



R/V Yokosuka & DSV Shinkai 6500 Cruise Report YK16-11_leg2

Geobiological Investigation of Southern Ryukyu Trench

&

**Investigation of Electrotrophic Microbial Community in Artificial
Hydrothermal Vents in Iheya North Original Field**



August 30, 2016 from Ishigaki -

September 6, 2016 to Naha

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

Acknowledgements

We are grateful to Captain Mr. S. Ryono, Chief Officer Mr. A. Tsuji and Chief Engineer Mr. T. Ohta for their safe navigation and their skillful handling of “R/V Yokosuka”. Great thanks are due to Submersible Operation Manager Mr. T. Sakurai and “Shinkai 6500” operation team for their operations in sampling. We also thank Mr. T. Minamizawa, Nippon Marine Enterprise, Ltd., for her attentive supports. We thank all the JAMSTEC persons who have supported us and this cruise. Finally, we would like to appreciate all the persons who have encouraged directly or indirectly this cruise.

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Cruise information

Cruise ID: YK16-11_leg2

Vessel: YOKOSUKA

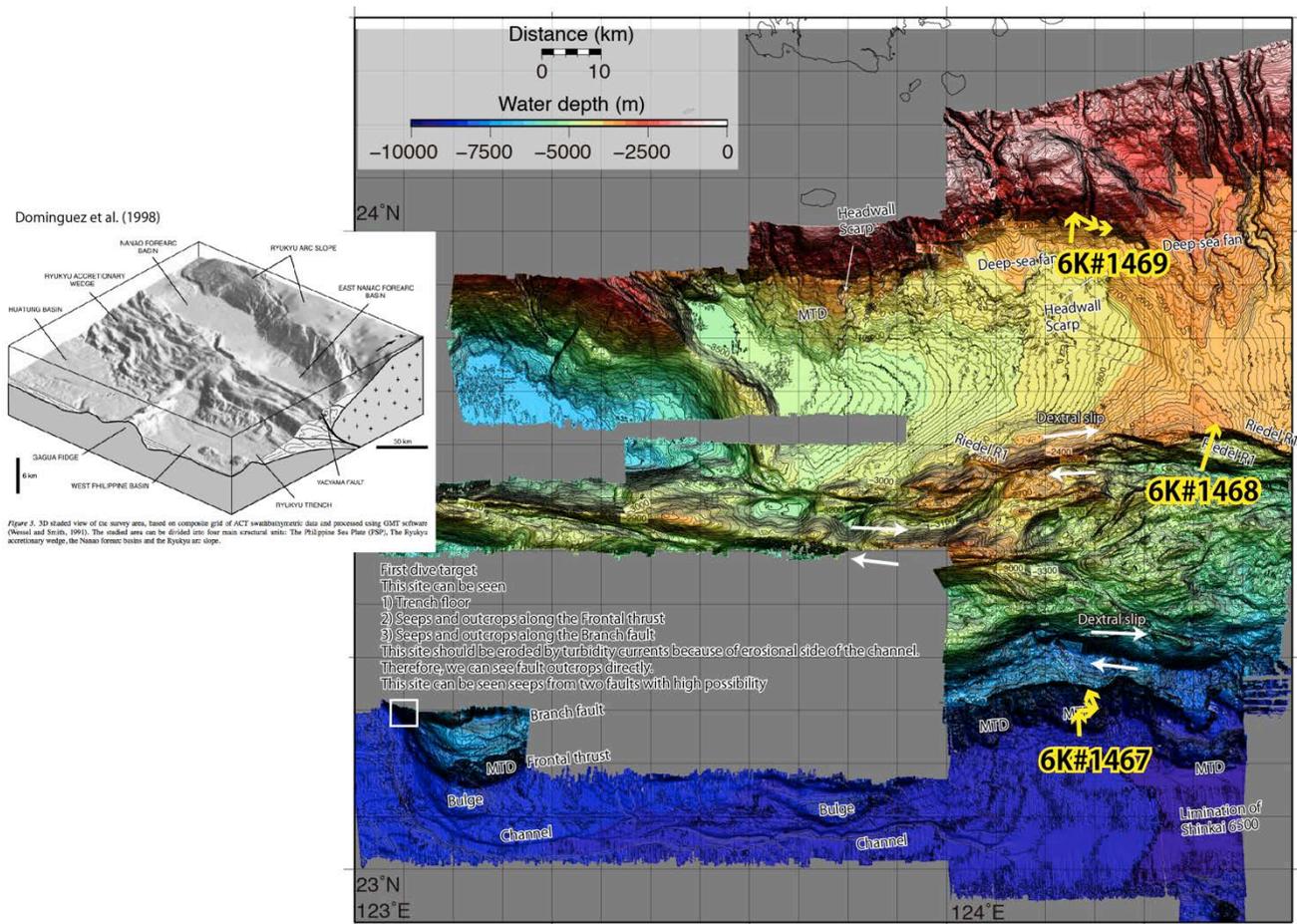
Title of the cruise: Geological and Geobiological Investigation of Southern Ryukyu Trench & Investigation of Electrotrophic Microbial Community in Artificial Hydrothermal Vents in Iheya North Original Field

Cruise period: August 30 – September 6, 2016

Ports of call: Ishigaki – Naha, Japan

Research area: Southwestern Ryukyu Trench & Iheya North Original field

Research map:



General topographic map of southern part of Ryukyu Trench.

List of Participants

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Dr. Shawn McGlynn

Associate Professor

Earth-Life Science Institute (ELSI), Tokyo Institute of Technology

Marine Technicians

Ms. Tomomi Minamizawa

Marine Science Department, Nippon Marine Enterprises, LTD.

Captain and crew of the R/V YOKOSUKA

Captain	Shinya Ryono
Chief Officer	Akihisa Tsuji
2nd Officer	Shozo Fujii
3rd Officer	Keiji Itahashi
Jr. 3rd Officer	Yuki Ito
Chief Engnieer	Minoru Tsukada
1st Engnieer	Takashi Oota
2nd Engnieer	Yoshinobu Hiratsuka
3rd Engnieer	Kazuki Ohno
Chief Radio Officer	Hiroyasu Saitake
2nd Radio Officer	Toshihiko Yuasa
3rd Radio Officer	Ryuji Onikubo
Boat Swain	Kazuo Abe
Quarter Master	Yasuo Konno
Quarter Master	Kaname Hirosaki
Quarter Master	Yukito Ishii
Quarter Master	Yamato Sekine
Sailor	Kyohei Murai
Sailor	Tomoki Asakuni
No.1 Oiler	Junji Mori
Oiler	Ryoto Suzuki
Oiler	Tatuomi Chino
Oiler	Ryo Matsuuchi
Assistant Oiler	Motohiro Kawano
Chief Steward	Sueto Sasaki
Steward	Hideo Fukumura
Steward	Hironobu Hodokuma
Steward	Tsuyoshi Nagatomo
Stewerd	Koki Shinohara
Stewerd	Yudai Kusunoki

“Shinkai 6500” Operation Team

Operation Manager	Toshiaki Sakurai
Deputy Operation Manager	Kazuhiro Chiba
1st Submersible Staff	Tetsuya Komuku
1st Submersible Staff	Keita Matsumoto
1st Submersible Staff	Mitsuhiro Ueki
1st Submersible Staff	Fumitaka Saito
2nd Submersible Staff	Hirofumi Ueki
2nd Submersible Staff	Takuma Ohnishi
2rd Submersible Staff	Keigo Suzuki
3rd Submersible Staff	Yoshikazu Kuramoto
3rd Submersible Staff	Hideya Sugiura

I. CRUISE SUMMARY

In YK16-11_leg2 cruise, we totally conducted 4 dives of Shinkai6500 in the southern Ryukyu Trench (3 dives) and in the Iheya North original hydrothermal field in the Okinawa Trough (1 dive). One of the cruise foci was the exploration of seepage and associated chemosynthetic microbial and animal communities in the southern Ryukyu Trench. With 3 dives of Shinkai6500, we surveyed the potential fault areas in the continental slope of Ryukyu Trench. Unfortunately, we did not successfully find any active seepage and associated microbial and animal communities there.

Interestingly, the hadal water near the bottom of Ryukyu Trench was turbid while no apparent ongoing turbulent sediments were observed by Shikai6500's survey (6K Dive#1467). This supports our hypothesis that landslides and turbulent sediments would recycle the buried organic compounds to the hadal water and the accumulated organic compounds would energize and enlarge the heterotrophic planktonic microbial functions and populations in the hadal waters. In addition, we found the clear evidences of many repeated landslides and turbulent sediments in the deepest slope of Ryukyu Trench at a depth range of 6000-6500 m.

In the middle of continental side slope where the potential large branching faults emerge, we observed several faults and fresh traces of landslides. These observation also support that the deep 'geofluids' inputs also would affect the bethic and planktonic microbial communities in the trench environments.

In the boundary between the forearc basin and continental shelf, we also observed the submarine channel and the flow erosion. The shallower zones of trench are highly affected by the energy and elemental inputs of surface waters and continental productions.

No special event was found during the this expedition, but the seafloor observation strongly reinforced our hypothetical models of development of hadal microbial ecosystem in the Ryukyu Trench and the global ultradeep trench environments.

In the Iheya North original hydrothermal field, one Shinaki6500 dive was conducted for the electrochemical experiments in the spontaneous electric generation of the deep-sea hydrothermal system and for the study of naturally occurring electrotrophic microbial communities. The in situ cultivation devices for electrotrophs were successfully deployed in several sites of the Iheya North field and the potentially electrotrophic microbial populations were successfully recovered from the artificial hydrothermal vent consisting of electrically conductive materials.

II. INTRODUCTION

General backgrounds & Scientific objectives

Ryukyu Trench:

Although many microbial explorations for sedimentary environments of ultradeep trenchedes began in the 1950s, the hadal bottom and water environments are one of the least-explored microbial biospheres. Recently, we have reported unexpected microbial ecosystems associated with the hadal trench water were discovered down to a 10,257-m water depth in the Challenger Deep of the Mariana Trench (Nunoura et al, 2015). This study points to the possible occurrence of microbial ecosystem unique to the hadal water regime, 'hadal microbial biosphere', and provides a plausible hypothesis that the hadal microbial biosphere is supported by the endogenous recycling of organic matter in the hadal waters associated with the trench geodynamics and geomorphology.

Currently, the existence of the hadal biosphere has been demonstrated for both benthic and planktonic microbial ecosystems in the Mariana Trench (Yayanos, 1986; Takami et al, 1997; Kato et al, 1998; Glud et al, 2013; Nunoura et al, 2015), the Ogasawara Trench (Nunoura et al, 2013) and the Japan Trench (Kawagucci et al, 2012; Nunoura et al, 2016). Nevertheless, the following points should be further addressed: whether the distinctive hadal microbial ecosystem is widespread in the global trench environments; whether the functions and members of hadal microbial communities are common in trenches under geologically and oceanographically different settings or specific in each hadal environment; and if different, what types of factors constrain the compositions and functions of hadal microbial communities and how they are controlled.

In this expedition, we are going to survey the planktonic and benthic hadal microbial communities and their environmental background in a geologically and oceanographically different setting of trench, the Ryukyu Trench. The southern Ryukyu Trench has been relatively intensively investigated by various geophysical and geological aspects to know the seafloor and crustal deformation by Yaeyama Earthquake that caused a great tsunami in 1771 (Arai et al, 2016). The seafloor observation by Shinkai6500 will provide important insights into the seafloor events associated with seismogenic and tsunamigenic mechanisms in the southern Ryukyu Trench.

It has been proved that deep-sea hydrothermal vents have potential for electricity generation. Power generation was succeeded by a hydrothermal fluid-seawater fuel cell system set on

deep-sea hydrothermal vent for 12 days with voltage of about 0.6 V, which was the maximum value thermodynamically calculated from the physical and chemical conditions. The effective power generation without energy loss was probably due to minerals or/and microorganisms growing on electrodes. In addition, we could observe that negative charge of redox potential on the surfaces of minerals around hydrothermal vents, suggesting that electricity generates spontaneously at wide area in hydrothermal field. In other words, deep-sea hydrothermal field functions as a giant power plant system containing natural chemical-electric energy exchange devices formed from minerals and microorganisms.

In this cruise, we are aimed at clarification of the electrochemical interaction liquids (hydrothermal fluid and seawater), rocks and organisms around deep-sea hydrothermal field. We are planning for on-site measurement of redox potential of various points in a deep-sea hydrothermal field with D-Pote (Deep-sea Potentiostat) System. In addition, we will collect deep-sea samples (e.g. rocks and bacteria mat) under electricity conditions. These samples are used for various analyses at laboratories.

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III. EXPLANATORY NOTE

1. Manned Research Submersible “Shinkai 6500”

Mission of “Shinkai 6500”

“Shinkai 6500” is able to operate surveys and observations down to the depth 6500 meters with one scientist and two pilots. During the operation, “Shinkai 6500” finds her position by two ways; Long Base Line system (LBL) and Super Short Base Line system (SSBL). The LBL system needs three bottom-mounted transponders to be deployed in the survey area. “Shinkai 6500” locates her own position by herself in real time and the mother ship determines the position of “Shinkai 6500” based on the position of transponders. The SSBL system does not require any transponder but the accuracy of the position is inferior to LBL system and “Shinkai 6500” cannot determine her own position.

Specifications

Length:	9.5m
Width:	2.7m
Height:	3.2m
Weight in air:	25.8t
Maximum operation depth:	6500m
Complement:	3 (2 pilots and 1 researcher)
Inner radius of pressure vessel:	2.0m
Normal dive time:	8 hours
Life support duration:	129 hours
Payload:	150kg (weight in air)
Under water speed:	0-2.0 knots (Emergency: 2.5 knots)
Observation instruments:	Pan-tilt-zoom color video camera Fixed-view color video camera 35mm still camera CTD sensors Gamma ray spectrometer CTFM sonar Video-image transmission system
Operating devices:	2 manipulators 2 retractable baskets

2. Research Vessel “Yokosuka”

Mission of “Yokosuka”

1) Operate submersible “Shinkai 6500”

2) Operate underway-geophysical equipments;

Multi Narrow Beam Echo Sounder (Sea Beam 2112.04)

Gravity meter (Type S-63)

Ship-borne three-components magnetometer (Type SFG-1212)

Proton magnetometer (Typ STC10)

Research Facilities

In wet laboratory, a fumigation chamber, Milli-Q water purification system, -80°C and -20°C freezer, incubator and rock saw are equipped. In addition, “Yokosuka” has on-board video editing system for digital video image.

Specifications

Length:	105.22m
Breadth:	16.0m
Height:	7.3m
Draft:	4.5m
Gross tonnage:	4439t
Cruising speed:	about 16kts
Cruising range:	about 9000mile

3. Sample Treatment

Sediment samples

Sediment samples were collected using H-type or MBARI corers.

Usually, four H-type core samples were obtained in each dive. Four cores (i.e., a to d, see below) were used for different purposes and processed as follows in each dive;

a) core was sliced into 6 layers; 0-0.5, 0.5-1, 1-2, 2-3, 3-4 and 4-5 cm below the sea floor for meiofaunal analysis. The samples were fixed and preserved individually in 5% buffered seawater formalin.

b) core was sliced into 6 layers; 0-0.5, 0.5-1, 1-2, 2-3, 3-4 and 4-5 cm below the sea floor. Half volume of sediment in each layer were sampled for metagenomic analysis (prokaryote and eukaryote) and was immediately deep frozen (-80°C).

c) core was sliced into 9 layers; 0-1, 1-2, 2-3, 3-4, 4-5, 5-7.5, 7.5-10, 10-15 and 15-20 cm below the sea floor for nutrient analysis. The samples were centrifuged at 2600×g for 5 min, and the extracted pore water was gently filtered through a 0.22 µm membrane filter attached to a 20-ml syringe and then deep frozen (-80°C). The remaining sediments were kept in deep freezer (-80°C) for measurement of TOC and TN concentrations.

d) core was sliced into four layers (i.e., 0-1 cm, 1-3 cm, 3-5 cm, 5 -20 cm) and only three upper samples were used for studies for microbial eukaryotes: Some volumes of each layer

sample were inoculated into the media for cell incubation and others were kept in 4°C for future incubation experiments (for fungi) and were fixed with glutaraldehyde for enumeration of eukaryotic microbes. The other volumes of each layer sample were kept under -80°C for DNA analyses (for future).

After MBARI core recovery, the sediment was divided into two parts; one half for microbiological study and the other half for the sedimentological study. The microbiological subsamples are a) gas component (1 cc sediments in 3 cc DW with HgCl at room temperature), b) microscopic observation (1 cc sediments in 5 cc PBS buffer with 4% formaldehyde at -80 °C), c) nucleic acid analyses (6 cc each for DNA- or RNA-based analysis at -80 °C), d) applied microbiology (5 cc x 6 for the later use at -80 °C) and e) cultivation (10 cc in 100 ml of glass bottle under N₂ atmosphere at 4 °C).

Water samples

We took 5L of deep seawater at three Shinkai 6500 dives (i.e., Dive #1467, #1468, #1469 and #1470) using two 2.5L niskin bottle. The water sampling was conducted at the same depth. The collected waters were subsequently divided into two sets of 2L and two sets of 0.5L for following analyses.

- 2L for RNA-seq analysis to understand the microbial community

- 2L for enumeration and cultivation of heterotrophic nanoflagellates

- 0.5L for nutrient analysis and LM observation (cell counting)

- 0.5L for cultivation of piezophilic prokaryote and DNA analysis of fish diversity

Surface seawater samplings were conducted, while #1467, #1468, #1469 and #1470 of Shinkai dives were operated. In each time, we took ca. 20L of surface water using a bucket with a rope. The collected waters were subsequently divided into three subsamples for following analyses.

- 6L for RNA-seq analysis to understand the microbial community

- 0.2L for nutrient analysis and LM observation (cell counting)

- 10.0L for DNA analysis of fish diversity

- 1.1 L for enumeration and cultivation of heterotrophic nanoflagellates

IV. DIVE REPORTS

#1467 DIVE (Ryukyu Trench)
#1468 DIVE (Ryukyu Trench)
#1469 DIVE (Ryukyu Trench)
#1470 DIVE (Iheya North Field)

Dr. Kiichiro Kawamura
Dr. Ken Takai
Dr. Kan-Hsi Hsiung
Dr. Masahiro Yamamoto

Dive Report: Shinkai 6500 Dive# 1467**Date:** September 1, 2016**Site:** Southern Ryukyu Trench**Landing:** 11:58; 23°13.3000'N, 124°09.0500E, D=6400 m**Leaving:** 14:51; 23°13.2993'N, 124°09.0488E, D=6371 m**Pilot:** Fumitaka Saito, **co-pilot:** Keita Matsumoto**Observer:** Kiichiro Kawamura (Yamaguchi University)**Objectives:**

The objectives of this dive are to observe strata distribution, structures, deformation styles, hydrogeological features related to the frontal thrust and submarine slides off Miyako Island. To sample rocks and sediments; the MBARI and push core samples for metal and fluid chemistry at cold seep sites. Also to sample chemosynthetic clams and/or tube worms for geochemical and/or biological research. Water sampler (D-WHATS) at cold seep sites.

Dive summary:

Dive 1467 route map is shown in figure of the dive track of 6K#1467 as below. I dived on foot of the landward trench slope at the frontal thrust of the Ryukyu Trench.

From about 6100 m in water depth, we noticed high turbidity by many white long particles (probably organic matters) of about 1 mm long.

At the altitude of 21 m high, seawater was sampled using two Niskin-type water sampler (sample name 6K#1467 water sample).

I landed on the flat seabed of the trench floor at 6371.00 m in water depth. Sediments were sampled using four H-type corers (sample name 6K#1467H-type 1-4) and one MBARI-type green corer (sample name 6K#1467MG). After the sampling, the sediment temperature was measured for 5 min. The sediments seemed to be very soft.

Going through the trench floor by heading north, I found suddenly 1-2 m mound, which was covered with thick muds. Then I changed the heading to east to go along the mound zone for seeking bacterial mats. As I arrived on the west part of a deep-sea fan, I changed the heading to north again to climb up the landward slope. On the lower slope at about 6350 m, I found one small outcrop of horizontal brown sediment layer of about 20 cm thick. There were several scars of N-S direction and valleys of E-W direction (but covered with totally muds) at 6200 m or shallower. At about 6160 m, I found an outcrop of three ~20 cm layers of horizontal brown sediments (similar to the outcrop before). At 6115 m, sediment sampled using MBARI red corer (sample name, 6K#1467MR), and I left the seabed at 6093 m.

Payloads:

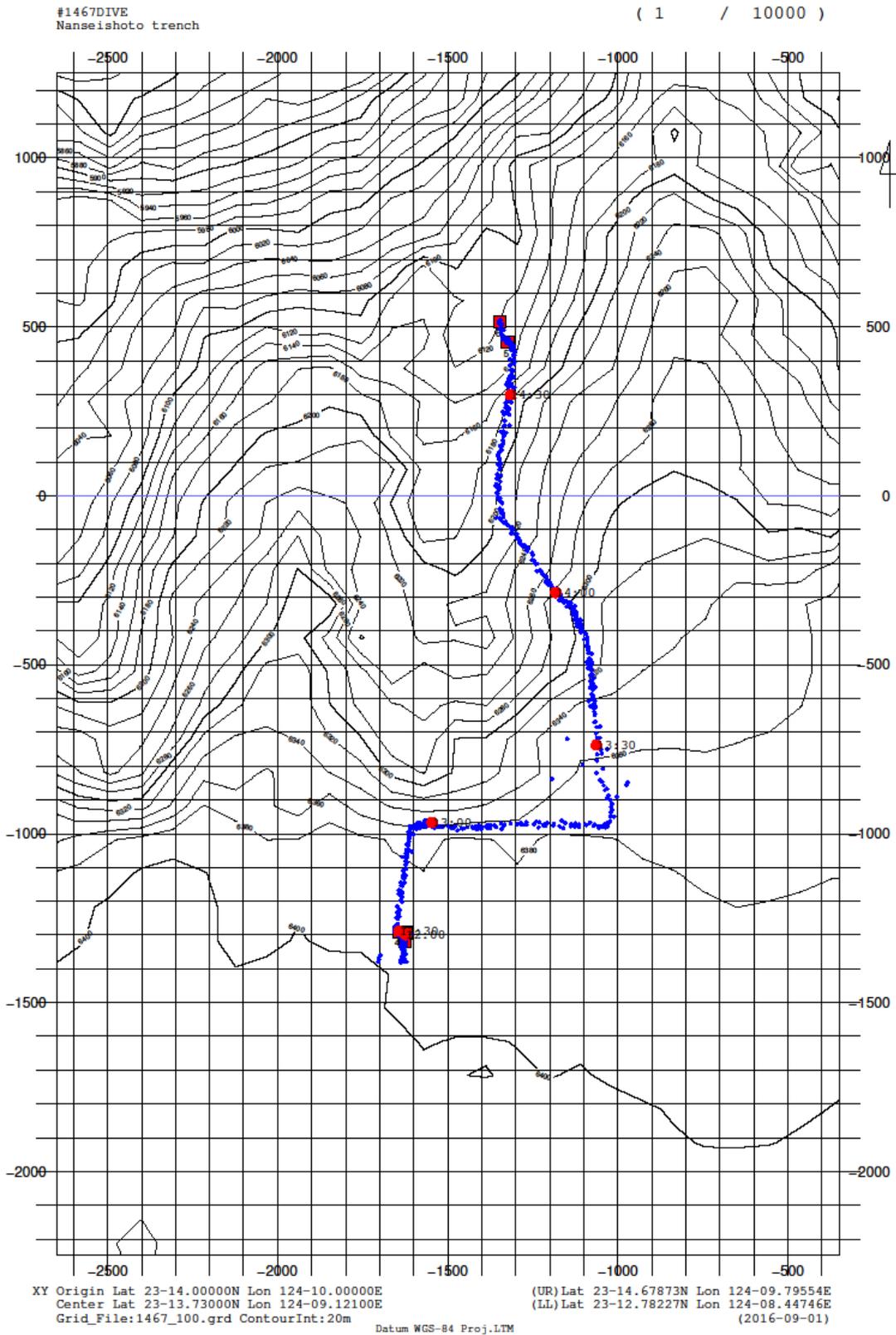
- H type core sampler (short) x 4

- MBARI core sampler (long) x 2
- D-WHATS water sampler
- Net scoop x 1
- Sample box x 2
- Marker x 2

Event list:

09.08	23°13.3000'N, 124°09.0500'E	Depth=6400 m	Position of the Planned Landing Target
11.51	23°13.2863'N, 124°09.0481'E	Depth=6350 m	Sampling Niskin (2) Alt = 21 m
11.58	23°13.2993'N, 124°09.0488'E	Depth=6371 m	Landing
12.33	23°13.3014'N, 124°09.00358'E	Depth=6371 m	Sampling Core (4), MBARI (green),
Measurement Temperature			
14.45	23°14.2477'N, 124°09.2242'E	Depth=6115 m	Sampling MBARI (red)
14.51	23°14.2799'N, 124°09.2101'E	Depth=6093 m	Left Bottom

Dive Track of 6K#1467



Dive Report: Shinkai 6500 Dive# 1468**Date:** September 2, 2016**Site:** Southern Ryukyu Trench**Landing:** 11:02; 23°37.8476N, 124°25.4856E, D=3653 m**Leaving:** 15:53; 23°41.0167N, 124°25.9685E, D=2466 m**Pilot:** Takuya Ohnishi, **co-pilot:** Hirofumi Ueki**Observer:** Ken Takai (JAMSTEC)**Objectives:**

The main objective of dive #1468 was to locate suspected seepage sites and associated chemosynthetic microbial and animal communities along a deep branching fault in an overlying plate of the southern Ryukyu Trench and to obtain the potential crustal fluids, sediments, microbial and animal communities.

Dive summary:

We landed on the seafloor at a depth of 3653 m and it was just located under the steep slope, which is the cliff potentially caused by side-slipping movement of the branching fault. Before landing, we obtained two Niskin water samples at a depth of 3610 m, 50 m above the seafloor. It was a quiet seafloor with a diversity of animals such as sea cucumbers. We obtained four H-type cores (30 cm) and one MBARI core here. After obtaining the core sediments, we headed to north and climbed the slope.

The first slope continued about 1.8 km. All the slope was covered the thick sediments and no apparent fault, microbial mat and chemosynthetic animal colony was found. However, we observed lots of animals, e.g., swimming sea cucumbers, benthic sea cucumbers, sea anemones, "Umiyuri", "Yagi", shrimps, crabs, polychaetes and fishes.

After arriving at the flat plain between the 1st slope and 2nd slope, we sometime observed several faults (reverse sense) and small outcrops of layered sedimentary rocks (23°39.00N – 23°39.50N). The faults and outcrops were directed to extend along east-west lines. In the middle point of the flat plain at 3063 m, we obtained two rocks from the outcrop. These area were likely the parts of the deep branching faults.

After the travel across the flat plain, we climbed the second slope. The second slope was not covered with the soft fresh sediments and partly hardened mud rocks seemed to be exposed to seafloor. Thus, it was a large outcrop or the seafloor washed by landslides of surface sediments. There were still lots of animals here as much as in the first slope and the flat plain. The upper 500 m of the 2nd slope was very steep and consisted of sharp rock surface. It was formed by the very recent collapse. However, we could not observe any signatures such as microbial mats and animal colonies of seepages. Two pieces of rock were collected at a depth of 2589 m and one sponge was sampled at a depth of 2555 m in the upper 500 m of the cliff.

After arriving at the top of 2nd slope, we left the bottom.

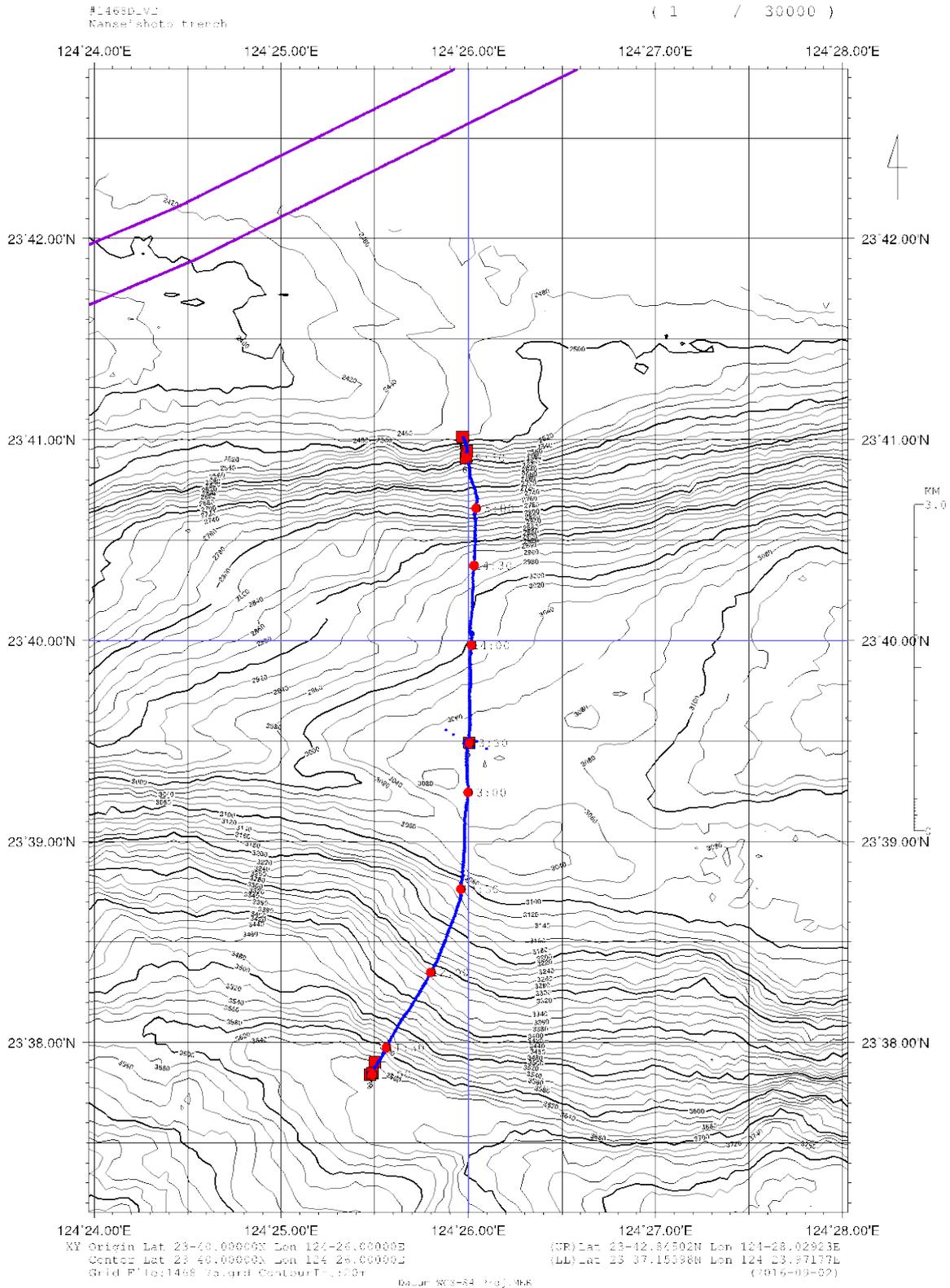
Payloads:

- H-type corer x 4
- MBARI corer x 2
- Deep-WHATS water sampler
- MJ water sampler x 1
- Thermometer with inlet x 1
- Methane sensor x 1
- Multi sensor x 1
- Standard solution (H₂, H₂S, CH₄) x 1
- Kumade sampler x 1
- Sample box x 2
- Marker x 3

Event list:

10:55	23°37.8404N, 124°25.4756E	Depth=3610m	Niskin water sampling
11:16	23°37.8476N, 124°25.4856E	Depth=3653	Landing and 4 H-type corer samples and 1 MBARI corer sample
13:32	23°39.4929N, 124°26.0058E	Depth=3063m	Sampling rocks
15:31	23°40.9088N, 124°25.9880E	Depth=2589m	Sampling rocks
15:40	23°40.9453N, 124°25.9921E	Depth=2555m	Sampling a sponge
15:53	23°41.0167N, 124°25.9685E	Depth=2466m	Left the bottom

Dive Track of 6K#1468



Dive Report: Shinkai 6500 Dive# 1469**Date:** September 3, 2016**Site:** north of Yaeyama Ridge, south of Ishigaki**Landing:** 11:20; 23°59.5000'N, 124°13.5000E, D=2600 m**Leaving:** 16:01; 23°59.8306'N, 124°14.8369E, D=2460 m**Pilot, co-pilot:** Komuku T, Suzuki K.**Observer:** Kan-Hsi Hsiung (ODS, JAMSTEC)**Objectives:**

The first objectives of this dive is to observe biogeological environment of the fault along the Yaeyama Ridge (accretionary prism of Ryukyu Trench) parallel to the southern Ryukyu Trench axis. The second objective is to observe the features of sedimentary features and structures in the submarine canyon mouth south of Ishigaki. We collect core samples for geochemical and biological researches. Water samplers are also collected for microbiological studies.

Dive summary:

Dive 1469 route map is shown in figure of the dive track of 6K#1469 as below. Before landing about 20 m to the seafloor, we collect seawater by Niskin Water samplers (Event 004). Landing point area in around 2600 m bathymetry shows flat and gray color seafloor with several small dunes. In general, few animals observed in this area. We measure the seafloor by thermometer for sediment (Event 005). We collect core samples MR (MBARI red), H3 and H4 in this site (Event 005). Further to the north, we observe a NNE-SSW direction scar which can be interpreted as the canyon wall in right side. The scar is about 1-1.5 m relief with at least two units of strata. We collected rock samples directly from the outcrop by using scoop (Event 006). Further eastward, we observed some massive sediments and two scars which caused by two or three times of submarine slides. Consequently, we observed the left wall of the canyon. The outcrop of scar of the left canyon wall shows similar units in three layers which can be correlated to the right canyon wall. Further southeastward, we choose a relative flat area to collect the core sample H2 in 2522 m bathymetry (Event 007). The tube of core sampler H1 was broken when taking in the basket. The core samples MG (MBARI green) was broken when sampling back from the seafloor. After survey we left the seabed at 2460.00 m.

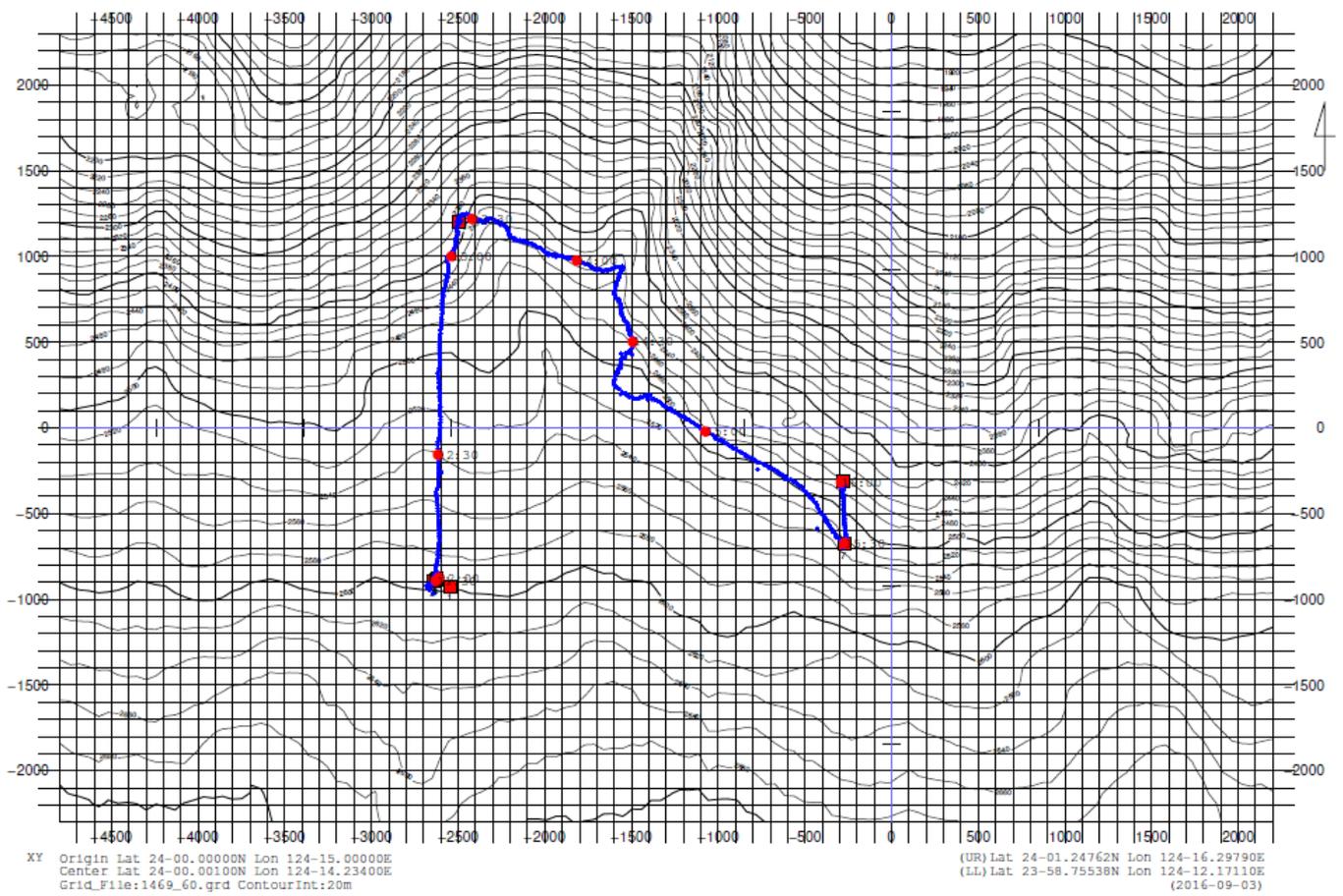
Payloads:

- H type core sampler (short) x 4
- MBARI core sampler (long) x 2
- D-WHATS water sampler
- Net scoop x 1
- Sample box x 2
- Marker x 2

Event list:

11:20	23°59.5164N, 124°13.4434E	Depth=2566 m	Sampling Niskin(green,red)	Alt=20m
11:25	23°59.5200N, 124°13.4499E	Depth=2584 m	Landing	
11:44	23°59.5197N, 124°13.4497E	Depth=2584 m	Sampling Water(MJ)	
12:12	23°59.5252N, 124-13.4547E	Depth=2583 m	Sampling MBARI(red), H3 and H4	
13:20	24°00.6512N, 124°13.5281E	Depth=2378 m	Sampling Scoop (Box1)	
15:43	23°59.6349N, 124°14.8419E	Depth=2522 m	Sampling Core (H2)	
16:01	23°59.8306N, 124°14.8369E	Depth=2460 m	Left Bottom	

Dive Track of 6K#1469



Dive Report: Shinkai 6500 Dive# 1470**Date:** September 5, 2016**Site:** Original site, Iheya North Field, Okinawa Trough**Landing:** 09:51; 27°47.4368N, 126°54.2140E, D=1051 m**Leaving:** 15:36; 27°47.5635N, 126°53.8568E, D=1003 m**Pilot:** Kazuhiro Tchiba, **co-pilot:** Fumitaka Saito**Observer:** Masahiro Yamamoto (JAMSTEC)**Objectives:**

The main objective of dive #1470 was to clarify electrochemical interaction between liquids (hydrothermal fluid and seawater), rocks and organisms around deep-sea hydrothermal field. We aimed to collect samples under strong electric conditions. It was planned that electric characteristic was analyzed on-site with Deep-sea Potentiostat System (D-Pote).

Dive summary:

After landing on seawater, we tested D-Pote several times, but the data communications were not available. Therefore we gave up measurement of electrochemical characteristic such as redox potentials (as it turned out, seawater was leaked into housing of D-Pote). Anyway, we tried to collect samples like under electric conditions.

We landed on the seafloor at a depth of 1051 m, where was about 250 m east of C0014G guide base. At the landing site, we obtained three H-type cores (30 cm).

We moved to C0014G guide base, and observed it. No spout of fluid was observed from the vent pipe. Temperature was measured as 4.3°C inside of the vent hole. We collected bacteria mat on surface of the pipe with bag water sampler (#1 Bag). We picked inside of the pipe hole, but the clog was too hard to be removed. We were planning to collect MBARI core sample at this site, but it was canceled because seafloor was solid.

Next, we moved to C9024A guide base that was newly constructed on 26 Feb 2016. It was very near about 10 m from C0014G. We observed the guide base roundly. We landed on the base, and collected bacteria mat on surface of guide base with bag water sampler (#2 Bag). Moreover, we tried to open the valve (C1) on the guide base, but the cock came off because of corrosion. Some natural hydrothermal vents were found out around the C9024A guide base. We measured temperature of hydrothermal fluid in one of the vents. The maximum temperature was 283 °C.

On the way to C0013E, we found sedimental area and obtained one MBARI core (green).

We observed C0013E guide base. The artificial vent was also clogged and no spout was observed from the pipe.

Next, we went to North Big Chimney (NBC). We set one Electrotrophic Microorganism Enrichment System (EMES-2, or Kashima plate) on the top part of the chimney. One rock was collected into a sample box (Rock-1 into right basket). Two Niskin bottle water samples (green

and red) were collected near the NBC vent.

Then, EMES-1 and a marker-No. 214 were set on the bottom of NBC, where was near from a casing pipe thrown down on seafloor. Two rocks were collected at this site (Rock-2 into Morinaga box-blue)

We moved to C0016B guide base, where was very near from NBC. We tried to access to the upper side of the guide base, but we gave up. There were several chimneys and no flat space on the base. Therefore, we landing on seafloor near the guide base, and obtained rock samples (Rock-3 into Morinaga box- yellow)

We went to and observed HRV chimney. We landed on middle part of the chimney. Some pieces of flange were collected from the active vent (Rock-4 into sample box-1). In addition, one block of rock was also collected (Rock-5 into sample box-2)

We moved back a little till at the bottom part of HRV chimney, and collected 2 rocks (Rock-6 into left basket).

We moved to NBC again, and collected 2 rocks (Rock-7 into left basket).

Although we kept on search for Makita plates (Iron oxidizing bacteria cultivation system, those were set on seafloor in this field in previous dive) during the dive, we missed Makita plates No.2-No.4. Finally, however, we found out Makita plate No.1. But we did not recovery it, because it must be collected in pairs (two or four of plates).

After move to north from the field, we left the bottom.

Payloads:

- H-type corer x 3
- MBARI corer x 1
- Bag water sampler x 2
- Niskin water sampler x 2
- Thermometer with inlet x 1
- D-Pote x 1
- EMES (Kashima plate) x 2
- Kumade sampler x 1
- Sample box x 5 (including Morinaga box)
- Marker x 2

Event list:

09:51	27°47.4368N, 126°54.2140E	Depth=1051m	Landing
10:07	27°47.4368N, 126°54.2140E	Depth=1051m	Sampling 3 H-type cores
10:19	27°47.4153N, 126°54.0588E	Depth=1055m	Finding color change area and guide base C0014G
10:45	27°47.4154N, 126°54.0471E	Depth=1055m	Landing on guide base C0016G, Sampling bacteria mat (#1 Bag), Measurement temperature, and Trial for clog remove
11:13	27°47.4087N, 126°54.0431E	Depth=1054m	Landing on guide base C9024A, Sampling bacteria mat

(#2 Bag), Trial for valve open (C1)

11:27	27°47.4087N, 126°54.0431E	Depth=1054m	Measurement temperature in hydrothermal fluid from natural vent chimney (283°C)
12:20	27°47.4248N, 126°53.9483E	Depth=1055m	Sampling MBARI core (green)
12:45	27°47.4402N, 126°53.8118E	Depth=1000m	Finding casing pipe
12:57	27°47.4533N, 126°53.7967E	Depth=980m	Landing on top part of NBC, and Setting EMES-2
13:06	27°47.4523N, 126°53.7965E	Depth=985m	Sampling rock (Rock-1; Right basket)
13:10	27°47.4522N, 126°53.7962E	Depth=986m	Sampling 2 Niskin (green and red)
13:29	27°47.4433N, 126°53.8165E	Depth=1007m	Landing on bottom part of NBC, and Setting EMES-1 and #214 marker
13:32	27°47.4439N, 126°53.8158E	Depth=1007m	Sampling rock (Rock-2; Morinaga box blue)
14:19	27°47.4460N, 126°53.7720E	Depth=994m	Landing on seafloor near C0013E, and Sampling 2 rocks (Rock-3; Morinaga box yellow)
14:37	27°47.4613N, 126°53.6942E	Depth=963m	Landing on middle part of HRV chimney, and Sampling flange (Rock-4; Sample box-1) and rock (Rock-5; Sample box-2)
14:46	27°47.4685N, 126°53.6942E	Depth=963m	Landing on bottom part of HRV chimney, and Sampling 2 rocks (Rock-6: Left basket)
15:10	27°47.4490N, 126°53.7931E	Depth=1000m	Landing on middle part of NBC, and Sampling 2 Rocks (Rock-7; Left sample box)
15:25	27°47.5069N, 126°53.8518E	Depth=1010m	Visual confirmation of No.1 Makita plate
15:36	27°47.5635N, 126°53.8568E	Depth=1003m	Left Bottom

Dive Track of 6K#1470

