

Cruise Report

NT13-22

R/V Natsushima & ROV Hyper Dolphin

Iheya North Ridge, Okinawa Through

2013

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1. Cruise Information

1.1. Cruise number

NT13-22

1.2. Name of vessel and submersible vehicle

R/V Natsushima and ROV Hyper Dolphin

1.3. Title of the cruise

Biological monitoring and physical exploration researches

1.4. Title of the proposals

- 1) Monitoring the hydrothermal ecosystem and assessment of effects of drilling activity
- 2) DC resistivity survey and OBEM operation
- 3) Feasibility study for mineral harvesting system from hydrothermal fluid

1.5. Cruise period

7 to 19 November y 2013

1.6. Ports of call

Departure: Yokosuka

Arrival: Naha

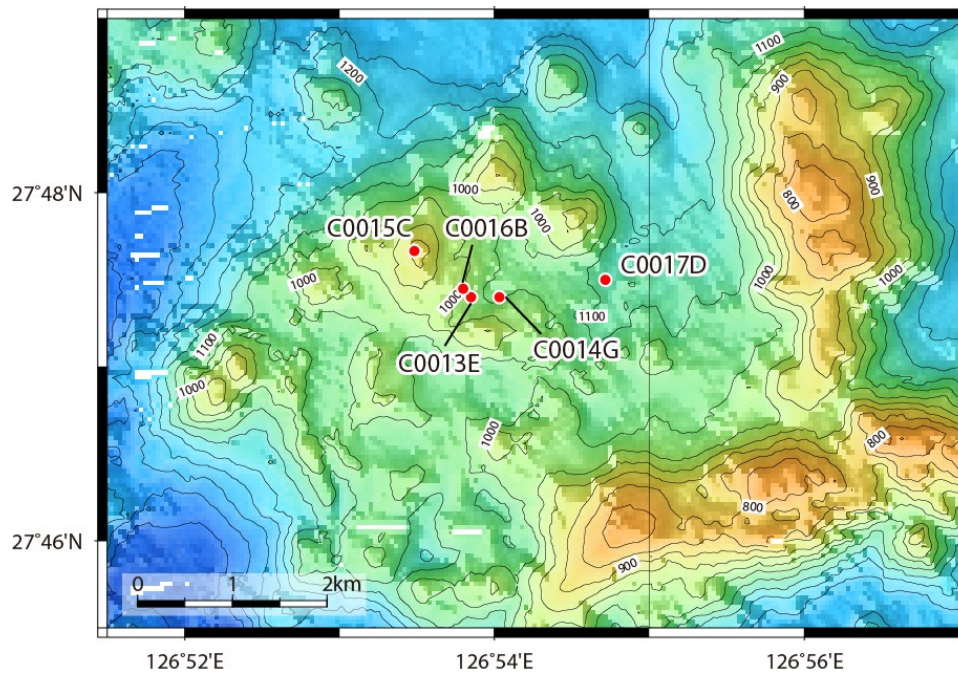
1.7. Research area

Iheya North Ridge, Okinawa Trough

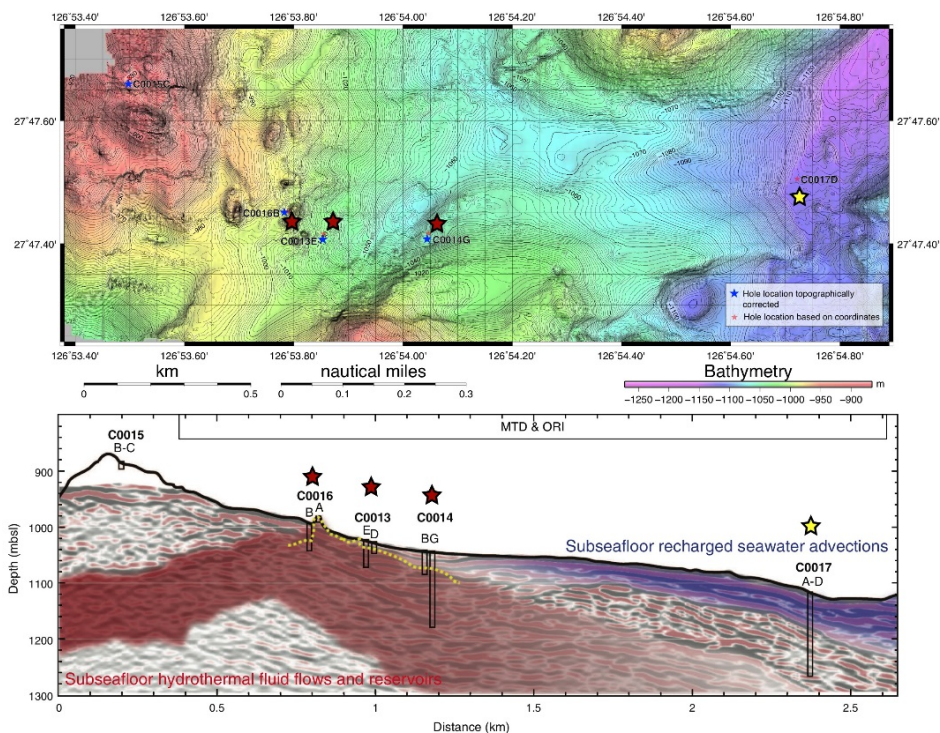
27° 46.5'N 126° 53.0'E to 27°49.0'N 126°55.3'E

Water depth: 850-1500m

2. Research map



Location of research area in Okinawa Trough

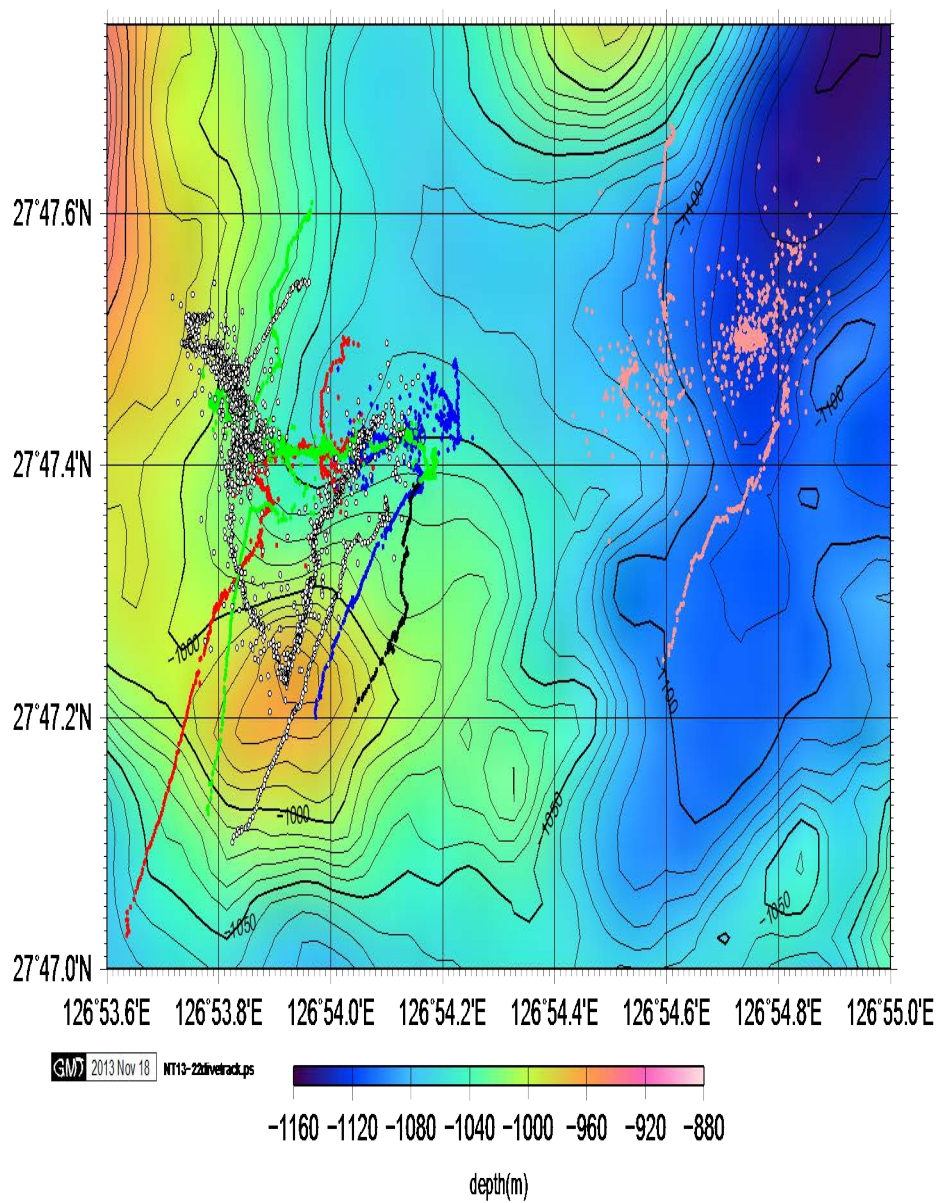


Surveillance points in hydrothermal field of Iheya North Knoll

C0013 : 27°47.42'N, 126°53.85'E, 1035m, C0014: 27°47.43'N, 126°54.05'E, 1059m,
 C0016: 27°47.45'N, 126°53.80'E, 998m, C0017: 27°47.50'N, 126°54.72'E, 1129m

NT13-22

- dive#1596
- dive#1595
- dive#1594
- dive#1593
- dive#1592
- dive#1591



3. Research team (onboard)

Chief Investigator:

Hiroyuki Yamamoto (JAMSTEC)

Onboard Researchers:

Video survey:

Tetsuya Miwa (JAMSTEC)

Ryota Nakajima (JAMSTEC)

Biological survey:

Masako Nakamura (OIST)

Takuya Yahagi (Tokyo Univ)

Seinosuke Teruya (Tokyo Univ)

Frederic Sinniger (JAMSTEC)

Environmental survey:

Junichi Miyazaki (JAMSTEC)

Katsunori Yanagawa (JAMSTEC)

Yuka Masaki (JAMSTEC)

Hideaki Machiyama (JAMSTEC)

Physical survey:

Tada-nori Goto (Kyoto Univ)

Takafumi Kasaya (JAMSTEC)

Engineering study:

Masayuki Watanabe (JAMSTEC)

Technical supporting stuff:

Hisanori Iwamoto (NME)

4. Observation / Investigation

4.1 Overview

This research cruise has been planned for three subject; 1) annual survey the post-drilling environments of IODP Expedition 331 on hydrothermal field in Iheya North Knoll, 2) DC resistivity survey and OBEM operation, and 3) feasibility study for mineral harvesting system from hydrothermal fluid.

4.2. Habitat mapping

Habitat mapping is a basic approach to understand a situation of community and a linkage between habitat condition and distribution pattern of organisms. The data on seafloor bathymetry, seabed classification, benthic faunae have been collected in this deep-sea expedition. The video survey of seafloor using downward-facing video camera was conducted to analyze the animal distribution.

4.3. Survey of biological diversity and distribution pattern

Hydrothermal system sustains dense and diverse communities in deep-sea ecosystem. In this cruise two approaches by taxon-based and gene-based have been conducted. Benthos aggregation and sediment were collected for this study.

4.4 In-situ experiment on benthic community

Understanding the process of migration and settlement of benthic community including microorganisms and megabenthos is a crucial issue in study of deep-sea ecosystem. In this cruise, we conducted in-situ experiment for larvae settlement of benthos, and in-situ cultivation system for prokaryotes. The long-term measurement of seawater movement in bottom layer was conducted to analyze the migration pathway of planktonic larvae.

4.5. Environmental survey using physical and chemical sensors

Physical and chemical properties in surrounding area of hydrothermal system are data to determine the extent of chemosynthesis-based ecosystem. In this cruise, several types of physicochemical sensors were examined.

4.6. DC resistivity survey and OBEM operation

4.6.1 DC resistivity survey

The recent growth of world-wide requirement of metals demands advanced explorations for finding metal mine and deposits. Especially, the submarine massive sulphides (SMS) have attracted mining companies because of its compactness with high grades. However, few exploration techniques were developed to evaluate the thickness of SMS and to find the buried SMS.

One of the great problems is the rough seafloor feature near the hydrothermal area, which restricts the ways for marine controlled-source electromagnetic (CSEM) survey. Recently, the deep-towed CSEM technique is used for imaging the shallower structure below the seafloor for detection of methane hydrate etc. (e.g., Schwalenberg et al., 2005). However, the deep-towed CSEM survey requires a long towed cable for source and receiver electrodes. The rough topography does not allow the towing just on the seafloor. The high altitude of towed cable gives us a chance of towing but the obtained data mainly reflect the seawater layer below the cable, so that the resolution to the sub-seafloor structure is decreased.

Here, we propose a new EM exploration technique with a Remotely Operated Vehicle (ROV) as shown in Fig. 4.6.1.1. In our concept, the ROV-based DC resistivity survey system consists of two instruments; i) on-line transmitter and receivers attached to ROV and ii) off-line receiver. The former can measure the seafloor resistivity with sounding depth of 1-2m due to the short source-receiver separation. The later receiver (ocean-bottom electrometer=OBE) can be simultaneously used for keeping far source-receiver distances to obtain the deeper images (with depth of

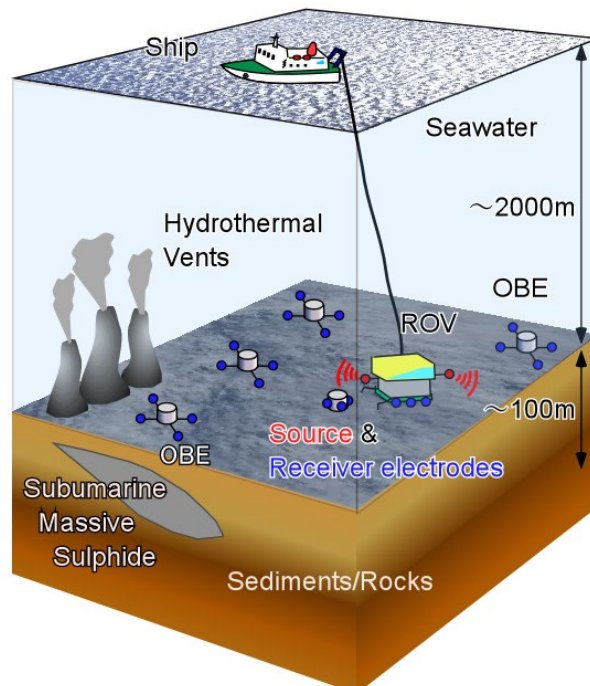


Fig. 4.6.1.1. Schematic drawing of ROV-based marine DC resistivity survey.

2-30m). In this cruise, we test our newly developed system to image the sub-seafloor resistivity structure below the SMS deposits in the Iheya north hydrothermal area. The detailed introduction of our DC resistivity survey system is summarized below (Figs. 4.6.1.2-4.6.1.3). In this study, we use only one OBE for the far receiver.

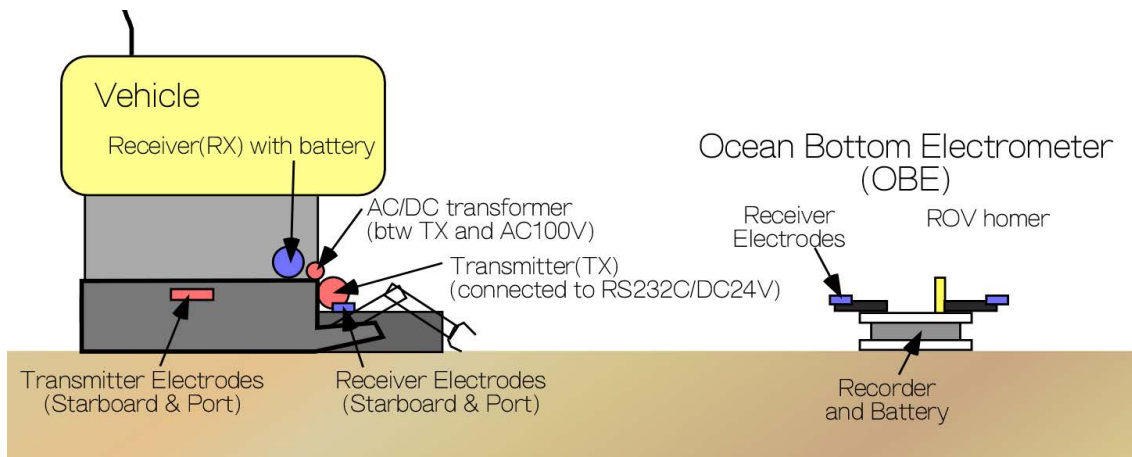


Fig. 4.6.1.2 Schematic drawings of ROV-based marine DC resistivity survey. The source amplitude was 1-10 amperes in this study. The dipole length of source (TX) and receiver (RX) were about 2m and 1m, respectively. The dipole length of OBE was about 1m.

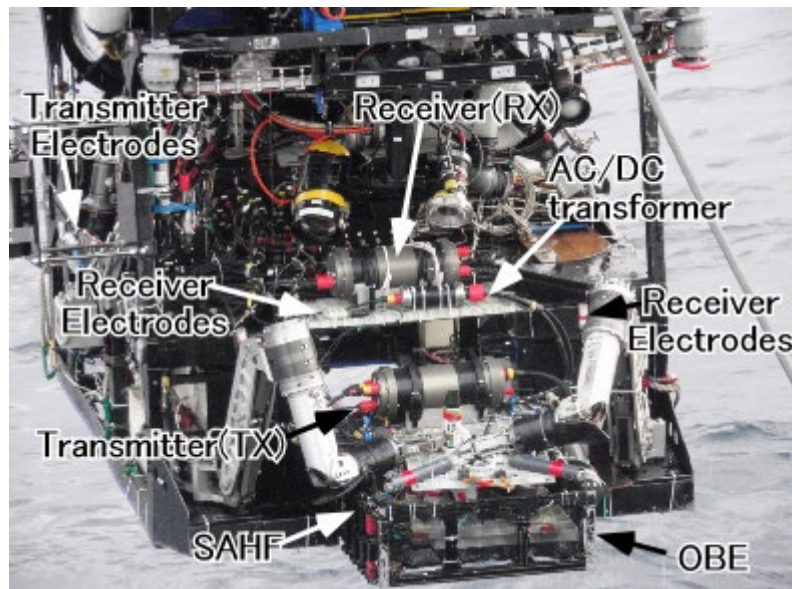


Fig. 4.6.1.3. Payload of Hyper-Dolphin Dive #1594. The payload setting was same at Dive s#1595 and #1596

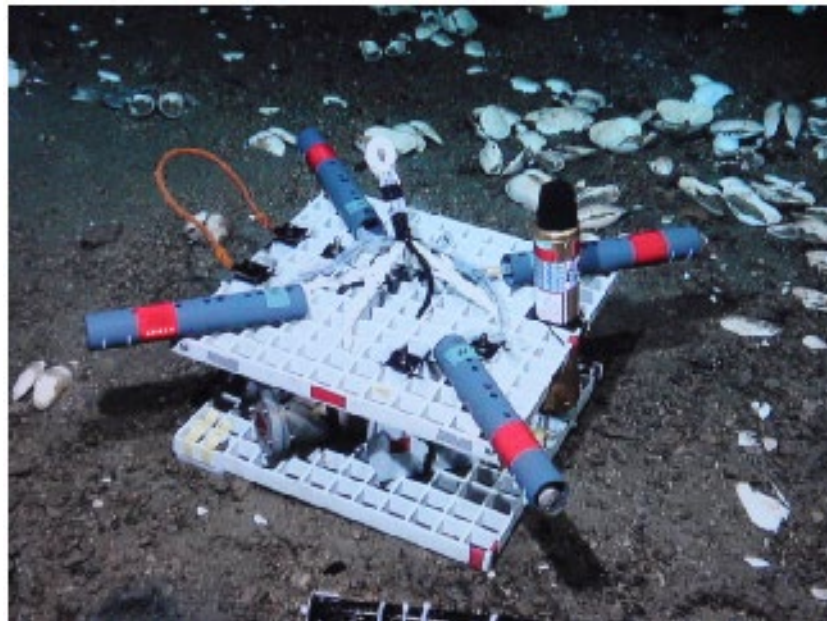
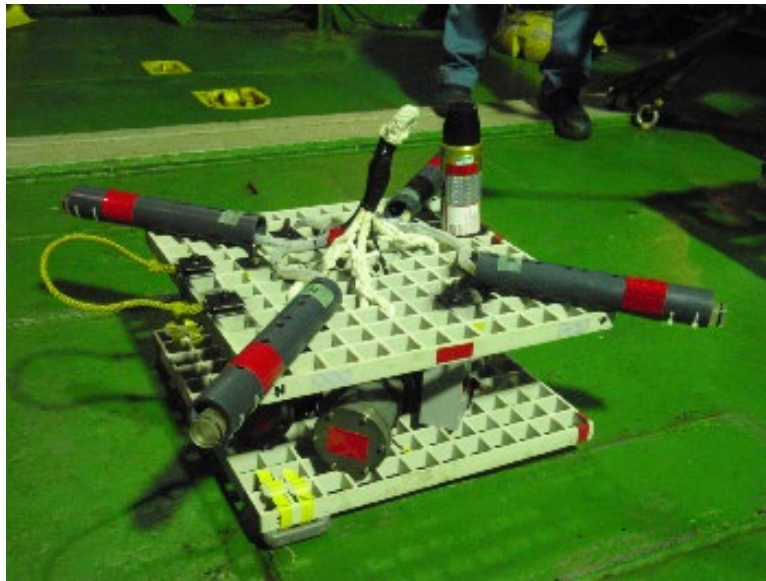


Fig. 4.6.1.4. Ocean Bottom Electrometer (OBE). Receiver electrodes are installed in the four pipes (with dipole length of about 1m).

4.6.2 OBEM

The OBEM system can measure time variations of three components of magnetic field, horizontal electric field, the instrumental tilts, and temperature. In this cruise, we carried out the deployment and recovery test operation of new type system. It mainly consists of one 17-inch glass sphere float, two aluminum pressure cases and electrode arm unit with arm holding mechanism (Fig. 4.6.2.1). The main aluminum case involves main

data logger and a lithium battery pack, and a fluxgate sensor is installed in a smaller case. The electrodes are Ag-AgCl equilibrium type made by Clover Tech. For electric field, four voltage differences between the electrodes on the tip of the pipes and the ground electrode are measured. A transponder unit, radio beacon and a flash light are also mounted on this system. The acoustic system can communicate with the SSBL system and it is easy for us to detect its position in the sea or on the seafloor. This system is based the existing OBEM system with the arm holding system developed by JAMSTEC (Kasaya and Goto, 2009). This arm holding mechanism (Japan patent No. 4346605), which electrode arm is folded when OBEM is in surfacing (Fig. 4.6.2.2), enable recovery operation.

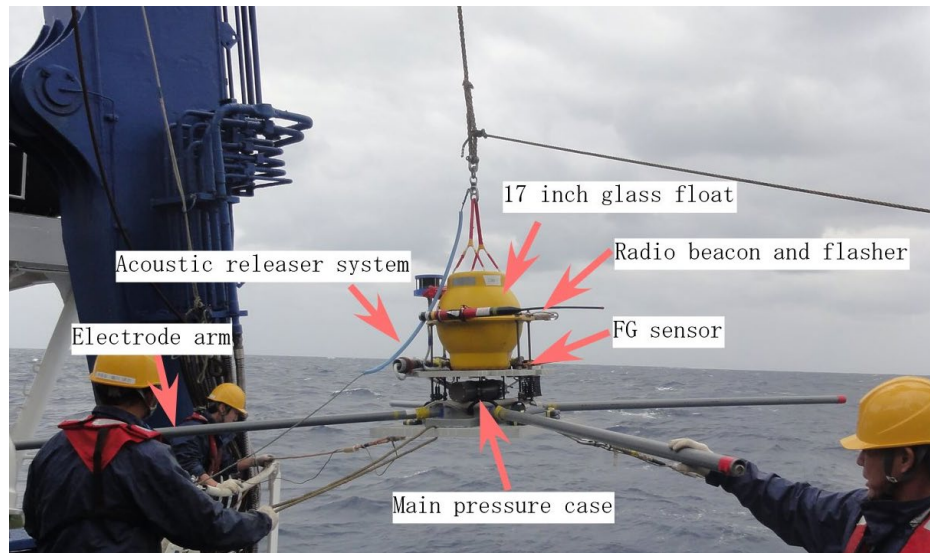


Fig. 4.6.2.1 New OBEM system

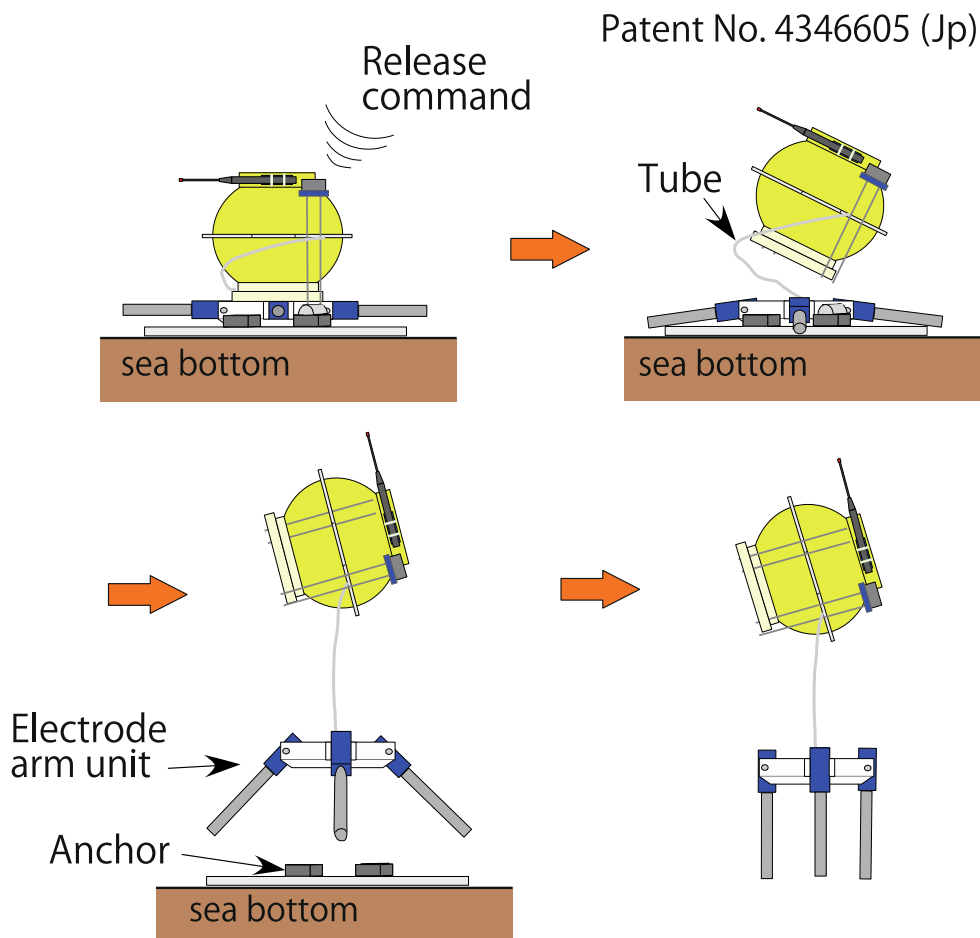


Fig. 4.6.2.2 Electrode arm-holding mechanism of an OBEM

4.5. Mineral harvesting system

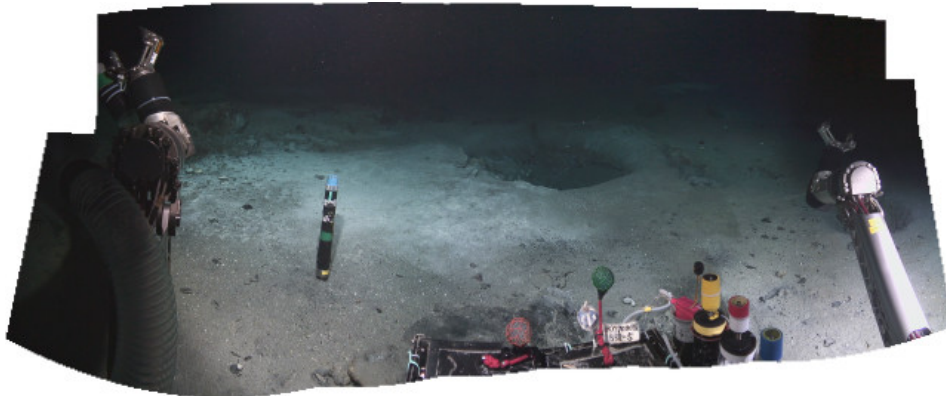
Hydrothermal fluid contains many minerals and metals, which are characterized by ingredients of seafloor layers. In this cruise, feasibility study on the mineral harvesting system has been planned.

5. Preliminary research results

Seafloor observations

Tetsuya Miwa, Ryota Nakajima

In order to investigate the seafloor in the Iheya North hydrothermal field, we conducted video transect surveys using a digital hi-vision camera (Sony, Handycam HDR-CX-700V) in an underwater titanium housing mounted on the ROV Hyper-Dolphin. The camera was held 1.2 m above the bottom of the vehicle. The video camera was maintained perpendicular to the substratum. The video transect surveys were conducted during the dives 1593, 1594, 1595 and 1596. In the ROV operation near the hydrothermal vent, we carried out a panorama synthetic photography. The videos will be analyzed at JAMSTEC, Yokosuka.



Stand-Alone Heat Flow meter (SAHF) measurements

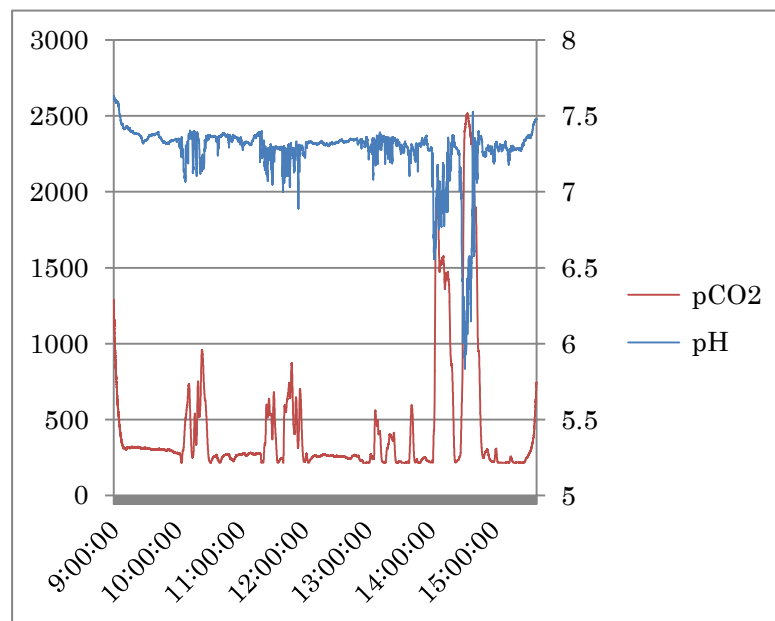
Yuka Masaki

During the NT13-22 cruise, 14 heat flow measurements were made around the Iheya-North hydrothermal field. The objective of the observation is to compare the previous heat flow data obtained before and after drilling. I prepared two heat flow probes #7 and #9 used by “Hyper Dolphin”. Stand-Alone Heat Flow meter (SAHF) is designed to measure heat flow by manned submersibles or ROVs. Five thermistors situated within the probe at 10 cm intervals. After HD lands on the seafloor, SAHF is grabbed by HD’s left manipulator and takes the reference temperature for 5 minutes. SAHF is then put vertically into sediment and measure temperature gradient for at 15 minutes. SAHF measurements were made 4 dives (1593, 1594, 1595, 1596). Detailed analysis will be continued onshore.

CO₂ measurement

Tetsuya Miwa

In order to investigate the Iheya North hydrothermal field, CO₂ measurement carried out by the Hybrid CO₂ Sensor (HCS) at dive #1593 of the ROV Hyper-Dolphin. CO₂ concentration become higher on hydrothermal vent. When the ROV landed and worked on the hydrothermal vent, CO₂ concentration was increased. During the ROV moving, the small peaks of CO₂ concentration were observed.



In situ microsensor measurements

Katsunori Yanagawa and Junichi Miyazaki

For in situ investigation of the geochemical and geophysical characteristics of the Iheya North hydrothermal field, we deployed an in situ microsensor (Unisense) using the ROV Hyper-Dolphin during the dive 1593. The sensors enable to measure in situ multiple parameters (pH, Redox, Temperature, O₂, H₂, H₂S, and N₂O) at once. The sensor recordings are stored internally. The measurements were conducted at shimmering fluid surrounded by habitat zones of galatheid crabs (*Shinkaia crosnieri*) at Site C0014, the diffuse fluid from chimney around the guide base of Hole C0016B, and hydrothermal vent fluid emanating from NBC mound. Detailed analysis will be continued onshore.

Survey of biological diversity and distribution pattern

Masako Nakamura, Seinosuke Teruya, Takuya Yahagi

Aiming to observe succession of animal community after IODP Expedition 331 on hydrothermal field in Iheya North Knoll, we retrieved settlement plates set on Jan. 2012 and deployed new ones at three different sites; [site 1] community which appeared after drilling, [site 2] community existed before drilling, [site 3] no community before and after drilling as a reference site. We also collected benthic animals quantitatively using a round quadrat from site 2 to compare the community on and around the plates. Animal communities on the plates largely differed among plates.

We also collected two vent shrimps, *Alvinocaris longirostris* and *Shinkaicaris leurokolos*, which represent dominant macrofaunal invertebrates in the Okinawa Trough. We try to clarify and compare the life history traits, such as reproductive biology, larval ecology, dispersal and trophic ecology, in order to understand the unknown role and biogeographic history of the deep-sea chemosynthetic ecosystem.

Preliminarily, we conducted fertilization experiment on *Bathycypraea secunda*. Gametes were treated with ammonia for maturation. This treatment is popular to use maturation of gametes in intertidal limpet. We could obtain mature oocytes under the conditions of 4 °C and 22 °C respectively. Fertilization experiments are still ongoing.

Environmental DNA survey

Frederic Sinniger

In order to estimate the biological diversity of organisms present in the sediments we collected several sediment cores in different locations and environments (near the boreholes C0013, C0014 and C0017). Environmental DNA will be extracted from the sediments and sequenced using high-throughput sequencing. The comparison of the data obtained from various environments will allow estimating the distribution of infaunal communities in the vent field. The data obtained will provide a reference to study the impact of hydrothermal activity on infaunal diversity and to detect potential bio-indicators for the different environmental conditions.

Isolation and Characterization of aerobic methanotroph

Hisako Hirayama (on shore) and Junichi Miyazaki (on board)

Methanotroph is a chemosynthetic microbe which obtains energy by oxidation of

methane. Although the microbes have been isolated from various environments and have been well-characterized, methanotrophs from deep-sea environments have never been isolated. It is known that there are two life styles about deep-sea methanotrophs, the one is free-living, and another is endosymbiont of mussels. Iheya North hydrothermal field is a best site to characterize free-living and symbiotic methanotrophs. Previous study demonstrated that since the methane was always supplies from hydrothermal fluid, they abundantly existed.

In this cruise, we sampled 32 mussels from the base of NBC mound and bred those on ship for 5 days. These mussels will be transported to JAMSTEC as soon as possible and will be used to isolation experiments and the methane-consuming assay to determine methane consuming rate of a mussel individual and a gill tissue. And also to capture drifting methanotrophs, we put 4 *in situ* colonization systems (ISCS) on the macrofauna colony site. In the ISCS, porous ceramic were enclosed to easily capture microbe. These ISCSs will be picked up in January cruise (KY14-0x) and will be used to isolation experiments of methanotroph.

DC resistivity survey and OBEM operation

Takafumi Kasaya, Tada-nori Goto

DC resistivity survey :

We successfully carried out the DC resistivity survey on the seafloor at the dives #1594, #1595 and #1595. The site list of DC resistivity survey was summarized as in Table 5.1.1. At these 15 sites, we put and recovered the OBE, which allows us to estimate the resistivity structure (about 3-30m below the seafloor). In addition to the 15 sites, the number of landing points of ROV Hyper- Dolphin exceeds 100, where the seafloor resistivity was measured by the receiver on the vehicle. Both of deep and shallow information give us sub-seafloor imaging of the hydrothermal zones in the Iheya area.

Table 5.1.1. Site summary of DC resistivity survey

Site ID	Seafloor	Receivers	Info.
Dive #1594			
Site 1	Flat	RX, OBE	
Site 2	Flat	RX, OBE	
Site 3	Flat	RX, OBE	SAHF(A-SHF-5)
Site 4	Rocky, NW of C0013	RX, OBE	
Site 5	Flat	RX, OBE	SAHF(A-SHF-6)
Site 6	Slope	RX, OBE	
Site 7	Seepage(NE of C0013)	RX, OBE	SAHF(A-SHF-7)
Site 8	Flat (far east from NBC)	RX, OBE	SAHF(A-SHF-8)
Site 9	Flat (far east from NBC)	RX only	SAHF(A-SHF-9)
Dive #1595			
Site10	Near chimney	RX, OBE	
Site11	Steep slope	RX, OBE	
Site12	Slope	RX, OBE	SAHF(A-SHF-10)
Site13	Near chimney (NEC)	RX, OBE	
Site14	Flat (west of NBC)	RX, OBE	SAHF(A-SHF-11)
Dive #1596			
Site15	East of C0017	RX, OBE	SAHF(A-SHF-12)
Site16	Beside C0017	RX only	SAHF(A-SHF-13)
Site17	flat, sand	RX only	SAHF(A-SHF-14)

The typical waveforms recorded by the transmitter (TX), receiver on the vehicle (RX) indicate clear coherence between them. Fig. 5.1.1 indicates the example at Site 15, far from the hydrothermal area and uniformly covered by sandy sediments. Spikes are the signals from TX (every 30 seconds). The TX shots the current into the seawater (especially at the positive polarity). The received voltage (electric field) by the RX indicates almost the same amplitude when the vehicle was landed on the seafloor. This implies that the surface resistivity around site 15 is almost uniform.

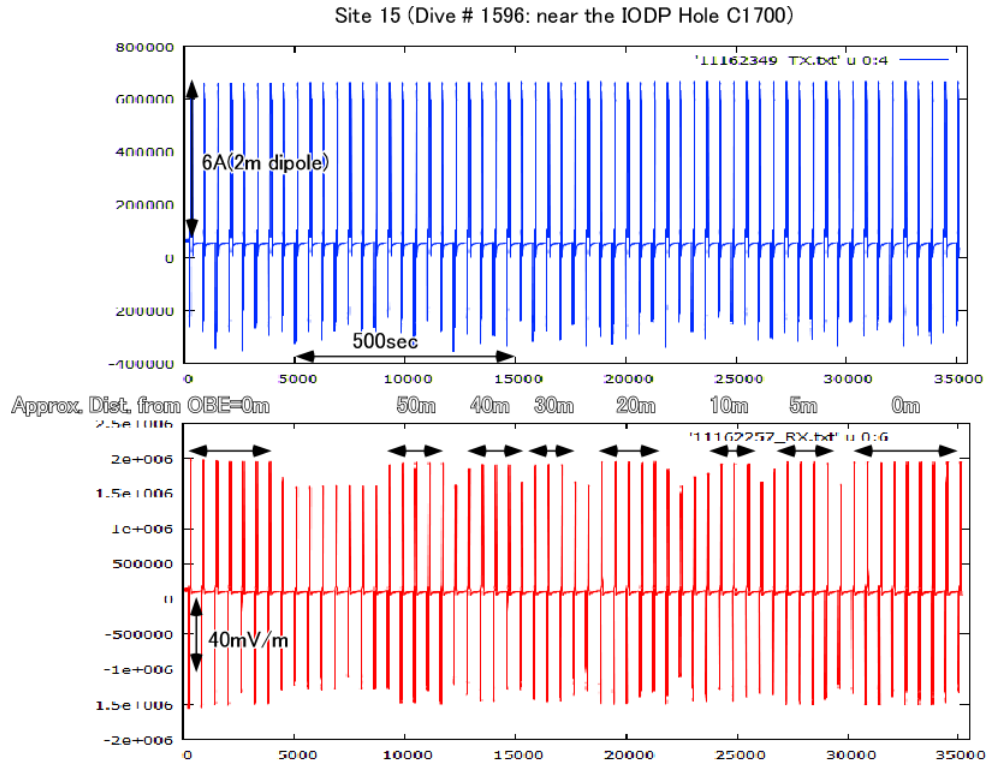


Fig. 5.1.1. Example of recorded data by TX (blue) and RX (red) at Site 15. Numbers (colored white with black border) indicate the approximate distance between the vehicle and off-line receiver (OBE). Allows means the time when the vehicle landed on the seafloor.

Contrary, the received voltages by RX implies heterogeneity of surface resistivity in the hydrothermal area. Fig. 5.1.2 indicates the example. It is different from the feature in Fig.5.1.1: the maximum amplitude of received voltages are varied at the landing points of vehicle. Since the current amplitude from TX are almost constant, the spatial variations of resistivity below the seafloor should be the major cause of this variations.

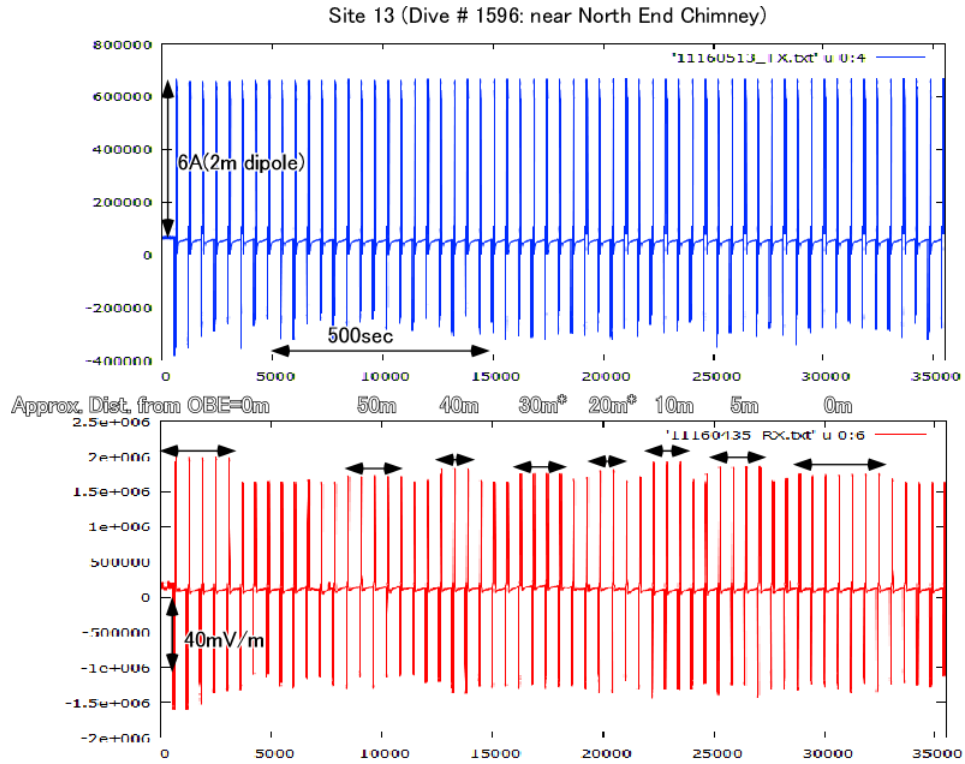


Fig. 5.1.2. Similar figure as Fig. 5.1.1, but in the hydrothermal area (Site 13).

We also succeed in the recording by off-line receiver (ocean bottom electrometer: OBE). The example of data obtained at Site 13 is shown in Fig. 5.1.3. Although the spike noises are included in the data by OBE, the noise source is known (from OBE recorder itself). It can be removed. Even in this situation, we can recognize the signal from TX in the recorded time series by OBE. As conclusion of the experiment, we successfully obtained the source signals by using two different recorders (RX and OBE). The data allows us the DC resistivity survey on the seafloor, and will give us information of resistivity structure in and out of the hydrothermal area.

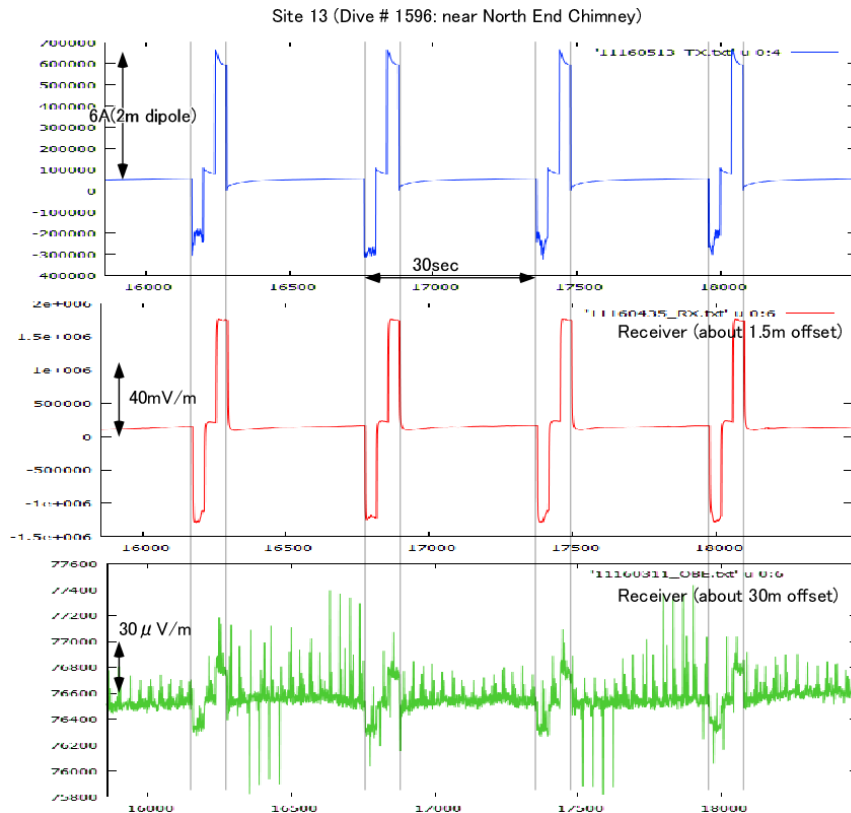


Fig.5.1.3. Example of recorded data by OBE (green).
The time series of TX (blue) and RX (red) are also shown

OBEM operation :

We deployed an OBEM on 12 Nov around the eastern side of the Iheya field. Deployment operation was finished without any trouble. The clock of OBEM was synchronized using a specialized GPS clock unit before deployment. Table 5.2.1 shows the information of this deployment. An averaged descent rate was 43.0 m/min. After landing, the settled position estimated using a SSBL system of R/V Natsushima (Fig. 5.2.1).

After four days observation, we carried out a recovery operation on 16 Nov. We send an acoustic release signal at 5:30 on 16th Nov, and it started to ascent at 5:44. The ascent rate was approximately 47 m/min. we found with the ship looking, radio beacon and flasher at 6:15. The clock of OBEM was compared with the GPS clock after the recovery operation. The time difference was about 4.3 seconds. Figure 5.2.2 and 5.2.3 show the recovery operation and the recovered OBEM on deck, respectively.

Table 5.2.1 Deployed OBEM information

Date	Sampling rate	launched time (JST)	settled time (JST)	settled position	settled depth (m)	Descent rate (m/min)
11/12	10 Hz	10:41	11:12	27:47.522' 126:58.149' N E	1280	43.0

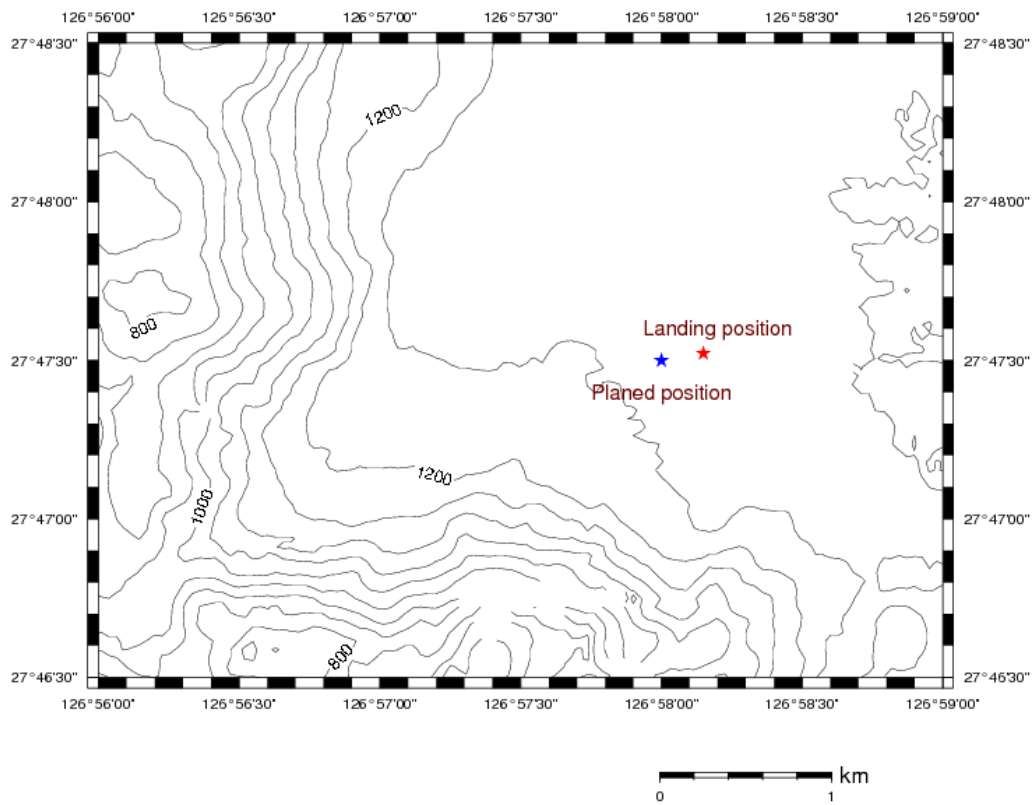


Fig. 5.2.1 Planed (blue) and settled (red) position of OBEM on the bathymetry map. Contour interval is 50 meters.



Fig 5.2.2 Recovery operation of the OBEM at starboard of the vessel.

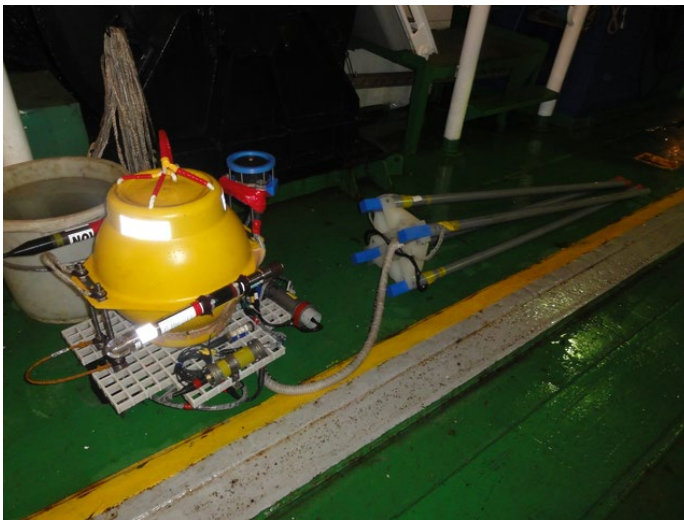


Fig. 5.2.3 Recovered OBEM on deck.

The test of TRDT, a downhole thermometer

Junichi Miyazaki

IODP exp.331 cruise at Iheya North hydrothermal field was conducted in September 2010. To measure temperature beneath the seafloor, APCT-3 was utilized during the drilling. However, since the ADCP-3 was available only under 55°C because of their thermo-tolerance, in more than 55°C environment (deeper than 40 mbsf in borehole C0014G), the ADCP-3 could not show accurate temperature. Therefore, during the cruise, accurate temperature information was not much enough to understand the structure of subseafloor.

TRDT was developed as a downhole tool to measure temperature at extreme hot environment. Several tests on shore demonstrated that TRDT was available at 350°C for

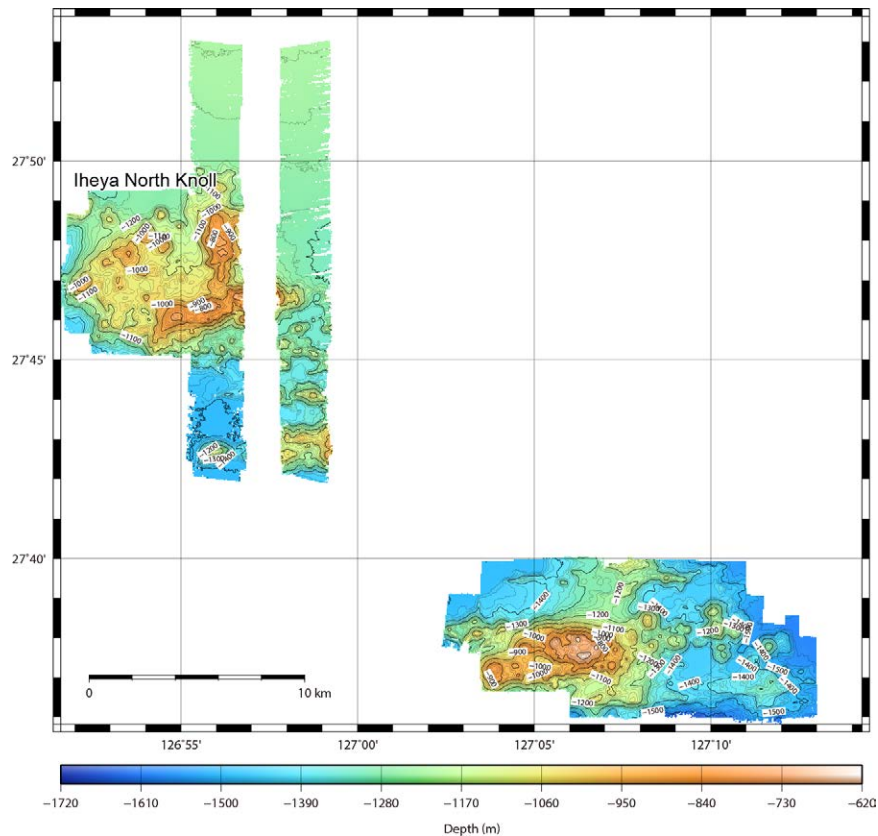
4 hour which is a time that temperature on electrical tools of TRDT becomes to 125°C (starting from room temperature (25°C)). Therefore this tool has a potential to measure temperature at subseafloor in Iheya North hydrothermal field. To the future drilling plan at Okinawa Trough, I need to acquire the proficiency in using the TRDT and to know the temperature property on the electrical tools of TRDT in deep-sea. To achieve these, in this cruise, I attached TRDT to the HyperDolphin to obtain information about temperature variation of the electrical tool of TRDT at deep-sea environment.

Bathymetry and hydrothermal plume survey

Hideaki Machiyama

Bathymetry survey was carried out by the multi beam echo sounder (MBES) using the SeaBat 8160 system around the Iheya North Knoll and a knoll in the southeast of the Iheya North Knoll. The result of bathymetry is illustrated in the figure below.

Acoustic hydrothermal plume survey using MBES SeaBat 8160 system was also carried out in the Iheya North Knoll. The purpose of this survey is to discover active hydrothermal vents within the knoll.



Observation for the recovery of the corrosion cap

Masayuki Watanabe, Yuka Masaki, Junichi Miyazaki, and Hideaki Machiyama

Hydrothermal fluid contains many minerals and metals from the sub-seafloor rock-water interactions. In this cruise, we tried to recover the corrosion caps, which are attached on each borehole guide base of IODP Hole C0013E and C0014G on hydrothermal vent (Figs. 1 and 2), for the install of a mineral harvesting system. However, we gave up recovering both corrosion caps because of their latch problems.

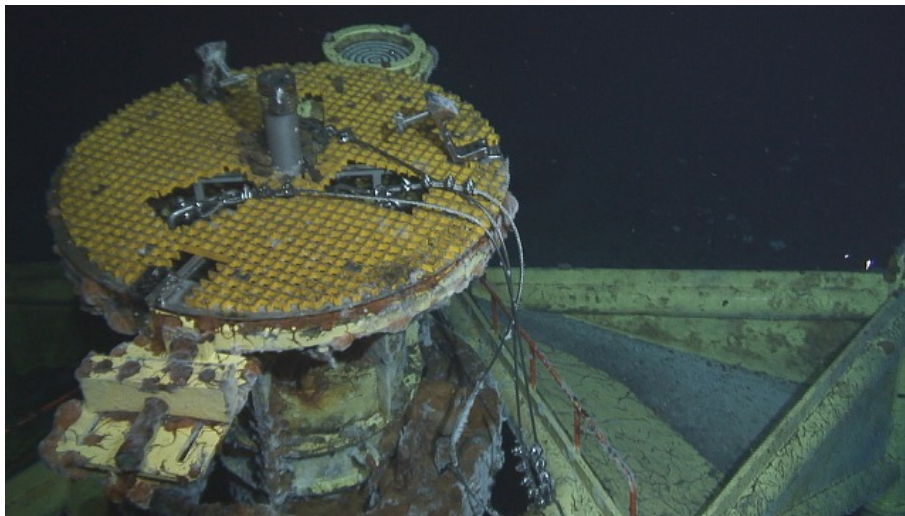


Fig. 1 Corrosion cap on the borehole guide base of C0013E (HPD Dive #1591).



Fig. 2 Corrosion cap on the borehole guide base of C0014G (HPD Dive #1591).

6. Acknowledgment

We are grateful thank to all crew of “R/V Natsushima” for the safe navigation, and great thanks are due to the “ROV Hyper Dolphin” operation team for the sampling and observation of deep-sea hydrothermal field.

7. Appendix

Payload plan

		I2	I3	I3	I4	I5	I6	I7
			AM	PM				
		deploy	remove	sampling & deployment	sampling	electro-magneto	mapping & electro-magneto & recovery	mapping & electro-magneto & recovery
Corrosion cap	construction		o					
Video cam bottom observation	self contained				o	o	o	o
Electromagnet	5 pin port, 24V	deploy OBEM				o	o recovery OBEM	o
gamma-ray sensor	5 pin port, 24V				o	o	o	o
Hybrid-pH-CO2 (HCS)	5 pin port, 24V				o			
multi-sensor system	4 pin port, 24V				o			
SHAF	self contained			1	1	1		1
CTD-pH	self-contained			o	o	o	o	o
MBARI core				2	3			3
Slurp Gun	oil pressure pump				6 canister			
sample box	plastic plates, ISCS			4	3			
Thermo probe borehole type	self contained					o	o	
ADCP/ADP/TS	deploy on seafloor			deployed				

R/V Natsushima and ROV Hyper Dolphin

Ocean research vessel Natsushima was built as a support vessel of submersible SHINKAI 2000 in 1980s. R/V Natsushima was reconstructed as a support vessel of Hyper Dolphin.

General information about NATSUSHIMA

Length:67.4m Bow thruster: 4T/1.4T×220kw/110kw×1 1

Width:13.0m Maximum speed:12.0kt

Depth:6.3m Duration:5000 mile

Max capacity: 55 persons (18 scientists)

Gross Tonnage:1739t

Main prop: Variable pitch propeller 2 axis×4 Wing CPP,540N

Research equipment

(1) MBES

Bathymetric data were collected by the SEABAT 8160 (RESON). The SEABAT is a multibeam survey system that generates data for and produces wide-swath contour maps and side scan images. It transmits a sonar signal from projectors mounted along the keel of the ship. The sonar signal travels through the sea water to the seafloor and is reflected off the bottom. Hydrophones mounted across the bottom of the ship receive the reflected sonar signals. The system electronics process the signals, and based on the travel time of the received signals as well as signal intensity, calculate the bottom depth and other characteristics such as S/N ratio for echoes received across the swath. Positioning of depths on the seafloor is based on GPS and ship motion input. The data is logged to the hard disk for post processing which allows for additional analysis. Plotters and side scan graphic recorder are also included with system for data recording and display.

Max depth: 3000 m

Frequency: 50 kHz

Number of beams: 126

Swath angle: 150 degree (depend on depth)

Each beam width: 1.5 x 1.5, 3.0, 4.5, or 6.0 degree

Minimum resolution: 1.4, 2.9, 8.9 cm (depend on above beam width)

Maximum transmit rate: 15 ping/sec

(2) PDR

This can record a water depth at right below and make contour map together with navigation data.

Max depth: more than 3000m

Record Range: 200~800m (changeable)

Frequency: 12kHz +/-5%

Output: more than 110dB (0dB unbar at 1m)

Directivity: conical beam pattern

Beam width: 15deg. +/-5 deg. (-3dB)

Pulse width: 1, 3, 10, 30msec

(3) XBT equipment

XBT profile a vertical water temperature by free-fall probe.

Maximum measurable depth:1830m

Measure range:-2 deg.~+35 deg.

(4) Navigation equipment

Position of the ship is measured by DGPS within about 3m error. ROV and transponder are measured by acoustic positioning system.

(5) Laboratory

There are laboratories at the back part of second deck. Each room has AC100V power supply and LAN network.

The video of HPD diving and deck-camera video are distributed to the laboratories and every cabin.

- Second laboratory: There are two desktop PCs (windows and Mac), equipment for video editing, color copy with printer, meeting desk and white board. Hi-definition video of HPD is distributed to this laboratory. You can copy from a digital data to HDD and DVD-R.
- Third laboratory: There are two sinks, refrigerator (-80deg. low temperature refrigerator, Incubator, domestic refrigerator, ice maker, ice crusher) and filtrate water system (Milliq Advance). And sea water for experiment is supply to the sink.
- Dry laboratory: There are a work desk and a shelf for baggage. This room has 4 beds to be used as a private one in case that there are many researchers.

At the work deck, there are rock-cutter rooms

- Rock-cutter room: There are a rock cutter and two grinders. And exclusive video player is set to describe rocks with playing video of ROV diving.

Hyper Dolphin

Hyper Dolphin is 3000m ROV which was built by SSI (Canada) in 2001. The vehicle has two manipulator, a Hi-definition super harp TV camera, and a color CCD TV camera. In addition, digital photo camera, black and white TV camera for back side monitoring, altitude sensor, depth sensor (with temperature sensor), sonar for obstacle avoidance sonar.

Principal specification

Length: about 3.0m	Depth capability: Maximum 3000m
Breadth: about 2.0m	Payload weight: -100kg (in the air)
Height: about 2.3m	Speed in the water: 0~3kt
Weight in the air: about 3800kg	Manipulators: 2 sets

(1) Manipulator capability

Pivot: 7 pivoted

Working load: in the water 68kg (max outreach)

Length of arm: 1.53m

Grasping power: 450kg

Hoisting power: max 250kg (vertical)

Hand opening width: right 77mm, left 195mm

(2) TV camera

Super Harp High-definition TV camera: 1

TV camera tube: 2/3"HD Super Harp tube, RGB3 tube

Optics system: F1.8, M type total reflection prism

Lens : F1.8(5.5 ~ 27.5mm)

Field angle : 72°

Sensitivity: 2000Lux @ F5.6 (high-quality mode)

2Lux @ F1.8 (high-sensitive mode)

Pan : +170°~-170°

Tilt : +90°~-90°

Color CCD TV camera 1

Type: ARIES (made by Insite Tritech, Inc)

Image-taking device : 1/2" Interline Transfer, POWER HAD CCD (×3)

Horizontal resolution: 750TVL

Lowest-light intensity: 5Lux @ F1.4

Lens : 5.5mm~77mm, 12×, F1.9~F16

Pan : more than 90°

Tilt : more than 90°

Black-and-white TV camera: 1

Type: EX520 (made by ELIBEX, Inc)

Horizontal resolution: 570TVL

Lowest-light intensity: 0.12Lux

Pan : 180°

Tilt : 180°

(3) Digital still camera

Type : Sea Max (DPC-7000, made by Deep Sea system, Inc)

Imaging sensor : 3.24 megapixel CCD

Lens : widest-angle~28mm~84mm (as 35mm film conversion)

Still image capacity : 2MB/1image

Laser scale : 4 point green laser(3mW), 10cm×10cm sq

(4) High-definition TV camera capture

HD images can capture by mouse click.

Dpi: 2 megapixels

Left clic : 1image(single shoot)

Light clic : 8images(serial shoot)

(5) Obstacle avoidance sonars

Type : SIMRAD MS1000

Range : 10, 20, 25, 50, 100, 200m change

Detective distance: max 100m

Transmission frequency : 330kHz±1kHz

(6) Altitude sonar

Type: SIMRAD MS1007

Frequency: 200 kHz

Measure range: -200m

Accuracy: -2m

(7) Depth sensor (with temperature sensor)

Type: made by Paroscientific, Inc

Range of measuring depth: -4000m

Range of measuring temperature: -2-40deg.

(8) Light

Type: Sea Arc2 (made by Deep Sea P&L, Inc)

Output power : 400W×5

(8) CTD/DO

Type: CTD Sensor : SBE19, DO Sensor; SBE43 (made by Sea Bird, Inc)

R/V NATSUSHIMA Crew

Captain	TANAKA HITOSHI
Chief Officer	MASUJIMA HOROAKI
2nd Officer	KATSUMATA MOTOI
3rd Officer	FUJII SYUNSUKE
Chief Engineer	KANEDA KAZUHIKO
1st Engineer	TADOOKA NAOHITO
2nd Engineer	MURAKAMI MORIHIKO
Jr.2nd Engineer	HIRATSUKA YOSHINOBU
3rd Engineer	YAMAGUCHI KATSUTO
Chief Electronics Operator	SUDA FUKUO
2nd Electronics Operator	KURAMOTO YOSHIKAZU
3rd Electronics Operator	TAKAKUWA TATSUHIRO
Boat Swain	HOSOKAWA SEIJI
Able Seaman	FUJII YOSHITSUGU
Able Seaman	CHIMOTO TSUYOSHI
Able Seaman	MIYASHITA TAKUYA
Sailor	KAWAMURA KOSEI
Sailor	NAKANISHI TORU
Sailor	KAWABE YASUNOBU
No.1 Oiler	IKEDA TOSHIKAZU
Oiler	SATO KAZUO
Oiler	TANAKA MASAKI
Oiler	MATSUUCHI RYO
Oiler	SUMITOMO SHOTARO
Chief Steward	MATSUMOTO ISAO
Steward	FUKUMURA HIDEO
Steward	OKADA YOSHIO
Steward	ITO KEI
Steward	EBIKO YOHEI

Hyper-Dolphin operation team

Operation Manager	ONO YOSHINARI
2nd ROV Operator	CHIBA KATSUSHI
2nd ROV Operator	CHIDA YOSUKE
2nd ROV Operator	KIKUYA SHIGERU
2nd ROV Operator	TAKENOUCHI ATSUSHI
3rd ROV Operator	GOTO TAKUMA
3rd ROV Operator	URATA DAICHI

