



SHINSEI MARU “Cruise Report”
KS-17-J05

Marine Ecosystems Investigation, Impact by the
mega-earthquake (the 2011 Earthquake of the Pacific
coast of Tōhoku) and Tsunami: For Recovery and Rebuilding
of Sanriku Fisheries Activities

Off Sanriku

Mar.12,2017-Mar.31,2017

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

Project: TEAMS (Tohoku Ecosystem Array of Marine Sciences)

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1. Outline

1.1. Cruise Information

Cruise ID : KS-17-J05

Name of vessel : SHINSEI-MARU

Title of the cruise

Marine Ecosystems Investigation, Impact by the mega-earthquake (the 2011 Earthquake of the Pacific coast of Tōhoku) and Tsunami: For Recovery and Rebuilding of Sanriku Fisheries Activities

Title of proposal

Marine Ecosystems Investigation, Impact by the mega-earthquake (the 2011 Earthquake of the Pacific coast of Tōhoku) and Tsunami: For Recovery and Rebuilding of Sanriku Fisheries Activities

Cruise period : 12th March to 31th March, 2017

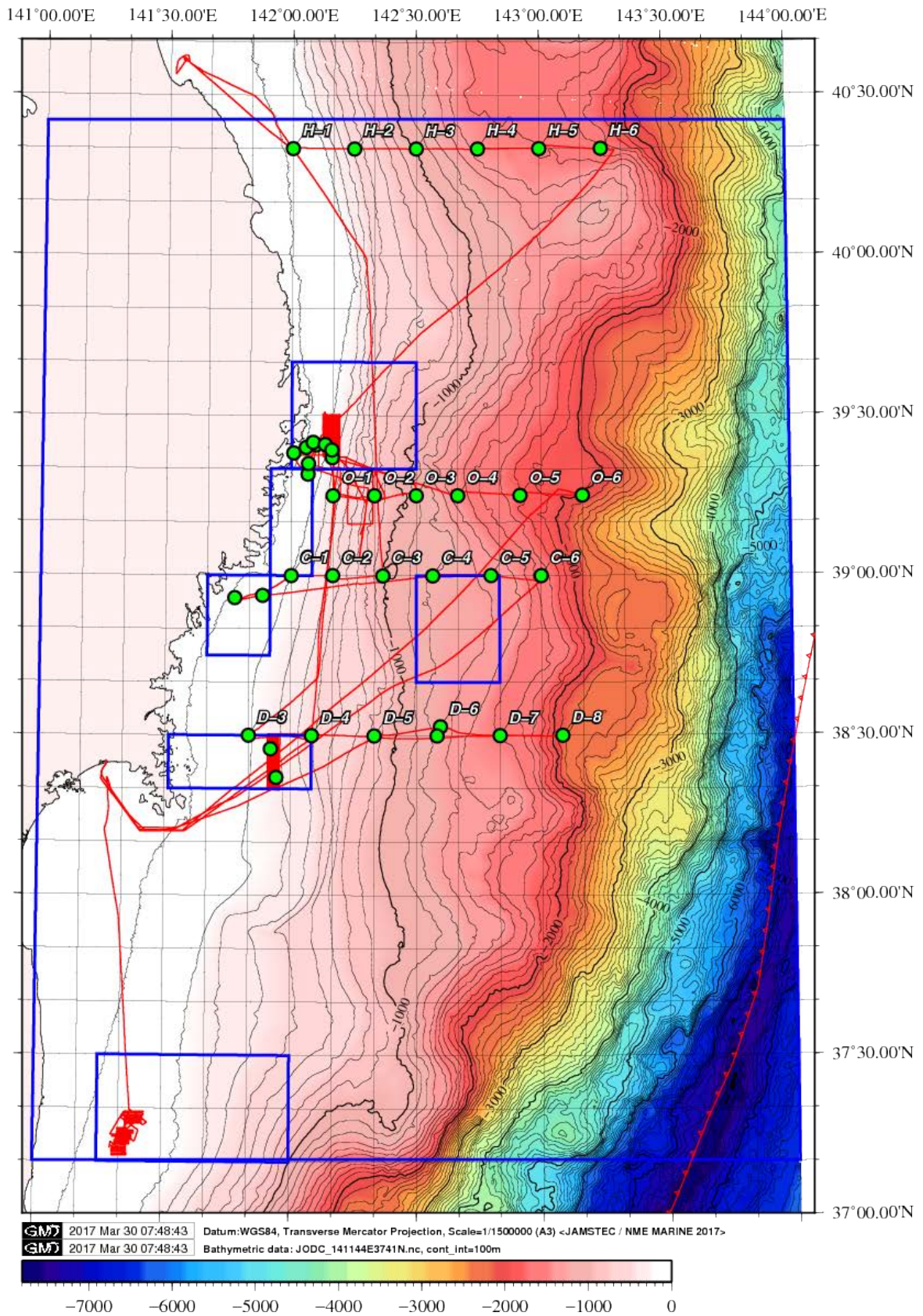
Ports of departure / call / arrival :

Ishinomaki (12th March) ~ Ishinomaki (22th March) ~ Yokosuka (31th March)

Research area : Off Sanriku

1.2. Research Map

KS-17-J05 R/V SHINSEIMARU Track and Research Area



1.3. Cruise log

2017/03/12 Eastern KINKASAN (38-19.5N, 141-49.5E)

Weather: bc / Wind direction: NNE / Wind force: 2 / Wave scale: 2 /
Swell scale: 2 / Visibility: 8 miles (12:00 JST)

08:00	onboard
09:00	let go all shore line, left ISHINOMAKI for OFF SANRIKU research area, point C-6
10:00-10:30	onboard education and training
10:30-11:05	scientists & crew research meeting
17:10	arrived at point C-6
17:15-17:32	carried out QES & NORPAK Net sampling at C-6
17:37-18:16	carried out FRRF operation at C-6
18:29-20:28	carried out CTD operation at C-6
21:31-21:48	carried out QES & NORPAK Net sampling at C-5
21:54-22:31	carried out FRRF operation at C-5
22:48-	com'ced CTD operation at C-5

2017/03/13 OFF SANRIKU (38-56.3N, 141-46.6E)

Weather: o / Wind direction: South / Wind force: 3 / Wave scale: 2 /
Swell scale: 1 / Visibility: 8 miles (12:00 JST)

00:47	finished CTD operation at C-5
02:00-02:16	carried out QES & NORPAK Net sampling at C-4
02:21-02:58	carried out FRRF operation at C-4
03:17-05:04	carried out CTD operation at C-4
07:53	released XBT at area C
09:08-13:25	carried out towing operation of SSS at area C
14:55-15:04	carried out QES & NORPAK Net sampling at C-1
15:11-15:39	carried out FRRF operation at C-1
15:49-16:33	carried out CTD operation at C-1
17:30-17:45	carried out QES & NORPAK Net sampling at C-2
17:50-18:26	carried out FRRF operation at C-2
18:38-19:46	carried out CTD operation at C-2
20:56-21:12	carried out QES & NORPAK Net sampling at C-3
21:26-22:04	carried out FRRF operation at C-3
22:31	com'ced CTD operation at C-3
23:50-23:53	carried out water sampling by bucket

2017/03/14 HACHINOHE-ko (40-34.2N, 141-31.1E)

Weather: r / Wind direction: SE / Wind force: 5 / Wave scale: 3 /
Swell scale: 3 / Visibility: 6 miles (12:00 JST)

00:12	finished CTD operation at C-3
00:30	com'ced proceeding to off HACHINOHE due to avoid rough sea
10:30	arrived at off HACHINOHE started to wait due to rough sea

2017/03/15 HACHINOHE-ko (40-33.9N, 141-31.3E)

Weather: o / Wind direction: NNE / Wind force: 3 / Wave scale: 3 /
Swell scale: 3 / Visibility: 7 miles (12:00 JST)

All-day	avoid rough sea and waited at HACHINOHE-ko
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2017/03/16 OFF HACHINOHE-ko (40-36.7N, 141-33.5E)

Weather: bc / Wind direction: WNW / Wind force: 6 / Wave scale: 3 /
Swell scale: 3 / Visibility: 8 miles (12:00 JST)

11:45 com'ced proceeding to H-1
15:00 arrived at H-1
15:01-15:08 carried out QES & NORPAK Net sampling at H-1
15:14-15:35 carried out FRRF operation at H-1
15:52-16:27 carried out CTD operation at H-1

2017/03/17 OFF SANRIKU (40-20.0N, 142-30.0E)

Weather: c / Wind direction: NW / Wind force: 5 / Wave scale: 3 /
Swell scale: 3 / Visibility: 8 miles (12:00 JST)

05:57-06:12 carried out QES & NORPAK Net sampling at H-2
06:15-06:50 carried out FRRF operation at H-2
07:04-08:14 carried out CTD operation at H-2
08:20-09:30 carried out water sampling by bucket
09:35-09:50 carried out QES & NORPAK Net sampling at H-3
09:56-10:29 carried out FRRF operation at H-3
10:42-12:22 carried out CTD operation at H-3
12:30-13:40 shifted to H-4
13:43-13:57 carried out QES & NORPAK Net sampling at H-4
14:03-14:38 carried out FRRF operation at H-4
14:53-16:57 carried out CTD operation at H-4
18:11-18:25 carried out QES & NORPAK Net sampling at H-5
18:30-19:08 carried out FRRF operation at H-5
19:23-21:30 carried out CTD operation at H-5
21:08-21:12 carried out water sampling by bucket
21:40-22:30 shifted to H-6
22:35-22:51 carried out QES & NORPAK Net sampling at H-6
22:55-23:31 carried out FRRF operation at H-6

2017/03/18 OFF SANRIKU (39-24.2N, 142-06.0E)

Weather: bc / Wind direction: NW / Wind force: 5 / Wave scale: 2 /
Swell scale: 1 / Visibility: 8 miles (12:00 JST)

00:00-02:07 carried out CTD operation at H-6
02:20 com'ced proceeding to area B
09:48 released XBT
10:16-12:06 carried out towing operation of SSS at area A
13:14-15:20 carried out towing operation of SSS at area A and B
15:55-17:08 carried out towing operation of SSS at area A
17:28-18:57 carried out SBP mapping survey at OHTSUCH WANKOBU
19:21 com'ced SBP mapping survey at OHTSUCH OKIAI

2017/03/19 OFF SANRIKU (38-21.0N, 142-03.5E)

Weather: bc / Wind direction: NE / Wind force: 5 / Wave scale: 3 /
Swell scale: 1 / Visibility: 8 miles (12:00 JST)

01:39 finished SBP mapping survey at OHTSUCH OKIAI
08:32-11:10 carried out towing operation of SSS at area A

11:35-13:37 carried out SBP mapping survey at OHTSUCH WANKOBU
14:19-16:28 carried out towing operation of SSS at area A
17:46 com'ced search for BIO TRAUCKING SYSTEM

2017/03/20 OFF SANRIKU (39-20.5N, 142-14.0E)

Weather: bc / Wind direction: NNE / Wind force: 4 / Wave scale: 2 /
Swell scale: 2 / Visibility: 8 miles (12:00 JST)

03:10 finished search for BIO TRAUCKING SYSTEM
05:26 com'ced MBES mapping survey
09:11 released XBT
11:36 finished MBES mapping survey
11:40 com'ced proceeding to O-4
11:45 released XBT
14:00 arrived at O-4
14:08-14:22 carried out QES & NORPAK Net sampling at O-4
14:26-15:00 carried out FRRF operation at O-4
15:27-17:27 carried out CTD operation at O-4
19:00-19:14 carried out QES & NORPAK Net sampling at O-5
19:17-19:52 carried out FRRF operation at O-5
20:17-22:27 carried out CTD operation at O-5
22:35 com'ced proceeding to O-6
23:55 arrived at O-6

2017/03/21 Southern KINKASAN (38-12.0N, 141-35.0E)

Weather: r / Wind direction: SSW / Wind force: 4 / Wave scale: 3 /
Swell scale: 2 / Visibility: 5 miles (12:00 JST)

00:02-00:16 carried out QES & NORPAK Net sampling at O-6
00:20-00:56 carried out FRRF operation at O-6
01:07-03:17 carried out CTD operation at O-6
03:30 com'ced proceeding to ISHINOMAKI
15:00 sent out 1st shore line, arrived at ISHINOMAKI

2017/03/22 ISHINOMAKI ko (38-25.2N, 141-16.2E)

Weather: bc / Wind direction: NW / Wind force: 6 / Wave scale: 2 /
Swell scale: 0 / Visibility: 8 miles (12:00 JST)

16:00 Let go all shore line & left ISHINOMAKI

2017/03/23 OFF SANRIKU (39-30.0N, 142-09.6E)

Weather: bc / Wind direction: NNW / Wind force: 5 / Wave scale: 3 /
Swell scale: 3 / Visibility: 8 miles (12:00 JST)

05:00 arrived at research area
05:30 com'ced MBES mapping survey <Area A, off OTSUCHI wan>
13:04 release XBT at 39-23.5518N, 142-09.6412E
15:53 finished MBES mapping survey
16:43-16:58 carried out QES & NORPAK Net sampling at O-1
17:00-17:37 carried out FRRF operation at O-1
17:50-18:50 carried out CTD operation at O-1
19:52-20:09 carried out QES & NORPAK Net sampling at O-2
20:12-20:44 carried out FRRF operation at O-2
20:58-22:23 carried out CTD operation at O-2

23:22-23:37 carried out QES & NORPAK Net sampling at O-3
23:41 com'ced FRRF operation at O-3

2017/03/24 OFF SANRIKU (39-28.5N, 142-11.2E)

Weather: c / Wind direction: North / Wind force: 3 / Wave scale: 2 /
Swell scale: 2 / Visibility: 8 miles (12:00 JST)

00:16 finished FRRF operation at O-3
00:27-02:12 carried out CTD operation at O-3
01:49-01:53 carried out water sampling by bucket
05:17 com'ced MBES mapping survey
15:37 finished MBES mapping survey
20:40 arrived at research area D-3
20:49-20:58 carried out QES & NORPAK Net sampling at D-3
21:00-21:29 carried out FRRF operation at D-3
21:44-22:32 carried out CTD operation at D-3
21:53-21:56 carried out water sampling by bucket
23:57 com'ced QES & NORPAK Net sampling at D-4

2017/03/25 OFF SANRIKU (38-20.5N, 141-56.1E)

Weather: bc / Wind direction: NW / Wind force: 4 / Wave scale: 2 /
Swell scale: 2 / Visibility: 8 miles (12:00 JST)

00:12 finished NORPAK Net sampling at D-4
00:15-00:48 carried out FRRF operation at D-4
01:03-02:07 carried out CTD operation at D-4
03:01 com'ced MBES mapping survey
08:42 released XBT at 38-22.1542N, 141-56.6631E
17:32 released XBT at 38-27.5158N, 141-55.2856E

2017/03/26 OFF SANRIKU (38-30.0N, 142-50.2E)

Weather: bc / Wind direction: SE / Wind force: 3 / Wave scale: 2 /
Swell scale: 1 / Visibility: 8 miles (12:00 JST)

00:05 finished MBES mapping survey, proceeding to D-8
05:30 arrived at D-8
05:55-06:07 carried out QES & NORPAK Net sampling at D-8
06:10-06:44 carried out FRRF operation at D-8
06:56-09:04 carried out CTD operation at D-8
08:44-08:49 carried out water sampling by bucket
09:10 shifted to D-7
10:13-10:27 carried out QES & NORPAK Net sampling at D-7
10:30-11:09 carried out FRRF operation at D-7
11:22-12:55 carried out CTD operation at D-7
13:20 shifted to D-6
14:25-14:39 carried out QES & NORPAK Net sampling at D-6
14:42-15:15 carried out FRRF operation at D-6
15:26-17:09 carried out CTD operation at D-6
18:25-18:38 carried out QES & NORPAK Net sampling at D-5
18:45-19:14 carried out FRRF operation at D-5
19:30-20:53 carried out CTD operation at D-5
20:30-20:34 carried out water sampling by bucket
21:04-21:26 figure eight turn running
21:30 proceeding to off ISHINOMAKI, due to avoiding rough sea

2017/03/27 OFF ISHINOMAKI ko (38-22.0N, 141-16.3E)
Weather: r / Wind direction: NW / Wind force: 4 / Wave scale: 2 /
Swell scale: 2 / Visibility: 4 miles (12:00 JST)

03:00 arrived at off ISHINOMAKI

2017/03/28 OFF ISHINOMAKI ko (38-22.0N, 141-16.3E)
Weather: bc / Wind direction: WNW / Wind force: 4 / Wave scale: 2 /
Swell scale: 2 / Visibility: 8 miles (12:00 JST)

15:03 proceeding to research area, off FUKUSHIMA, area F
20:55 arrived at research area
21:00 com'ced SBP survey

2017/03/29 OFF SANRIKU (37-18.0N, 141-24.0E)

Weather: bc / Wind direction: SE / Wind force: 2 / Wave scale: 2 /
Swell scale: 2 / Visibility: 8 miles (12:00 JST)

00:05 finished SBP survey
00:14 com'ced MBES mapping survey
06:45 release XBT at <37-13.6N, 141-21.68E>
07:59 finished MBES mapping survey
08:58 com'ced towing operation of SSS at area F
15:08 finished towing operation
15:49 com'ced towing operation at SW part of area F
17:27 finished towing operation
18:06 com'ced MBES mapping survey

2017/03/30 OFF SANRIKU (38-56.3N, 141-46.6E)

Weather: o / Wind direction: South / Wind force: 3 / Wave scale: 2 /
Swell scale: 1 / Visibility: 8 miles (12:00 JST)

2017/03/31 JAMSTEC (YOKOSUKA)

09:00 arrived at JAMSTEC, scientists disembarked
completed voy. No.KS-17-J05

2. Participants

Chief scientist

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Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
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Representative of the Science Party

Katsunori Fujikura (Dept. of Marine Biodiversity Research /JAMSTEC)

Science party

TAKAFUMI KASAYA (R&D Center for Earthquake and Tsunami, JAMSTEC)
MUTSUMI IIZUKA (Tokyo City University)
YOSHINORI MATUSMOTO (Windy Network)

SHUNGO OSHITANI (Marine Works Japan)
MASANORI ENOKI (Marine Works Japan)
KEISUKE MATSUMOTO (Marine Works Japan)
YASUHIRO ARII (Marine Works Japan)
KEITARO MATSUMOTO (Marine Works Japan)
RIO KOBAYASHI (Marine Works Japan)

TAKUYA ONODERA (~22 Mar.) (Nippon Marine Enterprises, LTD.)
MORIFUMI TAKAESU (22 Mar.~) (Nippon Marine Enterprises, LTD.)

R/V SHINSEIMARU Crew Member

Captain	YOSHIYUKI NAKAMURA
Chief Officer	YUKI FURUKAWA
2nd Officer	TETSUO SHIRAYAMA
3rd Officer	RYO YAMAGUCHI
Chief Engineer	KAZUNORI NOGUCHI
1st Engineer	WATARU KUROSE
2nd Engineer	NAOHITO TADOOKA
3rd Engineer	TAKAMASA OCHIAI
Chief Electronics Operator	TOKINORI NASU
2nd Electronics Operator	SHUNSUKE FUKAGAWA

Boat Swain	HIDEO ISOBE
Able Seaman	KATSUHIKO SATO
Able Seaman	HIROAKI NAGAI
Able Seaman	NAOKI IWASAKI
Able Seaman	NAO ISHIZUKA
Sailor	KYOHEI MURAI
Sailor	DAISUKE YAMAMOTO
No.1 Oiler	TOSHIKAZU IKEDA
Oiler	MASAMI UEDA
Oiler	TATSUOMI CHINO
Oiler	KOTA AIZAWA
Assistant Oiler	SHOTARO SUMITOMO
Chief Steward	YUKIO TACHIKI
Steward	YUKIHIDE CHIKUBA
Steward	KATSUYUKI OMIYA
Steward	HIROYUKI OHBA

3. Overview of the Observation

3.1. Introduction

The purpose of this cruise is to understand impacts on marine ecosystems by the 2011 Earthquake of the Pacific coast of Tōhoku and Tsunami, and to contribute for recover and rebuild of Sanriku fisheries activities in terms of marine science. Target areas are continental slope. This cruise is conducted under the TEAMS project, namely Tohoku Ecosystem Array of Marine Sciences. Detailed investigation subjects are distribution patterns and diversity of benthic organisms, seawater and sediments geochemistry, and sediments characteristics. Based on these data and samples, we will construct habitat map for ecosystem management in Sanriku areas.

3.2. Observations, Activities

1. CTD cast and water sampling/biogeochemical analysis
2. Assessment of phytoplankton photosynthesis by fast repetition rate fluorometry (FRRF)
3. Zooplankton sampling by using NORPAC net
4. Survey of zooplankton distribution by quantitative echo sounder
5. Bathymetric survey by Multi-narrow Beam Echo Sounding system (MBES) equipped on-board
6. Seafloor condition created by Side Scan Sonar (SSS) system under tow
7. Sub-bottom structure by the Sub-Bottom Profiler (SBP) system equipped on-board

3.3. Hydrographic observations

3.3.1. CTD cast and water sampling

Masahide WAKITA (JAMSTEC): Principal investigator

Shungo OSHITANI (MWJ): Operation leader

Keisuke MATSUMOTO (MWJ)

Rio KOBAYASHI (MWJ)

Yasuhiro ARII (MWJ)

(1) Objective

Investigation of oceanic structure and water sampling.

(2) Parameters

Temperature

Conductivity

Pressure

Dissolved Oxygen

Dissolved Oxygen voltage

Transmission % and beam attenuation coefficient and voltage

Formazin turbidity unit

Fluorescence

Photosynthetically Active Radiation

Altimeter

(3) Instruments and Methods

CTD/Carousel Water Sampling System, which is a 12-position Carousel water sampler (CWS) with Sea-Bird Electronics, Inc. CTD (SBE9plus), was used during this cruise. 12-litter sampling Bottles.

The sensors attached on the CTD were temperature, conductivity, pressure, dissolved oxygen (SBE43), transmission, turbidity, fluorescence, PAR, and altimeter. The Practical Salinity was calculated by measured values of pressure, conductivity and temperature. The CTD/CWS was deployed from starboard on working deck.

The CTD raw data were acquired on real time using the Seasave-Win32 (ver.7.21f) provided by Sea-Bird Electronics, Inc. and stored on the hard disk of the personal computer. Seawater was sampled during the up cast by sending fire commands from the personal computer. We stayed for 1

minute at above 400 m layers before fire command to stabilize CTD. At deeper layer, we stayed for 30 seconds. 24 casts of CTD measurements were conducted (Table 3.1-1).

Data processing procedures and used utilities of SBE Data Processing-Win32 (ver.7.21i) and SEASOFT were as follows:

(The process in order)

DATCNV: Convert the binary raw data to engineering unit data. DATCNV also extracts bottle information where scans were marked with the bottle confirm bit during acquisition. The duration was set to 2.0 seconds, and the offset was set to 0.0 seconds.

WILDEDIT: Mark 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 and dissolved oxygen voltage (SBE43).

FILTER: Perform a low pass filter on pressure with a time constant of 0.15 second. In order to produce zero phase lag (no time shift) the filter runs forward first then backward

WFILTER: Perform a median filter to remove spikes in the fluorescence, transmission and turbidity data. A median value was determined by 49 scans of the window.

ALIGNCTD: Convert the time-sequence of sensor outputs into the pressure sequence to ensure that all calculations were made using measurements from the same parcel of water. Dissolved oxygen data are 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 3.0 seconds advancing dissolved oxygen sensor (SBE43) output (dissolved oxygen voltage) relative to the temperature data.

CELLTM: Remove conductivity cell thermal mass effects from the measured conductivity. Typical values used were thermal anomaly amplitude $\alpha = 0.03$ and the time constant $1/\beta = 7.0$.

LOOPEDIT: Mark scans where the CTD was moving less than the minimum velocity of 0.1 m/s (traveling backwards due to ship roll).

DERIVE: Compute the Practical Salinity, sigma-theta and potential temperature.

BINAVG: Average the data into 1-dbar pressure bins.

BOTTLESUM: Create a summary of the bottle data. The data were averaged over 3.0 seconds.

Configuration file: KS-17-J05a.xmlcon

Specifications of the sensors are listed below.

CTD: SBE911plus CTD system

Under water unit:

SBE9plus (S/N 09P71874-1133, Sea-Bird Electronics, Inc.)

Pressure sensor: Digiquartz pressure sensor (S/N 127419)

Calibrated Date: 22 Apr 2016

Temperature sensors:

SBE03plus (S/N 03P5760, Sea-Bird Electronics, Inc.)

Calibrated Date: 10 Jan. 2017

Conductivity sensors:

SBE04C (S/N 044205, Sea-Bird Electronics, Inc.)

Calibrated Date: 10 Jan. 2017

Dissolved Oxygen sensor:

SBE43 (S/N 432525, Sea-Bird Electronics, Inc.)

Calibrated Date: 07 Jan. 2017

Transmissometer:

C-Star (S/N CST-1591DR, WET Labs, Inc.)

Calibrated Date: 24 Jan. 2013

Fluorescence:

Chlorophyll Fluorometer (S/N 3569, Seapoint Sensors, Inc.)

Turbidity: Turbidity meter (S/N 13371 Seapoint Sensors, Inc.)

Biospherical Surface PAR Light sensor:

QSR-2300 (S/N 70482, Biospherical Instruments Inc.)

Calibrated Date: 24 Jan. 2013

QSR-2200 (S/N20443, Biospherical Instruments Inc.)

Calibrated Date: 24 Jan. 2013

Altimeter: Benthos PSA-916T (S/N 58905, Teledyne Benthos, Inc.)

Carousel water sampler:

SBE32 (S/N 3271874-0929, Sea-Bird Electronics, Inc.)

Deck unit: SBE11plus (S/N 11-0956, Sea-Bird Electronics, Inc.)

(4) Preliminary Results

During this cruise, 24 casts of CTD observation were carried out. Date, time and locations of the

CTD casts are listed in Table 3.1-1. During this cruise, we judged noise, spike or shift in the data of some cast. These were as follows.

(5) Data archive

These data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via “Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)” in JAMSTEC web site.
<http://www.godac.jamstec.go.jp/darwin/e>

Table 3.1-1 KS-17-J05 CTD casttable

Stnnbr	Castno	Date(UTC)	Time(UTC)		BottomPosition		Depth	Wire	HT Above	Max	Max	CTD
		(mmddy)	Start	End	Latitude	Longitude		Out	Bottom	Depth	Pressure	
C6	1	31217	9:38	11:22	38-58.98N	143-00.04E	1585.7	1604	9.7	1575.9	1594	C6_1
C5	1	31217	13:56	15:41	39-00.08N	142-48.09E	1331.2	1343	10	1321.6	1336	C5_1
C4	1	31217	18:24	19:57	39-00.07N	142-33.91E	1197.9	1208	10.1	1188.5	1201	C4_1
C1	1	31317	6:57	7:27	39-00.01N	142-00.03E	198.8	191	9.9	191.4	193	C1_1
C2	1	31317	9:45	10:42	39-00.01N	142-09.97E	458.2	457	9.2	452	456	C2_1
C3	1	31317	13:40	15:06	38-59.85N	142-21.95E	978.6	986	9	969.3	979	C3_1
H1	1	31617	7:00	7:21	40-20.17N	142-00.20E	112.4	102	8.2	106.1	107	H1_1
H2	1	31617	22:12	23:08	40-20.02N	142-15.06E	518.8	519	10.1	514.3	519	H2_1
H3	1	31717	1:49	3:16	40-19.99N	142-30.02E	1043.1	1054	10	1037.3	1048	H3_1
H4	1	31717	6:00	7:51	40-20.00N	142-44.99E	1421.3	1440	9.8	1416.1	1432	H4_1
H5	1	31717	10:32	12:24	40-20.21N	143-00.22E	1489.2	1507	10.3	1483.1	1500	H5_1
H6	1	31717	15:08	17:01	40-19.88N	143-15.89E	1620.3	1651	9.1	1616.1	1635	H6_1
O4	1	32017	6:34	8:21	39-15.21N	142-39.59E	1452.4	1483	9.4	1450.7	1467	O4_1
O5	1	32017	11:25	13:21	39-15.14N	142-54.86E	1758.7	1806	8.4	1757	1778	O5_1
O6	1	32017	16:15	18:11	39-15.66N	143-07.06E	1914.9	1994	9.4	1916.3	1940	O6_1
O1	1	32317	8:58	9:44	39-14.99N	142-10.00E	351.1	347	9.8	345	348	O1_1
O2	1	32317	12:06	13:16	39-13.99N	142-20.01E	825.7	838	9.9	824	832	O2_1
O3	1	32317	15:34	17:05	39-16.35N	142-29.91E	1109	1123	9.5	1105.5	1117	O3_1
D3	1	32417	12:53	13:20	38-29.96N	141-49.99E	184.5	186	11.1	185.5	187	D3_1
D4	1	32417	16:10	17:01	38-29.42N	142-04.56E	475.1	473	9.6	467.9	472	D4_1
D8	1	32517	22:03	23:58	38-29.98N	143-04.97E	2141.7	2170	9.7	2133.7	2161	D8_1
D7	1	32617	2:30	4:05	38-29.93N	142-50.16E	1506.9	1523	9.6	1497.1	1514	D7_1
D6	1	32617	6:33	8:03	38-31.40N	142-35.72E	1296.1	1307	9.5	1286.2	1300	D6_1
D5	1	32617	10:37	11:46	38-30.06N	142-19.84E	825.8	830	10.2	817.2	825	D5_1

3.3.2. Salinity measurement

Masahide WAKITA (JAMSTEC)

(1) Objective

To measure bottle salinity obtained by CTD casts.

(2) Methods

a. Salinity Sample Collection

Seawater samples were collected with 10 liter Niskin bottles and bucket. The salinity sample bottles of the 250ml brown glass bottles with screw caps were used for collecting the sample water. Each bottle was rinsed three times with the sample water, and was filled with sample water to the bottle shoulder. The salinity sample bottles were sealed with plastic inner caps and screw caps because we took into consideration the possibility of storage for about a month. These caps were rinsed three times with the sample water before use. The bottle was stored for less than 1 month on the laboratory before the salinity measurement. The number of samples is total of ~370 for CTD casts.

b. Instruments and Method

The salinity analysis on the laboratory will be carried out using the salinometer (Model 8400B “AUTOSAL”; Guildline Instruments Ltd.) with an additional peristaltic-type intake pump (Ocean Scientific International, Ltd.). Digital thermometers (Model D617; Tateyama Kagaku Ind.) are used. The thermometer monitors the ambient temperature and the bath temperature of the salinometer.

The measurement system is almost the same as Aoyama et al. (2002). The salinometer is operated in the air-conditioned laboratory at a bath temperature of 24 deg C. The measurement for each sample is done with the double conductivity ratio and defined as the median of 60 readings of the salinometer. Data collection is started 5 seconds after filling the cell with the sample and it took about 15 seconds to collect 60 readings by a personal computer. Data are taken for the sixth and seventh filling of the cell after rinsing five times. 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 is used to calculate the bottle salinity with the algorithm for practical salinity scale, 1978 (UNESCO, 1981). If the difference is greater than or equal to 0.00003, an eighth filling of the cell is done.

(3) Data Archive

The distributions of salinity will be measured as soon as possible after this cruise. All measured data will be submitted to JAMSTEC Data Management Office (DMO).

(4) Reference

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

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

3.3.3. Dissolved oxygen

Masahide WAKITA (JAMSTEC): Principal Investigator

Masanori ENOKI (MWJ): Operation Leader

(1) Objectives

Determination of dissolved oxygen in seawater by Winkler titration.

(2) Parameter

Dissolved Oxygen (unit : $\mu\text{mol} \cdot \text{kg}^{-1}$)

(3) Instruments and Methods

Following procedure is based on an analytical method, entitled by “Determination of dissolved oxygen in sea water by Winkler titration”, in the WHP Operations and Methods (Dickson, 1996).

a. Instruments

Burette for sodium thiosulfate and potassium iodate;

EBU-610 / APB-620 manufactured by Kyoto Electronic Co. Ltd. / 10 cm^3 of titration vessel

Detector;

Automatic photometric titrator (DOT-05) manufactured by Kimoto Electronic Co. Ltd.

b. Reagents

Pickling Reagent I: Manganese chloride solution (3 mol dm^{-3})

Pickling Reagent II:

Sodium hydroxide (8 mol dm^{-3}) / sodium iodide solution (4 mol dm^{-3})

Sulfuric acid solution (5 mol dm^{-3})

Sodium thiosulfate (0.15 mol dm^{-3})

Potassium iodide ($0.001667 \text{ mol dm}^{-3}$)

c. Sampling

Seawater samples were collected with Niskin bottle attached to the CTD-system sampler. Seawater for oxygen measurement was transferred from sampler to a volume calibrated flask (ca. 100 cm^3). Three times volume of the flask of seawater was overflowed. Temperature was measured by digital thermometer during the overflowing. Then two reagent solutions (Reagent I and II) of 1 cm^3 each were added immediately into the sample flask and the stopper 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.

d. Sample measurement

At least two hours after the re-shaking, the pickled samples were measured on board. 1 cm³ sulfuric acid solution and a magnetic stirrer bar 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, we measured dissolved oxygen concentration using 1 set of the titration apparatus. Dissolved oxygen concentration ($\mu\text{mol kg}^{-1}$) was calculated by sample temperature during seawater sampling, salinity of the CTD sensor, and titrated volume of sodium thiosulfate solution without the blank.

e. Standardization and determination of the blank

Concentration of sodium thiosulfate titrant was determined by potassium iodate solution. Pure potassium iodate was dried in an oven at 130 °C. 1.7835 g potassium iodate weighed out accurately was dissolved in deionized water and diluted to final volume of 5 dm³ in a calibrated volumetric flask (0.001667 mol dm⁻³). 10 cm³ of the standard potassium iodate solution was added to a flask using a volume-calibrated dispenser. Then 90 cm³ of deionized water, 1 cm³ of sulfuric acid solution, and 1 cm³ of pickling reagent solution II and I were added into the flask in order. Amount of titrated volume of sodium thiosulfate (usually 5 times measurements average) gave the morality of sodium thiosulfate titrant.

The oxygen in the pickling reagents I (1 cm³) and II (1 cm³) was assumed to be 3.8×10^{-8} mol (Murray *et al.*, 1968). The blank due to other than oxygen was determined as follows. 1 and 2 cm³ of the standard potassium iodate solution were added to two flasks respectively using a calibrated dispenser. Then 100 cm³ of deionized water, 1 cm³ of sulfuric acid solution, and 1 cm³ of pickling reagent solution II and I each were added into the flask in order. The blank was determined by difference between the first (1 cm³ of KIO₃) titrated volume of the sodium thiosulfate and the second (2 cm³ of KIO₃) one. The results of 3 times blank determinations were averaged.

Table 3-2-3-3.-1 shows results of the standardization and the blank determination during this cruise.

Table 3-2-3-3.-1 Results of the standardization and the blank determinations during this cruise.

Date	KIO ₃ ID	Na ₂ S ₂ O ₃	DOT-05		Stations
			E.P. (cm ³)	Blank (cm ³)	
2017/3/11	K1605A08	KS17J05-1	0.6561	0.006	C6, C5, C4, C1, C2, C3, H1, H2, H3, H4, H5, H6, O4, O5,O6
2017/3/24	K1504F06	KS17J05-1	0.6588	0.007	O1, O2, O3, D3, D4, D8, D7, D6, D5

f. Repeatability of sample measurement

Replicate samples were taken at every CTD casts. Total amount of the replicate sample pairs of good measurement was 39. The standard deviation of the replicate measurement was 0.09 $\mu\text{mol kg}^{-1}$ that was calculated by a procedure in Guide to best practices for ocean CO₂ measurements Chapter4 SOP23 Ver.3.0 (2007). Results of replicate samples were shown in Table 4.1-2 and this diagram shown in Fig.3-2-3-3-1 and -2.

Table 3-2-3-3.-2 Results of the replicate sample measurements

Layer	Number of replicate sample pairs	Oxygen concentration ($\mu\text{mol kg}^{-1}$) Standard Deviation.
All	40	0.25

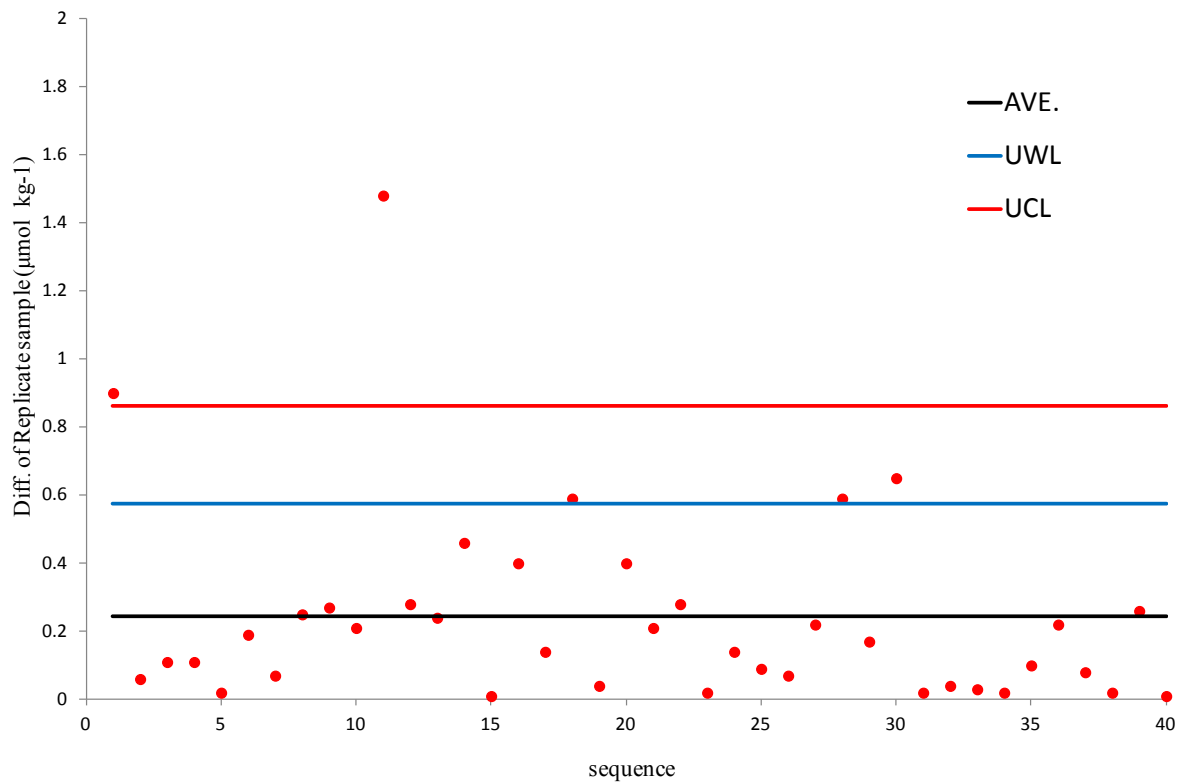


Fig. 3-2-3-3.-1 Differences of replicate samples against sequence number

(4) Data archive

All data will be submitted to Chief Scientist.

(5) References

Dickson, A.G., Determination of dissolved oxygen in sea water by Winkler titration. (1996)

Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.), Guide to best practices for ocean CO₂ measurements. (2007)

Culberson, C.H., WHP Operations and Methods July-1991 “Dissolved Oxygen”, (1991)

Japan Meteorological Agency, Oceanographic research guidelines (Part 1). (1999)

KIMOTO electric CO. LTD., Automatic photometric titrator DOT-01 Instruction manual

3.3.4. Nutrients

Masahide WAKITA (JAMSTEC)

(1) Objectives

Determination of nutrients in seawater by a continuous flow analyzer (QuAAtro 2-HR system, BL-Tech, Osaka, Japan)

(2) Parameters

The determinants are nitrate, nitrite, silicate, phosphate and ammonia in the Sanriku.

(3) Summary of nutrients analysis

We will make 1 QuAAtro run for the water columns sample at 24 casts during KS-17-J05. The total number of the seawater sample reached to ~2000. We made duplicate measurement.

(4) Instrument and Method

(4.1) Analytical detail using QuAAtro 2-HR systems (BL-Tech)

Nitrate + nitrite and nitrite are analyzed according to the modification method of Grasshoff (1970). The sample nitrate is reduced to nitrite in a cadmium tube inside of which was coated with metallic copper. The sample streamed with its equivalent nitrite is treated with an acidic, sulfanilamide reagent and the nitrite forms nitrous acid which reacts with the sulfanilamide to produce a diazonium ion. N-1-Naphthylethylene-diamine adds to the sample stream then coupled with the diazonium ion to produce a red, azo dye. With reduction of the nitrate to nitrite, both nitrate and nitrite reacts and are measured; without reduction, only nitrite reacted. Thus, for the nitrite analysis, no reduction is performed and the alkaline buffer is not necessary. Nitrate is computed by difference.

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 first formed from the silicate in the sample and adds molybdic acid; then the silicomolybdic acid is reduced to silicomolybdous acid, or "molybdenum blue" using ascorbic acid as the reductant. The analytical methods of the nutrients, nitrate, nitrite, silicate and phosphate, during this cruise are same as the methods used in (Kawano et al. 2009).

The phosphate analysis is a modification of the procedure of 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.

The ammonia in seawater is mixed with an alkaline containing EDTA, ammonia as gas state is

formed from seawater. The ammonia (gas) is absorbed in sulfuric acid by way of 0.5 µm pore size membrane filter (ADVANTEC PTFE) at the dialyzer attached to analytical system. The ammonia absorbed in sulfuric acid is determined by coupling with phenol and hypochlorite to form indophenols blue. Wavelength using ammonia analysis is 630 nm, which is absorbance of indophenols blue.

The details of modification of analytical methods used in this cruise are also compatible with the methods described in nutrients section in GO-SHIP repeat hydrography manual (Hydes et al., 2010). The flow diagrams and reagents for each parameter are shown in Figures 2.4.2. to 2.4.6.

(4.2) Nitrate + Nitrite Reagents

Imidazole (buffer), 0.06 M (0.4 % w/v)

Dissolve 4 g imidazole, $C_3H_4N_2$, in ca. 1000 ml DIW; add 2 ml concentrated HCl. After mixing, 1 ml Triton®X-100 (50 % solution in ethanol) is added.

Sulfanilamide, 0.06 M (1 % w/v) in 1.2M HCl

Dissolve 10 g sulfanilamide, $4-NH_2C_6H_4SO_3H$, in 900 ml of DIW, add 100 ml concentrated HCl. After mixing, 2 ml Triton®X-100 (50 % solution in ethanol) is added.

N-1-Naphthylethylene-diamine dihydrochloride, 0.004 M (0.1 %f w/v)

Dissolve 1 g NED, $C_{10}H_7NHCH_2CH_2NH_2 \cdot 2HCl$, in 1000 ml of DIW and add 10 ml concentrated HCl. After mixing, 1 ml Triton®X-100 (50 % solution in ethanol) is added. This reagent is stored in a dark bottle.

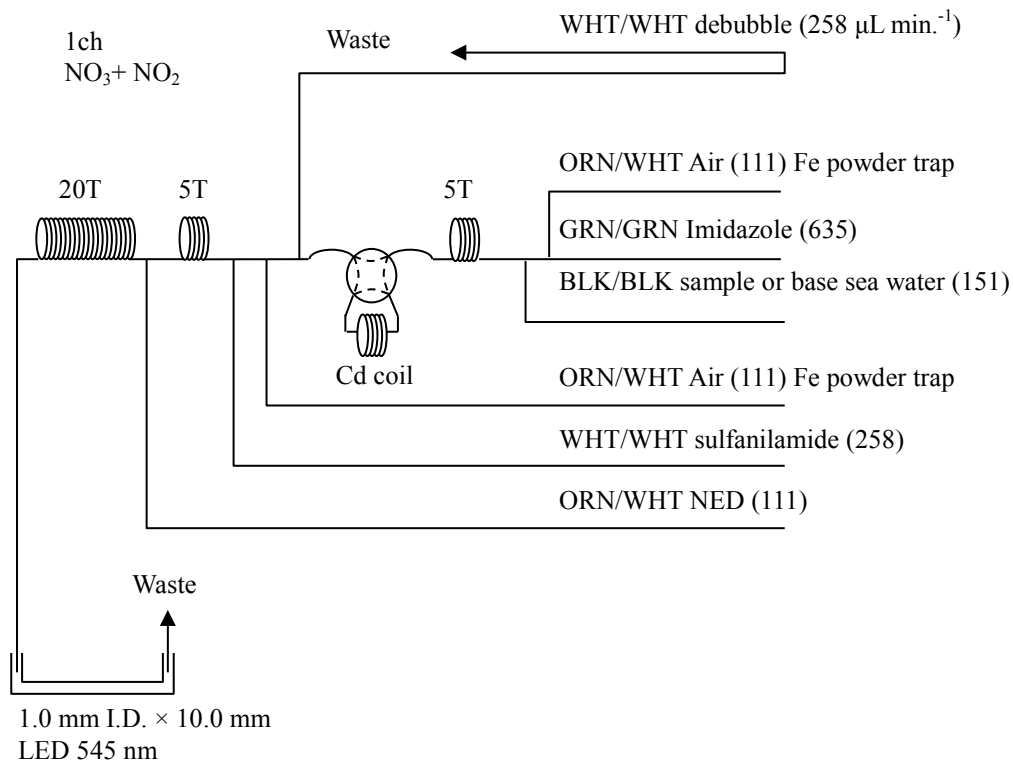


Figure 2.4.2. NO₃ + NO₂ (1ch.) Flow diagram.

(4.3) Nitrite Reagents

Sulfanilamide, 0.06 M (1 % w/v) in 1.2 M HCl

Dissolve 10g sulfanilamide, 4-NH₂C₆H₄SO₃H, in 900 ml of DIW, add 100 ml concentrated HCl. After mixing, 2 ml Triton®X-100 (50 % solution in ethanol) is added.

N-1-Napthylethylene-diamine dihydrochloride, 0.004 M (0.1 % w/v)

Dissolve 1 g NED, C₁₀H₇NHCH₂CH₂NH₂ · 2HCl, in 1000 ml of DIW and add 10 ml concentrated HCl. After mixing, 1 ml Triton®X-100 (50 % solution in ethanol) is added. This reagent is stored in a dark bottle.

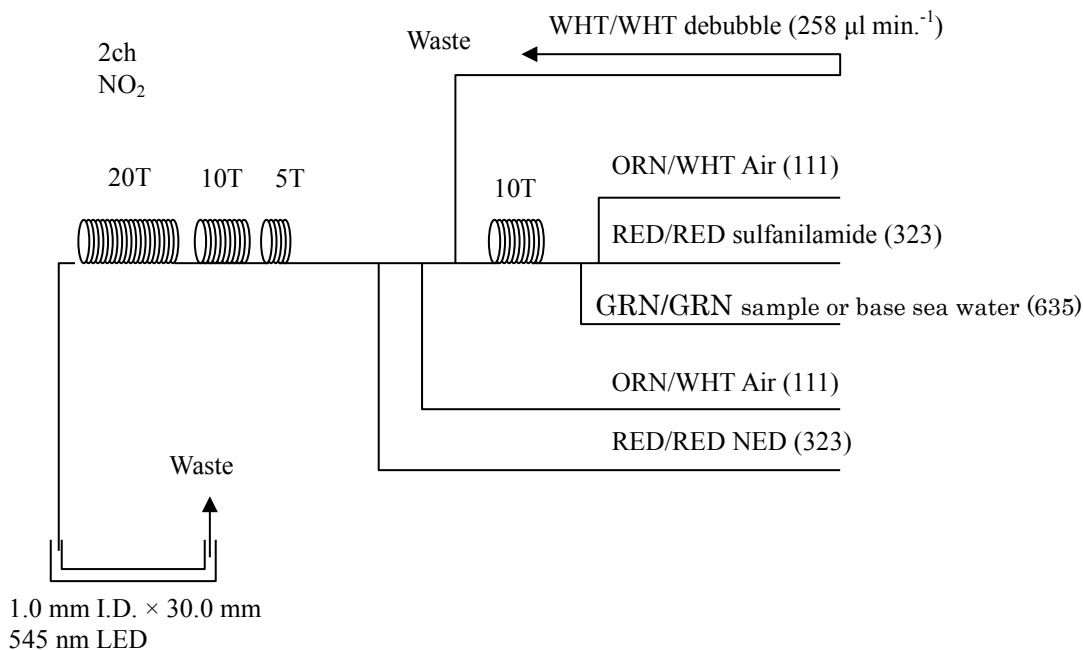


Figure2.4.3. NO₂ (2ch.) Flow diagram.

(4.4) Silicate Reagents

Molybdic acid, 0.06 M (2 % w/v)

Dissolve 15 g disodium molybdate(VI) dihydrate, Na₂MoO₄•2H₂O, in 980 ml DIW, add 8 ml concentrated H₂SO₄. After mixing, 20 ml sodium dodecyl sulphate (15 % solution in water) is added.

Oxalic acid, 0.6 M (5 % w/v)

Dissolve 50 g oxalic acid anhydrous, HOOC: COOH, in 950 ml of DIW.

Ascorbic acid, 0.01M (3 % w/v)

Dissolve 2.5g L (+)-ascorbic acid, C₆H₈O₆, in 100 ml of DIW. Stored in a dark bottle and freshly prepared before every measurement.

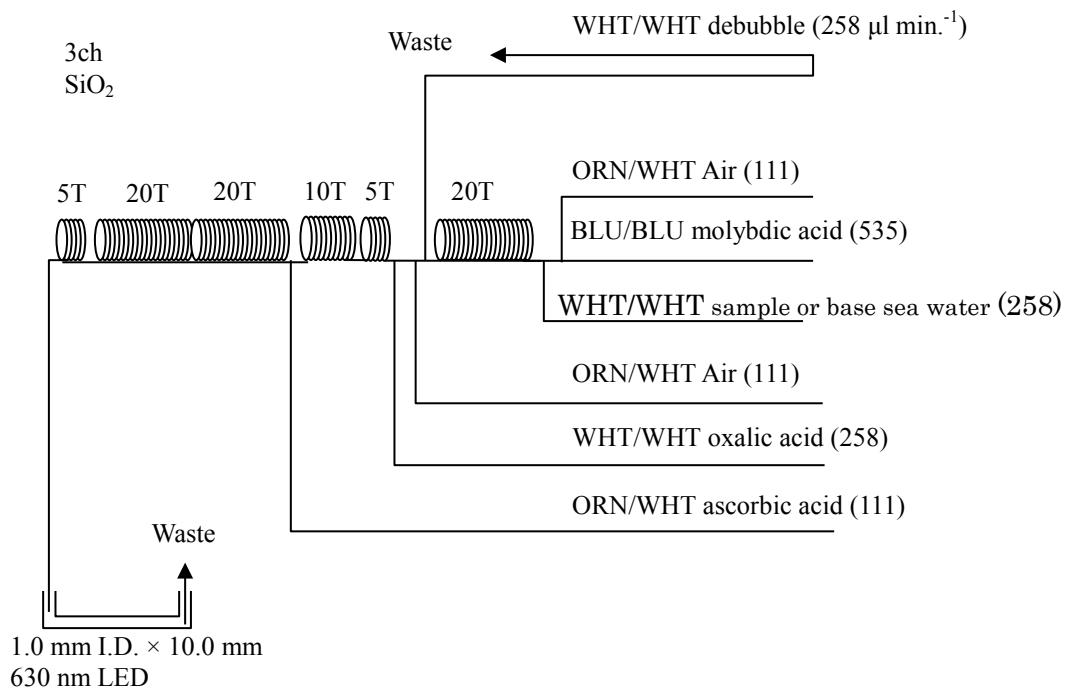


Figure 2.4.4. SiO₂ (3ch.) Flow diagram.

(4.5) Phosphate Reagents

Stock molybdate solution, 0.03M (0.8 % w/v)

Dissolve 8 g disodium molybdate(VI) dihydrate, Na₂MoO₄•2H₂O, and 0.17 g antimony potassium tartrate, C₈H₄K₂O₁₂Sb₂•3H₂O, in 950 ml of DIW and add 50 ml concentrated H₂SO₄.

Mixed Reagent

Dissolve 1.2 g L (+)-ascorbic acid, C₆H₈O₆, in 150 ml of stock molybdate solution. After mixing, 3 ml sodium dodecyl sulphate (15 % solution in water) is added. Stored in a dark bottle and freshly prepared before every measurement.

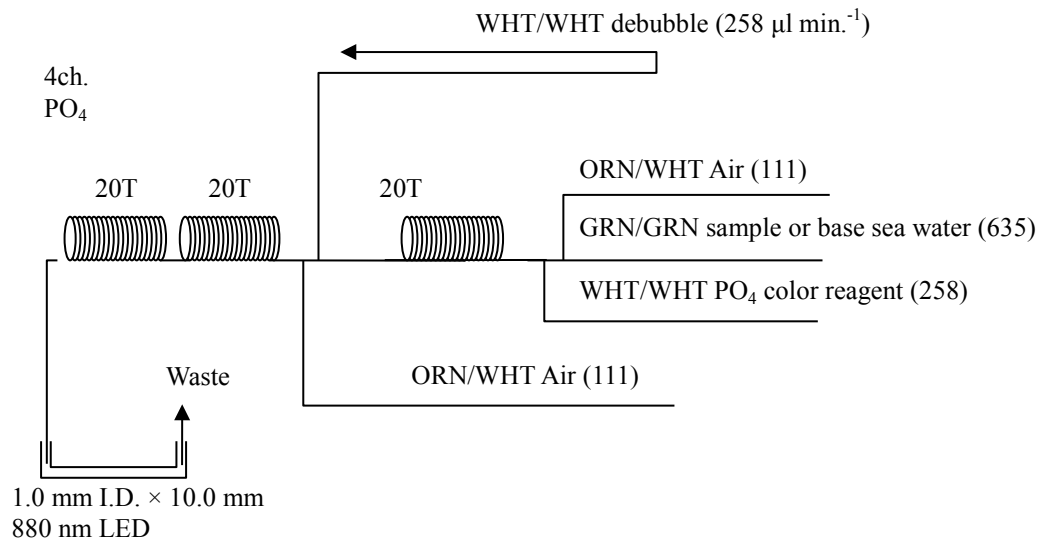


Figure2.4.5. PO₄ (4ch.) Flow diagram.

(4.6) Ammonia Reagents

EDTA

Dissolve 41 g EDTA (ethylenediaminetetraacetic acid tetrasodium salt), $C_{10}H_{12}N_2O_8Na_4 \cdot 4H_2O$, and 2 g boric acid, H_3BO_3 , in 200 ml of DIW. After mixing, 1 ml Triton®X-100 (30 % solution in DIW) is added. This reagent is prepared at a week about.

NaOH

Dissolve 5 g sodium hydroxide, NaOH, and 16 g EDTA in 100 ml of DIW. This reagent is prepared at a week about.

Stock Nitroprusside

Dissolved 0.25 g sodium pentacyanonitrosylferrate(II), $Na_2[Fe(CN)_5NO]$, in 100 ml of DIW and add 0.2 ml 1N H_2SO_4 . Stored in a dark bottle and prepared at a month about.

Nitroprusside solution

Mixed 4 ml stock nitroprusside and 5 ml 1N H_2SO_4 in 500 ml of DIW. After mixing, 2ml Triton®X-100 (30 % solution in DIW) is added. This reagent is stored in a dark bottle and prepared at every 2 or 3 days.

Alkaline phenol

Dissolved 10 g phenol, C_6H_5OH , 5 g sodium hydroxide and citric acid, $C_6H_8O_7$, in 200 ml DIW.

Stored in a dark bottle and prepared at a week about.

NaClO solution

Mixed 3 ml sodium hypochlorite solution, NaClO, in 47 ml DIW. Stored in a dark bottle and freshly prepared before every measurement. This reagent is prepared 0.3% available chlorine.

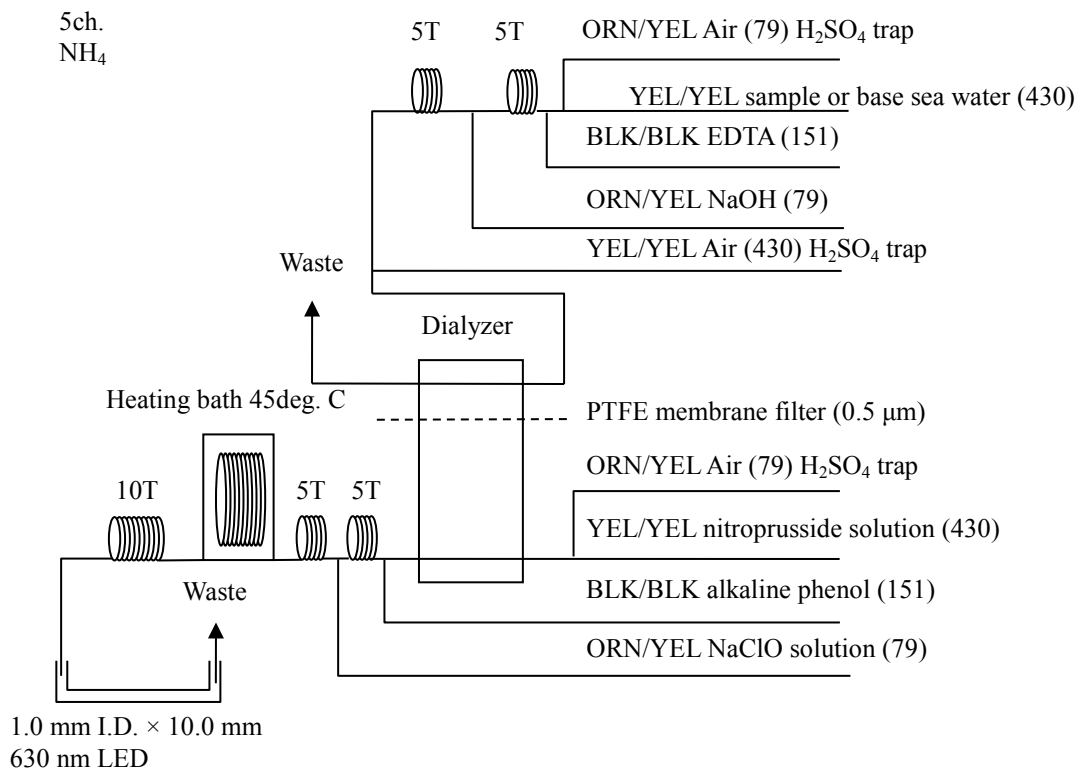


Figure 2.4.6 NH₄ (5ch.) Flow diagram.

(4.7) Sampling procedures

Sampling of nutrients followed that oxygen, salinity and trace gases. Samples were drawn into a virgin 10 ml polyacrylates vials without sample drawing tubes. These were rinsed three times before filling and vials were capped immediately after the drawing. After collection, samples are frozen upright and preserved at ~ -20 °C cold until analysis in our land laboratory. Before analysis, the vials return to ambient temperature, 20.0 ± 1.0 deg. C, in about 60 minutes before use to stabilize the temperature of samples. No transfer was made and the vials were set an auto sampler tray directly.

(4.8) Data processing

Raw data from QuAAtro were treated as follows:

- Check baseline shift.
- Check the shape of each peak and positions of peak values taken, and then change the positions of peak values taken if necessary.
- Carry-over correction and baseline drift correction were applied to peak heights of each samples followed by sensitivity correction.
- Baseline correction and sensitivity correction were done basically using liner regression.
- Calibration curves to get nutrients concentration were assumed second order equations.

(5) Nutrients standards

(5.1) Volumetric laboratory ware of in-house standards

All volumetric glass ware and polymethylpentene (PMP) ware used were gravimetrically calibrated. Plastic volumetric flasks were gravimetrically calibrated at the temperature of use within 4 K.

(5.1.1) Volumetric flasks

Volumetric flasks of Class quality (Class A) are used because their nominal tolerances are 0.05 % or less over the size ranges likely to be used in this work. Class A flasks are made of borosilicate glass, and the standard solutions were transferred to plastic bottles as quickly as possible after they are made up to volume and well mixed in order to prevent excessive dissolution of silicate from the glass. PMP volumetric flasks were gravimetrically calibrated and used only within 4 K of the calibration temperature.

The computation of volume contained by glass flasks at various temperatures other than the calibration temperatures were done by using the coefficient of linear expansion of borosilicate crown glass.

Because of their larger temperature coefficients of cubical expansion and lack of tables constructed for these materials, the plastic volumetric flasks were gravimetrically calibrated over the temperature range of intended use and used at the temperature of calibration within 4 K. The weights obtained in the calibration weightings were corrected for the density of water and air buoyancy.

(5.1.2) Pipettor

The pipettor used in this cruise has nominal calibration tolerances of 0.1 % or better. It was gravimetrically calibrated in order to verify and improve upon this nominal tolerance.

(5.2) Reagents, general considerations

(5.2.1) Specifications

For nitrate standard, “potassium nitrate 99.995 suprapur®” provided by Merck, Lot. B0771365211, CAS No.: 7757-91-1, was used.

For nitrite standard solution, we used “nitrous acid iron standard solution (NO₂⁻ 1000) provided by Wako, Lot ECP4122, Code. No. 140-06451.” This standard solution was certified by Wako using Ion chromatograph method. Calibration result is 999 mg L⁻¹ at 20 degree Celsius. Expanded uncertainty of calibration (k=2) is 0.7 % for the calibration result.

For phosphate standard, “potassium dihydrogen phosphate anhydrous 99.995 suprapur®” provided by Merck, Lot. B1144508528, CAS No.: 7778-77-0, was used.

For the silicate standard, we use “Silicon standard solution SiO₂ in NaOH 0.5 mol/l CertiPUR®” provided by Merck, CAS No.: 1310-73-2, of which lot number is HC54715536 are used. The silicate concentration is certified by NIST-SRM3150 with the uncertainty of 0.7 %. HC54715536 is certified as 1005 mg L⁻¹.

For ammonia standard, “ammonium Chloride” provided by NMIJ. We used NMIJ CRM 3011-a. The purity of this standard was greater than 99.9 %. Expanded uncertainty of calibration (k=2) is 0.065 %.

(5.2.2) Ultra-pure water

Ultra-pure water (Milli-Q water) freshly drawn was used for preparation of reagent, standard solutions and for measurement of reagent and system blanks.

(5.2.3) Low nutrients seawater (LNSW)

Surface water having low nutrient concentration was taken and filtered using 0.20 µm pore capsule cartridge filter. This water is stored in 20 liter cubitainer with paper box.

(6) Certified Reference Material of nutrients in seawater

To get the more accurate and high quality nutrients data to achieve the objectives stated above, huge numbers of the bottles of the Certified Reference Material of nutrients in seawater (hereafter CRM), which were recently certify by JAMSTEC and KANSO, are prepared (e.g., Aoyama et al., 2008). In the previous worldwide expeditions, such as WOCE cruises, the higher reproducibility and precision of nutrients measurements were required (Joyce and Corry, 1994). Since no standards were available for the measurement of nutrients in seawater at that time, the requirements were described in term of reproducibility.

(7) Quality control

(7.1) Precision of nutrients analyses during the measurement

Precision of nutrients analyses during this cruise is evaluated based on the repeated measurement of high concentration of standard, which are measured every 8 to 14 samples during the run.

(8) Data archive

These data obtained in this cruise will be submitted to JAMSTEC.

(9) References

- Aoyama M., J. Barwell-Clarke, S. Becker, M. Blum, Braga E. S., S. C. Coverly, E. Czobik, I. Dahllorf, M. H. Dai, G. O. Donnell, C. Engelke, G. C. Gong, Gi-Hoon Hong, D. J. Hydes, M. M. Jin, H. Kasai, R. Kerouel, Y. Kiyomono, M. Knockaert, N. Kress, K. A. Kroglund, M. Kumagai, S. Leterme, Yarong Li, S. Masuda, T. Miyao, T. Moutin, A. Murata, N. Nagai, G. Nausch, M. K. Ngirchchol, A. Nybakk, H. Ogawa, J. van Ooijen, H. Ota, J. M. Pan, C. Payne, O. Pierre-Duplessix, M. Pujo-Pay, T. Raabe, K. Saito, K. Sato, C. Schmidt, M. Schuett, T. M. Shammon, J. Sun, T. Tanhua, L. White, E.M.S. Woodward, P. Worsfold, P. Yeats, T. Yoshimura, A. Youenou, J. Z. Zhang, 2008: 2006 Intercomparison Exercise for Reference Material for Nutrients in Seawater in a Seawater Matrix, Technical Reports of the Meteorological Research Institute No. 58, 104pp.
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- Kawano, T., Uchida, H. and Doi, T. WHP P01, P14 REVISIT DATA BOOK, (Ryoin Co., Ltd., Yokohama, 2009).
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3.3.5. Chlorophyll *a* measurement by fluorometric determination

Masahide WAKITA (JAMSTEC): Principal Investigator

Keitaro MATSUMOTO (MWJ): Operation Leader

(1) Objective

Phytoplankton biomass can estimate as the concentration of chlorophyll *a* (chl-*a*), because all oxygenic photosynthetic plankton contain chl-*a*. Phytoplankton exist various species in the ocean, but the species are roughly characterized by their cell size. The objective of this study is to investigate the vertical distribution of phytoplankton and their size fractionations as chl-*a* by using the fluorometric determination.

(2) Sampling

Samplings of total chl-*a* were conducted from 8-12 depths between the surface and up to 300 m.

(3) Instruments and Methods

Water samples (0.5L) for total chl-*a* were filtered (<0.02 MPa) through 25mm-diameter Whatman GF/F filter. Size-fractionated chl-*a* were obtained by sequential filtration (<0.02 MPa) of 1-L water sample through 10- μ m, 3- μ m and 1- μ m polycarbonate filters (47-mm diameter) and Whatman GF/F filter (25-mm diameter). Phytoplankton pigments retained on the filters were immediately extracted in a polypropylene tube with 7 ml of N,N-dimethylformamide (Suzuki and Ishimaru, 1990). Those tubes were stored at -20°C under the dark condition to extract chl-*a* for 24 hours or more.

Fluorescences of each sample were measured by Turner Design fluorometer (10-AU-005), which was calibrated against a pure chl-*a* (Sigma-Aldrich Co.). We applied two kind of fluorometric determination for the samples of total chl-*a*: “Non-acidification method” (Welschmeyer, 1994) and “Acidification method” (Holm-Hansen *et al.*, 1965). Analytical conditions of each method were listed in table 1.

(4) Preliminary Results

The results of total chl-*a* at 4 observation lines were shown in Figure 1.

(5) Data archives

The processed data file of pigments will be submitted to the JAMSTEC Data Management Group (DMG) within a restricted period. Please ask PI for the latest information.

(6) Reference

Suzuki, R., and T. Ishimaru (1990), An improved method for the determination of phytoplankton chlorophyll using N, N-dimethylformamide, *J. Oceanogr. Soc. Japan*, 46, 190-194.

Holm-Hansen, O., Lorenzen, C. J., Holmes, R.W. and J. D. H. Strickland (1965), Fluorometric determination of chlorophyll. *J. Cons. Cons. Int. Explor. Mer.* 30, 3-15.

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

Table 1. Analytical conditions of “Non-acidification method” and “Acidification method” for chlorophyll *a* with Turner Designs fluorometer (10-AU-005).

	Non-acidification method	Acidification method
Excitation filter (nm)	436	340-500
Emission filter (nm)	680	>665
Lamp	Blue Mercury Vapor	Daylight White

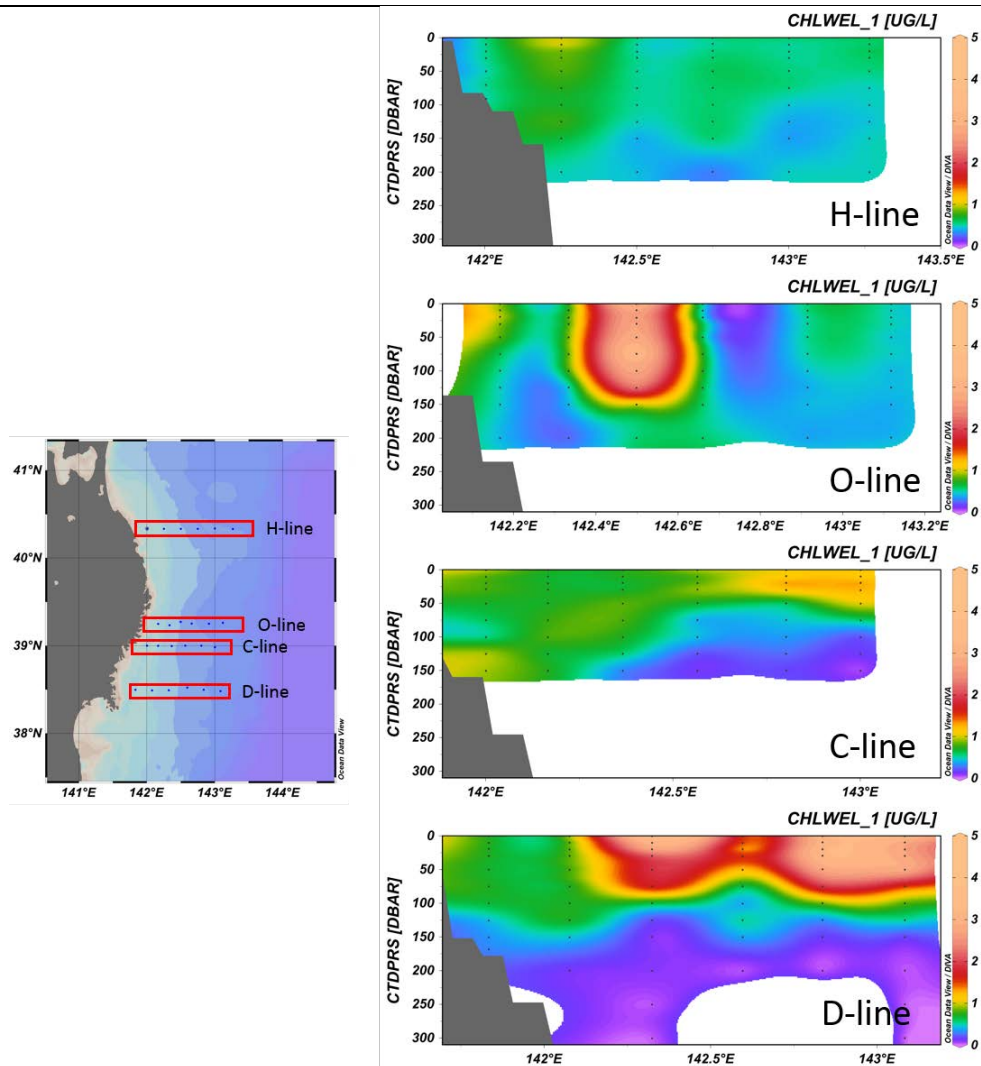


Figure 1. Vertical distribution of chlorophyll *a* (non-acidification) at 4 observation lines

3.3.6. Carbonate system (dissolved inorganic carbon and total alkalinity)

Masahide WAKITA (JAMSTEC)

Yasuhiro ARII (MWJ)

(1) Objective

Concentration of CO₂ in the atmosphere is now increasing owing to human activities such as burning of fossil fuels, deforestation, and cement production. The ocean plays an important role in buffering the increase of atmospheric CO₂. Approximately 30% of the total amount of anthropogenic CO₂ emitted into the atmosphere has accumulated in the global ocean [IPCC, 2013]. Ocean acidification is a direct consequence of the ocean absorbing large amounts of the anthropogenic CO₂. The CO₂ uptake by the oceans has led to lowering both pH and CaCO₃ saturation states with regard to the mineral phases due to increasing hydrogen ions (H⁺) and declining carbonate ion (CO₃²⁻), respectively. Because oceanic biological activity has an important role concerned to Carbon cycle in the ocean through its photosynthesis and respiration, the chemical changes associated with ocean acidification have the potential to affect ocean biogeochemistry and ecosystems in a myriad of ways. Therefore, it is important to clarify the mechanism of the oceanic CO₂ absorption and ocean acidification and to estimate CO₂ absorption capacity and decrease of pH and CaCO₃ saturation states in recent years. When CO₂ dissolves in water, chemical reaction takes place and CO₂ alters its appearance into several species. Concentrations of the individual species of the CO₂ system in solution cannot be measured directly, but calculated from two of four parameters: total dissolved inorganic carbon (DIC), total alkalinity (TA), pH and pCO₂. This study presents the distribution of DIC and TA in the Sanriku.

(2) Sampling

Seawater samples of DIC and TA were collected by 10 liter Niskin bottles mounted on the CTD/Carousel Water Sampling System and brought the total to ~400. Seawaters were sampled in a 150ml glass bottle for DIC and a 100ml glass bottle for TA. These bottles were previously soaked in 1M HCl solution at least 6 hours and was cleaned by fresh water for 7 times and Milli-Q deionized water for 3 times. A sampling silicone rubber tube with PFA tip 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. After collecting the samples on the deck, the glass bottles were carried to the laboratory. Within one hour after the sampling, 2 % by the bottle volume (2 ml) was removed from the glass bottle and poisoned with 0.1% by volume (0.1 ml) of over saturated solution

of mercury chloride. Then, the samples were sealed by rubber and aluminum caps. All samples preserved at $\sim 5^{\circ}\text{C}$ cold until analysis.

(3) Analysis

DIC and TA samples are measured by using coulometric and potentiometric techniques, respectively, according to Dickson et al., 2007. The DIC and TA values will be determined with calibration against certified reference material provided by Prof. A. G. Dickson (Scripps Institution of Oceanography) and KANSO.

(4) Preliminary result

The distributions of DIC and TA will be determined as soon as possible after this cruise.

3.3.7. Dissolved organic carbon (DOC) and Total dissolved nitrogen (TDN)

Masahide WAKITA (JAMSTEC)

(1) Objective

Variabilities in the dissolved organic carbon (DOC) in seawater have a potentially great impact on the carbon cycle in the marine system, because DOC is a major global carbon reservoir. A change by < 10% in the size of the oceanic DOC pool, estimated to be ~ 700 GtC (IPCC, 2007), would be comparable to the annual primary productivity in the whole ocean. In fact, it was generally concluded that the bulk DOC in oceanic water, especially in the deep ocean, is quite inert based upon ¹⁴C-age measurements. Nevertheless, it is widely observed that in the ocean DOC accumulates in surface waters at levels above the more constant concentration in deep water, suggesting the presence of DOC associated with biological production in the surface ocean. This study presents the distribution of DOC off the Sanriku.

(2) Sampling

Seawater samples of DOC and TDN were collected by 10 liter Niskin bottles mounted on the CTD/Carousel Water Sampling System and brought the total to ~300. Seawater from each Niskin bottle was transferred into 60 ml High Density Polyethylene bottle (HDPE) rinsed with same water three times. Water above the 200m depth is filtered using precombusted (450°C) GF/F inline filters as they are being collected from the Niskin bottle. After collection, samples are frozen upright and preserved at ~ -20 °C cold until analysis in our land laboratory. Before use, all glassware was muffled at 550 °C for 5 hrs.

(3) Analysis

Prior to analysis, samples are returned to room temperature and acidified to pH < 2 with concentrated hydrochloric acid. DOC/TDN analysis was basically made with a high-temperature catalytic oxidation (HTCO) system improved a commercial unit, the Shimadzu TOC-L (Shimadzu Co.). In this system, the non-dispersive infrared was used for carbon dioxide produced from DOC during the HTCO process (temperature: 680 °C, catalyst: 0.5% Pt-Al₂O₃). Non-purgeable dissolved nitrogen compounds are combusted and converted to NO which, when mixed with ozone, chemiluminesces for detection by a photomultiplier

(4) Preliminary result

The distributions of DOC and TDN will be determined as soon as possible after this cruise.

(5) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO) within 2 years.

3.3.8. H₂¹⁸O

Masahide WAKITA (JAMSTEC)

(1) Objective

The submarine ground fresh water discharge provides direct transport pathways for both water and other materials between the land groundwater system and the marine environment. The continental marginal sea is influenced by a huge amount of fresh water from ground water and river which is distributed widely on the continental shelf. The fresh water from ground water and river will affect salinity, biological activity, ocean circulation and cycle of geochemical properties

During the KS-17-J05 cruise, to evaluate the effect of fresh water off Sanriku, we have collected seawater samples for oxygen isotope analysis. Because oxygen isotope ratio of fresh water ($\delta^{18}\text{O}$) from the ground and rivers is different from sea water, causes of salinity changes can be quantitatively estimated from the salinity- $\delta^{18}\text{O}$ relationship.

(2) Sampling

Seawater samples were collected in 10L Niskin bottles mounted on the CTD-rosette system and then transferred into 10 ml glass vials for $\delta^{18}\text{O}$ analysis at all stations off Sanriku.

(3) Analysis

The oxygen isotope ratios will be automatically determined with a mass spectrometer (MAT 253, Thermo Fisher Scientific) with a CO₂-H₂O equilibration unit (Gas Bench, Thermo Fisher Scientific). Oxygen isotope ratio of water: expressed as a permil deviation of oxygen isotope ratio of the sample from that of international standard seawater (VSMOW).

$$\delta^{18}\text{O} = \{(\text{H}_2^{18}\text{O}/\text{H}_2^{16}\text{O})_{\text{sample}} - (\text{H}_2^{18}\text{O}/\text{H}_2^{16}\text{O})_{\text{VSMOW}}\} / (\text{H}_2^{18}\text{O}/\text{H}_2^{16}\text{O})_{\text{VSMOW}} \times 1000 \text{ [‰]}.$$

(4) Preliminary result

The distributions of DOC will be determined as soon as possible after this cruise.

(5) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO) within 2 years.

3.3.9. Phytoplankton abundance

Masahide WAKITA (JAMSTEC)

(1) Objective

The objective of this study is to estimate phytoplankton abundances and species richness in winter off Sanriku of the north-eastern Japan. Phytoplankton abundances and species richness were measured with microscopy for large size phytoplankton.

(2) Sampling

Samplings were conducted only using Niskin bottles, except for the surface water, which was taken by a bucket. Samplings were carried out at all CTD-water sampling stations.

(3) Methods

Water samples were placed in 500 ml plastic bottle. Samples were fixed with neutral-buffered formalin solution (1% final concentration). The microscopic measurements are scheduled after the cruise.

(4) Preliminary result

The distributions of phytoplankton abundance will be determined as soon as possible after this cruise.

(5) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO) within 2 years.

3.4. Fast repetition rate fluorometry (FRRF) observations

Masahide WAKITA (JAMSTEC)

Yasuhiro ARII (MWJ)

(1) Objective

During the past decade, the utilization of active fluorescence techniques in biological oceanography brought significant progress in our knowledge of phytoplankton productivity in the oceans. Above all, the fast repetition rate (FRR) fluorometry reduces the primary electron acceptor (Q_a) in photosystem II (PSII) by a series of subsaturating flashlets and can measure a single turnover (ST) fluorescence induction curve in PSII. The PSII parameters, such as the potential photosynthetic activity (F_v/F_m) and the functional absorption cross-section of PSII derived from the ST fluorescence induction curve can be used to estimate gross primary productivity. In the present study, to gain a better understanding of variability in phytoplankton productivity off the Sanriku, we measured the PSII parameters and primary productivity using the FRR fluorometry.

(2) Methods

Using the FRR fluorometer (Kimoto Electric Co., Ltd., Japan), the vertical variation in PSII parameters and primary productivity were examined off the Sanriku. The FRR fluorometer attached to the RINKO profiler (JFE Advantech Co., Ltd.) was moved up and down between surface and 200 m at the rate of 0.2 m s^{-1} using a ship winch. The RINKO profiler can measure the vertical profiles of water temperature, salinity, pressure, dissolved oxygen, chlorophyll and turbidity. The profiling rate of the observation buoy was set to minimal in order to detect small scale variations ($\sim 0.5 \text{ m}$) in measurements.

(4) Preliminary result

The distributions of phytoplankton abundance will be determined as soon as possible after this cruise.

(5) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO) within 2 years.

3.5. Zooplankton distribution by NORPAC net and quantitative echo sounder (QES)

Masahide WAKITA (JAMSTEC)

Keisuke MATSUMOTO (MWJ)

Rio KOBAYASHI (MWJ)

Takuya ONODERA (Nippon Marine Enterprises, LTD.)

Morifumi TAKAESU (Nippon Marine Enterprises, LTD.)

(1) Objectives

The objective of this study is to estimate zooplankton abundances and species richness in winter off Sanriku of the north-eastern Japan. Zooplankton abundances and species richness were measured with microscopy for large size phytoplankton and is compared against the zooplankton distribution by quantitative echo sounder (QES).

(2) Sampling by NORPAC net

Samplings were vertically hauled by using a NORPAC net (335 μ m mesh, NMG52) with a cod end. Plankton samplings were carried out at all CTD-water sampling stations. Plankton sample were placed in 500 ml plastic bottle and were fixed with neutral-buffered formalin solution (10% final concentration). The microscopic measurements are scheduled after the cruise.

(3) Observation by QES

In comparison with zooplankton distribution during NOPAC net sampling, we operated the Kongsberg EK 60 scientific echo sounder system equipped on board. The Kongsberg EK 60 scientific echo sounder system is designed for fishery research, as follows,

Technical specifications

Operation frequency: 18, 38, 70, 120, 200, 300 kHz

Operation modes: Active, Passive and Tes

Transmission power: Adjustable in steps

Ping rate: adjustable Maximum ping rate: 20 pings per sec

Data collection range: 0 to 15,000m

Receiver instantaneous dynamic range: 150 dB

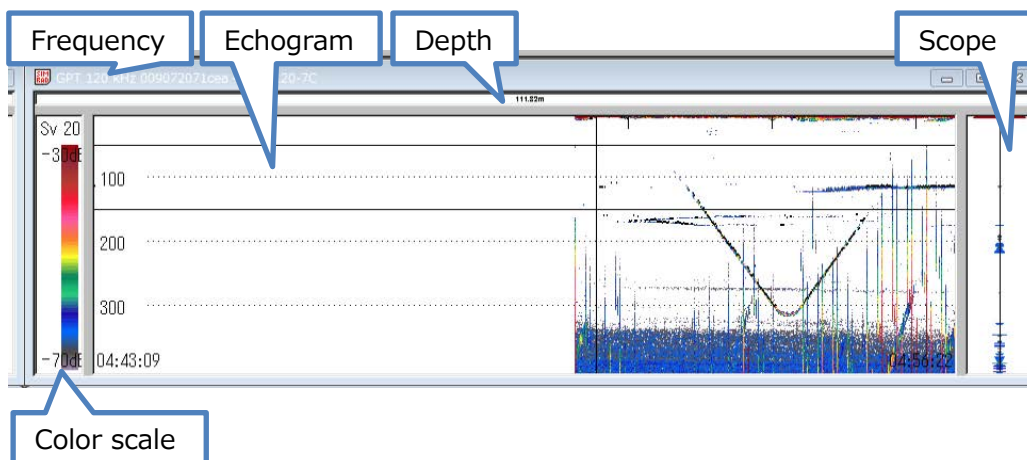
Receiver filtering: Matched digital filters

Receiver noise figure: 4 dB

Split beam: Complex digital demodulation

Synchronization: Internal and external

120 kHz echogram display at H-4 point, 17, March,2017



The view displays the current depth. The echogram contains information about the acoustic values. The Scope view provides oscilloscope visualization of the last ping. The view draws a range of horizontal symmetrical color line. The distance from the vertical center axis and the line color reflects the receiver echo scatter. The color scale view visualizes the mapping of echo strength into one out of 12 colors, light blue for weak signals and dark brown for strong signals. Basically, echo discrete color represents a 3 dB range of echo signal strength implying that the next color is selected every time the echo strength doubles. For example, horizontal axis means time series and color scale means reflective strength. The oblique line shows a sounding scatter of architect material (NORPAK net). The horizontal blue line at 100m depth shows observed strong reflection relative to back ground noise.

(4) Preliminary result

The distributions of zooplankton abundance will be determined as soon as possible after this cruise.

(5) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO).

3.6. Shipboard data (Bathymetry, SBP data)

Takafumi KASAYA (JAMSTEC)

Mutsumi IIZUKA (Tokyo City University)

Yoshinori MATUSMOTO (Windy Network)

Takuya ONODERA (Nippon Marine Enterprises, LTD.)

Morifumi TAKAESU (Nippon Marine Enterprises, LTD.)

The objective of MBES survey is collecting continuous bathymetric data as basic seafloor condition off Tohoku datasets. As a hull-mounted multi-narrow beam echo sounder, a “Seabeam 3020” and “SEABAT 7125” were equipped on the R/V Shinseimaru. However some troubles of electronics devices on Seabeam3020 system, a “SEABAT 7215 SV” was only used for bathymetry and seafloor mapping during the this cruise. The SEABAT 7125 SV system used 200/400 kHz signal and has hydrophone arrays that synthesize narrow, fan-shaped beams. Typical resolution of the depth measurement is generally within 0.25 % of the water depth. It can collect up to 256 soundings on each ping cycle over depths at 200 kHz varying from 10 to 500 meters, providing swath width coverage up to 165°. To get the accurate sound velocity of water column for ray-path correction of acoustic multi-beam signal, we used the deeper depth sound velocity profiles that were calculated from temperature and salinity profiles from XBT data by the equation in Mackenzie (1981) during the cruise. Figure3.6.1, 3.6.2 and 3.6.3 show the track lines of bathymetric survey. We will analyze the obtained data and integrate it with the compiled data set.

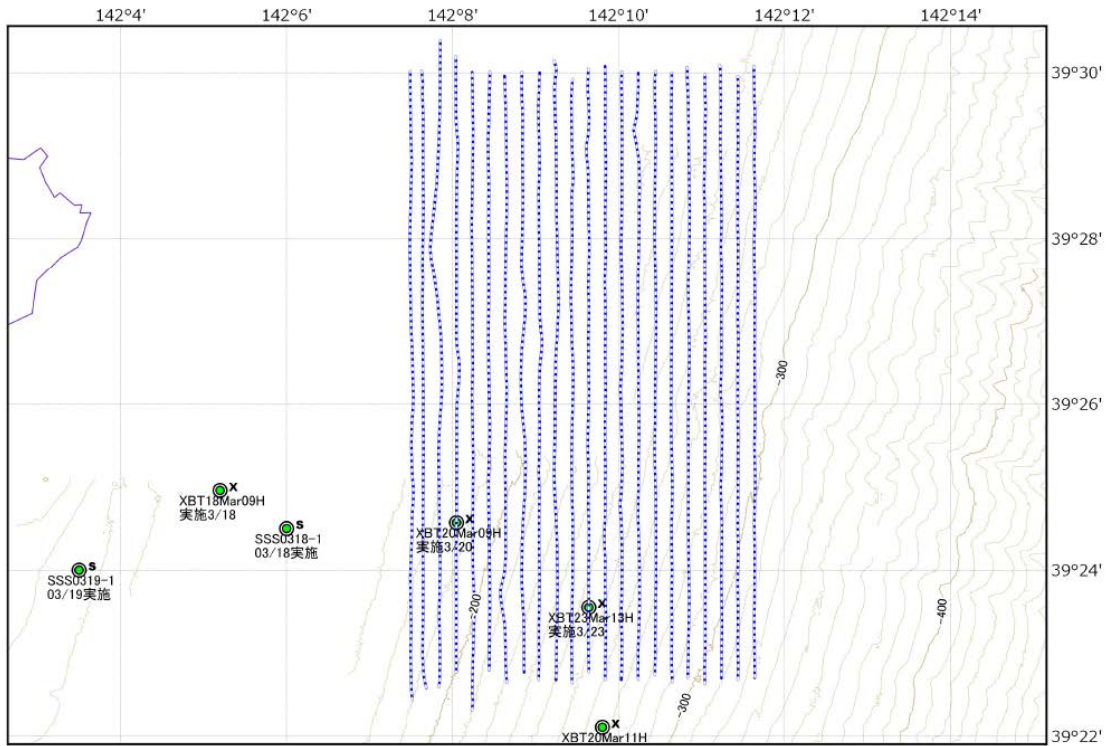


Fig. 3.6.1 MBES survey lines off the Otsuchi Bay.

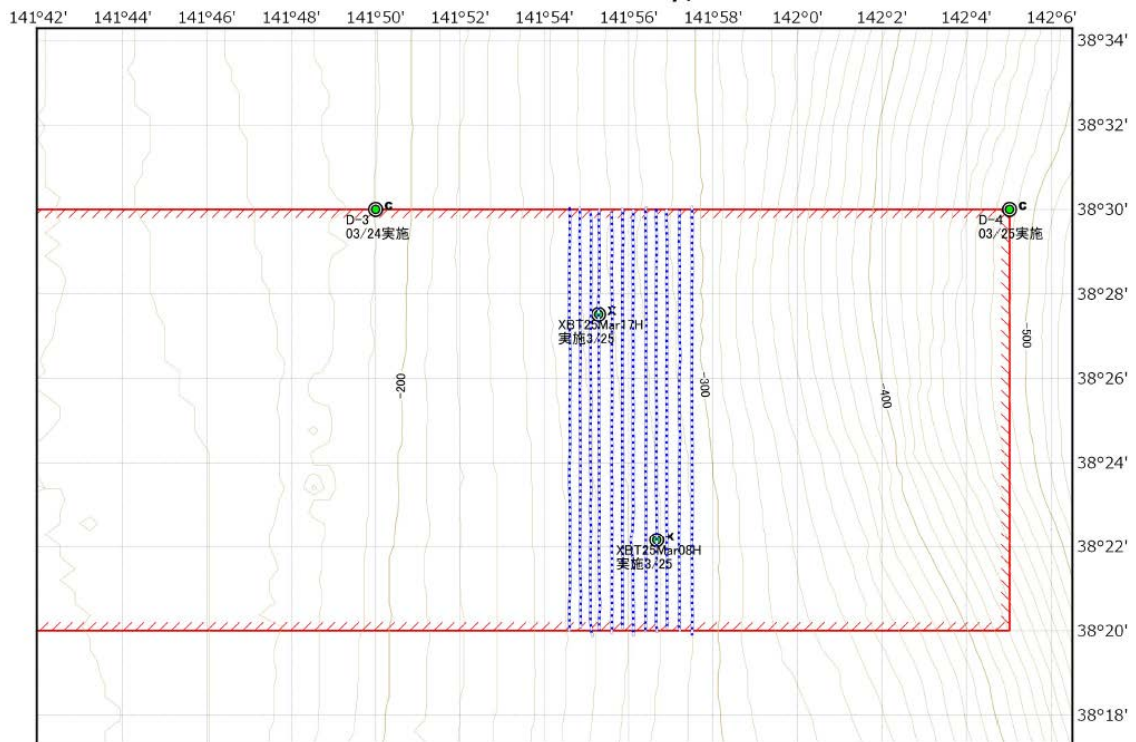


Fig. 3.6.2 MBES survey lines off the Onagawa Bay.

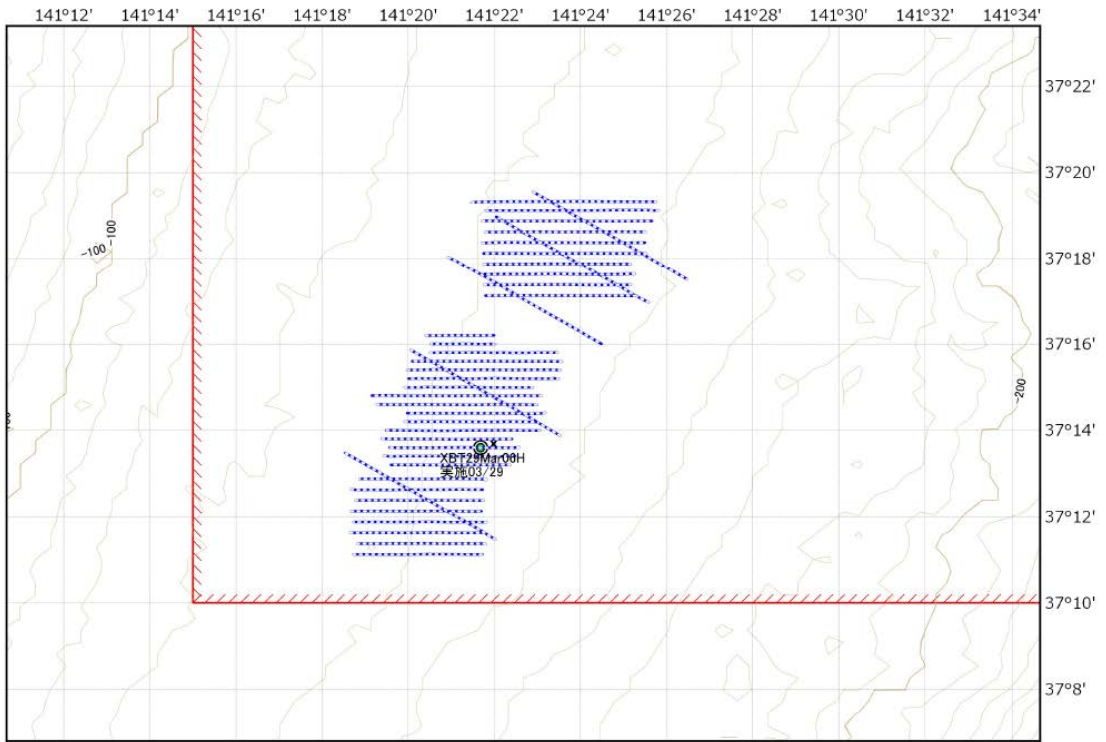


Fig. 3.6.3 MBES survey lines off Fukushima Prefecture.

3.7. Side scan sonar operation

3.7.1 Side scan sonar

We used the Edgetech 4200-MP side scan sonar system (Fig. 3.7.1) to collect the seafloor condition including the earthquake debris. This system used the full spectrum chirp signal for high resolution and good signal to noise ratio. This is also available with two dual simultaneous frequency sets (120 and 410 kHz). The collected sonar data are digitized in the towfish body, and then are transmitted to a deck unit through a coaxial cable with 200 meters (Fig. 3.7.2). Transmitted data are recorded the laptop PC installed the Edgetech's control software.

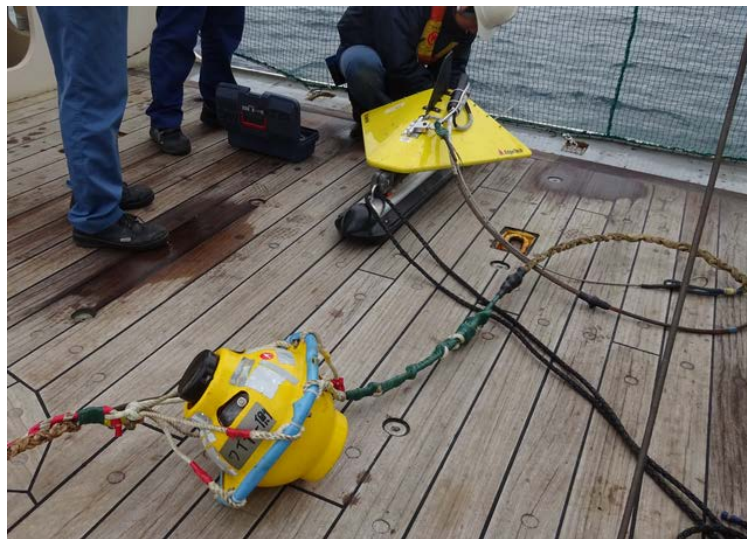


Fig. 3.7.1 Side scan sonar (Edgetech 4200MP) and transponder.

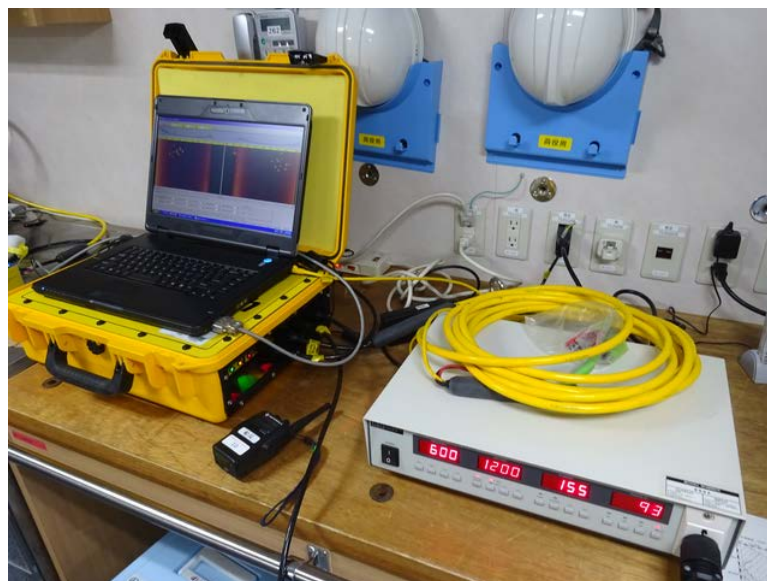


Fig. 3.7.2 Deck unit of a 4200MP system in the control room.

Table 3.7.1 Specification of side scan sonar system

Frequency	120 / 410 kHz
Modulation	Full Spectrum CHIP frequency modulated pluse
Resolution Across Track	100 kHz: 8 cm, 400 kHz: 2cm
Resolution Along Track	100 kHz: 2.m5 @ 200 meter range, 400 kHz: 0.5 @ 100 meter range
Weight in Air/Saltwater	48 / 36 kg (Stainless Steel)
Diameter / Length	11.4 cm / 125.6 cm
Operating Depth	2000 meters

3.7.2 Operation

To understand the distribution of sunken ships, artificial fish reef off the Hirota Bay and the Otuchi Bay, acoustic images has been obtained by the towed side scan sonar (SSS). In this cruise, we used the 600 m armored winch cable system to tow a sonar (Fig. 3.7.3 and 3.7.4). Figure 3.7.5, 3.7.6 and 3.7.7 show the track lines off the Hirota bay, off the Otsuchi Bay and off Fukushima Prefecture, respectively. The acoustic frequency of the SSS was used 400 KHz to obtain a detailed acoustic image in these operations. We could detect many sunken ships and artificial fish reefs in both area (Fig. 3.7.8). We will analyze these obtained data carefully.



Fig. 3.7.3 Photo of side scan sonar deployment.



Fig. 3.7.4 Photo of a electric cable winch used in this cruise.

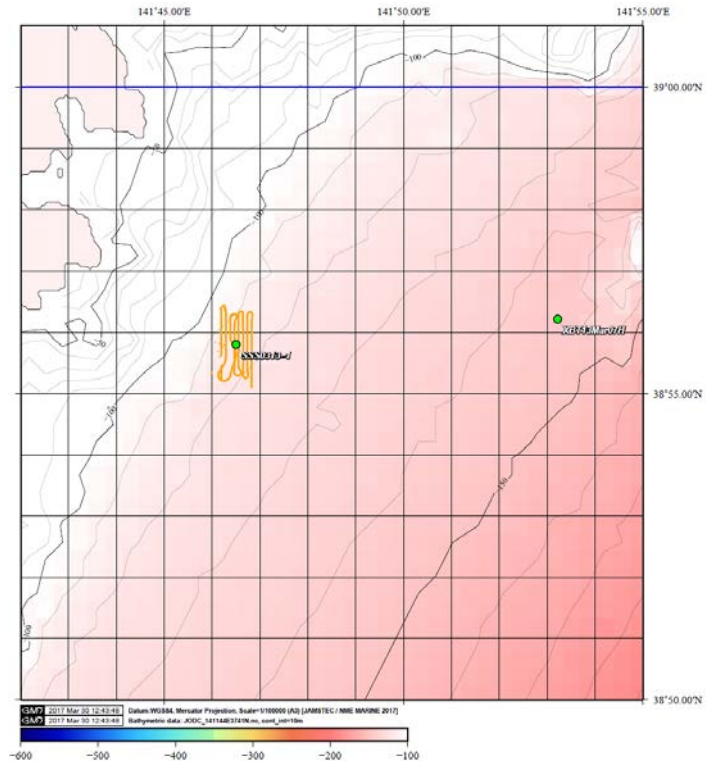


Fig. 3.7.5 Survey track lines used the acoustic transponder position off Hirota Bay.

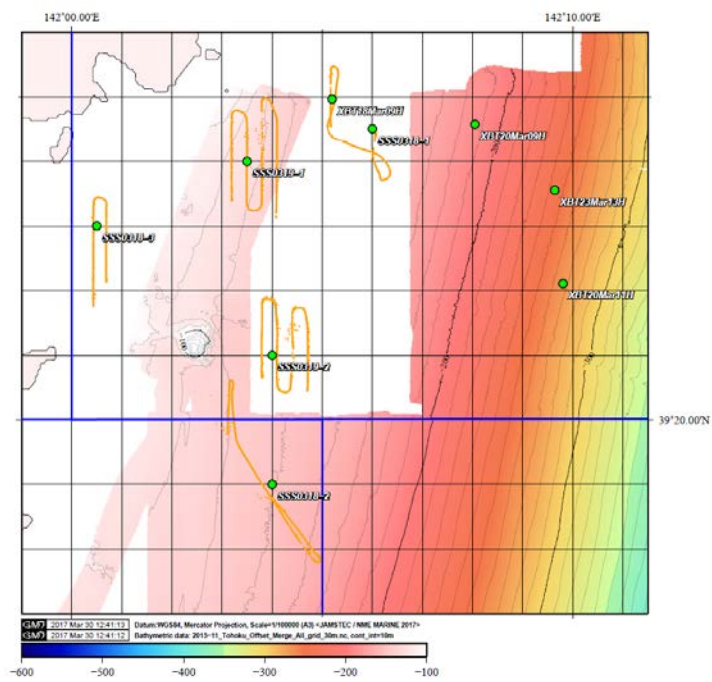


Fig. 3.7.6 Survey track lines used the acoustic transponder position off Otsuchi Bay.

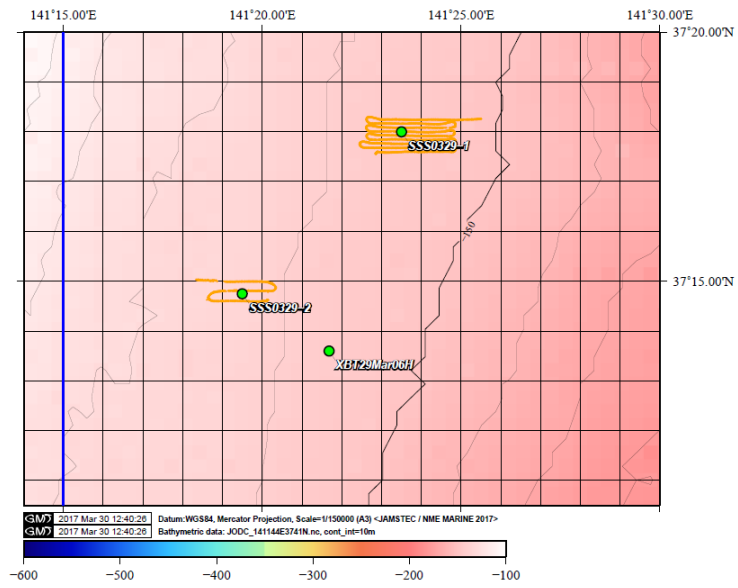


Fig. 3.7.7 Survey track lines used the acoustic transponder position off Fukushima.



Fig. 3.7.8 Raw backscatter data obtained side scan sonar in this cruise.

4. Notice on Using

Notice on using: Insert the following notice to users regarding the data and samples obtained.

This cruise report is a preliminary documentation as of the end of the cruise. This report may not be corrected even if changes on contents (i.e. taxonomic classifications) may be found after its publication. This report may also be changed without notice. Data on this cruise report may be raw or unprocessed. If you are going to use or refer to the data written on this report, please ask the Chief Scientist for latest information. Users of data or results on this cruise report are requested to submit their results to the Data Management Group of JAMSTEC.

5. Acknowledgments

We are grateful to the captain and crew of the R/V “SHINSEI-MARU” for their support during the cruise.

April 2017

Chief Scientist of KS-17-J05

Masahide Wakita
JAMSTEC