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Natsushima Cruise Report

NT11-20

Middle and south Okinawa Trough

September 29, 2011 – October 12, 2011

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

Contents

1. Cruise Information

1-1 Cruise summary

Cruise ID: NT11-20

Name of vessel: *Natsushima* with Hyper Dophine 3K

Title of the cruise: Pilgrmiage to hydrothermal fields in the Okinawa Trough

Title of proposal: History of hydrothermal activities and associated biological communities in the Okinawa Trough (S11-60)

Cruise Period: from September 29th to October 12th, 2011

Port Call: Naha

Research Area: Okinawa Trough

Cruise Track and Dive localities

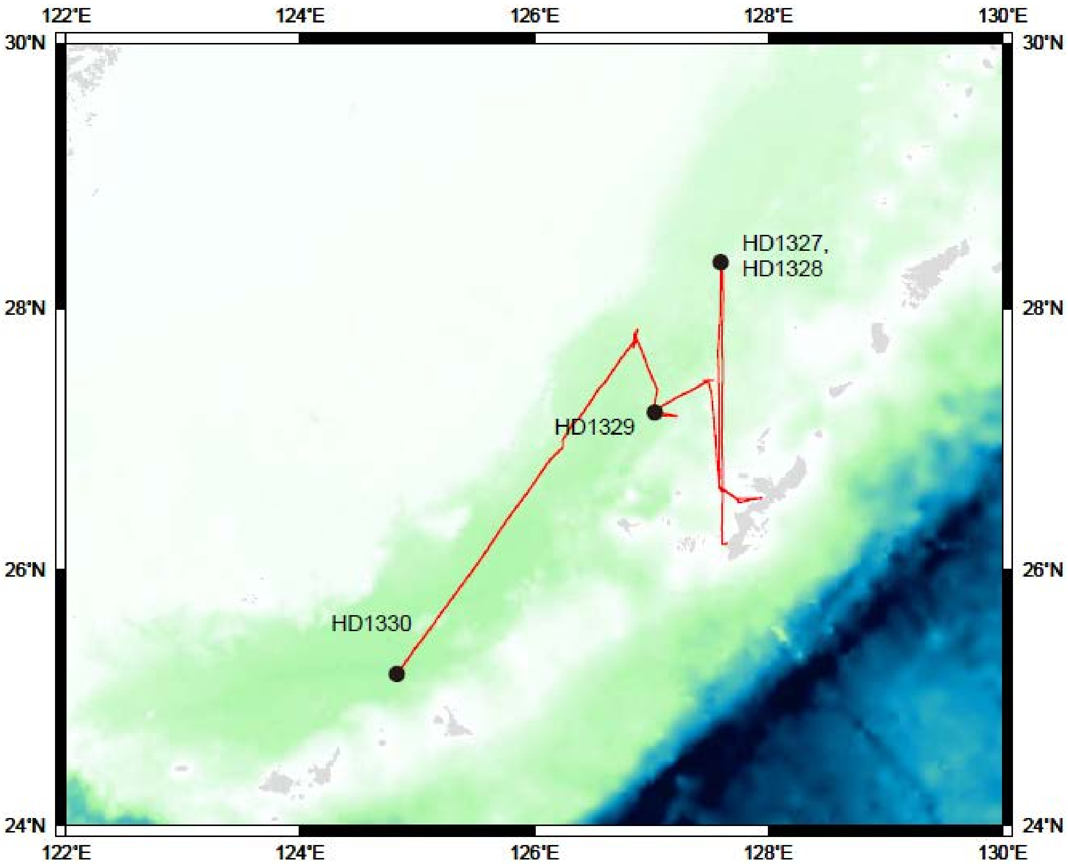


Fig. 1 Cruise track and dive localities of NT11-20 cruise

1-2 Cruise members

Science Party

Chief scientist, Geochemist	Jun-ichiro Ishibashi (Kyushu U., Facul. Science)
Vice chief scientist, Biologist	Hiromi Watanabe (JAMSTEC, Biogeos.)
Biologist	Hiroshi Miyake (Kitazato U., Schl. Marine Biosciences)
Microbiologist	Yukari Miyazaki (U. Tokyo, Facul. Science)
Biologist	Masako Nakamura (Okinawa Inst. Sci. Tech.)
Mineralogist	Yuuma Nishibayashi (Kumamoto U., Schl. Sci & Tech.)
Geochemist	Tatsuo Nozaki (JAMSTEC, IFREE)
Geochemist	Yuji Onishi (Okayama U., Facul. Science)
Biologist	Tomomi Ogura (JAMSTEC, Biogeos.)
Geochemist	Fumihiro Sato (Okayama Science U., Schl. Science)
Microbiologist	Yohey Suzuki (U. Tokyo, Schl. Science)
Biologist	Yoshimi Takahashi (JAMSTEC, Biogeos.)
Biologist	Takuya Yahagi (U. Tokyo, Schl. Frontier Sciences)
Microbiologist	Masahiro Yamamoto (JAMSTEC, Biogeos)
Microbiologist	Tomo-o Watsuji (JAMSTEC, Biogeos)
Chief Marine Technician	Masashi Ito (Nippon Marine Enterprise)

ROV Hyper-Dolphin Operation Team

Chief ROV Operator	Yoshinari Ono
1st Submersible Staff	Mitsuhiro Ueki
2nd Submersible Staff	Homare Wakamatsu
2nd Submersible Staff	Shigeru Kikuya
2ndSubmersible Staff	Yudai Sakakibara
3rd Submersible Staff	Atsushi Takenouchi

R/V NATSUSHIMA Crew

Captain	Yoshiyuki Nakamura
Chief Officer	Akihisa Tsuji
2nd Officer	Isao Maeda
3rd Officer	Akira Suzuki
Chief Engineer	Hiroyuki Shibata
1st Engineer	Wataru Kurose
2nd Engineer	Saburo Sakaemura
3rd Engineer	Shota Nagano

Chief Radio Operator	Masamoto Takahashi
2nd Radio Operator	Hiroki Ishiwata
3rd Radio Operator	Michiyasu Katagiri
Boat Swain	Kozo Yatogo
Able Seaman	Kuniharu Kadoguchi
Able Seaman	Takao Kubota
Able Seaman	Hideo Isobe
Able Seaman	Takuya Miyashita
Sailor	Hirotaka Shigeta
Sailor	Jun Shinoda
No.1 Oiler	Hiroyuki Oishi
Oiler	Katsuyuki Miyazaki
Oiler	Shinya Sugi
Oiler	Yuji Higashigawa
Oiler	Ryo Matsuuchi
Chief Steward	Ryuei Takemura
Steward	Yoshinobu Hasatani
Steward	Hideo Fukumura
Steward	Tatsuya Yamamoto
Steward	Hiroki Fukuda

1.3 Shipboard log

Date	Local Time	Note	Position/Weather/Wind/ Sea condition
29,Sept,2011		**Sail out and transit**	
	15:00	Let go all shore line,left NAHA.Proceeding to dive area(MINAMI ENSEI Knoll).	09/29 12:00(UTC+9h)
	15:30	Onboard education and safety training	26-14.3N 127-40.8E
			Fine but cloudy
			East-2(Light breeze)
			1(Calm)
			1(Low swell sea)
			Visibly:8
30,Sept,2011		**HPD#1327**	
	3:45	Arrived at dive area(MINAMI ENSEI Knoll).	09/30 12:00(UTC+9h)
	6:02	Released XBT at 28-23.2954N 127-38.3175E	27-23.4N 127-38.4E
	8:13	Hoisted up H.P.D.	Fine but cloudy
	8:25	Launched H.P.D. on the surface	North-2(Light breeze)
	8:35	H.P.D. dove & started her operation #1327	2(Sea smooth)
	9:21	H.P.D. launded on sea bottom.(D=706m)	2(Low swell long)
	11:02	H.P.D. left the sea bottom(D=692m)	Visibly:8
	11:24	H.P.D. floated	
	11:31	Hoisted up H.P.D.	
	11:38	Recovered H.P.D & finished above operation	
		HPD#1328	
	13:01	Hoisted up H.P.D.	
	13:05	Launched H.P.D. on the surface	
	13:15	H.P.D. dove & started her operation #1328	
	13:44	H.P.D. launded on sea bottom.(D=710m)	
	16:09	H.P.D. left the sea bottom(D=694m)	
	16:32	H.P.D. floated	
	16:39	Hoisted up H.P.D.	
	16:46	Recovered H.P.D & finished above operation.	
	20:30	Proceeding to NAGO WAN due to rough sea.	
01,Oct,2011		**Anchoring at off NAGO WAN**	
	7:00	Let go anchor,arrived at NAGO WAN.	10/01 12:00(UTC+9h)
			26-34.8N 127-58.4E
			Fine but cloudy
			NNE-6(Strong breeze)
			2(Sea smooth)
			2(Low swell long)
			Visbly:7
02,Oct,2011		**Anchoring at off NAGO WAN**	
			10/02 12:00(UTC+9h)
			26-34.8N 127-58.4E
			Cloudy
			NE-5(Fresh breeze)
			2(Sea smooth)
			2(Low swell long)
			Visibly:7
03,Oct,2011		**Anchoring at off NAGO WAN**	
			10/03 12:00(UTC+9h)
			26-34.8N 127-58.4E
			Overcast
			NE-4(Moderate breeze)
			1(Calm)
			2(Low swell long)
			Visibly:7
04,Oct,2011		**Suspended HPD#1329 operation**	
	5:40	Heaving anchor,then com'ced proceeding to dive area(YORON Knoll).	10/04 12:00(UTC+9h)
	13:00	Arrived at dive area (YORON Knoll).	27-20.3N 127-33.1E
	15:00	Suspended HPD#1329 operation,due to rough sea.	Overcast
	15:10	Left YORON,proceeding to dive area (IZENA HAKUREI site).	East-6(Storong breeze)
			5(Sea rough)
			4(Moderate average)
			Visibly:7

Date	Local Time	Note	Position/Weather/Wind/ Sea condition
05,Oct,2011		**HPD#1329**	
	5:00	Arrived at dive area.(IZENA HAKUREI site)	10/05 12:00(UTC+9h)
	6:00	Released XBT at 27-14.9528N 127-03.9080E	27-14.9N 127-04.1E
	9:55	Hoisted up H.P.D.	Rain
	9:59	Launched H.P.D. on the surface	NW-4(Moderate breeze)
	10:09	H.P.D. dove & started her operation #1329	2(Low swell long)
	11:02	H.P.D. launded on sea bottom.(D=1621m)	4(Moderate average)
	15:49	H.P.D. left the sea bottom(D=1549m)	Visibly:4
	16:36	H.P.D. floated	
	16:45	Hoisted up H.P.D.	
	16:51	Recovered H.P.D & finished above operation	
	17:00	Left IZENA,proceeding to dive area (IHEYA NORTH Knoll).	
06,Oct,2011		**Suspended HPD#1330 operation**	
	6:00	Arrived at dine area (IHEYA NORTH Knoll),then released XBT at 27-47.5608N 126-54.1071E	10/06 12:00(UTC+9h)
	8:45	Suspended HPD#1330 operation due to rough sea.Then proceeding to dive area(YAEYAMA(IRABU) Knoll).	27-21.0N 126-32.2E
			Fine but cloudy
			North-5(Fresh breeze)
			4(Sea moderate)
			5(Moderate long)
			Visibly:7
07,Oct,2011		**HPD#1330**	
	3:30	Arrived at dive area(YAEYAMA(IRABU) Knoll).	10/07 12:00(UTC+9h)
	6:00	Released XBT at 25-14.0742N 124-52.3021E	25-14.0N 124-52.5E
	8:11	Hoisted up H.P.D.	Fine but cloudy
	8:15	Launched H.P.D. on the surface	NE-5(Fresh breeze)
	8:25	H.P.D. dove & started her operation #1330.	4(Sea moderate)
	9:29	H.P.D. launded on sea bottom.(D=1977m)	3(Moderate short)
	16:02	H.P.D. left the sea bottom(D=1651m)	Visbly:7
	16:49	H.P.D. floated	
	16:57	Hoisted up H.P.D.	
	17:30	Recovered H.P.D & finished above operation,then proceeding to dive area(HATOMA Knoll).	
	23:00	Arrived at dive area(HATOMA Knoll).	
08,Oct,2011		**Suspended HPD#1331 operation**	
	6:00	Released XBT at 24-51.1617N 123-49.3231E	10/08 12:00(UTC+9h)
	10:00	Suspended HPD#1331 operation due to rough sea,then com'ced proceeding to OFF ISHIGAKI.	24-33.2N 123-56.8E
	13:00	Arrived at OFF ISHIGAKI,then com'ced drifting.	Overcast
			NE-6(Storong breeze)
			4(Sea moderate)
			5(Moderate long)
			Visibly:6
09,Oct,2011		**HPD#1331**	
	3:30	Finished drifting,then com'ced proceeding to dive area(HATOMA Knoll).	10/09 12:00(UTC+9h)
	6:30	Arrived at dive area(HATOMA knoll).	24-51.4N 123-50.5E
	8:11	Hoisted up H.P.D.	Overcast
	8:14	Launched H.P.D. on the surface	ESE-4(Moderate breeze)
	8:25	H.P.D. dove & started her operation #1331.	3(Sea slight)
	9:12	H.P.D. launded on sea bottom.(D=1518m)	4(Moderate average)
	14:44	H.P.D. left the sea bottom(D=1523m)	Visibly:4
	15:28	H.P.D. floated	
	15:38	Hoisted up H.P.D.	
	16:00	Recovered H.P.D & finished above operation,then com'ced proceeding to dive area(YAEYAMA(IRABU)Knoll).	
	21:30	Arrived at dive area(YAEYAMA(IRABU) knoll),then com'ced drifting.	
10,Oct,2011		**HPD#1332**	
			10/10 12:00(UTC+9h)
	7:08	Hoisted up H.P.D.	25-13.8N 124-52.2E
	7:12	Launched H.P.D. on the surface	Cloudy
	7:22	H.P.D. dove & started her operation #1332.	SSE-3(gentle breeze)
	8:20	H.P.D. launded on sea bottom.(D=1682m)	2(Sea smooth)
	11:49	H.P.D. left the sea bottom(D=1632m)	2(Low swell long)
	12:33	H.P.D. floated	Visibly:7

Date	Local Time	Note	Position/Weather/Wind/ Sea condition
	12:36	Hoisted up H.P.D.	
	12:48	Recovered H.P.D & finished above operation.	
	13:00	Com'ced proceeding to dive area(YORON Knoll).	
11,Oct,2011		**HPD#1333**	
	6:45	Arrived at dive area(YORON Knoll).	10/11 12:00(UTC+9h)
	6:56	Released XBT at 27-29.1471N 127-31.5019E	27-29.3N 127-32.1E
	8:12	Hoisted up H.P.D.	Fine but cloudy
	8:16	Launched H.P.D. on the surface	North-5(Fresh breeze)
	8:26	H.P.D. dove & started her operation #1333.	3(Sea slight)
	8:51	H.P.D. launded on sea bottom.(D=583m)	2(Low swell long)
	15:36	H.P.D. left the sea bottom(D=580m)	Visibly:7
	15:54	H.P.D. floated	
	16:00	Hoisted up H.P.D.	
	16:09	Recovered H.P.D & finished above operation.	
	16:30	Com'ced proceeding to NAHA..	
12,Oct,2011		**Entering NAHA**	
	9:00	Sent out 1st shore line,then arrived at NAHA.	

2. Outline of proposal

"History of hydrothermal activities and associated biological communities in the Okinawa Trough" (Proposal S11-60 by Jun-ichiro Ishibashi, Kyushu University)

Proponents of the proposal S11-60 are members of Team A03 of the TAIGA project, which is funded by MEXT from FY2008 to FY2012 as one of programs of "Scientific Research on Innovative Areas". Team A03 have developed methodologies to estimate ages of hydrothermal events and phenomena, those are helpful when investigating the evolving processes of subseafloor fluid circulation (TAIGA) systems. The members of Team A03 have studied two approaches for this purpose; one is geochronological studies of hydrothermal deposits and alteration minerals, and the other is ecological and molecular genetic studies of animals obligating to hydrothermal vent fields. Comparison of age determined by these quite different approaches would provide much reliable age information.

Hydrothermal fields in the Okinawa Trough are selected as one of important target fields of TAIGA project. They are recognized as "Taiga of methane" which is developed in a sediment-covered system with abundant organic material. Moreover, they would provide a good test field for substantiative researches for methodologies developed by Team A03 members, because two groups of known active hydrothermal fields are distantly located, in the middle Okinawa Trough and in the south Okinawa Trough.

Previous geophysical studies have proposed that tectonic evolution of the Okinawa Trough propagated from south to the north (that means the south part is older). However, a paleomagnetic study demonstrated long quiescent period and revealed the recent tectonic activity has started only 1 Ma. On the other hand, preliminary molecular genetic studies of vent animals suggested lower biodiversity in the hydrothermal fields in the south Okinawa Trough (that means the vent ecology in the south Okinawa Trough is more immature).

Proposal S11-60 aims to provide a new constraint for discussions on evolution history of hydrothermal fields in the Okinawa Trough. It is important to apply systematic and quantitative strategy for sampling of vent animals from all the visited hydrothermal fields, since unified sampling ensures reliable statistical analysis of obtained results of ecological and molecular genetic studies. Moreover, age data obtained by geochronological studies of collected hydrothermal deposits and alteration minerals will provide qualitative base for discussions on evolving processes of hydrothermal activities in the Okinawa Trough.

3. Record of dive surveys

3.1 Dive Summary

During NT11-20 cruise, we conducted dive surveys in five active hydrothermal fields in the Okinawa Trough as summarized in Table 1. We devised systematic research procedures to discuss diversity found in these hydrothermal fields, for example biological sampling using a quadrant frame, water sampling from the same animal colony, and measurement of chemical property using an in situ electrochemical sensor system. We also energetically collected geological samples such as volcanic rocks, hydrothermal ore deposits, and sediments. Moreover, we deployed an ADCP at the Irabu Knoll during HPD 1330 to monitor deep-sea water currents for about one year.

Table 1 Summary of ROV dives during NT11-20

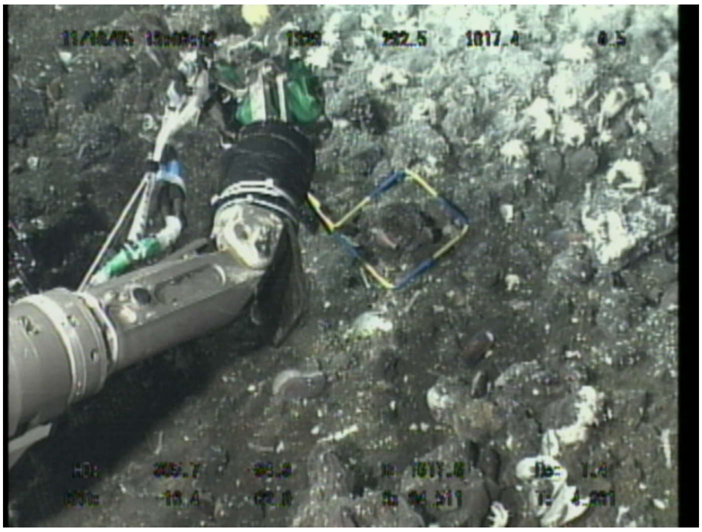
dive No.	date	landing	takeoff	area	latitude	longitude	depth	geological and fluid samples	operation
1327	9/30	9:21	11:02	Minami-Ensei Knoll	28°23.5'N	127°38.5'E	709 m	G01-04, WB1	deployment of marker H1327-1
1328	9/30	13:44	16:09	Minami-Ensei Knoll	28°23.5'N	127°38.5'E	710 m	G01-06, WB1-2, WW1-4	
1329	10/5	11:02	15:49	Izena Cauldron	27°15.0'N	127°04.0'E	1624 m	G01-06, M01, NR&NG, WW1-4, WB1-3, WV	
1330	10/7	9:29	16:02	Yaeyama (Irabu) Knoll	25°14.0'N	124°52.5'E	1978 m	G01-08, M01, WW1-4, WB1-3	deployment of ADCP, MASACOs
1331	10/9	9:12	14:44	Hatoma Knoll	24°51.5'N	123°50.5'E	1523 m	G01-08, NR&NG, WW1-4, WB1-3, WV	deployment of MASACOs
1332	10/10	8:20	11:49	Yaeyama (Irabu) Knoll	25°13.7'N	124°52.2'E	1684 m	G01-05, NR&NG, WB1-2, WV	
1333	10/11	8:51	15:36	Yoron Knoll	27°29.3'N	127°32.0'E	594 m	G01-12, NR, WB1-3, WW1-4, WV	deployment of MASACOs

3.2 Payload instruments

Quadrat

Size: 20cm x 20cm, or 30cm x 30cm.

Quadrat is a simple squared-frame to collect a quantitative animal sample. It is set on an animal assemblage by ROV, and all the animals in a quadrat are collected by a slurpgun (see below).

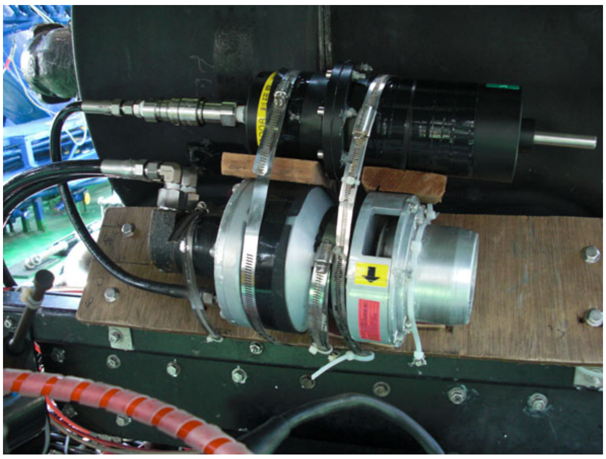


Slurpgun (Suction sampler for ROV)

Size: 14cm x 14cm x 27cm

Weight in air: 8kg, Weight in water: 5.5kg

Slurpgun is hydraulically-operated suction sampler mounted on ROV. It consists of inlet and outlet ducts and hydraulic pump system. Between the inlet duct and the pump system, single or multi-bottle canister (see below) is placed to trap the animals.



Multi-bottle canister
Size: 60cm x 50cm x 30cm
Weight in air: 35kg
Multi-bottle canister is used for collecting animals by ROV with slurpgun. It consists of a revolver including six bottles and a main tank where the revolver is placed. The bottles are covered with plankton nets (mesh opening = 500 micron).

WHATS sampler
Seawater in the *S. crosnieri* colonies was collected using a gas-tight fluid sampler "WHATS" (Water Hydrothermal-fluid Atsuryoku Tight Sampler) at the sampling sites of individuals of *S. crosnieri* in the deep-sea hydrothermal vent colonies (Saegusa et al., 2006). The *in situ* temperature of the hydrothermal effluent was simultaneously measured with a self-recording thermometer on the WHATS sampler. The colony-water was sampled into four of the WHATS gas-tight bottles (10 ml of volume). The bottles of colony-water are going to be used for the analysis of gas components.

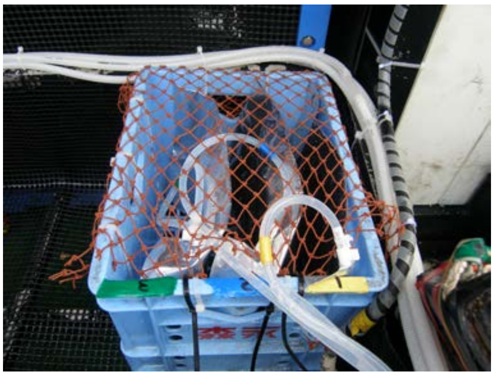
(Reference: Saegusa, S., Tsunogai, U., Nakagawa, F., and Kaneko, S. (2006) Development of a multi bottle gas-tight fluid sampler WHATS II for Japanese submersibles/ROVs. Geofluids 6: 234-240.

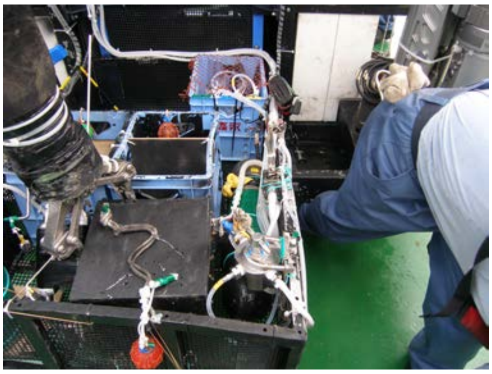
Vacuum sampler

A vacuum sampler, which is made of steinless steel, is designed to collect vent fluid under in-situ pressure conditions. A vacuum sampler consists of 150-ml containers and three-way valves, which are connected via tubing. By using an onboard gas extraction system, the interior of the sampler is evacuated at less than 50 mTorr before sampling. A whole amount of vent fluid including gases is extracted into glass vials and containers.

Bag sampler

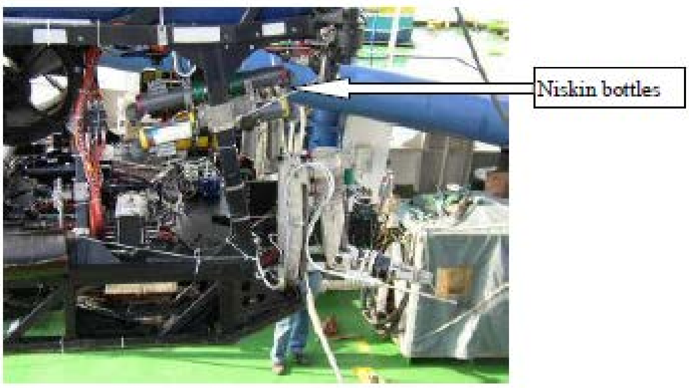
A bag sampler is designed to collect low-temperature vent fluid into a bag. A bag sampler is composed of a 5-way valve and three bags, which are connected through silicon tubes. A pump integrated into WHATS is shared due to limited electronic outlets. An aluminum bag is used for NT11-20 cruise, because the aluminum bag is gas-impermeable. Therefore, the oxidation of reduced compounds such as hydrogen sulfide and ferrous iron and the loss of gasses such as H_2 and CH_4 are minimized.



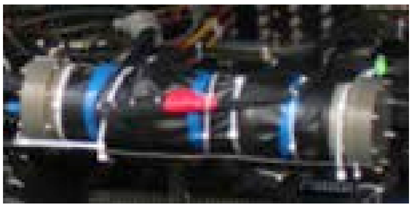


Niskin bottle

Bottom water samples were collected with a Niskin bottle. For each dive, two bottles were fitted to the front bar of the Hyper Dolphin. The bottle is made of polyvinyl chloride and has a volume of 2.5L. Two lids at each end of the bottle were closed by release of a trigger controlled by the operation room, to collect bottom water. After the recovery, water sample was drained from a plug hole, and provided for chemical analysis.



D-POTE
Product name: Deep-sea potentio/galvanostat system (D-POTE)
Maker: Hokuto-Denko Co. (Atsugi, Japan)
Size: ϕ140 mm × 550 mm
Weight: 10 kg (in the air), 3.3 kg (in the water)
Depth-resistance: 4500m
Power supply: DC 24V is required from outside
D-POTE (Deep-sea potentio/galvanostat system) is an electrochemical analyzation machine for use in deep-sea. This system is composed of a PC for the operation, a potentio/galvanostat in an anti-pressure capsule, and an electrode probe. The potentio/galvanostat and probe are equipped to a ROV, and you can operate the system by the PC on the mother ship through RS232C communication.

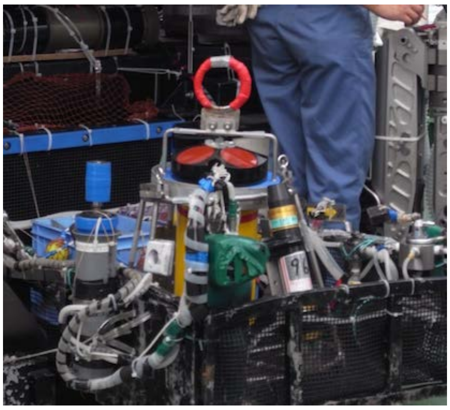


DO meter
Product name: Oxygen Optode 3830
Maker: JFE ALEC Co., Kobe, Japan
Size: ϕ54 mm × 272 mm
Weight: 1.0 kg (in the air), 0.6 kg (in the water)
Depth-resistance: 6000m
Power supply: size C lithium battery (3.5V) × 1
This DO meter is an optical sensor of dissolved oxygen (DO), which is available in deep-sea. It also includes a thermometer. This sensor works by a battery, and measurement data is stocked in a built-in memory.

Turbidity meter
Product name: Compact-LT ATU6-CMP
Maker: JFE ALEC Co., Kobe, Japan
Size: ϕ 54 mm × 210 mm
Weight: 0.8 kg (in the air), 0.48 kg (in the water)
Depth-resistance: 6500m
Power supply: size C lithium battery (3.5V) × 1
This turbidity meter is an optical sensor of turbidity, which is available in deep-sea. This meter works by a battery, and measurement data is stocked in a built-in memory.

Gamma ray detector
Size: 12cm x 54cm x 27cm
Weight in water: 9.5kg
The seafloor external doses can be measured by a NaI scintillation gamma ray detector. The NaI crystal emits lights when it received gamma rays. The lights are converted to electrons which are subsequently amplified electronically. The energy of the gamma ray is measured as the height of the electronic pulse. The detection system records the energies and number of gamma rays which correspond to the kind of radioactive nuclei and their amounts.

Acoustic Doppler Current Profiler（ADCP）
This is equipment to measure current directions and velocities for a range of depths using sonar. We put them at the flat bottom of deep-sea to observe the water current profiles from the bottom to near-surface.



Marine Sessile Animal Collector (MASACO)
This is a set of plates for providing substrates to settle for plaktonic larvae of marine sessile animals in deep-sea, similar to that used in Mullineaux et al. 2010. Six of 10 cm x 10 cm x 6mm clear polycarbonate plates are tied up together. The plates were polished by coarse sandpapers and 1-2mm groves for representing the microhabitat of deep-sea substrates. Three of a group of six plates are tied together with a 1 kg-weight, a reflector and a marker (buoy).
We set MASACOs near hydrothermal vent animals' communities to evaluate the number of new recruits.

3.3 Dive reports

Dive Report HPD #1327 2011/09/30 Minami-Ensei Knoll 1/1

Time	Depth(m)	Latitude (N)	Longitude (E)	Stop #	Event/Operation	Sample ID	Note
8:25	0				ROV launch		
8:35					ROV dive start		
8:40					gamma-ray meas.		
9:15	597				Niskin bottle (failure)		
9:21	706	28_23.454	127_38.422	1	ROV landing		
9:31	709	28_23.459	127_38.414	2	rock sampling	G01	in the sampling box
9:46					quadrat positioning		*Bathymodiolus*
10:03	701	28_23.476	127_38.392	3	bag sampler [yellow]	WB01	
10:11					bag sampler end		T = 7.2degC
10:18					slurp gun	#1	
10:23					slurp gun (cont.)	#2	obstructed by *Bathymodiolus* shells
10:27					slurp gun end		
10:28					marker-buoy deploy.		H1327-1
10:37	701	28_23.479	127_38.396	3	rock sampling	G02	in box #3
10:42	700	28_23.477	127_38.392	3	chimney sampling	G04	
10:43					drive toward Ev#3		
10:54	690	28_23.490	127_38.372	4	chimney sampling	G03	in box #1
11:02	692	28_23.495	127_38.372	4	ROV takeoff		
11:38					ROV recovery		

Dive Report HPD #1328 2011/09/30 Minami-Ensei Knoll 1/1

Time	Depth(m)	Latitude (N)	Longitude (E)	Stop #	Event/Operation	Sample ID	Note
13:05	0				ROV launch		
13:15					ROV dive start		
13:26	206				gamma-ray meas.		
13:44	710	28_23.442	127_38.434	1	ROV landing		
13:45					recognition of a fish net		N-S direction
13:53	709	28_23.445	127_38.412	2	rock sampling	G01, G02	in box #3 & #4
14:02	706	28_23.449	127_38.407	3	rock sampling	G03	in backend of the basket
14:08	698	28_23.462	127_38.398	4	chimney sampling	G04	on the sample box
14:16	700	28_23.475	127_38.392	5	recognition of the marker-buoy		H1327-1
14:37					quadrat positioning		
14:40					WHATS sampler	WW1-4	T=6.6 degC
14:43					WHATS sampler end		
14:56					bag sampler [yellow]	WB01	interruption at 15:00
15:03					bag sampler end		
15:06					slurp gun	#1	
15:11					slurp gun (continued)	#2	*Shinkaia* crab
15:15					slurp gun end		
15:18					quadrat positioning		
15:23					bag sampler [blue]	WB02	
15:28					bag sampler end		
15:35					slurp gun	#3	*Bathymodiolus-Shinkaia* boundary
15:40					slurp gun end		
15:48					drive along course 40		
15:53	694	28_23.496	127_38.412	6	rock sampling	G05	in backend of the basket
15:59	694	28_23.496	127_38.412	6	rock sampling	G06	in box #2
16:09	694				ROV takeoff		
16:46					ROV recovery		

Dive Report HPD #1329 2011/10/05 Izena Cauldron Hakurei 1/2

Time	Depth(m)	Latitude (N)	Longitude (E)	Stop #	Event/Operation	Sample ID	Note
9:59	0				ROV launch		
10:09					ROV dive start		
10:35	765				gamma-ray meas.		
10:50	1256	27_14.862	127_04.117	1	Niskin bottle [Red]	NR	
10:58	1520	27_14.864	127_04.124	2	Niskin bottle [Green]	NG	
11:02	1621	27_14.859	127_04.126	3	ROV landing		
11:10	1622	27_14.848	127_04.112	4	slurp gun	#1	holothrian
11:11	1621				slurp gun end		
11:18	1621	27_14.840	127_04.093	5	ROV landing		
11:27	1620				rock sampling	G01	in box 3
11:41	1614				recognition of the marker buoy		H1311-2
11:43	1617	27_14.815	127_04.089	6	ROV landing, observation		
12:02	1618				quadrat positioning		*Shinkaia* crab
12:19					bag sampler [yellow]	WB1	T = 3.2 - 4.0 degC
12:24					bag sampler end		
12:26					WHATS sampler	WW1-4	T = 3.8 degC
12:32					WHATS sampler end		
12:37					slurp gun	#2	*Shinkaia* crab
12:38					slurp gun end		
12:49					quadrat positioning		*Bathymodiolus*
13:14	1617				bag sampler [blue]	WB2	T = 3.3 degC
13:19					bag sampler end		
13:23					ore sampling	G02	with *Bathymodiolus*
13:24					slurp gun	#3	*Bathymodiolus*
13:27					slurp gun end		
13:46					quadrat positioning		
13:59					bag sampler [green]	WB3	T = 3.5 degC
14:06					bag sampler end		
14:08					slurp gun	#4	
14:10					slurp gun end		
14:15					ore sampling	G03	in box 4
14:23					quadrat positioning		
14:26					D-POTE meas.		
14:34					D-POTE end		
14:50					vacuum sampler	WV	
14:58					slurp gun	#5	*Paralvinella*
14:58					slurp gun end		

Dive Report HPD #1329 2011/10/05 Izena Cauldron Hakurei 2/2

Time	Depth(m)	Latitude (N)	Longitude (E)	Stop #	Event/Operation	Sample ID	Note
15:07					slurp gun	#6	*Shinkaia* crab
15:10					slurp gun end		
15:13					ore sampling	G04	in backend of the basket
15:20					slurp gun	#X	*Bathymodiolus*
15:23					slurp gun end		
15:27					MBARI corer	M01	
15:30					drive toward Ev#19		
15:42	1624	27_14.836	127_04.014	7	ROV landing		
15:44					chimney sampling	G05, G06	in box 2
15:49	1624				ROV takeoff		
16:51					ROV recovery		

Dive Report HPD #1330 2011/10/07 Yaeyama (Irabu) Knoll

Time	Depth(m)	Latitude (N)	Longitude (E)	Stop #	Event/Operation	Sample ID	Note
8:15					ROV launch		
8:25					ROV dive start		
9:10					gamma-ray meas.		
9:12					in a non-buoyant plume		
9:14					out a non-buoyant plume		
9:29	1977	25_14.378	124_52.855	1	ROV landing		
9:36	1978	25_14.378	124_52.863	2	deployment of ADCP		Homer ID = 96
9:43	1978				MBARI corer [blue]	M01	
9:46					drive along course 180		
9:51	1973				recognition of outcrop		
9:53	1974	25_14.353	124_52.854	3	rock sampling	G01	
10:02	1971				recognition of talus		
10:06	1971	25_14.307	124_52.846	4	rock sampling	G02	
10:16	1946				recognition of outcrop		
10:18	1935				drive toward Ev#7		
10:21	1922				recognition of talus		
10:24	1919	25_14.266	124_52.841	5	rock sampling	G03	
10:30	1902				observation of echinoderms		
10:43	1880	25_14.245	124_52.851	6	rock sampling	G04	
10:49	1860				obsevation of echinoderms		
11:01	1816	25_14.210	124_52.867	7	ROV landing near the top of SMt.		
11:03					shift to Ev#3		
11:13	1813				recognition of holothroid		
11:39	1813				reconigition of shrims		
11:45	1811				in a non-buoyant plume ?		
12:59	1658	25_13.738	124_52.226	8	ROV landing		
13:03	1660				slurp gun	#1	small animals
13:09					slurp gun end		
13:11					rocks sampling	G05, G06	
13:36	1649	25_13.752	124_52.213	9	quadrant positioning		*Shinkaia* crab
13:51					bag sampler [yellow]	WB1	T = 5.9 deg C
13:56					bag sampler end		
13:58					WHATS sampler	WW1-4	T = 4.0 deg C
14:03					WHATS sampler end		
14:08					slurp gun	#2	*Shinkaia* crab
14:14					deployment of MASACO		ID = 1
14:17					observaion of the active area		

Dive Report HPD #1330 2011/10/07 Yaeyama (Irabu) Knoll

Time	Depth(m)	Latitude (N)	Longitude (E)	Stop #	Event/Operation	Sample ID	Note
14:29					dirve toward Ev#4 cource 180		
14:35	1646	25_13.751	124_52.207	10	ROV landing		
14:41					quadrant positioning		*Neoverruca* barnacle
14:56					bag sampler [blue]	WB2	T = 5.0 deg C
15:01					bag sampler end		
15:05					slurp gun	#3	*Neoverruca* barnacle
15:11					rock sampling	G07	accompanied by *Neoverruca*
15:13					depoyment of MASACO		ID = 2
15:15					observation of the active area		
15:21	1651	25_13.756	124_52.211	11	ROV landing		
15:24					quadrant positioning		Alvinocaridid shrimps
15:38					bag sampler [green]	WB3	
15:39					photo of the collected rocks		
15:43					bag sampler end		
15:46					slurp gun	#4	Alvinocaridid shrimps
15:52					slurp gun	#5, #6	*Shinkaia*, alvinocaridid
15:59					rock sampling	G08	accompanied by small animals
16:02	1651				ROV take off		
17:04					ROV recovery		

Dive Report HPD #1331 2011/10/09 Hatoma Knoll 1/2

Time	Depth(m)	Latitude (N)	Longitude (E)	Stop #	Event/Operation	Sample ID	Note
8:14					ROV launch		
8:25					ROV dive start		
8:57	1011				gamma-ray meas.		
9:10	1468	24_51.440	123_50.445	1	Niskin bottle [red]	NR	
9:12	1518	24_51.442	123_50.450	2	ROV landing		
9:13	1518				dirve along course 70		
9:19	1506				rocognition of colonies		
9:24	1496				recognition of the ADP pedestal		
9:26	1498	24_51.451	123_50.478	3	ROV landing		
9:28					quadrant positioning		
9:32					D-POTE meas.		
9:37					D-POTE meas. End		
9:40					slurp gun	#1	shrimp
9:43					slurp gun end		
9:50	1496				ore sampling	G01	in box #2
9:57					drive along course 60		
10:02					recognition of the shade		ID = E3
10:06	1493	24_51.448	123_50.492	4	ROV landing		
10:11					quadrant positioning		
10:12					move the ore in box #2	G01	to backend of the basket
10:15					quadrant recovery		cancel positioning
10:19					ore sampling	G02	box #1
10:23					observation of the active area		
10:26					drive toward Ev#14		
10:35	1470				observation of colonies		*Shinkaia, Bathymodiolus*
10:36					collapse of the colony		
10:38	1470				observation of colonies		
10:44	1476	24_51.477	123_50.507	5	quadrant positioning		*Shinkaia* crab
10:46					D-POTE meas.		
10:48					flushing		T = 4 - 5 degC
10:52					recognition of the shade		ID = E2
10:59					bag sampler [yellow]	WB1	T = 4 - 5 degC
11:05					bag sampler end		
11:07					WHATS sampler	WW1-4	T = 4 - 5 degC
11:13					WHATS sampler end		
11:16					slurp gun	#2	*Shinkaia* crab
11:20					slurp gun end		

Dive Report HPD #1331 2011/10/09 Hatoma Knoll 2/2

Time	Depth(m)	Latitude (N)	Longitude (E)	Stop #	Event/Operation	Sample ID	Note
11:22					spil out *Shinkaia*	#3	*Shinkaia* crab
11:27					deployment of MASACO		ID = 3
11:32					ore sampling	G03	from the quadrant position
11:41					ROV landing		
11:46					quadrant positioning		shrimp
11:52					flushing		T = 3 - 4 degC
12:04					bag sampler [blue]	WB2	T = 3.0 - 3.5 degC
12:10					bag sampler end		
12:13					slurp gun	#4	
12:20					slurp gun end		
12:25					trial of quadrant positioning		*Bathymodiolus*
12:30					retrial of quadrant positioning		
12:33					re-re-trial of quadrant positioning		
12:38					quadrant positioning		
12:42					flushing		T = 3 deg C
12:54					bag sampler [green]	WB3	T = 2.9 deg C
12:59					bag sampler end		
13:05					slurp gun	#5, #6	*Bathymodiolus*
13:08					slurp gun end		
13:14					deployment of MASACO		ID = 4
13:30	1476				vacuum sampler	WV	
13:36					D-POTE meas.		sampling point of WV
13:41					D-POTE meas. end		
13:45					spil out *Bathymodiolus*	#3	
13:47					slurp gun	#3	shrimps
13:52	1481	24_51.484	123_50.513	6	rock sampling	G04	in backend of the basket
14:00					ROV landing		
14:04					failure of MBARI sampling		
14:07	1500	24_51.507	123_50.546	7	ROV landing		
14:09					ore sampling	G05	box 2
14:16	1490	24_51.520	123_50.559	8	ROV landing		
14:17					recognition of a tile		numbered as 2
14:21					ore sampling	G06, G07	box 2
14:38	1523	24_51.598	123_50.554	9	ROV landing		
14:42					rock sampling	G08	box 3
14:45	1523				take off		
14:50	1428	24_51.602	123_50.580	10	Niskin bottle [green]	NG	
15:42					ROV recovery		

Dive Report HPD #1332 2011/10/10 Yaeyama (Irabu) Knoll 1/2

Time	Depth(m)	Latitude (N)	Longitude (E)	Stop #	Event/Operation	Sample ID	Note
7:12					ROV launch		
7:22					ROV dive start		
8:00	1100				gamma-ray meas.		
8:10	1454	25_13.696	124_52.234	1	Niskin bottle [red]	NR	
8:20	1682	25_13.703	124_52.235	2	ROV landing		
8:24	1684				rock sampling	G01	in box #1
8:29	1683				rock samling	G02	in box #2
8:30					drive along course 340		
8:43					recogniction of the 6K buoy		
8:44	1647	25_13.737	124_52.209	3	ROV landing		
8:47					observation of the active area		
8:58					quadrant positioning		
9:01					flushing		T = 3.5 - 4.5 degC
9:12					bag sampler	WB1	T = 9.4 deg C
9:18					bag sampler end		
9:24					slurp gun	#1	shirimps, scale worms
9:25					slurp gun end		
9:26					recovery of the quadrant		
9:31					slurp gun	#2	same position as #1
9:34					slurp gun end		
9:36					rock sampling	G03	in backend of the basket
9:45					D-POTE meas.		T = 5-7 deg C
9:48					D-POTE meas. End		
9:48					ROV shift to the left		
9:50					D-POTE meas.		T = <14 deg C
10:01					vacuum sampler	WV	
10:12					D-POTE meas.		T = 13.2 - 14.1 deg C
10:15					flushing		T = 15.2 deg C
10:20					flushing again		T = 14.7 deg C
10:31					bag sampler	WB2	T = 14 - 15 deg C
10:36					bag sampler end		
10:40					slurp gun	#3	shrimps around the vent
10:44					slurp gun end		
10:47					ROV levitation		
10:48	1641				Niskin bottle [green]	NG	above the shimmering site
10:49					drive along course 340		
10:52	1647	25_13.758	124_52.204	4	ROV landing		

Dive Report HPD #1332 2011/10/10 Yaeyama (Irabu) Knoll 2/2

Time	Depth(m)	Latitude (N)	Longitude (E)	Stop #	Event/Operation	Sample ID	Note
10:55					rock sampling	G04	in box #3
10:58					slurp gun	#4	
11:01					drive along course 340		
11:07					sparse deistributuiion of anals		
11:10					recognition of clonies		
11:11	1632				ROV landing		
11:14					recognition of the 6K buoy		
11:17	1632	25_13.768	124_52.172	5	ROV landing		
11:17					observation of the active area		
11:27					slurp gun	#5	tube worm, barnacle, snails
11:30					slurp gun end		
11:33					rock sampling	G05	in the sample box
11:39					D-POTE meas.		at the sampling point
11:41					observation of the active area		
11:47					D-POTE meas. end		
11:49	1632				ROV take off		
12:46					ROV recovery		

Dive Report HPD #1333 2011/10/11 Yoron Knoll 1/2

Time	Depth(m)	Latitude (N)	Longitude (E)	Stop #	Event/Operation	Sample ID	Note
8:16					ROV launch		
8:26					ROV dive start		
8:37	200				gamma-ray meas.		
8:49	550	27_29.331	127_32.076	1	Niskin bottle [red]	NR	
8:51	583	27_29.332	127_32.087	2	ROV landing		
8:53					drive towered Ev.#12		
8:55	592	27_29.328	127_32.108	3	ROV landing		
8:59	593				rock sampling	G01	in box #1
9:03					recognition of a hermit crab		
9:06	586	27_29.330	127_32.113	4	ROV landing		
9:09	587				rock sampling	G02	in box #2
9:11	580	27_29.328	127_32.123	5	recognition of the marker		H1181-2
9:13	580				ROV landing		
9:27					recognition of comm jellys		
9:29					shift to other side of the chimney		
9:42					shift to the first point		
9:45					quadrant positioning		nearby the chimney
9:46					D-POTE meas.		
9:47					flushing		T = 9 deg C
9:59					bag sampler	WB1	
10:02					recognition of land slip		
10:04					bag sampler end		
10:08					slurp gun	#1	
10:09					slurp gun end		
10:13					quadrant positioning		on the surface of the chimney
10:15					recovery of the quadrant		after photo shoot
10:19					flushing		T > 50 deg C
10:24					vacuum sampler	WV	
10:35					trial of rock sampling		
10:40					slurp gun	#2	shrimps
10:41					slurp gun end		
10:45					flushing		T = 16 deg C
10:57					bag sampler	WB2	
11:02					bag sampler end		
11:03					WHATS sampler		T = 4 - 11 deg C
11:09					WHATS sampler end		
11:11					chimney sampling	G03	in box #3

Dive Report HPD #1333 2011/10/11 Yoron Knoll 2/2

Time	Depth(m)	Latitude (N)	Longitude (E)	Stop #	Event/Operation	Sample ID	Note
11:40					deployment of MASACO		ID = 5
11:42					ROV leviation		
11:58	560	27_29.341	127_32.139	6	drive toward Ev#4		without seafloor observation
12:13					ROV landing		
12:14	591	27_29.383	127_32.001	7	rock sampling	G04	in box #4
12:22					chimney sampling	G05	beside the sample box
12:28					rock sampling	G06	in backend of the basket
12:32					chimeny sampling	G07	by the slurp gun
12:39					slurp gun	#3	*paralvinella*
12:41					rock sampling	G08	in backend of the basket
12:43					rock sampling	G09	
12:47					deployment of MASACO		ID = 6
12:51					drive along course 360		
12:53	591	27_29.395	127_32.000	8	ROV landing		
13:07					chimeny sampling	G10-1, -2	in the sample box
13:43					sampling end		
13:43					drive toward Ev #2		
13:49	566	27_29.425	127_31.995	9	ROV landing beside the marker		H1181-1
13:54					quadrant positiong		on the surface of the chimney
					recovery of the quadrant		
14:03					flushing		T = 42 deg C
14:15					re-positioning the sample inlet		
14:15					flushing		T = 10 deg C
14:26					bag sampler	WB3	T = 10 deg C
14:31					bag sampler end		
14:35					slurp gun	#4	polychaetes
14:45					chimney sampling	G11	in box #2
14:54					slurp gun	#5	crabs, shrimps, polychaetes
14:57					drive towrd Ev#12		without seafloor observation
15:11	580				recognition of the seafloor		
15:21					recognition of the marker		H1181-2
15:22	580	27_29.328	127_32.123	5	ROV landing		
15:24					slurp gun	#6	crabs, *paralvinella*
15:30					slurp gun end		
15:33					chimney sampling	G12	in box #1
15:36	580				ROV take off		
15:38					gamma-ray meas. End		
16:09					ROV recovery		

4. Study plans

Dating of hydrothermal ore deposits and igneous rocks using radiometric dating techniques

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Asako Takamasa, Shunichi Nakai (ERI, U. Tokyo)
Keiko Sato, Hidenori Kumagai (JAMSTEC)

Since formation of hydrothermal ore deposits requires elemental accumulation over long time scale up to tens of thousands of years, it is important to understand the evolution process of seafloor hydrothermal activities. For this purpose, we have established application of K-Ar technique and of U-Th series disequilibrium dating technique to hydrothermal minerals collected from seafloor massive sulfide deposits. The Okinawa Trough would provide a good test field for our study, since hydrothermal fields have been located in both Mid-Okinawa Trough and South Okinawa Trough, which are considered as in different tectonic stages. Combining geochronological studies with geochemical and mineralogical studies of the collected geological samples would be important for reconstructing the evolution process of each hydrothermal field in related with geologic and tectonic background.

Dating of submarine hydrothermal activities

Fumihiro Sato and Shin Toyoda
(Okayama University of Science)

At the initial stage of studies on submarine hydrothermal activities, the activities were thought to be rather stable. We now know that the hydrothermal activities are not always stable but sometimes show changes, such as temperature fluctuation of effluent. However, there are few studies to investigate the history of hydrothermal activities. In this cruise, we aimed to take samples suitable for dating with spatial variation, in order to study the history of hydrothermal activities varied in the horizontal scale.

It is an important issue to determine the time scale of the submarine hydrothermal activities. We have studied ESR (electron spin resonance) dating of barite which is a mineral formed in hydrothermal sulfide deposits. ESR detects unpaired electrons which are created by natural radiation. The natural accumulated doses are estimated from the amount of unpaired electrons measured by ESR. Then, the doses are divided by the natural dose rate to deduce the age. In the course of this dating procedure, we have found that estimation of the natural dose rate from outside of the mineral may have problems. It is necessary, therefore, to make actual measurements of external dose rate in the seafloor with hydrothermal activities.

At the performance during the dives and cruise, we measured the seafloor external doses and dose rate from samples by a NaI scintillation gamma ray detector. The NaI crystal emits lights when it received gamma rays. The lights are converted to electrons which are subsequently amplified electronically. The energy of the gamma ray is measured as the height of the electronic pulse. The detection systems record the energies and number of gamma rays which correspond to the kind of radioactive nuclei and their amounts.

Comparative study between the SMS deposit in the Okinawa Trough and Kuroko-type sulfide deposit

Tatsuo, Nozaki
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Many seafloor massive sulfide (SMS) deposits are distributed in the Okinawa Trough and their stratigraphy, mineral assemblage, chemical composition are similar to those of Kuroko-type volcanogenic massive sulfide deposits. Since the first discovery of the SMS deposits on the East Pacific Rise, almost researchers considered that Kuroko-type deposits are the ancient counterparts of Cu-Pb-Zn-rich SMS deposits at the back-arc setting. In other words, the SMS deposit in the Okinawa Trough is a "natural modern analogue" of the Kuroko-type deposit. Although a SMS deposit in the Okinawa Trough is one of the most suitable areas in order to clarify the genesis of Kuroko-type deposits, the comparative studies between the SMS deposit in the Okinawa Trough and Kuroko- type deposits on land are still scarce. Thus, the main goals of my study are (1) determining the metal source of the SMS deposit based on the Os, Pb and S isotope analyses of fresh sulfide chimney samples, (2) comprehending the stratigrahic/ geochemical features of volcanic rocks by whole-rock XRF and ICP-MS analyses, (3) understanding the ore grade of SMS deposit in the Okinawa Trough using ICP-MS/AES and (4) comparing the stratigrahic, geological and geochemical features between SMS and Kuroko-type deposits.

**Relationships between biodiversity and environmental factors:
estimation of establishment age of animal communities in Okinawa Trough**

Hiromi Watanabe, Tomomi Ogura, Yoshimi Takahasi (JAMSTEC)
Takuya Yahagi, MiHye Seo, Shigeaki Kojima (Univ. Tokyo)

Animal assemblages associated with deep-sea hydrothermal vent hold far large biomass compared to those in the other deep-sea environment due to chemosynthetic primary production. The establishment and succession of vent animal assemblages must largely depend on hydrothermal activities. On the other hand, the animal assemblage itself changes through time. In NT11-20 cruise, we evaluate biodiversity of the animal assemblages associating to the hydrothermal vents in Okinawa Trough from several kinds of viewpoints (e.g. species diversity and genetic diversity). With measurements of environmental factors (e.g. temperature, dissolved oxygen, H_2S concentration, microbial assemblages), we attempt to reveal the relationships between biodiversity and the environmental factors in the hydrothermal vent fields in Okinawa Trough. Based on this relationships and DNA substitution rates, we will estimate the age (or order) of establishment of the animal communities in individual vent fields in the Okinawa Trough.

Studies on diversity of Alvinocaridid shrimps inhabiting hydrothermal-vent

Takuya Yahagi and Shigeaki Kojima
(Graduate School of Frontier Sciences, the University of Tokyo)

The Okinawa trough is a representative hydrothermal vent field in the western Pacific. In recent years, the hydrothermal deposits in vent fields has received social attention as metal resources. It is important to understand the biodiversity of chemosynthetic communities in order to avoid or reduce influence of development of the hydrothermal deposits. The purpose of my study is revealing relationships among species diversity, genetic diversity and life history of hydrothermal-vent endemic species by focusing alvinocaridid shrimps as a model group. To achieve this purpose, I will use ecological, morphological and genetic approaches. In addition, I will compare the results with those from closely related taxa.

Difference of size distribution, infestation rate and sex rate of the symbiotic scale-worm *Branchipolynoe pettiboneae* along the hydrothermal vents in Okinawa Trough and its relationships with host Bathymodiolus mussels.

Yoshimi Takahashi
(JAMSTEC)

The polychaete family Polynoidae (scale-worms) is common species at deep sea hydrothermal vents. Species of the genus Branchipolynoe inhabit inside the mantle cavity of vent and seep mytilids. *Branchipolynoe pettiboneae* reported from vent and seep areas in the western Pacific (Miura & Hashimoto, 1991). *B. pettiboneae* of host mussels *Bathymodiolus platifronts* and *Bathymodiolus japonicas* are dominant animals in the deep-sea chemosynthesis-based ecosystems of western Pacific. However, little is known about the relationship in the association between symbiotic polychaetes and host hydrothermal bivalves.

The aim of this study is to clarify the difference size distribution, infestation rate and sex rate of *B. pettiboneae* at the different hydrothermal vent along the Okinawa Trough. We collected quantitatively host Bathymodiolus mussels of *B. pettiboneae* using quadrat method from different hydrothermal vents along the Okinawa Trough. All samples were examined size distribution, varying infestation rate and sex rate. To investigate size relationships between the *B. pettiboneae* and its host, Bathymodiolus mussels, the antero - posterior length of the shell of mussels and its associated *B. pettiboneae* were measured to the nearest 0.01 mm using digital caliper. Sex rate of *B. pettiboneae* were examined by dissection and observing its nephridial papillae and the pygidium under a stereoscopic microscope.

The study of early life cycle of vent animals

Hiroshi Miyake
(Kitasato University)

There are unique biological communities based on chemosynthesis at deep-sea hydrothermal vents. To maintain species composition including endemic fauna, larval dispersion and recruitment of vent and seep animals are important. At the same time, a hydrothermal vent or cold seep is not permanent. However little information is known about larvae and larval dispersion of hydrothermal vent and cold seep animals.

In this cruise, I would like to collect eggs of vent animals on substrates like a rock and mature females of vent animals and keep them in aquarium to get larvae of them. If I got any larvae or eggs, I would like to describe their morph and observe their behavior and development under cultivation.

Recruitment pattern of hydrothermal vent organisms in Okinawa Trough

Masako Nakamura
(OIST)

1) Most of hydrothermal vent organisms have two stages in their life cycle, sessile adult and planktonic larval stages. The planktonic larval stage and subsequent recruitment are essential to determine community structure, population resilience and distribution range of a species. In Okinawa Trough, species diversity differs among sites. Variation in recruitment among sites may be one of driving factors to make such differences. However, knowledge on recruitment pattern along Okinawa Tough remains to be revealed. In this cruise, I will set recruitment plates to observe

spatial variation in recruitment along Okinawa Trough. In the future, we will add some knowledge on temporal variation in recruitment.

2) Recruitment pattern in a year could be affected mainly by the timing of spawning, planktonic larval duration and physico-chemical environments. The knowledge on early life history of hydrothermal vent organisms in Okinawa Trough is not still systematic. In this cruise, I try to accumulate data on reproductive biology of some gastropods in Okinawa Trough.

The correlation between physical, chemical and microbiological properties and vent animal distribution and nutrition at Okinawa Trough hydrothermal fields

Yukari Miyazaki, Michinari Sunamura and Yohey Suzuki (Faculty of Science, the University of Tokyo)

Okinawa Trough is a back-arc basin associated with diverse hydrothermal fields in terms of sediment thickness, host rock and fluid chemistry. We will investigate physical and chemical properties of mixing water (seawater and vent fluid), which tends to harbor free-living microbial flora and chemosynthetic animals associated with bacterial symbionts. As the vent ecosystem is mainly fueled by H_2S coupled to the oxidation of O_2, we quantify these compounds by onboard analyses in addition to Si, NH_4 and Fe(II). For shore-based studies, gaseous compounds such as CH_4, H_2 and CO_2, cations and anions, microbial abundances and community structures of free-living microbial populations and symbiotic bacteria will be characterized to reveal whether the distribution of vent animals and the energy-yielding metabolisms of bacterial symbionts are correlated to physical, chemical and microbiological features of mixing water. We will also conduct thermodynamic calculations that take the concentrations of dissolved gases and aqueous species into consideration to estimate energetically favorable metabolisms.

Relationship between an environment and the epibiotic microbial community in *Shinkaia crosnieri*

Tomo-o Watsuji
(JAMSTEC)

Many species of invertebrates dwelling in deep-sea hydrothermal vents and cold seeps are known to host bacteria (epibionts) on the surface of specialized tissues such as the dorsal setae of *Alvinella pompejana*, the gill chamber of *Rimicaris exoculata*, the setae of *Shinkaia crosnieri*, the setae of *Kiwa hirsuta*, and the sulfide-coated scales of scaly-foot snails. The epibiotic microbial community on *S. crosnieri* mainly included potential sulfur-oxidizing bacteria affiliated with the genus *Sulfurovum* within *Epsilonproteobacteria* and the Marin epibiont group I within *Gammaproteobacteria* and methanotroph belonging to *Gammaproteobacteria*. However it has been unknown that what determine their portions of the epibiotic microbial community. In this cruise, we are going to collect *S. crosnieri* individuals and its environmental seawater in various hydrothermal vent areas of the Okinawa Trough. We will clearly realize the relationship between bacterial phase of the epibiotic community on *S. crosnieri* and the environment by analyzing the epibiotic microbial community of *S. crosnieri* and its environmental seawater .

In-situ measurement of hydrogen sulfide in deep-sea hydrothermal fields

Masahiro Yamamoto
(JAMSTEC)

Hydrogen sulfide is one of the most important compounds for the ecosystem in hydrothermal environments. Various sulfide-oxidizing microorganisms have been reported as both free-living and symbiotic cells. We have collected hydrothermal fluids and seawater in the mixing zones, and measured the concentration of hydrogen sulfide by a chemical method. However, hydrogen sulfide is easily oxidized under the oxidative conditions, and it is difficult to know actual concentration of hydrogen sulfide in the environment. We have developed an electrochemical sensor system which available in deep-sea (Deep-sea potentio/galvanostat system: D-POTE). In this cruise, I am going to measure concentration of hydrogen sulfide in various deep-sea hydrothermal fields, and analyze interaction of the dynamics of hydrogen sulfide and the hydrothermal ecosystems.

Carbon, nitrogen, and sulfur isotopic compsoition of organisms collected from hydrothermal vent fields

Yuji Onishi, Hiromi Nagashio, Toshiro Yamanaka
(Okayama University)

To research the nutrient source of chemosynthetic life, we will conduct the isotopic analysis on the samples of organisms collected during this NT11-20 cruise. By comparing the analytical result of the samples of organisms from various hydrothermal vent fields, I consider nutrient source of animals inhabited around hydrothermal field.

In contrast to abyssal plain significantly high density of benthic animals has been observed around and in the hydrothermal field. However, food webs in the deep-sea ecosystem contains these organisms around hydrothermal field has been known clearly yet.

We plan to measure carbon, nitrogen and sulfur stable isotopic compositions of the animal samples collected during this cruise. Isotopic composition reflects that of nutrient source of the organisms or trophic level. For example, it is known that the value of stable isotope ratio increases 0 ~ +0.1‰ for carbon, +1-5‰ (average +3.4‰) for nitrogen, through the trophic level. Therefore, the isotopic compositions of the organisms indicate nutrient source of the organisms.

We will compare the analytical results among each animal species from various hydrothermal areas in order to estimate how the animals inhabited around hydrothermal field are supported by hydrothermal activities in middle Okinawa Trough. We will measure isotopic compositions of DOC (dissolved organic carbon) and rocks which animals may utilize as growth substratum, because relationship between such rocks and animals has not described yet.

Crystallographic analysis of hydrothermal cristobalite from submarine hydrothermal area

Yuma Nishibayashi and Hiroshi Isobe (Kumamoto Univ.)

Cristobalite and amorphous silica are characteristic metastable silica phases commonly occurred in acidic hydrothermal alteration area. Crystallinity of hydrothermal cristobalite is strongly depends on physical and chemical conditions of the hydrothermal processes including temperature, fluid acidity and alteration history. Crystallization of cristobalite originates from amorphous silica phase to well-crystallized crystals. Detailed crystallographic analysis of altered rocks sampled in the vicinity of submarine hydrothermal vents can provide us information on hydrothermal fluid and formation processes of submarine hydrothermal cristobalite and amorphous silica. Especially, pressure at the ocean floor can be effective on behavior of the super-critical hydrothermal fluid. Precious d-spacing and FWHM of submarine cristobalite and amorphous silica by X-ray diffraction will be discussed with those of the terrestrial hydrothermal silica phases.

Mineralogical and geochemical studies of hydrothermal alteration clay minerals collected from sediment-covered hydrothermal fields in the Okinawa Trough

Youko Miyoshi and Jun-ichiro Ishibashi (Kyushu University)

In sediment-covered seafloor hydrothermal system, hydrothermal fluid would flow out to the seafloor by diffuse circulation through sediment and experience fluid-sediment interactions within sediment layer. We will study surface sediment collected from active hydrothermal field by XRD, EPMA and TEM-EDS analyses to reveal occurrence of hydrothermal clay minerals which were formed by the fluid-sediment interactions. We also study geochemical profile of pore fluids to understand chemical balance during the fluid-sediment interactions. Since formation of hydrothermal alteration minerals are dependent on several factors such as temperature, host rock composition, chemistry of the fluids and porosity of the sediment, the results will provide important keys to discuss subseafloor physical, chemical and hydrological structure of a hydrothermal system.