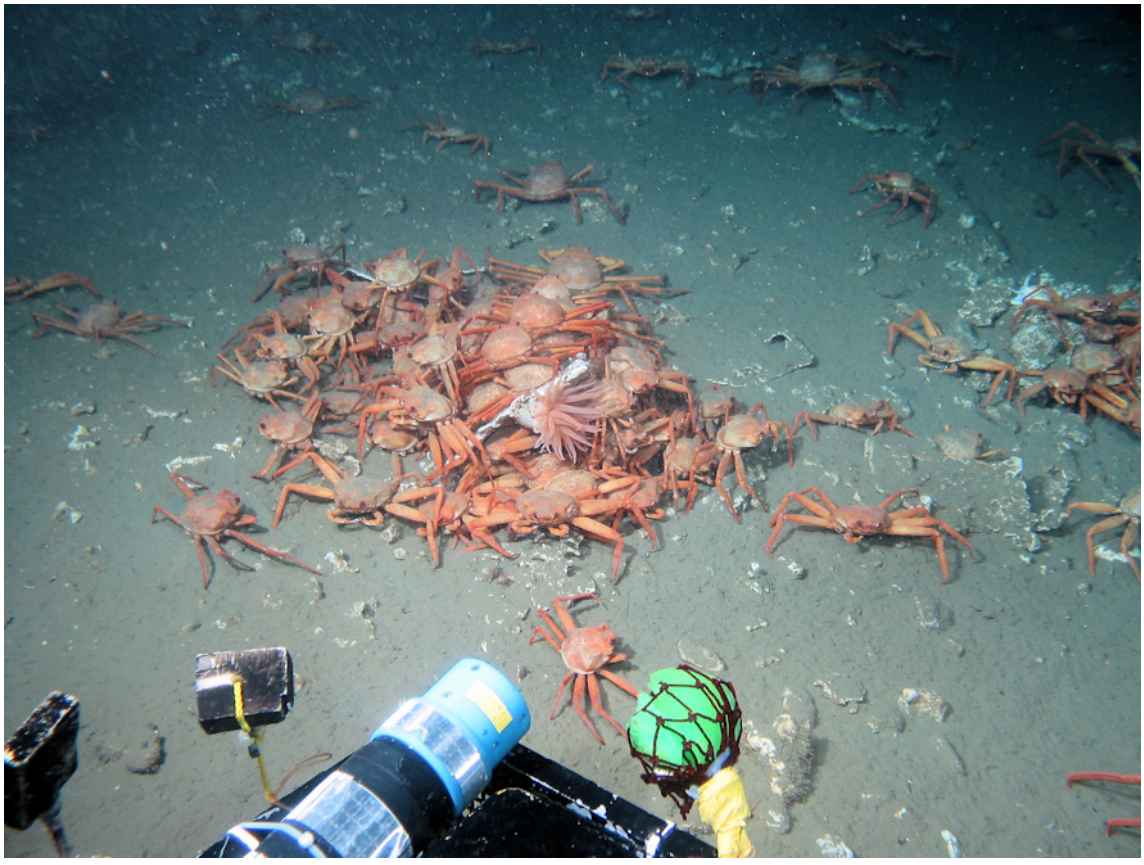
doi : 10.17596/0003346

R/V *NATSUSHIMA* Cruise Report
NT10-10 Leg 2

Japan Sea

– Western Joetsu Basin and Toyama Trough –



June 12 – 21, 2010

Miyako – JAMSTEC

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

Contents

Notice on using

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Users of data or results on this cruise report are requested to submit their results to the Data Management Group of JAMSTEC.

1. Cruise Information

1.1 Cruise ID

NT10-10 Leg 2

1.2 Ship Name

R/V *Natsushima*

1.3 Title of the Cruise

ROV *Hyper-Dolphin* submersible survey

1.4 Title of the Proposal

#1) Hydrological regime and properties of seafloor accumulation and auto-collapse of methane hydrate under high methane flux environment (Proponent: Hideaki Machiyama, JAMSTEC)

#2) Search for a linkage between the BSR and bottom water methane anomalies along the Toyama Deep Sea Channel in Toyama Trough (Proponent: Toshitaka Gamo, AORI, Univ. Tokyo)

1.5 Cruise Period

June 12 – 21, 2010

1.6 Ports of Call

June 12	Departure	Miyako Port, Iwate
June 21	Arrival	JAMSTEC Pier, Yokosuka, Kanagawa

1.7 Research Area

Japan Sea – western Joetsu Basin and the Toyama Trough –

This cruise was carried out in the western Joetsu Basin for the research proposal #1 and the northern Toyama Trough for the research proposal #2 (Fig. 1). The ship track is shown in the Figs. 2 and 3.

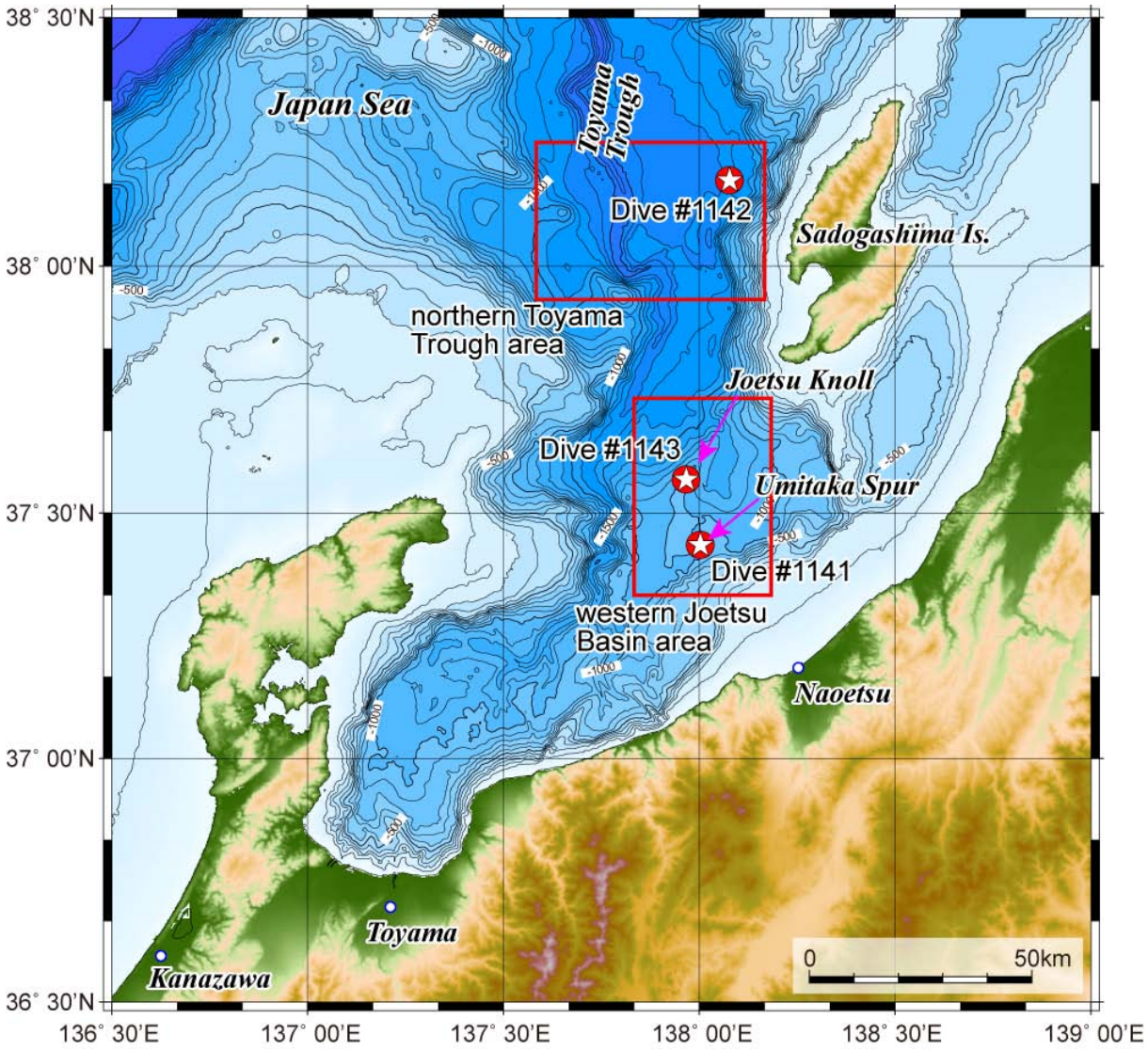

Fig. 1 Index map of the research area and the dive points in the NT10-10 Leg 2 Cruise.

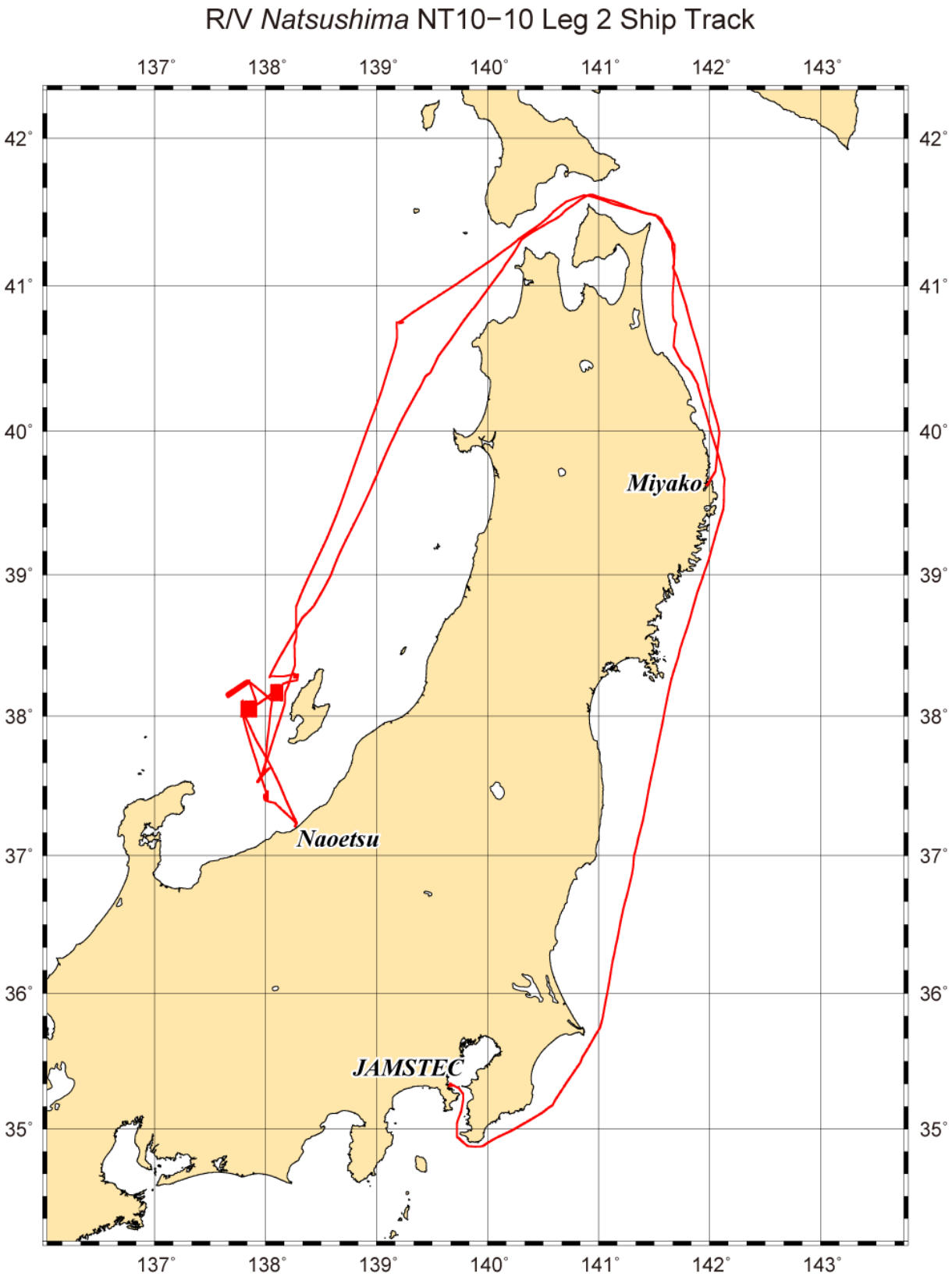

Fig. 2 Ship track map of the NT10-10 Leg 2 Cruise.

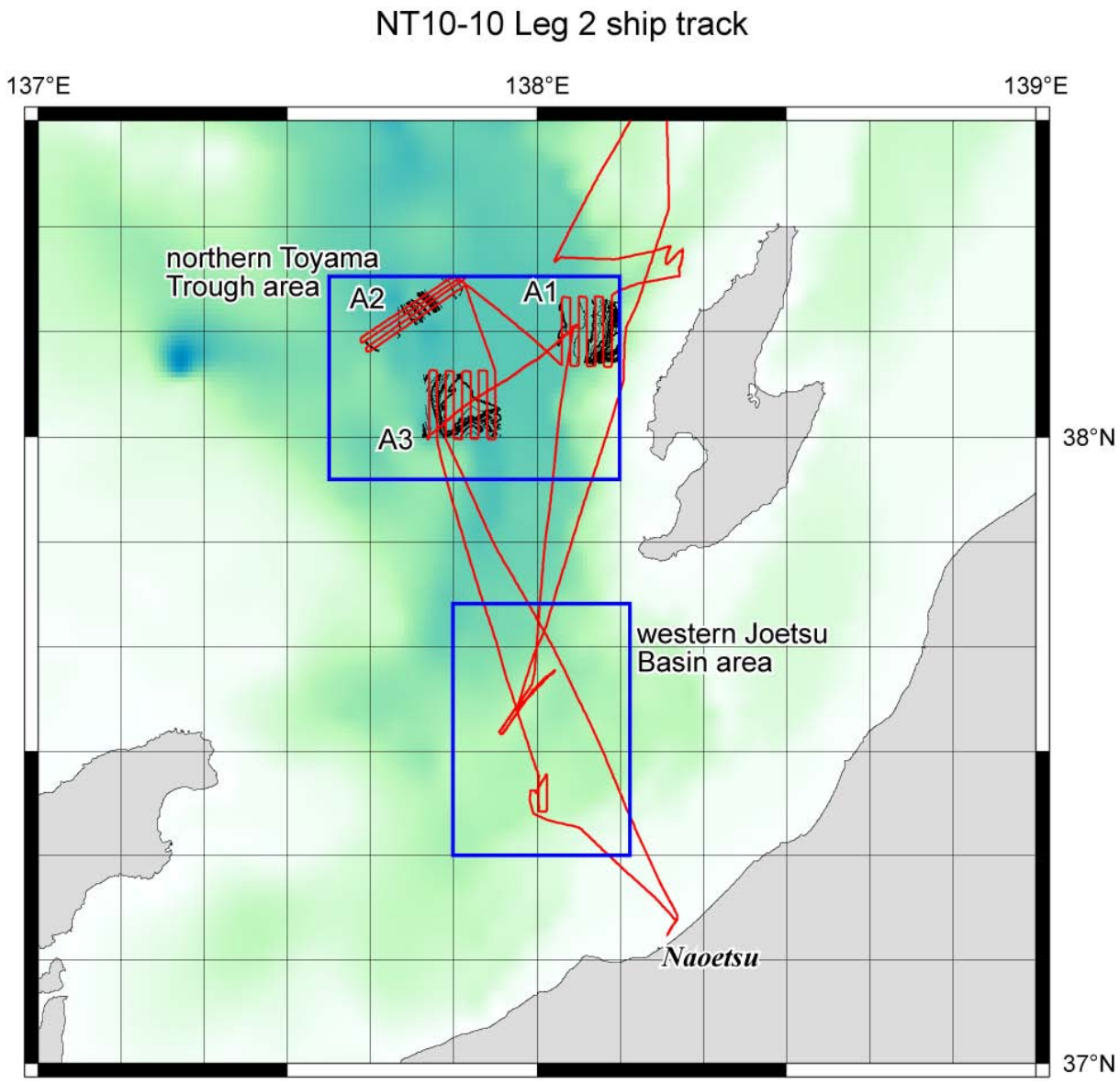

Fig. 3 Detailed ship track and the research area with bathymetry (A1 to A3 area) in the NT10-10 Leg 2 Cruise.

2. Participants

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Vice-chief Scientist

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ROV Operator

Kazuki IIJIMA
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Shigeru KIKUYA
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Chief Officer
Akihisa TSUJI
2nd Officer
Hiroyuki KATO
3rd Officer
Kanto ASAJI
Chief Engnieer
Hiroyuki SHIBATA
1st Engnieer
Koji FUNAE
2nd Engnieer
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Boat Swain
Kingo NAKAMURA
Able Seaman
Kozo YATOGO
Kazumi OGASAWARA
Hideo ISOBE
Yuki YOSHINO
Sailor
Hirotaka SHIGETA
Kosei KAWAMURA
No1. Oiler
Masaru KITANO
Oiler
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Toshikazu IKEDA
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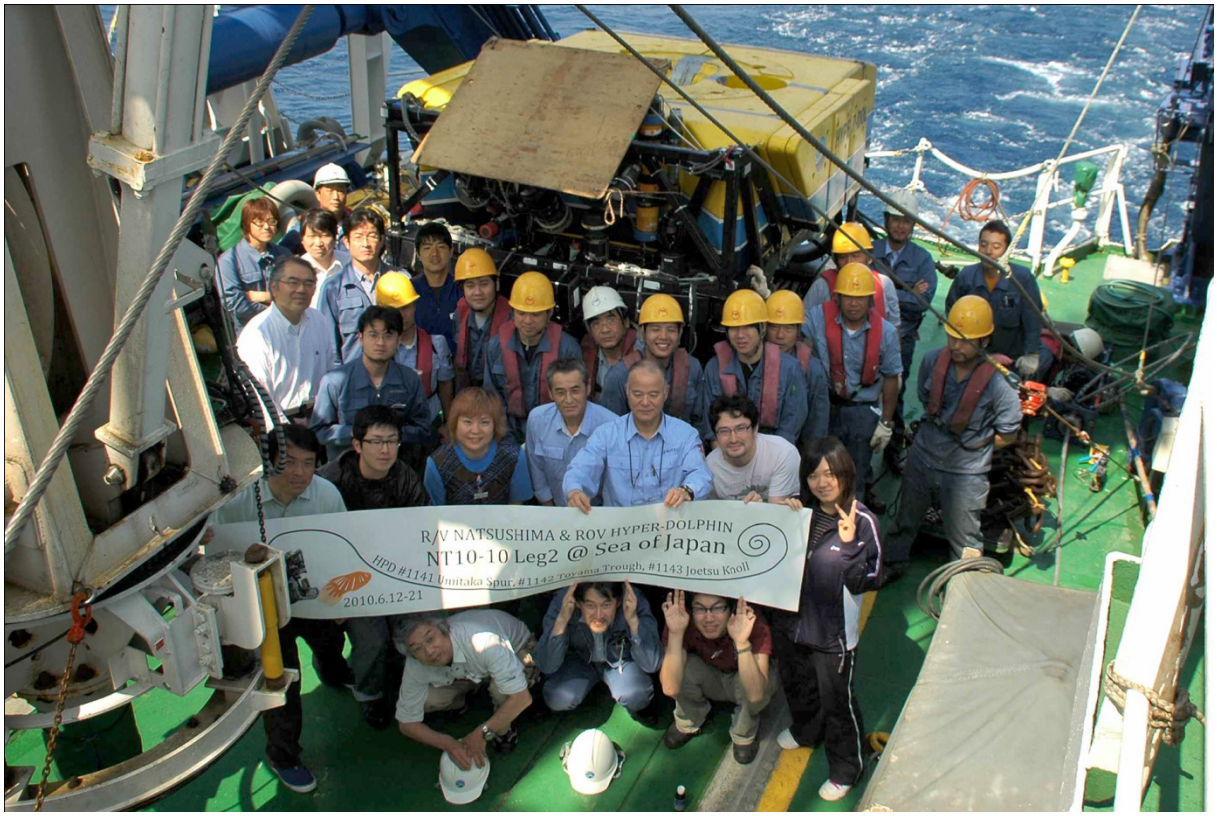
Shin TORAO
Daiki IGARASHI
Taijun IWAO
Chief Steward
Teruyuki YOSHIKAWA
Steward
Shinsuke TANAKA
Kiyotaka KOSUJI
Hiroyuki OBA
Mizuki NAKANO


R/V NATSUSHIMA & ROV HYPER-DOLPHIN
NT10-10 Leg2 @ Sea of Japan
HPD #1141 Umitaka Spur, #1142 Toy-ama Trough, #1143 Joetsu Knoll
2010.6.12-21

3. Cruise Log

Date	Time	Description	Remark	Position/Weather/ Wind/Sea condition (Noon)
June 12	8:00	boarding R/V *NATSUSIMA*		06/12 12:00(LCT) 40-03.0N, 142-04.8E Fog NNW-2(Light breeze) 2(Sea smooth) 4(Moderate average) Visibly: 1'
	9:00	sail out from MIYAKO port to research area	commenced Leg 2 cruise	
	10:00-11:00	Onboard seminar	for safety onboard life	
	13:00-14:00	scientists meeting		
June 13		transit to research area off SADO Is.		06/13 12:00(LCT) 39-38.0N, 138-58.0E Cloudy NE-1(Light air) 1(Sea rippled calm) 1(Low swell short) Visibly: 6'
	19:00-20:00	scientists meeting		
	20:00	arrived at research, Toyama Trough North		
	20:02	released XBT sensor	38-16.8N, 138-02.4E Depth: 1830m	
	21:15	commenced drifting this area		
June 14	4:00	commenced MBES mapping survey		06/14 12:00(LCT) 38-02.0N, 137-44.5E Cloudy NNE-3(Gentle breeze) 2(Sea smooth) 1(Low swell short) Visibly: 8'
	19:00-20:00	scientists meeting		
	23:39	finished MBES mapping survey		
		proceeding to NAOETSU port		
June 15	5:30	bore off NAOETSU port		06/15 12:00(LCT) 37-26.0N, 138-00.0E Fine but cloudy NNE-1(Light air) 1(Sea rippled calm) 1(Low swell short) Visibly: 8'
	05:40-06:10	pick up the cable using traffic boat		
	7:30	arrived at research area		
	8:21	released XBT sensor	37-26.2N, 138-00.1E Depth: 1831m	
	8:29	hoisted up HPD		
	8:33	Launched HPD on sea surface		
	8:44	started HPD#1141 dive		
	9:17	HPD landed at sea floor	Depth: 943m	
	16:21	HPD left the sea bottom	Depth: 903m	
	16:46	HPD floated		

	16:55	Hoisted up HPD		
	17:00	Recovered HPD and finished operation		
	17:27-19:40	carried out survey for methane gas plume		
	19:00-20:00	scientists meeting		
	22:27	MBES survey at area A		
June 16	0:15	finished MBES mapping survey		06/16 12:00(LCT) 38-10.5N, 138-04.5E Overcast NW-5(Fresh breeze) 3(Sea slight) 1(Low swell short) Visibly: 7'
	6:30	arrived at dive point		
	8:00	hoisted up HPD		
	8:04	Launched HPD on sea surface		
	8:15	started HPD#1142 dive		
	9:10	HPD landed at sea floor	Depth: 1783m	
	16:02	HPD left the sea bottom	Depth: 1784m	
	16:49	HPD floated		
	16:59	Hoisted up HPD		
	17:03	Recovered HPD and finished operation		
	19:00-20:00	scientists meeting		
	20:21-23:40	carried out survey for methane gas plume		
	23:45	commenced drifting		
June 17	4:00	commenced proceeding to dive point		06/17 12:00(LCT) 37-34.2N, 137-57.9E Fine but cloudy ESE-2(Light breeze) 1(Sea rippled calm) 1(Low swell short) Visibly: 8'
	6:15	arrived at dive point		
	6:29	released XBT sensor	37-34.2N, 137-57.9E Depth: 1831m	
	8:04	hoisted up HPD		
	8:07	Launched HPD on sea surface		
	8:21	started HPD#1143 dive		
	8:56	HPD landed at sea floor	Depth: 989m	
	16:11	HPD left the sea bottom	Depth: 984m	
	16:40	HPD floated		
	16:47	Hoisted up HPD		
	16:52	Recovered HPD and finished operation		

	17:00 19:00-20:00	commenced proceeding to UBC F.F. point scientists meeting		
June 18	9:00 9:30 10:01 13:55 14:00 19:00	scientist meeting arrived at F.F. point commenced Free Fall of umbilical cable finished F.F. left F.F. point commenced proceeding to YOKOSUKA scientists meeting	40-45.0N, 139-11.6E Depth: 3180m	06/18 12:00(LCT) 40-45.0N, 139-12.6E Cloudy East-3(Fresh breeze) 1(Sea rippled calm) 1(Low swell short) Visibly: 6'
June 19	 13:00	proceeding to YOKOSUKA onboard seminar	Machiyama (JAMSTEC) Takeuchi (Toyama Univ.) Jenkins (Yokohama Univ.)	06/19 12:00(LCT) 39-03.5N, 141-58.2E Cloudy NE-3(Fresh breeze) 2(Sea smooth) 1(Low swell short) Visibly: 4'
June 20	 18:20 18:27	proceeding to YOKOSUKA arrived at YOKOSUKA section 4 stationed for anchoring	35-20.1N, 139-39.8E	06/20 12:00(LCT) 35-04.1N, 140-22.6E Overcast SW-7(Near gale) 5(Sea rough) 3(Moderate short) Visibly: 5'
June 21	9:00	arrived at JAMSTEC quay finished NT10-10 Leg2 cruise		

4. Background and Objectives

4.1 Purpose of the Research Proposal #1

Hydrological regime and properties of seafloor accumulation and auto-collapse of methane hydrate under high methane flux environment

Joetsu Gas Hydrate Field of the western Joetsu Basin in the eastern margin of the Japan Sea is one of the best fields for gas hydrate studies. There are many methane plumes and active methane seeps associated with gas hydrate blocks in the several mounds on the Umitaka Spur and Joetsu Knoll (e.g., Matsumoto et al., 2009). The result of heat flow measurement through nine research cruises in 2004–2008 is summarized in Machiyama et al. (2009). They observed not only extremely high heat flow anomalies but also non-linear temperature profile such as concave/convex profiles and negative geothermal gradients on the mounds. The distribution of high heat flow anomalies and non-linear temperature profiles is important to understand a hydrological regime in the high methane flux area of the Joetsu Gas Hydrate Field.

The main purpose of this research proposal is to clarify the detailed fluid flow around the high methane flux area using multipoint heat flow measurement. The other research purposes are as follows:

1) To clarify the relationship between bottom water temperature fluctuation and the negative geothermal gradient in the Japan Sea Proper Water, we recover the water temperature data logger deployed in the NT09-16 Leg 1 Cruise.
2) To evaluate the amount of free gas in sediments, we conduct in situ measurement using TDR method.
3) To clarify fluid (interstitial water) geochemistry using push coring.
4) To verify the relationship between benthic organisms and methane seeps using stable isotope geochemistry.
5) To evaluate the methane plume activity, we conduct the acoustical survey using SeaBat 8160 (multibeam echo sounder).

Unfortunately, we could not recover the water temperature data logger because of the presence of fishing equipment (crab traps) in the central part of the Umitaka Spur.

References

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Kakuwa, Y., Ogihara, S., Yanagawa, K., Sunamura, M., Goto, T., Lu, H. and Kobayashi, T. (2009) Formation and collapse of gas hydrate deposits in high methane flux area of the Joetsu Basin, eastern margin of Japan Sea. *Jour. Geography*, 118, 43-71.

4.2 Purpose of the Research Proposal #2

Search for a linkage between the BSR and bottom water methane anomalies along the Toyama Deep Sea Channel in Toyama Trough

The purpose of the study is to search for a linkage between the bottom simulating reflector (BSR) in seismics and bottom water methane anomalies geochemically detected along the Toyama deep-sea channel in Toyama Trough.

This research project aims firstly to specify the sub-bottom source of supply of methane plume detected with the previous observations of marine chemistry during the ‘Tansei-maru’ cruise. Our target areas were selected carefully based on characteristics of detailed geomorphology and seismic prospecting data as well as the experience that we found the outcrops of pure methane hydrate in the previous research, NT06-19 Leg 1. The second aim is to find places of cold water seepage which discharge biogenic methane in origin different from the thermogenic as was found in the coastal area in the southern Toyama Trough, including the JOGMEC basic prospecting area ‘Sado Nansei-oki’.

5. Methods and Instruments

We used SAHF (Stand-Alone Heat Flow meter) in all diving surveys and TDR (Time Domain Reflectometry) sensor in Dive #1141 and #1143. The explanations of these instruments are as follows.

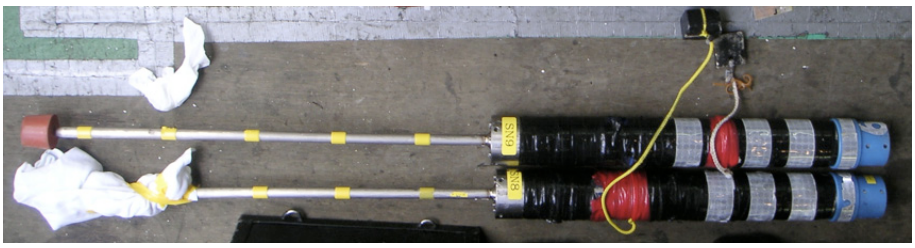
5.1 SAHF

Instrument

We use Stand-Alone Heat Flow meter (SAHF), designed to measure sub-seafloor temperature gradients and thermal conductivity with manned submersibles or ROVs (Fig. 4; Kinoshita et al., 2006). The pressure case contains an electric circuit including a data logger, tilt meters, a magnetic switch for emitting heat pulses, and a Li-ion battery pack. A serial port is emplaced at the upper side of the case. A pilot lamp outside the case informs the timing of temperature recording. The probe includes five thermistors with an 11 cm interval. A heater is situated close to one of the thermistors for emitting a heat-pulse. Table 1 gives a brief description for SAHF #8 and #9, which we used in the present cruise.

SAHF's measurement is “off-line” (requiring no electrical/mechanical connections with ROVs) so that it gives an operators time to conduct other operations during the measurement. SAHF can measure in situ thermal conductivity by the heat pulse method, in which a pulse of heat is emitted from a heater installed within the probe (the decay of temperature gives an estimation for the thermal conductivity).

(a)



(b)

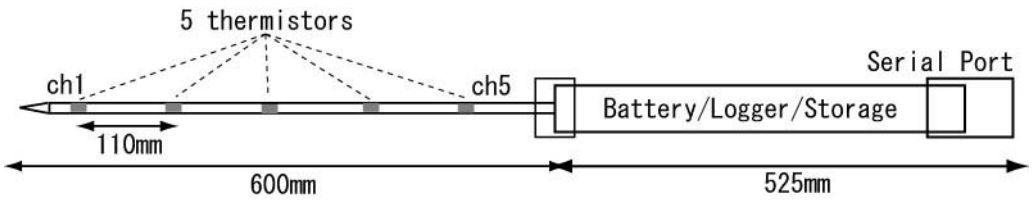


Fig. 4. (a) A photograph of SAHF #8 (lower) and SAHF #9 (upper). (b) Schematic diagram of SAHF #8 and #9.

Table 1 Specification of SAHF #8 and #9.

Material	Alloy of titanium
Weight	3.0 kg in air, 1.5 kg in seawater
Length of pressure case	525 mm
Diameter of pressure case	58 mm
Length of probe	600 mm
Diameter of probe	13.8 mm (filled by silicon oil inside)
Number of thermistors	5
Intervals of thermistors	110 mm
Accuracy	0.01 °C
Resolution	0.001 °C
External Interface	RS232C (9600BAUD, 8 BIT, Non-Parity, 2 STOP BIT)

Operation

When *Hyper Dolphin* (HPD) descends or ascends, SAHF is kept in its sample basket. After HPD lands on seafloor, SAHF is handled by the HPD's manipulator.

In this cruise, only temperature measurements are done, and thermal conductivity is not measured in situ. For each measurement, SAHF first records the reference bottom-water temperature for 2 to 5 minutes, and then pushed vertically into the sediment. The reference temperature measurement is skipped, when the location of the heat flow measurement is close to the previous location. If the penetration cannot insert at least four thermistors, re-penetration is done. The measurement of sub-seafloor temperature gradient takes 15 to 20 minutes in order to obtain reliable data

References

Kinoshita, M., Kawada, Y., Tanaka, A. and Urabe, T. (2006) Recharge/discharge interface of a secondary hydrothermal circulation in the Suiyo Seamount of the Izu-Bonin arc, identified by submersible-operated heat flow measurements. *Earth and Planet Science Letters*, 245, 498-508.

5.2 TDR Sensor

Time Domain Reflectometry (TDR) method is for measuring dielectric constant is lead with using the velocity of electromagnetic wave, and electrical conductivity is lead with damping of electromagnetic wave. Each material has specific dielectric constant such as water is around 80, soil is 3 to 9, and air is 1. We have to calculate bulk density of soil for separating soil. Then we estimate amount of gas in sea floor. TDR equipment (TDR100, Campbell products) and data logger (CR1000, Campbell products) are used for measurement. A TDR probe as a TDR censor is connected with TDR100 by coaxial cable. The gripe on the top of the TDR probe is for the ROV's arm to grab it for TDR probe to insert into sea floor. Probe's rod is covered by epoxy's coating and a heat contraction tube.

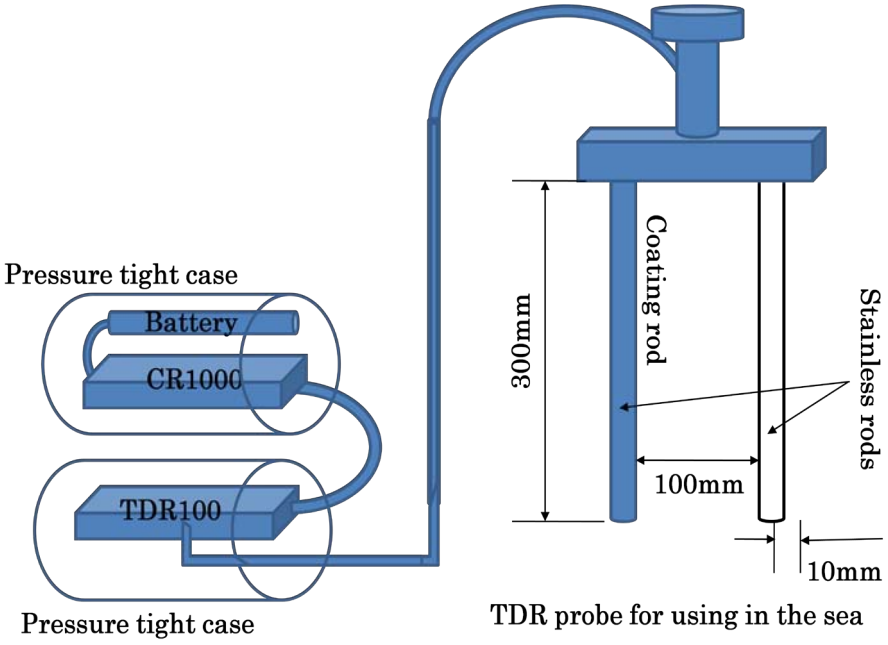
In the NT10-10 Leg 2 Cruise, TDR probe was set in a case at the right side of basket, and TDR100 and CR1000 were set at right side of ROV *Hyper-Dolphin* (HD) (Fig. 5). When HD landed on sea floor, TDR probe was grabbed by HD's manipulator on the right side, and was inserted vertically into sea floor (Fig. 6). Measurement times are for 2 minutes.

TDR censor

Material	stainless rods, acrylic stand, and stainless head
Weight	2kg in air
Length	50cm

Pressure tight cases (TDR100 & CR1000)

Material	Titanium
Weight	30kg in air
Size	20cm of diameter, and 30cm long
External Interface	RS232C



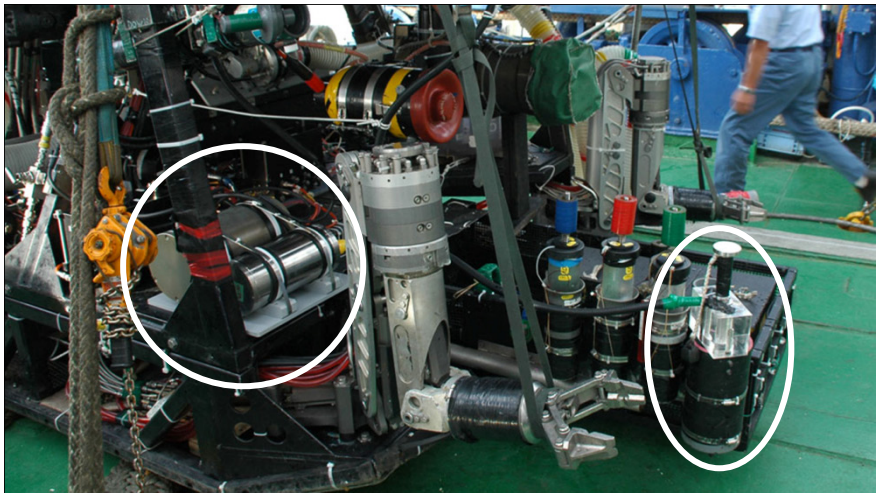


Fig. 5 Location of TDR Sensor with Hyper-Dolphin.

Fig. 6 TDR sensor into the seafloor by manipulator

6. Preliminary Results

6.1 Bathymetric Survey in the North-Central Toyama Trough

On 14-15th June 2010, NT10-10 Leg2 conducted the Multi-narrow beam echo sounding (MBES) utilizing the SeaBat8610 system within the rectangular area enclosed by the coordinates 37°56.0'N, 137°35.0'E, 38°15.0'N, 138°10.0'E. In the survey box three subarea, A1, A2, and A3 are filled with 0.5 to 1.0 miles interval of swaths. The system also acquires back-scattering data available to visualize as side scan sonar image.

This bathymetric investigation aims mainly to map any tectonic morphology.

The resultant bathymetry is illustrated in Figure 7.

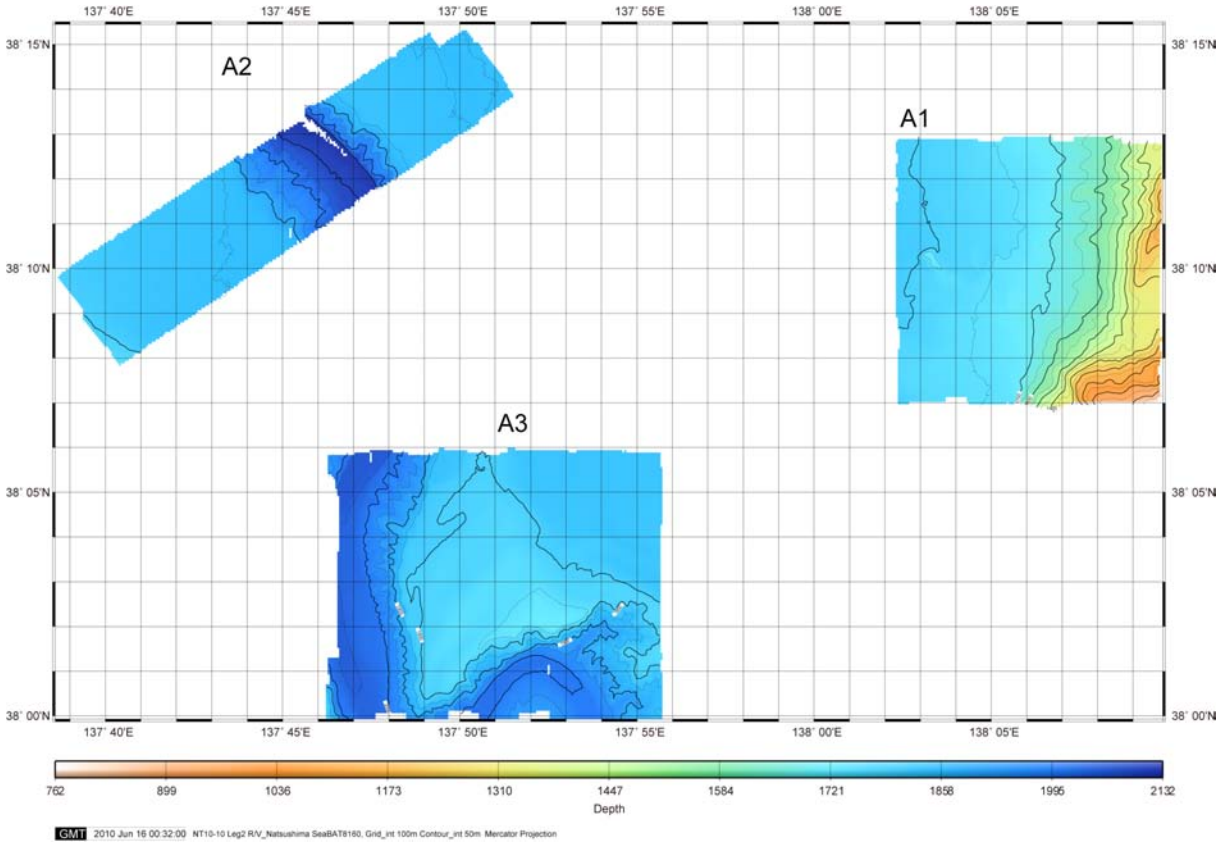


Fig. 7 Compiled bathymetric maps in the survey box A, NW offing Sadogashima.

The following aspects are pointed out.

(1) In the survey area A1 more than eighty two spots of strong back-scattering were recognized. Some source materials such as chemosynthesis livings, carbonate crusts, pock marks bared sandy and/or gravel-rich seabed, buried gas-hydrate dome, etc. are estimated during the MBES survey.

(2) The survey area A2 is a reference site for the sea-truth survey of back-scattering of the MBES system. The reflection pattern is smooth and flat and no reflective spot was observed. Bathymetry depicts asymmetrical profile of the Toyama deep-sea channel, whose wall display corrugation of numbers of erosion gullies and inclined stratification. On the sedimentary flat, superposed crescents of several old flowages were obviously imaged.

(3) The survey area A3 performs the remarkable meander of the Toyama deep-sea channel. Attacked side of the channel walls illustrates apparently horizontal stratification, whereas gliding slope and out-flown levee field display weak fabric of back scattering where several old flowages are recognizable. The previous submersible dives by “Shinkai 2000”, observed many steps of fluvial terraces with gravel beds in the gliding slope at the center of kinked channel. We conclude that the back-scattering from ordinary gravel beds is not so strong relative to the strong reflective spot.

6.2 Methane Plume Survey in the Western Joetsu Basin

Acoustic methane plume survey using SeaBat 8160 (multibeam echo sounder) was carried out in this cruise. The purpose of this survey is to evaluate the methane plume activity and its secular change by a repeated survey. Previous observation through the research cruises in 2004 – 2009 show the presence of many extensive methane plumes around the mounds on the summit of the Umitaka Spur and the Joetsu Knoll (Aoyama et al., 2005; Matsumoto et al., 2009). Two survey lines were set up on each summit (Fig. 8). Comparing investigation will be carried out after cruise.

References

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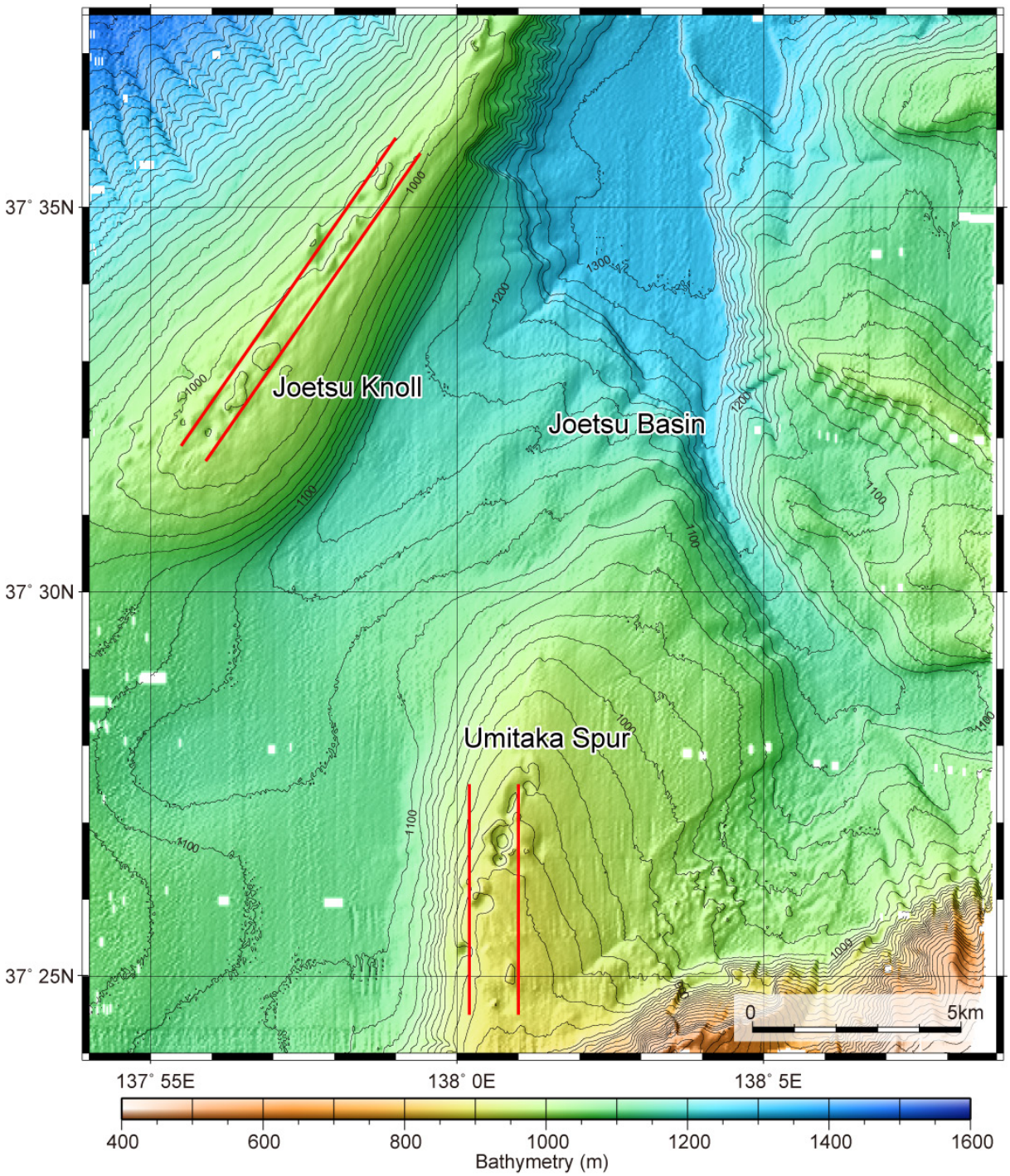


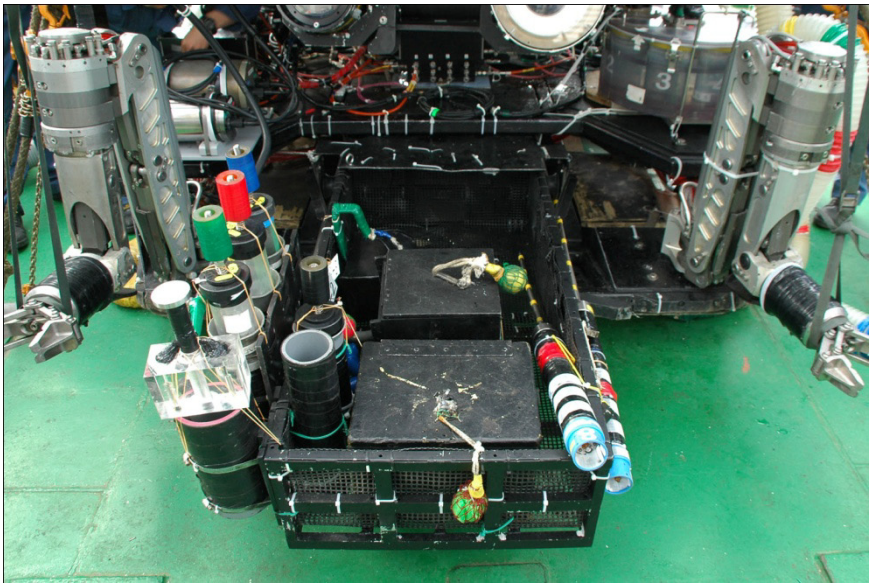
Fig. 8 Map showing acoustic methane plume survey lines on the Umitaka Spur and the Joetsu Knoll.

6.3 *Hyper-Dolphin* Submersible Survey

6.3.1 Dive #1141 (Umitaka Spur)

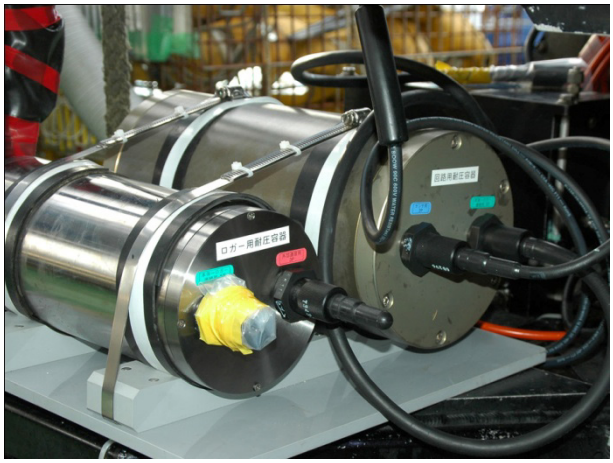
Payload

MBARI type push corer x4 (Blue, Red, Green, Black)
SAHF x2
TDR sensor x1
Slurp Gun with 6 canister bottles x1
Sampling box (small) x2
Kumade (all covered) sampler x1
Marker buoy x3

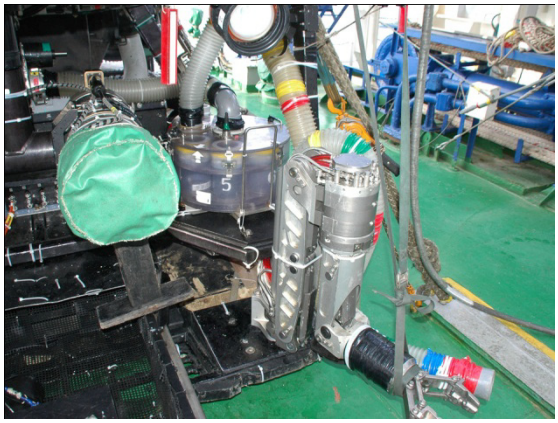


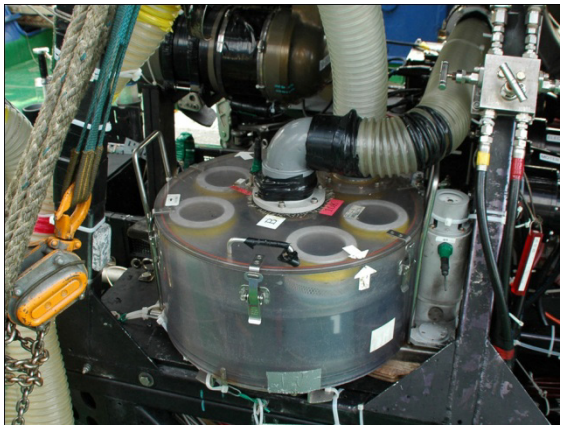
Payloads around sample basket for Dive #1141. MBARI push corers are attached to the basket at left side. The empty bottle (left front side) is for keeping a SAHF.

Photographs of MBARI type push corers and TDR sensor (having transparent acryl cubic).

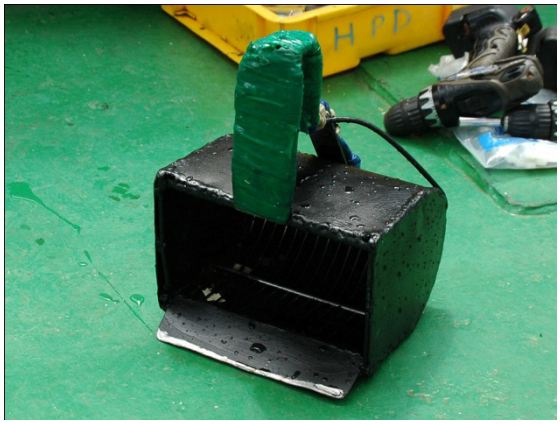


Above: Data logger for TDR sensor. It is located behind the sample basket. Right: Close up photograph of TDR sensor.





Left: Slurp Gun with 6 canister bottles system. Right: Close up photograph of 6 canister bottle system. This, each canister bottles were sealed by mesh cover.



Left: KUMADE sampler. All covered type. Right: Two small sample boxes.

ハイパードルフィン　潜航記録

平成 22 年　NT10-10　行動　　記載者　飯嶋 一樹

潜航年月日　2010/06/15
潜航回数　3回
通算潜航回数　1141回

位置　作図中心位置
緯度　37° 26.100 ' N
経度　138° 00.200 ' E
WGS-84

潜航海域　日本海　上越海盆西部

潜航目的　調査潜航　「高メタンフラックス下での表層型メタンハイドレートの集積・自己崩壊過程における流体挙動の解明」

調査主任　町山 栄章
ピークル指揮　光藤 数也

Pilot　飯嶋 一樹
Co. Pilot　石塚 哲也

作業経過時刻	
吊揚	08:29
着水	08:33
潜航開始	08:44
着底	09:17
離底	16:21
浮上	16:46
揚収完了	17:00

累計時間		
潜航時間		8:02
通算潜航		5305:31
ケーブル	ケーブルNo.	4
	使用時間	8:31
	通算時間	346:28

気象・海象

天候	風向	風力	風浪	うねり	視程
bc	NNE	1	1	1	8

最大潜航深度　943 m
着底深度　943 m
着底底質　泥

離底深度　903 m
離底底質　泥

記事　海底を観察しながら航走し、生物採集・岩石採取・採泥およびSAHF・TDRによる計測を実施した。

Hyper-Dolphin Dive Log

Dive Number : HPD#1141 (Umitaka Spur) **Date : 2010/06/15**

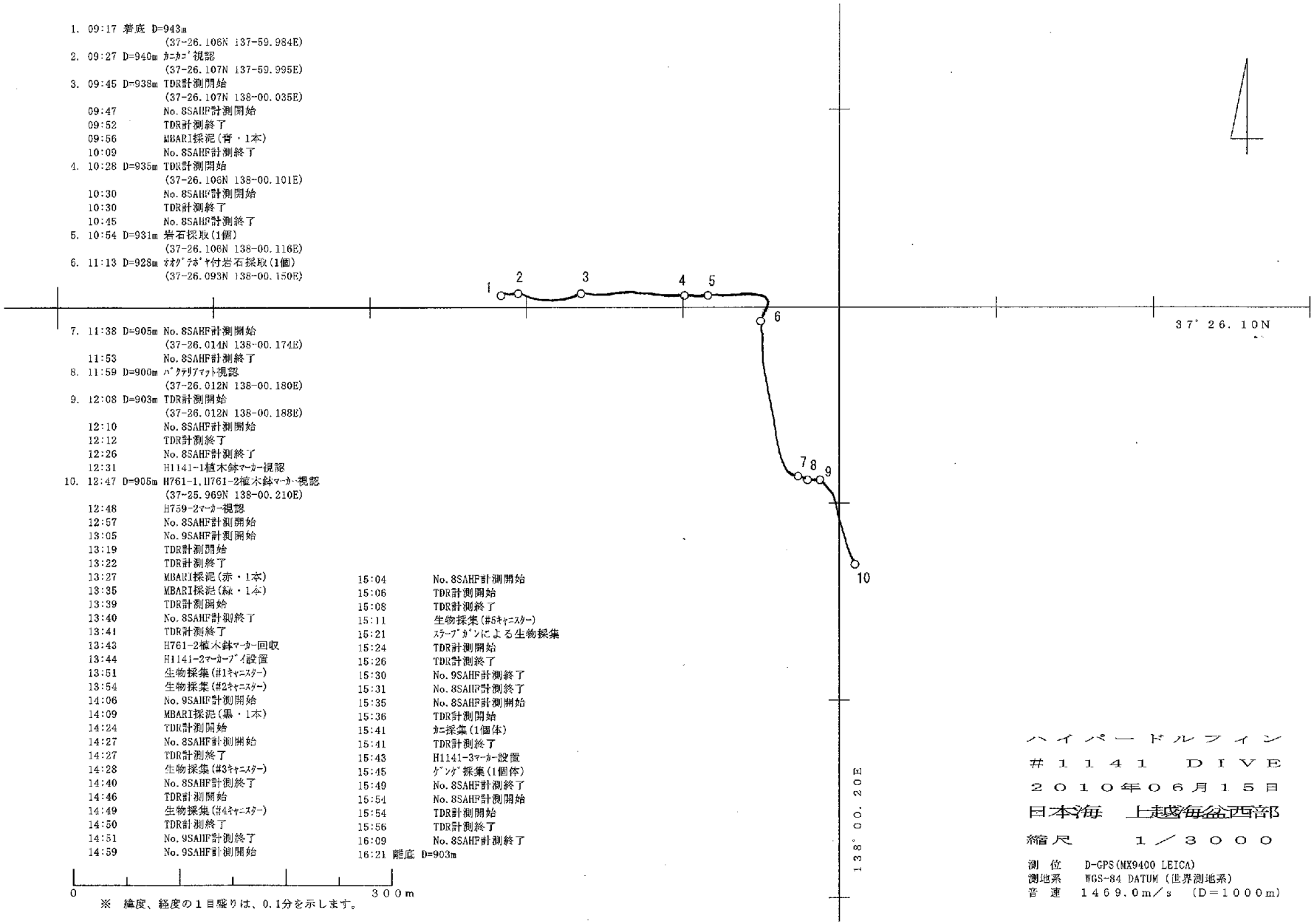
Time (LCT)	Dep. (m)	Alt. (m)	Head (Deg)	Description	Remarks (position)
08:44				Start diving	X, Y
08:58				Okiami shrimps (zooplankton)	
09:17				Arrive at bottom, genge fish, traces of living(shrimps?)	10.1, -
09:19	943.7	0		jellyfish	
09:20				sea anemone? on the garbage	
09:22			90	move for take photos the garbage	
09:24				take the photo(seamax), sponges	
09:25			97	start running	
09:26				wasted trap, crab, sea anemone, sponges	10, -298
09:27				kajika fish	
09:28				crab	
09:30				genge, starfish	27, -252
09:31	938			shrimp	8.5, -269
09:35	937.5	0.9	90	shrimps	11, -242
09:36				trace of shells	
09:37	938		92	stop running	9.5, -247.2
				check SAHF	
09:45				start TDR	
09:46				start SAHF No.8	
09:50				gokai worm, ami shrimps	
09:52				crab	
09:52				finish TDR	
09:55				sample MBARI blue	
09:57				start obsevation of crab	
10:08				finish SAHF No.8 (20 minutes)	
				start running	
10:13				zoarcid	
10:17				jelly fish	
10:19				bai , ebi ,star fish, zoarcid	
10:20				hikizuttaato	15.2,-
10:22				star fish	
10:24				sea anemone	
10:25	935		95	stop running	9.7,-147.8
10:28				start TDR	
10:29				start SAHF No.8	
10:30				finish TDR	
10:32				bai	
10:33				zoarcid child	
10:34				something broken	
10:36				zoarcid parent	
10:38				Okiami mit	
10:40				lump	
10:45				finish SAHF No.8 (15 minutes)	
10:46				bury	
10:47				crab	
10:48				curst	
10:49	934		94	stop running	8.4,-120.3
10:51				start SAHF No.8	
10:52				open sample box	
10:53				sampling rock	
10:54				finish SAHF	
10:55				start running	
10:58	930		96	matto	9.9,-82.2
11:01	927		97	hone?, ooguchi-hoya, ebi	4.2, 87.3

Dive Number : HPD#1141 (Umitaka Spur) **Date : 2010/06/15**

Time (LCT)	Dep. (m)	Alt. (m)	Head (Deg)	Description	Remarks (position)	
11:05			181	genge		
11:06	928		176	isoginnchaku, genge, kani, ooguchi-hoya,		11.2,72.4
11:11	928		183	samplimg ooguchi-hoya1, temae no box he		12.5, 73.3
11:14			175	isoginn-chaku		
11:14	924		175	genge, 3.		35.8, 70.3
11:16	919			3 genge		
11:18	917		175	kani, nimai-gai (oona-gai), ei		73.9,70.9
11:19	915	1.3	175	genge		
11:20	914			kajika, genge		
11:21	913			kurage, gennge		
11:23	911		122	genge, nimai-gai		137.2,
11:23	907		159	ganseki-hen, kajika, isoginn-cyaku		132.9,
11:26				kabo-nete-kurasuto, kani, nimai-gai		153.3,
11:27	909		183	tako		158.5,52.2
11:29	909		183	oona-gai		154.4,52.5
11:31	907	1.4	127	genge(takusan), kani, shiroi-hone?kakeraooi		159.1,
11:34	906	0.6	127	isoginn-chaku, tyakutei		160.3,
11:37	905	0	129	Start SAHF No.8		156.9,
11:40	905		131	kaiteikannsatsu-kaishi, kai		151.9,
11:42	905	0	131	isogin-chaku(takusan), kabonete-kurasuto, genge		151.3,
11:45	905	0	131	bakuteria-matto (mizu-ga-deteiru)		152.8,
11:58	905	0	130	Finish SAHF		
11:58	900	1.6	147	Crab		
12:00	900	0.9	146	bakuteria-matto		162.2-28.2
12:06		0	142	TDRstart,SAHF 8reference		
12:08	903	0.6	141	startSAHF8naname		164.7,17.5
12:13	903	0.6	141	Finish TDR		
12:19	903	0	141	isogincyaku,kani,sakana		
12:25	903	0	141	Finish SAHF8		
12:30	903	0	142	ika,tako		173.1,11.4
12:30	903	0.7	143	suionn-kei set		
12:38	900	1.3	180	kani(many),kurage		284.2,3.1
12:40	900	1.7	180	bakuteria-matto		214.2,8.4
12:42	900	1.5	165	oona-gai		220.8,8.5
12:45	902	1.7	179	bakuteria-matto (small),uekibachi-marker(H761-1,H761-		242.5,13.7
12:50		0	179	kurage		
12:51		0	179	SAHF8 reference		
12:56	904	0	179	StartSAHF8 (near-H761-1)		244.8,19.4
13:04	904	0	180	StartSAHFS9(nearH761-1)		240.2,15.4
13:18	904	0	55	Set TDR between SAHFs		236.9,14,2
13:22	905	0	55	Finish TDR(many crabs around)		
13:26	906	0	55	MBARI (red)		241.8,14,7
13:31	906	0	55	MBARI (green)		240.6,14,1
13:38	906	0	55	Set TDR near SAHF9		244.0,17.9
13:40	906	0	55	Finish SAHF8		
13:41				Finish TDR		
13:43				Take in H761-2		
13:44				Set H761-2 near H761-1		
13:48	905	0	53	Finish SAHF9		244.8,19.5
13:50	906	0	53	slurp canister-No.1		
13:51				slurp canister-No.2	X	Y
14:06	905	0	48	Start SAHF9	-240	22.5
14:08				sample MBARI (black)		
14:20				observe positions of SAHF and markers, take the photos		

Dive Number : HPD#1141 (Umitaka Spur) **Date : 2010/06/15**

Time (LCT)	Dep. (m)	Alt. (m)	Head (Deg)	Description	Remarks (position)	
14:24	905			start TDR	-238.7	18.8
14:26				start SAHF No.8		
14:27				finish TDR		
14:28				slurp mud to canister-No.3		
14:40				finish SAHF No.8		
14:46				start TDR	-236	17
14:48				slurp mud to canister-No.4		
14:50						
14:54				finish SAHF No.9		
14:59	904	0	119	Start SAHF No.9	-236	17
15:01	904	0	119	bacteria mat, crab	-242	18.8
15:03	905	0	120	Start SAHF No.8, Zoarcid	-242	18.8
15:07	905	0.6	124	start TDR	-242	18.8
15:08	905	0	124	Finish TDR, Zoarcids	-242	18.8
15:10	905	0	124	Slurp Gun, suck mud	-242	18.8
15:15	905	0	125	Slurp Gun, suck mud to maximum	-242	18.8
15:21	905	0	125	Slurp Gun finished	-242	18.8
15:24	905	0	125	Strart TDR	-242	18.8
15:26	905	0	125	TDR finished	-242	18.8
15:30	905	0	125	Finished SAHF No.9	-242	18.8
15:34	905	0	133	Start SAHF No.9	-242	18.8
15:36	905	0	122	Star TDR	-242	18.8
15:40	905	0	122	sampled a crab and put it in the basket	-242	18.8
15:41	905	0	123	put the marker No.3	-242	18.8
15:45	905	0	125	Slurp gun sampled a Zoarcids(gen ge)	-242	18.8
15:49	905	0.5	124	Finished SAHF No.8	-242	18.8
15:53	905	0	131	Start SAHF No.8	-242	18.8
15:55	905	0	131	Finished TDR	-242	18.8
15:59				zoarcid		
15:59				crab		
16:09	905		147	finish SAHF No.8		
16:11				start running		
16:11				fish born,crab		
16:12				crab		
16:13				crab,zoarcid,stop running		
16:15				start running		
16:15				stop running		
16:16				crab,zoarcid,something white		
16:17				start running		
16:18				crab,stone?bone?stop running		
16:21	903			leave bottom		231.3,245



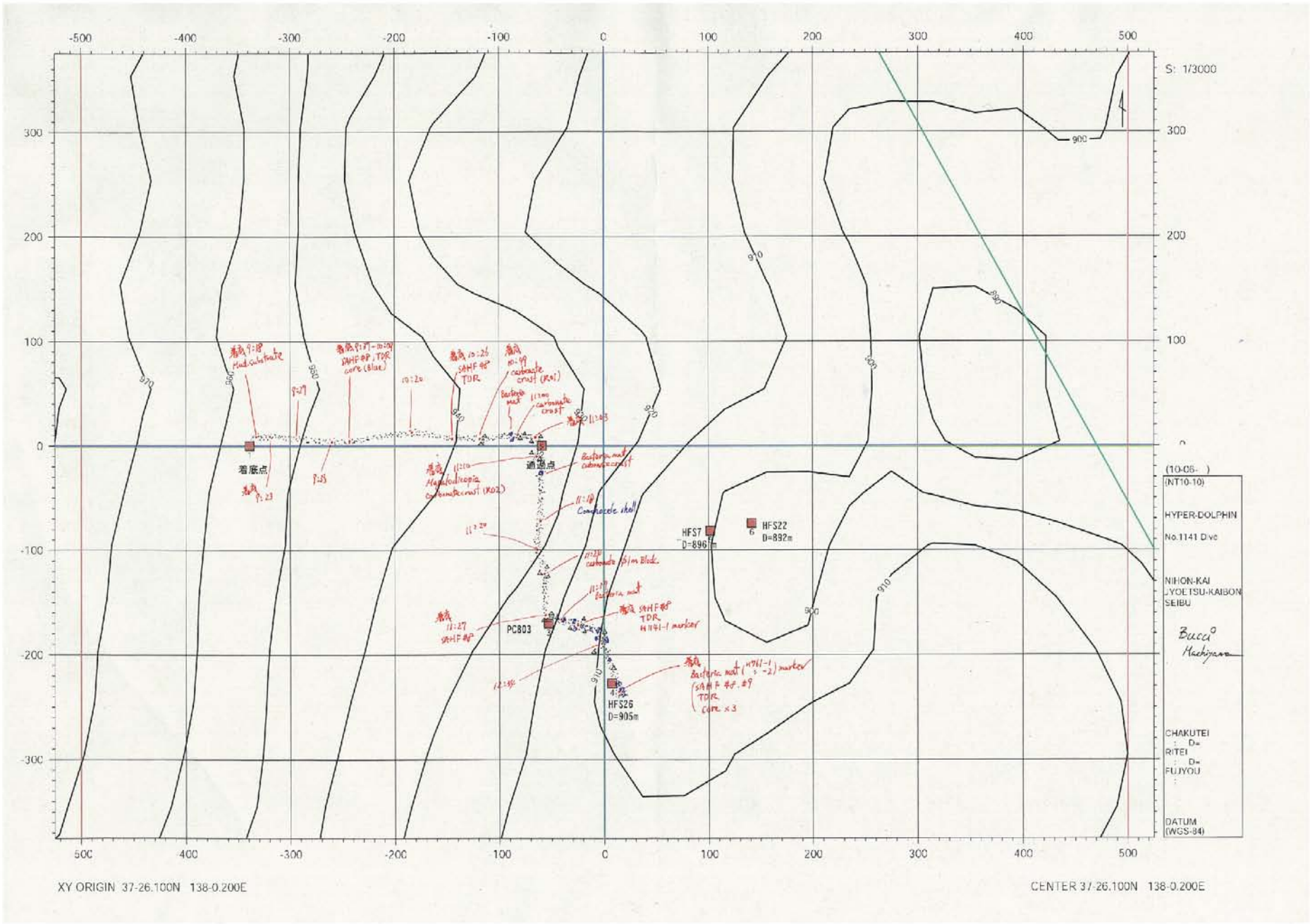
1. 09:17 着底 D=943m
(37-26.106N 137-59.984E)
2. 09:27 D=940m ｶﾆｶｺﾞ視認
(37-26.107N 137-59.995E)
3. 09:45 D=938m TDR計測開始
(37-26.107N 138-00.035E)
09:47 No.8SAHF計測開始
09:52 TDR計測終了
09:56 MBARI採泥(青・1本)
10:09 No.8SAHF計測終了
4. 10:28 D=935m TDR計測開始
(37-26.106N 138-00.101E)
10:30 No.8SAHF計測開始
10:30 TDR計測終了
10:45 No.8SAHF計測終了
5. 10:54 D=931m 岩石採取(1個)
(37-26.106N 138-00.116E)
6. 11:13 D=928m ｶｵｸﾞﾃﾗﾎﾞﾔ付岩石採取(1個)
(37-26.093N 138-00.150E)
7. 11:38 D=905m No.8SAHF計測開始
(37-26.014N 138-00.174E)
11:53 No.8SAHF計測終了
8. 11:59 D=900m ﾊﾞｸﾃﾘｱﾏｯﾄ視認
(37-26.012N 138-00.180E)
9. 12:08 D=903m TDR計測開始
(37-26.012N 138-00.188E)
12:10 No.8SAHF計測開始
12:12 TDR計測終了
12:26 No.8SAHF計測終了
12:31 H1141-1植木鉢ﾏｰｶｰ視認
10. 12:47 D=905m H761-1,H761-2植木鉢ﾏｰｶｰ視認
(37-25.969N 138-00.210E)
12:48 H759-2ﾏｰｶｰ視認
12:57 No.8SAHF計測開始
13:05 No.9SAHF計測開始
13:19 TDR計測開始
13:22 TDR計測終了
13:27 MBARI採泥(赤・1本)
13:35 MBARI採泥(緑・1本)
13:39 TDR計測開始
13:40 No.8SAHF計測終了
13:41 TDR計測終了
13:43 H761-2植木鉢ﾏｰｶｰ回収
13:44 H1141-2ﾏｰｶｰﾌﾞｲ設置
13:51 生物採集(#1ｷｬﾆｽﾀｰ)
13:54 生物採集(#2ｷｬﾆｽﾀｰ)
14:06 No.9SAHF計測開始
14:09 MBARI採泥(黒・1本)
14:24 TDR計測開始
14:27 No.8SAHF計測開始
14:27 TDR計測終了
14:28 生物採集(#3ｷｬﾆｽﾀｰ)
14:40 No.8SAHF計測終了
14:46 TDR計測開始
14:49 生物採集(#4ｷｬﾆｽﾀｰ)
14:50 TDR計測終了
14:51 No.9SAHF計測終了
14:59 No.9SAHF計測開始
15:04 No.8SAHF計測開始
15:06 TDR計測開始
15:08 TDR計測終了
15:11 生物採集(#5ｷｬﾆｽﾀｰ)
15:21 ｽﾗｰﾌﾟｶﾞﾝによる生物採集
15:24 TDR計測開始
15:26 TDR計測終了
15:30 No.9SAHF計測終了
15:31 No.8SAHF計測終了
15:35 No.8SAHF計測開始
15:36 TDR計測開始
15:41 カニ採集(1個体)
15:41 TDR計測終了
15:43 H1141-3ﾏｰｶｰ設置
15:45 ｹﾞﾝｹﾞ採集(1個体)
15:49 No.8SAHF計測終了
15:54 No.8SAHF計測開始
15:54 TDR計測開始
15:56 TDR計測終了
16:09 No.8SAHF計測終了
16:21 離底 D=903m

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
＃１１４１ ＤＩＶＥ
２０１０年０６月１５日
日本海 上越海盆西部
縮尺 １／３０００

測 位 D-GPS(MX9400 LEICA)
測地系 WGS-84 DATUM (世界測地系)
音 速 １４６９.０m／s (D＝１０００m)


S: 1/3000
着底点
通過点
PC803
HFS7
D=896m
HFS22
D=892m
HFS26
D=905m
HYPER-DOLPHIN
No.1141 Dive
NIHON-KAI
JYOETSU-KAIBON
SEIBU
CHAKUTEI
RITEI
FUJIYOU
DATUM
(WGS-84)
XY ORIGIN 37-26.100N 138-0.200E
CENTER 37-26.100N 138-0.200E

Submersible Observation

ROV submersible survey, HPD Dive #1141, was carried out on the western to southwestern slope of the southwestern mound in the middle part of the Umitaka Spur (Fig. 9). The main purpose of this survey is to clarify the detailed fluid flow around bacterial mats using multipoint heat flow measurement. Payloads are four MBARI type push corer, two SAHF, TDR sensor, slurp gun with six canister bottles, Kumade sampler, two small sampling box, and three marker buoys.

The ROV arrived at a depth of 943 m (St. 1141-1) on the western slope of the southwestern mound, and moved eastward then southward. Seafloor at the St. 1141-1 to 1141-7 (905 m) is covered by muddy sediments (Fig. 10). Carbonate crusts crop out around the St. 1141-5 (931 m) to 1141-6 (928 m). We sampled a carbonate crust (HPD #1141-R01) at the St. 1141-5 and an ascidian *Megalodicopia hians* (HPD #1141-B57) at the St. 1141-6 (Fig. 11). A number of carbonate crusts and bacterial mats are found around the St.

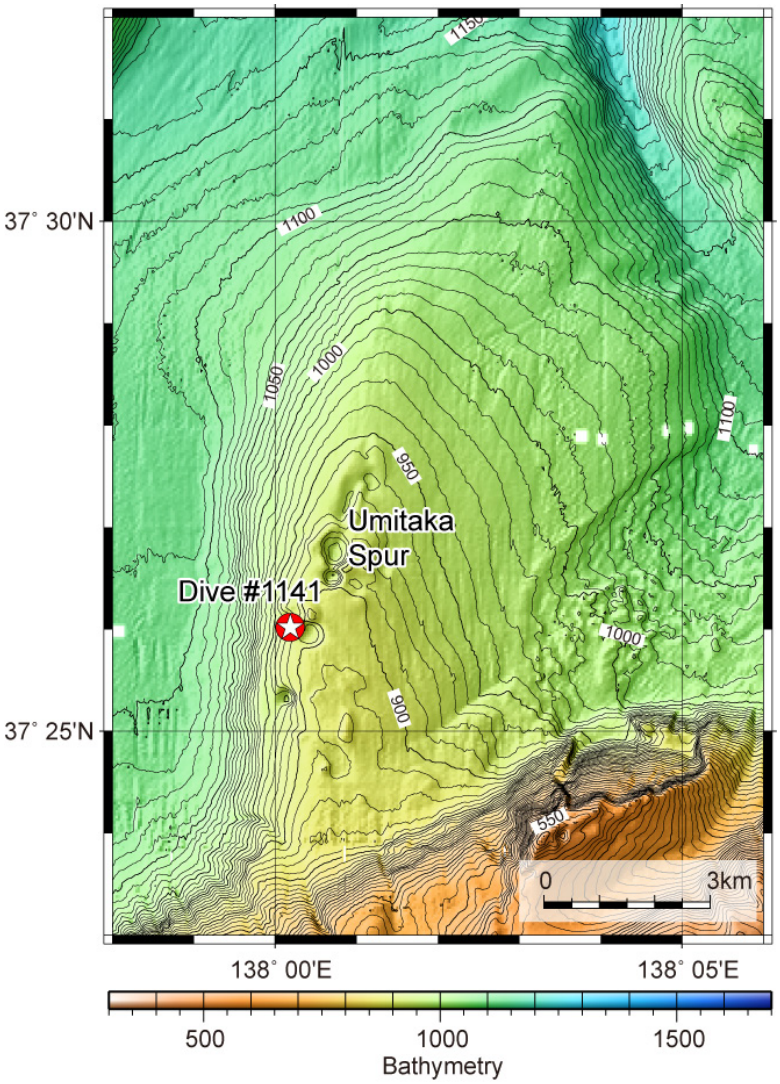


Fig. 9 Dive point of HPD Dive #1141 on the Umitaka Spur.

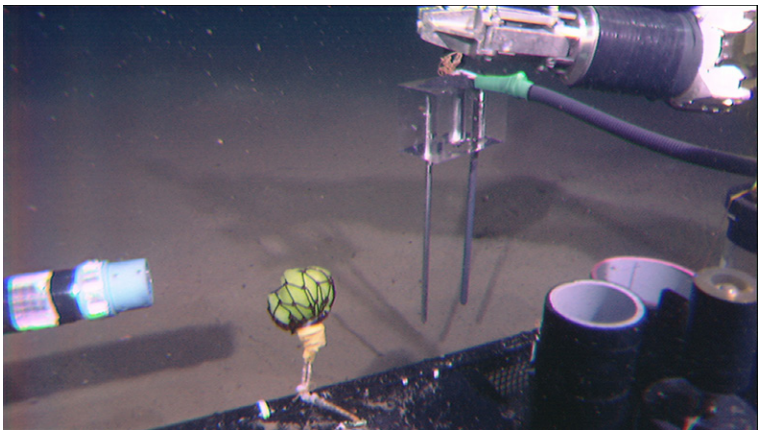


Fig. 10 TDR measurement on a muddy seafloor at St. 1141-3 (938 m).

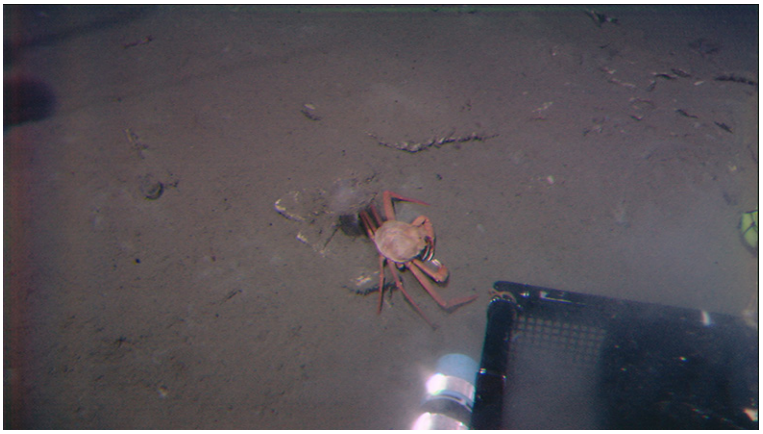


Fig. 11. An ascidian *Megalodicopia hians* at the St. 1141-6 (928 m).

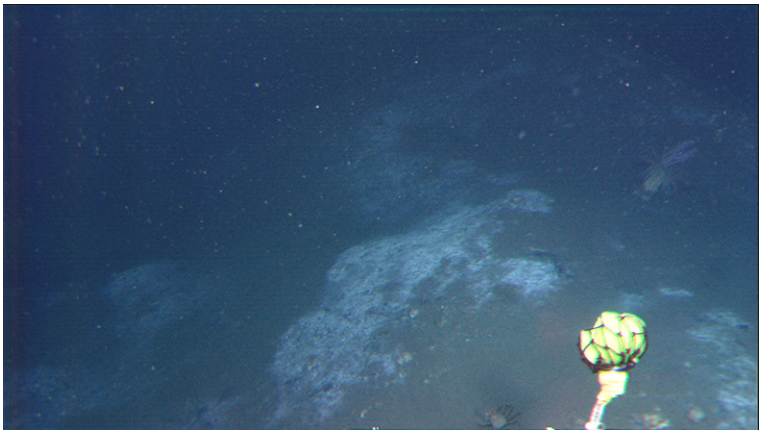


Fig. 12. A number of bacterial mats are found around the St. 1141-9 (903 m).

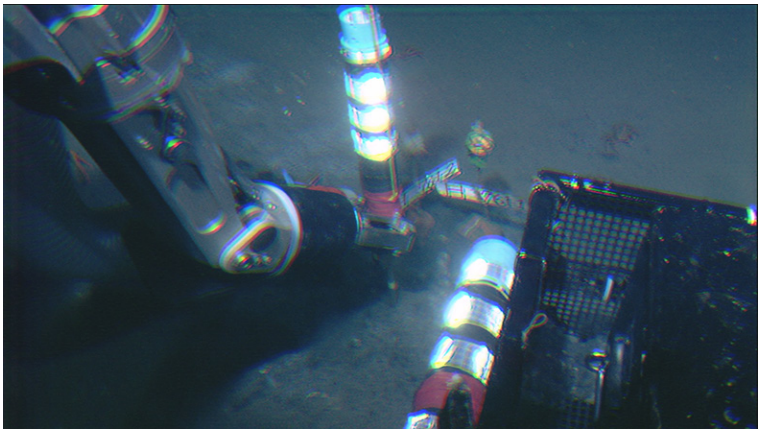


Fig. 13. Heat flow measurement using SAHF within a bacterial mat which was investigated in the NT07-20 Cruise at the St. 1141-10 (905 m).

1141-7 to 1141-9 (903 m) (Fig. 12). At the St. 1141-10 (905 m), where many bacterial mats and carbonate crusts are present, we found the bacterial mat which were investigated in the NT07-20 Cruise (Fig. 13). We conducted multipoint heat flow measurement around this station.

Unfortunately, we could not recover the water temperature data logger deployed in the NT09-16 Leg 1 Cruise, because of the presence of fishing equipment (crab traps) in the east of central part of the Umitaka Spur.

6.3.2 Dive #1142 (Toyama Trough)

Payload

Niskin water sampler x4 (Red, Green, Red, Blue)

MBARI type push corer x5 (Blue, Red, Green, Black, Yellow)

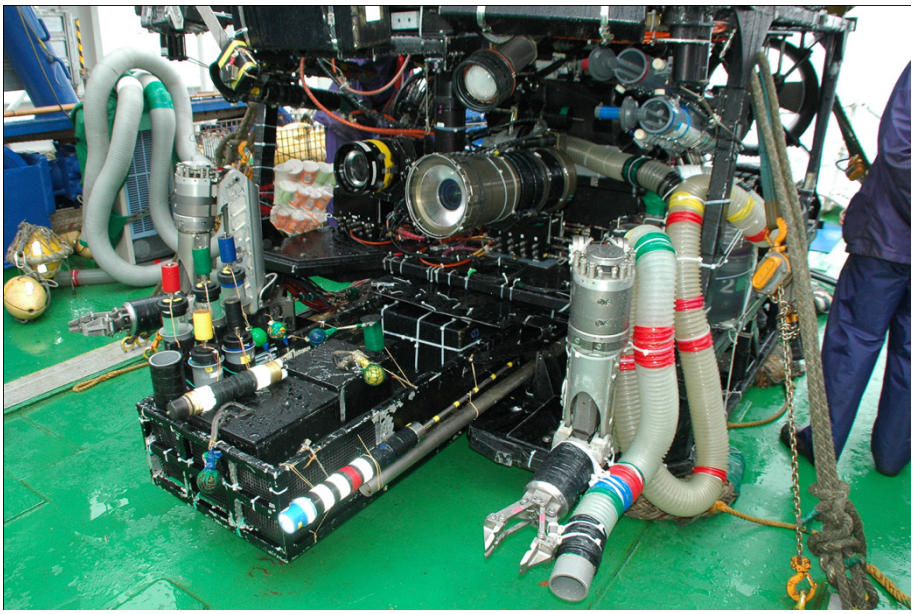
SAHF x1

Slurp Gun with 6 canister bottles x1

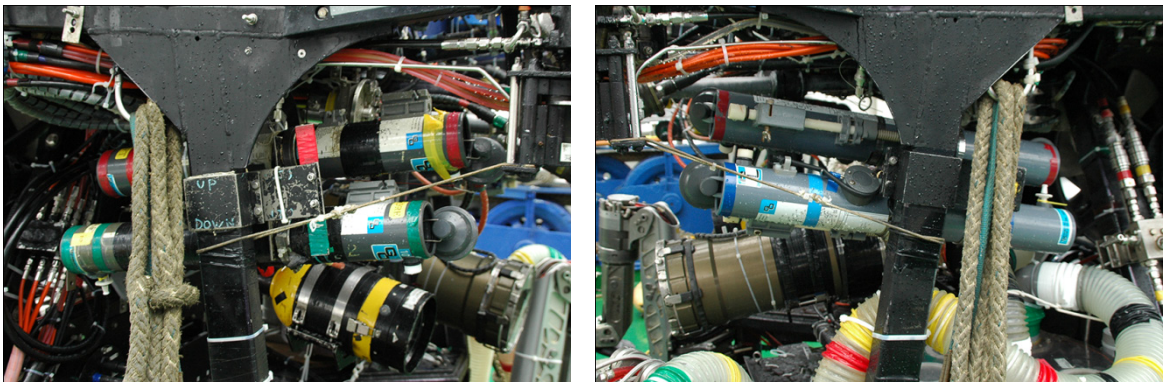
Sampling box (small) x2

Kumade (meshed) sampler x1

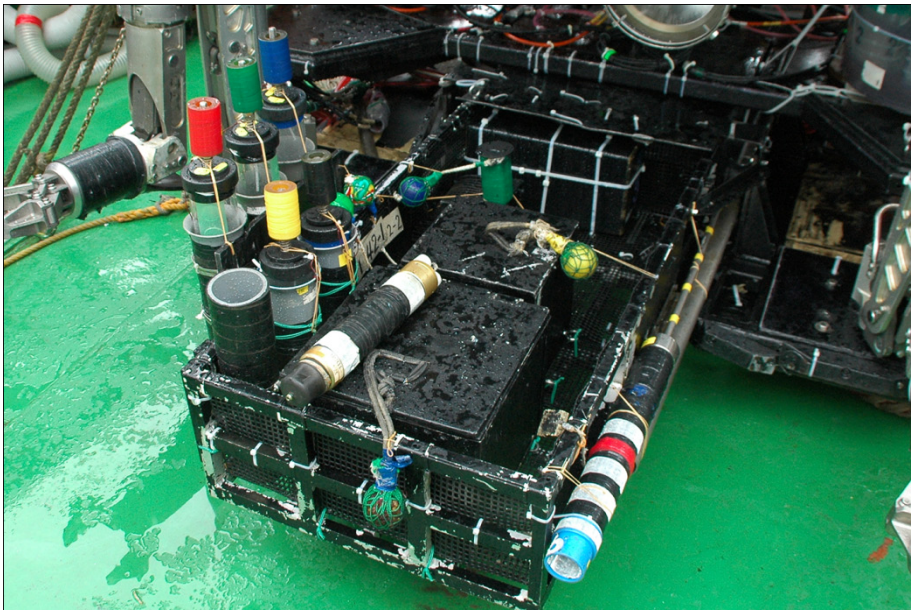
Marker buoy x2



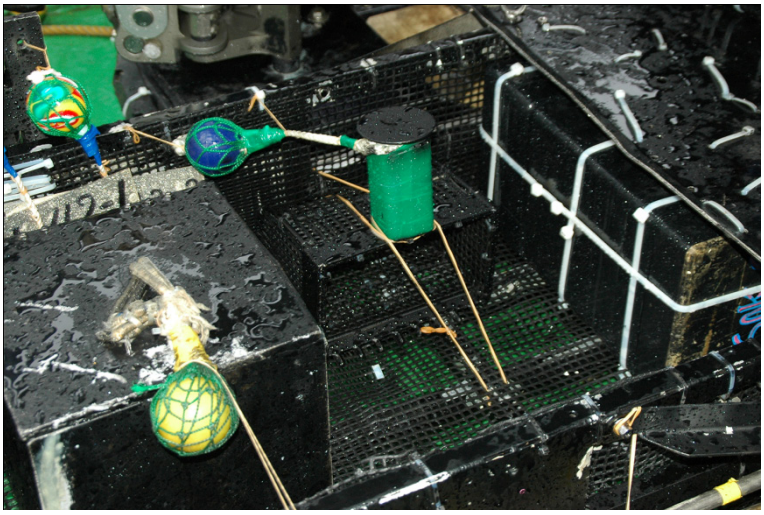
Payloads around sample basket for HPD Dive #1142.



Niskin water sampler attached to the ROV. Left: starboard side. Right: port side.



Payloads on sample basket. Five push corers are attached to the right side of the basket.



Meshed-type Kumade sampler on the sample basket.

ハイパードルフィン　潜航記録

平成 22 年　NT10-10　行動　　記載者　菊谷 茂

潜航年月日　2010/06/16
潜航回数　4回
通算潜航回数　1142回

位置　作図中心位置
緯度　38° 10.400 ' N
経度　138° 04.600 ' E
WGS-84

潜航海域　日本海　富山トラフ北部

潜航目的　調査潜航　「富山深海長谷の海底直上に検出されるメタン濃度異常と海底下BSRとの関連解明」

調査主任　町山 栄章
ピークル指揮　光藤 数也

Pilot　菊谷 茂
Co. Pilot　西郷 亮

作業経過時刻	
吊揚	08:00
着水	08:04
潜航開始	08:15
着底	09:10
離底	16:02
浮上	16:49
揚収完了	17:03

累計時間		
潜航時間		8:34
通算潜航		5314:5
ケーブル	ケーブルNo.	4
	使用時間	9:03
	通算時間	355:31

気象・海象

天候	風向	風力	風浪	うねり	視程
r	NW	4	3	1	6

最大潜航深度　1785 m
着底深度　1783 m
着底底質　泥

離底深度　1784 m
離底底質　泥

記事　海底を観察しながら航走し、採水・採泥・生物採集・SAHF温度計測及び岩石のサンプリングを行った。

Hyper-Dolphin Dive Log

Dive Number : HPD#1142 (Northern Toyama Trough) **Date : 2010/06/16**

Time (LCT)	Dep. (m)	Alt. (m)	Head (Deg)	Description	Remarks (position)
					X, Y
08:15				start diving	
	1000				-240
09:00	1454		171		-236, -498
09:07	1707	75	240		-235, -586
09:10	1784			arrive bottom	-229, -502
				sea anemone,zoarcid,crab	
09:13				start Mbari blue	
09:21				start saisui (can 1), start running	
09:24	1784	0.5		sea anemone,crab	
09:25	1785			stop running	-204, -503
				something yellow	
09:29				stop saisui (can 1)	
09:31	1785			start running	-202, -505
09:33				kaimenn ,sea anemone,stone	
09:35				stgop running	-173, -503
				sampling stone this side	
09:43				SAHF (can 4)	
09:52				start running	
09:53	1785	0	357	stop running	-173, -509
09:56				start running	
09:58				something white	
09:59	1784			Sea anemone garden, sea anemone attached to stones	
10:00				red queen crab	
10:01				fish	
10:02	1785			GENGE	
10:05				jelly fish	
10:05	1785			close to No.2	
10:06				jelly fish in CCD	
10:09				fish	
10:09				large mound, epifaunal animals (sea anemone, HARINADESHIKO,accumulated and attached to the mound), something animals with tentacles.	
10:17	1786			Rock sampling (R01). The sample was taken into box TEMAE. Sea anemone, something tentale animal, HARINADESHIKO attached to the sampled rock. Another rock sampling (R02). Thin clast-sheet tyep rock. The sample were divided into several parts and recovered into sample basket and box (TEMAE).	-24, -518
10:24				Run restart. Heading towards 90 degrees for Poiont No. 3.	
10:27				muddy bottom with scattered sea anemones. Yellow partiles are commonly scattered on the muddy floor. Fished can be seen occasionally.	
10:29				red queen crab	
10:30				jelly fish	
				stones with sea anemones	
10:32				stones increase in numbers and size	
				gabbage (GOMI)	
10:33	1785			large rock which has bedding-plane like liniation (probably sedimentrary rock), GOMI is located just beside the large rock HARINADESHIKO. Tentacled animals, sea anemones are attached to the rock	
10:40	1786			running restar. Heading 90 degrees.	
10:42				large rocks scattery distributed, small yellow (whitish) small particles are	
10:43				jelly fish	
10:44				wooden fall?	
10:45				sea glass fall (HONDAWARA)?	
10:45				red crab	
10:48				number of large stone decreased	
10:49				fish	
10:49				jelly fish	

Dive Number : HPD#1142 (Northern Toyama Trough) **Date : 2010/06/16**

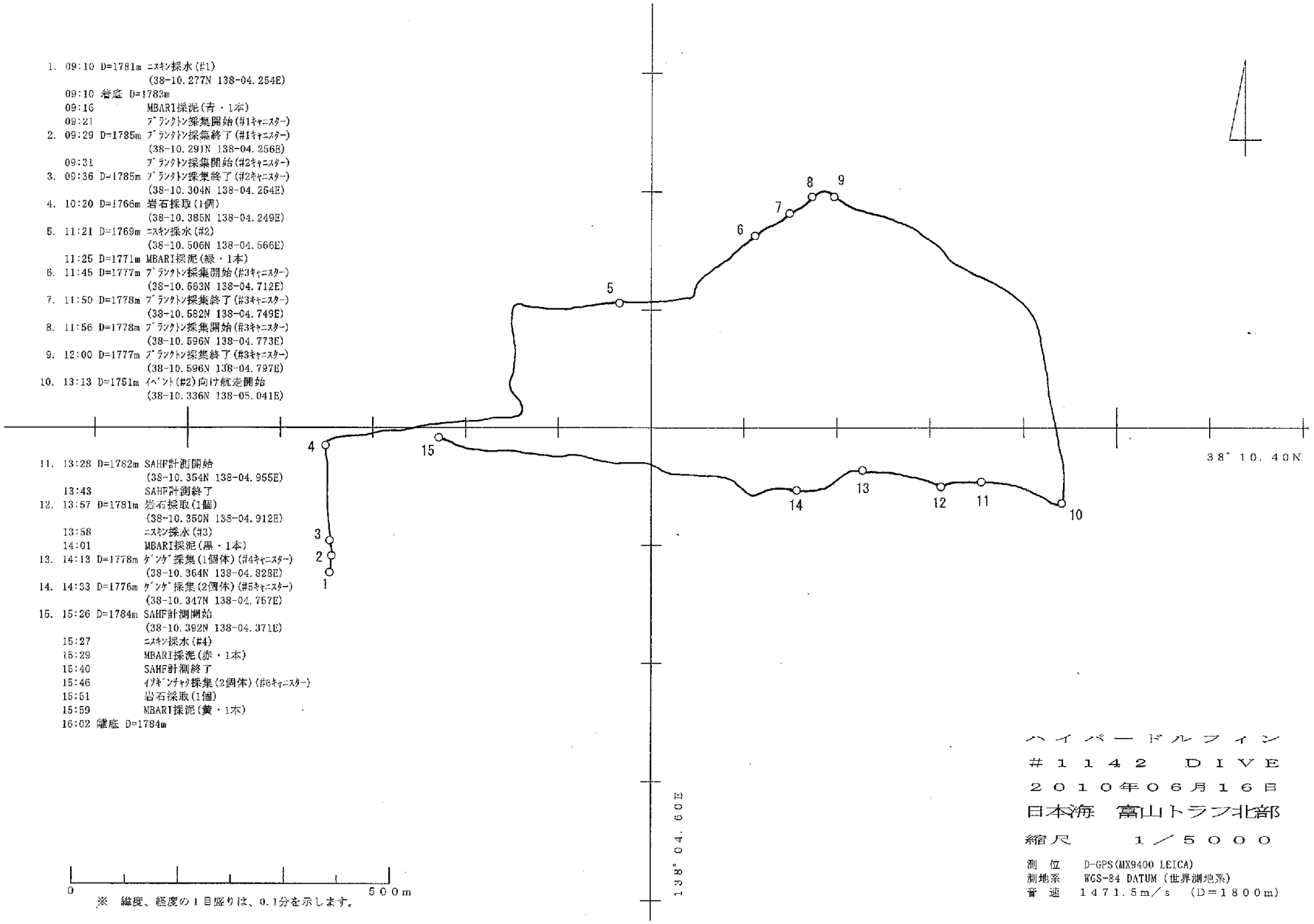
Time (LCT)	Dep. (m)	Alt. (m)	Head (Deg)	Description	Remarks (position)
10:51	1782			barriered structure? in sonar	
10:51	1781			veihcle go up slight slope	
10:52				very few large stones, but the yellow small particles are still visible	
10:53				rounded stone with sea anemons	
10:53				red crab, sea anemones, GENGE	
10:54				midium sized stones are scattery distributed	
10:56				stone on stone!	
10:58				many stones	
11:00				many stones and gravals	
11:01				stop running	
11:02				start running	
11:05				red crabs	
11:07				large stone	
11:10				many small stones	
11:13				accimurated small yellow stomnes	
11:17				no more many stone in this area	
11:18				no stones	
10:20				stop running	154.8,-44.1
11:20				take a water by NISUKI	
11:22				down to the bottom	
11:25				take mud by MBARI(green), try to get white spot	
11:25				start rinning	
11:30				no sensor reaction(no stone around here)	
11:33				pass the number 4 point	
11:33				one GENGE and one sea anemone at No.4 point	
11:38				some crabs, but no stones	
11:41				jelly fish	
11:44				Take water by slarp gun(No.2)	
11:46				crabs, sea anemone, and GENGE	
11:47				stone with sea anemones	
11:48				sea anemone, GENGE , and crab	
11:49				dish	
11:50				stone	
11:50				Take water by slarp gun(No.3)	
11:50				stone with many sea anemones	
11:52				pass the number 5 point	
11:52				50m over running to northeast by order	
11:55				crabs	
11:57	1777.7	0.5	70	crab	368.9,271.3
11:59	1777.7	0.6	120	crab,genge	363.5,278.8
12:01				genge	361.9,295.3
12:04	1777.7	0	115	crab,genge,isogincyaku	342.5,341.5
12:06				genge	333.8,340.9
12:09				crab	333.8,357.8
12:10	1777.3	0.5	120	many isogincyak(reki),genge,	329.4,368.4
12:12				isogincyaku	321.1,378.8
12:13				isogincyaku,crab	321.8,397.4
12:14	1776.4	0.5	125	genge	319.8,399.5
12:16				crab	388.4,411.9
12:17				isogincyaku,genge,crab	387.1,421.8
12:18	1775.5			isogincyaku,genge,crab	294.8,432.6
12:20	1775.2			crab,isogincyaku	284.3,454.5
12:21				gemge,isogincyaku	276.1,459.2
12:22	1774.9			genge,isogincyaku,crab	256.8,463.3

Dive Number : HPD#1142 (Northern Toyama Trough) **Date : 2010/06/16**

Time (LCT)	Dep. (m)	Alt. (m)	Head (Deg)	Description	Remarks (position)
12:23				genge	256.2,488.5
12:25				isogincyaku	249.7,492.5
12:27	1775.1	0.6	130	genge	241.3,513.5
12:29				genge,crab,small mud reki	227.8,534.9
12:30				umoreta crab	226.9,536.4
12:31	1775.1			isogincyaku	217.4,551.7
12:32				small genge,small isogincyaku	214.8,554.5
12:33				crab	212.5,558.8
12:34				genge	218.5,559.8
12:35				genge	206.8,583.8
12:35				genge,crab	281.9,5815
12:37	1777.1	0.9	171	genge	193.1,593.9
12:38				genge	179.2,598.5
12:40	1777.5	0.9	171	isogincyaku	173.5,597.3
12:42				crab	168.5,582.4
12:43				small enseki	155.6,582.8
12:44				crab,genge	147.3,598.2
12:44				genge	143.5,515.8
12:46	1780	1	180	genge	122.3,513.2
12:49	1780.1	1.7	180	many isogincyaku(potupotu tenzai),crab,genge	95.5,518.4
12:53	1780.8			isoginctaku,genge	55.1,521.3
12:54				crab	58.7,523,3
12:55				crab	51.7,528.8
12:56	1779.3	0.7	180	crab,isogincyaku	42.1,529.8
12:58				crab	35.9,535.5
12:59				crab,genge	38.5,527.6
13:01				genge	
13:02				crab	
13:03				genge	
13:04				genge+crab	
13:05				crab	
13:07				genge	37,84
13:07	1755			smalll mound-like structure	
13:08				crab	36,85
13:09				genge	
13:09	0:00			Rock	355,845
13:12	1750			mound-like structure (along the ROV route)	346,847
13:13				mound-like structure (along the ROV route)	334,872
13:17				jelly fish	
13:20	1780			slope	353,997
13:22	1781			iso, genge etc (on flat lsnd)	354,973
13:24	1782			stop running	356,959
13:28				SAHF (point1) five sensors penetrated	
				Memo: bluish gray soil	
13:43				SAHF (point1) END	
13:46				start running	
13:47	1781			crab,isogincyaku,genge	353,948
13:48				jelly fish	353,934
				Memo: isoginchaku takusan	
13:50				stop running	356,917
13:51				Sampling stone failed	
13:55				Sampling stone (R03)	
13:58				Niskin No.3 blue	
14:00				MBALI (Black) no.3	

Dive Number : HPD#1142 (Northern Toyama Trough) **Date : 2010/06/16**

Time (LCT)	Dep. (m)	Alt. (m)	Head (Deg)	Description	Remarks (position)
14:02				start running	
14:03				nstone,isogyuinchaku	
14:06				crab, flat bottom, no stone	
14:09				genge	
14:10				crab	
14:11				three isogyuinchakus	
14:12				genege sampling by slarp gun(No.4)	362,825
				genge to oni-gokko	
14:33				genege sampling by slarp gun(No.5)	343,755
14:34				start running	
14:35				crab, flat bottom, no stone	
14:36				crab, isogyuinchaku	
14:37	1773			2 crubs	
14:39				genges	
14:41				genge	
14:41				crab, genge	
14:42				isogyuinchaku	
14:43				isogyuinchaku,genge	
14:44				isogyuinchaku with small stone	
14:46				genge	
14:48				crab, genge	
14:49				crab, genge	
14:50				crabs and genges	
14:52				genge	
14:52				crab	
14:55				genge	
14:56	1770	0.6	264	moving	-43, -116
15:02	1772	0	250	landing, rock,	
15:05				moving	
15:06				genge	47.1,155.6
15:07	1772	0.5		isogincyaku	
15:08				isogincyaku	
15:10				genge	40,210
15:12	1775	0.9		isogincyaku	40,230
15:15	1777	0.7	269	moving	
15:20	1781	0.8	270	a lot of isogincyaku	26,318
15:22	1782	0.6	290	moving toward a rock	
15:23	1784	0	290	crab,isogincyaku,rock, start SAHF	
15:27	1784	0	289	Niskin No.4 red ,MBARI	
15:31	1784	0	289	take seamax photo on the MBARI hole	
15:34	1784	0	289	take a seamax photo on the rock	16,346
15:37	1784	0	289	finished SAHF	
15:44	1784	0	316	sampled isogintyaku and put in No6 Cyanister	
15:51	1784	0	324	sampled rock No.4	
15:53	1784			trying to capture sea anemone by MBARI	
16:00	1785			Sampling a sea anomone by MBARI (yellow)	-19, -353
16:02	1784			leave the sea bottom	

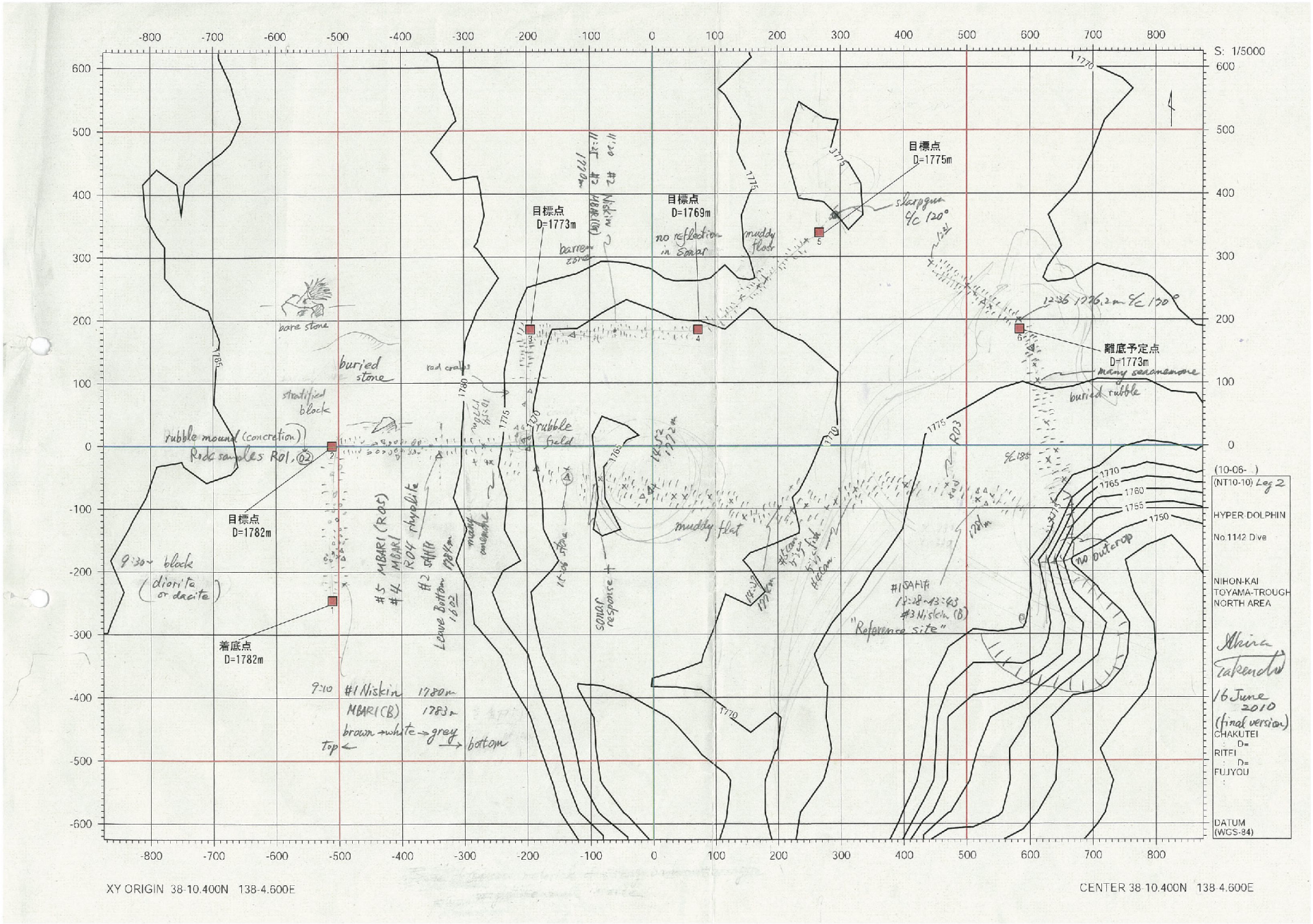


※ 緯度、経度の1目盛りは、0.1分を示します。

ハイパードルフィン
＃１１４２ ＤＩＶＥ
２０１０年０６月１６日
日本海 富山トラフ北部

縮尺 １／５０００

測 位 D-GPS(MX9400 LEICA)
測地系 WGS-84 DATUM (世界測地系)
音 速 １４７１.５m／s (D＝１８００m)


S: 1/5000
目標点
D=1782m
着底点
D=1782m
目標点
D=1773m
目標点
D=1769m
目標点
D=1775m
離底予定点
D=1773m
rubble mound (concretion)
Rock samples R01, 02
bare stone
buried stone
stratified block
rad crabs
rubble field
muddy flat
no reflection in Sonar
barren
many anemone
buried rubble
no outcrop
"Reference site"
9:30~ block
(diorite or dacite)
9:10 #1 Niskin 1780m
MBARI (B) 1783m
brown→white→grey
Top ← → bottom
XY ORIGIN 38-10.400N 138-4.600E
CENTER 38-10.400N 138-4.600E
(10-06-)
(NT10-10) Leg 2
HYPER DOLPHIN
No.1142 Dive
NIHON-KAI
TOYAMA-TROUGH
NORTH AREA
Akira Takenouchi
16 June 2010
(final version)
CHAKUTEI D=
RITEI D=
FUJYOU
DATUM (WGS-84)

Submersible Observation

On the basis of MBES survey in the A1 area NW offing Sadogashima Island, NT10-10 Leg2 conducted submersible survey utilizing the unmanned research vehicle *Hyper-Dolphin* (HPD dive #1142) on the eastern margin of sediment flat of the central Toyama Trough (Fig. 14). Payloads are four bottles of Niskin water sampler, 5 tubes of MBARI corer, one SAHF (Standalone Heat flow meter), 2 markers, scoop and slurp gun with 6 bottles.

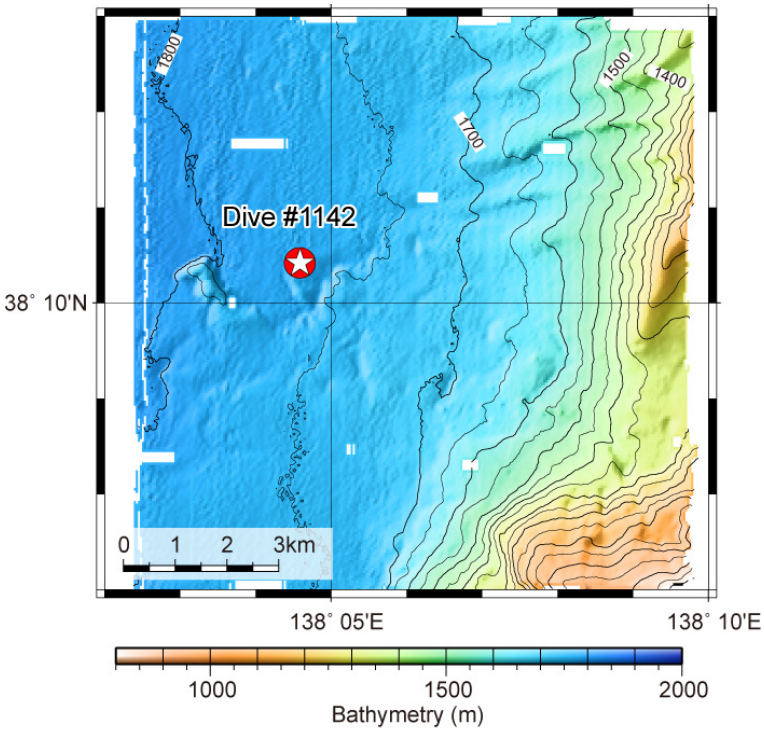


Fig. 14 Dive point of HPD Dive #1142.

The vehicle arrived 1785m.w.d. bottom (38°10.277' N 138°04.254' E) on one of the strong reflective spots which fringe the frontal zone of a diluvial apron (submarine fan).

The first MBARI corer recovered the surface sediment which consists of oxidized fragile clay, white soft clay and bluish grey colored semi-condensed clay. The middle layer seems like kaolin-like clay derived from eroded part of rhyolites.

No outcrop of bedrock was observed through the surveyed route but sometimes dense fields of sea anemones were happened to be found on muddy bottom. They seem to belong to only one species and stood on buried stones within the surface mud less than several centimeters in thickness. This interpretation was clearly justified by MBARI sampling (HPD1142-C05) which recovered bottom materials including a sea anemone and its basement stone (HPD1142-R05). Therefore distribution of numerous sea anemones (density is more than 1-2 individuals per 1 square meters) might indicate spatial distribution of float stones in the muddy floor.

Moreover, bared rocks in larger size were also observed to be foundation of sea anemones. Recovered rock samples (HPD1142-R01, R03-05) are igneous in origin.

Most interesting is a rubble mound found earlier in the dive, at 1776m.w.d. bottom (38°10.385' N 138°04.249' E), where is a little bit higher than the landed point (1785m.w.d.) (Fig. 15). Most rubble is of rectangular shaped rhyolite but planar carbonate crusts were also observed on the entire mound surface. One tip of carbonate crust was recovered interstitial

spaces (matrix) of this rubble mound were filled by pale skin-colored, kaolin clay (Fig. 16). Consequently, this mound concluded to be an old vent of a small ‘mud volcano’, although it includes many lags of rhyolite and rhyodacite.

To conclude the dive HPD #1142, it observed the facies boundary between sedimentary flat and piedmont apron of debris flows, although entire region is covered by fragile mud. The A1 area is composed of an intercalation (alternation) of debris flow deposits and hemipelagic and fluvial (back swamp) formations. The thickness of debris formation would be thickened towards the steep slope of the Sadogasima Island. Ground water discharge is probable more or less in the side of sedimentary flat along the facies boundary zone.

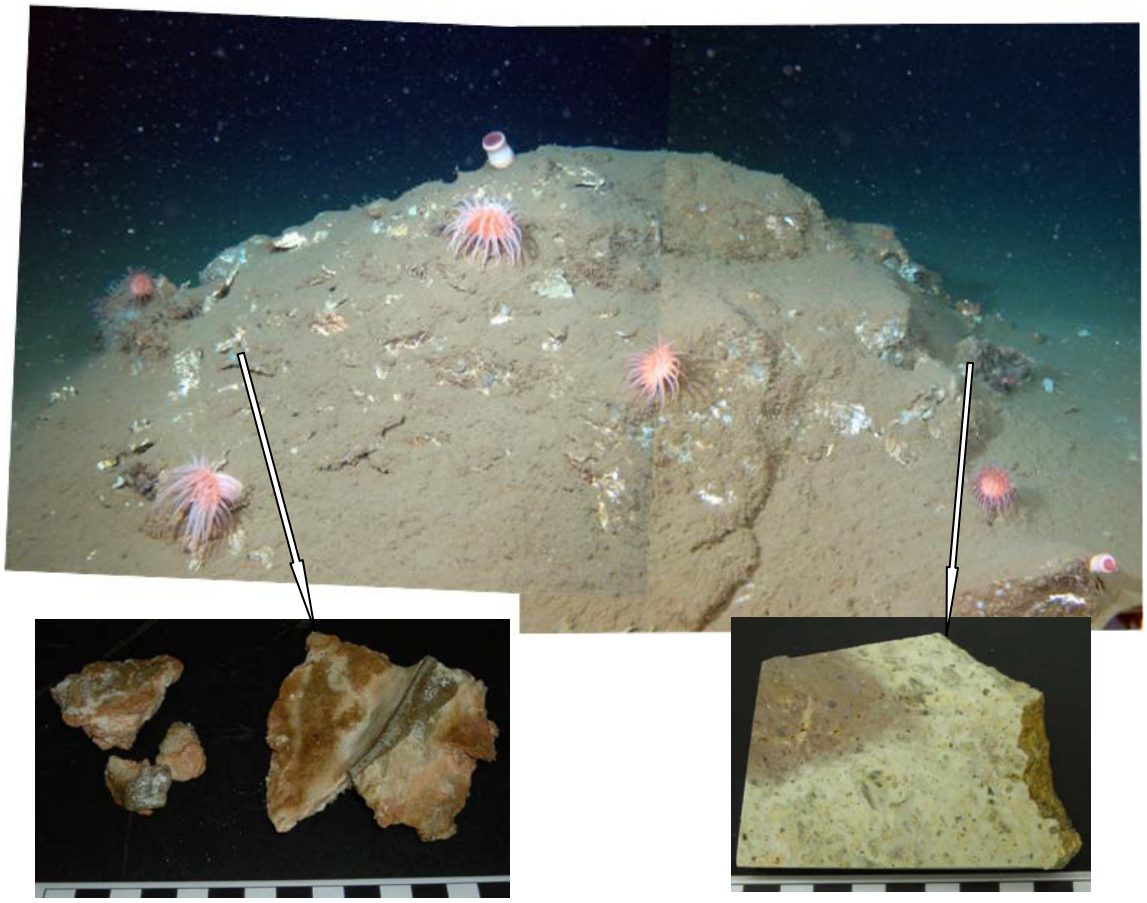


Fig. 15 Rubble mound at Event 2 (1766m.w.d.).
Top: An oblique view of the dome-like rubble mound. 1.8 x 1.2 x 0.7 m.
Bottom left: Sample HPD1142-R02 of carbonate crusts including a fossil nestles of benthos; bottom right: facet of sliced tip of rock sample R1. Arrows from top to bottom denote sampling locations.

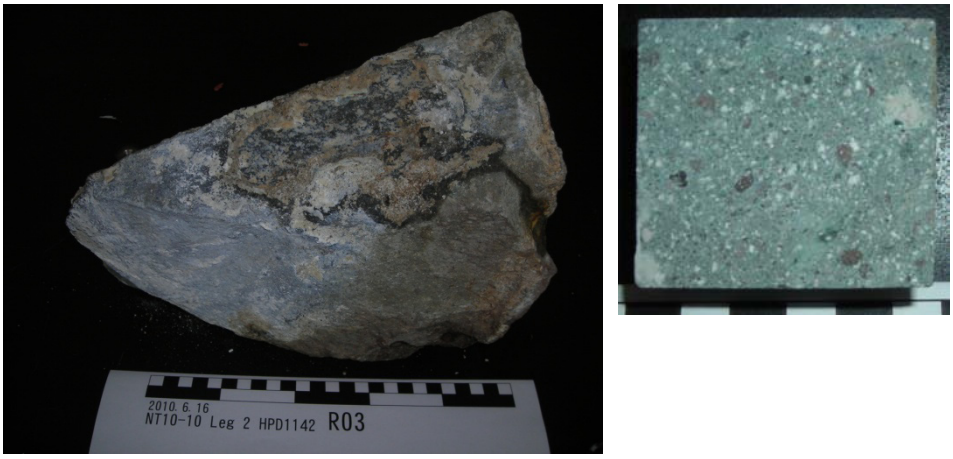
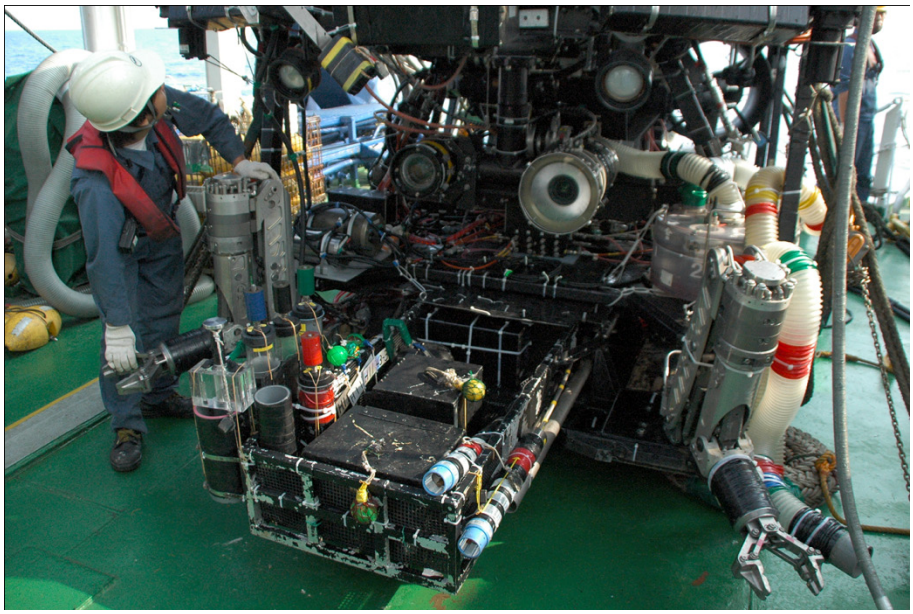


Fig. 16. Rock sample HPD1142-R03.
Left: The whole surface was covered by pale skin-colored kaolin clay and some parts were consolidated into carbonate crust.
Right: Facet of sliced sample of rhyodacite.

6.3.3 Dive #1143 (Joetsu Knoll)

Payload

MBARI type push corer x4 (Blue, Red, Green, Black)
SAHF x2
TDR sensor x1
Water temperature data logger x1
Slurp Gun with 6 canister bottles x1
Sampling box (small) x2
Kumade (all covered) sampler x1
Marker buoy x3



Payloads around sample basket for HPD Dive #1143. Payload setting is similar to that for the Dive #1141.

A water temperature data logger for long-term monitoring.

ハイパードルフィン　潜航記録

平成 22 年　NT10-10　行動　　記載者　竹ノ内 純

潜航年月日　2010/06/17
潜航回数　5回
通算潜航回数　1143回

位置　作図中心位置
緯度　37° 34.200 ' N
経度　137° 57.900 ' E
WGS-84

潜航海域　日本海　上越海盆西部

潜航目的　調査潜航　「高メタンフラックス下での表層型メタンハイドレートの集積・自己崩壊過程における流体挙動」

調査主任　町山 栄章
ピークル指揮　光藤 数也

Pilot　竹ノ内 純
Co. Pilot　飯嶋 一樹

作業経過時刻	
吊揚	08:04
着水	08:07
潜航開始	08:21
着底	08:56
離底	16:11
浮上	16:40
揚収完了	16:52

累計時間		
潜航時間		8:19
通算潜航		5322:24
ケーブル	ケーブルNo.	4
	使用時間	8:48
	通算時間	364:19

気象・海象

天候	風向	風力	風浪	うねり	視程
bc	SSW	3	2	1	8

最大潜航深度　989 m
着底深度　989 m
着底底質　泥

離底深度　984 m
離底底質　泥

記事　海底を観察しながら航走し、生物採集・採泥およびSAHF・TDRによる各計測、長期設置型温度計の設置を行った。

Hyper-Dolphin Dive Log

Dive Number : HPD#1143 (Joetsu Knoll) **Date : 2010/06/17**

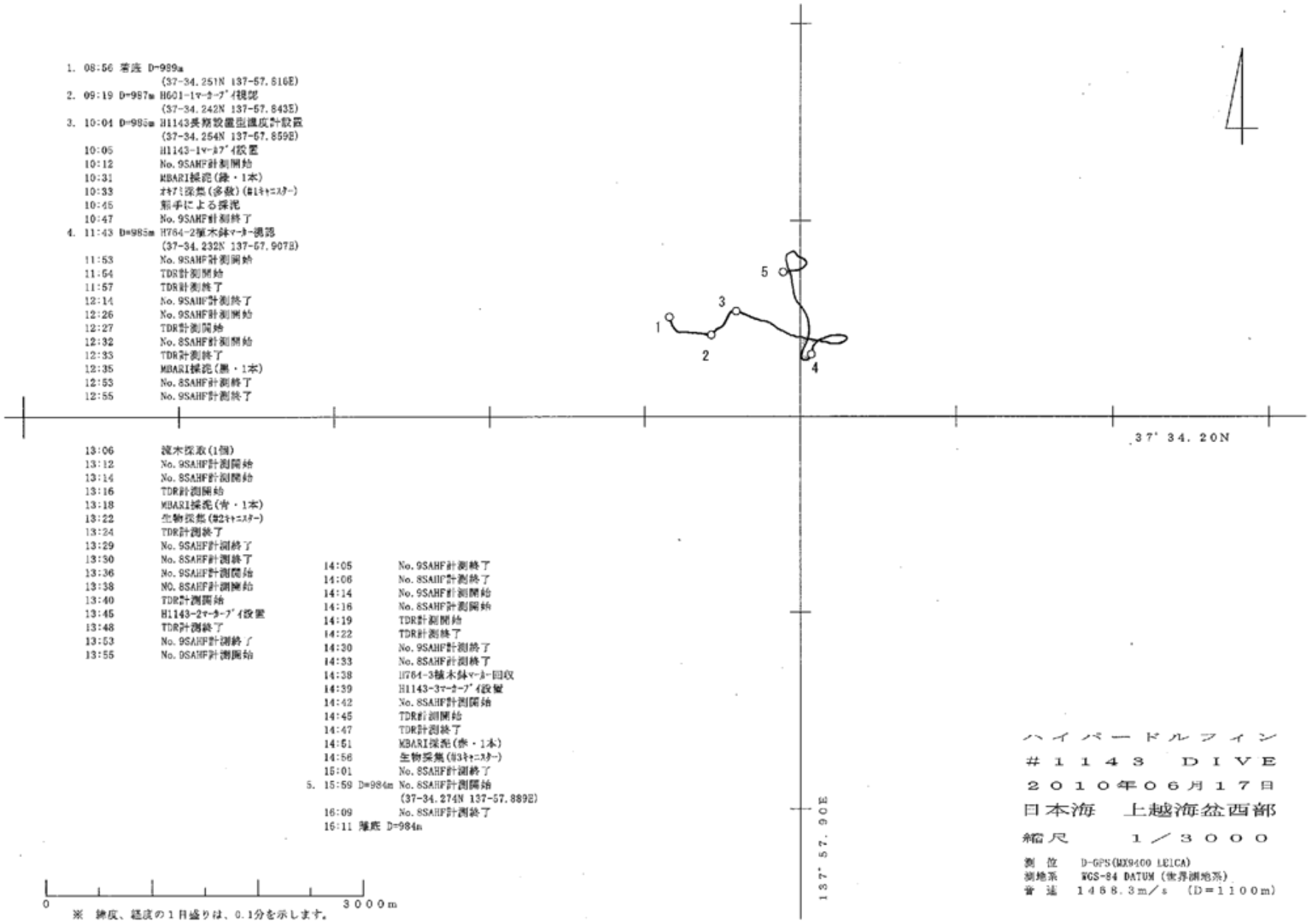
Time (LCT)	Dep. (m)	Alt. (m)	Head (Deg)	Description	Remarks (position)
					X, Y
08:21				start diving	
08:56	989			arrive at bottom, mud, crabs, Zoarcid	94.1, -124.7
08:58				crabs, Zoarcid	
09:00	993			stop running, seamax, crabs ball, sea anemone	82.7, -125.8
09:02				disturb the crab ball	
09:03				bai-gai snails in the crab ball, seamax	
09:07			170	start running	
09:09				shrimp, kajika, crab, bai	
09:09				stop running	74.8, -115.9
				set the canister to No.1 bottle	
09:13			90	start running	
			95		
09:17	988	4	100	crabs, sea anemone, gravel, sponges, find the marker	79.2, -87.5
09:20				bacteria mat	
09:21				sponge, crab	
09:23				stop running, failed MBARI(green), floor is hard and black	83.8, -78.7
09:33				Amphipoda	
09:35	986			stop running	91.4, -68.5
09:38				crab(Prof. Numanami said he is small male)	
09:44				nimble crab(eating something? Threating another?), empty snail shell	
09:59				start running	
10:00	985			bacteria mat	96.4, -62.3
10:01				stop running, crabs, kajika? Zoarcid	
10:04	985			set thermometer	99.8, -60.2
10:05				marker H1143-1	
10:08				start SAHF No.9 difference (2 minute)	
10:10				finish SAHF No.9 difference	
10:11				start SAHF No.9 (20 minute),a lot of shrimps,crab	
				bacteria mat,conch	
10:30				Mbari green	
10:31				srarp gun:yokoebi(can 1)	
10:38	985		119	soil sampling scoop box (this side)	98.3,-58.5
10:47				finish SAHF No.9	
10:50				start running	
10:51				crab	
10:55	982	1	119	crab	77.5, -11.6
11:00	982		129	kai, genge, crab	
11:01	982		124	many fishes	
11:02				genge, ebi, crab	
11:05	983		125	stop running, observation of sea bottom, many fishes, crab, ama-ebi	68.2, 19.7
11:08	974	6	90	start running	70.7, 41.1
11:11	981		263	stop running and landing,	72.1, 43.1
11:13	981			crab, many fishes, wating storm of sea bottom mud due to landing	73.3, 36.2
11:28	981		265	landing again, crab, some small rocks	75.2, 32.4
11:32	983		254	landing again for looking for cliff, crab	72.9, 28.3
11:36	982	1.2	240	taking off	
11:37	983		244	landing., many pices of rocks, some crabs, some fishes	72.8, 16.9
11:40	983	1.2	220	taking off	
11:41	983		221	fiding targets	64.3, 8.3
11:42	984		218	find targets named H764-2 and H764-3	58.7, 7.7
11:44	984		218	there is no previous outflow of gas. Some rocks	
11:52	984		221	Start SHAF	62.8, 9.4
11:54	985		220	Start TDR	59.4, 11.8

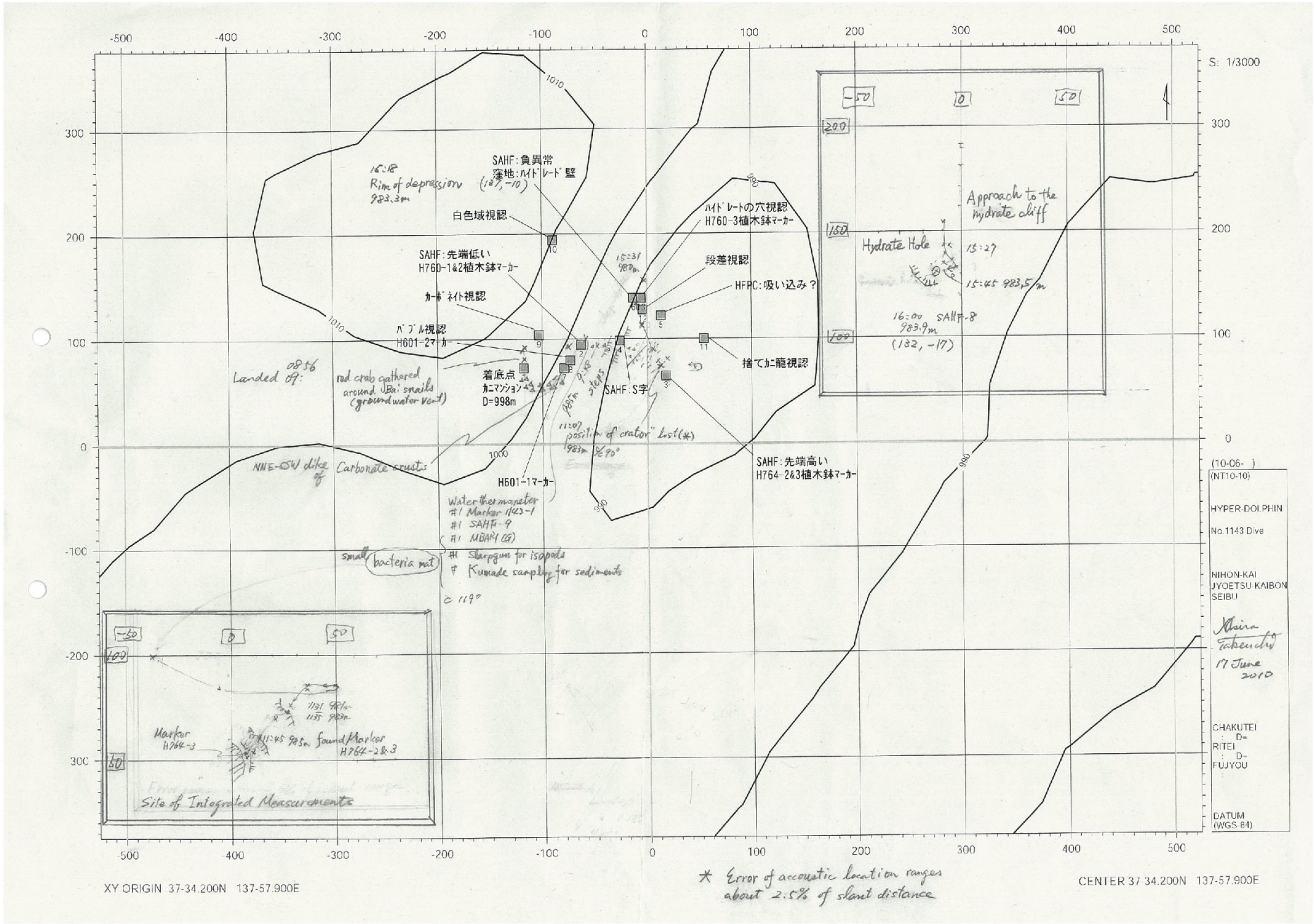
Dive Number : HPD#1143 (Joetsu Knoll) **Date : 2010/06/17**

Time (LCT)	Dep. (m)	Alt. (m)	Head (Deg)	Description	Remarks (position)
11:57				Finish TDR	
12:03				crab in mud(egg setting?)	
12:14				finish SAHF 9 (20 minute)	
12:16				start running	
12:16	984	0	235	finish running,and landing	55.8,17.8
12:18				driftwood, crabs,ebi	
12:25				start SAHF9	
12:26				start TDR	
12:29				reference SAHF8(2 mitutes)	
12:32				start SAHF8	
12:32				finish TDR	
12:35				get the core	
12:36				miss get a driftwood,manupirter hitted to SAHF9	
12:40				genge, crab	
12:53				finish SAHF8	
12:56				finish SAHF9	
13:06	984	0	238	driftwood in sample box	56.7,13.2
13:12				Start SAHF9(bubbling)	54.5,13.9
13:14				Start SAHF8(many bubbling)	
13:16				Start TDR	
13:18				MBARI blue	
13:22				Slurp surface small lives to bottle No.2	
13:24				Finish TDR	
13:30				Finish SAHF9	
13:31				Finish SAHF8	
13:37	985	0	240	Start SAHF9	54.8,11,5
13:38				Start SAHF8	
13:40				Start TDR	
13:46				Set MarkerH1143-2	54.2,7.6
13:49				Finish TDR	
13:53				Finish SAHF9	
13:55				Start SAHF9	
14:05	985	0	254	Finish SAHF9	56.4, 12.9
14:06				bubbling	
14:07				Finish SAHF8	
14:08				start running	
14:10	984			stop running	57.1, 11.5
14:14				Start SAHF9	
14:16				Start SAHF8, crab	
14:19				Start TDR	
14:22				Finish TDR	
14:29				observe mount, crabs, bacteria mat, filaments?	
14:30				Finish SAHF9	
14:33				Finish SAHF8	
14:34	982	2		start running	
14:35				squid	
14:36	984			stop running	56.6, 7.3
14:38				recovery the marker H764-3 into sample-box front side	
14:40				set the marker H1143-3	
14:40				move little	
14:42	983			Start SAHF8	55.1, 8.1
14:45				Start TDR	
14:47				Finish TDR	
14:50				sample MBARI red	

Dive Number : HPD#1143 (Joetsu Knoll) **Date : 2010/06/17**

Time (LCT)	Dep. (m)	Alt. (m)	Head (Deg)	Description	Remarks (position)
14:54	983	0.6	203	slurp gun started	
14:57	983	1.2	206	slurp gun started and conneted to No.6	
15:02	983	0.5	211	SAHF No.13 started	
15:05	983	0.7	355	Moving	
15:08	982	1.2	345	Moving slowly	39,4
15:10	980	2.1	345	fish,crabs,cliff	
15:15	982	0	350	Landed again, crabs	
15:19	983	0	348	Marine snow	
15:22	983	0	350	it is a fish	
15:23	983	0	350	crabs, shrimp	
15:27	983	0.9	359	crabs	
15:30	980	3.7	120	moving	145,6
15:35	982	0	259	Landed again,	136,4
15:41	983	0	270	muddy floor	
15:49	983	0	268	crabs	134,-8.9
15:56	983	0.7	245	moving	
15:57	983		245	Landing	134.4, -17.3
15:59	983	0	244	Start SAHF No. 8	131.9, -15.2
16:02	983		244	Crab	
16:06	983		244	some fishes	
16:09	983	0		finding hydrate	
16:09	983		244	Finish SAHF No.8	129.6, -18.3
16:11	983	0	252	Finish the project	128.6, -17.6
16:13				taking off	139.7, -5.1


1. 08:56 着底 D=989m
(37-34.251N 137-57.816E)
2. 09:19 D=987m H601-1マーカーブイ視認
(37-34.242N 137-57.843E)
3. 10:01 D=985m H1143長期設置型濁度計設置
(37-34.254N 137-57.859E)
10:05 H1143-1マーカーブイ設置
10:12 No.9SAHF計測開始
10:31 MBARI採泥(緑・1本)
10:33 オキアミ採集(多数)(第1キャニスター)
10:45 熊手による採泥
10:47 No.9SAHF計測終了
4. 11:43 D=985m H764-2種木鉢マーカー視認
(37-34.232N 137-57.907E)
11:53 No.9SAHF計測開始
11:54 TDR計測開始
11:57 TDR計測終了
12:14 No.9SAHF計測終了
12:26 No.9SAHF計測開始
12:27 TDR計測開始
12:32 No.8SAHF計測開始
12:33 TDR計測終了
12:35 MBARI採泥(黒・1本)
12:53 No.8SAHF計測終了
12:55 No.9SAHF計測終了
13:06 流木採取(1個)
13:12 No.9SAHF計測開始
13:14 No.8SAHF計測開始
13:16 TDR計測開始
13:18 MBARI採泥(青・1本)
13:22 生物採集(第2キャニスター)
13:24 TDR計測終了
13:29 No.9SAHF計測終了
13:30 No.8SAHF計測終了
13:36 No.9SAHF計測開始
13:38 NO.8SAHF計測開始
13:40 TDR計測開始
13:45 H1143-2マーカーブイ設置
13:48 TDR計測終了
13:53 No.9SAHF計測終了
13:55 No.9SAHF計測開始
14:05 No.9SAHF計測終了
14:06 No.8SAHF計測終了
14:14 No.9SAHF計測開始
14:16 No.8SAHF計測開始
14:19 TDR計測開始
14:22 TDR計測終了
14:30 No.9SAHF計測終了
14:33 No.8SAHF計測終了
14:38 H764-3種木鉢マーカー回収
14:39 H1143-3マーカーブイ設置
14:42 No.8SAHF計測開始
14:45 TDR計測開始
14:47 TDR計測終了
14:51 MBARI採泥(赤・1本)
14:56 生物採集(第3キャニスター)
15:01 No.8SAHF計測終了
5. 15:59 D=984m No.8SAHF計測開始
(37-34.274N 137-57.889E)
16:09 No.8SAHF計測終了
16:11 離底 D=984m
1
2
3
4
5
37° 34. 20N
137° 57. 90E
0
3000m
※ 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
#1143 DIVE
2010年06月17日
日本海 上越海盆西部
縮尺 1／3000
測位 D-GPS(MX9400 LEICA)
測地系 WGS-84 DATUM (世界測地系)
音速 1468.3m／s (D＝1100m)


S: 1/3000
SAHF:負異常
窪地:ハイドレード壁
(137, -10)
15:18
Rim of depression
983.3m
白色域視認
ハイドレートの穴視認
H760-3植木鉢マーカー
SAHF:先端低い
H760-1&2植木鉢マーカー
15:31
983m
段差視認
HFPC:吸い込み?
カーボネイト視認
バブル視認
H601-2マーカー
捨てカニ籠視認
着底点
カニマンション
D=998m
SAHF:S字
Landed 09:56
red crab gathered around Jaba'i snails (groundwater vent)
11:07
position of crator Lost(*)
983m
NNE-SSW dike of Carbonate crusts
H601-1マーカー
SAHF:先端高い
H764-2&3植木鉢マーカー
Water thermometer
#1 Marker 1143-1
#1 SAHF-9
#1 MBARI (S)
#1 Sharpgum for isopods
Kumade sampling for sediments
small bacteria mat
Approach to the hydrate cliff
Hydrate Hole
15:27
15:45 983.5m
16:00 SAHF-8
983.9m
(132, -17)
Marker H764-3
11:31 983m
11:35 983m
11:45 983m found Marker H764-2&3
Site of Integrated Measurements
(10-06-)
(NT10-10)
HYPER-DOLPHIN
No.1143 Dive
NIHON-KAI
JYOETSU-KAIBON
SEIBU
Akira Takeuchi
17 June 2010
CHAKUTEI : D=
RITEI : D=
FUJYOU :
DATUM (WGS-84)
XY ORIGIN 37-34.200N 137-57.900E
* Error of accoustic location ranges about 2.5% of slant distance
CENTER 37 34.200N 137-57.900E

Submersible Observation

ROV submersible survey, HPD Dive #1143, was carried out around a mound on the middle part of the Joetsu Knoll (Fig. 17). The main purpose of this survey is to clarify the hydrological regime around the crater site, which was found in NT07-20 Cruise, using multipoint heat flow measurement. Payloads are four MBARI type push corer, two SAHF, TDR sensor, slurp gun with six canister bottles, Kumade sampler, two small sampling box, three marker buoys, and a water temperature data logger for long-term monitoring.

The ROV arrived at a depth of 989 m (St. 1143-1) on the western slope of the mound, and moved eastward. Carbonate crusts are scattered on seafloor to the St. 1143-2 (987 m). We found a few flocks of red snow crabs gathering around of large carbonate crusts, which look like a crab apartment (called “Maison de Crabe”) (Fig. 18). This may be one of red snow crab behaviors.

We deployed a water temperature data logger at St. 1143-3 (985 m) for long-term monitoring (Fig. 19). We also measured heat flow and sampled

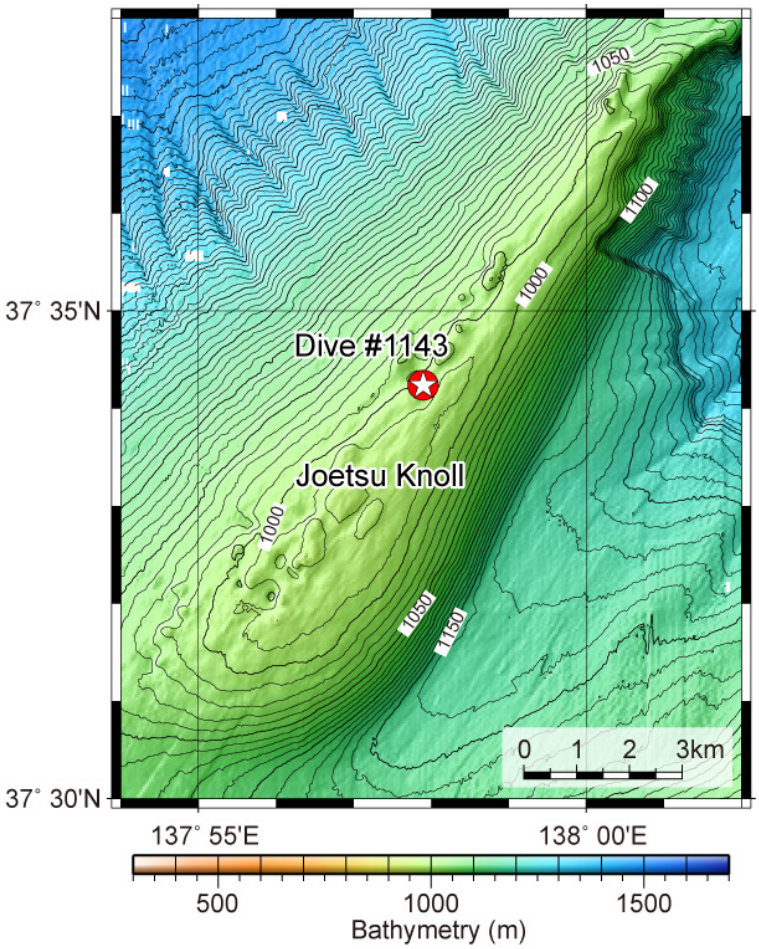


Fig. 17. Dive point of HPD Dive #1143 on the Joetsu Knoll.

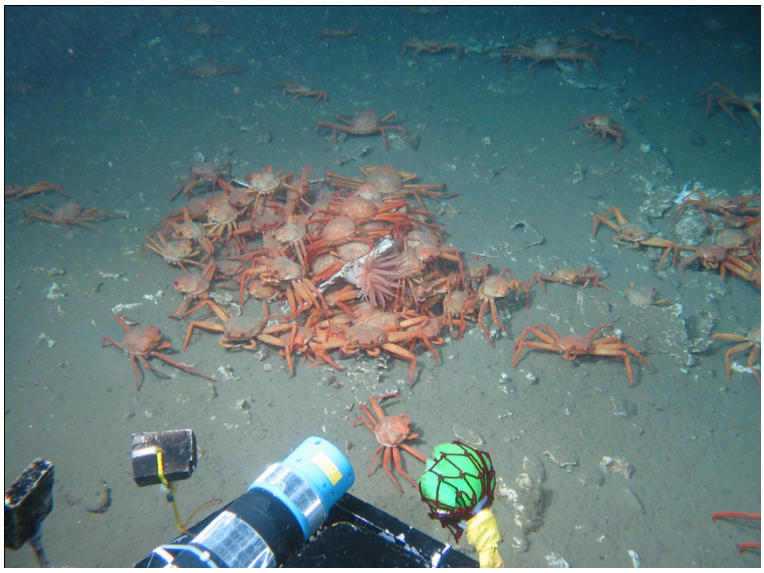


Fig. 18. A flock of red snow crabs gathering around of a large carbonate crust at St. 1143-2 (987 m).

mud and krill at this station. Then, we moved to southeastward area (crater site) of the mound. Unfortunately, it took one hour to find the crater site (St. 1143-4), because bottom water is turbid.

The crater-like depression was discovered in the NT07-20 Cruise, and formed by self-collapse and floating up of methane hydrate block (Matsumoto et al., 2009). After 2.7 years, this depression is now covered by about 30 cm-thick muddy sediments (Fig. 20). This means that sedimentation rate is extremely high in this area. We conducted multi-point heat flow measurement, TDR measurement, and sampling of push cores and some benthic organisms.

We moved to find the outcrop of methane hydrate wall to northward area of the mound. Unfortunately, turbid bottom water prevented us from finding the outcrop and time ran out.

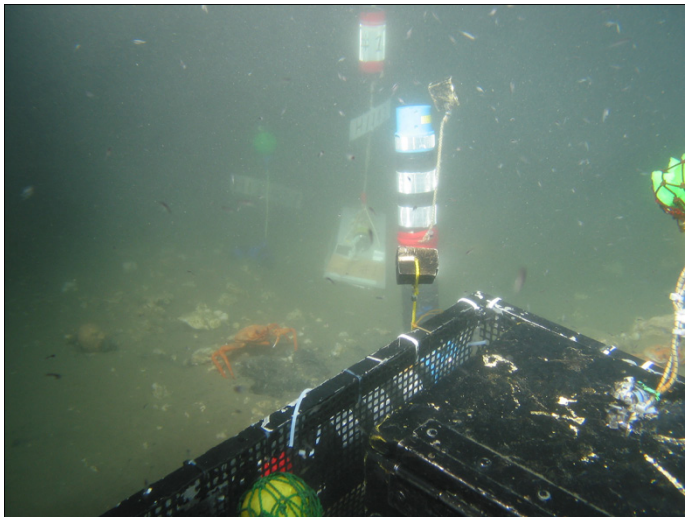


Fig. 19. A water temperature data logger at St. 1143-3 (985 m).

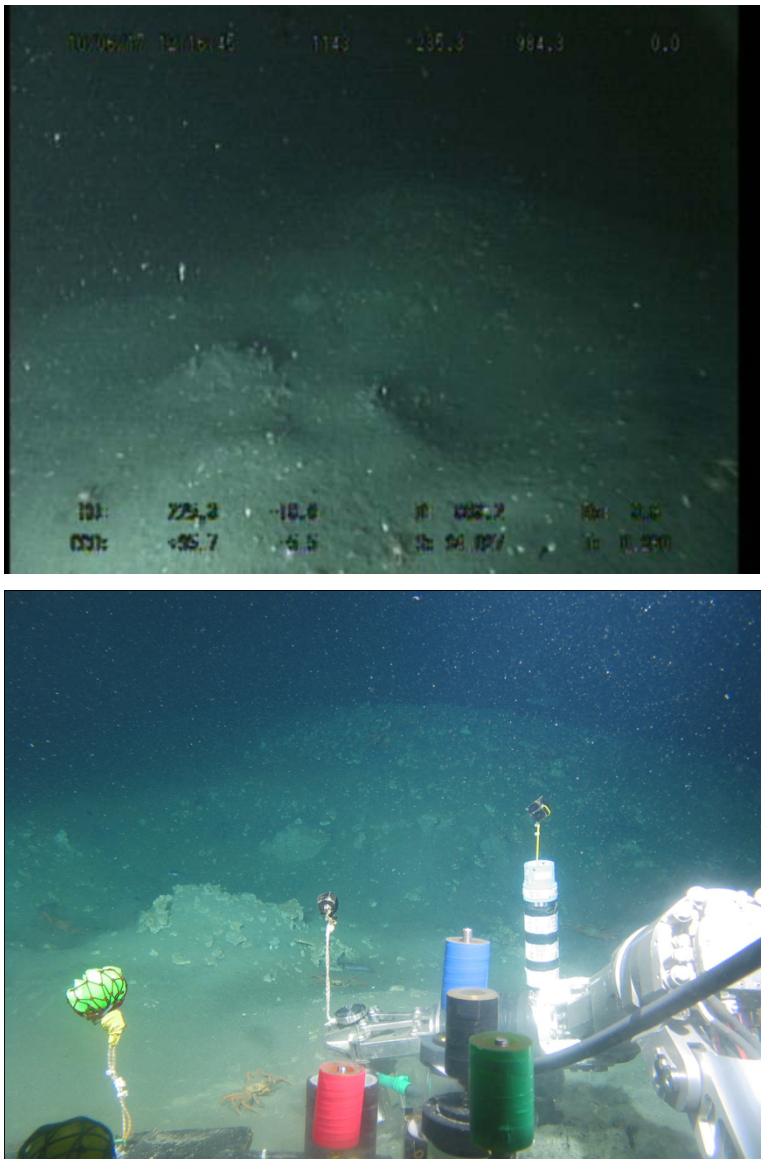


Fig. 20. A crater-like depression at St. 1143-4 (985 m). Top: CCD camera. Bottom: SEAMAX camera.

6.4 Heat Flow Measurement

Objectives

On several mounds at the Joetsu Gas Hydrate Field of the Joetsu Basin, Machiyama et al. (2009) have observed extremely high heat flow anomalies up to 4 W/m^2 and non-linear temperature profile such as upward/inward concave profiles and negative temperature gradients near the sites of methane seepage and methane outcrops. The distribution of high heat flow anomalies and non-linear temperature profiles is a key for understanding the role of upward fluid flow on the production of methane hydrates or bubbles. However, these anomalies are localized, and so far it has not been obtained a quantified picture for the magnitude of upward flow and methane budget.

In this cruise, we plan to obtain the distribution of heat flow precisely in order to grasp the locality of high heat flow anomalies and non-linear temperature profiles, which enables us to quantify the upward fluid flow and the methane budget. We conduct measurements at the middle part of the Umitaka Spur where the highest heat flow 4 W/m^2 were measured in 2007 and at the middle part of the Joetsu Knoll where negative temperature gradients were measured. We deploy a water temperature data logger at the middle part of the Joetsu Knoll in order to check whether long-range (day to year) fluctuations of the bottom water temperature affect the heat flow anomalies.

In addition, we have heat flow measurements at the northern part of the Toyama Trough, at which methane plume were detected.

Preliminary results

We had 27 SAHF measurements during the three dives (HPD #1141, HPD #1142, and HPD #1143) with two SAHF probes (one during HPD #1142). Table 2 summarizes the measured temperature data and the estimated heat flux through the seafloor for each measurement, and Figure 21 displays the temperature profiles. Here we calculate heat flow from the measured temperature gradient (with tilt correction) and an inferred thermal conductivity. We assume the thermal conductivity to be 0.9 W/K/m at all the measured points, referring a typical value for surface sediments in this site.

Figure 22 plots the locations of 12 heat flow stations at the middle part of the Umitaka Spur (HPD #1141) with the dive track. We observed heat flow at four stations outside the Spur (SHF1-4); the obtained values around 100 mW/m coincide with the regional value (Yamano et al., 1996). We conducted precise observations around two bacterial mats (SHF5-8, 9-12), around which very high heat flow 4 W/m^2 was observed in 2007. The maximum heat flow value up to 400 W/m was recorded near the center of the mats, and the heat flow value decreased with the distance from the center of the mats increases. At some stations, we measured kinked and upward concave temperature profiles.

Figure 23 plots the locations of two heat flow stations at the A1 site of the north of the

Toyama Trough (HPD #1142) with the dive track. We measured heat flow at two sites (SHF13, 14). The measured values ~100 mW/m^2 are in the range of the preexisting regional mean value (Yamano et al., 1996).

Figure 24 plots the locations of 13 heat flow stations at the middle part of the Joetsu Knoll (HPD #1143) with the dive track. We obtained low heat flow at which we deployed a water temperature data logger (SHF15), and a strong negative temperature slope near the site of hydrate exposure (SHF27). We conducted precise heat flow measurements in and around a collapsed crater (SHF16-26), which may be formed by self-destruction of an accumulated methane hydrate body under the condition of high methane flux (Matsumoto, 2009). The floor of the crater is covered with sediment (the thickness is estimated with 30 to 50 cm from photo analysis), and the tops of three debris mounds are protruded. This covered structure has been formed at least after the previous cruise conducted in Oct. 2007. On the two mounds, we obtained relatively low heat flow around 300 mW/m^2. In contrast, two meters away from the mounds, heat flow is as high as 600 mW/m^2. At some stations, we have kinked and upward/downward concave temperature profiles. We note that we observed bubbles emerging from the seafloor when SAHF was penetrated into the seafloor by 20-30 cm and was pulled out.

References

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Table 2 Summary of SAHF measurements.

Station	SN	Longitude	Latitude	Depth (m)	Penetration	Pull	N	G (mK/m)	Gerr (mK/m)	tilt (deg)	Q (mW/m^2)	Comment on G	Comment on location
								no tilt correction			with tilt correction		
2010.6.15 HD1141													
SHF1	8_1	138_00.035E	32_26.107N	938	9:47	10:09	5	99.5	0.76	5	89.9		on flat land
SHF2	8_2	138_00.101E	32_26.106N	935	10:30	10:45	5	101.5	1.37	11	93.0		on flat land
SHF3	8_3	138_00.174E	32_26.014N	905	11:38	11:53	5	80.2	1.44	14	74.4		on calcite crust
SHF4	8_4	138_00.188E	32_26.012N	903	12:10	12:26	5	118.2	0.76	44	147.8		
SHF5	8_5	138_00.210E	32_25.969N	905	12:57	13:40	5	396.4	6.46	5	358.1	upwelling?	near H1141-2 (on a bacterial mat)
SHF6	9_1	138_00.210E	32_25.969N	905	13:05	13:48	5	370.2	14.51	16	346.6		0.5 m away from SHF5
SHF7	9_2	138_00.210E	32_25.969N	905	14:06	14:40	5	310.9	0.55	4	280.5		2m away from SHF5
SHF8	8_6	138_00.210E	32_25.969N	905	14:27	14:51	5	269.9	4.37	18	255.4	upwelling?	1m away from SHF5
SHF9	9_3	138_00.210E	32_25.969N	905	14:59	15:30	5	249.0	1.50	10	227.6	upwelling?	on another bacterial mat
SHF10	8_7	138_00.210E	32_25.969N	905	15:04	15:31	5	271.2	1.32	20	259.7	upwelling?	0.5 m away from SHF9
SHF11	8_8	138_00.210E	32_25.969N	905	15:35	15:49	5	224.4	1.09	14	208.2		1.5 m away from SHF9
SHF12	8_9	138_00.210E	32_25.969N	905	15:54	16:09	5	151.0	2.31	15	140.7		near H759-2 (3 m away from SHF9)
2010.6.16 HD1142													
SHF13	9_1	138_04.955E	38_10.354N	1782	13:28	13:43	5	106.7	1.42	4	96.2		
SHF14	9_2	138_04.955E	38_10.392N	1784	15:26	15:40	5	115.5	3.11	1	103.9		
2010.6.17 HD1143													
SHF15	9_1	137_57.859E	37_34.254N	985	10:12	10:47	5	78.4	1.06	9	71.5	water temp varies?	near H1143-1
SHF16	9_2	137_57.907E	37_34.232N	985	11:53	12:14	5	347.5	0.75	23	339.7	kink or upweling?	near H764-2
SHF17	9_3	137_57.907E	37_34.232N	985	12:26	12:53	5	318.9	2.16	17	300.1		in the caldera floor
SHF18	8_1	137_57.907E	37_34.232N	985	12:32	12:55	5	337.4	2.12	22	327.4		in the caldera floor
SHF19	9_4	137_57.907E	37_34.232N	985	13:12	13:29	5	460.6	3.70	11	422.3	kink	in the caldera floor
SHF20	8_2	137_57.907E	37_34.232N	985	13:14	13:30	5	560.6	5.54	11	514.0		in the caldera floor
SHF21	9_5	137_57.907E	37_34.232N	985	13:36	13:53	5	257.2	0.74	19	244.8	downwelling?	in the caldera floor
SHF22	8_3	137_57.907E	37_34.232N	985	13:38	14:06	5	387.9	2.05	13	358.3		in the caldera floor
SHF23	9_6	137_57.907E	37_34.232N	985	13:55	14:05	5	359.2	3.78	7	325.7		in the caldera floor
SHF24	9_7	137_57.907E	37_34.232N	985	14:14	14:30	5	398.2	1.39	9	362.8		in the caldera floor
SHF25	8_4	137_57.907E	37_34.232N	985	14:16	14:33	5	465.0	3.24	11	426.4		in the caldera floor
SHF26	8_5	137_57.907E	37_34.232N	985	14:42	15:01	5	234.4	2.41	11	214.9		near H1143-3 (H764-2)
SHF27	8_6	137_57.889E	37_34.274N	984	15:59	16:09	5	N/A	N/A	19	N/A	negative	near hydrate wall

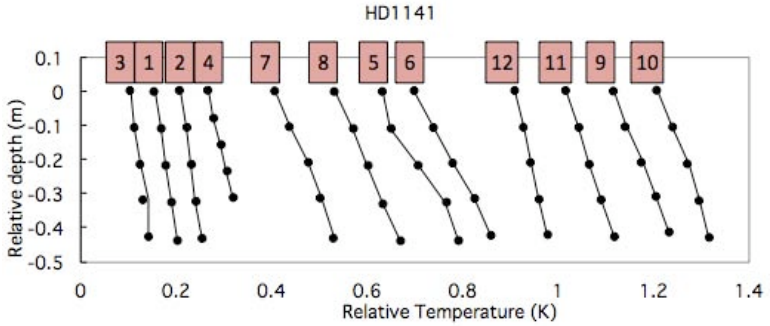
SN: serial number of SAHF in used

N: numbers of penetrated sensors

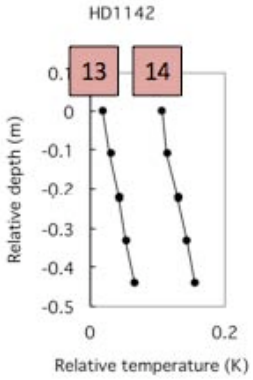
G: temperature gradient

Q: heat flow (with thermal conductivity 0.9 W/m/k)

(a)



(b)



(c)

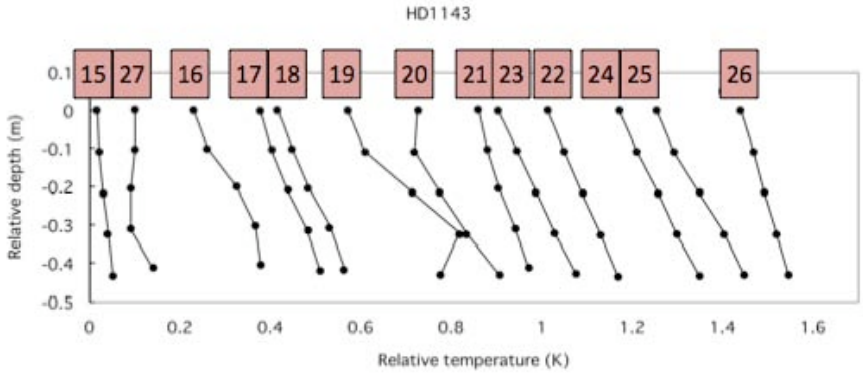
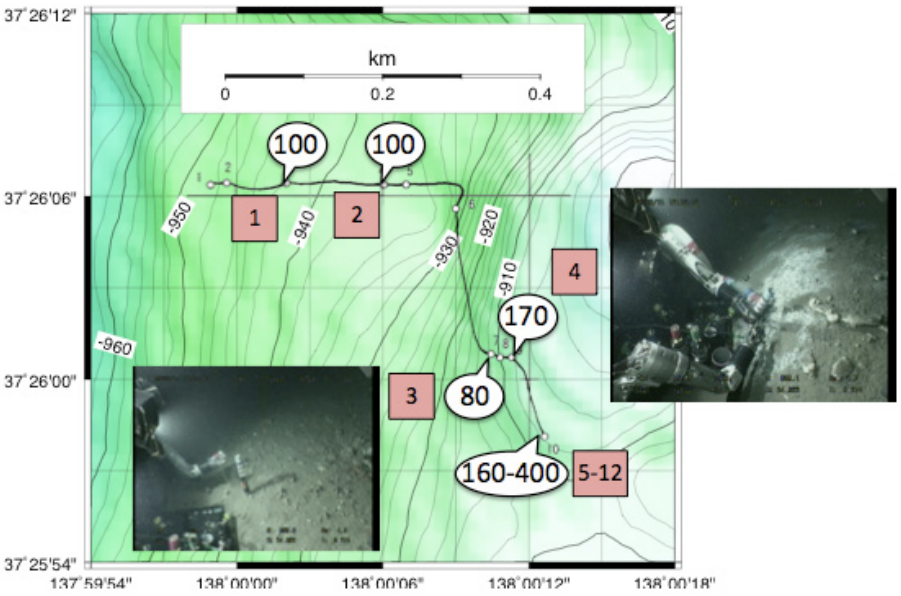
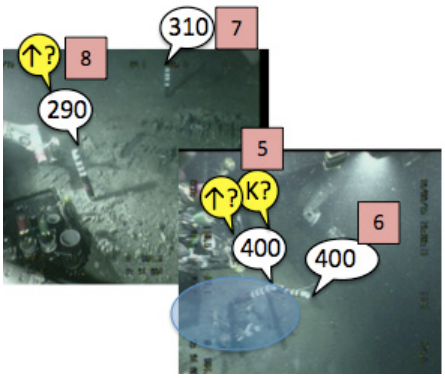


Fig. 21. Temperature profiles of 27 stations taken during the present cruise. (a), (b), and (c) are for the dives HPD #1141, HPD #1142, and HPD #1143, respectively. The pink squares correspond to the station numbers.

(a)



(b)



(c)

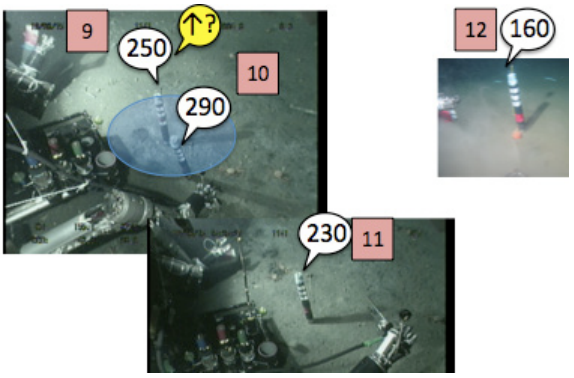


Fig. 22. (a) Locations of 12 SAHF stations taken during the dive HPD #1141 embedded on the dive track of HPD. (b) and (c) are the close up pictures of two bacterial mats at which heat flow measurements were conducted. The pink squares denote the station numbers, and the numerals in the white circles denote the temperature gradient in mK/m. The symbols↑" and "K" in the yellow circles denote the upwelling and kinked temperature profiles, respectively. (bathymetry data taken from Dr. Mineo Hiromatsu of Univ. Tokyo)

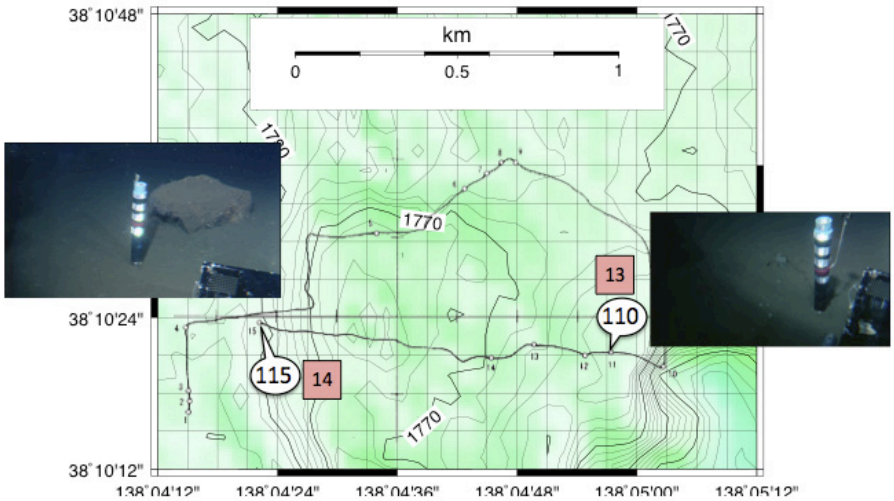
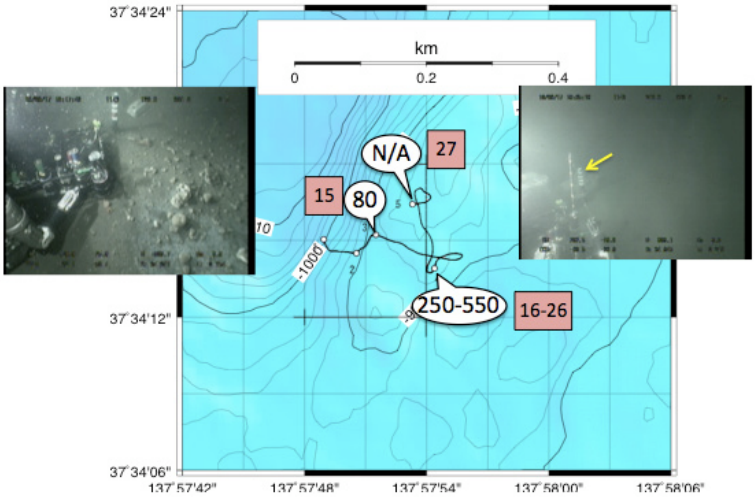


Fig. 23. Locations of 2 SAHF stations taken during the dive HPD #1142 embedded on the dive track of HPD. The meanings of the numbers and symbols are the same as those in Figure 22.

(a)



(b)

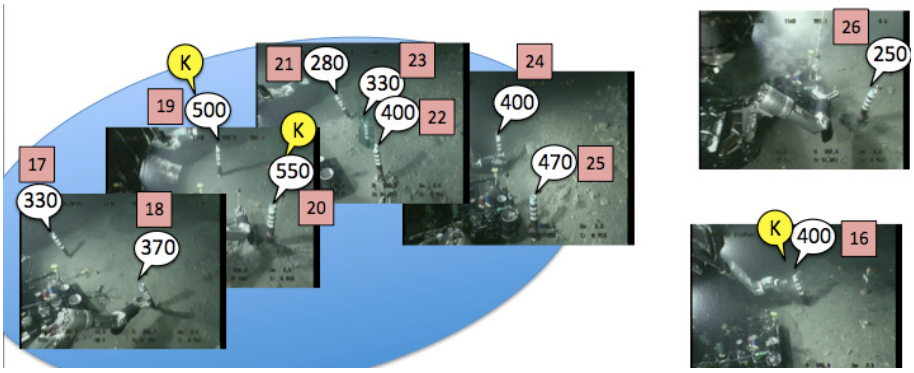


Fig. 24. (a) Locations of 13 SAHF stations taken during the dive HPD #1143 embedded on the dive track of HPD. (b) Close up pictures of the station 16 to 27. The meanings of the numbers and symbols are the same as those in Figure 22. (bathymetry data taken from Dr. Mineo Hiromatsu of Univ. Tokyo)

7. List of Post-Cruise Studies

Each plan of post-cruise studies is listed as follows.

(1)

Theme

Hydrological regime and properties of seafloor accumulation and auto-collapse of methane hydrate under high methane flux environment

Topics

1. Reanalysis of preliminary data as well as the pre-existing data (Machiyama et al., 2009), in especially with those with kinked and upward/downward concave temperature profiles.
2. Quantitative estimation of the strength of heat flow anomalies associate with bacterial mats at the middle part of the Umitaka Spur (data analysis with an aid of numerical modeling).
3. Estimation on whether thermal equilibrium is achieved on the sediment covered crater floor at the middle part of the Joetsu Knoll (data analysis with an aid of numerical modeling).
4. Modeling study on hydrology of methane supplying fluid flow.
5. Modeling study on the dynamics of methane hydrate in a collapsed crater upon abrupt sedimentation.

Researchers

Yoshifumi Kawada, Hiroaki Fukase, Hideaki Machiyama, Masataka Kinoshita, Makoto Yamano, Shusaku Goto, Ryo Matsumoto…etc.

Data

SAHF data, CTD data, video, and photographs from Dive #1141 and #1143

(2)

Theme

Analyzes on biotic components, distributions and food-web on methane-seep ecosystem around the Joetsu Knoll and the Umitaka Spur.

Researchers

Hideaki Numanami, Robert Jenkins

Data & Samples

Video, photographs, CTD data, biological samples and sediment samples from Dive #1141 and #1143,

(3)

Theme

A new technique for measuring gas bobbles in the sea floor by Time Domain Reflectometry (TDR) method

Researchers

Hiroyuki Ochiai., Kosuke Noborio, Ryo Matsumoto, Mineo Hiromatsu, and Hideaki Machiyama

Data

TDR data, CTD data, video, photographs from Dive#1141 and #1143

(4)

Theme

Geochemical and microbiological studies under high methane flux environment

Researchers

Hitoshi Tomaru, Katsunori Yanagawa, Robert Jenkins, Ryo Matsumoto, Yoshitaka Kakuwa, Shigenori Ogihara, Akihiro Hiruta, Antonio Fernando Menezes Freire…etc.

Data & Samples

Video, photographs, CTD data, sediment and rock samples, and interstitial water from Dive #1141 and #1143

(5)

Theme:

Seabed truth study for sources of strong back-scattering on the side-scan image, with the special reference to geomorphology, gravity and seismic profiling in the central Toyama Trough

Researchers:

Akira Takeuchi, Shigekazu Kusumoto, Hajime Chiba, Badalahu Bao, Ayaka Kiriyama, and Toshitaka Gamo

Data & Samples:

Video, photographs, CTD data, sediment and rock samples, and interstitial water from Dive #1142, existing geophysical data

(6)

Theme:

Research for sea water structure in Toyama trough by using the CTD data, the acoustic echo sounder data and the images at deep sea

Researchers:

Hajime Chiba, Akira Takeuchi, Shigekazu Kusumoto, Badalahu Bao, Ayaka Kiriyama, Tomonori Matsuura and etc.

Data & Samples:

Video, photographs, CTD data, acoustic echo sounder data

(7)

Theme

Search for the origin of methane supply along the Toyama Deep Sea Channel in Toyama Trough using chemical analysis

Researchers

Toshitaka Gamo, Noriko Nakayama, Jing Zhang, Urumu Tsunogai, Tomonori Matsuura, Peajin Kim, Kyohei Matsumoto, Tomoko Ota, Shintaro Sato.

Data & Samples

Video, photographs, CTD data, sediment and interstitial water, and bottom seawater from Dive #1142.

Acknowledgements

We are grateful to Captain Hitoshi Tanaka and the crew of R/V *Natsushima*, and Chief ROV Operator Kazuya Mitsufuji and the operators of ROV *Hyper-Dolphin* for their professional support during this cruise. We also thank Morifumi Takaesu, marine technicians, for making this cruise a success and Research Vessel Management and Operations Department of JAMSTEC for their kind and helpful supports.

APPENDIX

XBT DATA

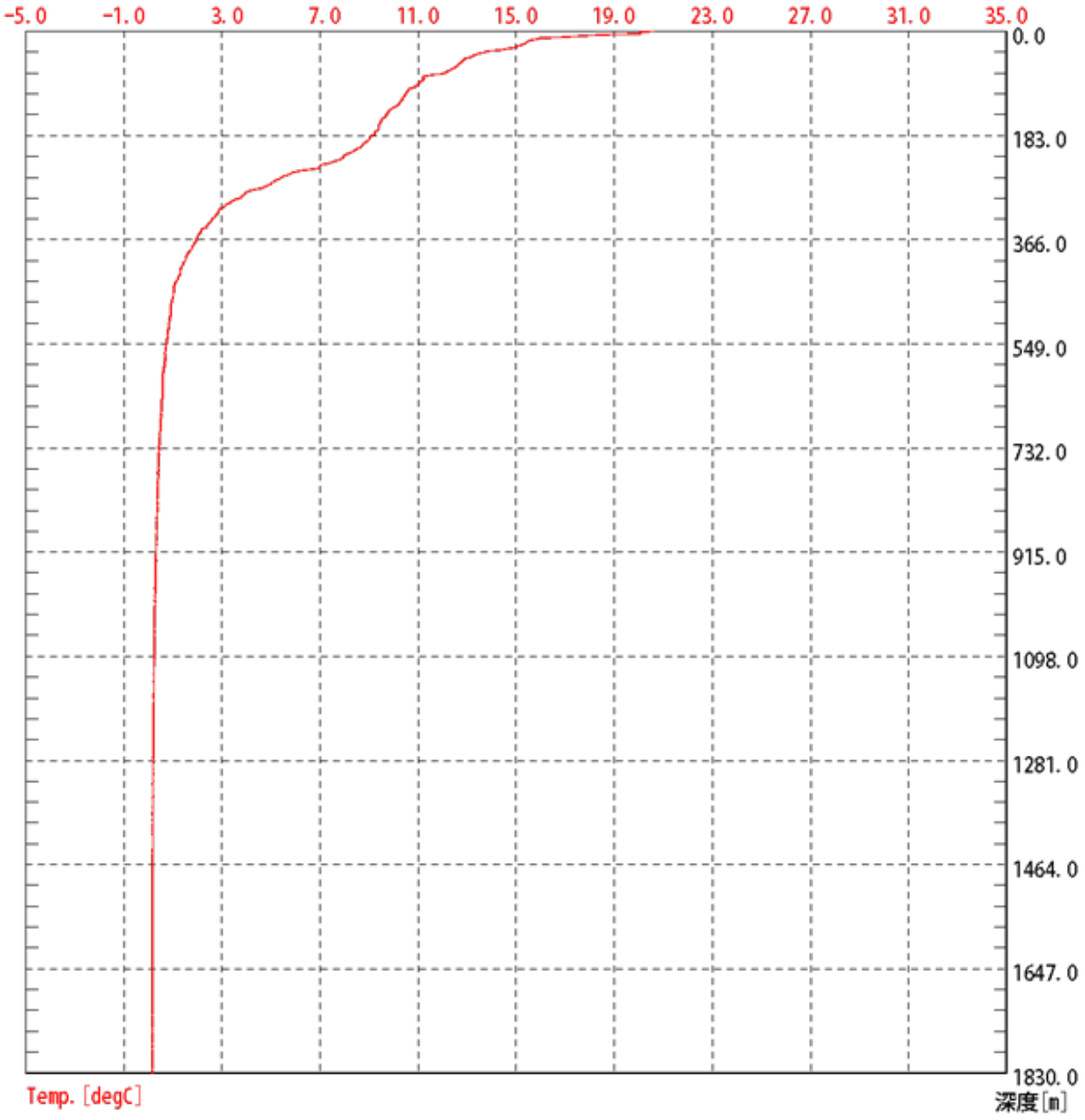
TSK XBT/XCTD-SYSTEM TS-MK130 Tsurumi-Seiki CO.,Ltd (Ver.2.06)

データパス名 ： c:¥Program Files¥MK-130¥data¥
データ名 ： BT-037320100613
データナンバ ： 0373
日付 ： 2010/06/13
時刻 ： 11:02:23
緯度 ： 38-16.7640N
経度 ： 138-02.4097E

ディバイス名 ： XBT
プローブタイプ ： T05
深度係数 a ： 6.828
深度係数 b ： -1.82
最大深度(m) ： 1830
データ数 ： 1831

BATHYプローブ ： 231
BATHY処理器 ： 43
深度ステップ ： 1m

TSK XBT/XCTD-SYSTEM TS-MK130 -鉛直分布図印刷- (Ver.2.06)



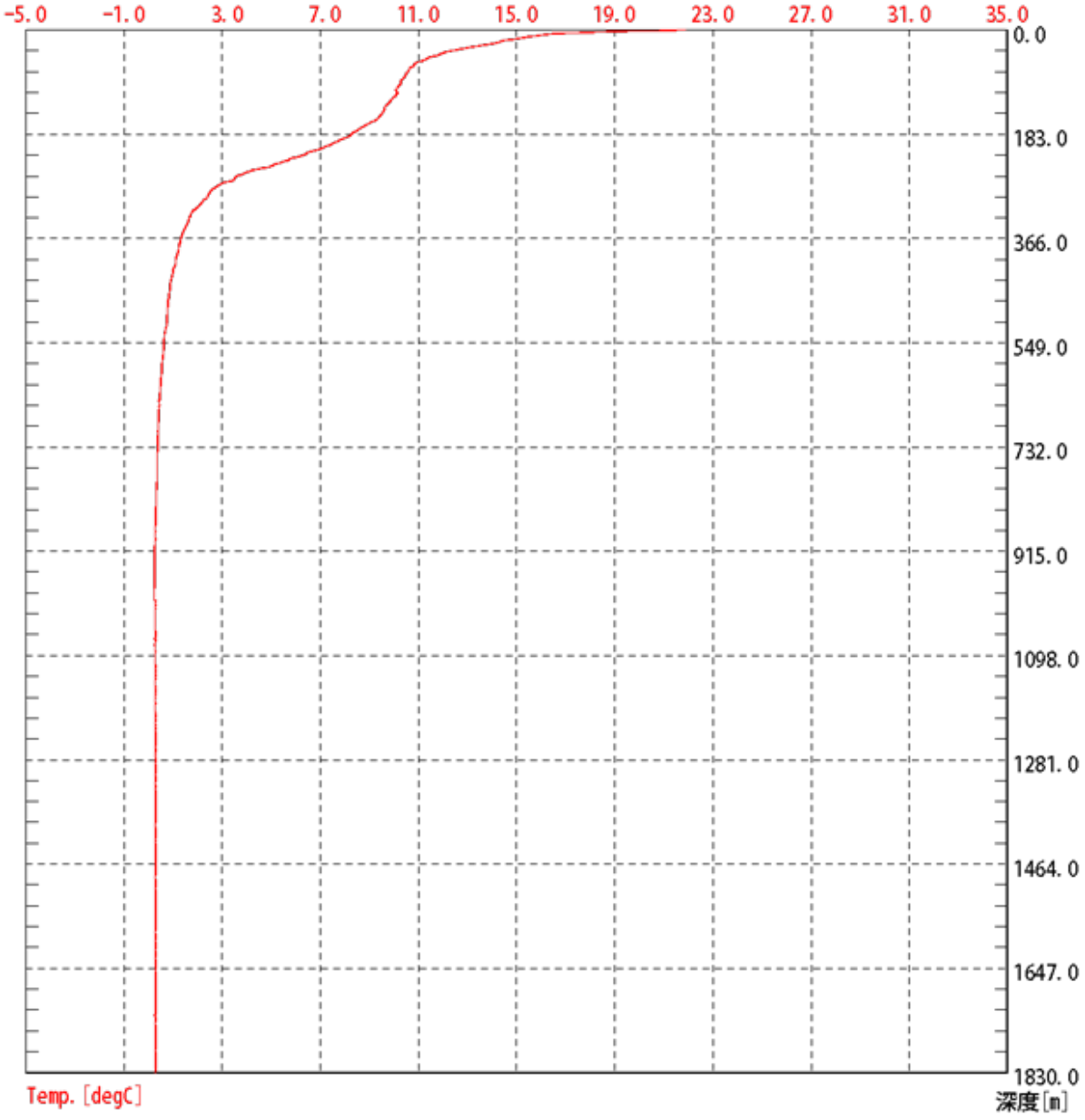
TSK XBT/XCTD-SYSTEM TS-MK130 Tsurumi-Seiki CO.,Ltd (Ver.2.06)

データパス名 ： c:¥Program Files¥MK-130¥data¥
データ名 ： BT-037420100614
データナンバ ： 0374
日付 ： 2010/06/14
時刻 ： 23:20:55
緯度 ： 37-26.1670N
経度 ： 138-00.0598E

ディバイス名 ： XBT
プローブタイプ ： T05
深度係数 a ： 6.828
深度係数 b ： -1.82
最大深度(m) ： 1830
データ数 ： 1831

BATHYプローブ ： 231
BATHY処理器 ： 43
深度ステップ ： 1m

TSK XBT/XCTD-SYSTEM TS-MK130 -鉛直分布図印刷- (Ver.2.06)



TSK XBT/XCTD-SYSTEM TS-MK130 Tsurumi-Seiki CO.,Ltd (Ver.2.06)

データパス名 ： c:¥Program Files¥MK-130¥data¥
データ名 ： BT-037520100616
データナンバ ： 0375
日付 ： 2010/06/16
時刻 ： 21:28:35
緯度 ： 37-34.1781N
経度 ： 137-57.7699E

ディバイス名 ： XBT
プローブタイプ ： T05
深度係数 a ： 6.828
深度係数 b ： -1.82
最大深度(m) ： 1830
データ数 ： 5790

BATHYプローブ ： 231
BATHY処理器 ： 43
深度ステップ ： ALL

TSK XBT/XCTD-SYSTEM TS-MK130 -鉛直分布図印刷- (Ver.2.06)