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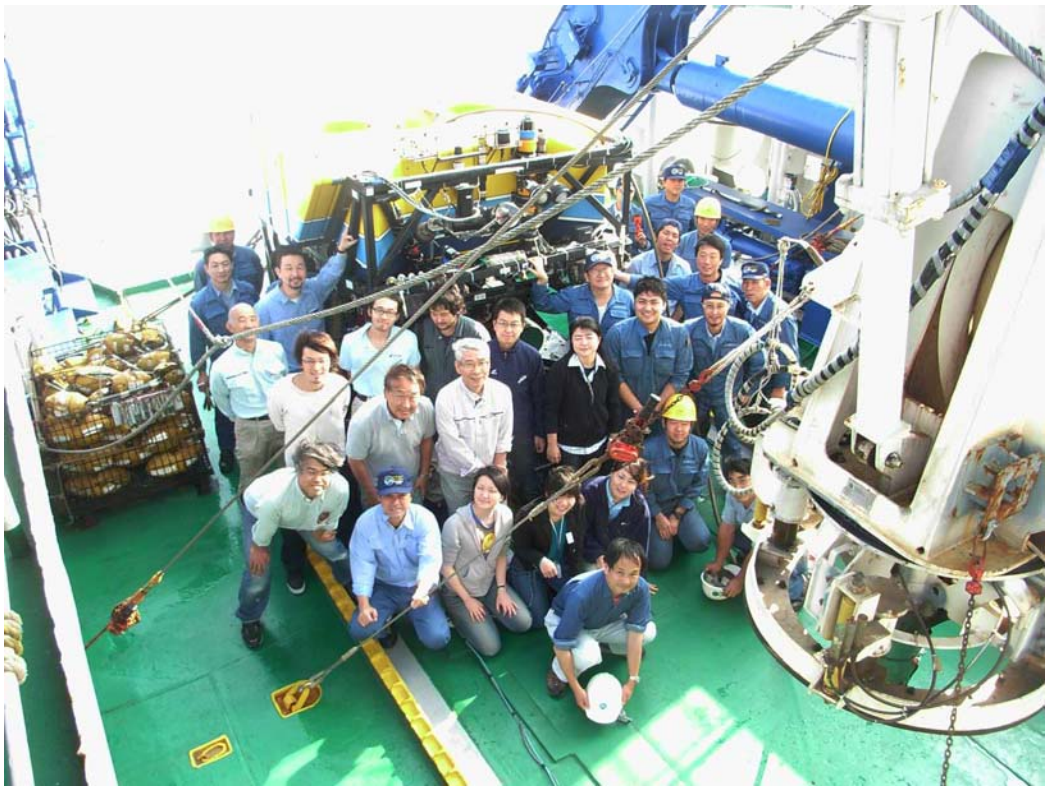
NATSUSHIMA Cruise Report NT09-05 Leg 2

Myojin Knoll & Myojinsho (Izu-Ogasawara Area)
And Nikko Seamount (Northern Mariana Area)

Possible Role of a Taurine Transporter in Adaptation Mechanisms to Sulfides
and
Studies on the Lifecycle of Hydrothermal-Vent Crustaceans in Terms of Heat Dependency

April 10-20, 2009

Principal Investigator
Koji INOUE
Ocean Research Institute, The University of Tokyo



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

CONTENTS

We express sincere thanks to the crew of R/V Natsushima, the operation team of ROV Hyper-Dolphin, and the stuff of JAMSTEC for their support of this cruise.

1. CRUISE INFORMATION

1) Cruise number/Ship name

NT09-05 (Leg. 2)/RV Natsushima and ROV Hyper-Dolphin

2) Title of cruise

“Hyper-Dolphin” Research Dive, Deep-sea Research, FY2009.

3) Title of the proposals (Representative of the proposals)

Possible Role of a Taurine Transporter in Adaptation Mechanisms to Sulfides.
(Koji INOUE, Ocean Research Institute, The University of Tokyo)

Studies on the Life Cycle of the Hydrothermal-Vent Crustaceans from the Viewpoint of Dependency on Temperature.
(Hiroshi MIYAKE, Kitasato University)

4) Period of cruise

From April 10 to April 21, 2009

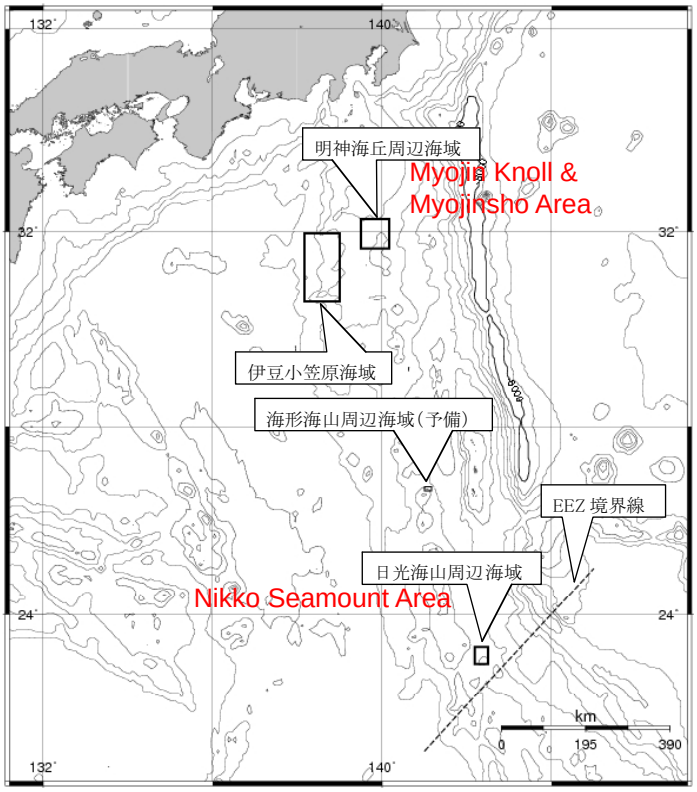
5) Port calls

From Hachijo Island (Yaene) (Tokyo, Japan) to JAMSTEC (Yokosuka, Japan)

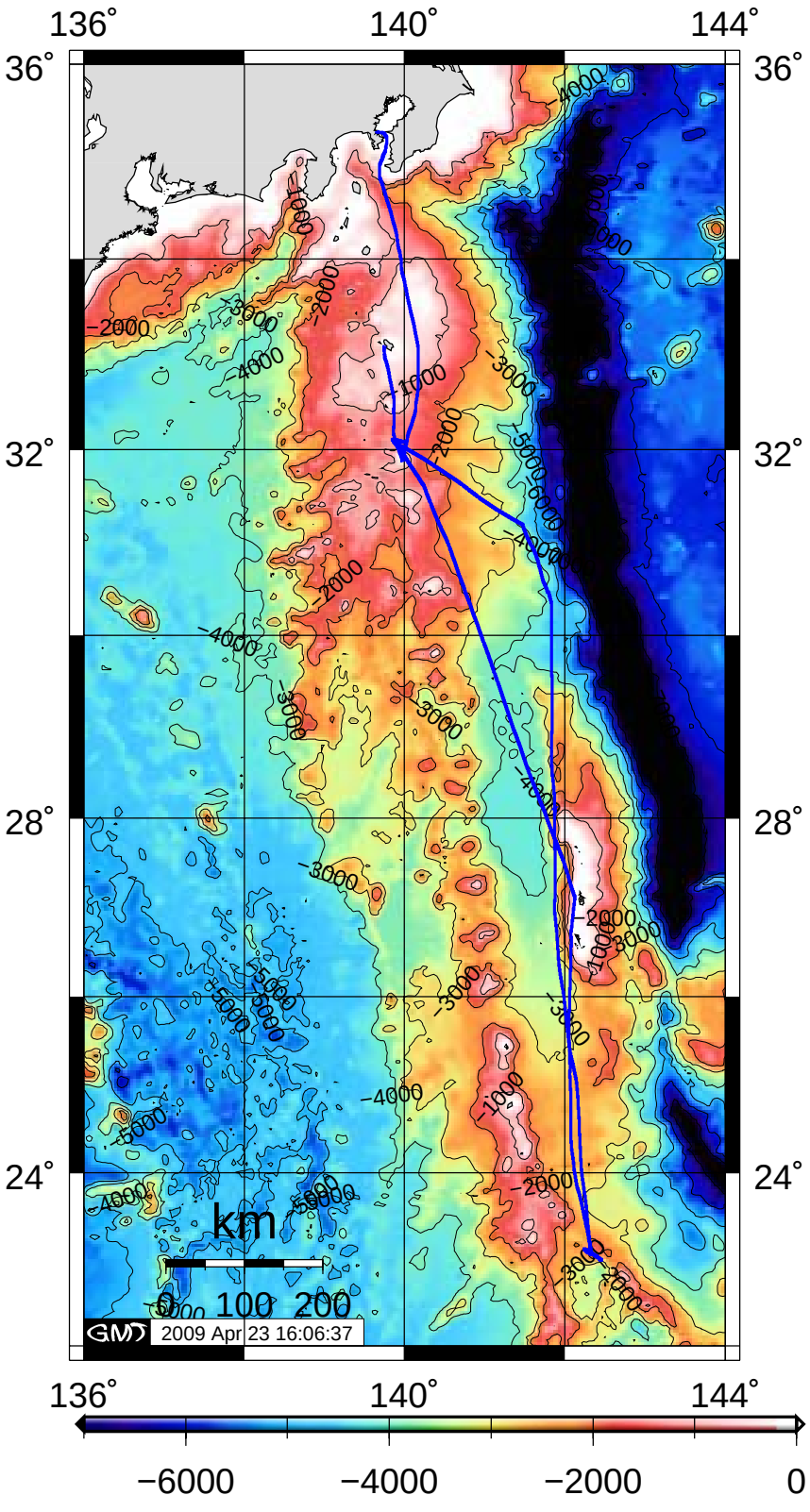
6) Investigation area

Izu-Ogasawara Area (Myojin Knoll, Myojinsho (Nyojin Reef)).

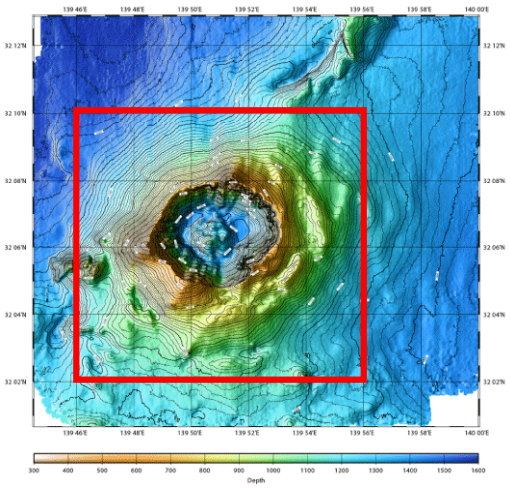
Northern Mariana Area (Nikko Seamount)



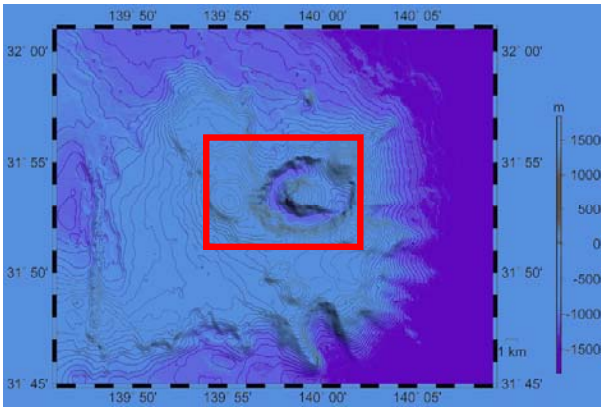
Research area



Cruise track chart

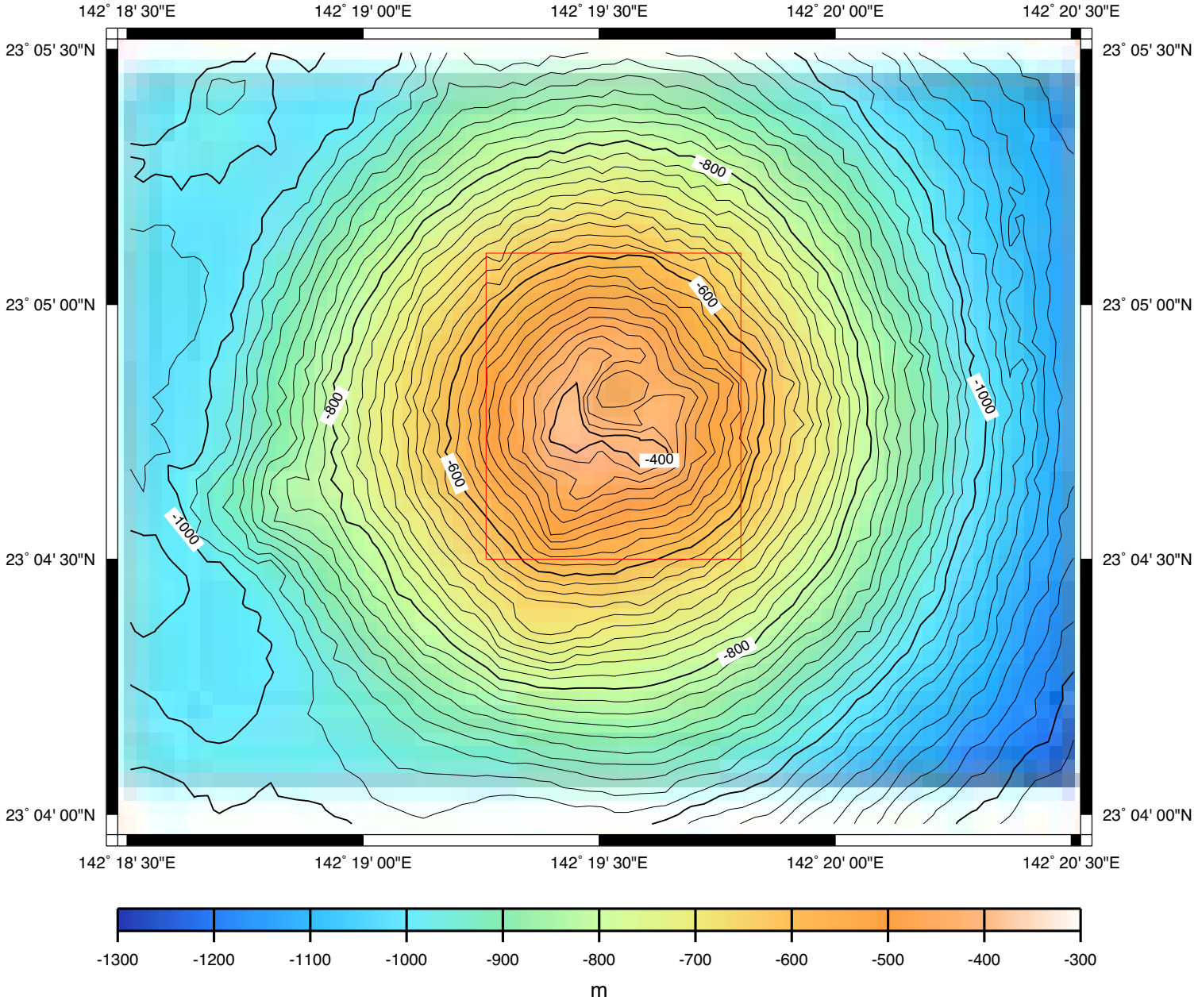


Map of Myojin Knoll.
The red square indicates the area
proposed in the cruise plan.



Map of Myojinsho (Myojin Reef).
The red square indicates the area proposed
in the cruise plan.

ID[M09-018] BATHYMETRIC MAP

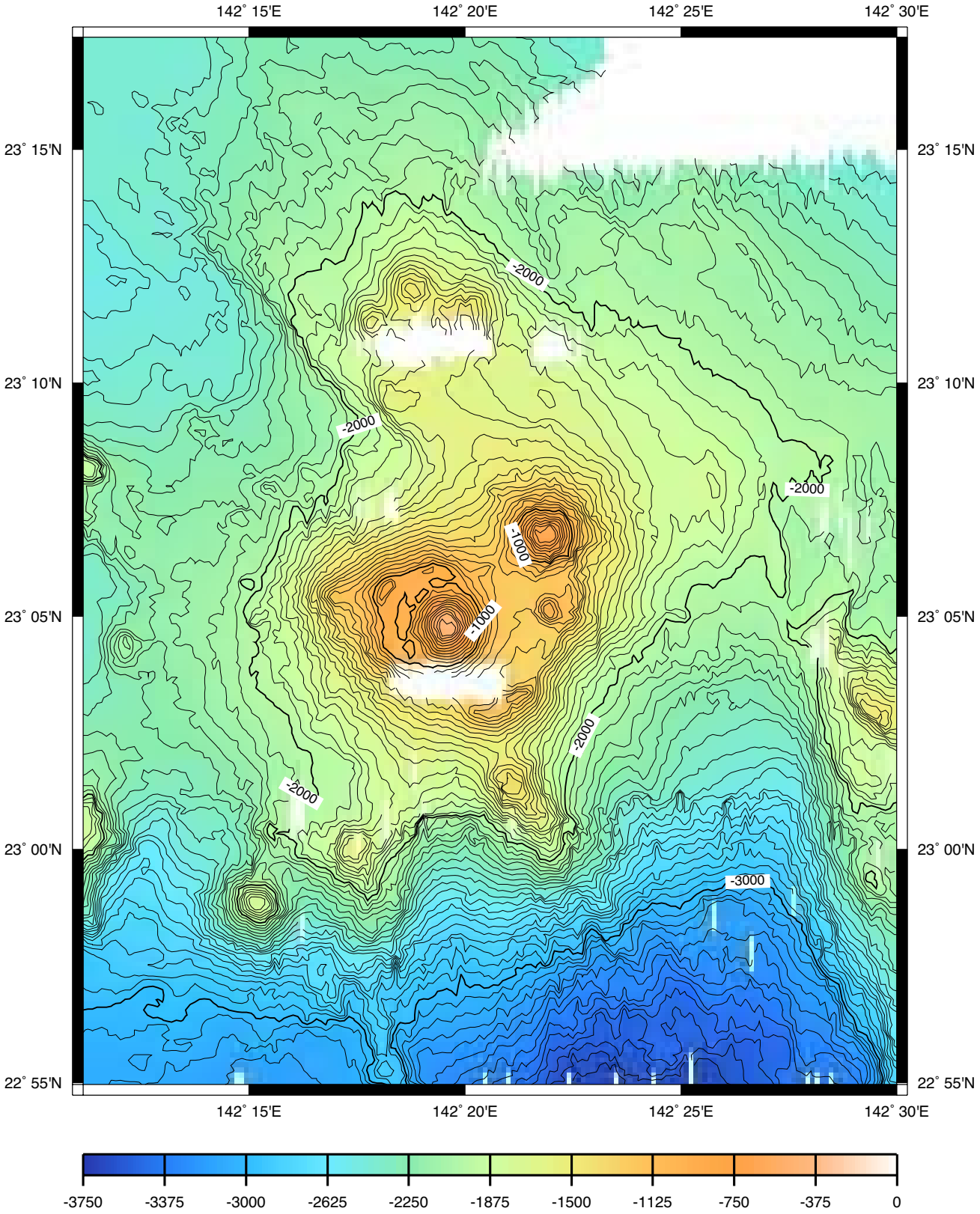


GMT Mar 3 11:53
GMT Mar 3 11:53

Data=JAMSTEC, Grid Interval=50m, Countor Interval=20m, Mercator Projection
Copyright.2009, JAMSTEC(M09-018), http://www.jamstec.go.jp/

Nikko Seamount

ID[M09-018] BATHYMETRIC MAP



Nikko Seamount

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GMT Mar 3 11:29

Data=JAMSTEC, Grid Interval=200m, Countor Interval=50m, Mercator Projection

7) Dive list

Dive #	Observers*	Dive points	Keywords
965	K. Inoue	Hydrothermal vent field of Myoji Knoll	Mussel collection, water sampling and setting of data-logger
966	H. Miyake	Hydrothermal vent field of Nikko Seamount	Search for vents and plume layer. Collection and observation of vent-specific organisms, water sampling, 3D movie recording
967	M. Jimbo	Hydrothermal vent field of Nikko Seamount	Collection and observation of vent-specific organisms. Temperature measurement
968	S. Nemoto	Hydrothermal vent field of Nikko Seamount	Collection and observation of vent-specific organisms. Plankton sampling
969	H. Miyake	Hydrothermal vent field of Nikko Seamount	Collection and observation of vent-specific organisms. Plankton sampling
970	K. Inoue	Hydrothermal vent field of Myoji Knoll	Mussel collection, water sampling and recovery of data-logger
971	K. Inoue	Hydrothermal vent field of Myoji Knoll	Mussel collection, water sampling and collection of vent-specific organisms
972	K. Inoue	Hydrothermal vent field of Myojinsho (Myojin Reef)	Search for hydrothermal-vents. Collection and observation of fishes and vent-specific organisms.

*Author of dive report. Actually, observation was performed by multiple researchers in the control room on Natsushima, through high-vision and CCD cameras equipped on ROV.

2. RESEARCHERS

1) Chief Scientist

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Japan Science Foundation.
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3. OBSERVATION

1) Summary of the cruise

In this cruise, we had eight dives of ROV/hyper-Dolphin: one at Myojin Knoll, four (during two

days) at Nikko Seamount, two (during one day) at Myojin Knoll again, and one at Myojin-sho. Scientists of two research groups joined in this cruise.

The major purpose of the Inoue group is to analyze the function of thiotaurine, a sulfur-containing amino acid, and its transporter (taurine transporter, TAUT), both of which have been suggested to be involved in detoxification and symbiosis. At Myojin Knoll, we chose some colonies of the deep-sea mussels Bathymodiolus septemdierum, each of which is exposed to the vent water at deferent degrees. Around the colonies, we also sampled the water to measure the sulfide concentration. In addition, we measured temperature and water current using a data-logger. We will use the mussels for amino acid and gene expression analyses. Some live mussels were also brought back and will be used for aquarium experiments.

The research objective of the Miyake group is to elucidate how the vent crustaceans utilize the high temperature of the vent seawater at each stage of the lifecycle. We estimated the layer structure of seawater above Nikko Seamount by observation though the Hi-Vision camera or using the CTD sensor. Then, sampling of planktonic larvae were attempted using a plankton net connected with the gate sampler, using which we could collect plankton samples of different layers separately during a single dive. In addition, we observed the distribution of Yunohana crabs using the 3D camera and the behavior of adult crabs around the vents using Hi-Vision camera, and also collected the crabs for biochemical analyses of digestive enzymes. Some live crabs were also maintained for aquarium experiments.

This cooperative cruise of the two groups offered a good opportunity to compare different types of hydrothermal vents.

2) Outline of activities

Feb 25 (Wed)	Meeting for the cruise at JAMSTEC, Yokosuka.
Apr 1 (Wed)	Loading of materials into Natsushima, at JAMSTEC, Yokosuka.
Apr 9 (Thu)	Scientists moved to Hachijo Island
Apr 10 (Fri)	Departure from Hachijo Island (Yaene)
Apr 11 (Sat)	Arrived at Myojin Knoll. Dive #965
April 12 (Sun)	Free fall Operation, then moved toward Nikko Seamount
Apr 14 (Tue)	Arrived at Nikko Seamount, Dive #966, 967
Apr 15 (Wed)	Dive #968, 969, left Nikko Seamount and started toward Myojin Knoll
Apr 18 (Sat)	Arrived at Myojin Knoll. Dive #970, 971. Moved to Myojinsho.
Apr 19 (Sun)	Dive #972, then left Myojinsho
Apr 20 (Mon)	Arrived at JAMSTEC, Packing and unloading of samples and materials, and cleaning of laboratories

3) Detailed time table

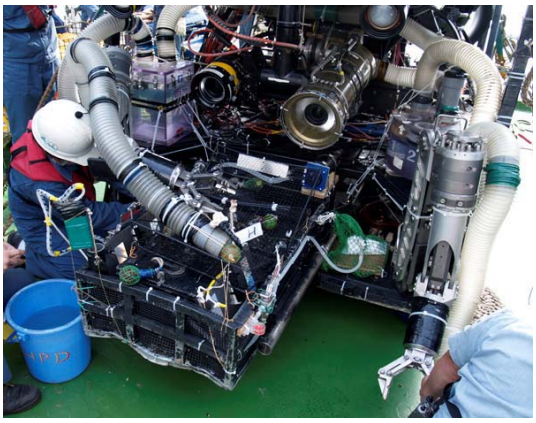
Actual schedule (NT09-05 Leg.2 09/4/10 - 09/4/20)				Position/Weather/Wind/Sea condition (Noon)
Date	Time	Description	Remark	
10,Apr,09	16:00	embarkation science group off HACHIJO		4/10 12:00
	18:00	on board seminar	for safety NATSUSHIMA life	33-04.5N,138-44.9E
	19:00	scientific meeting		fine but cloudy
				ESE-3(Gentle breeze)
11,Apr,09	6:30	arrived at research area		4/11 12:00
	6:33	released XBT		32-08.3N, 139-52.0E
	8:10	launched HPD		fine but cloudy
	8:25	started HPD Dive#965		NE-4(Moderate breeze)
	9:17	arrived at bottom	D=1229m	
	14:19	leave the bottom	D=1244m	
	14:59	surfaced HPD		
	15:25	recovered HPD		
	16:00	left research area for F.F. area		
	19:00	scientific meeting		
12,Apr,09	06:01 ～ 11:41	carried out F.F. of UBC		4/12 12:00
	12:00	departure from F.F. area		30-27.5N, 141-47.8E
	19:00	scientific meeting		rain
				SSE-5(Fresh breeze)
13,Apr,09	19:00	scientific meeting		4/13 12:00
				26-10.8N, 141-57.2E
				fine but cloudy
				NNW-4(Moderate breeze)
14,Apr,09	4:30	arrived at research area(NIKKO Sea Mt.)		4/14 12:00
	5:26	released XBT		23-04.8N, 142-19.6E
	8:03	launched HPD		fine but cloudy
	8:16	started HPD Dive#966		ESE-3(Gentle breeze)
	8:45	arrived at bottom	D=449m	
	10:58	leave the bottom	D=429m	
	11:16	surfaced HPD		
	11:30	recovered HPD		
	13:05	launched HPD		
	13:20	started HPD Dive#967		
	13:41	arrived at bottom	D=449m	
	16:01	leave the bottom	D=444m	
	16:15	surfaced HPD		
	16:30	recovered HPD		
	18:00	scientific meeting		
15,Apr,09	8:13	launched HPD		4/15 12:00

	8:26	started HPD Dive#968		23-04.8N, 142-19.62E
	9:22	arrived at bottom	D=469m	fine but cloudy
	10:57	leave the bottom	D=410m	S-4(Moderate breeze)
	11:11	surfaced HPD		
	11:28	recovered HPD		
	13:04	launched HPD		
	13:17	started HPD Dive#968		
	14:04	arrived at bottom	D=473m	
	16:12	leave the bottom	D=406m	
	16:26	surfaced HPD		
	16:39	recovered HPD		
	17:00	left research area for MYOJIN knoll		
	18:00	scientific meeting		
16,Apr,09	18:00	scientific meeting		4/16 12:00
				26-29.5N, 142-04.8E
				cloudy
				NNE-2(Light breeze)
17,Apr,09	18:00	scientific meeting		4/17 12:00
				30-24.0N, 140-47.4E
				over cast
				S-3(Gentle breeze)
18,Apr,09	8:09	launched HPD		4/18 12:00
	8:23	started HPD Dive#970		32-06.3N, 139-52.0E
	9:10	arrived at bottom	D=1245m	over cast
	11:02	leave the bottom	D=1224m	W-2(Light breeze)
	11:37	surfaced HPD		
	11:48	recovered HPD		
	13:05	launched HPD		
	13:21	started HPD Dive#968		
	14:21	arrived at bottom	D=1286m	
	16:48	leave the bottom	D=1224m	
	17:26	surfaced HPD		
	17:37	recovered HPD		
	18:00	scientific meeting		
19,Apr,09	8:04	launched HPD		4/19 12:00
	8:18	started HPD Dive#970		31-53.0N, 139-58.1E
	9:11	arrived at bottom	D=1245m	cloudy
	14:04	leave the bottom	D=1224m	E-4(Moderate breeze)
	14:33	surfaced HPD		
	14:49	recovered HPD		
	14:55	left research area for Yokosuka		
	18:00	scientific meeting		
20,Apr,09	13:00	arrived at JAMSTEC		
	17:00	left the ship and concluded NT0905		

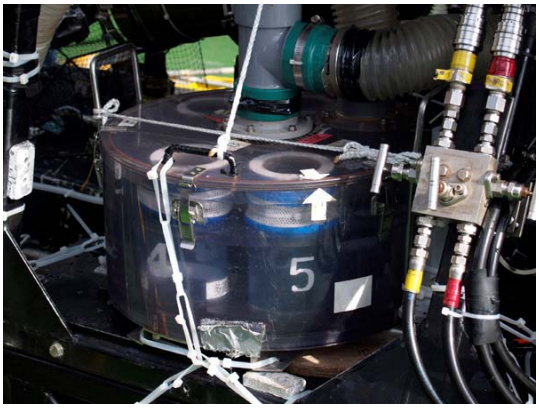
4) Major equipments loaded to Hyper-Dolphin

a) Slurp Gun (Suction sampler)

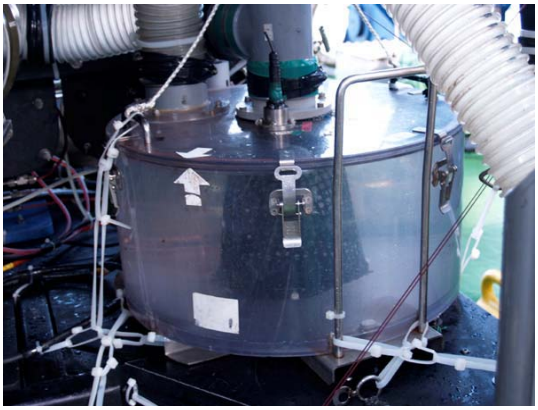
It was used to collect benthos, planktons and fish. The nozzle attached to the left hand of the manipulator was connected to a rotary canister containing 6 bottles. Mesh bags were put into the bottles for plankton sampling. Bottles were removed when necessary. In this cruise, another nozzle was set on the right hand, which was connected to another canister, which is cubic shape and contained no bottle.



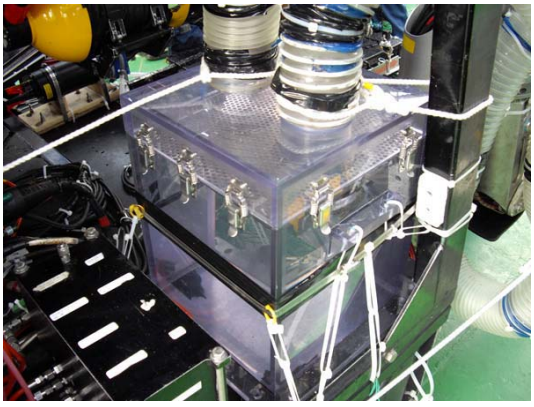
The arrangement of the slurp gun with two nozzle and two canisters



Rotary canister with 6 bottles



Rotary canister used without canister bottle



Cubic canister

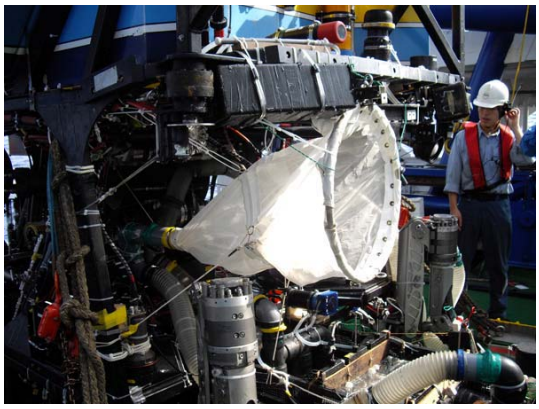
b) Sample boxes

Two sample boxes were loaded in front of the vehicle.

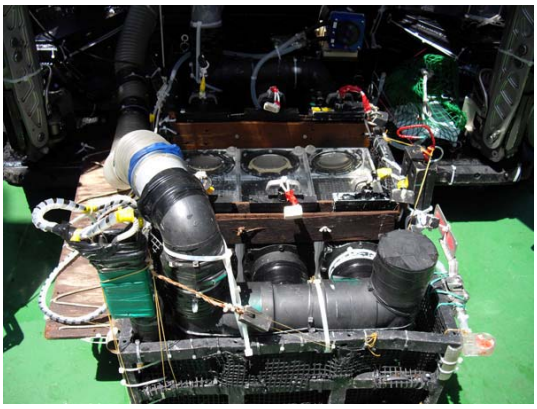
Sample boxes

c) Plankton net with the gate sampler

A plankton net was set in front of the vehicle. The net was connected to three boxes, each of which has a gate. By opening and shutting the gates of the three box, it is possible to collect plankton sample from three different sites or layers, separately.



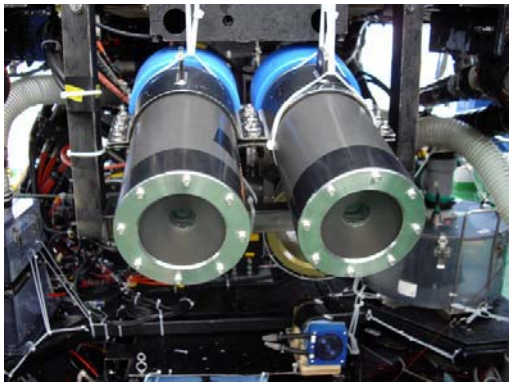
Plankton net



Gate sampler

d) 3D Hi-Vision video camera

The 3D Hi-Vision camera was developed by Okuno and his colleagues (http://www.jamstec.go.jp/jamstec-j/maritec/rvod/blue_earth/2008/program/pdf/PS34.pdf; in Japanese) and has been tested in previous cruises, NT08-03 and NT08-07.



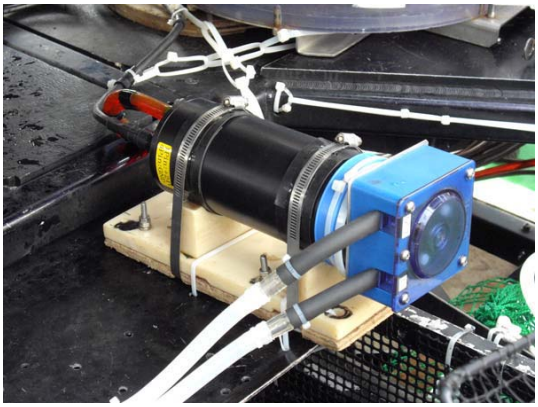
3D camera

e) Bag-type water sampler and RMT thermometer

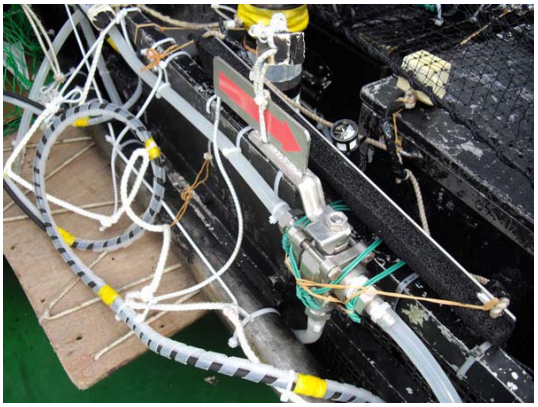
RMT thermometer was attached to the nozzle of the water sampler. The nozzle was connected to two plastic bags through a three direction connector with a selector lever. Water was evacuated using a perista pump.

The nozzle of water sampler

Sample bag



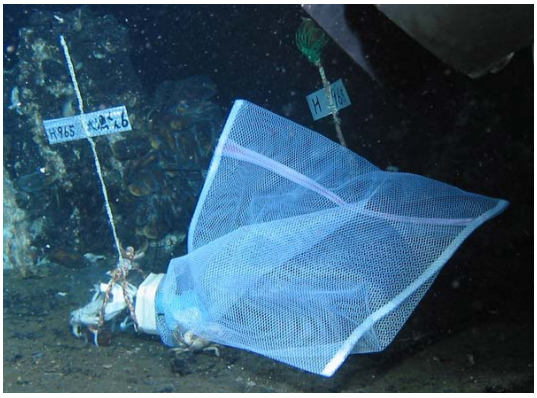
Perista pump



Three direction connector

f) Bait trap

A small trap, “Tairyo-kun ver.6.2”, made from PET bottle and nets, to catch crustacean. A trap cage for crabs, and fishing hook connected to a sinker and a float were also used.



Tairyo-kun

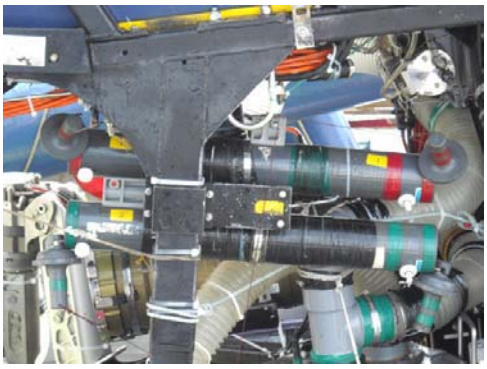
Crab cage

g) Niskin water sampler

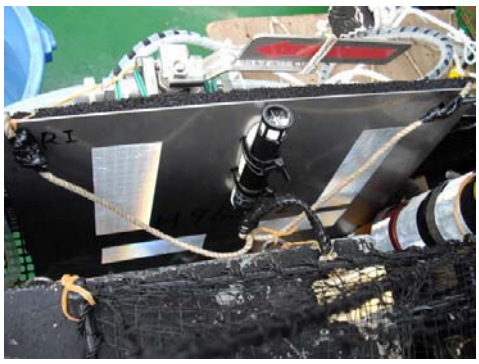
Seawater for larvae culture was sampled using this type of water sampler.

h) Data logger (Little Leonardo W2000L-PD2GT)

This logger is tolerant to high pressure of the deep-sea. It can collect temperature, flow speed, and acceleration. For handling by manipulator, it was mounted to a metal board.



Niskin water sampler



Data logger

5) Summary of dives

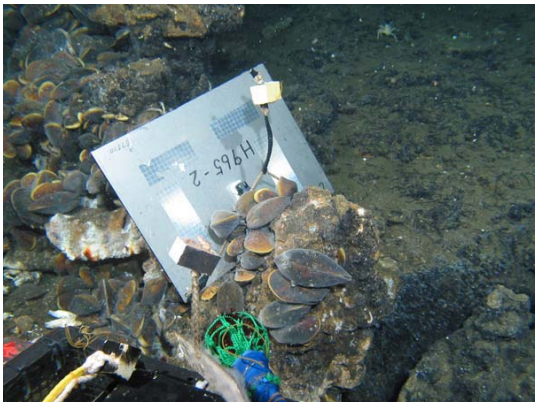
a) Dive #965 (April 11, 2009; Myojin Knoll; Reporter, K. Inoue)

Objective : Collection of vent-specific animals, sampling of water just above mussel colonies, setting of traps, setting of data logger, recovery of transplanted mussel cages

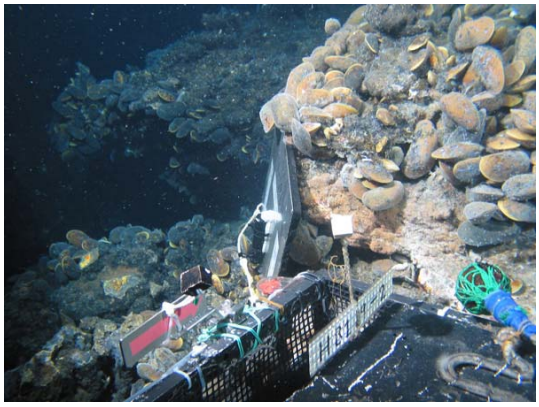
Equipments loaded: Suction sampler (Slurp gun) with a rotary canister containing 6-bottles, and that with a square canister. Bag-type water sampler and RMT thermometer, Sample Boxes, Bait traps.

Arrangement of research equipments at Dive #965

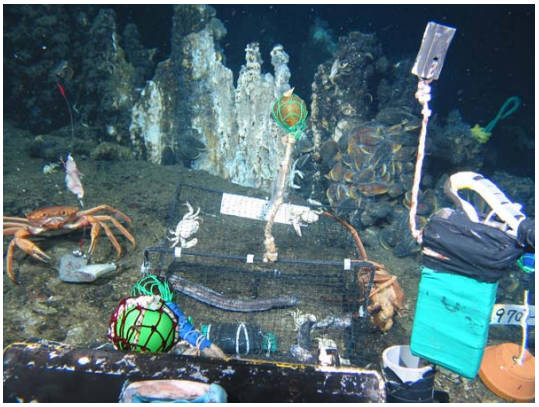
Summary: The dive #965, the first dive of the leg 2 of NT09-06, was carried out under fine but wavy condition at the southern area of the caldera of Myojin Knoll. The vehicle, Hyper-Dolphin, dived toward the point 17 (corresponding to the point 19 of NT08-07), which is suitable to set experimental equipments using ROV because there is flat sand floor in front of a row of active chimneys. At the point, we recovered two net bags, which were set at NT08-07 approximately 1 year ago, for a transplantation experiment of the mussel *B. septemdierum* from an active chimney to sand floor next to the original site, and also set a net cage and a bate trap, which will be recovered during the dives on the way returning from Nikko Seamount. We subsequently sampled mussels in the colony at the end of the chimney row, and hot seawater flushing the mussels. We also set a data logger to collect temperature and water current on the colony. In addition to mussels, we collected Yunohana crabs, squat lobsters, a starfish, and some pieces of chimneys with barnacles, and also took pictures of a mussel colony to analyze the changes in the population of the mussel colony by comparing with the previous pictures of the same colony. The vehicle left the bottom and looked around, keeping the height of several meters, to find another mussel colony. A large colony was found soon and we sampled seawater just above the mussel colony and a number of mussels, and set a data logger as done at the point 17. Pieces of chimney, and some crabs and shrimps were also sampled.



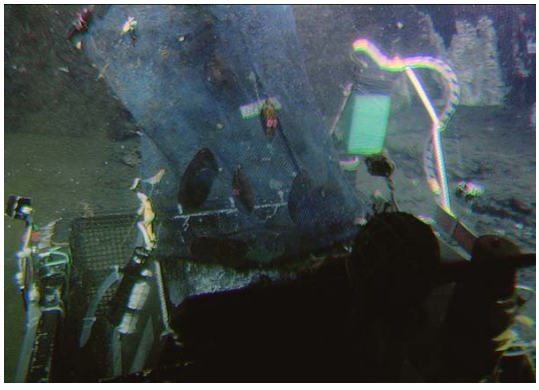
Setting of data logger (H965-2)



Setting of data logger (H965-1)

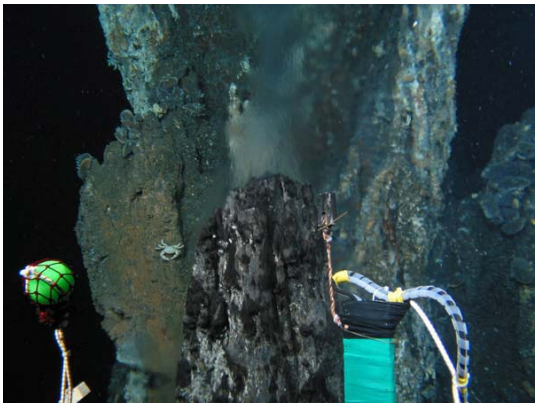


Cage trap set in front of chimneys



Recovery of the transplantation net.

Finally, the vehicle moved to the giant chimney at point No. 7. We took picture of a mussel colony to analyze the change in mussel population as described above. After collection of some additional chimney pieces, the vehicle left the bottom and returned to Natsushima.



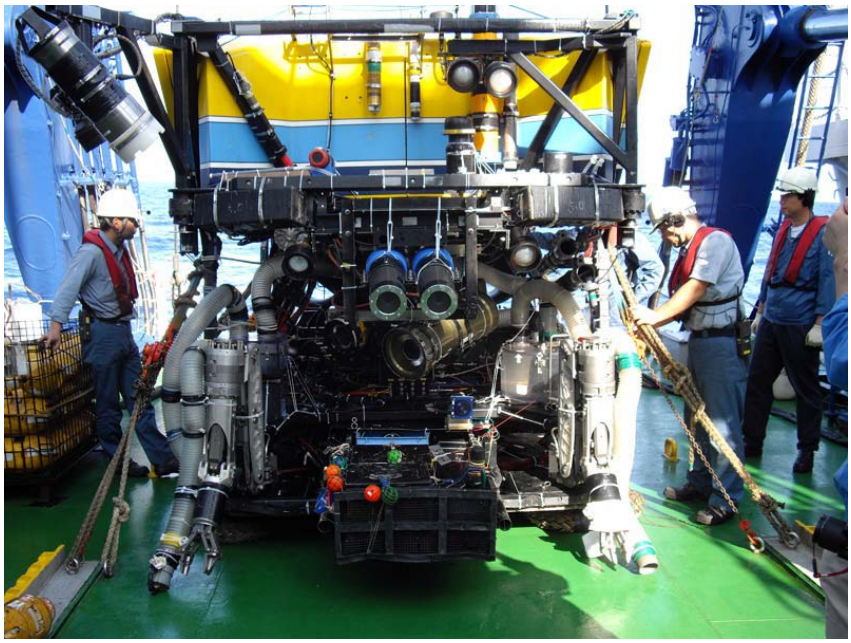
A thermal vent of the giant chimney

A thermal vent near the top of the giant chimney. Paralvinella is observed around the vent.

b) Dive #966 (April 14, 2009; Nikko Seamount; Reporter, H. Miyake)

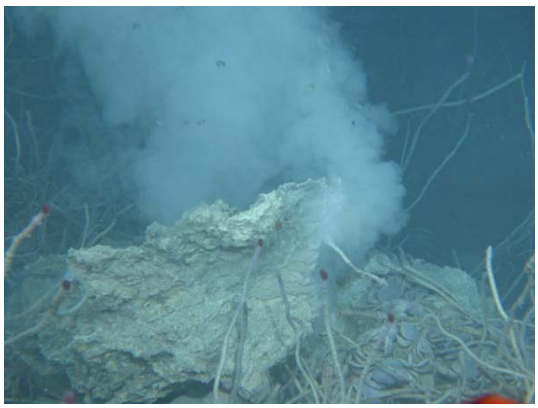
Objective : Collection of vent-specific animals, Sampling of water above the tubeworm colonies, Temperature measurement of Yunohana crab colonies, Observation of organisms using 3D camer

Equipments loaded: Suction sampler (Slurp gun) with a rotary canister without bottles, and that with a square canister. Niskin water sampler, 3D camera, Sample Boxes, Shovel, and ALEK thermometer.

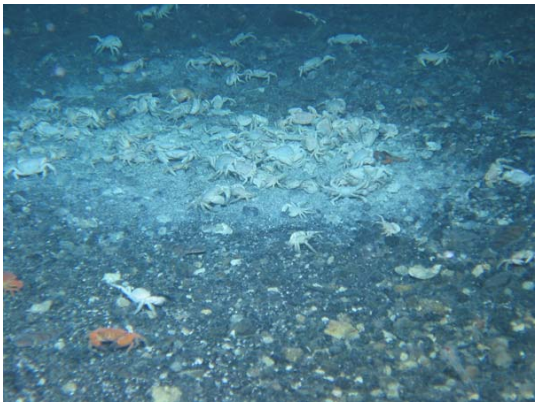


Arrangement of research equipments at Dive #966

Summary: We expected to see the plume layer during the course of diving to the bottom but the vehicle arrived at the bottom within 30 min without finding plume. The bottom was red-brownish, suggesting the existence of iron derived from the plume layer. The vehicle cruised toward the points #9 and #10, watching the bottom carefully. We soon found white-colored bottom of sand and small stones. The vehicle settled there and the behavior of Yunohana crab and tonguefish *Symphurus thermophilus* was observed using the Hi-vision camera. We found a point with dense white sediment, where many Yunohana crabs were getting together. We compared the temperature of the place with that of neighboring places with less number of crabs. We put a marker #966-1 there and also sampled some Yunohana crabs and tongue fishes. The vehicle then moved toward points #4 and #6, and found large colonies of the Satsuma tubeworm *Lamellibrachia satsuma*. We sampled the alvinocaridid shrimps and mussels likely to be *Gigantidas* sp., inhabiting the colony of the tubeworm. Subsequently, the vehicle moved toward the point #12, and found a white smoker surrounded by the tubeworms. The tube of the tubeworm around the vent was strait and thick, and bearing less sessile organisms than those of other sites. After the observation of the vent area, the vehicle restarted toward the point #2, where vents flushing liquid sulfur had been found. We found another site where many Yunohana crabs exist and put a marker #966-2 there. On the way to #2, the vehicle met dense plume and could not have enough visibility to go further. The vehicle stopped there, and sampled the water above the colony of the tubeworm using the Niskin sampler, and also the tubeworms using the manipulator, and left the bottom.



A thermal vent of Nikko Seamount



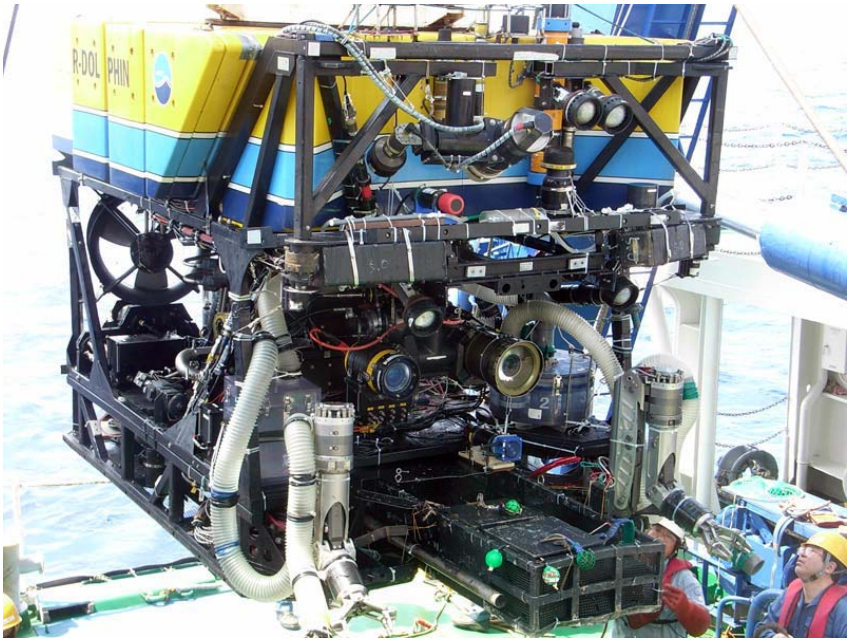
Yunohana and xanthidid crabs around a leakage of hot water on the bottom.

Satsuma tubeworms, a starfish and tonguefish. On the tube of some groups of tubeworms, many sessile organisms were observed.

Satsuma tubeworms and a tonguefish

Gigantisas-like mussels and tubeworms.

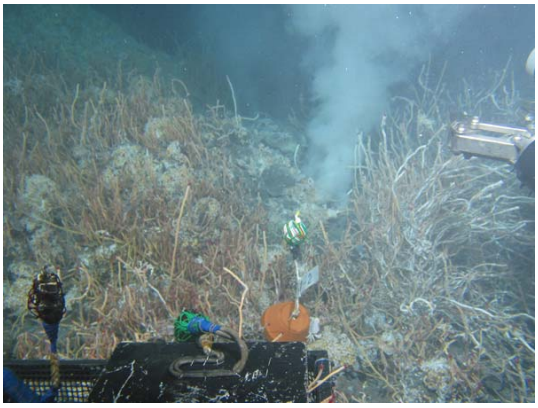
c) Dive #967 (April 14, 2009; Nikko Seamount; Reporter, M. Jimbo)
Objective：Collection of vent-specific animals, Sampling of water above the colonies
Equipments loaded: Suction sampler (Slurp gun) with a rotary canister containing 6-bottles, and that with a square canister. Niskin water sampler, 3D camera, Sample Boxes, Shovel, and ALEK thermometer.



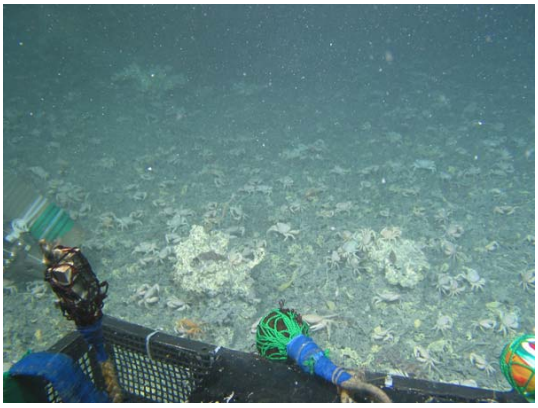
Arrangement of research equipments at Dive #967

Summary: In Dive 967, observation and collection of organism, and measurement of temperature at their habitat were carried out. After settlement at 13:40, Hyper-Dolphin went to the point No. 9, and got water sample with Niskin water sampler. After arrival to No. 6, the

vehicle set a marker labeled “H967-1”, and measured temperature. On the way to No. 12, a hydrothermal vent with white smoke was seen. At the place, the vehicle set a marker H967-2, and collect barnacles, and alvinocaridid shrimps. Next, vehicle went to the point No. 8, and collected small organisms inhabiting tubeworm colonies using the slurp gun. Then the vehicle left the sea floor. Throughout the dive, the organisms, especially Yunohana crab and tonguefish *Symphurus thermophilus* were very common, and tubeworm colonies spread wide region. The tubeworm, *Lamellibrachia satsuma*, usually grows upward direction, but some *L. satsuma* in this area grew horizontal or downward directions.



Hydrothermal vents

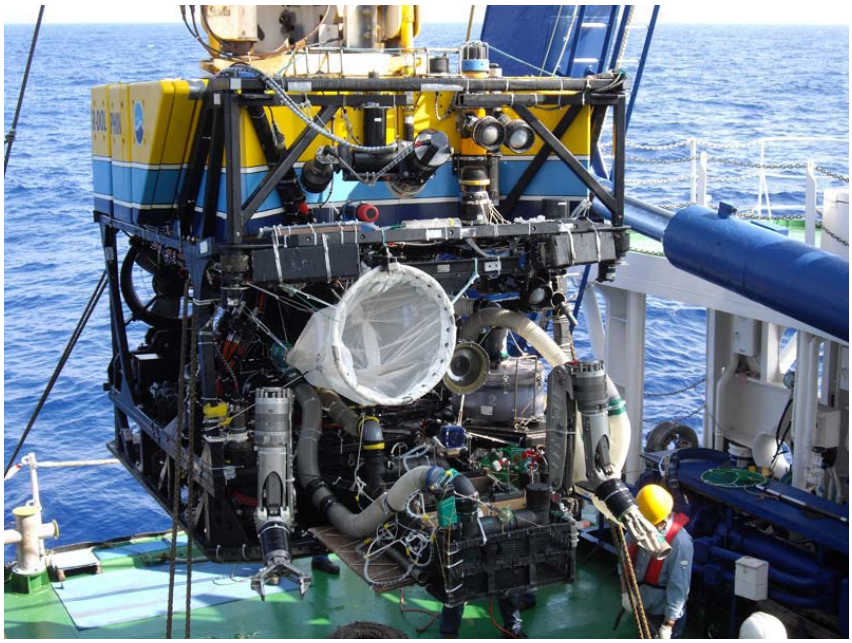


Enormous number of Yunohana crabs on the bottom.

Tubeworms and barnacles

Sulfur on the bottom and Yunohana crabs.

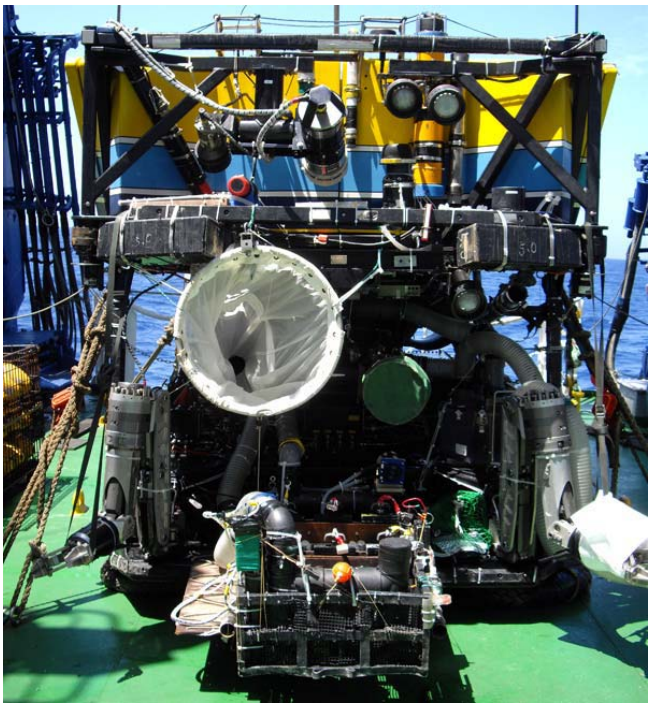
Dive #968 (Date :April 15, 2009; Nikko Seamount; Reporter, S. Nemoto)
Objective : Observation of sea floor, sampling of vent-specific animals and their larvae, sampling and temperature measurement of water just above mussel colonies
Equipments loaded: Suction sampler (Slurp gun) with a rotary canister containing 6-bottles, and that with a square canister. Bag-type water sampler and RMT thermometer, Niskin water sampler, Sample Boxes, and Plankton net with the gate sampler. Sea-Max camera was removed.



Arrangement of research equipments at Dive #968

Summary: Prior to settlement, plankton sampling was carried out using a plankton net, which was set in front of the vehicle and connected to the gate sampler, by cruising the three points #17, #12, and #7 at two different layers (depth, 400 and 420 m). The plume layer was observed at the depth of 420 m. The vehicle settled at the point #17, and we observed the behavior of a Yunohana crab digging sand floor and some individuals attacking it. The vehicle cruised just above the bottom toward north-west, collecting planktons into the third gate box, and settled again at a place near the point #7, where patchy distribution of the Satsuma tubeworm was observed. We collected alvinocaridid shrimps using the slurp gun, and also the tubeworm using the manipulator. Then the vehicle moved to the direction of SWS, and found a hydrothermal vent, where vent water was sampled using bag-type water sampler, and the temperature was also measured. At this place, we observed the behavior of Yunohana crab, e.g., a crab quickly running, holding a dead crab, and some entering into the vent. We put a marker here, and went ahead toward north. At the point #8, large colonies of the Satsuma tubeworm were discovered and animals inhabiting the tubeworm colonies were caught. At the west side of the point #8, we found a rocky area at which many xanthidid crabs were observed. We collected the crab and also some rocks on which some organisms are attaching. Subsequently, the vehicle moved to a colony of Satsuma tubeworm. At this point, water was sampled using the Niskin sampler. After the sampling of some tubeworms, the vehicle left the bottom.

e) Dive #969 (April 15, 2009; Nikko Seamount; Reporter, H. Miyake)
Objective : Collection of vent-specific animals and their larvae, sampling of water above their colonies, sampling of water from white smoker
Equipments loaded: Suction sampler (Slurp gun) with a rotary canister without bottles, and that with a square canister. Bag-type water sampler and RMT thermometer, Niskin water sampler, Sample Boxes, and Plankton net with the gate sampler. Sea-Max camera was removed.



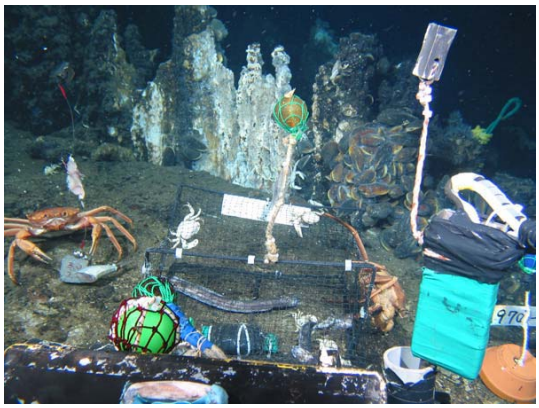
Arrangement of research equipments at Dive #969

Summary: The vehicle dived toward the point #3 where active vents and plume layer were observed. At the depth of 400 m, sampling of plankton, using plankton net with gate sampler, was carried out cruising between points #3 and #7 three times (gate #1). The same sampling was carried out at the depth of 420 m (gate #2). Then the vehicle cruised above the bottom for a while and collected planktonic larvae into the gate #3. After closed the gate #3, the vehicle settled onto the point where many xanthidid crabs had been observed at the previous dive. Crabs were sampled using the slurp gun, water by the Niskin sampler, and the tubeworms using the manipulator. Then the vehicle moved toward the point #6, and collected the tonguefish and Yunohana crab. We observed the behavior of the crab defending a hole on the bottom using the Hi-vision camera. The vehicle then moved toward the point #14. We found an active mound, around which much sulfur, solidified in a shape of the flow, was observed. The water of the vent was sampled using the bag-type water sampler and some rocks bearing sessile organisms were collected. The vehicle then left the bottom but unfortunately, the rocks and tubeworms placed in the basket were lost just after leaving.

Dive #970 (April 18, 2009; Myojin Knoll; Reporter, K. Inoue)
Objective : Collection of vent-specific animals, sampling of water just above mussel colonies, recovery of traps and data-loggers, and recovery of traps.
Equipments loaded: Suction sampler (Slurp gun) with a rotary canister containing 6-bottles, and that with a square canister, Bag-type water sampler and RMT thermometer, Sample Boxes, and Fishing Hook.

Arrangement of research equipments at Dive #970

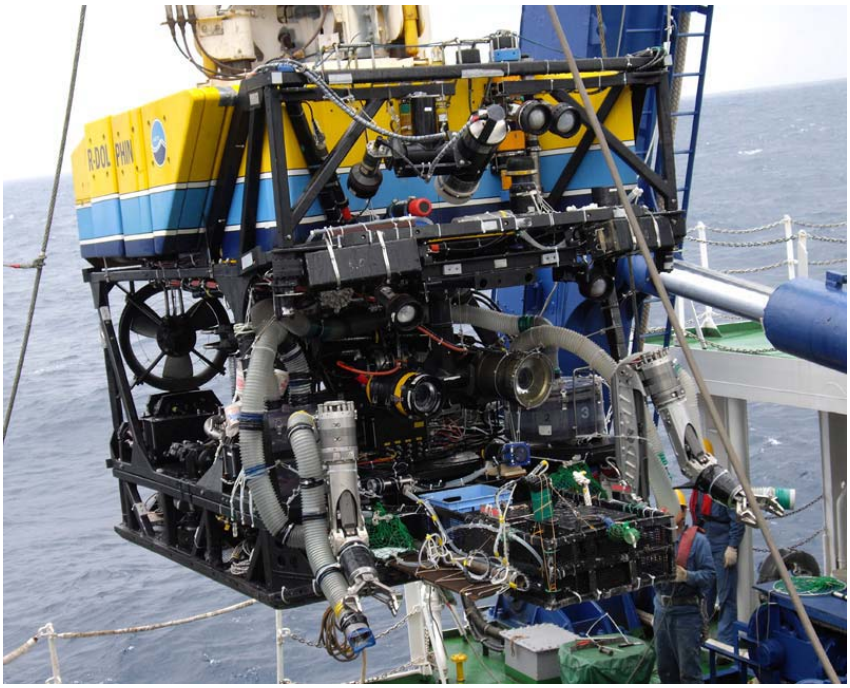
Sampling of water on the mussel colony



Bate trap (crab cage). Conger eels and crabs were caught.

Summary: This is the second dive at Myojin Knoll. The vehicle dived toward the point where the ROV homer was set at the dive #965. At the point, data logger #1 was recovered. Then vent water was sampled using a bag-type water sampler, and mussels (*B. septemdierum*) being directly exposed to the vent water were sampled, using the slurp gun, into a canister bottle. After the sampling of the mussels, the plankton in the mussel colony was sampled using the slurp gun into the canister bottle with mesh. The vehicle moved to the point #17 after recovery of the ROV homer and setting a marker (#970-1). During this operation, a tube of the bag-type sampler was accidentally disconnected and it became impossible to collect water samples. At the point #17, the data logger #2 was recovered and then a marker (#970-2) was set there. After the recovery of the bate-trap and the cage trap, the vehicle left the bottom.

f) Dive #971 (April 18, 2009; Myojin Knoll; Reporter, K. Inoue)
Objective：Collection of vent-specific animals, sampling of water just above mussel colonies
Equipments loaded: Suction sampler (Slurp gun) with a rotary canister containing 6-bottles, and that with a square canister, Bag-type water sampler and RMT thermometer, and Sample Boxes.

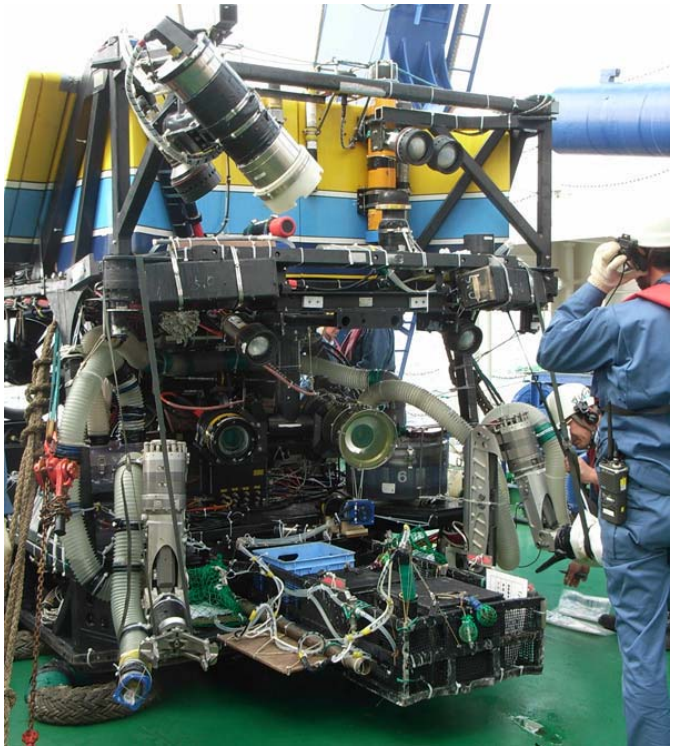


Arrangement of research equipments at Dive #971

Summary: As we could not obtain water sample at the point 17 during the dive #970 due to accident in the bag-type water sampler, we gave up the plan to visit the north-west region of the caldera and visited the same area again. The vehicle dived toward the area around the point #20, and after reaching the bottom, it moved slowly toward the point #17, observing the fauna of the bottom. On the way, a fish was caught using the slurp gun. At the point #17, plankton in the mussel colony was sampled using the slurp gun into the bottle with mesh. Then alvinocaridid

shrimps in mussel colonies were caught using the slurp gun. We sampled water just above the mussel colony, which is not directly exposed to vent water, and also mussel specimens from the colony using the slurp gun. Finally, water at barnacle colony, and a chimney with barnacles were sampled and the vehicle left the bottom.

g) Dive 972 (April 19, 2009; Myojinsho; Reporter, K. Inoue)
Objective : Discovery of hydrothermal vents, Observation of the fauna, Collection of vent-specific animals.
Equipments loaded: Suction sampler (Slurp gun) with a rotary canister containing 6-bottles, and that with a square canister, Bag-type water sampler and RMT thermometer, Sample Boxes



Arrangement of research equipments at Dive #972

Summary: The last dive of this leg was carried out in the caldera of Myojinsho (Myojin Reef). The vehicle dived toward the area where hydrothermal vents were discovered at the cruise NT07-17. After reaching the bottom, the vehicle slowly cruised several meters above the bottom seeking the hydrothermal vents. After about one hour, a site where hot water is leaking from the bottom was discovered. The depth was almost 900 m. A crab and a rock were sampled there. After short cruise for several minutes, we found an enormous number of small propeamussiid-like scallops. We collected some scallops there. We also found another small vent, where a small colony of *Bathymodiolus*-like mussels. We collected some mussels and also pieces of rocks with barnacles. Because of the complicated geographic structure, the vehicle could not proceed along the bottom from the point. Thus, it left the bottom and moved about a

hundred meter. After settled again, the vehicle continued to seek hydrothermal vents. We found white bottom, where we sampled the white mad to collect polychaets (However, it did not contained any polychaets actually). As we could not proceed to north- and eastward because of the cliff-like topography, we returned westward. Around the depth of 970 m, many fish were observed. We attempted to catch fish using the slurp gun until 14:00, and some fish were successfully caught.

Propeamussiid-like scallops

Propeamussiid-like scallops

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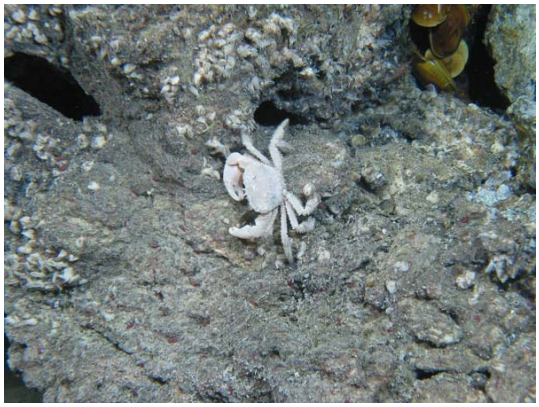
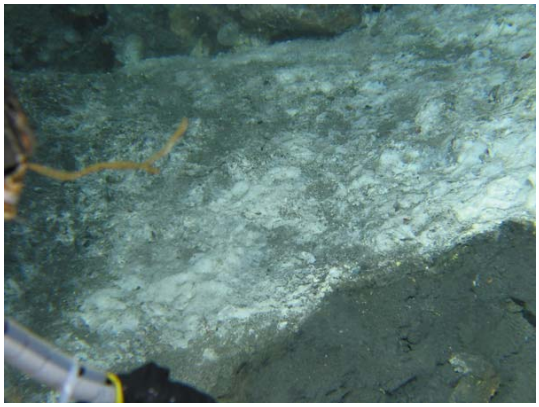
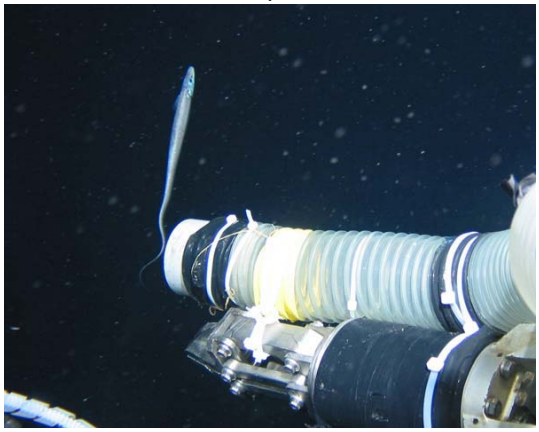
A small mussel colony around a small vent.



Yunohana crab around the mussel colony.



White bottom around a small vent.



Attempt to capture a fish

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4. RESEARCH PEPORTS (Methods and Preliminary Results)

1) Studies on mechanisms of adaptation to the sulfur-rich environment of hydothermal vents

Koji INOUE[1], Tomoko KOITO[1], Shinichiro MORIMOTO[2] and Haruhiko[2] TOYOHARA
[1]*Ocean Research Institute, The University of Tokyo;* [2]*Graduate School of Agriculture, Kyoto University*

Objective

Various invertebrates inhabiting hydrothermal vents contain sulfur-oxidizing bacteria in their tissues. However, the mechanisms to deliver toxic sulfides to the endosymbionts remain unknown. In recent years, involvement of thiotaurine in detoxification of sulfides has been suggested. We are trying to understand the detoxification process by characterizing the taurine transporter (TAUT), a transporter protein that transport taurine and related amino acids across the cell membrane. We have already cloned the TAUT cDNA from the deep-sea mussel *Bathymodiolus septemdierum*, and demonstrated that it transports thiotaurine and its precursors (FEBS letters 582, 1542-1546, 2008). We also established a real-time PCR system to quantify the level of mRNA. In the present cruise, we tried to compare TAUT mRNA level between mussels collected at the high sulfide environment and those from low sulfide environment.

Achievement in this cruise

In the caldera of Myojin Knoll, we collected live *B. septemdierum* specimens from a colony facing to an active vent and those from a colony that is not exposed directly to vent water. The specimens were dissected and frozen for mRNA analyses and also fixed for histological analyses. We also brought back live specimens for laboratory experiments. In addition, we obtained samples of some mussels likely to be *Gigantidas* sp. At Nikko Seamount to compare the structure of TAUT.

Future studies

a) Rearing of the mussels in aquarium under the different condition (e.g., with/without sulfide).
b) Quantification of TAUT mRNA level by real-time PCR.
c) Analysis of free amino acids.
d) Histological analyses.
e) Cloning and characterization of TAUT genes of the mussel likely to be *Gigantidas* sp.
f) Phylogenetic analyses on TAUT sequences of various marine organisms.

2) Studies on the function of taurine-related compounds of *B. septemdierum* for the adaptation to the sulfur-rich environment of hydrothermal vents

Haruhiko TOYOHARA[1], Shinichiro MORIMOTO[1], Tomoko KOITO[2], and Koji INOUE[2]
[1]*Graduate School of Agriculture, Kyoto University;* [2]*Ocean Research Institute, University of Tokyo*

Objective

Sulfur-containing amino acids, such as taurine related amino acids are assumed to be implicated in the adaptation to the environment of hydrothermal vents. These amino acids are possibly involved in the detoxification of sulfides and/or the symbiosis with bacteria. From the amino acid analysis of the gill of *B. septemdierum*, thiotaurine is assumed to contribute to the detoxification of H_2S, but it may possibly contribute to the symbiosis with bacteria. To elucidate this possibility, we measure the change in the amount of thiotaurine in the *B. septemdierum* kept in the presence of various antibiotics that suppress the growth of symbiotic bacteria.

Achievement in this cruise

We reared the mussels collected at Myojin Knoll in aquaria on board with or without a set of antibiotics, ampicilin, tetracycline, kanamycin and chloramphenicol. The set of antibiotics was proved to be effective to suppress the activities of the bacteria, when it was added to culture plates and also when added to aquarium water (Fig.).

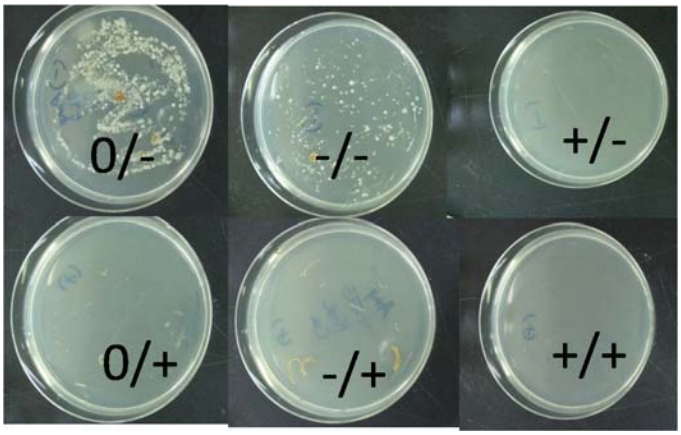


Fig. Effect of antibiotics on the growth of bacteria of the gill. Antibiotics used were as follows. Ampicilin, tetracycline, kanamycin and chloramphenicol and final concentration in the plate (LB) and the cultured sea water were 50 mg/L, 15 mg/L, 20 mg/L and 100mg/L, respectively. 0/-, freshly prepared gill fragment was rubbed on the plate without antibiotics; 0/+, freshly prepared gill fragment was rubbed on the plate with antibiotics; -/-, gill fragment prepared from the mussels cultured in the seawater overnight without antibiotics was rubbed on the plate without antibiotics; -/+, gill fragment prepared from the mussels cultured overnight in the seawater without antibiotics was rubbed on the plate with antibiotics; +/-, gill fragment prepared from the mussels cultured overnight in the seawater with antibiotics was rubbed on the plate with antibiotics; +/+, gill fragment prepared from the mussels cultured overnight in the seawater with antibiotics was rubbed on the plate with antibiotics. Incubation was performed at room temperature (ca. 25 °C).

At the start of rearing, and after 1, 3, 5, 7 days, the gill and mantle were collected and quickly frozen for the analysis. Specimens for histological analysis were also fixed at the same time. We also collected *Gigantidas* sp. at Nikko Seamount to compare the amino acid composition with *B. septemdierum*.

Future studies

a) Analysis of free amino acids of the gill and mantle.
b) Analysis of taurine, thiotaurine and hypotaurine of the gill and mantle.
c) Histological analyses.

3) Studies on necessity of heat for vent crustaceans

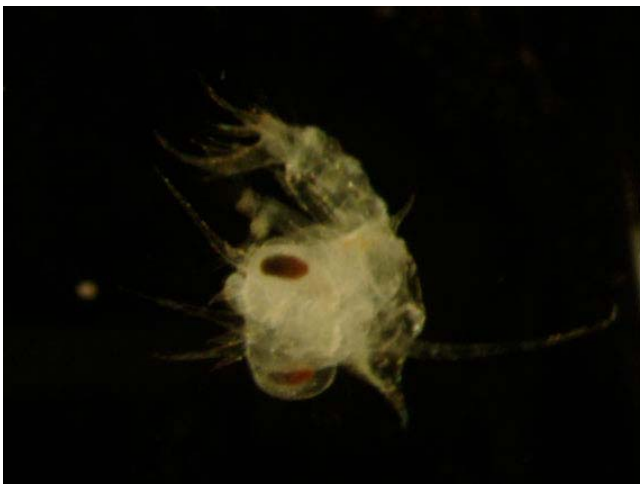
Hiroshi MIYAKE and Shuhei IKEDA
School of Marine Biosciences, Kitasato University

Objective

Gandalfus yunohana and *Opaepele loihi* live around hydrothermal vent. They also come together around heater in aquarium. They could not live over the long term without heat source. To clear why they need heat source to live, we will conduct an analysis of protease activity of them and rearing experiment using hot water vent of various temperature.

To study the life cycle of them, we also tried to collect larvae of them using plankton net.

Achievement in this cruise



We succeeded in collection of *G. yunohana* and *O. loihi*. Some crabs were dissected and surgically removed gut. We observed gut contents and extract enzyme. Enzyme extract and remains of crabs tissue were frozen in -80°C.

Other live crabs and shrimps were kept in aquarium on board.

In plankton sample, we could collect zoea larvae of crab and shrimp. Zoea of crab was not identified yet, but shrimp were identified as *Opaepele loihi*. They were collected in and under the plume of hydrothermal vent.

After cruise, collected animals were sent by home delivery service to Kitasato University.

Future studies

d) Rearing of the vent crab and shrimps in aquarium under the different heat condition
e) Observation of behavior of crabs and shrimps to heat source.
f) Analysis of protease activity of vent crab and shrimp

g) Observation of intra relationship in vent crab population in captivity
h) Phylogenetic analyses on vent crab and shrimps

4) Faunal study of fish found around the Myojin-knoll and Nikko Seamount

Hitoshi IDA
School of Marine Biosciences, Kitasato University

Objective

The present study aims to clarify the ichthyo-fauna formed around hydro-thermally active areas in comparison with other deep sea habitats

Material & Methods

Fish gathering around the Myojin Knoll and Nikko Sea-mount will be observed by highly sensitive camera and if possible, collection of them will be tried by a slurp gun (a suction sampler). The fauna will be compared with those found in hydro-thermally inactive areas.

Results

Only few individuals of rat-tails (Coelorhynchidae) and a deepsea conger (Synaphobranchidae) were observed at Myojin Knoll. On the contrary, populations of high density of a tongue-sole, *Symphurus thermophilus*, were observed at Nikko Seamount. Specimens of the tongue-sole were successfully collected. Several individuals of mesopelagic fish species were collected by plankton net.

Perspectives

Sequences of mt-DNA will be analyzed in comparison with the related species dwelling in other habitat. Larvae of mesopelagic fish species will be described in detail in the future.

5) Studies on larval dispersal and settlement of hydrothermal vent barnacles

Takefumi YORISUE, Shigeaki KOJIMA
Ocean Research Institute, The University of Tokyo

Objectives

Because barnacles are sessile organism, they need to inhabit gregariously to mate with neighboring individuals. Therefore, larval dispersal and settlement are important processes for barnacles. At the Myojin Knoll, it is known that two species of barnacles, *Neoverruca* sp. and *Ashinkailepas seepiophilia*, are distributed around active and inactive chimney, respectively. However, it is unknown how their larvae disperse among vent/seep sites and settle gregariously. We purposed to elucidate the mechanisms of dispersal and settlement of *Neoverruca* sp. and *A. seepiophilia*. In recent years, larval culture experiment of *Neoverruca* sp. suggested temperature is a important factor for the dispersal and settlement. Furthermore, settlement

inducing protein complex (SIPC) has been cloned from *Balanus Amphitrite* and various barnacles have SIPC like protein. To achieve the purpose, we will analyze larval period, SIPC and observe larval morphology.

Achievement in this cruise

We collected *Neoverruca* sp. from the Myojin Knoll and the Nikko Seamount and *A. seepiophilia* from the Myojin Knoll. Most of them are kept in aquarium to obtain larvae and part of the samples is frozen for SIPC analysis.

Future studies

a) Culture larvae of *A. seepiophilia* under different temperature condition.
b) Observe larval morphology of *Neoverruca* sp. and *A. seepiophilia* with Scanning Electron Microscope (SEM)
c) Cloning SIPC of *Neoverruca* sp. and *A. Seepiophilia*.

6) Development of vestimentiferan tubeworms and metamorphosis-inducing substances

Mitsuru JIMBO and Shino SUZUKI
School of Marine Biosciences, Kitasato University

Objective

The Satsuma tubeworm *Lamellibrachia satsuma* is a tubeworm species inhabiting the depth range of 100-400 m and is maintainable under atomospheric pressure. This species forms dense colonies in the natural habitat. The larvae have planktonic stages and it is supposed that settlement and metamorphosis are induced by unknown cues. In the case of *Alaysia* sp. of Sagami Bay, the settlement was induced by the addition of the hemolymph. It has been also suggested that metamorphosis after settlement is also accelerated by the hemolymph. Thus, it is presumed that the settlement and metamorphosis are induced by chemical factors. In this study, we collect larvae of Satsuma tubeworm and observe the developmental process. We also examine the effect of various fraction of extract of the adult tubeworms.

Achievement in this cruise

Larvae were successfully obtained. We found that most embryos reach to the blastula stage but tended to aggregate each other after the start of swimming. The development delayed when they are reared at high density; they remained at 1-cell stage more than 24 h at high density but the development restarted after dilution. We also reared the larvae using the seawater near the colony of wild tubeworms, obtained using Niskin sampler, and filtered surface seawater obtainable from the water supply system of R/V Natsushima, and compared the development. However, we could not find any difference until blastula stages.

Future studies

a) The effect of the tubeworm hemolymph and adult extract on settling will be examined.
b) Establishment of assay system using trocophore larvae to examine the effect of chemicals.

7) Studies on lectins of deep-sea mollusks

Mitsuru JIMBO and Hisao KAMIYA
School of Marine Biosciences, Kitasato University

Objective

Many mollusks have symbiotic bacteria in the gill and obtain organic matter from them. However, information on the mechanism of symbiosis is limited at present. It has been proposed that symbiosis, parasitism, and infection are derived from the common origin. Thus, it is possible that lectins (a group of proteins that bind to specific sugar), which are important members of the defense mechanisms of invertebrates, are involved in symbiosis. We have purified lectins from the Satsuma tubeworm and the vesicomyid clam *Calyptogena soyoae* and have demonstrated that the lectins bind to the sulfur-oxidizing symbionts. In this study, we collect hemolymph from the mussels *Gigantidas* sp. and *Bathymodiolus septemdierum*, and assay for hemoagglutination, and also obtain large amount of hemolymph and organs of the species that showed hemoagglutination activity.

Achievement in this cruise

The hemolymph of *B. septemdierum* showed hemoagglutination activities on horse and goose red blood cells (dilution rate, >256 and 8, respectively), and also showed hemolytic activities on rabbit blood. As *Gigantidas* hemolymph also has high hemoagglutination activity on the horse red blood cells, it is likely that the structure of lectins of the two closely related species are similar. For purification of lectins, we collected 2050 ml and 260 ml hemolymph from *B. septemdierum* and *Gigantidas* sp., respectively. We also collected the gill, foot, mantle and frozen usinf liquid nitrogen for molecular cloning. Some tissues are also fixed using Bouin's fixative for histological analyses.

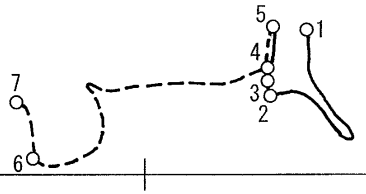
Future studies

a) Purification of lectins
b) cDNA cloning
c) Distribution analyses by western blotting and immunohistochemistry.

Appendix

(Point maps and route maps)

1. 09:17 着底 D=1229m reached the bottom
(32-06.244N 139-52.158E)
2. 09:38 D=1223m H965カニ籠設置 Setting of trap and cage
(32-06.224N 139-52.145E)
09:39 H965ﾍﾞｲﾄﾄﾗｯﾌﾟ設置
09:47 H819-1放流ﾈｯﾄ回収 Recovery of transplantation nets
09:50 H819-2放流ﾈｯﾄ回収
3. 10:06 D=1223m #2Bag採水開始 Water sampling
(32-06.229N 139-52.144E)
10:09 #2Bag採水終了
4. 10:15 D=1223m ｼﾝｶｲﾋﾊﾞﾘｶﾞｲ採集(#2ｷｬﾆｽﾀｰ・多数) Collection of mussels
(32-06.232N 139-52.144E)
10:20 ﾕﾉﾊﾅｶﾞﾆ･ｺｼｵﾘｴﾋﾞ採集(#4ｷｬﾆｽﾀｰ) Collection of shrimp
10:27 #2小糸ﾛｶﾞｰ設置 Setting of logger
10:34 温度計測開始 Water temperature measurement
10:39 温度計測終了
10:42 生物採集(#5ｷｬﾆｽﾀｰ・多数) Collection of organisms
2. 11:00 D=1221m 生物付ﾁﾑﾆｰ片採取(1個) Collection of chimney
11:07 ﾋﾄﾃﾞ採集(1個体) Starfish
11:20 D=1219m 高度を取って移動開始
5. 11:23 D=1230m 海底視認
(32-06.245N 139-52.146E)
4. 11:35 D=1224m #1Bag採水開始 Water sampling
11:39 #1Bag採水終了
12:10 ｼﾝｶｲﾋﾊﾞﾘｶﾞｲ採集(単ｷｬﾆｽﾀｰ・多数) Mussel collection
12:27 ﾕﾉﾊﾅｶﾞﾆ採集(空ｷｬﾆｽﾀｰ・多数) Crab collection
12:32 #1小糸ﾛｶﾞｰ設置 Setting of logger
12:38 ROVﾎｰﾏｰ:ID=43設置
13:17 ﾁﾑﾆｰ片採取(1個) Chimney collection
13:18 高度を取って移動開始
6. 13:30 D=1245m ﾋﾞｯｸﾁﾑﾆｰ視認 A=10m Visit to big chimney
(32-06.205N 139-52.060E)
7. 13:35 D=1245m ﾋﾞｯｸﾁﾑﾆｰ視認 A=23m
(32-06.222N 139-52.054E)
13:53 ﾁﾑﾆｰ片採取(1個) Chimney piece
14:18 D=1244m ﾁﾑﾆｰ片採取(1個)
14:19 離底 D=1244m Left the bottom



139° 52.00E

32° 06.20N

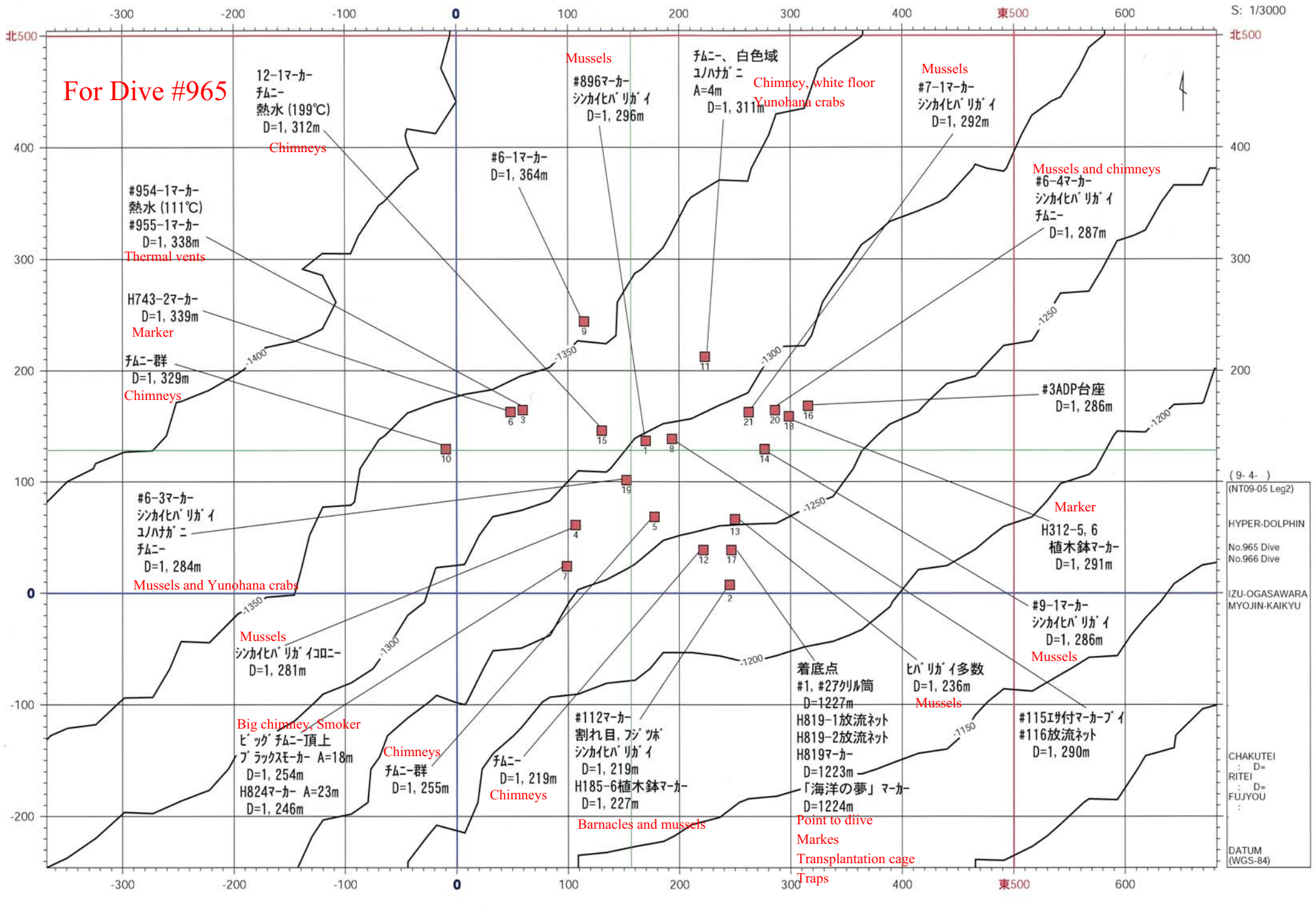
0 300m

※ 緯度、経度の１目盛りは、0.1分を示します。

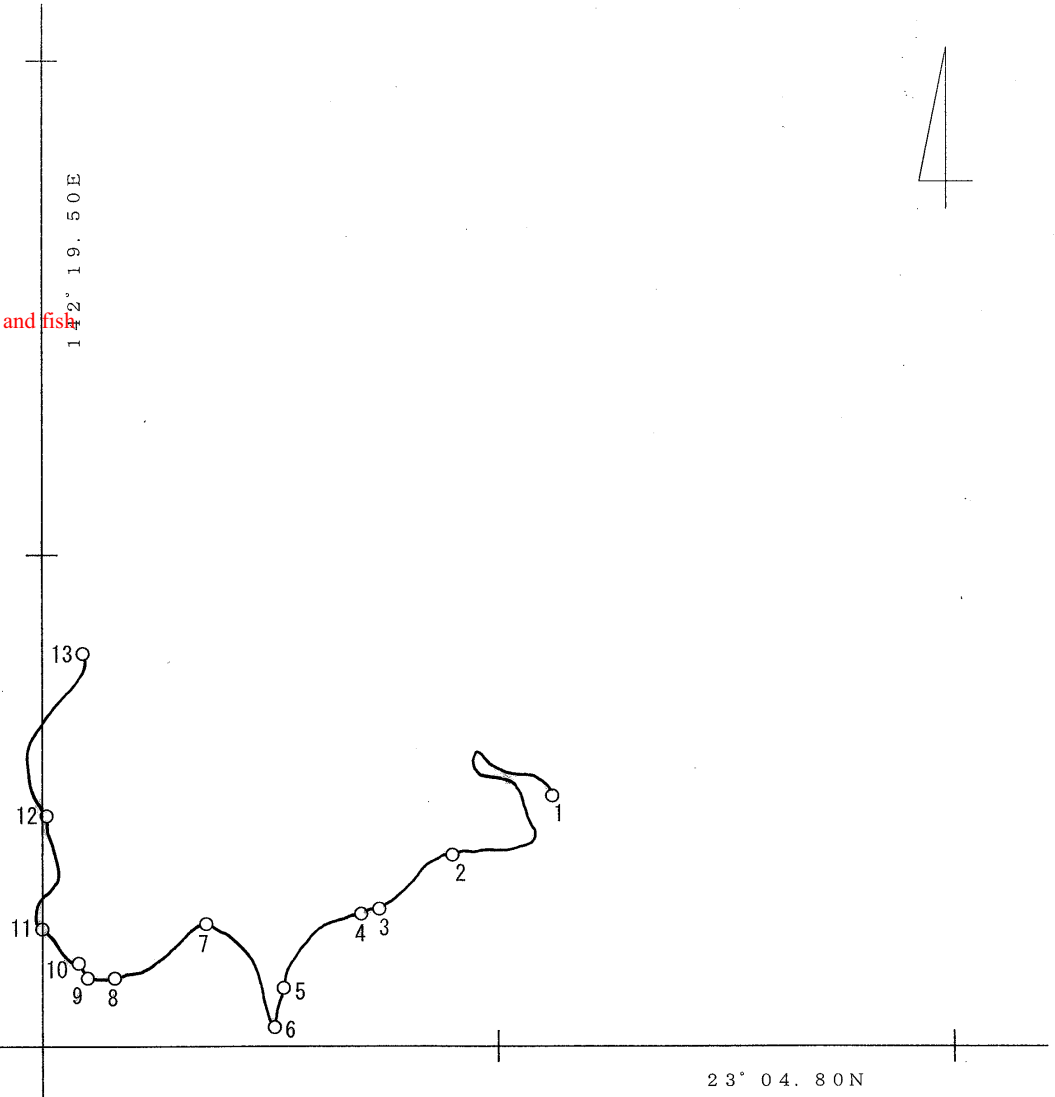
ハイパードルフィン
＃９６５ ＤＩＶＥ
２００９年０４月１１日
伊豆・小笠原 明神海丘

縮尺 １／３０００

測 位 D-GPS(MX9400 LEICA)
測地系 WGS-84 DATUM（世界測地系）
音 速 １４９４．７m／s（D＝１３００m）


For Dive #965
S: 1/3000
北500
東500
12-1マーカー
チムニー
熱水 (199℃)
D=1, 312m
Chimneys
Mussels
#896マーカー
シンカイヒバリガイ
D=1, 296m
チムニー、白色域
ユノハナガニ
A=4m
D=1, 311m
Chimney, white floor
Yunohana crabs
Mussels
#7-1マーカー
シンカイヒバリガイ
D=1, 292m
#6-1マーカー
D=1, 364m
Mussels and chimneys
#6-4マーカー
シンカイヒバリガイ
チムニー
D=1, 287m
#954-1マーカー
熱水 (111℃)
#955-1マーカー
D=1, 338m
Thermal vents
H743-2マーカー
D=1, 339m
Marker
チムニー群
D=1, 329m
Chimneys
#3ADP台座
D=1, 286m
#6-3マーカー
シンカイヒバリガイ
ユノハナガニ
チムニー
D=1, 284m
Mussels and Yunohana crabs
Marker
H312-5, 6
植木鉢マーカー
D=1, 291m
#9-1マーカー
シンカイヒバリガイ
D=1, 286m
Mussels
Mussels
シンカイヒバリガイコロニー
D=1, 281m
着底点
#1, #27クリル筒
D=1227m
H819-1放流ネット
H819-2放流ネット
H819マーカー
D=1223m
「海洋の夢」マーカー
D=1224m
Point to diive
Markes
Transplantation cage
Traps
ヒバリガイ多数
D=1, 236m
Mussels
Big chimney, Smoker
ビッグチムニー頂上
ブラックスモーカー A=18m
D=1, 254m
H824マーカー A=23m
D=1, 246m
Chimneys
チムニー群
D=1, 255m
チムニー
D=1, 219m
Chimneys
#112マーカー
割れ目, フジツボ
シンカイヒバリガイ
D=1, 219m
H185-6植木鉢マーカー
D=1, 227m
Barnacles and mussels
#115エサ付マーカーブイ
#116放流ネット
D=1, 290m
(9- 4-)
(NT09-05 Leg2)
HYPER-DOLPHIN
No.965 Dive
No.966 Dive
IZU-OGASAWARA
MYOJIN-KAIKYU
CHAKUTEI
RITEI
FUJYOU
DATUM
(WGS-84)
XY ORIGIN 32-6.200N 139-52.000E
CENTER 32-6.270N 139-52.100E

1. 08:45 着底 D=449m Reached the bottom
(23-04.851N 142-19.612E)
2. 08:53 D=452m 熱水ﾌﾟﾙｰﾑ視認 A=5m Plume
(23-04.839N 142-19.590E)
3. 08:56 D=472m ﾕﾉﾊﾅｶﾞﾆ多数視認 Yunohana crabs
(23-04.828N 142-19.574E)
09:04 温度計設置 Temperature measurment
09:19 ｽﾗｰﾌﾟｶﾞﾝによるﾕﾉﾊﾅｶﾞﾆ・ｳｼﾉｼﾀ採集(多数) Sampling of crabs and fish
09:19 温度計回収
09:20 H966-1植木鉢ﾏｰｶｰ設置
4. 09:22 D=472m ﾊｵﾘﾑｼ視認
(23-04.827N 142-19.570E)
5. 09:41 D=471m ｽﾗｰﾌﾟｶﾞﾝによるｲｶﾞｲ採集(多数) Mussel collection
(23-04.812N 142-19.553E)
6. 09:52 D=462m ｽﾗｰﾌﾟｶﾞﾝによるｲｶﾞｲ採集(多数) Mussel collection
(23-04.804N 142-19.551E)
7. 09:58 D=473m 生物ｺﾛﾆｰ視認
(23-04.825N 142-19.536E)
8. 10:02 D=464m 大規模なﾊｵﾘﾑｼｺﾛﾆｰ視認 A=3m Tubeworms observed
(23-04.814N 142-19.516E)
9. 10:03 D=467m ﾎﾜｲﾄｽﾓｰｶｰ視認 White smoker observed
(23-04.814N 142-19.510E)
10. 10:09 D=465m ﾊﾞﾌﾞﾙ視認
(23-04.817N 142-19.508E)
11. 10:15 D=466m 温度計設置 Temperature mesurment
(23-04.824N 142-19.500E)
10:16 ﾊｵﾘﾑｼ・ｲｶﾞｲ多数視認 Tubeworms and mussels observed
10:33 温度計回収
10:35 ﾕﾉﾊﾅｶﾞﾆ採集(多数) Crab collection
10:36 H966-2植木鉢ﾏｰｶｰ設置
12. 10:42 D=451m ﾋﾊﾞﾘｶﾞｲｺﾛﾆｰ視認 A=3m
(23-04.847N 142-19.501E)
13. 10:51 D=429m ﾆｽｷﾝ採水(#1・#2) Water sampling
(23-04.880N 142-19.509E)
10:58 ﾊｵﾘﾑｼ採集(多数) Tubeworm collction
10:58 離底 D=429m



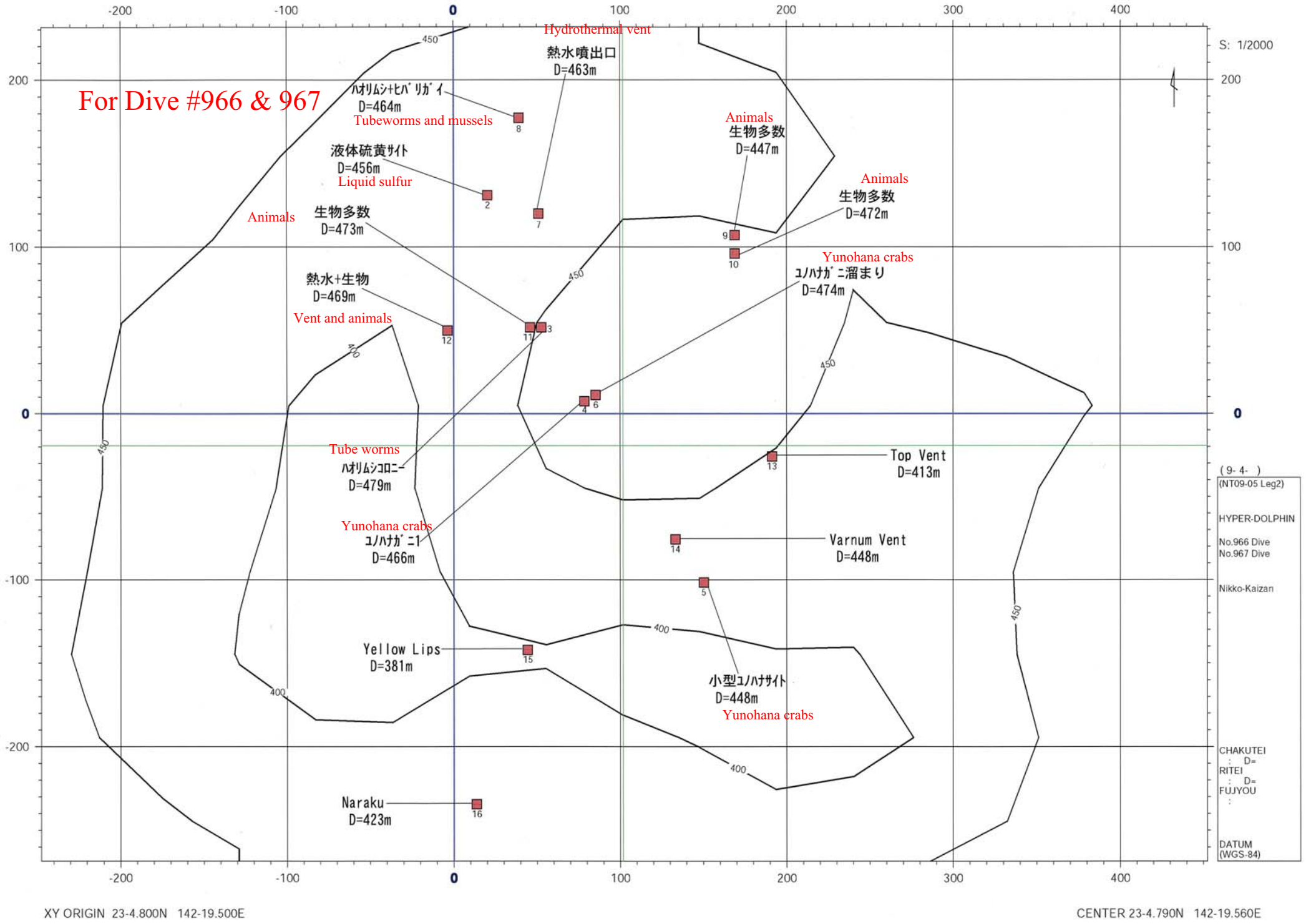
0 200m

※ 緯度、経度の１目盛りは、0.1分を示します。

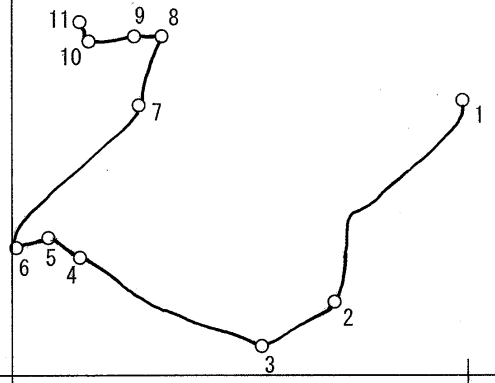
ハイパードルフィン
＃９６６ ＤＩＶＥ
２００９年０４月１４日
マリアナトラフ 日光海山

縮尺 １／２０００

測 位 D-GPS(MX9400 LEICA)
測地系 WGS-84 DATUM (世界測地系)
音 速 １５２４．７m／s (D＝４５０m)


For Dive #966 & 967
Hydrothermal vent
熱水噴出口
D=463m
ﾊｵﾘﾑｼ+ﾋﾊﾞﾘｶﾞｲ
D=464m
Tubeworms and mussels
液体硫黄ｻｲﾄ
D=456m
Liquid sulfur
Animals
生物多数
D=473m
Animals
生物多数
D=447m
Animals
生物多数
D=472m
熱水+生物
D=469m
Vent and animals
Yunohana crabs
ﾕﾉﾊﾅｶﾞﾆ溜まり
D=474m
Tube worms
ﾊｵﾘﾑｼｺﾛﾆｰ
D=479m
Top Vent
D=413m
Yunohana crabs
ﾕﾉﾊﾅｶﾞﾆ1
D=466m
Varnum Vent
D=448m
Yellow Lips
D=381m
小型ﾕﾉﾊﾅｻｲﾄ
D=448m
Yunohana crabs
Naraku
D=423m
S: 1/2000
(9- 4-)
(NT09-05 Leg2)
HYPER-DOLPHIN
No.966 Dive
No.967 Dive
Nikko-Kaizan
CHAKUTEI : D=
RITEI : D=
FUJYOU :
DATUM (WGS-84)
XY ORIGIN 23-4.800N 142-19.500E
CENTER 23-4.790N 142-19.560E

1. 13:41 着底 D=449m Reached the bottom
(23-04.856N 142-19.599E)
2. 13:59 D=464m 大規模なﾊｵﾘﾑｼｺﾛﾆｰ視認 Tubeworms observed
(23-04.815N 142-19.571E)
13:59 ﾆｽｷﾝ採水(#1) Water sampling
3. 14:13 D=467m ｳｼﾉｼﾀ採集(#2ｷｬﾆｽﾀｰ・多数) Tonguefish collection
(23-04.806N 142-19.555E)
14:13 ﾕﾉﾊﾅｶﾞﾆ・ｳｼﾉｼﾀ多数視認 Crabs and tonguefish observed
14:15 D=468m 温度計設置
14:16 H967-1 植木鉢ﾏｰｶｰ設置
14:25 ｳｼﾉｼﾀ採集(#3ｷｬﾆｽﾀｰ・多数) Tonguefish sampling
14:38 ｽﾗｰﾌﾟｶﾞﾝによるﾕﾉﾊﾅｶﾞﾆ・ｳｼﾉｼﾀ採集(多数) Crabs and tonguefish collection
14:39 温度計回収
4. 14:48 D=471m 白色域視認 White bottom
(23-04.824N 142-19.515E)
5. 14:49 D=468m ﾎﾜｲﾄｽﾓｰｶｰ視認 White smoker
(23-04.828N 142-19.508E)
14:49 ﾌｼﾞﾂﾎﾞ多数視認 Barnacles observed
14:55 H967-2植木鉢ﾏｰｶｰ設置
15:01 ﾌｼﾞﾂﾎﾞ付岩石採取(3個) Sampling of rocks with barnacles
15:14 ｽﾗｰﾌﾟｶﾞﾝによる生物採集(多数) Sampling of organisms
6. 15:18 D=468m ﾊﾞﾌﾞﾙ視認
(23-04.826N 142-19.501E)
15:19 ﾆｽｷﾝ採水(#2) Water sampling
7. 15:30 D=456m ﾕﾉﾊﾅｶﾞﾆ・ｳｼﾉｼﾀ多数視認 Crabs and tonguefish observed
(23-04.855N 142-19.528E)
8. 15:34 D=456m 熱水噴出孔視認 Thermal vent
(23-04.869N 142-19.533E)
9. 15:39 D=456m 熱水噴出孔視認 Thermal vent
(23-04.869N 142-19.527E)
10. 15:45 D=450m 熱水噴出孔視認 Thermal vent
(23-04.868N 142-19.517E)
11. 16:00 D=444m ﾊｵﾘﾑｼ採集(多数) Tubeworm sampling
(23-04.872N 142-19.515E)
16:01 離底 D=444m Left the bottom



142° 19.50E

23° 04.80N

0 200m

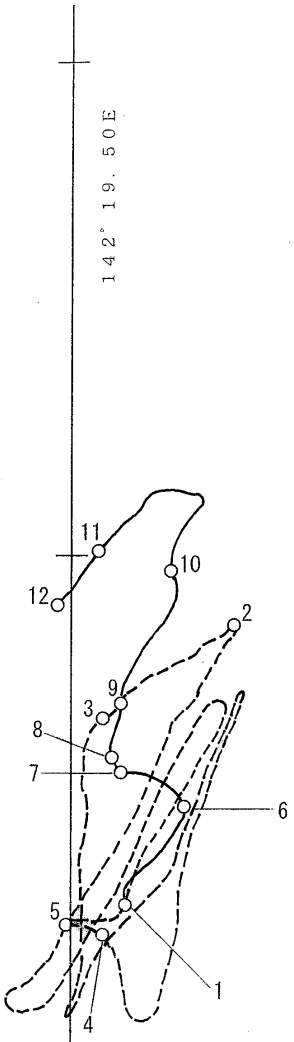
※ 緯度、経度の１目盛りは、0.1分を示します。

ハイパードルフィン
#967 DIVE
2009年04月14日
マリアナトラフ 日光海山

縮尺 1／2000

測 位 D-GPS(MX9400 LEICA)
測地系 WGS-84 DATUM (世界測地系)
音 速 1524.7m／s (D＝450m)

1. 08:47 D=400m 中層観察開始 A=64m
(23-04.829N 142-19.512E)
08:48 ﾌﾟﾗﾝｸﾄﾝ採集開始(#1ｹﾞｰﾄｻﾝﾌﾟﾗｰ) Plankton sampling
2. 09:02 D=400m ﾌﾟﾗﾝｸﾄﾝ採集終了(#1ｹﾞｰﾄｻﾝﾌﾟﾗｰ)
(23-04.886N 142-19.536E)
3. 09:04 D=400m ﾌﾟﾗﾝｸﾄﾝ採集開始(#2ｹﾞｰﾄｻﾝﾌﾟﾗｰ) Plankton samling
(23-04.867N 142-19.507E)
4. 09:15 D=420m ﾌﾟﾗﾝｸﾄﾝ採集終了(#2ｹﾞｰﾄｻﾝﾌﾟﾗｰ)
(23-04.823N 142-19.507E)
5. 09:17 D=419m ﾌﾟﾗﾝｸﾄﾝ採集開始(#3ｹﾞｰﾄｻﾝﾌﾟﾗｰ) Plankton sampling
(23-04.825N 142-19.499E)
1. 09:22 D=469m 着底
6. 09:34 D=458m ﾌﾟﾗﾝｸﾄﾝ採集終了(#3ｹﾞｰﾄｻﾝﾌﾟﾗｰ)
(23-04.849N 142-19.525E)
09:40 生物採集(#2ｷｬﾆｽﾀｰ・多数) Sampling of organisms
09:42 ﾊｵﾘﾑｼ付岩石採取(1個) Sampling of a rock with tubeworms
7. 09:48 D=458m 熱水噴出孔視認 Hydrothermal vents
(23-04.856N 142-19.511E)
09:54 D=459m Bag採水開始 Water sampling
09:58 Bag採水終了
09:59 H968 植木鉢ﾏｰｶｰ設置
8. 10:06 D=450m 熱水噴出孔視認 A=3m Hydrothermal vent
(23-04.859N 142-19.509E)
9. 10:09 D=443m 熱水噴出孔視認 A=2m Hydrothermal vent
(23-04.870N 142-19.511E)
10. 10:23 D=418m ﾕﾉﾊﾅｶﾞﾆ採集(#3ｷｬﾆｽﾀｰ・多数) Collection of crabs
(23-04.897N 142-19.522E)
11. 10:39 D=412m ﾕﾉﾊﾅｶﾞﾆ採集(#4ｷｬﾆｽﾀｰ・多数) Collection of crabs
(23-04.901N 142-19.506E)
10:45 ﾌｼﾞﾂﾎﾞ付岩石採取(1個) Sampling of a rock with barnacles
10:46 ﾕﾉﾊﾅｶﾞﾆ採集(多数) Sampling of crabs
12. 10:54 D=410m ﾆｽｷﾝ採水(#1・#2) Water sampling
(23-04.890N 142-19.497E)
10:55 ﾊｵﾘﾑｼ採集(多数) Tubeworm sampling
10:57 離底 D=410m Left the bottom



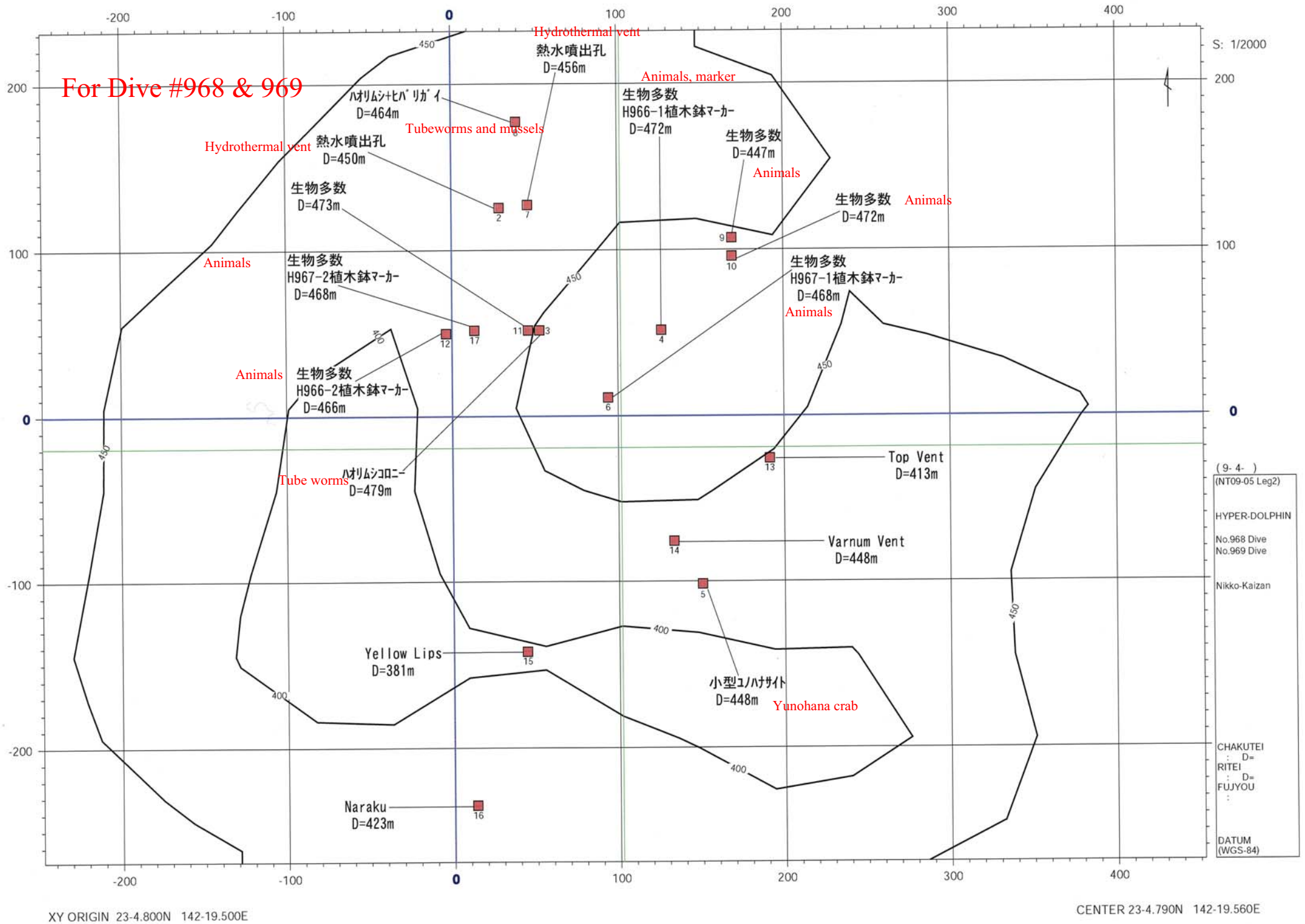
0 200m

※ 緯度、経度の１目盛りは、0.1分を示します。

ハイパードルフィン
＃９６８ ＤＩＶＥ
２００９年０４月１５日
マリアナトラフ 日光海山

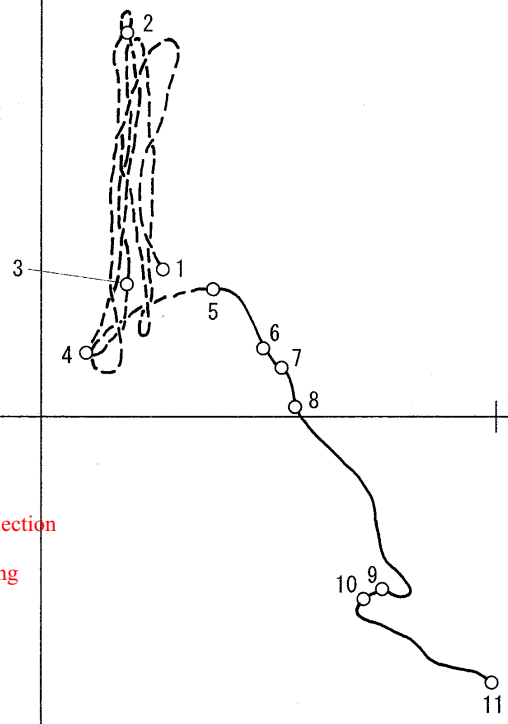
縮尺 １／２０００

測 位 D-GPS(MX9400 LEICA)
測地系 WGS-84 DATUM（世界測地系）
音 速 １５２３．６m／s（D＝５００m）


For Dive #968 & 969
Hydrothermal vent
熱水噴出孔
D=456m
Animals, marker
生物多数
H966-1植木鉢マーカー
D=472m
ハオリムシ+ヒバリガイ
D=464m
Tubeworms and mussels
Hydrothermal vent
熱水噴出孔
D=450m
生物多数
D=447m
Animals
生物多数
D=473m
生物多数
D=472m
Animals
Animals
生物多数
H967-2植木鉢マーカー
D=468m
生物多数
H967-1植木鉢マーカー
D=468m
Animals
Animals
生物多数
H966-2植木鉢マーカー
D=466m
Tube worms
ハオリムシコロニー
D=479m
Top Vent
D=413m
Varnum Vent
D=448m
Yellow Lips
D=381m
小型ユノハナサイト
D=448m
Yunohana crab
Naraku
D=423m
S: 1/2000
(9- 4-)
(NT09-05 Leg2)
HYPER-DOLPHIN
No.968 Dive
No.969 Dive
Nikko-Kaizan
CHAKUTEI
: D=
RITEI
: D=
FUJYOU
:
DATUM
(WGS-84)
XY ORIGIN 23-4.800N 142-19.500E
CENTER 23-4.790N 142-19.560E

1. 13:39 D=400m 中層観察開始 A=55m
(23-04.830N 142-19.527E)
13:39 ﾌﾟﾗﾝｸﾄﾝ採集開始(#1ｹﾞｰﾄｻﾝﾌﾟﾗｰ) Plankton sampling
2. 13:48 D=400m ﾌﾟﾗﾝｸﾄﾝ採集終了(#1ｹﾞｰﾄｻﾝﾌﾟﾗｰ)
(23-04.878N 142-19.519E)
13:50 D=414m ﾌﾟﾗﾝｸﾄﾝ採集開始(#2ｹﾞｰﾄｻﾝﾌﾟﾗｰ) Plankton sampling
3. 13:58 D=420m ﾌﾟﾗﾝｸﾄﾝ採集終了(#2ｹﾞｰﾄｻﾝﾌﾟﾗｰ)
(23-04.827N 142-19.519E)
4. 14:00 D=420m ﾌﾟﾗﾝｸﾄﾝ採集開始(#3ｹﾞｰﾄｻﾝﾌﾟﾗｰ) Plankton sampling
(23-04.813N 142-19.510E)
5. 14:04 着底 D=473m Reached the bottom
(23-04.826N 142-19.538E)
14:04 ﾌﾟﾗﾝｸﾄﾝ採集終了(#3ｹﾞｰﾄｻﾝﾌﾟﾗｰ)
14:13 ｽﾗｰﾌﾟｶﾞﾝによるﾕﾉﾊﾅｶﾞﾆ採集(多数) Crab collection
6. 14:19 D=471m ﾆｽｷﾝ採水(#1)
(23-04.814N 142-19.549E)
14:23 ｽﾗｰﾌﾟｶﾞﾝによるﾕﾉﾊﾅｶﾞﾆ採集(数個体) Crab collection
14:25 D=470m ﾊｵﾘﾑｼ採集(数個体) Tubeworm collection

7. 14:36 D=470m ｲｶﾞｲ・ﾊｵﾘﾑｼ採集(多数) Mussels and tubeworms collection
(23-04.810N 142-19.553E)
8. 14:50 D=466m ｽﾗｰﾌﾟｶﾞﾝによるｳｼﾉｼﾀ採集(多数) Tonguefish sampling
(23-04.802N 142-19.556E)
15:00 ｽﾗｰﾌﾟｶﾞﾝによるﾕﾉﾊﾅｶﾞﾆ採集(多数) Crab sampling
9. 15:18 D=444m 熱水噴出孔視認
(23-04.765N 142-19.575E)
15:24 H969植木鉢ﾏｰｶｰ設置
15:33 Bag採水開始 Water sampling
15:39 Bag採水終了
15:47 岩石片採取(数個) Sampling of rocks
10. 15:49 D=441m 熱水噴出孔多数視認 A=2m Many hydrothermal vents observed
(23-04.763N 142-19.571E)
11. 16:08 D=406m ﾊｵﾘﾑｼ採集(多数) Sampling of tubeworms
(23-04.746N 142-19.599E)
16:10 生物付岩石採取(1個) Sampling of a rock
16:12 離底 D=406m Left the bottom



23° 04.80N

142° 19.50E

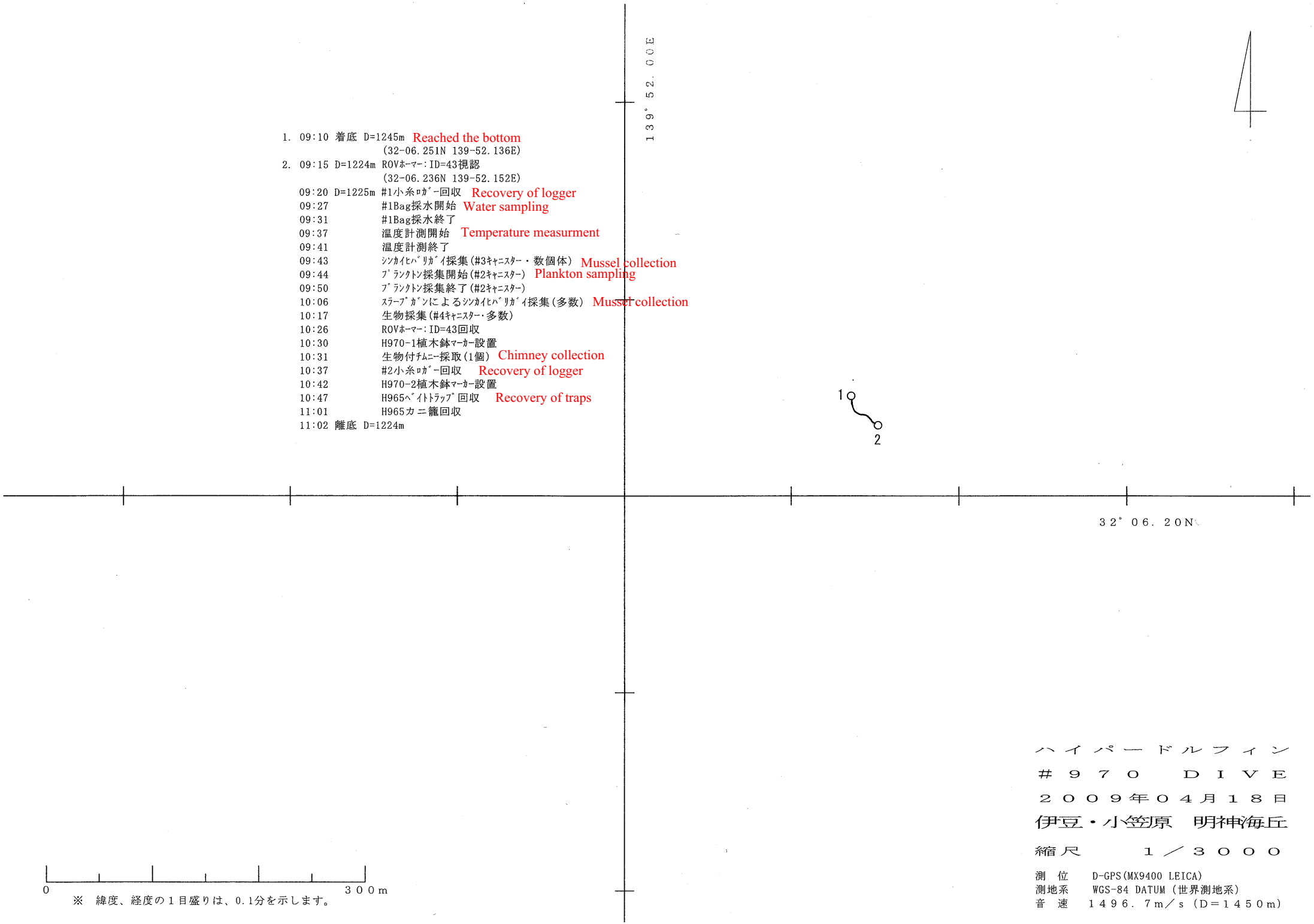
0 200m

※ 緯度、経度の１目盛りは、0.1分を示します。

ハイパードルフィン
＃９６９ ＤＩＶＥ
２００９年０４月１５日
マリアナトラフ 日光海山

縮尺 １／２０００

測 位 D-GPS(MX9400 LEICA)
測地系 WGS-84 DATUM (世界測地系)
音 速 １５２３．６m／s (D＝５００m)



1. 09:10 着底 D=1245m Reached the bottom
(32-06.251N 139-52.136E)
2. 09:15 D=1224m ROVﾎｰﾏｰ:ID=43視認
(32-06.236N 139-52.152E)
09:20 D=1225m #1小糸ﾛｶﾞｰ回収 Recovery of logger
09:27 #1Bag採水開始 Water sampling
09:31 #1Bag採水終了
09:37 温度計測開始 Temperature measurment
09:41 温度計測終了
09:43 ｼﾝｶｲﾋﾊﾞﾘｶﾞｲ採集(#3ｷｬﾆｽﾀｰ・数個体) Mussel collection
09:44 ﾌﾟﾗﾝｸﾄﾝ採集開始(#2ｷｬﾆｽﾀｰ) Plankton sampling
09:50 ﾌﾟﾗﾝｸﾄﾝ採集終了(#2ｷｬﾆｽﾀｰ)
10:06 ｽﾗｰﾌﾟｶﾞﾝによるｼﾝｶｲﾋﾊﾞﾘｶﾞｲ採集(多数) Mussel collection
10:17 生物採集(#4ｷｬﾆｽﾀｰ・多数)
10:26 ROVﾎｰﾏｰ:ID=43回収
10:30 H970-1植木鉢ﾏｰｶｰ設置
10:31 生物付ﾁﾑﾆｰ採取(1個) Chimney collection
10:37 #2小糸ﾛｶﾞｰ回収 Recovery of logger
10:42 H970-2植木鉢ﾏｰｶｰ設置
10:47 H965ﾍﾞｲﾄﾄﾗｯﾌﾟ回収 Recovery of traps
11:01 H965カニ籠回収
11:02 離底 D=1224m

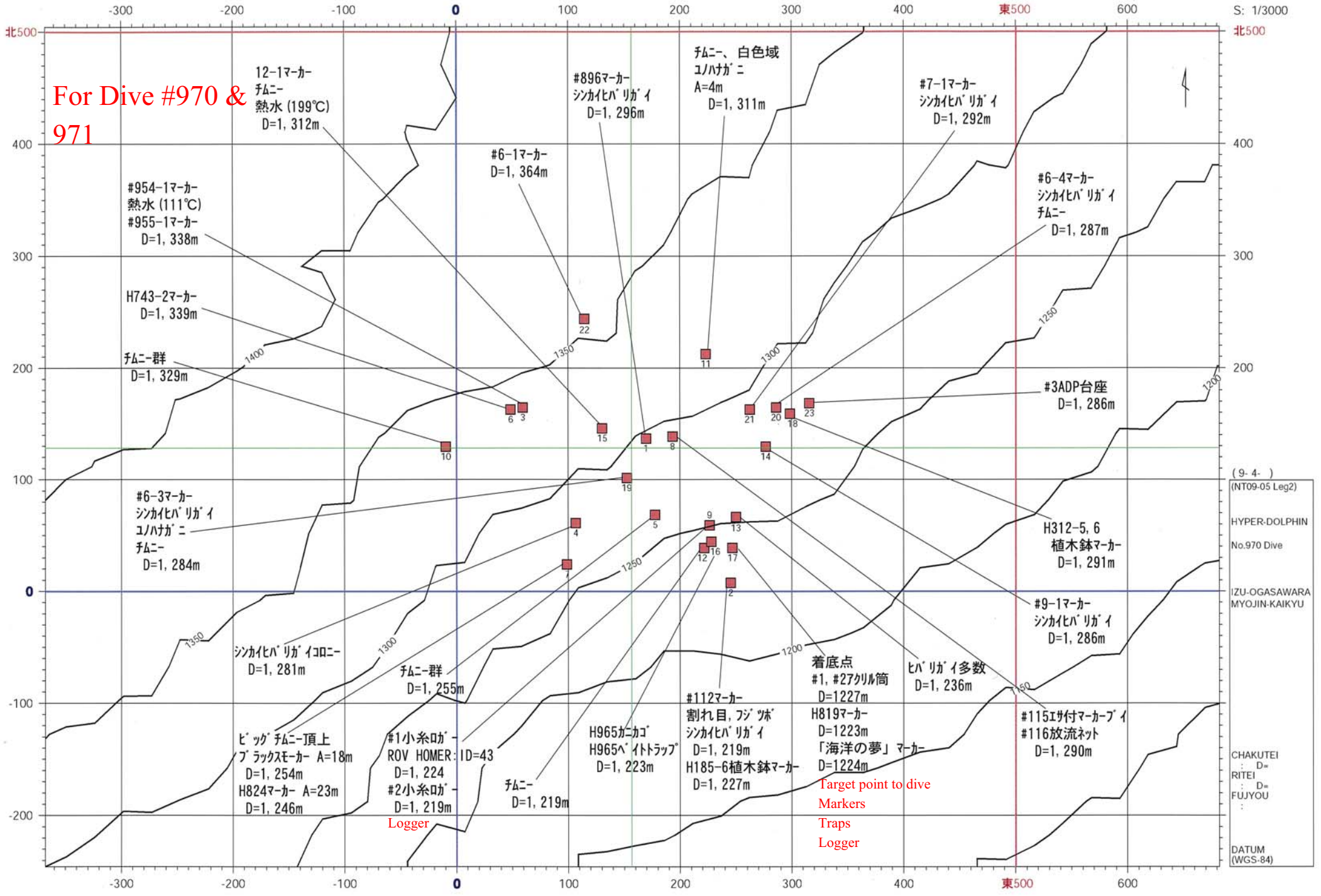
0 300m

※ 緯度、経度の１目盛りは、0.1分を示します。

ハイパードルフィン
＃９７０ ＤＩＶＥ
２００９年０４月１８日
伊豆・小笠原 明神海丘

縮尺 １／３０００

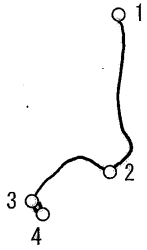
測 位 D-GPS(MX9400 LEICA)
測地系 WGS-84 DATUM (世界測地系)
音 速 １４９６．７m／s (D＝１４５０m)


For Dive #970 & 971
12-1マーカー
チムニー
熱水 (199℃)
D=1, 312m
#896マーカー
シンカイヒバリガイ
D=1, 296m
チムニー、白色域
ユノハナガニ
A=4m
D=1, 311m
#7-1マーカー
シンカイヒバリガイ
D=1, 292m
#6-1マーカー
D=1, 364m
#954-1マーカー
熱水 (111℃)
#955-1マーカー
D=1, 338m
#6-4マーカー
シンカイヒバリガイ
チムニー
D=1, 287m
H743-2マーカー
D=1, 339m
チムニー群
D=1, 329m
#3ADP台座
D=1, 286m
#6-3マーカー
シンカイヒバリガイ
ユノハナガニ
チムニー
D=1, 284m
H312-5, 6
植木鉢マーカー
D=1, 291m
#9-1マーカー
シンカイヒバリガイ
D=1, 286m
シンカイヒバリガイコロニー
D=1, 281m
チムニー群
D=1, 255m
着底点
#1, #2アクリル筒
D=1227m
ヒバリガイ多数
D=1, 236m
#112マーカー
割れ目, フジツボ
シンカイヒバリガイ
D=1, 219m
H185-6植木鉢マーカー
D=1, 227m
H819マーカー
D=1223m
「海洋の夢」マーカー
D=1224m
#115エサ付マーカーブイ
#116放流ネット
D=1, 290m
ビックチムニー頂上
ブラックスモーカー A=18m
D=1, 254m
H824マーカー A=23m
D=1, 246m
#1小糸ロガー
ROV HOMER: ID=43
D=1, 224
#2小糸ロガー
D=1, 219m
Logger
チムニー
D=1, 219m
H965カニカゴ
H965ベイトトラップ
D=1, 223m
Target point to dive
Markers
Traps
Logger
北500
東500
S: 1/3000
(9- 4-)
(NT09-05 Leg2)
HYPER-DOLPHIN
No.970 Dive
IZU-OGASAWARA
MYOJIN-KAIKYU
CHAKUTEI
: D=
RITEI
: D=
FUJYOU
:
DATUM
(WGS-84)
XY ORIGIN 32-6.200N 139-52.000E
CENTER 32-6.270N 139-52.100E

1. 14:21 着底 D=1286m Reached the bottom
(32-06.286N 139-52.185E)
2. 14:37 D=1250m 魚採集(#3ｷｬﾆｽﾀｰ･1個体) Fish sampling
(32-06.238N 139-52.182E)
3. 15:02 D=1225m 生物採集(#4ｷｬﾆｽﾀｰ)
(32-06.229N 139-52.154E)
15:03 ﾌﾟﾗﾝｸﾄﾝ採集開始(#2ｷｬﾆｽﾀｰ) Plankton sampling
15:09 ﾌﾟﾗﾝｸﾄﾝ採集終了(#2ｷｬﾆｽﾀｰ)
15:47 ｴﾋﾞ類採集(#4ｷｬﾆｽﾀｰ･多数) Shrimp collection
15:55 D=1224m #1Bag採水開始 Water sampling
15:58 #1Bag採水終了
16:06 D=1223m ｼﾝｶｲﾋﾊﾞﾘｶﾞｲ(#5ｷｬﾆｽﾀｰ･数個体) Mussel sampling
4. 16:17 D=1222m #2Bag採水開始 Water sampling
(32-06.225N 139-52.158E)
16:21 #2Bag採水終了
16:30 ﾁﾑﾆｰ片採取 Chimney collection
3. 16:48 離底 D=1224m Left the bottom

139° 52.00E

32° 06.20N



0 300m

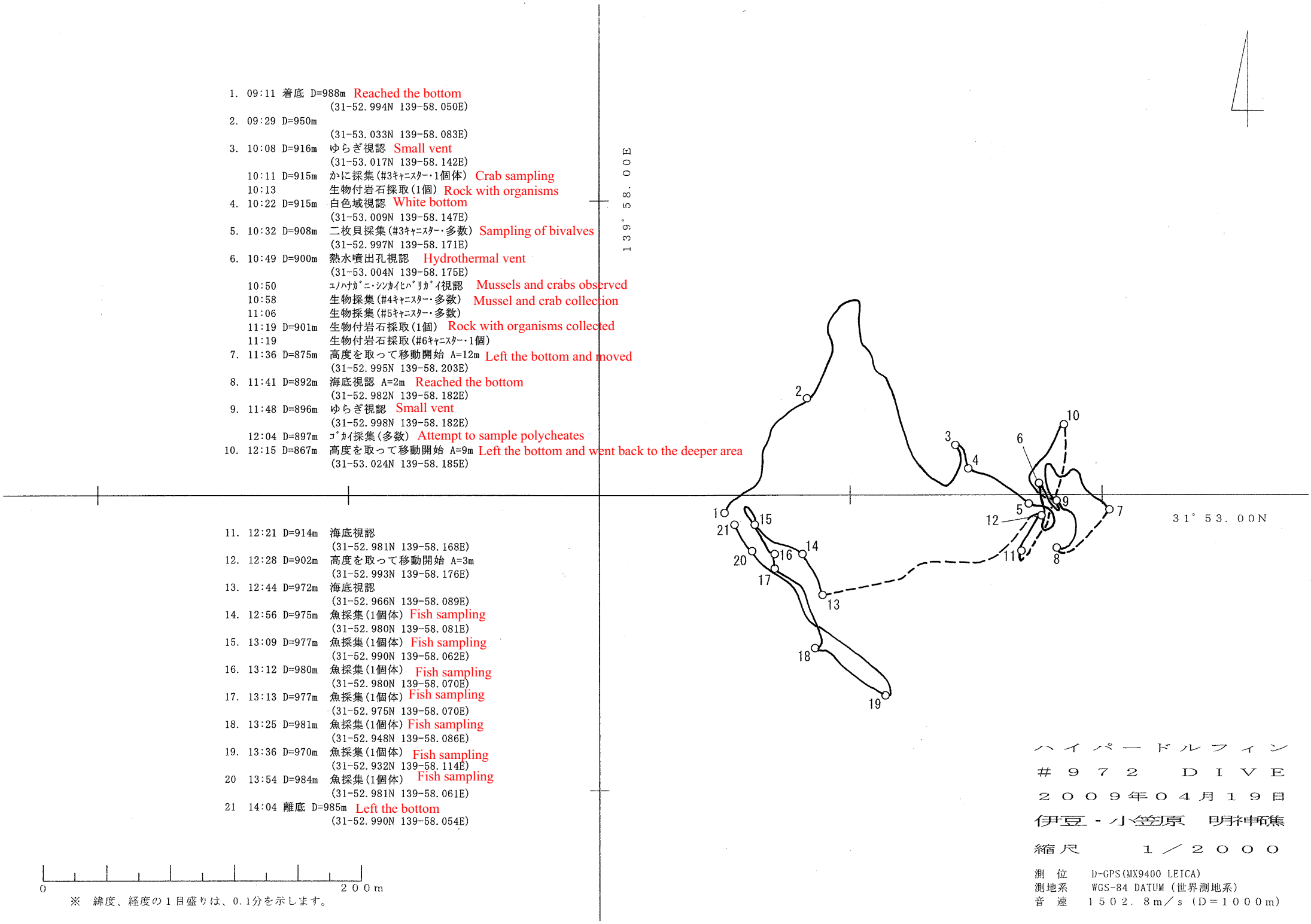
※ 緯度、経度の１目盛りは、0.1分を示します。

ハイパードルフィン
＃９７１ ＤＩＶＥ
２００９年０４月１８日
伊豆・小笠原 明神海丘
縮尺 １／３０００

測 位 D-GPS(MX9400 LEICA)
測地系 WGS-84 DATUM（世界測地系）
音 速 １４９６．７ｍ／ｓ（Ｄ＝１４５０ｍ）

1. 09:11 着底 D=988m Reached the bottom
(31-52.994N 139-58.050E)
2. 09:29 D=950m
(31-53.033N 139-58.083E)
3. 10:08 D=916m ゆらぎ視認 Small vent
(31-53.017N 139-58.142E)
10:11 D=915m かに採集(#3ｷｬﾆｽﾀｰ･1個体) Crab sampling
10:13 生物付岩石採取(1個) Rock with organisms
4. 10:22 D=915m 白色域視認 White bottom
(31-53.009N 139-58.147E)
5. 10:32 D=908m 二枚貝採集(#3ｷｬﾆｽﾀｰ･多数) Sampling of bivalves
(31-52.997N 139-58.171E)
6. 10:49 D=900m 熱水噴出孔視認 Hydrothermal vent
(31-53.004N 139-58.175E)
10:50 ﾕﾉﾊﾅｶﾞﾆ･ｼﾝｶｲﾋﾍﾞﾘｶﾞｲ視認 Mussels and crabs observed
10:58 生物採集(#4ｷｬﾆｽﾀｰ･多数) Mussel and crab collection
11:06 生物採集(#5ｷｬﾆｽﾀｰ･多数)
11:19 D=901m 生物付岩石採取(1個) Rock with organisms collected
11:19 生物付岩石採取(#6ｷｬﾆｽﾀｰ･1個)
7. 11:36 D=875m 高度を取って移動開始 A=12m Left the bottom and moved
(31-52.995N 139-58.203E)
8. 11:41 D=892m 海底視認 A=2m Reached the bottom
(31-52.982N 139-58.182E)
9. 11:48 D=896m ゆらぎ視認 Small vent
(31-52.998N 139-58.182E)
12:04 D=897m ｺﾞｶｲ採集(多数) Attempt to sample polycheates
10. 12:15 D=867m 高度を取って移動開始 A=9m Left the bottom and went back to the deeper area
(31-53.024N 139-58.185E)

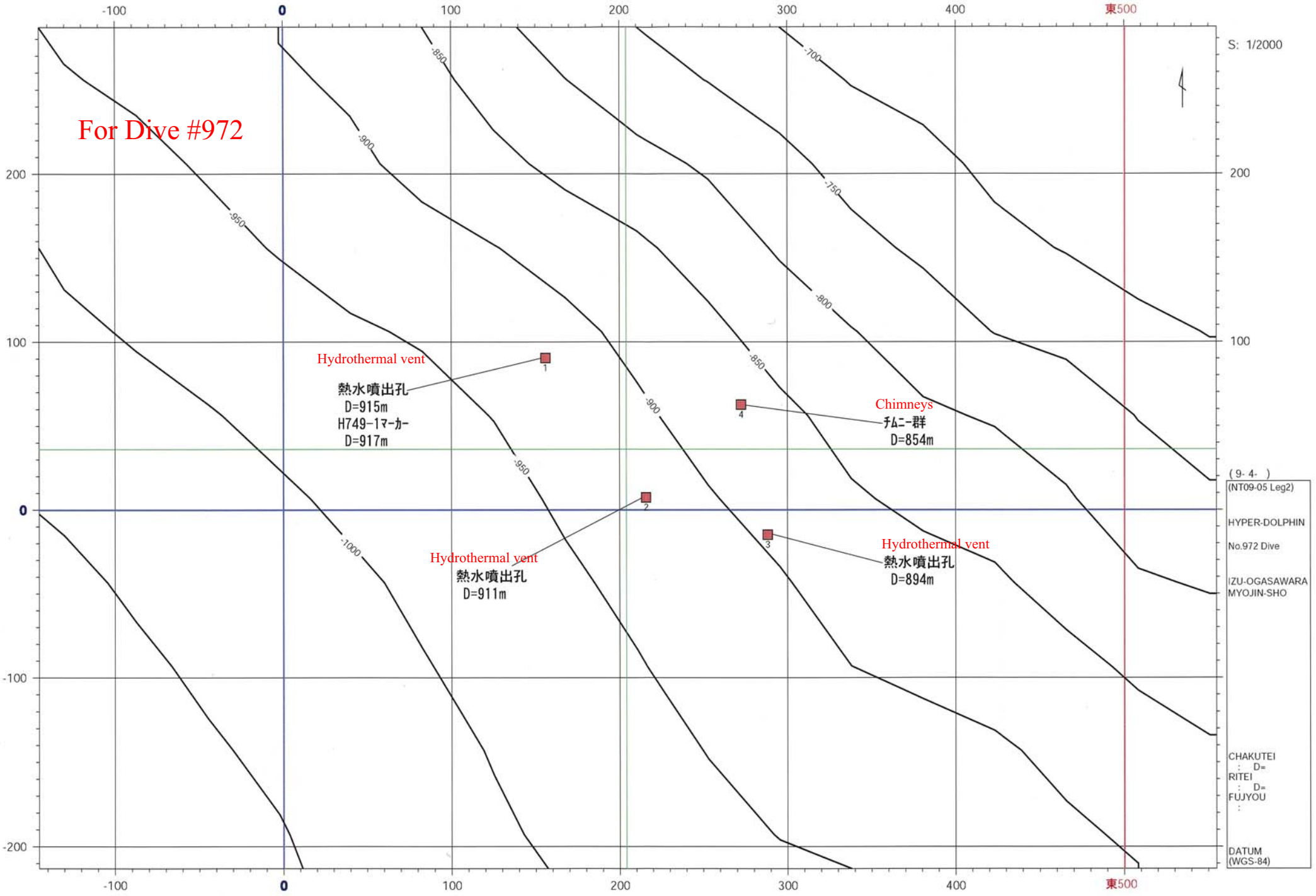
11. 12:21 D=914m 海底視認
(31-52.981N 139-58.168E)
12. 12:28 D=902m 高度を取って移動開始 A=3m
(31-52.993N 139-58.176E)
13. 12:44 D=972m 海底視認
(31-52.966N 139-58.089E)
14. 12:56 D=975m 魚採集(1個体) Fish sampling
(31-52.980N 139-58.081E)
15. 13:09 D=977m 魚採集(1個体) Fish sampling
(31-52.990N 139-58.062E)
16. 13:12 D=980m 魚採集(1個体) Fish sampling
(31-52.980N 139-58.070E)
17. 13:13 D=977m 魚採集(1個体) Fish sampling
(31-52.975N 139-58.070E)
18. 13:25 D=981m 魚採集(1個体) Fish sampling
(31-52.948N 139-58.086E)
19. 13:36 D=970m 魚採集(1個体) Fish sampling
(31-52.932N 139-58.114E)
20 13:54 D=984m 魚採集(1個体) Fish sampling
(31-52.981N 139-58.061E)
21 14:04 離底 D=985m Left the bottom
(31-52.990N 139-58.054E)



※ 緯度、経度の１目盛りは、0.1分を示します。

ハイパードルフィン
＃９７２ ＤＩＶＥ
２００９年０４月１９日
伊豆・小笠原 明神礁
縮尺 １／２０００

測 位 D-GPS(MX9400 LEICA)
測地系 WGS-84 DATUM (世界測地系)
音 速 １５０２．８m／s (D＝１０００m)


For Dive #972
S: 1/2000
-100
0
100
200
300
400
東500
200
100
0
-100
-200
-850
-900
-950
-1000
-700
-750
-800
Hydrothermal vent
熱水噴出孔
D=915m
H749-1マーカー
D=917m
Hydrothermal vent
熱水噴出孔
D=911m
Chimneys
チムニー群
D=854m
Hydrothermal vent
熱水噴出孔
D=894m
1
2
3
4
(9- 4-)
(NT09-05 Leg2)
HYPER-DOLPHIN
No.972 Dive
IZU-OGASAWARA
MYOJIN-SHO
CHAKUTEI
: D=
RITEI
: D=
FUJYOU
:
DATUM
(WGS-84)
XY ORIGIN 31-53.000N 139-58.000E
CENTER 31-53.020N 139-58.130E