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Cruise Report

MR12-E02 Leg1

Off Sanriku, north-eastern Japan

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

R. V. Mirai

March 6, 2012- March 15, 2012

Project: TEAMS (Tohoku Ecosystem Array of Marine Sciences)

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1.Cruise information and summary of MR12-E02 Leg1 cruise

1.1 Cruise Information

Cruise ID: MR12-E02 Leg1

Name of vessel: R. V. Mirai

Chief scientist: Takafumi Kasaya (IFREE/JAMSTEC)

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

Cruise period: 6 Mar. 2012 – 15 Mar. 2012

Ports of call: Yokohama port – Hachinohe port

Research area: Off-Sanriku area

Research map: Fig. 1

1.2 Cruise summary

The purpose of this cruise is to understand impact to marine ecosystems by the 2011 Earthquake of the Pacific coast of Tōhoku) and Tsunami, and to contribute by marine science aspects for recover and rebuild of Sanriku fisheries activities. Target areas are sea bottom layers off Sanriku. This cruise is conducted under the TEAMS project, namely Tohoku Ecosystem Array of Marine Sciences. Detail investigation subjects are topographic surveys, mapping of scattered debris, distribution patterns and diversity of benthic organisms, seawater and sediments chemical and sediments components. Based on these data and samples, we will construct habitat map for ecosystem management in Sanriku areas.

In this leg, we obtained acoustic data to fully understand the recent bathymetry, seafloor condition and sub-bottom structure after earthquake. We also tried out the high accuracy bathymetric survey for detection the existence of marine earthquake debris using a deep-tow system .

MR12-E02 Leg 1, Ship Track

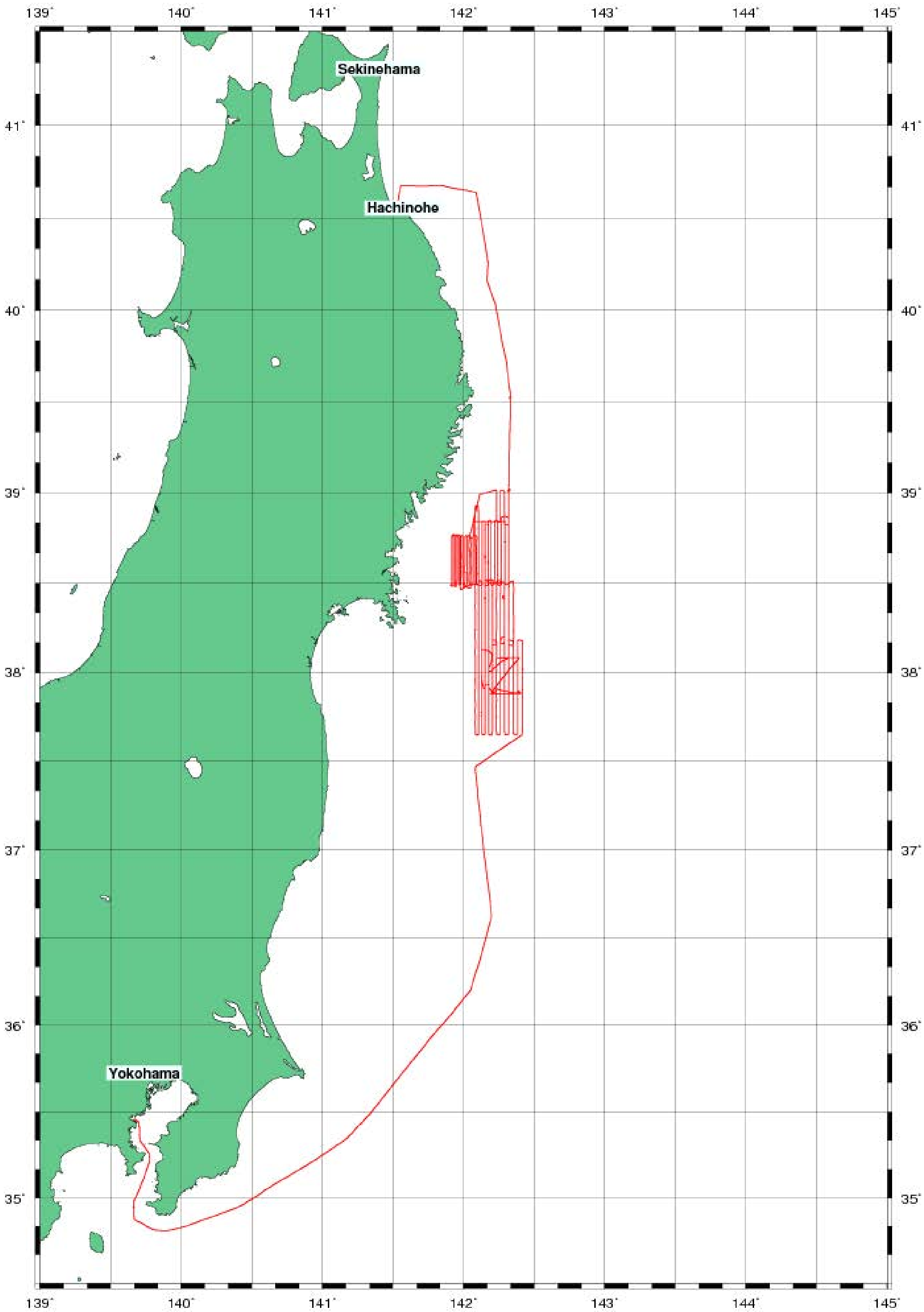

Fig. 1 Ship track of the MR12-E01 Leg1 cruise.

2. List of Participants

Onboard Scientists

Chief Scientist (IFREE / JAMSTEC)	Takafumi Kasaya
Scientist (BioGeos / JAMSTEC)	Yoshihiro Fujiwara
Scientist (MARITEC / JAMSTEC)	Fujio Yamamoto
Scientist (Research Support Division / JAMSTEC)	Hiroyasu Matsui
Scientist (GODAC / JAMSTEC)	Kenzaburo Sawano

Marine Technicians

Chief Technician (Global Ocean Development Inc)	Wataru Tokunaga
Technician (Global Ocean Development Inc)	Toshio Furuta
Chief Technician (Marine Works Japan Ltd)	Akira So
Technician (Marine Works Japan Ltd)	Naotaka Togashi
Technician (Marine Works Japan Ltd)	Takami Mori
Technician (Marine Works Japan Ltd)	Sayaka Kawamura
Technician (Marine Works Japan Ltd)	Yuki Miyajima

R/V MIRAI Crews

Master	Yasushi Ishioka
Chief Officer	Takeshi Isohi
1st Officer	Hajime Matsuo
2nd Officer	Haruka Wakui
3rd Officer	Hiroki Kobayashi
Chief Engineer	Hiroyuki Suzuki
1st Engineer	Hiroyuki Tohken
2nd Engineer	Toshio Kiuchi
3rd Engineer	Yusuke Kimoto
Technical Officer	Ryo Kimura
Technical Officer	Ryo Oyama
Boatswain	Kazuyoshi Kudo
Able Seaman	Tsuyoshi Sato
Able Seaman	Takeharu Aisaka

Able Seaman	Tsuyoshi Monzawa
Ordinary Seaman	Hideaki Tamotsu
Ordinary Seaman	Hideyuki Okubo
Ordinary Seaman	Ginta Ogaki
Ordinary Seaman	Masaya Tanikawa
Ordinary Seaman	Hajime Ikawa
Ordinary Seaman	Shohei Uehara
Ordinary Seaman	Tomohiro Shimada
No. 1 Oiler	Sadanori Honda
Oiler	Kazumi Yamashita
Oiler	Daisuke Taniguchi
Ordinary Oiler	Keisuke Yoshida
Ordinary Oiler	Hiromi Ikuta
Ordinary Oiler	Yuichiro Tani
Chief Steward	Hitoshi Ota
Cook	Tatsuya Hamabe
Cook	Tamotsu Uemura
Cook	Sakae Hoshikuma
Steward	Shohei Maruyama

3. Ship Logs

Logbook MR12-E02 6/March/12 - 15/March/12, for 10 days

Date	Time	Description	Position, depth
6-Mar-12	8:50	Depart from the Yokohama port	
7-Mar-12	8:25	XBT	37-36.51N, 142-20.20E
	8:55	Start MBES, SBP survey	
	12:13	XBT	38-09.61N, 142-23.01E
8-Mar-12	6:06	Finish MBES, SBP survey	
	7:00	Arrive at DT-1C site	37-53.00N, 142-23.00E
	8:08	Start DT-1C	37-52.93N, 142-22.61E Depth:950m
	16:55	Finish DT-1C	37-52.09N, 142-11.04E Depth:747m
	17:00	Start MBES, SBP survey	
	19:20	XBT	38-07.51N, 142-12.31E
9-Mar-12	6:00	Finish MBES, SBP survey	
	6:18	Arrive at DT-2C site	37-53.00N, 142-12.00E
	7:06	Change DT-2C site because of cross over with fisherman boat	
	8:36	Arrive at DT-2C site	38-05.00N, 142-23.00E
	9:00	Start DT-2C	38-05.03N, 142-22.30E Depth:1,006m
	16:58	Finish DT-2C	38-05.05N, 142-19.01E Depth:950m
	17:00	Start MBES, SBP survey	
	21:26	XBT	38-28.57N, 142-12.31E
10-Mar-12	0:03	XBT	38-14.73N, 142-13.96E
	6:06	Finish MBES, SBP survey	

	6:36	Arrive at DT-3C site	38-30,00N, 142-10.00E
	6:48	Cancel DT-3C because of weather condition	
		Start MBES, SBP survey	
	18:08	XBT	37-52.97N, 142-06.29E
11-Mar-12	2:00	XBT	38-40.21N, 142-04.99E
	7:00	Arrive at DT-3C site	38-30.00N, 141-58.05E
		Finish MBES, SBP survey	
	8:53	Start DT-3C	38-30.20N, 141-58.52E Depth:324m
	16:44	Finish DT-3C	38-39.05N, 141-58.05E Depth:306m
	16:48	Start MBES, SBP survey	
	23:19	XBT	38-31.39N, 141-57.11E
12-Mar-12	6:18	Arrive at DT-4C site	38-30.00N, 142-03.00E
		Finish MBES, SBP survey	
	6:59	Start DT-4C	38-30.18N, 142-03.02E Depth:444m
	14:30	Finish DT-4C	38-39.03N, 142-03.01E Depth:398m
	14:42	Start MBES, SBP survey	
	18:33	XBT	38-39.60N, 142-01.38E
	21:16	XBT	38-31.76N, 142-04.08E
13-Mar-12	3:02	XBT	38-48.98N, 142-07.80E
	7:18	Tow cesium magnetometer	38-46.87N, 142-10.40E
	10:54	XBT	38-30.92N, 142-13.15E
	13:23	XBT	38-49.01N, 142-14.46E
14-Mar-12	5:48	Finish MBES, SBP survey	
	6:12	Arrive at DT-5C site	38-50.0N, 142-04.0E
	6:45	Finish cesium magnetometer	38-49.31N, 142-03.80E
	7:05	Start DT-5C	38-50.09N, 142-04.02E

			Depth 350m
	13:54	Finish DT-5C	38-59.12N, 142-06.72E Depth 356m
	14:18	Start MBES, SBP survey	
	14:44	XBT	39-00.43N, 142-11.72E
15-Mar-12	9:00	Arrive at Hachinohe port	

4. Instruments

4.1. Shipboard observation system

4.1.1 Seabeam 2112.004

The “SEABEAM 2112.004” (SeaBeam Instruments Inc.) is the Multi-narrow Beam Echo Sounding system (MBES) equipped on-board *R/V MIRAI*. This system is including the Sub-Bottom Profiler (SBP) system. Table 4.1.1.1 shows system configuration and performance of SEABEAM 2112.004 system.

Table 4.1.1.1 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
Sweep:	50 msec (select: 5, 25, 50, 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 sediment type)

4.1.2 Magnetometer

1) Three-component magnetometer

The 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 of 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 utilizing a ring-laser gyro installed for controlling attitude of a Doppler radar. Ship's position (GPS) and speed data are taken from LAN every second.

2) Cesium marine magnetometer r

The G-882 magnetometer uses an optically pumped Cesium-vapor atomic resonance system. The sensor fish towed 500 m behind the vessel to minimize the effects of the ship's magnetic field. Table 4.1.2.1 shows system configuration of MIRAI cesium magnetometer system.

Table 4.1.2.1 system configuration

Cesium marine magnetometer (G-882)	
Dynamic operating range:	20,000 to 100,000 nT
Absolute accuracy:	<±2 nT throughout range
Setting: Cycle rate;	0.1 sec
Sensitivity;	0.001265 nT at a 0.1 second cycle rate
Sampling rate;	1 sec

4.1.3 Gradiomete

The LaCoste and Romberg air-sea gravity meter S-116 (Micro-g LaCoste, LLC) is equipped on-board *R/V MIRAI*. Table 4.1.3. shows system configuration of MIRAI gravity meter.

Table 4.1.3. system configuration

LaCoste and Romberg air-sea gravity meter meter (S-116)	
Range:	12,000 mGal
Drift rate:	<±3.0 mGal/month
Temperature setpoint:	46 to 55 deg-C
Resolution:	0.01 mGal
Static repeatability:	0.05 mGal
Accuracy at sea:	1.0 mGal or better
Sampling rate:	1 sec
Relative gravity	Counter unit [CU]
	To change gravity [mGal] = (coef1: 0.9946) * [CU]

4.2 Seabat 7125 system

SeaBat7125 mounted on 4KC deep-tow system during MR12-E02 Leg1 cruise is a 400 kHz high resolution bathymetric system that collects high resolution bathymetric data and backscattering intensity data simultaneously. 512 beams and equi-distant footprints provide us extremely high density and maximizing swath width. All measurements are corrected for actual 4KC attitude by using PhinsDVL motion sensing unit. The specification of the system is shown in Table 4.2.1.

Table 4.2.1

SeaBat7125

Frequency : 400kHz

Max Slant Range : 300m

Swath Coverage : 128°

Beam Width : 0.5× 1 ° （Along-track ×Across-track）

Number of Beams : 256 / 512 Equi-angle or 512 Equi-distant

Depth Resolution： 6 mm

Operating Depth : 6000m

PhinsDVL

Heading Accuracy : 0.01°(working with GPS)

Roll / Pitch Accuracy : 0.01°rms

DVL Frequency : 600kHz

Operating Depth : 6000m

SeaBat7125 system is composed of the receiver array, projector array, and SeaBat7125 Control PC (see, Fig.4.2.1). PhinsDVL is a subsea inertial navigation system providing position, true heading (Fiber Optic Gyroscope), attitude, speed and heave. To increase position accuracy, 600 kHz Doppler Velocity Log (DVL) and depth sensor are connected to PhinsDVL. However, DVL was only used during DT1C dive due to acoustic interference with SeaBat7125,

Because the system acquires huge amount of dataset, and the No.1 towing cable that we used for this high resolution bathymetric survey is co-axial cable (not fiber), there is not enough data transmission capability to surface. Therefore, real time monitoring of the SeaBat7125 and PhinsDVL data is not available.

All data are stored on a hard disk drive in SeaBat7125 Control PC pressure case. After recovery of 4KC, all data are forward to onboard PC via Ethernet link. Data acquisition parameter settings for the system are done via Ethernet link before 4KDT deployment. Power for both SeaBat7125 and PhinsDVL are supplied through No.1 cable. Block diagram of the system used during MR12-E02 Leg1 cruise is shown in Fig.4.2.2.

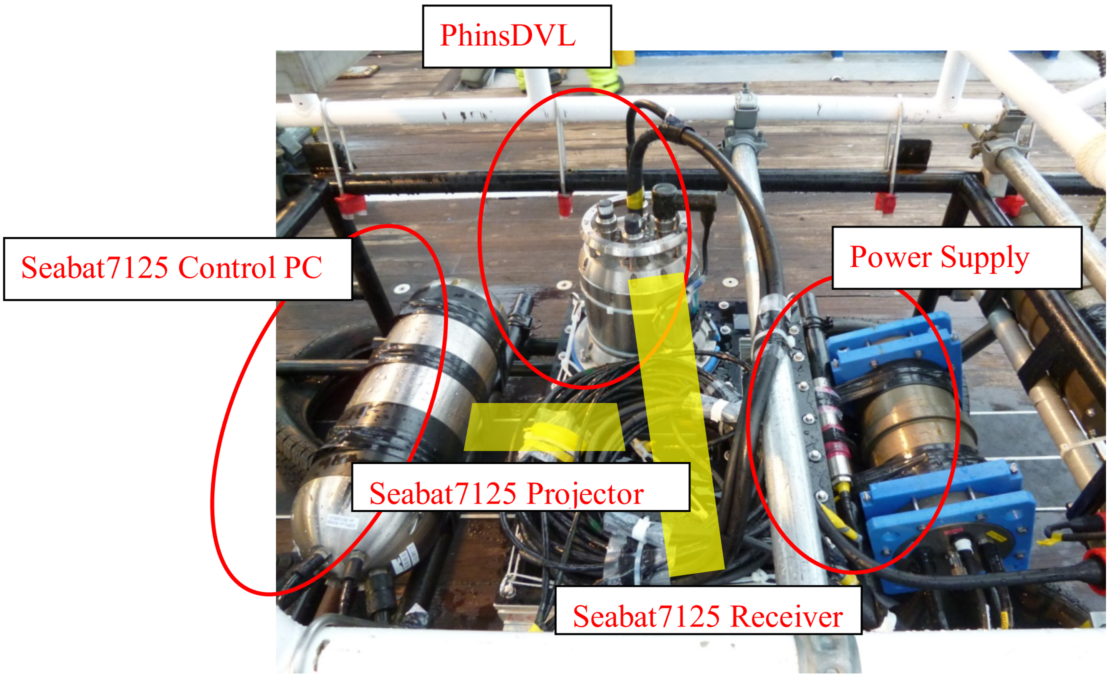

Fig.4.2.1 SeaBat 7125 and PhinsDVL

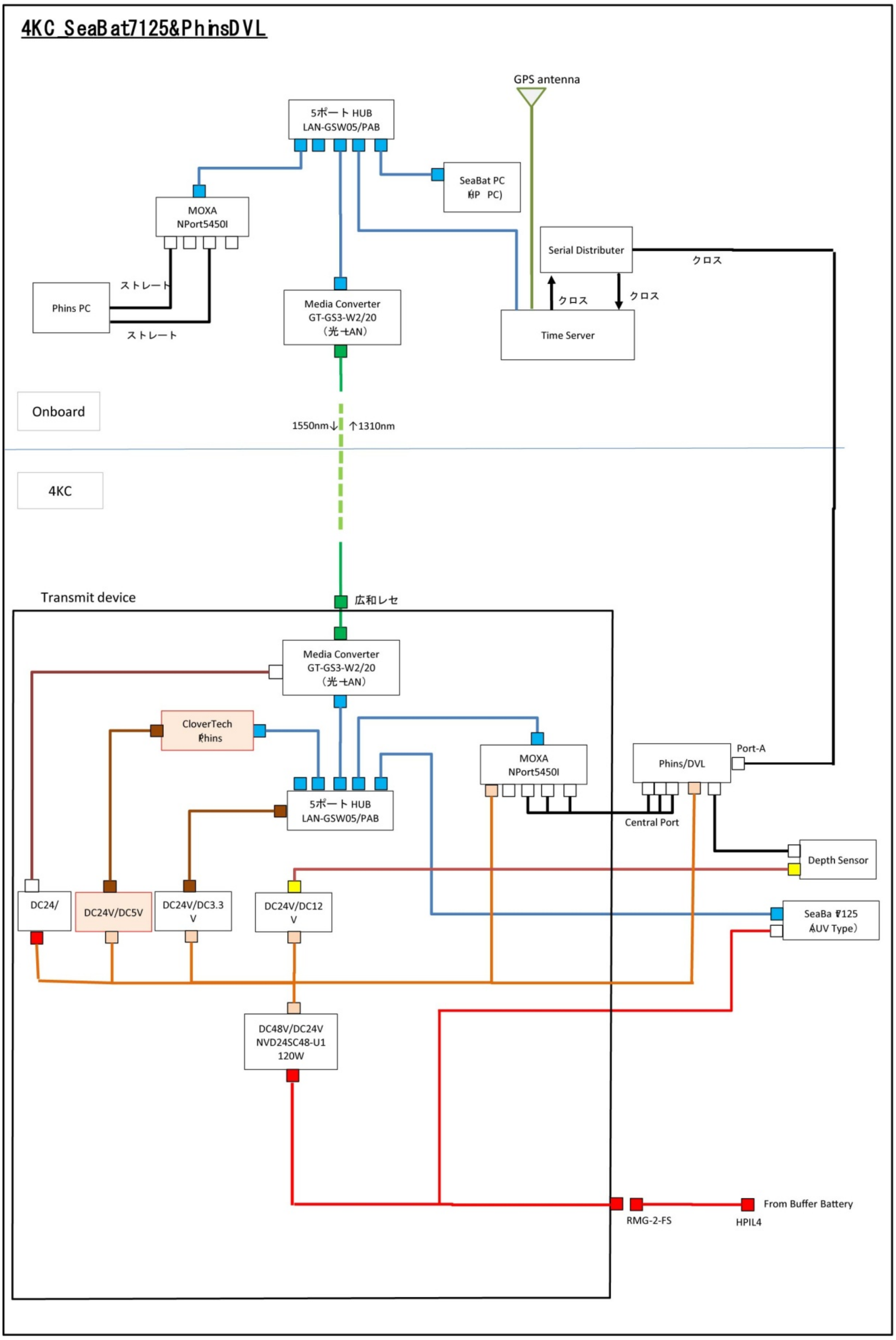

Fig.4.2.2 Block diagram of the SeaBat7125

5. Operation report and preliminary results

5.1 Shipboard data

5.1.1 Bathymetiric data

The objective of MBES is collecting continuous bathymetric and SBP data along ship's track to make a contribution to geological and geophysical investigations and global datasets. The "SEABEAM 2112.004" on R/V MIRAI was used for bathymetry and seafloor mapping during the MR12-E02 Leg1 cruise from 6 March 2012 to 14 March 2012. 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 XBT data by the equation in Mackenzie (1981) during the cruise. Figure 5.1.1.1 shows the track lines of bathymetric survey. Preliminary result of bathymetric data is shown Fig. 5.2.1.1.

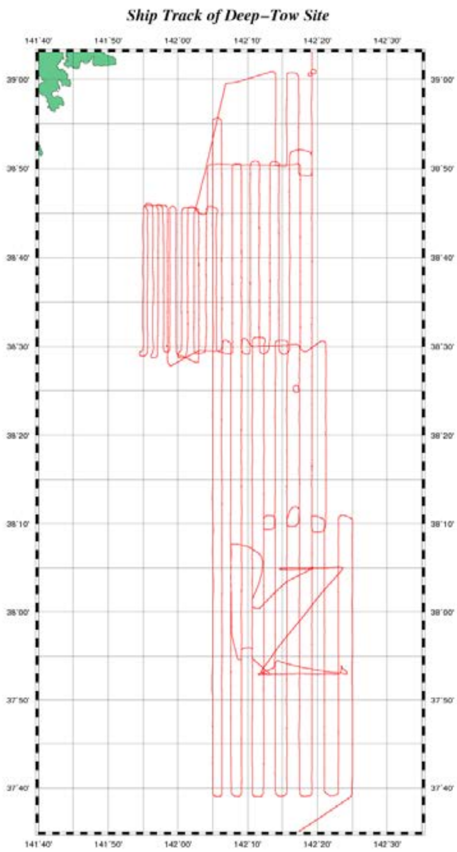

Fig. 5.1.1.1 Survey tracks of this cruise

5.1.2 Geophysical survey data

Measurements of magnetic force on the sea are 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 (Tierra Tecnica SFG1214) and cesium marine magnetometer (Geometrics Inc., G-882).　The local gravity is an important parameter in geophysics and geodesy.We measured during the MR12-E02 Leg1 cruise from 5 March 2012 to 14 March 2012. We measured relative gravity using LaCoste and Romberg air-sea gravity meter S-116 (Micro-g LaCoste, LLC) during the MR12-E02 Leg1 cruise from 6 March 2012 to 15 March 2012. To convert the relative gravity to absolute one, we measured gravity, using portable gravity meter (Scintrex gravity meter CG-5), at Yokohama before cruise, and will measure after MR12-E02 Leg3 at Yokohama, as the reference point.

We also measured total geomagnetic field using a cesium marine total force magnetometer (Geometrics Inc., G-882) and recorded by G-882 data logger (Clovertech Co., Ver.1.0.0) during the site survey area from 12 March 2012 to 13 March 2012. A red line of Figure 5.1.2.1 shows the survey track of a cesium magnetometer.

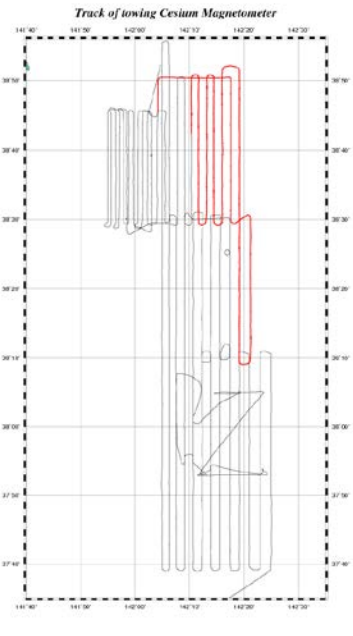

Fig. 5.1.2.1 Survey track of a cesium magnetometer (red line).

5.2 Deep-tow dives

5.2.1 Dive information

We carried out five dives for a detailed bathymetric survey using the seabat 7125 system off the Sanriku area. Table 5.2.1.1 shows detailed information of each 4k camera deep-tow dive. The 4k deep-tow system was towed at the height of 50-100 meters. Towed velocity was about 1.0 to 1.5 knt. Acoustic signal of altimeter interfere with a multi-beam echo sounder data at 1st and 2nd dive. Therefore, we stopped to use an altimeter, and used a depth data of a CTD and a water depth for a depth navigation of the deep-tow system after third dive.

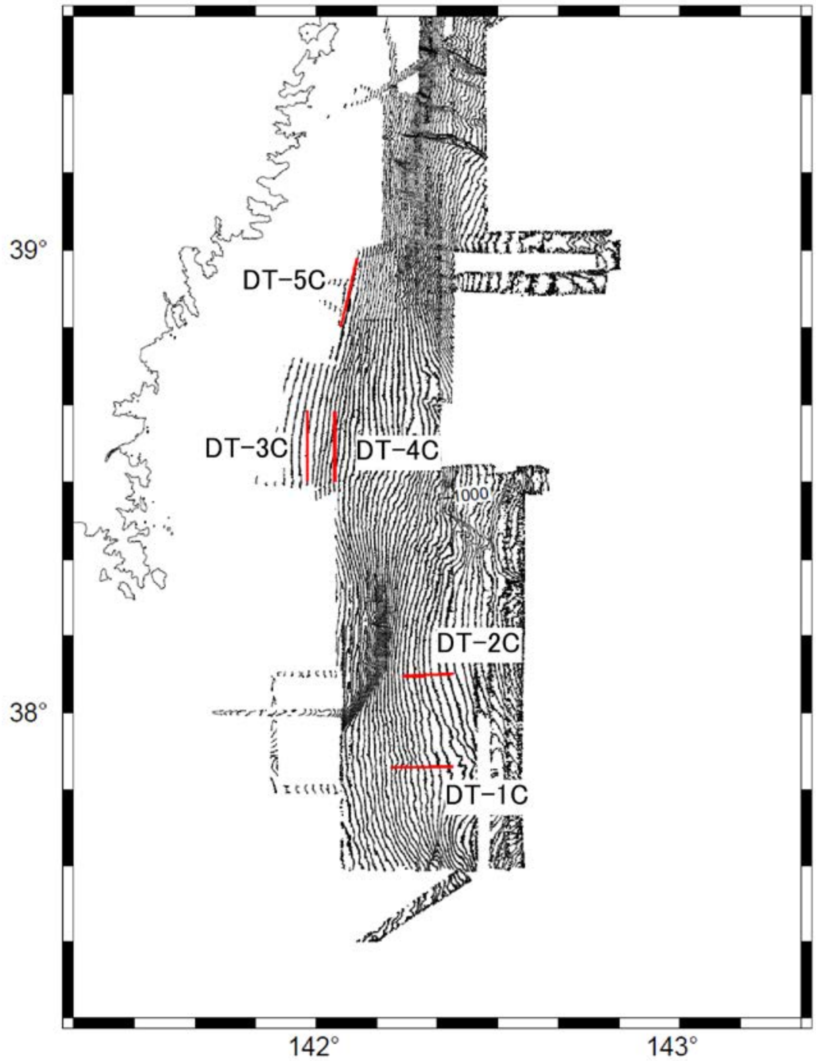

Figure 5.2.1.1 Survey tracks of a 4k deep-tow system (red lines). Back ground data is the bathymetry map used the obtained Seabeam data in this leg.

Table 5.2.1.1 Dive list

日　付 (JST)	測線 No.		時間 (JST)	曳航体 緯　度	経　度	A:CTD 深度(m)	B:高度 (m)	水深(m)：A+B	海域
2012/3/8	DT-1C	Start	9:06	37_52.973 N	142_22.634 E	898.8	50.0	948.8	仙台沖
		End	16:30	37_52.872 N	142_12.170 E	649.4	102.8	752.2	
2012/3/9	DT-2C	Start	9:33	38_05.068 N	142_22.679 E	924.0	84.9	1008.8	仙台沖
		①	14:00	38_04.847 N	142_14.737 E	801.3	67.0	868.4	
		②	14:34	38_04.728 N	142_14.589 E	782.7	81.6	864.3	
		End	16:30	38_04.765 N	142_18.060 E	857.8	81.1	938.9	
2012/3/11	DT-3C	Start	9:22	38_30.125 N	141_58.500 E	218.3	100.0	318.3	仙台沖
		End	16:30	38_39.316 N	141_58.503 E	207.8	100.0	307.8	
2012/3/12	DT-4C	Start	7:29	38_30.060 N	142_03.001 E	342.8	100.0	442.8	仙台沖
		End	14:17	38_39.177 N	142_03.035 E	295.1	100.0	395.1	
2012/3/14	DT-5C	Start	7:30	38_50.032 N	142_04.024 E	249.5	110.0	359.5	仙台沖
		End	13:40	38_58.967 N	142_06.691 E	241.6	110.0	351.6	

5.2.2 Seabat data

We could obtain the bathymetry data and back scattering data using a seabat 7125 system on a 4k deep-tow system. Time data recording to raw binary data of seabat did not work well. We tried to correct this error on board. However, we could not complete this error correction. We could only play back of back scattering data, and detect some artificial like objects.

5.2.3 Deep-tow data

The 4k deep-tow system can obtain the conductivity, temperature and depth data by a CTD system. Figure 5.1.2.1 shows the temperature time series at the DT-3C line. Operator kept depth of a deep-tow at almost same depth. However, temperature showed the extremely changes around the middle area of this towed line. Surface ocean current around off sanriku region is very complicated because the “cold” Oyashi current and the “warm” Kuroshio current mix in confusion around this region.

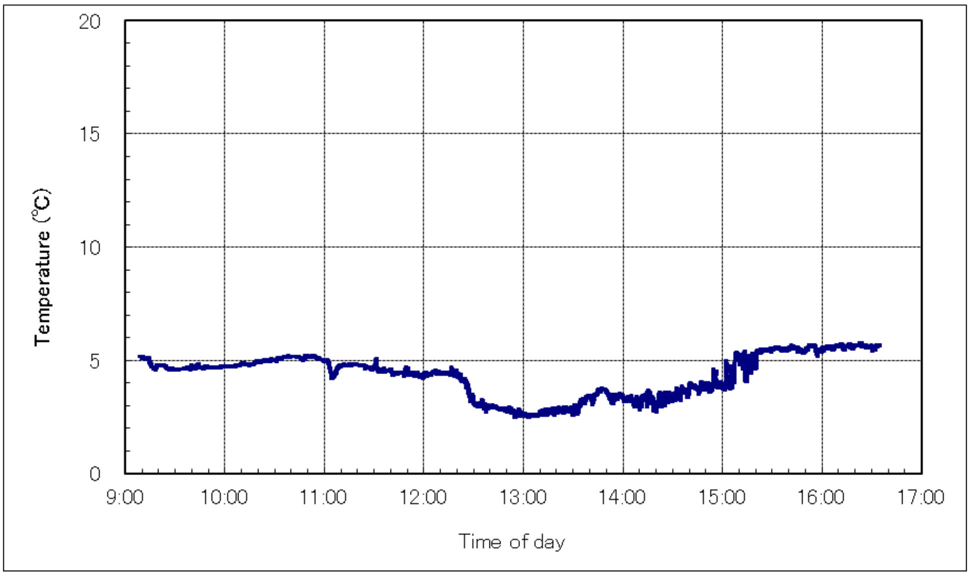

Fig 5.2.3.1 Observed raw temperature data of the DT-3D dive.