	13.4	11.6	89	13.0	0	2.2	10.9
3/18	21:00	47_01	74_41	333	7	o	1011.5	14.5	10.7	78	13.0	0	1.7	10.4
3/19	0:00	47_19	75_11	8	14.8	o	1007.8	13.6	11.2	85	13.2	0	2.9	11.5
3/19	3:00	47_42	74_47	8	18	r	1004.8	12.7	12.1	96	12.4	2.6	1.6	12.5
3/19	6:00	47_57	74_22	309	12.4	o	1003.3	13.8	10.9	83	10.4	7	1.6	21.7
3/19	9:00	47_59	73_45	282	14.3	o	1004.8	13.9	7.4	65	9.8	0	1.4	9.6
3/19	12:00	47_59	73_47	294	10.7	bc	1007.4	12.5	4.6	59	9.6	0	0.5	3.5
3/19	15:00	47_60	73_47	292	11.8	c	1009.5	13.1	4.8	57	9.6	0.9	0.4	3.4
3/19	18:00	47_59	73_47	288	12	d	1012.1	12.8	5.7	62	10.0	0	0.5	3.3
3/19	21:00	47_58	73_48	334	6.1	bc	1016.2	13.3	3.0	50	10.0	0	0.5	9.0

Time		Position		W.D.	W.S.	Weather	Press.	Dry Temp	Dew P.T.	RH	SST	Rain	Wv. Ht.	Wv. Pd.
UTC		Lat S	Lon W	(deg)	(m/s)		(hPa)	(DEG-C)	(DEG-C)	(%)	(DEG-C)	(mm/h)	(m)	(sec)
3/20	0:00	47_59	74_16	271	5	c	1018.2	11.1	6.6	74	10.6	0	0.2	5.6
3/20	3:00	47_58	74_17	309	4.9	o	1018.5	11.5	6.3	70	10.6	0	0.2	6.3
3/20	6:00	47_43	74_45	347	12	o/r	1018.8	11.6	8.6	82	12.4	0.2	1.6	7.1
3/20	9:00	47_44	74_44	359	13.6	o	1018.0	11.7	9.0	84	12.4	0.1	1.5	10.0
3/20	12:00	47_42	74_44	9	12.1	r	1018.2	11.2	9.5	89	12.4	0.3	1.8	8.3
3/20	15:00	47_43	74_44	11	11.3	r/o	1018.0	10.9	9.8	93	12.4	0.6	1.7	8.1
3/20	18:00	47_42	74_44	15	10.6	r	1017.4	11.0	9.9	93	12.4	1	1.5	7.6
3/20	21:00	47_45	74_47	356	8.9	o	1016.6	12.3	10.5	89	12.5	0	1.4	7.8
3/21	0:00	47_37	74_52	358	8.6	o	1017.0	12.6	10.3	86	12.7	0	1.5	6.4
3/21	3:00	47_31	75_35	326	11.9	c	1015.1	12.9	10.9	88	12.8	0	2.9	9.4
3/21	6:00	47_37	75_53	319	10.7	bc	1014.4	12.5	11.2	92	11.8	0	3.1	11.0
3/21	9:00	47_46	75_54	309	8.6	c	1013.1	12.4	11.5	94	12.1	0	3.1	12.0
3/21	12:00	47_49	75_52	333	11.6	c	1011.9	12.5	11.2	92	12.1	0	2.9	9.7
3/21	15:00	47_49	75_52	346	12.4	r/o	1010.7	12.6	11.3	92	12.0	0	3.2	9.9
3/21	18:00	47_50	75_51	343	13.8	r	1008.3	12.5	11.6	95	12.1	0.5	3.7	9.5
3/21	21:00	47_54	76_03	329	12.2	o	1006.7	12.7	10.5	87	11.9	0	3.3	11.0
3/22	0:00	47_45	76_02	291	12.1	c	1006.4	11.8	9.8	88	11.5	0.2	3.2	8.3
3/22	3:00	47_32	75_54	280	12.1	c	1009.0	11.9	9.4	85	11.8	0	3.5	13.6
3/22	6:00	47_20	75_21	255	9.8	c	1010.8	12.6	4.3	57	13.2	0	3.6	13.0
3/22	9:00	47_32	74_59	274	9.6	bc	1012.1	11.4	6.1	70	12.8	0	3.4	13.0
3/22	12:00	48_02	74_38	357	5.5	c	1013.6	9.1	5.6	79	11.3	1.1	0.3	11.4
3/22	15:00	48_41	74_25	327	5.4	o	1013.3	10.2	5.7	74	9.8	0	0.4	11.9
3/22	18:00	49_20	74_23	3	10.1	d	1010.7	9.5	7.2	86	9.6	0.3	0.3	8.7
3/22	21:00	50_02	74_32	40	10.6	d	1006.9	9.8	6.3	79	9.2	0.8	0.7	14.5
3/23	0:00	50_43	74_34	349	13.6	o	1001.7	10.5	7.7	83	10.4	1.3	0.7	15.8
3/23	3:00	51_23	74_04	341	14.5	r	995.3	10.7	7.7	82	9.9	0.3	0.9	17.5
3/23	6:00	51_59	73_41	336	15.7	r	990.8	10.6	8.6	87	9.6	3.4	0.7	16.4
3/23	9:00	52_31	73_38	273	13	r	989.6	10.4	7.6	83	9.4	3	0.3	10.8
3/23	12:00	52_54	73_55	303	20.4	c	992.2	9.3	3.3	66	9.9	0.2	5.4	14.5
3/23	15:00	53_09	73_11	299	16.5	c	995.1	8.6	2.5	66	9.2	0.1	2.0	18.9
3/23	18:00	53_08	73_12	294	21.4	c	996.5	9.3	1.7	59	9.4	0	1.1	3.8
3/23	21:00	53_09	73_11	298	20.5	c	1000.3	9.3	2.6	63	9.4	0	1.1	4.1
3/24	0:00	53_09	73_08	299	17.6	c	1003.2	8.7	2.9	67	9.3	0	1.3	7.9
3/24	3:00	53_05	73_26	339	14.6	r/c	1004.4	8.0	2.6	69	9.8	0.1	2.1	7.3
3/24	6:00	52_59	73_45	332	14.3	o	1003.9	8.3	3.5	72	9.9	0.1	1.9	6.9
3/24	9:00	52_52	74_04	335	11.8	r	1002.9	8.9	4.7	75	10.1	1.2	2.3	7.5
3/24	12:00	52_52	74_05	349	12.7	r	999.8	8.6	4.7	77	10.4	0	2.4	8.1
3/24	15:00	52_52	74_05	353	14	r	996.5	9.3	5.7	78	10.3	0	1.7	7.2
3/24	18:00	52_54	74_06	300	12.9	r	995.4	6.4	4.2	86	10.1	5.3	2.1	7.4
3/24	21:00	53_02	73_38	291	11.6	bc	996.5	9.1	2.0	61	9.6	0	1.7	20.1
3/25	0:00	53_31	72_39	319	12.9	c	996.6	6.4	3.2	80	9.3	0.7	0.4	10.6

Time		Position		W.D.	W.S.	Weather	Press.	Dry Temp	Dew P.T.	RH	SST	Rain	Wv. Ht.	Wv. Pd.
UTC		Lat S	Lon W	(deg)	(m/s)		(hPa)	(DEG-C)	(DEG-C)	(%)	(DEG-C)	(mm/h)	(m)	(sec)
3/25	3:00	53_53	71_31	294	10.5	bc	996.6	6.8	2.1	72	8.2	0	0.7	15.3
3/25	6:00	54_25	71_03	306	4.2	bc	997.2	5.2	1.8	79	8.2	0	0.4	8.1
3/25	9:00	54_31	72_06	297	11.9	bc	996.6	6.9	0.5	64	8.8	1.2	2.0	6.2
3/25	12:00	54_49	71_05	318	7.2	c	996.9	6.4	1.7	72	8.4	0	1.0	17.4
3/25	15:00	54_52	69_52	301	8.3	c	997.0	7.2	0.8	64	8.1	0	0.3	7.7
3/25	18:00	54_55	68_36	74	1.6	c	995.1	7.8	-0.3	57	8.0	0	0.2	9.0
3/25	21:00	54_55	67_19	329	9.9	c	994.3	9.3	0.7	55	8.5	0	0.3	8.5
3/26	0:00	55_28	66_34	338	12.7	c	992.5	9.1	2.3	62	9.1	0	1.3	11.9
3/26	3:00	55_47	66_13	287	11.1	c	990.7	8.5	2.5	66	8.7	0	2.5	10.9
3/26	6:00	56_15	66_10	287	15.1	o	989.2	6.4	2.7	77	6.8	0	4.8	16.2
3/26	9:00	56_15	66_14	273	14.7	o	990.0	5.0	2.2	82	6.8	0	4.7	14.0
3/26	12:00	56_07	66_21	300	18	r	988.7	4.1	2.0	86	7.7	0.1	2.8	10.0
3/26	15:00	55_56	66_09	267	14.5	r	987.9	5.7	3.4	85	7.7	0.2	3.1	9.6
3/26	18:00	55_44	66_02	251	17.1	o	991.7	7.5	0.5	61	7.7	0	4.1	7.3
3/26	21:00	55_41	66_06	242	16.6	p/o	995.8	6.2	2.5	77	8.7	0.2	4.2	9.2
3/27	0:00	55_26	66_03	248	13.6	c	999.4	7.0	1.7	69	8.9	0	3.4	9.9
3/27	3:00	55_30	66_05	307	10.9	c	1000.1	6.9	0.1	62	8.8	0	2.0	7.1
3/27	6:00	55_45	66_17	336	11.1	bc	998.3	7.2	0.3	62	9.1	0	2.1	8.4
3/27	9:00	55_40	66_12	326	9.9	bc	997.1	7.4	1.5	66	9.1	0	2.4	11.9
3/27	12:00	55_43	66_08	9	9	c	994.3	8.5	2.5	66	8.9	0	1.6	8.2
3/27	15:00	55_43	66_08	13	12.5	c	989.1	7.9	3.4	73	9.0	0	1.7	6.7
3/27	18:00	55_33	66_03	34	12.9	c	982.3	9.2	3.1	66	9.0	0	1.8	6.3
3/27	21:00	55_28	66_35	56	11.5	o	974.7	8.9	8.0	94	9.1	0	1.8	10.6
3/28	0:00	54_55	67_19	56	2.4	r	969.4	8.9	6.2	83	8.5	0.2	0.2	8.5
3/28	3:00	54_54	68_36	166	2.4	o	966.2	8.1	5.0	81	7.8	0	0.2	9.8
3/28	6:00	54_52	69_49	225	1.9	r	966.8	6.8	5.8	93	7.8	0.1	0.2	8.8
3/28	9:00	54_51	70_60	287	7.2	c	966.8	7.9	3.9	76	8.1	0.1	0.4	5.9
3/28	12:00	54_36	72_02	350	4.4	c	966.7	7.4	3.3	75	8.4	0.1	0.4	11.6
3/28	15:00	54_31	72_06	38	5.7	c	966.5	7.6	4.0	78	8.5	0	1.1	7.3
3/28	18:00	54_31	72_08	322	3.7	c	967.0	8.9	3.1	67	8.6	0	1.1	8.7
3/28	21:00	54_31	72_08	251	9.9	r/c	969.2	7.8	5.5	85	8.6	0.4	1.5	10.0
3/29	0:00	54_21	71_28	256	13	o	971.1	7.9	3.9	76	8.3	0	1.4	22.4
3/29	3:00	54_14	70_56	237	5.2	o	972.3	7.8	3.9	76	8.3	0.1	0.4	11.9
3/29	6:00	53_50	70_57	249	17.1	c	975.8	7.3	4.4	82	8.4	0	1.8	9.4
3/29	9:00	53_32	70_44	235	13.1	bc	980.1	7.0	3.0	76	8.5	0	1.7	9.5
3/29	12:00	53_26	70_39	240	10.9	bc	984.2	5.5	-1.0	63	8.4	0	1.1	5.1
3/29	15:00	53_26	70_38	232	12.5	c	988.0	4.5	-1.3	66	8.4	0	1.7	5.4
3/29	18:00	53_23	70_35	258	11.6	c	991.0	4.2	0.8	79	8.4	0	1.5	5.4
3/29	21:00	53_20	70_36	239	14.6	c	993.9	3.9	-0.1	75	N/A	0	1.4	5.4
3/30	0:00	53_23	70_39	235	5.8	o	996.2	4.2	-0.7	71	N/A	0	1.0	4.6
3/30	3:00	53_21	70_38	249	10.5	o	997.4	4.3	-0.1	73	N/A	0	1.0	4.6

Time		Position		W.D.	W.S.	Weather	Press.	Dry Temp	Dew P.T.	RH	SST	Rain	Wv. Ht.	Wv. Pd.
UTC		Lat S	Lon W	(deg)	(m/s)		(hPa)	(DEG-C)	(DEG-C)	(%)	(DEG-C)	(mm/h)	(m)	(sec)
3/30	6:00	53_20	70_37	257	14.4	bc	998.6	3.9	1.3	83	N/A	0	1.0	4.1
3/30	9:00	53_17	70_38	266	10.7	bc	1000.7	4.8	-2.1	61	N/A	0	0.9	4.5
3/30	12:00	53_13	70_41	250	12.2	bc	1003.8	3.3	0.8	84	N/A	0	0.9	4.2

Weather notation

- b: blue sky (Cloud 0-2)
- bc: Fine but Cloudy (Cloud 3-7)
- c: Cloudy (Cloud 8-10)
- d: Drizzling rain
- o: Overcast (Cloud 10)
- p: Passing showers
- r: Rain

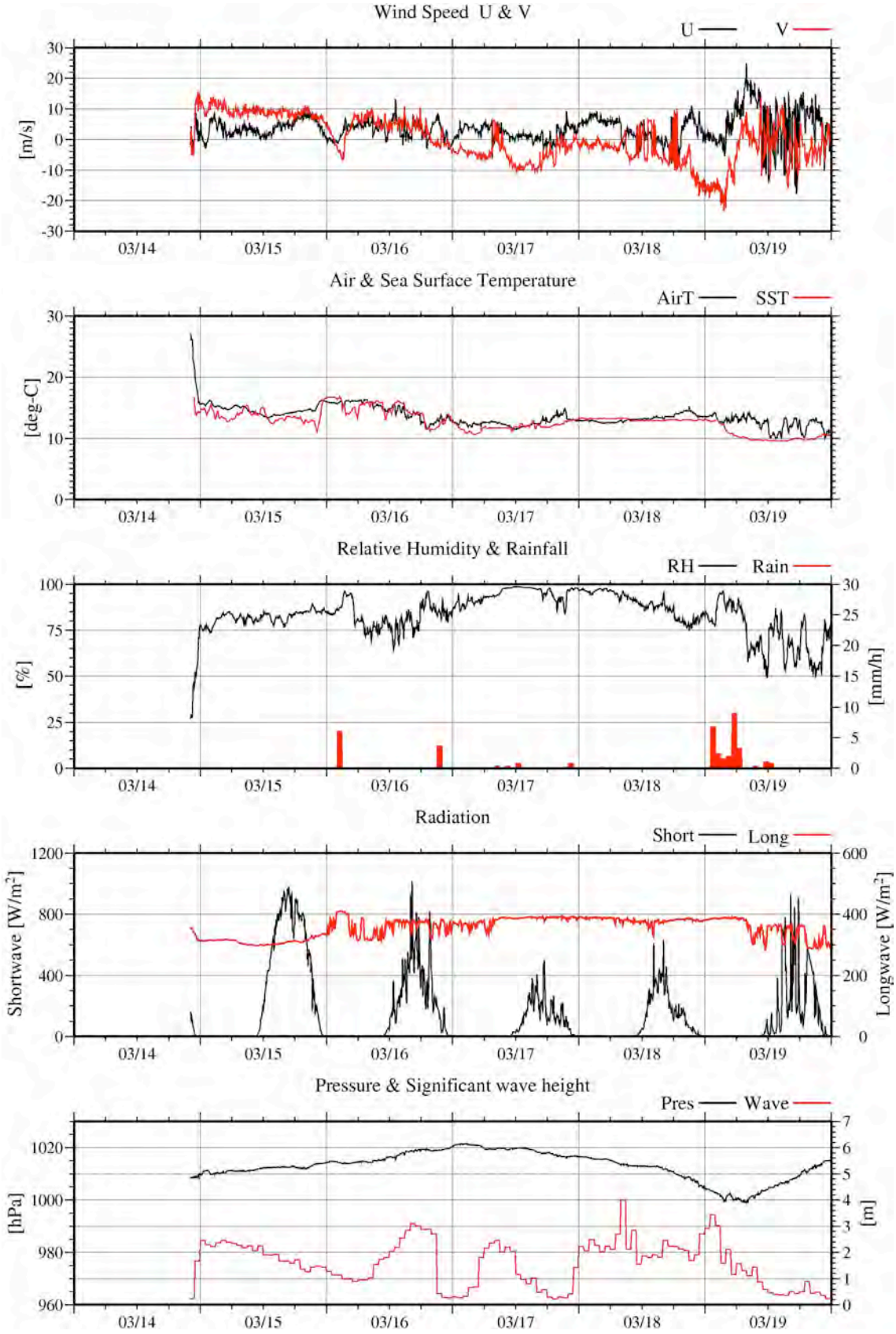

Fig. 7.1.1-1 Time series of surface meteorological parameters during the MR08-06 Leg.2 cruise

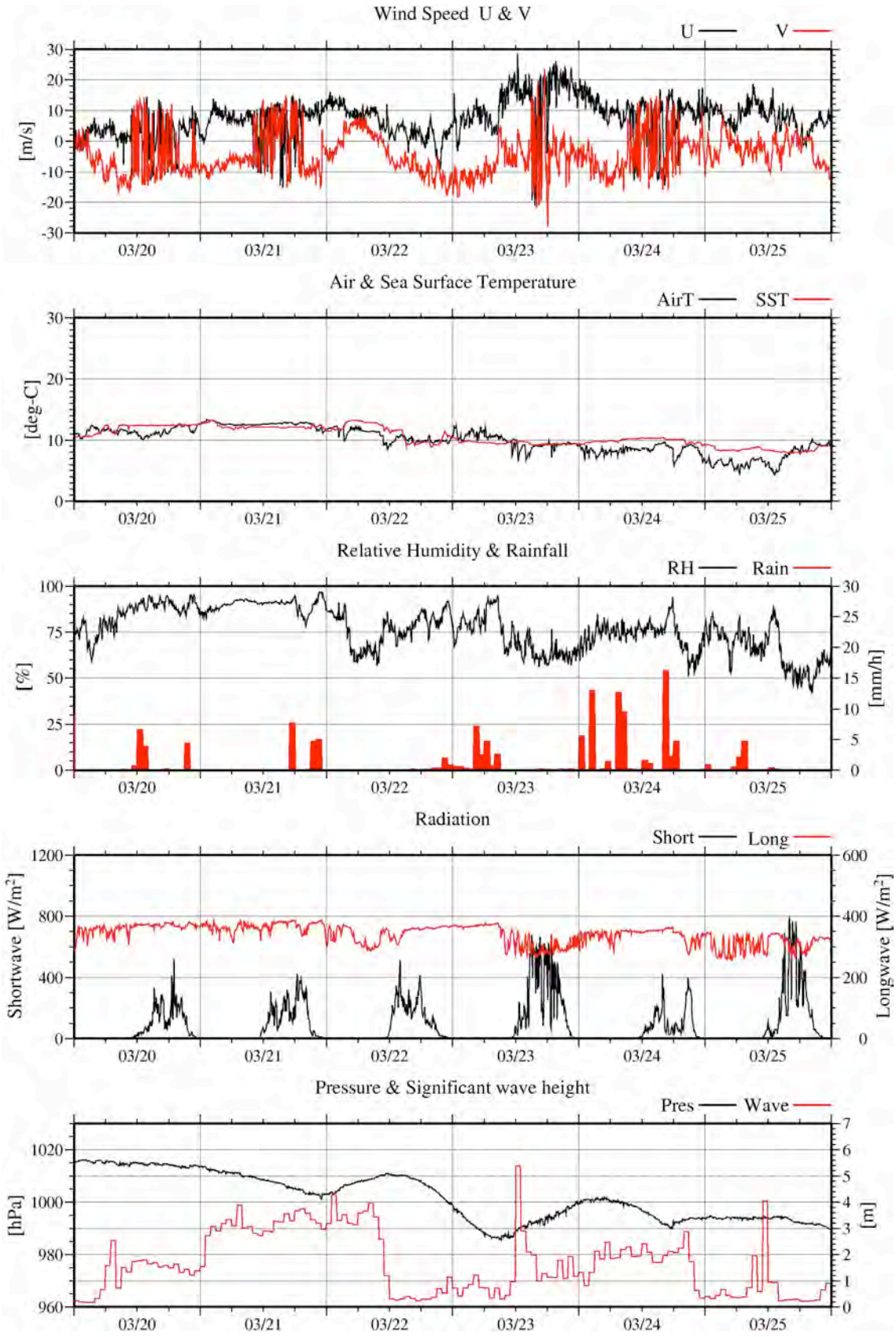

Fig. 7.1.1-1 (Continued)

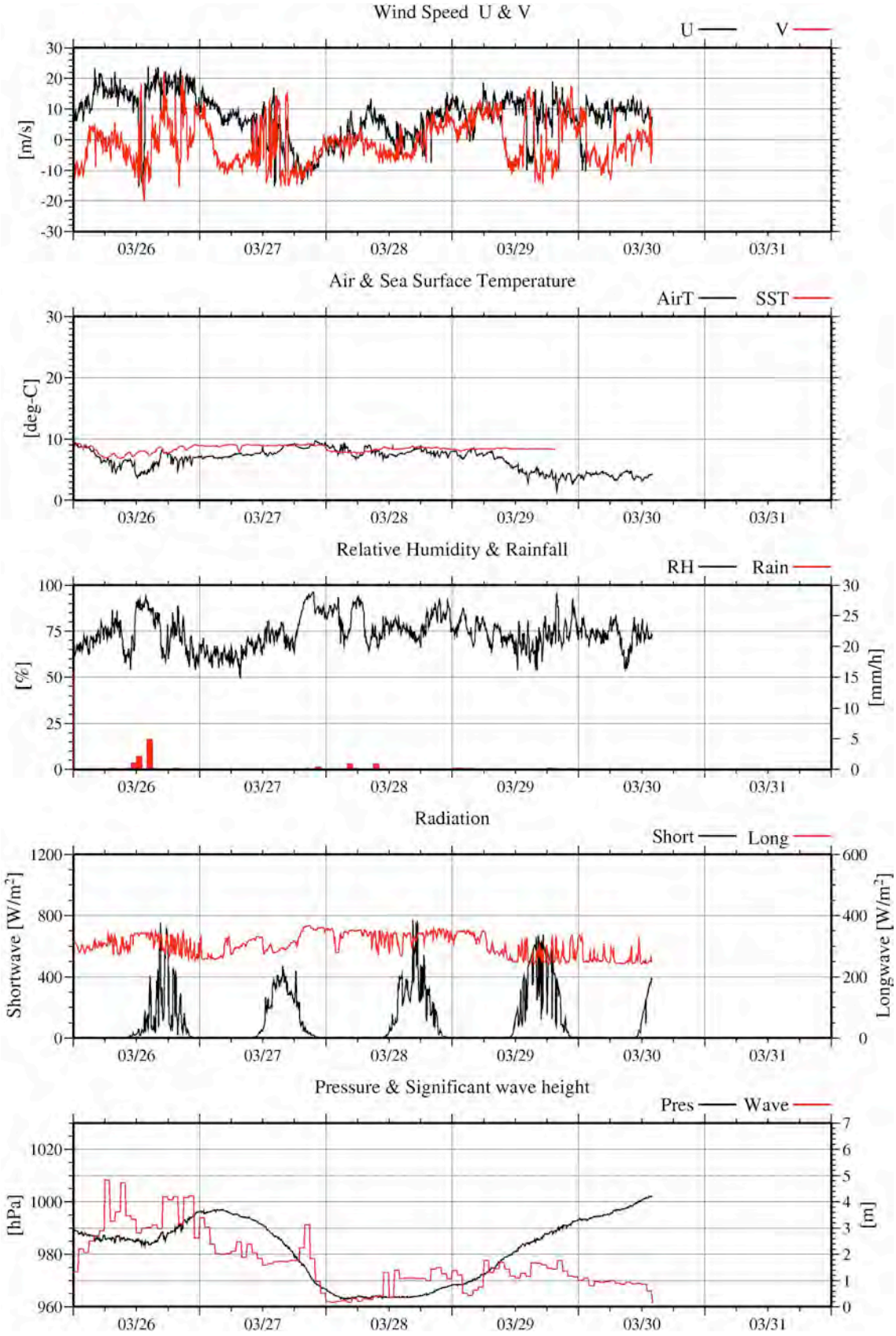

Fig. 7.1.1-1 (Continued)

7.1.2 Ceilometer Observations

(1) *Personnel*

Kunio Yoneyama *	JAMSTEC	: Principal Investigator
Satoshi Okumura	GODI	: Operation Leader
Harumi Ota	GODI	
Takashi Kawamura	GODI	

* : Not on-board

(2) *Objectives*

The information of cloud base height and the liquid water amount around cloud base is important to understand the process on formation of the cloud. As one of the methods to measure them, the ceilometer observation was carried out.

(3) *Measured Parameters*

i. Cloud base height [m].
ii. Backscatter profile, sensitivity and range normalized at 30 m resolution.
iii. Estimated cloud amount [oktas] and height [m]; Sky Condition Algorithm.

(4) *Instrument and Methods*

We measured cloud base height and backscatter profile using ceilometer (CT-25K, VAISALA, Finland) throughout the MR08-06 Leg.2 cruise.

Major parameters for the measurement configuration are as follows;

Laser source:	Indium Gallium Arsenide (InGaAs) Diode
Transmitting wavelength:	905±5 mm at 25 degC
Transmitting average power:	8.9 mW
Repetition rate:	5.57 kHz
Detector:	Silicon avalanche photodiode (APD) Responsibility at 905 nm: 65 A/W
Measurement range:	0 ~ 7.5 km
Resolution:	50 ft in full range
Sampling rate:	60 sec
Sky Condition	0, 1, 3, 5, 7, 8 oktas (9: Vertical Visibility) (0: Sky Clear, 1:Few, 3:Scattered, 5-7: Broken, 8: Overcast)

On the archive dataset, cloud base height and backscatter profile are recorded with the resolution of 30 m (100 ft).

(5) *Preliminary results*

The Fig.7.1.2-1 shows the time series of the lowest, second and third cloud base height during the cruise.

(6) *Data archives*

The raw data obtained during this cruise were submitted to the Data Integration and Analysis Group (DIAG) of JAMSTEC.

(7) *Remarks*

The timing of window cleanings were at 13:54UTC 17th March, and 21:04UTC 24th March, 2009.

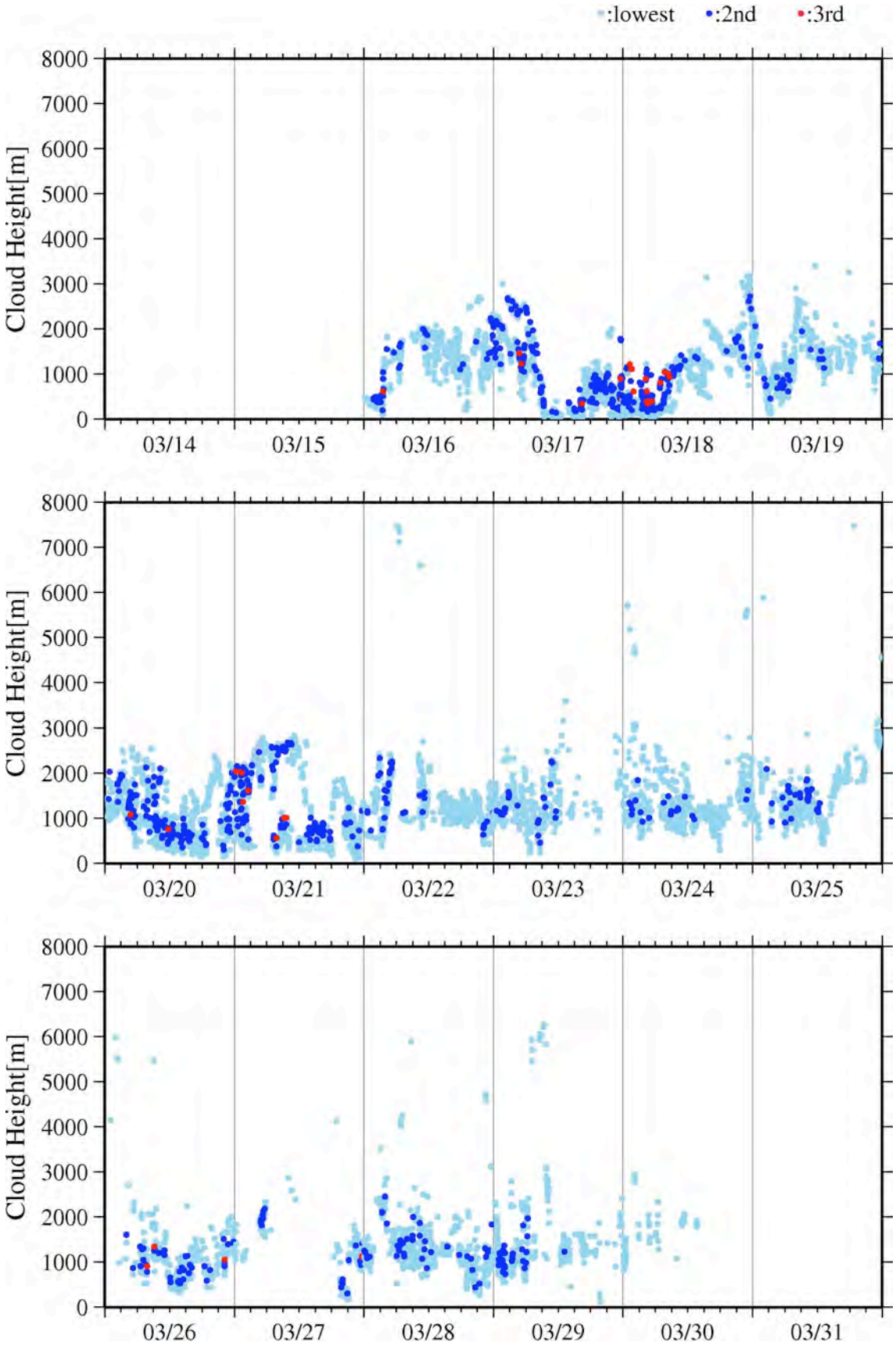

Fig. 7.1.2-1 Lowest, 2nd and 3rd cloud base height during the cruise

7.1.3 Lidar observations of clouds and aerosols

(1) *Personnel*

Nobuo Sugimoto*	National Institute for Environmental Studies (NIES): Principal Investigator
Ichiro Matsui*	NIES
Atsushi Shimizu*	NIES
Tomoaki Nishizawa*	NIES
Satoshi Okumura	GODI: Operation Leader
Harumi Ota	GODI
Takashi Kawamura	GODI

*: Not on board

(2) *Objectives*

Objectives of the observations in this cruise is to study distribution and optical characteristics of ice/water clouds and marine aerosols using a two-wavelength lidar.

(3) *Measured parameters*

i. Vertical profiles of backscattering coefficient at 532 nm
ii. Vertical profiles of backscattering coefficient at 1064 nm
iii. Depolarization ratio at 532 nm

(4) *Method*

Vertical profiles of aerosols and clouds were measured with a two-wavelength lidar. The lidar employs a Nd:YAG laser as a light source which generates the fundamental output at 1064 nm and the second harmonic at 532 nm. Transmitted laser energy is typically 30 mJ per pulse at both of 1064 and 532 nm. The pulse repetition rate is 10 Hz. The receiver telescope has a diameter of 20 cm. The receiver has three detection channels to receive the lidar signals at 1064 nm and the parallel and perpendicular polarization components at 532 nm. An analog-mode avalanche photo diode (APD) is used as a detector for 1064 nm, and photomultiplier tubes (PMTs) are used for 532 nm. The detected signals are recorded with a transient recorder and stored on a hard disk with a computer. The lidar system was installed in a container, which has a glass window on the roof, and the lidar was operated continuously regardless of weather. Every 10 minutes vertical profiles of four channels (532 parallel, 532 perpendicular, 1064, 532 near range) are recorded.

(5) *Results*

This observation was unattended and data collection is planned when MIRAI comes back to Japan. At present only several sample data files were transferred to NIES by email. The figure 7.1.3-1 shows an example of lidar vertical profile obtained on March 21. Strong backscattering from two cloud layers are evident. Thin clouds below 1000 m altitude were consistent with water droplet, which indicated lower depolarization ratio. Another cloud detected at 8500 m with high depolarization ratio was cirrus consist of non-spherical ice particles. Signal between them indicates that there was no aerosol layer (molecular

scattering only).

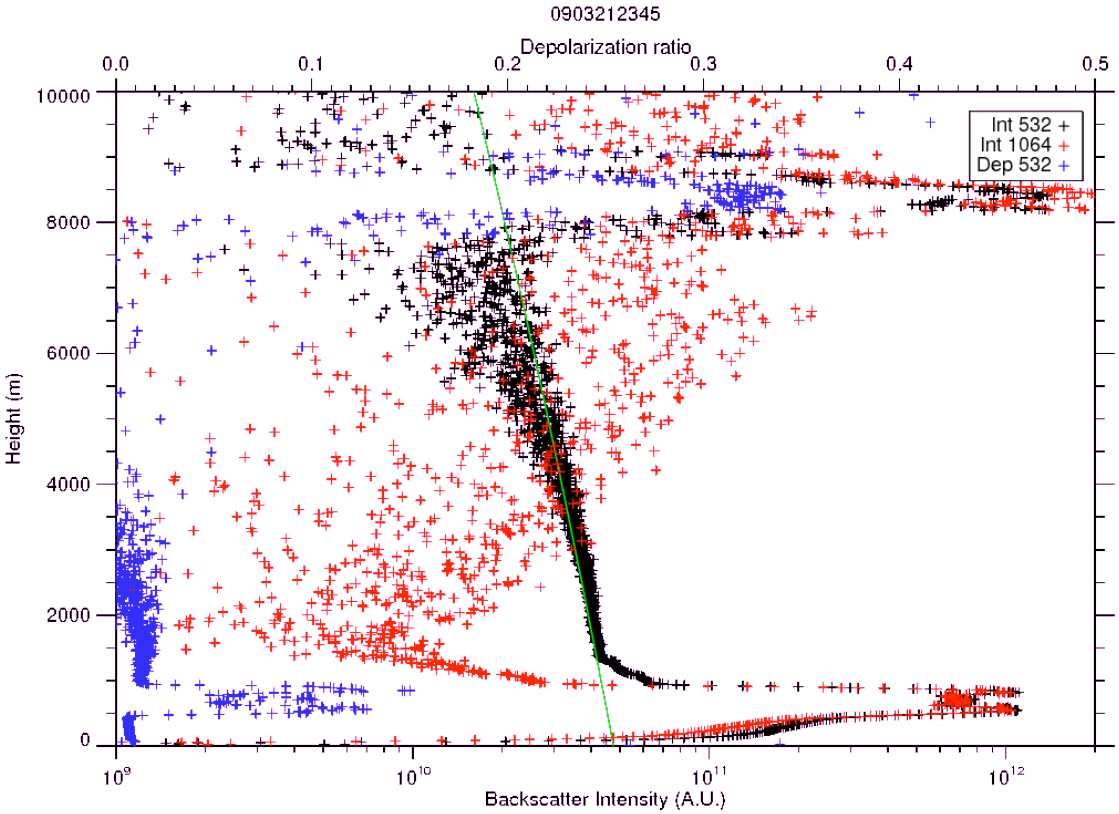

Figure 7.1.3-1: Vertical profiles of lidar backscattering intensity at 532/1064 nm and depolarization ratio at 532 nm obtained at 23:45UTC on March 21, 2009.

(6) *Data archive*

i. Raw data

Lidar signal at 532 nm

Lidar signal at 1064 nm

Depolarization ratio at 532 nm

Temporal resolution 15min/ vertical resolution 6 m

Data period (UTC): March 15, 2009 – March 30, 2009

ii. Processed data (plan)

Cloud base height, apparent cloud top height

Phase of clouds (ice/water)

Cloud fraction

Boundary layer height (aerosol layer upper boundary height)

Backscatter coefficient of aerosols

Particle depolarization ratio of aerosols

(7) *Data policy and citation*

Please contact NIES lidar team (nsugimot/i-matsui/shimizua/nisizawa@nies.go.jp) to utilize lidar data for productive use.

7.1.4 Air-sea surface eddy flux measurement

(1) *Personnel*

Osamu Tsukamoto*	Okayama University:	Principal Investigator
Fumiyoshi Kondo*	Okayama University	
Hiroshi Ishida*	Kobe University	
Satoshi Okumura	GODI : Operation Leader	
Harumi Ota	GODI	
Takashi Kawamura	GODI	

*: Not on board

(2) *Objective*

To better understand the air-sea interaction, accurate measurements of surface heat and fresh water budgets are necessary as well as momentum exchange through the sea surface. In addition, the evaluation of surface flux of carbon dioxide is also indispensable for the study of global warming. Sea surface turbulent fluxes of momentum, sensible heat, latent heat, and carbon dioxide were measured by using the eddy correlation method that is thought to be most accurate and free from assumptions. These surface heat flux data are combined with radiation fluxes and water temperature profiles to derive the surface energy budget.

(3) *Instruments and Methods*

The surface turbulent flux measurement system (Fig. 7.1.4-1) consists of turbulence instruments (Kaijo Co., Ltd.) and ship motion sensors (Kanto Aircraft Instrument Co., Ltd.). The turbulence sensors include a three-dimensional sonic anemometer-thermometer (Kaijo, DA-600) and an infrared hygrometer (LICOR, LI-7500). The sonic anemometer measures three-dimensional wind components relative to the ship. The ship motion sensors include a two-axis inclinometer (Applied Geomechanics, MD-900-T), a three-axis accelerometer (Applied Signal Inc., QA-700-020), and a three-axis rate gyro (Systron Donner, QRS-0050-100). LI7500 is a CO_2/H_2O turbulence sensor that measures turbulent signals of carbon dioxide and water vapor simultaneously. These signals are sampled at 10 Hz by a PC-based data logging system (Labview, National Instruments Co., Ltd.). By obtaining the ship speed and heading information through the Mirai network system it yields the absolute wind components relative to the ground. Combining wind data with the turbulence data, turbulent fluxes and statistics are calculated in a real-time basis. These data are also saved in digital files every 0.1 second for raw data and every 1 minute for statistic data.

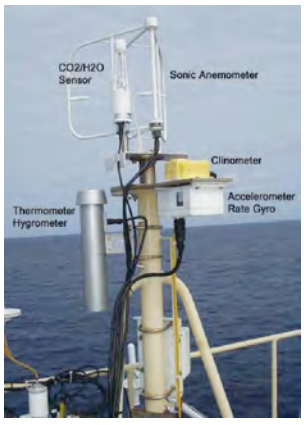

Figure 7.1.4-1 Turbulent flux measurement system on the top deck of the foremast.

(4) *Observation log*

The observation was carried out throughout this cruise.

(5) *Data Policy and citation*

All data are archived at Okayama University, and will be open to public after quality checks and corrections. Corrected data will be submitted to JAMSTEC Data Integration and Analysis Group (DIAG).

7.1.5 Biogenic volatile organic compounds (BVOC) sampling

(1) *Personnel*

Yoko Yokouchi*	National Institute for Environmental Studies: Principal Investigator
Satoshi Okumura	GODI: Operation Leader
Harumi Ota	GODI
Takashi Kawamura	GODI

*: Not on board

(2) *Objectives*

To know the distribution of volatile organic compounds emitted from marine biota.

(3) *Measured compounds*

i. Dibromomethane
ii. Methyl iodide
iii. Methyl chloride
iv. Methyl bromide
v. Dimethyl sulfide
vi. Carbonyl sulfide
vii. Isoprene
viii. Chloroform

(4) *Methods*

Air samples were taken on board forward of any potential contamination from the stack, at the front of the uppermost deck on the MIRAI. Samples were collected every 3 degree latitude between [34°S, 72°W] and [56°S, 66°W] (15 March – 27 March). Evacuated 6-L stainless steel canisters with inert surfaces were used for the collection. All air samples were collected by marine technicians of GODI.

Samples will be analyzed using a preconcentration/capillary gas chromatographic/mass spectrometer (GC/MS) after the cruise.

(5) *Results*

The air samples were collected following positions in Table 7.1.5-1.

Table 7.1.5-1 Air sampling log sheet MR08-06 Leg.2

No.	Canister No.	Date (UTC)	Time (UTC)	Date (LCT)	Time (LCT)	Lon	Lat	Weather	Remarks
35	H1017	2009.03.15	06:21	2009.03.15	02:21	72_20.9W	34_02.4S	b	<352> p:1.32
36	1310	2009.03.15	23:02	2009.03.15	19:02	74_00.1W	37_00.3S	b	<9> p:1.22
37	1116	2009.03.16	12:02	2009.03.16	08:02	74_10.8W	40_02.9S	c	<19> p:1.15
38	H1040	2009.03.17	02:43	2009.03.17	10:43	73_14.9W	43_00.1S	c	<41> p:1.17
39	1883	2009.03.18	00:51	2009.03.17	20:51	75_21.0W	46_02.4S	d	<31> p:1.20
40	5424	2009.03.22	16:47	2009.03.22	12:47	74_25.6W	49_03.4S	d	<55> p:1.15
41	5372	2009.03.23	06:25	2009.03.23	02:25	73_44.0W	52_04.6S	r	<150> p:1.21
42	H1257	2009.03.25	22:07	2009.03.25	18:07	67_00.4W	55_05.6S	r	<223> p:1.17
43	6006	2009/3/37	10:59	2009.03.27	06:59	66_08.0W	55_42.6S	b	<117> p:1.21

Weather notification

b = blue sky

bc = Fine but Cloudy

c = Cloudy

d = Drizzling rain

r = Rain

f = Fog

q = Squalls

<> =Relative wind

p = pressure in canister

(6) *Data Policy and citation*

All data are archived at NIES, and will be open to public after quality checks and corrections. Corrected data will be submitted to JAMSTEC Data Integration and Analysis Group (DIAG).

7.1.6 Atmospheric vapor, rain and sea surface water sampling for stable isotopes measurement

(1) *Personnel*

Naoyuki Kurita*	JAMSTEC: Principal Investigator
Ryu Uemura*	Le Laboratoire des Sciences du Climat et I'Environment
Kimpei Ichiyanagi*	Kumamoto University
Hironori Fudeyasu*	University of Hawaii
Satoshi Okumura	GODI: Operation Leader
Harumi Ota	GODI
Takashi Kawamura	GODI

*: Not on board

(2) *Objective*

It is well known that the variability of stable water isotopes (HDO and $H_2{}^{18}O$) is closely related with the moisture origin and hydrological processes during the transportation from the source region to deposition site. Thus, water isotope tracer is recognized as the powerful tool to study of the hydrological cycles in the atmosphere. However, oceanic region is one of sparse region of the isotope data, it is necessary to fill the data to identify the moisture sources by using the isotope tracer. In this study, to fill this sparse observation area, intense water isotopes observation was conducted along the cruise track of MR-08-06 Legs.2 and 3.

(3) *Method*

Following observation was carried out throughout this cruise.

i. Atmospheric moisture sampling

Water vapor was sampled from the height about 20m above the sea level. The air was drawn at rate of 1.5-4L/min through a plastic tube attached to top of the compass deck. The flow rate is regulated according to the water vapor content to collect the sample amount 10-20ml. The water vapor was trapped in a glass trap submerged into an ethanol cooled to 100 degree C by radiator, and then they are collected every 3 to 6 hour during the cruise. After collection, water in the trap was subsequently thawed and poured into the 6ml glass bottle.

ii. Rainwater sampling

Rainwater samples gathered in rain collector were collected just after precipitation events have ended. The collected sample was then transferred into glass bottle (6ml) immediately after the measurement of precipitation amount.

iii. Surface seawater sampling

Seawater sample taken by the pump from 4m depth were collected in glass bottle (6ml) around the noon at the local time. The surface water taken by bucket from the deck was also sampled in case the bucket water sampling has carried out to compare the 4m depth samples.

All samples were taken by marine technicians of GODI.

(4) *Results*

Sampling of water vapor for isotope analysis is summarized in Table 7.1.6-1 (35 samples). The detail of

rainfall sampling (18 samples) is summarized in Table 7.1.6-2. Described rainfall amount is calculated from the collected amount of precipitation. Sampling of surface seawater is summarized in Table 7.1.6-3 (34 samples).

(5) *Data archive*

Isotopes (HDO, $H_2{}^{18}O$) analysis will be done at IORGC/JAMSTEC. All analyzed isotopes data are archived at RIGC/JAMSTEC, and will be open to public after quality checks and corrections. Corrected data will be submitted to JAMSTEC Data Integration and Analysis Group (DIAG).

Table 7.1.6-1 Summary of water vapor sampling for isotope analysis.

Sample	Start		End					
	Date	Time (UTC)	Date	Time (UTC)	Lon	Lat	Total (m^3)	MASS (ml)
V-1	14-Mar	12:24	14-Mar	22:10	71-37W	33-02S	0.87	7.7
V-2	14-Mar	22:19	15-Mar	11:02	72-46W	34-49S	1.13	9.4
V-3	15-Mar	11:09	15-Mar	23:07	74-00W	37-01S	1.43	11.0
V-4	15-Mar	23:11	16-Mar	10:57	74-10W	39-47S	1.41	12.2
V-5	16-Mar	11:03	16-Mar	22:58	73-06W	42-07S	1.43	10.0
V-6	16-Mar	23:03	17-Mar	11:01	73-41W	43-43S	1.44	10.8
V-7	17-Mar	11:10	17-Mar	23:00	74-57W	45-49S	1.41	11.8
V-8	17-Mar	23:11	18-Mar	10:59	74-45W	46-59S	1.77	15.8
V-9	18-Mar	11:05	18-Mar	23:01	75-01W	47-14S	1.78	14.0
V-10	18-Mar	23:06	19-Mar	11:00	73-47W	47-59S	1.77	14.8
V-11	19-Mar	11:03	19-Mar	23:01	74-15W	47-59S	1.79	8.8
V-12	19-Mar	23:07	20-Mar	11:01	74-44W	47-42S	2.14	14.0
V-13	20-Mar	11:05	20-Mar	23:03	74-45W	47-44S	2.15	16.8
V-14	20-Mar	23:08	21-Mar	11:06	75-52W	47-48S	2.16	18.2
V-15	21-Mar	11:10	21-Mar	23:00	75-47W	47-45S	2.12	16.8
V-16	21-Mar	23:08	22-Mar	11:03	74-44W	47-51S	2.50	15.0
V-17	22-Mar	11:09	22-Mar	23:00	74-49W	50-31S	2.49	14.0
V-18	22-Mar	23:05	23-Mar	11:01	73-51W	52-48S	2.49	16.2
V-19	23-Mar	11:04	23-Mar	23:01	73-12W	53-09S	2.51	11.4
V-20	23-Mar	23:06	24-Mar	11:01	74-05W	52-52S	2.86	12.8
V-21	24-Mar	11:05	24-Mar	23:02	72-59W	53-22S	2.85	14.0
V-22	24-Mar	23:06	25-Mar	10:59	71-27W	54-44S	2.85	11.2
V-23	25-Mar	11:03	25-Mar	23:04	66-45W	55-16S	2.88	10.0
V-24	25-Mar	23:09	26-Mar	11:02	66-25W	56-16S	2.84	11.6
V-25	26-Mar	11:06	26-Mar	22:59	66-11W	55-35S	2.85	12.0
V-26	26-Mar	23:04	27-Mar	11:03	66-08W	55-43S	2.87	10.2
V-27	27-Mar	11:08	27-Mar	15:17	-	-	-	4.2
V-28	27-Mar	19:37	28-Mar	11:06	71-46W	54-44S	-	22.8
V-29	28-Mar	11:15	28-Mar	23:01	71-42W	54-21S	2.82	14.2
V-30	28-Mar	23:05	29-Mar	11:03	70-41W	54-27S	2.87	13.0
V-31	29-Mar	11:07	29-Mar	23:01	70-38W	53-22S	2.85	9.8
V-32	29-Mar	23:04	30-Mar	11:03	70-39W	53-14S	2.87	9.6
V-33	30-Mar	11:09	31-Mar	12:21	70-54W	53-10S	3.79	13.0
V-34	31-Mar	12:24	1-Apr	11:06	70-54W	53-10S	3.41	12.8
V-35	1-Apr	11:10	2-Apr	11:02	70-54W	53-10S	3.56	18.2

Table 7.1.6-2 Summary of precipitation sampling for isotope analysis.

Sample	Start				End				
	Date	Time (UTC)	Lon	Lat	Date	Time (UTC)	Lon	Lat	Rain (ml)
R-1	9-Mar	00:08	75-01W	45-17S	16-Mar	04:28	74-12W	38-17S	4.2
R-2	16-Mar	04:30	74-12W	39-19S	17-Mar	09:37	74-03W	43-37S	1.0
R-3	17-Mar	09:39	74-03W	43-37S	17-Mar	15:05	73-30W	44-38W	15.5
R-4	17-Mar	15:10	73-30W	44-39S	17-Mar	21:18	74-25W	45-47S	1.0
R-5	17-Mar	21:19	74-25W	45-51S	19-Mar	09:35	73-46W	48-01S	163.0
R-6	19-Mar	09:49	73-46W	48-01S	19-Mar	12:51	73-47W	47-59S	7.2
R-7	19-Mar	12:54	73-47W	47-59S	19-Mar	17:05	73-47W	47-59S	18.9
R-8	19-Mar	17:08	73-47W	47-59S	19-Mar	20:09	73-45W	48-00S	15.0
R-9	19-Mar	20:11	73-45W	48-00S	20-Mar	23:17	74-45W	47-44S	94.5
R-10	20-Mar	23:20	74-45W	47-43S	22-Mar	13:59	74-30W	48-29S	18.5
R-11	22-Mar	14:11	74-28W	48-31S	22-Mar	23:08	74-48W	50-33S	53.0
R-12	22-Mar	23:11	74-48W	50-34S	23-Mar	09:58	73-42W	52-39S	205.5
R-13	23-Mar	10:03	73-43W	52-40S	24-Mar	21:03	73-37W	53-03S	77.5
R-14	24-Mar	21:06	73-36W	53-03S	25-Mar	11:16	71-21W	54-44S	18.5
R-15	25-Mar	11:20	71-19W	54-44S	25-Mar	23:20	66-42W	55-20S	12.2
R-16	25-Mar	23:24	66-41W	55-20S	27-Mar	15:10	66-07W	55-43S	1.0
R-17	27-Mar	15:12	66-07W	55-43S	28-Mar	13:15	72-06W	54-31S	17.2
R-18	28-Mar	13:19	72-06W	54-31S	2-Apr	11:09	70-54W	53-10S	41.5

* Rainfall shows collected amount (ml).

Table 7.1.6-3 Summary of surface seawater sampling for isotope analysis.

Sampling No.		Date	Time (UTC)	Position		Remarks
				Lon	Lat	
Leg2 O-	1	15-Mar	15:59	73-15W	35-40S	
Leg2 O-	2	16-Mar	15:58	74-11W	40-55S	
Leg2 O-	3	17-Mar	07:37	74-04W	43-37S	St.37
Leg2 O-	4	17-Mar	16:01	73-31W	44-52S	
Leg2 O-	5	18-Mar	11:26	73-49W	47-14S	St.38
Leg2 O-	6	18-Mar	16:02	74-49W	47-14S	
Leg2 O-	7	19-Mar	12:15	73-47W	47-59S	St.42
Leg2 O-	8	19-Mar	16:06	73-47W	47-59S	
Leg2 O-	9	19-Mar	23:37	74-15W	47-59S	St.41
Leg2 O-	10	20-Mar	12:33	74-44W	47-43S	St.40
Leg2 O-	11	20-Mar	16:37	74-44W	47-43S	

Leg2 O-	12	21-Mar	11:17	75-52W	47-49S	St.43
Leg2 O-	13	21-Mar	16:08	75-52W	47-50S	
Leg2 O-	14	22-Mar	16:05	74-24W	48-55S	
Leg2 O-	15	23-Mar	16:00	73-11W	53-09S	
Leg2 O-	16	24-Mar	11:52	74-05W	52-52S	St.46
Leg2 O-	17	24-Mar	16:05	74-06W	52-53S	
Leg2 O-	18	25-Mar	16:00	69-26W	54-54S	
Leg2 O-	19	26-Mar	12:34	66-21W	56-03S	St.44
Leg2 O-	20	26-Mar	16:08	66-09W	55-45S	
Leg2 O-	21	27-Mar	10:30	66-08W	55-43S	St.44B
Leg2 O-	22	28-Mar	13:39	72-06W	54-31S	St.45
Leg2 O-	23	28-Mar	16:04	72-07W	54-30S	
St.	37	17-Mar	07:34	74-03.36W	43-37.58S	
St.	38	18-Mar	11:02	74-45.01W	47-00.00S	
St.	42	19-Mar	12:24	73-47.33W	47-59.30S	
St.	41	19-Mar	22:55	74-15.44W	47-58.80S	
St.	40	20-Mar	12:09	74-44.39W	47-42.40S	
St.	43	21-Mar	10:03	75-51.66W	47-48.80S	
St.	46	23-Mar	15:17	73-10.74W	53-08.64S	
St.	46B	24-Mar	11:48	74-05.17W	52-51.99S	
St.	44	26-Mar	12:40	66-20.67W	56-03.10S	
St.	44B	27-Mar	10:02	66-08.00W	55-42.51S	
St.	45	28-Mar	13:31	72-06.29W	54-31.11S	

7.1.7. Physical and chemical properties of marine aerosols and atmospheric deposition: Geological distribution and impact to marine biogeochemical cycles in the North and South Pacific Oceans

(1) *Personnel*

Hiroshi Furutani	Ocean Research Institute (ORI), The University of Tokyo: Principal Investigator
Jinyoung Jung	ORI, The University of Tokyo
Kazuhiko Miura*	Science University of Tokyo
Mitsuo Uematsu*	ORI, The University of Tokyo

* : Not on board

(2) *Background and Objectives*

Increased marine primary production is considered to increase emissions of particulate matter and/or gaseous precursors (e.g., dimethyl sulfide and isoprene) from ocean to atmosphere, which is expected to lead a creation of new atmospheric aerosols through a nucleation process and/or growth of existing atmospheric aerosols through condensation of the gas precursors to the existing aerosols. On the other hand, depositions of atmospheric aerosols, precipitation, and trace gases into ocean surface will supply essential nutrients for marine primary producers (e.g., iron, phosphorus, and nitrate) and further enhance their primary production. This suggests that physicochemical properties of atmospheric aerosols and marine biota may be linked and the linkage may be an important part of the global climate system since ocean covers about 70 % of the earth's surface. However, it is difficult to gauge the significance of the linkage to the earth system through observations on the land or in the coastal region where impact of anthropogenic emission is dominant due to increasing human activity. Therefore, to understand the linkage, it is desired to conduct atmospheric observation in the distant open ocean regions where impact of the anthropogenic matter is limited and effect of the linkage is expected more pronounced.

The MR08-06 cruise provides a unique opportunity for the study of the linkage: The MR08-06 cruise encompasses almost half the earth's globe (from 40°N to 55°S and from 142°E to 66°W) and travels regions which are distant from the areas with heavy human activity.

Our objectives in the MR08-06 cruise are

i. To observe physical and chemical properties of atmospheric aerosols, such as size distribution, number concentration, cloud condensation nuclei (CCN) concentration, chemical compositions (ionic composition, trace metals, phosphorous, nitrogen, and organic compositions) and their size distribution and mixing states, including composition of precipitations.
ii. To observe geological distribution of the physical and chemical properties of atmospheric aerosols and depositions mentioned above and evaluate their potential relationship with marine primary production.
iii. To estimate the flux of the atmospheric depositions into ocean and their geological distribution based on the observation.
iv. To evaluate a potential impact of the atmospheric depositions to marine primary production

(3) *Methods and Observations*

Table 7.1.7-1 summarizes observations carried out during MR08-06 cruise (leg 1 and 2, 1/15/2009 ~ 3/30/2009) and their methods, sampling time resolutions and frequencies. All observation instruments were installed in the three places on the R/V MIRAI, (i) a newly constructed container laboratory installed in the #1 storage (Plate 7.1.7-1), (ii) compass deck (Plate 7.1.7-2), and (iii) general purpose observation room. The container lab in the #1 storage was constructed to accommodate aerosol measurement instruments which were newly introduced in this cruise (ATOFMS, CCN and CN counters). Aerosol measurements are generally divided into two different types of observation/analysis. One is a *real-time* and *in-situ* observation/analysis with a high time resolution from 1 second to 2 hours (*e.g.*, ATOFMS, CCN, CN, SMPS, OPC, sulfate and carbon monitors), while another is an aerosol collection followed by further detailed *off-line* chemical analysis with a relatively low time resolution from 1 ~ 3 days (*e.g.*, all aerosol sampling with filter collection method, mist-chamber total sampler). The combination of two different types of observations allows more comprehensive and better understanding of atmospheric aerosol processes. Air sampling in aerosol samplers which was continued for a longer time period (from 12 hours to 2 weeks) was controlled by a wind sector system to avoid a contamination of engine exhaust from the funnel of the R/V MIRAI. Aerosol samplers were activated only when wind blew in a direction from the fore of the ship with a certain wind speed (> 1 m/s).

(4) *Preliminary Results and Further Analysis*

Figure 7.1.7-1 shows temporal variations of selected *in-situ* measurements from 1/15/2009 to 3/30/2009. There are several clear changes in the temporal trends. During 1/15/2009 to 1/29/2009, a steep decline in CO, O_3, sulfate, nitrate, and CN, which are generally indicators of anthropogenic emission, was observed as the R/V MIRAI was getting away from Japan, indicating that influence of anthropogenic impact from Japan and Eurasia continent declined and more clean background condition became predominant. After 1/29/20009, although there were many occasions in which engine exhaust from R/V MIRAI impacted our aerosol measurements (and resulted in a sudden increase in SO_2 and aerosol number concentrations), clean marine background air masses were generally observed during the rest of the time period. Currently, detailed laboratory chemical analysis and data analysis are underway. Results from these atmospheric observations and their temporal/spatial/latitudinal variations will be further compared with temporal variations in nutrient concentrations and/or amount of biomass at the surface of ocean. A potential linkage between atmospheric aerosols and marine primary production will be evaluated.

Table 7.1.7-1. List of aeorosol and atmospheric measurements conducted during MR08-06 (1/15/09 - 3/30/09).

Categoly	Type of Meas.	Meas. Range / Property	Time Res.	Instrument / Analysis	Installed Location*	Note
Atmospheric Aerosols	Size Distribution	(1) 10~500 nm	3 min	SMPS	CN-Lab	64 size bins
		(2) 100~500 nm	1 min	OPC 1	Cmp-Deck	5 size bins
		(3) 0.5 ~ 5 mm	1 min	OPC 2	Cmp-Deck	5 size bins
	Number Conc.	(4) Total number conc. for d > 5 nm	1 sec	CPC	CN-Lab	d > 5 nm
		(5) Cloud Concendation Nuclei Conc.	1 sec	CCN Counter	CN-Lab	S = 0.1~0.8 %
	Composition	(6) Inorganic/ organic/ total phosphorus, nitrogen, and carbon	3~5 days	Filter sampling Laboratry analysis 1	Cmp-Deck	2 size fractions (d > 2.5 mm, d < 2.5 mm)
		(7) Trace meta, ionic comp.	3~5 days	Filter sampling Laboratry analysis 2	Cmp-Deck	2 size fractions (d > 2.5 mm, d < 2.5 mm)
		(8)Trace metal, ionic comp.	12 h	Filter sampling Laboratry analysis 3	Cmp-Deck	No size fraction
		(9) Size-resolved phosphorus, nitrogen, carbon, and ionic comp.	14 days	Filter sampling Laboratry analysis 4	Cmp-Deck	12 size fractions for d = 0.06～12 μm
		(10) Water soluble total gas and aerosol comp.	1 day	Mist chamber total gas/aerosol collector	Cmp-Deck	Both gas and aerosol
		(11) d = 100~2500 nm, Single particle analysis, Organic, inorganic, and metal comp.	Real time	Aerosol Time-Of-Flight Mass Spectrometer (ATOFMS)	CN-Lab	Size-resolved single particle chemical comp.
		(12) Total sulfate conc.	10 min	Sulfate monitor	Cmp-Deck	Mass conc. of aerosol phase sulfate
		(13) Total nitrate conc.	10 min	Nitrate monitor	Cmp-Deck	Mass conc. of aerosol phase nitrate
		(14) Total carbon conc.	2 h	Carbon monitor	Cmp-Deck	Mass conc. of aerosol phase carbon
Rain	Composition	Dissolved Matter: Ionic comp. / Total phosporus / Total nitrogen	While raining	Collection and laboratory analysis	Cmp-Deck	
Atmosheric Gases	Concentration	O_3 / CO / SO_2	1 min		GP-ObsRM	

*CN-Lab: *Container Laboratory* in #1 storage, Cmp-Deck: Compass Deck, GP-ObsRM: General Purpose Observation Room

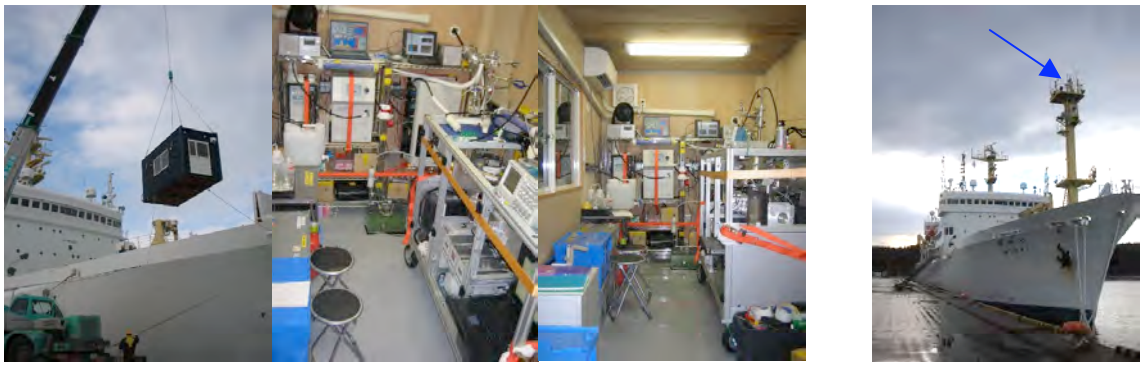

Plate 7.1.7-1. Installation of a newly constructed container laboratory to #1 storage in R/V Mirai; inside the container laboratory during MR08-06 cruise; air sampling inlet for the instruments in the container laboratory (blue arrow).

Plate 7.1.7-2. Aerosol instruments installed on compass deck

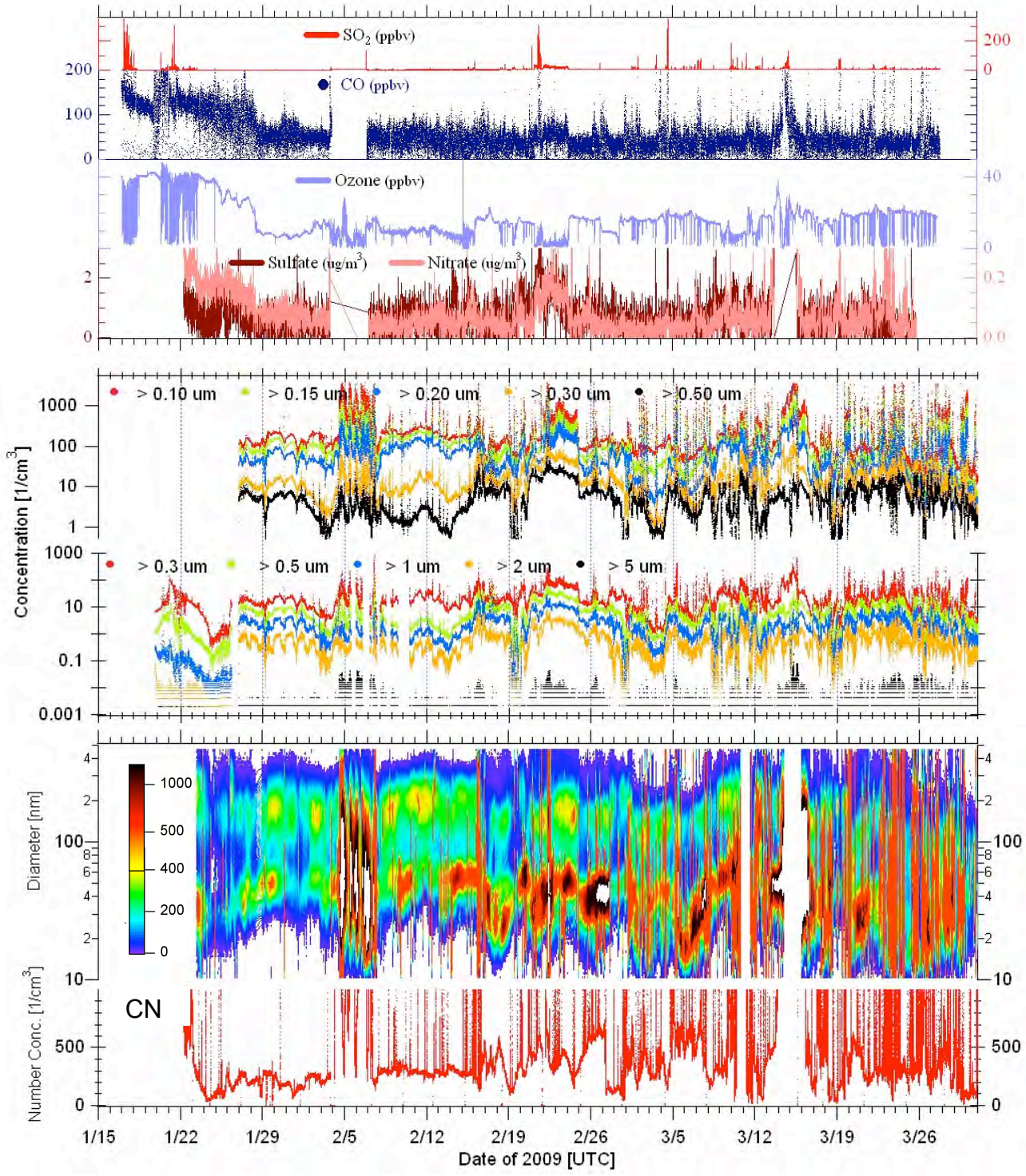

Figure 7.1.7-1. Preliminary results of selected real-time/in-situ aerosol observations during MR08-06. From top to bottom, temporal variations of trace gases (SO_2, CO, O_3), aerosol phase sulfate (SO_4^{2-}) and nitrate (NO_3^-), size-resolved number concentrations (0.1~5 um), size distribution (10~500 nm) observed by a SMPS, and total aerosol number concentration (CN).

7.2 Physical Oceanographic Observations
7.2.1 Shipboard ADCP

(1) *Personnel*

Satoshi Okumura	GODI: Operation Leader
Harumi Ota	GODI
Takashi Kawamura	GODI

(2) *Objectives*

The objective of this observation is to obtain continuous measurement of the current profile along the cruise track.

(3) *Measured parameters*

The data was configured for 16 m processing bin, 8 m intervals and starting 22.5m below the surface. Every ping was recorded as raw ensemble data (.ENR). Also, 60 seconds and 300 seconds averaged data were recorded as short term average (.STA) and long term average (.LTA) data, respectively.

(4) *Instrument and Method*

Upper ocean current measurements were made throughout MR08-06 Leg.2 cruise, using the hull mounted Acoustic Doppler Current Profiler (ADCP) system. For most of its operation, the instrument was configured for water-tracking mode recording. Bottom-tracking mode, interleaved bottom-ping with water-ping, was made in shallower water region to get the calibration data for evaluating transducer misalignment angle.

The system consists of following components;

i. The R/V MIRAI has installed the Ocean Surveyor for vessel-mount (acoustic frequency 76.8 kHz; Teledyne RD Instruments). It has a phased-array transducer with single ceramic assembly and creates 4 acoustic beams electronically. We mounted the transducer head rotated to a ship-relative angle of 45 degrees azimuth from the keel.

ii. The ship's gyro compass (Tokimec, Japan) is used as a heading data, which is continuously providing heading to the ADCP system directory. In addition, the Inertial Navigation System (INS), which provides high-precision heading, pitch and roll, attitude information, is used. The data is stored in ".N2R" data files with a time stamp.

iii. GPS navigation receiver (Trimble DS4000) provides position fixes.

iv. The VmDas version 1.4.2 (TRD Instruments) is used for data acquisition.

v. The clock of the logging computer is adjusted to GPS time every 1 minute to synchronize time stamp of ping with GPS time.

vi. The ethylene glycol is added into the fresh water to prevent freezing in the sea chest.

vii. The sound speed at the transducerr affects the vertical bin mapping and vertical velocity measurement, is calculated from temperature, salinity (constant value; 35.0 psu) and depth (6.5 m; transducer depth) by using the equation reported by Medwin (1975).

(5) *Preliminary results*

The Figs. 7.2.1-1, 7.2.1-2, 7.2.1-3 and 7.2.1-4 show current vector of 50 – 100m water depth, along the cruise track. The data is a 10-minute time average of absolute velocity data.

(6) *Data archive*

These data obtained in this cruise will be submitted to the Data Integration and Analysis Group (DIAG) of JAMSTEC, and will be opened to the public via "R/V MIRAI Data Web Page" in JAMSTEC home page.

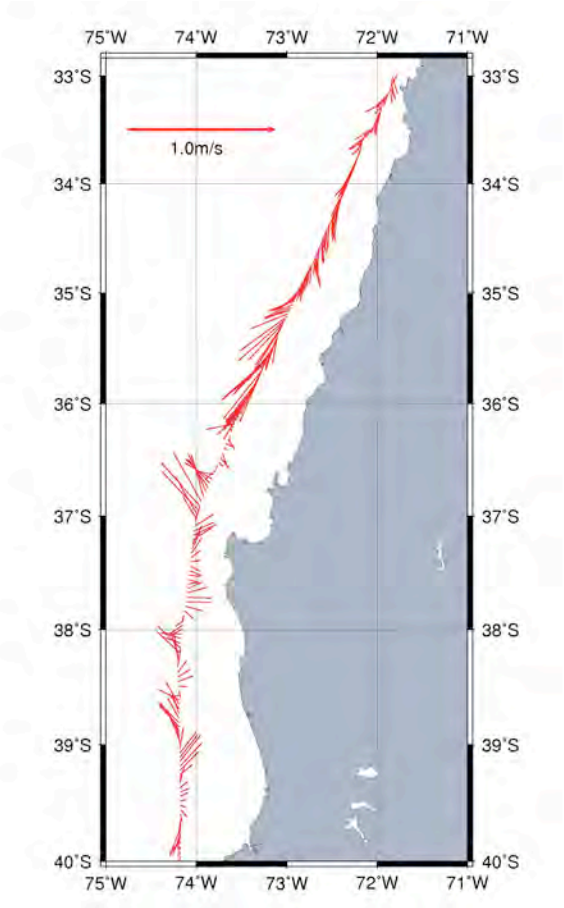

Fig. 7.2.1-1 Current vector (33˚S – 40˚S, water depth: 50 - 100m)

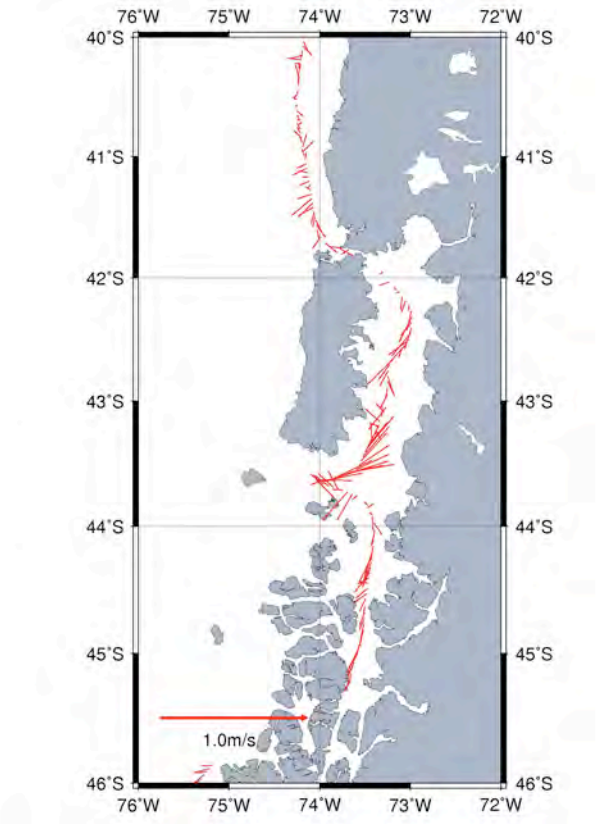

Fig. 7.2.1-2 Current vector (40˚S – 46˚S, water depth: 50 - 100m)

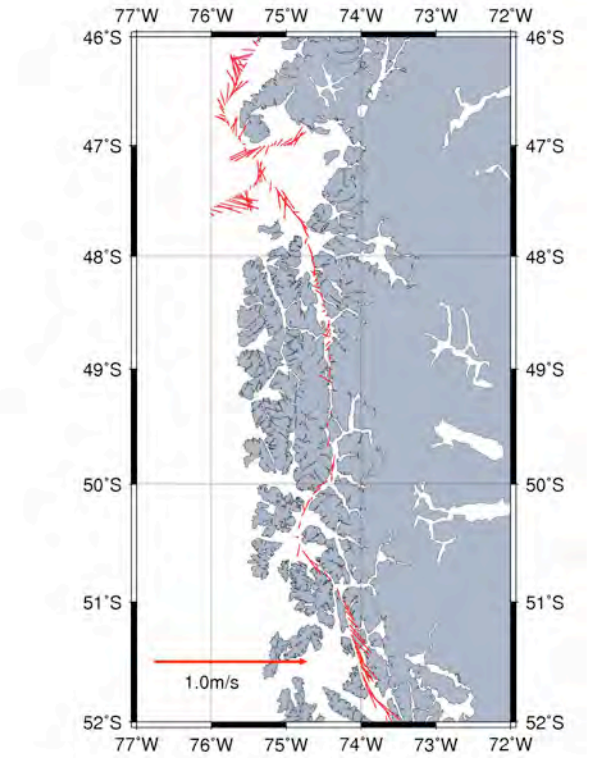

Fig. 7.2.1-3 Current vector (46˚S – 52˚S, water depth: 50 - 100m)

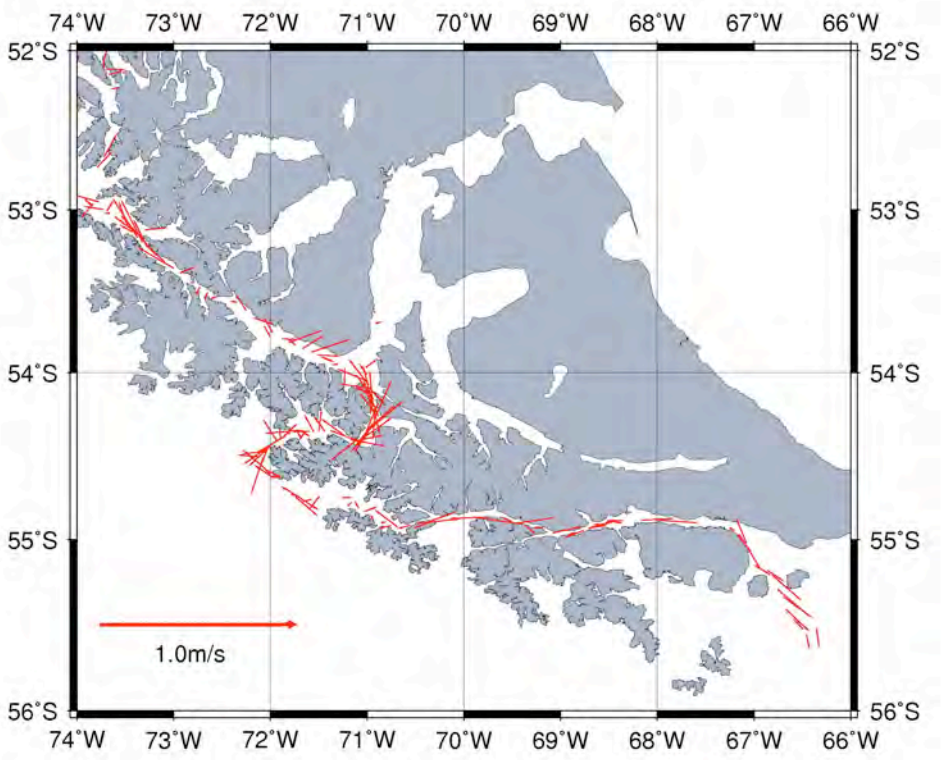

Fig. 7.2.1-4 Current vector (52˚S – 56˚S, water depth: 50 - 100m)

7.2.2 CTD and water sampling

(1) *Personnel*

Naomi Harada	JAMSTEC : Principal investigator
Shinsuke Toyoda	Marine Works Japan Co. Ltd (MWJ) : Operation leader ;
Satoshi Ozawa	MWJ
Tatsuya Tanaka	MWJ
Wolfgang Schneider	COPAS/University of Concepción

(2) *Objectives*

The main objective is to understand physical structure of water mass and collect water samples at multiple depths.

(3) *Overview of the equipment and observation*

A CTD/Carousel water sampling system (CTD system), which equipped a 36-position Carousel Water Sampler (SBE 32) with SBE 9plus (Sea-Bird Electronics Inc., USA) and other sensors, was used during this cruise. The Niskin bottles, which have 12-liter inner volume, were used for water sampling. For measurement of trace elements, another Niskin bottles, which have 12L inner volume, were also used. The CTD system was deployed from starboard on the working deck. During this cruise, 17 casts of CTD observation were carried out (see Table 7.2.2-1).

The file CTD raw data named with station number and the file name distinguishes down or up casts. For the case of the down cast at St. 37, the file name is to be 037M01, and the up cast, the file name of CTD raw data is to be 037M01_1. The file name of the processed data of down and up casts are d037M01 and u037M01, respectively.

During the 2nd cast of the down cast at St. 43, noise was observed in the transmission raw data, and during the up cast, noise also affected CTD raw data. However, the raw data was corrected and this noise problem was finally eliminated.

(4) *List of sensors and equipments*

Under water unit:	SBE, Inc., SBE 9plus, S/N 0575
Temperature sensor:	SBE, Inc., SBE 03plus, S/N 03P4421
Conductivity sensor:	SBE, Inc., SBE 04-02/O, S/N 041088
Dissolved oxygen sensor:	SBE, Inc., SBE 43, S/N 430949
Fluorescence sensor:	Seapoint sensors, Inc, S/N 3054
Transmission sensor:	Wetlabs, Inc., S/N CST-207RD
Altimeter:	BENTHOS, Inc., PSA-916T, S/N 1100
Pump:	SBE, Inc., SBE 5T, S/N 054595
Deck unit:	SBE, Inc., SBE 11plus, S/N 11P7030-0272
Carousel Water Sampler:	SBE, Inc., SBE 32, S/N 3227443-0391
Water sample bottle:	General Oceanics, Inc., 12-liter Niskin-X, and 12-liter clean

(5) *Data processing*

The SEASOFT-Win32 (Ver. 7.18c) was used for processing the CTD data. Descriptions and settings of the parameters for the SEASOFT were written as follows.

i. The DATCNV converted the raw data to scan number, pressure, depth, temperature, conductivity, dissolved oxygen voltage, fluorescence, transmission, altimeter, descent rate, modulo error count and pump status. The DATCNV also extracted bottle information where scans were marked with the bottle confirm bit during acquisition. The duration was set to 3.0 seconds, and the offset was set to 0.0 seconds.

ii. The ROSSUM created a summary of the bottle data. The bottle position, date, time were output as the first two columns. Scan number, pressure, depth, temperature, conductivity, dissolved oxygen voltage, fluorescence, transmission, altimeter, descent rate were over 3.0 seconds. Oxygen, salinity, sigma-theta, potential temperature were calculated.

iii. The ALIGNCTD converted the time-sequence of dissolved oxygen sensor outputs into the pressure sequence to ensure that all calculations were made using measurements from the same parcel of water. For a SBE 9plus CTD with the ducted temperature and conductivity sensors and a 3000 rpm pump, the typical net advance of the conductivity relative to the temperature is 0.073 seconds. The SBE 11plus deck unit was set to advance the primary conductivity for 1.73 scans (1.75/24 = 0.073 seconds). Dissolved oxygen data are also systematically delayed with respect to depth mainly because of the long time constant of the dissolved oxygen sensor and of an additional delay from the transit time of water in the pumped plumbing line. This delay was compensated by 6 seconds advancing dissolved oxygen sensor output (dissolved oxygen voltage) relative to the pressure.

iv. The WILDEDIT marked extreme outliers in the data files. The first pass of WILDEDIT obtained an accurate estimate of the true standard deviation of the data. The data were read in blocks of 1000 scans. Data greater than 10 standard deviations were flagged. The second pass computed a standard deviation over the same 1000 scans excluding the flagged values. Values greater than 20 standard deviations were marked bad. This process was applied to pressure, depth, temperature, conductivity, dissolved oxygen voltage, fluorescence, transmission, altimeter, and descent rate.

v. The CELLTM used a recursive filter to remove conductivity cell thermal mass effects from the measured secondary conductivity. Typical values used were thermal anomaly amplitude alpha = 0.03 and the time constant 1/beta = 7.0.

vi. The FILTER performed a low pass filter on pressure with a time constant of 0.15 seconds. In order to produce zero phase lag (no time shift) the filter runs forward first then backwards.

vii. The WFILTER performed as a median filter to remove spikes in fluorescence and transmission data. A median value was determined by 49 scans of the window.

viii. The SECTIONU selected a time span of data based on scan number in order to reduce the file size. The minimum number was set to be the starting time when the CTD package was beneath the sea-surface after activation of the pump. The maximum number was set to be the end time when the package came up from the surface.

ix. The LOOPEDIT marked scans where the CTD was moving less than the minimum velocity of 0.0 m/s (traveling backwards due to ship roll).

x. The DERIVE was used to compute dissolved oxygen.

xi. The BINAVG averaged the data into 1 m depth bins. The center value of the first bin was set equal to the bin size. The bin minimum and maximum values are the center value plus and minus half the bin size. Scans with pressure greater than the minimum and less than or equal to the maximum were averaged. Scans were interpolated so that a data record exists in every m.

xii. The DERIVE was used to compute salinity, sigma-theta, potential temperature.

xiii. The SPLIT was used to split data into the down cast and the up cast.

(6) *Preliminary results*

The date, time and locations of the CTD casts are listed in Table.7.2.2-1. The vertical profiles (down cast) of temperature, salinity, dissolved oxygen, fluoresce and transmission with pressure are shown in Figure 7.2.2-1 - 7.2.2-9.

We also compared CTD-salinity and Bottle-salinity, CTD-dissolved oxygen and Bottle-dissolved oxygen. All bottle data were used for comparison. The results are shown in Figure.7.2.2-10 - 11.

(7) *Data archive*

All raw and processed data files are submitted to the DIAG and will be opened to public via “R/V MIRAI Data Web Page” in the JAMSTEC web site.

Table.7.2.2-1 CTD/ water sampling casts

Stnnbr	Castno	Date(UTC)	Time(UTC)		BottomPosition		Depth	Wire Out	HT Above Bottom	Max Depth	Max Pressure	CTD Filename	Remark
		(mmddyy)	Start	End	Latitude	Longitude							
037	1	031709	07:35	08:00	43-37.09S	074-03.71W	201.0	182.8	8.0	188.0	189.6	037M01	rawdata filename downcast: 037M01, upcast: 037M01_1 processed data filename 037M01
038	1	031809	11:03	11:20	46-59.96S	074-45.00W	88.0	70.5	10.2	75.0	75.3	038M01	
042	1	031909	10:26	10:40	47-59.40S	073-47.25W	1061.0	47.8	-	50.4	50.8	042M01	
042	2	031909	12:02	13:10	47-59.32S	073-47.28W	1061.0	1052.9	9.5	1048.8	1060.4	042M02	
041	1	031909	22:46	23:39	47-58.79S	074-15.47W	737.0	721.1	9.7	716.9	724.2	041M01	
040	1	032009	10:58	11:13	47-42.45S	074-44.42W	258.0	46.3	-	50.5	51.0	040M01	
040	2	032009	12:09	12:38	47-42.38S	074-44.40W	260.0	242.7	10.1	245.0	246.3	040M02	
043	1	032109	10:04	10:26	47-48.80S	075-51.67W	1385.0	95.8	-	100.0	100.3	043M01	#1: clean Niskin bottle
043	2	032109	14:48	16:12	47-49.29S	075-52.36W	1415.0	1395.2	8.2	1385.5	1399.6	043M02	#1, #2, #3: clean Niskin bottles dowm cast: Noise was observed in the transmission raw data. up cast: Noise affected CTD raw data. The processed data could be corrected.
046	1	032309	15:17	15:32	53-08.58S	073-10.78W	713.0	45.9	-	50.1	50.5	046M01	#1, #2, #3: clean Niskin bottles
046	2	032409	10:03	10:21	52-52.00S	074-05.07W	559.0	46.5	-	50.0	50.7	046M02	#1, #2, #3: clean Niskin bottles
046	3	032409	11:49	12:39	52-51.99S	074-05.41W	560.0	560.1	9.3	547.4	552.5	046M03	#1, #2, #3: clean Niskin bottles
044	1	032609	12:39	13:02	56-03.10S	066-20.63W	632.0	93.2	-	100.6	100.5	044M01	#1, #2, #3: clean Niskin bottles
044	2	032709	10:04	10:19	55-42.50S	066-08.00W	675.0	49.6	-	50.4	51.5	044M02	#1, #2, #3: clean Niskin bottles
044	3	032709	11:44	12:31	55-42.50S	066-07.69W	664.0	720.9	8.0	663.5	671.2	044M03	#1, #2, #3: clean Niskin bottles
045	1	032809	13:32	13:47	54-31.10S	072-06.28W	488.0	49.8	-	52.3	53.2	045M01	#1, #2, #3: clean Niskin bottles
045	2	032809	15:03	15:41	54-30.75S	072-06.43W	464.0	446.5	11.5	442.6	447.9	045M02	#1, #2, #3: clean Niskin bottles

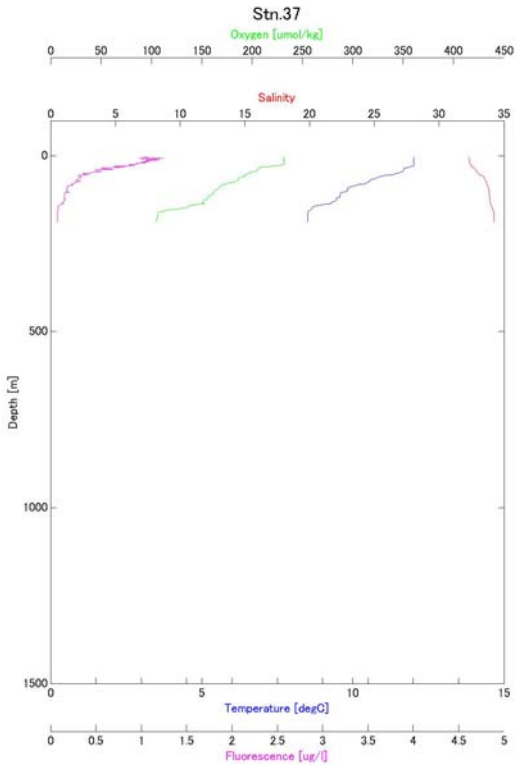

Fig.7.2.2-1 Oxygen, temperature, salinity and fluorescence data during the CTD cast at St.37.

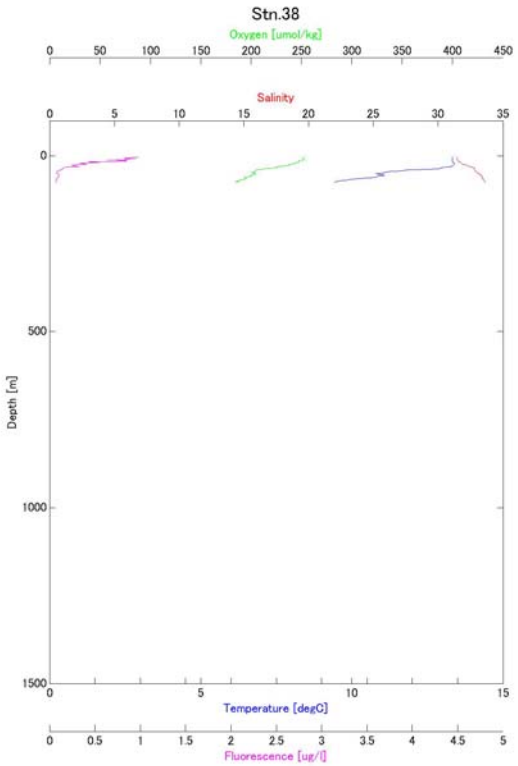

Fig.7.2.2-2 Oxygen, temperature, salinity and fluorescence data during the CTD cast at St.38.

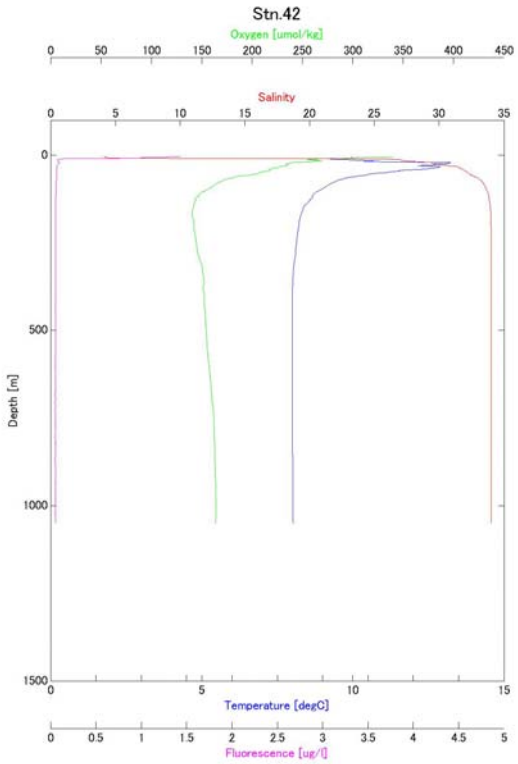

Fig.7.2.2-3 Oxygen, temperature, salinity and fluorescence data during the CTD cast at St.42.

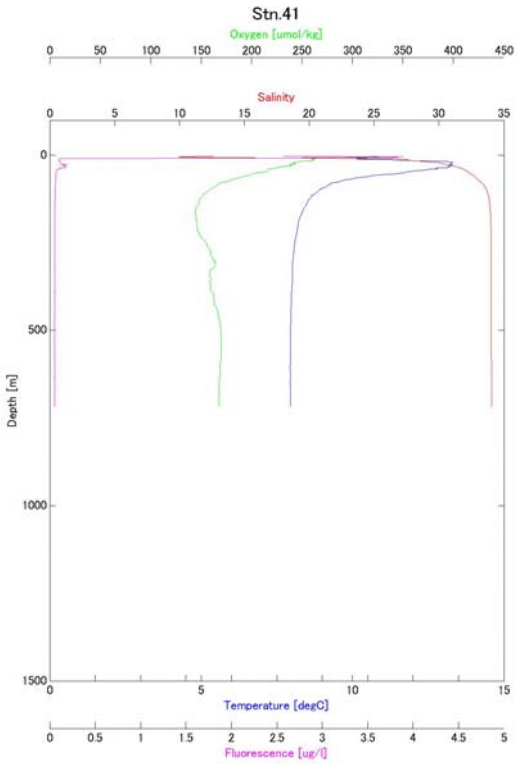

Fig.7.2.2-4 Oxygen, temperature, salinity and fluorescence data during the CTD cast at St.41.

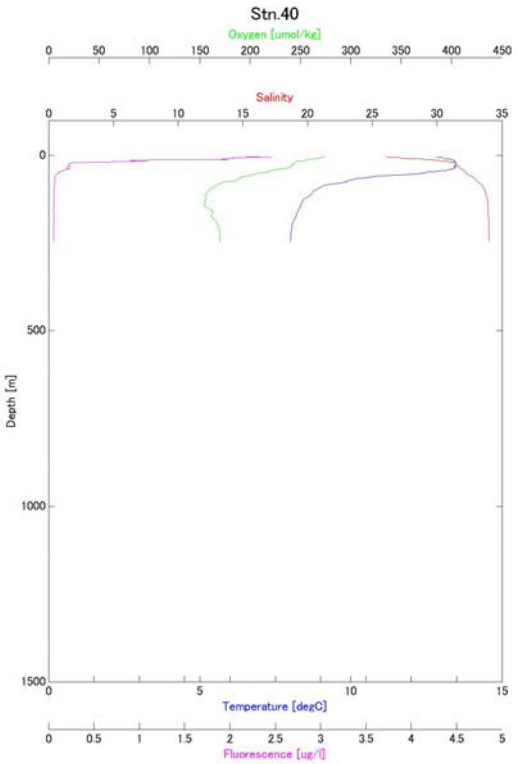

Fig.7.2.2-5 Oxygen, temperature, salinity and fluorescence data during the CTD cast at St.40.

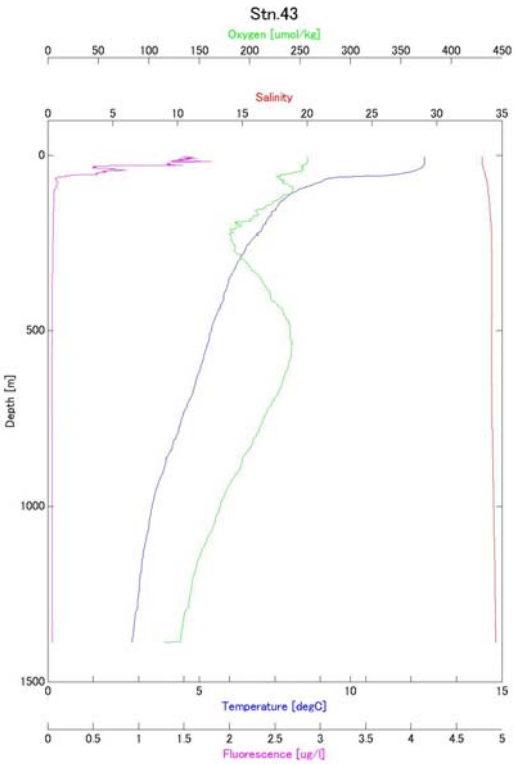

Fig.7.2.2-6 Oxygen, temperature, salinity and fluorescence data during the CTD cast at St.43.

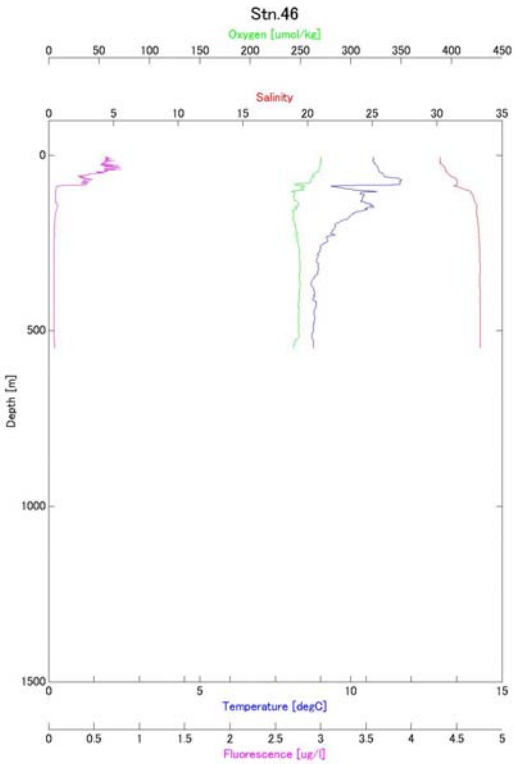

Fig.7.2.2-7 Oxygen, temperature, salinity and fluorescence data during the CTD cast at St.46.

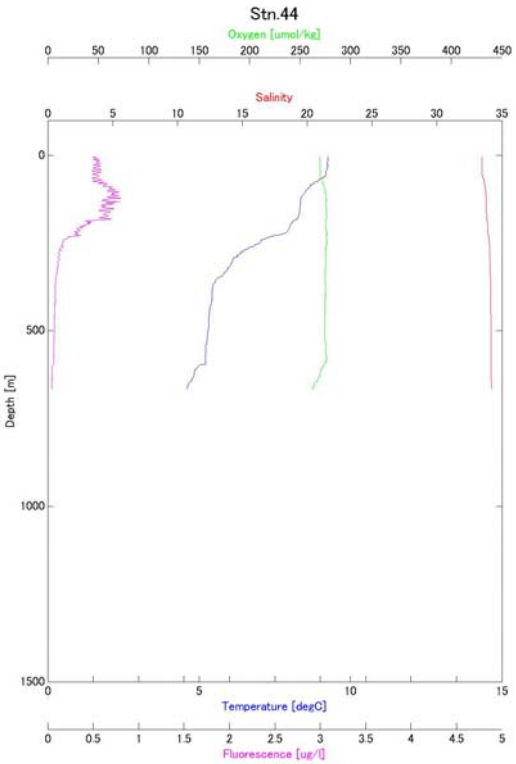

Fig.7.2.2-8 Oxygen, temperature, salinity and fluorescence data during the CTD cast at St.44.

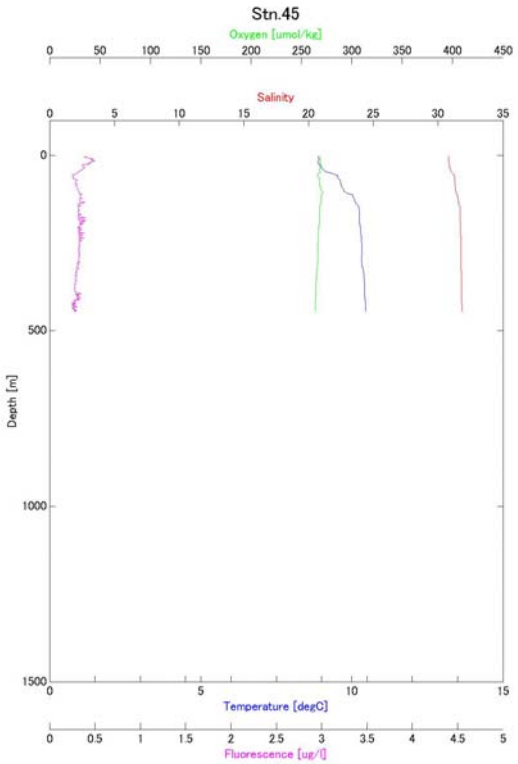

Fig.7.2.2-9 Oxygen, temperature, salinity and fluorescence data during the CTD cast at St.45.

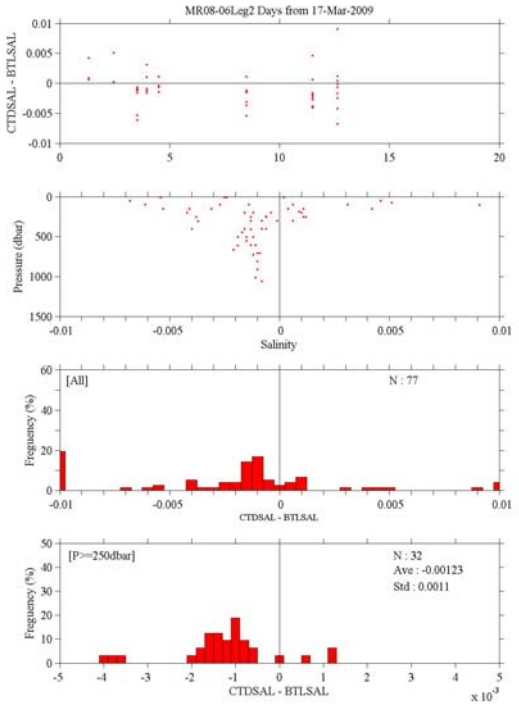

Fig.7.2.2-10 Comparison of salinity between bottle and sensor equipped with CTD.

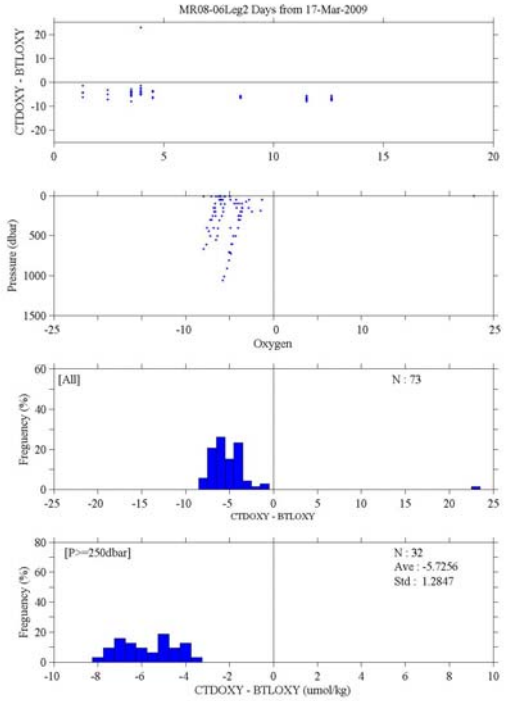

Fig.7.2.2-11 Comparison of dissolved oxygen between bottle and sensor equipped with CTD.

7.3 Chemical oceanographic observations

7.3.1. Salinity

(1) *Personnel*

Naomi Harada	JAMSTEC: Principal Investigator
Tatsuya Tanaka	MWJ: Operation Leader

(2) *Objectives*

To understand the physical structure of water mass, salinity of water samples collected by Niskin bottles during the CTD casts, sea surface water collected by bucket, bottom water samples collected by Benthic Boundary Layer (BBL) sampler and EPCS (Leg1 and Leg2) were measured.

(3) *Measured parameters*

Salinity of seawater

(4) *Instruments and methods*

i. Seawater sample collection

Seawater samples were collected by using Niskin bottles, bucket, BBL, and EPCS (Leg1 and Leg2). The brown grass bottle having 250ml volume with screw cap was used for sub-sampling of seawater. Each bottle was rinsed three times by the seawater beforehand, and was filled with sample water to the bottle shoulder. The sample bottle for BBL and EPCS was sealed with a plastic insert thimble, which are rinsed by the seawater beforehand and a screw cap. The glass bottle was stored for more than 20 hours in the laboratory under the room temperature before the salinity measurement. The number of seawater samples collected during this cruise are listed in Table 7.3.1-1.

Table 7.3.1-1 Number of seawater samples for salinity measurement

Samples	Number
Niskin bottles and Bucket	120
BBL	7
EPCS (Leg1)	89
EPCS (Leg2)	19
Total	235

ii. Instruments and methods

Salinity of seawater samples was measured by using a salinometer (Model 8400B “AUTOSAL” ; Guildline Instruments Ltd.: S/N 62827) with an additional peristaltic-type intake pump (Ocean Scientific International, Ltd.) equipped on R/V MIRAI during the MR08-06 cruise. A pair of precision digital thermometers (Model 9540 ; Guildline Instruments Ltd.) were also used. The

thermometer monitored the ambient temperature and another monitored a water bath temperature. The specifications of AUTOSAL salinometer and thermometer are shown as follows

Salinometer (Model 8400B "AUTOSAL" ; Guildline Instruments Ltd.)
Measurement Range : 0.005 to 42 (PSU)
Accuracy : Better than ±0.002 (PSU) over 24 hours without re-standardization
Maximum Resolution : Better than ±0.0002 (PSU) at 35 (PSU)

Thermometer (Model 9540 ; Guildline Instruments Ltd.)
Measurement Range : -40 to +180 deg C
Resolution : 0.001
Limits of error ±deg C : 0.01 (24 hours @ 23 deg C ±1 deg C)
Repeatability : ±2 least significant digits

The measurement was carried out in accordance with the instructions reported by Aoyama *et al.* (2002). The salinometer was operated at a bath temperature of 24 deg C under the air-conditioned ship's laboratory. The ambient temperature varied from approximately 21 deg C to 25 deg C, while the bath temperature was very stable and varied within +/- 0.002 deg C on rare occasion. The measurement for each sample was done with the duplicate conductivity ratio and defined as the median of 31 readings of the salinometer. Data collection started after 10 seconds since the cell was filled by seawater. The data collection took about 10 seconds for 31 readings by a personal computer. Data were accumulated for the sixth and seventh filling of the cell. In the case of the difference of the double conductivity ratio of these two fillings being smaller than 0.00002, the average value of the double conductivity ratio was used to calculate the bottle salinity by using the algorithm for practical salinity scale, 1978 (UNESCO, 1981). If the difference was greater than or equal to 0.00003, an eighth filling of the cell was done. In the case of the difference between the double conductivity ratio of these two fillings being smaller than 0.00002, the average value of the double conductivity ratio was used to calculate the bottle salinity. In the case of the double conductivity ratio of eighth filling did not satisfy the criteria above, we measured a ninth filling or a tenth filling of the cell and calculated the bottle salinity above. The measurement was conducted in about 5 - 9 hours per day and the cell was cleaned with detergent after the measurement of the day.

(5) *Preliminary results*

i. Standard Seawater

Standardization control of the salinometer was set to 466 and all measurements were done at this setting. The value of STANDBY varied from 5395 to 5402 during the cruise and +/- 0001 during the day. The value of ZERO was 0.0+0001 +/- 0001. The conductivity ratio of IAPSO Standard Seawater batch P150 was 0.99978 (the double conductivity ratio was 1.99956) and was used as the standard for salinity. We measured 19 bottles of P150.

The Fig.7.3.1-1 shows the temporal variation of the double conductivity ratio of the Standard Seawater batch P150 before correction. The average of the double conductivity ratio was 1.99959 and the standard deviation was 0.00002, which is equivalent to 0.0004 in salinity.

The Fig.7.3.1-2 shows the temporal variation of the double conductivity ratio of the Standard Seawater batch P150 after correction. The average of the double conductivity ratio after correction was 1.99956 and the standard deviation was 0.00001, which is equivalent to 0.0002 in salinity.

The specifications of SSW used in this cruise are shown as follows ;

batch	:	P150
conductivity ratio	:	0.99978
salinity	:	34.991
preparation date	:	22nd-May-2008

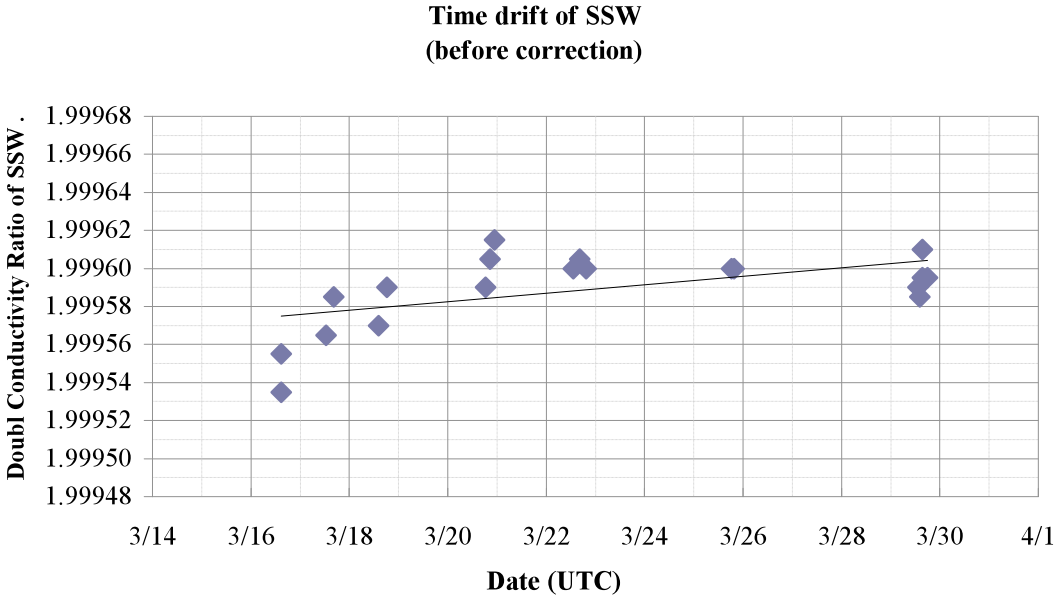

Fig. 7.3.1-1 The temporal variation of the double conductivity ratio for the Standard Seawater batch P150 (before correction)

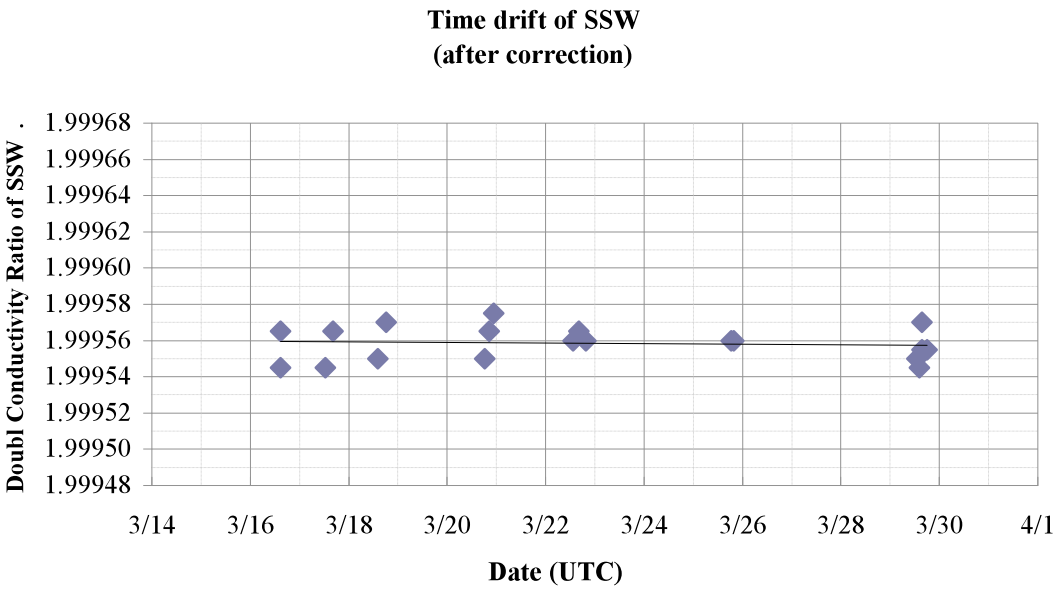

Fig. 7.3.1-2 The temporal variation of the double conductivity ratio for the Standard Seawater batch P150 (after correction)

ii. Standard Seawater for Linearity

The salinity of IAPSO Standard Seawater batch 38H10, 30L14 and 10L11 were 37.997, 30.003 and 9.998 respectively and was used as the standard for the linearity measurement of the instrument. We measured 3 bottles for each batch 38H10, 30L14 and 10L11.

The Fig.7.3.1-3 shows the linearity of the salinity of the Standard Seawater batch P150, 38H10, 30L14 and 10L11 after correction by batch P150. The average of the salinity after correction batch P150, 38H10, 30L14 and 10L11 were 37.9967, 30.0023 and 9.9988, respectively.

The specifications of SSW for linearity used in this cruise are shown as follows ;

batch	:	38H10	30L14	10L11
conductivity ratio	:	1.07562	0.87154	0.32060
salinity	:	37.997	30.003	9.998
preparation date	:	1st-Oct-2008	29-Sep-20008	23-July-2008

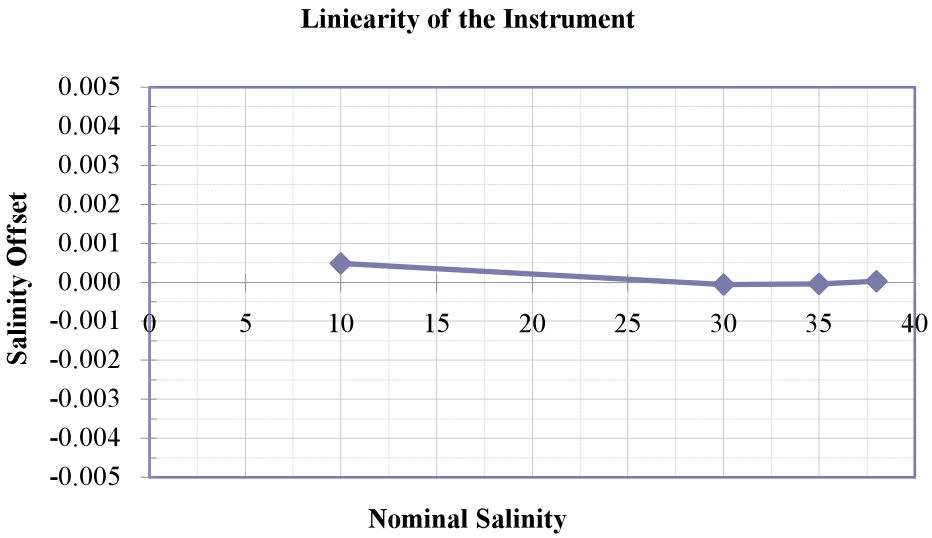

Fig. 7.3.1-3 The linearity of the salinity of the Standard Seawater batch P150, 38H10, 10L14 and 10L11 after correction by batch P150.

iii. Sub-Standard Seawater

Sub-standard seawater was made from deep-sea water filtered by a pore size of 0.45 micrometer and stored in a 20-liter container made of polyethylene and stirred for at least 24 hours before measuring. It was measured about every 6 samples in order to check for the possible sudden drifts of the salinometer.

iv. Replicate Samples

We estimated the precision of this method using 16 pairs of replicate samples taken from the same Niskin bottle. The average and the standard deviation of absolute deference among 15 pairs of replicate samples except one pair that would be collected on discontinuous layer were 0.0001 and 0.0001 in salinity, respectively.

(6) *Data archive*

These raw datasets are submitted to JAMSTEC Data Integration and Analyses Group (DIAG).

(7) *Reference*

Aoyama, M., T. Joyce, T. Kawano and Y. Takatsuki (2002) Standard seawater comparison up to P129. Deep-Sea Research, 49, 1103-1114.

UNESCO (1981) Tenth report of the Joint Panel on Oceanographic Tables and Standards. UNESCO Tech. Papers in Mar. Sci., 36, 25 pp.

7.3.2 Dissolved oxygen measurement

(1) *Personnel*

Naomi Harada	JAMSTEC : Principal Investigator
Masanori Enoki	MWJ : Operation Leader
Misato Kuwahara	MWJ

(2) *Objectives*

Determination of dissolved oxygen in seawater by Winkler titration.

(3) *Measured parameters*

Dissolved oxygen of sampled seawater

(4) *Instruments and methods*

i. Reagents

Pickling Reagent I: Manganous chloride solution (3M)
Pickling Reagent II: Sodium hydroxide (8M) / sodium iodide solution (4M)
Sulfuric acid solution (5M)
Sodium thiosulfate (0.025M)
Potassium iodate (0.001667M)

ii. Instruments:

Burette for sodium thiosulfate;
APB-510 manufactured by Kyoto Electronic Co. Ltd. / 10 cm^3 of titration vessel
Burette for potassium iodate;
APB-510 manufactured by Kyoto Electronic Co. Ltd. / 10 cm^3 of titration vessel
Detector and Software;
Automatic photometric titrator (DOT-01) manufactured by Kimoto Electronic Co. Ltd.

iii. Sampling

The measurement procedure is based on the WHP Operations and Methods (Culberson, 1991; Dickson, 1996; Dickson et al., 2007;). Seawater samples were collected by Niskin bottles equipped with the CTD Carosel-system. Seawater for oxygen measurement was transferred from Niskin bottles to a volume calibrated glass flask (ca. 100 cm^3). The flask was filled by seawater after overflow of three times flask volume of seawater. Temperature was measured by digital thermometer during the overflowing. Then two reagent solutions (Reagent I and II) of 0.5 cm^3 each were added immediately into the sample flask and the cap was inserted carefully into the flask. The sample flask was then shaken vigorously to mix the contents and to disperse the precipitate finely throughout. After the precipitate has settled at least halfway down the flask, the flask was shaken again vigorously to disperse the precipitate. The sample flasks containing pickled samples were stored in a laboratory until they were titrated.

iv. Sample measurement

At least two hours after the re-shaking, the pickled samples were measured. A magnetic stirrer bar and 1 cm^3 sulfuric acid solution were added into the sample flask and stirring began. Samples were titrated by sodium thiosulfate solution whose morality was determined by potassium iodate solution. Temperature of sodium thiosulfate during titration was recorded by a digital thermometer. During this cruise the DOT-01 (#1) was used as an instrument for measurement of dissolved oxygen concentration.

Dissolved oxygen concentration (μmol kg^{-1}) was calculated by sample temperature during seawater sampling, salinity of the sample, and titrated volume of sodium thiosulfate solution which the blank is subtracted from.

v. Standardization and determination of the blank

Concentration of sodium thiosulfate titrant (ca. 0.025M) was determined by potassium iodate solution. Pure potassium iodate was dried in an oven at 130°C. The 1.7835g potassium iodate weighed out accurately was dissolved in deionized water and diluted to final volume of 5 dm^3 in a calibrated volumetric flask (0.001667M). The 10 cm^3 of the standard potassium iodate solution was added to a flask using a calibrated dispenser. Then, the 90 cm^3 of deionized water, the 1 cm^3 of sulfuric acid solution, and the 0.5 cm^3 of pickling reagent solution II and I were added into the flask in order. Amount of sodium thiosulfate titrated gave the morality of sodium thiosulfate titrant.

The blank from the presence of redox species apart from oxygen in the reagents was determined as follows. First of all, the 1 cm^3 of the standard potassium iodate solution was added to a flask using a calibrated dispenser. Then, the 100 cm^3 of deionized water, the 1 cm^3 of sulfuric acid solution, and the 0.5 cm^3 of pickling reagent solution II and I were added into the flask in order. Secondary, the 2 cm^3 of the standard potassium iodate solution was added to a flask using a calibrated dispenser. Then, the 100 cm^3 of deionized water, the 1 cm^3 of sulfuric acid solution, and the 0.5 cm^3 of pickling reagent solution II and I were added into the flask in order. The blank was determined by difference between the first and second titrated volumes of the sodium thiosulfate. The results of the standardization and the blank determination during this cruise are shown in the Table 7.3.2-1.

Table 7.3.2-1 Results of the standardization and the blank determinations during this cruise.

Date (UTC)	KIO_3 NO.	$Na_2S_2O_3$ NO.	DOT-01 #1		Samples (Station)
			E.P.(cm^3)	Blank(cm^3)	
2009/3/17	20080722-05-01	20080704-1-1-1	3.961	-0.002	S037 cast1 S038 cast0 S038 cast1 S042 cast0 S042 cast2 S041 cast0 S041 cast1 S040 cast0 S040 cast2 S043 cast1 S043 cast2
2009/3/18	CSK	20080704-1-1-1	3.951	-	-
2009/3/21	20080722-05-02	20080704-1-1-1	3.954	-	-
2009/3/22	20080722-05-03	20080704-1-1-1	3.951	-0.001	-
2009/3/23	20080722-05-03	20080704-1-1-2	3.960	-0.003	S046 cast0 S046 cast1 S046 cast3 S044 cast0 S044 cast1 S044 cast2 S044 cast3 S045 cast1 S045 cast2
2009/3/26	20080722-05-04	20080704-1-1-2	3.960	-	-
2009/3/28	20080722-05-05	20080704-1-1-2	3.960	-0.002	-
2009/3/28	CSK	20080704-1-1-2	3.953	-	-

vi. Reproducibility of sample measurements

Replicate samples were taken at every CTD cast; usually these were 5 - 10 % of seawater samples of each cast during this cruise. Results of the replicate samples were shown in Table 7.3.2-2 and this histogram shown in Fig. 7.3.2-1. The standard deviation was calculated by a procedure (SOP23) 2007 Guide to best practices for ocean CO_2 measurements.

Table 7.3.2-2 Results of the replicate samples measurements

Number of replicate sample pairs	Oxygen concentration (μmol/kg)
	Standard Deviation.
23	0.17

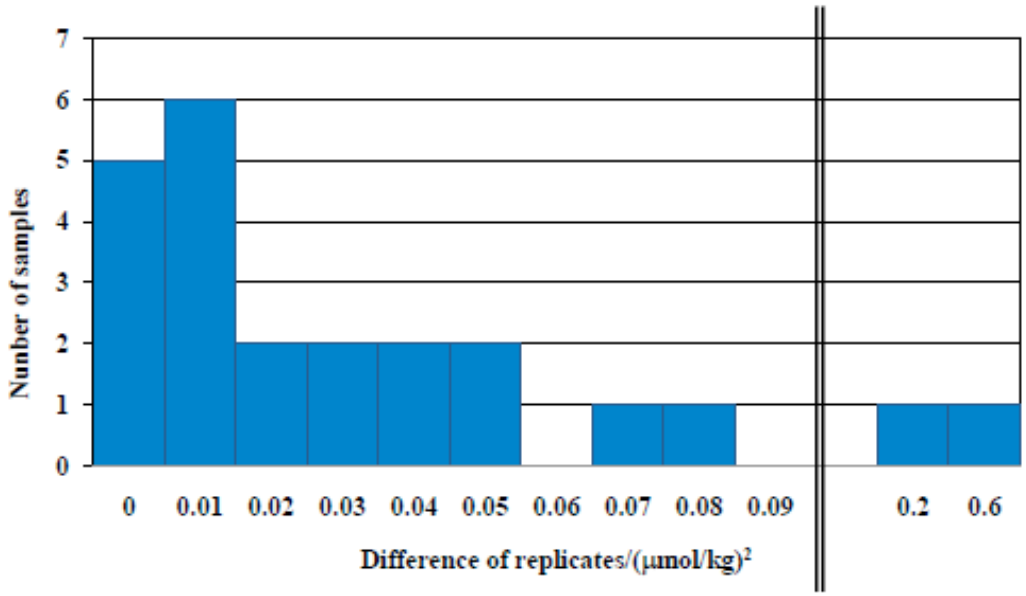

Fig.7.3.2-1 Results of the replicate samples measurements

(5) *Preliminary Result*

During this cruise, we measured oxygen concentration in 131 seawater samples at 9 stations.

(6) *Data archives*

These raw datasets will be submitted to JAMSTEC Data Integration and Analyses Group (DIAG).

(7) *Reference*

Dickson, A. (1996) Determination of dissolved oxygen in sea water by Winkler titration, in WHPO Pub.91-1 Rev. 1, November 1994, Woods Hole, Mass., USA

Dickson, A. G., Sabine, C. L. and Christian, J. R. (eds.) (2007) Guide to best practices for ocean CO_2 measurements; PICES Special Publication 3, 191pp.

Culberson, C.H. (1991) Dissolved oxygen, WHPO Pub.91-1 Rev. 1, November 1994, Woods Hole, Mass., USA.

Japan Meteorological Agency (1999) Manual on Oceanographic Observation Part1, 48-63.

7.3.3 Nutrients measurement

(1) *Personnel*

Naomi Harada	JAMSTEC: Principal Investigator
Junji Matsushita	MWJ: Operation Leader
Kenichiro Sato	MWJ

(2) *Objectives*

The vertical and horizontal distributions of the nutrients are one of the most important factors on the primary production. In addition, nutrients data are used to study of climate change as chemical tracers of seawater mass movement. Therefore, the main objective of nutrients measurement is to understand the mechanism of the primary production and seawater circulation.

(3) *Measured parameters*

Macro nutrients, nitrate, nitrite, silicate (although silicic acid is correct, we use silicate because a term of silicate is widely used in oceanographic community), phosphate and ammonia were measured onboard.

(4) *Instruments and methods*

Nutrient analysis was performed on the BRAN+LUEBBE TRAACS 800 system. The laboratory temperature was maintained between 22-26 deg C.

i. Measured parameters

Nitrate + nitrite and nitrite in seawater were analyzed by the procedure which is modified method based on Grasshoff (1970). The nitrate in seawater sample is reduced to nitrite in a cadmium tube inside of which is coated with metallic copper. The sample stream with its equivalent nitrite is treated with an acidic sulfanilamide reagent and the nitrite formed nitrous acid, which reacts with the sulfanilamide to produce a diazonium ion. A reagent, N1-Naphthylethylene-diamine added to the sample stream then couples with the diazonium ion to produce a red, azo dye. With reduction of the nitrate to nitrite, both nitrate and nitrite react and are measured; without reduction, only nitrite reacts. Thus, for the nitrite analysis, no reduction is performed and the alkaline buffer is not necessary. Nitrate is computed by difference. Absorbance of 550 nm by azo dye in analysis is measured using 3 cm in length flow cell for nitrate and 5 cm in length flow cell for nitrite.

The silicate method is analogous to that described for phosphate. The method used is essentially that of Grasshoff et al. (1983), wherein silicomolybdic acid is the first formed from the silicic acid in the sample and added molybdic acid; then the silicomolybdic acid is reduced to silicomolybdous acid, or "molybdenum blue," using L-ascorbic acid as the reductant. Absorbance of 630 nm by silicomolybdous acid in analysis is measured using 3 cm in length flow cell.

The phosphate analysis was carried out by a modified procedure based on Murphy and Riley (1962). Molybdic acid is added to the seawater sample to form phosphomolybdic acid, which is in turn reduced to phosphomolybdous acid using L-ascorbic acid as the reductant. Absorbance of 880 nm by phosphomolybdous acid in analysis is measured using 5 cm in length flow cell.

Ammonia in seawater is mixed with an alkaline solution containing EDTA, ammonia as gas state is formed from seawater. The ammonia (gas) is absorbed in sulfuric acid solution by way of 0.5 μm pore size membrane filter (ADVANTEC PTFE) at the dialyzer equipped with analytical system. The ammonia absorbed in acid solution is determined by coupling with phenol and hypochlorite solution to from an indophenol blue compound. Absorbance of 630 nm by indophenol blue compound in analysis is measured by using 3 cm in length flow cell.

ii. Nutrients standard

Silicate standard solution, the silicate primary standard, was obtained from Merck, Ltd. This standard solution, traceable to SRM from NIST was 1000 mg L^{-1}. Since this solution is alkaline solution of 0.5 M NaOH, an aliquot of 40 ml solution were diluted to 500 ml together with an aliquot of 20 ml of 1 M HCl. Primary standard for nitrate (KNO_3) and phosphate (KH_2PO_4) were obtained from Merck, Ltd., nitrite ($NaNO_2$) and ammonia ($(NH_4)_2SO_4$) were obtained from Wako Pure Chemical Industries, Ltd.

iii. Sampling procedures

Samples were drawn into virgin 10 ml polyacrylates vials that were rinsed three times before sampling without sample drawing tubes.

iv. Calibration and reference material

Sets of 4 different concentrations for nitrate, nitrite, silicate, phosphate and ammonia of the shipboard standards were analyzed at beginning and end of each group of analysis. The standard solutions of the highest concentration were measured every 6 to 10 samples and were used to evaluate precision of nutrients analysis during the cruise.

We also used reference material for nutrients in seawater, RMNS (KANSO Co., Ltd.; lots BA, AS, AX, BD and AZ), for every measurement to secure comparability on nutrients analysis throughout the cruise.

v. Low nutrients seawater (LNSW)

Surface water having low nutrient concentration was taken and filtered using 0.45μm pore size membrane filter. This water is stored in 20 liter cubitainer with paper box. The concentrations of nutrient of this water were measured carefully in Jury 2008.

(5) *Preliminary results*

Analytical precisions were 0.12% (46 μM) for nitrate, 0.09% (1.0 μM) for nitrite, 0.08% (70 μM) for silicate, 0.10% (3.0 μM) for phosphate and 0.21% (4.0 μM) for ammonia in terms of median of precision, respectively. Results of RMNS analysis are shown in Table 7.3.3-1 and Table 7.3.3-2 for the station comparability.

(6) *Data archives*

All data are submitted to JAMSTEC Data Management Office (DIAG) and is currently under its control.

(7) *References*

Grasshoff, K. (1970) Technical paper, 691-57.

Grasshoff, K., Ehrhardt, M., Kremling K. et al. (1983) Methods of seawater analysis. 2nd rev. Weinheim: Verlag Chemie, Germany, West.

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

Table 7.3.3-1 Results of RMNS Lot. AX analysis in this cruise. (unit; μmol kg^{-1})

Station	serial	Nitrate	Nitrite	Silicate	Phosphate
37	1952	21.50	0.36	58.05	1.61
38	149	21.56	0.37	58.05	1.61
38	1952	21.41	0.37	58.19	1.62
42	149	21.48	0.36	57.90	1.61
41	1732	21.44	0.36	58.17	1.62
41	149	21.46	0.36	58.14	1.62
40	1732	21.44	0.36	58.17	1.62
40	149	21.46	0.36	58.14	1.62
43	1732	21.40	0.36	57.89	1.62
46	286	21.45	0.36	58.02	1.62
46	1732	21.51	0.36	58.14	1.62
44	286	21.44	0.36	58.05	1.62
44	1021	21.52	0.36	58.17	1.63
44	286	21.59	0.36	58.21	1.63
45	1021	21.59	0.37	58.13	1.62

Table 7.3.3-2 Results of RMNS Lot. AZ analysis in this cruise. (unit; μmol kg^{-1})

Station	RMNS serial	Ammonia
37	504	0.55
37	743	0.57
38	830	0.55
38	504	0.54
42	1266	0.54
42	830	0.55
41	991	0.56
41	1266	0.53
40	991	0.56
40	1266	0.53
43	445	0.57
43	991	0.58
44	838	0.57
44	605	0.58
44	869	0.56
44	838	0.57
45	187	0.59
45	869	0.57

7.3.4 Partial pressure of CO_2 (pCO_2) and carbonate system in seawater
7.3.4.1 Partial pressure of CO_2 (pCO_2)

(1) *Personnel*

Naomi Harada	JAMSTEC: Principal Investigator
Yasuhiro Arii	MWJ: Operation Leader
Minoru Kamata	MWJ

(2) *Objectives*

Concentrations of CO_2 in the atmosphere are now increasing at a rate of 1.5 ppmv y^{-1} owing to human activities such as burning of fossil fuels, deforestation, and cement production. It is an urgent task to estimate as accurately as possible the absorption capacity of the oceans against the increased atmospheric CO_2, and to clarify the mechanism of the CO_2 absorption, because the magnitude of the anticipated global warming depends on the levels of CO_2 in the atmosphere, and because the ocean currently absorbs 1/3 of the 6 Gt of carbon emitted into the atmosphere each year by human activities.

When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, the concentrations of the individual species of CO_2 system in solution cannot be measured directly. There are, however, four parameters (alkalinity, dissolved inorganic carbon, pH and pCO_2) that can be measured. When more than two of the four parameters are measured, the concentration of CO_2 system in the water can be estimated (DOE, 1994). We here report on board measurements of pCO_2 during MR08-06 Leg2 cruise. This sub-chapter is also related with the "7.3.5 Sea surface monitoring".

(3) *Methods, apparatus and performance*

Partial pressures of CO_2 in the atmosphere and in the surface seawater were measured continuously during the cruise using an automated system with a non-dispersive infrared gas analyzer (NDIR; MLT 3T-IR).

The automated system was operated by on one and a half hour cycle. In one cycle, standard gasses, marine air and equilibrated air with surface seawater within the equilibrator were analyzed subsequently. The concentrations of the standard gas were 278.48, 338.35, 376.32 and 440.19 ppmv.

To measure marine air concentrations (mol fraction) of CO_2 in dry air (xCO_2-air), marine air sampled from the bow of the ship (approx.30m above the sea level) was introduced into the NDIR by passing through a mass flow controller which controls the air flow rate at about 0.5 L min^{-1}, a cooling unit, a perma-pure dryer (GL Sciences Inc.) and a desiccant holder containing $Mg(ClO_4)_2$.

To measure surface seawater concentrations of CO_2 in dry air (xCO_2-sea), marine air equilibrated with a stream of seawater within the equilibrator was circulated with a pump at 0.7-0.8 L min^{-1} in a closed loop passing through two cooling units, a perma-pure dryer (GL Science Inc.) and a desiccant holder containing $Mg(ClO_4)_2$. The seawater taken by a pump from the intake placed at the approx. 4.5m below the sea surface flowed at a rate of 5-6 L min^{-1} in the equilibrator. After that, the equilibrated air was introduced into the NDIR.

(4) *Preliminary results*

Concentrations of CO_2 (xCO_2) of marine air and surface seawater are shown in Fig. 7.3.4.1-1.

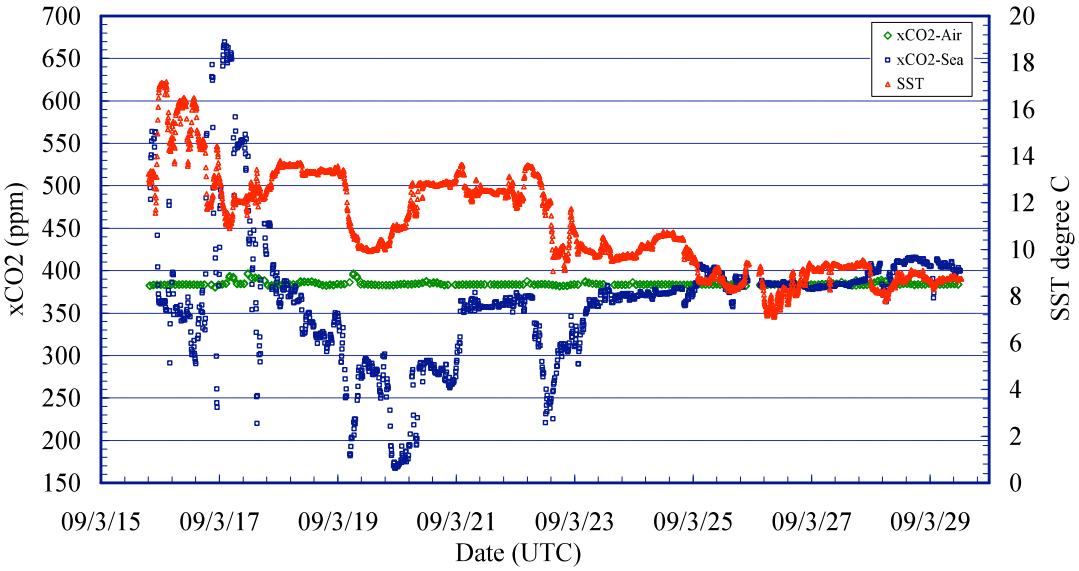

Figure 7.3.4.1-1 Temporal changes of concentrations of CO_2 (xCO_2) in atmosphere (green) and surface seawater (blue), and SST (red).

(5) *Data Archive*

All data are submitted to JAMSTEC Data Management Office (DIAG) and is currently under its control.

(6) *Reference*

DOE (1994), Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water; version 2, A. G. Dickson & C. Goyet, Eds., ORNS/CDIAC-74

Manual on Oceanographic Observation Part 1 (1999), Japan Meteorological Agency

7.3.4.2 Dissolved inorganic carbon (DIC)

(1) *Personnel*

Naomi Harada	JAMSTEC: Principal Investigator
Yasuhiro Arii	MWJ: Operation Leader
Minoru Kamata	MWJ

(2) *Objectives*

Concentrations of CO_2 in the atmosphere are now increasing at a rate of 1.5 ppmv y^{-1} owing to human activities such as burning of fossil fuels, deforestation, and cement production. It is an urgent task to estimate as accurately as possible the absorption capacity of the oceans against the increased atmospheric CO_2, and to clarify the mechanism of the CO_2 absorption, because the magnitude of the anticipated global warming depends on the levels of CO_2 in the atmosphere, and because the ocean currently absorbs 1/3 of the 6 Gt of carbon emitted into the atmosphere each year by human activities.

Since the global warming is becoming an issue world-widely, studies on green house gases such as CO_2 are drawing high attention. Because the ocean plays an important role in buffering the increase of atmospheric CO_2, surveys on the exchange of CO_2 between the atmosphere and the sea becomes highly important. When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, concentrations of the individual species of CO_2 system in solution cannot be measured directly. There are, however, four parameters that could be measured; total alkalinity, total dissolved inorganic carbon, pH and pCO_2. When more than two of the four parameters are measured, the concentration of CO_2 system in the water can be estimated (Dickson et al., 2007). We here report on-board measurements of DIC performed during the MR08-06 Leg2 cruise.

(3) *Methods, apparatus and performance*

i. Seawater sampling

Seawater samples were collected by 12L Niskin bottles at 9 stations. Seawater was sub-sampled in a 300ml glass bottle (SCHOTT DURAN) that was previously soaked in 5% non-phosphoric acid detergent (pH13) solution at least 3 hours and was cleaned by fresh water for 5 times and Milli-Q deionized water for 3 times. A sampling tube was connected to the Niskin bottle when the sampling was carried out. The glass bottles were filled from the bottom, without rinsing, and were overflowed for 20 seconds. They were sealed using the 29mm polyethylene inner lids with care not to leave any bubbles in the bottle. Prior to the analysis, 3ml of the sample (1% of the bottle volume) was removed from the glass bottle in order to make a headspace. The samples were then poisoned with 100µl of over saturated solution of mercury chloride within one hour from the sampling point. After poisoning, the samples were sealed using the 31.9mm polyethylene inner lids and were stored in a refrigerator at approximately 5deg C until analyzed.

ii. DIC analysis

Measurements of DIC were made with total CO_2 measuring system (systems C; Nippon ANS, Inc.). The system was composed of seawater dispensing system, a CO_2 extraction system and a coulometer (systems N2; Nippon ANS, Inc.).

The seawater dispensing system has an auto-sampler (6 ports), which takes seawater into a glass bottle and dispenses the seawater to a pipette of nominal 21ml volume by PC control. The pipette was kept at 20 ± 0.05 deg C by a water jacket, in which water from a thermostatic water bath (LP-3110,

ADVANTEC) set at 20 deg C is circulated.

The CO_2 dissolved in a seawater sample is extracted in a stripping chamber of the CO_2 extraction system by adding phosphoric acid (10% v/v). The stripping chamber is made approx. 25 cm long and has a fine frit at the bottom. The acid is added to the stripping chamber from the bottom of the chamber by pressurizing an acid bottle for a given time to push out the right amount of acid. The pressurizing is made with nitrogen gas (99.9999%). After the acid is transferred to the stripping chamber, a seawater sample kept in a pipette is introduced to the stripping chamber by the same method as that for adding an acid. The seawater reacted with phosphoric acid is stripped of CO_2 by bubbling the nitrogen gas through a fine frit at the bottom of the stripping chamber. The CO_2 stripped in the chamber is carried by the nitrogen gas (flow rates of 140ml min^{-1}) to the coulometer through a dehydrating module. The module consists of two electric dehumidifiers (kept at 4 deg C) and a chemical desiccant ($Mg(ClO_4)_2$).

The measurement sequence such as 1.4% CO_2 gas in a nitrogen base, system blank (phosphoric acid blank), and seawater samples (6 samples) was programmed to repeat. The measurement of 1.4% CO_2 gas was made to monitor response of coulometer solutions.

(4) *Preliminary results*

During the cruise, 124 samples were analyzed for DIC. A replicate analysis was performed at the interval decided beforehand and the difference between each pair of analyses was plotted on a range control chart (Figure 7.3.4.2-1). The average of the differences was 1.9µmol kg^{-1} (n=10). The standard deviation was 1.5µmol kg^{-1}, which indicates that the analysis was accurate enough according to the guide (Dickson et al., 2007).

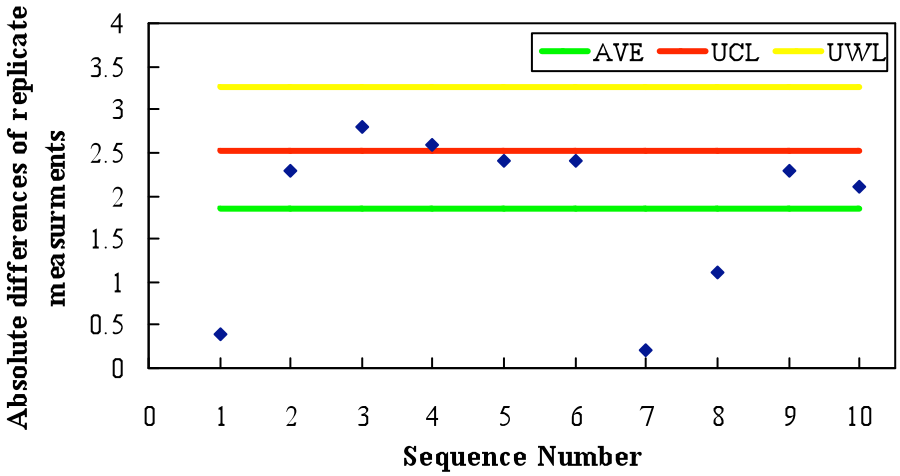

Figure 7.3.4.2-1 Range control chart of the absolute differences of replicate measurements carried out in the analysis of DIC during the MR08-06 Leg2 cruise. The UCL and UWL represent the upper control limit and upper warning limit, respectively.

(5) *Data Archive*

All data are submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control.

(6) *Reference*

Dickson, A. G., Sabine, C. L. and Christian, J. R. (2007) Guide to best practices for ocean CO_2 measurements; PICES Special Publication 3, 199pp.

7.3.4.3 Total alkalinity (TA)

(1) *Personnel*

Naomi Harada	JAMSTEC: Principal Investigator
Minoru Kamata	MWJ: Operation Leader
Tomonori Watai	MWJ

(2) *Objectives*

The southern region of the eastern South Pacific is known as a formation area of Subantarctic Mode Water, subducting and spreading through the main thermocline and forming an Antarctic Intermediate Water, plays an important role to remove of atmospheric carbon dioxide (CO_2) and changes both oceanic and atmospheric temperature anomalies. The coastal region of Chilean coastal area with complex system of fjords and channels is also known to have vulnerable system to climate change and human influences. In order to contribute to elucidate these mechanisms, we have analyzed total alkalinity (TA) of seawater during the MR08-06 Leg2 cruise along the Baker fjord and in the southernmost Patagonian coastal area. When CO_2 dissolves in seawater, chemical reaction takes place and CO_2 alters its appearance into several species. The concentrations of the individual species of CO_2 system in solution cannot be measured directly, however, two of the four measurable parameters (alkalinity, total dissolved inorganic carbon, pH and pCO_2) can estimate each concentration of CO_2 system (Dickson et al., 2007). In this sub-chapter, we describe onboard measurements of TA during this cruise.

(3) *Measured parameters*

Total alkalinity (TA)

(4) *Instruments and methods*

Seawater samples were collected in 12 L Niskin bottles equipped with the CTD carousel system. A sampling silicone rubber with PFA tip was connected to the Niskin bottle when the sub-sampling was carried out. Seawater was overflowed for 2 times of bottle volume (10 seconds) in the 125 ml borosilicate glass bottles (SHOTT DURAN) without rinsing, and then was gently filled from the bottom with care not to leave any bubbles in the bottle. These glass bottles were washed by soaking in 5 % non-phosphoric acid detergent (pH = 13) for more than 3 hours and then rinsed 5 times with tap water and 3 times with Milli-Q deionized water beforehand. After the sub-sampling of seawater on deck, bottles were carried into the lab and put in the water bath kept about 25° C for one hour before the measurement.

TA of the seawater was measured by a TA measuring system (Nippon ANS) according to the scheme of Yao and Byrne (1998). The seawater in the glass bottle is transferred to a sample cell in the spectrophotometer (Carry 50 Scan, Varian) via dispensing unit. The length and volume of the cell are 8 cm and 13 ml, respectively, and its temperature is kept at 25.00 ± 0.05° C in a thermostatic compartment. The TA is calculated by measuring two sets of absorbance at three wavelengths (750, 616 and 444 nm). At first, the absorbance of seawater samples before injecting an acid with indicator solution (bromocresol green) was measured. Next, the acid with indicator solution was added into the seawater and was sufficiently circulated through the line by a peristaltic pump 5 and half minutes before the measurement, and then the absorbance of seawater samples was measured.

The TA is calculated based on the following equation:

$$pH_T = 4.2699 + 0.002578 * (35 – S) + \log ((R(25) – 0.00131) / (2.3148 – 0.1299 * R(25))) - \log (1 – 0.001005 * S), \quad (1)$$

$$A_T = (N_A * V_A – 10 \wedge pH_T * DensSW (T, S) * (V_S + V_A)) * (DensSW (T, S) * V_S)\text{-}1, \quad (2)$$

where, R(25) represents the difference of absorbance at 616 and 444 nm between before and after the injection. The absorbance of wavelength at 750 nm is used to subtract the variation of absorbance caused by the system. DensSW (T, S) is the density of seawater at temperature (T) and salinity (S), N_A is the concentration of the added acid, V_A and V_S are the volume of added acid and seawater, respectively.

To keep the high precision during analysis, the acid with indicator solution stored in 1 L DURAN bottle is kept in a bath under 25° C, and TYGON tube used on the peristaltic pump for mixing the seawater and acid with indicator solution was periodically renewed. Absorbance was measured 10 times during each analysis, and the stable last five and three values were averaged and used for calculation by using the above equation for before and after the injection.

(5) *Results*

Replicate analyses of seawater sample were made on Niskin bottle number of both 34 and 25 with their depth range from 50 to 800 m. The difference between each pair of analyses was plotted on a range control chart (see Figure 7.3.4.3-1). The average of the difference was 0.61 µmol kg^{-1} (n = 10 pairs) and its standard deviation was 0.54 µmol kg^{-1}.

(6) *Data archives*

All data are submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control.

(7) *Reference*

Dickson, A.G., C. Sabine, and J. Christian, eds. (2007) Guide to Best Practices for Oceanic CO_2 Measurements - PICES Series Publication 3, IOCCP Report No. 8, 191 pp

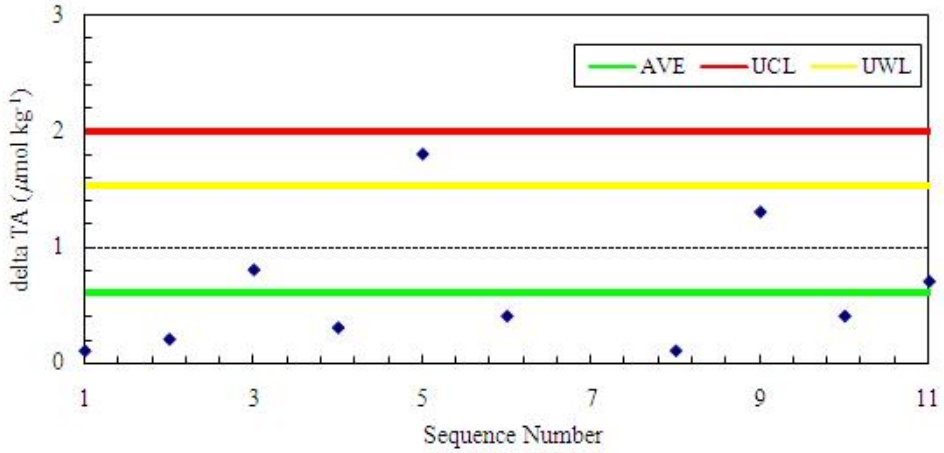

Figure 7.3.4.3-1 Range control chart of the absolute differences of duplicate measurements of TA carried out during the cruise. AVE represents the average value, UCL upper control limit (UCL = AVE * 3.267), and UWL upper warning limit (UWL = AVE * 2.512) (Guide, 2007).

7.3.4.4 Total hydrogen ion concentration scale (pH)

(1) *Personnel*

Naomi Harada	JAMSTEC: Principal Investigator
Minoru Kamata	MWJ: Operation Leader
Tomonori Watai	MWJ

(2) *Objective*

To understand dynamics of carbonate chemistry related with the climate change in the Chilean marginal area including the fjord system, total hydrogen ion concentraion scale (pH) of seawater was measured along the Baker fjord and in the southernmost Patagonian coastal area during the MR08-06 Leg2 cruise. When CO_2 dissolves in seawater, chemical reaction takes place and CO_2 alters its appearance into several species. The concentrations of the individual species of CO_2 system in solution cannot be measured directly, however, two of the four measurable parameters (alkalinity, total dissolved inorganic carbon, pH and pCO_2) can estimate each concentration of CO_2 system. In this sub-chapter, we describe onboard measurements of pH in the coastal area off Chile.

(3) *Measured Parameters*

pH (Total hydrogen ion concentration scale)

(4) *Apparatus and performance*

i. Seawater sampling

Seawater samples were collected by12L Niskin bottles equipped with CTD carousel system. Seawater was sub-sampled in a 125ml glass bottle that was previously soaked in 5% non-phosphoric acid detergent (pH13) solution at least 3 hours and was cleaned by fresh water for 5 times and Milli-Q deionized water for 3 times. A sampling tube was connected to the Niskin bottle when the sub-sampling was carried out. Seawater samples were overflowed for 2 times volume of glass bottles (10 seconds) without rinsing, and were gently filled from the bottom with care no leaving any bubbles in the bottle. The glass bottles were kept under the water bath at about 25^{o}C before the measurement.

ii. pH analysis

The pH (-log[H^+]) of seawater in the glass bottles was measured potentiometrically at the temperature 25 ^{o}C. Value of pH in the seawater sample was determined experimentally from sequential measurements of the electromotive force (the e.m.f.) of electrode cell in a standard buffer of known (defined) pH.

Ag, AgCl | solution of KCl || test solution | H+ -glass –electrode.

The e.m.f. of the glass / reference electrode cell was measured with a pH / Ion meter (Radiometer PHM240). Separate glass (Radiometer pHG201) and reference (Radiometer REF201) electrodes were used. To avoid the exchange CO_2 between seawater sample and the atmosphere during pH measurement, closed glass bottle was used. The temperature was kept to 25 ^{o}C within ±0.05 ^{o}C with monitoring by

temperature sensor (Radiometer T201) during pH measurement.

To calibrate electrodes in the TRIS buffer (Lot=081217-1: pH=8.0904 pH units at 25 °C, Delvalls and Dickson, 1998) and AMP buffer (Lot=081217-1: pH=6.7835 pH units at 25 °C, DOE, 1994) in the synthetic seawater, pH of TRIS and AMP buffers were also used.

pH_T of seawater sample (pH_{samp}) is calculated from the expression:

$$pH_{samp} = pH_{TRIS} + (E_{TRIS} - E_{samp}) / ER$$

where, electrode response "ER" is calculated as follows:

$$ER = (E_{AMP} - E_{TRIS}) / (pH_{TRIS} - pH_{AMP})$$

ER value should be equal to the ideal Nernst value as follows:

$$ER = RT\ LN(10) / F = 59.16\ mV / pH\ units\ at\ 25\ ^oC$$

(5) *Preliminary results*

A replicate analysis was made on one or two samples at each station and the difference between each pair of analyses was plotted on a range control chart (see Figure 7.3.4.4-1). The average of the difference was 0.001 pH units (n=11 pairs). The standard deviation was 0.001 pH units, which indicates that the analysis was accurate enough according to DOE (1994).

(6) *Data Archive*

All data are submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control.

(7) *Reference*

DOE (1994), Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water; version 2, A. G. Dickson & C. Goyet, Eds., ORNS/CDIAC-74.

DelValls, T. A. and Dickson, A. G., (1998) The pH of buffers based on 2-amino-2-hydroxymethyl-1,3-propanediol ('tris') in synthetic sea water. Deep-Sea Research 45, 1541-1554.

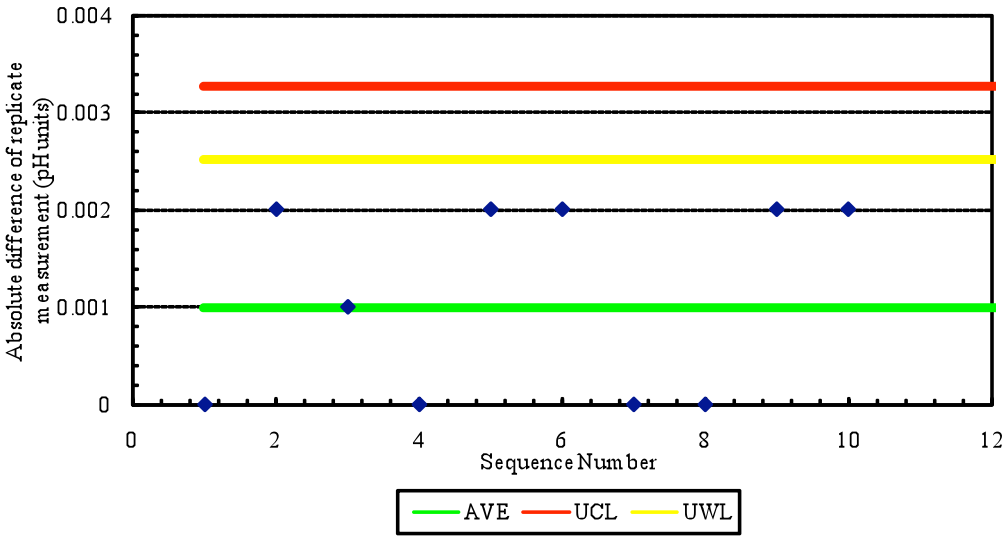

Figure 7.3.4.4-1 Range control chart of the absolute differences of replicate measurements carried out in the analysis of pH during this cruise.

7.3.5 Sea surface water monitoring

(1) *Personnel*

Naomi Harada	JAMSTEC: Principal Investigator
Minoru Kamata	MWJ: Operation Leader
Yasuhiro Arii	MWJ

(2) *Objective*

To understand temporal and special distribution of biogeochemical characteristics in the Chilean coastal area, sea surface temperature, salinity, dissolved oxygen and fluorescence were measured continuously the sea surface water underway along the cruise track.

(3) *Measured parameters*

Sea surface temperature, salinity, dissolved oxygen, and fluorescence

(4) *Instruments and methods*

The continuous sea surface water monitoring system (Nippon Kaiyo Co. Ltd.) that equips five sensors 1) temperatures (two sensors), 2) salinity, 3) dissolved oxygen, and 4) fluorescence can continuously monitor their values in near-sea surface water. Salinity is calculated by conductivity on the basis of PSS78. This system is settled in the "sea surface monitoring laboratory" on R/V MIRAI. Near-surface water (at 4m below from sea surface) was continuously pumped up to the system through a vinyl-chloride pipe. The flow rate of seawater in the system is adjusted to be 12 L min^{-1} except for the fluorometer (about 0.5 L min^{-1}) and can be manually controlled by several valves. Each flow rate is monitored with respective flow meter. The system is connected to shipboard LAN-system, and measured data is stored in a hard disk of PC every 1-minute together with time (UTC) and position of the ship.

Specification of sensors is as follows:

i. Temperature and Conductivity sensor

Model:	SBE-21, SEA-BIRD ELECTRONICS, INC.
Serial number:	2118859-3126
Measurement range:	Temperature -5 to +35℃, Conductivity 0 to 7 S m^{-1}
Resolution:	Temperatures 0.001℃, Conductivity 0.0001 S m^{-1}
Stability:	Temperature 0.01℃ 6 $months^{-1}$, Conductivity 0.001 S m^{-1} $month^{-1}$

ii. Bottom of ship thermometer

Model:	SBE 3S, SEA-BIRD ELECTRONICS, INC.
Serial number:	032175
Measurement range:	-5 to +35℃
Resolution:	±0.001℃
Stability:	0.002℃ $year^{-1}$

iii. Dissolved oxygen sensor

Model:	2127A, Hach Ultra Analytics Japan, INC.
Serial number:	61230
Measurement range:	0 to 14 ppm
Accuracy:	±1% in ±5℃ of correction temperature
Stability:	5% $month^{-1}$

iv. Fluorometer

Model:	10-AU-005, TURNER DESIGNS

Serial number: 5562 FRXX
Detection limit: 5 ppt or less for chlorophyll a
Stability: 0.5% month^{-1} of full scale

v. Flow meter
Model: EMARG2W, Aichi Watch Electronics LTD.
Serial number: 8672
Measurement range: 0 to 30 L min^{-1}
Accuracy: <= ±1%
Stability: <= ±1% day^{-1}

(5) *Preliminary Result*

The monitoring period (UTC) during this cruise started at 17:04, 2009/03/15 and stopped at 13:00, 2009/03/29.

Preliminary data of temperature, salinity, dissolved oxygen, fluorescence at sea surface are shown in Fig.7.3.5-1. We took the surface water samples once a day to compare sensor data with bottle data of salinity, dissolved oxygen and chlorophyll-*a*. The results of salinity and dissolved oxygen are shown in Figs.7.3.5-2, and 7.3.5-3, respectively. All salinity samples were analyzed by the Guildline 8400B "AUTOSAL", dissolved oxygen samples were analyzed by KIMOTO DOT-01 using Winkler method and spectrophotometoric titration, and chlorophyll-*a* samples were analyzed by TURNER DESIGNS 10-AU-005 using Welschmeyer method.

(6) *Date archive*

All data are submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control and will be opened to public via "R/V MIRAI Data Web Page" in JAMSTEC homepage.

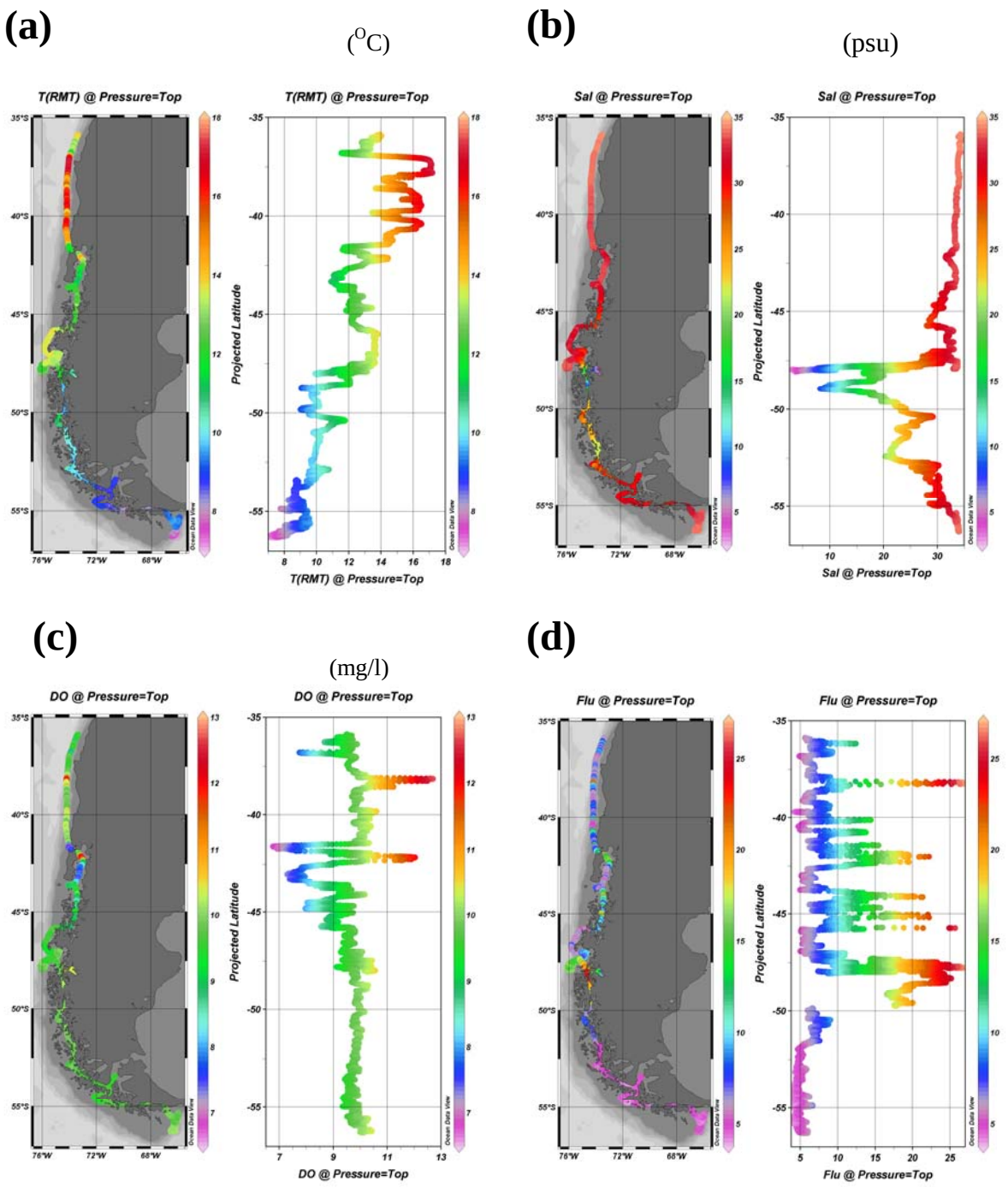

Fig. 7.3.5-1 Spatial and temporal distribution of (a) temperature, (b) salinity, (c) dissolved oxygen and (d) fluorescence in MR08-06 Leg.2 cruise. Fluorescence is relative value.

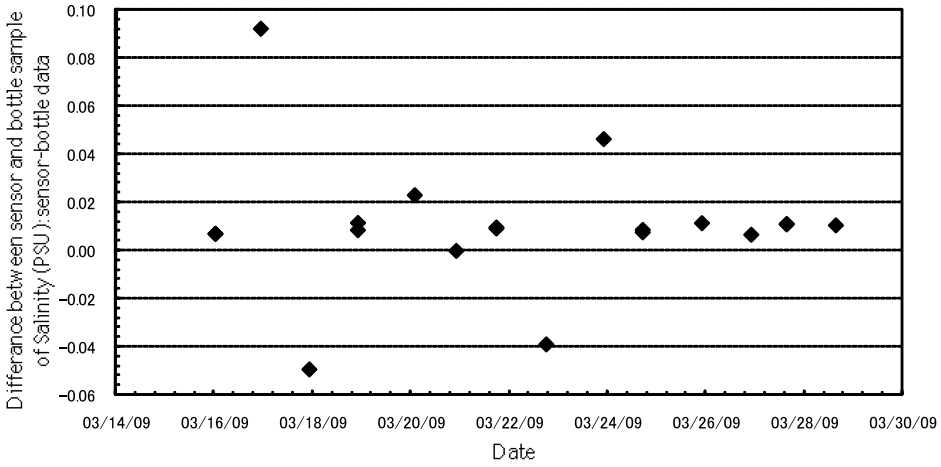

Fig.7.3.5-2 Difference of salinity between sensor data and bottle data

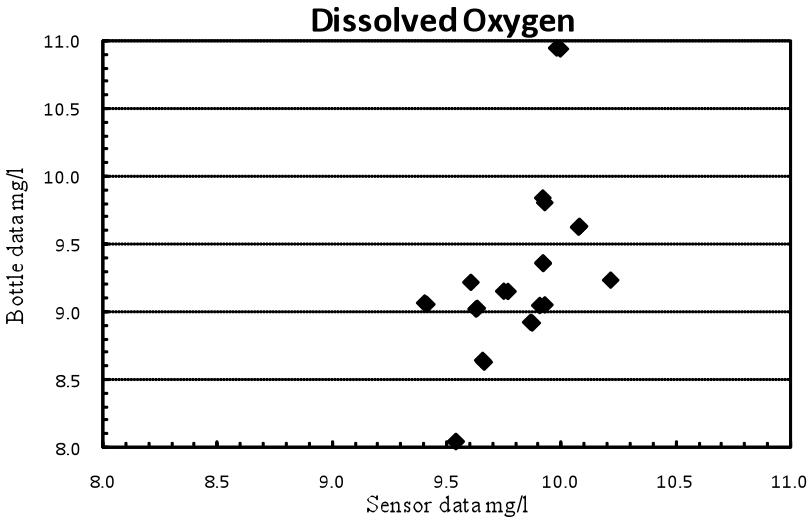

Fig.7.3.5-3 Comparison between dissolved oxygen sensor and bottle data

7.3.6 Water sampling at Benthic Boundary Layer

(1) *Personnel*

Renato A. Quiñones	Centro de Investigación Oceanográfica en el Pacífico Sur-Oriental (FONDAPCOPAS), Universidad de Concepción, Casilla 160-C, Concepción, Chile : Principal Investigator
Karol Espejo	Centro de Investigación Oceanográfica en el Pacífico Sur-Oriental (FONDAPCOPAS), Universidad de Concepción

(2) *Objectives*

The research conducted onboard the R/V MIRAI cruise (MR08-06 Leg 2) has the following objectives:

1) To estimate aerobic and anaerobic metabolism of microplankton communities in the water column and benthic boundary layer Chilean southern fjords and adjacent oceanic zone
2) To estimate total microplankton biomass (as ATP content) in the water column and benthic boundary layer of the Chilean southern fjords and adjacent oceanic zone
3) To explore the diversity of marine microorganisms in the water column and benthic boundary layer using molecular biological techniques

Here, we operationally define microplankton as those organisms able to pass through a 100 um sieve.

(3) *Measured parameters*

The samples were collected onboard and preserved in liquid nitrogen for future analysis in the laboratory. The following enzymatic activities of the microplankton community will be measured: lactate dehydrogenase (LDH), octopine dehydrogenase (OPDH), alanopine dehydrogenase (ALPDH), strombine dehydrogenase (STRDH); ethanol dehydrogenase (EtOHDH); malate dehydrogenase (MDH); citrate synthase (CS) and Electron Transport System activity (ETS). Total biomass of the microplankton community will also be estimated as total ATP (Adenosine-5'-triphosphate) content. In addition the diversity of marine microorganisms will be analyzed using molecular biology techniques such as polymerase chain reaction (PCR). Samples for total bacterial abundance (DAPI method) were also collected and preserved for future analysis.

(4) *Instruments and methods*

i. Samples

Seawater samples were taken in every oceanographic station of the MIRAI MR08-06 Leg 2 (Table 7.3.6-1). At each station, CTD casts were conducted and water samples were taken with Niskin bottles. In addition, water from the benthic boundary layer (BBL) was obtained using a BBL-sampler, a device which settles in the bottom of the ocean and it gathers water about a maximum of 30 cm from the ocean floor.

The water (4 to 10 L from each depth) was pre-filtered through at 100 μm and then filtered onto cellulose ester membrane filters (Millipore 0.22 μm) with a pressure of less than 100 mm Hg for future enzymatic activity analysis, ATP-P and PCR determinations. All filters were stored in liquid nitrogen until their analysis in the laboratory. In addition, at each depth of the water column and BBL seawater samples were also taken for bacteria abundance determinations.

ii. Enzyme assays:

The following enzymes will be analyzed: pyruvate oxidoreductases (PORs): lactate dehydrogenase (LDH, EC 1.1.1.27), octopine dehydrogenase (OPDH, EC 1.5.1.15), alanopine dehydrogenase (ALPDH, EC 1.5.1.17), and strombine dehydrogenase (STRDH, EC 1.5.1.22); ethanol dehydrogenase (EtOHDH, EC 1.1.1.1); malate dehydrogenase (MDH, EC 1.1.1.37); citrate synthase (CS, EC 4.1.3.7); and the Electron Transport System activity (ETS). Pyruvate oxidoreductase (LDH, OPDH, ALPDH, STRDH) activities will be measured with a reaction mixture modified from Schiedek (1997). L-malate dehydrogenase (MDH) activity will be assayed using the procedure modified from Childress and Somero (1979) and Vetter et al. (1994). Absorption is monitored at 340 nm following the addition of the supernatant and activity measurements are corrected for nonspecific NADH oxidation. The citrate synthase (CS) activity assay will be modified from Childress and Somero (1979) and Vetter et al. (1994). Absorbance will be observed at 412 nm. All determinations were corrected using a blank that contained the same aliquot of supernatant but no oxalacetate. The activity of the respiratory electron transport system (ETS) of the microplankton will be determined according to the method described by Packard (1985). Absorbance will be observed at 490 nm.

iii. Particulate ATP-P (Adenosin triphosphate-particulate)

ATP concentration is used to estimate microbial biomass. Approximately 2 L of seawater was filtered onboard and stored in liquid nitrogen until its analysis in the laboratory. Quantification will be done with the bioluminescence assay (Holm-Hansen and Booth, 1966; Karl, 1993) using a Turner Designs Model TD 20/20 ATP meter.

iv. PCR determinations

Approximately 1 L of seawater was filtered onboard and stored in liquid nitrogen until its analysis in the laboratory. Quantification will be done with the real time PCR assay.

v. Bacteria abundance

The 50 mL of seawater samples are fixed with formaldehyde 2% final concentration for direct counts with fluorescing DNA stain, 4'6-diamidino-2-phenilyndole (DAPI) (Porter and Feig, 1980).

(5) *Results (preliminary or expected)*

The results will be available only after the laboratory measurements are conducted. Table 7.3.6-1 presents a summary of the samples collected during the R/V MIRAI Cruise.

(6) *Date archive*

All data are submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control and will be opened to public via "R/V MIRAI Data Web Page" in JAMSTEC homepage.

Table 7.3.6-1: List of samples collected in the MIRAI MR08-06 Leg 2
S: Sampled; NS: Not Sampled

St.	Cast	Depth	Enzymes	ETS	ATP	PCR	Bacteria
37	Bucket	Surface	S	S	S	S	S
	1	10	S	S	S	S	S
	1	50	S	S	S	S	S
	1	100	S	S	S	S	S
	1	150	S	S	S	S	S
	1	Bottom-10	S	S	S	S	S
38	Bucket	Surface	S	S	S	S	S
	1	5	S	S	S	S	S
	1	10	S	S	S	S	S
	1	25	S	S	S	S	S
	1	50	S	S	S	S	S
	1	Bottom-10	S	S	S	S	S
		BBL (90m)	S	S	S	S	S
40	Bucket	Surface	S	S	S	S	S
	2	5	S	S	S	S	S
	2	10	S	S	S	S	S
	2	25	S	S	S	S	S
	2	50	S	S	S	S	S
	2	100	S	S	S	S	S
	2	150	S	S	S	S	S
	2	200	S	S	S	S	S
	2	Bottom-10	S	S	S	S	S
		BBL (245m)	S	S	S	S	NS
41	Bucket	Surface	S	S	S	NS	S
	1	5	S	S	S	S	S
	1	10	S	S	S	S	S
	1	25	S	S	S	S	S
	1	50	S	S	S	S	S
	1	100	S	S	S	S	S
	1	300	S	S	S	S	S
	1	500	S	S	S	S	S
	1	Bottom-10	S	S	S	S	S
		BBL (740m)	S	S	S	S	S
42	Bucket	Surface	S	S	S	S	S
	2	5	S	S	S	S	S
	2	10	S	S	S	S	S
	2	25	S	S	S	S	S
	2	50	S	S	S	S	S
	2	100	S	S	S	S	S
	2	150	S	S	S	S	S
	2	200	S	S	S	NS	S
	2	250	S	S	S	S	S
	2	300	S	S	S	S	S
	2	400	S	S	S	S	S
	2	500	S	S	S	S	S
	2	600	S	S	S	S	S
	2	700	S	S	S	S	S
	2	800	S	S	S	S	S
	2	900	S	S	S	S	S
	2	1000	S	S	S	S	S
	2	Bottom-10	S	S	S	S	S
		BBL (1060m)	S	S	S	S	S
43	Bucket	Surface	S	NS	S	S	S
	1	5	S	S	S	S	S

	1	10	S	S	S	S	S
	1	25	S	S	S	S	S
	1	50	S	S	S	S	S
	1	100	S	S	S	S	S
	2	200	S	S	S	S	S
	2	300	S	S	S	S	S
	2	500	S	S	S	S	S
	2	1000	S	S	S	S	S
	2	Bottom-10	S	S	S	S	S
44	Bucket	Surface	S	S	S	S	S
	1	5	S	S	S	S	S
	1	10	S	S	S	S	S
	1	25	S	S	S	S	S
	1	50	S	S	S	S	S
	1	100	S	S	S	S	S
	Bucket	Surface	S	S	S	S	S
	2	5	S	S	S	S	S
	2	10	S	S	S	S	S
	2	25	S	S	S	S	S
	2	50	S	S	S	S	S
	2	100	S	S	S	S	S
	2	300	S	S	S	S	S
	2	500	S	S	S	S	S
	2	Bottom-10	S	S	S	S	S
		BBL (690m)	S	S	S	S	S
45	Bucket	Surface	S	S	S	S	S
	1	5	S	S	S	S	S
	1	10	S	S	S	S	S
	1	25	S	S	S	S	S
	1	50	S	S	S	S	S
	2	100	S	S	S	S	S
	2	300	S	S	S	S	S
	2	400	S	S	S	S	S
	2	Bottom-10	S	S	S	S	S
		BBL (470m)	S	S	S	S	S
46	Bucket	Surface	S	S	S	S	S
	1	5	S	S	S	S	S
	1	10	S	S	S	S	S
	1	25	S	S	S	S	S
	1	50	S	S	S	S	S
	Bucket	Surface	S	S	S	S	S
	3	5	S	S	S	S	S
	3	10	S	S	S	S	S
	3	25	S	S	S	S	S
	3	50	S	S	S	S	S
	3	100	S	S	S	S	S
	3	300	S	S	S	S	S
	3	500	S	S	S	S	S
	3	Bottom-10	S	S	S	S	S
		BBL (560m)	S	S	S	S	S

7.4 Biological and biogeochemical observations in the seawater
7.4.1 Chlorophyll a measurements

(1) *Personnel*

Naomi Harada	JAMSTEC: Principal Investigator
Masanori Enoki	MWJ: Operation Leader

(2) *Objectives*

Chlorophyll *a* is one of the most convenient indicators of standing stock of phytoplankton, and has been used extensively for the estimation of phytoplankton abundance in various aquatic environments. The objective of this observation is to understand the vertical and spatial distribution of phytoplankton in the Chilean coastal area.

(3) *Measured parameters*

Chlorophyll *a*

(4) *Instruments and methods*

Water samples were collected for chlorophyll *a* measurement from surface-subsurface layers (between surface-100m) at CTD hydrocast. The water samples were gently filtrated by low vacuum pressure (<15cmHg) through Whatman GF/F filter (diameter 25mm) in the dark room. Phytoplankton pigments on the filter were immediately extracted in 7ml of N,N-dimethyl formamide (DMF) after filtration. The filter samples were stored in the freezer (-20℃) over 24 hours until the analysis of fluorometric determination.

Fluorescence of each extracted pigment samples were measured by Turner Design fluorometer (10-AU-005), which was calibrated by using a pure chlorophyll *a* material (Sigma chemical Co.) beforehand. We applied the fluorometric "Non-acidification method" (Welschmeyer, 1994) for the samples of chlorophyll *a*. Analytical conditions of instrument were listed in Table 7.4.1-1.

(5) *Results*

The vertical profiles of total chlorophyll *a* concentration were shown every each station in Figure 7.4.1-1.

(6) *Data Archive*

The processed data of pigments are submitted to the JAMSTEC Data Integration and Analysis Group (DIAG) within a restricted period.

(7) *Reference*

Welschmeyer, N. A. (1994) Fluorometric analysis of chlorophyll *a* in the presence of chlorophyll *b* and pheopigments, Limnology and Oceanography, 39, 1985-1992.

Table 7.4.1-1. Analytical conditions of "Non-Acidification method" for chlorophyll *a* with Turner Designs fluorometer (10-AU-005).

	Non-acidification method
Excitation filter (nm)	436nm
Emission filter (nm)	680nm
Lamp	Blue Mercury Vapor

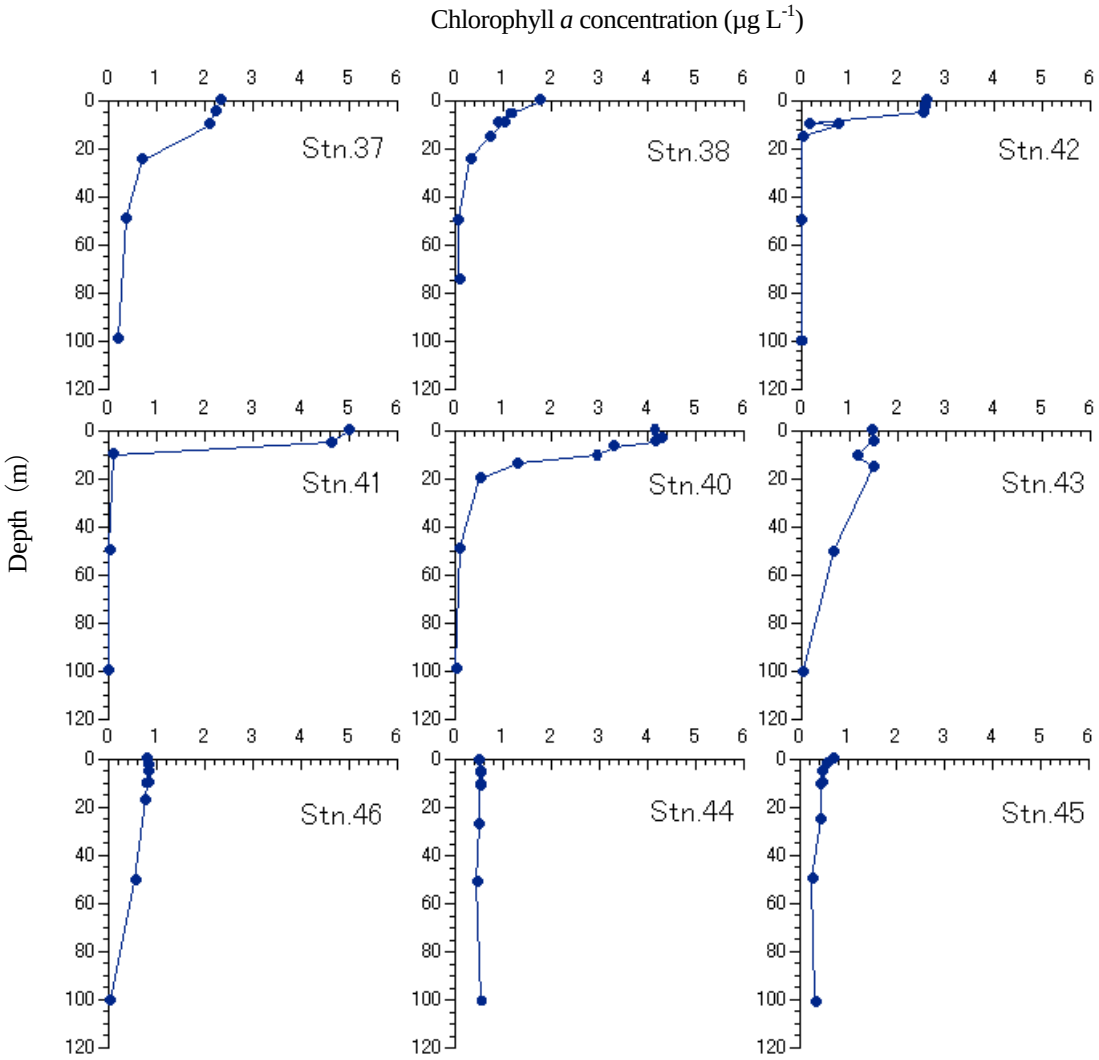

Figure 7.4.1-1. Vertical distribution of chlorophyll *a* concentration at each station.

7.4.2 Plankton and drifting sediment trap experiment

(1) *Personnel*

Humberto E. González	COPAS/Universidad Austral de Chile: Principal Investigator
Eduardo Menschel	COPAS/Universidad Austral de Chile

(2) *Objectives*

To assess the spatial variability of the bacteria, flagellate (<20 µm) and microzooplankton abundances, as well as the pigment (chlorophyll-*a*, Chl-*a*) and particulate organic carbon (POC) concentrations in the water column.

To estimate the export flux and the main particles contributing to the vertical flux in the Patagonia region of southern Chile.

(3) *Measured parameters*

i. Bacterioplankton abundance and biomass
ii. Flagellates (<20µm) abundance and biomass
iii. Microzooplankton abundance and biomass
iv. Size fractioned chlorophyll-a concentration in the water column
v. Particulate organic carbon (POC) concentration in the water column
vi. Export flux

(4) *Instruments and methods*

Water samples were collected for plankton (bacterioplankton, flagellates, phytoplankton and microzooplankton) counts, and Chl-a and POC determinations in the water column. In addition, free-drifting, surface-tethered sediment tramps were deployed at 50 and 150 m depth. A detailed information on the stations, date, position, and depths at which the different types of samples were collected are given in Table 7.4.2-1.

For phytoplankton, 250 mL water samples were preserved in borax-buffered formaline (these samples will be analysed by Dr. José Luis Iriarte). For microzooplankton, 6-10 Lt of seawater were filtered through a 20 µm sieve, concentrated to a final volumen of 100 ml and preserved in borax-buffered formaline. Bacteria/flagellate samples (50 ml) were preserved in glutaraldehyde and sediment traps samples in borax-buffered formaline. For Chl-a and POC determinations, 200 mL and 500/1000 mL of seawater from different depths (see Table 7.4.2-1) were filtered through precombusted MFS filters (0.7 nominal pore size) and storaged at -20°C.

(5) *Results*

i. Fractioned Chlorophyll-a (preliminary results)

Chlorophyll-a concentrations in the Penas Gulf, Magellan Strait and Cape Horn ranged between 0.04 and 2.8 mg m^{-3}. High values were recorded at surface samples collected S-SE of the Penas Gulf, specifically at St. 40 in the Messier Channel (2.9 mg m^{-3}) and Sts. 41- 42 within the Baker Channel area (2.7-2.4 mg m^{-3}, respectively). In these stations, higher concentrations were found within the upper 10 m water column and

dominated by microphytoplankton (Sts. 40, 41 and 42). Conversely, the other stations in the area (Sts. 38 and 43) showed low Chl-a concentrations (<1 mg m^{-3}) and were dominated by pico- and nanophytoplankton (Fig. 7.4.2-1).

Low Chl-a concentrations (<1 mg m^{-3}) were found in the areas of the Magellan Strait and Cape Horn and were also dominated by pico- and nano-phytoplankton size fractions.

(6) *Data archives*

The data of pigments will be submitted to the JAMSTEC Data Integration and Analysis Group (DIAG) within a restricted period.

Table 7.4.2-1. Stations, date, position (latitude and longitude) and depth at which the water samples for determination of (1) Phytoplankton, (2) Microzooplankton, (3) total and fractioned chlorophyll-a, (4) POC, (5) Bacteria and flagellates, (6) drifting sediment traps were collected. ns= denotes no sample.

Station	Date dd.mm.yy	Latitude °S	Longitude °W	Sample (1)(2)(5) Depth (m)	Sample (3) Depth (m)	Sample (4) Depth (m)	Sample (6) Depth (m)
38	18.03.09	47°00'18''	74°45'21''	0-5-10-25-50	0-5-10-25	0-5-10-25-50	50
42	19.03.09	47°59'36''	73°47'23''	0-5-10-50	0-5-10-25	0-5-10-25-50-100-200	50-150
41	19.03.09	---	---	0-5-10-25-50	0-5-10-25	0-5-10-25-50-100-200	ns
40	20.03.09	47°42'71''	74°44'54''	0-5-10-25-50	0-5-10-25	0-5-10-25-50-100-200	50-150
43	22.03.09	47°48'83''	75°51'63''	0-5-10-25	0-5-10-25	0-5-10-25-50-100-200	50-150
46 (1)	23.03.09	---	---	0-5-10-25-50	0-5-10-25	0-5-10-25-50-100-200	ns
46 (2)	24.03.09	52°51.9316	74°05.024	0-5-10-25-50	0-5-10-25	0-5-10-25-50-100-200	50-150
44	26.03.09	---	---	0-5-10-25-50	0-5-10-25	0-5-10-25-50-100-200	ns
44(2)	27.03.09	55°42.6665	66°08.2069	0-5-10-25-50	0-5-10-25	0-5-10-25-50-100-200	50-150
45	28.03.09	55°31.93	66°00.49	0-5-10-25-50	0-5-10-25	0-5-10-25-50-100-200	50-150

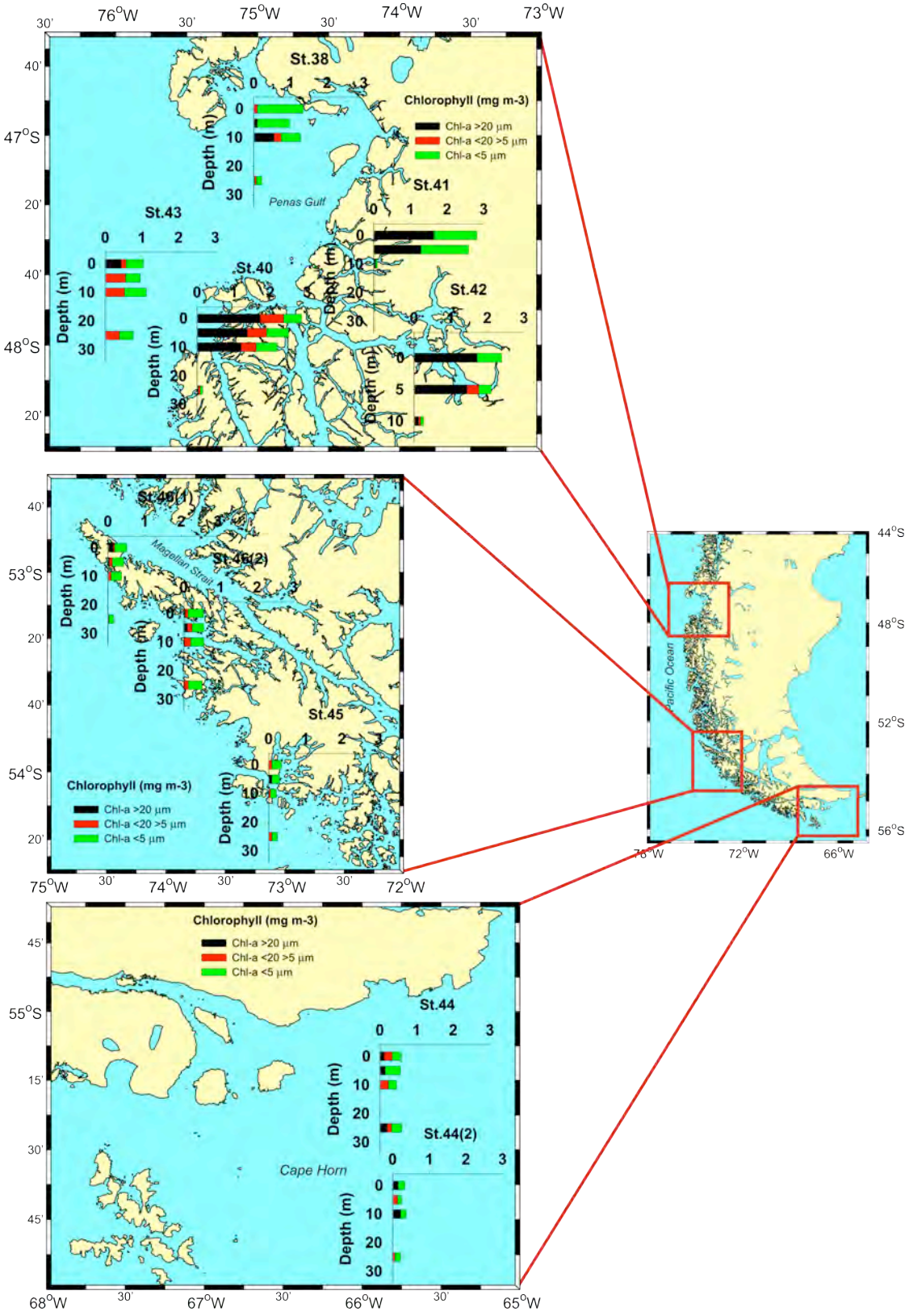

Figure 7.4.2-1. Size fractionated Chlorophyll-a concentration (mg m^{-3}) collected at the biological stations during the MIRAI cruise.

ANNEX: Detailed information of the collected samples

Table 7.4.2-2. Chlorophyll-a samples

Station	Date	Size fraction	Depth (m)	Nº Filter	Filtered Vol. (mL)
38	18.03.09	Total Chl-a	0	1-2	200
		Total Chl-a	5	3-4	200
		Total Chl-a	10	5-6	200
		Total Chl-a	25	7-8	200
		Chl-a <20	0	9-10	200
		Chl-a <20	5	11-12	200
		Chl-a <20	10	13-14	200
		Chl-a <20	25	15-16	200
		Chl-a <5	0	17-18	200
		Chl-a <5	5	19-20	200
		Chl-a <5	10	21-22	200
		Chl-a <5	25	23-24	200
42	19.03.09	Total Chl-a	0	34-35	200
		Total Chl-a	5	36-37	200
		Total Chl-a	10	38-39	200
		Chl-a <20	0	40-41	200
		Chl-a <20	5	42-43	200
		Chl-a <20	10	44-45	200
		Chl-a <5	0	46-47	199
		Chl-a <5	5	48-49	199
		Chl-a <5	10	50-51	200
41	19.03.09	Total Chl-a	0	66-67	200
		Total Chl-a	5	68-69	200
		Total Chl-a	10	70-71	200
		Total Chl-a	25	72-73	200
		Chl-a <20	0	76-77	200
		Chl-a <20	5	78-79	200
		Chl-a <20	10	80-81	200
		Chl-a <20	25	82-83	200
		Chl-a <5	0	86-87	200
		Chl-a <5	5	88-89	200
		Chl-a <5	10	90-91	200
		Chl-a <5	25	92-93	200
40	20.03.09	Total Chl-a	0	103-104	200
		Total Chl-a	5	105-106	200
		Total Chl-a	10	107-108	200
		Total Chl-a	25	109-110	200

		Chl-a <20	0	111-112	200
		Chl-a <20	5	113-114	200
		Chl-a <20	10	115-116	200
		Chl-a <20	25	117-118	200
		Chl-a <5	0	119-120	200
		Chl-a <5	5	121-122	200
		Chl-a <5	10	123-124	200
		Chl-a <5	25	125-126	200
43	21.03.09	Total Chl-a	0	142-143	200
		Total Chl-a	5	144-145	200
		Total Chl-a	10	146-147	200
		Total Chl-a	25	148-149	200
		Chl-a <20	0	150-151	200
		Chl-a <20	5	152-153	200
		Chl-a <20	10	154-155	200
		Chl-a <20	25	156-157	200
		Chl-a <5	0	158-159	200
		Chl-a <5	5	160-161	200
		Chl-a <5	10	162-163	200
		Chl-a <5	25	164-165	200
46 (1)	23.03.09	Total Chl-a	0	181-182	200
		Total Chl-a	5	183-184	200
		Total Chl-a	10	185-186	200
		Total Chl-a	25	187-188	200
		Chl-a <20	0	189-190	200
		Chl-a <20	5	191-192	200
		Chl-a <20	10	193-194	200
		Chl-a <20	25	195-196	200
		Chl-a <5	0	197-198	200
		Chl-a <5	5	199-200	200
		Chl-a <5	10	201-202	200
		Chl-a <5	25	203-204	200
46 (2)	24.03.09	Total Chl-a	0	210-211	200
		Total Chl-a	5	212-213	200
		Total Chl-a	10	214-215	200
		Total Chl-a	25	216-217	200
		Chl-a <20	0	218-219	200
		Chl-a <20	5	220-221	200
		Chl-a <20	10	222-223	200
		Chl-a <20	25	224-225	200
		Chl-a <5	0	226-227	200
		Chl-a <5	5	228-229	200
		Chl-a <5	10	230-231	200
		Chl-a <5	25	232-233	200

44	26.03.09	Total Chl-a	0	249-250	200
		Total Chl-a	5	251-252	200
		Total Chl-a	10	253-254	200
		Total Chl-a	25	255-256	200
		Chl-a <20	0	259-260	200
		Chl-a <20	5	261-262	200
		Chl-a <20	10	263-264	200
		Chl-a <20	25	265-266	200
		Chl-a <5	0	267-268	200
		Chl-a <5	5	269-270	200
		Chl-a <5	10	271-272	200
		Chl-a <5	25	273-274	200
44 (2)	27.03.09	Total Chl-a	0	281-282	200
		Total Chl-a	5	283-284	200
		Total Chl-a	10	285-286	200
		Total Chl-a	25	287-288	200
		Chl-a <20	0	289-290	200
		Chl-a <20	5	291-292	200
		Chl-a <20	10	293-294	200
		Chl-a <20	25	295-296	200
		Chl-a <5	0	297-298	200
		Chl-a <5	5	299-300	200
		Chl-a <5	10	301-302	200
		Chl-a <5	25	303-304	200
45	28.03.09	Total Chl-a	0	312-313	200
		Total Chl-a	5	314-315	200
		Total Chl-a	10	316-317	200
		Total Chl-a	25	318-319	200
		Chl-a <20	0	320-321	200
		Chl-a <20	5	322-323	200
		Chl-a <20	10	324-325	200
		Chl-a <20	25	326-327	200
		Chl-a <5	0	328-329	200
		Chl-a <5	5	330-331	200
		Chl-a <5	10	332-333	200
		Chl-a <5	25	334-335	200

Table 7.4.2-3. POC samples

Station	Date	Sample type	Depth (m)	Nº Filter	Filtered Vol. (mL)
38	18.03.09	POC	0	25	500
		POC	5	26	500
		POC	10	27	500
		POC	25	28	500
		POC	50	29	500
42	19.03.09	POC	0	52	500
		POC	5	53	500
		POC	10	54	500
		POC	25	n.d.	n.d.
		POC	50	55	500
		POC	100	56	1000
		POC	200	57	1000
41	19.03.09	POC	0	96	500
		POC	5	97	500
		POC	10	98	500
		POC	25	99	500
		POC	50	100	500
		POC	100	101	1000
		POC	200	102	1000
40	20.03.09	POC	0	127	500
		POC	5	128	500
		POC	10	129	500
		POC	25	130	500
		POC	50	131	500
		POC	100	132	1000
		POC	200	133	1000
43	21.03.09	POC	0	166	500
		POC	5	167	500
		POC	10	168	500
		POC	25	169	500
		POC	50	170	500
		POC	100	171	1000
		POC	200	172	1000
46	23.03.09	POC	0	205	500
		POC	5	206	500
		POC	10	207	500
		POC	25	208	500
		POC	50	209	500
46 (2)	24.03.09	POC	0	234	500
		POC	5	235	500
		POC	10	236	500
		POC	25	237	500
		POC	50	238	500

		POC	100	239	1000
		POC	200	240	1000
44	26.03.09	POC	0	275	500
		POC	5	276	500
		POC	10	277	500
		POC	25	278	500
		POC	50	279	500
		POC	100	280	1000
44 (2)	27.03.09	POC	0	305	500
		POC	5	306	500
		POC	10	307	500
		POC	25	308	500
		POC	50	309	500
		POC	100	310	1000
		POC	200	311	1000
45	28.03.09	POC	0	336	500
		POC	5	337	500
		POC	10	338	500
		POC	25	339	500
		POC	50	340	500
		POC	100	341	1000
		POC	200	342	1000

Table 7.4.2-4. Sediment trap deployments

Station	Date	Latitude	Longitude	Time in	Time out	Trap	Depth (m)
38	18.03.09	47º0’18,92’’	73º42’46,5’’	08:45	17:15	4 cups	50
42	19.03.09	47º59’36’’	73º47’23’’	09:30	16:25	4 cups	50-150
40	20.03.09	47º42’71’’	74º44’54’’	09:10	11:00	4 cups	50-150
40	20.03.09	47º42’29’’	74º44’34’’	15:00	19:00	4 cups	50-150
43	21.03.09	47°48’83	75°51’63	08:15	15:00	4 cups	50-150
46(2)	24.03.09	52°51.9316	75°05.024	07:40	15:30	4 cups	50-150
44(2)	27.03.09	55°42.6665	66°08.2069	07:30	15:00	4 cups	50-150
45	28.03.09	54°30.85	72°06.35	10:55	16:30	4 cups	50-150

Table 7.4.2-5. Chl-a and POC in sediment trap samples

Station	Date	Sample type	Depth (m)	Nº filter	Filtered Vol (mL)
38	18.03.09	Total Chl-a	50	30-31	104
		POC	50	32-33	100
42	19.03.09	Total Chl-a	150	58-59	100
		POC	150	60-61	149
		Total Chl-a	50	62-63	100
		POC	50	64-65	123
40	20.03.09	Total Chl-a	150	138-139	120
		POC	150	140-141	83
		Total Chl-a	50	134-135	100
		POC	50	136-137	100
43	21.03.09	Total Chl-a	150	177-178	130
		POC	150	179-180	100
		Total Chl-a	50	173-174	100
		POC	50	175-176	139
46(2)	24.03.09	Total Chl-a	150	245-246	100
		POC	150	247-248	154
		Total Chl-a	50	241-242	100
		POC	50	243-244	150
44(2)	27.03.09	Total Chl-a	150	316-317	120
		POC	150	318-319	151
		Total Chl-a	50	312-313	100
		POC	50	314-315	171
45	28.03.09	Total Chl-a	150	347-348	120
		POC	150	349-350	149
		Total Chl-a	50	343-344	120
		POC	50	345-346	150

7.4.3. Organic biomarkers, biogenic and lithogenic silica, colored dissolved organic matter, methane, methanol, and diversity and abundance of marine fungi

(1) *Personnel*

Silvio Pantoja	UdeC, Dept. of Oceanography and COPAS Center: Principal Investigator
Alejandro Avila	Udec, Dept. of Oceanography and COPAS Center
Lilian Muñoz	Udec, Dept. of Oceanography and COPAS Center
Eduardo Tejos	Udec, Dept. of Oceanography and COPAS Center
Gerdhard Jessen	Udec, Dept. of Oceanography and COPAS Center
Collaborator:	
Carina Lange	UdeC, Dept. of Oceanography and COPAS Center

(2) *Objectives*

i. Assess the relationships between water column biogenic silica (BSi) and primary production, and between lithogenic silica (LSi) and continental runoff
ii. Calibration of proxies in the modern ocean
iii. Understanding the modifications that the proxies undergo in the water column
iv. Study the influence of terrestrial material in the coastal zone

(3) *Measured parameters*

Water samples for particulate BSi and LSi were collected at various depths from the hydrocast bottles; one liter from each sample depth were combined and then filtered through 0.8 μm nuclepore filters to obtain integrated intervals, as indicated in the following table. Filters are kept frozen. In some cases, water was also filtered for future diatom studies (marked with * in Table 7.4.3-1); these are kept refrigerated at 4°C.

Table 7.4.3-1 Samples for BSi and LSi measurements, and protein from drifting sediment trap. These correspond to stations 38, 40, 42, 43, 44, 45, 46.

Station nº	Integrated interval (m)
37	0-5-10 25-50-100
38	0-5-10 25-50-B-10
42	0-5-10-25-50 * 300-600-700-1000 *
41	0-10 * 50-100 *
40	0-5-10-25-50 *
43	0-5-50-100 * 300-500-1000-B-10 *
46	0-10-50 * 100-200 * 300-500-B-10 *
44	0-50-100 * 100-200-300-500-B-10 *
45	0 * 50-100 * 200-300-400-460 *

Table 7.4.3-2 List of samples for Fungi DNA and biomass, methane and methanol, and organic biomarkers at each station

STATION 37

sample	particulate	SW	SW	particulate
analyses	DNA fungi	fungi biomass	CH4/MeOH	organic biomarkers
prof (m)				
0	X		X	X
4	X	x		
5				X
10				X
25				X
50				X
100				X

STATION 38

sample	particulate	SW	SW	particulate
analyses	DNA fungi	fungi biomass	CH4/MeOH	organic biomarkers
prof (m)				
0				X
4	X	X	X	
5				X
10				X
25				X
50				X
80				
150				

STATION 40

sample	particulate	SW	SW	particulate
analyses	DNA fungi	fungi biomass	CH4/MeOH	organic biomarkers
prof (m)				
0				X
4	X	X	X	
5				X
10				X
25				X
50				X
100				X
150				X
200				X

STATION 41

sample	particulate	SW	SW	particulate
analyses	DNA fungi	fungi biomass	CH4/MeOH	organic biomarkers
prof (m)				
0				X
4	X	X	X	
10				X
50				X
100				X

STATION 42

sample	particulate	SW	SW	particulate
analyses	DNA fungi	fungi biomass	CH4/MeOH	organic biomarkers
prof (m)				
0				X
4	X	X	X	
5				X
10				X
25				X
50				X
150				
300				X
600				X
700				X
1000				X

STATION 43

sample	particulate	SW	SW	particulate
analyses	DNA fungi	fungi biomass	CH4/MeOH	organic biomarkers
prof (m)				
0	X	X		X
4	X	X	X	
5	X	X		X
50	X	X		X
100	X	X		X
150	X	X		X
300	X	X		X
500	X	X		X
1000	X	X		X
1375	X			X

STATION 44

sample	particulate	SW	SW	particulate
analyses	DNA fungi	fungi biomass	CH4/MeOH	organic biomarkers
prof (m)				
0	X	X		X,X
4		X	X	
10		X		
50	X	X		X
100	X	X		X
150				
200	X	X		X
300	X	X		X
500	X	X		X
600		X		
680	X	X		X

STATION 45

sample	particulate	SW	SW	particulate
analyses	DNA fungi	fungi biomass	CH4/MeOH	organic biomarkers
prof (m)				
0	X	X		X
4			X	
50				X
100				X
150				
200				X
300				X
400				X
470				X

STATION 46

sample	particulate	SW	SW	particulate
analyses	DNA fungi	fungi biomass	CH4/MeOH	organic biomarkers
prof (m)				
0	X	X	X, X	X
4			X	
10			X	X
50			X	X
100			X	X
150			X	
200			X	X
300			X	X
550			X	

(4) *Instruments and methods*

i. BSi and LSi measurements:

Particulate BSi and LSi will be measured according to the methodology described by Ragueneau and Tréguer (1994).

ii. Colored Dissolved Organic Matter (CDOM).

CDOM was measured on board according to Chen (1999) with a Turner Trilogy fluorometer. Water samples were previously filtered on combusted GFF filters.

iii. Fungal abundance

Seawater samples (50 mL) were collected in sterile tubes and preserved in the dark with formaldehyde (2% final concentration) for estimation of fungal abundance. In the laboratory, aliquots (5-30 mL) are filtered on 0.22-µm pore-size black polycarbonate filters (Millipore Corp.) and stained with Calcofluor white (1% final concentration).

v. DNA extraction and PCR amplification

DNA extraction from filters is done using the Power Soil DNA Kit (MO BIO Laboratories, Inc.). Template DNA (1-3 µL) will be subjected to standard PCR, using fungal general primers NS1 and ITS4 (White et al. 1990).

(5) *Results (preliminary or expected)*

Laboratory analyses for opal will start during the first semester of 2009, focusing first on the Baker channel transect (stations 40, 42, 43) and the Golfo de Penas station 38 since these sites are directly related to the objectives of the *COPAS Sur-Austral* program. Water column data (from hydrocasts and drifting sediment traps) will be compared with opal measurements from surface Multiple cores with the purpose of calibration of proxies in the modern ocean, and understanding the modifications that the proxies undergo in the water column and on the seafloor.

CDOM measurements will be used in combination with those of Dissolved Organic Carbon concentrations in parallel samples collected by G. Daneri during the cruise. The goal is to evaluate the fraction of dissolved organics being delivered to the coastal ocean.

Data from the transit Valparaiso-Drake Passage will allow having the variation of parameters in the long and variable Chilean coast.

All MIRAI data will also be integrated with data from a previous cruise in Caleta Tortel, thus yielding a transect that goes from the interior (Tortel) to the mouth of the Baker Channel.

(6) *Data archives*

The data of pigments will be submitted to the JAMSTEC Data Integration and Analysis Group (DIAG) within a restricted period.

(7) *References*

Chen, R.F. (1999) In situ fluorescence measurements in coastal waters. Marine Chemistry, 30, 397-409.

Ragueneau, O., Tréguer, P. (1994) Determination of biogenic silica in coastal waters: applicability and limits of the alkaline digestion method. Marine Chemistry, 45, 43–51.

White T.J., Bruns T.D., Lee S.B., Taylor J.W. (1990) Analysis of phylogenetic relationships by amplification and direct sequencing of ribosomal DNA genes. In: Innis M.A., Gelfand D.H., Sninsky J.J., White T.J. (eds) PCR protocols: A Guide to Methods and Applications. Academic Press, San Diego, p 315-322.

7.4.4 Micro size phytoplankton in the southeastern South Pacific

(1) *Personnel*

Susumu Konno	Yamagata University: Principal Investigator
Atsushi Kurasawa	Hokkaido University/JAMSTEC
Miyako Sato	JAMSTEC
Richard W. Jordan	Yamagata University

(2) *Objectives*

The main aims of this observation are:

i. Study on microplankton communities in the surface waters along continuous transects to understand the biogeographic distributions of individual species and the effects of oceanographic features like straits, harbours and oceanic frontal systems.

ii. Study on vertical distribution of microplankton communities to understand the ecologic preferences of individual species.

iii. Study on taxonomy of various microplankton groups and to compile photographic catalogues (identification guides) for publication and laboratory use.

(3) *Methods*

Surface water samples were obtained using the shipboard seawater supply for research use on a regular basis, 1-4 times a day when the ship was steaming (i.e. not on station) and more often when travelling through island passes. About 1-2 L of seawater were collected in plastic bottles with the following information recorded at the same time as sampling: the date and time (GMT), coordinates, and those parameters (such as temperature, salinity, and chlorophyll-*a*) being continuously recorded by instruments connected to the seawater supply. In total, 39 samples were collected using this method during Leg 2 of MR08-06 (see Figure 7.4.4-1 and Table 7.4.4-1).

Most of the water samples collected were then filtered through 47 mm inner diameter (0.45 μm pore size) HA-type Millipore polycarbonate filter using an Eyela A3-S aspirator and 3 filter holder manifold system. The filters were air dried, not washed and then stored in plastic Petri slide. Later, the filters will be washed briefly by distilled water and air-dried again. A 3 x 3 mm portion of each filter will be cut out and mounted onto an aluminum SEM stub, coated with Pt/Pd in an Eiko IB-3 ion sputter coater, and observed in a Hitachi S-2250N SEM.

(4) *Data archives*

The data of pigments will be submitted to the JAMSTEC Data Integration and Analysis Group (DIAG) within a restricted period.

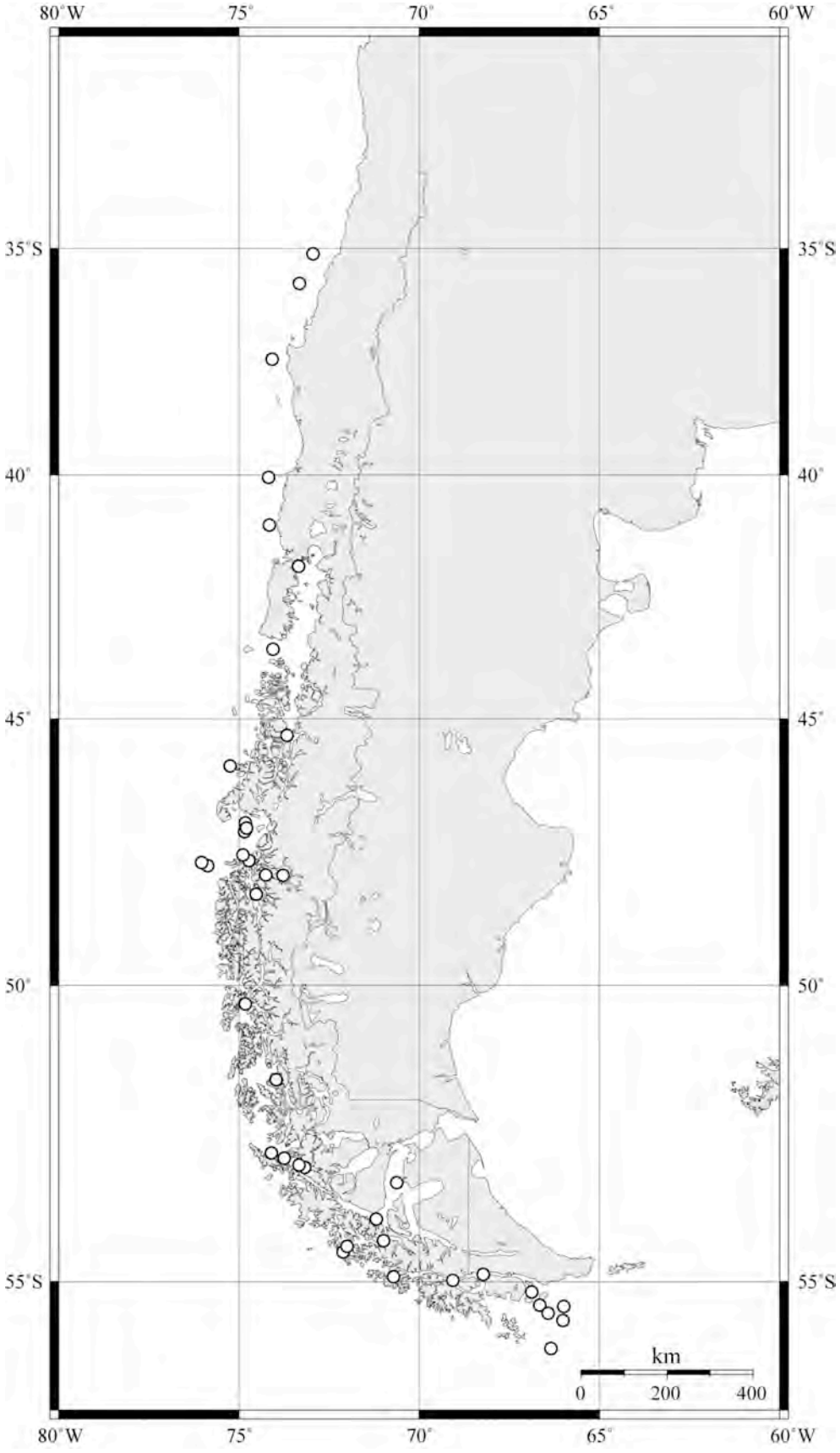

Figure 7.4.4-1 Sampling sites of seawater for microplankton observation (white circles).

Table 7.4.4-1 Seawater sampling date, time (GMT) and location for microplankton

Date	Time	Station	Latitude			Longitude		
2009/3/15	12:47	UW00	35	7.4064	S	72	56.6692	W
2009/3/15	16:46:00	UW01	35	47.7897	S	73	19.6298	W
2009/3/16	1:06:00	UW02	37	29.1352	S	74	4.3359	W
2009/3/16	12:04:00	UW03	40	3.1258	S	74	10.832	W
2009/3/16	16:34	UW04	41	3.6396	S	74	9.1303	W
2009/3/16	21:54	UW05	41	55.1745	S	73	20.9073	W
2009/3/17	9:12	UW06	43	37.1585	S	74	3.0964	W
2009/3/17	17:54	UW07	45	19.7117	S	73	39.8012	W
2009/3/18	0:05	UW08	45	54.7559	S	75	14.6805	W
2009/3/18	10:11	UW09	47	0.0125	S	74	49.1415	W
2009/3/18	16:29	UW10	47	10.2296	S	74	50.8071	W
2009/3/18	21:46	UW11	47	6.142	S	74	47.1055	W
2009/3/19	16:01	UW12	47	59.3139	S	73	46.8658	W
2009/3/20	0:11	UW13	47	58.7861	S	74	15.616	W
2009/3/20	19:35	UW14	47	42.6452	S	74	43.5979	W
2009/3/21	0:06	UW15	47	36.2575	S	74	53.3193	W
2009/3/21	11:12	UW16	47	48.7106	S	75	51.6727	W
2009/3/21	23:59	UW17	47	45.0031	S	76	2.265	W
2009/3/22	13:23	UW18	48	20.1979	S	74	31.0653	W
2009/3/22	22:17	UW19	50	19.5082	S	74	49.0154	W
2009/3/23	4:09	UW20	51	39.166	S	73	57.8204	W
2009/3/23	12:30	UW21	52	59.0484	S	73	44.9878	W
2009/3/23	17:01	UW22	53	8.2831	S	73	10.987	W
2009/3/24	2:10	UW23	53	5.8645	S	73	20.2427	W
2009/3/24	16:49	UW24	52	53.7861	S	74	6.003	W
2009/3/25	3:51	UW25	53	59.7703	S	71	11.2273	W
2009/3/25	12:58	UW26	54	55.366	S	70	42.8478	W
2009/3/25	16:53	UW27	54	58.8061	S	69	4.2892	W
2009/3/25	23:35	UW28	55	22.4456	S	66	39.3497	W
2009/3/26	12:30	UW29	56	3.2159	S	66	20.6902	W
2009/3/26	21:29	UW30	55	37.0101	S	66	0.3966	W
2009/3/27	1:33	UW31	55	23.5691	S	65	59.3575	W
2009/3/27	20:33	UW32	55	30.1992	S	66	25.5065	W
2009/3/27	22:29	UW33	55	10.2396	S	66	52.8036	W
2009/3/28	2:10	UW34	54	53.2102	S	68	13.6583	W
2009/3/28	13:11	UW35	54	31.5623	S	72	6.3407	W
2009/3/28	21:45	UW36	54	26.3184	S	72	0.1432	W
2009/3/29	2:09	UW37	54	20.664	S	70	59.0205	W
2009/3/29	13:41	UW38	53	23.7246	S	70	37.2311	W

7.4.5 Genetic diversity of planktonic foraminifera

(1) *Personnel*

Atsushi Kurasawa	Hokkaido University/JAMSTEC: Principal Investigator
Masashi Tsuchiya	JAMSTEC
Takashi Toyofuku	JAMSTEC
Hiroshi Kitazato	JAMSTEC
Hiroshi Nishi	Hokkaido University

(2) *Background and objectives*

Marine planktonic species exhibit broad distributions and are assumed to form genetically continuous populations since they are considered to have high dispersal ability. However, recent molecular phylogenic studies revealed that many marine planktonic groups show high intra-specific genetic diversity (i.e. Knowlton, 1993). Occasionally, the trends of distribution patterns are different among genotypes, which may reflect difference in the environmental preferences. Furthermore, subtle morphological differences among genotypes are also recognized in various marine planktonic taxa (i.e. Huber et al., 1997; Saez et al., 2003; Mann et al., 2004). These results suggest that the diversity of the marine planktonic organisms have been overlooked, and these genotypes may represent cryptic species.

Planktonic foraminifer is a single-celled calcite secret organism, which can be found in surface seawater around the world. Identification of planktonic foraminiferal species are based on morphological characters of test, however, molecular phylogenetic studies have revealed the presence of genetically discrete groups (genotypes) within many morphological species (i.e. Huber et al., 1997; Darling et al.,1999, 2000; Stewart et al., 2001; de Vargas et al., 1999). Some of the distribution patterns of these genotypes correspond to oceanic provinces and oceanic current systems, which potentially reflect the distinct ecological features of each genotype. Revealing the biogeography of planktonic foraminiferal genotypes and its correlations to oceanic environments in the Pacific is essential to reconstruct the divergence and formation of genotype and the gene flow between the Northern and Southern hemisphere. In order to reveal the genetic diversity of planktonic foraminifera, we have studied the molecular phylogenetic and biogeography of *Globigerina bulloides* in the northwestern North Pacific. Our previous study (Kurasawa, 2007MS) shows that the distribution patterns of the genotypes of *G. bulloides* exhibit good correlation with the water mass structures. However, the genetic diversity in the South Pacific is largely unknown hence whether bipolarity of planktonic foraminiferal genotypes, which is reported for some genotypes in the Atlantic, also exists in the Pacific is not clarified. The purpose of this observation is (i) to reveal the genetic diversity of *G. bulloides* and other planktonic foraminifera in the North and the South Pacific, (ii) to reveal the correlation between the biogeography of genotype and the oceanic environments, and (iii) to reconstruct the patterns of gene flow within the Pacific and gene flow between the Pacific and other oceans. In order to collect living planktonic foraminiferal specimens for molecular phylogenetic analysis, we conducted surface seawater filtration sampling (pump method) and plankton net sampling.

(3) *Instruments and method*

i. Surface seawater filtration sampling (Pump method)

Plankton samples in the sea surface were collected by filtering surface seawater in the laboratory during ship navigation. Sampling location, sampling time, water temperature, and number of sorted specimens were recorded. A Filtering apparatus (100 μm mesh) was used to filter planktonic foraminifera (Fig. 7.4.5-1). The apparatus was connected to seawater supply tap and placed in a bucket. Surface seawater was filtrated for several hours at each sampling sites. Plankton samples in the sea surface water were collected by pump method at 23 locations during navigation (Table 7.4.5-1, Fig. 7.4.5-2).

Fig. 7.4.5-1 Surface water filtration apparatus consists of 100 μm opening mesh and glass bottle.

Table 7.4.5-1. Surface seawater filtration sampling locations.

Sample Name	Start latitude			Start longitude			End latitude			End longitude			Starting Date (UTC)	
	degree	minute	S	degree	minute	W	degree	minute	S	degree	minute	W	Date	Time
S75	32	58.10	S	71	42.21	W	33	26.48	S	72	01.11	W	2009.3.14	23:22
S76	35	07.41	S	72	56.67	W	35	34.20	S	73	11.87	W	2009.3.15	12:47
S77	37	28.91	S	74	04.30	W	38	00.58	S	74	09.48	W	2009.3.16	1:05
S78	40	19.75	S	74	13.52	W	40	49.45	S	74	12.40	W	2009.3.16	13:10
S79	42	16.81	S	72	59.09	W	42	37.92	S	73	09.48	W	2009.3.16	23:41
S80	43	37.53	S	74	01.93	W	43	03.78	S	73	16.65	W	2009.3.17	2:58
S81	45	19.71	S	73	39.80	W	45	41.13	S	73	51.32	W	2009.3.17	17:54
S82	47	00.14	S	74	45.30	W	47	02.65	S	74	42.11	W	2009.3.18	14:39
S83	47	59.33	S	73	47.25	W	47	59.52	S	73	07.07	W	2009.3.19	13:16
S84	47	43.26	S	74	44.45	W	47	42.39	S	74	44.37	W	2009.3.20	15:19
S85	47	51.42	S	75	54.23	W	47	45.00	S	76	02.27	W	2009.3.21	20:00
S86	48	22.36	S	74	30.40	W	48	33.45	S	74	25.37	W	2009.3.22	13:33
S87	50	43.10	S	74	33.31	W	51	13.26	S	74	08.77	W	2009.3.23	0:02
S88	53	02.80	S	73	36.14	W	53	05.86	S	73	20.24	W	2009.3.23	12:56
S89	53	10.59	S	73	21.86	W	53	36.81	S	72	15.79	W	2009.3.24	21:52
S90	54	55.37	S	70	42.85	W	54	58.81	S	69	04.29	W	2009.3.25	12:58
S91	54	54.84	S	67	16.36	W	55	22.45	S	66	39.35	W	2009.3.25	21:06
S92	55	37.74	S	66	09.03	W	56	02.83	S	66	11.01	W	2009.3.26	1:22
S93	56	02.83	S	66	11.01	W	55	44.18	S	66	03.39	W	2009.3.26	14:12
S94	55	42.63	S	66	08.02	W	55	30.21	S	66	25.09	W	2009.3.27	13:56
S95	55	10.24	S	66	52.80	W	54	54.81	S	67	17.56	W	2009.3.27	22:29
S96	54	30.76	S	72	07.18	W	54	24.68	S	71	55.79	W	2009.3.28	16:50
S97	53	23.72	S	70	37.23	W	63	23.36	S	70	34.32	W	2009.3.29	13:41

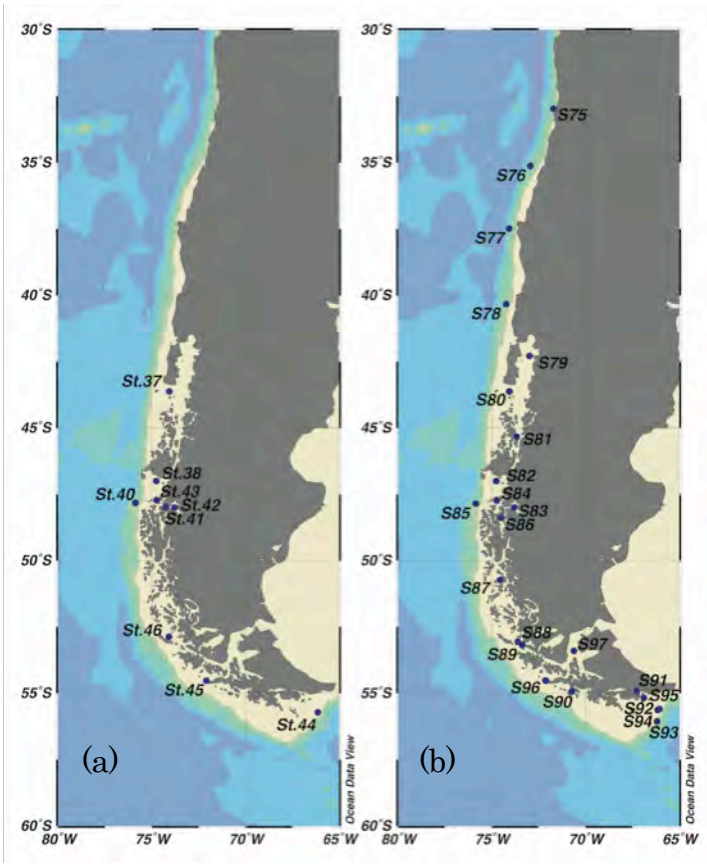

Fig. 7.4.5-1 (Left) Locations of sampling sites. (a) plankton net sampling sites, (b) surface seawater filtration sites (starting locations).

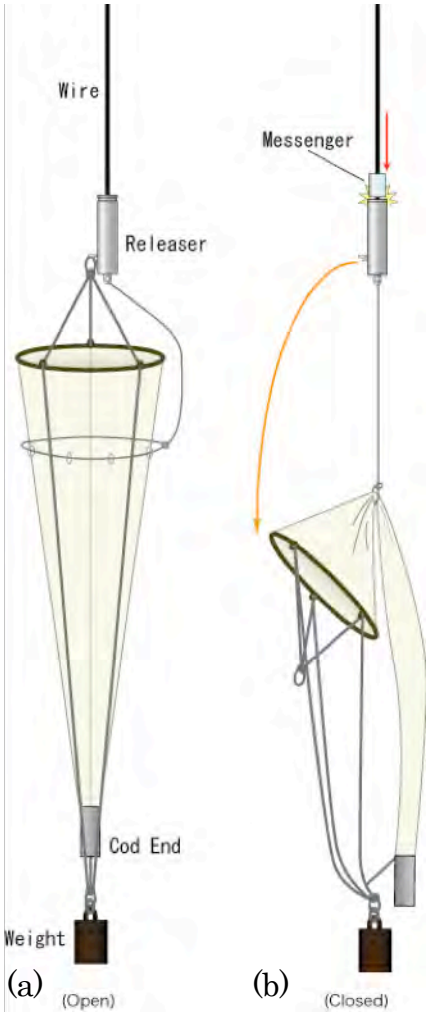

Fig. 7.4.5-2 (Right) Schematic illustration of closing plankton net. (a) Plankton net is open during vertical towing, and (b) closed at the top of the sampling depth range by deploying a messenger.

ii. Plankton net sampling

Vertical tows of closing NORPAC plankton net (Fig. 7.4.5-3) were conducted for multi-depth plankton sampling. The sampling depths were divided into 3 to 5 strata. The sampling depth intervals were determined from CTD profiles. The net was washed with surface seawater and the recovered samples were collected in plastic bottles and kept at 4 ºC until picking of specimens. A CTD logger (Star-Oddi Ltd., DST-CTD) was attached to the ring of the net to obtain the depths, temperature and salinity profiles of the water column during towing. Data recording interval of the logger was set to 2 seconds. Plankton net sampling was conducted at nine sites and 39 tows were carried out (Table 7.4.5-2, and Fig. 7.4.5-2).

Table 7.4.5-2. Plankton net sampling locations and numbers of picked foraminifera.

Station	Date	Sample Name	Latitude (S)		Longitude (W)		Depth	Number of picked forams	DNA extraction and PCR
			degree	minute	degree	minute	(m)		
St. 37	2009.3.17	N37-1	43	37.23	74	03.51	0-25	1	
		N37-2	43	37.32	74	03.52	25-50	1	
		N37-3	43	37.42	74	03.43	50-70	0	
St. 38	2009.3.18	N38-1	46	59.95	74	45.00	0-25	1	
		N38-2	46	59.95	74	45.99	25-50	2	
		N38-3	46	59.96	74	45.00	50-70	1	
St. 40	2009.3.20	N40-1	47	42.65	74	44.52	0-20	0	
		N40-2	47	42.67	74	44.54	20-50	4	
		N40-3	47	42.60	74	44.52	50-100	0	
		N40-4	47	42.60	74	44.54	100-200	0	
St. 41	2009.3.19	N40-1	47	58.78	74	15.60	0-15	0	
		N40-2	47	58.78	74	15.59	15-50	0	
		N40-3	47	58.78	74	15.59	50-100	0	
		N40-4	47	58.78	74	15.59	100-200	0	
St. 42	2009.3.19	N42-1	47	59.58	73	47.40	0-15	0	
		N42-2	47	59.39	73	47.40	15-50	0	
		N42-3	47	59.41	73	47.39	50-100	0	
		N42-4	47	59.44	73	47.43	100-200	0	
St. 43	2009.3.21	N43-1a*	47	50.01	75	50.52	0-20	-	
		N43-1b*	47	50.40	75	50.55	0-20	-	
		N43-1	47	50.81	75	50.63	0-20	140**	5
		N43-2	47	50.81	75	50.65	20-40	132**	
		N43-3	47	50.10	75	50.72	40-100	130**	
		N43-4	47	50.13	75	50.73	100-200	200**	
		N43-5	47	50.18	75	50.78	200-500	20	
St. 44	2009.3.27	N44-1a*	55	34.84	66	02.91	0-20	-	
		N44-1	55	34.60	66	02.94	0-20	50	
		N44-2	55	34.48	66	02.95	20-80	132**	5
		N44-3	55	34.28	66	02.99	80-100	132**	
		N44-4	55	33.99	66	03.20	100-200	145**	
St. 45	2009.3.28	N45-1	54	30.84	72	07.46	0-20	31	
		N45-2	54	30.88	72	07.54	20-50	21	
		N45-3	54	30.93	72	07.58	50-100	28	
		N45-4	54	31.00	72	07.62	100-200	18	
St. 46B	2009.3.24	N46-1a*	52	53.73	74	06.00	0-20	-	
		N46-1	52	53.75	74	06.14	0-20	7	
		N46-2	52	53.76	74	06.35	20-60	10	
		N46-3	52	53.77	74	06.43	60-100	3	
		N46-4	52	53.56	74	06.24	100-200	1	

* Unsuccessful cast

** Foraminfiera were not entirely picked

iii. Onboard sample treatment

Living planktonic foraminifera were picked under stereomicroscope with needles and fine brushes and transferred on faunal slides. Specimens were air dried on the slides and stored at -80 ºC. Residue of the samples were stored in plastic bags at -80 ºC. DNA extraction and PCR amplification of small sub-unit ribosomal DNA (SSU rDNA) were carried out for some of the *G. bulloides* specimens (Table 7.4.5-2). Total DNA was extracted with Guanidine buffer (modified from Pawlowski, 2000). PCR amplification was carried out with TaKaRa Ex Taq (TaKaRa Bio inc., Japan). A *G. bulloides* specific primer s14f1+40 (5'-ACGCGGAAAAGCTTATCTGGT-3') and sB-2A (5'-TTCTGCAGGTTCACCTACGGATG-3'), which is universal primer, were used for amplifying approximately 1000 bp of 5'-terminal region of SSU rDNA. PCR condition consists of initial denature at 94ºC for 5 minutes followed by 40 cycles of denature, annealing, and extension (94ºC for 30 seconds, 55ºC for 30 seconds, and 72ºC for 1 minute, respectively) and final extension at 72ºC for 5 minutes. Size of amplified products was confirmed by 1.5% agarose gel electrophoresis. Extracted DNA and PCR products were stored under -20 ºC.

(4) *Preliminary results*

The depth logs and vertical temperature/salinity profiles recorded by CTD logger are shown in Figs. 7.4.5-4 and 7.4.5-5, respectively. The total numbers of picked foraminifera are listed in Table 7.4.5-3. The abundances of planktonic foraminifera are variable among plankton net sampling sites. Although neither of surface water filtration sampling and plankton net sampling are quantitative methods, number of picked foraminiferal specimens of plankton net samples clearly shows that the planktonic foraminifera abundance is greatly reduced in fjord sites compared to the oceanic sites. The CTD profiles in the fjord sites exhibit extremely low salinity in the surface layer and relatively high salinity water mass below the surface layer, suggesting that the deep water in fjord is connected to oceanic water; however, the low abundances in fjord area suggest that intrusion of planktonic foraminifera from ocean to fjord may be limited.

The results of further molecular phylogenetic analysis will be significant data to understand the genetic diversity of planktonic foraminifera in the Pacific Ocean and the gene flow patterns between the Northern Pacific and Southern Pacific can be examined. Further molecular phylogenic analysis and morphological observations will be carried out after cruise at JAMSTEC.

(5) *Date archive*

All data are submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control and will be opened to public via "R/V MIRAI Data Web Page" in JAMSTEC homepage.

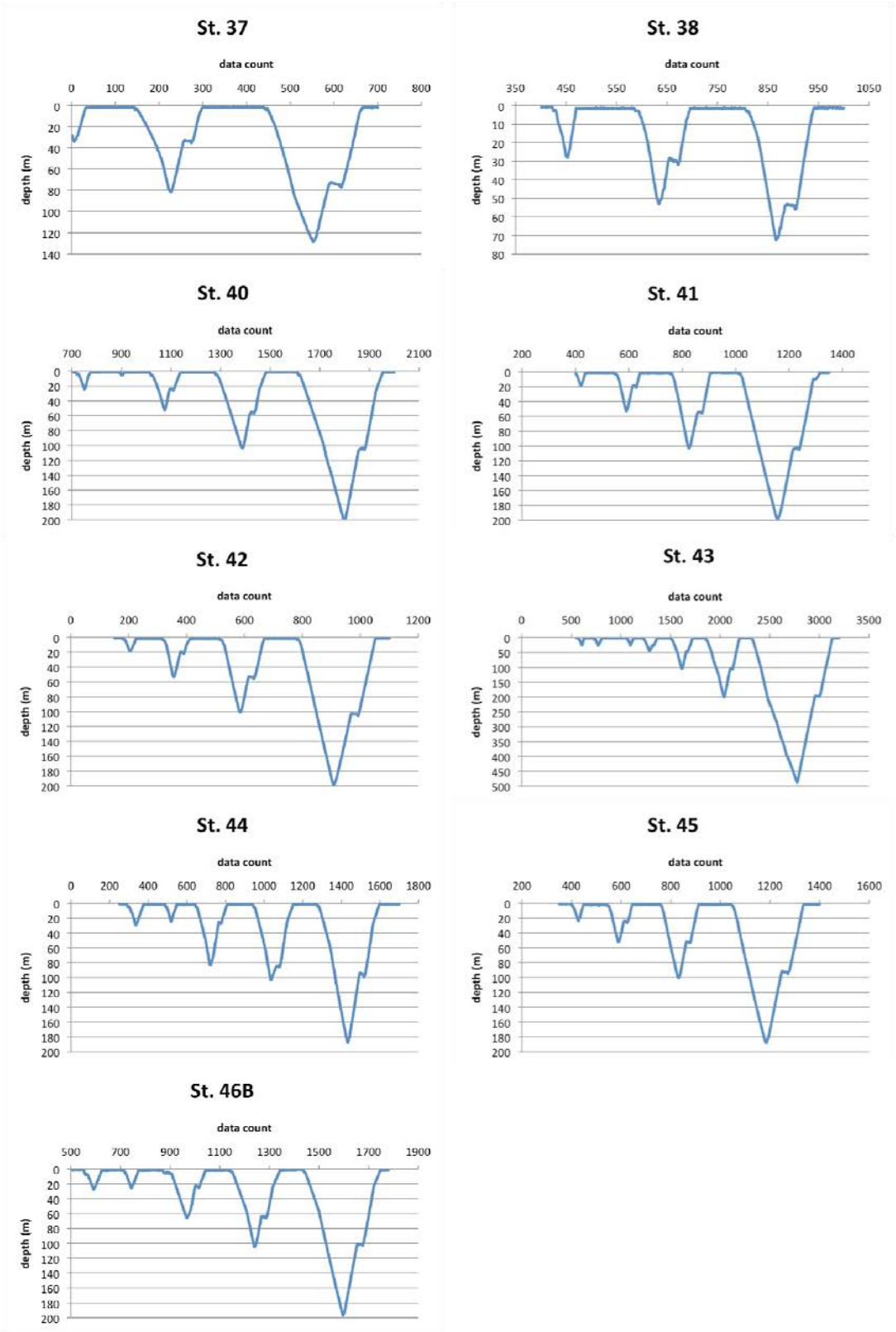

Fig. 7.4.5-3 Depth log of plankton net tows (Data logging interval=2 seconds).

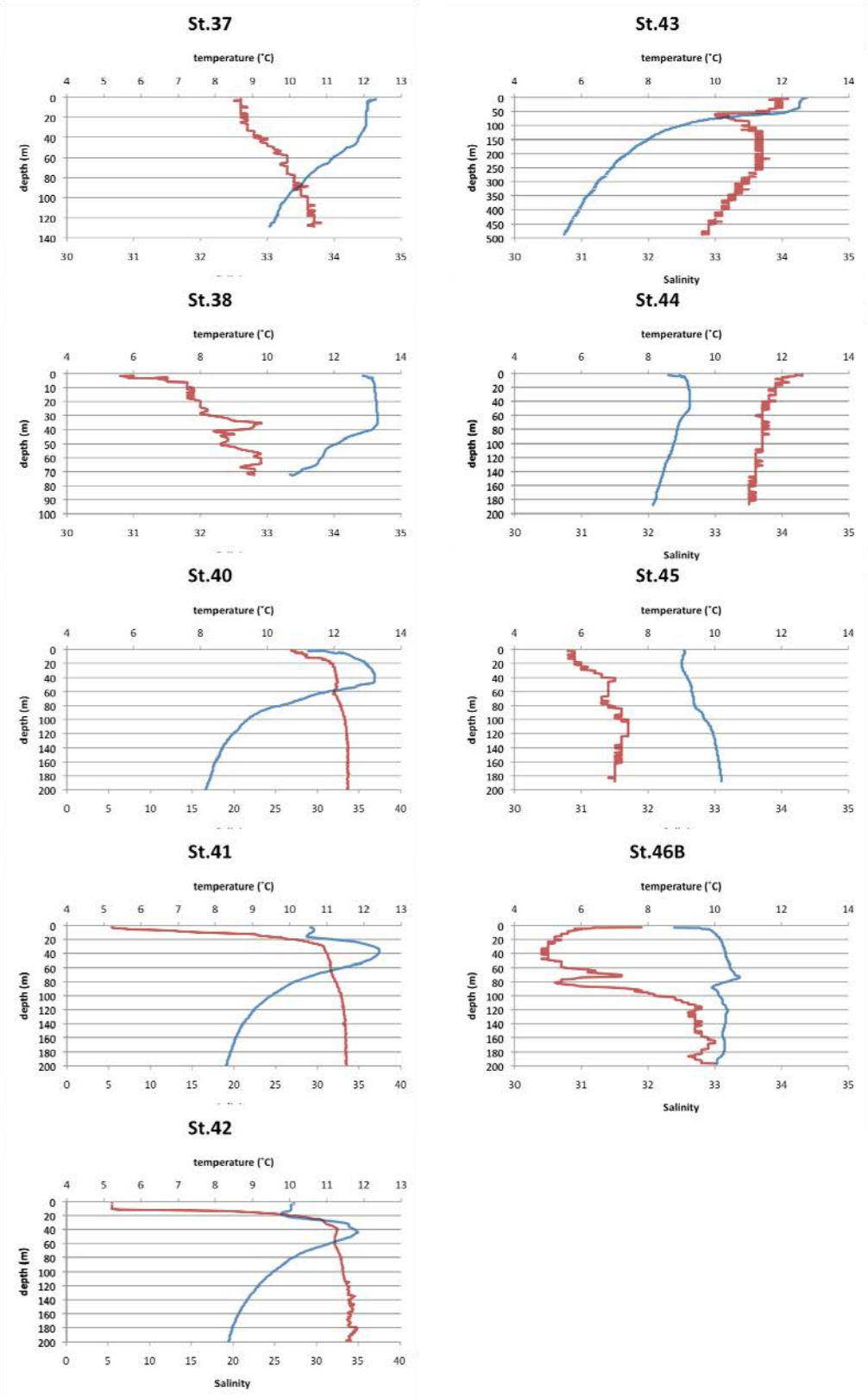

Fig. 7.4.5-4 Vertical profiles of temperature (blue line) and salinity (red line) measured by CTD logger during plankton net tows.

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7.5 Sediment Observations

7.5.1 Site survey (bathymetry and sediment structure) observations

(1) *Personnel*

Naomi Harada	JAMSTEC: Principal Investigator
Satoshi Okumura	GODI: Operation Leader
Harumi Ota	GODI
Takashi Kawamura	GODI

(2) *Objective*

To find best location taking the sediment for paleoceanography, site survey was conducted using the Multi Beam Echo Sounding system (MBES), SEABEAM 2112.004 on R/V MIRAI. Sub Bottom Profiler (SBP) is an add-on option to the "SEABEAM 2100". SBP system collected vertical information of sediments.

(3) *Measured parameters*

System configuration, performance and data acquisition of SEABEAM 2112.004 system showed "7.6.3 Swath Bathymetry".

(4) *Preliminary results*

Figures 7.5.1-1 to 7.5.1-18 show survey maps and sub-bottom profiles for Station 37, 38, 40, 41, 42, 43, 44, 45 and 46. Sediment coring was conducted at 9 stations using multiple and piston coring system. Geographic positions of each station were shown in Table 7.5.1-1 below.

(5) *Date archive*

All data are submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control and will be opened to public via "R/V MIRAI Data Web Page" in JAMSTEC homepage.

Table 7.6.1-1 Positions of each station during MR08-06 Leg2 cruise

Date	Core ID	Location	Lat.（SOJ）	Lon.（SOJ）	Water Depth (m)	Remarks
3/17	MC37	Guafo Channel	43-37.13'S	74-03.13'W	199	No survey
3/18	MC38, PC05	Taitao	47-14.14S	74-50.36'W	187	-
3/19	MC42, MC42B	Baker Fjord C	47-59.31S	73-47.30'W	1,063	-
3/20	MC40, MC40B, PC06	Baker Fjord A	47-42.39'S	74-44.38'W	260	-
3/20	MC41, MC41B	Baker Fjord B	47-58.79'S	74-15.61'W	737	-
3/21	MC43, PC07	Oceanic Baker	47-48.71'S	75-51.67'W	1,389	-
3/24	MC46, PC08	Magellan Mouth	52-52.00'S	74-05.00'W	558	No survey
3/27	MC44, PC09	Drake	55-42.58'S	66-08.06'W	685	-
3/28	MC45	Agnes Island	54-31.07'S	72-06.36'W	487	-

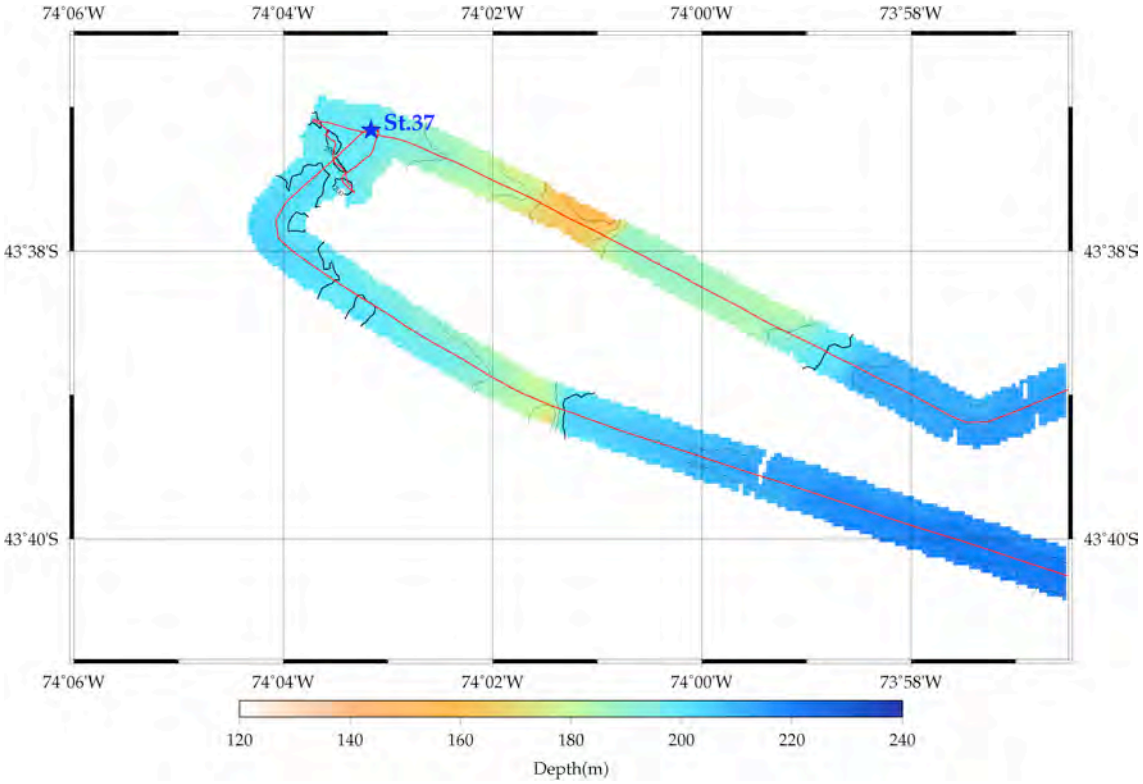

Fig. 7.5.1-1. Bathymetric map with track lines around Station 37.

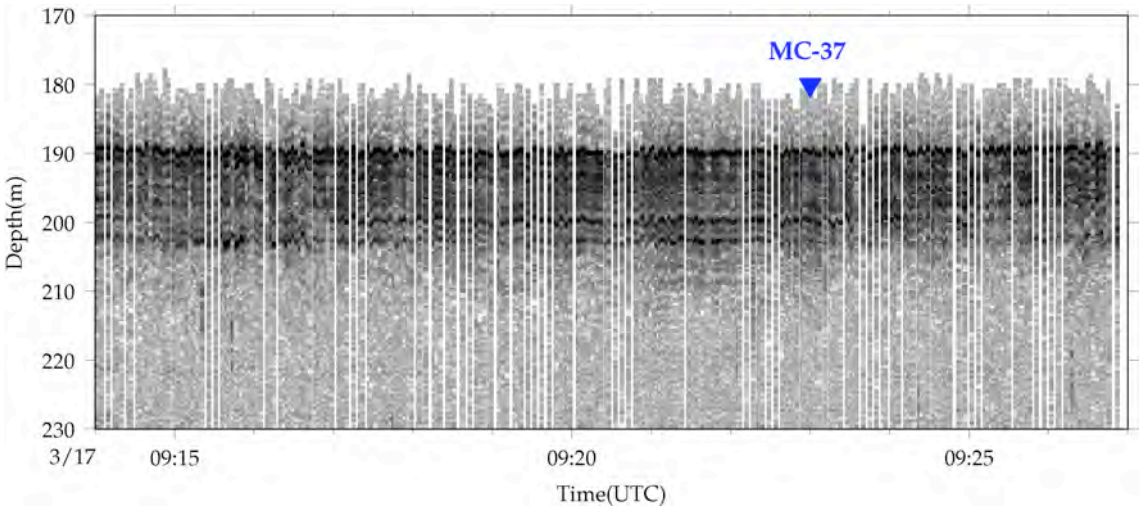

Fig 7.5.1-2. Sub-bottom profile during multiple-coring operation.

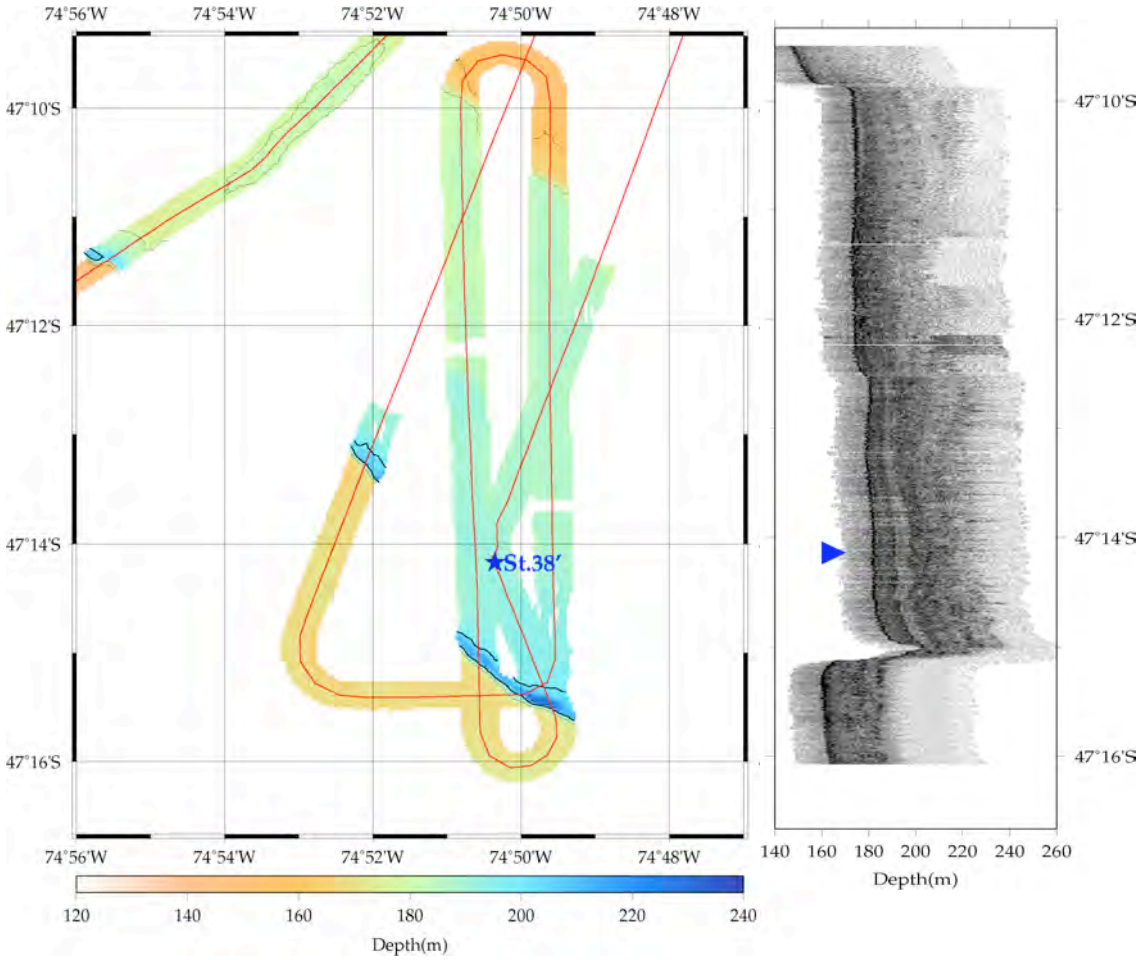

Fig. 7.5.1-3. Bathymetric map with track lines, and sub-bottom profiles around Station 38.

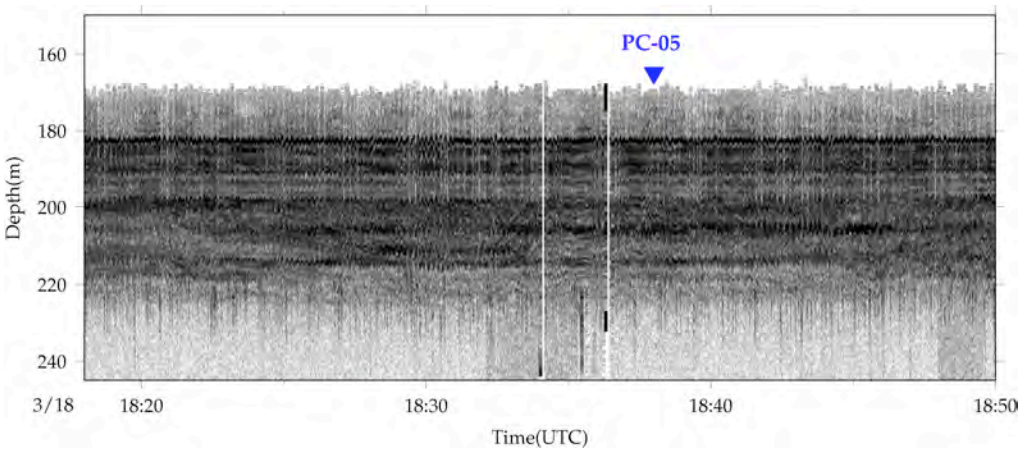

Fig. 7.5.1-4. Sub-bottom profile during piston-coring operation.

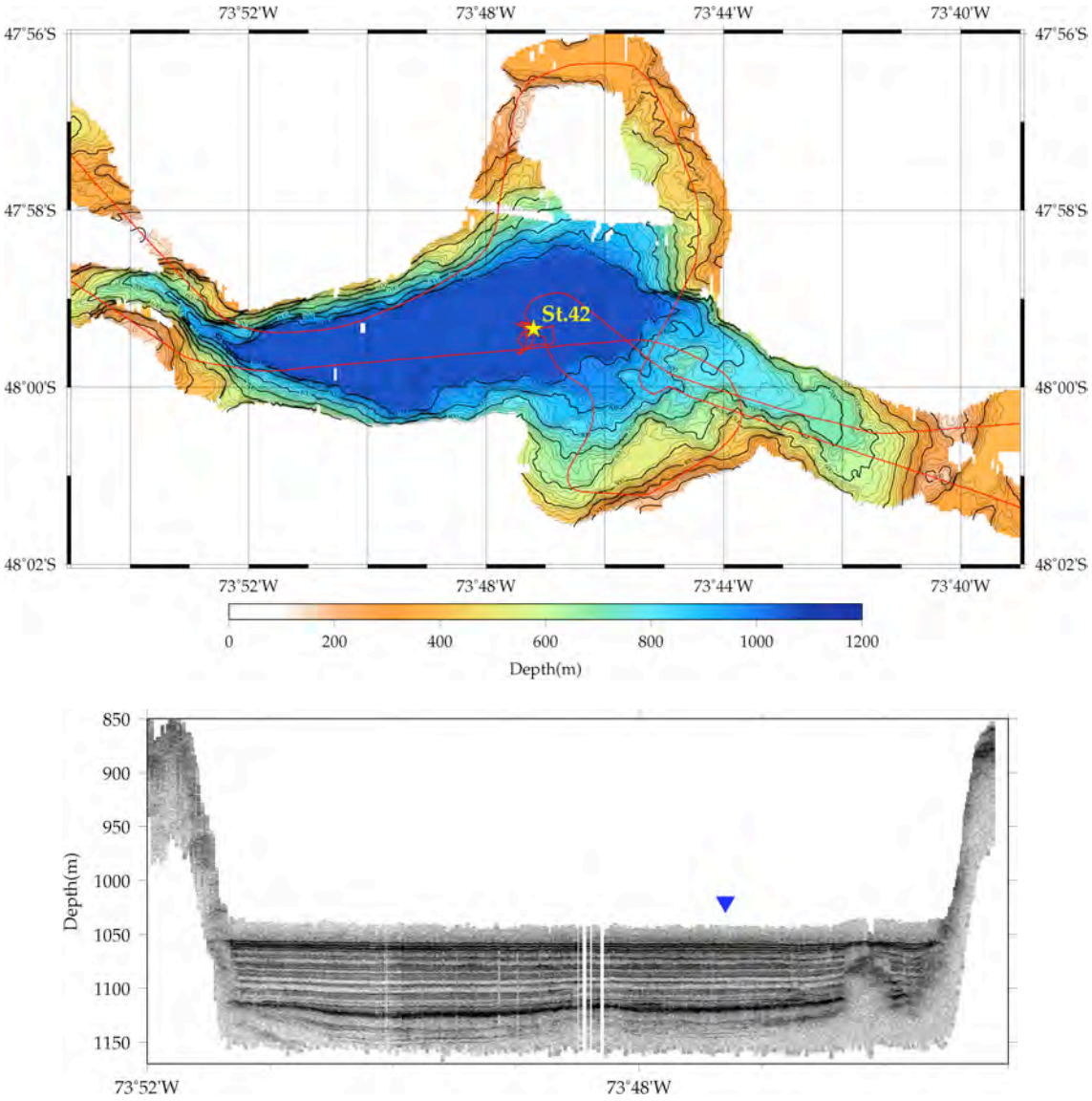

Fig. 7.5.1-5. Bathymetric map with track lines, and sub-bottom profiles around Station 42.

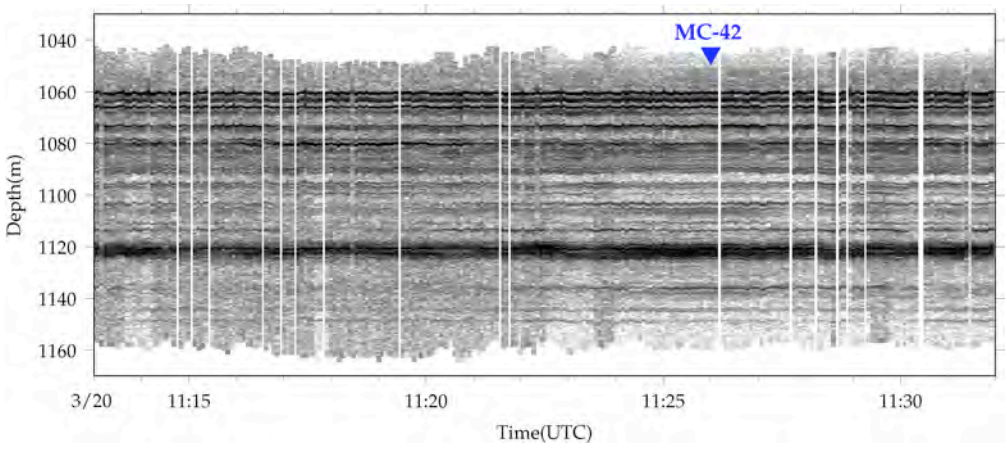

Fig. 7.5.1-6. Sub-bottom profile during multiple-coring operation.

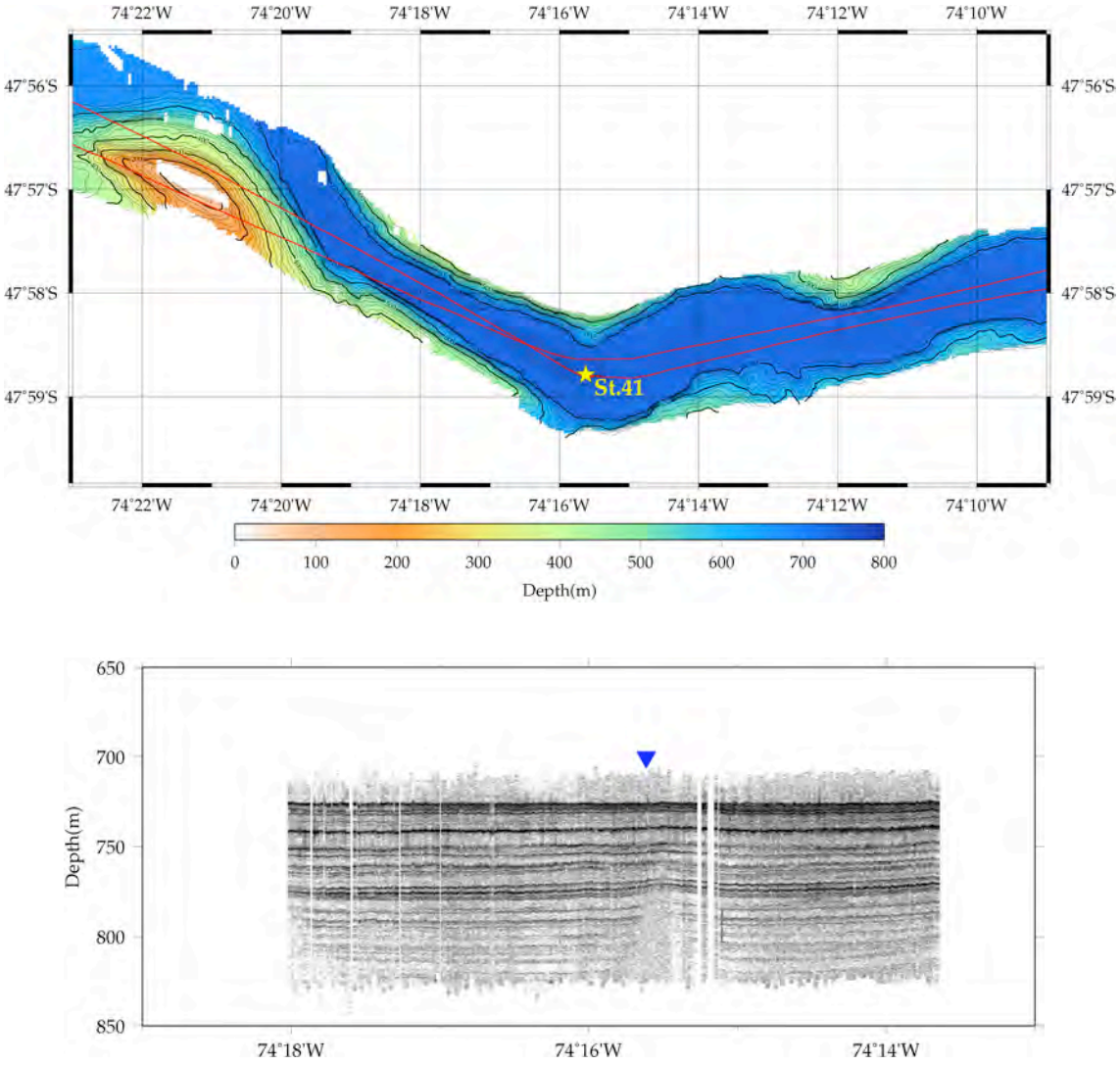

Fig. 7.5.1-7. Bathymetric map with track lines, and sub-bottom profiles around Station 41.

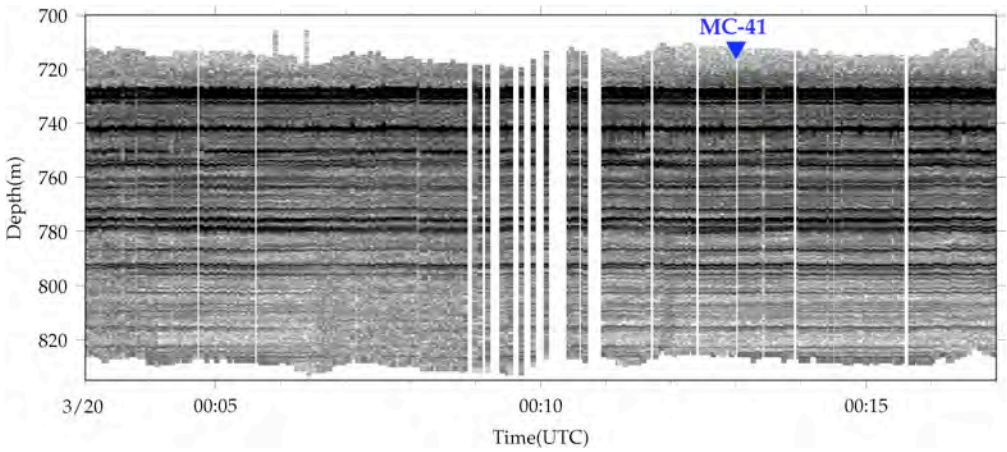

Fig. 7.5.1-8. Sub-bottom profile during multiple-coring operation.

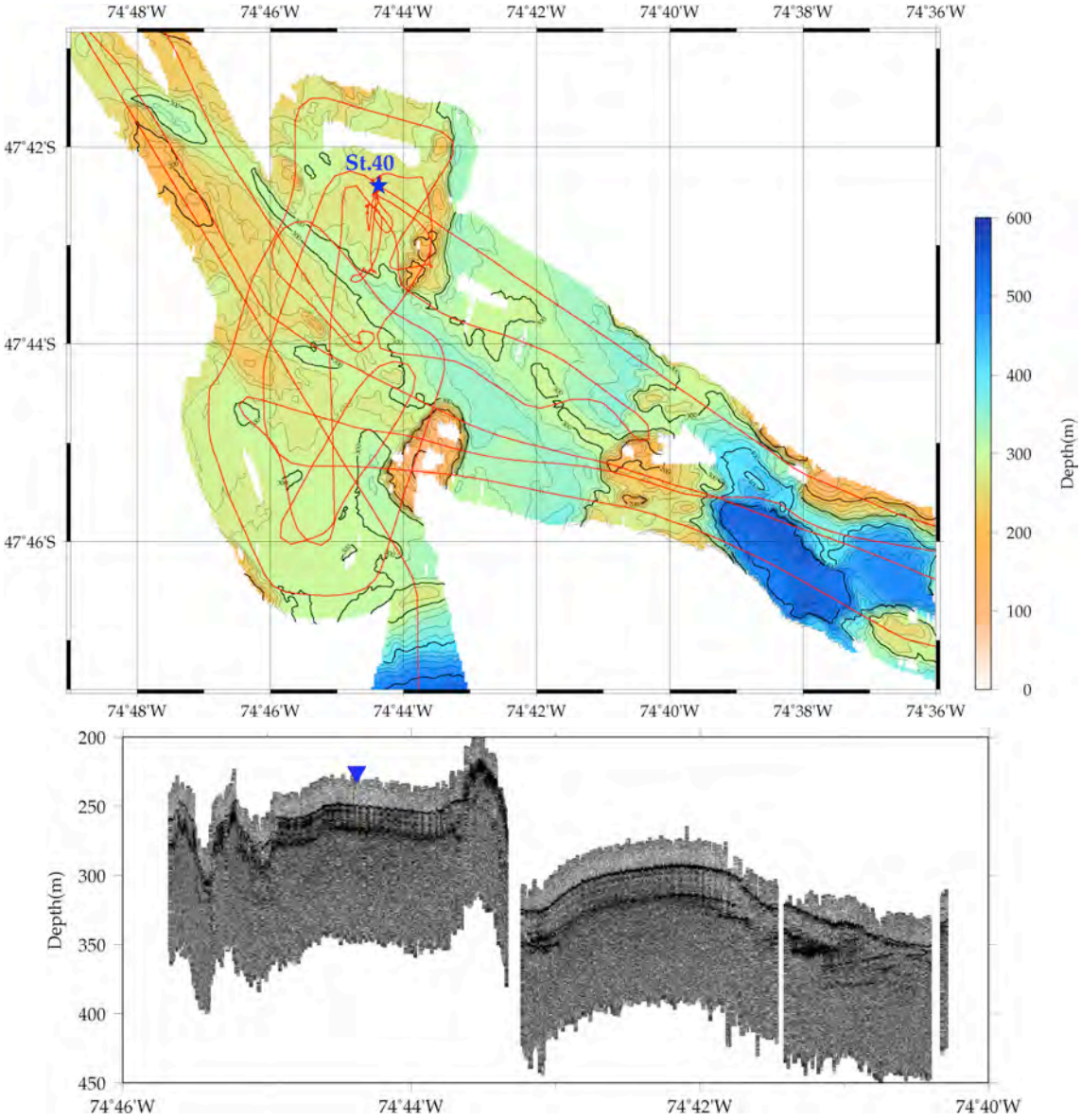

Fig. 7.5.1-9. Bathymetric map with track lines, and sub-bottom profiles around Station 40.

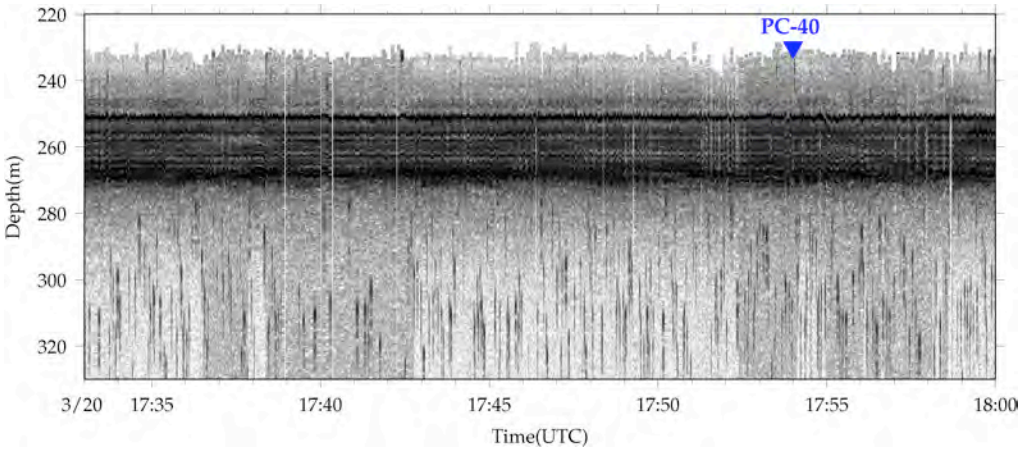

Fig. 7.5.1-10. Sub-bottom profile during multiple-coring operation.

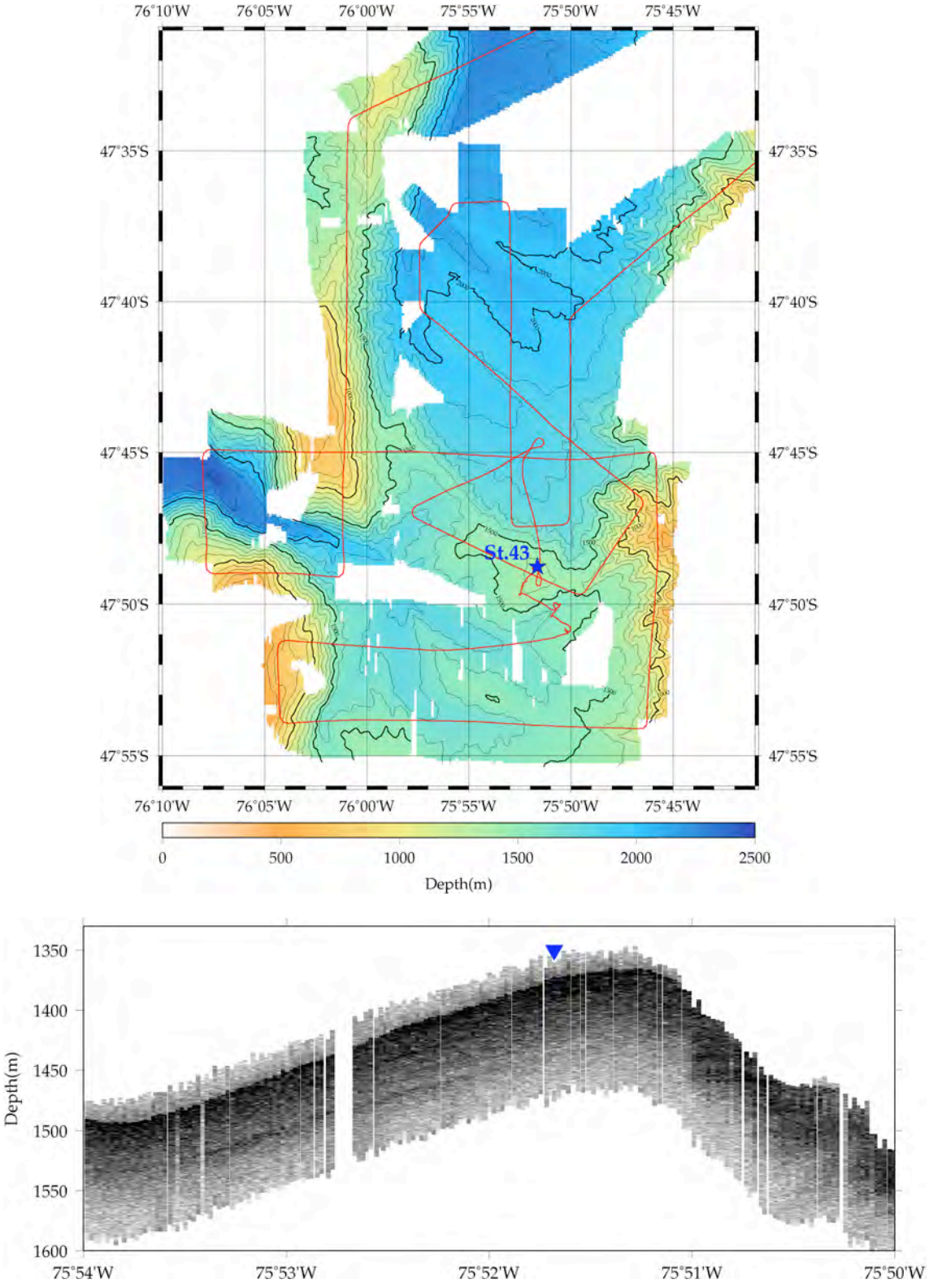

Fig. 7.5.1-11. Bathymetric map with track lines, and sub-bottom profiles around Station 43.

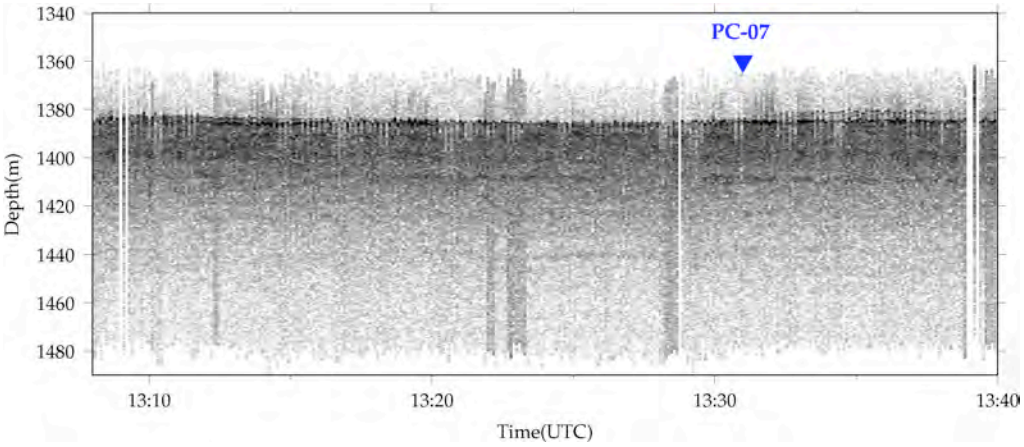

Fig. 7.5.1-12. Sub-bottom profile during piston-coring operation.

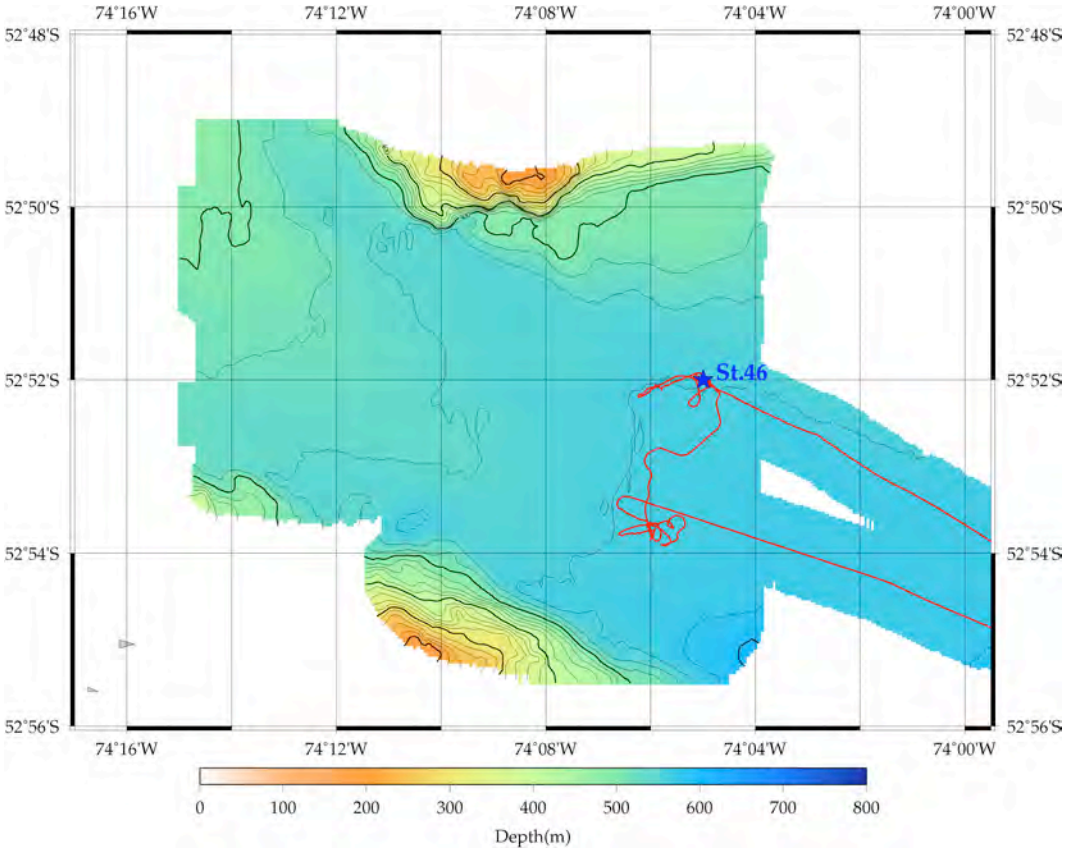

Fig. 7.5.1-13. Bathymetric map with track lines around Station 46.

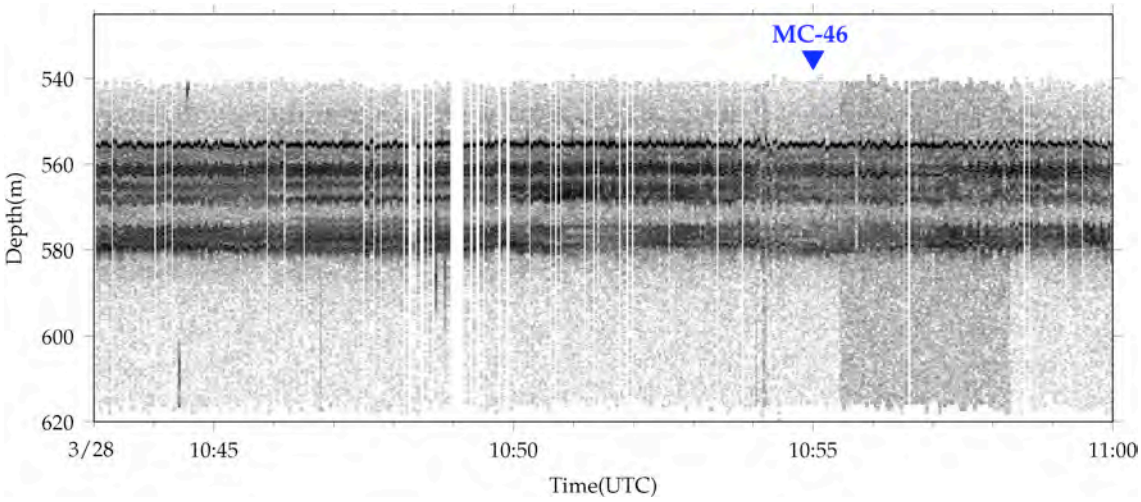

Fig. 7.5.1-14. Sub-bottom profile during multiple-coring operation.

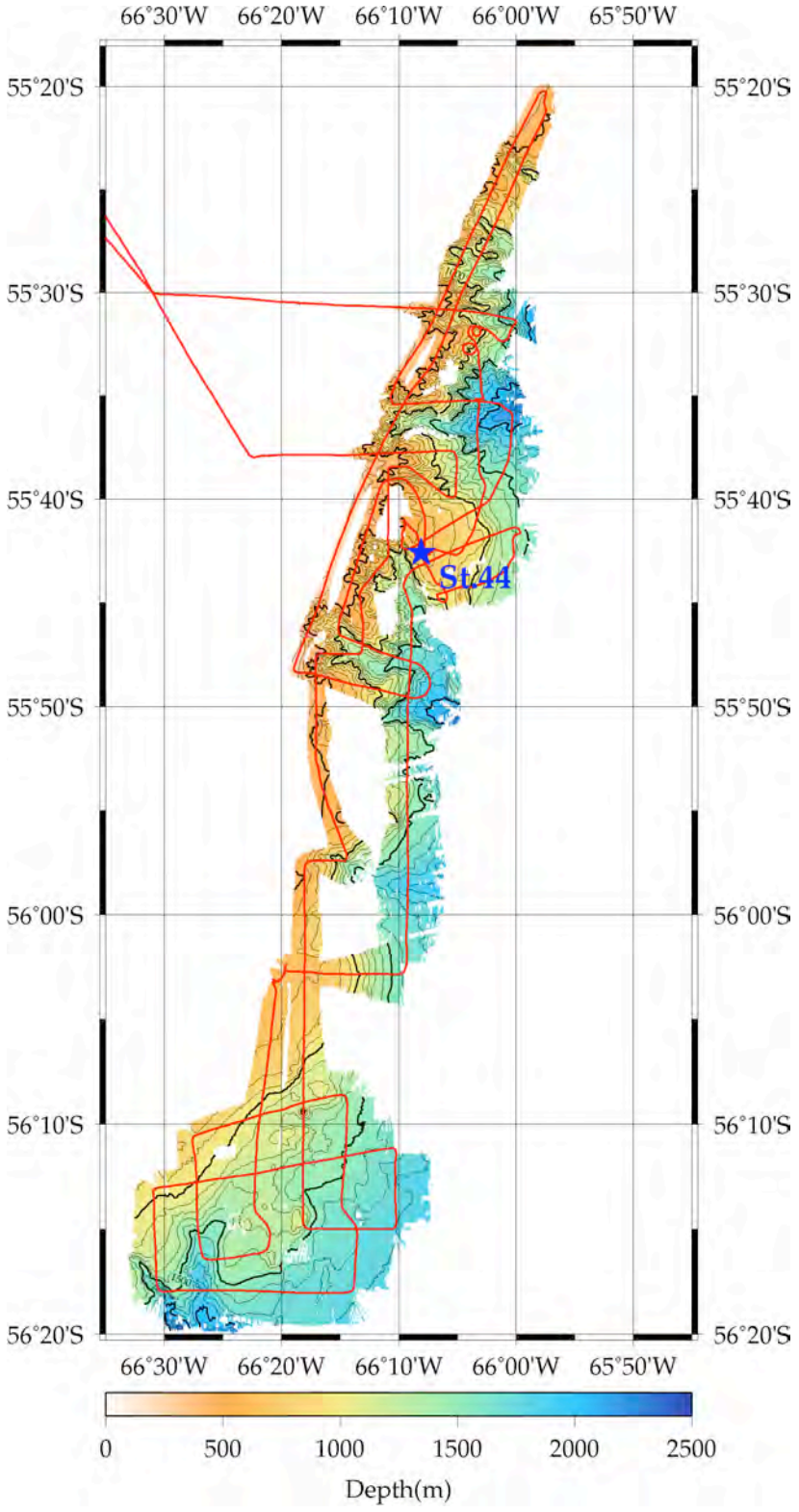

Fig. 7.5.1-15. Bathymetric map with track lines, and sub-bottom profiles around Station 44.

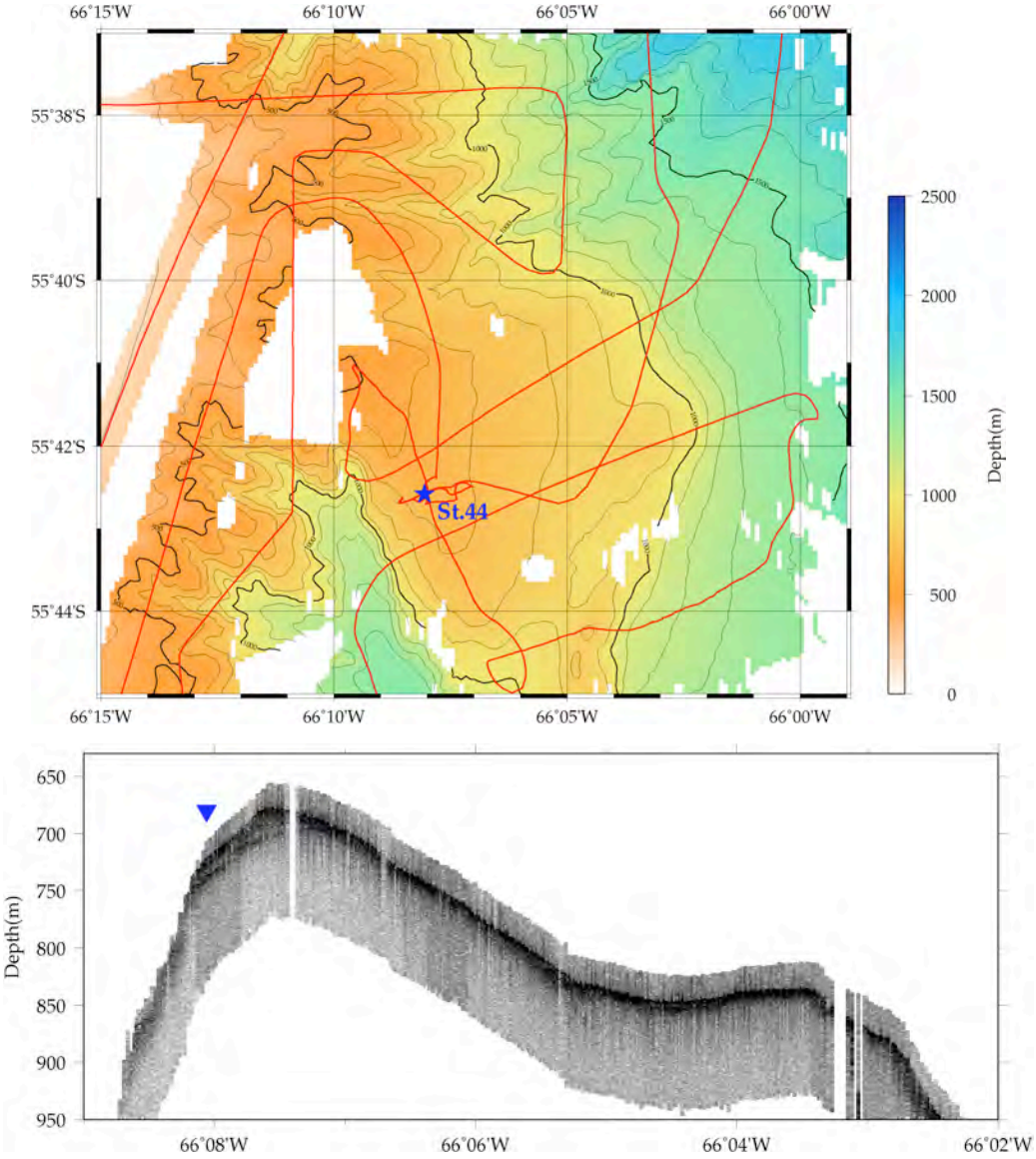

Fig. 7.5.1-15. Bathymetric map with track lines, and sub-bottom profiles around Station 44.(Continue)

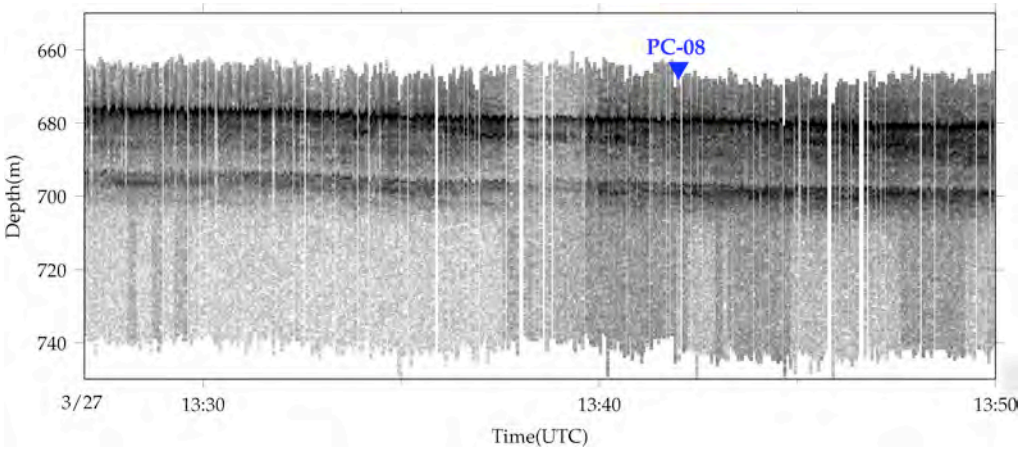

Fig. 7.5.1-16. Sub-bottom profile during piston-coring operation.

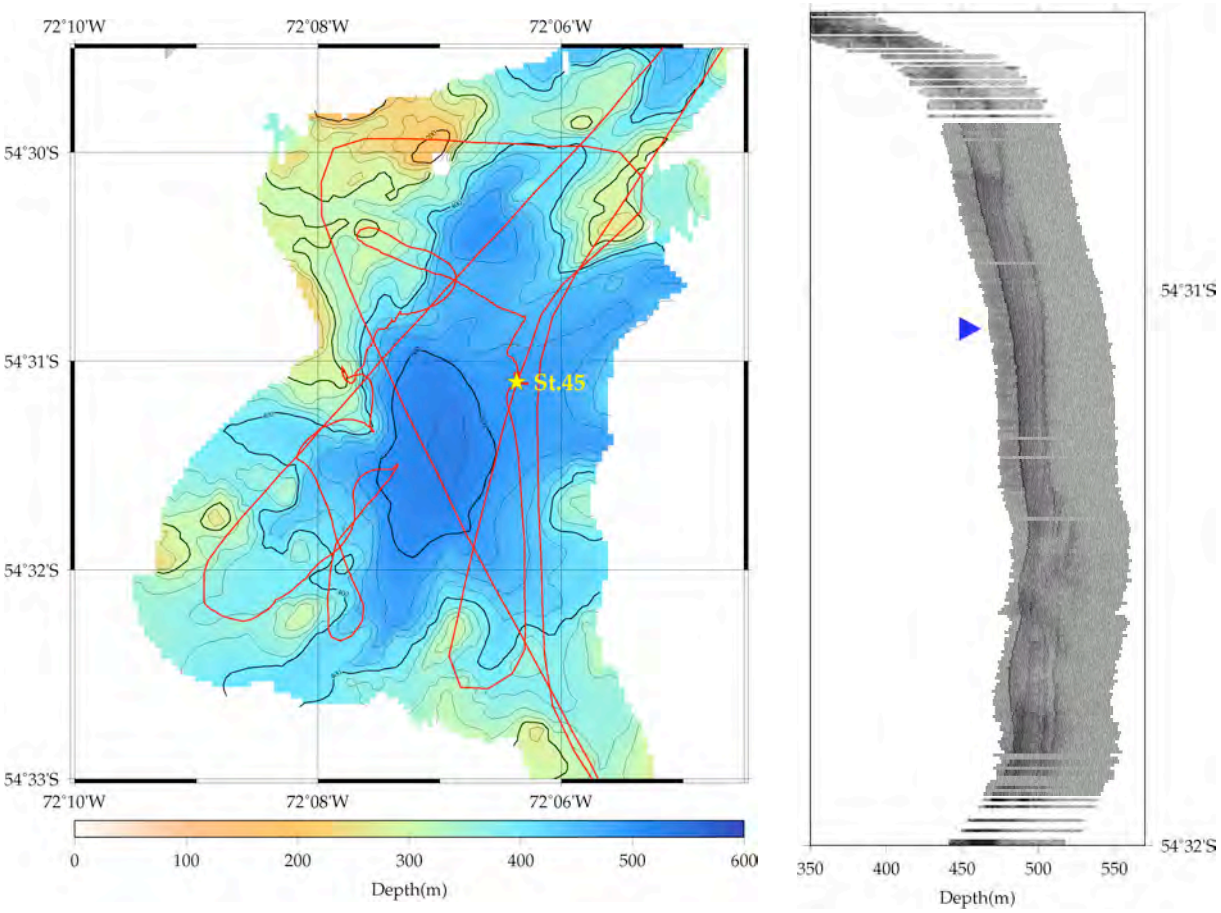

Fig. 7.5.1-17. Bathymetric map with track lines, and sub-bottom profiles around Station 45.

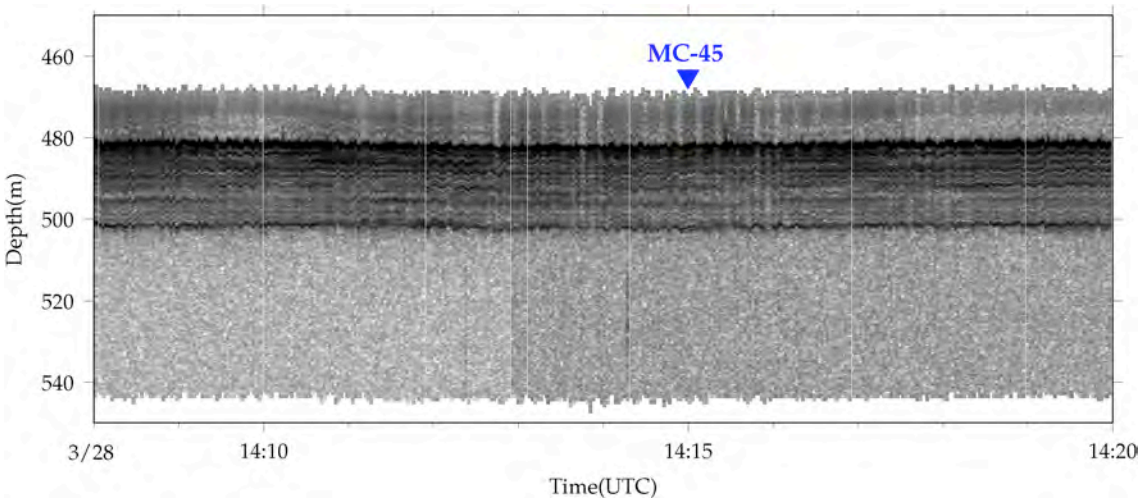

Fig. 7.5.1-18. Sub-bottom profile during multiple-coring operation.

7.5.2 Operation summary

7.5.2.1 Piston corer system

(1) *Personnel*

Naomi Harada	JAMSTEC: Principal Investigator
Kazuhiro Yoshida	MWJ: Operation Leader;
Yusuke Sato	MWJ
Yohei Taketomo	MWJ
Ei Hatakeyama	MWJ
Takami Mori	MWJ

(2) *Objectives*

Collection of sea floor sediment

(3) *Instruments and method*

The piston corer system is composed of weight of corer, barrels, piston, catcher, bit, trigger and pilot corer. The duralumin pipes are used for the barrel. A total 10 or 20m-long duralumin pipe is composed of four 5m segments which are combined one another by stainless joint sleeves. An ewing type corer was used as a pilot corer. For PC05, PC06, PC07 and PC08, polycarbonate liner tubes (Inner type) were also used as inner liners. For PC09, we didn't use inner liners (Outer type). A compass with inclinometer was attached above the weight of the corer to confirm performance of the corer. Diagram of this system is shown in the Fig. 7.5.2.1-1.

The handling procedure of Inner type piston corer is as follows: inner tubes are pulled out from the duralumin pipes after operation. The inner tubes filled by sediments are cut into 1m each by the handy cutter. Each sediment section is longitudinally split into working and archive halves by a splitting devise and a stainless wire. After splitting, both sediment halves are marked by white pins at interval of 2cm and blue pins at interval of 10cm.

The handling procedure of Outer type piston corer is as follows; after cutting duralumin pipes into 1 m in length by a band saw, sediment is extruded on half round PVC liner using the hydraulic piston. The sediment on which another half round PVC liner is put, is longitudinally divided into working and archive halves by a stainless wire. After that, both sediment halves are marked with the white and blue pins in the 2 cm and 10 cm intervals, respectively.

Specification of the piston corer system is shown below.

i. Head of the corer Main unit (Stainless, Lead):
   Weight; 1.3ton
ii. Barrel (Duralumin):
   Length; 5m
   Inner diameter; 80mm
   Outer diameter; 92mm
iii. Inner tube (Polycarbonate):

Length; 5m
Inner diameter; 74mm
Outer diameter; 78mm

(4) *Winch operation*

At the beginning of piston corer system going down, the speed of wire out is set to be 0.2 m/s, and then it made gradually increase to the maximum of 1.0 m/s. Wire out is stopped at a depth about 100 m above the sea floor and the piston corer system is left stand for 3-5 minutes to reduce any pendulum motion of the system. After the piston corer system is stabilized, the wire is stored out at a speed of 0.3 m/s., with carefully watching a tension meter. When the piston corer system touches the bottom, the tension of wire promptly decreases. After confirmation that the piston corer system touches the bottom, wire out is immediately stopped. Rewinding of the wire is started at a dead slow speed (~0.3m/s.), until the tension gauge indicates that the piston corer system is lifted off the bottom. After leaving the bottom, winch wire was wound up at the maximum speed (>1.0 m/s).

(5) *Results*

Details of coring position and core length are shown in the Appendix 1 (Coring summary).

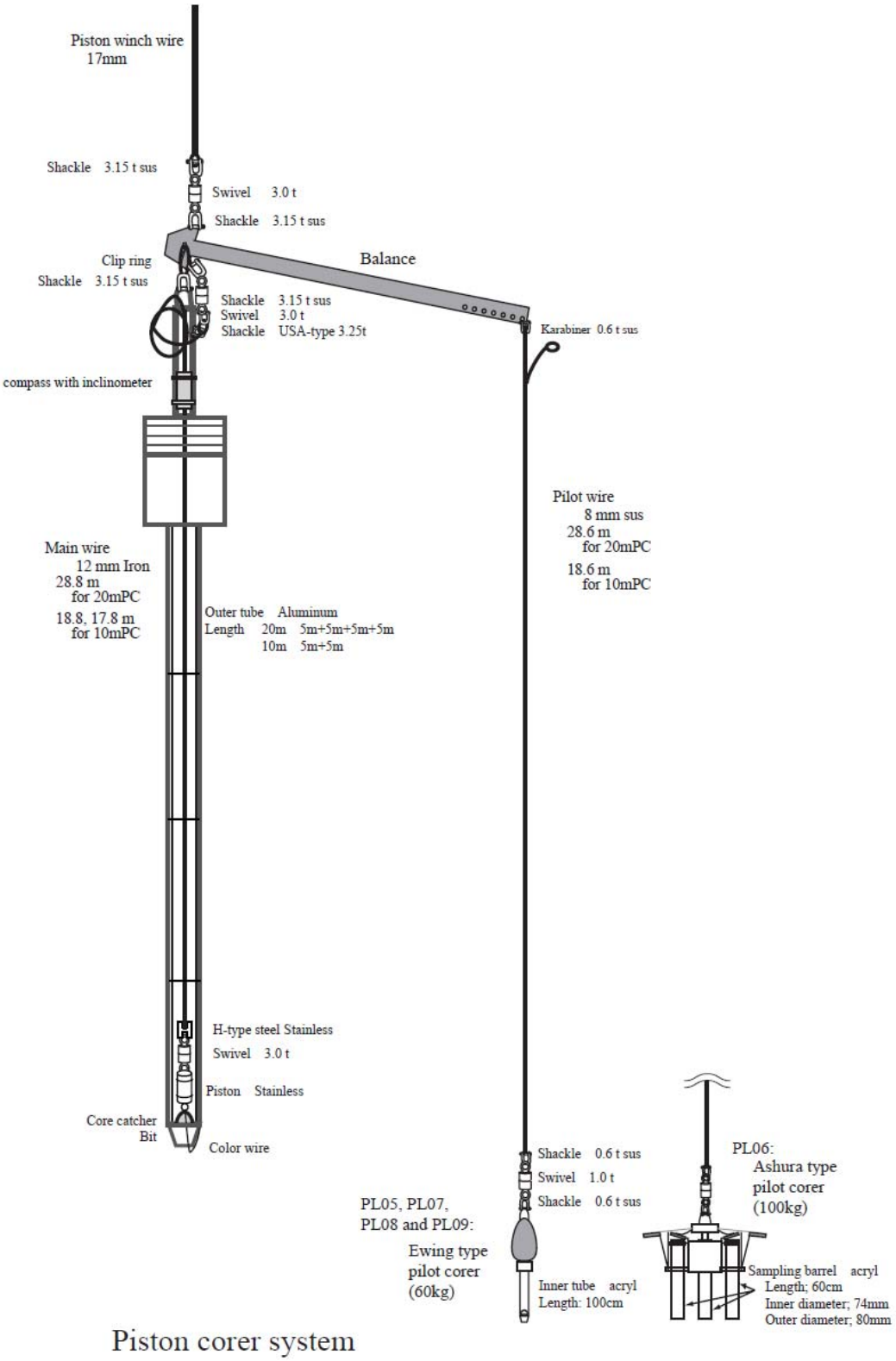

Fig. 7.5.2.1-1. Diagram of piston corer system.

7.5.2.2 Multiple Corer system

(1) *Personnel*

Naomi Harada	JAMSTEC: Principal Investigator
Ei Hatakeyama	MWJ: Operation Leader;
Yusuke Sato	MWJ
Kazuhiro Yoshida	MWJ
Yohei Taketomo	MWJ
Takami Mori	MWJ

(2) *Objectives*

Collection of surface sediment

(3) *Instruments and method*

Multiple Corer system used in this cruise consists of main body (620kg weight) and eight sub-corer attachments. We used 7 acryl pipes and 1 polycarbonate pipe. Core barrel of both acryl and polycarbonate is 60cm length and 74mm inner diameter. One of sub-cores is used to take routine physical property data (visual description, magnetic susceptibility, colors, soft-X ray photograph and normal photograph) and the sub-core for taking routine data should be split longitudinally into two halves. Because of polycarbonate pipe is easier to divide into two halved than acryl pipe, polycarbonate pipe is also utilized for taking routine data.

(4) Winch Operation

At the beginning of multiple corer system going down, the speed of wire out is set to be 0.2 m/s, and then it made gradually increase to the maximum of 1.0 m/s. Wire out is stopped at a depth about 50 m above the sea floor and the corer system is left stand for 3 minutes to reduce any pendulum motion of the system. After the multiple corer system is stabilized, the wire is stored out at a speed of 0.3 m/s with carefully watching a tension meter. When the multiple corer system touches the bottom, the tension of wire promptly decreases. After confirmation that the multiple corer system touches the bottom, wire out is immediately stopped and then is again out another 3~5 m. The rewinding of the wire is started at a dead slow speed (~0.3m/s.), until the tension gauge indicates that the multiple corer system is lifted off the bottom. After leaving the bottom, winch wire is wound up at the maximum speed (>1.0 m/s). The MC came back ship deck, the core barrel was detached main body.

(5) *Results*

Details of coring position and core length are shown in the Appendix 1 (Coring summary).

7.5.3 Physical properties measurements

7.5.3.1 Multi-Sensor Core Logger

(1) *Personnel*

Yohei Taketomo	MWJ: Operation Leader
Ei Hatakeyama	MWJ

(2) *Objectives*

To understand characteristics of sediment samples and to correlate different cores, physical properties, magnetic susceptibility was taken by using the whole round core sections before splitting and the GEOTEC multi-sensor core logger (MSCL).

(3) *Measured parameters*

The three sensors, gamma-ray attenuation, P-wave velocity, and magnetic susceptibility (MS) are equipped with the MSCL. Only MS was measured on whole-core section. Gamma-ray attenuation and P-wave velocity could not be taken, because some electrical problems had occurred.

(4) *Instruments and method*

Whole round cores are carried to the wet laboratory and leave them stand for one night to make the sediment temperature be constant and same as room temperature. After that, MS is measured by the Bartington loop sensor having an inner diameter of 100 mm equipped with MSCL. Measurement interval of sediment cores is carried on every 2 cm.

MS is detected by an oscillator circuit in the sensor, which produces a low intensity (approx. 80 A/m RMS) non-saturating, alternating magnetic field (0.565kHz) every 1 second. The unit switch should always be on SI. During this cruise, MS was manually operated, because automatic conveyor belt did no work due to electronic problem. All data were referred to the display of MS operation panel.

(5) Results

The MS raw data are shown in Fig.7.5.3.1-1~13. Data gaps of all results between sections are eliminated and then plotted in.

(6) *Date archive*

All data are submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control and will be opened to public via “R/V MIRAI Data Web Page” in JAMSTEC homepage.

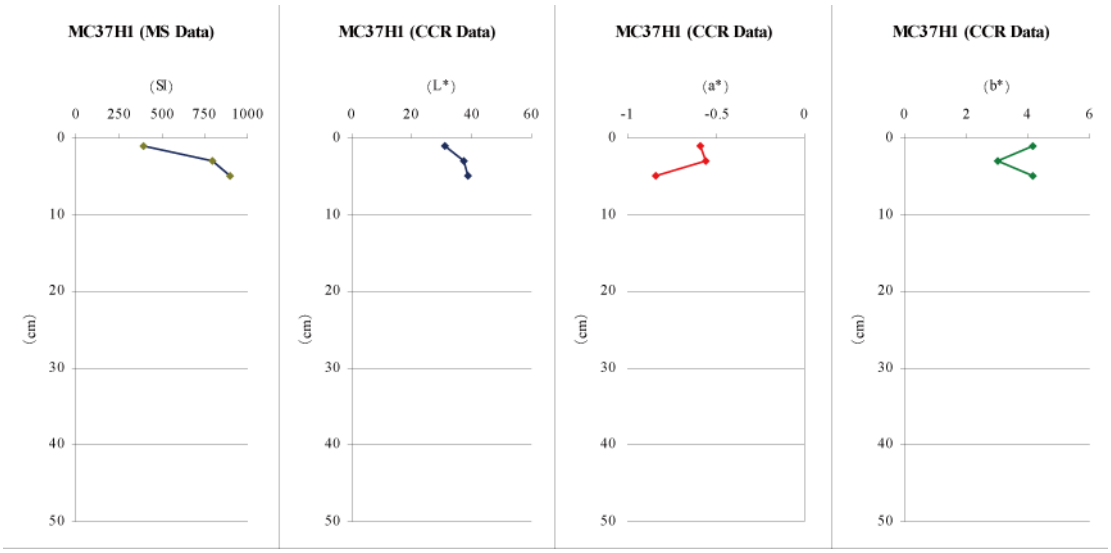

Fig.7.5.3.1-1 MS raw data and color data. (St.37 Guafo Channel)

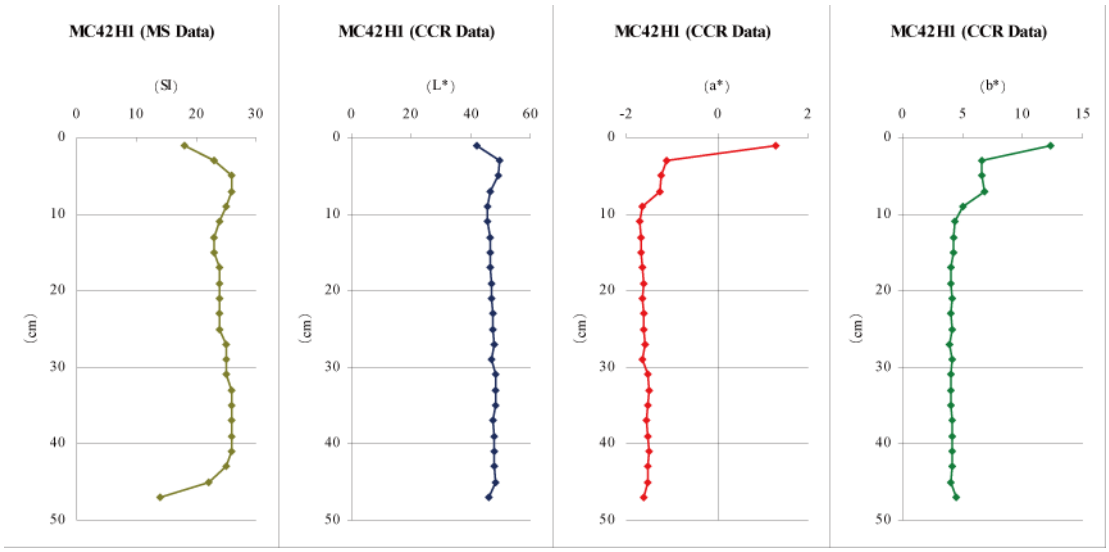

Fig.7.5.3.1-2 MS raw data and color data. (St.42 Baker Fjord C)

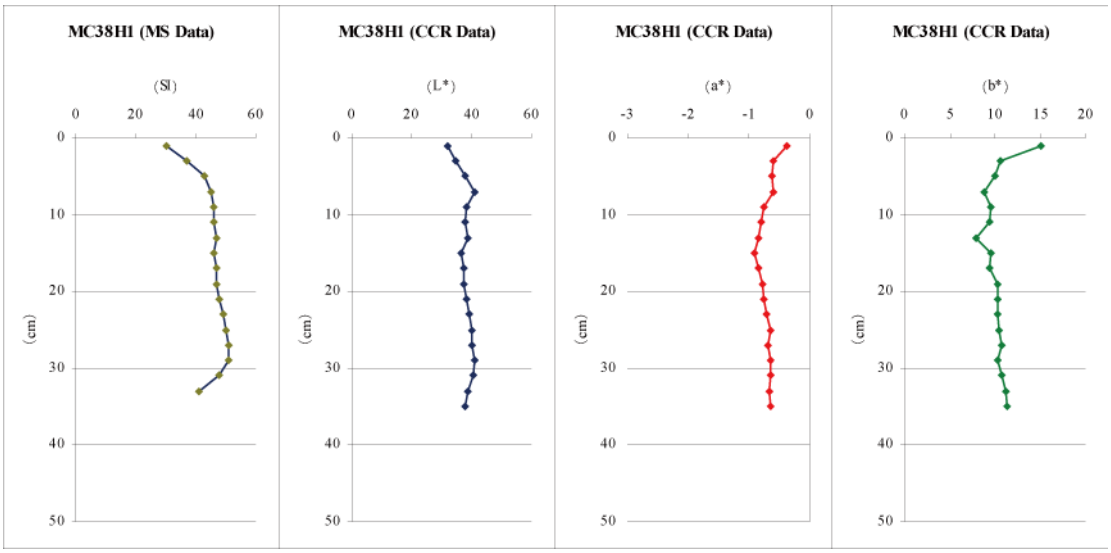

Fig.7.5.3.1-3 MS raw data and color data. (St.38 Taitao)

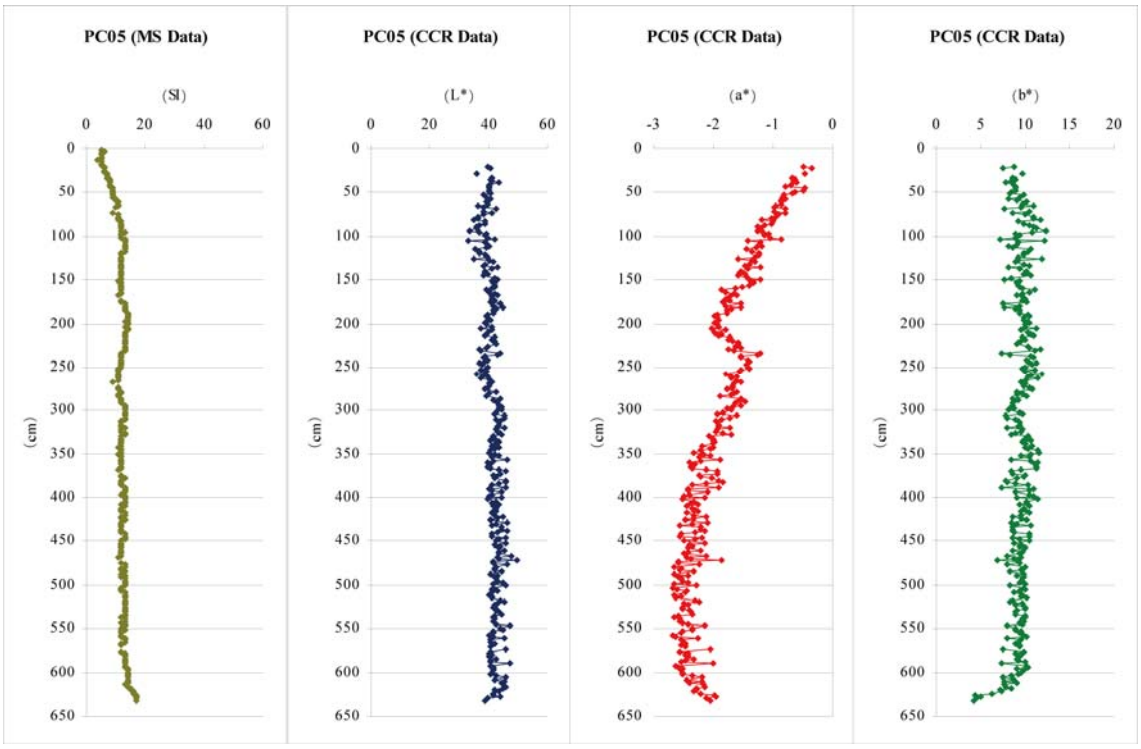

Fig.7.5.3.1-4 MS raw data and color data. (St.38 Taitao)

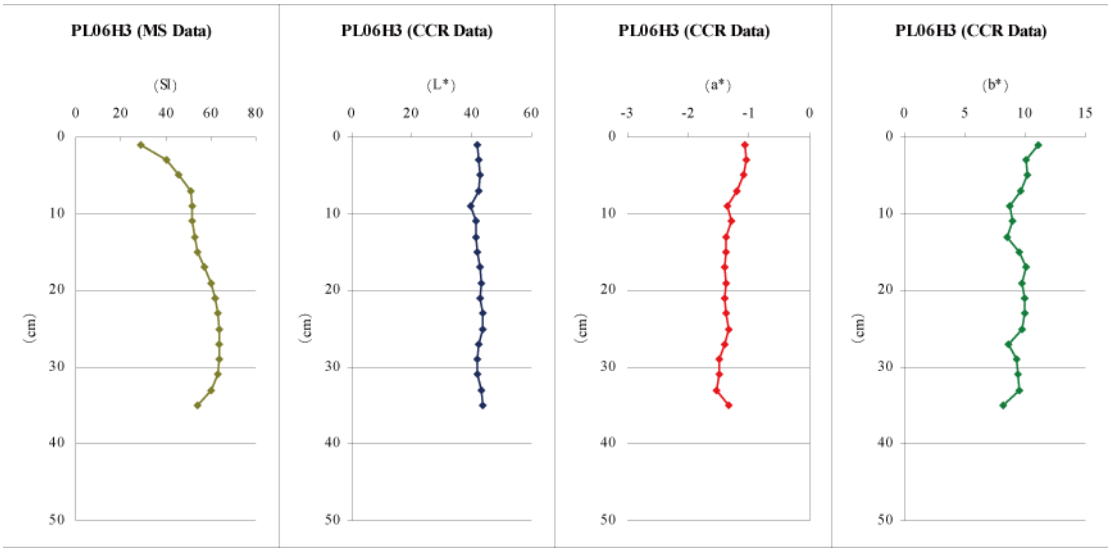

Fig.7.5.3.1-5 MS raw data and color data. (St.40 Baker Fjord A)

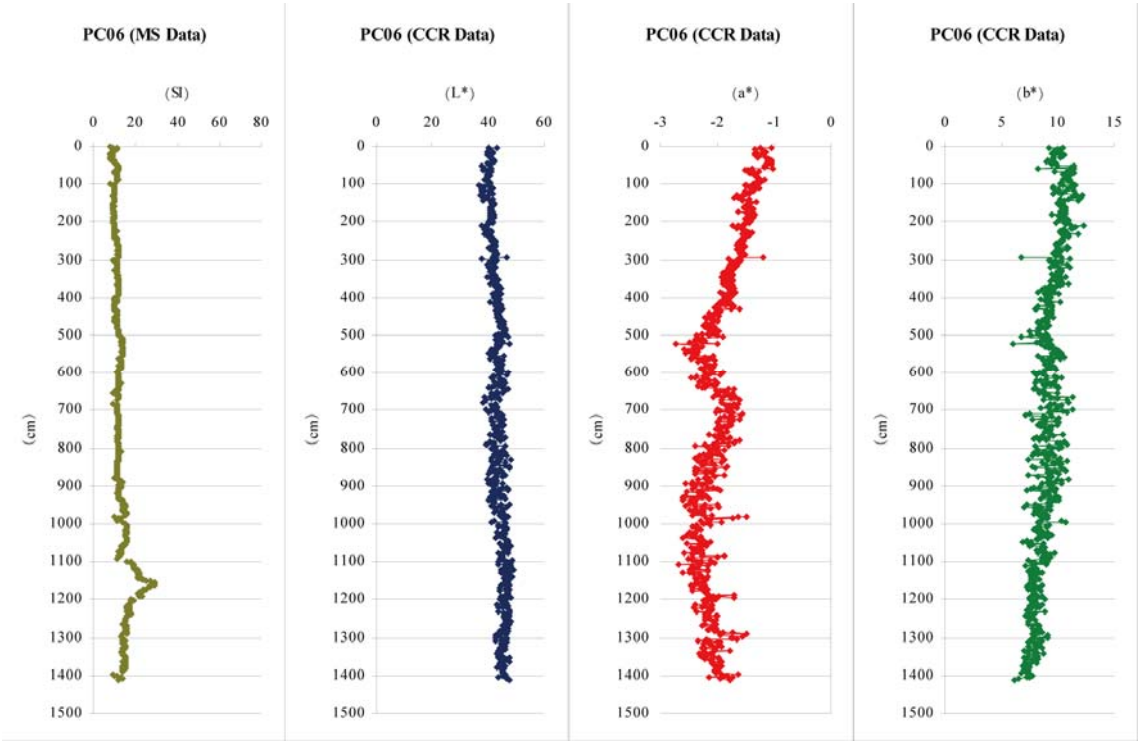

Fig.7.5.3.1-6 MS raw data and color data. (St.40 Baker Fjord A)

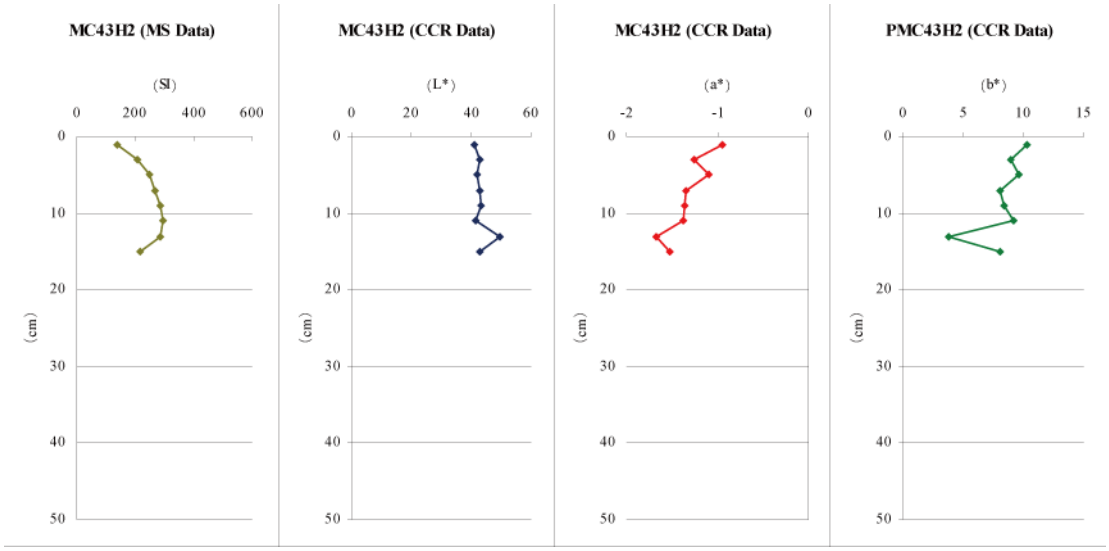

Fig.7.5.3.1-7 MS raw data and color data. (St.43 Oceanic Baker)

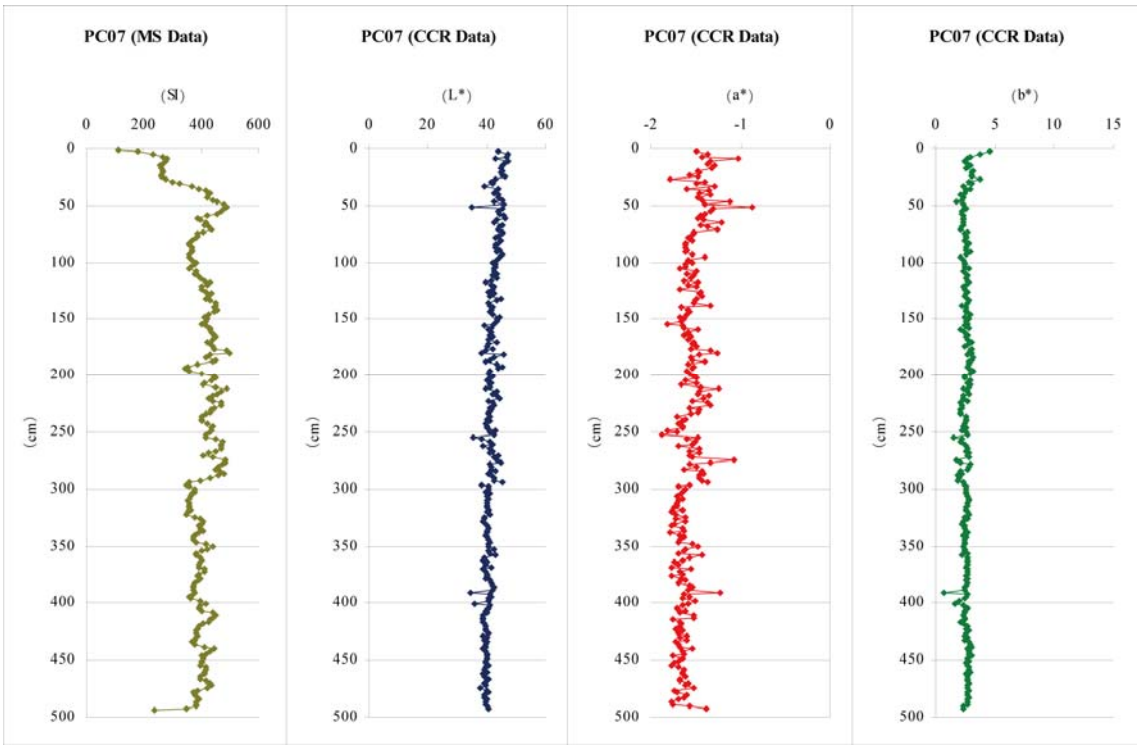

Fig.7.5.3.1-8 MS raw data and color data. (St.43 Oceanic Baker)

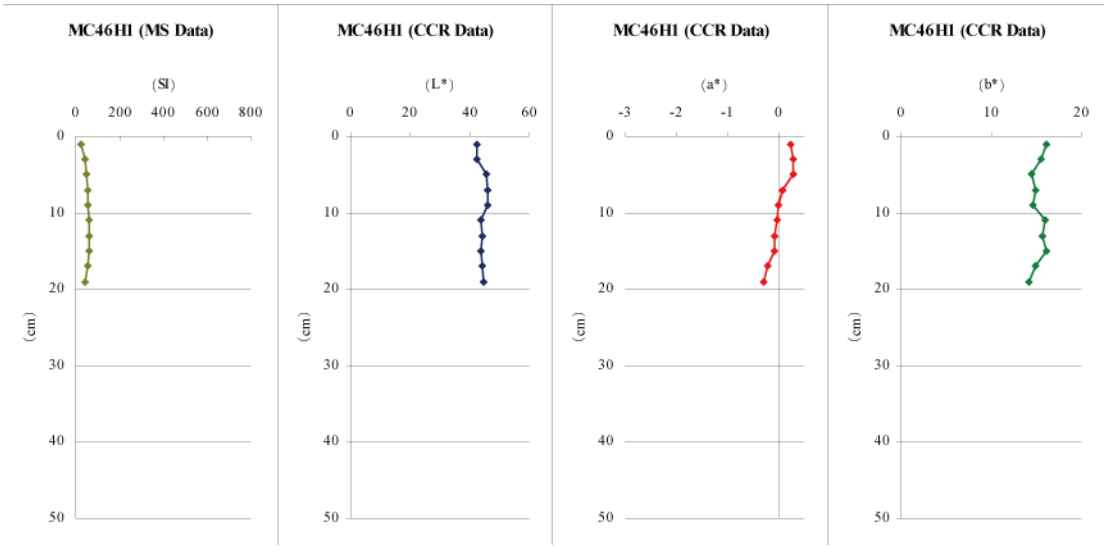

Fig.7.5.3.1-9 MS raw data and color data. (St.46 Magellan Mouth)

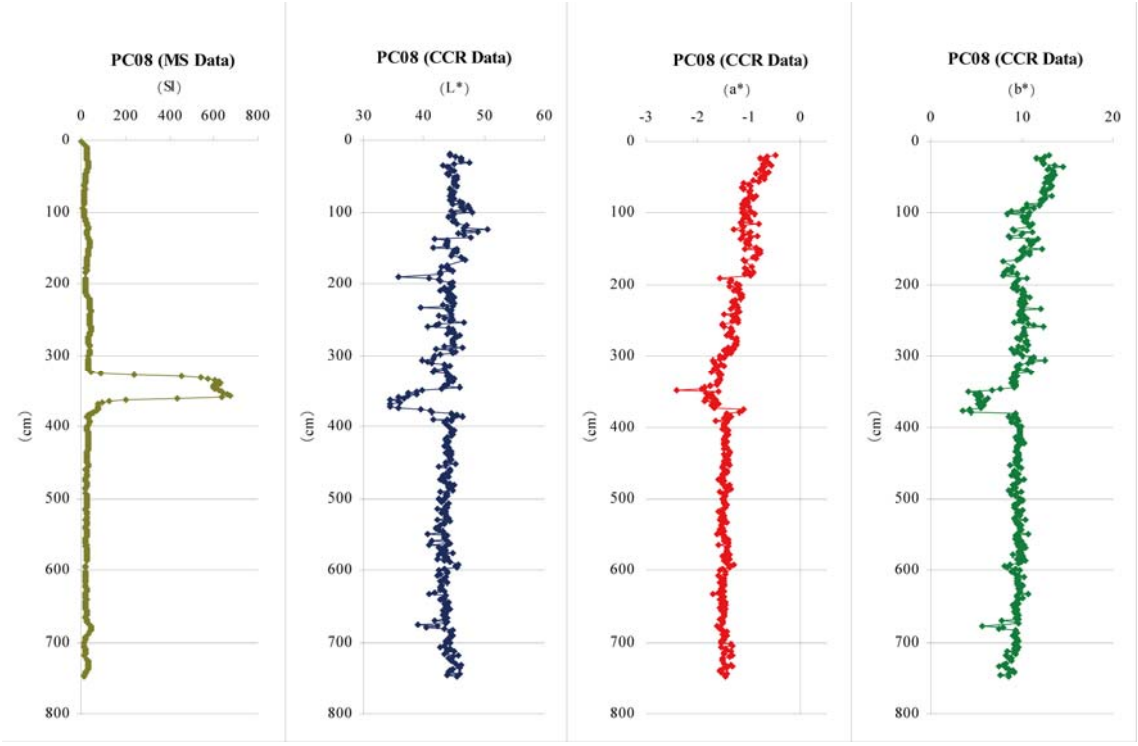

Fig.7.5.3.1-10 MS raw data and color data. (St.46 Magellan Mouth)

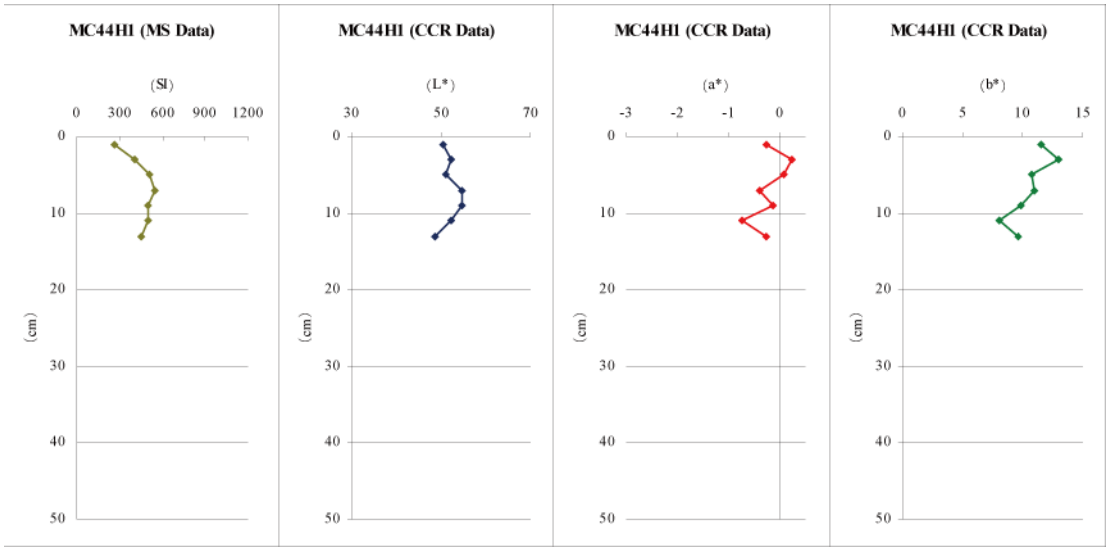

Fig.7.5.3.1-11 MS raw data and color data. (St.44 Drake)

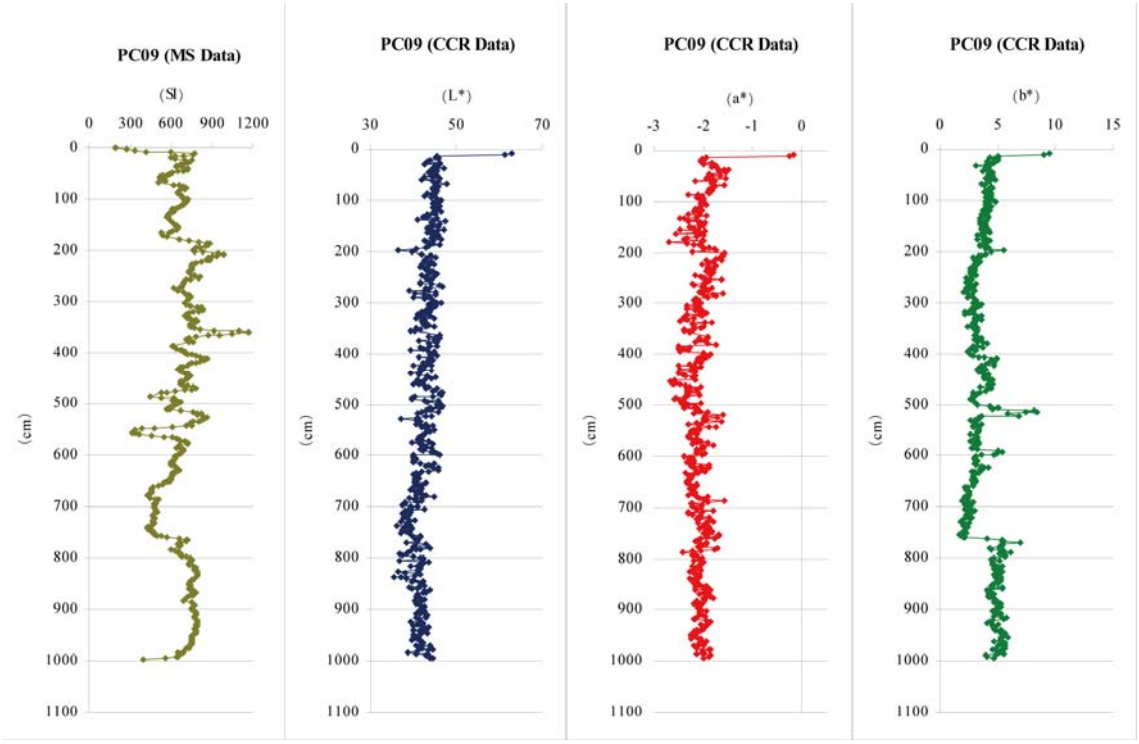

Fig.7.5.3.1-12 MS raw data and color data.. (St.44 Drake)

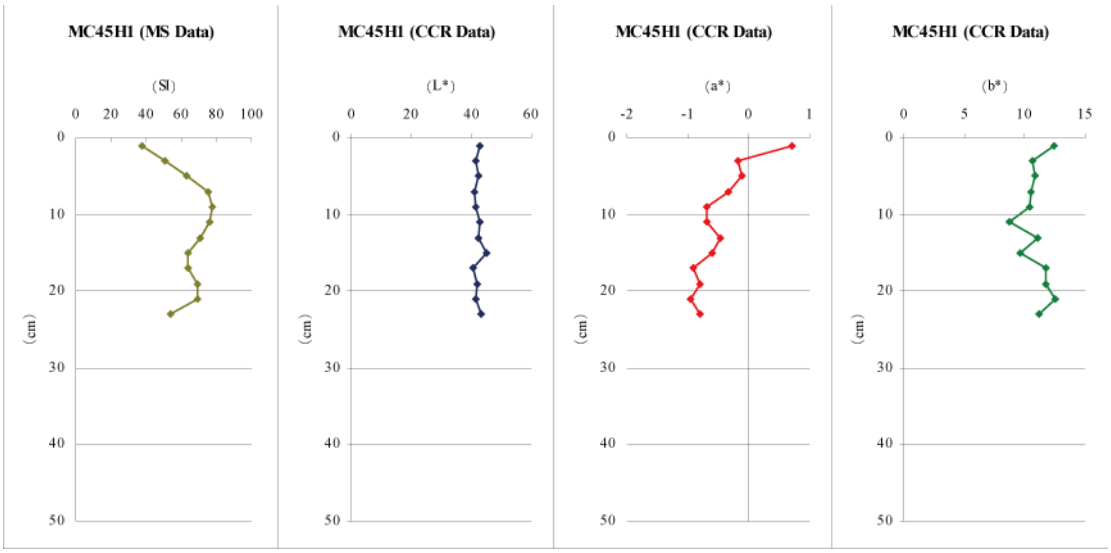

Fig.7.5.3.1-13 MS raw data and color data. (St.45 Agnes Island)

7.5.3.2 Sediment color

(1) *Personnel*

Kazuhiro Yoshida MWJ: Operation Leader

(2) *Objectives*

To understand characteristics of sediments such as lithology, redox condition, relative carbonate content, organic matter content and certain inorganic compounds, color reflectance was measured for split half sediments.

(3) *Measured parameters*

While there are a few methods to quantify color reflectance for soil and sediment, the most popular method is the L*a*b* system, and this method is also referred to as the CIE (Commision International d'Eclairage) LAB system. It can be visualized as a cylindrical coordinate system in which the axis of the cylinder is the lightness variable L*, ranging from 0% (black) to 100% (white), and the radii are the chromaticity variables a* and b*. Variable a* is the green (negative) to red (positive) axis, and variable b* is the blue (negative) to yellow (positive) axis. Spectral data can be used to estimate the abundance of certain components of sediments.

(4) *Instruments and methods*

Color reflectance of sediment was measured by using the Minolta CM-2002 reflectance photospectrometer having a range from 400 to 700nm in wavelengths. This is a compact and hand-held instrument, and can measure spectral reflectance of sediment surface with a scope of 8mm diameter. To ensure accuracy, the CM-2002 was used with a double-beam feedback system, monitoring the illumination on the specimen at the time of measurement and automatically compensating for any changes in the intensity or spectral distribution of the light. The Minolta CM-2002 has a switch that allows the specular component to be included (SCI) or excluded (SCE). Including the specular component (SCI) essentially includes glare and provides a better estimate of color as seen by the human eye. However, glare does not contribute to the spectrum reflected from the sediments. We recommend setting the switch to SCE. The SCE setting is the recommended mode of operation for sediments in which the light reflected at a certain angle (angle of specular reflection) is trapped and absorbed at the light trap position on the integration sphere.

Calibration was carried out using the zero and white calibration piece (Minolta CM-2002 standard accessories) without crystal clear polyethylene wrap before the measurement of core samples. The color of the sediment surface of split working half core was measured on every 2-cm through crystal clear polyethylene wrap. Measurement parameters are displayed Table 7.5.3.2-1.

Table 7.5.3.2-1. Measurement parameters.

Instrument	Minolta Photospectrometer CM-2002
Illuminant	d/8 (SCE)
Light source	D_{65}
Viewing angle	10 degree
Color system	L*a*b* system

(5) *Results*

The core color data are compiled in the Fig.7.5.3.1-1~13 with MS data.

(6) *Date archive*

All data are submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control and will be opened to public via “R/V MIRAI Data Web Page” in JAMSTEC homepage.

7.5.3.3 Photograph

(1) *Personnel*

Ei Hatakeyama MWJ: Operation Leader

(2) *Objectives*

Photographs were taken to observe sedimentary structures of the cores.

(3) *Instruments and method*

After splitting each section of piston, pilot and multiple cores into working and archive halves, sectional photographs of archive were taken using a digital camera (Camera body: Nikon D1x / Lens: Nikon AF Zoom-Nikkor 24-50mm). The shutter speed was 1/40 ~ 1/5 sec, F-number was 7.1～11.0. Sensitivity was ISO 125. File format of raw data is JPEG. Details for settings were included on property of each file.

(4) *Results*

Photographs of all cores are attached as Appendix 2.

(5) *Date archive*

All data are submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control and will be opened to public via “R/V MIRAI Data Web Page” in JAMSTEC homepage.

7.5.3.4 Soft-X ray photographs

(1) *Personnel*

Takami Mori	MWJ: Operation Leader
Yusuke Sato	MWJ
Kazuhiro Yoshida	MWJ
Yohei Taketomo	MWJ
Ei Hatakeyama	MWJ

(2) *Objective*

To obtain information of invisible sedimentary microstructure, soft-X ray photographs were taken onboard.

(3) *Instruments and methods*

Sediment was sub-sampled by using an original plastic case (200mm x 7mm x 3mm) from half sections. The voyage code, core number, section number, case number, and the position range (cm) printed on the TEPRA label was put on each case, and sub-sampled plastic cases were tightly sealed to avoid exudation of pore water by using thin film seal "PARAFILM".

Soft-X ray photographs were taken by SOFTEX PRO-TEST 150 on board. Soft-X ray photographs of sediment samples through the cases were in the situation of standard power (50 kVp, and 2 mA in 200 seconds). In case that indistinct development photograph is taken, irradiation time of X-ray was shortened in 150 seconds. All negative films of soft-X ray photograph were developed by a device FIP-1400 on board. These negative films were scanned by EPSON Offirio ES-10000G and were preserved as electric files.

(4) *Preliminary results*

In this cruise, the total 214 samples were sub-sampled in plastic cases, and the total 55 negative films of soft-X ray photograph (including re-photograph) were taken and developed.

(5) *Date archive*

All data are submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control and will be opened to public via "R/V MIRAI Data Web Page" in JAMSTEC homepage.

7.5.4 Redox measurements

(1) Personnel

Noriko Kawamura*	Japan Coast Guard Academy: Principal Investigator
Atushi Kurasawa	Hokkaido University/JAMSTEC

* Not onboard

(2) Objectives

Many elements are dissolved and/or precipitated within sediments and across sediment-water interface. During dissolution and precipitation processes, primary information recorded in sediments is lost or possibly emphasized. It is thus important to clarify the process of chemical change in bottom and interstitial water for evaluating paleoenvironment from marine sediments.

(3) *Instruments and methods*

In order to clarify chemical change of bottom and interstitial water, Eh (mV), pH, and dissolved oxygen (DO) were measured on board. Sediment cores up to 48 cm in length and bottom water were collected using a multiple corer at seven stations (St. 27, 28, 42, 43, 44, 45, and 46). These coring locations are described tables in the Appendix 2 “Sediment data”. Eh, pH, and DO of bottom and interstitial water were directly measured with a DO meter (HORIBA, Ltd.,OM-51-2). The top of DO electrode is covered with a thin-film, coarse grains like sand are possible to damage to the film. Thus, the measurements of interstitial water were conducted only silty clay recovered at St. 38. Measurement procedures followed those of Passier et al. (1998). The cores were split and opened, and Eh, pH, and DO were immediately measured after the core recovery. The geochemical data were obtained in the water just above the sediments (bottom water) and on the surface of cores. The measurements were carried out at every 7-8 cm in cores.

(4) *Date archive*

All data are submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control and will be opened to public via “R/V MIRAI Data Web Page” in JAMSTEC homepage.

(5) *Reference*

Passier, H. F., M. J. Dekkers, and G. J. de Lange (1998) Sediment chemistry and magnetic properties in an anomalously reducing core from the eastern Mediterranean Sea, *Chem. Geol.*, **152**, 287–306.

7.6 Underway Geophysical Observations

7.6.1 Gravity field measurement

(1) *Personnel*

Takeshi Matsumoto *	University of the Ryukyus: Principal Investigator
Masao Nakanishi *	Chiba University: Principal Investigator
Satoshi Okumura	GODI: Operation Leader
Harumi Ota	GODI
Takashi Kawamura	GODI

* : Not on-board

(2) *Introduction*

The difference of local gravity is an important parameter in geophysics and geodesy. We collected gravity data at the sea surface during the MR08-06 Leg2 cruise departure from Valparaiso on 14 March 2009 to arrival of Punta Arenas on 30 March 2009.

(3) *Measured Parameters*

Relative Gravity [mGal] = Data reading value [CU] * coef.

Converting Relative Gravity coefficient: coef. = 0.9946

(4) *Instrument and method*

We have measured relative gravity using on-board gravity meter (Micro-g LaCoste Air-sea gravity meter S-116) during this cruise. To calculate the absolute gravity, we measured at gravity reference points of Valparaiso and Punta Arenas, using portable gravity meter (Scintrex gravity meter CG-3M).

(5) *Preliminary Results*

Absolute gravity shown in Table 7.6.1-1

Table 7.6.1-1

No.	Date	U.T.C.	Port	Absolute Gravity [mGal]	Sea Level [cm]	Draft [cm]	Gravity at Sensor *[1] [mGal]	L&R *[2] Gravity [mGal]
#01	Mar/14	12:20	Valparaiso	979620.13	364	630	979621.30	11890.06
#02	Mar/30	23:43	Punta Arenas	981320.18	215	645	981320.90	13589.40

*[1]: Gravity at Sensor = Absolute Gravity + Sea Level*0.3086/100 + (Draft-530)/100*0.0431

*[2]: Micro-g LaCoste air-sea gravity meter S-116

Differential	G at sensor	L&R value
#02 - #01	1699.60 mGal ---(a)	1699.34 mGal ---(b)
L&R drift value (b)-(a)	-0.26 mGal	16.2592 days
Daily drift ratio	0.01600 **mGal/day**	

(6) *Data Archives*

Gravity data obtained during this cruise will be submitted to the Data Integration and Analysis Group (DIAG) of JAMSTEC, and will be archived there.

7.6.2 Three-component magnetic field measurement

(1) *Personnel*

Takeshi Matsumoto *	University of the Ryukyus :Principal Investigator
Masao Nakanishi *	Chiba University:Principal Investigator
Satoshi Okumura	GODI: Operation Leader
Harumi Ota	GODI
Takashi Kawamura	GODI

* : Not on-board

(2) *Introduction*

Measurement of magnetic force on the sea is required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. We measured geomagnetic field using a three-component magnetometer during the MR08-06 Leg2 cruise departure from Valparaiso on 14 March 2009 to arrival of Punta Arenas on 30 March 2009.

(3) *Principle of ship-board geomagnetic vector measurement*

The relation between a magnetic-field vector observed on-board, Hob, (in the ship's fixed coordinate system) and the geomagnetic field vector, F, (in the Earth's fixed coordinate system) is expressed as:

$$\mathbf{H}\mathrm{ob} = \mathbf{A}\,\mathbf{R}\,\mathbf{P}\,\mathbf{Y}\,\mathbf{F} + \mathbf{H}\mathrm{p} \qquad \text{(a)}$$

where **R**, **P** and **Y** are the matrices of rotation due to roll, pitch and heading of a ship, respectively. $\tilde{\mathbf{A}}$ is a 3 x 3 matrix which represents magnetic susceptibility of the ship, and **H**p is a magnetic field vector produced by a permanent magnetic moment of the ship's body. Rearrangement of Eq. (a) makes

$$\mathbf{B}\,\mathbf{H}\mathrm{ob} + \mathbf{H}\mathrm{bp} = \mathbf{R}\,\mathbf{P}\,\mathbf{Y}\,\mathbf{F} \qquad \text{(b)}$$

where **B** = A-1, and **H**bp = -B **H**p. The magnetic field, **F**, can be obtained by measuring **R**, **P**, **Y** and **H**ob, if **B** and **H**bp are known. Twelve constants in **B** and **H**bp can be determined by measuring variation of **H**ob with **R**, **P** and **Y** at a place where the geomagnetic field, **F**, is known.

(4) *Instruments on R/V MIRAI*

A shipboard three-component magnetometer system (Tierra Tecnica SFG1214) is equipped on-board R/V MIRAI. Three-axes flux-gate sensors with ring-cored coils are fixed on the fore mast. Outputs from the sensors are digitized by a 20-bit A/D converter (1 nT/LSB), and sampled at 8 times per second. Ship's heading, pitch and roll are measured by the Inertial Navigation System (INS). Ship's position (GPS) and speed data are received through LAN every second.

(5) *Data Archives*

These data obtained in this cruise will be submitted to the Data Integration and Analysis Group (DIAG) of JAMSTEC.

(6) *Remarks*

For calibration of the ship’s magnetic effect, we made a “figure-eight” turn (a pair of clockwise and anti-clockwise rotation, 17:57 - 18:34 UTC, 27 March 2009, about at 55-32.3S, 66-03.7W)

7.6.3 Swath Bathymetry

(1) *Personnel*

Takeshi Matsumoto*	University of the Ryukyus	: Principal Investigator
Masao Nakanishi*	Chiba University	: Principal Investigator
Satoshi Okumura	GODI	: Operation Leader
Harumi Ota	GODI	
Takashi Kawamura	GODI	

* : Not on-board

(2) *Introduction*

R/V MIRAI is equipped with a Multi narrow Beam Echo Sounding system (MBES), SEABEAM 2112.004 (SeaBeam Instruments Inc.), and Sub-Bottom Profiler (SBP) optional system. The objective of MBES is collecting continuous bathymetric data along ship's track to make a contribution to geological and geophysical investigations and global datasets.

(3) *Data Acquisition*

The "SEABEAM 2112.004" on R/V MIRAI was used for bathymetry mapping during the MR08-06 Leg.2 cruise from 14 March 2009 to 30 March 2009.

To get accurate sound velocity of water column for ray-path correction of acoustic multibeam, we used Surface Sound Velocimeter (SSV) data to get the sea surface (6.2m) sound velocity, and the deeper depth sound velocity profiles were calculated by temperature and salinity profiles from CTD data by the equation in Mackenzie (1981) during the cruise.

Table 7.6.3-1 shows system configuration and performance of SEABEAM 2112.004 system.

Table7.6.3-1 System configuration and performance

SEABEAM 2112.004 (12 kHz system)

Frequency:	12 kHz
Transmit beam width:	2 degree
Transmit power:	20 kW
Transmit pulse length:	3 to 20 msec.
Depth range:	100 to 11,000 m
Beam spacing:	1 degree athwart ship
Swath width:	150 degree (max)
	120 degree to 4,500 m
	100 degree to 6,000 m
	90 degree to 11,000 m
Depth accuracy:	Within < 0.5% of depth or +/-1m,
	whichever is greater, over the entire swath.
	(Nadir beam has greater accuracy;
	typically within < 0.2% of depth or +/-1m, whichever is greater)

Sub-Bottom Profiler (4kHz system)

Frequency:	4 kHz
Transmit beam width:	5 degree
Transmit pulse length:	5 to 100 msec
Depth Penetration:	As much as 75 m (varies with bottom composition)
Resolution of sediments:	Under most condition within < tens-of-centimeters range
	(dependent upon depth and Transmit pulse length)

(4) *Preliminary Results*

The results will be published after primary processing.

(5) *Data Archives*

Bathymetric data obtained in this cruise will be submitted to the Data Integration and Analysis Group (DIAG) of JAMSTEC, and will be archived there.

7.7 Analytical plan on land

7.7.1 Alkenone analysis for paleo-thermometer

(1) *Personnel*

Naomi Harada	JAMSTEC: Principal Investigator
Miyako Sato	JAMSTEC

(2) *Objectives*

The eastern South Pacific Ocean is one of the least explored and most productive regions of the global ocean. Circulation along the Chilean coastline is controlled by the West Wind Drift (WWD) which approaches the coast at 45°S, where it splits into the Peru-Chile Current (PCC) and the Cape Horn Current (CHC). The PCC flows equatorward to ca. 4°S where it turns westward. The CHC flows poleward along the southernmost coast of Chile. The area north of ca. 40°S is characterized by very high productivity due to coastal upwelling of nutrient-rich equatorial subsurface waters (ESSW) and a sub-surface oxygen minimum zone. South of this latitude, productivity is also high due to the interplay of nutrients from the south and runoff from the Chilean fjord system. Antarctic Intermediate Water, which has high oxygen, low nutrients and salinity, is present at the depths 400–900m. Thus, the Chilean marginal area has been recognized as a key area for biogeochemical cycle of carbon in the global oceans not only during modern times but also over the past geological period. Studies over the past decade have focused on the area north of ca. 43°S but little is known of the paleoceanographic history in the southern region.

Therefore, the main goal of this leg is to study changes in the biological pump, sea surface water temperature and ventilation speed of the intermediate water during the recent past geological era, and to clarify the bio-optical dynamics in the surface water at present times.

(3) *Instruments and methods*

The alkenone unsaturation index, $U^{K'}_{37}$, which is derived from the relative abundance of methyl alkenones with 37 carbon atoms and two or three double bonds ($U^{K'}_{37} = (C_{37:2})/(C_{37:2} + C_{37:3})$), will be used as a proxy for a water thermometer because a linear relationship exists between $U^{K'}_{37}$ and the temperature of the water in which the alkenone producers live (Brassell et al., 1986; Prahl et al., 1988). For the alkenone analysis, a sediment sample (2–4 g dry weight) is ground into powder. The fractions containing bulk organic compounds are extracted from sediment samples with an Accelerated Solvent Extractor (ASE-200, DIONEX Japan Ltd.). The extracts are saponified in 0.5 M KOH in methanol and the neutral fraction is recovered with a pipette, dissolved in hexane, and then separated into subfractions by silica gel column chromatography using an automatic solid-preparation system (Rapid Trace SPE Workstation, Zymark, UK). An aliquot of the alkenone fraction is analyzed by capillary gas chromatography with an Agilent 6890N gas chromatograph, Agilent (USA) equipped with an fused-silica column, a cold on-column injector, and a flame ionization detector.

(4) *Expected results*

Based on the above-mentioned purpose, alkenone-derived sea surface temperature (SST) will be analyzed by using piston cores with fine time as much as we can. Changes in SST will be accompanied by changes in primary productivity proxies such as biogenic opal, total organic carbon, total nitrogen, and isotopes of organic matter $d^{13}C$ and $d^{15}N$, as well as changes in ventilation based on carbon isotope data of planktic and benthic foraminifers. From alkenone-derived SST changes, we will discuss changes of SST with fine time resolution to clarify the mechanisms of abrupt climate changes and both hemispheric telleconection comparing the proxy records previously reported from North Pacific.

(5) *Date archive*

All data will be submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control and will be opened to public via “R/V MIRAI Data Web Page” in JAMSTEC homepage.

7.7.2 Geochemical analyses (Nd, Sr, and N isotopes, and REE abundance) of fjord and oceanic sediments

(1) *Personnel*

Keiji Horikawa Nagoya University

(2) *Analytical plan of sediments on land*

i. To reconstruct temporal changes in sediment sources, I will measure Nd and Sr isotopes and rare earth elements of bulk sediments using Thermal Ionization Mass Spectrometer (TIMS) and Inductively Coupled Plasma Mass Spectrometer (ICP-MS).

ii. To reconstruct temporal changes in bottom water Nd isotopes, I will measure Nd isotopes of Fe-Mn oxyhydroxide coatings of bulk sediments using TIMS. Moreover, I will measure Nd isotopes in bottom sea-water, and compare to Nd isotopes of Fe-Mn oxyhydroxide coatings of the surface sediments at the same site.

iii. If there is a relationship between Sr isotopes in surface water (sea-water samples) and SSS (sea-surface salinity) in Fjord settings, Sr isotopes in foraminiferal calcite can be used to reconstruct paleo-SSS. Therefore, if planktonic foraminifera are abundant in sediments, I will measure Sr isotopes in foraminiferal calcite.

iv. To reconstruct nutrient conditions from the last glacial maximum through the Holocene in the Antarctic Circumpolar current, I will measure bulk ^{15}N isotopic compositions of some cores (PC-6, 7, and 9).

(3) *Date archive*

All data will be submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control and will be opened to public via “R/V MIRAI Data Web Page” in JAMSTEC homepage.

7.7.3 Radiolaria

(1) *Personnel*

Isao Motoyama	University of Tsukuba: Principal Investigator
Yasumi Yamada	University of Tsukuba

(2) *Objectives*

The cored sites of this cruise are located in/close to the region that was covered by expanded Patagonian Glacier during the last glacial period. Our interests are projected to the process of the retreat of the glacier through the deglacial to Holocene time. Oceanic water intrusion into fjords in association with past sea level rises and glacier retreat might be recorded by occurrence of oceanic radiolarian species in the cored sediments recovered from the fjords (PC-5, PC-6 and PC-8). Radiolarians from deep-sea cores (PC-7 and PC-9) are expected to reflect past changes in surface to deep-water conditions.

(3) *Instruments and methods*

Bulk sediment samples are freeze-dried and weighed before treatment with hydrogen dioxide (H_2O_2) and hydrochloric acid (HCl). Disaggregated particles are sieved wet through 45 μm mesh sieves. Remaining coarse particles are mounted on glass slides with Canada Balsam or alternative mount media.

(4) *Preliminary results and analytical plan on land*

Because our shipboard results show rare radiolarians from PC-8 and PC-9 (see below), we will have to roughly search the sediments of the five cores for radiolarians first, and then choose some appropriate cores for radiolarian work. We preliminarily searched five sediment samples from cores PC-8 and PC-9 for radiolarians onboard. The wet samples were treated with H_2O_2 and rinsed with 45 μm mesh sieves. Remaining particles were pipetted onto glass slides and mounted with Entellan New. An optical microscope was used for observation and identification. Radiolarians are rare or absent in the samples and some species are identified as follows:

PC-8 (St. 46B), sec. 1-41

Actinomma boreale
Amphimelissa sp. A
Cenosphaera? sp.
Lithomelissa setosa
Lophophaena sp.
Tetrapyle octacantha

PC-8 (St. 46B), sec. 4-44

Amphimelissa sp.
Lithelius sp.
Lithomelissa setosa

Lithomelissa? sp.
Lophophaena sp.
Spirocyrtis seriata
Stylodictya multispina?
Tetrapyle octacantha
Theocorythium trachelium

PC-9 (St. 44), sec. 1-31
Barren of radiolarians.

PC-9 (St. 44), sec. 3-45
Barren of radiolarians.

PC-9 (St. 44), sec. 10-43
Phorticium? sp.
Spongodiscus sp.

(5) *Date archive*

All data will be submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control and will be opened to public via "R/V MIRAI Data Web Page" in JAMSTEC homepage.

7.7.4. ^{14}C age analysis of fjord and oceanic sediments

(1) *Personnel*

Kazuyo Shiroya	The University of Tokyo: Principal Investigator
Yusuke Yokoyama*	The University of Tokyo

* Not on board

(2) *Objectives*

i. To reconstruct ages of sediments and the age-depth relationship of fjord and oceanic sediments

ii. To obtain information of environmental changes using chemical composition of sediment

(3) *Measured parameters*

^{14}C, dry bulk density and chemical composition

(4) *Instruments and methods*

i. We will use planktonic or benthic foraminifera to reconstruct ^{14}C ages of sediments. We will handpick planktonic or benthic foraminifera from sediments in each depth, and measure ^{14}C concentrations of handpicked specimens using Accelerator Mass Spectrometry at Univ. of Tokyo.

ii. We have sampled sediments with cube (~2.2 cm) on board and those samples will be used for the experiments of dry bulk density measurement. Then the major element of the sediments will be analyzed by XRF.

(5) *Expected results*

We will obtain information of sedimentation rates from ^{14}C ages of sediments in each depth. ^{14}C ages by AMS and chemical compositions by XRF data will help us to understand the past geological events and evolution of climate change in the Chilean continental marginal area.

(6) *Data archives*

All data will be submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control and will be opened to public via “R/V MIRAI Data Web Page” in JAMSTEC homepage.

7.7.5 Biomarkers, opal and microfossil analyses from fjord and oceanic sediments (Multiple cores and Piston cores)

(1) *Personnel*

Carina Lange	UdeC, Dept. of Oceanogr., & COPAS Center: Principal Investigator
Silvio Pantoja	UdeC, Dept. of Oceanogr., & COPAS Center
Alejandro Avila	UdeC, Dept. of Oceanogr., & COPAS Center
Lilian Muñoz*	UdeC, Dept. of Oceanogr., & COPAS Center
Praxedes Muñoz*	Universidad Católica del Norte
Margarita Marchant*	UdeC,, Dept. of Zoology

* Not on board

(2) *Objectives*

i. Calibration of proxies in the modern ocean
ii. Understanding the modifications that the proxies undergo until they are finally preserved in the sedimentary column.
iii. Construct age model of Multicores based on ^{210}Pb
iv. Reconstructing historical changes (100-200 years of deposition depending on sedimentation rate) in export production, from Multicores
v. Reconstructing long-term changes in export production, from Piston cores
vi. Integrating marine and continental proxies in order to understand recent and past land-ocean interactions

(3) *Measured parameters*

For the Multiple cores, the upper 5 cm were sampled at 0.5 cm resolution; thereafter, sampling resolution was 1 cm until the end of the core. The following table shows the Multiple cores sampled for analysis of biogenic and lithogenic opal (A. Avila and C. Lange), selected biomarkers (pigments, alkenones, n-alkanes; S. Pantoja), microfossils (C. Lange and M. Marchant), and ^{210}Pb (P. Muñoz). Samples for biomarkers are kept in aluminum bags; all other samples are kept in ziploc bags. The inventory of multiple cores is shown in Table 7.7.5-1.

Table 7.7.5-1 Inventory of multiple core samples.

Sample Name	Remarks
muc 38-2	kept as archive for concepcion
muc 38-3	sampled for biomarkers at 0,5cm from 0 to 5; sampled at 1cm from 5 to end of core
muc 38-4	sampled for Opal and microfossils at 0,5cm from 0 to 5; sampled at 1cm from 5 to end of core
muc 40-2	sampled for biomarkers and 210Pb at 0,5cm from 0 to 5; sampled at 1cm from 5 to end of core
muc 42-7	sampled at 0,5cm from 0 to 3 only
muc 43-4	sampled for Opal, microfossils and 210Pb at 0,5cm from 0 to 5; sampled at 1cm from 5 to end of core
muc 43-8	sampled at 0,5cm from 0 to 4,5 only. note: labels lost in freezer samples unusable
muc 44-2	sampled for 210Pb at 0,5cm from 0 to 1; sampled at 1cm from 1 to 12
muc 44-3	sampled for biomarkers at 0,5cm from 0 to 1; sampled at 1cm from 1 to 5
muc 44-4	sampled for Opal and microfossils at 0,5cm from 0 to 1; sampled at 1cm from 1 to 12
muc 45-2	sampled for 210Pb at 0,5cm from 0 to 1; sampled at 1cm from 1 to 20 cm
muc 45-3	sampled for Opal and microfossils at 0,5cm from 0 to 1; sampled at 1cm from 1 to 20 cm
muc 45-4	sampled for biomarkers and 210Pb at 0,5cm from 0 to 5; sampled at 1cm from 5 to 21 cm
muc 46b-2	sampled for microfossils at 0,5cm from 0 to 5; sampled at 1cm from 5 to end of core
muc 46b-3	sampled for 210Pb at 0,5cm from 0 to 5; sampled at 1cm from 5 to end of core
muc 46b-4	sampled for biomarkers at 0,5cm from 0 to 5; sampled at 1cm from 5 to end of core

For the Piston cores, the archive half of each piston core was sampled for analysis of biogenic and lithogenic opal (A. Avila and C. Lange), biomarkers (pigments, n-alkanes; S. Pantoja), and microfossils (C. Lange and M. Marchant), according to the following Table 7.7.5-2:

Table 7.7.5-2 Inventory of piston core samples

Sample name	Remarks
PC-05	Archive half, sections 1 to 7 odd cubes for Opal and microfossils; even cubes for biomarkers
PC-06	Archive half, sections 1 to 14 odd cubes for Opal and microfossils; even cubes for biomarkers
PC-07	Archive half, sections 1 to 5 odd cubes for Opal and microfossils; even cubes for biomarkers
PC-08	Archive half, sections 1 to 7 odd cubes for Opal and microfossils; even cubes for biomarkers
PC-09	Archive half, sections 1 to 10 odd cubes for Opal and microfossils; even cubes for biomarkers

Samples for biomarkers are kept in aluminum bags; samples for opal and microfossils are kept in Ziploc bags.

(4) *Instruments and Methods*

i. *Opal measurements*

Freeze-dried samples from Multiple cores and piston cores will be used for measurements of biogenic and lithogenic silica. Each subsample of 25 mg will be subject to the molibdenum blue method of Mortlock and Froelich (1989).

ii. Microfossils:

Multiple core and piston core samples will be analyzed for their siliceous microfossil content. Freeze-dried sediment will be treated according to the technique described in Schrader and Gersonde (1978). Two permanent slides per acid-cleaned material sample will be prepared and analyzed with a

Zeiss-Axioscope 2 plus microscope with phase-contrast illumination. Foraminifer assemblages will be studied depending on funding sources.

iii. *Photosynthetic pigments and biomarkers (sterols, n-alkanes)*

Photosynthetic pigments and biomarkers (sterols, n-alkanes) will be determined in samples collected in with multicore at stations 37, 38, 44, 45 y 46, and in the piston core samples. Photosynthetic pigments, biomarkers (sterols, n-alkanes, alkenones), bulk $\delta^{15}N$, and bulk delta $\delta^{13}C$ will be measured in samples collected from multicores at stations 39, 40, 41, 42 y 43.

iv. Stable isotopes analyses

Sediment samples will be freeze-dried, ground, and homogenized in an agate mortar before processing. About 30 mg of sediment will be weighed in tin cups and carbonates removed by acidification with 50% v/v sulfurous acid. Organic carbon, total nitrogen, bulk $\delta^{13}C$, and $\delta^{15}N$ will be analyzed at the University of California Davis Stable Isotope Facility.

v. Lipid biomarkers

Lipids will be extracted from freeze dried sediments in an Accelerated Solvent Extraction System using a mixture of CH2Cl2:MeOH 9:1 at 100 ºC and 1000 psi, and prepared for GC-MS analysis (Prahl & Wakeham 1987, Wakeham et al. 2002).

vi. *Pigments*

Pigments will be determined according to Villanueva & Hastings (2000).

vii. *^{210} Pb*

The age model of Multicores will be based on ^{210}Pb analyses, carried out by alpha spectrometry of its daughter ^{210}Po (Flynn, 1968). The ages will be calculated using the inventory of activities in excess according to the constant rate of the supply model (CRS), which assumes a constant input of ^{210}Pb, unaffected by changes in sediment type or sedimentation rate and constant porosity (Appleby and Oldfield, 1978; McCaffrey and Thompson, 1980).

(5) *Results (preliminary or expected)*

Laboratory analyses of Multiple core samples will start during the first semester of 2009, focusing first on the Baker channel transect (stations 40, 42, 43) and the Golfo de Penas station 38 since these sites are directly related to the objectives of the *COPAS Sur-Austral* program.

Surface samples from Multiple cores will be integrated with water column measurements (from hydrocasts and drifting sediment traps) with the purpose of calibration of proxies in the modern ocean, and understanding the modifications that the proxies undergo until they are finally preserved in the sedimentary column. The sedimentary column of Multiple cores will serve for reconstructing historical changes (100-200 years of deposition depending on sedimentation rate) in export primary production, and also for integrating marine and continental proxies in order to understand land-ocean interactions in

the recent past. The expected results will be compared with published results from our previous studies in fjords from northern Patagonia (Rebolledo et al., 2005, 2008; Sepúlveda et al., 2005).

Laboratory analyses of Piston core samples will start as age models become available, focusing first on the Baker and Golfo de Penas sites (40 and 38, respectively). We will reconstruct past changes in export production, and also integrate marine and continental proxies in order to understand land-ocean interactions. Our results will be compared and integrated with previous publications (e.g. Lamy et al., 2004) as well as results from PACHIDERME MD 159 cruise on RV Marion Dufresne.

(6) *Data archives*

All data will be submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and is currently under its control and will be opened to public via "R/V MIRAI Data Web Page" in JAMSTEC homepage.

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7.7.6. Magnetic properties, bulk composition of sediments and age distribution of clastic zircons

(1) *Personnel*

Ryo Anma	University of Tsukuba: Principal Investigator

(2) *Objectives and scientific interests*

i. Anisotropy of magnetic susceptibility and remanent magnetism

I am interested in testing if it is possible to determine paleo-current direction from recovered rather homogeneous sediments using anisotropy of magnetic susceptibility. My research interest extends to determining intensity of remanent magnetization of sediments to estimate the age of deposition.

ii. Bulk composition of sediments

Primary target of this study is to provide basic data to estimate how any subducted sediments have influence on generation of magmas in the ridge subduction zone, that eventually returned to the surface as volcanic ejecta or as intrusion of igneous body.

iii. Age distribution of clastic zircons

I intend to study distribution of U-Pb ages of clastic zircons separated from sediments in Golfo de Penas region. Down-hole age distribution of clastic zircon may provide important clue to understand when Rio Baker started transecting the Andes. Age distribution of clastic zircons is also useful when estimating influence of subducted sediments on generation of magmas in the ridge subduction zone.

7.8 Visual core description

(1) *Personnel*

Ryo Anma	University of Tsukuba: Principal Investigator
Kiichiro Kawamura	Fukada Geological Institute
Isao Motoyama	University of Tsukuba, Japan
Yasumi Yamada	University of Tsukuba

(2) *Methods*

The sampling sites for multiple coring and piston coring are shown in Figure 7.8-1, together with grain components of the surface sediments.

Observation for visual core description (VCD) for core samples was made on split surface of working half sections. The split surface was scraped using a glass plate to expose fresh surface. Lithological and sedimentological features were described on a VCD spread sheet (see Appendix 2: Sediment data) for each section. Information in the VCD spread sheets was used to synthesize the stratigraphical column of PC-5 ~ PC-9 (Figure 7.8-2~ Figure 7.8-11). Symbols used for VCD is listed in Figure 7.8-12. Primary sediment lithology name was first described on core and then confirmed under a microscope (see Appendix 2: Sediment data). We adopted the IODP-style nomenclature for lithological description (e.g., Mazzullo et al., 1988) with some modifications. Sediment classification scheme used here was the Shepard's ternary diagram for sand-silt-clay component system.

(3) *Results*

i. Surface sediments

The components of surface sediments from Stations 37 to 46 are summarized in Figure 7.8-1. Station 38 corresponds to PC-05 site, Station 40 to PC-06 site, Station 43 to PC-07 site, Station 46 to PC-08 site and Station 44 to PC-09 site, respectively. Siliciclastic grains are predominant in sediments of the surface layers from northern latitudes between 43^{o} S and 49^{o} S, regardless inside or outside of the fjord. Nannofossils, diatoms and foraminifers were observed inside and offshore of the Golfo de Penas. In contrast, surface sediments in the southern latitudes (> 52^{o} S) mainly consist of bioclasts, micro- and nannofossils, and contain only less than 30 % siliciclastic grains.

ii. Piston cores

We used piston core with inner tube for PC-05 to PC-08 and without inner tube for PC-09. Length of the piston core was 20 m for PC-05, PC-06 and PC-08, and 10 m for PC-07 and PC-09. Lithology, photograph, detailed description, color reflectance, magnetic susceptibility and sediment composition of each core are summarized in Figures 7.8-2 through 7.8-11. The followings are brief description of each core.

PC-05: Total length of recovered core sample was 778.5 cm. Vertical structures due to flow-in were observed in section below 624.0 cm below sea floor (bsf) and hence, we do not describe this part of the

core. Sediments of PC-05 consist of silt and clay (Figure 7.8-2) with siliciclastic grains and clay minerals more than 80 % throughout the core (Figure 7.8-3). Nannofossils, diatoms and foraminifers are present (few %) throughout the core. Neritic grains such as coarse-grained calcareous bioclasts and peloids are also present but less than 15 %. We therefore, used principal names applied for siliciclastic sediments (Mazzullo et al., 1988) for VCD in Figure 7.8-2.

Surface layer is composed of dark olive gray silty clay. The surface clay layer continues down to 70.5 cm bsf increasing degree of consolidation as sediments buried. Very dark gray to dark gray clayey silt composes sediments of the interval 70.5 - 271.3 cm bsf. This section is homogeneous and there was no visible evidence for bioturbation. H_2S smell was recognized in this section. Below this section, interval 271.3 - 624.0 cm bsf consists of semiconsolidated and heavily bioturbated, dark greenish gray silty clay to clayey silt. Laminated beds (472 - 491 cm and 601 - 624 cm bsf) or color banding (540 - 573 cm bsf) were observed in places. Shell fragments were distributed at interval 242 - 271 cm bsf, and at 384 cm bsf. Black patches defined by pyrite concentration were observed at interval 497 – 532 cm bsf.

PC-06: Total length of the recovered core was 1411.0 cm. Sediments of PC-06 consists of dark greenish gray to dark gray silty clay to clayey silt (Figure 7.8-4). Siliciclastic components increase downward from ~ 60 % to 80 %, except for smear slide at 203 cm bsf where nannofossils and pellets occupy approximately 35 % of the sediment (Figure 7.8-5). Nannofossils were frequently observed in the upper part of PC-06 and disappeared at ~ 670 cm bsf. Pellets were frequently observed (less than 10 %) throughout the core. Minor amount of diatoms and foraminifers were also observed throughout section. Hence, we used principal names applied for siliciclastic sediments with modifier (Mazzullo et al., 1988) for VCD of PC-06 (Figure 7.8-4).

Uppermost part of the PC-06 down to 198.3 cm bsf consists of homogeneous clayey silt and silty clay (50.0 - 97.3 cm bsf). There was no visible structure and visible evidence for bioturbation in this section. Interval between 198.3 - 694.7 cm bsf consists of dark gray silty clay with increasing degree of consolidation down section, from very soft (watery) to semiconsolidated. This section is homogeneous. Except for patches of dark greenish silty clay distributed in places (518 - 525 cm bsf), there was no visible evidence for bioturbation. Vertical fractures and voids with irregular shapes due to gas expansion were observed at intervals 265 - 298 cm bsf and below 342 cm bsf, respectively. Amount of gas caves increases below 342 cm bsf. Nannofossils disappeared at around 670 cm bsf in this section. The lowermost part of this section (680 - 695 cm bsf) was pyrite-rich. Below it, gas-free and bioturbated sediments of semiconsolidated dark gray silty clay were distributed at interval 694.7 - 797.2 cm bsf. This section is underlain by semiconsolidated olive gray silty clay (797.2 - 995 cm bsf) with thin horizontal cracks due to gas expansion, which increase both thickness and frequency below 880 cm bsf. Dark gray clayey silt (995.0 - 1195.0 cm bsf) with minor gas cracks and dark greenish gray silty clay (below 1195.0 cm bsf) with thicker and more frequently distributed gas cracks compose the lowermost part of the PC-06. Shell fragments and bioclasts were distributed throughout the core.

PC-07: Total length of the recovered core was 495.7 cm. Sediments of PC-07 consists mainly of

siliciclastic grains of silty clay to very fine sand size (Figure 7.8-6) with minor amount of nannofossils, foraminifers, pellets and bioclasts less than 10 % in total (Figure 7.8-7). Below around 360 cm bsf, we did not observe any bioclasts or microfossils.

Bioturbated, dark gray to dark greenish gray silty clay comprises sediments in the uppermost part (0 - 45.0 cm bsf) of the PC-07 (Figure 7.8-6). This surface layer is underlain by semiconsolidated, dark gray silty clay interbedded with very fine sand and silt that continue to the bottom of the PC-07. This section typically develops few mm to cm thick fine layers of sand and silt throughout the section. Only minor influence of bioturbation was observed in places. Structures observed in the upper part of the section (interval 45.0 - 303.4 cm bsf) include: sharp or gradual boundaries between bedding planes, scoured boundaries (erosional and/or bioturbated), normal and anti-grading in sandy layer, color banding, patches or lenses of silt/sand. Structures observed in lower part of the section include: low-angle reverse and normal faults with few mm displacements, normal grading at the lowermost section (below 413 cm bsf), color banding and patches of dark silt. Ice rafted debris were distributed only at intervals 142 – 168 cm and 250 - 275 cm bsf. Pyrite enriched zones were observed in places.

PC-08: Total length of the recovered core was 749.7 cm. Bioclasts are more frequently observed in the PC-08 and are the predominant component at interval ~ 200 - 300 cm bsf (Figure 7.8-9). Smearslide at 208.8 cm bsf contains as much as 63 % bioclasts. Nevertheless, most sediments of PC-08 consist mainly of siliciclastic grains, and we used principal names applied for siliciclastic sediments with modifier for VCD of PC-08 (Figure 7.8-8). Except for minor facies at 520.3 cm bsf (a patch of very fine sand), all smearslide samples contain bioclasts and sponge spicules. Nannofossils and foraminifers were observed throughout the PC-08.

Thin layer (10 cm thick) of clayey silt comprises the uppermost surface layer of the PC-08 (Figure 7.8-8). Calcareous clayey sand observed in the pilot core (see Figure 7.8-1) was not preserved in the piston core. Homogeneous, olive gray to olive silty very fine sand to sandy silt comprise the upper part of the PC-08 sediments in interval 10.0 – 348.9 cm bsf. Mixed sediments with bioclasts are distributed in the middle of this section. There were few burrows in the upper part, but middle part was homogeneous and there was no visible evidence for bioturbation. The lowermost part of this section is heavily bioturbated. Minor gas caves were observed in places. Smell H_2S.

Interval 348.9 - 380.9 cm bsf is composed of fine to very fine sand with cross and parallel laminas. Below this sand layer, gas-rich dark gray to olive gray silt to very fine sand composes interval 380.9 - 686.4 cm bsf. Grain size coarsens downward. This section was less consolidated than above section. Horizontal fractures due to gas expansion were observed throughout this section with increasing frequency and thickness downward. Although, lenses and entrainment of very dark gray fine sand along the core wall were observed throughout, this section is structurally homogeneous and there was no visible evidence for bioturbation. The lowermost part of the PC-08 (686.4 - 749.7 cm bsf) is composed of olive gray to dark greenish gray fine sandy silt with horizontal gas cracks. Shell fragments were observed throughout the PC-08 sediments.

PC-09: Total length of the recovered core was 997.2 cm. The mixed sediments of 11 cm-thick surface

layer (plus burrow-fill at 20 cm bsf) are foraminifer sand and calcareous sand, and are completely different from sediments in beneath (Figure 7.8-11). Below the surface layer, the sediments consist mainly of siliciclastic grains with clay to fine sand size. Thus, we used principal names applied for siliciclastic sediments with modifier for the summary of VCD in Figure 7.8-10. Bioclasts, foraminifers, nannofossils and sponge spicules were observed throughout the core. Distribution of pellets is limited compared to the other cores.

The surface layer is 11 cm-thick light gray fine to medium foraminifer sand (Figure 7.8-10). This thin mixed sediment is underlain by thick layer of dark gray clayey silt with lenses and layers of fine sand (interval 11.0 - 760.0 cm bsf). This section is heavily bioturbated and frequently contains ice rafted debris throughout the section. Pyrite-rich zones were observed in places. Structures observed in this section include sandy layers with normal grading and parallel laminas. Below this section, very fine sand with parallel lamina is distributed at interval 760.0 – 786.2 cm bsf. Below this sand layer, no ice rafted debris was observed. Interval 786.2 – 997.2 cm bsf is composed of dark greenish gar silt and very fine sandy silty clay with bioturbation. Shell fragments were distributed throughout the core.

We observed siliciclastic sediments derived most likely from glacier through the Rio Baker in the surface sediments in the Golfo de Penas. There was only few, if any, ice rafted debris in the samples obtained by piston coring from the same sites (PC-05 and PC-06). Ice rafted debris were however, recognized offshore region in the same latitude (PC-07). In southern latitudes, on the contrary, the surface sediments were mostly composed of bioclasts and micro- and nannofossils, but ice rafted debris were more frequently distributed in the piston core samples (PC-08 and PC-09).

(4) *References*

Mazzullo, J., Meyer, A. and Kidd, R. (1988) New sediment classification scheme for the Ocean Drilling Program. Appendix I, In “Handbook for shipboard sedimentologists” eds. Mazzullo, J. and Graham, A. G., ODP Technical Note, 8, 44-63.

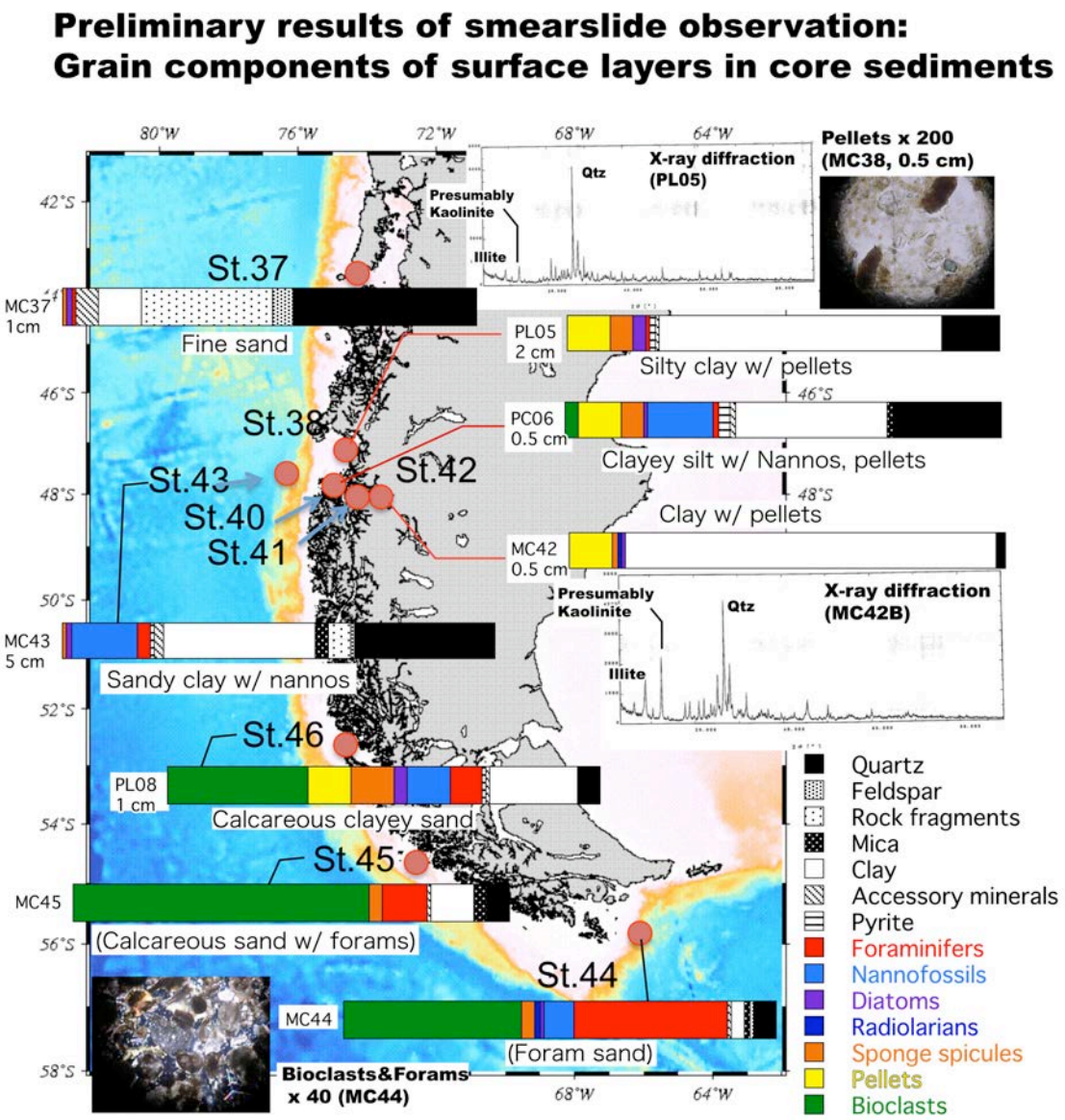


Figure 7.8-1 Sampling locations for sediments of the surface layers and their compositions.

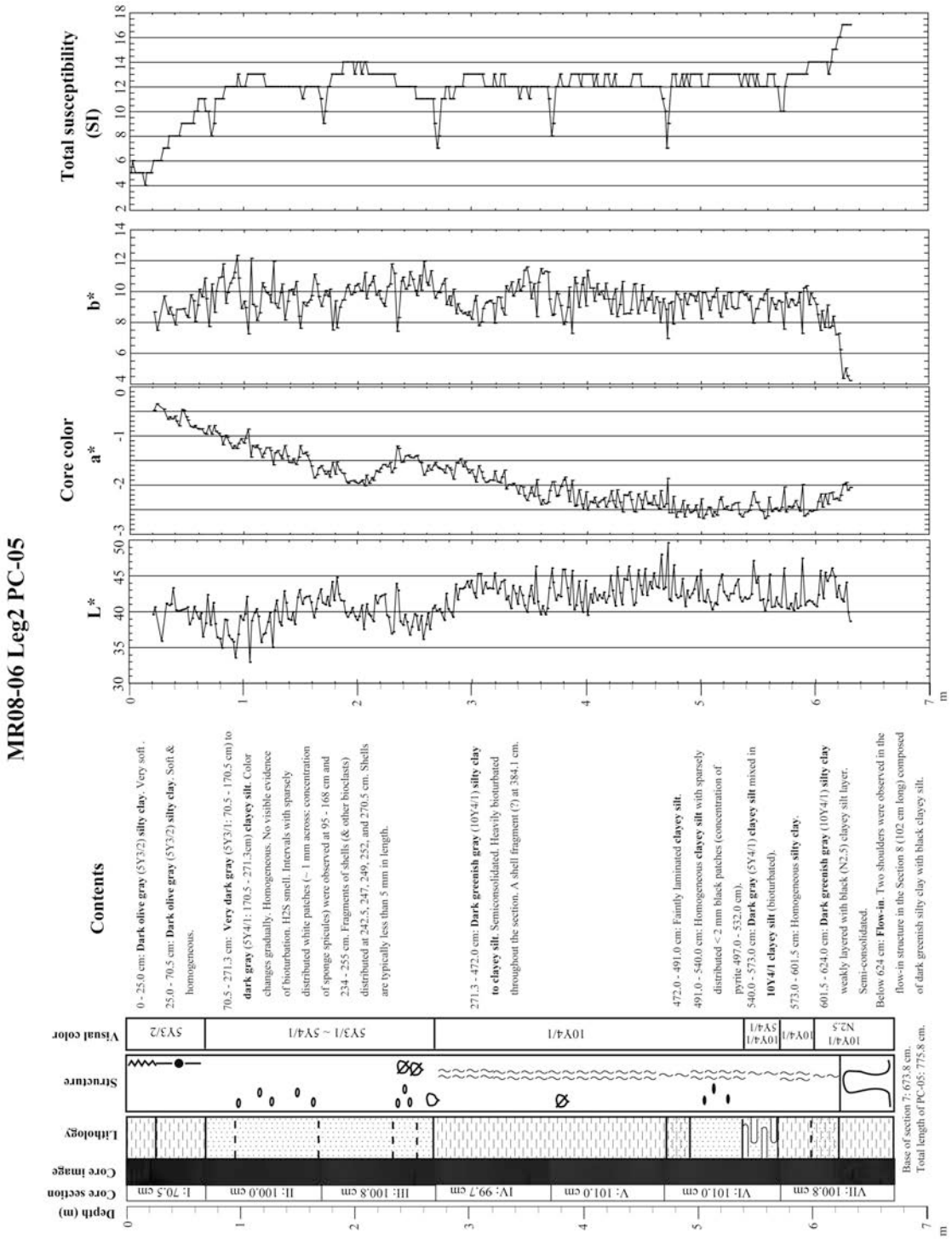


Figure 7.8-2 Visual core description for PC-05.

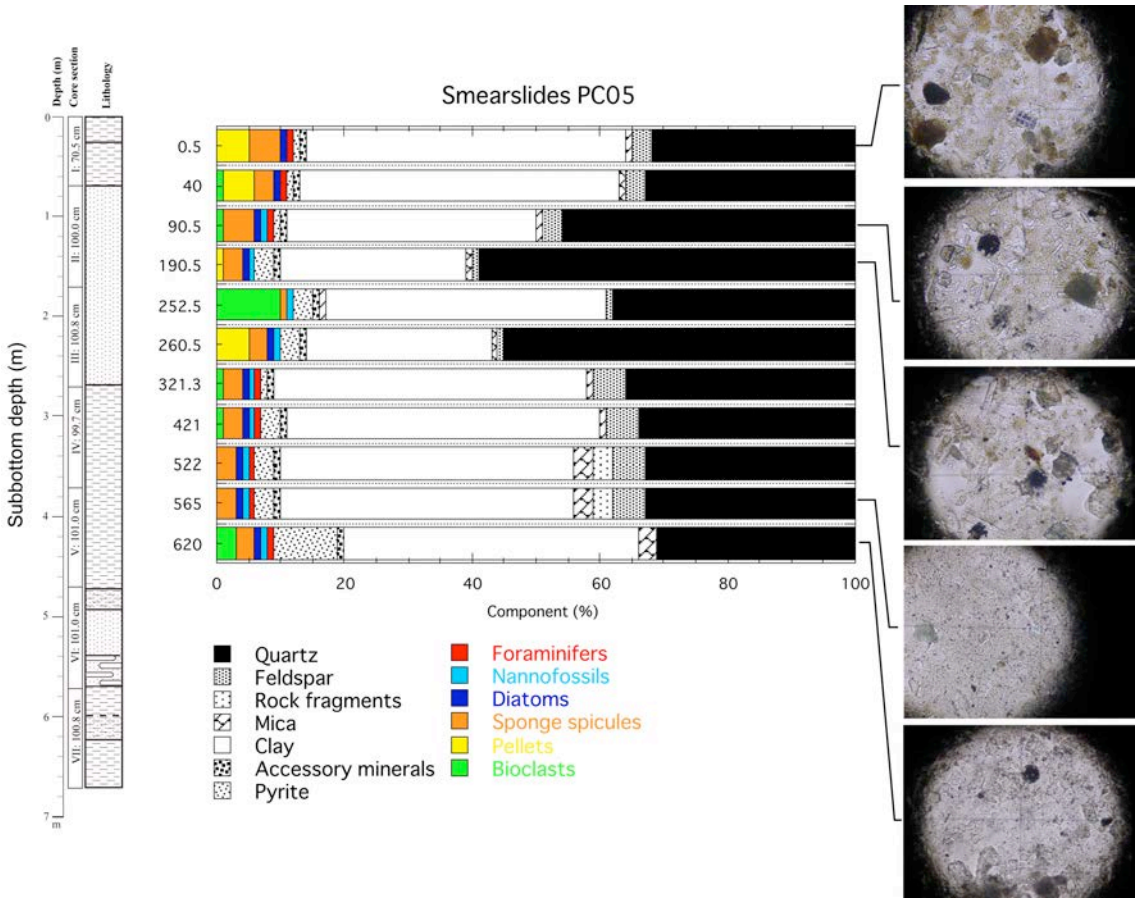


Figure 7.8-3 Composition of sediments of PC-05.

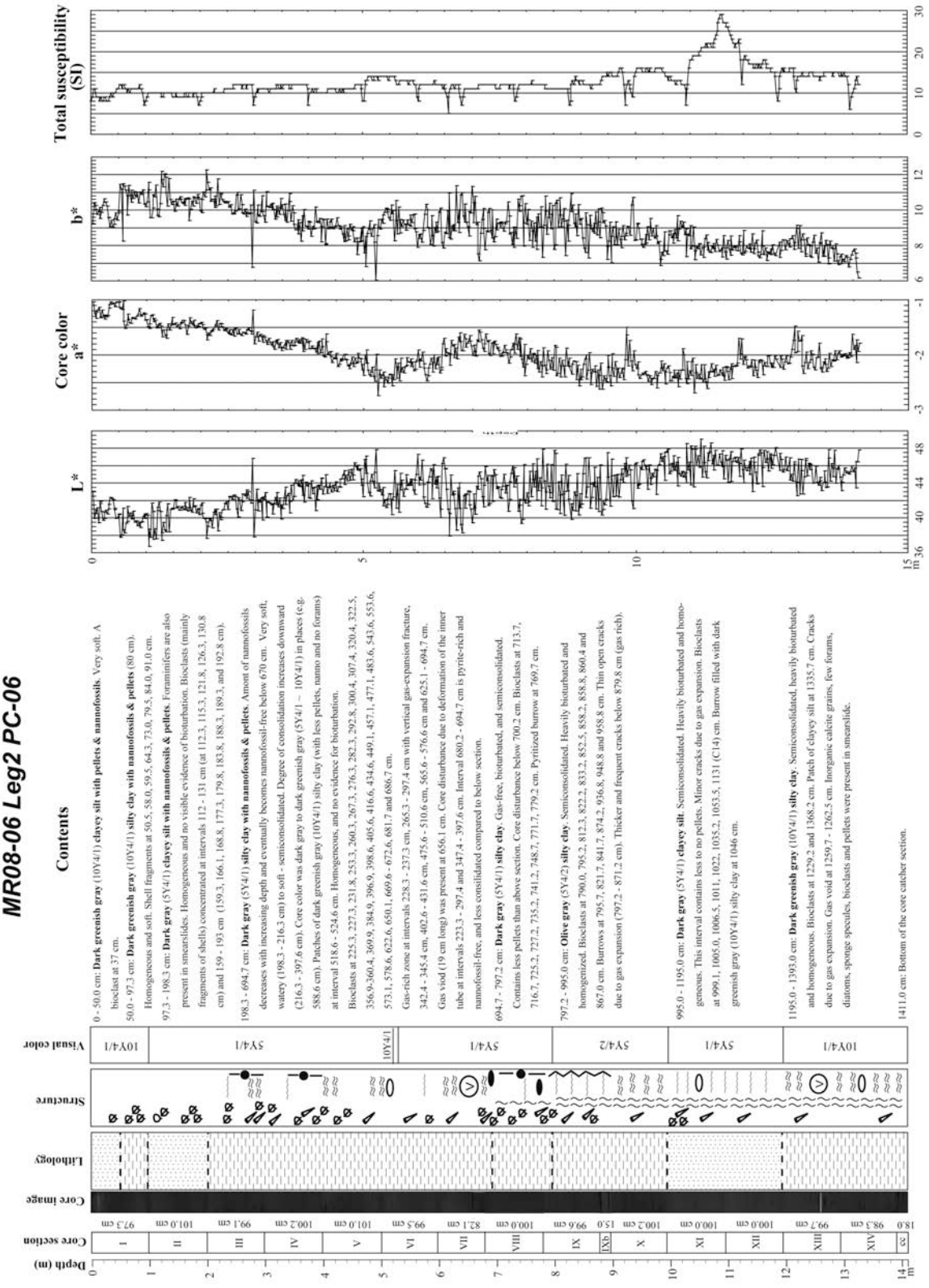


Figure 7.8-4 Visual core description for PC-06.

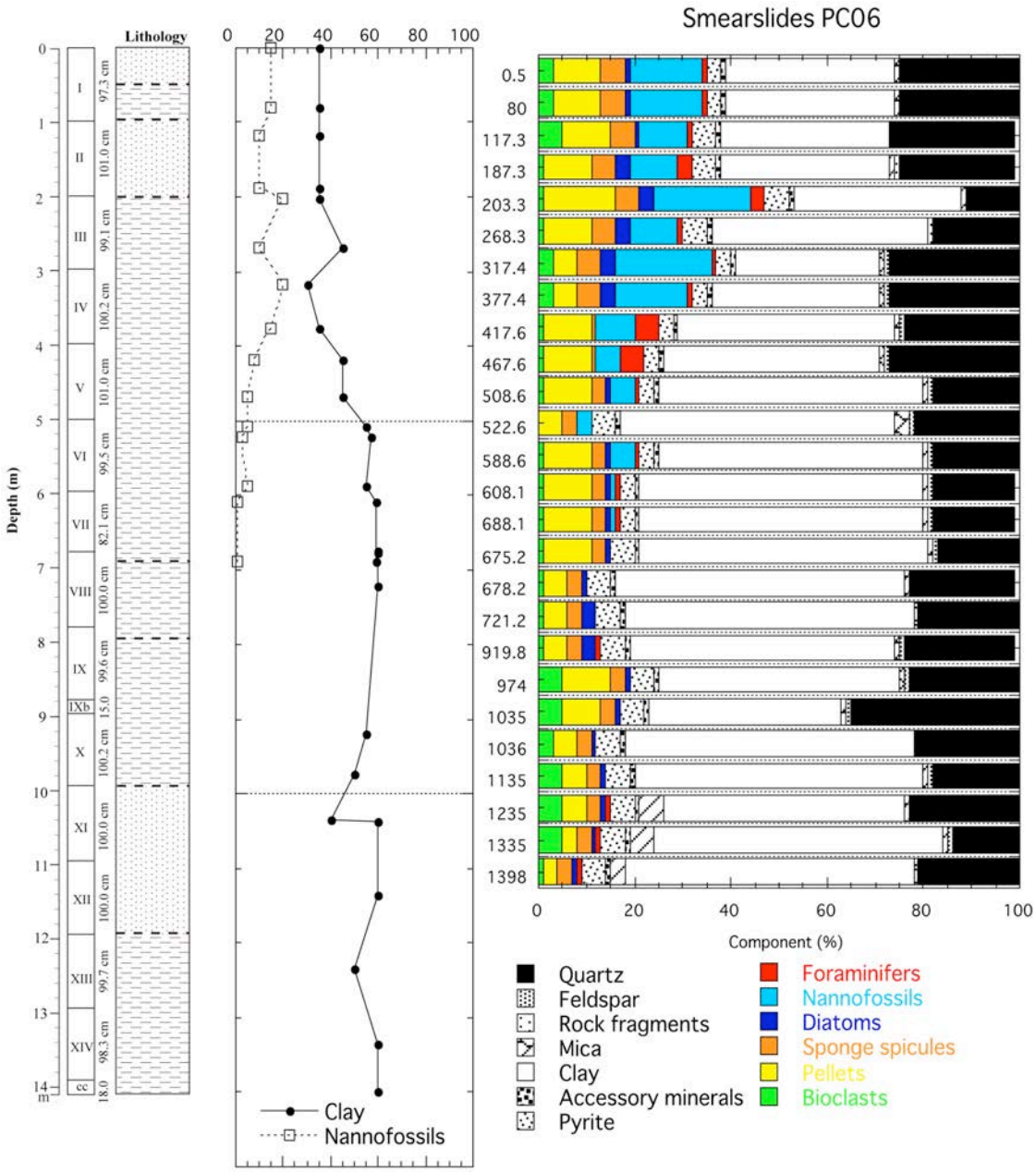


Figure 7.8-5 Composition of sediments of PC-06.

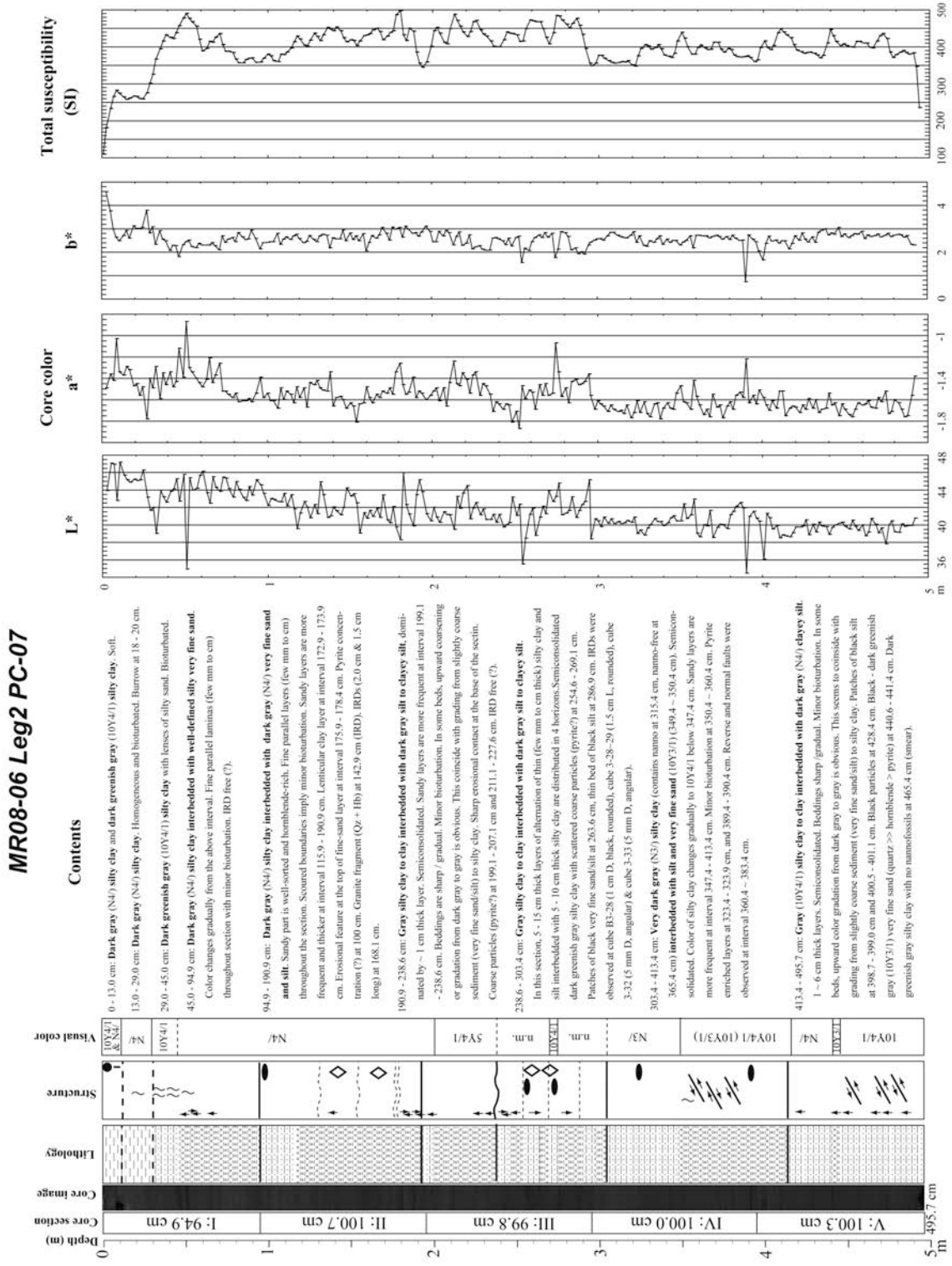


Figure 7.8-6 Visual core description for PC-07.

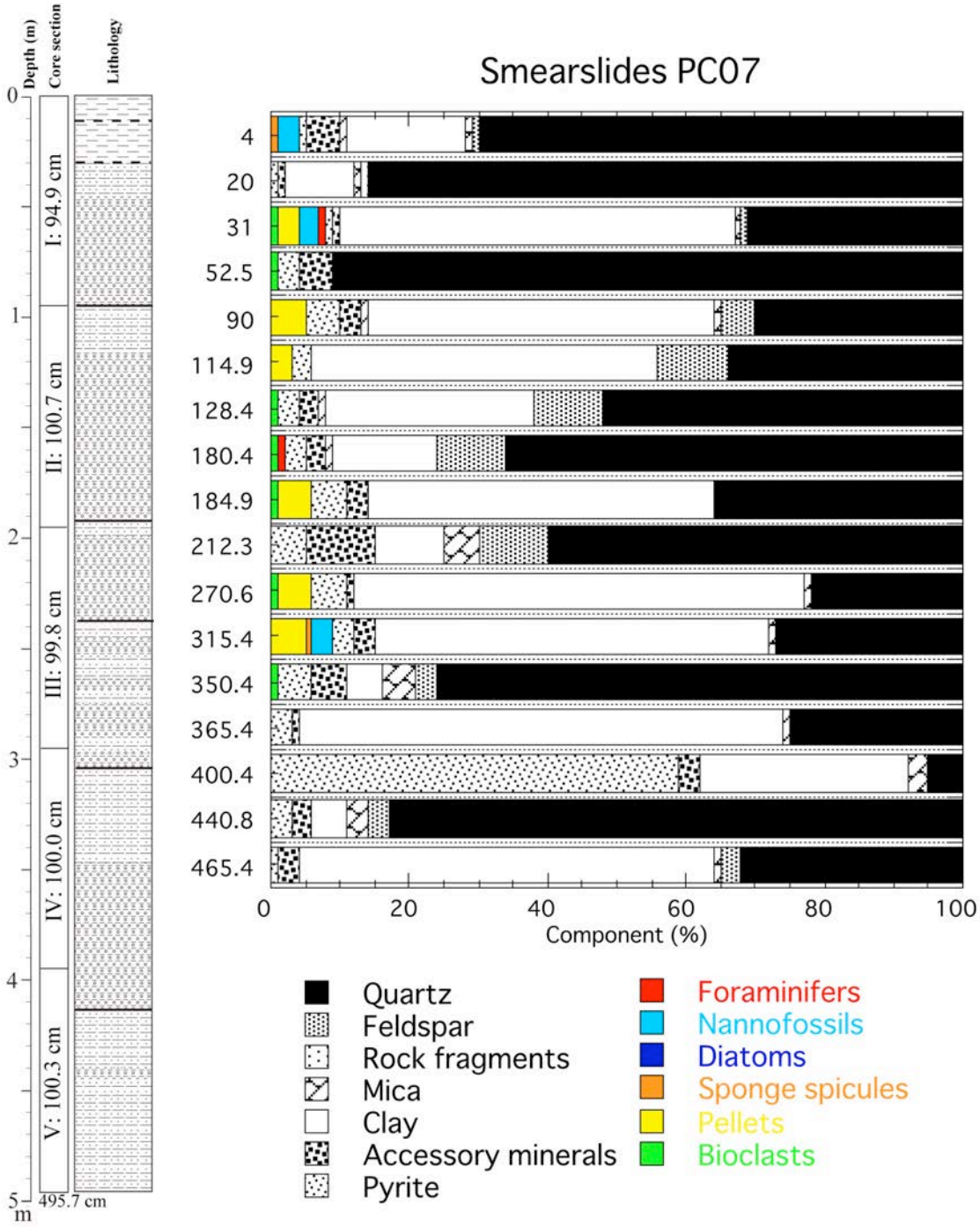


Figure 7.8-7 Composition of sediments of PC-07.

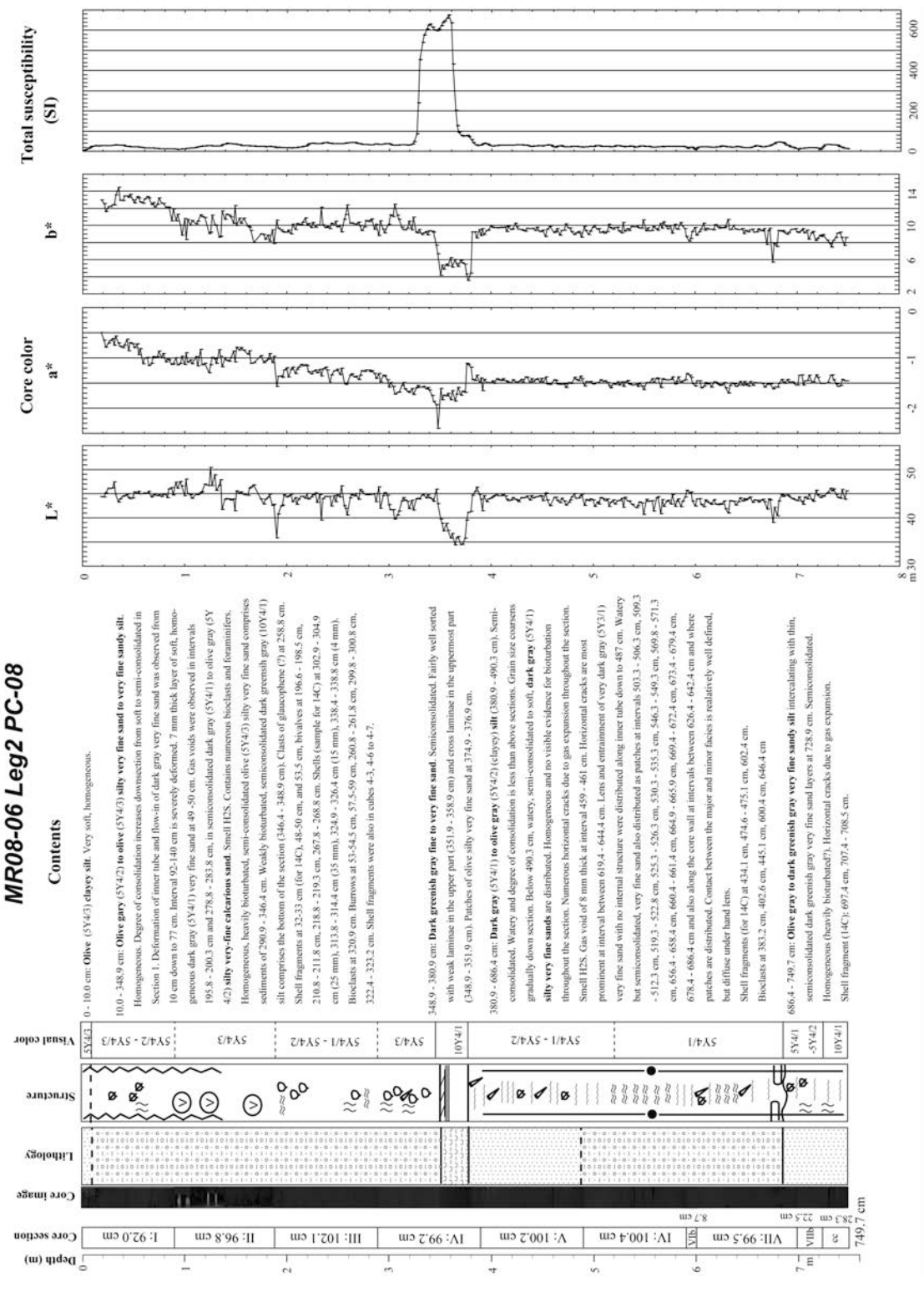


Figure 7.8-8 Visual core description for PC-08.

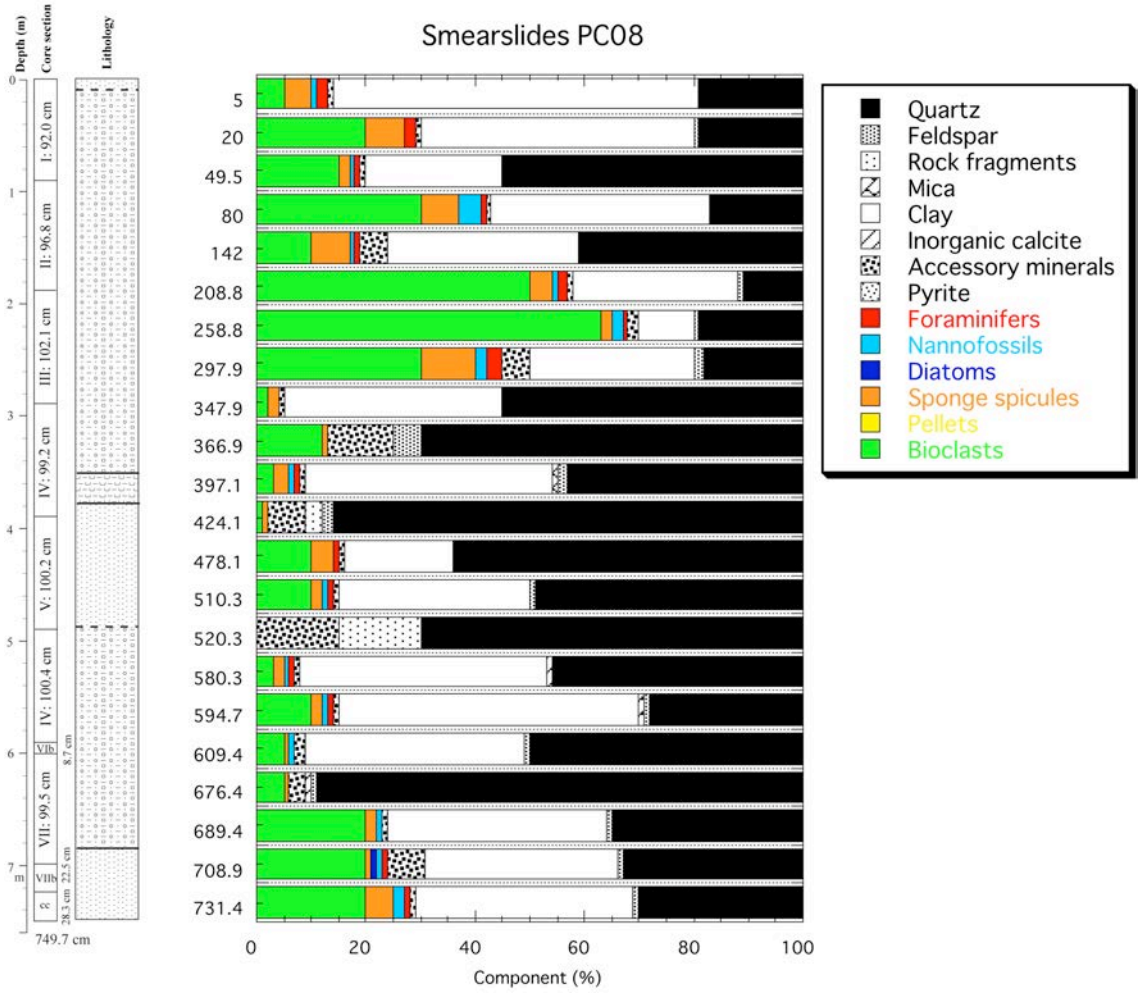


Figure 7.8-9 Composition of sediments of PC-08.

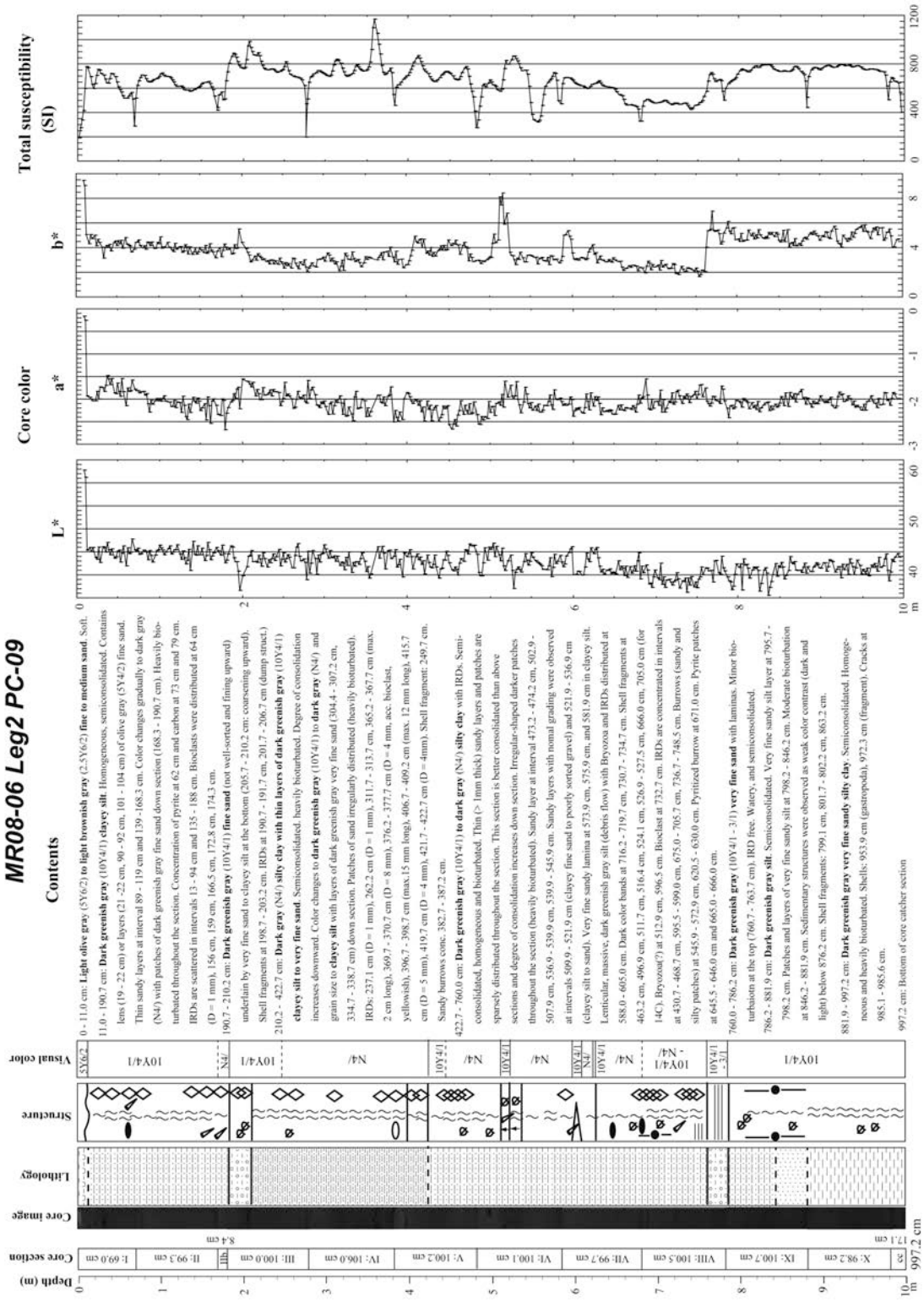


Figure 7.8-10 Visual core description for PC-09.

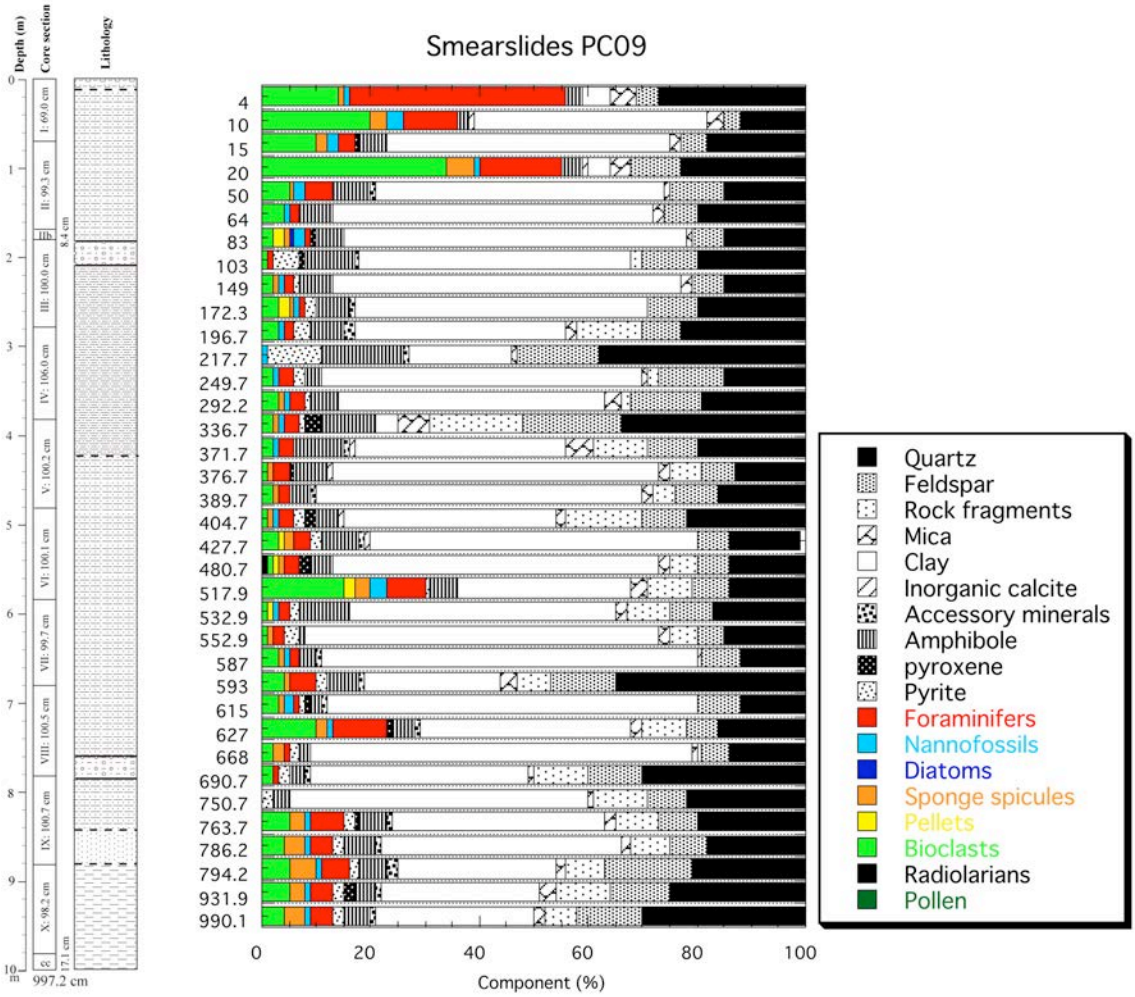
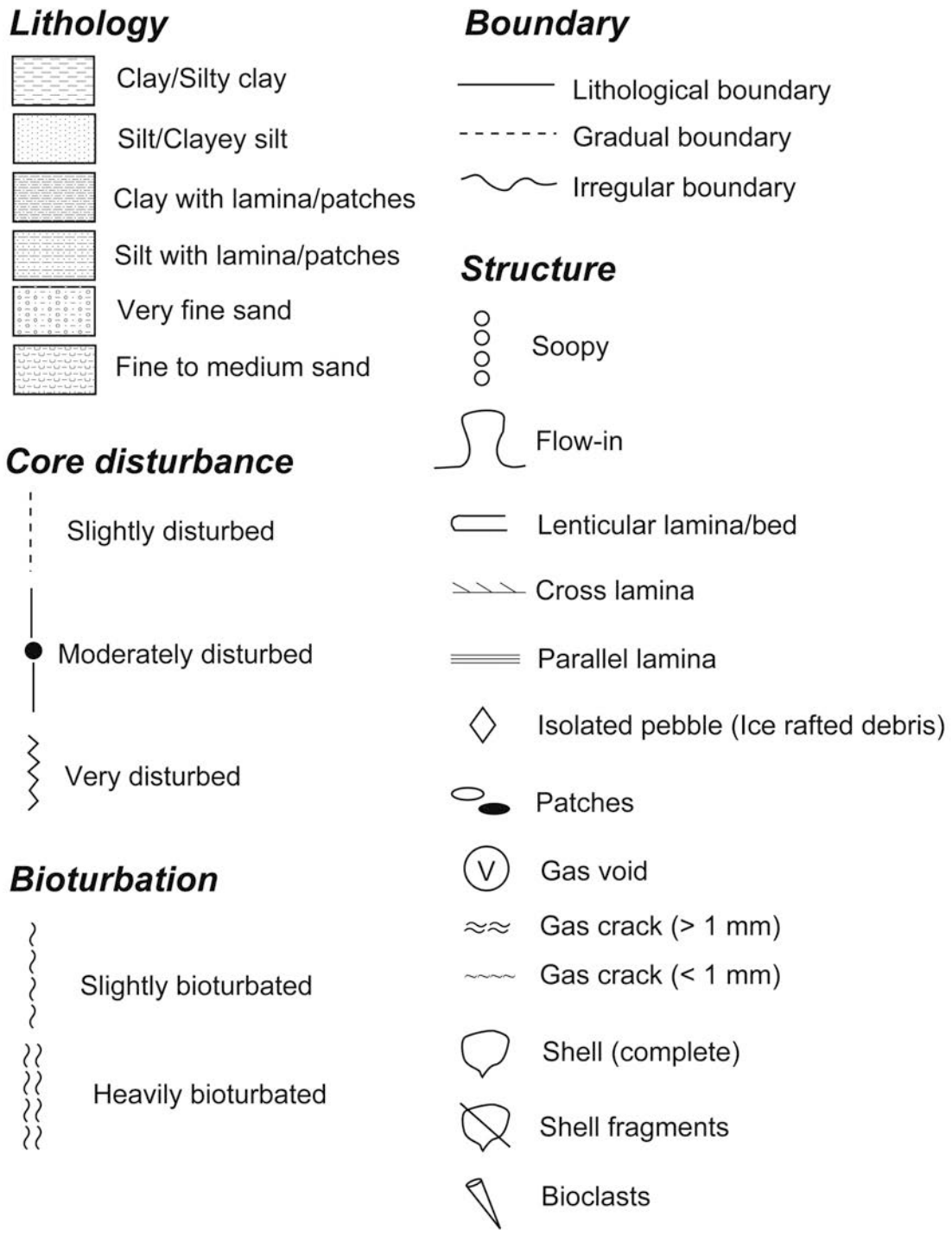


Figure 7.8-11 Composition of sediments of PC-09.



Symbols used for visual core description.

Figure 7.8-12 Legend for core description.