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Natsushima Cruise Report

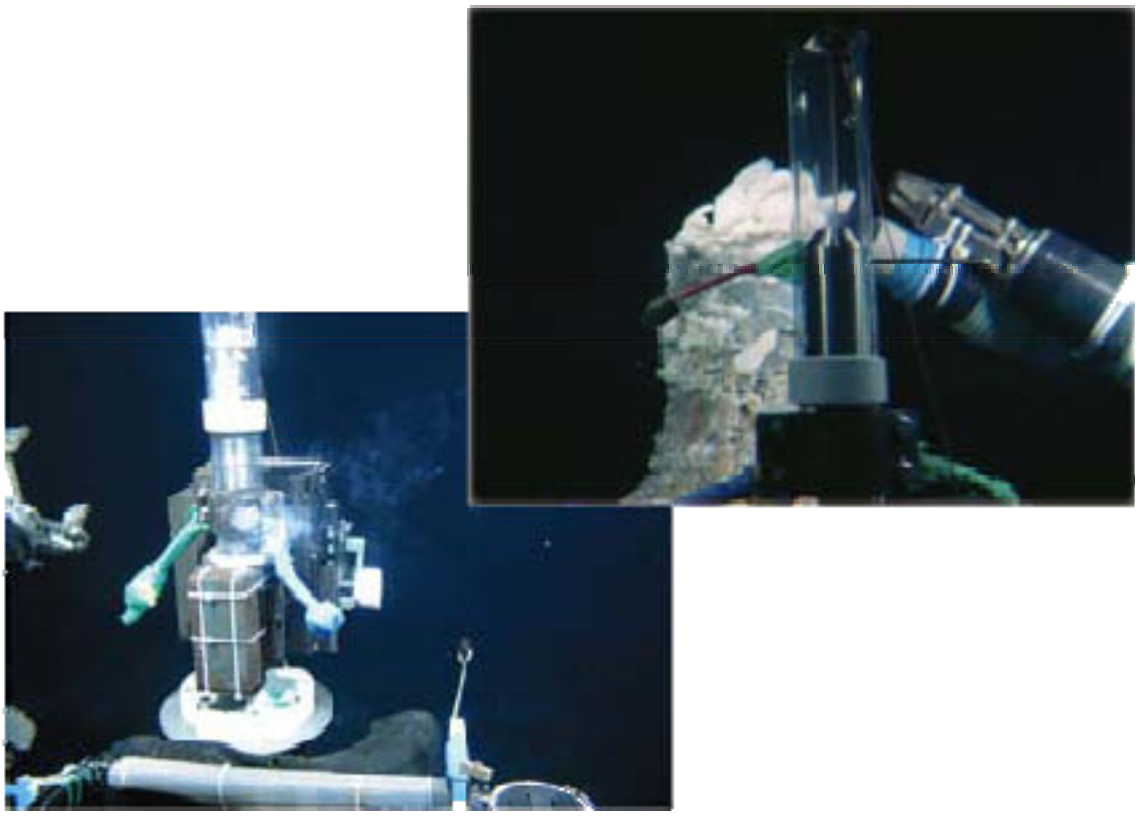
NT10-13 Leg1

Deep Alkaline Serpentine Aquifer Exploration

III of South Chamorro Seamount

Where is the alkaline pH limitation of the active life?

–Investigating the alkaline pH limitation of life through the borehole-deployment system –



July 21, Guam – July 24, Guam, 2010

Japan Agency for Marine-Earth Science & Technology

(JAMSTEC)

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Finally, we would like to appreciate all the person who supported directly or indirectly this cruise.

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Able Seaman	TAKAO KUBOTA
Able Seaman	YUKI YOSHINO
Sailor	HIROTAKA SHIGETA
Sailor	HIDEO ITO
No1. Oiler	SEIICHI MATSUDA
Oiler	TSUNEO HARIMOTO
Oiler	HIROYUKI OISHI
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Oiler	SHIN TORAO
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Steward	TORU WADA
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ROV Operator	KAZUKI IIJIMA

ROV Operator	KEITA MATSUMOTO
ROV Operator	KATSUSHI CHIBA
ROV Operator	HOMARE WAKAMATSU
ROV Operator	TOMOE KONDO
ROV Operator	ATSUSHI TAKENOUCHI
ROV Operator	FUMITAKA SAITOU

Shipboard Log of NT10-13 Leg1

2010/07/20

Weather: fine but cloudy/ Wind direction: ENE/ Wind force: 3/ Wave: 1m/ Swell: 1 m/ Visibility: 8nautical miles (12:00 JST + 1h)

22:00	Onboard

2010/07/21

Weather: fine but cloudy/ Wind direction: East/ Wind force: 4/ Wave: 1m/ Swell: 1 m/ Visibility: 8nautical miles (12:00 JST + 1h)

13:00	Departure from Guam
14:00-15:00	Briefing about ship's life and safety
18:00-18:30	Scientific Meeting

2010/07/22

Weather: fine but cloudy/ Wind direction: East/ Wind force: 3/ Wave: 2m/ Swell: 2 m/ Visibility: 8nautical miles (12:00 JST + 1h)

06:30	XBT
08:29	Launch HPD (HPD#1158dive)
09:55	HPD lands (2,951m)
12:57	HPD leaves the bottom (2,946m)
14:34	HPD on deck

2010/07/23

Weather: fine but cloudy/ Wind direction: ESE/ Wind force: 3/ Wave: 2m/ Swell: 2 m/ Visibility: 8nautical miles (12:00 JST + 1h)

07:15	Launch HPD (HPD#1159dive)
08:42	HPD lands (2,943m)
12:25	HPD leaves the bottom (2,946m)
13:58	HPD on deck
15:47	Launch HPD (HPD#1160dive)
17:15	HPD lands (2,962m)
19:11	HPD leaves the bottom (2,947m)
20:45	HPD on deck

2010/07/24

08:45 Arrival at Guam, NT10-13_Leg1 finish and disembarkation

I. CRUISE SUMMARY

In this cruise, we succeeded in (1) sampling water from 180 mbsf of borehole by Kandata system (Borehole-deployment sampling system) (2) collecting microbial mats attached to the top of the CORK, and (3) recovering the Kochi 3 x 6L SIP bag sampler. But water sampling at 180 mbsf was not fully successful because the water bottle was not full so that we could not sample fluid enough to characterize the deep crustal fluid of 180 mbsf of the borehole. Therefore, we need still more to improve the Kandata system for future post-drilling studies. And also we could not deployed in situ colonization at depths of borehole by the dead line of operation. The fluid data obtained from the on-board and the future onshore investigation will be integrated and compared with samples at both NT09-01 and NT09-07 cruises. The combined data from the three successive cruises with R/V Natsushima and ROV HyperDolphin will provide important insights into a key question: are the functionally microbial communities which prescribe the pH limitation of life truly present in the serpentinized-derived, extremely alkaline deep crustal fluid flows?

II. Introduction

General background and objectives

The primary scientific objective of this research project is to clarify whether a true active subseafloor microbial ecosystem which prescribes pH limitation of life is present and functioning in the subseafloor environment of the Mariana Forearc South Chamorro Seamount or not. And also in this NT10-13 Leg 1 cruise, there is an additional technical objective, innovating borehole deployment sampling system.

In 2001, Ocean Drilling Program (ODP) expedition Leg#195 was conducted to obtain the samples of serpentinization-derived fluids, rocks and mud in the South Chamorro Seamount located in the Mariana Forearc, approximately 140 km east-northeast from the Guam Island (Salisbury et al., 2002). The geochemistry characterization of the pore-water samples demonstrated that the subseafloor environment of the South Chamorro Seamount is an extreme environment of which pH reaches to pH12.5, among the strongest hyperalkaline in this planet (Mottl et al., 2003). Meanwhile, the microbiological exploration suggested interesting but somewhat contradicting image of the subseafloor biosphere. Based on the culture-independent (lipid) surveys, there were detected hot spots of microbial populations at several depths (Mottl et al., 2003) while the culture-dependent surveys indicated the occurrence of active microbial communities in the very shallow subsurface (Takai et al., 2005). The subseafloor environment under pH12.5 is marginal for the microbial habitability (the highest pH limit for microbial growth is known as pH12.4) (Takai et al., 2001).

To know whether there are the active biosphere in the subseafloor on South Chamoro Seamount, NT09-01 and NT09-07 cruise were conducted in 2009. We analyzed chemical profile of the fluid sampled from top of the CORK which was deployed at one of the boreholes in the ODP#195. The pH of the fluids showed 12.1-12.3, and magnesium and sulfate concentration was very little. We also detected microbial activity demonstrated by radio isotopes (RI) analysis using methane, formate, and acetate as a substrate. However, microbial community structure of the fluid showed that aerobic methanotrophs dominated in the fluids.

These results suggested that the fluid from the top of the CORK contain seawater. Therefore, it has possibility that the activity shown by RI were derived from microbes depending on fluid-seawater mixing. However, only a few percent of clones of 16S rRNA had a close similarity to *Alkaliphilus transvaalensis* which can grow in pH12.4. Therefore, in the depths of borehole, it may be possibility that there are microbial ecosystem depending on deep crustal water with high alkaline pH. And also chemical profiles of at ODP#195 were considerably different from those of fluid from the top of the CORK at NT09-01 and NT09-07. These results indicate that we must sample deep crustal water from depths of borehole to know whether there is the active microbial ecosystem depends on hyper-alkaline crustal water of South Chamoro Seamount or not.

To accomplish these questions, we developed the borehole-deployment sampling system project, “Kandata project”. Kandata project is a post-drilling project to develop the system sampling fluid or microbes directly from depths of borehole. This project has been supported by JAMSTEC AWARDS for “Observing system research and technological development”. This system has two rules. One is that this Kandata system must be conducted only by Hyper Dolphin, although many of post drilling research required a large drilling ship to access bore hole. Another feature is that this Kandata system required a tight system to prevent contaminations from seawater. These contaminations cause the error for detecting lower microbial population in subvent biosphere. In this NT10-13 Leg1, we will use this Kandata system to sample “true” deep crustal water by Deep Sampler and collect microbes by Bio Sampler to clarify the above question.

Finally, the NT10-13 leg1 cruise will also collect the microbial mats consisted by aerobic methanotrophs. South Chamoro Seamount is good place for aerobic methanotrophs which has not been isolated from deep-sea environment.

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III. DIVE REPORT

HPD#1158 DIVE (South Chamorro Seamount) Dr. J. Miyazaki
HPD#1159 DIVE (South Chamorro Seamount) Dr. J. Miyazaki
HPD#1160 DIVE (South Chamorro Seamount) Dr. J. Miyazaki

Dive Report: HyperDolphin Dive #1158

Date: 22 July, 2010
Site: ODP#195 CORK at borehole 1200c site of South Chamoro Seamount
Landing: 9:55; 13°47.074'N, 146˚00.099'E, 2951m
Leaving: 12:57; 13˚47.051'N, 146˚00.180'E, 2945m
Observer: Junichi Miyazaki (SUGAR Project, JAMSTEC)

Objectives:
The objectives of this dive are 1) Water sampling from the top of the CORK by WHATS and Bag Sampler, 2) Water sampling from 110 mbsf of the borehole, and 3) the 3 x 6L SIP bags recovering.

Dive Summary:
At 9:55, we landed on the bottom which was covered with serpentine mud. We headed to the CORK while looking for the 3 x 6L SIP Bags. We reached the CORK and observed large white-colored mat and white-smoker from the top of the CORK. After we sampled the bacterial mat by sucssion sampler, we next succeefully obtained water from top of the CORK by using WHAT and Bag sampler. Next, we tried to set up Watanabe's winch system with Deep Sampler. After pulling the stopper for the Deep Sample, unexpectedly the Deep Sampler was freely fallen due to trouble of winch system. After stopping free-fall by HPD manipulator, we clarified that deep sampler was positioned at 180 mbsf. We dropped trigger weight to start sampling water. After we clarified that the trigger reached the Deep Sampler, we tried to recover the Deep Sampler. However, the hydraulic motor was broken. Therefore we gave up the recovering. The Deep Sampler was fallen to the 202 mbsf. After we left the CORK, we picked up the 3 x 6L SIP Bags and then left the bottom.

Payloads:
1) WHATS without a temperature probe
2) 20L bag x 1
3) Watanabe's winch system
4) Deep Sampler
5) Sucssion Sampler

Location of Events:

Time	Position	Depth	Event
9:55	13°47.074'N, 146˚00.99'E,	2951m	Landing on serpentine mud
10:03	13˚47.063’N, 146˚00.108'E,	2943m	Finding CORK
10:15	13˚47.052'N, 146˚00.153'E,	2943m	Covered by white-colored mat. White Smoker was observed.
10:15	13˚47.049'N, 146˚00.123'E,	2940m	Landing on the CORK and Sampling bacterial mat.
10:24	13˚47.049'N, 146˚00.123'E,	2940m	WHATS (1) (Temp1.1°C)
10:32	13˚47.049'N, 146˚00.123'E,	2940m	WHATS (2) (Temp1.1°C)
10:38	13˚47.049'N, 146˚00.123'E,	2940m	WHATS (3) (Temp1.0°C)
10:45	13˚47.049'N, 146˚00.123'E,	2940m	WHATS (4) (Temp1.0°C)
10:52	13˚47.049'N, 146˚00.123'E,	2940m	Bag (20L)
11:45	13˚47.049'N, 146˚00.123'E,	2940m	Setting up Winch system
12:05	13˚47.049'N, 146˚00.123'E,	2940m	Pulling stopper but Deep sampler was free-fallen.
12:11	13˚47.049'N, 146˚00.123'E,	2940m	Pulling stopper for Weight trigger
12:35	13˚47.049'N, 146˚00.123'E,	2940m	Left the CORK
12:44	13˚47.047'N, 146˚00.128'E,	2945m	Recover 3 x 6L Bag
12:57	13˚47.047'N, 146˚00.128'E,	2946m	Left the Bottom

Dive Report: HyperDolphin Dive #1159

Date: 23 July, 2010
Site: ODP#195 CORK at borehole 1200c site of South Chamoro Seamount
Landing: 8:42; 13°47.074'N, 146˚00.124'E, 2943m
Leaving: 12:25; 13˚47.047'N, 146˚00.128'E, 2946m
Observer: Junichi Miyazaki (SUGAR Project, JAMSTEC)

Objectives:
The objective of this dive is recovering the Deep Sampler with Watanabe's Winch system.

Dive Summary:
At 8:42, we landed on the bottom. We headed to the CORK. We reached the CORK and start rolling up to recover the deep sampler. When the Deep Sampler reached at 160mbsf, the preventive stopper for rolling down was correctly worked. When the Deep sampler reached at 70 mbsf in the borehole, the winch connector for the hydraulic motor was broken. Therefore we tried to roll up by HPD manipulator. At 12:24, we successfully recovered Deep Sampler.

Payloads:
1) Balast chain
2) Cutter
3) Jigs for Watanabe's winch system

Location of Events:

Time	Position	Depth	Event
8:42	13°47.074'N, 146˚00.124'E,	2943m	Landing on serpentine mud
8:45	13˚47.070'N, 146˚00.127'E,	2942m	Finding CORK
8:48	13˚47.073'N, 146˚00.126'E,	2940m	Landing on the CORK
9:08	13˚47.073'N, 146˚00.126'E,	2940m	Rolling up winch
11:55	13˚47.049'N, 146˚00.123'E,	2940m	Finishing roll up
12:24	13˚47.049'N, 146˚00.123'E,	2946m	Recover winch and Deep sampler

12:25 13˚47.047'N, 146˚00.128'E, 2946m Left the Bottom

Dive Report: HyperDolphin Dive #1160

Date: 23 July, 2010
Site: ODP#195 CORK at borehole 1200c site of South Chamoro Seamount
Landing: 17:15; 13°47.076'N, 146˚00.128'E, 2962m
Leaving: 19:11; 13˚47.051'N, 146˚00.180'E, 2945m
Observer: Junichi Miyazaki (SUGAR Project, JAMSTEC)

Objectives:
The objective of this dive is deployment of Bio Sampler at 180mbsf of borehole1200c.

Dive Summary:
At 17:15, we landed on the bottom. We headed to the CORK. We reached the CORK and tried to setting up winch system on top of the CORK. But PVC manifold inserted in the CORK was broken, therefore we could not set up the winch system. At 18:50, we gave up setting and left the bottom.

Payloads:
1) Bio Sampler
2) Watanabe's winch system
3) Hirayama's in situ colonization system attached to the winch system
4) Gali in situ colonization system attached to the winch system.

Location of Events:

Time	Position	Depth	Event
17:15	13°47.076'N, 146˚00.128'E,	2943m	Landing on serpentine mud
17:25	13˚47.071'N, 146˚00.127'E,	2942m	Finding CORK
17:29	13˚47.072'N, 146˚00.129'E,	2940m	Landing on the CORK
17:08	13˚47.072'N, 146˚00.129'E,	2940m	Trying to set up the winch system
18:50	13˚47.072'N, 146˚00.129'E,	2940m	Give up setting winch.
19:11	13˚47.047'N, 146˚00.128'E,	2947m	Left the Bottom

IV. APPENDIX

Sample list for Microbiology, Biology and Geochemistry

HPD#1158

Sample	JAMSTEC/SUGAR	JAMTEC/PEL	JAMSTEC/Kochi Core	Sampling Site
WHATS1	150 mL (Gas extraction)			Fluid from the top of the CORK
WHATS2			150 mL (Fixation)	
WHATS3	68 ml (Amino acid) 68 ml (Sulfur isotope) 4 ml (pH & alkalinity)	12 mL ($d^{15}NH_4^+$)		
WHATS4	20 mL (NH_4^+) 10 mL (ICP-AES) 5 mL (H_2S)	12 mL ($d^{15}NH_4^+$)		
Microbial Mat (g)	250 g (Cultivation & DNA)			Attached to the top of the CORK
Bag (20L)		20 L (^{129}I SI analysis)		Fluid from the top of the CORK
3 x SIP BAG1			4L (Fixation)	Fluid from the top of the CORK. Deployed at seafloor for 14 months.
3 x SIP BAG2			4L (Fixation)	
3 x SIP BAG3			4L (Fixation)	

HPD#1159

Sample	JAMSTEC/SUGAR	JAMTEC/PEL	JAMSTEC/Kochi Core	Sampling Site
Deep Sampler	5mL (IC and ICP-AES) 20 ml (Amino acid) 68 ml (Sulfur isotope) 8 ml (pH & alkalinity) 5mL (H_2S)	12 mL ($d^{15}NH_4^+$)	10 mL (Cell Counting)	Crustal water at 180mbsf of borehole
Serpentine mud	5 g (Cultivation & DNA)			Attached with Deep Sampler