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NATSUSHIMA Cruise Report
NT11-18

Photo by Masayuki Miyazaki

Tarama Knoll & off Kuroshima

September 12, 2011 – September 17, 2011
Japan Agency for Marine-Earth Science & Technology
(JAMSTEC)

Contents

1. Onboard members

1.1. Natsushima Crew

Captain: **YOSHIYUKI NAKAMURA**

Chief Officer: **AKIHISA TSUJI**
2nd Officer: **ISAO MAEDA**
3rd Officer: **KAZUKI MIYAKE**

Chief Engineer: **EIJI SAKAGUCHI**
1st Engineer: **WATARU KUROSE**
2nd Engineer: **SABURO SAKAEMURA**
3rd Engineer: **SHOTA NAGANO**

Chief Radio Officer: **MASAMOTO TAKAHASHI**
2nd Radio Officer: **MICHIYASU KATAGIRI**
3rd Radio Officer: **TATSUHIRO TAKAKUWA**

Boat Swain: **HATSUO ODA**
Able Seaman: **TAKAO KUBOTA**, **HIDEO ISOBE**, **NAOKI IWASAKI**, **TAKUYA MIYASHITA**

Sailor: **JUN SHINODA**, **RYOMA TAMURA**

No1. Oiler: **HIROYUKI OISHI**
Oiler: **KATSUYUKI MIYAZAKI**, **SHINYA SUGI**, **YUJI HIGASHIGAWA**, **SHOTA SHIMOHATA**

Chief Steward: **RYUEI TAKEMURA**
Steward: **YOSHINOBU HASATANI**, **HIDEO FUKUMURA**, **MASARU TAKADA**, **TAKUMI YAMADA**

Hyper Dolphin Operation team

Chief ROV Operator: **KAZUYA MITSUFUJI**
ROV Operator: **KAZUKI IIJIMA**, **KATSUSHI CHIBA**, **SHIGERU KIKUTANI**, **YUDAI SAKAKIBARA**, **RYO SAIGO**

NME Marine Technician

Chief Marine Technician: **KYOKO TANAKA**

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Safety and Environment Management Office, Japan Agency for Marine-Earth Science & Technology (JAMSTEC)

2. Cruise Information

2.1. Cruise Summary

Cruise number: NT11-18

Research vessel: R/V *Natsushima* and ROV *Hyper-Dolphin 3000*

Title of the Cruise:

・Elucidation of the microbial ecosystems utilizing iron and their environmental factor to support their activity in the Tarama Knoll "iron-containing flocculent mats".

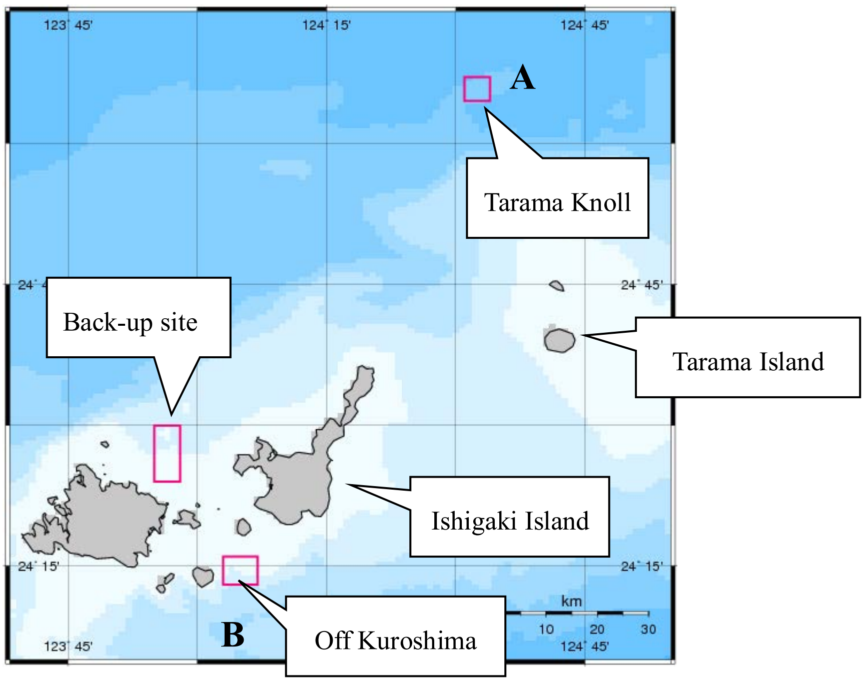
・Investigating and sampling benthic biodiversity along a reef-deep transect: PICASSO as a pre-site survey tool.

・Revaluation of geochemical study concerned with interaction between phase separated hydrothermal fluids and the associated rock.

Cruise Period and Ports of Call: From September 12th (Ishigaki Island) to 17th (Ishigaki Island), 2011

Research area and Depths: Tarama Knoll (~2,100 m), off Kuroshima (~500 m)

Research Map:



A and B areas were investigated during NT11-18 cruise.

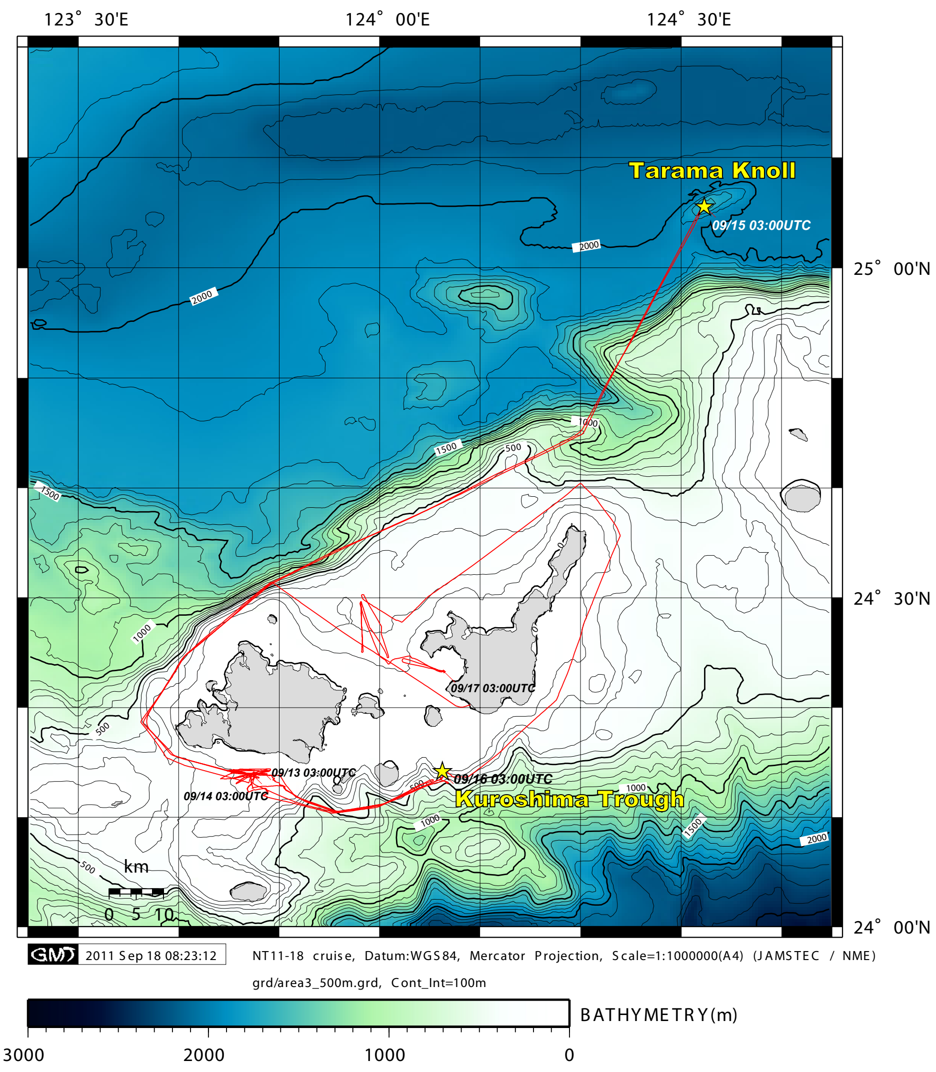
2.2. Shipboard Log

NT11-18 Shipboard Log
(12.September.2011-17.September.2011）

Date	Local Time	Note	Position/Weather/Wind/Sea condition
12.Sep,2011	15:00	Let go all shore line,left ISHIGAKI.	09/12 12:00 (UTC+9h)
	15:30-16:20	Onboard education and safety training.	24-20.3N,124-09.0E
	16:30-17:00	Meeting for HPD operation.	rain
	19:00-20:00	Scientists meeting.	NE-3 (gentle breeze)
	20:36	Stopped engine, commenced drifting.	1 (sea rippled calm)
			1 (Low swell sea)
			Visibly:4
13.Sep.2011	4:00	Com'ced proceeding to research area. (KUROSHIMA TROUGH)	09/13 12:00 (UTC+9h)
	6:00	Arrived at dive point.	24-14.3N,123-47.9E
		Released XBT at 24-12.9675N 124-04.0346E	Cloudy
	6:30	Suspended dive operation by HPD due to rough sea.	NE-5 (fresh breeze)
	8:15	Stopped engine, commenced drifting.	4 (sea moderate)
	10:09-10:32	Carried out Plankton Net at 24-12.2312N, 123-51.1699E)	5 (Long moderate sea)
	10:39-12:30	Shifted to Eastward.	Visibly:4
	16:30-18:15	Shifted to Eastward.	
	19:00-20:00	Scientists meeting.	
	20:45-23:00	Shifted to Eastward.	
14.Sep.2011	4:00	Com'ced proceeding to research area. (KUROSHIMA TROUGH)	09/14 12:00 (UTC+9h)
	6:00	Arrived at dive point.	24-14.0N,123-46.9E
	7:00	Suspended dive operation by HPD due to rough sea.	Fine but cloudy
	8:09	Stopped engine, commenced drifting.	ENE-6 (light breeze)
	10:08-10:30	Carried out Plankton Net at 24-13.8943N 123-46.9780E	4 (sea moderate)
	11:15	Used engine.	4 (Average moderate sea)
	14:00	Stopped engine, commenced drifting.	Visibly:8
	14:03-14:25	Carried out Plankton Net at 24-13.8943N 123-46.9780E	
	17:46-18:07	Carried out Plankton Net at 24-13.8908N 123-46.9607E	
	19:00-19:30	Scientists meeting.	
	19:00-19:45	Shifted to Eastward.	
	20:30	Finished drifthing then com'ced proceeding to research area. (TARAMA KNOLL)	
15.Sep.2011		**HPD#1322**	09/15 12:00 (UTC+9h)
	6:00	Arrived at research area. (TARAMA KNOLL)	25-05.6N, 124-32.4E
		Released XBT at 25-05.2113N,124-32.0322E.	Fine but cloudy
	8:23	Hoisted up H.P.D.	NNE-5 (fresh breeze)
	8:27	Launched H.P.D. on the surface.	4 (sea moderate)
	8:40	H.P.D. dove & started her operation #1322.	4 (Average moderate sea)
	9:38	H.P.D. launded on sea bottom. (D=1747m)	Visibly:8
	15:31	H.P.D. left the sea bottom. (D=1532m)	
	16:13	H.P.D. floated.	
	16:23	Hoisted up H.P.D.	
	16:30	Recovered H.P.D & finished above operation.	
	16:50	Com'ced proceeding to research area. (KUROSHIMA TROUGH)	
16.Sep.2011		**HPD#1323**	09/16 12:00 (UTC+9h)
	6:00	Arrived at research area. (KUROSHIMA TROUGH)	24-13.9N,124-06.3E
	8:06	Hoisted up H.P.D.	Fine but cloudy
	8:10	Launched H.P.D. on the surface.	NNW-6 (strong breeze)
	8:21	H.P.D. dove & started her operation #1323.	3 (sea slight)
	8:47	H.P.D. launded on sea bottom. (D=498m)	2 (Long swell sea)
	13:17	H.P.D. left the sea bottom. (D=265m)	Visibly:8
	13:31	H.P.D. floated.	
	13:41	Hoisted up H.P.D.	
	13:47	Recovered H.P.D & finished above operation.	
	14:00	Com'ced proceeding to off ISHIGAKI.	
17.Sep.2011	9:00	Get off NATSUSHIMA at ISHIGAKI.	

by Kyoko Tanaka

NT11-18 Okinawa Trough vessel track



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2.3. Dive report

2.3.1. #1322

Date: September 15, 2011 **Site:** Tarama Knoll, Okinawa Trough **Depth:** 1,532-1,747 m
Landing (Lat., Long., Time, Depth): 14°36.060'N, 144°46.444'E, 09:15, 625m
Leaving (Lat., Long., Time, Depth): 14°36.072'S, 144°46.574'E, 15:00, 526m
Pilot: Yudai Sakakibara **Co-Pilot**: Ryo Saigo
Theme: Elucidation of the microbial ecosystems utilizing iron and their environmental factor to support their activity in the Tarama Knoll "iron-containing flocculent mats". AND Revaluation of geochemical study concerned with interaction between phases separated hydrothermal fluids and the associated rock.

Purpose:
1. Sampling and observing on vent-associated animals around Tarama Knoll.
2. Water sampling on the plume and vent fluid.
3. Sediment sampling around low temperature hydrothermal vents.
4. Setting and recovering the GALI (Genba-Atsuryoku Lithoautotroph *In situ* colonization system) on the iron mat.
5. Measuring environmental conditions (temperature, salinity, DO, turbidity, pH and H_2S) at the iron mat.

Payload Equipment:
Slurp gun, suction sampler with canisters, WHATS water sampler, Cheap-WHATS water sampler, bag water sampler, Niskin water sampler, sample box, RI vacuum water sampler, turbidity meter, DO meter, GALI, H1322-Marker (2 sets)

Sampling Points and Markers:

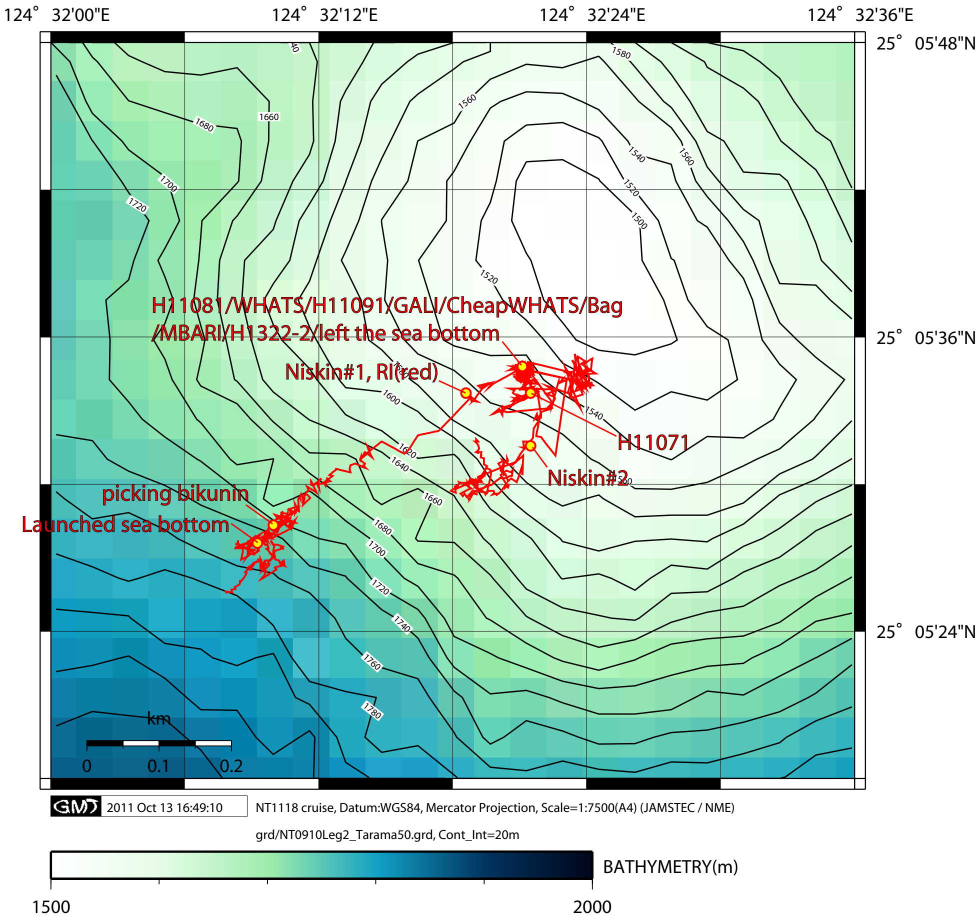
Events	*Time*	*Depth (m)*	*Sample*	*Lat./Long.*
Suction sampling	09:46	1,732	Animal	25°05.469'N/124°32.165'E
Niskin (#1)	10:48	1,570	Fluid	25°05.559'N/124°32.312'E

RI bottle (Red)	10:52	1,536	Fluid	25°05.559'N/124°32.312'E
WHATS (#1)	12:43	1,532	Fluid	25°05.578'N/124°32.351'E
WHATS (#2)	12:52	1,532	Fluid	25°05.578'N/124°32.351'E
WHATS (#3)	13:31	1,532	Fluid	25°05.578'N/124°32.351'E
WHATS (#4)	13:40	1,532	Fluid	25°05.578'N/124°32.351'E
Manipulator- Recovery	13:44	1,532	H1109-1	25°05.578'N/124°32.351'E
Manipulator- Recovery	13:45	1,532	GALI-3	25°05.578'N/124°32.351'E
Cheap WHATS (B)	14:08	1,532	Fluid	25°05.578'N/124°32.351'E
Bag water sampler	14:32	1,532	Fluid	25°05.578'N/124°32.351'E
Manipulator- Put in	14:46	1,532	GALI-11	25°05.578'N/124°32.351'E
Manipulator- Put in	14:51	1,532	H1322-1	25°05.578'N/124°32.351'E
M type (Green)	15:05	1,532	Sediment	25°05.578'N/124°32.351'E
M type (Blue)	15:24	1,532	Sediment	25°05.578'N/124°32.351'E
M type (Red)	15:27	1,532	Sediment	25°05.578'N/124°32.351'E
Manipulator – Put in	15:30	1,532	H1322-2	25°05.578'N/124°32.351'E
Niskin (#2)	15:36	1,435	Fluid	25°05.528'N/124°32.355'E

Dive Summary

Hyper-Dolphin #1322 started to descend at 8:40 a.m. *Hyper-Dolphin* (HPD) landed at 1,747 m water depth off the west side of Tarama No.1 Knoll. We planned to go over the Fox Vent site (this site has a thick iron mat with low temperature hydrothermal flow) to the marker #H1109 set during NT10-06 Leg 2 in 2010. Although we could not find marker #1109, we could find marker #1107. After going near the summit of Tarama No. 1 Knoll, we then successfully found #1108 and #1109 markers and GALI-3. We recovered marker #1109 and GALI-3. Moreover, we placed GALI-XI and markers #1322-1 and #1322-2. We tried to collect the iron mat with the M-type sediment sampler. Additionally, we collected fluid in the iron mat with the WHATS and Cheap-WHATS samplers. After taking samples HPD left the bottom at 15:31 pm at a water depth of 1,532 m.

NT11-18 HPD#1322 Hyper Dolphin 3000 tracking map



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2.3.2. #1323

Date: September 16, 2011 **Site:** Kuroshima sea valley **Depth:** 265 - 500 m

Landing (Lat., Long., Time, Depth): 24°13.602'N, 124°06.283'E, 08:47, 498 m

Leaving (Lat., Long., Time, Depth): 24°14.156'S, 124°06.306'E, 13:17, 265 m

Pilot: Shigeru Kikuya **Co-Pilot**: Kazuki Iijima

Theme: Investigating and sampling benthic biodiversity along a reef-deep transect: PICASSO as a pre-site survey tool.

Purpose:

To conduct a transect from 500 to 200 meters off Kuroshima Island, with HD video data as we can use this later to compare with PICASSO data, and also with NT11-21 (Kikaijima Island) data.

1. Sampling and observing of benthos.
2. MBARI core and fluid sampling at 500, 400, 300, and 250 m..
3. Measuring environmental factors (temperature, salinity, DO and turbidity) at the habitat of sampled benthos.

Payload Equipment:

Slurp gun, suction sampler with canister, MBARI core sampler (4), Niskin water sampler, sample box, turbidity meter, DO meter

Sampling Points and Markers:

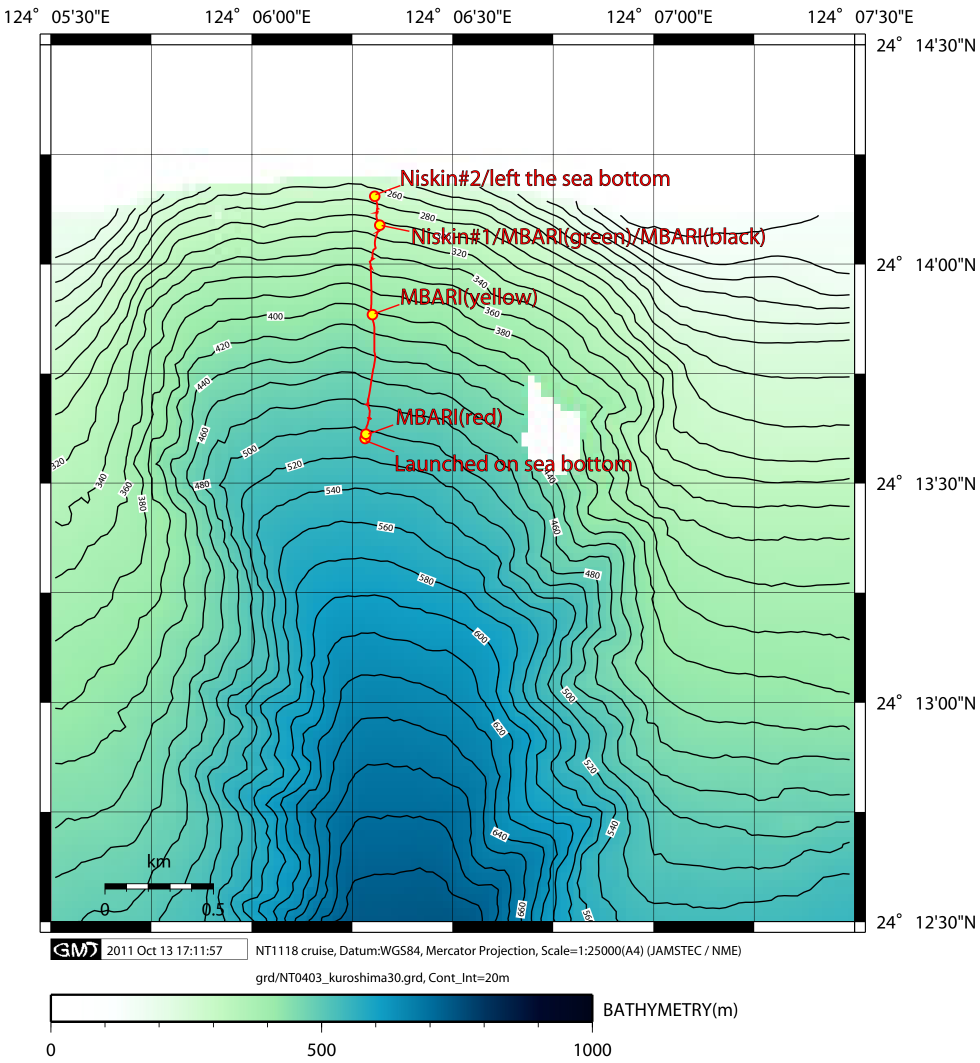
Events	*Time*	*Depth (m)*	*Sample*	*Lat./Long.*
MBARI (Red)	08:55	500	Sediment	24°13.605'N/124°06.283'E
Manipulator	09:11	485	Benthos	24°13.650'N/124°06.290'E
Manipulator	09:22	476	Benthos	24°13.681'N/124°06.288'E
Suction sampling	09:26	476	Benthos	24°13.681'N/124°06.288'E
Manipulator	09:43	476	Benthos	24°13.681'N/124°06.288'E
Manipulator	09:57	471	Benthos	24°13.696'N/124°06.289'E
Suction sampling	10:05	468	Benthos	24°13.704'N/124°06.290'E
Suction sampling	10:11	462	Benthos	24°13.724'N/124°06.288'E
Manipulator	10:32	453	Benthos	24°13.745'N/124°06.300'E

Suction sampling	10:49	419	Benthos	24°13.834’N/124°06.303’E
MBARI (Yellow)	11:12	401	Sediment	24°13.881’N/124°06.301’E
Manipulator	11:24	369	Benthos	24°13.954’N/124°06.297’E
Suction sampling	11:34	351	Benthos	24°13.992’N/124°06.294’E
Manipulator	11:55	328	Benthos	24°14.036’N/124°06.305’E
Manipulator	12:08	308	Benthos	24°14.076’N/124°06.314’E
Niskin (#1)	12:14	301	Fluid	24°14.089’N/124°06.315’E
MBARI (Green)	12:22	301	Sediment	24°14.089’N/124°06.315’E
MBARI (Black)	12:34	301	Sediment	24°14.089’N/124°06.315’E
Manipulator	12:51	287	Benthos	24°14.118’N/124°06.312’E
Manipulator	12:55	287	Benthos	24°14.118’N/124°06.312’E
Manipulator	13:05	283	Benthos	24°14.118’N/124°06.312’E
Manipulator	13:13	265	Benthos	24°14.126’N/124°06.316’E
Niskin (#2)	13:15	265	Fluid	24°14.156’N/124°06.306’E

Dive Summary

Hyper-Dolphin #1323 started to descend at 8:22 a.m. *Hyper-Dolphin* (HPD) landed at 498 m depth to the northeast of Kuroshima at 8:47 a.m. Asides from the HD camera going offline on the descent, the dive went as planned, with a transect from 498 m to 265 m accomplished. MBARI cores, Niskin water samples and 30+ biological specimen sampling events (=>80 specimens) were collected with no major problems. After taking samples HPD left the bottom at 13:15 pm at a water depth of 265 m.

NT11-18 HPD#1323 Hyper Dolphin 3000 tracking map



by Kyoko Tanaka

3. Scientific Reports

3.1. Elucidation of the microbial ecosystems utilizing iron and their environmental factor to support their activity in the Tarama Knoll "iron-containing flocculent mats".

Hiroko Makita, Masayuki Miyazaki, Takuro Nunoura (JAMSTEC)

3.1.1. Purpose

It is believed that the most important energy source in the ocean crust or sub-seafloor is vastly abundant iron. Therefore, it is suggested that the iron-oxidizing chemolithautotrophic microbe is a key player in the microbial ecosystem. In recent years, many iron mats have been discovered at deep-sea hydrothermal fields worldwide. Culture–dependent and –independent microbiological characterization has demonstrated that the zeta-proteobacteria "*Mariprofundus ferrooxidans*" (Emerson D., *et al*., 2007), which utilizes ferrous iron choemolithoautotrophic microorganisms, is commonly observed in iron mats with low-temperature hydrothermal flow (Davis and Moyer, 2008, Kato *et al*., 2009, Emerson and Moyer, 2010). However, little is known about these iron-utilizing chemolithomicroorganisms, for example regarding their diversity, the dominant species at each site, what precise role they play in situ, and how they interact with other microorganisms and rocks. To clarify these questions, we investigated the iron-containing flocculent mat at Tarama Knoll.

The purpose of this cruise is to obtain sediment at the iron mat with the GALI (Genba-Atsuryoku Lithoautotroph *In situ*) colonization system to examine the associations between endolithic microorganisms, especially iron-utilizing microorganisms, and corrosion processes at deep-sea low-temperature hydrothermal fields. Our objectives on this cruise included; 1) setting and recovering GALI on the iron mat, 2) collecting sediment of the iron mat, 3) collecting low temperature fluids for examining environmental factors to support iron-utilizing microbial activities.

3.1.2. Materials and Methods

On-board processing

Some iron mat and GALI were collected. After recovery on board the samples were kept cool (4°C) prior to sample processing and were processed as quickly as possible.

Iron mat samples were slurried with filter-sterilized seawater under N2 for cultivation. For molecular analysis, the remaining pieces were kept at -80 °C. For cultivation, water samples collected by WHATS were immediately poured into sterilized glass vials under the atmosphere of nitrogen gas.

3.1.3. Future works

Objectives of our microbiological studies include: 1) evaluation of microbial diversity and distribution by using DNA and RNA approaches (e.g. 16S rRNA gene analysis), fluorescence *in situ* hybridization (FISH), quantitative polymerase chain reaction (Q-PCR) and T-RFLP analysis, 2) measurement of microbial activity by using cultivation-, enzymatic-, DNA and RNA approaches, and metabolic product analysis.

3.2. Investigating and sampling benthic biodiversity along a reef-deep transect: PICASSO as a pre-site survey tool.

James Reimer, Kristine White, Haruka Shikiba, Erina Kawai, Nanae Fukumoto
(TRO-SIS, University of the Ryukyus, Kitasato University, JAMSTEC)

3.2.1. Purpose

The purpose of this dive was originally to confirm the presence and identity of benthos in images acquired by the ROV PICASSO off Kuroshima, Okinawa. PICASSO was scheduled to dive in the region of Kuroshima in September 2011. However, PICASSO cannot sample due to its small size, and thus our proposed cruise is to locate, sample, and confirm the identity of benthos identified from the PICASSO cruise using the HyperDolphin. As PICASSO could not dive in September 2011 due to typhoons and budget issues, the PICASSO dives have been rescheduled to early FY2012. With the collection of transect data and specimens, we can more fully understand the reef to deep ecotone, allowing us to more fully understand how biodiversity changes as these ecosystems change into each other. The classification and examination of new species will allow us to provide baseline data for future biodiscovery and biodiversity research. Specimens will be preserved for both morphologic and genetic analyses, and we will maximize bottom time by also collecting sediment samples using MBARI corers.

3.2.2. Materials and Methods

On-board processing

After recovery on-board, all biological specimens were immediately moved to the 4°C cold room for initial storage, and then assigned specimen numbers and preserved. Depending on the specimen's taxon, specimens were preserved in 70% ethanol, 99.5% ethanol, or 4% saltwater formalin. Sponges were dissected to locate symbiotic amphipods, and only small sample sections were kept to limit ethanol usage.

For MBARI cores (n=3), 5-25 mg of the top 2 or 3 cm of cores were sampled in sterile plastic tubes, and frozen in -80°C. One MBARI core was given to the Makita/Yamanaka team for analysis.

For Niskin water samples, these were passed directly to the Makita/Yamanaka team for analysis after recovery.

3.2.3. Future works

Images and biological specimens will be compared with PICASSO images to be obtained in spring 2012. Furthermore, all specimens will be examined both molecularly and morphologically to identify to the species level. If species are new to science, they will be described by appropriate experts.

3.3. Revaluation of geochemical study concerned with interaction between phase separated hydrothermal fluids and the associated rock.

Toshiro Yamanaka, Hiromi Nagashio, Tomohiro Toki, Hiromi Watanabe, Yuji Ise

(Okayama University, Ryukyu University, JAMSTEC, the Univsersity of Tokyo)

3.3.1. Purpose

For understanding of whole Okinawa Trough as a single system, it is necessary to research of a blank area of possible hydrothermal activity. It is expected o strongly improve the knowledge how geology and tectonics control chemistry of the hydrothermal fluids and distribution of the related (micro-) organisms in the Okinawa Trough. To reach the goal our targets of this cruise were focused on the Tarama knoll, which are located southeastern part of western edge of the Okinawa Trough. Significant methane-concentration anomaly possibly originated in hydrothermal activity has been found on the summit of Tarama knoll during the KT05-26 cruise in 2005 by surface ship study. Although we surveyed the Tarama knoll using HyperDolphin during NT09-10 leg.2 and NT10-06 leg.2 cruises, we found dense turbid water around the summit and weak shimmering from the seafloor covered with characteristic red-brown sediment. From preliminary result of the shimmering fluid geochemistry, it is characterized by low cations (Na, K, and Ca) concentration, suggesting that phase separation of hydrothermal fluid is expected beneath the seafloor. It also means that brine rich hot fluid is emitting elsewhere. The brine-rich fluid may be cause of dense plume observed around the knoll. However, we could not found hydrothermal vent emitting high temperature fluid. Therefore, we try again to find venting site at the Tarama knoll for finding venting site. After the identifying the venting sites we plant to conduct the geological, geochemical and (micro-) biological sampling and clarify the nature. Then we compare the nature with the known hydrothermal sites in the Okinawa Trough for further understanding of the linkage between the chemical and biological nature and the geological and tectonic background.

3.3.2. Materials and Methods

For accomplish the purpose, we sampled seawater (Niskin bottle, bag pump sampler, multi syringe water sampler and WHATS with temperature probe), sediments (push corer), rocks and organisms (sponge, fish, etc. with suction sampler).

3.3.3. Future works

We got seawater, sediment, rocks and biological samples during the dives. The water samples are provided to analyze some metal species for determining the hydrothermal contribution. From the interstitial water and its dissolved gas chemistries in the red-brown sediment sample we plan to decide whether the temperature anomaly is caused by a hydrothermal activity. Dissolved organic chemicals in the seawater samples are also important object for understanding the character of hydrothermal activity occurred in Okinawa Trough. DOC, volatile organic acids, amino acids, and some protein also plan to measure at the onshore-based laboratories. Such geochemical studies are conducted at the following institutions and colleagues: Okayama, Kyushu, University of Ryukyus, Hiroshima University and Kochi University. In addition, from the isotopic signatures of the benthos samples we try to estimate whether they rely on the chemosynthesis-based primary production. Such biogeochemical studies are conducted at the following institutions and colleagues: Misaki Marine Biological Station and AORI, the University of Tokyo, JAMSTEC, and Okayama University.

3.4. Microbial uptake of carbon substrate in deep-sea hydrothermal plume.

Katsunori Yanagawa, Yoshikazu Mochizuki (The University of Tokyo, JAMSTEC)

3.4.1. Purpose

Gammaproteobacterial sulfur-oxidizers show the dominance in deep-sea hydrothermal plume (i.e., SUP05 group). They have been regarded as chemolithoautotorophic organisms that assimilate carbon dioxide as a sole carbon source, based on the comparison with their closest neighbors from their phylogenetic position. In this cruise, in order to elucidate their abilities to assimilate the carbon dioxide, we focused on the carbon substrate utilization and the carbon flow from microbial cells into extracellular materials such as DOC and virus-like particles.

3.4.2. Materials and Methods

We used the pressure-tight-stainless-steel bottles (Swagelock, Sweden), containing radioisotope-labeled carbon substrate (RI vacuum sampler). The hydrothermal plume-like turbid water sample was collected at the slopes of Tarama Knoll in *HyperDolphin* dive #1322. Immediately after sampling, RI vacuum sampler was incubated at 4°C for 12 hours on board. The microbial activity was stopped by addition formalin (final conc. 3.8%) and kept at 4°C for 12 hours. Then the microbial cells and virus-like particles in the sample were filtered onto 0.2μm-pore sized polycarbonate membrane and 0.02μm-pore-size Anodisc membrane filter, respectively. The filtrated water, which passed through a filter with a nominal pore size of 0.2μm, was used for dissolved organic carbon analysis. These samples were stored at -80°C until future onshore analysis.

3.4.3. Future works

Radioactivity measurements of microbial cells, virus-like particles, and DOC by liquid scintillation are planned for near future. Furthermore, microautoradiography and

FISH (MAR-FISH), which is an important tool for microbial ecology and able to detect the utilization and uptake of RI-labeled substrate at a single cell level, will be the next step to clarify the phylogenetic affiliation of the autotrophic microbes in the deep-sea hydrothermal plume.

3.5. Adsorption behavior of trace elements onto bacteriogenic iron oxides (BIOS)

Sakiko Kikuchi (Hiroshima University)

3.5.1. Purpose

Iron oxides are ubiquitous minerals which often coprecipitate with organic materials and bacterial cells. These iron oxides are referred to as bacteriogenic iron oxides (BIOS). Since iron oxides control the behavior of trace elements through adsorption onto their surface, the adsorption mechanisms of trace elements onto various iron oxides have been well studied. However, these studies concern synthetic iron oxides only. Moreover, few studies report the adsorption behavior of trace elements onto BIOS which is actual iron oxides in natural environment. Some studies have suggested the characteristic property such as surface charge which may lead to the peculiar adsorption behavior of BIOS (Katsoyannis et al., 2006; Martinez et al., 2003). Thus, it is considered that results of previous study by using synthetic iron oxides do not represent the adsorption reaction at subsurface environment.

According to this background, the purposes of our study in this cruise are 1) to identify the mineral species of natural BIOS and, 2) to identify the adsorption behavior of trace elements onto natural BIOS by X-ray absorption fine structure (XAFS) analysis.

3.5.2. Materials and Methods

On board processing

<u>BIOS sample treatments</u>

After recovery on board, a portion of the BIOS samples were kept in 4^{o}C prior to the adsorption experiments. Another portion of the BIOS were kept in -20 ^{o}C to avoid further reaction and transformation for XAFS analysis. A final portion was fixed with formaldehyde (final conc. 3.7%) at 4^{o}C for microscopic observation.

Fe^{2+} measurement

The concentration of ferrous iron were determined by using the 1,10-phenanthroline assay (Harvey et al., 1955).

3.5.3. Future works

To study the role of BIOS for their accumulation of trace elements, future works were discussed separatly by 2 sections written below.

Identification of mineral species of BIOS by XAFS

XAFS measurement will be performed in 26th, October at SPring-8 in Hyogo. Since we already collected XAFS spectra of BIOS at other sites, comparison of mineral species with other sites will be discussed.

Adsorption behavior of arsenic onto BIOS

Arsenic (As) adsorption experiments onto BIOS will be conducted and compared to that with synthetic iron oxides. We also plan to study the amount of As adsorbed onto synthetic BIOS in laboratory which has lower initial trace elements contamination.

4. Acknowledgments

We are grateful to captain Y. Nakamura and the crews of the R/V *Natsushima* for their invaluable supports during the cruise. We are also grateful to ROV *Hyper-Dolphin* operation manager K. Mitsufuji and the operation team for their skillful operation of the ROV. We thank all onshore staff for their support on the NT11-18 cruise.

5. Notice on using

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This report may not be corrected even if changes of contents are found after its publication.

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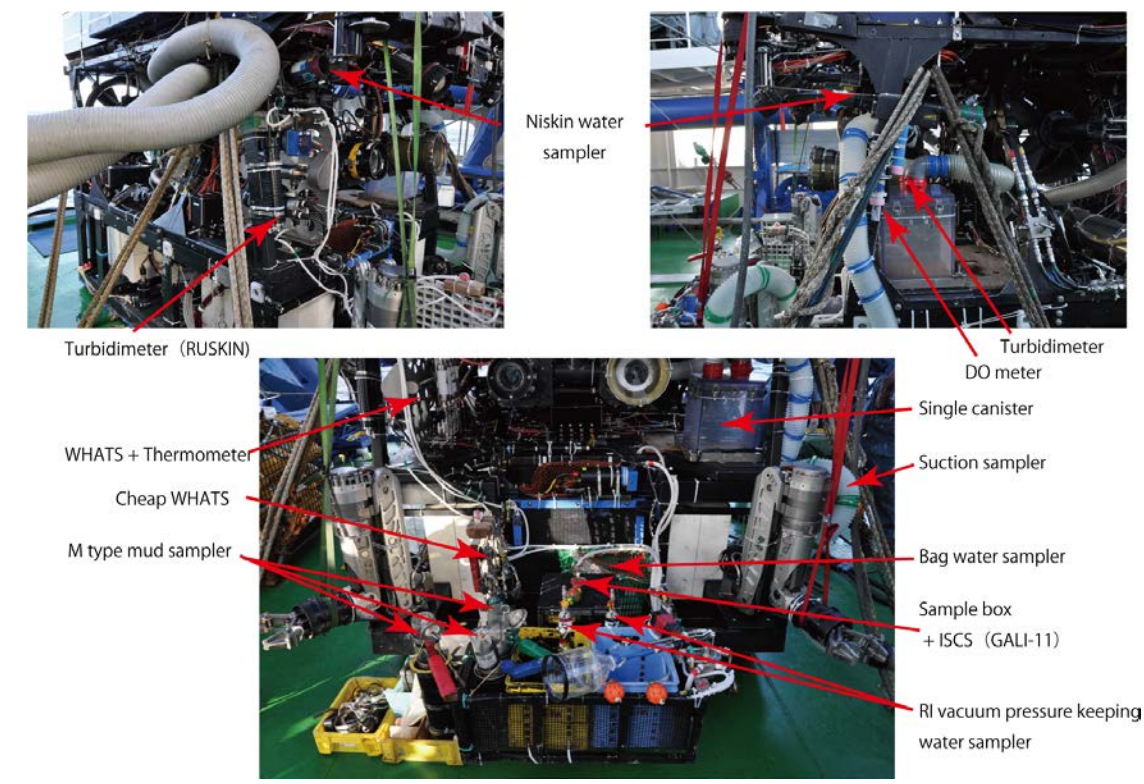
6. Appendix 1. Payload Pictures

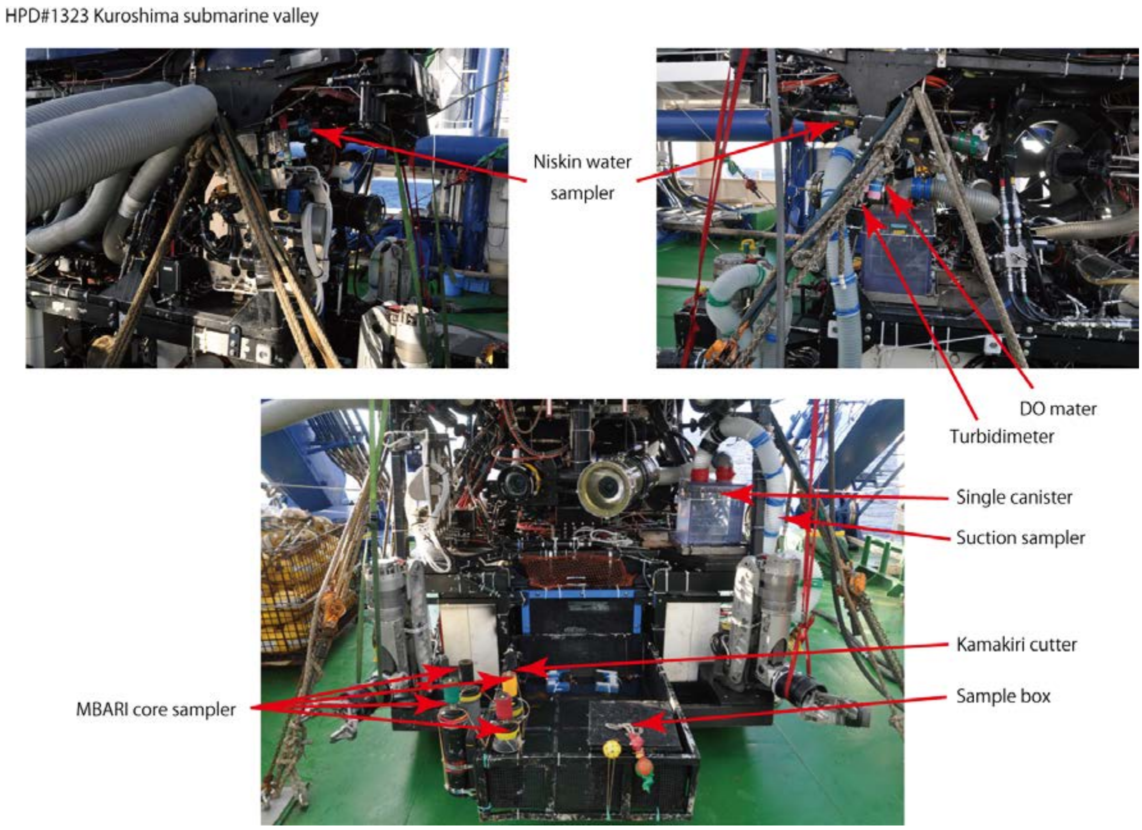
#1322 (20110915), Tarama Knoll

HPD#1322 Tarama sea knoll in Okinawa trough



by Masayuki Miyazaki

#1323 (20110916), off Kuroshima



by Masayuki Miyazaki