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R/V Yokosuka & DSV Shinkai6500 Cruise Report

YK19-10

Basic investigation for translocation of chemosynthetic populations in deep-sea hydrothermal systems and JAMSTEC's educational exploration for new generations and talents in Ocean

August 19, 2019 from Tokyo –

August 27, 2019 to Ogasawara

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

Acknowledgements

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Cruise information

Cruise ID: YK19-10

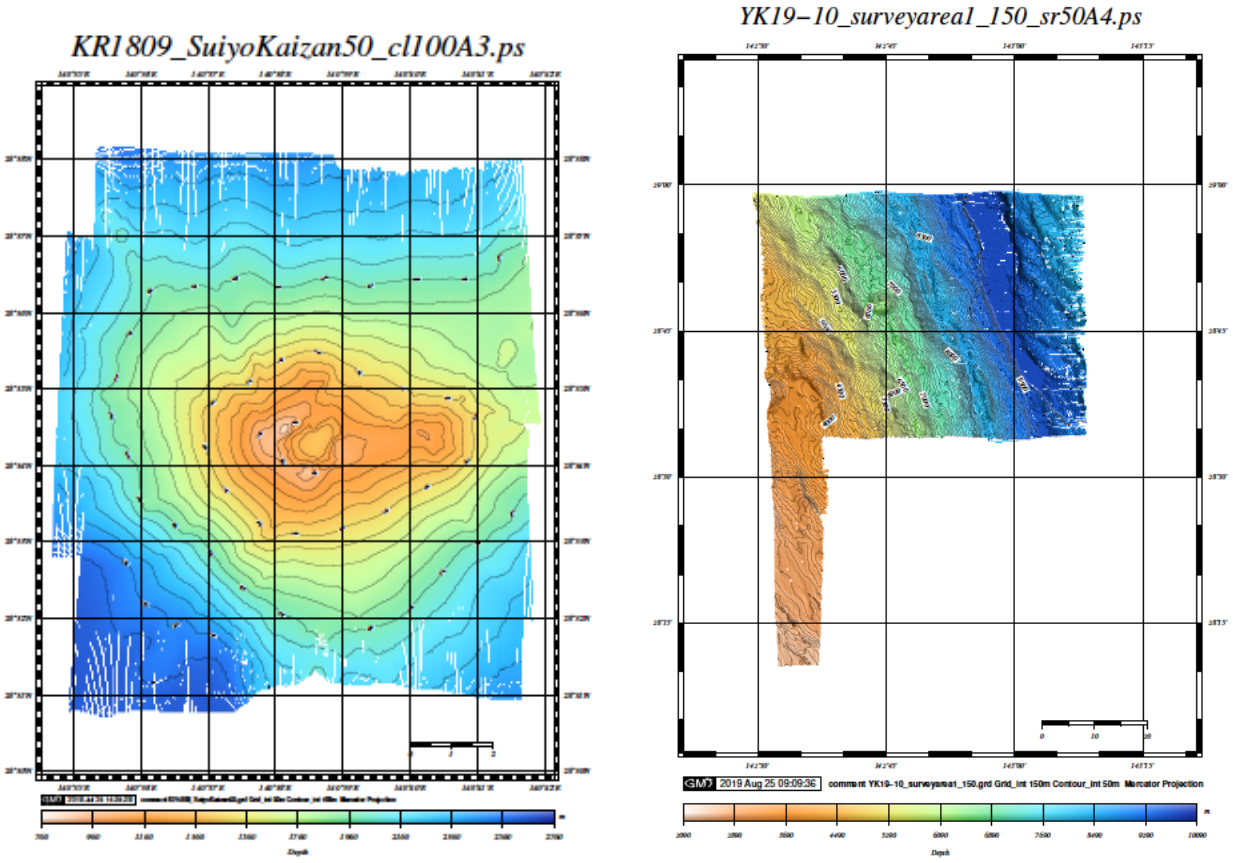
Vessel: Yokosuka

Title of the cruise: Basic investigation for translocation of chemosynthetic populations in deep-sea hydrothermal systems and JAMSTEC's educational exploration for new generations and talents in Ocean

Cruise period: August 19 – August 27, 2019

Ports of call: Tokyo – Ogasawara, Japan

Research area: Suiyo Seamount
Research map:



General topographic map of Suiyo Seamount and Ogasawara Forearc.

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Steward	**TOSHIYUKI ASANO**
Steward	**TAKAHIRO ABE**
Steward	**KOKI SHINOHARA**
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3rd Submersible Staff	**NAOKI SATO**
3rd Submersible Staff	**MOTOHIRO MATSUSAKA**

I. CRUISE SUMMARY

In YK19-10 cruise, we totally conducted 4 dives of Shinkai6500 in the Suiyo Seamount. One of the cruise foci was the preliminary investigation for the future artificial translocation and immigration of hydrothermal vent-endemic chemosynthetic animal populations. In this cruise, the main target was the *Alviniconcha* population in the Suiyo Seamount, the only population found in Japanese EEZ so far.

What we suspected before the cruise was whether there is still *Alviniconcha* population living in the Suiyo Seamount. In 2007, the first individual of *Alviniconcha* sp. was found and recovered. The sole individual was used for the taxonomy of host and the characterization of symbionts. In 2011, several tens of *Alviniconcha* individuals were photographed, and this result strongly suggested that the *Alviniconcha* populations were surely immigrated into the Suiyo Seamount from somewhere. However, the up and down of certain chemosynthetic animal populations and the sudden extinction have been known to occur, and we were very anxious about the existence of *Alviniconcha* individuals in the Suiyo Seamount. Fortunately, the first dive (6K#1549) found the dense colony of Suiyo Seamount *Alviniconcha* population. Throughout the dive observation in this cruise, this was probably the only colony of *Alviniconcha* population in the Suiyo Seamount even though *Bathymodiolus* populations were everywhere.

Based on the rest 3 dives, we conducted the translocation and relocation experiments of Suiyo Seamount *Alviniconcha* population from the original habitat to the shallower and warmer seafloor environment in the Suiyo Seamount outer ridge. In addition, lots of *Alviniconcha*, *Bathymodiolus* and other chemosynthetic animal individuals were successfully recovered. The relocated individuals will be monitored and recovered in 2020. The genetic, physiological and transcriptomic analyses will be conducted onshore after the cruise.

The other focus of this cruise was JAMSTEC's educational exploration for new generations and talents in Ocean. Seven selected elite undergraduate students from 224 applicants were onboard and 3 of them experienced Shinkai6500 dive with the well-experienced researchers. All the students joined the onboard research activities. We hope that these experiences become kinds of triggers for their growth during undergraduate and graduate studies and will have great impacts on their future directions and carrier passes. In addition, all the students served as the real-time reporter of research in Ocean. We are very happy if their outreach activities will lead to recruitment of 2nd JAMSTEC's educational exploration for new generations and talents in Ocean in 2020.

II. INTRODUCTION

General backgrounds & Scientific objectives

Suiyo Seamount hydrothermal system was discovered by seafloor observation of Shinkai2000 in 1991 (Kasuga and Kato, 1992). After the first discovery, many dives of human occupied vehicle (HOV) and remotely operative vehicle (ROV) have been conducted. Remarkable scientific achievements are isolation of many of new extremophilic microorganisms endemic to this hydrothermal field (Takai and Horikoshi, 1999; Takai et al., 2006) and shallow scientific drilling expeditions and their post-drilling multidisciplinary research (e.g., Higashi et al., 2004; Kato et al., 2009). In addition, the deep-sea hydrothermal systems in the Izu-Ogasawara Arc are now known to have excellent potentials for the future exploration of seafloor hydrothermal mineral deposits (Marumo et al., 2008).

The macrofaunal communities in the Suiyo Seamount have been not so interested in as compared to the microbial communities and hydrothermal fluid and mineral chemistry (Kojima, 2002). In the early stage of research, several predominant chemosynthetic animals such as mussels and crabs were described (Miyazaki et al., 2004; Desbruyeres et al., 2006), while the detail distribution and genetic diversity of the macrofaunal populations were not reported. In 2007, the first individual of *Alviniconcha* sp. was found and recovered (Fujiwara et al., 2013; Johnson et al., 2015). The only individual was used for the taxonomy and characterization of symbionts. Then, it seemed likely that the emerging “lucky” individual was arrested and the Suiyo Seamount would remain without *Alviniconcha* sp. for certain period. However, in 2011, several tens of *Alviniconcha* individuals were photographed, and this result strongly suggested that the *Alviniconcha* populations were surely immigrated into the Suiyo Seamount. It is still uncertain how and where the *Alviniconcha* population was naturally immigrated from its host hydrothermal system(s).

The Suiyo Seamount population was the only *Alviniconcha* population found in Japanese EEZ so far. The present and past submarine hydrothermal systems in the Izu-Ogasawara Arc including the Suiyo Seamount are among the possible target places for the future exploration of submarine hydrothermal mineral resources. If the future exploration will be conducted in the Suiyo Seamount, the chemosynthetic macrofaunal populations, especially *Alviniconcha* population, will encounter the hard danger for the extinction. If the Suiyo Seamount *Alviniconcha* population can be artificially translocated and immigrated into the adjacent hydrothermal systems as it was immigrated from some hydrothermal systems in the western Pacific, it may escape from the extinction.

The challenges of artificial translocation and immigration have several approaches. One of the most plausible ways is use of eggs and infants, but it does not yet reach the in situ experiments and needs much more onshore and in situ preliminary investigations. Another possible way is the tentative translocation and relocation of adults.

In this cruise, the genetic and physiological investigation of Suiyo Seamount *Alviniconcha* population are conducted using the recovery individuals and the in situ translocation and relocation experiments of Suiyo Seamount *Alviniconcha* population from the original habitat to the shallower and warmer seafloor environment in the Suiyo Seamount.

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III. EXPLANATORY NOTE

1. Manned Research Submersible “Shinkai 6500”

Mission of “Shinkai 6500”

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

Specifications

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

2. Research Vessel “Yokosuka”

Mission of “Yokosuka”

1) Operate submersible “Shinkai 6500”

2) Operate underway-geophysical equipments;

Multi Narrow Beam Echo Sounder (Sea Beam 2112.04)

Gravity meter (Type S-63)

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

Proton magnetometer (Typ STC10)

Research Facilities

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

Specifications

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

IV. DIVE REPORTS

6K#1549 DIVE (Suiyo SMt)	**Dr. C. Chen**
6K#1550 DIVE (Suiyo SMt)	**Dr. K. Takai and Ms. M. Yamamoto**
6K#1551 DIVE (Suiyo SMt)	**Dr. H. Watanabe and Mr. T. Asano**
6K#1552 DIVE (Suiyo SMt)	**Dr. J. Miyazaki and Ms. S. Ito**

Dive Report: Shinaki6500#1549
Date: August 21, 2019
Site: Suiyo Seamount, Izu-Ogasawara Arc
On bottom: 11:15; 28˚34.2962'N, 140˚38.6392'E, D=1386 m
Leave bottom: 16:30; 28˚34.2144'N, 140˚38.5232'E, D=1359 m
Observer: Chong Chen (JAMSTEC)

Objectives:
The single most important objective of this dive was to locate a colony of the chemosymbiotic snail *Alviniconcha adamantis*, in order to carry out the translocation experiment planned for the following dives. This colony was serendipitously discovered when reviewing images taken during cruise NT11-09 by ROV *Hyper-Dolphin* (HPD#1287), and has never been sampled. Prior to this, only a single individual of *A. adamantis* has been collected from Suiyo Seamont. Other objectives include sampling of other vent animals, collection of water samples from two depths (in vent plume and near sea bottom), taking calibration data and standard fluids for subsequent dives, and the deployment of a hydrophone for recovery in the next dive.

Dive summary:

During *Shinkai 6500*'s descent to the seafloor, one water sample was taken using niskin sampler (red) at the depth of 1100 m where vent plume was sighted, and another at 5 m above the sea bottom (green; depth 1381 m) just before landing.

Then, *Shinkai 6500* landed on the seafloor (11:15) where the substrate was rubble among sand. An individual of the *Grimpoteuthis* cf. *hippocrepium* octopus was sighted. At this point, the current was rather weak. A couple of issues were found with the systems of *Shinkai 6500*, mainly that the *'Shinkai* track' system for navigation was down and the main video camera (#1) remained foggy. After checking that the temperature probe, METS methane sensor, UNISENS multi-sensor, and perister pump were all communicating as normal with their respective computers, *Shinkai 6500* left the seafloor and headed to the point where a colony of *Alviniconcha adamantis* was sighted during cruise NT11-09. As the '*Shinkai* track' system was down, it was necessary to ask R/V *Yokosuka* for positions of *Shinkai 6500* frequently during this entire dive.

Since we landed at the east side of Suiyo Seamount hydrothermal vent field and the *Alviniconcha* point was on the south side, *Shinkai 6500* passed through the main active venting areas while on the move. The vents were almost always densely covered by dense colonies of the chemosymbiotic mussel *Bathymodiolus septemdierum*. Although the observer and pilots looked carefully for any traces of *A. adamantis*, none could be seen. A number of old markers were seen, but they were all heavily covered by bacterial growth and only one associated with a drill pipe, APSK09, could be read.

As *Shinkai 6500* neared the *Alviniconcha* point, the currents became very strong and it was often difficult to maneuver *Shinkai 6500* to the desired direction. A large rock (a few meters wide and high) blocked our way, but due to the currents it took over half an hour for the submersible to circumnavigate it. After circumnavigating the rock and re-approaching from the southern side, the observer located the *Alviniconcha* colony; about 50 individuals could be counted and the largest individual was over 8 cm in shell length when measured by laser. Deployment of a marker, the homer beacon, and the hydrophone were all done in this spot. Following this, the perister pump was used to pump the standard fluid through the sensors and stopped after sampling 4.5 L to retain the fluid in the MiyaJun-type fluid sampler. The functionality of the slurp gun for the *in situ* sampler in the next dive was also confirmed here.

After completion of the main objective, finding the *Alviniconcha* colony, *Shinkai 6500* headed back to the main venting areas in the center of Suiyo Seamount vent field in order to sample other vent animals. Sampling by slurp gun was undertaken in a number of *Bathymodiolus* colonies where the observer was able to located interesting sampling targets through the zoom function on the cameras (13:41-14:29). During sampling, the manipulator was used to tease apart the dense *Bathymodiolus* layers to reveal the animals beneath. Although the observer had hoped to find *Alviniconcha* hiding beneath *Bathymodiolus*, none could be found. A large piece of rock with numerous individuals of the vent snail *Desbruyeresia armata* was sampled into the sample box to augment samples taken by the slurp gun. Current was strong still, vent orifices were numerous and located close to each other, which made each landing somewhat difficult. The valve of the water line was shut during one of the animal sampling events.

Roving around the vent field, the observer and pilots realised that the venting activity did not cease to the southeastern side of the main venting area but continued upslope. This was a previously unknown area of venting activity on the Suiyo Seamount and in hope to find another *Alviniconcha* colony, *Shinkai 6500* moved upslope southeasternly from the center of the vent field. This stretch of venting orifices lasted for about 150 m in distance. Though numerous *Bathymodiolus* colonies existed, again no *Alviniconcha* could be located.

Slightly disappointed, the observer decided to return to the central venting area for a final animal sampling before leaving the bottom. Due to the currents and difficulty in navigating without the '*Shinkai* track' system it took over 30 minutes for *Shinkai 6500* to return to the central area. At this point, the main video camera had cleared up and it appeared to function as normal. On the way, *Shinkai 6500* passed through the *Alvinoconcha* point and it was note that due to the large rock, signal from the homer transponder was blocked when pinging from some directions. The submersible arrived in the central venting area around 16:00, took one more animal sample using slurp gun, and left the bottom on 16:30.

During ascend, data recordings for the temperature probe and METS methane sensor were stopped at 500 m depth, and their power were also cut at the same time along with power

for the perister pump.

Payloads:

- Slurp gun with multi-canister
- Slurp gun for *in situ* fixation (test only; no canister)
- Sample box
- Temperature probe
- MiyaJun-type water sampler
- METS methane sensor
- UNISENS multi-sensor
- Standard liquid (bag)
- Perister pump
- Niskin sampler x 2 (red and green)
- Marker x 2
- Homer beacon
- Hydrophone
-

Event list:

10:53 28°34.3391'N, 140°38.6569'E Depth=1100 m Fired red niskin sampler (success)

11:05 28°34.2962'N, 140°38.6392'E Depth=1381 m Fired green niskin sampler 5 m above sea bottom (success)

11:15 28°34.2962'N, 140°38.6392'E Depth=1386 m Landed on seafloor (rubble among sand)

12:32 28°34.2715'N, 140°38.6216'E Depth=1384 m Discovered *Alviniconcha adamantis* colony; deployed 6K marker, homer beacon, and hydrophone

13:41 28°34.3120'N, 140°38.5724'E Depth=1378 m Sampled animals using slurp gun

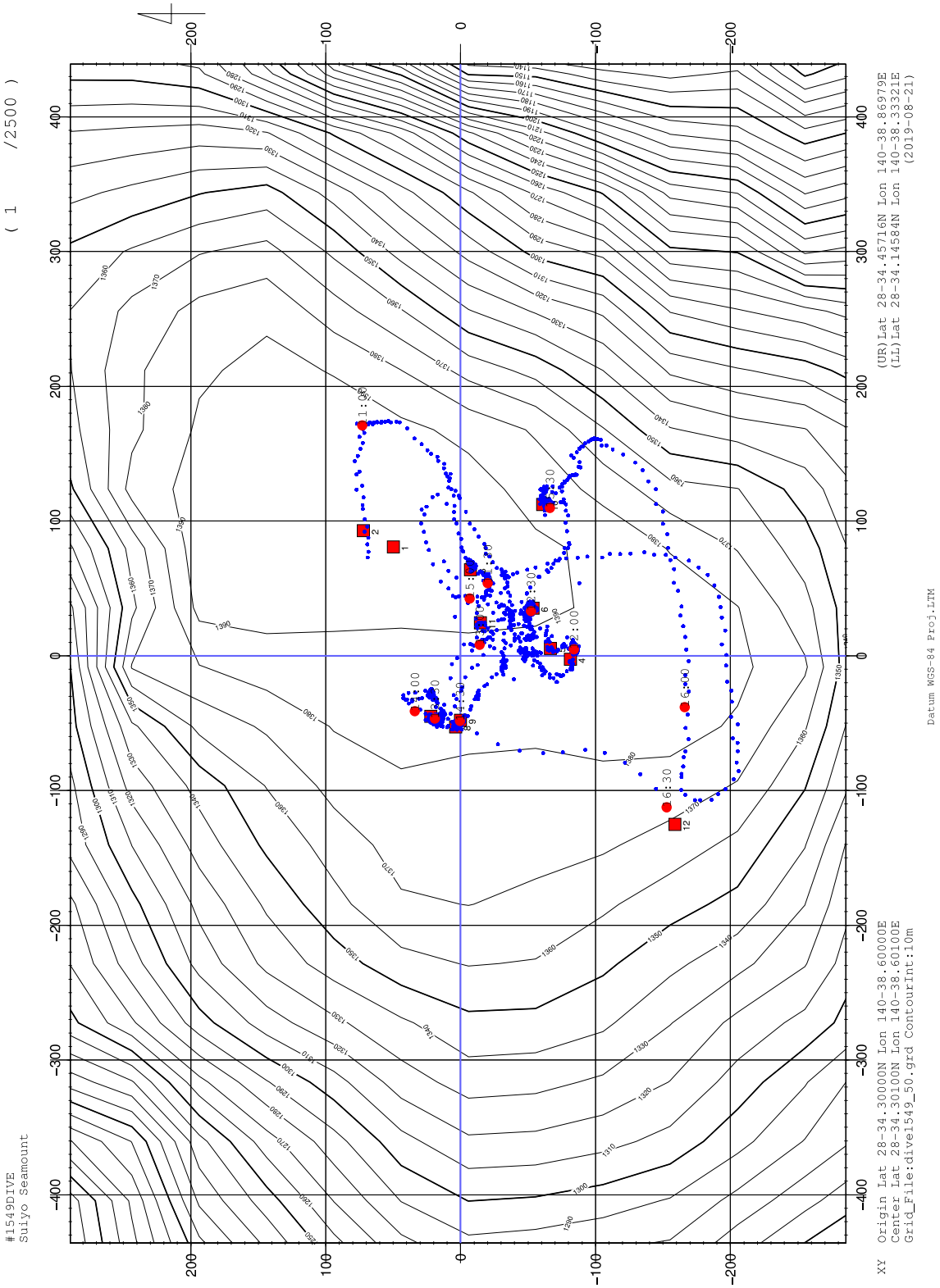
14:09 28°34.3024'N, 140°38.5676'E Depth=1377 m Sampled animals using slurp gun

14:29 28°34.3000'N, 140°38.5707'E Depth=1377 m Sampled animals using slurp gun; sampled a rock with *Desbruyeresia* spp. attached (sample box)

16:22 28°34.2926'N, 140°38.6150'E Depth=1383 m Sampled animals using slurp gun

16:30 28°34.2144'N, 140°38.5232'E Depth=1359 m Left bottom (altitude = 11 m)

Dive Track of Shinaki6500#1549



Dive Report: Shinaki6500#1550
Date: August 22, 2019
Site: Suiyo Seamount
Landing: 11:15; 28˚34.320'N, 140˚38.635'E, D=1324 m
Leaving: 16:01; 28˚34.1007N, 140˚38.922'E, D=999 m
Observer: Ken Takai (JAMSTEC), Miyu Yamamoto (JAMSTEC/Univ. Tokyo)

Objectives:
The objectives of this dive are to collect plume waters and chimneys, to measure the physical and chemical conditions of Alviniconcha and Bathymodiolus colones, and to translocate Alviniconcha individuals to shallower depths of seafloor, in the Suiyo Seamount caldera.

Dive summary:

During the dive, the reference deep seawater was sampled by Niskin sampler (red) at a depth of 800 m. Then, we landed on the sandy seafloor about 100 m northeast from the Alviniconcha colony site. First, we headed to west.

After several 10s meters of navigation, we found small chimneys directly growing from the sandy seafloor and landed there. We tried to take the chimneys but failed to recover because they were soft beehive structures. About ten meters of west from the site, we found small hydrothermal mound and went to recover the chimney structures. Here, several pieces of chimney structures were successfully recovered and the temperature of discharging fluid was measured to be maximally 311˚C. Then, just adjacent to the mound, dense Bathymodiolus colonies were recognized. Thus, we moved to measure the physical and chemical conditions of Bathymodiolus colonies. First the dissolved oxygen concentrations were measured by DO meter at two different points (12:24-). Next the colony water was subject to the in situ H_2 and H_2S sensors (ave. T was about 4.0 ˚C)(-12:31).

After operation at the site, we moved to the Alviniconcha colony. At the caldera bottom seafloor, the bottom current was strong and the direction was changing. The traffic was quite difficult. During the navigation, we fortunately found very active venting and big chimneys site (Oresijo Hottest site) and set Marker (6K#235).

Finally, we arrived at the Alviniconcha colony and first recovered the hydrophone and transponder deployed at 6K#1549. Next we measured the physical and chemical conditions (DO, H_2 and H_2S sensors) of different points of the colony water(13:26-13:30, 13:30-13:32, and 13:32-13:35 for DO, 13:37-13:41, 13:41-13:44, and 13:44-13:48 for H_2 and H_2S sensors). The temperature was 6.5 – 29 ˚C and the water was sampled by MJ water sampler. Then, each of 4 individuals were sampled and located into the cages (White and Red) and 8 individuals were collected into the canister.

Finally, with the caught Alviniconcha individuals, we moved to the outer ridge of Suiyo

Seamount. During the navigation, we collected Niskin water sample (Green) at 1150 m. There were some troubles but we successfully reached the good point at the shallowest part (996 m) and left two cages of Alviniconcha individuals and set hydrophone and transponder again. Then we left the bottom.

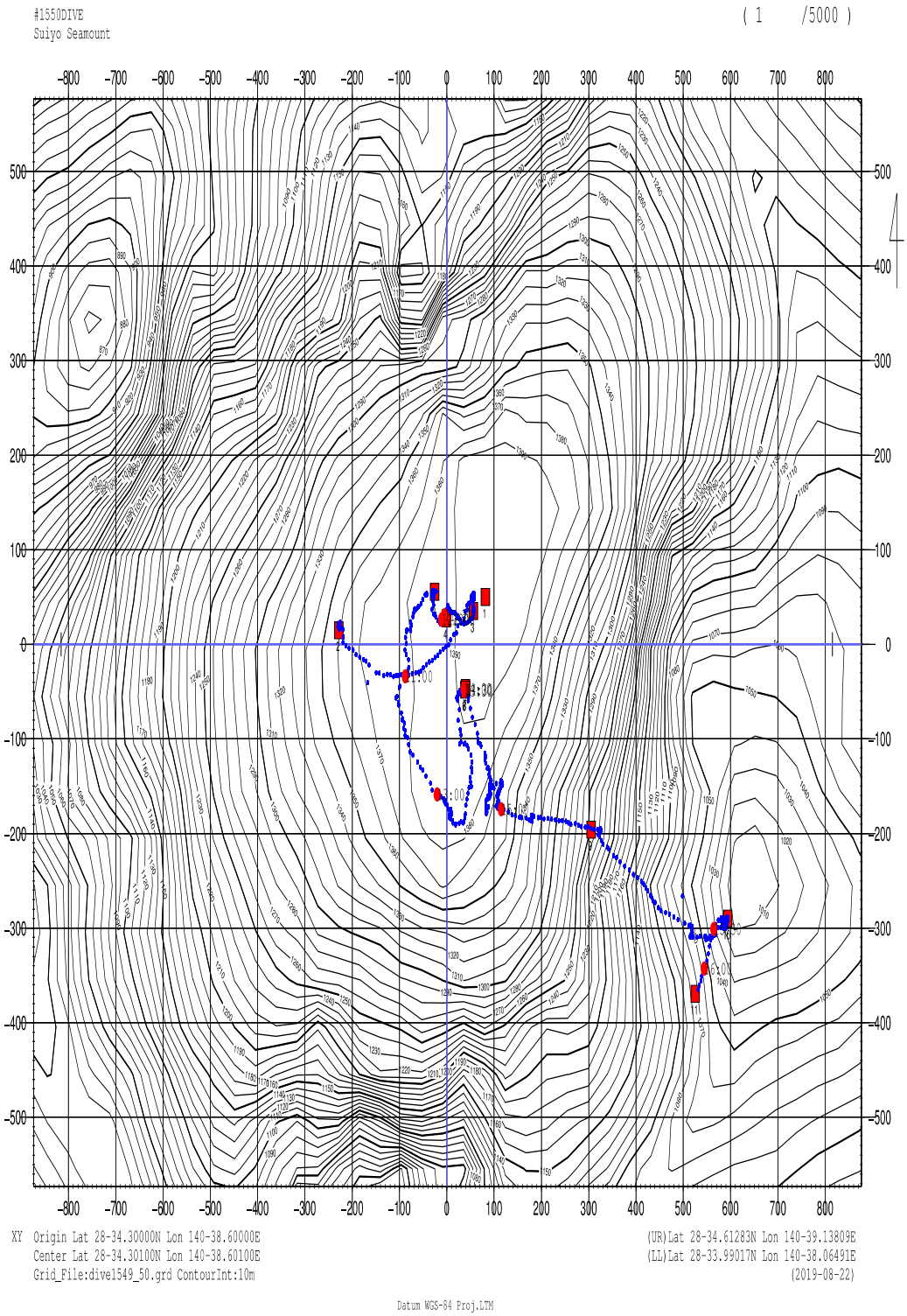
Payloads:

- Suction sampler with single canister
- DO meter
- MJ water sampler
- H_2 and H_2S sensors
- Hydrophon
- Sample box
- Alviniconcha cage (x2)

Event list:

10:53	28˚34.3089'N, 140˚38.4601'E,	800m	Sampling Niskin(Red)
11:15	28˚34.3197'N, 140˚38.6346'E	1324m	Landing
12:32	28˚34.3158'N, 140-38.5996'E	1383m	Sampling Chimney, Measurement Temprerature, Multisensor
12:42	28˚34.3304'N, 140˚38.5842'E	1381m	Set Marker #235
13:25	28˚34.2745'N,140˚38.6237'E	1385m	Retrieve Homer & Hydrophone. Measurement DO & temp. sensor, Sampling Alviniconcha
14:08	28˚34.2750'N, 140˚38.6243'E,	1385m	Sampling Alviniconcha
14:16	28˚34.2749'N, 140˚38.6242'E	1385m	Sampling Alviniconcha, Measurement Temprerature
15:05	28˚34.1946'N, 140˚38.7873'E	1150m	Sampling Niskin(Green)
15;52	28˚34.1438'N, 140˚38.9641'E	994m	Set Homer#70, Hydrophone, Box(2), Marker #236
16:01	28˚34.1007"N, 140˚38.9222'E,	999m	Left Bottom "

Dive track of 6K#1550



Dive Report: Shinaki6500#1551
Date: August 23, 2019
Site: Suiyo Seamount
Landing: 11:03; 28˚34. 1103'N, 140˚38.9941'E, D=1021 m
Leaving: 15:29; 28˚34. 3142'N, 140˚38. 5188'E, D=1369 m
Observer: Hiromi Watanabe (JAMSTEC), Takesi Asano (JAMSTEC/Univ. Tokyo)

Objectives:
The objectives of this dive were to place *Alviniconcha* individuals back to their original habitat, operate in-situ fixation of the translocated *Alviniconcha*, collect Bathymodiolus individuals and measure their habitat temperature and DO concentration, in the Suiyo Seamount Caldera.

Dive summary:

After the landing at the top of the caldera wall of the Suiyo Seamount (D = 995m), the deployed homer, hydrophone and two cages (white and red) containing each of four individuals of *Alviniocncha* were found. Before the retrieval, temperature and DO above the cages were measured. All of *Alviniconcha* were looked healthy, and the white cage was fixed by RNAlater-MJ in the box. Unfortunately, the box was not completely closed and keep closing the rid by manipulater. We retrieved all of the other deployments at this point and headed to the original habitat of *Alviniconcha*, where is located southwest of this site.

On the way to the original habitat of *Alviniconcha*, water sample was collected the depth of 1050m (green) and 1200m (red) by Niskin sampler. At the depth of 1274m, turbidity seemed to be higher compared to the other layer. Calibration of METS Methane sensor was attempted but the voltage of the methane sensor did not work (temperature could be measured).

At the original habitat of *Alviniconcha*, temperature and DO were measured and the remind the cage of *Alviniconcha* and transponder was deployed beside *Alviniconcha* assemblage. Then, we headed to Oresijo Hottest site where the marker 6K#235 was deployed.

We attempted to approach to the site from southward but the westward current was strong near the bottom (visual identification of the marker was difficult due to the shimmering) in this site, and we could not access to Oresijo Hottest site. We re-entered to this site from southward again, and finally, landed beside Oresijo Hottest site. The hydrophone was deployed near the gray smoker where about 3m southeast of Oresijo Hottest site.

At the south of Oresijo Hottest site, we found several patches of *Bathymosiolus* mussels with small shrimps and we landed in front of one of the patches. We measured temperature and DO to compare those of in *Alviniconcha* assemblage, and collected more than 50 individuals of *Bathymodiolus* mussels with hundreds of *Opaepele* shrimps. It was about the time to leave the bottom and we traveled to northwest and left the bottom.

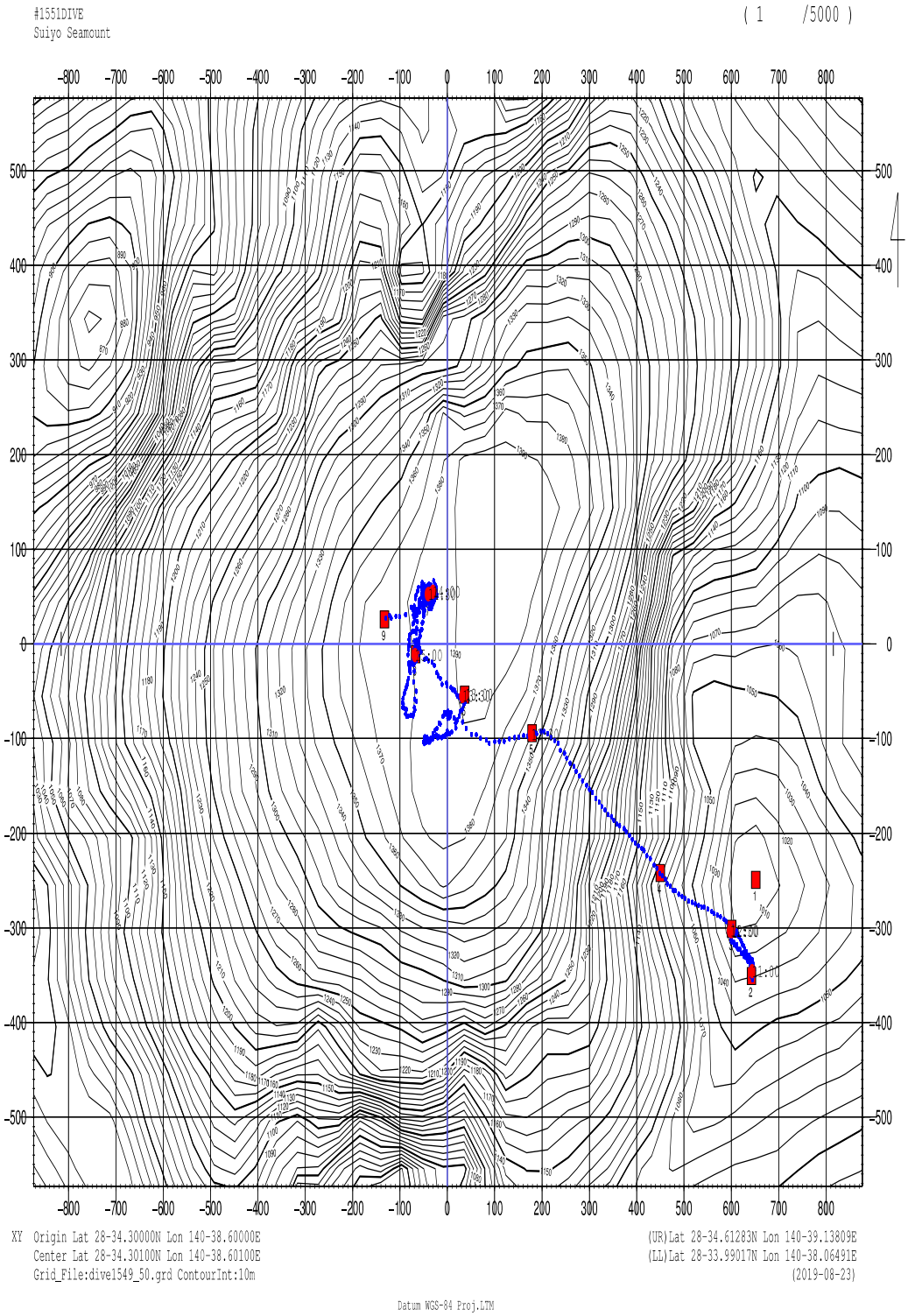
Payloads:

- Suction sampler with single canister
- DO meter
- Niskin water sampler (Green and Red)
- MJ water sampler
- METS Methane sensor
- H_2 and H_2S sensors
- Hydrophone
- In-situ fixation box filled with RNAlater
- Sample box

Event list:

11:03	28˚34.1103'N, 140˚38.9941'E,	1021m	Landing
11:31	28˚34. 1377'N, 140-38.9683'E	994m	Retrieve Homer, Hydrophone & *Alviniconcha* cage (Red). Measurement of DO & temperature. In-situ fixation of *Alviniconcha* cage (White)
12:17	28˚34.1692'N, 140˚38.8759'E	1060m	Sampling Niskin (Green)
12:29	28˚34.2493'N, 140˚38.7098'E	1202m	Sampling Niskin (Red)
13:30	28˚34.2710'N, 140˚38.6226'E,	1385m	Measurement of DO & temperature, deployment of *Alviniconcha* cage (Red) and Homer
14:35	28˚34.3288'N, 140˚38.5758'E	1381m	Deployment of Hydrophone
15:07	28˚34.2949'N, 140˚38.5590'E	1376m	Measurement of DO & temperature. Sampling of *Bathymodiolus* mussels
15:29	28˚34.3142'N, 140˚38.5188'E	1369m	Left Bottom

Dive track of 6K#1551



Dive Report: Shinaki6500#1552
Date: August 25, 2019
Site: Suiyo Seamount
Landing: 10:57; 28˚34.171'N, 140˚38.6163'E, D=1366 m
Leaving: 15:25; 28˚34.3535'N, 140˚38.5117'E, D=1353 m
Observer: Junichi Miyazaki (JAMSTEC), Seina Ito (JAMSTEC/Ritsumeikan Univ.)

Objectives:
The objectives of this dive were to confirm whether previously re-set snails are dead or alive, to measure chemical properties of snail's habit, to fix snails for RNA extraction and to sample snails, in the Suiyo Seamount caldera.
Sampling chimney structures and measuring temperature are also the purposes of this dive No.1552.

Dive summary:

Before landing, when we reached to the depth of 1260 m, we sampled deep seawater including plumes derived from hydrothermal fluids by Niskin sampler (red). Moreover, when we reached to the depth of 1300 m, we also sampled deep seawater was sampled by Niskin sampler (green). We landed on the rocky seafloor about 200 m south from the Alviniconcha colony site. We set marker#237 to surely re-vist to snail site in Suiyo seamount and then we headed to north.

After about 10 minuites of navigation, we easily found markers and transponder which were set at *Alviniconcha* colony in previous dives. We observed the colony for a while and then we picked up the transponder for the following operations. First, we confirmed whether snails which were transferred cage and were experienced top of caldera wall, were dead or alive {11:15-11:40}. We picked up cage, observed and judged that snails in the cage were alive. For the following operations, we moved the cage to the left basket. After moving to the cage, we measured dissolved oxygen of the habitat (4 points (Solitaire {11:42-11:44}, Edmond {11:45-11:47}, Kairei {11:47-11:49}, Dragon {11:50-11:52}) was measured). And more we measured temperature by temperature sensor and changes of voltage for both H_2 and H_2S by multisensory at the same 4 points (Solitaire {11:54-11:56}, Edmond {11:57-12:02}, Kairei {12:02-12:06}, Dragon {12:08-12:11}). Moreover, we sampled water into Alviniconcha colony at Dragon point {12:15-12:20}. After measuring chemical and physical properties, to fix snails for RNA extraction, we sampled 4 snails into the canister connected to a plastic container packing solution for RNA protection {12:28-12:34}. And then we captured and moved 5 snails to the new cage (white) in sample box {12:40-12:46}. Next we sampled 12 snails into normal canister {12:47-12:51}. After sampling snails, we measured temperature at Edmond {12:55-12:56} and Doragon points {12:56-12:57}. Finally, we set red cage to Edmond point and

white cage to Dragon point {12-58-13:13}.

We headed to big chimney site (Oresijo hottest site). After 20 min moving, we found merker#235 and hydrophone which was set in previous dive#1551. We first recovered hydrophone. Next, we tried to sample chimney structure from Oresijo hottest chimney (3-m height). We approached to the middle of the chimney by contacting left basket. Several pieces of chimney structures were collected, but we could not obtain enough. Therefore, we tried to strike chimney by left manipulator and hole-in-one to sample box in right box. However as soon as trying that way, the chimney was broken. To avoid white out by breaking chimney, we went up and escaped to 50-m south. After about 5 min, we continued to try chimney sampling. We approached Oresijo hottest chimney from south and tried to sample chimney structure. However, we got only a few chimney pieces. Since we come to time in which we had to leave the bottom, we gave up sampling more chimney structure and measuring temperature of hydrothermal fluid. We moved to northwest and left the bottom {15:25}.

Payloads:

- Suction sampler with single canister
- Suction sampler with single canister connected to plastic container packed solution for in situ RNA fixation
- DO meter
- Temperature sensor
- MJ water sampler
- H_2 and H_2S sensors {Multi sensor}
- METS sensor
- Turbidity sensor
- Sample box
- 1 x Alviniconcha cage (white)
- 2 x NISKIN sampler (Red and Green)

Event list:

10:48	28°34.1646'N, 140°38.5855'E	D=1257	Sampling Niskin(Red)
10:51	28°34.1660'N, 140°38.6020'E	D=1306	Sampling Niskin(Green)
10:57	28°34.1714'N, 140°38.6163'E	D=1366	Landing,Set Marker(#237)
11:27	28°34.2701'N, 140°38.6261'E	D=1385	Retrieve Homer #70
13:09	28°34.2701'N, 140°38.6261'E	D=1385	Measurement DO, Multisensor, Temperature Sampling Water, Alviniconcha, Set Box(2)
13:52	28°34.3231'N, 140°38.5782'E	D=1380	Retrieve Hydorophone
13:56	28°34.3225'N, 140°38.5834'E	D=1377	Finding Chimney
14:44	28°34.3202'N, 140°38.5708'E	D=1352	Sampling Chimney
15:16	28°34.3270'N, 140°38.5753'E	D=1379	Sampling Chimney

15:25 28°34.3535'N, 140°38.5117'E D=1353 Left Bottom

Dive track of 6K#1552