

S/V Yokosuka Cruise Report
YK14-10

Jun. 13, 2014 - Jun. 18, 2014

Tamaki Ura
Chief Scientist
Kyushu Institute of Technology

1. Cruise Information

- Cruise ID YK14-10
- Name of Vessel S/V Yokosuka
- Cruise Title AUV-based near bottom magnetic survey for uncovering the correlation between magnetic anomalies and submarine hydrothermal activities (I), and Preliminary survey for submarine drilling by IODP in northern Izu-Bonin Arc
- Chief Scientist Tamaki Ura [Kyushu Institute of Technology]
- Proposals
Subject 1: AUV-based near bottom magnetic survey for uncovering the correlation between magnetic anomalies and submarine hydrothermal activities
Subject 2: Preliminary survey for submarine drilling by IODP in northern Izu-Bonin arc
- Representatives of the Science Parties
Subject 1: Tamaki Ura [Kyushu Institute of Technology]
Subject 2: Moe Kyaw [JAMSTEC]
- Cruise Period 13th June 2014 - 18th June 2014
- Ports of Call JAMSTEC, Yokosuka ~ JAMSTEC, Yokosuka
- Research Area Bayonnaise Knoll Caldera, Myojin Caldera, and east off Aogashima (see Fig. 1.1)
- Survey Area (Map)

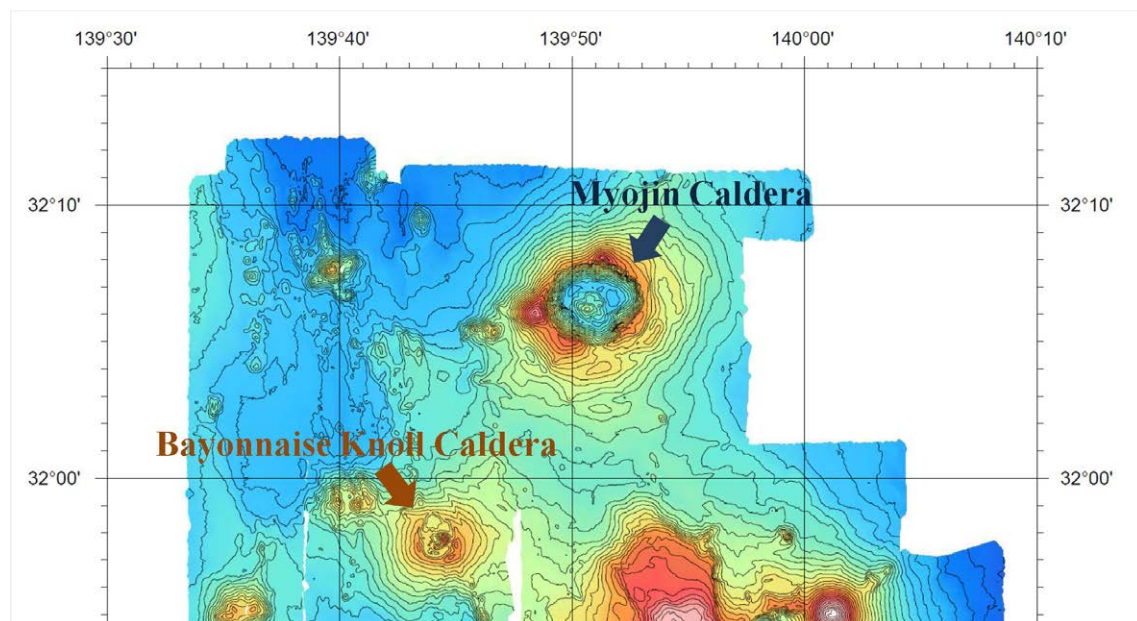
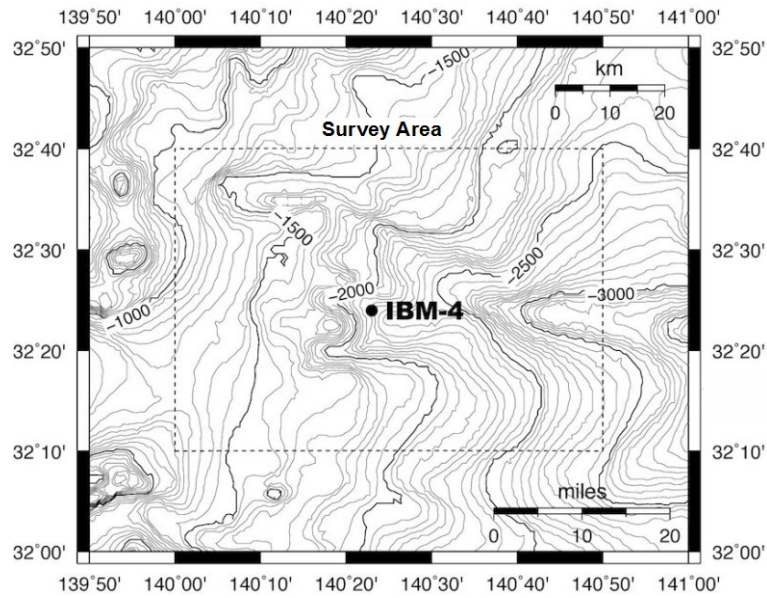


Fig.1.1 Location of the YK14-10 cruise :
(a) Bayonnaise Knoll Caldera, Myojin Caldera Area.



(b) East off Aogashima area.

2. Researchers

- Chief scientist

Tamaki Ura, Kyushu Institute of Technology

- Representative of the science party

Tamaki Ura, Kyushu Institute of Technology

- Scientist party (List)

Tamaki Ura, Kyushu Institute of Technology

Kangsoo Kim, National Maritime Research Institute

Kan Aoike, JAMSTEC

Dhugal John Lindsay, JAMSTEC

Kanae Komaki, Kochi University

Taku Suto, IHI Corporation

Arnab Das, Japan Ship Technology Research Association

Takashi Sonoda, Kyushu Institute of Technology

- NME Marine Technician

Satoshi Okada, Chief Marine Technician

Shusuke Machida, Marine Technician

Takuya Onodera, Marine Technician

Koki Kuno, Marine Technician

- MWJ Marine Technician

Hirokatsu, Marine Technician

Tatsuya Tanaka, Marine Technician

Akira Watanabe, Marine Technician

3. Introduction to the Cruise

Kangsoo Kim
National Maritime Research Institute

3.1 Overview

3.1.1 Subject 1 of YK14-10 Cruise

In the vicinity of the latitude 32° in Izu-Bonin Arc region, there are two well-known submarine hydrothermal deposits called Hakurei deposit in Bayonnaise knoll caldera, and Sunrise deposit in Myojin caldera. While the former has the area of 500 m × 700 m wide, the latter is about 400 m × 700 m. Curiously, both deposits are located on the southeast slopes of each caldera. Though look similar at first glance, two hydrothermal deposits were born on the basis of totally different tectonic backgrounds. Located close to each other but having different tectonic backgrounds, Hakurei and Sunrise deposits are expected to have difference in their formative factors, as well as underground structures. In this cruise, we made AUV- based magnetic field survey in Bayonnaise knoll caldera and Myojin caldera, in order to elucidate the origin and structure of these calderas. For Bayonnaise knoll site, we conducted 5 dive surveys using two AUVs before this cruise. In 2008, an AUV "r2D4" developed by Institute of Industrial Science (IIS), the University of Tokyo made 3 dive surveys in Bayonnaise knoll caldera. Followed by these, an AUV "Urashima" developed by JAMSTEC (Japan Agency for Marine-Earth Science and Technology), were deployed 2 times for the near-bottom magnetic survey of Bayonnaise knoll caldera during YK11-11 Yokosuka cruise. During these dives, we could gather a lot of data which has importance in uncovering the magnetic structure of Bayonnaise knoll caldera. Despite these 5 dives, however, still there have been regions of data gap in Bayonnaise knoll caldera. To fill the gap and construct a magnetic map which covers entire Bayonnaise knoll caldera, 2 dives were conducted during YK14-10 cruise.

In case of Myojin caldera, on the other hand, although numerous shipborne surveys by acoustic, seismic, bathymetric, and magnetic means have been made so far, near-bottom magnetic survey has not been conducted yet, resulting in complete ignorance of magnetization structure of the site. Overcoming current situation and acquiring near-bottom magnetic field data, 2 Urashima dives were made in Myojin caldera.

3.1.2 Subject 2 of YK14-10 Cruise

The main purpose of subject 2 of YK14-10 cruise is to clarify the long-term sea currents and bottom conditions of IBM-4 site which is one of the potential locations for IODP drilling.

3.2 Cruise objectives

In the magnetic survey of YK14-10 cruise, we have three targets as follows:

- 1) The high resolution magnetic field data in Bayonnaise knoll caldera. To obtain the magnetic field data at a high resolution, the survey lines was arranged densely (~120 m apart) and the altitude of the vehicle was taken as low as possible (~80 m above the bottom).
- 2) Revealing the magnetic structure of the whole caldera by compiling the result of the previous research

cruises together (R/V Hakurei-maru No.2 in 2008 and YK11-11 in 2011).

3) Magnetic field data at the Sunrise sulfide deposit in the southeastern Myojin caldera, located in the southeastern margin of the caldera floor. The magnetic feature of the Sunrise deposit is not known yet, as no near-bottom magnetic survey in the caldera has been conducted. Arranging several long survey lines going along the topographic contours we investigate from the southeastern to the southern margin of the caldera floor. Figure 3.1 shows 3-D perspective view of the seafloor in the survey sites.

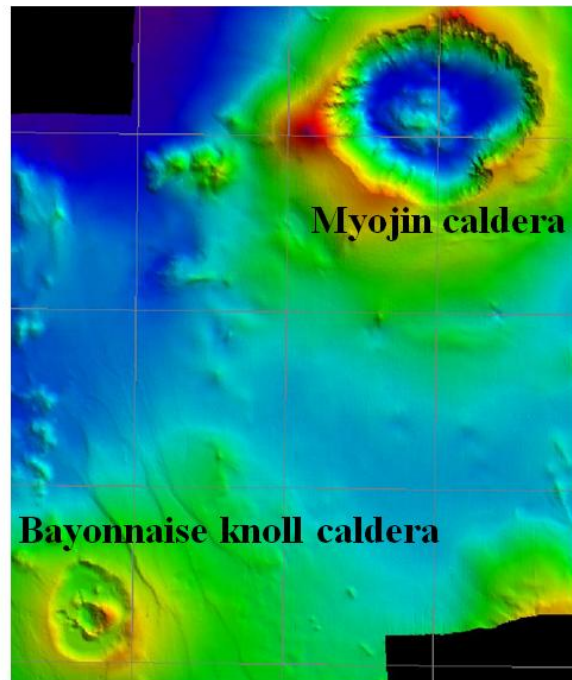


Fig.3.1 Bathymetric map of Bayonnaise knoll caldera and Myojin caldera.

4. Equipments

4.1 AUV "Urashima"

Kangsoo Kim
National Maritime Research Institute

Developed by Japan Agency for Marine-Earth Science and Technology (JAMSTEC) since 1998, "Urashima" is one of the largest AUVs currently working in the world. Its large size enables the Urashima to realize the long duration, leading to the long cruise range of 100 km (with Li-ion battery), or 300 km (with fuel cell). As an underwater navigation device, Urashima employs high-precision inertial navigation system (INS) composed of ring-laser gyro and Doppler velocity log (DVL). During the dive, Urashima collects oceanographic data such as salinity, water temperature, pH, conductivity, and dissolved oxygen. At the same time, Urashima is able to investigate the sea bottom and sub-bottom structure by using acoustic imaging devices such as side scan sonar (SSS) or sub-bottom profiler. Fig. 4.1 shows the overall feature of Urashima. Principal dimensions and main specifications of Urashima are listed in Table 4.1. Figure 4.1 shows overall feature of Urashima.

Table 4.1 Principal dimensions and main specifications of Urashima.

L.O.A.	10 m
Breadth	1.3 m
Height	1.5 m
Speed (Max. / Cruising)	4.0 / 2.5 kts
Max. Operating Depth	3500 m
Energy Source	Fuel Cell / Li-ion Battery
Duration @ 3.0kts	39 / 20 hrs
Mass	10000 kg / 7500 kg
Observation Equipments	- SSS - Multi-Narrow Beam - CTD - Sub-Bottom Profiler

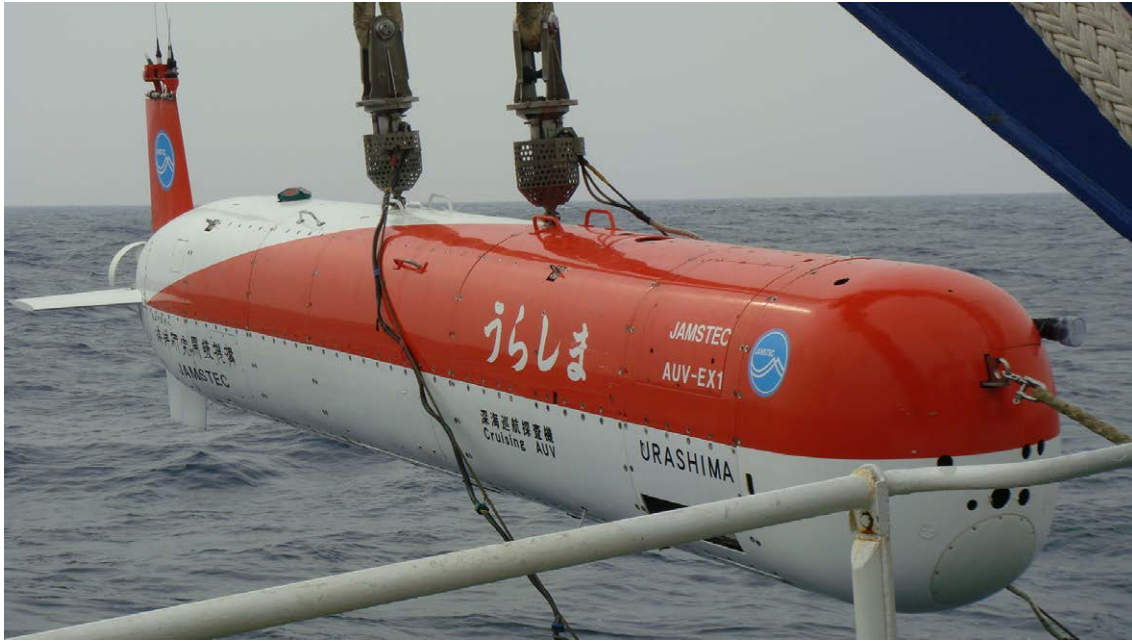


Fig.4.1 Overall feature of a cruising AUV Urashima.

4.2 Three-component magnetometer

Kangsoo Kim
National Maritime Research Institute

Vector geomagnetic field were measured by deep sea three-component magnetometers (TIERRA TECNICA Tech Inc., Japan; National Institute of Polar Research). This system consists of a three-axis fluxgate-type sensor (Bartington MAG-03H), an A/D conversion unit (3ch-32bit-A/D), and a data controller/logger (Linux OS). The circuit case of the A/D conversion unit and data controller/logger was fixed in the bow payload space of Urashima (Fig.4.2).

The geomagnetic field are measured with dynamic range of ± 70000 nT, resolution of 0.01 nT, sampling interval of 10 kHz, and accuracy of 0.4 nT. Attitude data from gyro compass (heading, pitch, roll), GMT time, vehicle position data from inertia navigation system (INS), and depth from CTD sensor was also recorded with magnetic data in the same files. Note that vehicle position is also measured by shipborne Super Short Base Line (SSBL) positioning system independently. The three magnetic sensors were attached to the starboard, central, and port part in the bow payload space of Urashima (Fig.4.2). Definition of the coordinate system (XYZ) of the three magnetometers (FG1, FG2, FG4) is the same and as follows; the +X axis orients ship's bow, +Y points starboard, and +Z downward.

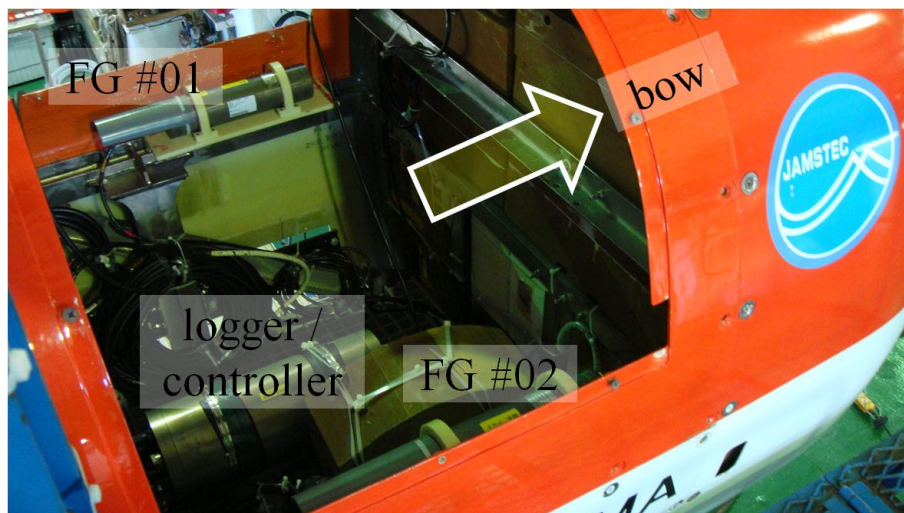


Fig.4.2 Arrangements of magnetometers installed in Urashima.

4.3 Multiple water sampler "MINIMONE"

Kei Okamura
Kochi University

MINIMONE is a newly developed multi-water-sampling system for autonomous underwater vehicle and remotely operated underwater vehicle exploration. Water samplers are continuously collected by the MINIMONE sampler by an in situ water pump at 10 mL/min and are sent to a selection valve unit that consists of 24 valves connected to 10 mL sampling bottles (20 cm in length). Each valve in the unit is selected and opened at preprogrammed intervals.

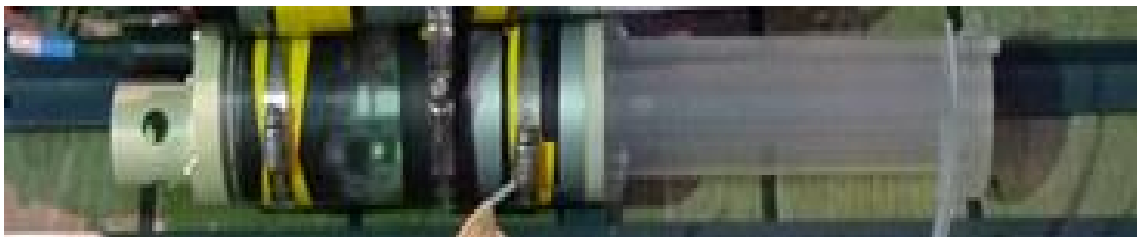


Fig.4.3 "MINIMONE" water sampler.

4.4 Acoustic Doppler Current Profiler (ADCP) and Doppler Velocity Log (DVL)

Kanae Komaki, Mayumi Hatta, Kei Okamura
Kochi University

4.4.1 Introduction

To investigate hydrothermal environments such as hot water spreading with geo-chemical components over a caldera, it should be currently the most effective observation method that an AUV approaches very close to the vent fields. In this cruise, we investigate the Bayonnaise knoll caldera with using "Urashima" to measure the currents and echo amplitude, which reflects to turbidity, by using an up-looking 600-kHz acoustic Doppler current profiler (ADCP) and also a 300-kHz down-looking Doppler velocity logger (DVL) usually mounted on the AUV.

4.4.2 Instruments

We applied an ADCP and a DVL, which are mounted on the Urashima for the navigation as usual, to the observation of the currents and echo amplitude. The ADCP measures current velocity in water column. It converts acoustic Doppler shifts into current velocity when sound pulses from the ADCP transducers are reflected by floating substances. As well as the ADCP, the DVL measures current velocity in a water layer above the seabed, and velocity of the AUV against the seabed. Our first purpose of this cruise is to observe local currents in detail over the Bayonnaise knoll caldera using these instruments, and analyze with distribution of water-mass characteristics and chemical components. We used a 600-kHz Navigation ADCP and a 300-kHz DVL of the Teledyne RD Instruments (Fig.4.4).



Fig.4.4 The ADCP and DVL mounted on the Urashima.

5. AUV Dives

Kangsoo Kim
National Maritime Research Institute

5.1 Urashima dive #169

Starting dive at central east part of the caldera, Urashima completed to travel four tracklines which crosses the caldera in east-west direction. Figure 5.1 shows the actual dive trajectory of Urashima taken by super short baseline (SSBL) positioning system installed on S/V Yokosuka. Summary of Urashima dive #169 is as follows.

Date : 15th Jun., 2014

Location : Bayonnaise knoll caldera site

Purpose : Near-bottom geomagnetic survey

Duration : 5hrs. 38min.

Dive event log

11:34 Dive initiation

16:45 Dive termination

17:12 Surface

17:42 Retrieval completion

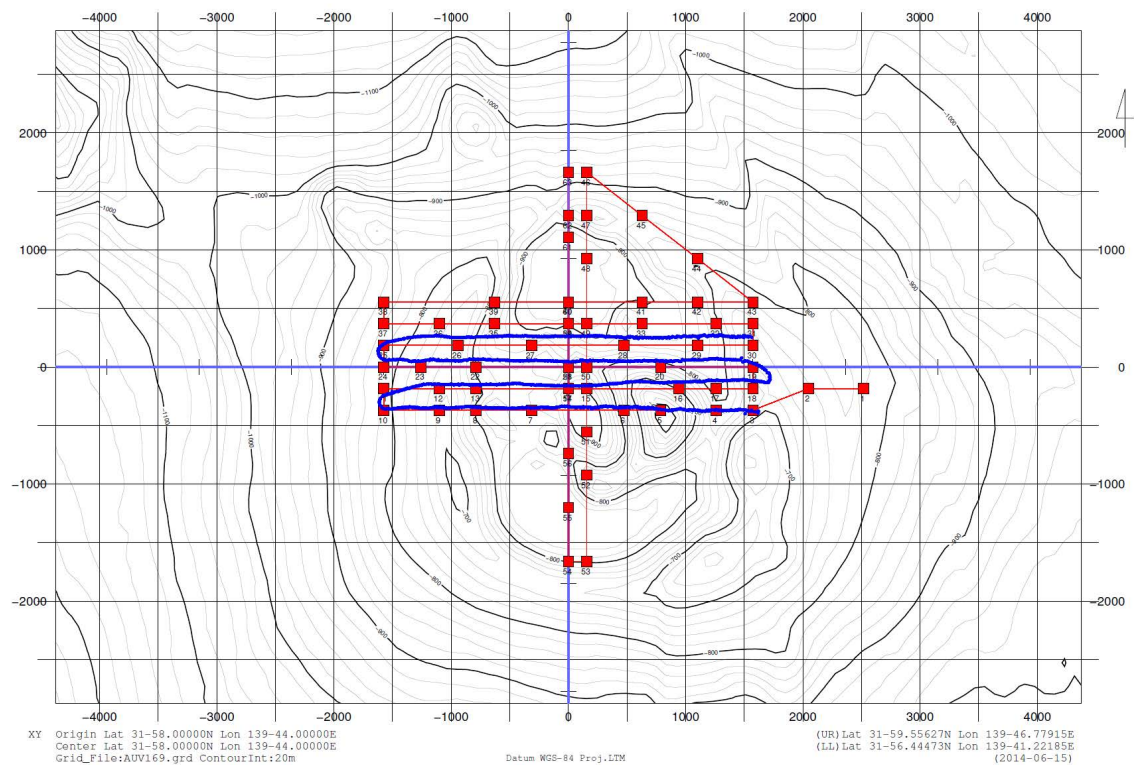


Fig.5.1 Vehicle trajectory of Urashima dive #169.

5.2 Urashima dive #170

Starting from the point where the former dive (dive #169) terminated, Urashima travelled the central region of the caldera following the tracklines which crosses the caldera in north-south and east-west directions. Figure 5.2 shows the actual dive trajectory of Urashima taken by super short baseline (SSBL) positioning system installed on S/V Yokosuka. Summary of Urashima dive #170 is as follows.

Date : 16h Jun., 2014

Location : Bayonnaise knoll caldera site

Purpose : Near-bottom geomagnetic survey

Duration : 9 hrs. 16 min.

Dive event log

07:24 Dive initiation

16:19 Dive termination

16:40 Surface

17:04 Retrieval completion

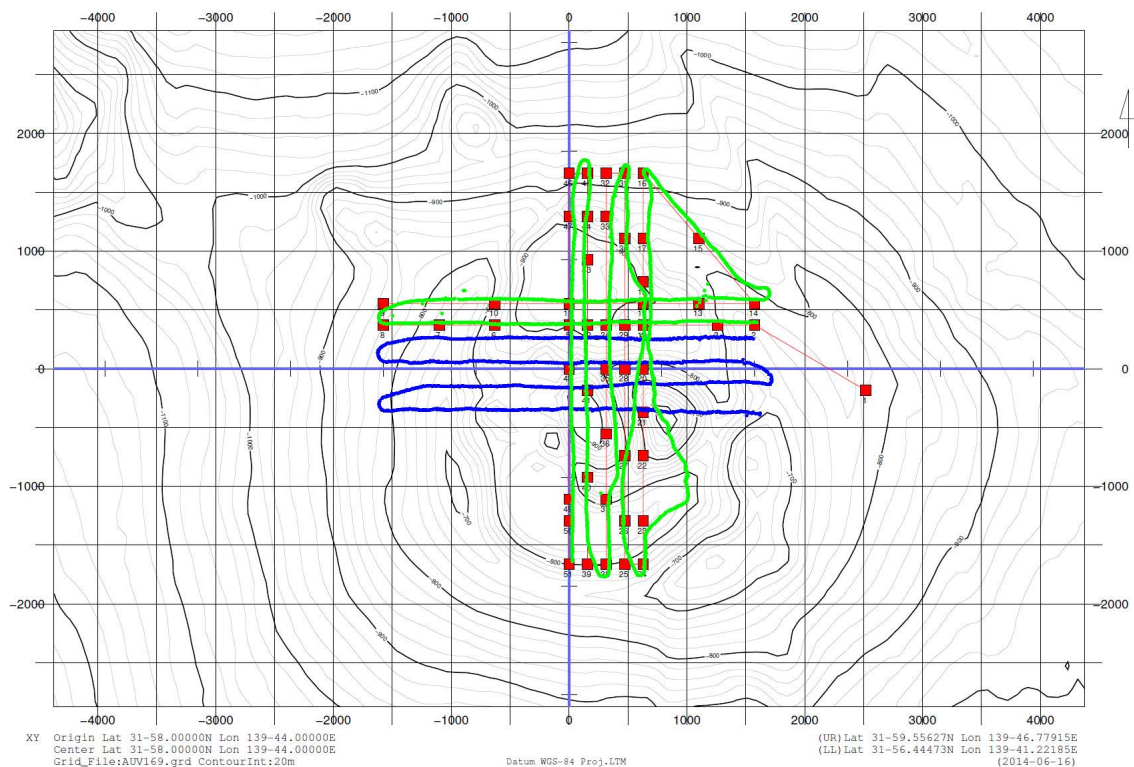


Fig.5.2 Vehicle trajectory of Urashima dive #170.

6. Observations

6.1 Geomagnetic field observation

Kangsoo Kim

National Maritime Research Institute

To calibrate the magnetic field generated by body of the vehicle, a coupled contour motion called figure-eight maneuver was conducted right before approaching the bottom and ascending to the surface in every dive. During figure-eight maneuver, the vehicle is made to change its heading $-180^\circ \sim 180^\circ$ while changing its pitch $-25^\circ \sim 25^\circ$ simultaneously. Figure 6.1 shows time series of the vehicle's heading and pitch during the figure-eight maneuver.

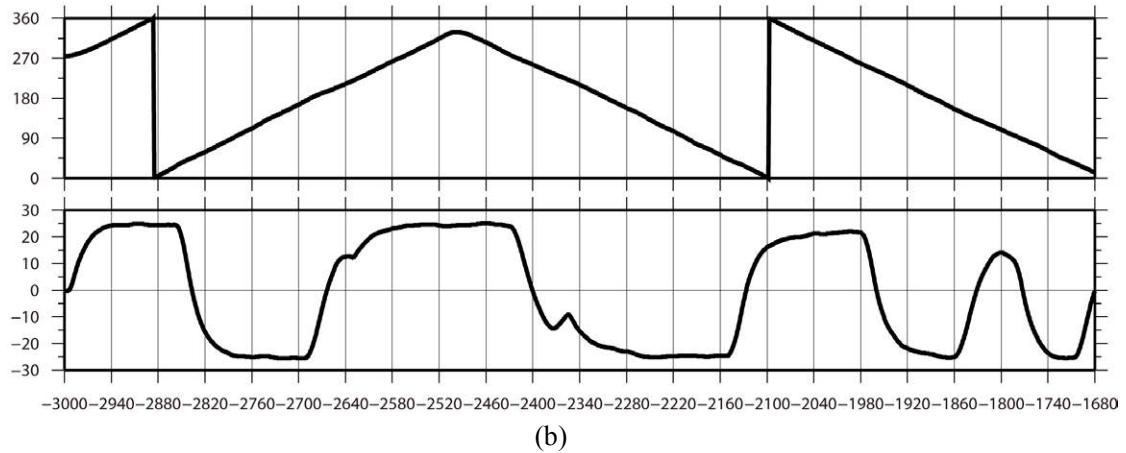
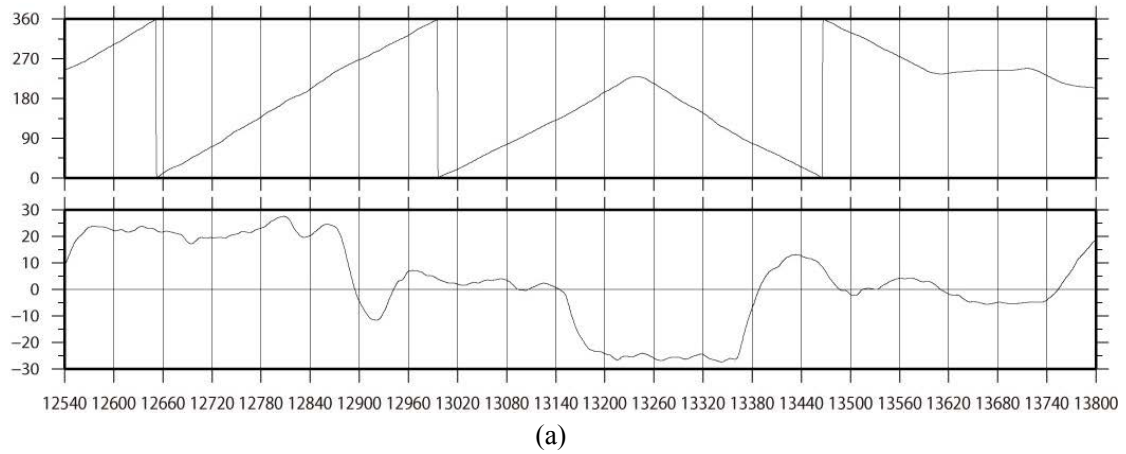


Fig.6.1 Time series of heading (upper) and pitch (lower) during a figure-eight maneuver:
(a) dive #169 (b) dive #170.

Figure 6.2 shows measured magnetic field with respect to the earth-fixed frame of reference. In the figure, red, green, and blue lines represent measured magnetic field in north, east, and depth directions, respectively.

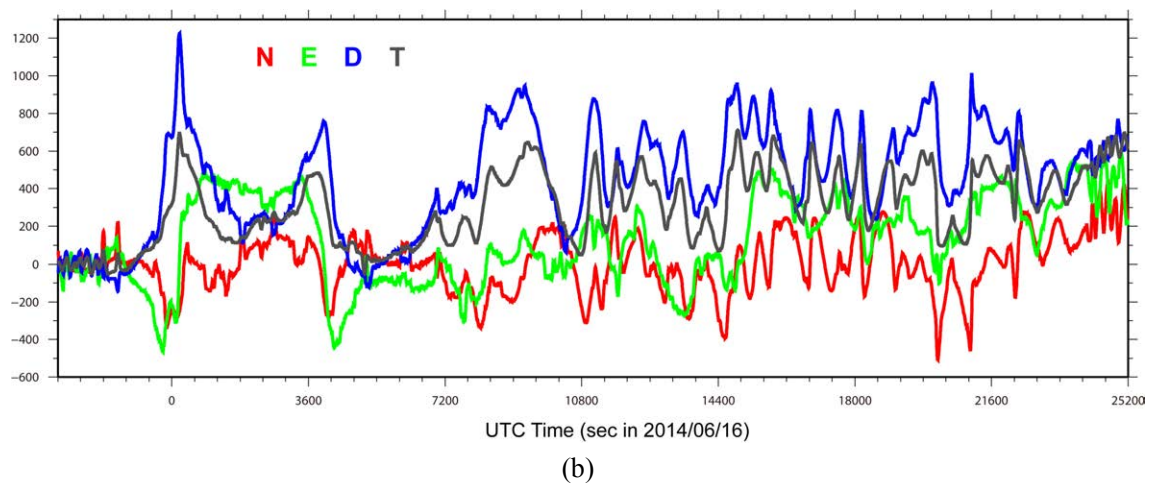
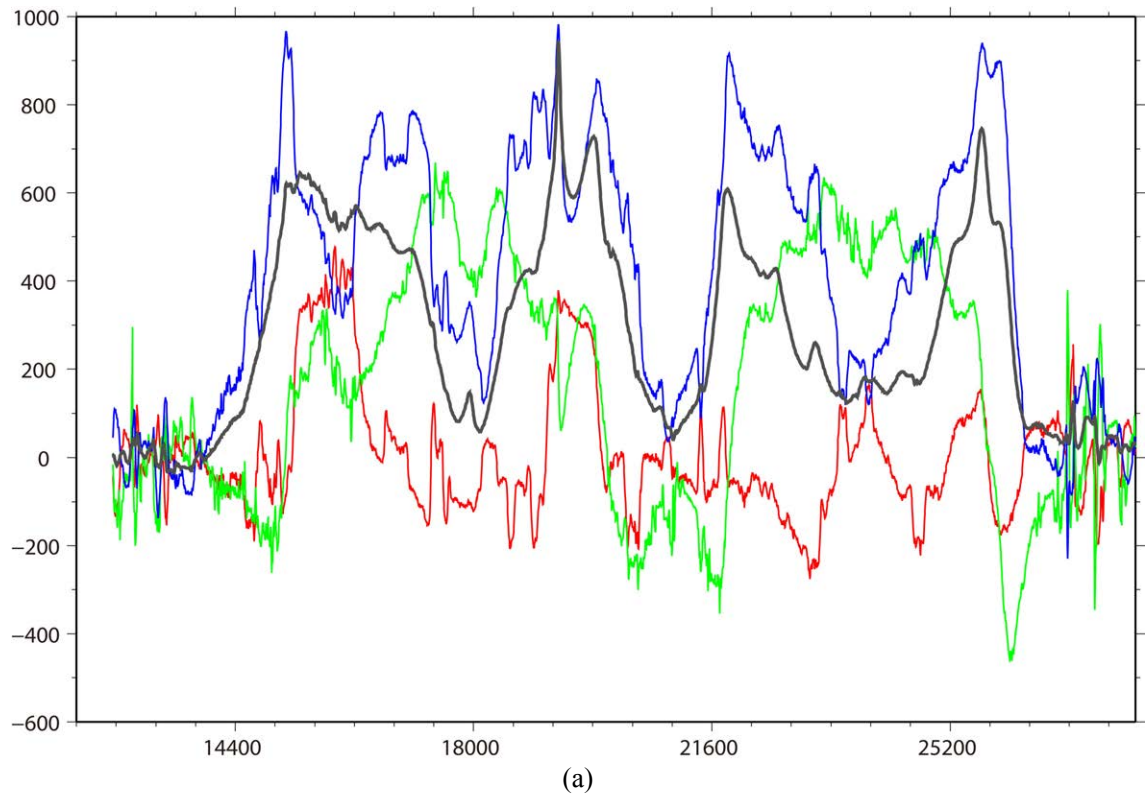


Fig.6.2 Measured geomagnetic field during (a) dive #169 (b) dive #170.

7. Data Processing

Takashi Sonoda
Kyushu Institute of Technology

7.1 Visualizing trajectory of AUV

In order to verify the trajectory, the dive data was visualized. Urashima's position information during the dive is important in order to process the magnetic survey accurately. The location data of Urashima from the start to the end of the dives were measured by using the sensors that is installed in Yokosuka and Urashima. And those data are plotted on the graphs. The main sensors for localization of Urashima are an INS and a SSBL. Urashima records the data such as the time, the depth, the altitude, the roll, the pitch, the heading, the latitude, the longitude and the x-y-z distances. Fig.7.1 shows the visualized log data by time series 2-D and 3-D graphs using the visualizer software made by MATLAB scripts.

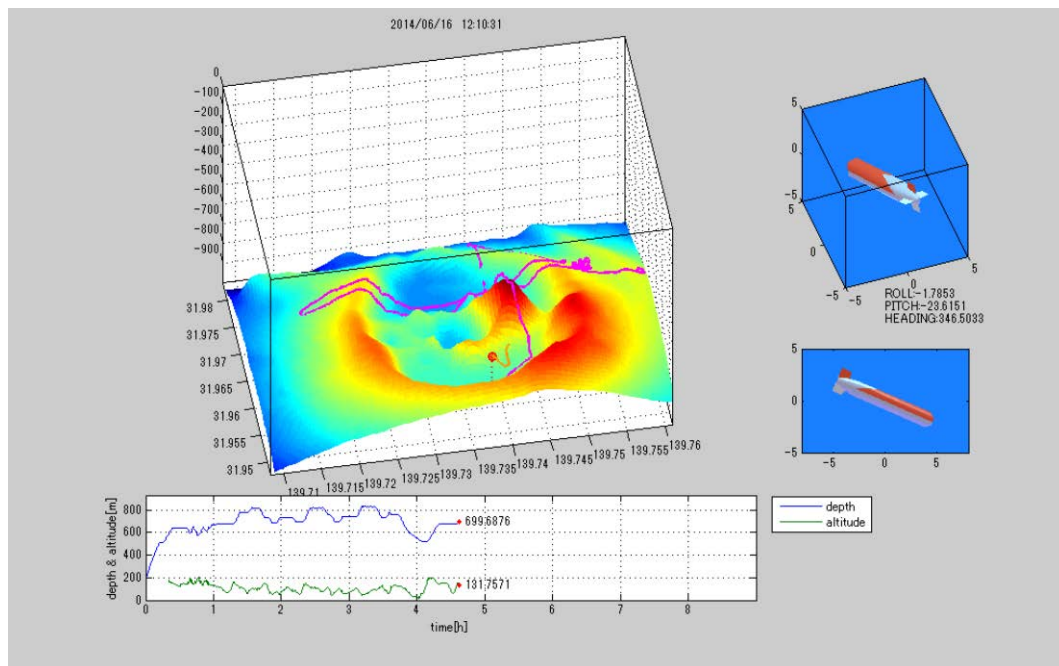


Fig.6.1 3D trajectory of Urashima dive #170 in Bayonnaise Knoll Caldera.

7.2 Post-processing for analyzing magnetic survey data

The locational information from the INS and the SSBL include some errors according to the environmental situations, so it needs some proper post-processing. The dive locational log of the INS is obtained only by the two-step integration of the inertial sensor data in case that it cannot get the ground speed from the DVL. In locational log data, integration errors is also included.

On the other hand, by the shipborne SSBL localization, comparatively better global position of Urashima it is able to be obtained. However, SSBL localization is noisier and offers lower sampling ratio. Yokosuka sends "position-update" commands when INS-based position becomes much different from the global position. Then the stepped trajectory is caused by the command into the INS locational log (Fig.6.2). Therefore, the stepped trajectory areas should be corrected by a proper post-processing.

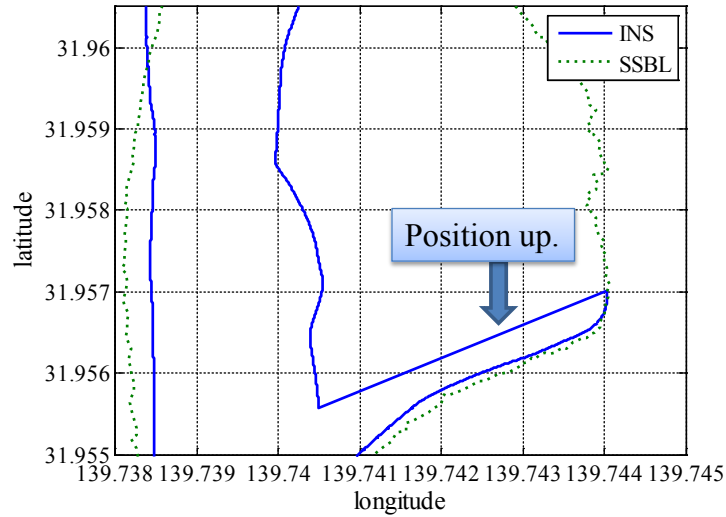


Fig.6.2 Trajectories by INS and SSBL including a point of position update.

In order to correct the raw INS trajectory by using SSBL data, INS position is subtracted from the SSBL position. In Fig.6.3, red line is the corrected trajectory by using the SSBL data. As a result, we could to obtain a smooth trajectory which passes SSBL data points.

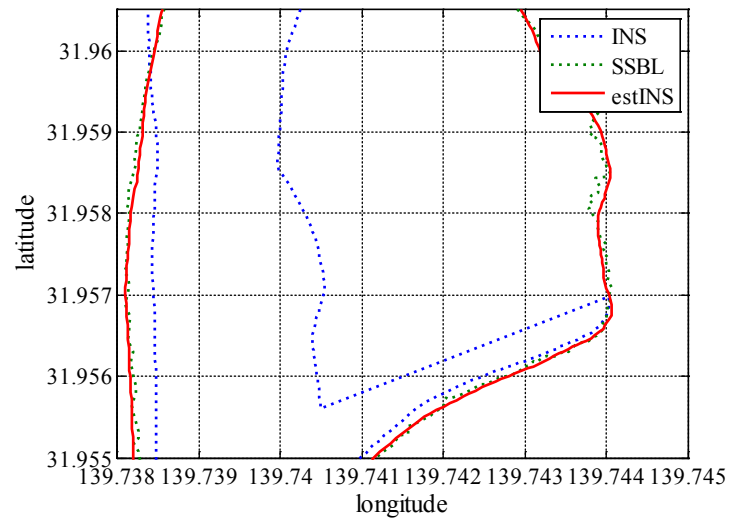


Fig.6.3 Corrected vehicle trajectory using SSBL data.

8. Subject 2: Site Survey for IODP Drilling in the Site IBM-4

Kan Aoike

Japan Agency for Marine-Earth Science and Technology

The Site IBM-4 is the location where scientific deep riser drilling is proposed in the International Ocean Discovery Program (IODP) with the purpose of elucidating the formation of a continental crust in an oceanic island arc, and is potentially drilled by D/V Chikyu in near future. One of two objectives of the YK14-10 cruise is to carry out operational site surveys in the Site IBM-4 in order to obtain fundamental data for safety assessment of the future riser drilling. The operational site surveys are carried out as needed basis if the site survey data provided by proponents of a drilling proposal is insufficient for detailed planning by the operator, i.e., CDEX. In this cruise, two main and two supplemental operational site surveys were planned as follows:

[Main]

- 1) To install two sets of mid-depth subsurface mooring system for a long-term ocean current monitoring near the IBM-4,
- 2) To obtain ultra-high resolution bathymetry, acoustic images of the seafloor and sub-bottom profiles near the IBM-4 by using AUV Urashima,

[Supplemental]

- 3) To fill in gaps of the preexisting multi-beam bathymetry map around the IBM-4 by using the hull-mounted SeaBeam system during night time, and
- 4) To obtain vertical ocean current profiles by using the hull-mounted ADCP during the vessel is in the site.

The data recorded by the mooring systems installed by survey 1) shall be used for an analysis of behavior and fatigue of the riser pipe under strong ocean current conditions, so-called a riser analysis, which is an indispensable study for any riser drilling operations offshore. Further, high-resolution data of seafloor conditions, less than 10 m in special resolution, is also required as well to assess appropriateness of the seafloor for setting the top hole structures (i.e., well head and conductor pipe) and presence or absence of obstacles in case of an emergency disconnection. The survey 2) by AUV Urashima provides data of much higher resolution than the multi-beam system of the mother vessel (e.g., 100 m at 2000 m water depth). The surveys 3) and 4) are carried out to complete the SeaBeam bathymetry map of the areas where D/V Chikyu's approach or escape routes are potentially set and to take supplemental ocean current data, respectively.

8.1 Personnel

1) Proponent of the Survey

Principal Investigator (not aboard): Moe Kyaw^{1]}
Researcher aboard: Kan Aoike^{2]}
Other Researcher (not aboard): Tomokazu Saruhashi^{2]}
Eigo Miyazaki^{2]}
Takamitsu Sugihara^{2]}

^{1]} Research and Development Center for Ocean Drilling Science, JAMSTEC

^{2]} Center for Deep Earth Exploration, JAMSTEC

2) Science Support

Marine Technician: Shusuke Machida^{3]}
Takuya Onodera^{3]}
Koki Kuno^{3]}
Hirokatsu Uno^{4]}
Tatsuya Tanaka^{4]}
Akira Watanabe^{4]}

^{3]} Nippon Marine Enterprises Co., Ltd.

^{4]} Marine Works Japan Co., Ltd.

8.2 Survey Area

The Site IBM-4 is located 80 km east off the Aogashima island in a forearc slope of the northern Izu-Bonin arc (Fig. 8.1). The area of 50' longitudinal x 30' latitudinal around the IBM-4 was defined as the survey area of this theme in the YK14-10 cruise (Fig. 8.2).

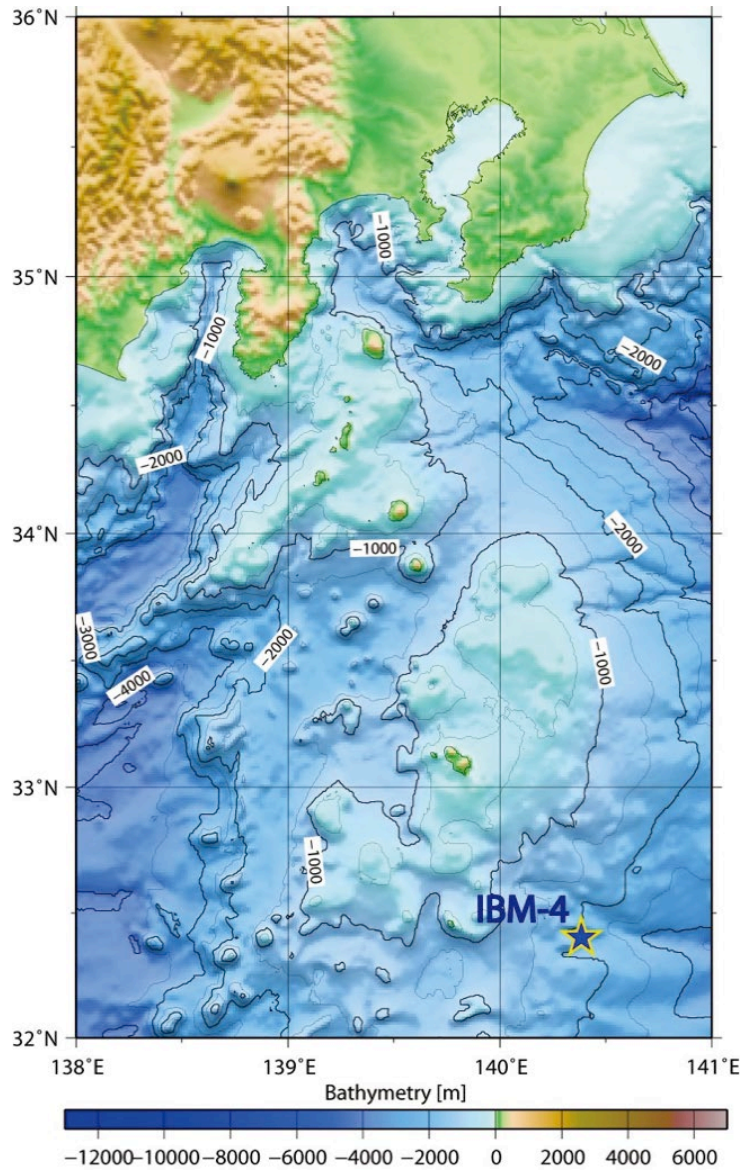


Figure 8.1 Regional bathymetry map of the northern Izu-Bonin arc and the location of the Site IBM-4

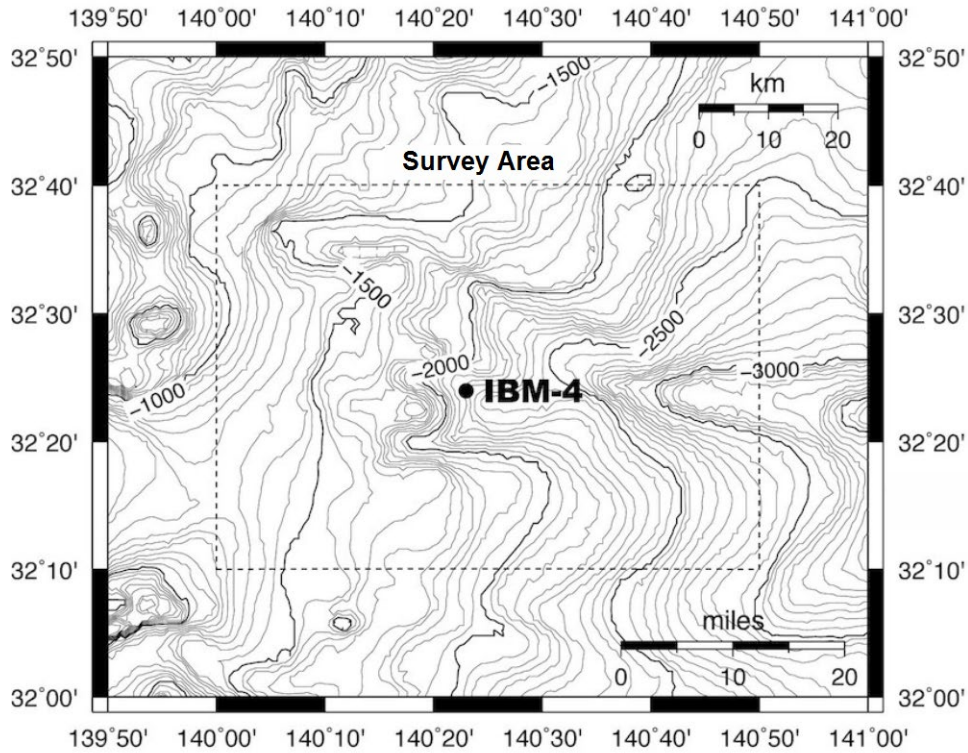


Figure 8.2 Proposed survey area for the Theme-2

8.3 Mooring Installation

Two sets of mid-depth subsurface mooring systems for long-term ocean current observation were planned to install to the Site IBM-4 in this cruise. We intended to carry out this operation on June 14, the first day in the operational period of the cruise, in view of forecasted sea conditions; however, we had to postpone due to an incident (personal injury) occurred in that morning. Finally, two sets of mooring systems were successfully installed to locations of CM-07 and CM-08 on June 17, the fifth day of the cruise (Table 8.1 and Fig. 8.2).

Each mooring system is equipped with a Long-ranger Acoustic Doppler Current Profiler (LR-ADCP, Teledyne RD Instruments) at the top buoy, five single-depth Doppler current meters (DW-Aquadopp, Nortech), three Conductivity Temperature Depth profilers (CTD, Sea-Bird Electronics) and a pair of underwater acoustic releasers of two different manufacturers (Nichiyu Giken and EdgeTech), about 1500 m long, designed to place the top buoy at 300 – 490 m below the sea surface under any conceivable sea current conditions (Fig. 8.4). The observation specifications (parameter settings) of each sensor are listed in Table 8.2 as well. The target locations for the two mooring systems were allocated in the north and southwest of the Site U1436 (= IBM-4GT), taking a distance of the water depth plus 500 m (= 2300 m) away from a known submarine cable without changing the water depths planned originally in the cruise program (Fig. 8.3). The Site U1436 is

expected to be the riser site and was drilled as a geotechnical site by the D/V JOIDES Resolution during the IODP Expedition 350 in April 2014. Timing of anchor drop was decided under Captain's directions. The actual installed positions were determined by triangulation with acoustic ranging between the releaser and the vessel at three points after each installation (Figs. 8.5 and 8.6). As a result, the CM-07 mooring was installed 269 m south of the target and 10 m deeper, while the CM-08 mooring was installed 616 m away to the southwest from the target and 25 m shallower (Table 8.3).

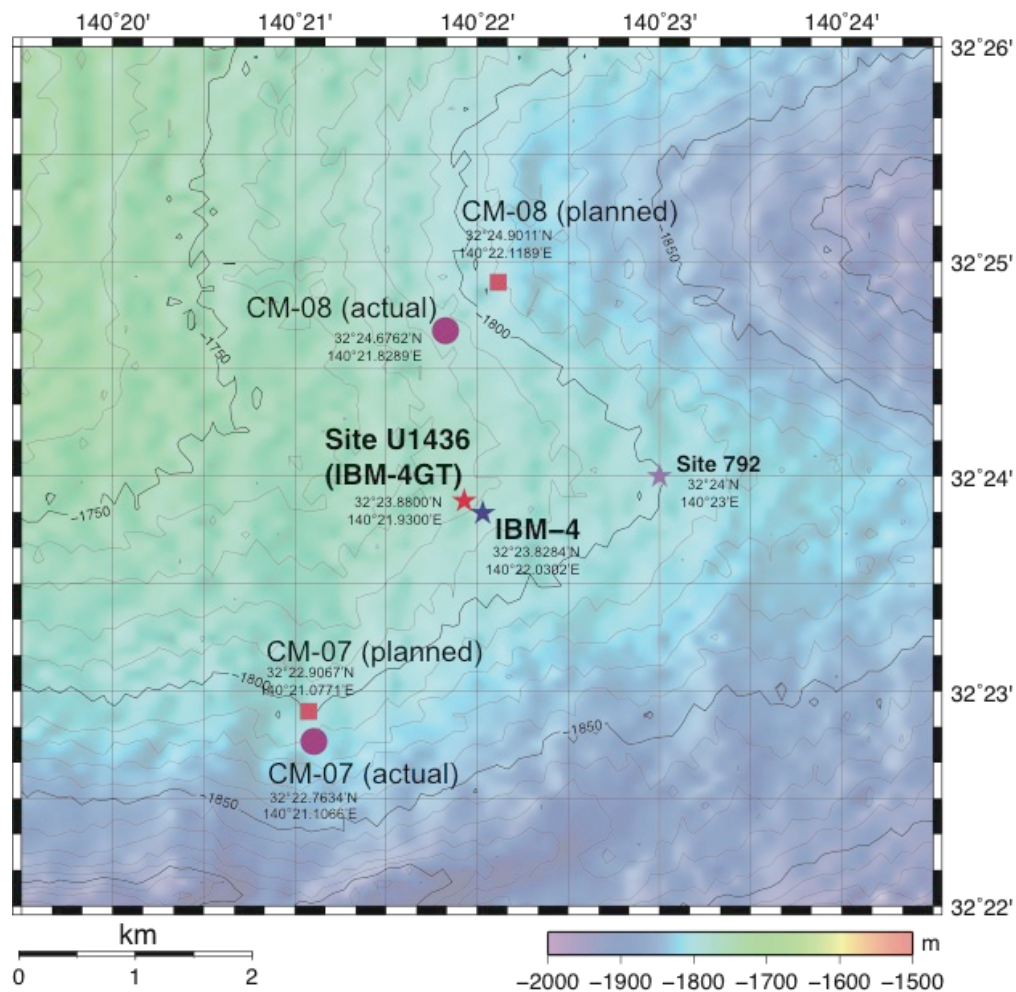


Fig. 8.3 Close-up bathymetry map around the Sites IBM-4 and IBM-4GT. The target and actual installation positions of each mooring system are shown by blue and pink circles, respectively. The target positions were selected to keep an enough distance, water depth plus 500 m, away from a known submarine cable (not shown in the figure).

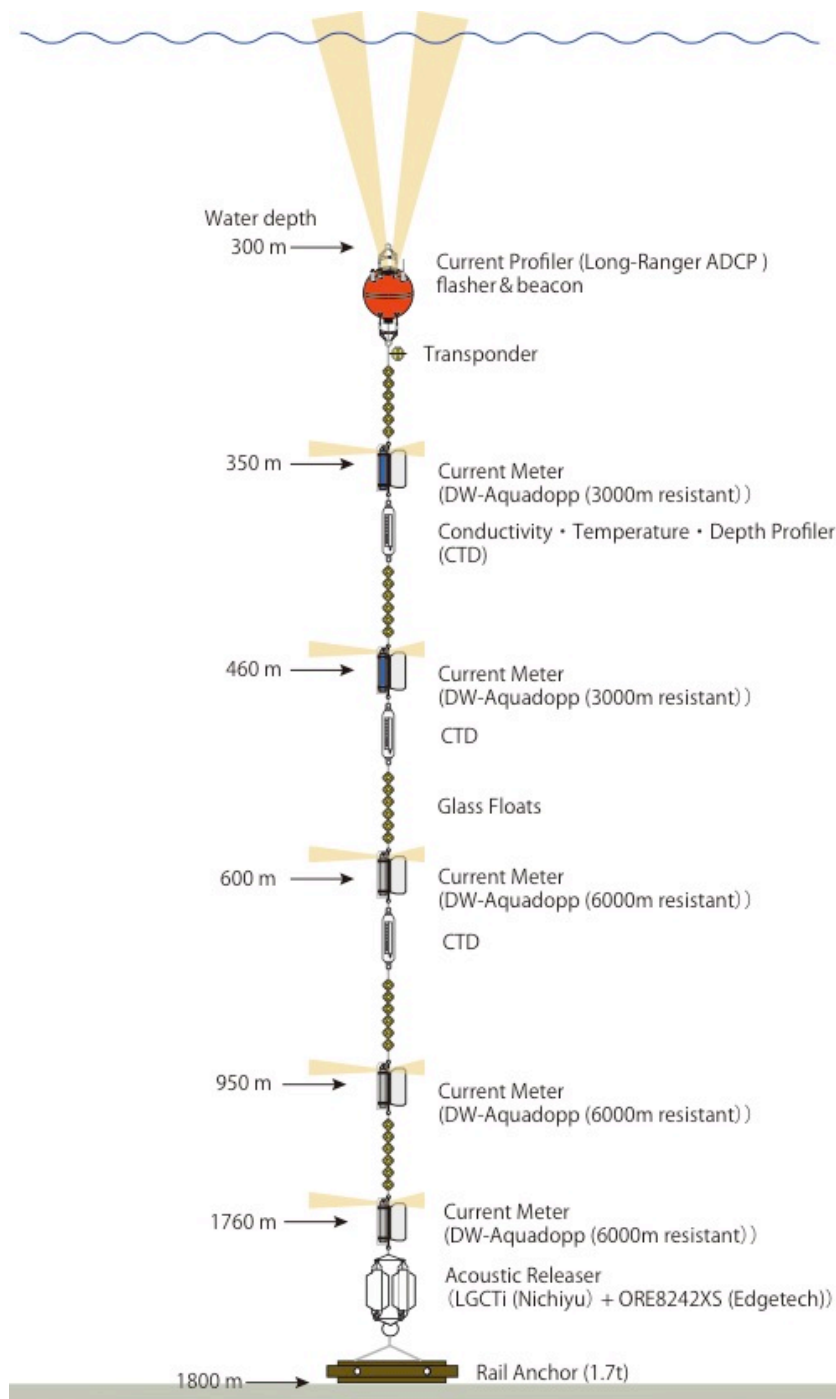


Fig. 8.4 Schematic diagram of the mid-depth subsurface mooring system for long-term ocean current observation installed in the Site IBM-4.

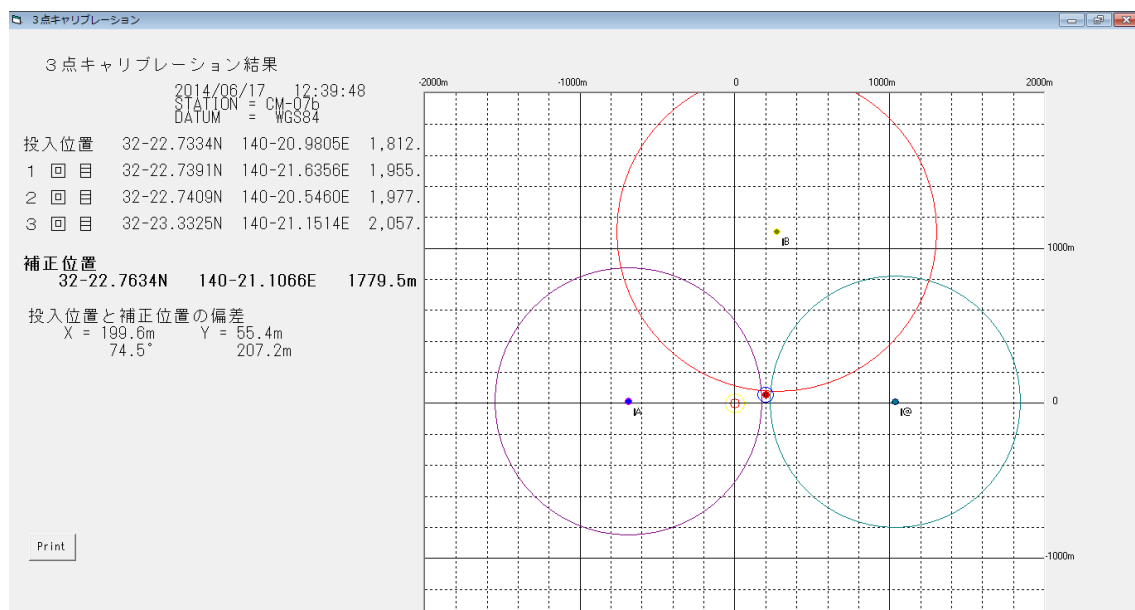


Fig.8.5 Positioning result of the CM-07 mooring system by triangulation.

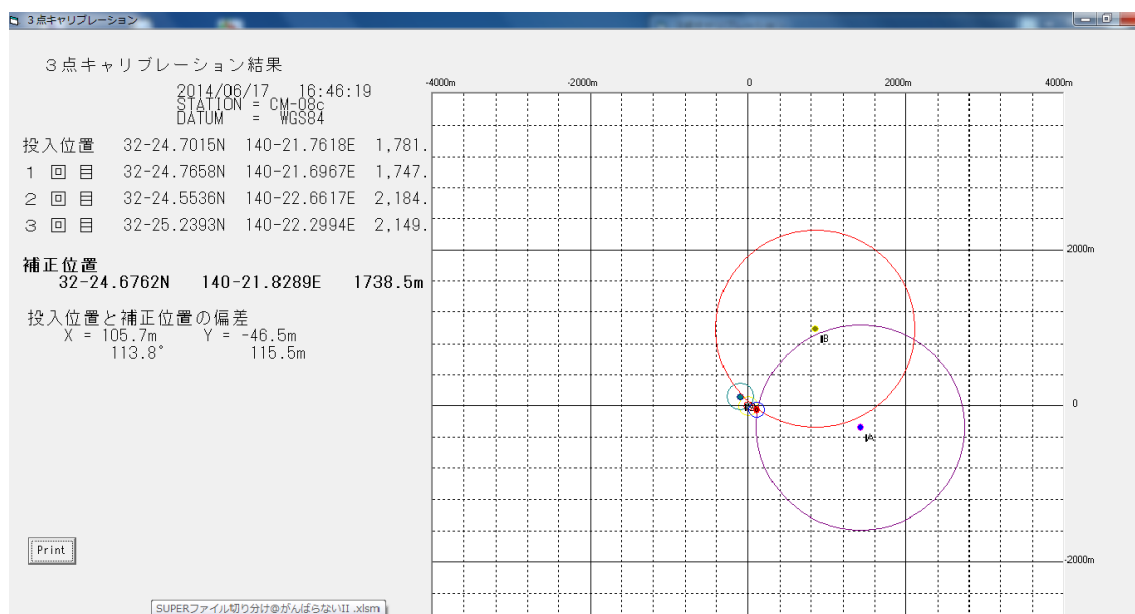


Fig.8.6 Positioning result of the CM-08 mooring system by triangulation.

Table 8.1 Brief event log of the mooring installation operations.

June 17	
06:00	Arrive the IBM-4 site. Start preparation for installation.
07:45	Hold a pre-job meeting.
08:25	Arrive the installation route of the CM-07 mooring.
08:38	Land the top buoy on the water.
10:44	Drop the rail anchor to the water @1812 m point (12 m deeper than planned)
11:15	Start triangulation of the CM-07 (releaser position).
11:50	Finish triangulation, then move to the CM-08 location. Hold a pre-job meeting.
13:30	Land the top buoy on the water.
13:34	Drop the rail anchor to the water @1780 m (30 m shallower than planned)
15:18	Start triangulation of the CM-08 (releaser position).
15:45	Finish triangulation, then move to the northern area of the IBM-4 site for
16:40	the multi-beam survey.

Table 8.2 Observation specifications (parameter settings) for each sensor equipped on the mooring systems.

ADCP		DW-Aquadopp		CTD	
Duration (days)	730	Duration (days)	730		
Ensemble interval (sec)	1800	Measurement interval (sec)	1800	Ensemble interval (sec)	1800
Pings Per Ensemble	22	Measurement load (%)	43		
Ping interval (sec)	5				
Number of Depth Cells	65	Vertical vel.prec. (cm/sec)	0.6		
Depth Cell Size (mm)	800	Horizont vel.prec. (cm/sec)	0.4		
First cell range (m)	16.62				
Last cell range (m)	528.62				
Max range (m)	559.69				
Battery capacity (Wh) *Safty line 3840Wh	4800	Battery capacity (Wh)	330	Battery Endurance (days)	7746
Power usage (Wh)	3771.72	Battery utilization (% of capacity)	76		
Ensemble Size (bytes)	1454				
Storage required (MB)	48.59	Memory required (MB)	2.6		
Standard deviation (cm/sec)	3.12				

Table 8.3 Summary of the mooring system installation positions.

Location Name	Target Point		Anchor Drop Point	Releaser Position		Difference	
	Latitude Longitude	Water Depth	Latitude Longitude	Latitude Longitude	Water Depth	from Target	from Drop Point
						Distance Azimuth	Distance Azimuth
CM-07	32°22.9067'N	1800 m	32°22.7334'N	32°22.7634'N	1810 m	268.9 m	207.2 m
	140°21.0771'E		140°20.9805'E	140°21.1066'N		170.1°	74.5°
CM-08	32°24.9011'N	1810 m	32°24.7015'N	32°24.6762'N	1785 m	616.0 m	115.5 m
	140°22.1189'E		140°22.2994'E	140°21.8289'E		227.6°	113.8°

8.4 Hull-mount Multi-beam Bathymetry Survey

Bathymetric survey with the hull-mount multi-beam bathymetry system was carried out in the northwest to north-northwest area of the Site IBM-4, where the multi-beam bathymetry by the JAMSTEC fleet had not been covered yet, in the nighttime of June 15 and 17 (Fig. 8.7). Although there were several candidate areas for the bathymetry survey in the plan, this area on which the D/V Chikyu's escape routes potentially pass was chosen to mend preferably. By this survey, a major data gap was disappeared from the northern part of the adjacent area around the IBM-4.

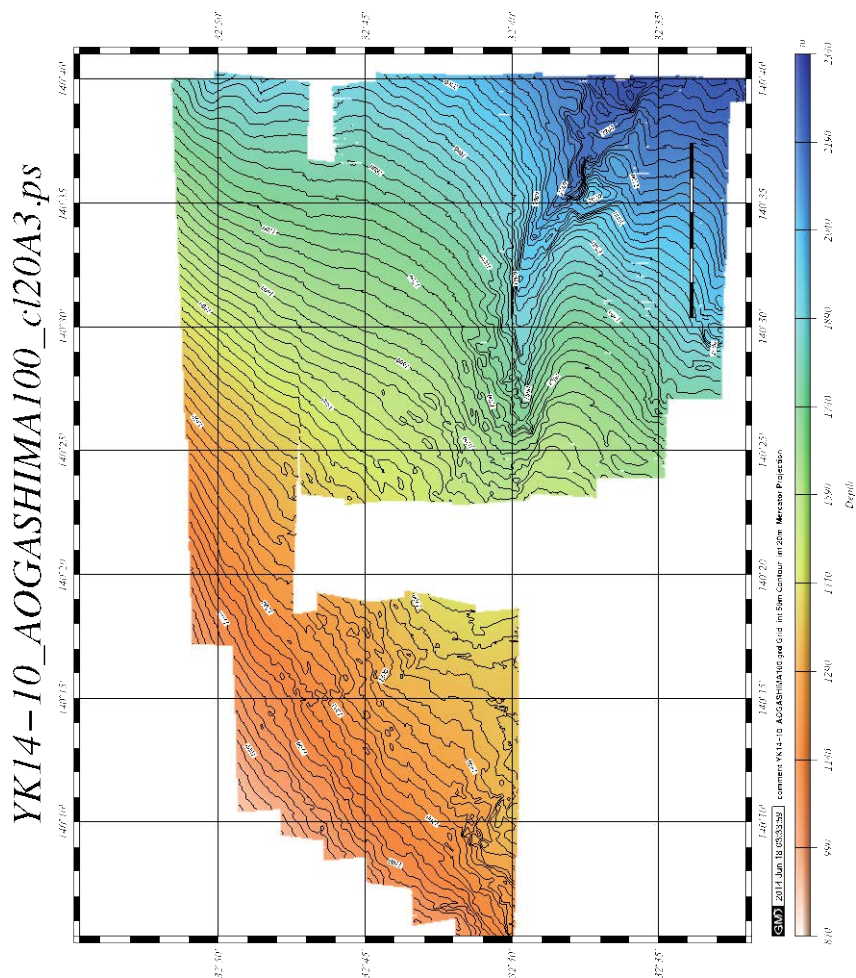


Fig.8.7 Multi-beam bathymetry map of the north to north-northeast of the IBM-4 obtained by surveys carried out in the nighttime of June 15 and 17.

8.5 Hull-mount ADCP Ocean Current Survey

Ocean current data was taken while the vessel is in the survey area. No strong current was observed throughout the cruise and it was generally less than 1.5 knot. A snap shot of current profiles is shown in Fig.8.8.

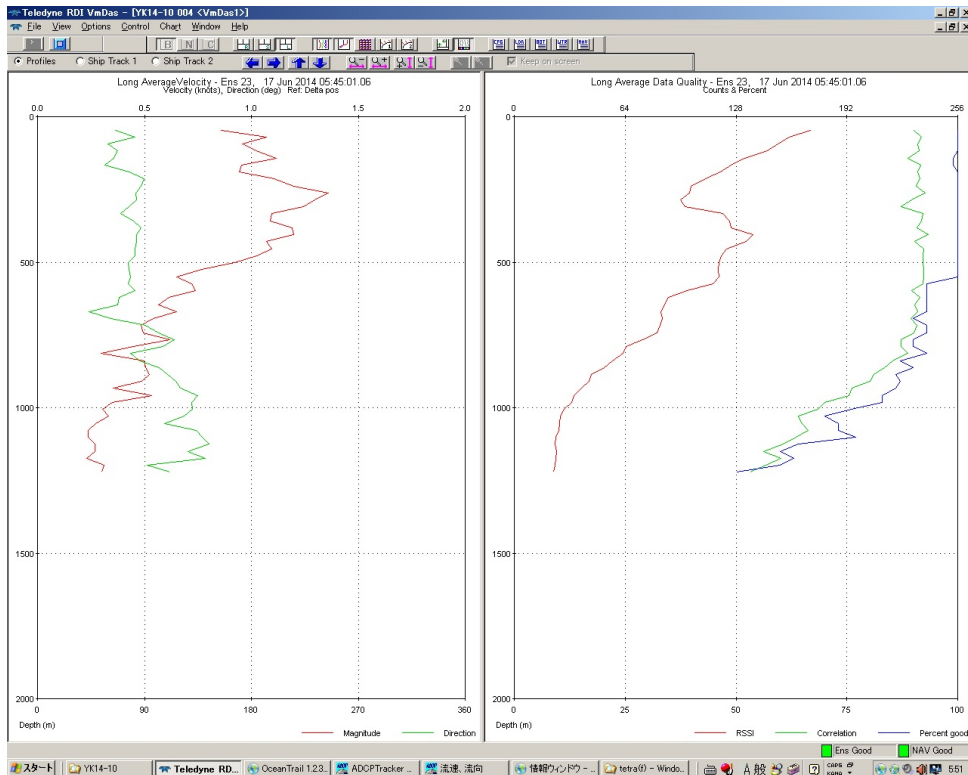


Figure 8.8 A snap shot of ADCP current profiles at 17:45, June 17.

8.6 AUV Urashima Survey

The last day of the original operation period, June 18, was the only room left for the AUV Urashima survey in the IBM-4, however, we finally reconciled to do in this cruise because of rough weather forecasted for June 18-19. Therefore, no AUV survey was carried out in the IBM-4.

9. Future Perspectives and Suggestions

Kangsoo Kim
National Maritime Research Institute

In YK14-10 cruise, Urashima accomplished completed two geomagnetic survey dives (dive #169, #170) successfully. Quality of obtained data is expected to be notably high, since the figure-eight motions for magnetic field calibration were completed successfully, as well as Urashima travelled the survey site keeping its attitude stable. Together with magnetic field data obtained from r2D4 dives in 2008, and YK11-11 Urashima dives in 2011, we could complete a magnetic field map which covers entire region of Bayonnaise Knoll Caldera. In general, an AUV provides geomagnetic data of far higher quality in comparison to a surface vessel, since it can dive merely tens of meters above the bottom. As of now, it is the first achievement that we completed a map covering entire region of a submarine caldera the data of which are taken around 80 m distance off the bottom. Thus, it can be said that in view of the availability of high-quality bottom geomagnetic data, our map or database of the magnetic field in Bayonnaise Knoll Caldera has important meaning.

Due to the restricted ship time and the sea states often unfavorable, AUV-based geomagnetic survey in Myojin Caldera was left to our next mission. Starting with Bayonnaise Knoll Caldera, we are planning to conduct AUV-based geomagnetic surveys covering the bottoms, such as Myojin Caldera, Aogashima Caldera, Izena Caldron, and so forth which are believed to be closely related to submarine hydrothermal activities.

Acknowledgment

The author would like to express thanks to all officers and crew members of S/V "Yokosuka" and AUV "Urashima", Captain Nakamura and Chief Chiba, heading the list. It is their every effort that enabled us to complete our mission in YK14-10 cruise. We also have to express our special thank to Dr. Kasaya of JAMSTEC, Prof. Okino and Mr. Fujii of ORI, the Univ. of Tokyo, and Prof. Seama of Kobe Univ., for being given full facilities in use of the magnetometer system.

Appendix

Photos of YK14-10 cruise



Voyage started (leaving JAMSTEC wharf)



Urashima control room



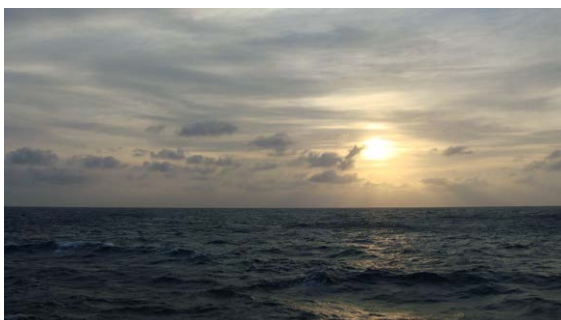
S/V Yokosuka



Urashima in maintenance state



Bow payload space of Urashima



The sunset



Aogashima



Hachijojima



Inlet of VPR



Works for deploying Urashima



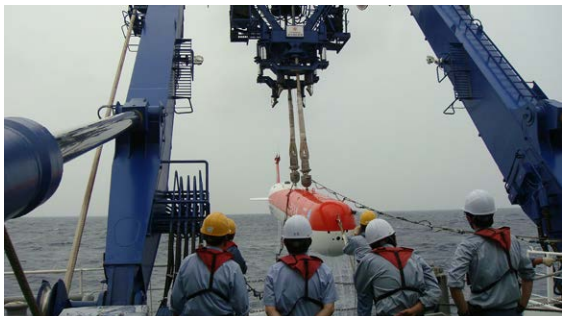
Researchers watching deployment of Urashima



Dive started



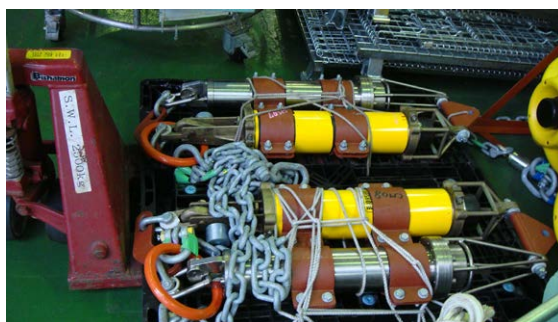
Real-time vehicle trajectory on console



Retrieving Urashima



Approaching Urashima for retrieval



acoustic releasing device



Chief scientist with guests



The wounded and the chief scientist



Praying for the success of the mission



Floater as a 'Kamisama'