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Natsushima Cruise Report

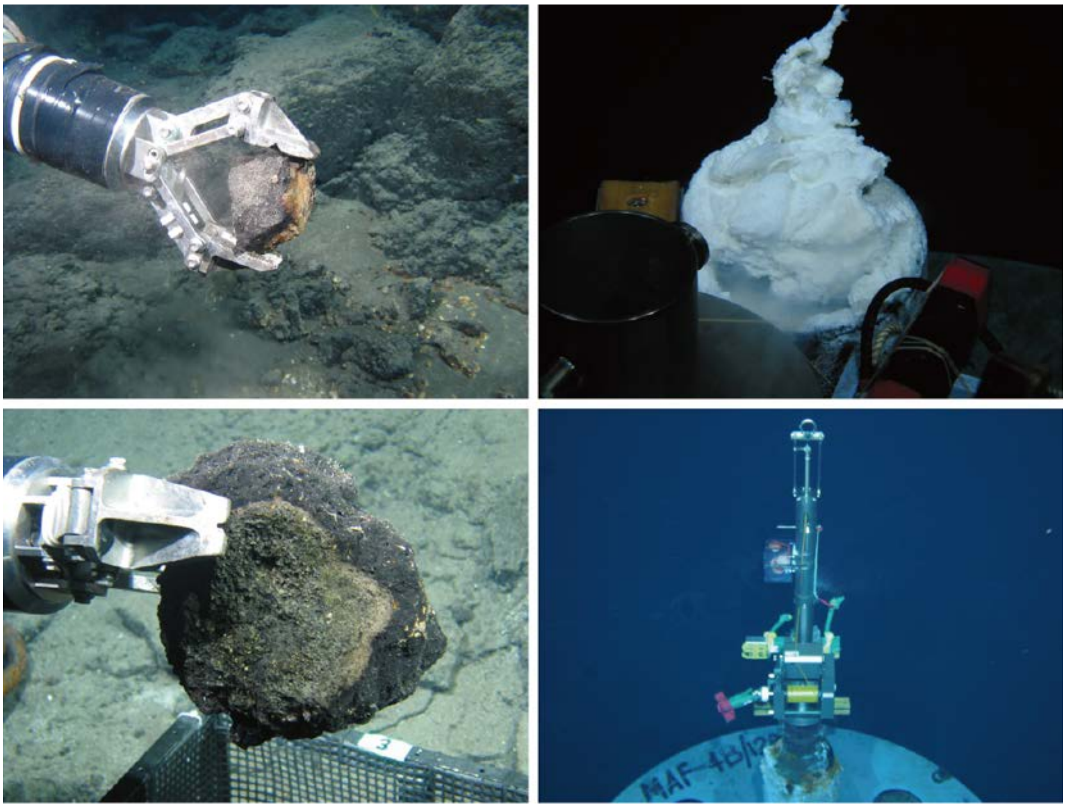
NT12-04

Deep Alkaline Serpentine Aquifer Exploration IV of South Chamorro Seamount

–Investigating deep subseafloor microbial ecosystem by Kandata system –

&

A mystery of Pagan and Alamagan: Andesites from Mariana islands arc.



13th February 2012, JAMSTEC – 26th February 2012, Saipan, 2012

Japan Agency for Marine-Earth Science & Technology

(JAMSTEC)

Acknowledgements

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

Contents

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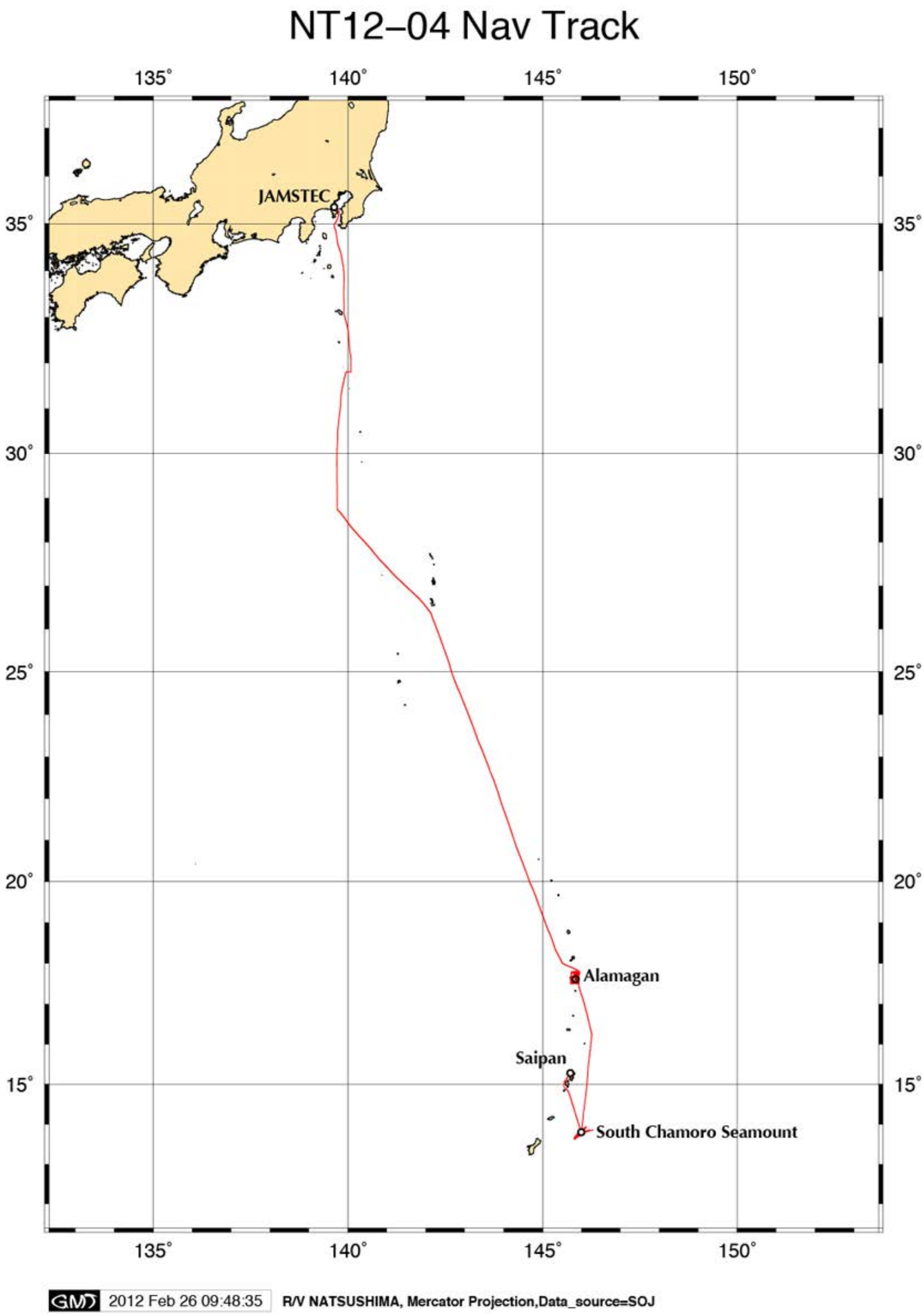
2nd Submersible Technical Officer	YUDAI SAKAKIBARA
2nd Submersible Technical Officer	SHIGERU KIKUYA
3rd Submersible Technical Officer	RYO SAIGO

Shipboard Log of NT12-04

Date	Local Time	Note	Description	Position/Weather/Wind /Sea condition
13 Feb 2012		**Sail out, proceeding to research area**		
	09:00	boarded		
	14:00	let go all shore line, left JAMSTEC		
	16:00	scientific meeting		
	16:40 -17:00	The Kom'pira-san Ceremony, praying for a safe and successful cruise		
14 Feb 2012		**Proceeding to research area**		12:00 (UTC+9h)
				31-47.6'N, 140-05.0'E
				Overcast
				SW-6(Strong breeze)
				4 (Sea moderate)
				3 (Moderate short)
				Visibly: 7'
15 Feb 2012		**Proceeding to research area**		12:00 (UTC+9h)
				31-47.6'N, 140-05.0'E
				Fine but cloudy
				SW-3 (Gentle breeze)
				2 (Sea smooth)
				2 (Low swell long)
				Visibly: 7'
16 Feb 2012		**Proceeding to research area**		12:00 (UTC+9h)
				24-01.0'N, 143-04.7'E
				Fine but cloudy
				NE-3 (Gentle breeze)
				2 (Sea smooth)
				2 (Low swell long)
				Visibly: 8'
17 Feb 2012		**Proceeding to research area**		12:00 (UTC+10h)
	00:00	Time adjustment : 1hour ahead (JST +1 h)		20-02.2'N, 144-39.5'E
				Fine but cloudy
				NW-3 (Gentle breeze)
				2 (Sea smooth)
				2 (Low swell long)
				Visibly: 8'

18 Feb 2012	01:52	**Arrived at research area "Alamagan"**		12:00 (UTC+10h)
	01:52	commenced MBES(Multi Beam Echo Sonund survey) mapping survey		17-45.0'N, 145-57.0'E
	06:20	finished MBES mapping survey		Fine but cloudy
	06:23	deployed XBT		SE-2 (Light breeze)
	09:10	Commenced MBES mapping survey		1 (Sea calm)
	13:00	Scientific meeting		2 (Low swell long)
				Visibly: 8'
19 Feb 2012		**HPD II#1347 (Alamagan)**		12:00 (UTC+10h)
	06:20	finished MBES mapping survey		17-31.3'N, 145-53.0'E
	08:24	launched (HPD II#1347)		Fine but cloudy
	9:36	lands (2,076 m)		ENE-3 (Gentle breeze)
	16:09	leaves the bottom (1,369m)		2 (Sea smooth)
	17:06	HPD on deck		2 (Low swell long)
	18:58	Commenced MBES mapping survey		Visibly: 8'
20 Feb 2012		**HPD II#1348 (Alamagan)**		12:00 (UTC+10h)
	05:16	finished MBES mapping survey		17-43.7'N, 145-54.2'E
	08:31	Launched (HPD II#1348)		Fine but cloudy
	9:54	lands (2,025 m)		NE-5 (Fresh breeze)
	15:34	leaves the bottom (1,901m)		3 (Sea slight)
	16:58	HPD on deck		3 (Moderate short)
	17:40	Commenced MBES mapping survey		Visibly: 8'
	19:20	finished MBES mapping survey		
	19:20	Proceeding to research area "South Chamorro Seamount"		
21 Feb 2012		**Proceeding to research area**		12:00 (UTC+9h)
	09:00-10:00	Scientific seminar for crew		14-35.1'N, 146-05.5'E
				Fine but cloudy
				ENE-6 (Strong breeze)
				3 (Sea slight)
				4 (Moderate average)
				Visibly: 8'
22 Feb 2012	06:00	**Arrived at research area "South Chamorro Seamount"**		12:00 (UTC+10h)
	06:22	deployed XBT		13-51.8'N, 146-03.8'E
		Canceled HPD dive due to rough sea condition		Fine but cloudy
				ENE-5 (Fresh breeze)
				4 (Sea moderate)
				4 (Moderate average)
				Visibly: 8'
23 Feb 2012		**HPD II#1349**		12:00 (UTC+10h)

		(South Chamorro Seamount)		
	08:27	Launched (HPD Ⅱ#1349)		13-47.1'N, 146-00.1'E
	10:04	lands (2,945 m)		Fine but cloudy
	13:58	leaves the bottom (2,916m)		East-5 (Fresh breeze)
	15:28	HPD on deck		3 (Sea slight)
				4 (Moderate average)
				Visibly: 8'
24 Feb 2012		**HPD Ⅱ#1350** **(South Chamorro Seamount)**		12:00 (UTC+10h)
	15:13	Launched (HPD Ⅱ#1350)		13-47.1'N, 146-00.8'E
	16:57	lands (2,951 m)		Fine but cloudy
	20:02	leaves the bottom (2,937m)		East-4 (Moderate breeze)
	21:39	HPD on deck		3 (Sea slight)
				4 (Moderate average)
				Visibly: 8'
25 Feb 2012		**HPD Ⅱ#1351** **(South Chamorro Seamount)**		12:00 (UTC+10h)
	12:02	Launched (HPD Ⅱ#1351)		13-47.2'N, 146-00.2'E
	13:36	lands (2,948 m)		Fine but cloudy
	16:32	leaves the bottom (2,916m)		East-3 (Gentle breeze)
	18:04	HPD on deck		2 (Sea smooth)
				4 (Moderate average)
				Visibly: 8'
26 Feb 2012	11:00	**Arrived at "SAIPAN"**		
	12:00	disembarked at NATSUSHIMA		
		finished NT12-04 cruise		


NT12−04 Nav Track
135°
140°
145°
150°
35°
30°
25°
20°
15°
JAMSTEC
Alamagan
Saipan
South Chamoro Seamount
GMT 2012 Feb 26 09:48:35
R/V NATSUSHIMA, Mercator Projection,Data_source=SOJ

I. CRUISE SUMMARY

In this NT12-04 cruise, we completed 5 ROV HyperDolphin dives in South Chamorro seamount and Alamagan area, and we accomplished our purposes

In South Chamorro seamount, we conducted 3 HPD dives and we could (1) sample deep crustal water at 170 mbsf (m below seafloor) of the ODP#195 borehole 1200c by Kandata system (Borehole-deployment sampling system) and (2) deploy *in situ* colonization system at 170 mbsf of the borehole. The deployed ISCS will be recovered in next September cruise. And also we could sample microbial mats, rocks and macrofaunas. The fluid data obtained from the on-board and the future onshore analyses will be integrated and compared with samples obtained from NT09-01, NT09-07, NT10-13 Leg1 cruises. The combined data from the four 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?

In Alamagan, we conducted 2 dives and collected over 39 rock and sediment samples. We also undertook Seabat surveys around Alamagan Island which have greatly improved the resolution of the bathymetry of the submarine flanks of Alamagan volcano. These samples will be analyzed to investigate petrological differences between Pagan and Alamagan volcanoes and to understand the magmatic evolution of Alamagan volcano.

II. Deep Alkaline Serpentine Aquifer Exploration IV of South Chamorro Seamount

1. 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 Chamorro Seamount, NT09-01 and NT09-07 cruises 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. These results suggested that the fluids from the top of the CORK contaminate seawater. Therefore, it has possibility that the activity shown by RI were derived from microbes depending on fluid-seawater mixing. However, several percent of clones in 16S rRNA library had a close similarity to *Alkaliphilus transvaalensis* which can grow in pH12.4. Therefore, in the depths of borehole, it may be possible that there are microbial ecosystem depending on deep crustal water with high alkaline pH. And also we detected hyperthermophilic archaeon which occupied only a few percent of 16S RNA clone library. If these archaeaon dominate in subseafloor of South Chamorro seamount, the new story will be constructed about mantle-dependent subseafloor microbial ecosystem.

Moreover, chemical profiles of fluid sampled from the top of the CORK in NT09-01 and NT09-07 cruises were considerably different from those of pore water in ODP#195 cruise. Therefore, these results indicate that we must directly 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 Chamorro Seamount or not.

To clarify these questions, we developed the borehole-deployment sampling system project, “Kandata project” (Figure 1). 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 fatal errors for detecting lower microbial population in subseafloor biosphere.

We challenged water sampling and *in situ* colonization deployment by using the Kandata system in NT10-13 Leg1 cruise, however we failed to sampling and deployment. After NT10-13 Leg1 cruise, we improved the Kandata system and performed sampling test on shore.

The objectives of this NT12-04 cruise are that by using Kandata system, (1) sampling deep crustal water from screen region (Figure 1) of the borehole 1200c and (2) deployment of in situ colonization system in screen region of the borehole

1200c. These direct sampling from screen region of borehole will provide us to the answer for the question whether there is the active microbial ecosystem depends on hyper-alkaline crustal water of South Chamorro Seamount or not.

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3. Salisbury, M. H., and ODP Leg 195 Shipboard Scientific Party (2002) Site 1200. Proc. ODP Init. Rep. 195.
4. Takai, K., Moyer, C. L., Miyazaki, M., Nogi, Y., Hirayama, H., Nealson, K. H., and Horikoshi, K. (2005) Marinobacter alkaliphilus sp. nov., a novel alkaliphilic bacterium isolated from subseafloor alkaline serpentine mud from Ocean Drilling Program Site 1200 at South Chamorro Seamount, Mariana Forearc. Extremophiles 9:17-27.

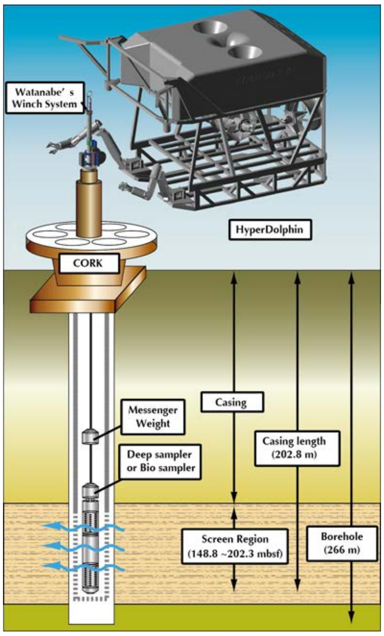
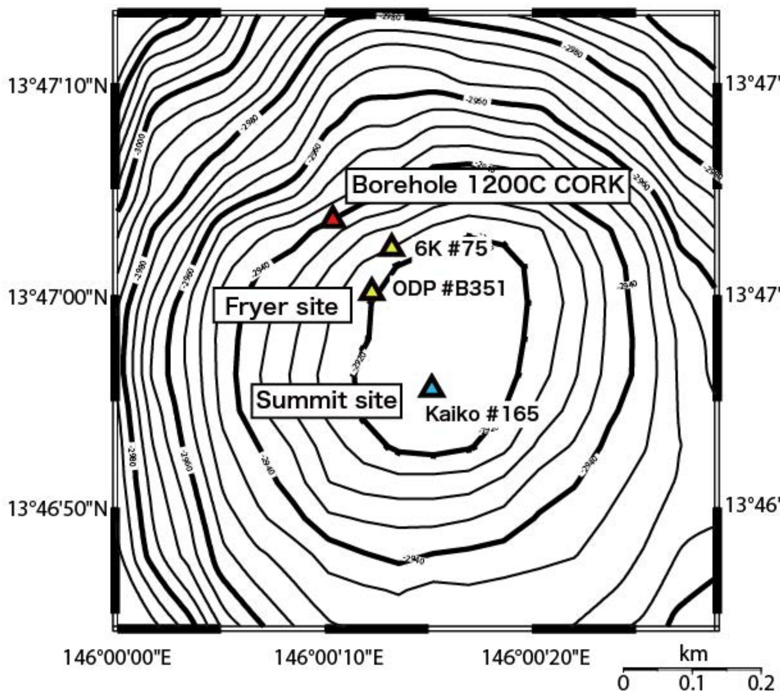


Figure 1. Schematic view of Kandata system which can directly sample from the deep region of borehole. Deep sampler and Bio sampler are indicate water sampler and in situ colonization system, respectively.

2. DIVE REPORTS

HPD#1349 DIVE (South Chamorro Seamount)	Dr. K. Takai
HPD#1350 DIVE (South Chamorro Seamount)	Dr. J. Miyazaki
HPD#1351 DIVE (South Chamorro Seamount)	Dr. H. Hirayama



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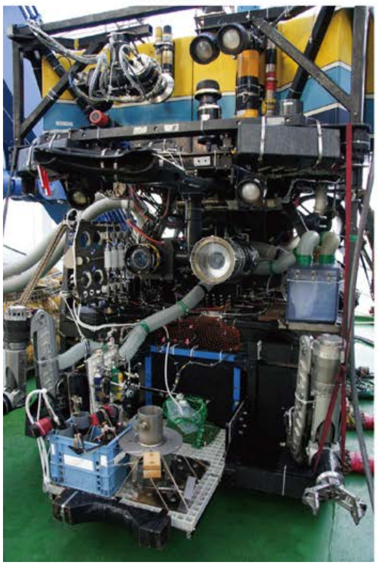

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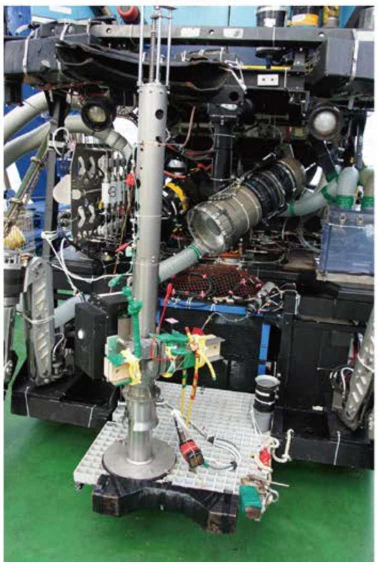

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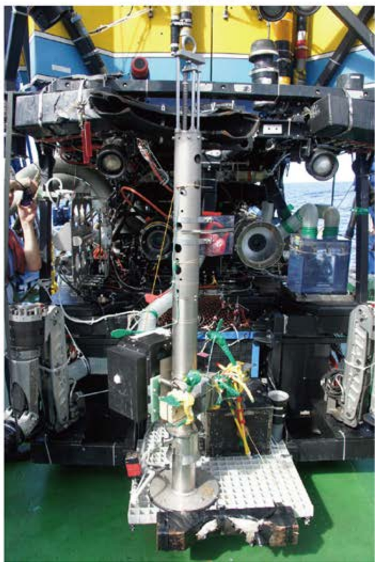

Dive Report: HyperDolphin Dive #1349

Date: February 23, 2012
Site: ODP#195 CORK at borehole 1200c site of South Chamorro Seamount
Landing: 10:05; 13°47.068'N, 146˚00.143'E, 2944m
Leaving: 13:58; 13˚46.928'N, 146˚00.214'E, 2916m
Observer: Ken Takai (SUGAR Project, JAMSTEC)

Objectives:
The objectives of this dive are 1) Water sampling from top of the CORK by WHATS and RI samplers, and 2) Clean up the top pipe of the CORK that was stucked with the broken pipe pieces and deployment of the DEEP SAMPLER base.

Dive Summary:
At 10:05, we landed on the bottom east from the CORK which was covered with serpentine mud. We headed to the CORK. We reached the CORK and observed large white-colored brucite structure and white-smoker from the top of the CORK. After we sampled the brucite structure by suction sampler, we tried to clean up the top pipe of the CORK. With a zoom camera, we identified a piece of pipe hindering the pipe hole. We struggled to pick up the piece. We successfully cleaned up the plastic pipe. Next, we collected serpentinized fluids. The serpentinized fluid temperature was 1.7 ˚C, which was 0.1 ˚C higher than the ambient seawater. Reference: Serpentinized fluid is 1.8 ˚C and ambient seawater is 1.5 ˚C. During WHATS sampling, we took RI samples #1&3. After WHATS sampler, we deployed the basement of the DEEP SAMPLER. The basement was perfectly set. Next, RI sampler was competed (#2&4). Then, we collected white microbial filaments and jelly mats covering the CORK pipe. After the operation, we found the chemosynthetic communities at the summit site. Finally, we left the bottom at the summit site.

Payloads:
1) WHATS with a temperature probe
2) RI sampler
3) Basement of DEEP SAMPLER

4) Suction Sampler
5) Picking tools

Location of Events:

Time	Position	Depth	Event
10:04	13°47.068'N, 146˚00.143'E,	2944m	Landing on serpentine mud
10:12	13˚47.063’N, 146˚00.108'E,	2943m	Finding CORK
10:21	13˚47.073'N, 146˚00.144'E,	2940m	Collect the brucites.
10:46	13˚47.073'N, 146˚00.144'E	2940m	Removing a broken pipe piece.
10:59	13˚47.073'N, 146˚00.144'E,	2940m	WHATS (1) (Avg. Temp:1.6°C (max1.7°C))
11:08	13˚47.073'N, 146˚00.144'E,	2940m	WHATS (2) (Avg.Temp:1.61°C (max1.7°C))
11:17	13˚47.073'N, 146˚00.144'E,	2940m	WHATS (3) (Avg.Temp:1.61°C (max1.7°C))
11:45	13˚47.073'N, 146˚00.144'E,	2940m	RI sampler (#1&3)
11:45	13˚47.073'N, 146˚00.144'E,	2940m	WHATS (4) (Avg.Temp:1.64°C (max1.8°C))
12:02	13˚47.073'N, 146˚00.144'E,	2940m	Deployment of basement
12:13	13˚47.073'N, 146˚00.144'E,	2940m	RI sampler (#2&4)
12:26	13˚47.073'N, 146˚00.144'E,	2940m	Collect the microbial mats
12:30	13˚47.073'N, 146˚00.144'E,	2940m	Left the CORK
13:45	13˚46.928'N, 146˚00.214'E,	2916m	Found the summit site
13:59	13˚46.928'N, 146˚00.214'E,	2916m	Left the Bottom

Dive Report: HyperDolphin Dive #1350

Date: 24 February 2012
Site: ODP#195 CORK at borehole 1200c site of South Chamorro Seamount
Landing: 16:57; 13°47.069'N, 146˚00.110'E, 2951m
Leaving: 20:01; 13˚47.073'N, 146˚00.144'E, 2940m
Observer: Junichi Miyazaki (SUGAR Project, JAMSTEC)

Objectives:

The objectives of this dive are 1) Water sampling from 180 mbsf of the borehole by Kandata system, and 2) Water sampling of reference seawater.

Dive Summary:

Before landing, we sampled seawater by WHATS to use as a reference when the ROV reached water depth 2300 m. We landed on the bottom and immediately headed to the CORK. At 17:20, we approached to the top of the CORK and tried set Watanabe's winch system on the basement which was deployed yesterday. However, strong tide prevented us to access to the top of the CORK. And also the basement was come off from CORK. Therefore, we once recovered the basement and tried to re-deploy. It took about an hour to contact the top of the CORK and to re-deploy the basement. The tide became weak, and therefore we deployed the Watanabe's winch system on the basement. After we released the Deep sampler by pulling out the stopper pin, we lowered the Deep sampler by free-fall lever. At 19:01, deep sampler was arrived at 170 mbsf. Considering the remaining dive-time, we dropped trigger weight to close Deep Sampler and about a minute later, we clarified that the trigger reached to the Deep Sampler by spring detector. After waiting for 5 minutes to measure temperature, we rolled up the Deep Sampler. At 19:20, the Deep sampler was reached at 80mbsf, and we had measured temperature for 5 min. We re-rolled up the Deep Sampler. At 19:33, Deep sampler was stored into winch system. After recovering the winch system into the stage attached to the hyperdolphin, we left the bottom at 20:01.

Payloads:

1) Watanabe's winch system

2) Deep sampler with logger-type thermometer
3) WHATS with temperature probe
4) Sucssion Sampler

Location of Events:

Time	Position	Depth	Event
16:45	13°47.074'N, 146˚00.99'E,	2300m	Start water sampling by WHATS (2 bottles, Temp. 1.7°C (Max & Avg)).
16:57	13°47.069'N, 146˚00.110'E,	2951m	Landing on serpentine mud
18:25	13˚47.073'N, 146˚00.144'E,	2940m	Landing on the CORK and setting up Winch system
18:44	13˚47.073'N, 146˚00.144'E,	2940m	Lowering the Deep sampler
19:01	13˚47.073'N, 146˚00.144'E,	2940m	Reached to 170mbsf
19:03	13˚47.073'N, 146˚00.144'E,	2940m	Dropping Messenger
19:04	13˚47.073'N, 146˚00.144'E,	2940m	Confirming the shut of Deep sampler
19:07	13˚47.073'N, 146˚00.144'E,	2940m	Rolling-up
19:20	13˚47.073'N, 146˚00.144'E,	2940m	Reached to 80 mbsf and temperature measurement
19:25	13˚47.073'N, 146˚00.144'E,	2940m	Re-rolling up
19:33	13˚47.073'N, 146˚00.144'E,	2940m	Finishing the rolling-up and recovering the winch system.
20:01	13˚47.073'N, 146˚00.144'E,	2940m	Left the bottom

Dive Report: HyperDolphin Dive #1351

Date: February 25, 2012

Site: ODP#195 CORK at borehole 1200c site and summit site of South Chamorro Seamount

Landing: 13:36; 13°47.083'N, 146˚00.134'E, 2948m

Leaving: 16:32; 13˚46.913'N, 146˚00.226'E, 2916m

Observer: Hisako Hirayama (SUGAR Project, JAMSTEC)

Objectives:

The objectives of this dive are 1) Deployment of KANDATA BIO-sampler with Hirayama's ISCS in the CORK, 2) Water sampling at a *Bathymodiolus* mussel colony at the summit site by WHATS sampler, 3) Rock sampling at a mussel colony, and 4) Sampling of *Bathymodiolus* mussels and *Calyptogena* clams.

Dive Summary:

We landed on the bottom north of the CORK. After we reached the CORK, we started to deploy the KANDATA BIO-sampler on the CORK. At the head of the KANDATA BIO-sampler, Hirayama's ISCS was set to collect aerobic microorganisms. After the KANDATA BIO-sampler was deployed on the top of the CORK, a free fall of BIO-sampler was started. The free fall was stopped when the BIO-sampler reached 170 mbsf. The KANDATA BIO-sampler deployed in the CORK will be retrieved 6 month later. Then, we left the CORK and headed for the Summit site. We found the Kaiko maker and *Bathymodiolus* mussel colonies at the Summit site. We collected fluid by WHATS sampler at the fissure of the bottom where *Bathymodiolus* musses colonized. During the fluid sampling, we collected a piece of rock at the mussel colony and deployed a HyperDolphin marker (H1351). After we collected 2 bottles of fluid by WHATS (temperatures were 1.5°C, slightly lower than seawater (1.6°C)), we collected *Bathymodiolus* mussels and *Calyptogena* clams by the suction sampler. At the end of the dive, we sampled a big serpentinized rock at the fissure. Finally, we left the bottom at the summit site.

Payloads:

1) Watanabe's winch system with Hirayama's ISCS

2) KANDATA BIO-sampler with logger-type thermometer
3) WHATS with a temperature probe
4) Suction Sampler
5) Sample box (black)

Location of Events:

Time	Position	Depth	Event
13:36	13°47.083'N, 146˚00.134'E	2948m	Landed on serpentine mud
14:01	13˚47.054’N, 146˚00.144'E	2943m	Found CORK
14:07	13˚47.049'N, 146˚00.123'E	2939m	Started to deploy Kandata
14:20	13˚47.049'N, 146˚00.123'E	2939m	Finished to deploy Kandata
14:32	13˚47.049'N, 146˚00.123'E	2939m	Started a free-fall of the BIO-sampler
14:48	13˚47.049'N, 146˚00.123'E	2939m	Finished the free-fall at 170 mbsf
15:43	13˚46.913'N, 146˚00.226'E	2915m	Found the Kaiko maker
15:55	13˚46.913'N, 146˚00.226'E	2916m	Started WHATS (1) near *Bathymodiolus* colony at summit site
16:02	13˚46.913'N, 146˚00.226'E	2916m	Finished WHATS (1) (Avg.Temp:1.44°C(max1.6°C)). Sampled the rock
16:04	13˚46.913'N, 146˚00.226'E	2916m	Started WHATS (2). Deployed a maker (H1351).
16:11	13˚46.913'N, 146˚00.226'E,	2916m	Finished WHATS (2) (Avg.Temp:1.42°C (max1.5°C))
16:16	13˚46.913'N, 146˚00.226'E	2916m	Sampled animals
16:27	13˚46.913'N, 146˚00.226'E	2916m	Sampled the big rock
16:32	13˚46.913'N, 146˚00.226'E	2916m	Left the bottom

III. A mystery of Pagan and Alamagan: Andesites from Mariana islands arc.

1. Purpose and background

On average the composition of continental crust is equivalent to the andesites that dominate arc magmatism. The process of crust formation with andesite composition is currently not well understood. By comparing mantle-derived undifferentiated mafic magmas and the andesite magmas erupted at the surface we will obtain important clues that will help us to understand this process better. Pagan volcano in Mariana arc is characterized by the eruption of basaltic lavas, whereas Alamagan volcano, just 60 km south of Pagan volcano, erupts andesitic lavas. Previous work on Pagan volcano has revealed that small parasitic cones on the flank of larger volcanoes yield more undifferentiated lavas than the main edifice. If more undifferentiated mafic samples can be sampled during HYPER-DOLPHIN dives on Alamagan volcano, this may help in resolving the processes of how andesite magma forms. The chief aims of this cruise were to investigate petrological differences between Pagan and Alamagan volcanoes and to find undifferentiated basaltic lavas in order to understand the magmatic evolution of Alamagan volcano.

2. DIVE REPORTS

HPD#1347 DIVE (Alamagan) Hiroshi Shukuno

HPD#1348 DIVE (Alamagan) Hiroshi Shukuno

Dive Report: HYPER-DOLPHIN DIVE #1347

TECHNICAL INFORMATION

Location: SE flank of Alamagan.

Objective: Firstly traverse up a small cone and then climb prominent spur on SE flanks of Alamagan. Recover primitive lavas from Alamagan and compare lavas recovered from the two traverses.

DIVE 1347	**On bottom:**	**Off bottom:**
Transect #1:		
Time (local): February 19, 2012	09:35	10:50
Latitude:	17° 31.249' N	17° 31.359' N
Longitude:	145° 53.712' E	145° 53.695' E
Depth (m):	2076	1992
Transect #2:		
Time (local): February 19, 2012	13:45	16:10
Latitude:	17° 31.134' N	17° 31.334' N
Longitude:	145° 51.745' E	145° 51.634' E
Depth (m):	1549	1369

Samples returned: 14 rocks recovered and accounted for.

SCIENTIFIC SUMMARY:

Alamagan Island lies about 60 km south of Pagan Island. The island is approximately circular with a diameter of just under 4 km and reaches an altitude of a little above 500 m above sea level. However, the island is just the top of a much larger edifice that is actually elongated in a north-south direction, ~36 km long and ~25 km wide above the 2500 mbsl contour. This dive investigated features on the south-eastern flank of this edifice at water depths of around 2000 mbsl. Two transects were planned; the first up the southern slope of a small cone, the second up part of the southern slope of the most prominent feature on the southern submarine flank of Alamagan, a spur that juts out about 2 km and forms the steepest part of the southern slopes. The primary objective was to recover primitive magmas from the lower flanks of Alamagan and also to compare the magmas recovered during the two traverses.

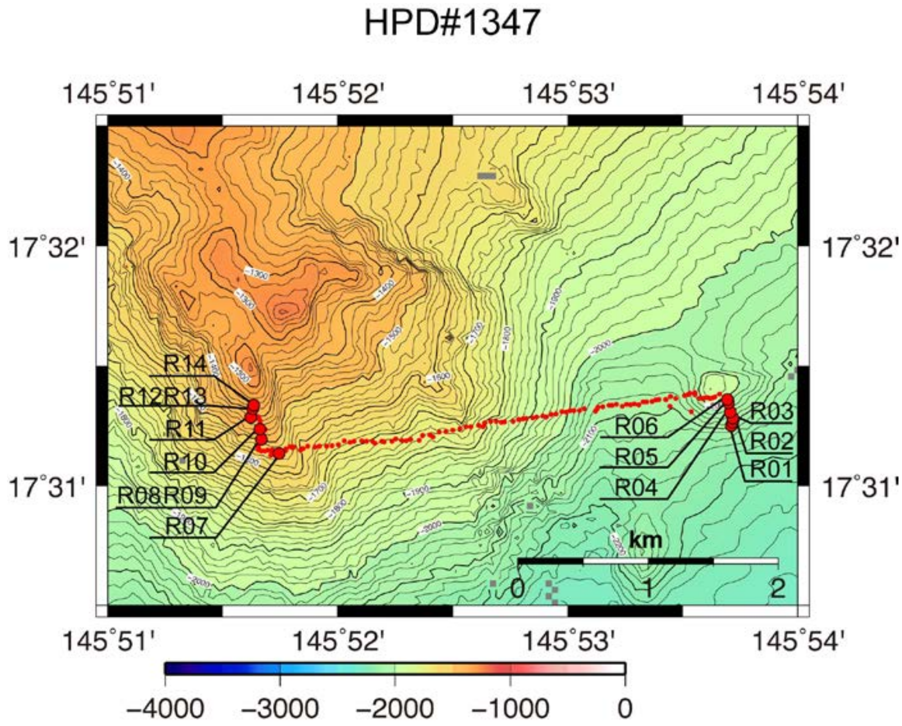

Figure 1: HPD #1347 dive track and sampling points.

Traverse #1: 84 m of the southern slopes of the cone were traversed from 2076 to 1992 mbsl, reaching near to the summit of the cone. The slopes of the cone consisted of rocky areas of outcrop or talus alternating with areas of, often dark, gravels. The gravels were notable for extensive well-developed ripple marks or striations that were sometimes parallel to slope and sometimes across slope. All the samples recovered from the cone (R01-R06) are of a similar lithology and were taken from what appeared to be outcrop. All samples are porphyritic basalts containing abundant plagioclase (at least 8%, up to at least 10 mm in size, sometimes occurring in glomerocrysts up to 30 mm in size). Pyroxene (~4%) and olivine (~3%) also occurred in lesser amounts. In places the lava appeared to exhibit weak columnar jointing (e.g., between ~2040~2030 mbsl, R04).

Traverse #2: The second transect traversed 180 m of the southern slope of the spur, from 1549 to 1369 mbsl, reaching some 90 m below the summit of the spur. As with the cone, the traverse crossed alternating rocky areas of outcrop or talus and gravelly areas. More stable areas of the slope were indicated where coral, sponges and seapens had become established. The gravels often exhibited extensive fields of ripples or striations, mostly running parallel to the slope, but sometimes trending across slope. Samples were taken from the rockier areas. Sample R07 was lying loose in an area of talus and is a distinctive highly phyric pyroxene-olivine-plagioclase basalt with large phenocrysts of pyroxene up to 12 mm in size. R08 is a friable slab and was taken amongst rubbly talus, although it may have originated from a nearby outcrop with a similar thickness. However, the sample is lithified Mn fragments. Sample R09 was a loose boulder lying on a thinly bedded outcrop and is a vesicular sparsely phyric plagioclase basalt. Sample R10 was taken from a rubbly, layered outcrop. There was some difficulty with sampling at this site due to the Mn-coating. R10 is similar to R07, a distinctive highly phyric pyroxene basalt. The pyroxene phenocrysts are particularly impressive in this sample with huge euhedral crystals. Basal and prismatic sections up to 12 mm in size exhibiting clear cleavage and crystal faces intersecting at 90 □ can be seen in the freshly cut surfaces on the hand specimen. R11, R12, R13, R14 are all altered volcaniclastics. R11 was broken off from a slabby outcrop or large boulder, R12 and R14 were lying loose, while R13 was broken off a ridge running parallel to the slope.

Summary

The two traverses yielded two quite different lithologies. The cone yielded one type of lava, while the spur yielded volcaniclastics and two different types of lava. Thus during the dive, three types of distinct lava types were recovered from the southern slopes of Alamagan: (i) a highly phyric plagioclase-pyroxene-olivine phyric basalt from the cone; (ii) a distinctive highly phyric pyroxene basalt; and (iii) a vesicular sparsely phyric plagioclase basalt.

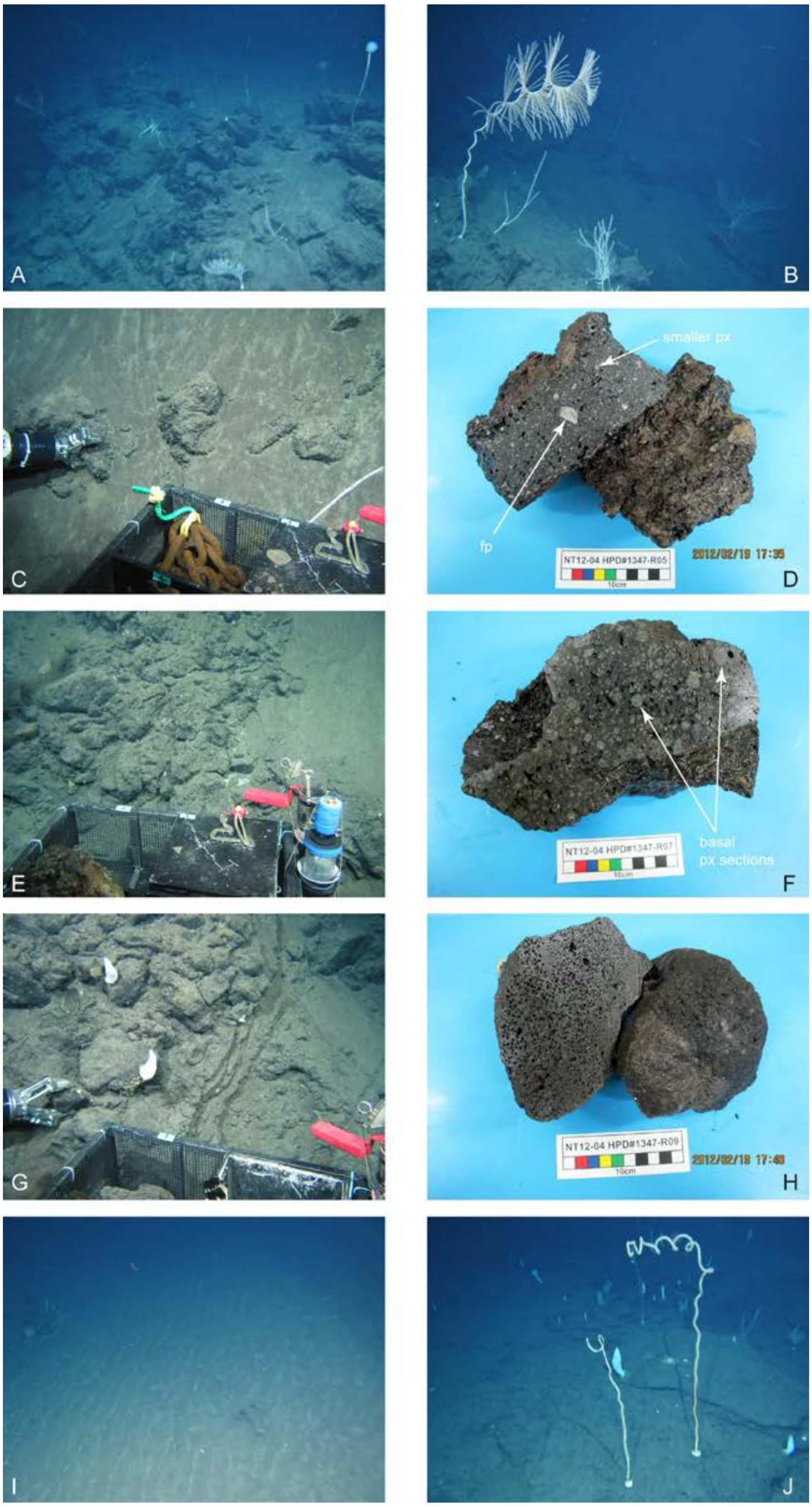

Figure 2: Representative pictures from HPD #1347. A: Typical view of seafloor during traverse up cone; a mixture of rockier and gravelly areas (SeaMax: 2012_0219_102446AA.JPG) *B: Spirally coral seen on traverse up small cone (SeaMax: 2012_0219_102709AA.JPG). C: Sampling R05, partially buried in sediment on small cone (SeaMax: 2012_0219_103016AA.JPG). D: Sample R05,*

representative of the highly phyric plagioclase-pyroxene basalt lava type from the small cone. E: Area from which sample R07 was taken (SeaMax: 2012_0219_135011AA.JPG). *F: Sample R07, representative of the highly phyric pyroxene-olivine plagioclase basalt lava type from the spur. G: Sampling R09, lying on thinly layered outcrop (SeaMax: 2012_0219_142933AA.JPG). H: Sample R09, representative of the third lava type, the vesicular sparsely phyric plagioclase basalt from the spur. I: Ripple marks on gravelly seafloor parallel to slope (SeaMax: 2012_0219_143244AA.JPG). J: Field of corals and seapens seen near top of traverse 2 (SeaMax: 2012_0219_152756AA.JPG).*

Dive Report: HYPER-DOLPHIN DIVE #1348

TECHNICAL INFORMATION

Location: Lower NE flank of Alamagan.

Objective: Firstly traverse up S flanks of the plateau (at 1400 mbsl) on outer NE flanks of the Alamagan edifice, and then traverse NE flanks of small knoll on the outer NE flanks of the Alamagan edifice about 1 km to the SW of the plateau. Recover primitive lavas from Alamagan; compare lavas recovered from the two traverses and with those recovered in HPD#1347.

DIVE 1348	**On bottom:**	**Off bottom:**
Transect #1:		
Time (local): February 20, 2012	09:54	12:22
Latitude:	17° 43.599' N	17° 43.823' N
Longitude:	145° 54.191' E	145° 54.214' E
Depth (m):	2025	1649
Transect #2:		
Time (local): February 20, 2012	13:32	15:32
Latitude:	17° 43.201' N	17° 43.047' N
Longitude:	145° 53.881' E	145° 53.726' E
Depth (m):	2055	1901

Samples returned: 23 rocks and 2 push cores recovered and accounted for.

SCIENTIFIC SUMMARY:

This dive investigated the lower north-eastern flank of the Alamagan volcanic edifice, some 12 km from the north-eastern shore of the island and 22 km from yesterday's dive, HPD#1347. The first part of the dive observed and sampled the southern slopes of the plateau extending to the east at water depths of 1400 mbsl. The second part climbed a small knoll in the submarine flank of Alamagan, about 1 km just to the south-west of this plateau. The aim was to recover lavas from the submarine flanks of Alamagan, hopefully with primitive compositions, and to compare those recovered during the two traverses with each other and those recovered in dive HPD#1347.

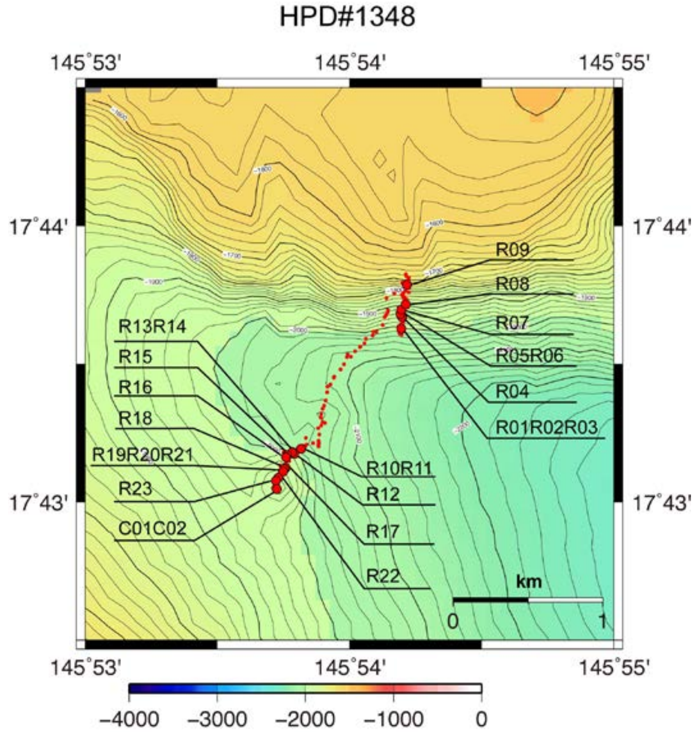

Figure 1: HPD #1348 dive track and sampling points.

Traverse #1: The first traverse began at the base of the plateau at 2025 mbsl and climbed 376 m of its southern slope, up to where it began to flatten out at 1646 mbsl. Eight of the nine rocks recovered during this traverse were carbonates, the samples were a mixture of fossilized coral debris and calcareous sediments. The one exception was R03, a moderately phyric plagioclase-pyroxene basalt. This was a loose block, but was sampled immediately below a dark rocky outcrop, from which it could have been derived. The predominance of carbonates amongst the samples recovered during this dive suggests that the plateau is a submerged reef. The reef built upon lavas, which the moderately phyric plagioclase-pyroxene basalt may represent.

Traverse #2: After about 1 hour of flight the Hyper-Dolphin reached the seafloor at the bottom of the knoll and began the second traverse. The traverse covered the steepest ~150 m of the north-eastern slope of the knoll from 2050 to 1901 mbsl. Initially the seafloor was covered in gravelly sediments with ripple marks. As the slope steepened, the grain size increased and the seafloor became increasingly rocky. Two loose boulders (R10 and R11) were taken from this rocky debris at the foot of the steep slope. These were a sparsely phyric plagioclase basalt and a sparsely phyric plagioclase-pyroxene basalt, respectively. As the slope steepened there appeared to be more outcrop. R12 was levered out of the rock face, thus possibly in-situ, and is a sparsely phyric plagioclase-pyroxene basalt. R13 taken from nearby was loose, and also a sparsely phyric plagioclase-pyroxene basalt. At 2020 mbsl features that appeared to be tongues of lava with striations and ropey-like surface texture were glimpsed. Sample R14 was taken nearby to these features and is yet another sparsely phyric plagioclase-pyroxene basalt. For the next ~70 m of ascent the seafloor alternated between gravelly and more rocky areas. Loose boulders were sampled from the rockier areas (R15 – R18) and all appear to be similar sparsely phyric plagioclase-pyroxene basalts. At around 1950 mbsl (where samples R19 and R20 were taken) possible cooling joints and weak columnar jointing were seen in the outcrop. R19 is a polygonal prism, possibly a cooling unit from a columnar jointed flow. Both R19 and R20 are sparsely phyric plagioclase-pyroxene basalt. R21, yet another sparsely phyric plagioclase-pyroxene basalt, was broken off a ledge on the outcrop at 1940 mbsl. R22 and R23 were broken off from large boulders amongst loose rocky debris and are both sparsely phyric plagioclase basalt. As the slope leveled off the sediment cover increased and the rockier areas disappeared. The sediment exhibited well developed ripple marks parallel to the slope. Two push cores of the sediment were taken before leaving the seafloor.

Summary

The plateau extending to the east at depths of 1400 mbsl from the lower submarine north-eastern flanks of the Alamagan edifice appears to be a submerged carbonate reef. On the basis of the only lava sample recovered, the reef may be capping moderately phyric plagioclase-pyroxene basalts that are distinct from the lavas making up the neighboring knoll. The knoll, about 1 km to the south-west, is made up of uniform sparsely phyric plagioclase ± pyroxene basalts. Based on vesicularity and phenocryst size and abundance, these lavas appear to be different from those recovered from both the cone and the knoll on the submarine south-eastern flanks of the Alamagan edifice.

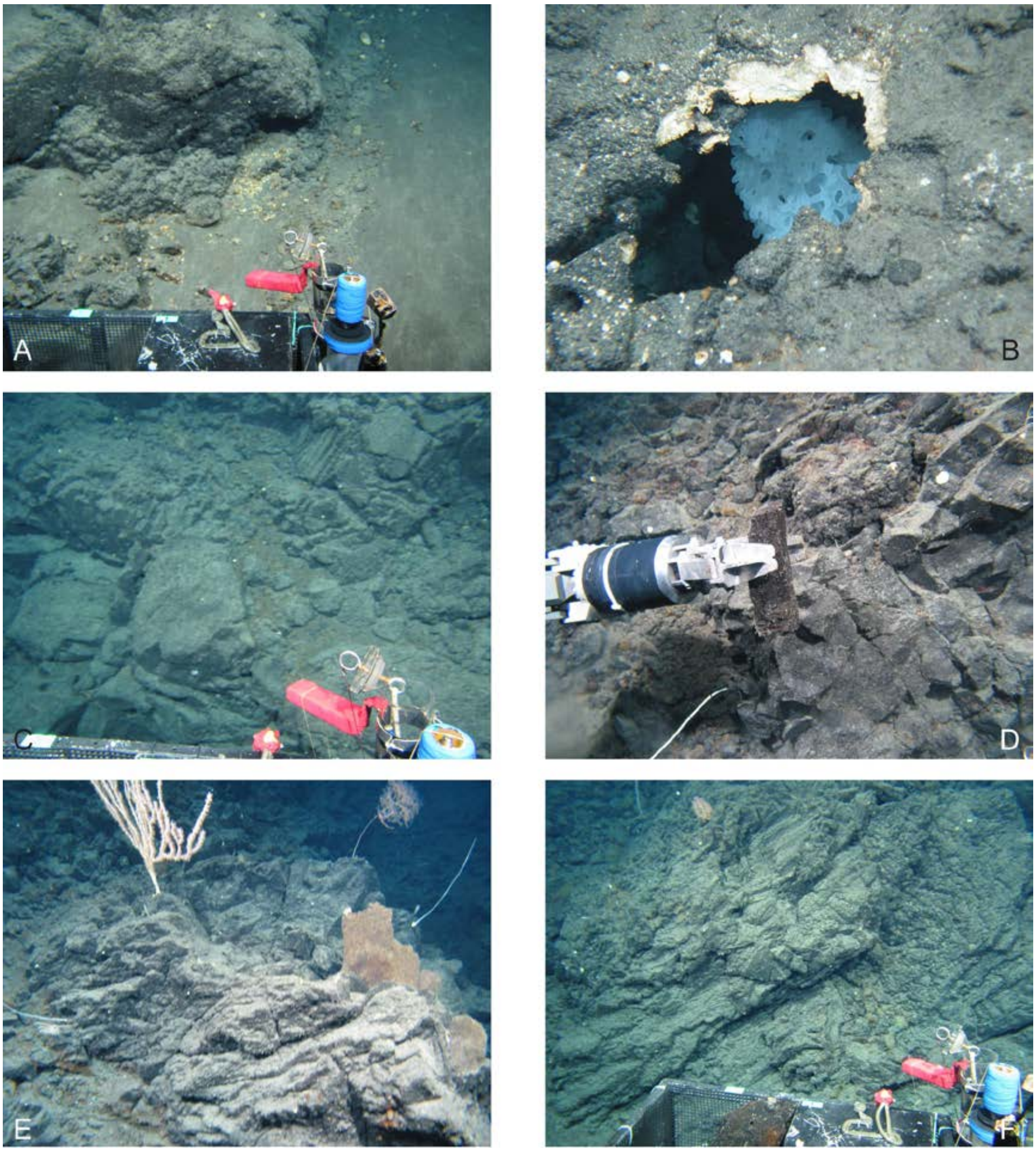

Figure 2: Representative pictures from HPD #1348. A: Rocky outcrop below which sample R03 was taken (SeaMax: 2012_0220_101026AA.JPG). B: Carbonate exposed during sampling of R07, coral living inside hole (SeaMax: 2012_0220_111222AA.JPG). C: Ropey texture on outcrop near R14 sampling site (SeaMax: 2012_0220_140942AA.JPG). D: Weak columnar jointing and prismatic sample R19 (SeaMax: 2012_0220_144858AA.JPG). E: Weakly layered outcrop with corals living on top (SeaMax: 2012_0220_145440AA.JPG). F: Ledge and weakly defined layering from which sample R21 was taken (SeaMax: 2012_0220_145713AA.JPG).