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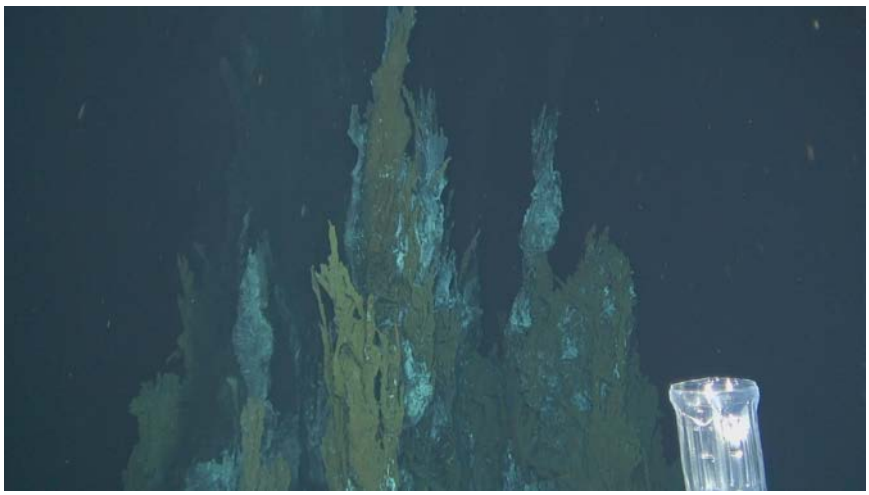
Natsushima Cruise Report
NT12-24

Exploration of iron-based microbial ecosystems at hydrothermal vent sites in the Southern Mariana Trough



September 14, 2012, Guam-September 22, 2012, Guam

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

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Contents

1. Cruise Information

Cruise ID: NT12-24

Name of vessel: R/V Natsushima

Title of the cruise: Exploration of iron-based microbial ecosystems at hydrothermal vent sites in the Southern Mariana Trough

Title of proposals:

(1) Is "hydrothermal fluid-seawater mixing process" a factor controlling variability in hydrothermal ecosystems?

(2) What are the representative physiological characteristics of *Zetaproteobacteria*?

Cruise period: September 14, 2012 (Guam)-September 22, 2012 (Guam)

Research area:

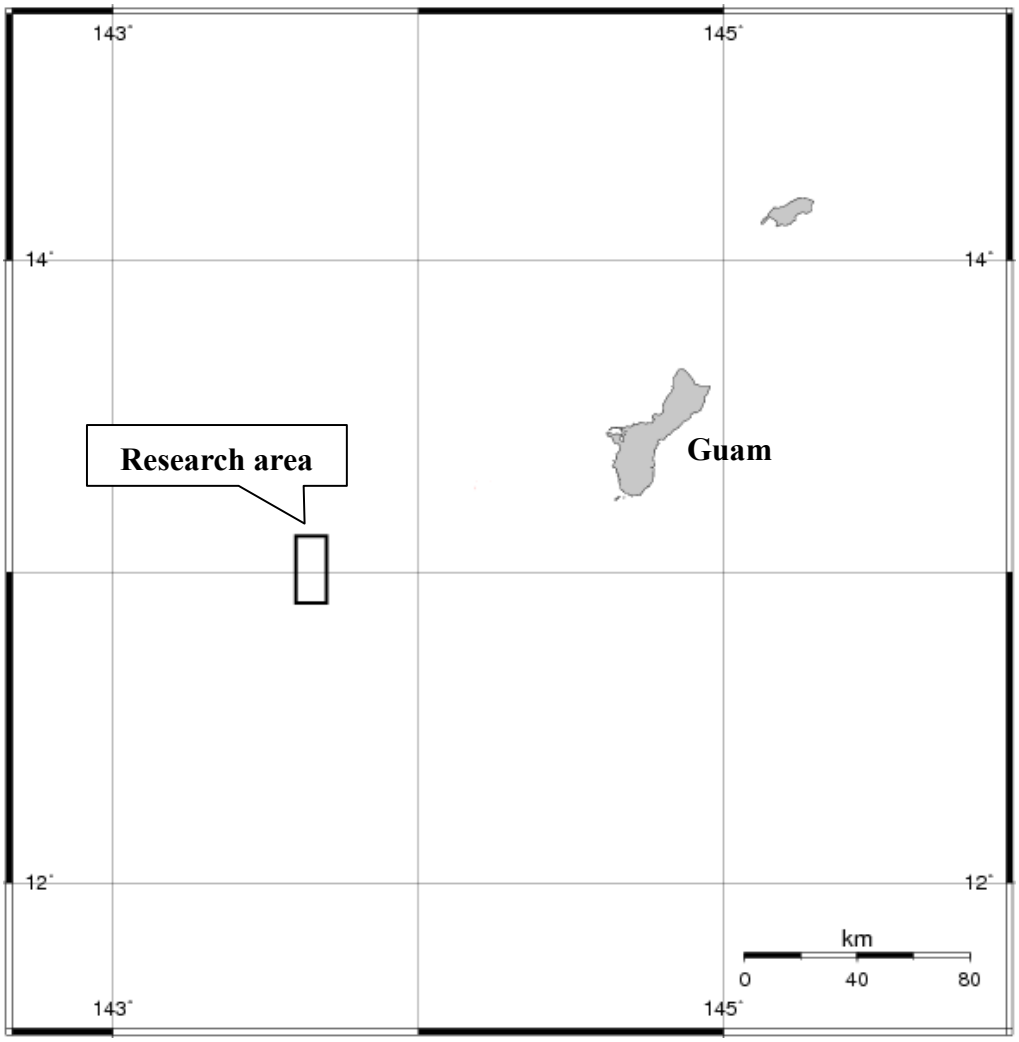


Fig. 1-1. Index map showing location of the research area.

Shipboard Log of NT12-24

日付 Date	時間 Local Time	内容 Note	本船位置／気象／海象 Position/Weather/Wind/Sea condition
14-Sep-12		**Sail out, proceeding to research area**	09/14 12:00 (UTC+10h)
	10:50-11:15	Carried out shipboard education for scientists.	13-27.7N 144-40.1E
	14:55	Let go all shore lines, left GUAM, then proceeding to research area.	Fine but cloudy
	19:00-19:45	Scientists meeting.	East-3(Gentle breeze)
			1(Calm)
			0(No swell)
			Visibly: 8'
15-Sep-12		**HPD#1435_Urashima hydrothermal field**	09/15 12:00(UTC+10h)
	05:55	Arrived at research area.	12-55.3N 143-38.9E
			Fine but cloudy
			East-3(Gentle breeze)
	07:10	Arrived at dive point (Urashima hydrothermal field).	2(Sea smooth)
	08:09	Hoisted up HPD.	3(Moderate short)
	08:14	Launched HPD.	Visibly:8'
	08:24	HPD dove & started her operation #1435.	
	10:04	HPD landed on the sea bottom (D=2940m).	
	15:20	HPD left sea bottom (D=2787m).	
	16:34	HPD floated.	
	16:45	Recovered HPD & finished the operation.	

16-Sep-12		**HPD#1436_ Urashima hydrothermal field**	09/16 12:00(UTC+10h)
	08:11	Hoisted up HPD.	12-55.4N 143-39.0E
	08:16	Launched HPD.	Fine but cloudy
	08:24	HPD dove & started her operation #1436.	South-1(Light air)
	09:58	HPD landed on the sea bottom (D=2943m).	1(Calm)
	15:16	HPD left sea bottom (D=2896m).	3(Moderate short)
	16:31	HPD floated.	Visibly:8'
	16:43	Recovered HPD & finished the operation.	
17-Sep-12		**HPD#1437_ Urashima hydrothermal field**	09/17 12:00(UTC+10h)
	08:08	Hoisted up HPD.	12-55.3N 143-38.9E
	08:14	Launched HPD.	Cloudy
	08:22	HPD dove & started her operation #1437.	SSE-2(Light breeze)
	10:02	HPD landed on the sea bottom (D=2932m).	2(Sea smooth)
	15:00	HPD left sea bottom (D=2770m).	3(Moderate short)
	17:16	HPD refloted.	Visibly:8'
	17:36	Recovered HPD & finished the operation.	
18-Sep-12		**HPD#1438_ Urashima hydrothermal field**	09/18 12:00(UTC+10h)
	08:08	Hoisted up HPD.	12-55.4N 143-39.1E
	08:12	Launched HPD.	Overcast
	08:21	HPD dove & started her operation #1438.	SE-5(Fresh breeze)
	10:14	HPD landed on the sea bottom (D=2964m).	4(Sea moderate)
	15:20	HPD left sea bottom (D=2894m).	3(Moderate short)
	16:41	HPD refloted.	Visibly:8'

	16:56	Recovered HPD & finished the operation.	
19-Sep-12		**HPD#1439_Snail hydrothermal field**	09/19 12:00(UTC+10h)
	07:00	Arrived at dive point (Snail hydrothermal field).	12-27.2N 143-37.1E
	08:13	Hoisted up HPD.	Fine but cloudy
	08:18	Launched HPD.	East-5(Fresh breeze)
	08:27	HPD dove & started her operation #1439.	3(Sea slight)
	09:53	HPD landed on the sea bottom (D=2872m).	3(Moderate short)
	15:13	HPD left sea bottom (D=2868m).	Visibly:8'
	16:29	HPD refloted.	
	16:43	Recovered HPD & finished the operation.	
20-Sep-12		**HPD#1440_ Urashima hydrothermal field**	09/20 12:00(UTC+10h)
	07:15	Arrived at dive point (Urashima hydrothermal field).	12-55.4N 143-39.0E
	08:13	Hoisted up HPD.	Overcast
	08:18	Launched HPD.	ESE-2(Light breeze)
	08:28	HPD dove & started her operation #1440.	2(Sea smooth)
	09:55	HPD landed on the sea bottom (D=2945m).	3(Moderate short)
	15:21	HPD left sea bottom (D=2944m).	Visibly:8'
	16:45	HPD refloted.	
	16:56	Recovered HPD & finished the operation.	
21-Sep-12		**HPD#1441_ Urashima hydrothermal field**	09/21 12:00(UTC+10h)
	08:30	Hoisted up HPD.	12-55.4N 143-39.0E
	08:34	Launched HPD.	Overcast
	08:43	HPD dove & started her operation #1441.	ESE-5(Fresh breeze)
	10:15	HPD landed on the sea bottom (D=2975m).	3(Sea slight)

	15:35	HPD left sea bottom (D=2898m).	3(Moderate short)
	16:52	HPD refloted.	Visibly:6'
	17:03	Recovered HPD & finished the operation.	
	17:20	Left research area, then proceeding to GUAM.	
22-Sep-12		**Entered GUAM, completed NT12-24.**	
	08:30	Sent out 1st shore line, then arrived at GUAM.	

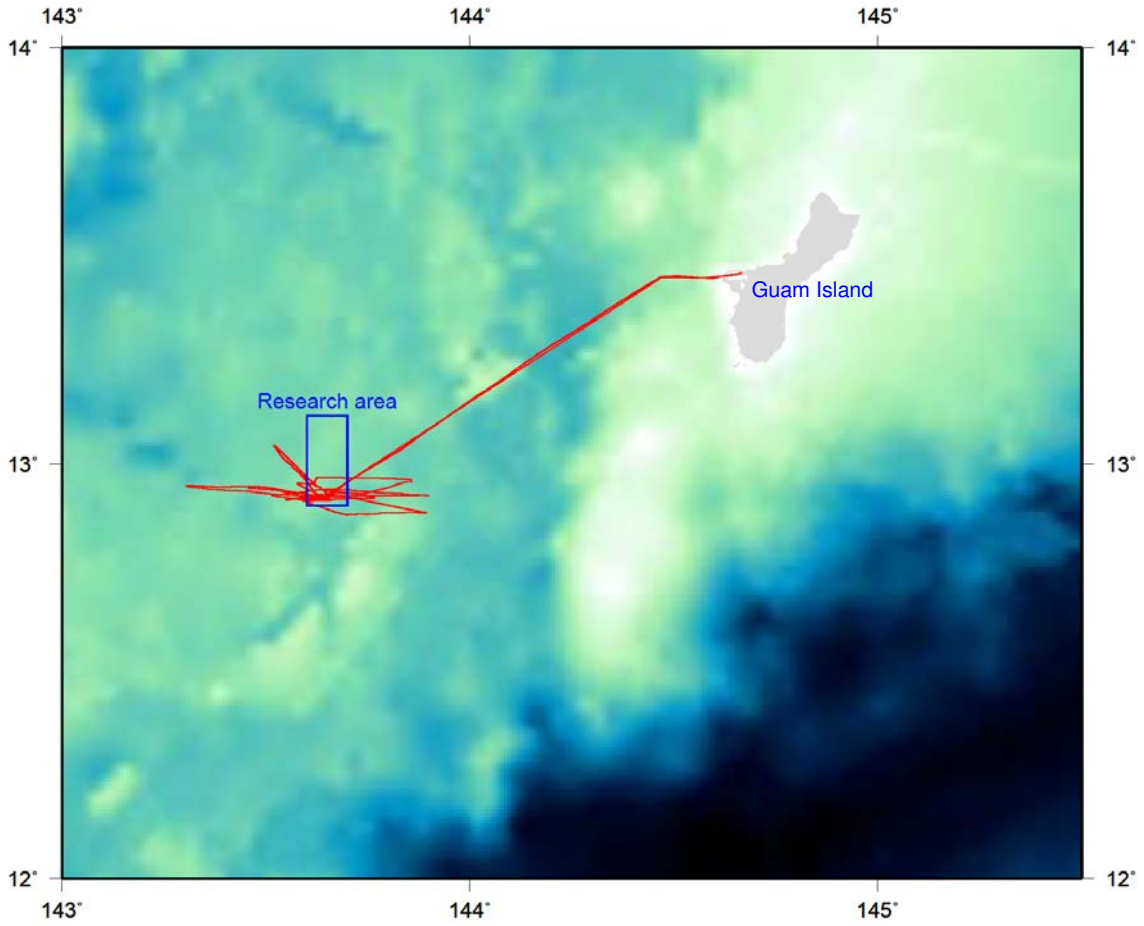


Fig. 1-2. Navigation track of NT12-24 cruise.

2. List of participants

Science party

Chief Scientist
Dr. Kentaro NAKAMURA
Petrologist
Precambrian Ecosystem Laboratory (PEL),
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Dr. Shingo Kato
Microbiologist
Japan Collection of Microorganisms, RIKEN BioResource Center

Dr. Tomohiro Toki
Geochemist
Faculty of Science, University of the Ryukyus

Ms. Miki Tawata
Geochemist
Graduate School of Engineering and Science, University of the Ryukyus

Dr. Hiroko Makita
Microbiologist
Institute of Biogeosciences (Biogeos), Japan Agency for Marine-Science and Technology (JAMSTEC)

Dr. Yukari Yoshida
Virologist
Institute of Biogeosciences (Biogeos), Japan Agency for Marine-Science and Technology (JAMSTEC)

Mr. Hiroki Suga
Geochemist
Graduate School of Science, Hiroshima University

Ms. Sakiko Kikuchi
Geochemist
Graduate School of Science, Hiroshima University

Dr. Yohey Suzuki
Geomicrobiologist
Department of Earth and Planetary Science, the University of Tokyo

Mr. Hitoshi Furutani
Geomicrobiologist
Department of Earth and Planetary Science, the University of Tokyo

Dr. Rejishkumar V. J.
Microbiologist
Tokyo University of Pharmacy and Life Science

Mr. Shota Nitahara
Microbiologist
Tokyo University of Pharmacy and Life Science

Ms. Yuki Mizuno
Organic geochemist
Graduate School of Science, Osaka City University

Marine Technician
Mr. Masashi ITO
Nippon Marine Enterprises, LTD.

Crew

R/V Natsushima Officer and Crews

Captain	**Hitoshi Tanaka**
Chief Officer	**Takafumi Aoki**
2nd Officer	**Masato Chiba**
3rd Officer	**Yumihiko Kobayashi**
Chief Engineer	**Koji Funae**
1st Engineer	**Naohito Tadooka**
2nd Engineer	**Kenichi Shirakata**
3rd Engineer	**Koichi Hashimoto**
Chief Electronic Operator	**Yoichi Inoue**
2nd Electronic Operator	**Yohei Yamamoto**
Boat Swain	**Hatsuo Oda**
Able Seaman	**Shuji Takuno**
Able Seaman	**Yasuo Konno**
Able Seaman	**Nobuyuki Ichikawa**
Able Seaman	**Yukihito Ishii**
Sailor	**Hideo Ito**
Sailor	**Yusaku Kanada**
No.1 Oiler	**Masaru Kitano**
Oiler	**Tsuneo Harimoto**
Oiler	**Moriya Abe**
Oiler	**Toshinori Matsui**
Oiler	**Daiki Sato**
Chief Steward	**Tomihisa Morita**
Steward	**Koji Kirita**
Steward	**Kiyotaka Kosuji**
Steward	**Mizuki Nakano**
Steward	**Katsuhiro Kawase**

ROV Hyper Dolphin Operation team

Submersible Operation Manager	**Yoshinari Ono**
2nd Submersible Technical Officer	**Katsushi Chiba**
2nd Submersible Technical Officer	**Yosuke Chida**

2nd Submersible Technical Officer	**Yudai Sakakibara**
2nd Submersible Technical Officer	**Shigeru Kikuya**
2nd Submersible Technical Officer	**Ryo Saigo**

3. Observation

3.1. Cruise summary

The purpose of this cruse is to clarify chemical linkage between iron-oxidizing microbial activity and host vent fluids in the Urashima and Snail hydrothermal vent site at the Southern Mariana Trough (SMT). The iron-oxidizing microbial communities in deep-sea hydrothermal sites are so far observed at Loihi seamount of Hawaii, Lilliput hydrothermal vent site in the Mid-Atlantic Ridge, and Tarama seamount in the Southern Okinawa Trough, as well as Snail and Urashima hydrothermal vent sites in the SMT. Previous studies on the hydrothermal sites hosting iron-oxidizing bacterial communities have revealed that these sites are low-temperature hydrothermal vent sites where high-temperature end-member fluids can not be obtained. For the reason, sub-seafloor hydrothermal (geochemical) processes controlling the presence of iron-oxidizing bacteria have not been well understood. The two hydrothermal vent sites at the SMT, Snail and Urashima sites, are among the best place to study geochemical linkage between hydrothermal fluids and iron-oxidizing microbial activity due to the following reasons: (1) the Urashima site is the only site where both iron-oxidizing bacterial activity and high-temperature fluid venting have been observed, and (2) there are two drilled boreholes in Snail site, which allow us to approach directly iron-oxidizing bacterial communities below the seafloor. In the NT12-24 cruise, therefore, we have conducted 7 ROV (Hyper Dolphin: HPD) dives at the two hydrothermal vent sites, and successfully obtained the following results.

In the Urashima hydrothermal vent site, we conducted 6 HPD dives. During the dives, we sampled 4 black smoker fluids, 1 white smoker fluid, 4 clear shimmering fluids, and 4 iron-mat fluids. Maximum temperature of the fluids were 271 ℃ for black smoker fluids, 243 ℃ for white smoker fluid, 160 ℃ for clear shimmering fluids, and 53 ℃ for iron-mat fluids. We also sampled active chimney fragments, iron-mat samples, as well as inactive chimney fragments. All of the samples were collected from the newly discovered vents in the Urashima hydrothermal site.

In the Snail hydrothermal vent site, we conducted 1 HPD dive. During the dive, we sampled 1 hydrothermal fluid from a borehole and 1 shimmering fluid from an iron-mat mound. Maximum temperature of the fluids was 46 ℃ for borehole fluid or 52 ℃ for iron-mat fluid. We also sampled 2 iron-mat and 2 inactive-chimney samples. Furthermore, we recovered two *in-situ* colonization systems from the boreholes, which were set in Oct 2010. We succeeded in setting of Yamanaka-type in-situ pore water extraction system on a hydrothermal mound covered with iron mats and recovering it.

Except for a few fluid chemistry data, chemical analyses and microbiological studies on the fluid and chimney samples will be conducted on shore. The results of the shore-based studies will provide important insights into biogeochemical linkage between iron-oxidizing microbial activity and chemical compositions of hydrothermal fluids.

3.2. General background and research objectives

It is well known that seafloor hydrothermal systems support a variety of biological communities that are sustained by primary production of chemolithoautotrophic microorganisms (e.g., Fisher et al., 2007). This type of biological communities does not depend directly on photosynthesis and thus, often referred to as a plausible candidate of early life on Earth as well as extraterrestrial life on other planets and moons (e.g., Schulte et al., 2006). Because the symbiotic and free-living chemolithoautotrophic microorganisms obtain energy from inorganic substances derived from hydrothermal vent fluids (e.g., H_2S, H_2, and CH_4), the diversity and abundances of the hydrothermal vent-endemic biological communities are considered to be controlled by chemical and physical conditions of hydrothermal fluids. Elucidating the physical and chemical relationships between hydrothermal fluids and biological activities, therefore, can provide important insights into the presence of life on early Earth and extraterrestrial planets and moons.

The Urashima hydrothermal field, the proposed site of this project, was discovered in August 2010 at the Southern Mariana Trough by using a manned submersible *Shinkai 6500* (Miyazaki et al., 2010). This site can be considered as an ideal hydrothermal vent site for our studies, because a variety of hydrothermal fluids (from high-temperature black smoker fluids to low-temperature shimmering fluids) and corresponding microbial activities (e.g., white-colored sulfur-oxidizing bacterial mat, brownish-colored iron-oxidizing bacterial mat) have been observed in the hydrothermal site.

The snail site was also discovered at the Southern Mariana Trough, where iron-rich microbial mats associated with low-temperature hydrothermal fluids were found. Furthermore, in this site, there are two boreholes that were drilled using the benthic multi-coring system (BMS) in Feb 2004 and May 2010. Fluid discharging from the two boreholes was confirmed in Oct 2010 and thus, we can access subseafloor fluids directly.

In this cruise, therefore, we have conducted systematic sampling and analyses of hydrothermal fluids and microbial mats in the hydrothermal fields in order to clarify

physical and chemical relationships between hydrothermal vent fluids and chemolithoautotrophic microbial activities in seafloor hydrothermal systems.

References:

Fisher, C.R., Takai, K., and LeBris, N. (2007) Hydrothermal vent ecosystems. *Oceanography* **20**, 14-23.

Schulte, M., Blake, D., Hoehler, T., and McCollom, T.M. (2006) Serpentinization and its implications for life on the early Earth and Mars. *Astrobiology* **6**, 364-376.

Miyazaki, J. and YK10-10 Scientific Party (2010) Are there HyperSLiMEs in the subseafloor on basaltic hydrothermal field? Yokosuka Cruise Report YK10-10, JAMSTEC, http://docsrv.godac.jp/MSV2_DATA/23/YK10-10_all.pdf

3.3. Dive summary

HPD#1435 DIVE (Urashima hydrothermal field)
HPD#1436 DIVE (Urashima hydrothermal field)
HPD#1437 DIVE (Urashima hydrothermal field)
HPD#1438 DIVE (Urashima hydrothermal field)
HPD#1439 DIVE (Snail hydrothermal field)
HPD#1440 DIVE (Urashima hydrothermal field)
HPD#1441 DIVE (Urashima hydrothermal field)

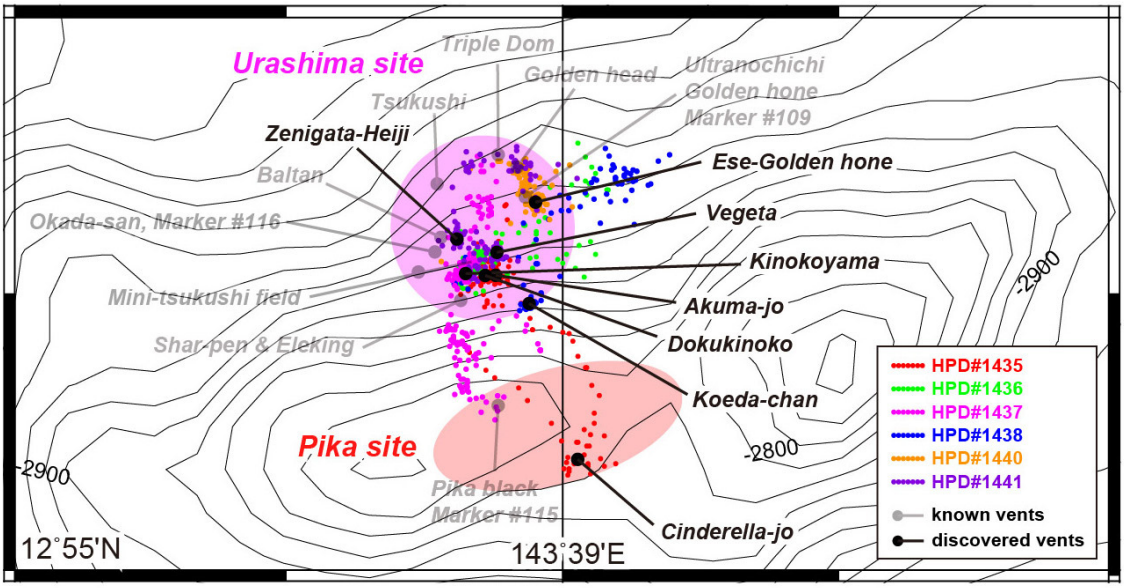


Fig. 3-1. Dive tracks of the six ROV Hyper Dolphin dives conducted at the Urashima hydrothermal vent site.

Dive Report: Hyper Dolphin Dive #1435

Date: September 15, 2012
Site: Urashima hydrothermal field
Landing: 10:04; 12°55.336'N, 143˚38.893'E; 2940m
Leaving: 15:20; 12˚55.130'N, 143˚38.972'E; 2787m

Dive Summary:

The target of today's observation is 6K marker #116 (called "Okada-san chimney"). We landed on approximately 100 m north of the marker #116 at 10:04, immediately after a Niskin water sampling at 10:03. First, we headed to the Baltan chimney that is only one black smoker chimney so far found in the Urashima site and then, headed to the marker #116. However, we were not able to get the both Baltan chimney and the maker #116. After that, we once went to north and then tried again to find marker #116. Although we were not able to find the marker #116 again, we fortunately found a new big black smoker chimney at 11:10. From the newly found black smoker chimney, the hydrothermal fluids were collected by CC-WHATS at 11:59 and Bag water sampler at 12:19. Maximum temperature recorded from the fluid samples were 208 °C. Then, several pieces of the chimney were sampled by manipulator. On the chimney, many of shrimps, crabs, and possibly a kind of snails (Alviniconcha?) were found, whereas we have not sampled any animal samples. After the fluid and chimney sampling, we moved to the base of the big black smoker chimney. At the base of the chimney, we found a portion of clear fluid shimmering. We collected the shimmering fluid by CC-WHATS at 13:13 and Bag water sampler at 13:24. Maximum temperature of the fluids were fairly low (max. 39 °C), indicative of significant contamination of ambient seawater during the sampling. Another water sampling was conducted by vacuum water sampler at 13:41. After that we tried to sample chimney fragments from the shimmering portion. However, we could not sample them and finally gave up sampling chimneys in this portion. Then, we sampled inactive chimneys at the portion very near to the fluid sampling sites (14:06). Next, we headed to the Pika site, approximately 500 m south of the Urashima site. On the way, we sampled hydrothermal sediment by M-type mud sampler at 14:20, then headed to the Pika site, again. On the northern slope of the Pika site, we saw many pillow basalt fragments at the base of the slope, and beautiful pillow basalt outcrop at the upper part of the slope. After climbing the slope, we reached the Pika site (top of the seamount) at 15:09 and successfully found a huge chimney shimmering clear hydrothermal fluid. Probably, this chimney has

not seen yet. We then found an inactive chimney at the base of the huge shimmering chimney and sampled several pieces of the inactive chimney at 15:15. Finally, we left bottom at 15:20.

Payloads:

1) WHATS with a temperature probe
2) CC-WHATS
3) Bag water sampler
2) Niskin water sampler
3) Vacuum water sampler
4) Suction sampler
5) M-type mud sampler
6) SUDO-type mud sampler
7) Conductivity meter
8) Sample box
9) HPD marker

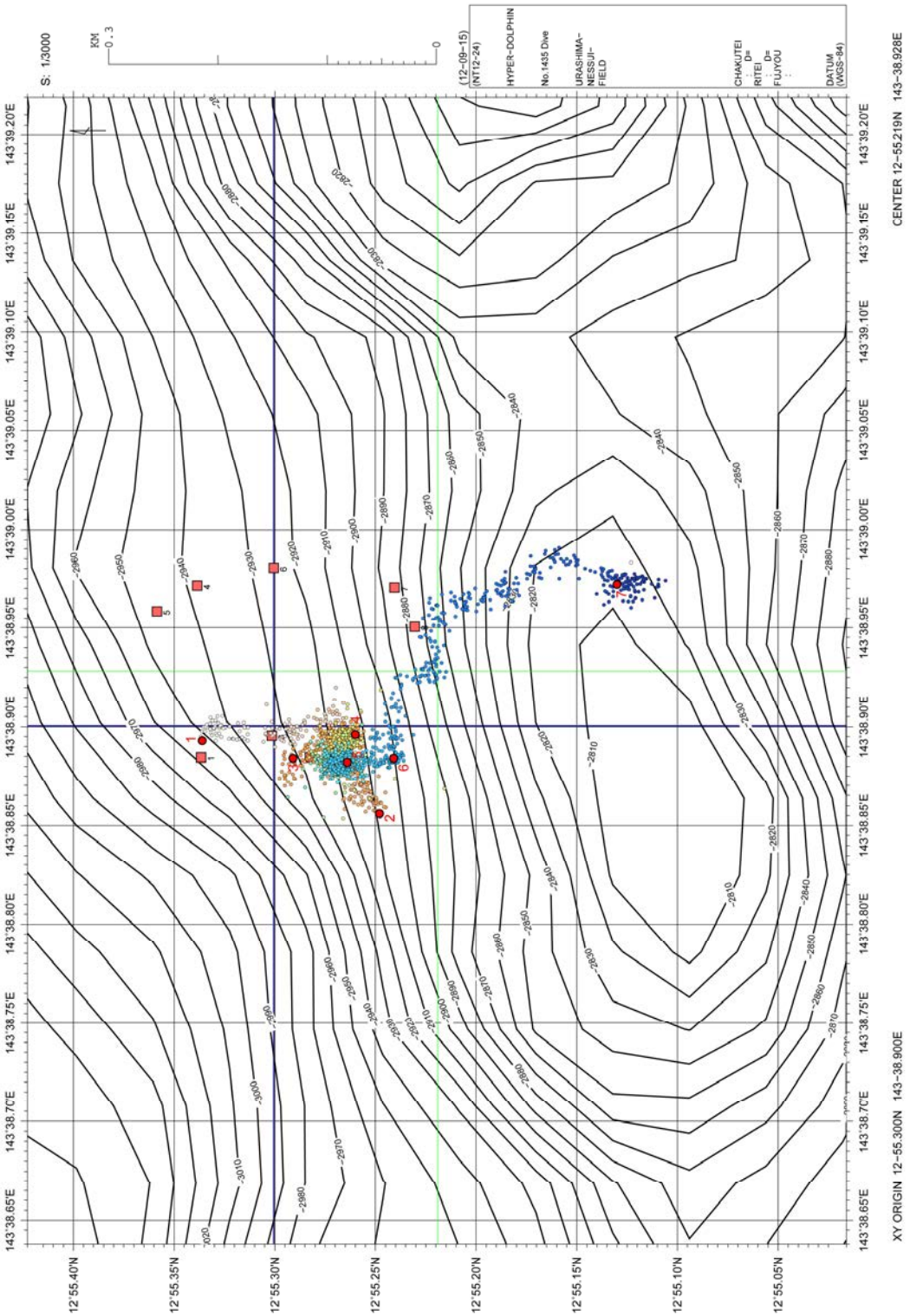
Location of Events:

Time Position Depth Event

10:03 12°55.336'N, 143°38.893'E 2940m Niskin water sampling
10:04 12°55.336'N, 143°38.893'E 2940m Landing
11:10 12°55.260'N, 143°38.896'E 2908m Find black smoker
11:20 12°55.260'N, 143°38.896'E 2908m Sampling chimney
11:56 12°55.260'N, 143°38.896'E 2908m Start CC-WHATS sampling
11:59 12°55.260'N, 143°38.896'E 2908m Finish CC-WHATS sampling
12:12 12°55.260'N, 143°38.896'E 2908m Start bag sampling
12:19 12°55.260'N, 143°38.896'E 2908m Finish bag sampling
12:24 12°55.260'N, 143°38.896'E 2908m Sampling chimneys
13:03 12°55.264'N, 143°38.882'E, 2912m Start CC-WHATS sampling
13:13 12°55.264'N, 143°38.882'E 2912m Finish CC-WHATS sampling
12:17 12°55.264'N, 143°38.882'E 2912m Start bag sampling
12:24 12°55.264'N, 143°38.882'E 2912m Finish bag sampling
12:41 12°55.264'N, 143°38.882'E 2912m Vacuum sampling
14:06 12°55.264'N, 143°38.882'E 2911m Sampling inactive chimney
14:20 12°55.241'N, 143°38.884'E 2906m M-type mud sampling

15:09 12°55.130'N, 143˚38.972'E 2783m Find the Pika site
15:15 12°55.130'N, 143˚38.972'E 2787m Sampling inactive chimneys
15:20 12°55.130'N, 143˚38.972'E 2787m Left the bottom

Dive track of the HPD#1435



Dive Report: Hyper Dolphin Dive #1436

Date: September 16, 2012
Site: Urashima hydrothermal field
Landing: 09:58; 12°55.378'N, 143˚38.973'E; 2943m
Leaving: 15:20; 12˚55.268'N, 143˚38.872'E; 2896m

Dive Summary:

The target of today's observation is 6K marker #109 at the "Ultra-no-chichi chimney). We landed on approximately 100 m north of the marker #109, immediately after a Niskin water sampling at 09:58. First, we headed to the marker #109 to find out the Ultra-no-chichi chimney. However, we could not get the maker, and we found only a few small inactive chimneys, even though the Ultra-no-chichi chimney is known to be surrounded by many big active and inactive chimneys. Then, we headed to east, but there are completely no chimney structures, and only flat sandy plane with several small lava fragments (outcrops?) was observable. We noticed that we were now at out of the Urashima hydrothermal field. After that, we headed to west to enter the central part of the Urashima hydrothermal site. We looked for chimney structures around the central part of the Urashima site, but we could not find out any chimney structures, except for a few inactive chimneys and several very small iron-mat chimneys that are quite different from typical occurrence of chimneys so far found in the Urashima site. It was clear that the ROV was not in the Urashima hydrothermal vent site, even though the positioning system indicated that the vehicle was at the center of the Urashima site. After that, we headed to the west again in order to confirm the position of the big black smoker chimney discovered in the Urashima site yesterday. On the way to the black smoker chimney, we found a new big simmering chimney complex at 11:32. At the base of the chimney complex, we found several iron-mat chimneys and, we sampled iron-mat from one of the chimneys by M-type mud sampler at 12:02. Then, at a shimmering chimney issuing clear fluid at the top, the hydrothermal fluids were collected by CC-WHATS at 12:43 and Bag water sampler at 13:04. Maximum temperature recorded from the fluid samples were 160 °C. Then, we tried to sample some chimney fragments by manipulator, but we failed to sample them because the chimney was very hard. We moved to the different chimney and tried again to get chimney samples. Several pieces of the chimney were sampled at 14:13. On the shimmering chimneys, some shrimps and crabs were found, whereas we have not collected any animal samples. After the fluid and chimney sampling, we moved further to the different chimney and collected another

set of shimmering fluid samples by CC-WHATS at 14:40 and Bag water sampler at 14:55. Maximum temperature of the fluids was 70 °C. After the fluid sampling, we sampled several pieces of the chimney fragments at 15:13. After the sampling, we set H1436-1 marker on the top of the chimney at 15:14. Finally, we left bottom at 15:16.

Payloads:

1) WHATS with a temperature probe
2) CC-WHATS
3) Bag water sampler
2) Niskin water sampler
3) Vacuum water sampler
4) Suction sampler
5) M-type mud sampler
6) SUDO-type mud sampler
7) Conductivity meter
8) Sample box
9) HPD marker

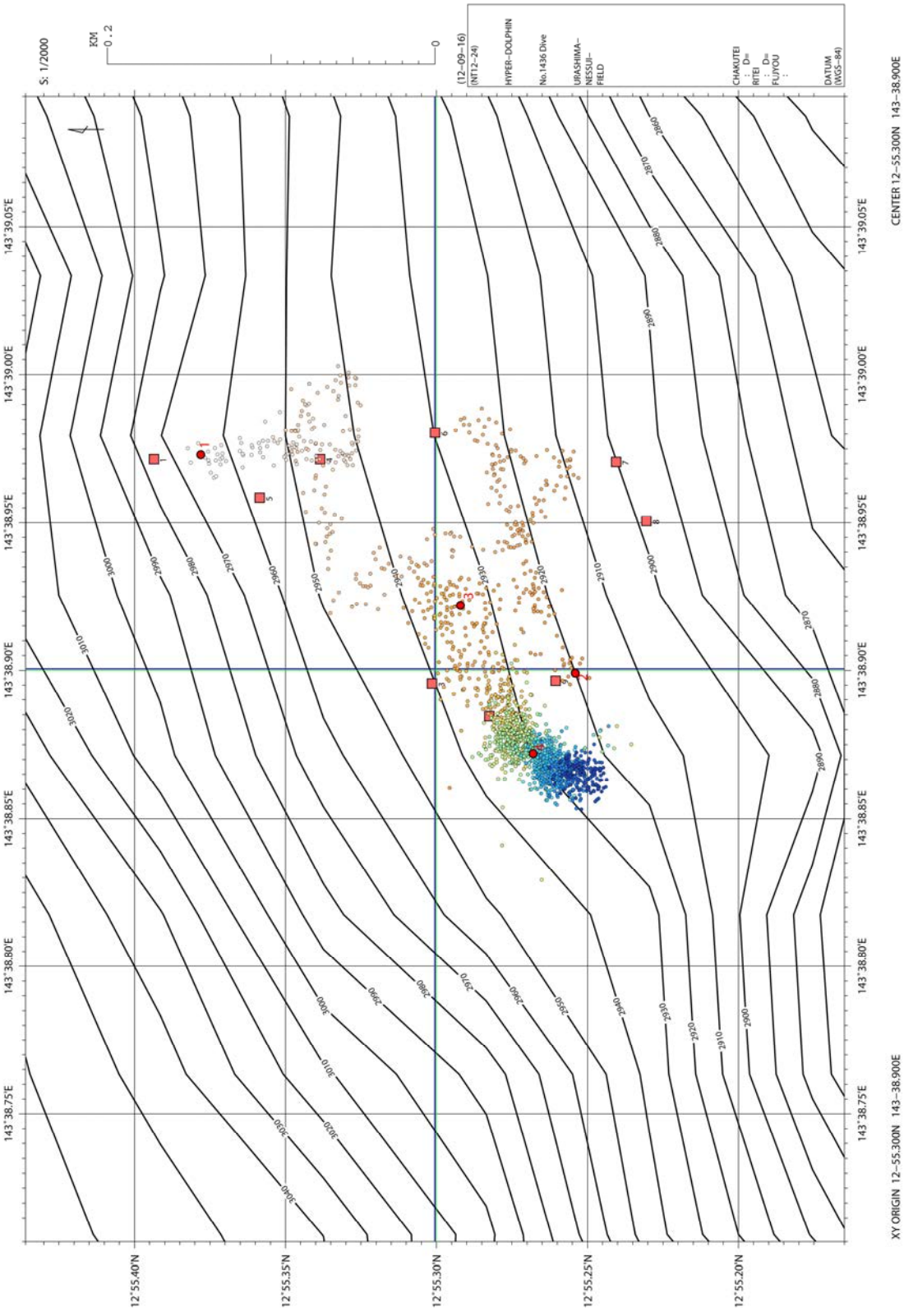
Location of Events:

Time Position Depth Event

09:58 12°55.378'N, 143°38.973'E 2943m Niskin water sampling
09:58 12°55.378'N, 143°38.973'E 2943m Landing
11:32 12°55.268'N, 143°38.872'E 2900m Find shimmering chimney complex
12:02 12°55.268'N, 143°38.872'E 2895m M-type mud sampling
12:31 12°55.268'N, 143°38.872'E 2896m Start CC-WHATS sampling
12:43 12°55.268'N, 143°38.872'E 2896m Finish CC-WHATS sampling
12:57 12°55.268'N, 143°38.872'E 2896m Start bag sampling
13:04 12°55.268'N, 143°38.872'E 2896m Finish bag sampling
14:13 12°55.268'N, 143°38.872'E 2897m Sampling chimneys
14:29 12°55.268'N, 143°38.872'E 2897m Start CC-WHATS sampling
14:40 12°55.268'N, 143°38.872'E 2897m Finish CC-WHATS sampling
14:49 12°55.268'N, 143°38.872'E 2897m Start bag sampling
14:55 12°55.268'N, 143°38.872'E 2897m Finish bag sampling
15:13 12°55.268'N, 143°38.872'E 2896m Sampling inactive chimney
15:14 12°55.268'N, 143°38.872'E 2896m Set H1436-1 marker

15:16 12°55.268'N, 143˚38.872'E 2896m Left the bottom

Dive track of the HPD#1436



Dive Report: Hyper Dolphin Dive #1437

Date: September 17, 2012
Site: Urashima hydrothermal field
Landing: 10:02; 12°55.319'N, 143˚38.876'E; 2932m
Leaving: 15:00; 12˚55.141'N, 143˚38.901'E; 2770m

Dive Summary:

At 10:02, we landed on approximately 100 m north of the marker H1436 that was set on a big shimmering chimney complex named "Kinoko-no-yama vent" yesterday. Then we headed to south to get the marker. First time , we failed to find the marker, but second time we successfully reached the "Kinoko-no-yama vent" and found out the marker on top of a big shimmering chimney at 10:37. After that, we looked around the base of the chimneys in order to find out iron-mat chimneys. After one hour search for iron-mat chimneys, we found out several small iron-mat chimneys at the base of a shimmering chimney, and then landed in front of an iron-mat chimney for sampling. The hydrothermal fluids were collected by CC-WHATS at 11:56 and Bag water sampler at 12:46. Maximum temperature recorded from the fluid samples were 16 °C. We also sample another hydrothermal fluid by vacuum water sampler at 13:14. Then, we tried to sample some chimney fragments by manipulator, but we failed to sample them because the iron-mat chimney was extremely soft. Thus we changed sampling method from manipulator to M-type mud sampler and finally we got iron-mat sample from one of the iron-mat chimney at 13:36. Then, we further looked around the base of the big shimmering chimneys to find out inactive chimneys. During the search, we sampled ambient seawater by Niskin water sampler at 13:48. Soon after, we found several inactive chimneys at the base of a big shimmering chimney. Whereas we tried to sample inactive chimney fragments by manipulator, we could not get any inactive chimney samples because the inactive chimneys were very soft. After that we gave up sampling inactive chimney at the site and headed to south to find out the marker #115 at the Pika hydrothermal site located at several hundreds of meters south of the Urashima site. At the Pika site, we found several inactive chimneys and one of them was sampled at 14:48. Then we headed to east to get the marker #115. Soon after, we successfully found out the marker #115 at the base of big black smoker chimneys at 14:59. At 15:00, oil pressure of the ROV was lost and thus, we left bottom immediately. It was very fortunate that the trouble happened at the end of this dive (HPD#1437) and thus all the planned observation and sampling had been done. On top of that, because we have successfully found out the marker #115 set by the *Shinkai 6500* during YK10-10 cruise,

we have confirmed and corrected a systematic difference between vent location data obtained by YK10-10 cruise and this cruise.

Payloads:

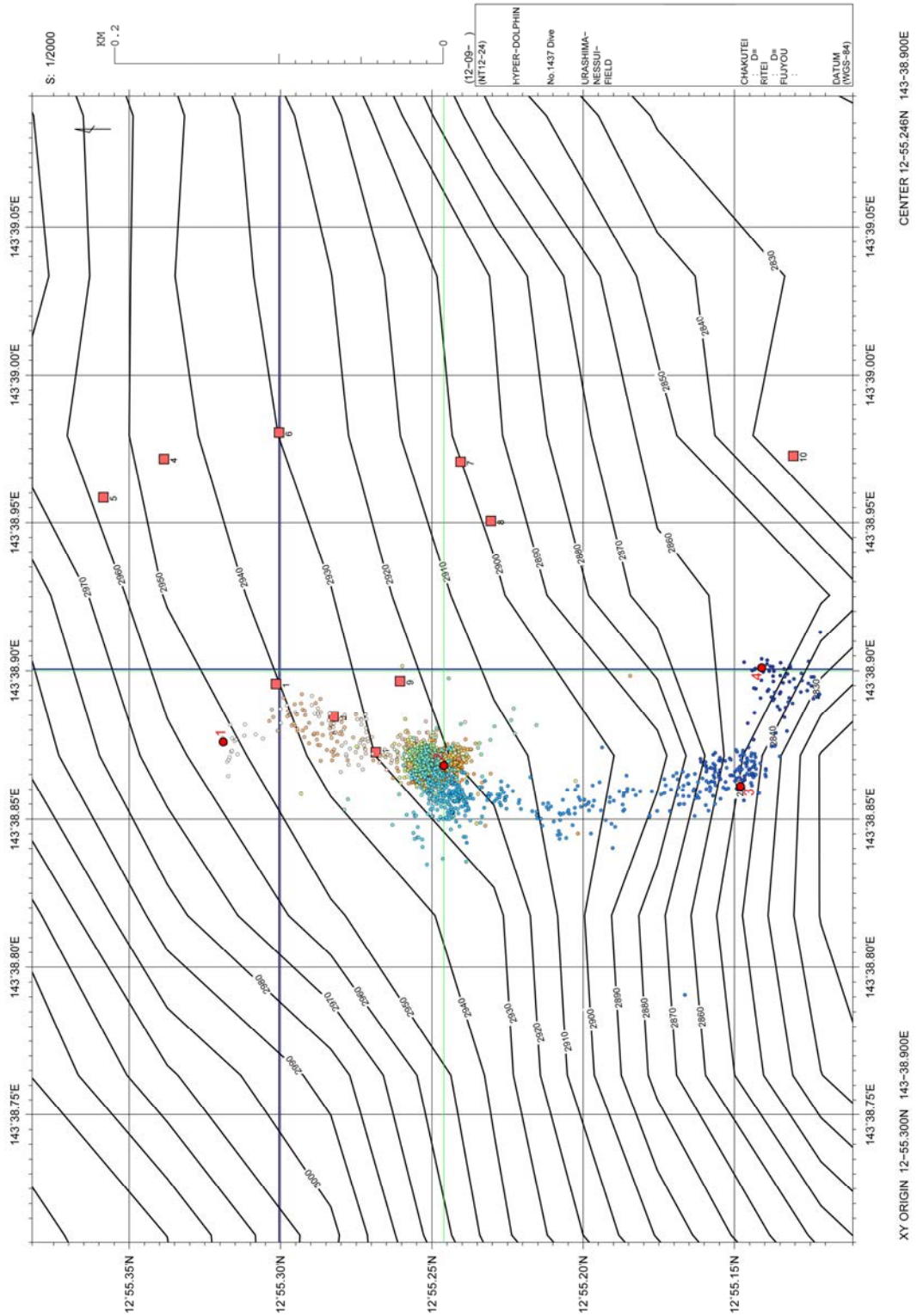
1) WHATS with a temperature probe
2) CC-WHATS
3) Bag water sampler
2) Niskin water sampler
3) Vacuum water sampler
4) Suction sampler
5) M-type mud sampler
6) Conductivity meter
7) Sample box
8) HPD marker

Location of Events:

Time Position Depth Event

10:02 12°55.319'N, 143°38.876'E 2932m Landing
10:37 12°55.246'N, 143°38.868'E 2901m Find H1436 marker
11:38 12°55.246'N, 143°38.868'E 2900m Start CC-WHATS sampling
11:56 12°55.246'N, 143°38.868'E 2900m Finish CC-WHATS sampling
12:29 12°55.246'N, 143°38.868'E 2900m Start bag sampling
12:46 12°55.246'N, 143°38.868'E 2900m Finish bag sampling
13:14 12°55.246'N, 143°38.868'E 2900m Vacuum water sampling
13:36 12°55.246'N, 143°38.868'E 2900m M-type mud sampling
13:48 12°55.246'N, 143°38.868'E 2902m Niskin water sampling
14:48 12°55.148'N, 143°38.861'E 2809m Sampling inactive chimney
14:59 12°55.141'N, 143°38.901'E 2777m Find 6K marker #115
15:00 12°55.141'N, 143°38.901'E 2770m Left the bottom

Dive track of the HPD#1437



Dive Report: Hyper Dolphin Dive #1438

Date: September 18, 2012
Site: Urashima hydrothermal field
Landing: 10:14; 12°55.374'N, 143˚39.055'E; 2964m
Leaving: 15:20; 12˚55.264'N, 143˚38.863'E; 2894m

Dive Summary:

We landed on approximately 100 m northeast of the 6K marker #109 set at "Ultra-no-chichi chimney" and sampled ambient seawater by Niskin water sampler. Then, we headed to southwest to find the marker. However , we could not find out the marker. After that, we were looking for the marker at around the place where the "Ultra-no-chichi chimney" is located. After about two hour search for the 6K marker #109, we finally gave up to find out the marker and "Ultra-no-chichi chimney". Then, we headed to southwest to find the marker H1436 set on a big shimmering chimney complex of "Kinoko-no-yama vent". On the way to the "Kinoko-no-yama vent", we found relatively fresh sulfide breccia indicative of the presence of active hydrothermal vent near by. We changed the heading from southwest to south and climbed a steep slope from which the sulfide breccia was collapsed and falling. On the half way up the steep slope, we found a black smoker chimney that is a newly found hydrothermal vent in the Urashima hydrothermal site. At the vent, we collected black smoker fluid by CC-WHATS at 12:59. Maximum temperature recorded from the fluid samples were 271 °C. Around the black smoker vent, we also sampled inactive chimney fragments by manipulator at 13:26. Then, we headed to northwest to get the "Kinoko-no-yama vent" again. About 30 minutes after, we found the marker H1436 and arrived at the "Kinoko-no-yama vent". At the vent, we found an iron-mat chimney shimmering clear fluid. We sampled iron-mat covering the chimney by M-type mud sampler at 14:00. We did not sample any water samples at the chimney. Then, we found another iron-mat chimney in close proximity. At the chimney, the hydrothermal fluids were collected by Bag water sampler at 14:34 and CC-WHATS at 14:53 . Maximum temperature recorded from the fluid samples were 8°C. We also tried to get water sample by vacuum water sampler, but the sampling did not make it. After that, we sampled iron-mat by M-type mud sampler at 15:17. Finally, we left bottom at 15:20. Immediately after that, we sampled ambient seawater by Niskin water sampler at 15:21.

Payloads:

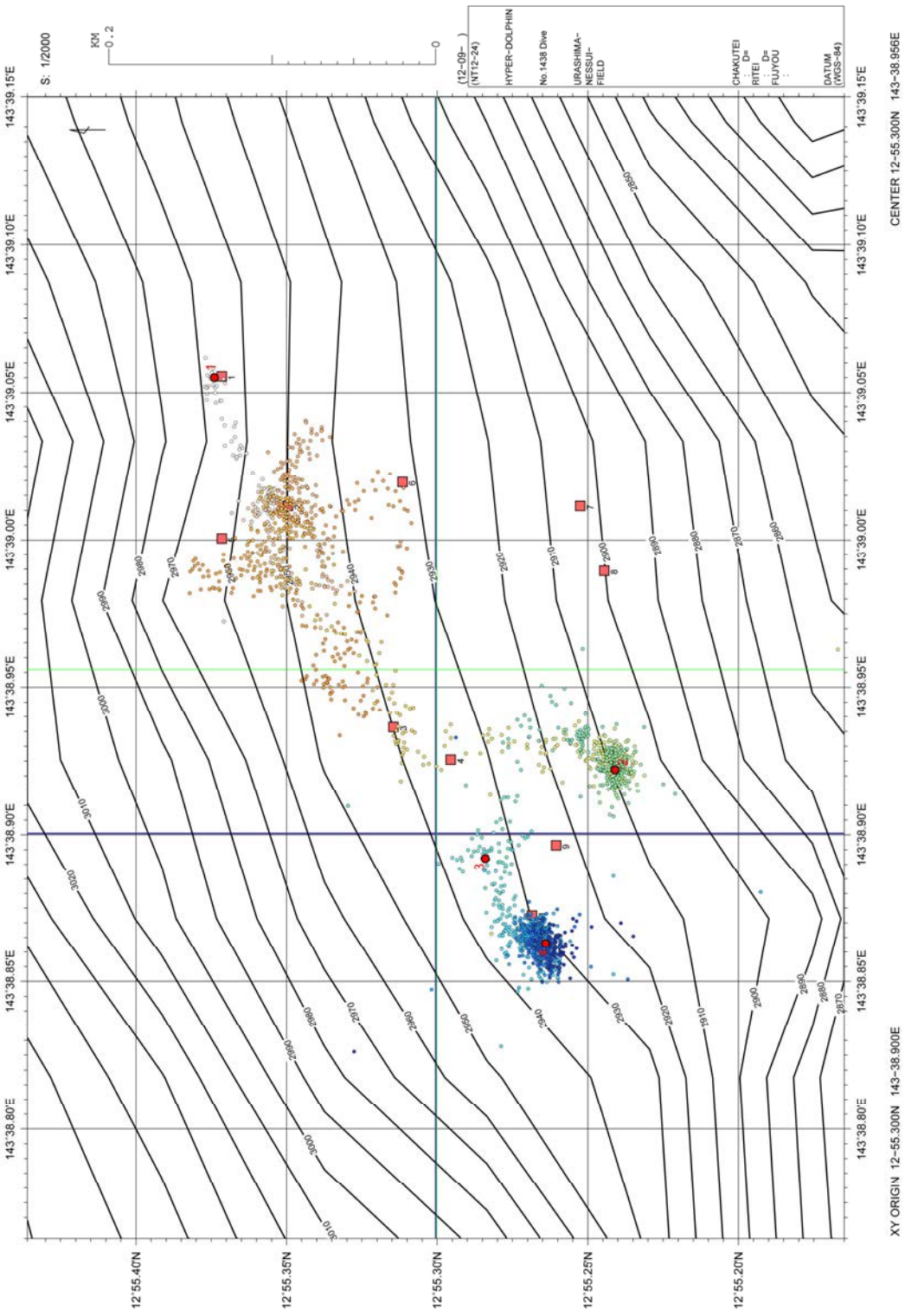
1) WHATS with a temperature probe
2) CC-WHATS
3) Bag water sampler
2) Niskin water sampler
3) Vacuum water sampler
4) M-type mud sampler
5) Conductivity meter
6) Sample box
7) HPD marker

Location of Events:

Time Position Depth Event

10:14 12°55.374'N, 143°39.055'E 2964m Landing
10:15 12°55.374'N, 143°39.055'E 2964m Niskin water sampling
12:29 12°55.241'N, 143°38.922'E 2870m Find black smoker
12:50 12°55.241'N, 143°38.922'E 2870m Start CC-WHATS sampling
12:59 12°55.241'N, 143°38.922'E 2870m Finish CC-WHATS sampling
13:26 12°55.241'N, 143°38.922'E 2870m Sampling inactive chimney fragments
14:00 12°55.264'N, 143°38.863'E 2902m M-type mud sampling
14:17 12°55.264'N, 143°38.863'E 2899m Start bag sampling
14:34 12°55.264'N, 143°38.863'E 2899m Finish bag sampling
14:37 12°55.264'N, 143°38.863'E 2899m Start CC-WHATS sampling
14:53 12°55.264'N, 143°38.863'E 2899m Finish CC-WHATS sampling
15:17 12°55.264'N, 143°38.863'E 2899m M-type mud sampling
15:20 12°55.264'N, 143°38.863'E 2894m Left the bottom
15:21 12°55.264'N, 143°38.863'E 2890m Niskin water sampling

Dive track of the HPD#1438



Dive Report: Hyper Dolphin Dive #1439

Date: September 19, 2012
Site: Snail hydrothermal field
Landing: 09:53; 12º57.166N, 143º37.060E; 2872m
Leaving: 15:13; 12º57.151N, 143º37.128E; 2868m

Dive Summary:

We landed on approximately 150 m east of the 6K marker #108 and sampled ambient seawater with Niskin water sampler. Then, we headed for west to find the marker. Firstly, we found the marker ODP#A on the top of the big rock covered with white microbial mats on the way. Next, we found the 6K#112 and ODP#18 at southwest of ODP#A, and finally found the 6K#108 at southeast of 6K#112. We set iPow on a sulfide mound covered with yellowish iron-rich microbial mats near mrk#108, and then start iPow sampling. The sampling nozzle was not stabbed any point because iPow stayed unstably on the mound. After that, we moved an iron-mat mound at mrk#108. The iron mats were collected with M-type mud sampler, and then hydrothermal fluids (~52ºC) from the mound were collected with a Bag sampler, a CC-WHATS, and Vacuum sampler. Next, we headed for the TAIGA10M01 casing pipe and found. We recovered the in-situ colonization system (ISCS) from the pipe. We observed iron-rich mats within the pipe after the recovering; however, we did not confirm any fluid emission. And then, we headed for the APM01 casing pipe and found it and mrk#113 at south of TAIGA10M01. We recovered ISCS from the pipe. We observed fluid discharging from the pipe, and then we collected the fluids (~46ºC) with Bag sampler. After the sampling, we collected ambient seawater with Niskin. Next, we tried to find a relatively high-temperature hydrothermal vent around the mound with ODP#A. Unfortunately, we failed it. Although we found a vent, we did not collect the fluid because its temperature was low (<5ºC). We collected two inactive chimneys at the point. Next, we headed for iPow with a homer and recovered it. After that, we left bottom.

Payloads:

1) WHATS with a temperature probe
2) CC-WHATS
3) Bag water sampler
2) Niskin water sampler

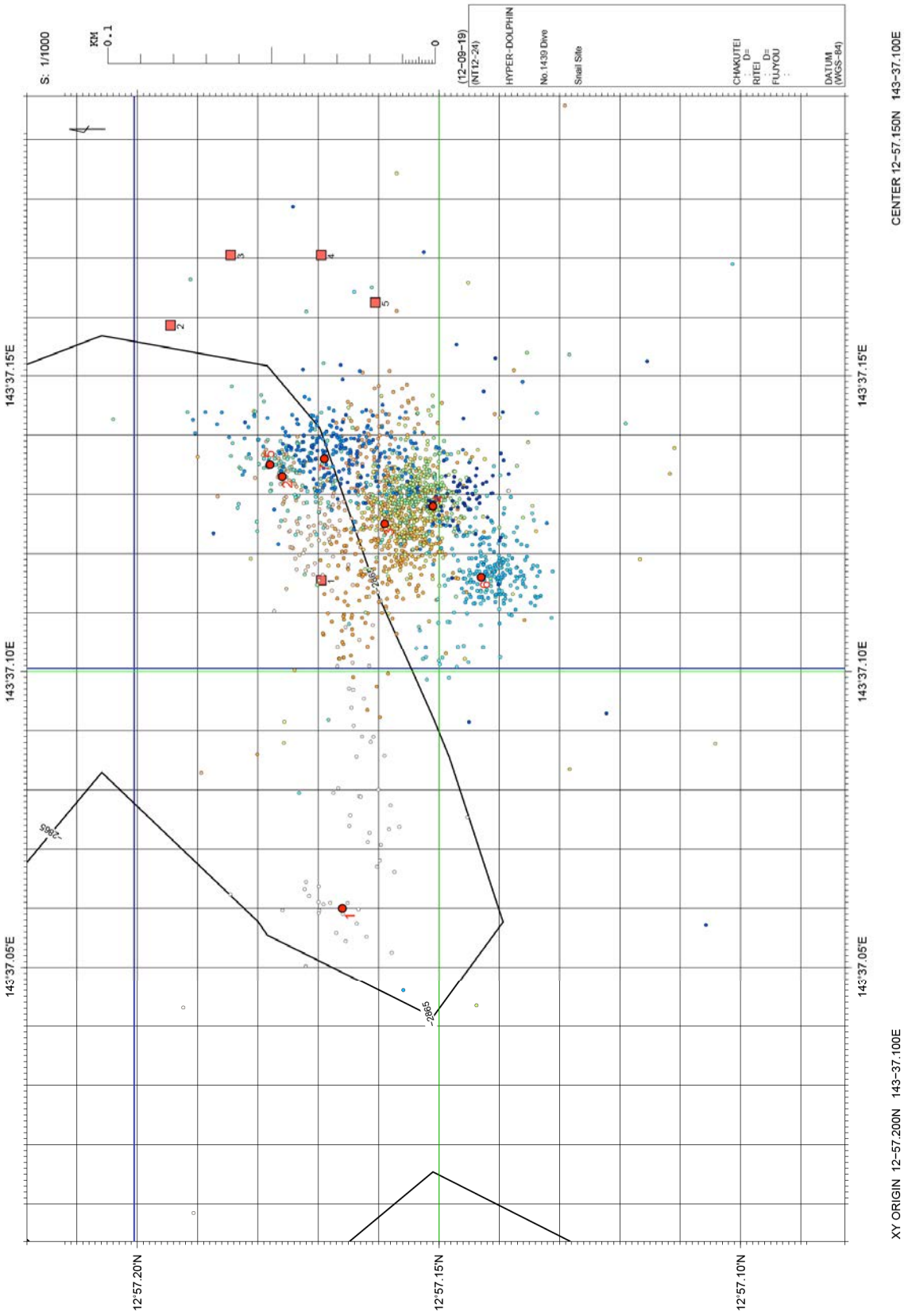
3) Vacuum water sampler
4) M-type mud sampler
5) Conductivity meter
6) Sample box
7) iPow

Location of Events:

Time Position Depth Event

09:53 12º57.166N, 143º37.060E 2872m Landing
09:55 12º57.166N, 143º37.060E 2872m Niskin water sampling
10:16 12º57.176N, 143º37.133E 2863m Find Snailpoint(ODP#A)
10:50 12º57.159N, 143º37.125E 2868m Find marker 6K#112
11:21 12º57.151N, 143º37.128E 2868m Find marker 6K#108
11:28 12º57.151N, 143º37.128E 2868m Start setting iPow
11:47 12º57.151N, 143º37.128E 2868m Finish setting iPow
12:01 12º57.151N, 143º37.128E 2868m M-type mud sampling
12:12 12º57.151N, 143º37.128E 2868m M-type mud sampling
12:21 12º57.151N, 143º37.128E 2868m Start bag sampling
12:30 12º57.151N, 143º37.128E 2868m Finish bag sampling
12:38 12º57.151N, 143º37.128E 2868m Start CC-WHATS sampling
12:48 12º57.151N, 143º37.128E 2868m Finish CC-WHATS sampling
13:05 12º57.151N, 143º37.128E 2868m Vacuum water sampling
13:14 12º57.178N, 143º37.135E 2865m Find TAIGA01 casing pipe
13:19 12º57.178N, 143º37.135E 2865m Recover in-situ cultivation system
13:41 12º57.143N, 143º37.116E 2869m Find APM01 and marker 6K#113
13:41 12º57.143N, 143º37.116E 2869m Recover in-situ cultivation system
14:00 12º57.143N, 143º37.116E 2869m Start bag sampling
14:08 12º57.143N, 143º37.116E 2869m Finish bag sampling
14:12 12º57.143N, 143º37.116E 2869m Niskin water sampling
15:00 12º57.169N, 143º37.136E 2865m Sampling two inactive chimneys
15:04 12º57.151N, 143º37.128E 2868m Start recovering iPow
15:12 12º57.151N, 143º37.128E 2868m Finish recovering iPow
15:13 12º57.151N, 143º37.128E 2868m Left the bottom

Dive track of the HPD#1439



Dive Report: Hyper Dolphin Dive #1440

Date: September 20, 2012
Site: Urashima hydrothermal field
Landing: 09:55; 12°55.356'N, 143˚38.966'E; 2945m
Leaving: 15:21; 12˚55.305'N, 143˚38.938'E; 2944m

Dive Summary:

We landed on approximately 100 m east of the 6K marker #109 set at "Ultra-no-chichi chimney" and sampled ambient seawater by Niskin water sampler. Then, we headed to west to find the marker. Soon after, we found many big chimneys covered with iron-mat. At an iron-mat chimney, we sampled chimney fragments at 10:25, whereas we did not sample any water samples at the chimney. After that, we headed to south to look for the #109 marker at around the place where the "Ultra-no-chichi chimney" is located. Although we still could not find the marker, we found another big iron-mat chimney. At the chimney, we sampled iron-mat by M-type mud sampler at 12:16. Then, we started bag water sampling at 13:44. However, five minutes after, we noticed that the bag was not swelling, indicative of failure of the bag water sampling. We, thus, finished the bag sampling and started another hydrothermal fluid sampling by CC-WHATS at 13:54. Maximum temperature recorded from the fluid samples was 33°C. After the CC-WHATS sampling, we tried again to get bag water sample two times. However, the bag was not swelling and the sampling was failed again. We finally gave up bag water sampling and moved to another iron-mat chimney issuing clear shimmering fluid. At the vent, we collected the shimmering fluid by CC-WHATS at 14:43. Maximum temperature recorded from the fluid samples was 53°C. We also conducted water sampling of the shimmering fluid by WHATS at 14:48 and vacuum water sampler at 14:59. Then, we sampled iron-mat covering the chimney by M-type mud sampler at 15:13. Finally, we sampled ambient seawater samples by Niskin water sampler and WHATS at 15:16 and 15:19, respectively, and then we left bottom at 15:21.

Payloads:

1) WHATS with a temperature probe
2) CC-WHATS
3) Bag water sampler
2) Niskin water sampler
3) Vacuum water sampler

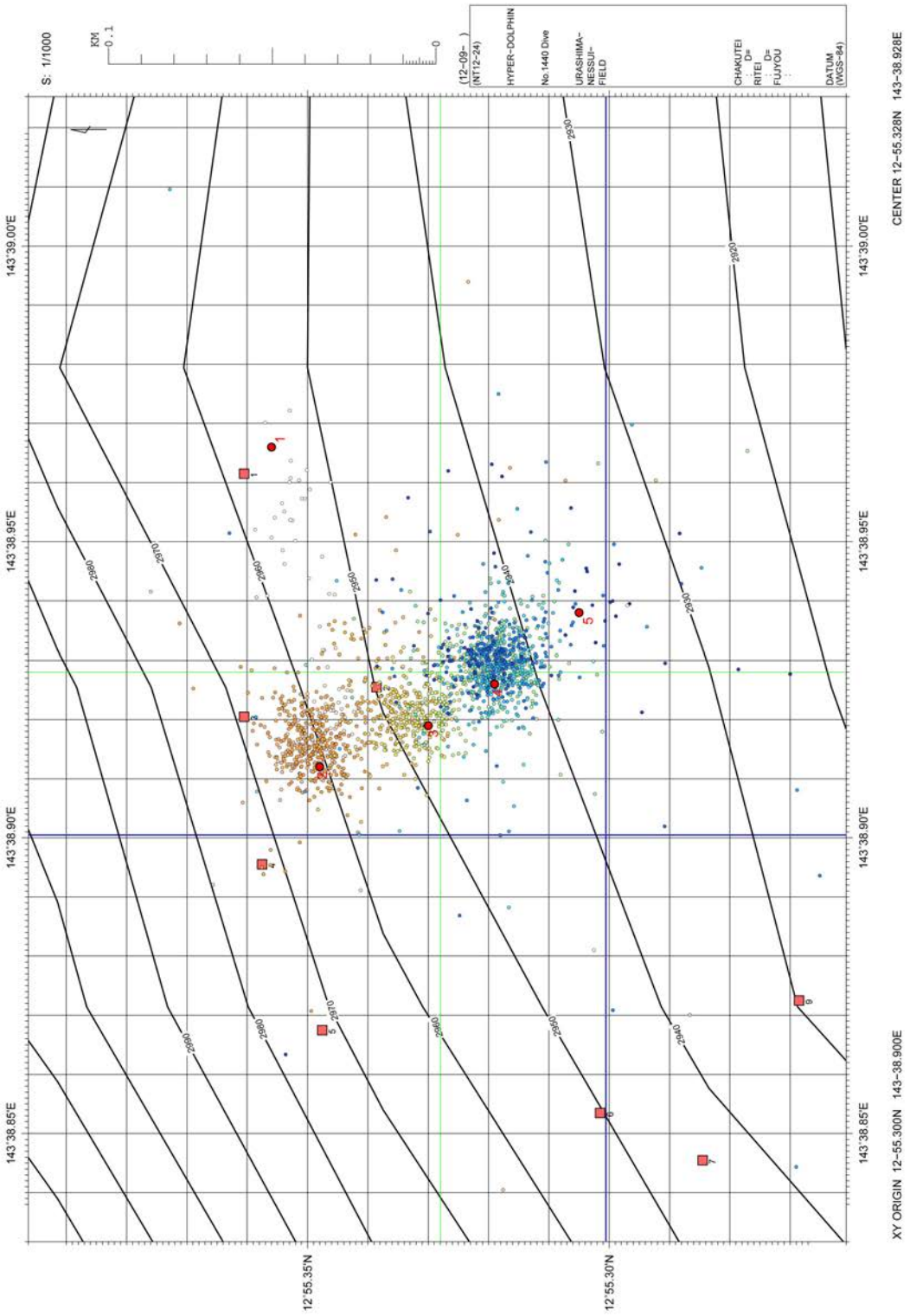
4) M-type mud sampler
5) Conductivity meter
6) Sample box
7) HPD marker

Location of Events:

Time Position Depth Event

09:55 12°55.356'N, 143°38.966'E 2945m Landing
09:57 12°55.356'N, 143°38.966'E 2943m Niskin water sampling
10:06 12°55.348'N, 143°38.912'E 2957m Find chimneys
10:25 12°55.348'N, 143°38.912'E 2956m Sampling chimney fragments
12:16 12°55.330'N, 143°38.919'E 2951m M-type mud sampling
13:44 12°55.319'N, 143°38.926'E 2947m Start bag sampling
13:51 12°55.319'N, 143°38.926'E 2947m Finish bag sampling
13:54 12°55.319'N, 143°38.926'E 2947m Start CC-WHATS sampling
14:06 12°55.319'N, 143°38.926'E 2947m Finish CC-WHATS sampling
14:10 12°55.319'N, 143°38.926'E 2947m Start bag sampling
14:13 12°55.319'N, 143°38.926'E 2947m Finish bag sampling
14:29 12°55.319'N, 143°38.926'E 2947m Start bag sampling
14:31 12°55.319'N, 143°38.926'E 2947m Finish bag sampling
14:34 12°55.319'N, 143°38.926'E 2947m Start CC-WHATS sampling
14:43 12°55.319'N, 143°38.926'E 2947m Finish CC-WHATS sampling
14:44 12°55.319'N, 143°38.926'E 2947m Start WHATS sampling
14:48 12°55.319'N, 143°38.926'E 2947m Finish WHATS sampling
14:59 12°55.319'N, 143°38.926'E 2947m Vacuum water sampling
15:13 12°55.319'N, 143°38.926'E 2947m M-type mud sampling
15:16 12°55.319'N, 143°38.926'E 2940m Niskin water sampling
15:16 12°55.319'N, 143°38.926'E 2940m Start WHATS sampling
15:19 12°55.305'N, 143°38.938'E 2944m Finish WHATS sampling
15:21 12°55.305'N, 143°38.938'E 2944m Left the bottom

Dive track of the HPD#1440



Dive Report: Hyper Dolphin Dive #1441

Date: September 21, 2012
Site: Urashima hydrothermal field
Landing: 10:15; 12°55.366'N, 143˚38.918'E; 2975m
Leaving: 15:35; 12˚55.256'N, 143˚38.864'E; 2898m

Dive Summary:

We landed on approximately 100 m east of “Triple Dom chimneys” that are active clear smoker chimneys found in 2010, and sampled ambient seawater by Niskin water sampler. We headed to west to find the chimneys, but we could not find any active chimneys. Then, we headed to southeast to find “Ultra-no-chichi” chimney. However, we could not the chimney and then headed to west to get the 6K marker #116 “Okada-san chimney”. On the way, we found small iron-mat chimneys and sampled them by M-type mud sampler at 11:43. We continue to look for the marker #116, but we could not find it. Instead, we found shimmering of clear fluid at the base of a big chimney and we sampled the fluid by CC-WHATS and bag water sampler at 12:16 and 12:30, respectively. Then we sampled chimney fragments by manipulator at 12:47. After that, we moved up to the top of the chimney and then recognized that the chimney is an active black smoker, venting black smoke vigorously from the top. We thus decided to sample the black smoker fluid and sampled it by CC-WHATS at 13:06. Maximum temperature of the fluid was 270°C. After that we set the marker H1441-1 at 13:12 and sampled ambient seawater by Niskin water sampler at 13:14. We headed to southeast to find “Akuma-jo chimney” that was discovered at the dive HPD#1435. Before we reached to “Akuma-jo chimney”, we found another new big black smoker chimney at 13:24. At the chimney, we collected fluid samples by WHATS and bag water sampler at 13:56 and 14:12, respectively. Maximum temperature of the fluid was 261°C. We also sampled chimney fragment by manipulator. Then, we headed to west to get “Kinoko-no-yama chimneys”. After half an hour try, we could not find out the chimney complex, whereas a new white smoker vent was discovered. Before we sampled the white smoker fluids, we found the marker deployed on “Kinoko-no-yama chimneys” on the back of the ROV. Then, we sampled the white smoker fluids by WHATS at 15:32. Maximum temperature of the fluid was 243°C. After finishing the fluid sampling, we left bottom at 15:35.

Payloads:

1) WHATS with a temperature probe
2) CC-WHATS
3) Bag water sampler
2) Niskin water sampler
3) Vacuum water sampler
4) M-type mud sampler
5) Conductivity meter
6) Sample box
7) HPD marker

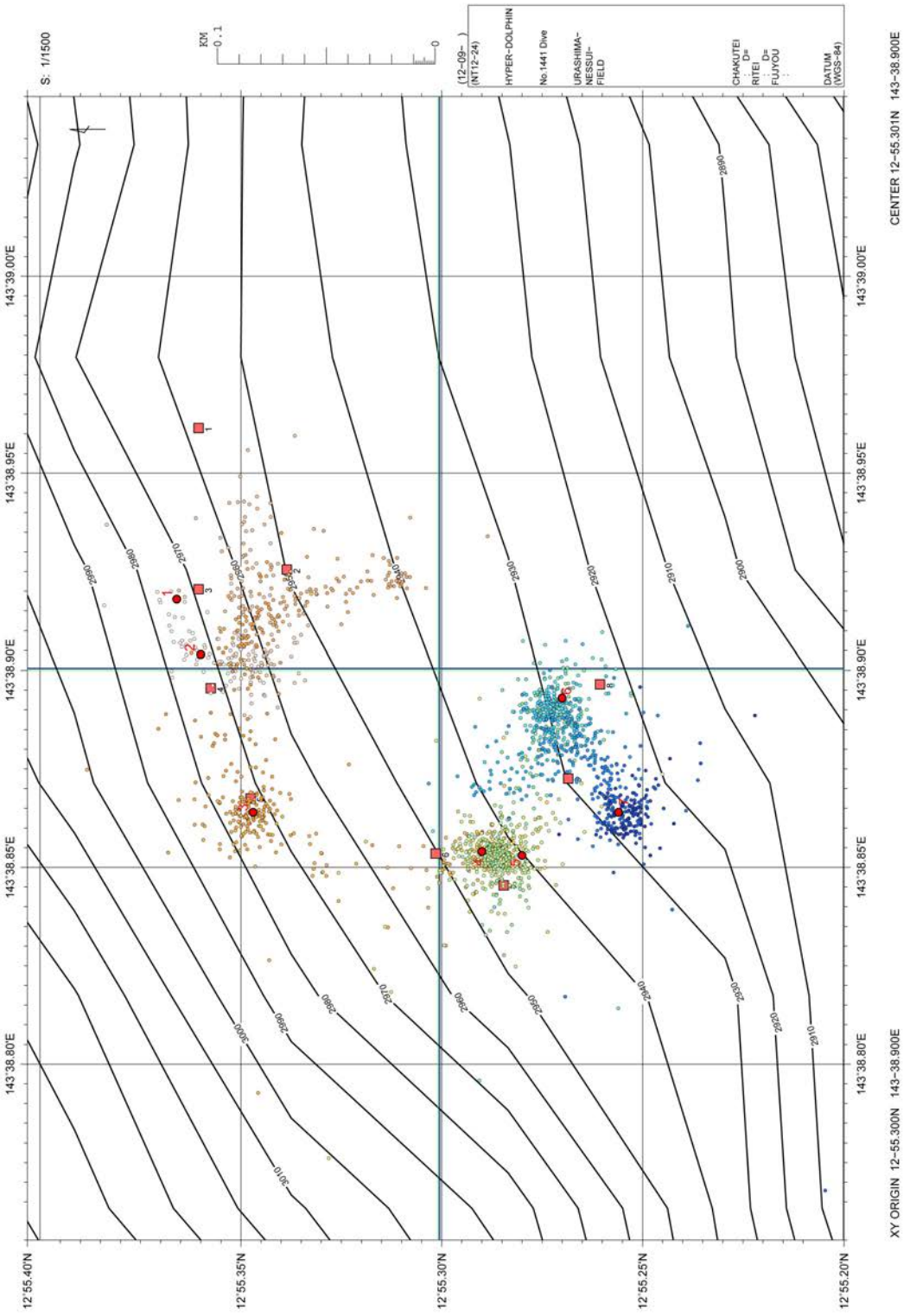
Location of Events:

Time Position Depth Event

10:15 12°55.366'N, 143°38.918'E 2975m Landing
10:16 12°55.356'N, 143°38.966'E 2974m Niskin water sampling
10:21 12°55.360'N, 143°38.904'E 2966m Find inactive chimneys
11:43 12°55.347'N, 143°38.864'E 2956m M-type mud sampling
12:08 12°55.290'N, 143°38.854'E 2939m Start bag sampling
12:16 12°55.290'N, 143°38.854'E 2939m Finish bag sampling
12:19 12°55.290'N, 143°38.854'E 2939m Start CC-WHATS sampling
12:30 12°55.290'N, 143°38.854'E 2939m Finish CC-WHATS sampling
12:47 12°55.290'N, 143°38.854'E 2937m Sampling chimney fragments
12:49 12°55.280'N, 143°38.853'E 2935m Find black smoker
12:57 12°55.280'N, 143°38.853'E 2935m Start CC-WHATS sampling
13:06 12°55.280'N, 143°38.853'E 2935m Finish CC-WHATS sampling
13:12 12°55.280'N, 143°38.853'E 2935m Set H1441 marker
13:14 12°55.280'N, 143°38.853'E 2935m Niskin water sampling
13:24 12°55.270'N, 143°38.893'E 2908m Find black smoker
13:47 12°55.270'N, 143°38.893'E 2908m Start WHATS sampling
13:56 12°55.270'N, 143°38.893'E 2908m Finish WHATS sampling
14:00 12°55.270'N, 143°38.893'E 2908m Start bag water sampling
14:12 12°55.270'N, 143°38.893'E 2908m Finish bag water sampling
14:16 12°55.270'N, 143°38.893'E 2908m Sampling chimney fragments
15:05 12°55.256'N, 143°38.864'E 2896m Find white smoker
15:21 12°55.256'N, 143°38.864'E 2898m Start WHATS sampling

15:32 12°55.256'N, 143˚38.864'E 2898m Finish WHATS sampling
15:35 12°55.256'N, 143˚38.864'E 2898m Left the bottom

Dive track of the HPD#1441



Acknowledgements

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