



Yokosuka+ “Cruise Report”

Cruise ID YK15-08

Array observation of ocean bottom pressure and
AUV-based near bottom magnetic survey

May 21,2015-June 02,2015

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

●Contents

1. Cruise Information

- Cruise ID: YK15-08

- Name of vessel: Yokosuka

- Title of the cruise:

Array observation of ocean bottom pressure and AUV-based near bottom magnetic survey

- Title of proposal:

(1) Array observation of ocean bottom pressure for studying phenomena in the ocean/solid Earth system

(2) AUV-based near bottom magnetic survey for uncovering the correlation between magnetic anomalies and submarine hydrothermal activities

- Cruise period: 21st May 2015 – 2nd June 2015

- Ports of departure / call / arrival: JAMSTEC, Yokosuka ~ JAMSTEC, Yokosuka,

- Research area

(1A) Off east of Aogashima Is. (water depth: 1,600m~2,250m)

Area is defined by the following latitudinal and longitudinal ranges.

32°12.0' N , 32°32.0' N

140°10.0' E , 140°35.0' E.

(1B) Far off east of Torishima Is. (water depth: 4,500m~5,700m)

Area is defined by the following latitudinal and longitudinal ranges.

30°50.0' N , 31°18.0' N

141°30.0' E , 141°54.0' E

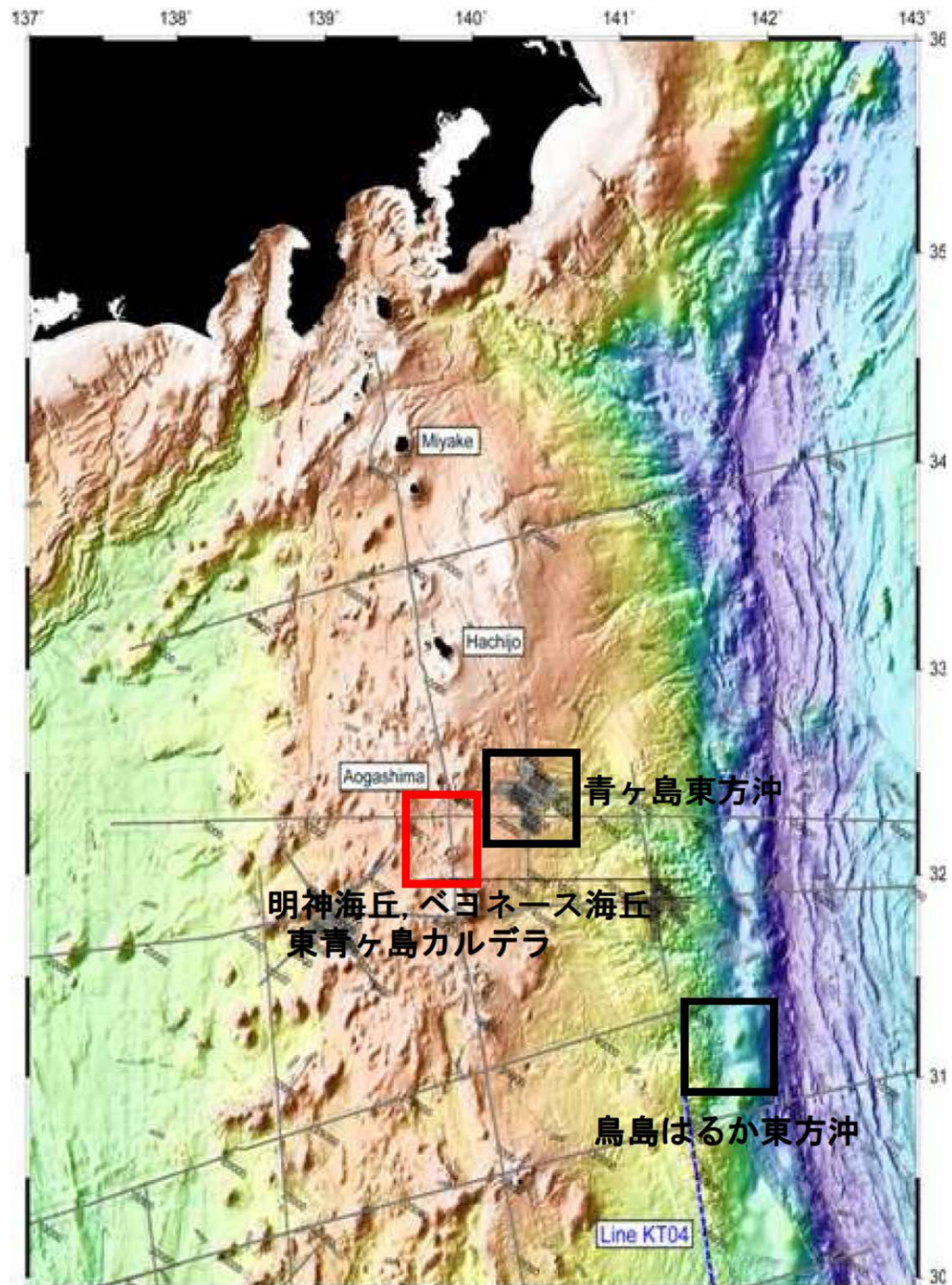
(2) Northwest Bayonnaise Knoll Caldera, Myojin Caldera, and East of Aogashima Caldera (water depth: 700m~1,500m)

Area is defined by the following latitudinal and longitudinal ranges.

31°57.0' N , 32°35.0' N

139°36.0' E , 140°00.0' E

- Research Map



2. Researchers

- Chief scientist: Yoshio Fukao (JAMSTEC)
- Representative of the science party:
 - (1) Yoshio Fukao (JAMSTEC)
 - (2) Kangsoo Kim (National Marine Research Institute)
- Science party:
 - (1) Yoshio Fukao (JAMSTEC)
 - Hiroko Sugioka (JAMSTEC)
 - Aki Ito (JAMSTEC)
 - Hajime Shiobara (ERI, Univ. Tokyo)
 - (2) Kangsoo Kim (National Marine Research Institute)
 - Saori Yokota (National Marine Research Institute)

3. Observation

- Observation

(1) Array observation of ocean bottom pressure for studying phenomena in the ocean/solid Earth system

Purpose:

We make an array observation of ocean bottom pressure towards establishing an observational approach of looking both upward and downward from the seafloor to understand coupling phenomena between the ocean and the solid Earth.

Objectives:

We have so far developed an array system of high resolution ocean bottom pressure gauges to observe geophysical phenomena occurring above and below the seafloor simultaneously. We deploy this system to observe, among others, internal tides, ocean infragravity waves and low-frequency earthquakes on the seafloor off east of Aogashima Island for about a year period from May 13, 2014, and far off east of Torishima Island for the next year from the end of May, 2015. The recovery of the instruments from the seafloor off east of Aogashima Is. and the re-installation of them far off east Torishima Is. are planned to carry out in one cruise. These observations are expected to retrieve signals of low order internal tides, to obtain information about the sources of infragravity waves and to give any idea of understanding what are happening along the largely aseismic plate boundary of the Izu-Bonin Trench by detecting any anomalous inter-plate slips..

Result of recovering instruments from ocean bottom off east of Aogashima Is.

On 22nd, May we recovered the OBPs from sites A07, A08, A09, A10, A06, A05, A04 and A03. We also recovered the BBOBS+DPG from A05. We also made a XCTD measurement at each site. At the night of May 23rd we recovered the OBP from A01 and made an XCTD measurement there. At the

last site, A02, we attempted to communicate by sending acoustic signals for 20 minutes but had no response from this site. We decided to have another chance to recover the instrument at A02. We confirmed that all the recorders were in operation all the way through the observational period. We also compared the internal clock at each station with the GPS clock to confirm that the internal clocks are in general advanced with respect to the GPS clock but that the advances are well within the factory-specified limits. After the completion of the instrumentation of the OBPs and BBOBS+DPG far off east of Torishima Is., we came back to the observational sites off east of Aogashima Is. to finally recover the OBP from the A02 site, where we also conducted XCTD measurement.

Result of installing instruments on the seafloor off east of Torishima Is.

On 28th and 29th May we installed the OBPs at sites B07, B08, B09, B10, B04, B35, B01, B02 and B06, and finally the BBOBS+DPG at the B05 site.. We also made an XCTD measurement at each of all the sites. At the night of May 23rd We recovered the OBP from A01 and made an XCTD measurement there. At the last site, A02, we attempted to communicate by sending acoustic signals for 20 minutes but had no response from this site. We decided to have another chance to recover the instrument at A02. We confirmed that all the recorders were in operation all the way through the observational period. We also compared the internal clock at each station with the GPS clock to confirm that the internal clocks are in general advanced with respect to the GPS clock but that the advances are well within the factory-specified limits. We were not able to install an OBP at B05 because the acoustic beacon for the OBP recovered from A02 was found to have almost exhausted its life. Instead, the DPG attached to the BBOBS can be a replacement of the OBP because this DPG can be carefully calibrated with the OBP based on the data at the A05 site.

Figure 3-1. Installation of an OBP at the B04 site (by T. Minamisawa)

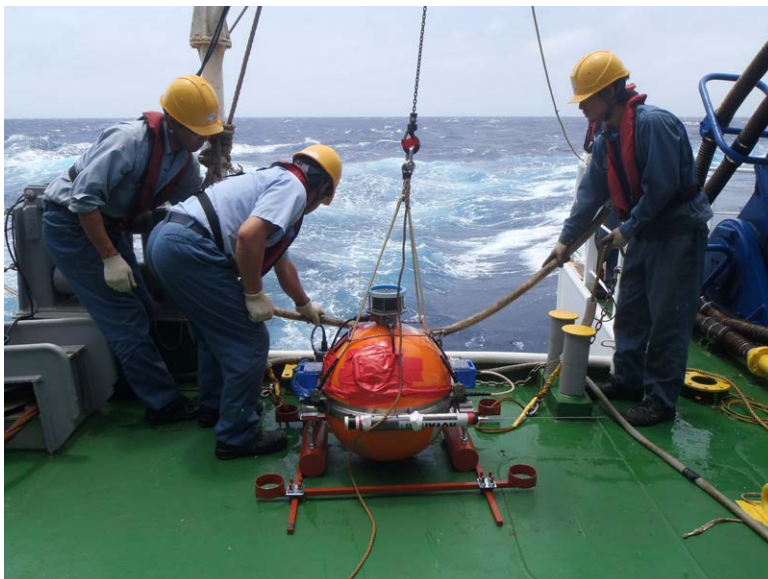


Fig.3-2. Locations of XCTD casts off east of Aogashima Is.

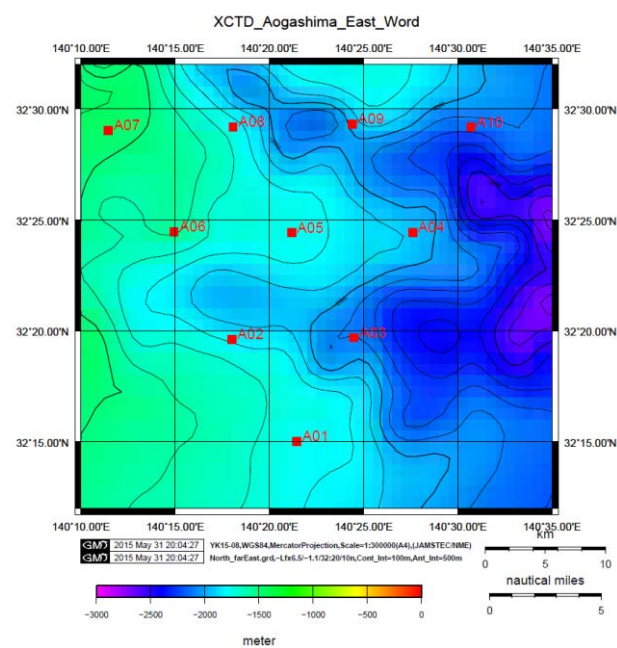
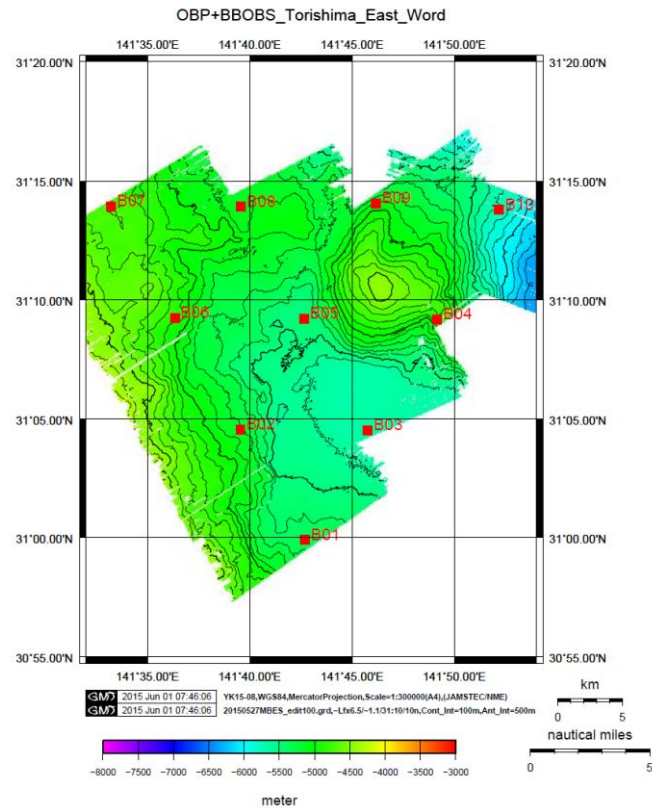


Fig.3-3. Locations of XCTD casts far off east of Trishima Is.



4. List of observation equipments

4.1 AUV "Urashima"

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

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.

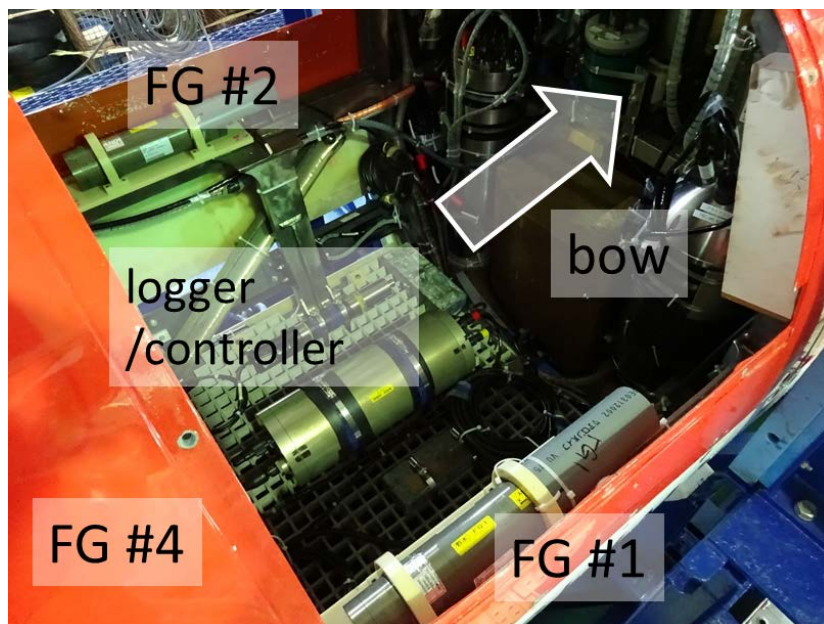


Fig.4.2 Arrangements of magnetometers installed in Urashima.

5. AUV Dives

5.1 Urashima dive #204

Starting dive at south part of the caldera, Urashima traveled the east side of the caldera following the tracklines which crosses the caldera in north-south 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 #204 is as follows.

Date : 23th May, 2015
 Location : Myojin caldera site
 Purpose : Near-bottom geomagnetic survey
 Duration : 9hrs. 18min.
 Dive event log
 07:22 Dive initiation
 15:42 Dive termination
 16:21 Surface
 16:40 Retrieval completion

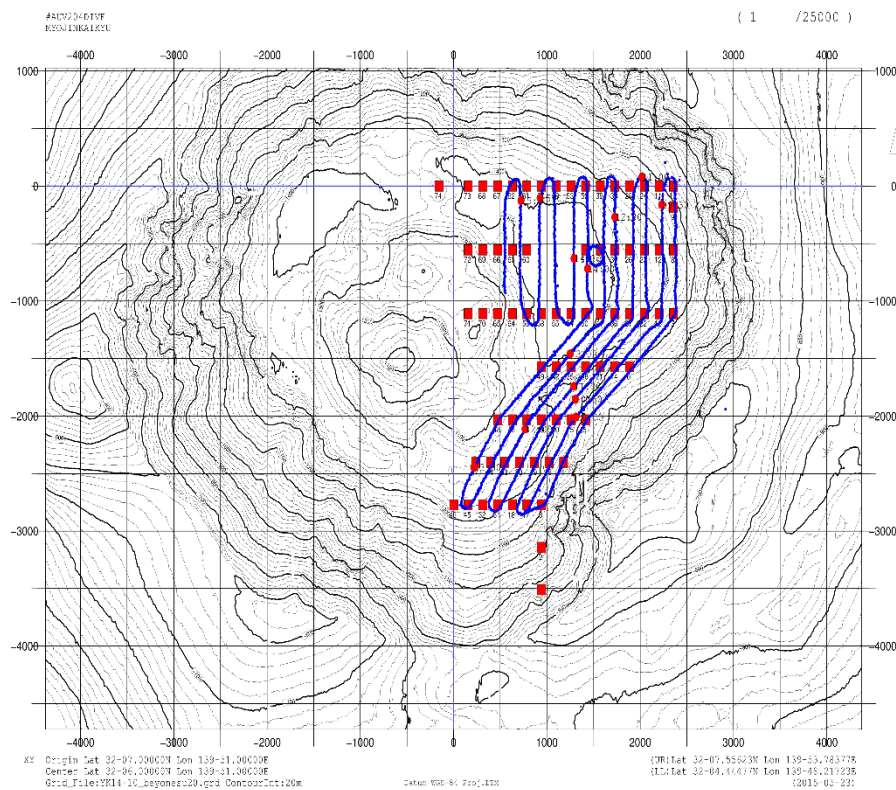


Fig.5.1 Vehicle trajectory of Urashima dive #204.

5.2 Urashima dive #205

Starting from the point where the former dive (dive #204) terminated, Urashima traveled the west side of the caldera following the tracklines which crosses the caldera in north-south direction. 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 #205 is as follows.

Date : 27th May, 2015
 Location : Myojin caldera site

Purpose : Near-bottom geomagnetic survey

Duration : 10 hrs. 2min.

Dive event log

07:22 Dive initiation

16:37 Dive termination

16:58 Surface

17:24 Retrieval completion

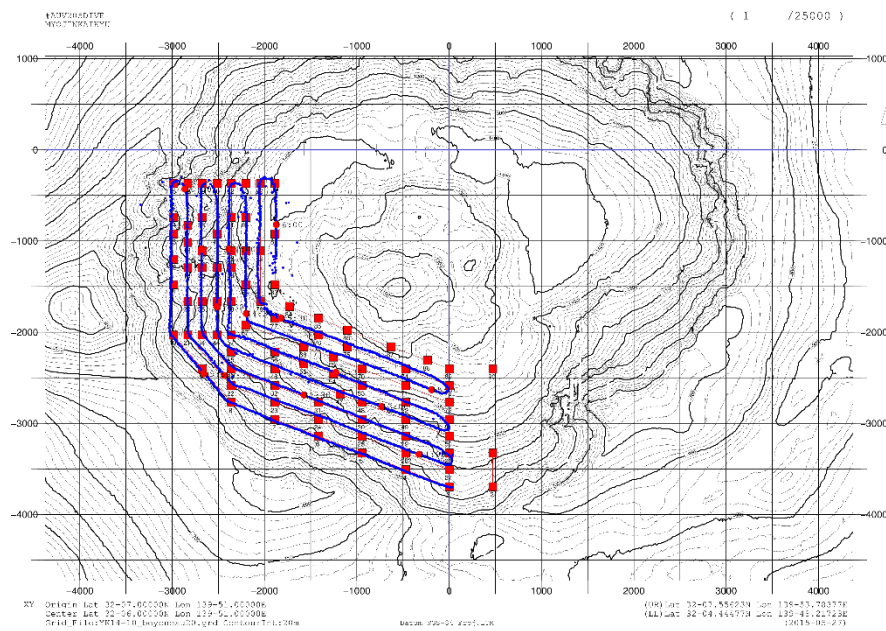


Fig.5.2 Vehicle trajectory of Urashima dive #205.

5.3 Urashima dive #206

Starting dive at west part of the caldera, Urashima traveled the west side of the caldera following the tracklines which crosses the caldera in north-south and west-east direction. 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 #206 is as follows.

Date : 1st Jun., 2015

Location : Myojin caldera site

Purpose : Near-bottom geomagnetic survey

Duration : 7hrs. 7min.

Dive event log

07:22 Dive initiation

13:39 Dive termination
 14:00 Surface
 14:29 Retrieval completion

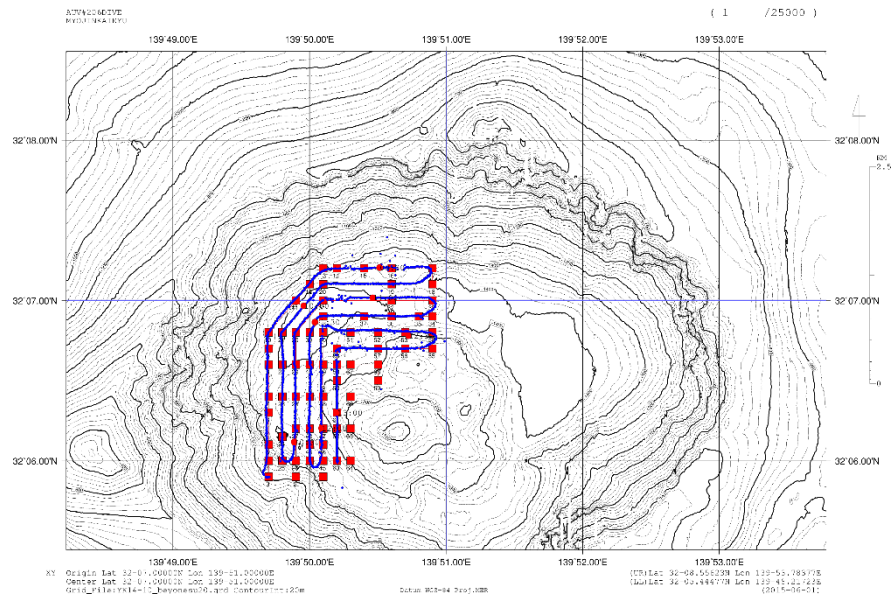


Fig.5.2 Vehicle trajectory of Urashima dive #206.

6. Observations

6.1 Geomagnetic field observation

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. And Figure 6.2 shows the actual dive trajectory of Urashima during the figure-eight maneuver.

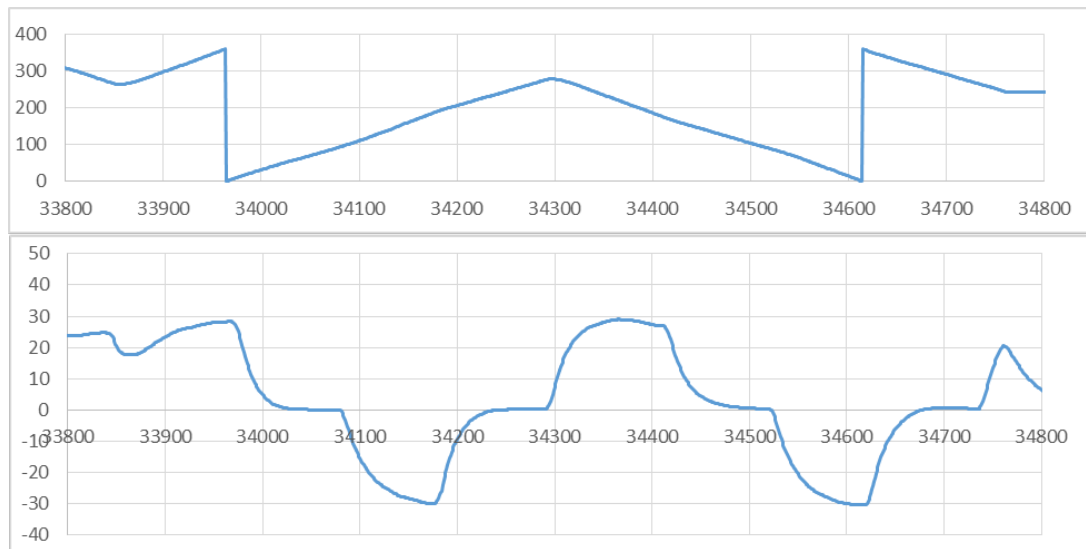


Fig.6.1 Time series of heading (upper) and pitch (lower) during a figure-eight maneuver dive #205.

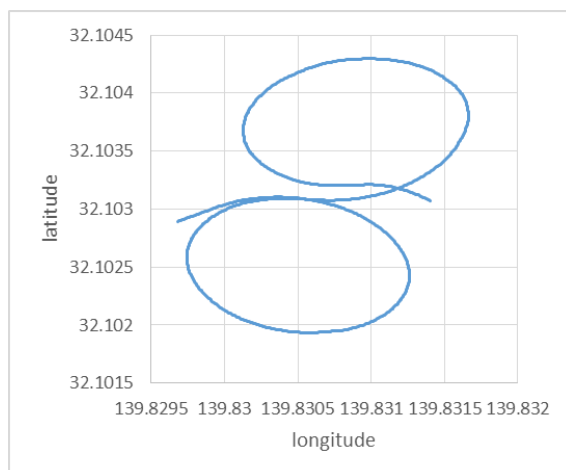


Fig.6.2 Vehicle trajectory of Urashima during a figure-eight maneuver dive #205

Figure 6.3 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.

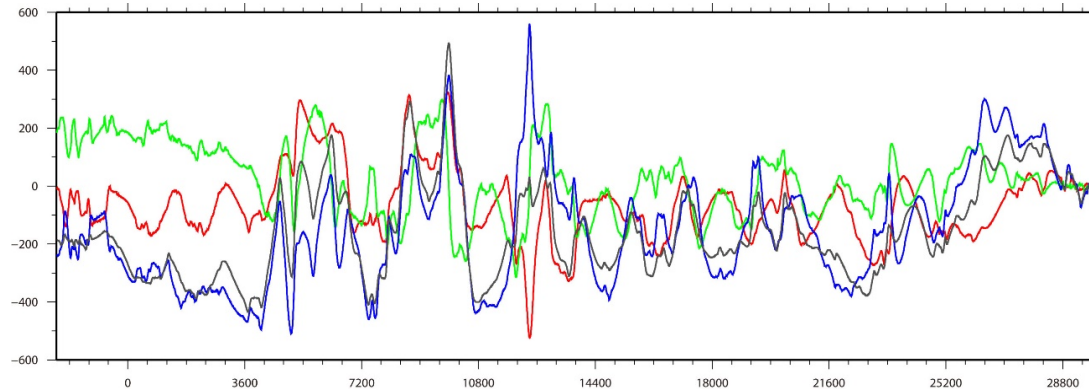


Fig.6.3 Measured geomagnetic field during dive #204.

7. Future Perspectives and Suggestions

In YK15-08 cruise, Urashima accomplished completed two geomagnetic survey dives (dive #204, #205) 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 YK14-11 Urashima dives in 2014, we could complete a magnetic field map which covers entire region of Myojin 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 Myojin Caldera has important meaning.

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

8. Notice on Using

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.