doi : 10.17596/0002919

Natsushima / *HYPER-DOLPHIN* Cruise Report

NT14-11 Leg.1 and Leg.2

Elucidation of the marine ecosystem fluctuation mechanism in the

Sanriku offshore area

Sanriku offshore area

June 23, 2014 – July 25, 2014

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

Contents of NT14-11 Leg.1 and Leg.2 Cruise Report

0. Acknowledgements

We are grateful to Captain Mr. Hiroaki Masujima and Masayoshi Ishiwata, Chief Officer Mr. Takaaki Shishikura and Chief Engineer Mr. Kazunori Noguchi for their safe navigation and their skillful handling of "R/V Natsushima".

Great thanks are due to Commander Mr. Tomoe Kondo and Mr. Yoshinari Ohno and "*HYPER-DOLPHIN*" operation team for their operations in sampling.

We also thank Mr. Hisanori Iwamoto and Mr. Yuji Fuwa, Nippon Marine Enterprises, Ltd., for his attentive supports.

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

1. Cruise Information

1.1 Cruise ID : NT14-11 (Leg.1 & Leg.2)

1.2 Name of vessel : R/V Natsushima *HYPER-DOLPHIN* 3000

1.3 Title of the cruise :

Elucidation of the marine ecosystem fluctuation mechanism in the Sanriku offshore area

1.4 Title of proposal :

Elucidation of the marine ecosystem fluctuation mechanism in the Sanriku offshore area

1.5 Representative of the Science Party: Yasuo Furushima [JAMSTEC]

1.6 Cruise period : June 23th, 2014 - July 25th , 2014

Leg.1: June 23th - July 10th, 2014

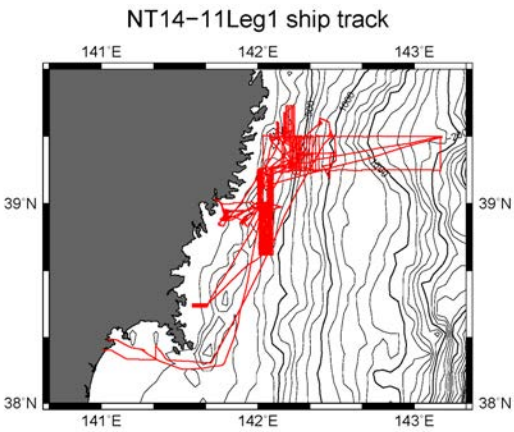
Leg.2: July 12th - July 25th, 2014

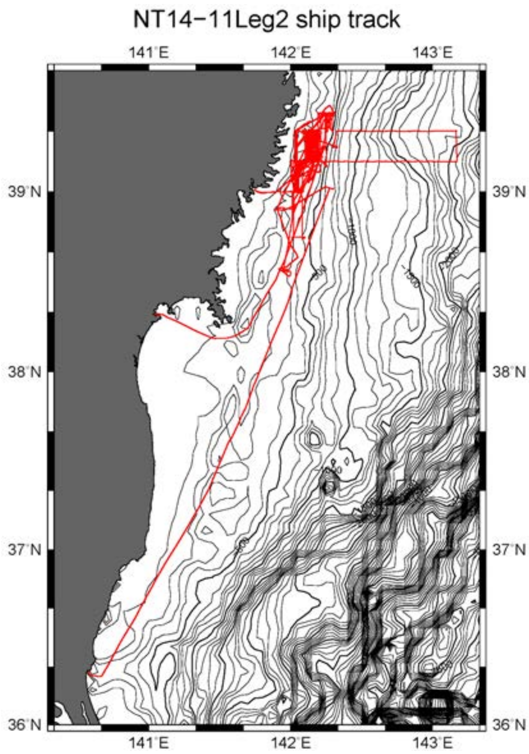
1.7 Ports of call :

Sendai Shiogama Port (Miyagi) – Shiogama Port (Miyagi) – Ooarai Port (Ibaraki)

1.8 Research area : Sanriku offshore area

1.9 Research Map





1.10 Cruise Log

NT14-11 Leg1 Shipboard Log (23th June, 2014 – 10th July, 2014)

Date and Local Time		Description	Position/Weather/Wind/ Sea condition
23-Jun-14	12:00	scientists onboard	6/23 12:00 (UTC+9h)
	12:40-13:00	scientists meeting	38-16.4N,141-00.2E
	13:00	departure from Sendai Shiogama port, Miyagi	fine but cloudy
	13:30-14:10	lecture for life of shipboard life and safety	SSE-3 (gentle breeze)
	14:15-14:35	operation meeting between scientists and ship crew	1 (sea calm)
	16:40-17:00	pray to KONPIRASAN for safety cruise	0 (No swell)
	19:00-19:25	scientists meeting	Visibly: 8'
24-Jun-14	06:48-07:03	deploy 1000 m lander	6/24 12:00 (UTC+9h)
	07:30-07:33	calibrating lander position	39-20.6N,142-10.0E
	07:48-07:50	recover shuttle elevator	fine but cloudy
	11:31	release XBT	NE-1 (light air)
	13:06	launching HPD (HPD#1664Dive)	1 (calm)
	13;31	HPD landing (293m)	1 (Low swell sea)
	16:32	HPD leave the bottom (295m)	Visibly: 8'
	17:01	HPD come up to the surface	
	17:50-	finding 300m lander by acoustic deck unit	
	19:00-19:10	scientists meeting	
25-Jun-14	-03:00	finding 300m lander by acoustic deck unit	6/25 12:00 (UTC+9h)
	06:40	released XBT	38-56.5N,141-47.0E
	08:00-16:35	Interferometoric sonar operation	cloudy
	17:59	released XBT	South-2 (light breeze)
	18:03-	MBES survey	1 (calm)
	19:01	released XBT	1 (Low swell sea)
	19:00-19:25	scientists meeting	Visibly: 6'
26-Jun-14	04:16	released XBT	6/26 12:00 (UTC+9h)
	-06:00	MBES survey	38-56.5N,141-47.0E
	07:58-16:35	Interferometoric sonar operation	fine but cloudy
	17:23	released XBT	SSE-3 (gentle breeze)
	17:24-	MBES survey	2 (sea smooth)
	18:27	released XBT	1 (Low swell sea)
	19:05-19:40	scientists meeting	Visibly: 8'
27-Jun-14	-04:00	MBES survey	6/27 12:00 (UTC+9h)
	04:00	released XBT	38-30.0N,141-40.0E
	08:04-16:23	Interferometoric sonar operation	fine but cloudy
	08:21	released XBT	SSE-4 (moderate breeze)
	19:00-19:40	scientists meeting	2 (sea smooth)
	20:50-	MBES survey	1 (Low swell sea)
	20:56	released XBT	Visibly: 8'
28-Jun-14	04:16	released XBT	6/28 12:00 (UTC+9h)
	-06:14	MBES survey	39-24.0N,142-08.0E
	08:55-16:44	Interferometoric sonar operation	fine but cloudy
	09:54	released XBT	SSE-3 (gentle breeze)
	19:00-19:20	scientists meeting	2 (sea smooth)
	19:07-	MBES survey	3 (Moderate short)
	19:11	released XBT	Visibly: 8'
	21:35	released XBT	
29-Jun-14	04:09	released XBT	6/29 12:00 (UTC+9h)
	06:43	released XBT	39-00.8N,141-44.9E
	-09:09	MBES survey	rain

	10:25	let go anchor at off Ofunato port	ENE-5 (fresh breeze)
	13:00-13:10	scientists meeting	3 (sea slight)
			3 (Moderate short)
			Visibly: 5'
30-Jun-14	07:00	arrived at research area	6/30 12:00 (UTC+9h)
	07:13-15:34	Interferometoric sonar operation	38-55.0N,141-48.0E
	07:32	released XBT	fine but cloudy
	16:44-21:29	MBES survey	SSW-3 (gentle breeze)
	16:47	released XBT	2 (sea smooth)
	18:55	released XBT	3 (Moderate short)
	19:00-19:25	scientists meeting	Visibly: 8'
01-Jul-14	07:35	Three scientists (Fujikura, Matsumoto, Yokooka) embarked and six scientists (Oguri, Kasaya, Sawa, Tanaka, Nakatsuka, Yokoyama) disembarked	7/1 12:00 (UTC+9h) 38-55.5N,141-46.5E
	10:09	launching HPD (HPD#1665Dive)	fine but cloudy
	10:27	HPD landing (114m)	ENE-3 (gentle breeze)
	16:20	HPD leave the bottom (117m)	2 (sea smooth)
	16:34	HPD come up to the surface	2 (Low swell long)
	18:18-	MBES survey	Visibly: 8'
	18:19	released XBT	
	19:00-19:35	scientists meeting	
	20:46	released XBT	
02-Jul-14	00:07	released XBT	7/2 12:00 (UTC+9h)
	-03:49	MBES survey	39-24.0N,142-24.0E
	03:49	released XBT	fine but cloudy
	07:02	released XBT	ENE-1 (light air)
	09:01	launching HPD (HPD#1666Dive)	1 (calm)
	09:35	HPD landing (911m)	1(Low swell sea)
	14:05	HPD leave the bottom (888m)	Visibly: 8'
	14:30	HPD come up to the surface	
	18:40-18:55	scientists meeting	
03-Jul-14	06:42-07:43	MBES survey	7/3 12:00 (UTC+9h)
	07:52	released XBT	39-24.0N,142-24.0E
	09:16	launching HPD (HPD#1667Dive)	fine but cloudy
	09:49	HPD landing (787m)	South-4 (moderate breeze)
	15:58	HPD leave the bottom (718m)	3 (sea slight)
	16:23	HPD come up to the surface	2 (Low swell long)
	18:51-19:57	MBES survey	Visibly: 8'
	18:55	released XBT	
	19:00-19:45	scientists meeting	
	20:02	released XBT	
04-Jul-14	06:33	released XBT	7/4 12:00 (UTC+9h)
	08:24	launching HPD (HPD#1668Dive)	39-11.5N,142-13.0E
	08:50	HPD landing (569m)	cloudy
	16:00	HPD leave the bottom (453m)	NNE-3 (gentle breeze)
	16:16	HPD come up to the surface	2 (sea smooth)
	17:46	released XBT	2 (Low swell long)
	17:48-23:59	MBES survey	Visibly: 1'
	19:00-19:35	scientists meeting	
	21:07	released XBT	
05-Jul-14	08:35	launching HPD (HPD#1669Dive)	7/5 12:00 (UTC+9h)
	08:58	HPD landing (508m)	39-11.0N,142-12.0E
	14:14	HPD leave the bottom (463m)	cloudy
	14:30	HPD come up to the surface	North-4 (moderate breeze)

	15:44-23:35 15:48 17:31 19:00-19:30 21:51	MBES survey released XBT released XBT scientists meeting released XBT	3 (sea slight) 2 (Low swell long) Visibly: 6'
06-Jul-14	05:58-06:33 11:00-11:35 11:52-14:52 14:55-15:52 17:11- 17:15 17:30-17:55	recover sediment trap deploy 6 BTS frame location calibration of BTS frame transponder test MBES survey released XBT scientists meeting	7/6 12:00 (UTC+9h) 39-12.0N,142-12.5E cloudy NNE-2 (light breeze) 1 (calm) 1 (Low swell sea) Visibly: 1'
07-Jul-14	00:06 04:17 -06:16 11:00 12:31-18:16 17:11 19:00-19:30 20:05- 20:09	released XBT released XBT MBES survey Dive was postponed MBES survey and lander finding released XBT scientists meeting MBES survey released XBT	7/7 12:00 (UTC+9h) 39-12.0N,142-12.5E fog SSE-2 (light breeze) 1 (calm) 1 (Low swell sea) Visibly: 0.03'
08-Jul-14	00:06 06:01 -07:18 07:21 09:18 09:37 16:15 16:32 17:45- 18:30-19:10	released XBT released XBT MBES survey released XBT launching HPD (HPD#1670Dive) HPD landing (487m) HPD leave the bottom (481m) HPD come up to the surface XCTD survey line scientists meeting	7/8 12:00 (UTC+9h) 39-12.0N,142-12.5E fine but cloudy WSW-3 (gentle breeze) 2 (sea smooth) 2 (Low swell long) Visibly: 8'
09-Jul-14	-07:23 09:03 09:42 15:01 15:27 17:03 17:28-19:56 17:36 19:10-19:30	XCTD survey line launching HPD (HPD#1671Dive) HPD landing (846m) HPD leave the bottom (755m) HPD come up to the surface release XCTD MBES survey release XBT scientists meeting	7/9 12:00 (UTC+9h) 39-14.5N,142-12.5E cloudy SSE-4 (moderate breeze) 2 (sea smooth) 2 (Low swell long) Visibly: 4'
10-Jul-14	08:00	arrived at Shiogama- port, MIYAGI	7/10 12:00 (UTC+9h) SHIOGAMA

NT14-11 Leg2 Shipboard Log (12th July, 2014 – 25th July, 2014)

Date and Local Time		Description	Position/Weather/Wind/ Sea condition
12-Jul-14	10:00	scientists onboard	7/12 12:00 (UTC+9h)
	11:00-11:50	lecture for life of shipboard and safety	38-19.1N,141-02.4E
	13:00-13:10	evacuation drill	fine but cloudy
	15:00	departure from Shiogama- port, Miyagi	SE-2 (light breeze)
	16:45-17:00	pray to KONPIRASAN for safety cruise	1 (calm)
	18:35-19:35	scientists meeting	0 (No swell)
			Visibly: 8'
13-Jul-14	08:39	launching HPD (HPD#1672Dive)	7/13 12:00 (UTC+9h)
	09:06	HPD landing (495m)	38-11.7N,142-12.3E
	16:18	HPD leave the bottom (485m)	overcast
	16:39	HPD come up to the surface	SW-2 (light breeze)
	18:16-23:17	MBES	1 (calm)
	19:00-20:15	scientists meeting	1 (Low swell sea)
	19:03	released XBT	Visibly: 8'
	20:58	released XBT	
14-Jul-14	06:50	released XBT	7/14 12:00 (UTC+9h)
	08:40	launching HPD (HPD#1673Dive)	39-14.8N,142-14.2E
	09:03	HPD landing (518m)	fine but cloudy
	16:24	HPD leave the bottom (547m)	NNE-4 (moderate breeze)
	16:43	HPD come up to the surface	3 (sea slight)
	17:21-	MBES survey	2 (Low swell long)
	19:00-20:15	scientists meeting	Visibly: 8'
15-Jul-14	04:35	released XBT	7/15 12:00 (UTC+9h)
	-05:45	MBES survey	39-18.0N,142-02.6E
	07:18	released XBT	fine but cloudy
	09:58-12:11	MBES survey	South-4 (moderate breeze)
	13:46	launching HPD (HPD#1674Dive)	2 (sea smooth)
	14:07	HPD landing (408m)	2 (Low swell long)
	18:24	HPD leave the bottom (407m)	Visibly: 6'
	18:41	HPD come up to the surface	
	19:40-20:25	scientists meeting	
16-Jul-14	03:49-05:46	MBES survey	7/16 12:00 (UTC+9h)
	04:06	released XBT	39-25.5N,142-14.5E
	08:35	launching HPD (HPD#1675Dive)	cloudy
	08:52	HPD landing (395m)	SE-1 (light air)
	11:05	HPD leave the bottom (376m)	1 (calm)
	11:24	HPD come up to the surface	1 (Low swell sea)
	14:04	launching HPD (HPD#1676Dive)	Visibly: 4'
	14:24	HPD landing (395m)	
	15:39	HPD leave the bottom (398m)	
	15:56	HPD come up to the surface	
	19:00-19:15	scientists meeting	
17-Jul-14	08:29	launching HPD (HPD#1677Dive)	7/17 12:00 (UTC+9h)
	08:46	HPD landing (396m)	39-25.7N,142-15.9E
	16:22	HPD leave the bottom (396m)	fine but cloudy
	16:37	HPD come up to the surface	East-3 (gentle breeze)
	18:11-20:11	MBES survey	2 (sea smooth)

	19:45-20:20	scientists meeting	1 (Low swell sea) Visibly: 8'
18-Jul-14	03:15-06:00 08:27 08:59 16:15 16:41 17:34- 19:30-20:45	MBES survey launching HPD (HPD#1678Dive) HPD landing (823m) HPD leave the bottom (783m) HPD come up to the surface XCTD survey line scientists meeting	7/18 12:00 (UTC+9h) 39-14.5N,142-18.0E overcast SW-3 (gentle breeze) 2 (sea smooth) 1 (Low swell sea) Visibly: 6'
19-Jul-14	-04:42 07:50 10:15 10:16 11:10 11:31 16:22 16:40 17:59 18:27 18:41- 19:00-19:25 19:37	XCTD survey line Two scientists (Adrian, Uemura) disembarked arrived at research area released XBT launching HPD (HPD#1679Dive) HPD landing (490m) HPD leave the bottom (493m) HPD come up to the surface released XCTD released XCTD MBES survey scientists meeting released XBT	7/19 12:00 (UTC+9h) 38-11.7N,142-12.5E overcast ESE-4 (moderate breeze) 3 (sea slight) 2 (Low swell long) Visibly: 6'
20-Jul-14	 00:00 08:39 10:05 13:27 -15:03 18:00-18:20	HPD maintenance day released XBT released XBT released XBT released XBT MBES survey scientists meeting	7/20 12:00 (UTC+9h) 39-15.0N,142-06.5E rain North-4 (moderate breeze) 3 (sea slight) 2 (Low swell long) Visibly: 2'
21-Jul-14	05:03-06:18 06:24 08:23 08:37 16:21 16:34 18:43- 19:00-19:40 19:05	MBES survey released XBT launching HPD (HPD#1680Dive) HPD landing (285m) HPD leave the bottom (293m) HPD come up to the surface MBES survey scientists meeting released XBT	7/21 12:00 (UTC+9h) 38-34.0N,141-57.0E fine but cloudy NNE-4 (moderate breeze) 3 (sea slight) 3(Moderate short) Visibly: 8'
22-Jul-14	00:03 -05:38 08:27 08:51 10:38 11:14 13:36 14:02 15:21 15:48 17:48- 18:00 18:30-18:50	released XBT MBES survey launching HPD (HPD#1681Dive) HPD landing (495m) HPD leave the bottom (499m) HPD come up to the surface launching HPD (HPD#1682Dive) HPD landing (492m) HPD leave the bottom (487m) HPD come up to the surface MBES survey released XBT scientists meeting	7/22 12:00 (UTC+9h) 39-11.3N,142-13.4E fine but cloudy South-4 (moderate breeze) 3 (sea slight) 4 (Moderate average) Visibly: 8'

	21:15	released XBT	
23-Jul-14	-01:44 07:19 07:41 08:49 09:16 11:27 11:49 17:28 17:48 18:51- 19:10-19:30 20:35 22:19	MBES survey launching HPD (HPD#1683Dive) HPD landing (480m) HPD leave the bottom (475m) HPD come up to the surface launching HPD (HPD#1684Dive) HPD landing (535m) HPD leave the bottom (576m) HPD come up to the surface MBES survey scientists meeting released XBT released XBT	7/23 12:00 (UTC+9h) 39-14.7N,142-14.5E overcast SW-5 (fresh breeze) 3 (sea slight) 3(Moderate short) Visibly: 3'
24-Jul-14	-00:49 08:48-09:03 08:56 10:03 10:34 16:20 16:49 19:00-19:45	MBES survey MBES survey released XBT launching HPD (HPD#1685Dive) HPD landing (804m) HPD leave the bottom (746m) HPD come up to the surface scientists meeting	7/24 12:00 (UTC+9h) 39-01.0N,142-17.2E fine but cloudy NW-2 (light breeze) 2 (sea smooth) 1 (Low swell sea) Visibly: 3'
25-Jul-14	11:00	arrived at Ooarai- port, IBARAKI	7/25 11:00 (UTC+9h) Ooarai

2. Cruise Abstract

This following survey was conducted during the cruise for the purpose of elucidating marine ecosystem fluctuation mechanisms in off the Sanriku coast as part of "The Tohoku Ecosystem-Associated Marine Sciences (TEAMS) research program".

- Submarine topography survey using multi-beam echo sounder (MBES: Seabat8160) equipped on "Natsushima" and highly precise offshore prospecting using synthetic opening sonar (SAS: synthetic aperture sonar)
- Installation and recovery of the long-term marine environment monitoring system (lander)
- Observation of the target resembling a sunken ship confirmed by a sonar survey last year
- Recovery of a sediment trap
- Marine environment observation (such as a grid survey by XCTD, and monitoring of surface seawater)
- Distribution and movement examination of the fisheries resources organism using Biotracking system (such as the release of organisms which attached pingers, in-situ pinger mounting experiment, and environmental research with the ADCP)
- High-resolution sea bottom 3D mapping examination (SeaXerocks: high altitude 3D mapping, Serpent: high accuracy 3D mapping)
- Sampling of deep-sea organisms, seawater, bottom sediment (core), debris

The general description of the results is as follows.

- ➢ An apparatus could confirm the survey using the SAS from on board, therefore highly precise and widespread offshore prospecting was possible even if there was some fishing gear.
- ➢ The substance confirmed by a sonar survey was sunken ship. However, the sunken ship was not due to the huge tsunami of 3.11.
- ➢ In submarine canyon of the Otsuchi offshore area, we discovered white-colored sediments which spread through several kilometers to the east and west. We are analyzing whether this transmutation of the sea bottom is due to the effects of the earthquake.
- ➢ From 3D mapping survey, more detailed information on debris deposition sites were obtained as images.
- ➢ Many basic data about movements of animals such as *Chionoecetes opilio* or *Sebastolobus macrochir* were obtained due to Bio tracking system. Moreover, basics technique to mount pinger to target organisms in in-situ was enabled by using the spear gun.
- ➢ The recovery of the sediment trap succeeded, but the 300m lander system was not recovered successfully.

In addition, each researcher are analyzing obtained many samples and marine environment data.

3. Participants aboard

3.1 Research group

● NT14-11 Leg.1

Chief scientist	Yasuo FURUSHIMA (JAMSTEC)
Associate chief scientist	Shinji TSUCHIDA (JAMSTEC)
Scientist*2	Katsunori FUJIKURA (JAMSTEC)
Scientist	Yoshitaka WATANABE (JAMSTEC)
Scientist*1	Takafumi KASAYA (JAMSTEC)
Scientist*1	Takao SAWA (JAMSTEC)
Scientist*1	Kazumasa OGURI (JAMSTEC)
Graduate student	Haruka SHIBATA (Kitasato Univ.)
Graduate student	Ayako SUDA (Tohoku Univ.)
Research student	Satsuki IIJIMA (Tokai Univ.)
Engineer*1	Nobuhiro TANAKA (Aiichi Industry Co., Ltd)
Engineer*1	Akatsuki YOKOYAMA (Aiichi Industry Co., Ltd)
Engineer*1	Kunihiko NAKATSUKA (SAS Co., Ltd)
Engineer*2	Kyohei MATSUMOTO (NiGK Corporation)
Scientist*2	Hiroyuki YOKOOKA (IDEA Consultants, Inc.)
Marine Technician	Hisanori IWAMOTO (NME Ltd)
Marine Technician	Yuji FUWA (NME Ltd)

<Boarding period>

*1 June 23th – July 1st, 2014

*2 July 1st – July 10th, 2014

● NT14-11 Leg.2

Chief scientist	Yasuo FURUSHIMA (JAMSTEC)
Associate chief scientist	Shinji TSUCHIDA (JAMSTEC)
Scientist	Yoshihiro FUJIWARA (JAMSTEC)
Scientist	Masaru KAWATO (JAMSTEC)
Scientist	Takehisa YAMAKITA (JAMSTEC)
Dedicated staff	Yoshimi TAKAHASHI (JAMSTEC)
Graduate student	Naoto JIMI (JAMSTEC)
Temporary staff	Ayaka KASAI (JAMSTEC)
Scientist*3	Adrian BODENMANN (IIS Univ. of Tokyo)
Scientist	Kazunori NAGANO (IIS Univ. of Tokyo)
Scientist	Akihiro OKAMOTO (NMRI)

Robotics Engineer	Andrew Durrant (Univ. of Sydney)
Engineer*3	Takayuki UEMURA (KOWA Co., Ltd)
Director	Tsuyuko WATANABE (TV Asahi)
Marine Technician	Hisanori Iwamoto (NME)

<Boarding period>

*3 July 12th – July 19th, 2014

3.2 Operation team of the ROV *HYPER-DOLPHIN*

● NT14-11 Leg.1

Operation Manager	Tomoe KONDO
2nd ROV Operator	Katsushi CHIBA
2nd ROV Operator	Yosuke CHIDA
2nd ROV Operator	Teppei KIDO
2nd ROV Operator	Takuma ONISHI
2nd ROV Operator	Atsushi TAKENOUCHI

● NT14-11 Leg.2

Operation Manager	Yoshinari ONO
1st ROV Operator	Tomoe KONDO
2nd ROV Operator	Katsushi CHIBA
2nd ROV Operator	Yosuke CHIDA
2nd ROV Operator	Teppei KIDO
2nd ROV Operator	Ryo SAIGO
3rd ROV Operator	Shinnosuke KUMAGAI

3.3 Captain and crew of the R/V Natsushima

● NT14-11 Leg.1

Captain	Hiroaki MASUJIMA
Chief Officer	Takaaki SHISHIKURA
2nd Officer	Takeshi MURAMATSU
3rd Officer	Kanto ASAJI
Chief Engineer	Kazunori NOGUCHI
1st Engineer	Daisuke GIBU
2nd Engineer	Saburo SAKAEMURA
3rd Engineer	Kota KATAOKA
Chief Electronics Operator	Takehito HATTORI

2nd Electronics Operator	Michiyasu KATAGIRI
3rd Electronics Operator	Takayuki MABARA
Boat Swain	Seiji HOSOKAWA
Able Seaman	Kazumi OGASAWARA
Able Seaman	Toshiaki MATSUO
Able Seaman	Jiro HANAZAWA
Sailor	Hirotaka SHIGETA
Sailor	Toshiya SAGA
No.1 Oiler	Katsuyuki YOSHIDA
Oiler	Masanori UEDA
Oiler	Eiji ARATAKE
Oiler	Daiki SATO
Oiler	Aoi TAKAMIYA
Oiler	Tomonori YAMANE
Chief Steward	Ryuei TAKEMURA
Steward	Yoshinobu HASATANI
Steward	Kazuhiro HIRAYAMA
Steward	Hiroaki MORIMOTO
Steward	Ryu KUBOTA

● NT14-11 Leg.2

Captain	Masayoshi ISHIWATA
Chief Officer	Takaaki SHISHIKURA
2nd Officer	Takeshi MURAMATSU
3rd Officer	Kanto ASAJI
Chief Engineer	Kazunori NOGUCHI
1st Engineer	Daisuke GIBU
2nd Engineer	Saburo SAKAEMURA
3rd Engineer	Daisuke MATSUSHITA
Chief Electronics Operator	Takehito HATTORI
2nd Electronics Operator	Michiyasu KATAGIRI
3rd Electronics Operator	Takayuki MABARA
Boat Swain	Seiji HOSOKAWA
Able Seaman	Kazumi OGASAWARA
Able Seaman	Yoshiaki MATSUO
Able Seaman	Jiro HANAZAWA

Sailor	Hirotaka SHIGETA
Sailor	Yusaku KANADA
Sailor	Toshiya SAGA
No.1 Oiler	Hiroyuki OISHI
Oiler	Katsuyuki MIYAZAKI
Oiler	Eiji ARATAKE
Oiler	Daiki SATO
Oiler	Aoi TAKAMIYA
Oiler	Tomonori YAMANE
Chief Steward	Ryuei TAKEMURA
Steward	Yoshinobu HASATANI
Steward	Tatsunari ONOUE
Steward	Kazuhiro HIRAYAMA
Steward	Ryu KUBOTA


The captain controlled in bridge.
SUPER ROCK
NT14-11 Leg.2

4. Proposals

4.1 Comprehensive proposal

The objectives of the research were to elucidating marine ecosystem fluctuation mechanisms in off the Sanriku coast as part of "The Tohoku Ecosystem-Associated Marine Sciences (TEAMS) research program".

4.2 Respective proposal

The respective proposal of this cruise is as follows.

- Submarine topography survey using multi-beam echo sounder (MBES: Seabat8160) equipped on "Natsushima" and highly precise offshore prospecting using synthetic opening sonar (SAS: synthetic aperture sonar)
- Installation and recovery of the long-term marine environment monitoring system (lander)
- Observation of the target resembling a sunken ship confirmed by a sonar survey last year
- Recovery of a sediment trap
- Marine environment observation (such as a grid survey by XCTD, and monitoring of surface seawater)
- Distribution and movement examination of the fisheries resources organism using Biotracking system (such as the release of organisms which attached pingers, in-situ pinger mounting experiment, and environmental research with the ADCP)
- High-resolution sea bottom 3D mapping examination (SeaXerocks: high altitude 3D mapping, Serpent: high accuracy 3D mapping)
- Sampling of deep-sea organisms, seawater, bottom sediment (core), debris

5. Bathymetric survey using acoustic instruments

The purpose of acoustic survey is to obtain a basic information to understand the impacts to marine ecosystems by the 2011 Earthquake off the Pacific coast of Tohoku) and Tsunami. In this cruise, we obtained acoustic data using hull-mounted multi beam echo sounder to fully understand the recent bathymetry, seafloor condition and a towing synthetic aperture sonar system to obtain higher accuracy data for correcting the current seafloor condition including marine earthquake debris.

5.1 High accuracy acoustic image acquisition using a synthetic aperture sonar

To survey the distribution of earthquake debris transported offshore by backwash of the tsunami, we conducted a detailed seafloor mapping survey. A high frequency multi beam echo sounder and/or a side scan sonar system are often used, in general. In this cruise, we used the synthetic aperture sonar (SAS) system developed by JAMSTEC. This system has the ability to detect double far objects and generate over tenth detail image than conventional side scan sonar. In addition, motion compensation on array signal processing achieves making stabilized image in bad weather condition when sonar systems are rocked.

5.1.1 Instruments

The synthetic aperture sonar consists of two tx-rx array transducer, two rx long array transducer, cylinder for underwater electronics and onboard controller PC. The tx-rx array transducer sends chirp pulses under controlling vertical beam width and directivity, and receives echo like a multi-beam echo sounder. The rx array is used to synthesize long aperture. An original neutral buoyancy tow-fish as a platform of the SAS is used in this cruise. The sonar is towed at about 7m depth to avoid waves and bubbles on sea surface.

5.1.2 Operation summary

The tow-fish are on the aft deck of the ship in initial. The tow-fish is lift up with a crane and release from the ship aft (sea Fig. 6.1.1), and the tow-fish follows the ship going slow. A weight or a depressor is attached tow cable and is hanged down from the same aft deck second. The ship tows the depressor, then the tow-fish follows the depressor. The depths of the tow-fish are controlled by the depressor' depth. The tow-fish is at about 8m in tow, following the ship about 10m apart (see Fig. 6.1.2).The sonar on the tow-ship pings during the operation and record echos in the underwater electronics continuously. When the operation is finished, depressor is retrieved first, the tow-fish later.

Shores near Otsuchi and Onagawa, and near Hirota bay are surveyed. The areas in this cruise are shown Fig. 6.1.3.

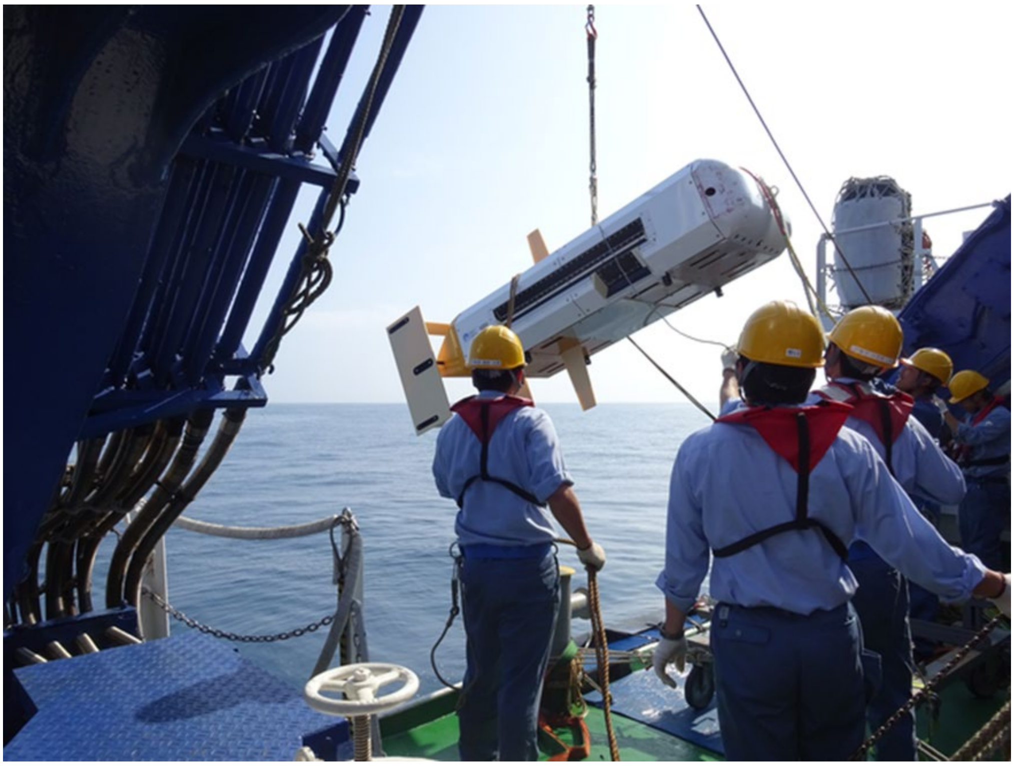


Fig. 5.1.1 Photo of shipboard operation of a synthetic aperture sonar.

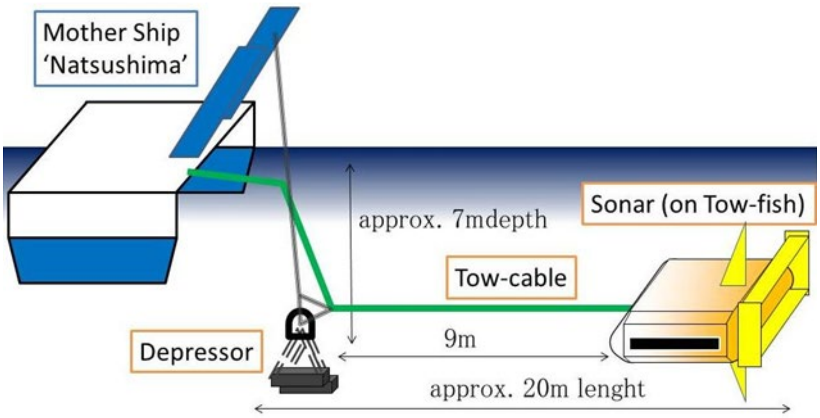


Fig. 5.1.2 The schematic image of the survey used a synthetic aperture sonar.

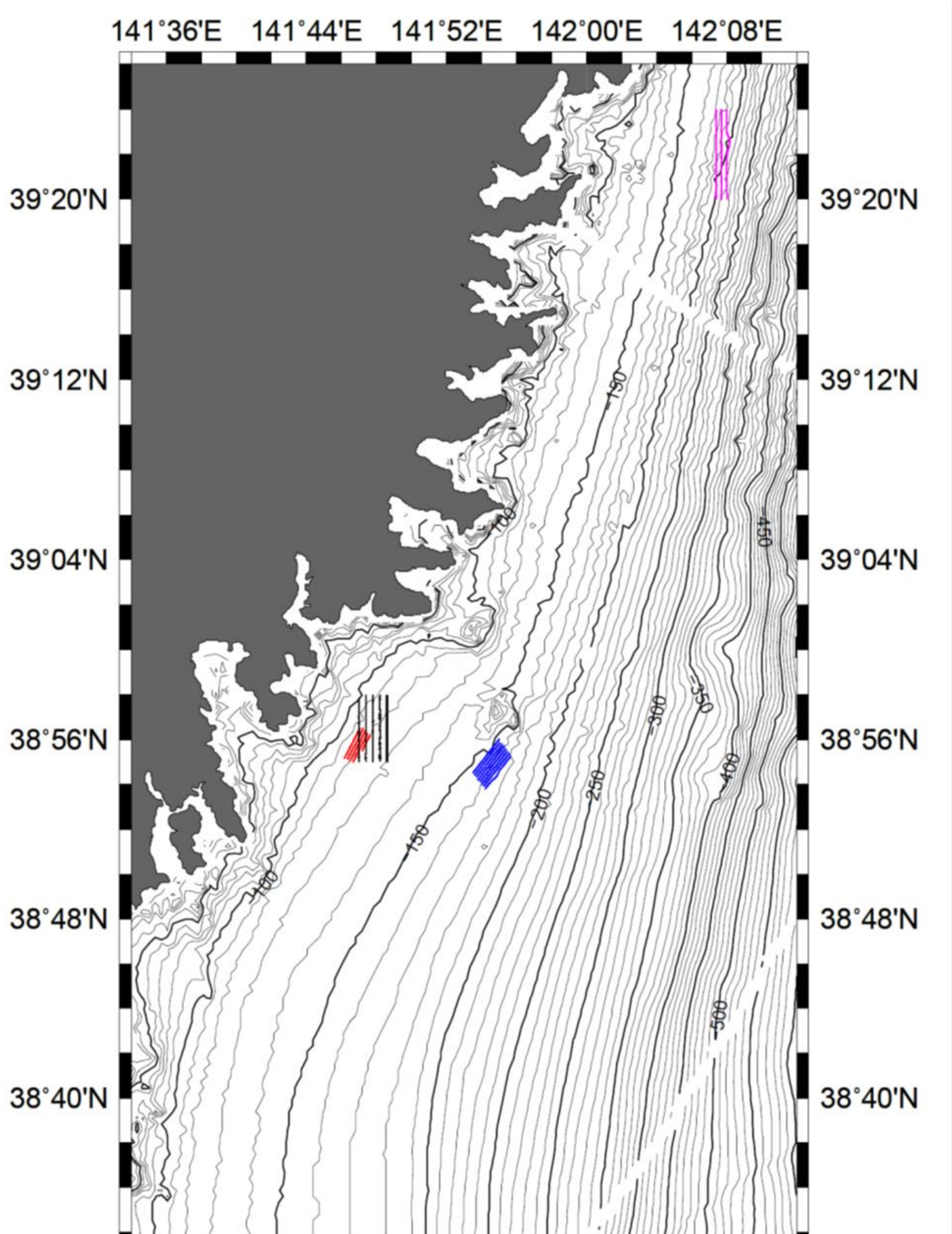


Fig. 5.1.3 Ship tracks of surveys using a synthetic aperture sonar.

Table 5.1.1 Specification of a synthetic aperture sonar system.

Weight	SAS alone: 80 kg in air, 50kg in water. Total underwater system: 250 kg in air, 0 kg in water.
L x W x H	2.3 x 1.2 x 0.7 m
Depth rating	SAS alone: 3000m Total underwater system: 100m
Acoustic pulse	Chirp pulse from 101.5 to 106.5 kHz, 10 msec length
Power	24VDC or 48VDC
Resolution	0.14m Max. in range and azimuth
Transducer array	Two 4ch tx-rx array and two 8ch rx long array

Table 5.1.2 List of SAS survey lines.

Interferometry sonar survey line list

Line Name	Start				End				Remark
	Date	time(UTC)	Latitude	Longitude	Date	time(UTC)	Latitude	Longitude	
6/25 Hirota-wan									
Line1	6/25	03:16:47	38-56.5317N	141-47.0802E	6/25	04:01:20	38-55.1467N	141-46.1581E	detour by buoy from 03:29:00 to 03:31:32
Line2	6/25	04:12:13	38-55.1122N	141-46.3385E	6/25	04:52:54	38-56.4936N	141-47.2502E	
Line3	6/25	05:14:19	38-56.4387N	141-47.4010E	6/25	06:02:37	38-55.0307N	141-46.4777E	
Line4	6/25	06:12:10	38-54.9814N	142-04.9914E	6/25	06:50:01	38-44.9922N	142-04.9914E	
Line5	6/25	07:03:40	38-56.1921N	141-47.6430E	6/25	07:24:49	38-55.4885N	141-47.1854E	
6/26 Hirota-wan									
Line H-1	6/25	23:08:09	38-55.2760N	141-55.6940E	6/25	23:52:35	38-53.7895N	141-54.1888E	
Line H-2	6/26	00:04:20	38-53.9141N	141-54.1094E	6/26	01:02:49	38-55.4085N	141-55.6099E	
Line H-3	6/26	01:12:21	38-55.4973N	141-55.5004E	6/26	01:56:01	38-53.9867N	141-53.9864E	
Line H-4	6/26	02:08:48	38-54.1118N	141-53.9059E	6/26	03:09:46	38-55.6061N	141-55.4074E	
Line H-5	6/26	03:18:47	38-55.7063N	141-55.3140E	6/26	04:05:13	38-54.1839N	141-53.7802E	
Line H-6	6/26	04:16:31	38-54.3116N	141-53.7118E	6/26	05:17:34	38-55.8100N	141-55.2152E	
Line H-7	6/26	05:27:06	38-55.8677N	141-55.0678E	6/26	06:07:59	38-54.3974N	141-53.6015E	
Line H-8	6/26	06:19:19	38-54.5063N	141-53.5058E	6/26	07:26:52	38-56.0242N	141-55.0294E	
6/27 Off onagawa									
Line On-1	6/26	23:16:00	38-29.9960N	141-40.0100E	6/27	01:04:39	38-30.0051N	141-34.9625E	
Line On-2	6/27	01:18:04	38-29.7026N	141-35.0417E	6/27	03:04:11	38-29.6930N	141-40.0051E	
Line On-3	6/27	03:16:46	38-29.3960N	141-39.9724E	6/27	05:09:40	38-29.3987N	141-34.9837E	
Line On-4	6/27	05:20:42	38-29.0911N	141-35.0267E	6/27	07:15:36	38-29.0952N	141-39.9932E	
6/28 Off ootsuchi									
Line Ot-1	6/28	00:42:02	39-20.0260N	142-08.0057E	6/28	02:59:59	39-23.9980N	142-08.0028E	
Line Ot-2	6/28	03:12:28	39-24.0087N	142-07.7038E	6/28	04:56:26	39-19.9804N	142-07.7002E	
Line Ot-3	6/28	05:06:23	39-20.0135N	142-07.4062E	6/28	07:24:29	39-24.0021N	142-07.3993E	
6/30 Hirota-wan									
Line S1	6/29	22:24:27	38-57.8697N	141-46.9984E	6/29	23:50:39	38-54.9899N	141-46.9971E	
Line S2	6/30	00:05:23	38-55.0100N	141-47.4025E	6/30	01:26:47	38-58.0034N	141-47.4023E	
Line S3	6/30	01:44:12	38-58.0091N	141-47.7972E	6/30	03:17:37	38-54.9897N	141-47.7970E	
Line S4	6/30	03:29:57	38-55.0277N	141-48.1952E	6/30	04:45:56	38-58.0240N	141-48.2005E	
Line S5	6/30	04:59:43	38-57.9867N	141-48.6076E	6/30	06:19:47	38-54.9844N	141-48.6042E	

5.2 Bathymetric survey

The objective of MBES survey is collecting continuous bathymetric data as a basic seafloor condition of Tohoku datasets. The "SEABAT 8160" on R/V Natsushima was used for bathymetry and seafloor mapping during the NT13-21 Leg2 cruise. Bathymetric data were collected by a hull-mounted multi-narrow beam echo sounder "SEABAT 8160" of the R/V Natsushima. The SEABAT 8160 system used 50 kHz signal and has hydrophone arrays that synthesize narrow, fan-shaped beams. The detailed specifications are shown in Table 5.2.1

Table 5.2.1 Specifications of a SEABAT8610 system.

Max depth	3000 m
Frequency	50 kHz
Number of beams	126
Swath angle	150 degree (depend on depth)
Each beam width	1.5 x 1.5, 3.0, 4.5, or 6.0 degree
Minimum resolution	1.4, 2.9, 8.9 cm (depend on the above beam width)
Maximum transmit rate	15 ping/sec

To correct the accurate sound velocity of water column for ray-path correction of acoustic multi-beam signal, we used the deeper depth sound velocity profiles that were calculated from temperature from XBT or XCTD data by the equation in Mackenzie (1981) during the cruise. Figure 6.2.1 shows the track lines of bathymetric survey, and Table 5.1.1 shows a list of MBES survey list. The preliminary result of bathymetric data is shown Fig. 5.2.2.

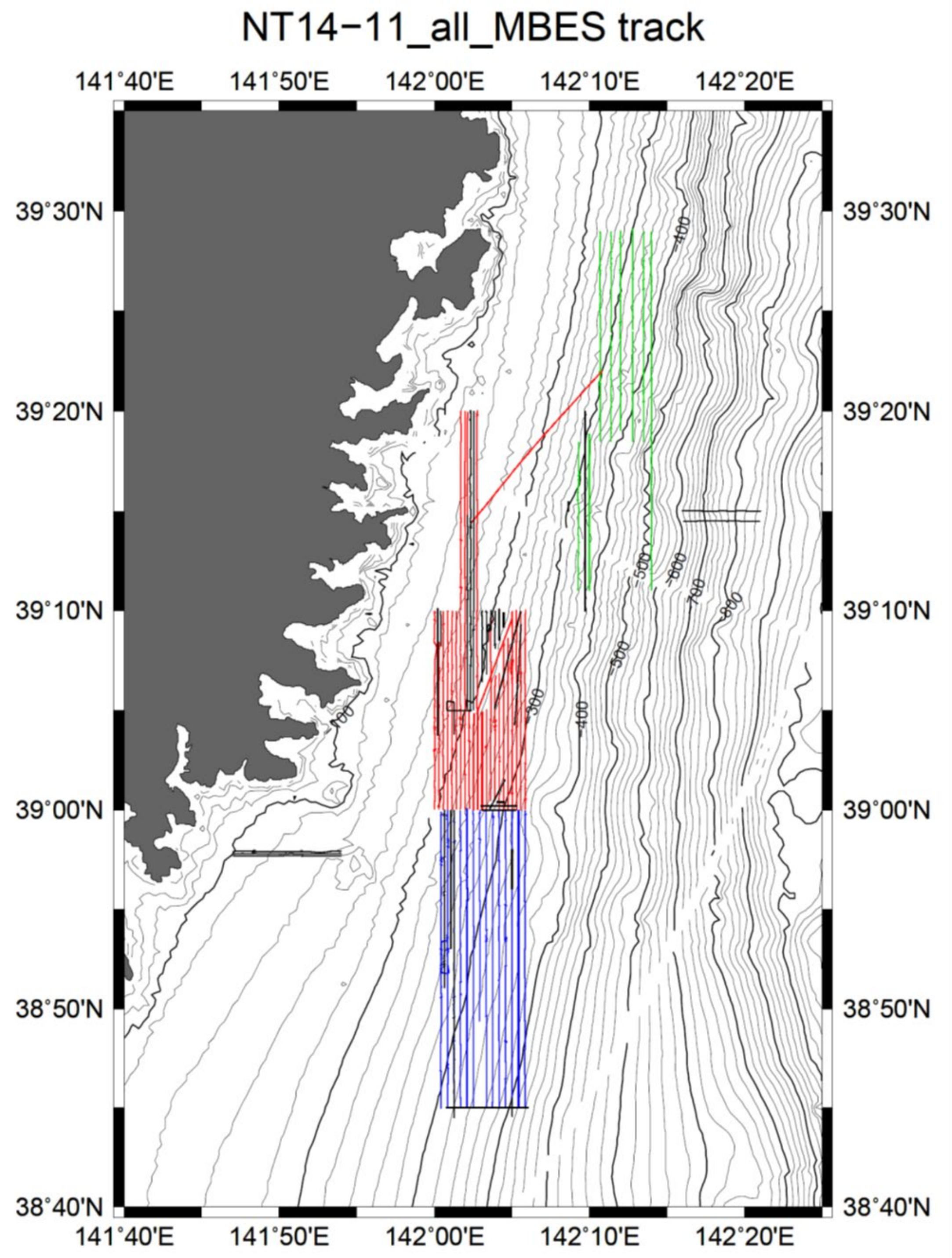


Fig. 6.2.1 Survey lines on this cruise. Dashed lines show survey lines of insufficient quality data. Plotted bathymetric data were the compiled data obtained in previous cruises this project.

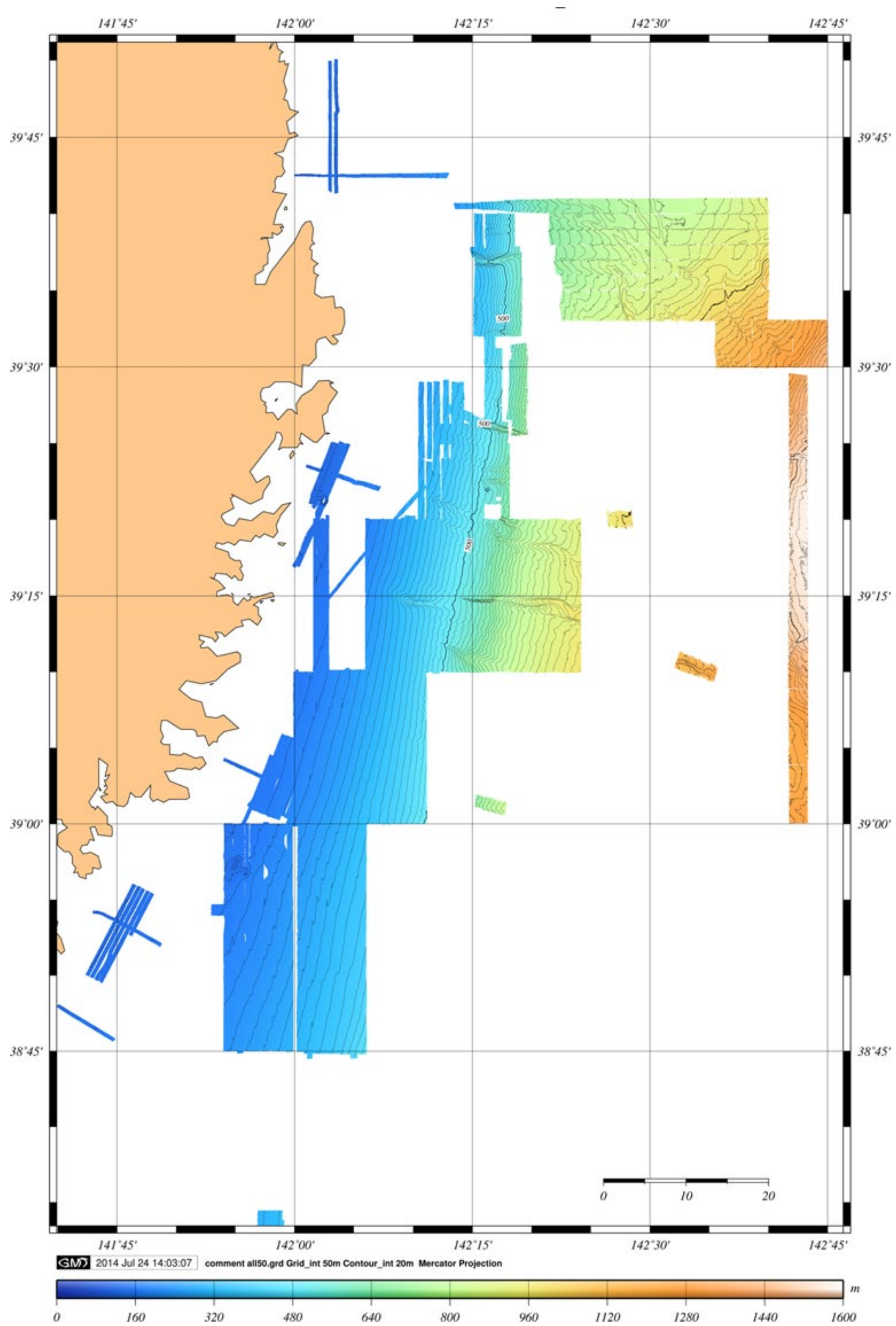


Fig. 6.2.2 Preliminary results obtained MBES data in this cruise.

Table 6.2.1 List of MBES survey lines.

NT14-11 Leg1 MBES survey line list

Line Name	Start				End				Remark
	Date	time(UTC)	Latitude	Longitude	Date	time(UTC)	Latitude	Longitude	
6/25									
Line B1	6/25	09:03:23	38-59.9786N	142-05.8604E	6/25	10:53:24	38-44.9622N	142-05.8449E	
Line B2	6/25	11:00:10	38-45.0437N	142-05.4172E	6/25	12:52:15	39-00.0065N	142-05.4266E	
Line B3	6/25	12:57:44	38-59.9646N	142-05.0033E	6/25	14:47:45	38-44.9922N	142-04.9914E	
Line B4	6/25	14:53:40	38-45.0189N	142-04.5914E	6/25	16:46:57	39-00.0391N	142-04.5923E	
Line B5	6/25	16:51:04	39-00.0067N	142-04.1709E	6/25	18:43:26	38-44.9598N	142-04.1727E	
Line B6	6/25	18:48:54	38-45.0183N	142-03.7494E	6/25	21:00:00	39-00.0172N	142-03.7737E	
6/26									
Line B7	6/26	08:24:01	39-00.0020N	142-03.3340E	6/26	10:18:23	38-44.9601N	142-03.3554E	
Line B8	6/26	12:06:04	38-49.3362N	142-02.9132E	6/26	13:26:22	39-00.0247N	142-02.9323E	
Line B9	6/26	13:30:55	39-00.0062N	142-02.4999E	6/26	15:22:10	38-44.9679N	142-02.5099E	
Line B10	6/26	15:32:45	38-45.0146N	142-02.0991E	6/26	17:14:35	39-00.0615N	142-02.1013E	
Line B11	6/26	17:18:22	38-59.9912N	142-01.6686E	6/26	19:00:44	38-44.9728N	142-01.6980E	
6/27									
Line L1	6/27	11:50:44	39-11.0143N	142-10.0002E	6/27	13:46:37	39-18.8572N	142-09.9955E	
Line L2	6/27	14:14:17	39-19.0253N	142-11.9987E	6/27	16:36:36	39-29.0318N	142-12.0045E	
Line L3	6/27	17:01:55	39-28.9890N	142-14.0017E	6/27	21:14:37	39-11.0079N	142-14.0050E	
6/28									
Line B12	6/28	10:07:42	38-59.9971N	142-01.2738E	6/28	12:32:28	38-45.0191N	142-01.2727E	
Line R1	6/28	14:08:14	38-59.9882N	142-05.8626E	6/28	15:30:22	39-10.0846N	142-05.8668E	
Line R2	6/28	15:34:56	39-09.9977N	142-05.5887E	6/28	17:36:39	38-59.9791N	142-05.5721E	
Line R3	6/28	17:41:20	38-59.9771N	142-05.3106E	6/28	18:56:02	39-10.0519N	142-05.2923E	
Line R4	6/28	19:00:48	39-09.9738N	142-05.0182E	6/28	20:44:49	38-59.9766N	142-05.0365E	
Off hirota1	6/28	21:38:43	38-57.9358N	141-54.0208E	6/28	22:20:33	38-57.9110N	141-46.9827E	
Off hirota2	6/28	22:24:07	38-57.8070N	141-47.0173E	6/28	23:21:11	38-57.8006N	141-53.9924E	
Off hirota3	6/28	23:26:58	38-57.6894N	141-54.0255E	6/29	00:09:53	38-57.6996N	141-46.9872E	
6/30									
Line B13	6/30	07:44:49	38-59.9120N	142-00.4409E	6/30	09:45:49	38-44.9481N	142-00.4405E	
Line B14	6/30	09:51:16	38-45.0020N	142-00.8659E	6/30	12:29:58	39-00.0236N	142-00.8456E	
7/1									
Line R5	7/1	09:18:00	39-00.0199N	142-00.0201E	7/1	10:32:13	39-10.0166N	142-00.0292E	

Line R4-2	7/1	11:42:41	39-09.9838N	142-05.0276E	7/1	13:19:50	39-00.0000N	142-05.0290E	re-survey of R4
Line R6	7/1	13:27:13	39-00.0190N	142-04.7507E	7/1	14:32:46	39-08.6251N	142-04.7345E	
Line R7	7/1	14:36:14	39-08.3777N	142-04.4874E	7/1	15:39:42	38-59.9723N	142-04.4718E	
Line R8	7/1	15:44:30	39-00.0067N	142-04.1994E	7/1	16:37:44	39-06.8885N	142-04.1960E	
Line R9	7/1	16:41:45	39-06.7555N	142-03.9781E	7/1	17:30:32	39-00.4816N	142-03.9083E	
Line R10	7/1	17:33:51	39-00.4289N	142-03.6189E	7/1	18:49:30	39-09.5715N	142-03.6996E	
7/2									
HPD1667-pre1	7/1	21:42:22	39-14.9993N	142-21.0614E	7/1	22:12:25	39-15.0091N	142-15.9547E	
HPD1667-pre2	7/1	22:17:41	39-14.4912N	142-16.0296E	7/1	22:43:21	39-14.4936N	142-21.0095E	
7/3									
Line R11	7/3	09:51:09	39-00.0093N	142-00.2899E	7/3	10:57:52	39-08.4533N	142-00.3173E	
7/4									
Line W1	7/4	08:48:31	39-10.0054N	142-12.3500E	7/4	10:02:00	39-20.0131N	142-12.3321E	
Line W2	7/4	10:08:06	39-20.0032N	142-12.9195E	7/4	11:19:02	39-10.0079N	142-12.9049E	
Line W3	7/4	11:26:39	39-10.0014N	142-13.4773E	7/4	12:53:13	39-19.9962N	142-13.4791E	
Line W4	7/4	13:00:51	39-20.0263N	142-14.0226E	7/4	14:59:50	39-09.9985N	142-14.0180E	
7/5									
Line R12	7/5	06:44:57	39-09.9986N	142-00.5694E	7/5	08:23:46	38-59.9909N	142-00.5745E	
Line R13	7/5	08:30:44	39-00.0121N	142-00.8525E	7/5	10:22:46	39-10.0289N	142-00.8729E	
Line R14	7/5	10:28:00	39-09.9970N	142-01.1808E	7/5	12:09:29	38-59.9995N	142-01.1520E	
Line R15	7/5	12:15:23	39-00.0209N	142-01.4267E	7/5	13:40:17	39-09.9889N	142-01.4142E	
Line R16	7/5	13:49:13	39-09.9966N	142-01.6412E	7/5	14:35:26	39-04.9985N	142-01.6932E	
7/6									
Line L4	7/6	08:11:28	39-11.0190N	142-09.2415E	7/6	10:06:44	39-18.4560N	142-09.3098E	
Line L5	7/6	10:31:08	39-18.4708N	142-10.6949E	7/6	12:01:57	39-23.9560N	142-10.6969E	
Line L6	7/6	12:14:42	39-23.7985N	142-11.3937E	7/6	13:33:30	39-18.4479N	142-11.3942E	
Line L7	7/6	13:56:16	39-18.4606N	142-12.8058E	7/6	15:25:21	39-24.0113N	142-12.7898E	
Line L8	7/6	15:37:25	39-23.9993N	142-13.5081E	7/6	16:59:09	39-18.4487N	142-13.4827E	
Line W5	7/6	17:22:29	39-20.0117N	142-14.5618E	7/6	18:38:45	39-09.9853N	142-14.5848E	
Line W6	7/6	18:45:00	39-09.9736N	142-15.1314E	7/6	20:02:40	39-20.0247N	142-15.1377E	
Line W7	7/6	20:09:18	39-19.9861N	142-15.6738E	7/6	21:16:36	39-09.9836N	142-15.6871E	
7/7									
Line L9	7/7	03:32:35	39-23.9855N	142-10.7428E	7/7	04:58:09	39-28.9932N	142-10.6863E	
Line L10	7/7	05:10:26	39-28.9883N	142-11.4003E	7/7	06:18:11	39-23.9663N	142-11.3853E	

Line L11	7/7	06:43:48	39-24.0593N	142-12.7944E	7/7	08:13:44	39-29.1241N	142-12.7954E	
Line L12	7/7	08:24:12	39-29.0038N	142-13.5295E	7/7	09:26:20	39-23.9746N	142-13.4942E	
Line W8	7/7	11:05:40	39-10.0160N	142-16.2587E	7/7	12:23:27	39-20.0357N	142-16.2537E	
Line W9	7/7	12:30:00	39-19.9945N	142-16.8098E	7/7	13:46:49	39-09.9989N	142-16.8123E	
Line W10	7/7	13:57:14	39-10.0021N	142-17.7955E	7/7	15:13:53	39-20.0769N	142-17.7894E	
Line W11	7/7	15:20:59	39-19.9986N	142-18.7805E	7/7	16:35:52	39-09.9703N	142-18.7694E	
Line W12	7/7	16:44:46	39-10.0016N	142-19.7227E	7/7	18:00:36	39-20.0360N	142-19.7451E	
Line W13	7/7	18:09:34	39-20.0184N	142-21.0010E	7/7	19:23:54	39-09.9440N	142-21.0077E	
Line W14	7/7	19:41:36	39-09.9923N	142-22.2462E	7/7	20:56:25	39-20.0420N	142-22.2522E	
Line W15	7/7	21:10:39	39-19.9794N	142-23.4509E	7/7	22:18:32	39-09.9736N	142-23.5103E	
7/9									
Line R2-1	7/9	08:23:13	39-20.0082N	142-01.9852E	7/9	10:56:17	38-59.9997N	142-01.9859E	

NT14-11 Leg2 MBES survey line list

Line Name	Start				End				Remark
	Date	time(UTC)	Latitude	Longitude	Date	time(UTC)	Latitude	Longitude	
7/13									
Line R17	7/13	09:16:47	39-04.9491N	142-01.6995E	7/13	09:51:47	39-00.0023N	142-01.6868E	
Line R18	7/13	09:59:33	39-00.0363N	142-02.2612E	7/13	10:42:20	39-05.0369N	142-02.2421E	
Line R19	7/13	10:50:01	39-04.8417N	142-02.5507E	7/13	11:25:38	38-59.9974N	142-02.5298E	
Line R20	7/13	11:30:47	39-00.0173N	142-02.8027E	7/13	12:09:40	39-05.0382N	142-02.8069E	
Line R21	7/13	12:14:26	39-04.9514N	142-03.0810E	7/13	12:50:53	38-59.9876N	142-03.0847E	
Anaume-1	7/13	12:58:00	39-00.1951N	142-02.9845E	7/13	13:12:53	39-00.2072N	142-05.3416E	
Anaume-2	7/13	13:17:27	38-59.9964N	142-05.2735E	7/13	13:30:18	38-59.9998N	142-03.0468E	
Line R22	7/13	13:38:19	39-00.0261N	142-03.3587E	7/13	14:17:31	39-05.0734N	142-03.3633E	
7/14									
Anaume-3	7/14	09:21:08	39-04.9863N	142-02.4142E	7/14	09:48:48	39-03.7816N	142-01.2681E	
Anaume-4	7/14	09:57:39	39-03.7492N	142-00.2056E	7/14	10:46:03	39-10.1454N	142-00.2037E	
Anaume-5	7/14	11:49:17	39-00.0064N	142-01.2668E	7/14	14:37:21	38-44.4882N	142-01.2650E	
Anaume-6	7/14	14:46:50	38-44.9930N	142-00.7620E	7/14	15:18:27	38-44.9986N	142-06.0572E	
Anaume-7	7/14	15:29:29	38-44.5241N	142-05.0264E	7/14	15:37:34	38-45.5452N	142-04.9990E	
Anaume-8	7/14	16:40:15	38-56.0155N	142-05.0040E	7/14	16:55:25	38-58.0234N	142-04.9981E	
Anaume-9	7/14	17:15:02	39-00.3853N	142-04.0125E	7/14	17:18:00	39-00.3989N	142-04.5187E	
Anaume-10	7/14	17:42:41	39-04.2338N	142-05.1709E	7/14	18:13:32	39-09.3346N	142-05.5907E	
Anaume-11	7/14	18:21:18	39-09.9787N	142-05.5791E	7/14	19:17:35	39-05.0968N	142-03.8901E	

Anaume-12	7/14	19:33:06	39-05.0363N	142-02.1312E	7/14	20:45:15	39-14.8150N	142-02.1281E	
7/15									
Anaume-13	7/15	00:58:00	39-20.0638N	142-02.3438E	7/15	02:04:15	39-09.9463N	142-02.3326E	
Anaume-14	7/15	02:09:05	39-09.9390N	142-02.5523E	7/15	03:11:07	39-20.0164N	142-02.5404E	
Line R31	7/15	18:49:02	39-10.0149N	142-01.6794E	7/15	20:03:00	39-20.0321N	142-01.7036E	
Line R32	7/15	20:07:56	39-19.9830N	142-02.1574E	7/15	20:46:19	39-14.4974N	142-02.1297E	
Line R33	7/15	20:49:31	39-14.3995N	142-02.3671E	7/15	21:45:00	39-22.0061N	142-10.8060E	
7/17									
Line R34	7/17	18:15:01	39-09.5957N	142-05.0018E	7/17	18:57:52	39-04.8207N	142-02.7352E	
Line R35	7/17	19:11:50	39-04.9276N	142-02.7630E	7/17	21:00:00	39-20.0570N	142-02.7653E	
7/18									
Anaume-15	7/18	20:34:05	39-01.5361N	142-04.5653E	7/18	20:44:12	39-00.0373N	142-03.5603E	
7/19-20									
Line Add-1	7/19	09:41:16	39-20.0462N	142-06.1273E	7/19	10:55:29	39-09.9879N	142-06.1363E	
Line Ad-1	7/19	11:05:12	39-10.0885N	142-05.6315E	7/19	11:47:17	39-04.7881N	142-03.1214E	
Line Add-18	7/19	12:44:41	39-09.8894N	142-11.9221E	7/19	13:57:09	39-20.0542N	142-11.9283E	
Line Add-17	7/19	14:09:34	39-19.1817N	142-11.4366E	7/19	15:29:59	39-09.9957N	142-11.4390E	
Line Add-18	7/19	15:36:29	39-10.0243N	142-10.9617E	7/19	16:53:42	39-20.0285N	142-10.9570E	
Line Add-19	7/19	16:58:52	39-20.0005N	142-10.4515E	7/19	18:36:58	39-09.9884N	142-10.4692E	
Anaume-16	7/19	19:09:53	39-09.9308N	142-04.4754E	7/19	19:16:48	39-09.1717N	142-04.4767E	
Anaume-17	7/19	19:28:58	39-08.5127N	142-04.1843E	7/19	19:46:07	39-10.0953N	142-04.1930E	
Anaume-18	7/19	19:50:11	39-10.0111N	142-03.9277E	7/19	20:07:19	39-08.0864N	142-03.9215E	
Anaume-19	7/19	20:22:42	39-09.0024N	142-03.6410E	7/19	20:44:19	39-10.0464N	142-03.6442E	
Anaume-20	7/19	20:50:34	39-10.0239N	142-03.3268E	7/19	21:19:34	39-06.7829N	142-03.3650E	
Anaume-21	7/19	21:30:12	39-06.4139N	142-03.0824E	7/19	22:10:15	39-10.0206N	142-03.0882E	
Anaume-22	7/19	22:17:29	39-09.9872N	142-02.5212E	7/19	23:02:58	39-04.9878N	142-02.5336E	
Anaume-23	7/19	23:07:40	39-04.9728N	142-02.3463E	7/19	23:53:07	39-10.0110N	142-02.3309E	
Anaume-24	7/20	00:10:32	39-10.0143N	142-00.3980E	7/20	00:25:12	39-08.1966N	142-00.4285E	
Line Add-2	7/20	01:01:35	39-10.0084N	142-06.4243E	7/20	02:17:44	39-20.0062N	142-06.4159E	
Line Add-3	7/20	02:21:50	39-19.9665N	142-06.6983E	7/20	03:39:38	39-09.9844N	142-06.6983E	
Line Add-4	7/20	03:45:25	39-10.0110N	142-06.9719E	7/20	05:15:47	39-20.0319N	142-06.9704E	

Line Add-5	7/20	05:19:37	39-19.9897N	142-07.2647E	7/20	06:03:19	39-15.8454N	142-07.2414E	
7/21									
Anaume-25	7/21	09:43:11	38-51.0269N	142-00.6486E	7/21	10:57:05	39-00.0251N	142-00.6530E	
Anaume-26	7/21	11:02:13	38-59.9829N	142-01.0551E	7/21	11:52:44	38-52.9964N	142-01.0477E	
Line Add-14	7/21	13:53:32	39-10.0059N	142-09.9734E	7/21	16:03:55	39-20.0255N	142-09.9774E	
Line Add-15	7/21	16:10:19	39-19.9814N	142-09.4874E	7/21	17:27:08	39-09.9755N	142-09.4845E	
Line Add-16	7/21	17:31:41	39-10.0054N	142-09.2148E	7/21	19:04:44	39-20.1330N	142-09.2049E	
Line Add-17	7/21	19:20:15	39-19.9711N	142-07.2462E	7/21	20:38:28	39-09.9792N	142-07.2463E	
7/22									
Line Add-6	7/22	08:48:00	39-20.0127N	142-07.5403E	7/22	10:05:30	39-09.9566N	142-07.5292E	
Line Add-7	7/22	10:10:27	39-09.9857N	142-07.8002E	7/22	11:30:40	39-20.0236N	142-07.8237E	
Line Add-8	7/22	11:33:58	39-20.0025N	142-08.1159E	7/22	12:47:14	39-09.9980N	142-08.0964E	
Line Add-9	7/22	12:52:00	39-10.0000N	142-08.3711E	7/22	14:08:26	39-20.0110N	142-08.3642E	
Line Add-10	7/22	14:12:26	39-19.9984N	142-08.6516E	7/22	15:25:11	39-09.9602N	142-08.6532E	
Line Add-11	7/22	15:29:41	39-09.9697N	142-08.9293E	7/22	16:44:32	39-20.0255N	142-08.9386E	
Anaume-27	7/22	17:14:57	39-15.4731N	142-08.6424E	7/22	17:18:45	39-14.9769N	142-08.6559E	
7/23									
Line Add-1	7/23	09:51:00	39-20.0119N	142-14.5855E	7/23	10:28:10	39-25.0270N	142-14.5864E	
Line Add-2	7/23	10:34:09	39-25.0040N	142-15.1596E	7/23	11:09:46	39-19.9954N	142-15.1258E	
Line Add-3	7/23	11:15:58	39-19.9971N	142-15.6974E	7/23	11:52:47	39-25.0314N	142-15.6956E	
Line Add-4	7/23	11:58:35	39-25.0396N	142-16.2603E	7/23	12:24:30	39-21.5200N	142-16.2592E	
Line Add-6-2	7/23	12:47:44	39-20.0106N	142-17.7741E	7/23	13:24:12	39-25.0020N	142-17.7939E	
Line Add-5	7/23	13:32:49	39-24.9948N	142-16.8231E	7/23	13:58:40	39-21.4890N	142-16.8159E	
Anaume-28	7/23	14:34:23	39-19.9958N	142-09.7188E	7/23	15:49:06	39-09.9818N	142-09.7114E	

6. Dive survey results of *HYPER-DOLPHIN*

6.1 Dive list

Dive No.	Date	Time: Landing / Leaving bottom	Site	Latitude (N)	Longitude (E)	Depth (m)	Main purposes
#1664	2013/6/24	13:31	Off Otsuchi	39-19.844	142-10.016	293	Confirmation of recovery of lander system
		16:31		39-19.856	142-10.043	293	
#1665	2014/7/1	10:27	Off Hirota bay	38-55.579	141-46.498	114	Search for a sunken ship
		16:20		38-55.574	141-46.535	117	
#1666	2014/7/2	9:35	Funakoshi submarine canyon	39-23.994	142-23.994	911	To select bio tracking examination area and sampling of snow crab
		14:05		39-24.348	142-23.478	898	
#1667	2014/7/3	9:49	Kamaishi submarine canyon	39-14.771	142-18.508	787	To select bio tracking examination area and sampling of snow crab
		15:58		39-14.766	142-17.066	718	
#1668	2014/7/4	8:50	Off Kamaishi	39-11.485	142-13.420	569	Search for an area for Bio-Tracking System, and sampling snow crabs
		16:00		39-11.584	142-11.864	453	
#1669	2014/7/5	8:58	Kamaishi submarine canyon	39-11.399	142-12.945	508	To collect snow crab for bio tracking examination
		14:14		39-11.410	142-11.995	463	
#1670	2014/7/8	9:37	Kamaishi submarine canyon	39-11.637	142-12.563	487	Biotracking system check, pingered samples release and water gun test
		16:15		39-11.571	142-12.427	481	
#1671	2014/7/9	9:42	White bacteria mat site	39-14.766	142-19.553	846	To detect distribution area of bacteria mat
		15:01		39-14.437	142-18.485	755	
#1672	2014/7/13	9:06	Kamaishi submarine canyon	39-11.544	142-12.739	495	3D Mapping survey in the bio tracking sea area, To confirm the base station for bio tracking.
		16:18		39-11.643	142-21.471	485	
#1673	2014/7/14	9:03	Gareki site	39-14.683	142-14.352	518	3D mapping at a deep sea valley and outside of the valley
		16:24		39-14.834	142-14.214	547	
#1674	2014/7/15	14:07	Trawl track area off Otsuchi	39-25.704	142-14.825	408	Comparison of biomass and biodiversity between locations with and without trawl tracks using two types of 3D mapping system
		18:24		39-25.716	142-14.729	407	

#1675	2014/7/16	8:52	Trawl track area off Otsuchi	39-25.619	142-14.543	395	Comparison of biomass and biodiversity between locations with and without trawl tracks using two types of 3D mapping system
		11:05		39-25.578	142-14.479	376	
#1676	2014/7/16	14:24	Trawl track area off Otsuchi	39-25.623	142-14.493	395	Comparison of biomass and biodiversity between locations with and without trawl tracks using two types of 3D mapping system
		15:39		39-25.627	142-14.511	398	
#1677	2014/7/17	8:46	Trawl track area off Otsuchi	39-25.610	142-14.537	396	Comparison of biomass and biodiversity between locations with and without trawl tracks using two types of 3D mapping system.
		16:22		39-25.606	142-14.488	396	
#1678	2014/7/18	8:59	Bacteria mat area	39-14.672	142-19.092	823	Survey of extending bacteria mat using 3D mapping system (Serpent) and sampling the mat.
		16:15		39-14.740	142-18.442	783	
#1679	2014/7/19	11:31	Bio-tracking site	39-11.561	142-12.648	490	To install pingers to snow crabs for Bio-Tracking System
		16:22		39-11.648	142-12.607	493	
#1680	2014/7/21	8:37	Ophiuroidea area off Minami-Sanriku	38-33.941	141-56.907	285	Observation and two types of 3D mapping of the dense Ophiuroidea population area.
		16:21		38-33.955	141-57.084	293	
#1681	2014/7/22	8:51	Bio-tracking site	39-11.845	142-12.690	495	To recovery Bio-Tracking System No.1 and No.4
		10:38		39-11.688	142-12.679	499	
#1682	2014/7/22	14:02	Bio-tracking site	39-11.561	142-12.648	492	To recovery Bio-Tracking System No.3, No.5 and ADCP
		15:21		39-11.648	142-12.607	487	
#1683	2014/7/23	7:41	Bio-tracking site	39-11.576	142-12.458	480	To recovery Bio-Tracking System No.2 and No.6
		8:49		39-11.669	142-12.330	475	
#1684	2014/7/23	11:49	Debris site	39-14.663	142-14.540	535	Observation and two types of 3D mapping of marine debris area
		17:28		39-14.802	142-14.443	576	
#1685	2014/7/24	10:34	Gentle Slope Canyon, Off Ryori Bay	39-00.971	142-17.613	804	To observe southern slope area
		16:20		39-01.128	142-16.300	746	

6.2 Preliminary results

● **Dive number: HD#1664**

Date: Jun 24, 2014

Site: water depth of ca. 300 m, off Otsuchi

(Arrival 39-19.844N, 142-10.016E; Leave 39-19.856N, 142-10.043E)

Chief observer: Kazumasa Oguri (JAMSTEC)

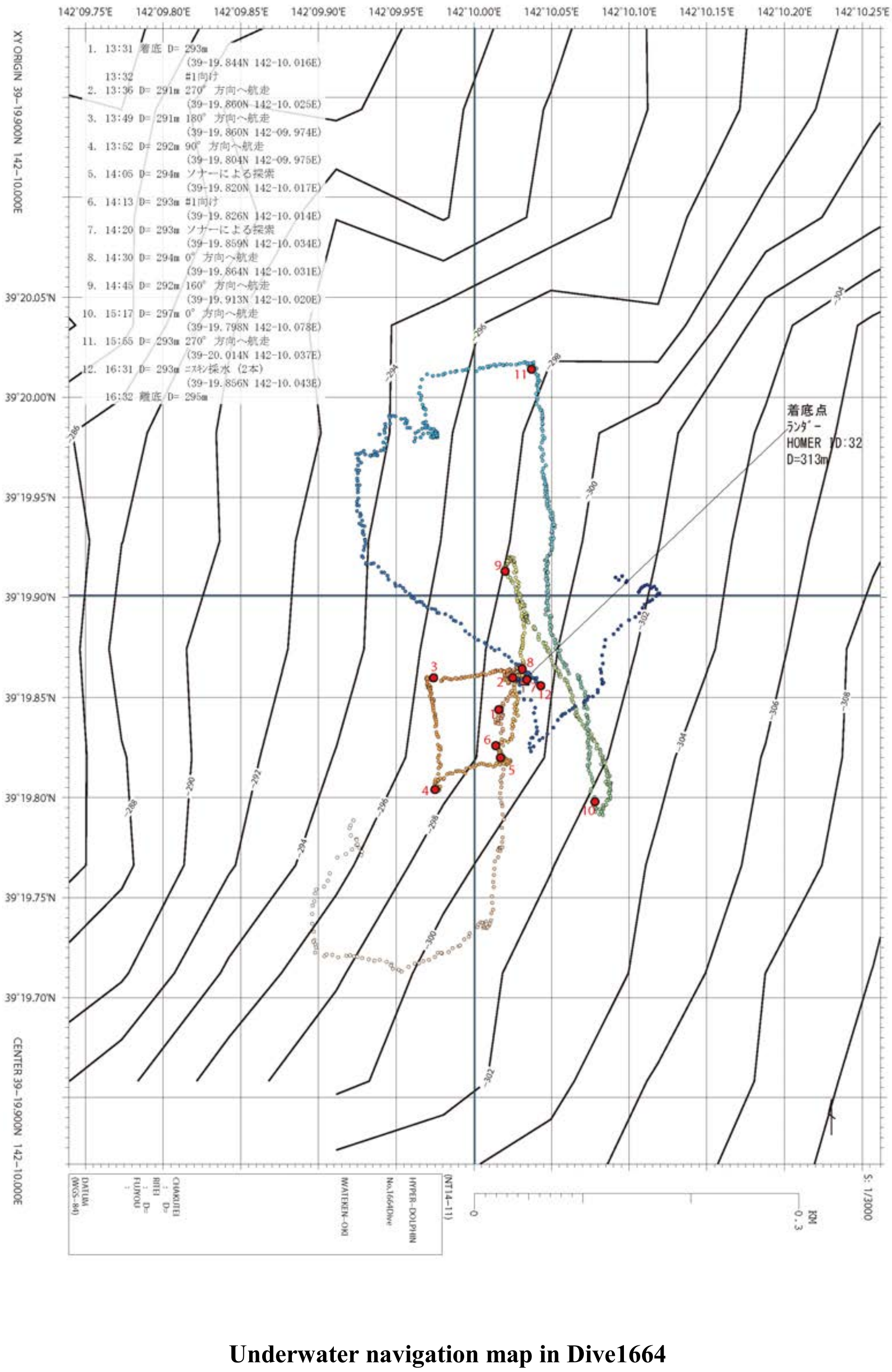
Main purposes: Confirmation of recovery of lander system deployed on November, 1, 2013.

Payload equipment:

1. Niskin bottles	2
2. Aanderaa Optode 4330 oxygen sensor and data logger	1/each
3. Sample box	1
4. Hooks	2
5. Cutter	1
6. ROV homer	1
7. Suction sampler & multiple canisters	1

Dive summary

Dominant habitat at the sea bottom was ophiuroids. Small organisms were observed in bottom water. Cod fish was appeared. Unfortunately, acoustic response from the lander (deployed at close site) was not obtained. Sonar response did not detect any response of the lander.



Underwater navigation map in Dive1664

NT14-11 leg.1 (Dive 1664) Jun. 24th , 2014

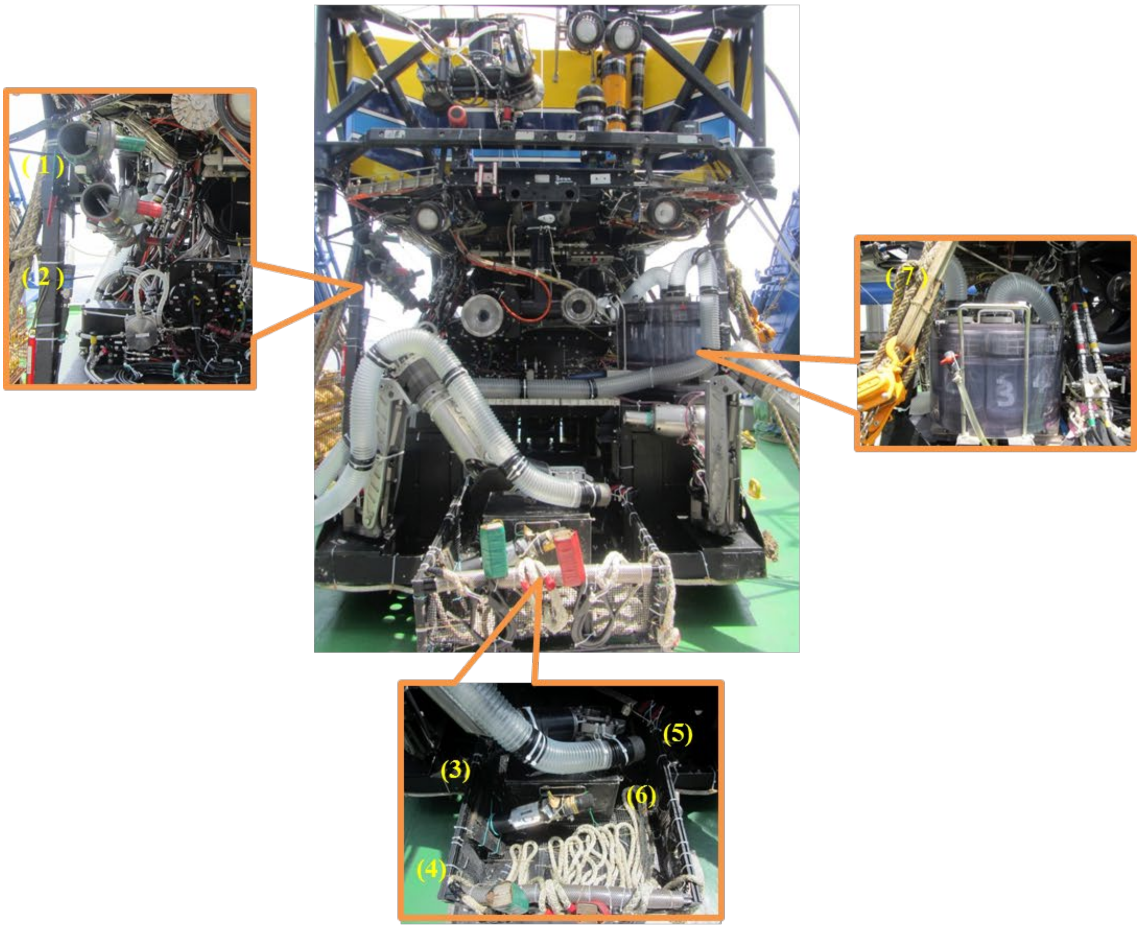


Table Devices mounted on HPD

Payload	QTY.
(1) Niskin bottles	2
(2) Aanderaa Optode 4330 oxygen sensor and data logger	1
(3) Sample box	1
(4) Hook	2
(5) Cutter	1
(6) ROV Homer	1
(7) Suction sampler & multiple canisters	1

Payload in Dive1664

- **Dive number: HD#1665**

Date: July 1, 2014

Site: Off Hirota Bay, Iwate Prefecture, Japan

(Arrival 38-55.579N, 141-46.498E; Leave 38-55.574N, 141-46.535E)

Chief observer: Katsunori Fujikura (JAMSTEC)

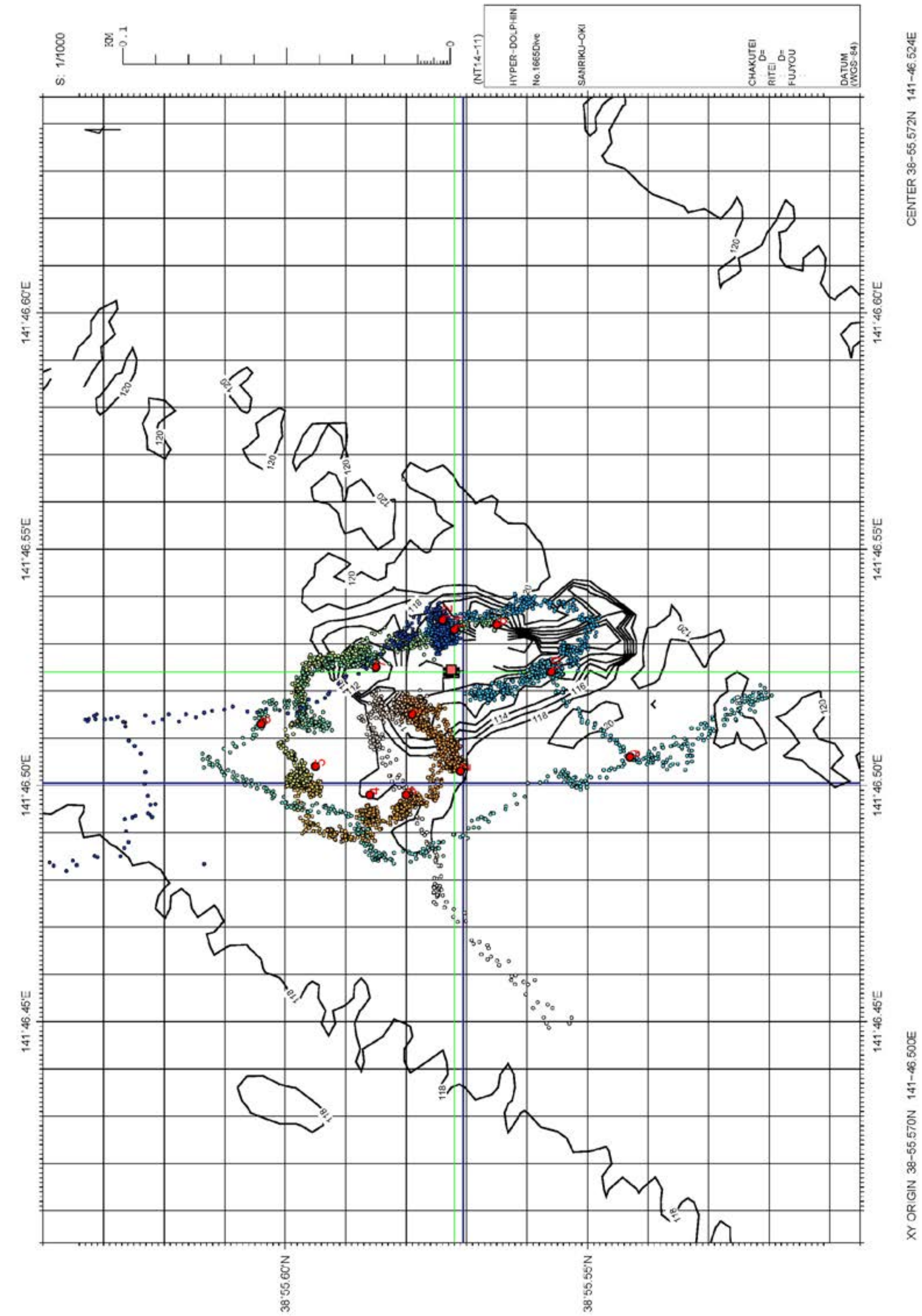
Main purposes: Search for a sunken ship

Payload equipment:

1. DO sensor	1
2. Maker Buoy	2
3. Sample box	1
4. MBARI-type core	2
5. Cutter	1
6. Cutter with manipulator	1
7. Suction sampler & multiple canisters	1

Dive summary

According to pre-site surveys, we discovered hitherto unknown a large sunken ship off Hirota Bay. The aim of this dive is to detect the 2011 off the Pacific coast of Tohoku Earthquake caused this sunken ship or not. Due to too much rust, it is not seems the sinking of the ship was caused by the earthquake. A lot of fishing gears tangled on the ship. These gears were relatively new. It indicates this large sunken ship is an obstacle for local fishing.



Underwater navigation map in Dive1665

NT14-11 leg.1 (Dive 1665) Jul. 1st , 2014

Table Devices mounted on HPD

Payload	QTY.
(1) DO sensor	1
(2) Maker Buoy	2
(3) Sample box	1
(4) MBARI-type core	2
(5) Cutter	1
(6) Cutter with manipulator	1
(7) Suction sampler & multiple canisters	1

Payload in Dive1665

● **Dive number: HD#1666**

Date: July 2, 2014

Site: Funakoshi submarine canyon, Iwate Prefecture, Japan

(Arrival 39-23.994N, 142-23.994E; Leave 39-24.348N, 142-23.478E)

Chief observer: Yasuo Furushima (JAMSTEC)

Main purposes: To select bio tracking examination area and sampling of snow crab for bio tracking. Also carry out sea bottom observation and debris sampling.

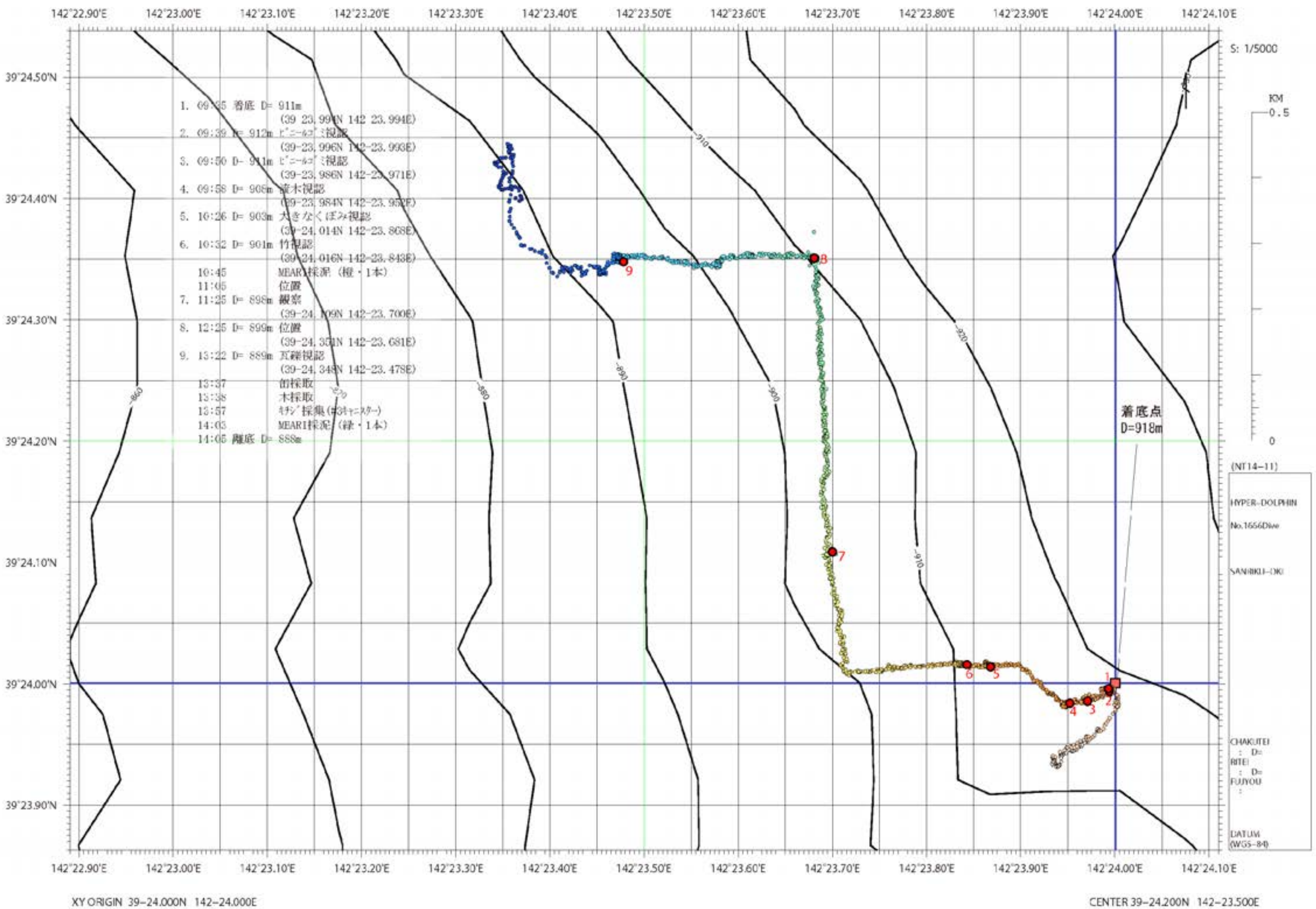
Payload equipment:

1. DO sensor	1
2. MBARI-type core	2
3. Sample box	1
4. Maker Buoy	2
5. Suction sampler & multiple canisters	1

Dive summary

The main purpose of this dive was to select bio tracking examination area. Also carried out the sampling of snow crab for bio tracking, sea bottom observation and the debris sampling.

The depth of this point was approximately 910m, and the bottom sediment was mud. The distribution density depended on a site, but much ophiuroids inhabited the bottom. Debris such as a drift wood, bamboo, vinyl, the empty can were sometimes observed. In this point, Macrouridae were observed much than the *Sebastolobus macrochir* which was a target of research. The snow crab was not observed, and therefore we concluded it that bio tracking experiment was not possible at this point.



Underwater navigation map in Dive1666

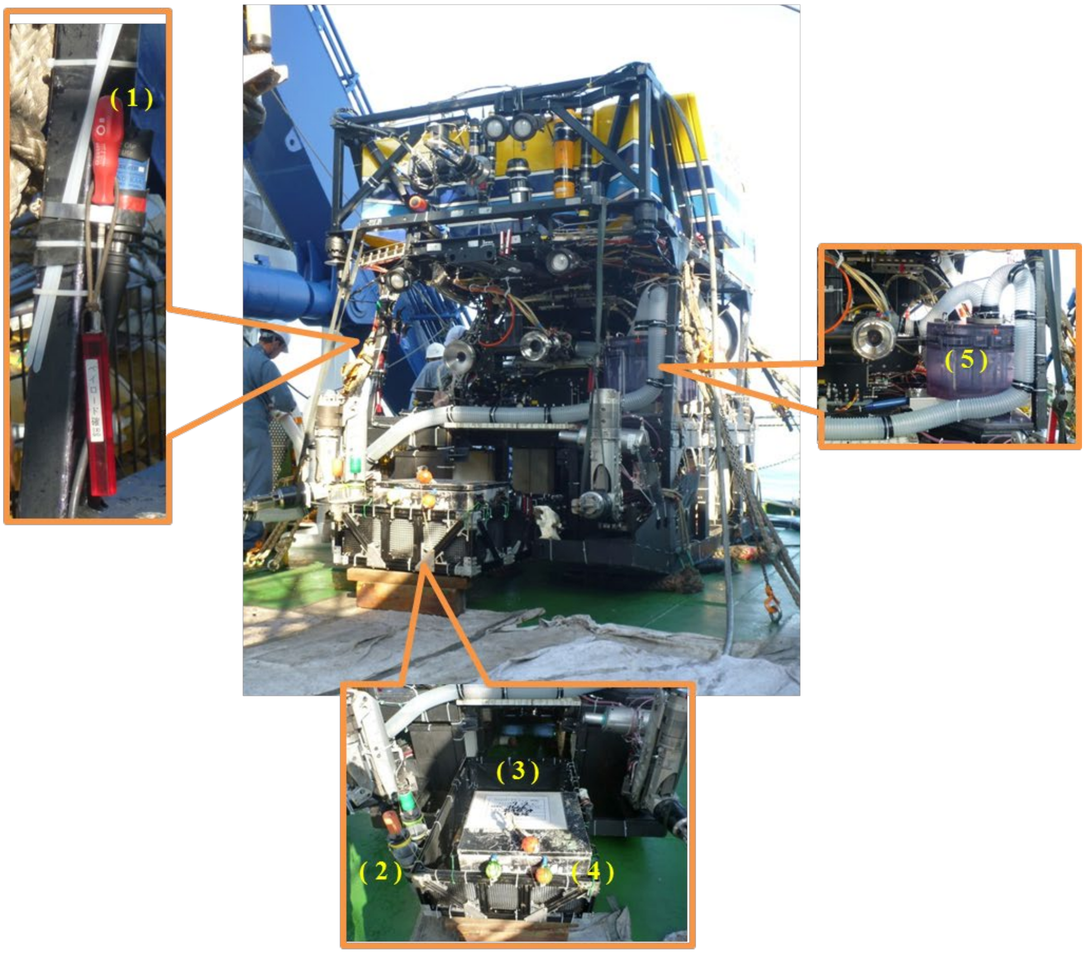


Table Devices mounted on HPD

Payload	QTY.
(1) DO sensor	1
(2) MBARI-type core	2
(3) Sample box	1
(4) Marker Buoy	2
(5) Suction sampler & multiple canisters	1

Payload in Dive1666

● **Dive number: HD#1667**

Date: July 3, 2014

Site: Kamaishi submarine canyon, Iwate Prefecture, Japan

(Arrival 39-14.771N, 142-18.508E; Leave 39-14.766N, 142-17.066E)

Chief observer: Shinji Tsuchida (JAMSTEC)

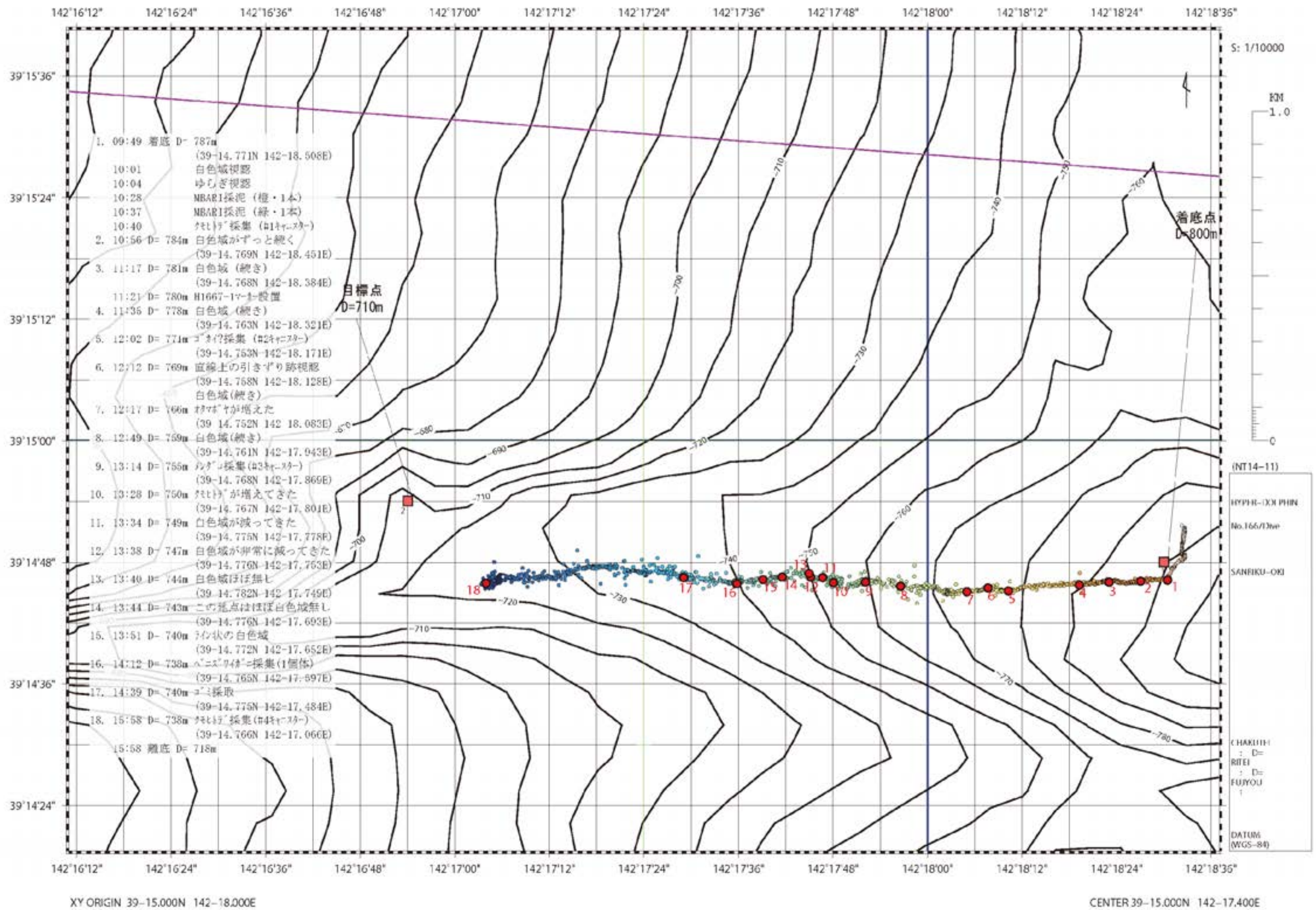
Main purposes: To find a candidate site for deploying the bio-tracking system. Also to observe and collect benthic animals and debris.

Payload equipment:

1. DO sensor	1
2. MBARI-type core	2
3. Sample box	1
4. Maker Buoy	2
7. Suction sampler & multiple canisters	1

Dive summary

Main objective in this dive is to find a candidate site for deploying the bio-tracking system in the Kamaishi deep-sea canyon. First of all, we landed at the bottom, 787m depth, and observed whitish bacterial mat widely covered the bottom. Here, we collected two sediment samples by MBARI corer and some individuals of brittle stars by the suction sampler. Then we moved westward and climbing upward along the canyon. Around 1000m from the lading point, deep-sea bottom was covered thickly by the whitish bacterial mat. From this point to the west, benthic animals like as snow crabs, brittle stars were increased instead of mat. Also, we observed many long straight trace made by probably artificial activities in this canyon.



Underwater navigation map in Dive1667

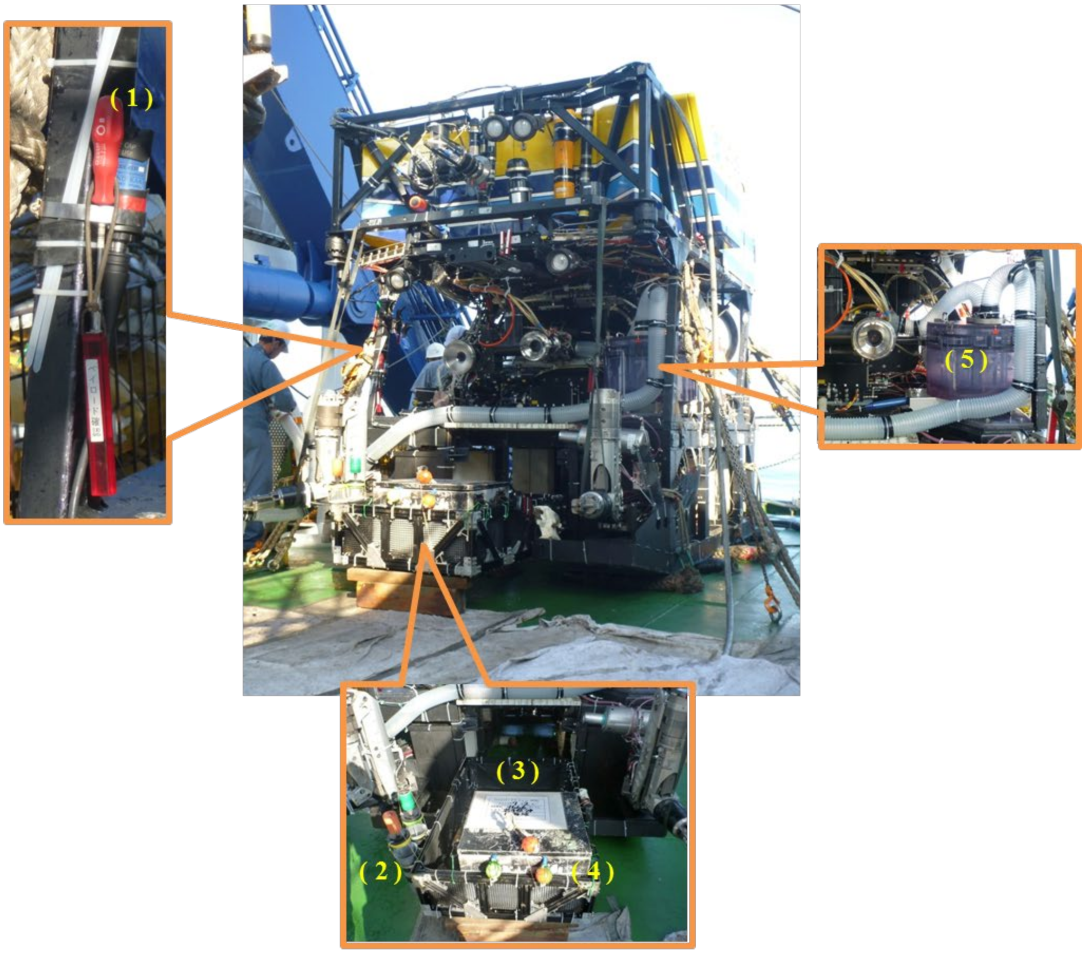


Table Devices mounted on HPD

Payload	QTY.
(1) DO sensor	1
(2) MBARI-type core	2
(3) Sample box	1
(4) Marker Buoy	2
(5) Suction sampler & multiple canisters	1

Payload in Dive1667

● **Dive number: HD#1668**

Date: July 4, 2014

Site: Off Kamaishi, Iwate prefecture, Japan

(Arrival 39-11.485N, 142-13.420E; Leave 39-11.584N, 142-11.864E)

Chief observer: Yoshitaka Watanabe (JAMSTEC)

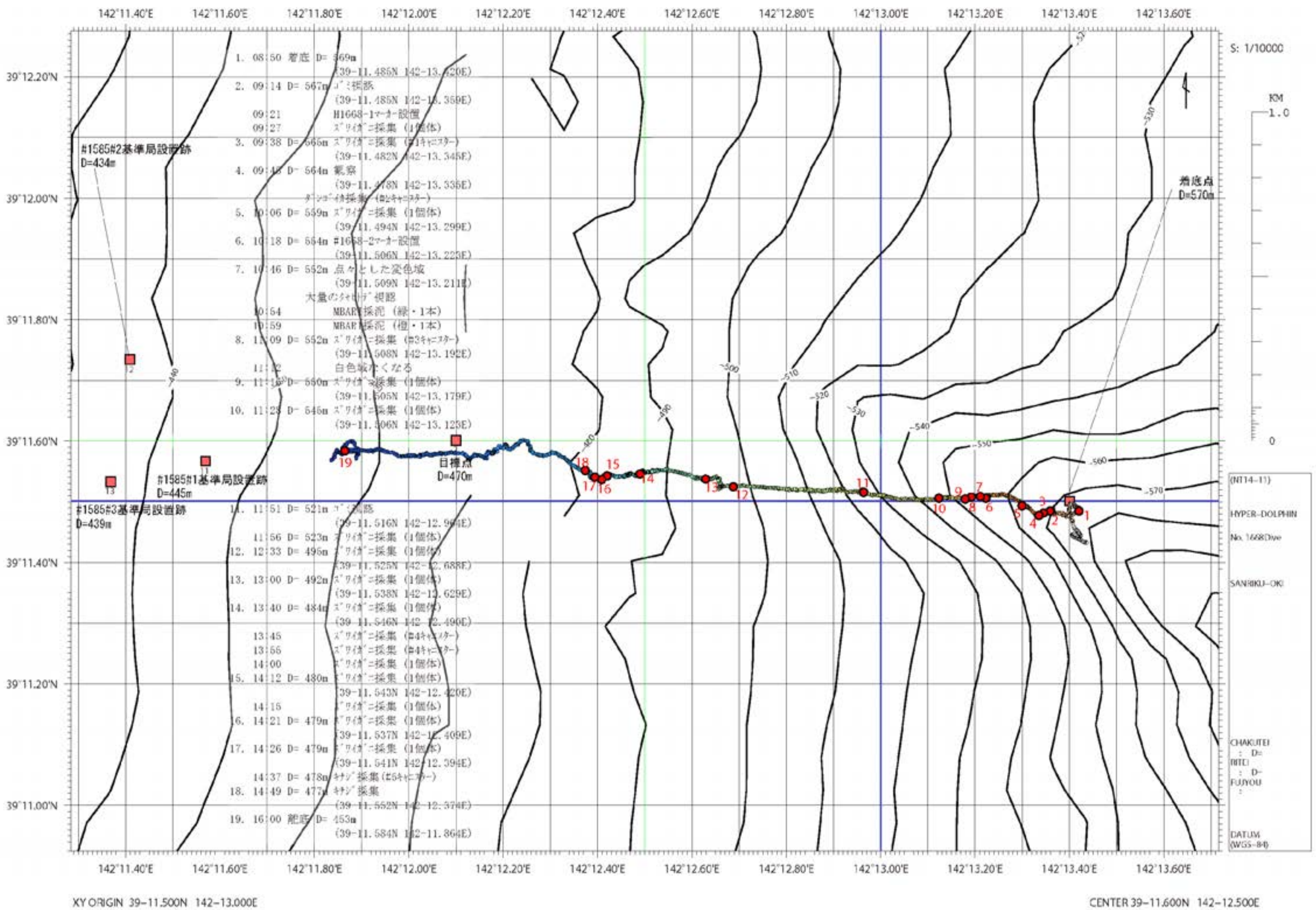
Main purposes: Search for an area for Bio-Tracking System, and sampling snow crabs

Payload equipment:

1. DO sensor	1
2. Maker Buoy	2
3. Sample box	1
4. MBARI-type core	2
5. Suction sampler & multiple canisters	1

Dive summary

HYPER-DOLPHIN reached the bottom at beginning area of a submarine valley where the water depth is about 570 meters, cruised 2.5 km westward while crumbing the sloping bottom, and ascended from the bottom where the water depth is about 460 m. There was an area with rubble and dust at 570 – 550 meters depth. There was also white-colored ground, of which the width was dozens of meters. A large amount of brittle stars lived in the white-colored ground area, and it is different situation from that in dive #1667. Snow crabs and kichiji rockfishes begun to be frequently found from around 500 meters depth, where almost top end of the submarine valley. A dozen snow crabs and a kichiji rockfish were sampled. This area was decided as a placing area of the Bio-Tracking System. Flapjack octopuses and pacific cods were observed relatively more than previous dives in this cruise.



Underwater navigation map in Dive1668

NT14-11 leg.1 (Dive 1668) Jul. 4th , 2014

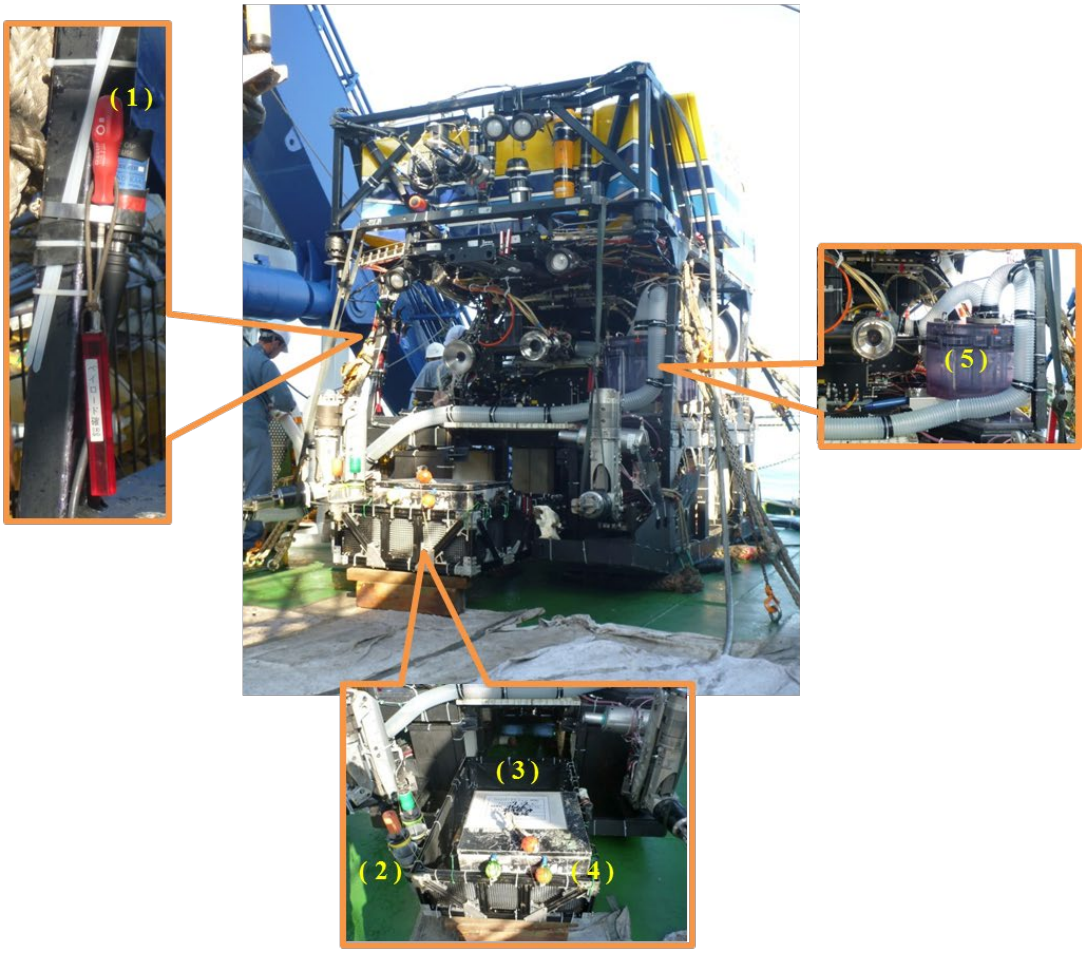


Table Devices mounted on HPD

Payload	QTY.
(1) DO sensor	1
(2) MBARI-type core	2
(3) Sample box	1
(4) Marker Buoy	2
(5) Suction sampler & multiple canisters	1

Payload in Dive1668

● **Dive number: HD#1669**

Date: July5, 2014

Site: Kamaishi submarine canyon (Bio tracking site), Iwate Prefecture, Japan
(Arrival 39-11.399N, 142-12.945E; Leave 39-11.410N, 142-11.995E)

Chief observer: Yasuo Furushima (JAMSTEC)

Main purposes: To collect snow crab for bio tracking examination. Also carry out sea bottom observation and sampling such as core or marine organisms.

Payload equipment:

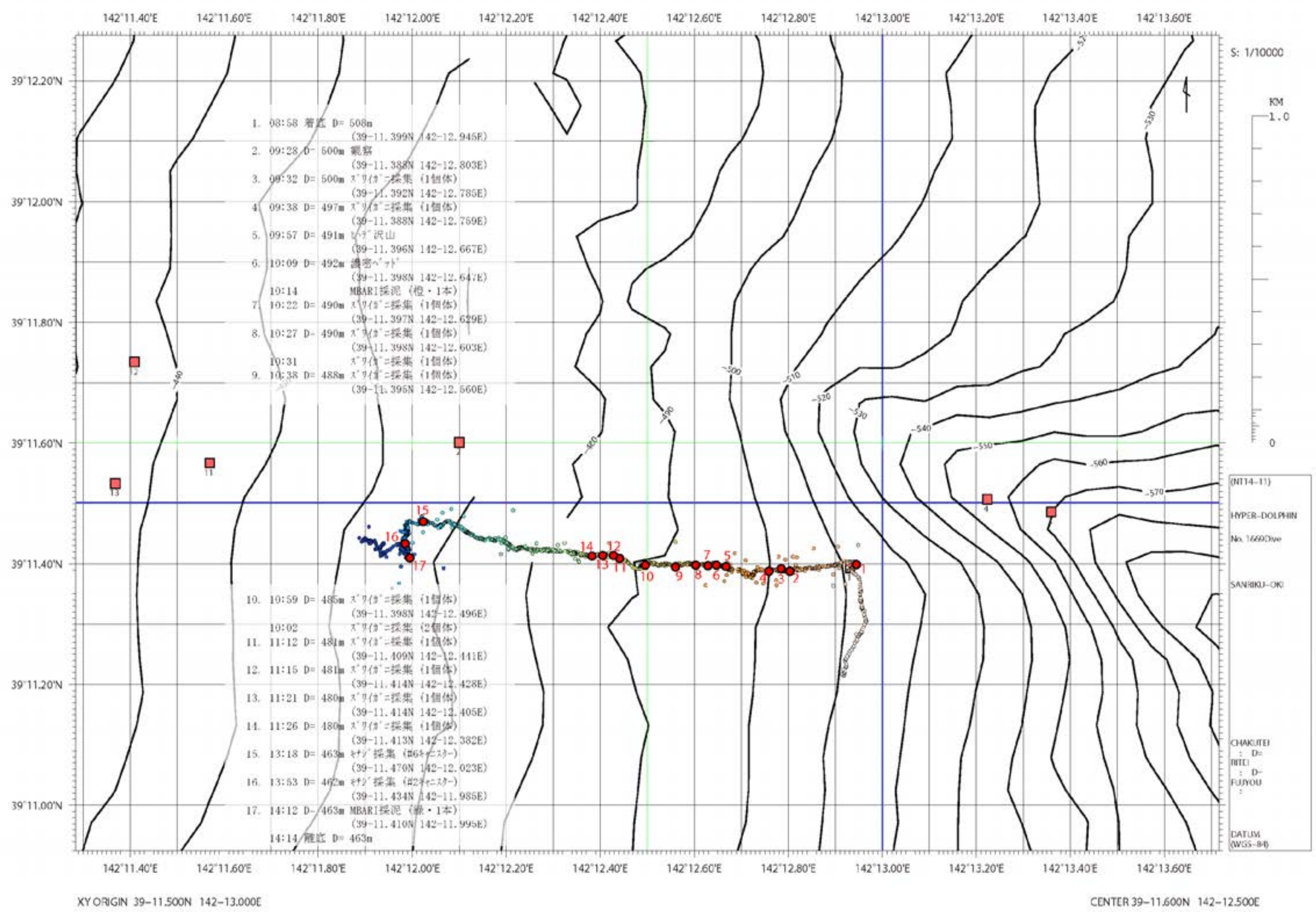
1. DO sensor	1
2. Sample box (small)	1
3. Maker Buoy	2
4. MBARI-type core	2
5. Sample box (big)	1
6. Suction sampler & multiple canisters	1

Dive summary

In this dive point (Kamaishi submarine canyon), it was decided with an area to carry out bio tracking examination in the yesterday's underwater navigation. The main purpose of this dive was collecting snow crab for bio tracking examination, sea bottom observation and sampling such as core. The depth of this point was approximately 500m, and the bottom sediment was mud.

Ten snow crab and two Sebastolobus macrochir to use for bio tracking examination were collected by Suction sampler. This point was the relatively flat site of the submarine canyon and had little distribution of the debris. Not only snow crab and Sebastolobus macrochir but also the marine organisms such as Holothuroidea, ophiuroids and Solasteridae etc. were observed near the bottom. Attach pinger to sampled snow crab on board and a few days later, release in a bio tracking site.

Underwater navigation map in Dive1669



NT14-11 leg.1 (Dive 1669) Jul. 5th, 2014

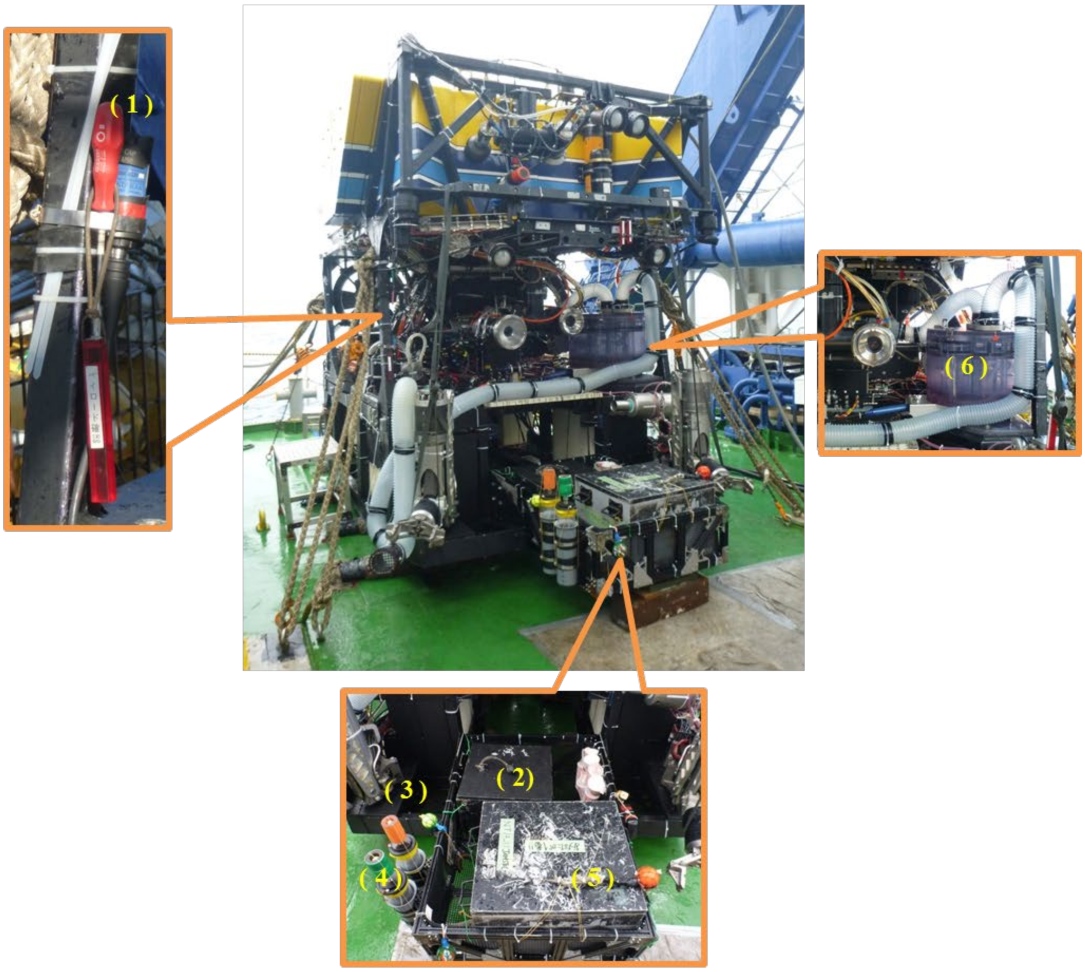


Table Devices mounted on HPD

Payload	QTY.
(1) DO sensor	1
(2) Sample box (small)	1
(3) Marker Buoy	2
(4) MBARI-type core	2
(5) Sample box (big)	1
(6) Suction sampler & multiple canisters	1

Payload in Dive1669

● **Dive number: HD#1670**

Date: July 8, 2014

Site: Kamaishi submarine canyon (Bio tracking site), Iwate Prefecture, Japan

(Arrival 39-11.637N, 142-12.563E; Leave 39-11.571N, 142-12.427E)

Chief observer: Shinji Tsuchida (JAMSTEC)

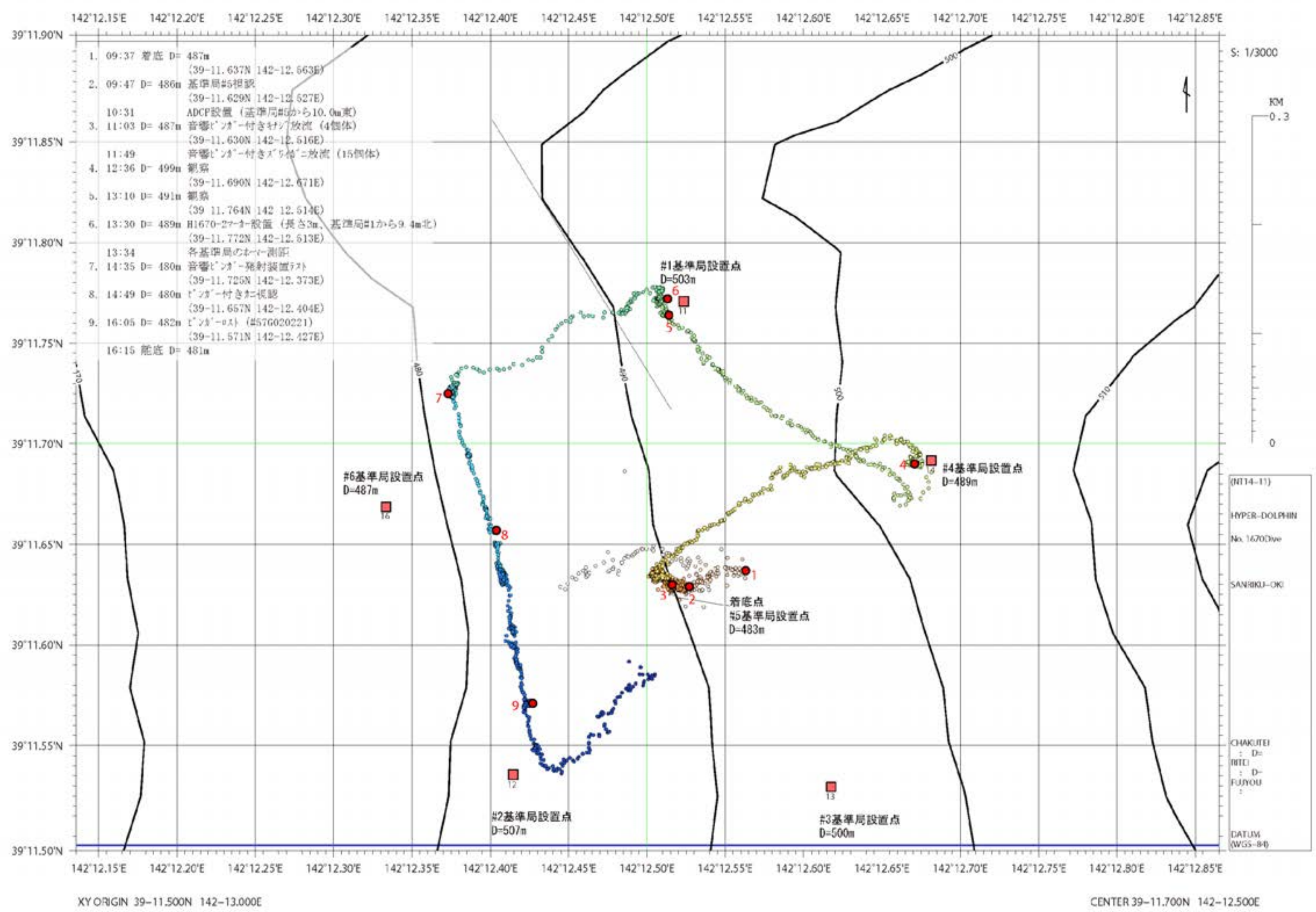
Main purposes: To check and observe the deployed bio-tracking station at the bottom, to release tagged crabs (fifteen inds.) and stone fish (three inds.), and to tag acoustic small pingers on the dorsal body of snow crabs by the pinger attachment gun.

Payload equipment:

1. DO sensor	1
2. Sample box (small)	1
3. Maker Buoy	2
4. Water gun	1
5. Sample box (big)	1
6. ADCP	1
7. Suction sampler & multiple canisters	1

Dive summary

We landed at the bottom near the bio-tracking station #5 where was the center of deployed other station forming as a pentagon. At the point about 10m east from the station#5, ADCP was deployed at the bottom. Then, we released fifteen tagged snow crabs and three tagged stone fish (Kichiji) with a non tagged small one. We moved to north-east ward at the station#4 around 250m distance from #5. After checking the position of #4, we again moved around 300m to north-west ward at the station#1. Near the #1 station, we deployed a marker buoy with three acoustic pingers. We moved to west-southwest ward and landed around 200m distance from the station#1. We examined to shoot a pinger by Pinger attachment gun, but unfortunately missed the crab. On the way to move south ward, a tagged crab which was released at the first landing point was found. Again, we tried to shoot a pinger to a crab, but it was out of target.



Underwater navigation map in Dive1670

NT14-11 leg.1 (Dive 1670) Jul. 8th , 2014

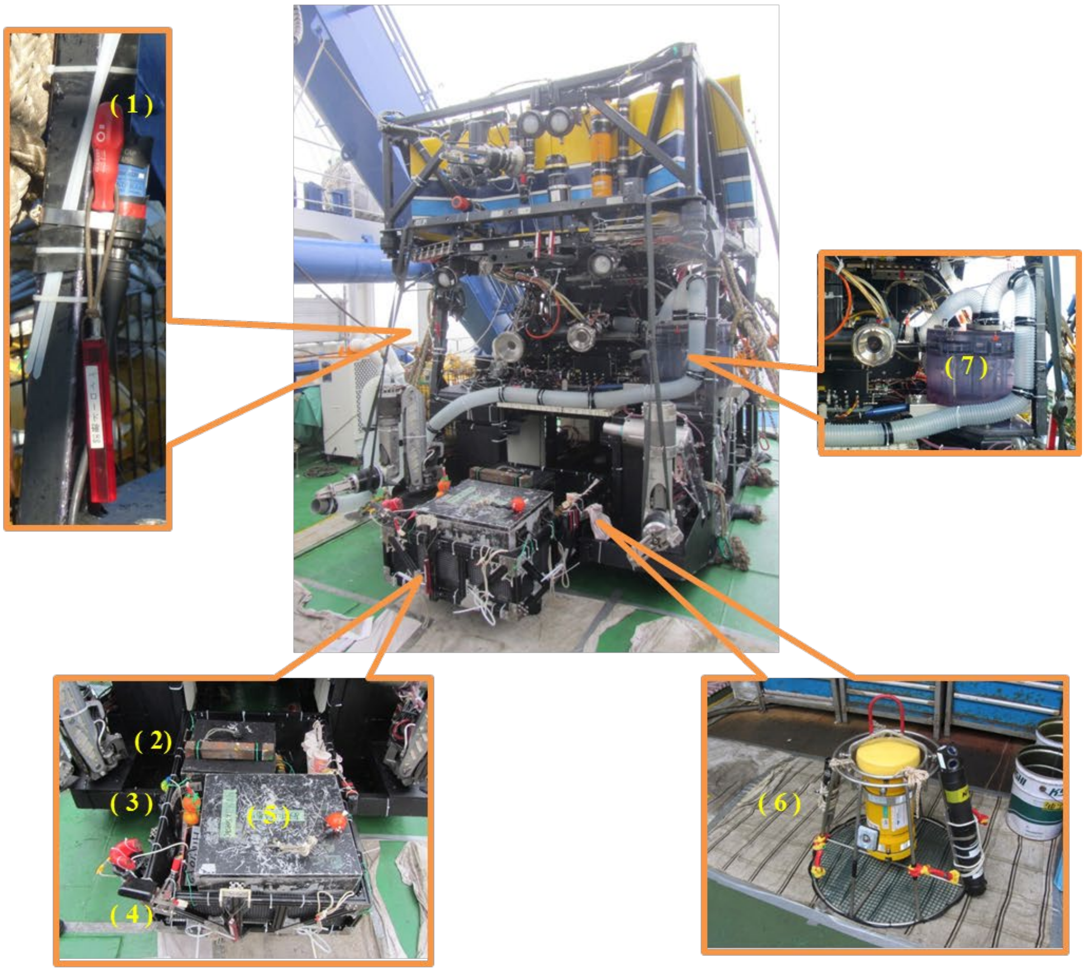


Table Devices mounted on HPD

Payload	QTY.
(1) DO sensor	1
(2) Sample box (small)	1
(3) Marker Buoy	2
(4) Water gun	1
(5) Sample box (big)	1
(6) ADCP	1
(7) Suction sampler & multiple canisters	1

Payload in Dive1670

● **Dive number: HD#1671**

Date: July 9, 2014

Site: White bacteria mat site, Submarine Canyon, Off Iwate Prefecture, Japan

(Arrival 39-14.766N, 142-19.553E; Leave 39-14.437N, 142-18.485E)

Chief observer: Katsunori Fujikura (JAMSTEC)

Main purposes: To detect distribution area of bacteria mat

Payload equipment:

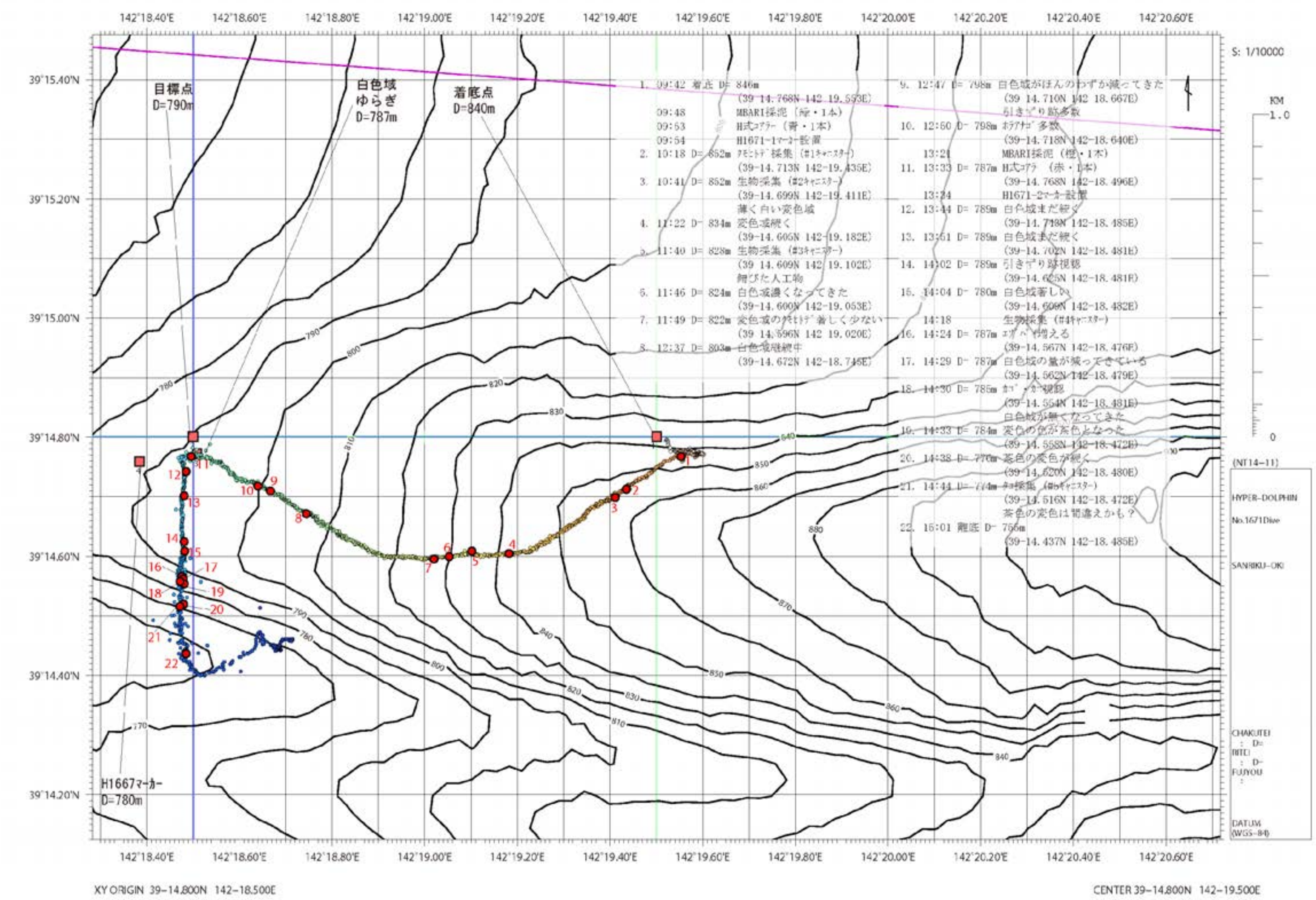
1. DO sensor	1
2. Maker Buoy	4
3. Sample box	1
4. MBARI-type core	2
5. H-type core	2
6. Scoop sampler	1
7. Suction sampler & multiple canisters 1	

Dive summary

Aims of this dive survey are;

1) To detect distribution area of bacteria mat,
2) Sampling sediments for bacteria mat detection,
3) To detect characteristics of white color sediments in comparison with normal seafloor,
4) To collect baseline data for future surveys.

The HPD landed at 1 nm eastern point far from #1667 dive landing point. We collected 2 cores, one for foraminiferan analysis and other for bacteria and organic matter analysis, and deployed one HPD1671-1 maker. The HPD run to 240° for ca. 300 m and run to 280° to No.3 point which is #1667 dive landing point. At this point, we also collected 2 cores, one for foraminiferan analysis and other for bacteria and organic matter analysis, and deployed one HPD1671-2 maker. Then, the HPD run to 180° to detect the end of white color sediments area. We could detected the south end of white color sediments area.



Underwater navigation map in Dive1671

NT14-11 leg.1 (Dive 1671) Jul. 9th , 2014

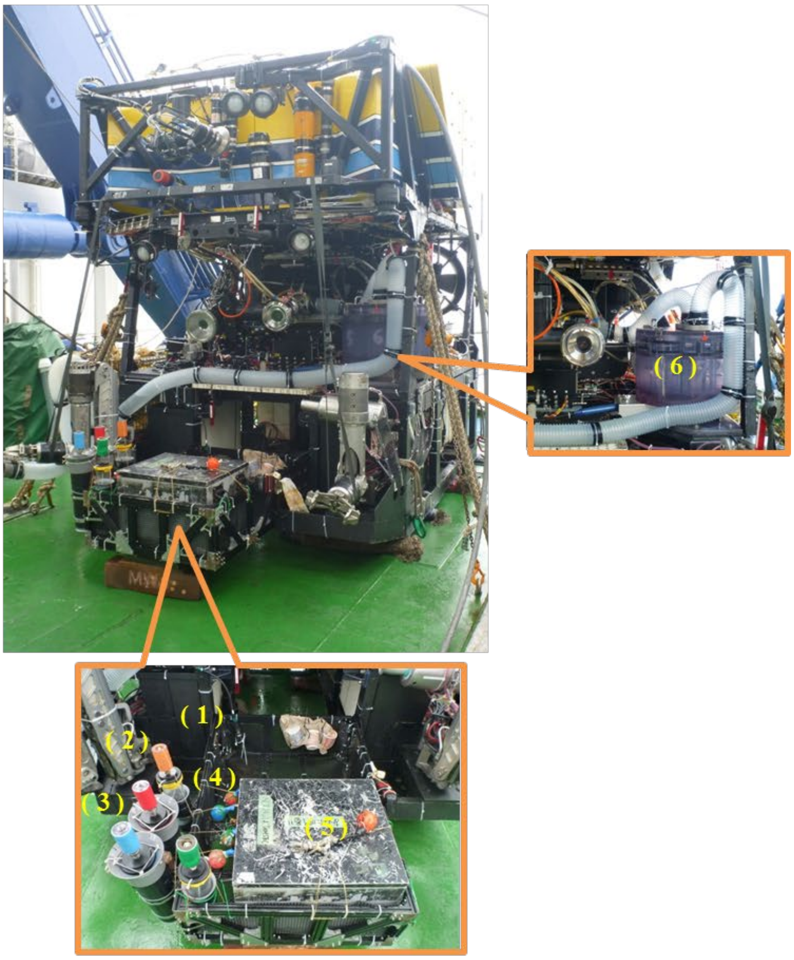


Table Devices mounted on HPD

Payload	QTY.
(1) DO sensor	1
(2) MBARI-type core	2
(3) H-type core	2
(4) Maker Buoy	4
(5) Sample box	1
(6) Suction sampler system	1
(7) Scoop sampler	1

Payload in Dive1671

● **Dive number: HD#1672**

Date: July 13, 2014

Site: Kamaishi submarine canyon (Bio tracking site), Iwate Prefecture, Japan

(Arrival 39-11.544N, 142-12.739E; Leave 39-11.643N, 142-21.471E)

Chief observer: Yasuo Furushima (JAMSTEC)

Main purposes: To carry out 3D Mapping survey in the bio tracking sea area.

To confirm the base station for bio tracking.

To carry out the shooting test of the aqua gun for pinger attachment.

For the sampling of marine organisms and core.

Payload equipment:

1. 3D Mapping system (high altitude) SeaXerocks	1
2. 3D Mapping system (high resolution) Serpent	1
3. Suction sampler & multiple canisters	1
4. Sample box	1
5. Aqua gun for pinger attachment	1
6. MBARI-type core	4
7. DO sensor	1

Dive summary

This research area is installation points of the basis station for bio tracking research selected in NT14-11_Leg.1. Because the basis station were cast from on board by free fall, it was necessary to confirm installation conditions in the bottom. The main purposes of this dive are as follows.

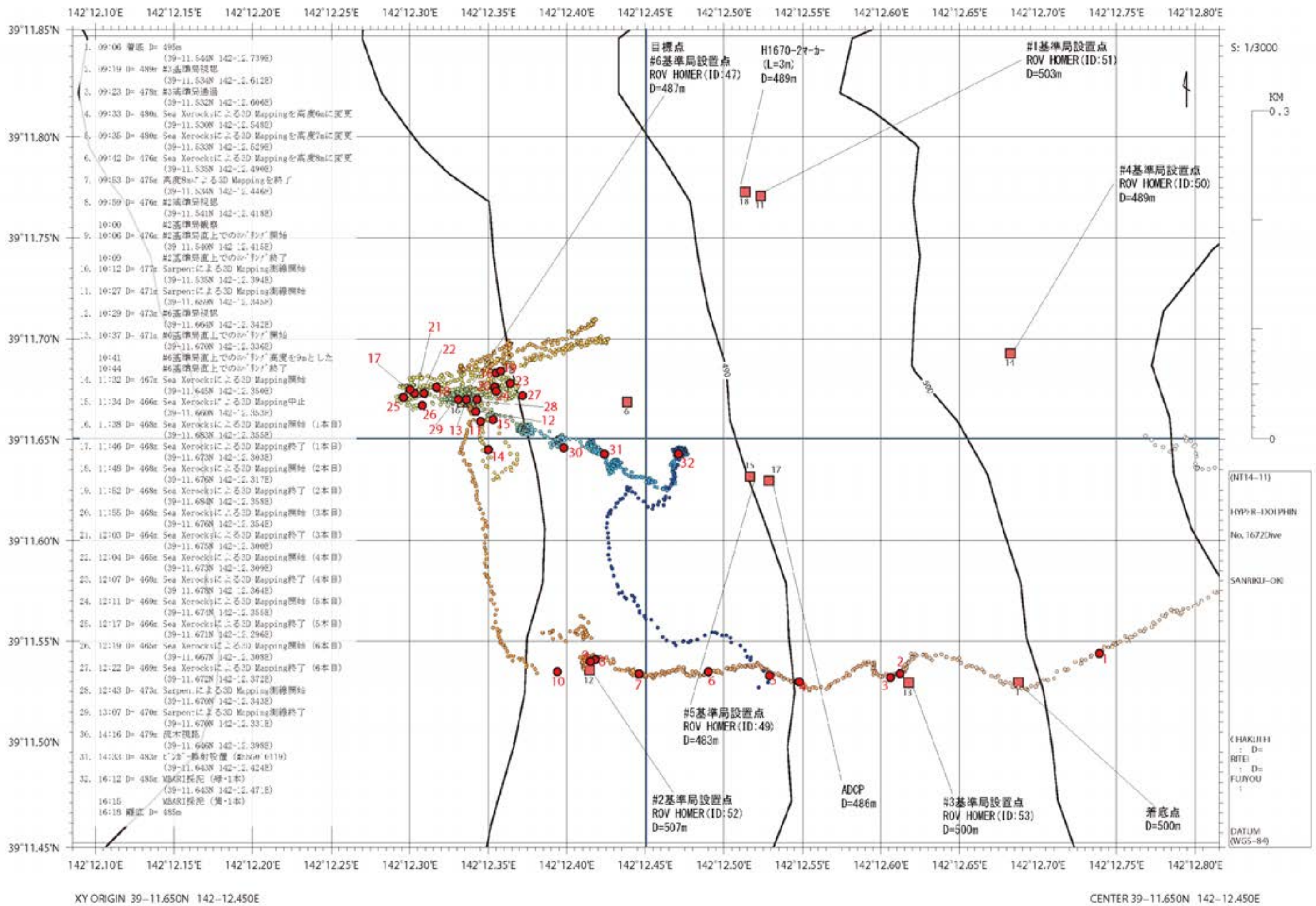
Confirm the installation conditions of the bio tracking base station.

Carry out an imaging of the sea bottom with high accuracy, high-resolution 3D Mapping apparatus.

Shooting test of the aqua gun to attach pinger to snow crab in in-situ.

Sampling such as core and the marine organisms and the bottom observation.

Installation conditions of each basis stations (No.3, No.2, No.6) were confirmed with keeping altitude of *HYPER-DOLPHIN*. The pilot survey of SeaXerocks system and Serpent system was able to be carried out with basis station No. 3 and No. 2 respectively. The survey using two kinds of 3DMapping systems was carried out in an area of 60m *80m established near No. 6 base station. Finally, we examined of the shooting of the aqua gun using the manipulator of *HYPER-DOLPHIN*.



Underwater navigation map in Dive1672

NT14-11 leg.2 (Dive 1672) July. 13th , 2014

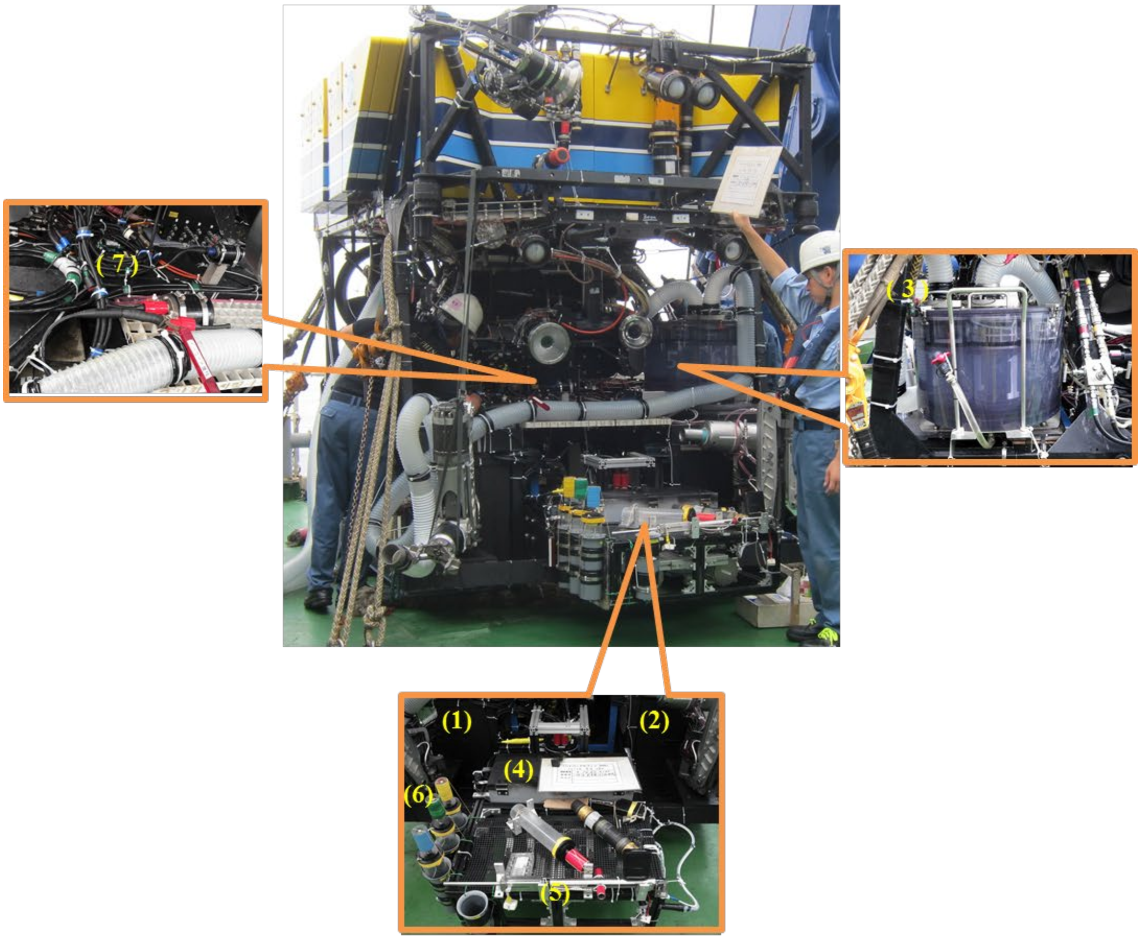


Table Devices mounted on HPD

Payload	QTY.
(1) SeaXerocks	1
(2) Serpent	1
(3) Suction sampler & multiple canisters	1
(4) Sample box	1
(5) Aqua gun for pinger attachment	1
(6) MBARI-type core	4
(7) DO sensor	1

Payload in Dive1672

● **Dive number: HD#1673**

Date: July 14, 2014

Site: Gareki site Off Kamaishi valley, Iwate Prefecture, Japan

(Arrival 39-14.683N 142-14.352E; Leave 39-14.8338N 142-14.214E)

Chief observer: Takehisa Yamakita (JAMSTEC)

Main purposes: 3D mapping at a deep sea valley and outside of the valley

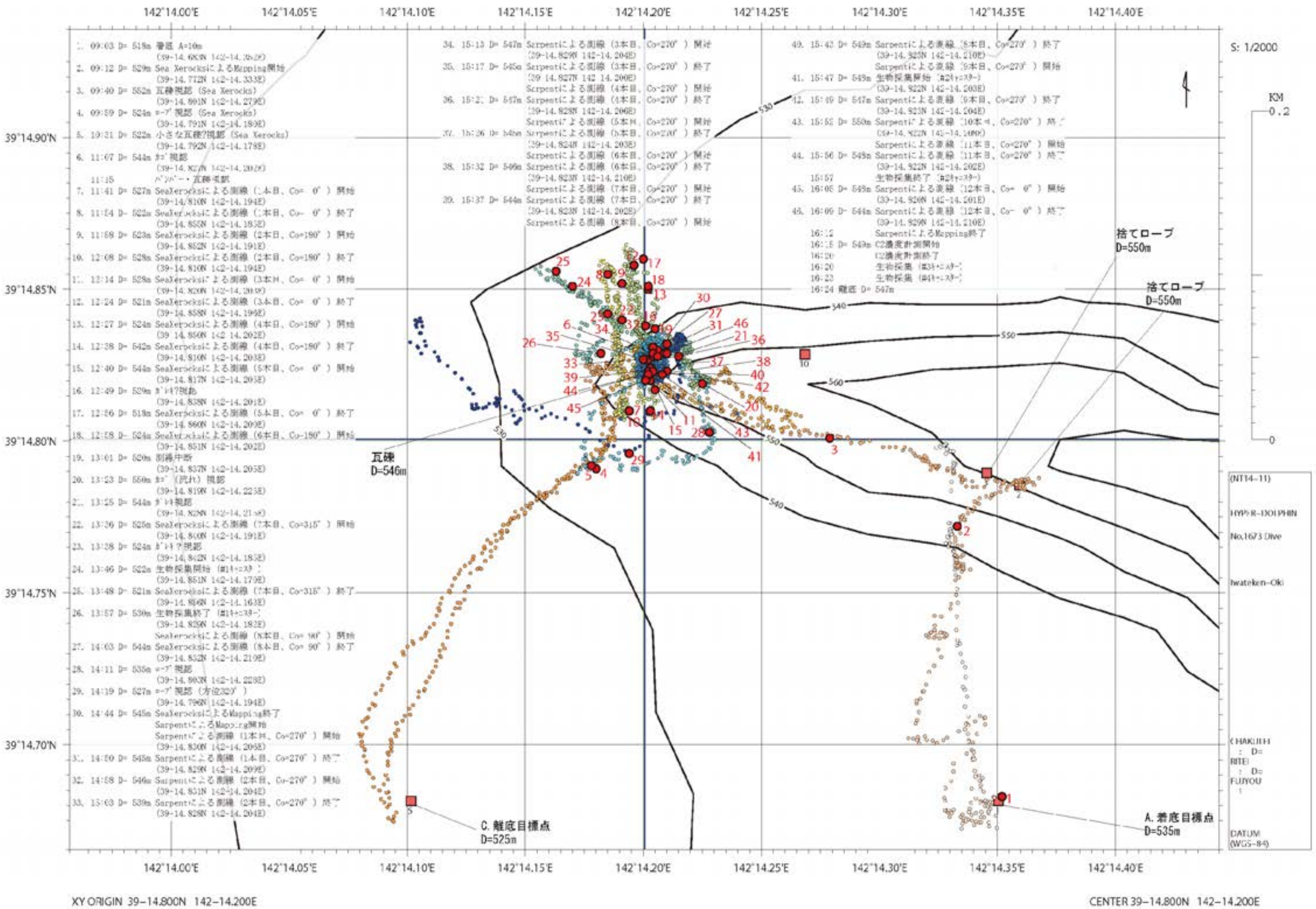
Payload equipment:

1. 3D Mapping system (high altitude) SeaXerocks	1
2. 3D Mapping system (high resolution) Serpent	1
3. Suction sampler & multiple canisters	1
4. Sample box	1
5. MBARI-type core	4
6. DO sensor	1

Dive summary

According to pre-site surveys, we discovered accumulation of marine debris and organisms at the top of the valley. The aim of this dive is to conduct mapping of bottom images and topography both inside of the valley and outside of the valley. We conducted 3D line mapping using SeaXerocks from 6m above all over the survey line which was close (a little south route) to the dive HPD#1582 NT13-21. Then we conducted 3D grid mapping in 80 x 60 m area from 6m above. Finer grid mapping was also conducted 10 x10m area from 3m above using Serpent.

During this survey we observed, pretty of marine snow. Brittle stars were dominated at the outside of valley, other species of brittle stars and fishes also observed in the valley area.



Underwater navigation map in Dive1673

NT14-11 leg.2 (Dive 1673) July. 14th , 2014

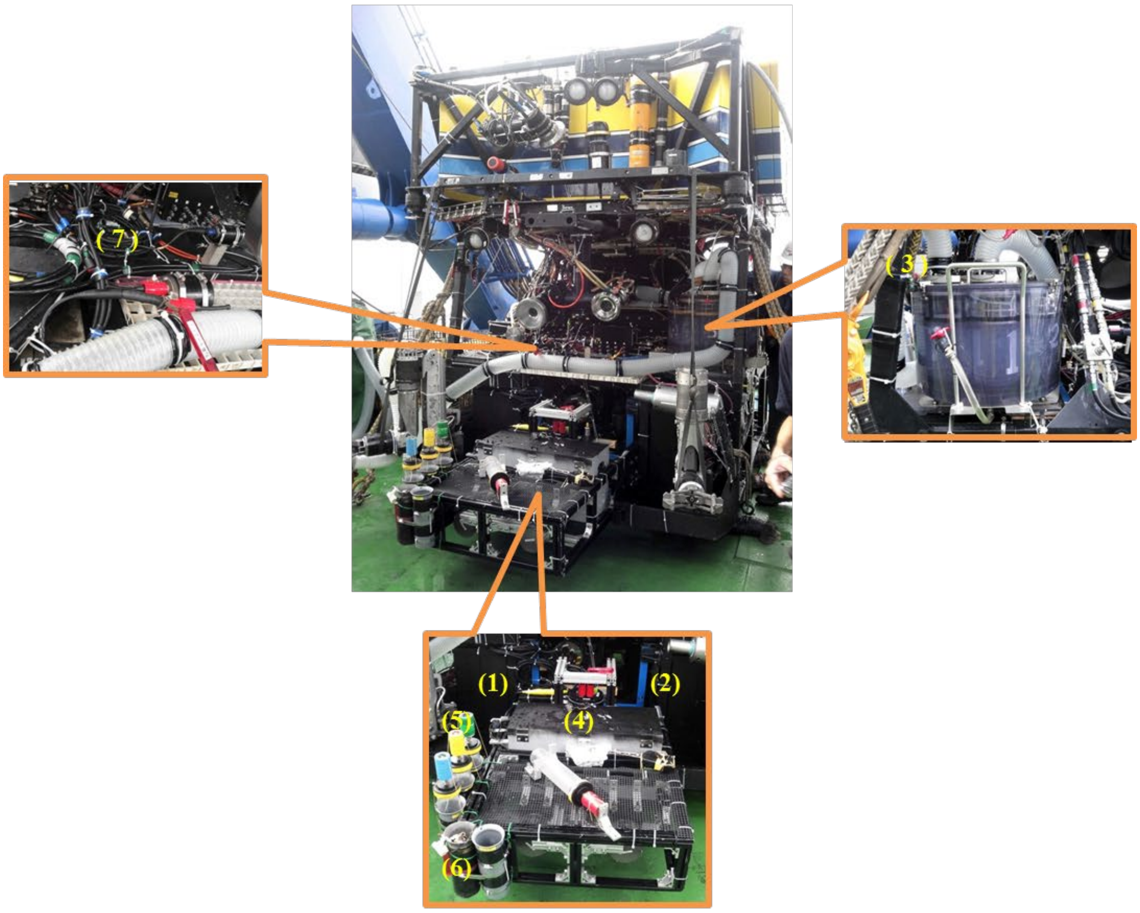


Table Devices mounted on HPD

Payload	QTY.
(1) SeaXerocks	1
(2) Serpent	1
(3) Suction sampler & multiple canisters	1
(4) Sample box	1
(5) MBARI-type core	4
(6) DO sensor	1

Payload in Dive1673

.

● **Dive number: HD#1674**

Date: July 15, 2014

Site: Trawl track area, Off Otsuchi, Iwate Prefecture, Japan

(Arrival 39-25.704N, 142-14.825E; Leave 39-25.716N, 142-14.729E)

Chief observer: Yoshihiro Fujiwara (JAMSTEC)

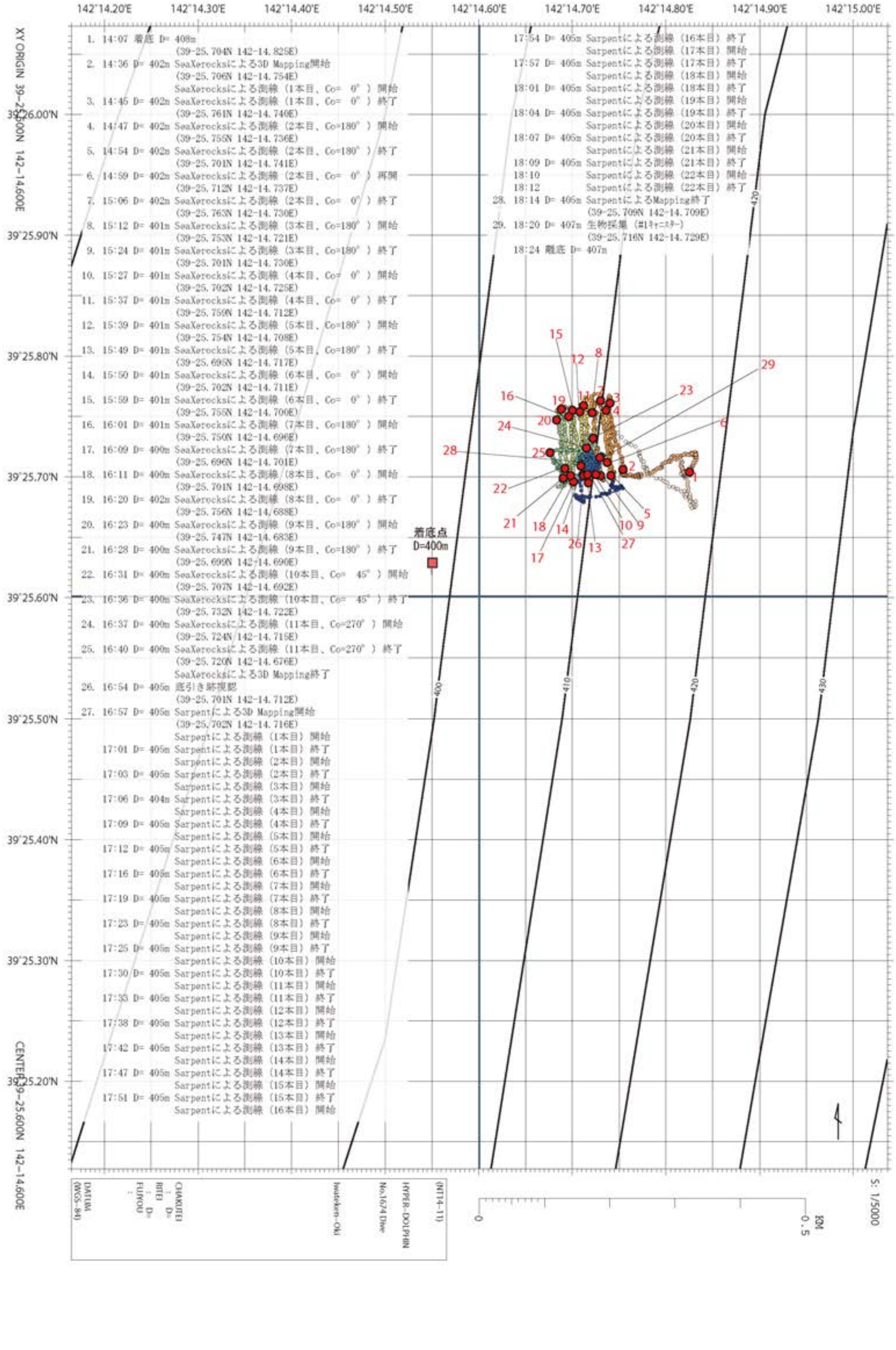
Main purposes: Comparison of biomass and biodiversity between locations with and without trawl tracks using two types of 3D mapping system

Payload equipment:

1. 3D Mapping system (wider area)	"SeaXerocks"	1
2. 3D Mapping system (higher resolution)	"Serpent"	1
3. Suction sampler & multiple canisters		1
4. Sample box		1
5. MBARI-type core		4
6. DO sensor (fixed on ROV)		1
7. REDOX sensor (controllable using manipulators)		1

Dive summary

Three-dimensional mapping of deep-sea floors were conducted using two different types of the mapping system. Due to a mechanical problem of *HYPER-DOLPHIN*, only the trawl track area was mapped. The areas of 50m x 100m and 25m x 20m were surveyed using the "SeaXerocks" and "Serpent," respectively. The trawl tracks were existed but were sparser that that during ROV Crambon dive #008 conducted in 2013. The density of ophiuroids, cods and crabs were relatively small.



Underwater navigation map in Dive1674

NT14-11 leg.2 (Dive 1674) July. 15th , 2014

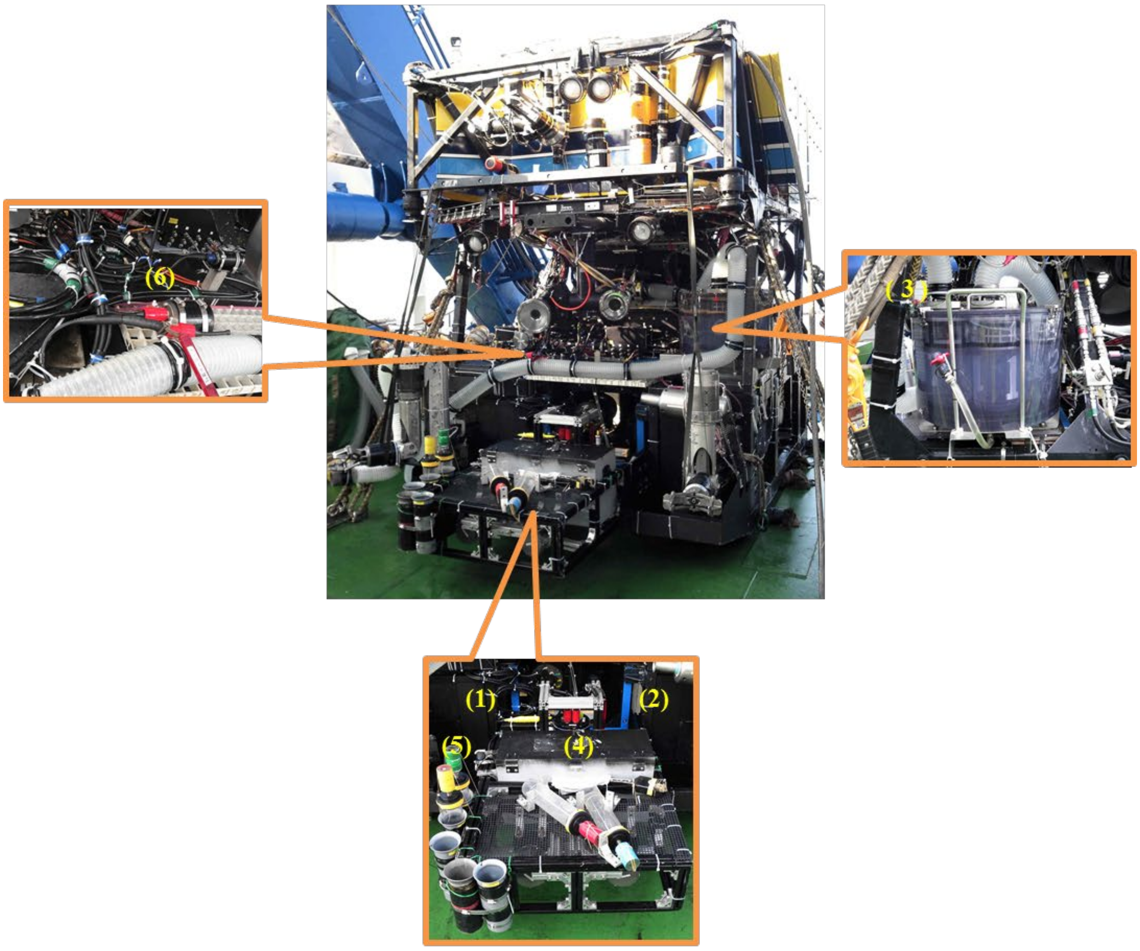


Table Devices mounted on HPD

Payload	QTY.
(1) SeaXerocks	1
(2) Serpent	1
(3) Suction sampler & multiple canisters	1
(4) Sample box	1
(5) MBARI-type core	4
(6) DO sensor	1
(7) REDOX sensor	1

Payload in Dive1674

● **Dive number: HD#1675 & 1676**

Date: July 16, 2014

Site: Off Hirota Bay, Iwate Prefecture, Japan

(HD#1675 arrival 39-25.619N, 142-14.543E; Leave 39-25.578N, 142-14.479E)

(HD#1676 arrival 39-25.623N, 142-14.493E; Leave 39-25.627N, 142-14.511E)

Chief observer: Shinji Tsuchida (JAMSTEC)

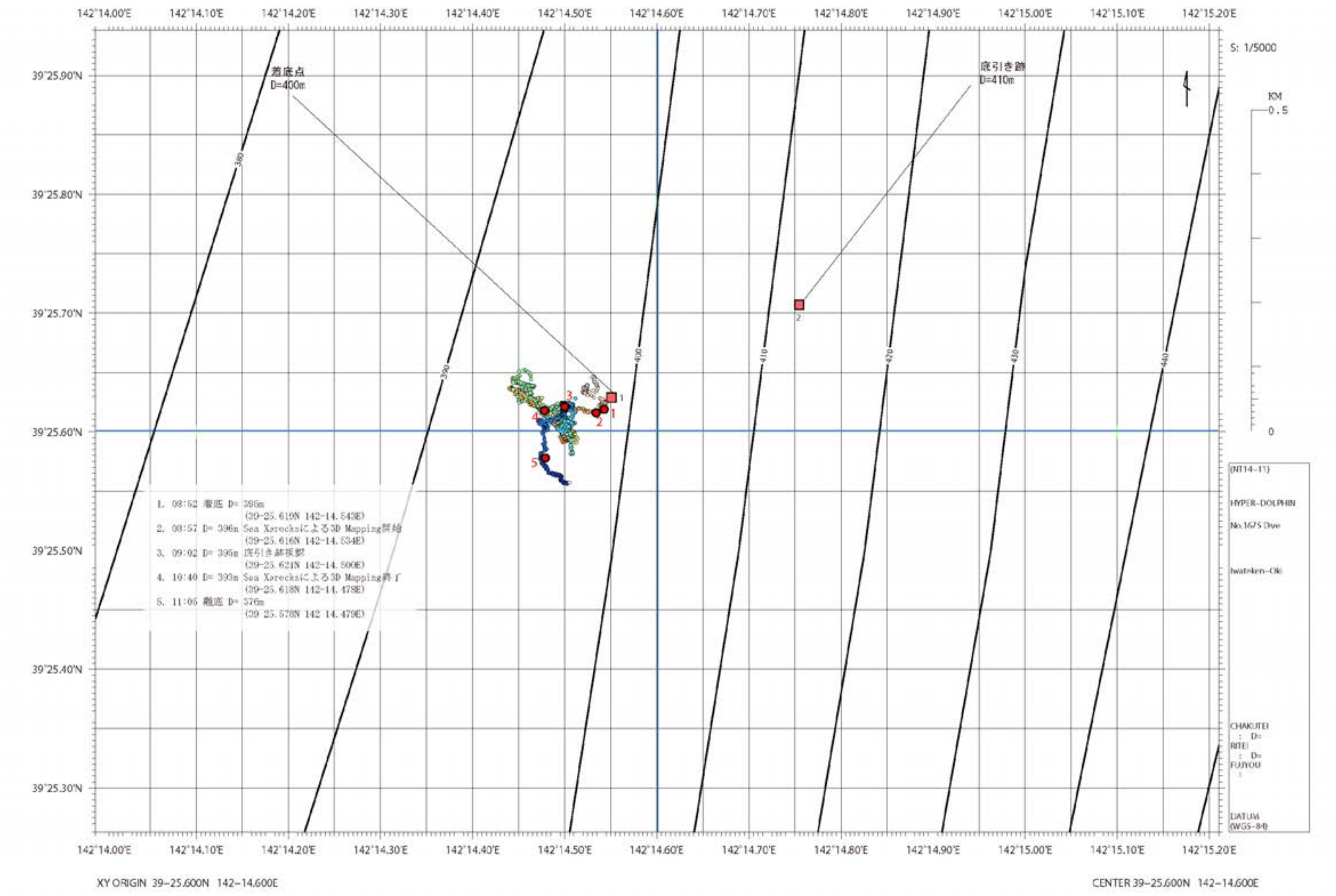
Main 3D mapping on the traces of trawl fishing activity

Payload equipment:

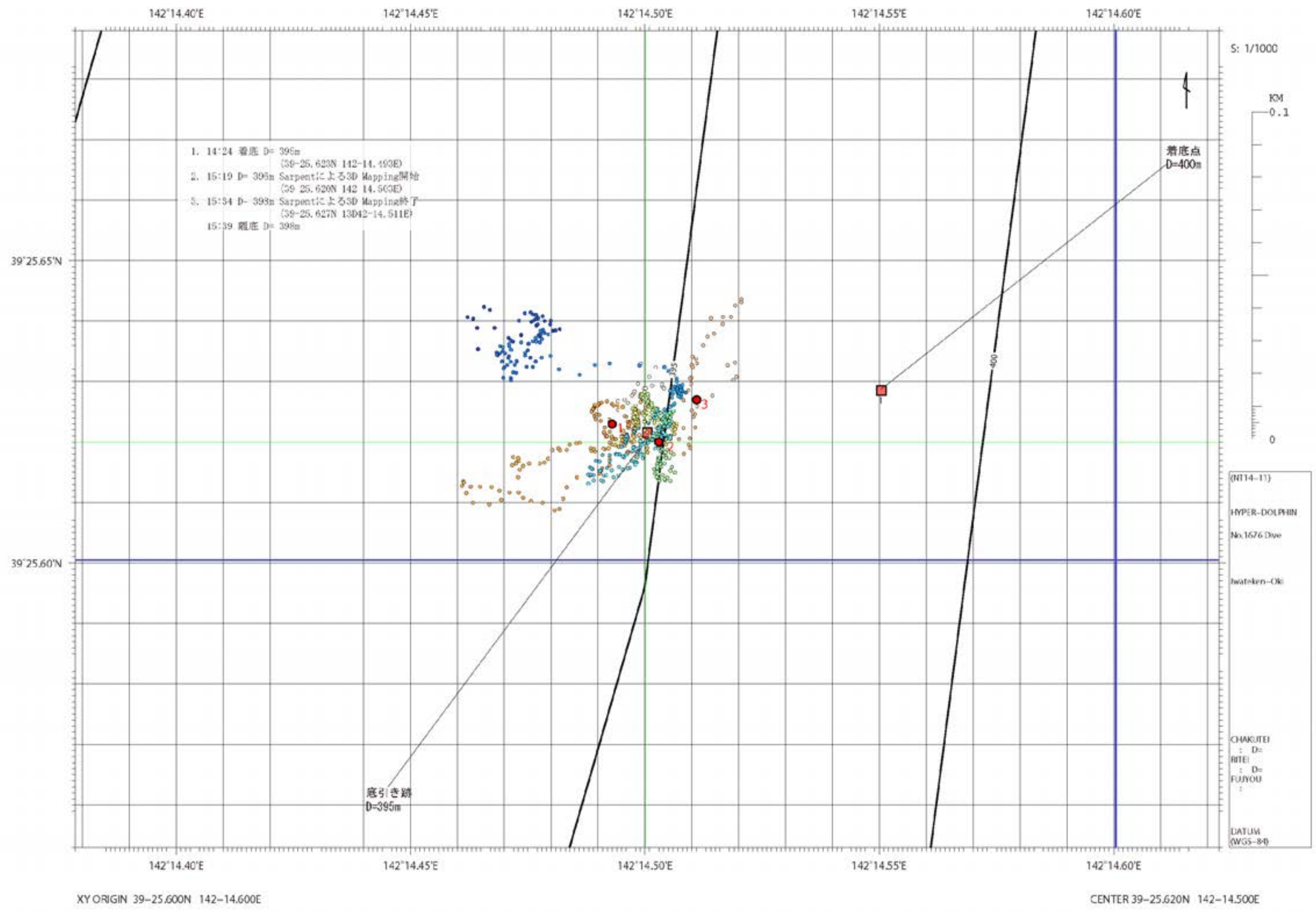
1. 3D Mapping system (wider area)	"SeaXerocks"	1
2. 3D Mapping system (higher resolution) "Serpent"		1
3. Suction sampler & multiple canisters		1
4. Sample box		1
5. MBARI-type core		4
6. DO sensor (fixed on ROV)		1
7. REDOX sensor (controllable using manipulators)		1

Dive summary

According to the previous research (NT13-21 Cruise), we discovered naked bottom without thick bed of benthic animals such as brittle stars where seemed to be damaged by some fishing activities e.g. bottom trawling nets. In the dive #1675, we tried to get a high resolution 3D map off Otsuchi area. We landed at the site of 395m depth and found traces on the bottom by probably some kind of fishing activities and then started 3D mapping by the SeaXerocks. On the way of mapping, we found oil leaking from the Hyper-Dolphin, and soon decided to cancel the dive. In the afternoon, Hyper-Dolphin was completely recovered and we had a short time to dive the same point in #1676 dive. We landed the same point as the dive#1675, but unfortunately DVL loaded on the SeaXerocks didn't work and made impossible for grid mapping. Then we decided to cancel the dive again and ascent to deck.



Underwater navigation map in Dive1675



Underwater navigation map in Dive1676

NT14-11 leg.2 (Dive 1675) July. 16th , 2014

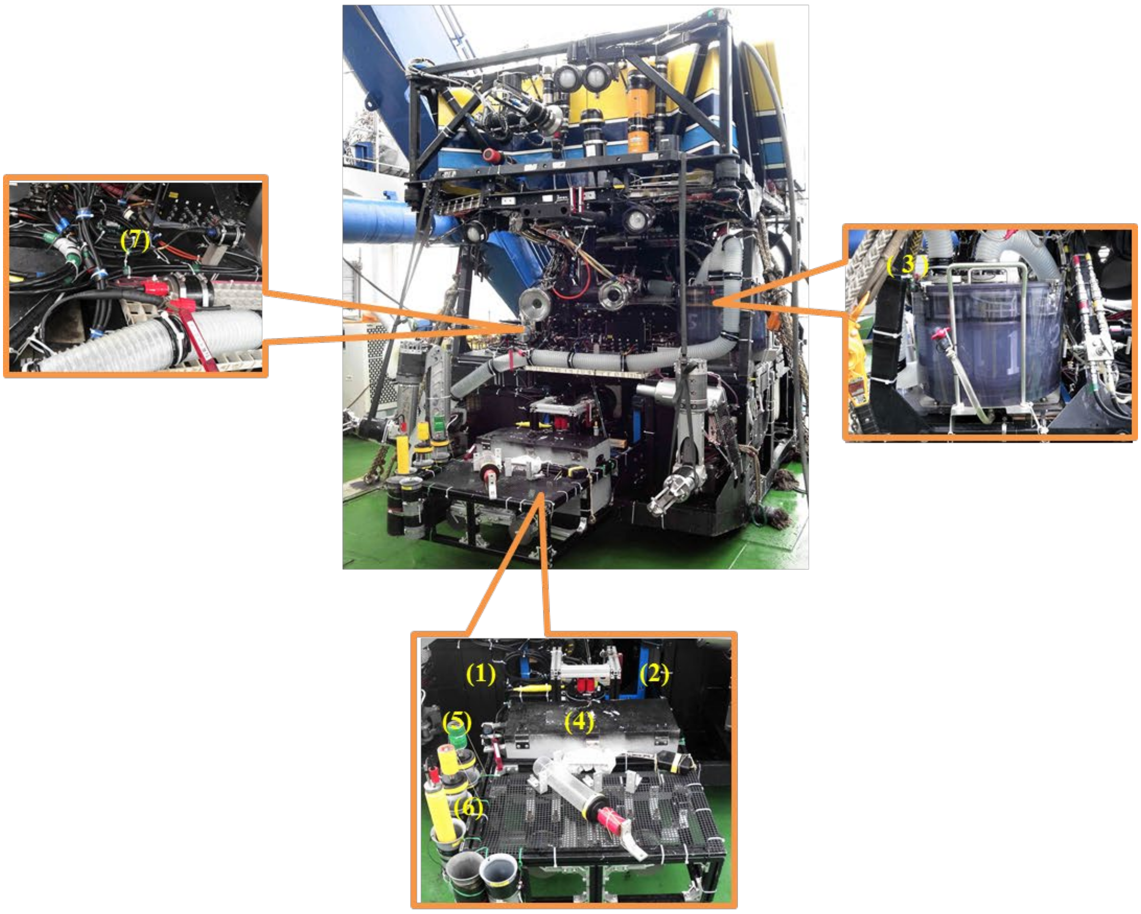


Table Devices mounted on HPD

Payload	QTY.
(1) SeaXerocks	1
(2) Serpent	1
(3) Suction sampler & multiple canisters	1
(4) Sample box	1
(5) MBARI-type core	4
(6) DO sensor	1
(7) REDOX sensor	1

Payload in Dive1675

NT14-11 leg.2 (Dive 1676) July. 16th , 2014

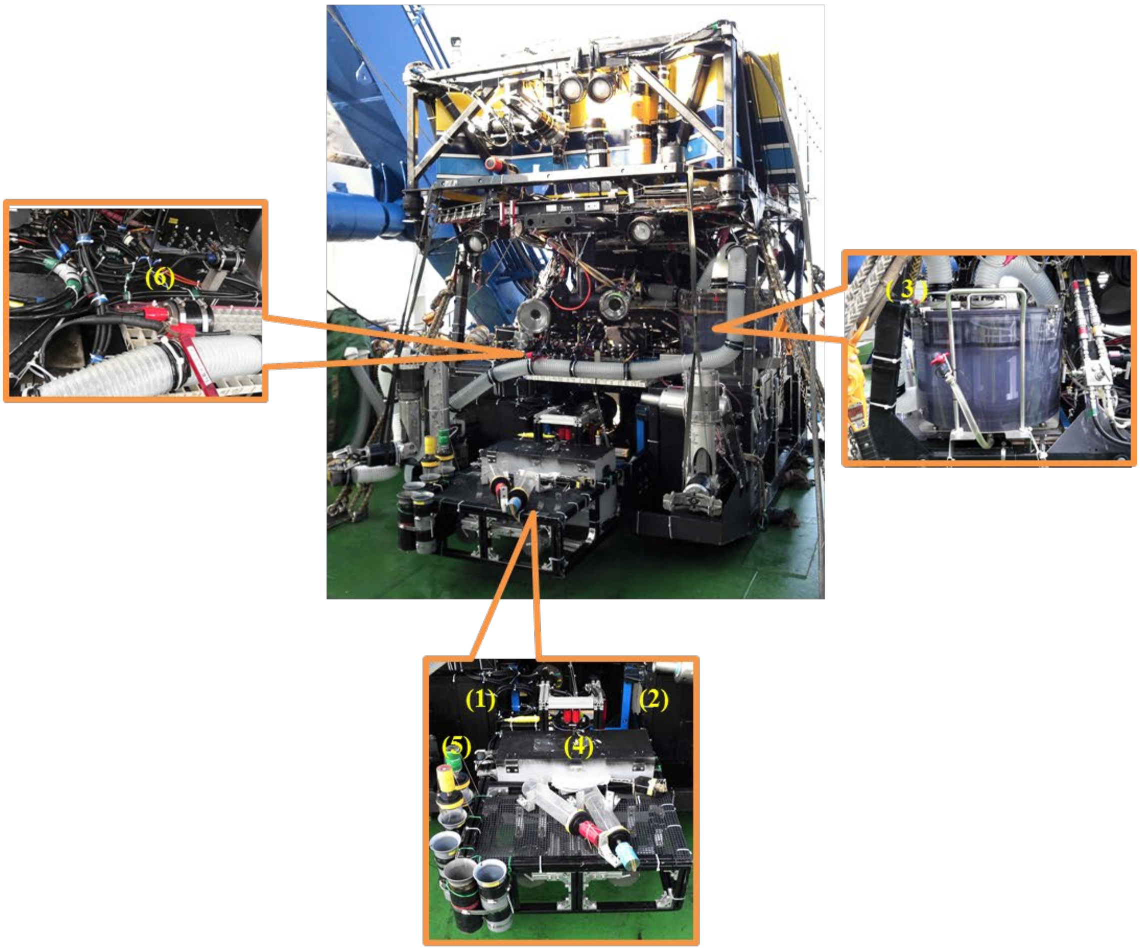


Table Devices mounted on HPD

Payload	QTY.
(1) SeaXerocks	1
(2) Serpent	1
(3) Suction sampler & multiple canisters	1
(4) Sample box	1
(5) MBARI-type core	4
(6) DO sensor	1
(7) REDOX sensor	1

Payload in Dive1676

● **Dive number: HD#1677**

Date: July 17, 2014

Site: Trawl track area, Off Otsuchi, Iwate Prefecture, Japan

(Arrival 39-25.610N, 142-14.537E; Leave 39-25.606N, 142-14.488E)

Chief observer: Yoshihiro Fujiwara (JAMSTEC)

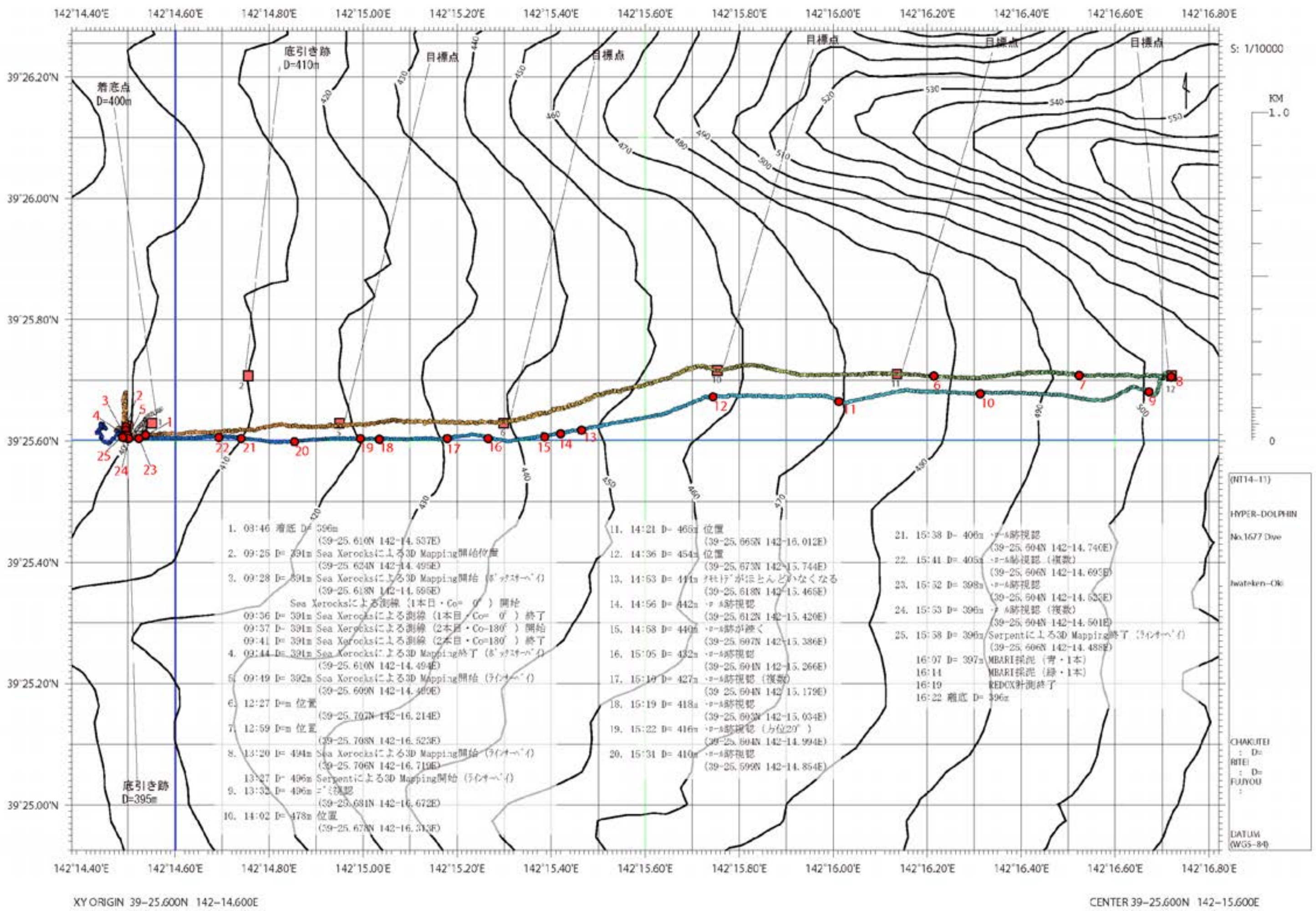
Main purposes: Comparison of biomass and biodiversity between locations with and without trawl tracks using two types of 3D mapping system.

Payload equipment:

1. 3D Mapping system (wider area)	"SeaXerocks"	1
2. 3D Mapping system (higher resolution)	"Serpent"	1
3. Suction sampler & multiple canisters		1
4. Sample box		1
5. MBARI-type core		3
6. DO sensor (fixed on ROV)		1
7. REDOX sensor (controllable using manipulators)		1

Dive summary

Three-dimensional mapping of deep-sea floors were conducted using two different types of the mapping system. Due to a mechanical problem of DVL installed on the SeaXerocks system, a box survey was terminated. Instead, two lines were surveyed primarily using both systems. The SeaXerocks mapping was conducted from west to east (from the depths of 392m to 494m) in the total distance of ca. 3.2km and the Serpent mapping from east to west along a way that was slightly southward from the SeaXerocks track. Trawl tracks were found shallower than 450m and the benthos biomass were much smaller in the trawl area than that in the other. Two sediment cores (light blue and green ones) were collected and REDOX measurements were conducted in the trawl area at the end of 3D mapping.



Underwater navigation map in Dive1677

NT14-11 leg.2 (Dive 1677) July. 17th , 2014

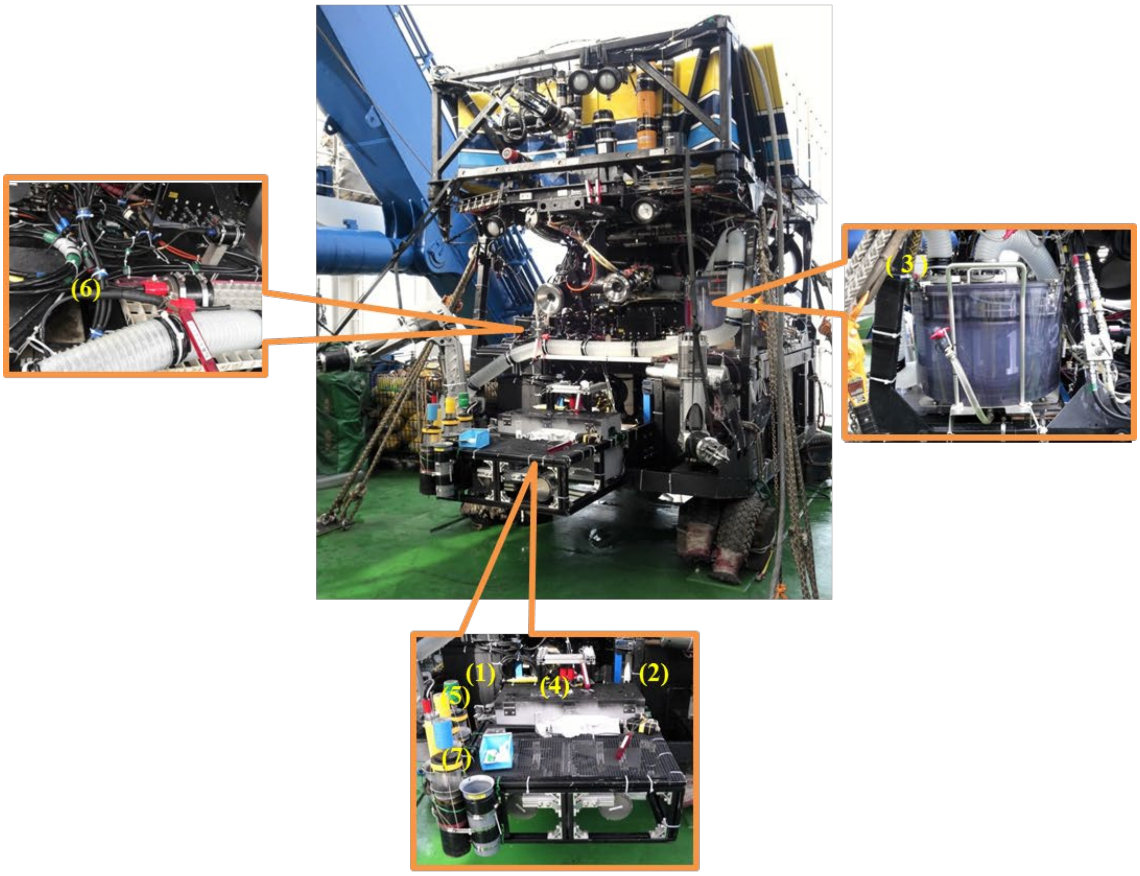


Table Devices mounted on HPD

Payload	QTY.
(1) SeaXerocks	1
(2) Serpent	1
(3) Suction sampler & multiple canisters	1
(4) Sample box	1
(5) MBARI-type core	3
(6) DO sensor	1
(7) REDOX sensor	1

Payload in Dive1677

● **Dive number: HD#1678**

Date: July 18, 2014

Site: bacteria mat area, Off Otsuchi, Iwate Prefecture, Japan

(Arrival 39-14.672N, 142-19.092E; Leave 39-14.740N, 142-18.442E)

Chief observer: Kazunori NAGANO (University of Tokyo: IIS)

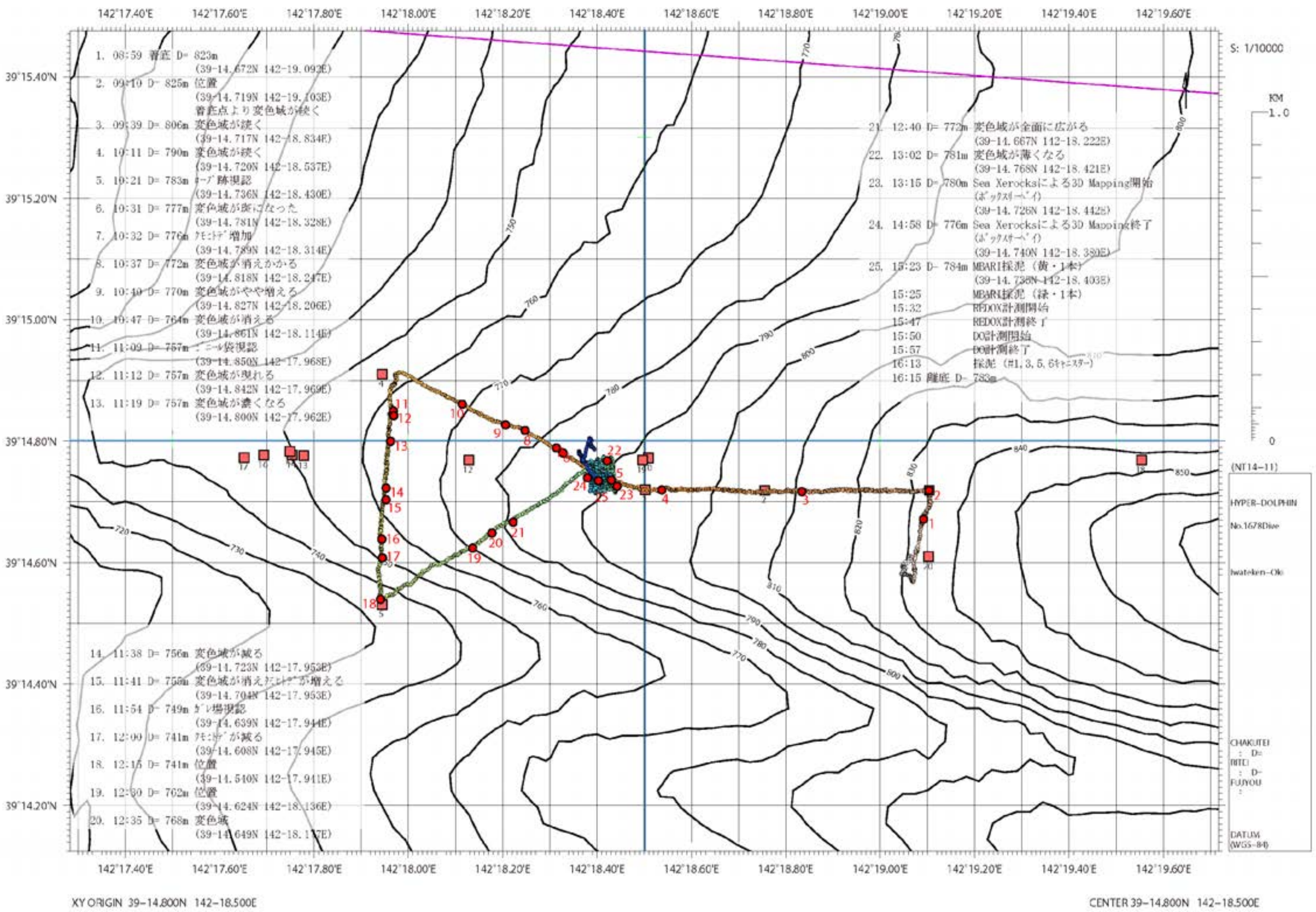
Main purposes: Survey of extending bacteria mat using 3D mapping system (Serpent) and sampling the mat.

Payload equipment:

1. 3D Mapping system (wider area)	"SeaXerocks"	1
2. 3D Mapping system (higher resolution)	"Serpent"	1
3. Suction sampler & multiple canisters		1
4. Sample box		1
5. MBARI-type core		3
6. DO sensor (fixed on ROV)		1
7. REDOX sensor (controllable using manipulators)		1
8. DO sensor		

Dive summary

At first, we arrived at Bacteria mat and started Three-dimensional mapping using a mapping system (Serpent). We went to south direction about 1km. And then, we found tracks about loops. Second, we decided to route likely triangle. We survey about extending bacteria mat. And then, we try to Three-dimensional grid mapping using Serpent at found tracks about loops area. Finally, two sediment cores (light yellow and green ones) were collected, DO measurements and REDOX measurements were conducted.



Underwater navigation map in Dive1678

NT14-11 leg.2 (Dive 1678) July. 18th , 2014

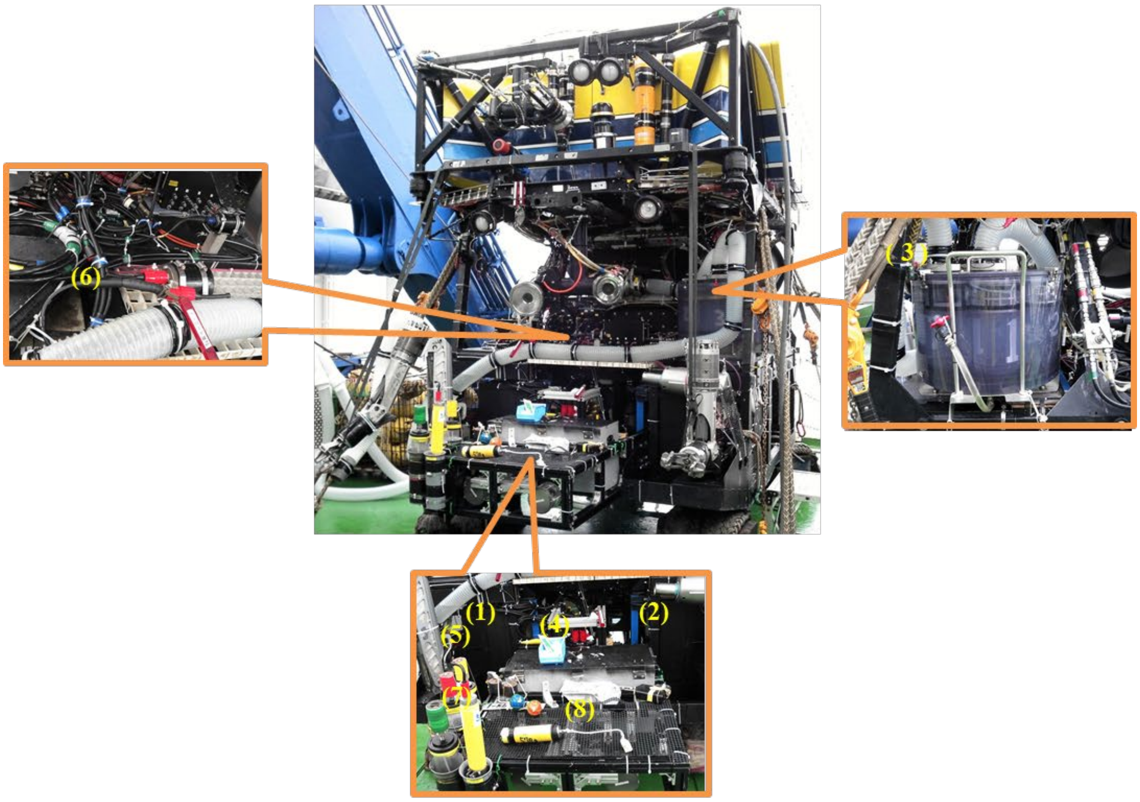


Table Devices mounted on HPD

Payload	QTY.
(1) SeaXerocks	1
(2) Serpent	1
(3) Suction sampler & multiple canisters	1
(4) Sample box	1
(5) MBARI-type core	3
(6) DO sensor	1
(7) REDOX sensor	1
(8) Do sensor ②	1

Payload in Dive1678

● **Dive number: HD#1679**

Date: July 19, 2014

Site: Bio-tracking site, Off Iwate Prefecture, Japan

(Arrival 39-11.561N 142-12.648E; Leave 39-11.648N 142-12.607E)

Chief observer: Akihiro Okamoto (NMRI)

Main purposes: To install pingers to snow crabs for Bio-Tracking System

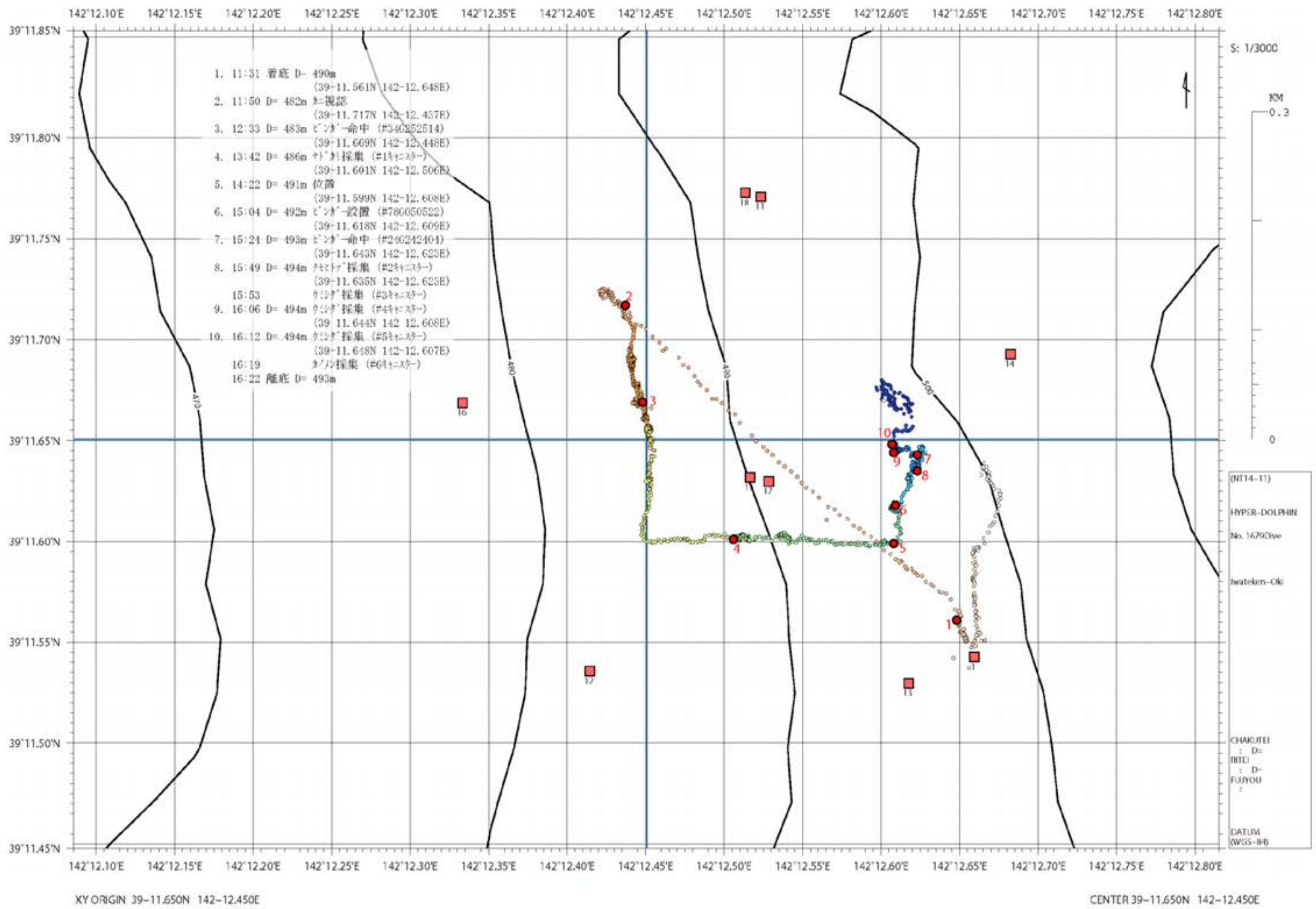
Payload equipment:

1. 3D Mapping system (wider area)	"SeaXerocks"	1
2. 3D Mapping system (higher resolution)	"Serpent"	1
3. Suction sampler & multiple canisters		1
4. Sample box		1
5. PINGU		1

Dive summary

The trial installation for Bio-Tracking System was conducted using a gun-like pinger installation device as well as the dive HD#1672. Although there were some accidents with the device that pinger bullets could not be shot out, first and seventh shot hit and was attached to snow crabs respectively, and this result of hitting of two shots out of seven appears to be good for a trial installation. Subsequently, it was observed that many brittle stars crowded toward the bleeding crabs equipped with the pingers.

A sampling with suction sampler was also conducted and several species were obtained such as brittle stars, feather stars and so on.



Underwater navigation map in Dive1679

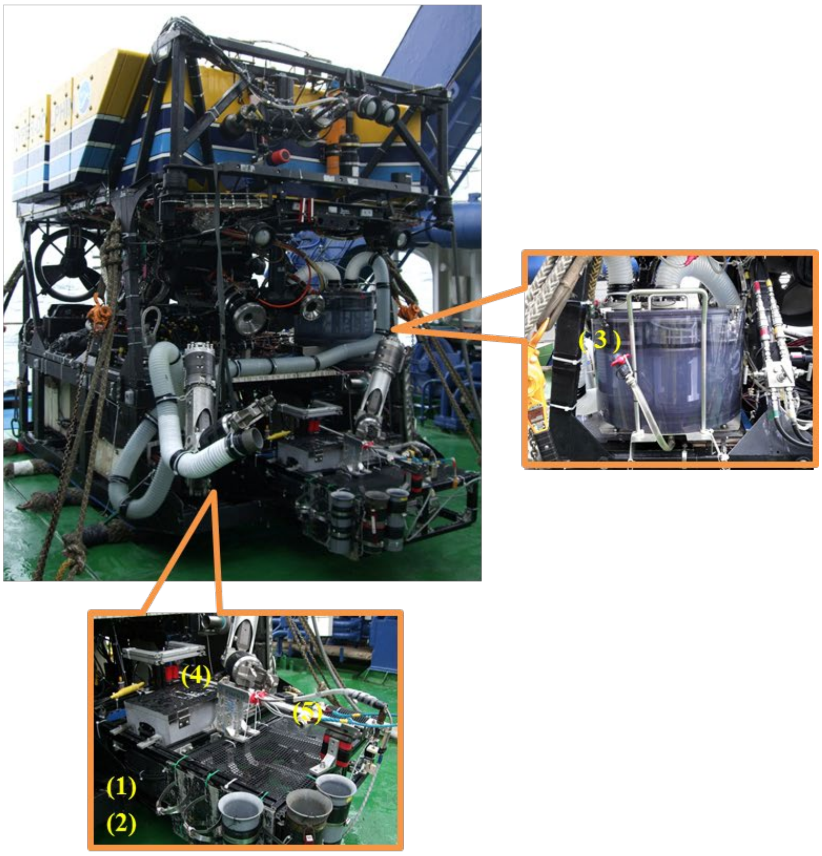


Table Devices mounted on HPD

Payload	QTY.
(1) SeaXerocks	1
(2) Serpent	1
(3) Suction sampler & multiple canisters	1
(4) Sample box	1
(5) PINGU	1

Payload in Dive1679

● **Dive number: HD#1680**

Date: July 21, 2014

Site: Ophiuroidea area, Off Minami-Sanriku, Miyagi Prefecture, Japan

(Arrival 38-33.941N, 141-56.907E; Leave 38-33.955N, 141-57.084E)

Chief observer: Masaru Kawato (JAMSTEC)

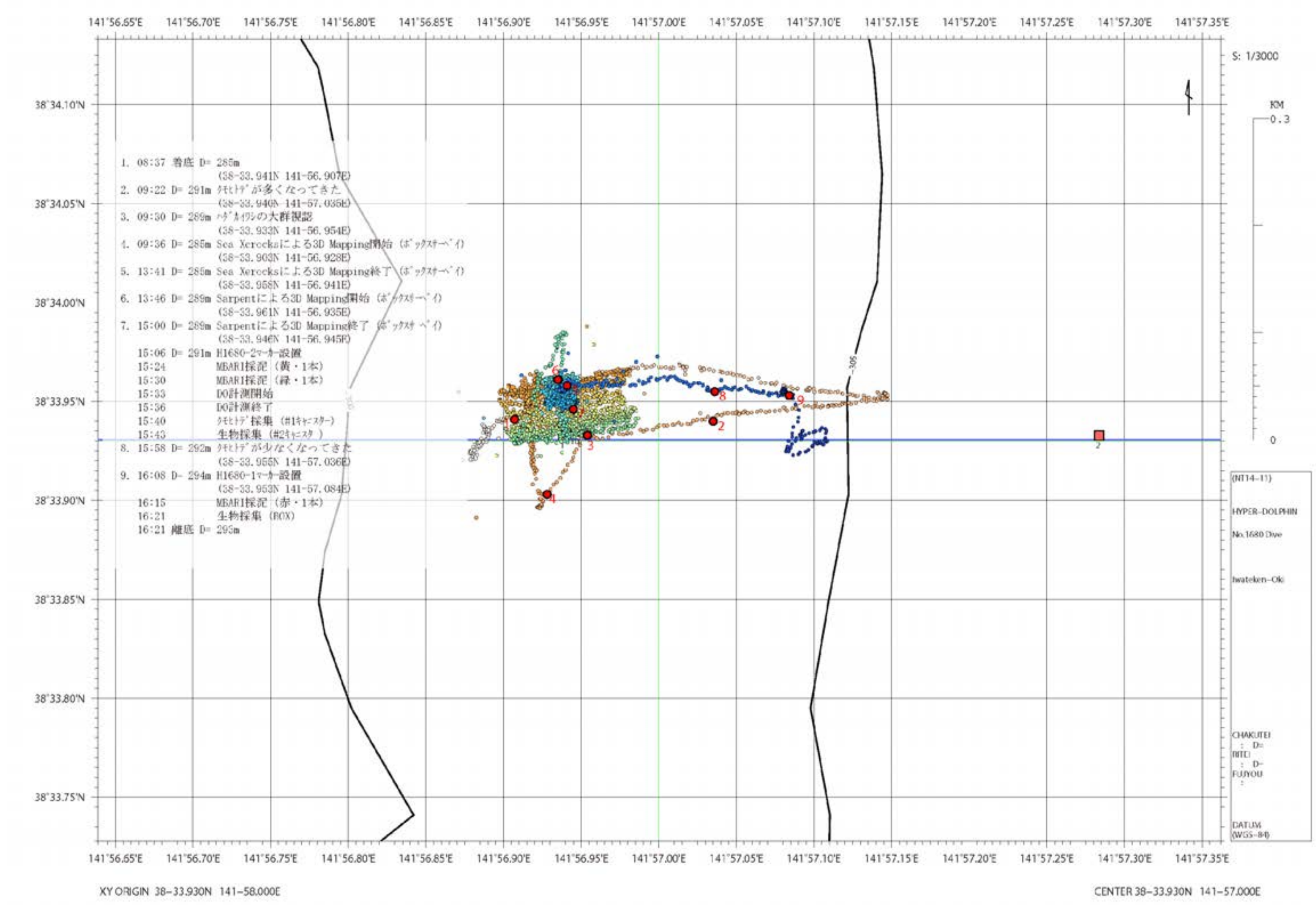
Main purposes: Observation and two types of 3D mapping of the dense Ophiuroidea population area.

Payload equipment:

1. 3D Mapping system (wider area)	"SeaXerocks"	1
2. 3D Mapping system (higher resolution)	"Serpent"	1
3. Suction sampler & multiple canisters		1
4. Sample box		1
5. MBARI-type core		3
6. DO sensor (fixed on ROV)		1
7. Markers		2

Dive summary

Three-dimensional mapping of deep-sea floors where many Ophiuroidea were colonized were conducted using two different types of the mapping system. The areas of 100m x 100m and 25m x 25m were surveyed using the "SeaXerocks" and "Serpent," respectively. The dense aggregation of the Ophiuroidea was observed all around at the depth of 290m. After finishing the mapping, many ophiuroids and one Liponematidae could be collected using the MBARI-type cores and the suction sampler.



Underwater navigation map in Dive1680

NT14-11 leg.2 (Dive 1680) July. 21th , 2014

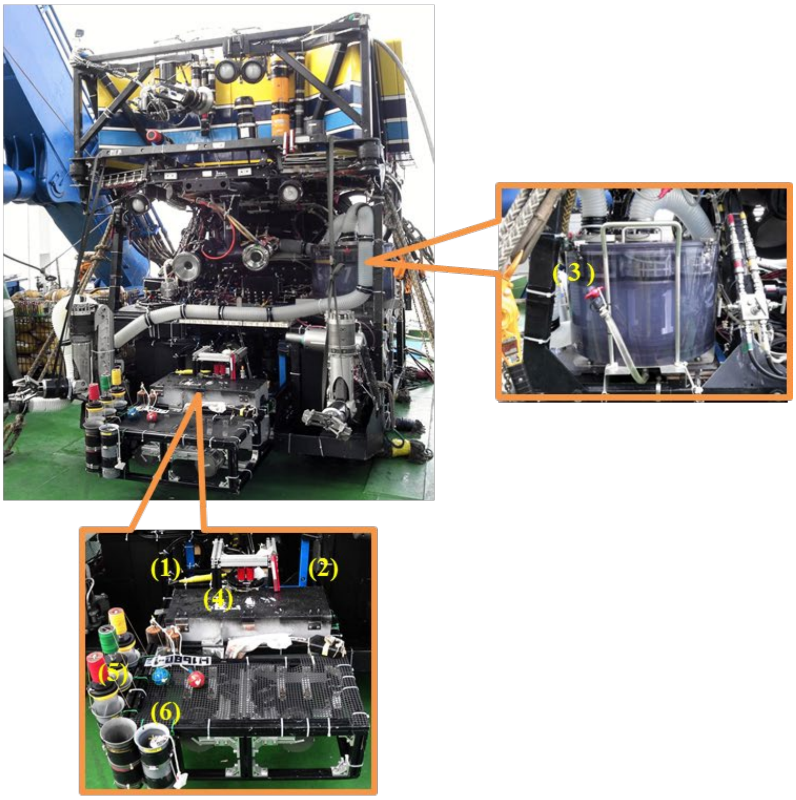


Table Devices mounted on HPD

Payload	QTY.
(1) SeaXerocks	1
(2) Serpent	1
(3) Suction sampler & multiple canisters	1
(4) Sample box	1
(5) MBARI-type core	3
(6) DO sensor	1
(7) Markers	2

Payload in Dive1680

● **Dive number: HD#1681 & HD#1682**

Date: July 22, 2014

Site: Bio-tracking site, Off Iwate Prefecture, Japan

(HD#1681 arrival 39-11.845N 142-12.690E; Leave 39-11.688N 142-12.679E)

(HD#1682 arrival 39-11.561N 142-12.648E; Leave 39-11.648N 142-12.607E)

Chief observer: Shinji Tsuchida (JAMSTEC)

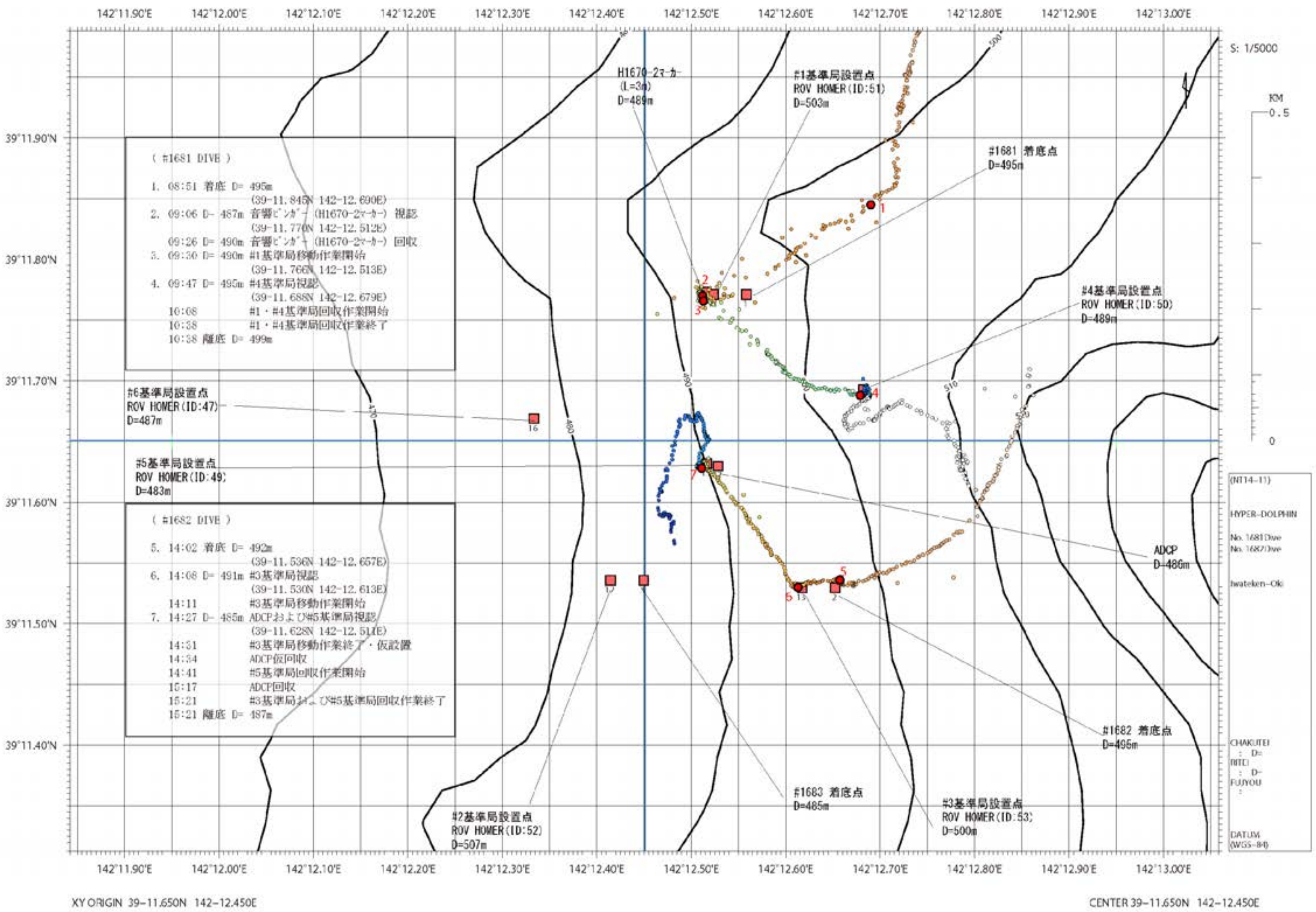
Main purposes: To recovery Bio-Tracking System No.1 and No.4 at HD#1681. To recovery Bio-Tracking System No.3, No.5 and ADCP at HD#1682.

Payload equipment:

1. Sample box	1
2. Recovery rope and hook	4
3. Cutter	1

Dive summary

In the dive#1681, we landed at the point about 300m NE from the Bio-Tracking Station #1. We approached to the station and landed again at the front of the maker H1670-2 with three acoustic pingers deployed nearby the station. Then we recovered it and grasped the station #1 by the manipulator of HPD. Holding the station, we moved to the station #4. At the point of the station #4, we tied two stations by hooked lopes to the HPD, and ascend to the deck. In next dive #1682, we went down to the station #3, and grasping the frame of #3 moved to the station #5. At the point, we recovered the ADCP on the sample basket and tied these stations by hooked lopes. During these dive, we successfully recovered four stations, a maker, and ADCP.



Underwater navigation map in Dive1681 – Dive1682

NT14-11 leg.2 (Dive 1681-1683) July. 22-23th , 2014

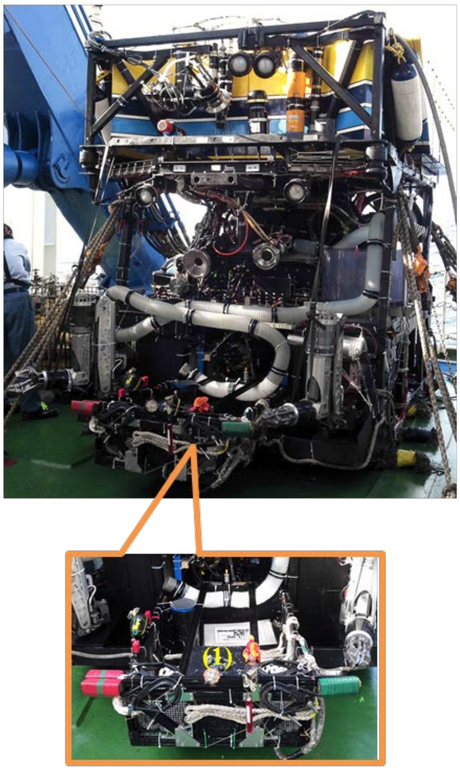


Table Devices mounted on HPD

Payload	QTY.
(1) Sample box	1
(2) Recovery rope and hook	4
(3) Cutter	1

Payload in Dive1681 - Dive1683

● **Dive number: HD#1683**

Date: July 23, 2014

Site: Bio-tracking site, Off Iwate Prefecture, Japan

(Arrival 39-11.576N 142-12.458E; Leave 39-11.669N 142-12.330E)

Chief observer: Shinji Tsuchida (JAMSTEC)

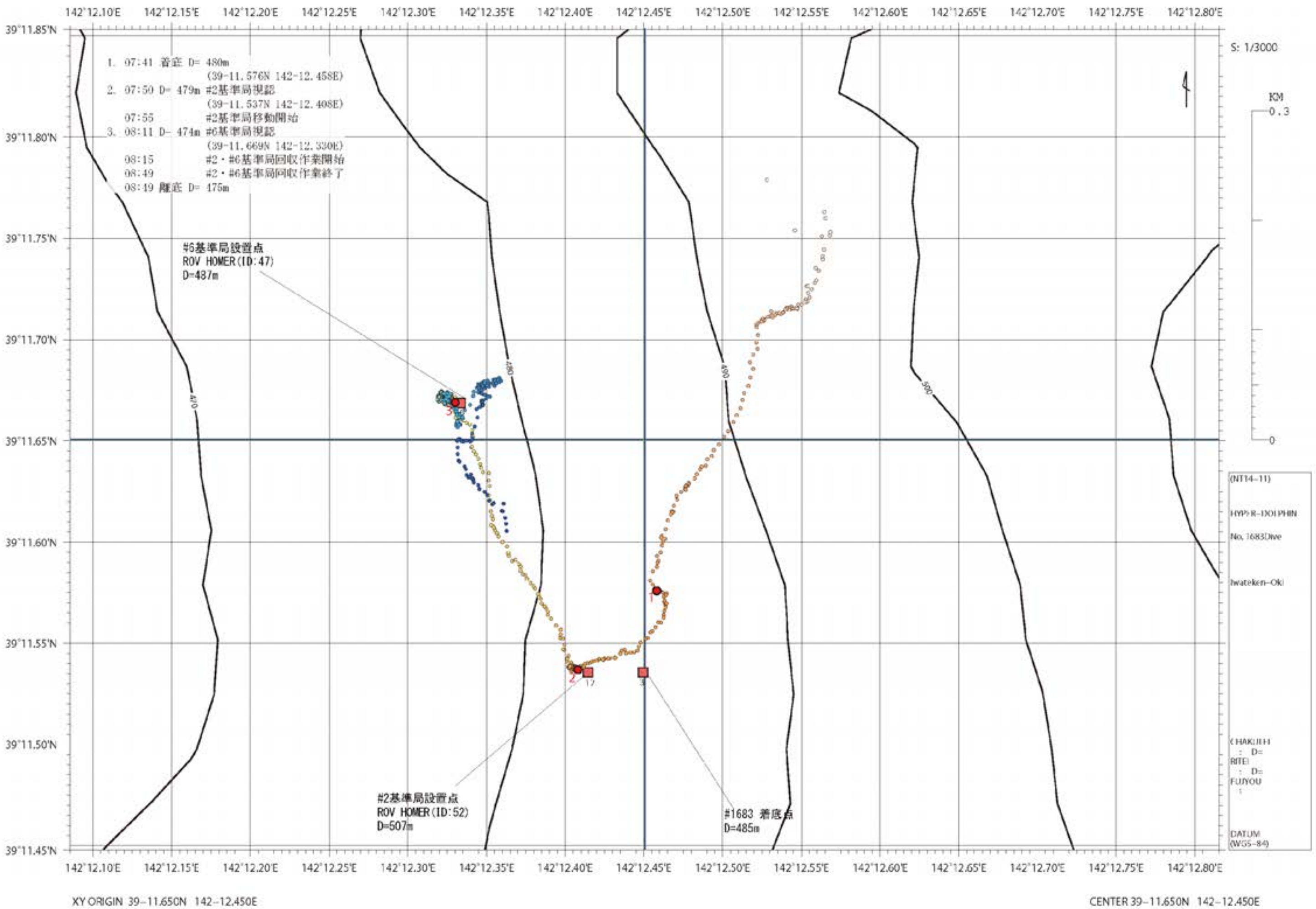
Main purposes: To recovery Bio-Tracking System No.2 and No.6

Payload equipment:

1. Sample box	1
2. Recovery rope and hook	4
3. Cutter	1

Dive summary

In this dive, we descended at the point about 100m NE from the Bio-Tracking Station #2. We landed at the station and grasped it by the manipulator of HPD. Holding the station, we moved to the station #6. At this point, we tied two stations by hooked lopes to the HPD, and ascend to the deck.



Underwater navigation map in Dive1683

● **Dive number: HD#1684**

Date: July 23, 2014

Site: Debris site, Kamaishi submarine canyon, off Otsuchi, Iwate Prefecture, Japan
(Arrival 39-14.663N 142-14.540E; Leave 39-14.802N 142-14.443E)

Chief observer: Yoshimi Takahashi (JAMSTEC)

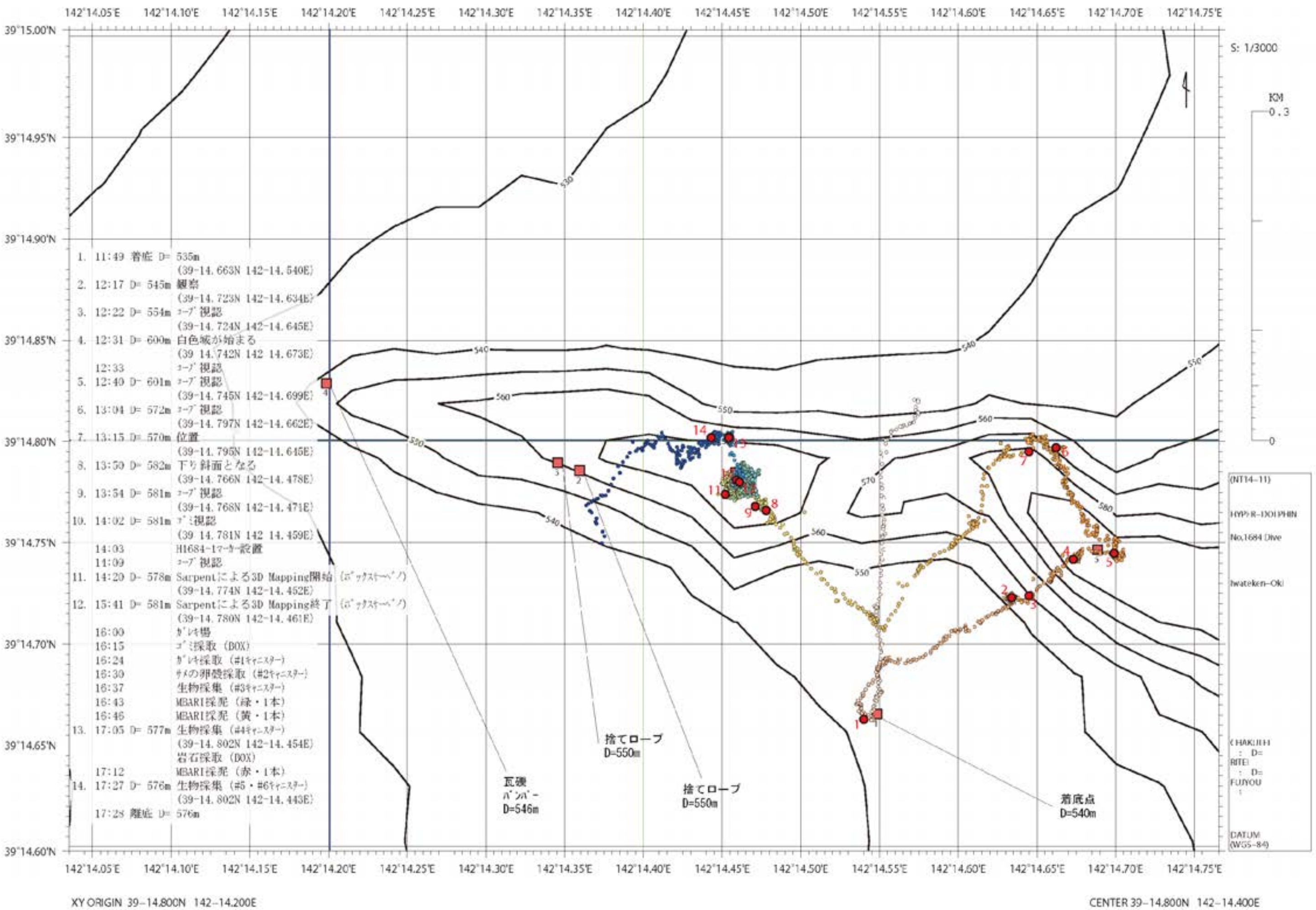
Main purposes: Observation and two types of 3D mapping of marine debris area.

Payload equipment:

1. 3D Mapping system (wider area)	“SeaXerocks”	1
2. 3D Mapping system (higher resolution)	“Serpent”	1
3. Suction sampler & multiple canisters		1
4. Sample box		1
5. MBARI-type core		3
6. DO sensor (fixed on ROV)		2

Dive summary

Three-dimensional mapping of deep-sea floors where many marine debris were conducted using the mapping system. The areas of 25 m x 25 m were surveyed using the “Serpent,” respectively. The dense aggregation of the marine debris and sharks egg were found around the canyon. After finishing the mapping, many marine debris and sharks egg could be collected using the suction sampler.



Underwater navigation map in Dive1684

NT14-11 leg.2 (Dive 1684) July. 23th , 2014

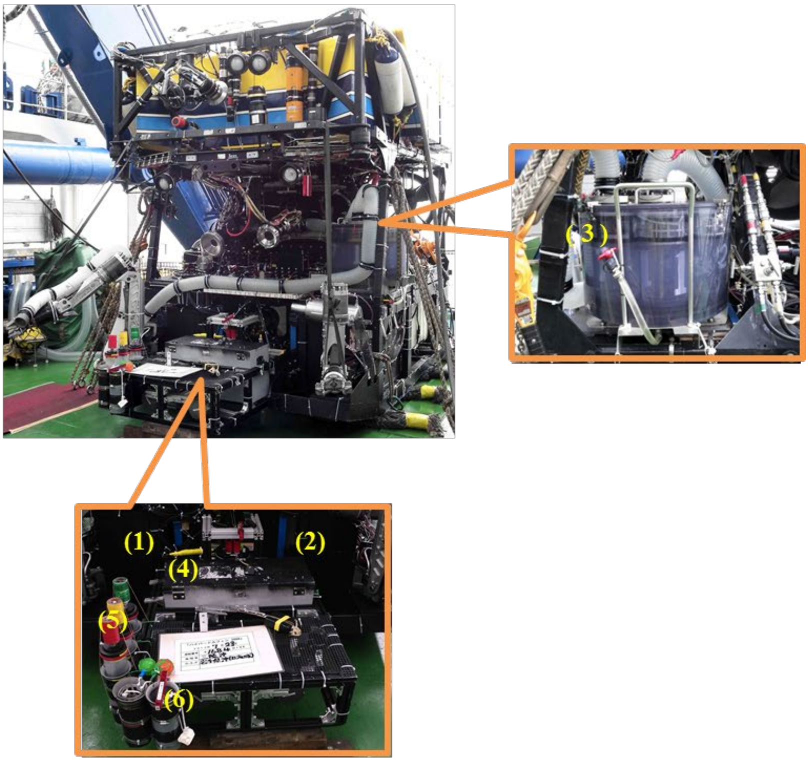


Table Devices mounted on HPD

Payload	QTY.
(1) SeaXerocks	1
(2) Serpent	1
(3) Suction sampler & multiple canisters	1
(4) Sample box	1
(5) MBARI-type core	3
(6) DO sensor	2

Payload in Dive1684

● **Dive number: HD#1685**

Date: July 23, 2014

Site: Gentle Slope Canyon, Off Ryori Bay, Ofunato city, Iwate Prefecture, Japan
(Arrival 39-00.971N 142-17.613E; Leave 39-01.128N 142-16.300E)

Chief observer: Takehisa Yamakita (JAMSTEC)

Main purposes: To observe southern slope area

Payload equipment:

1. DO sensor	1
2. Maker Buoy	2
3. Sample box	1
4. MBARI-type core	2
5. 3D Mapping system SeaXerocks	1
6. 3D Mapping system Serpent	1
7. Suction sampler & multiple canisters	1

Dive summary

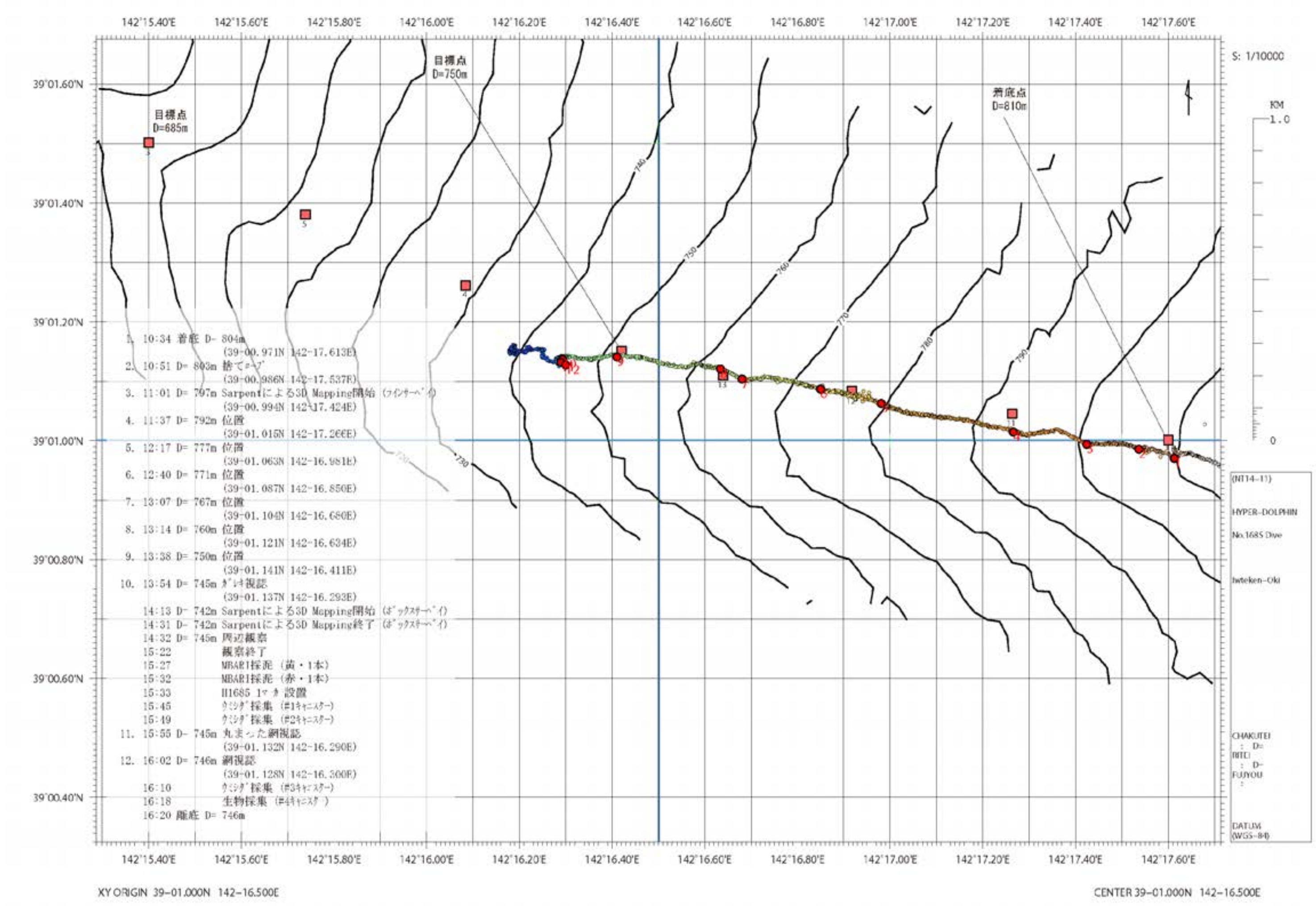
Aims of this dive survey are;

1) To conduct first observation of gentle slope valley southern area from previous researches

2) To map distribution of species and topography using 3d mapping camera system

3) To find debris and to know where the debris came from

The HPD landed at gentle slope valley at southern area from previous observation of deep sea valley in Kamaishi and Otsuchi. We conducted observation include 3D mapping by Serpent and some sampling. Basically the bottom was float topography and we observed sparce distribution of whelks, congers, feather stars, and brittle stars (not Ophiura sarsii probably Ophiophthalmus normani). We also observed some debris such as bedclothes and collected the debris on sample box. 2 cores near the debris are also collected.



Underwater navigation map in Dive1685

NT14-11 leg.2 (Dive 1685) July. 24th, 2014

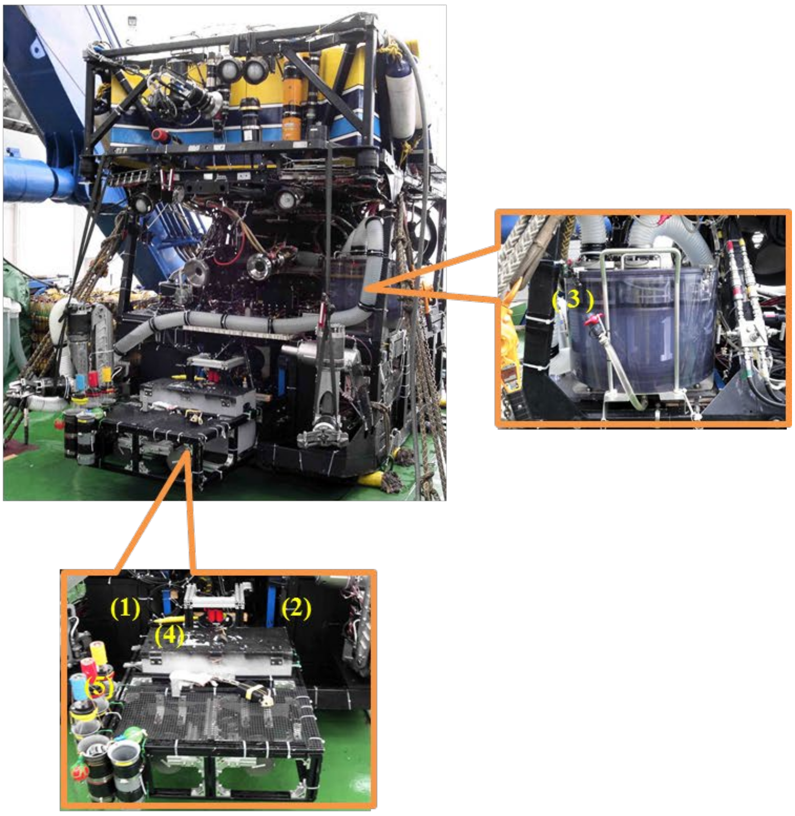


Table Devices mounted on HPD

Payload	QTY.
(1) SeaXerocks	1
(2) Serpent	1
(3) Suction sampler & multiple canisters	1
(4) Sample box	1
(5) MBARI-type core	4
(6) DO sensor	1
(7) Maker Buoy	2

Payload in Dive1685

7. Marine environment monitoring

7.1 Long-term monitoring of the bottom environment at off Otsuchi continental shelf to the slope

7.1.1 Deployment of lander system

A lander system was deployed to investigate bottom environment of off Otsuchi bay (Figs. 7.1.1.-7.1.2.). The lander was installed ADCP, CTD, DO and turbidity sensors, HDTV camera system and transponders (Tables 7.1.1.-7.1.4.). At the deployment, the mooring system was connected with the lander (Fig. 7.1.3.) and released from the ship. The descending speed and the slant range were measured from the ship to connect the acoustic instrument with the transducer mounted to the ship bottom. The descending speed was estimated to 43.5 m/min. After confirming the landing, the exact location was determined by SSBL with on board instrument (Table 7.1.1.). After the positioning, the mooring system was released by acoustic command. Ascending speed of the mooring system was ca. 100m/min. The mooring system was recovered on deck (Fig. 7.1.4.).

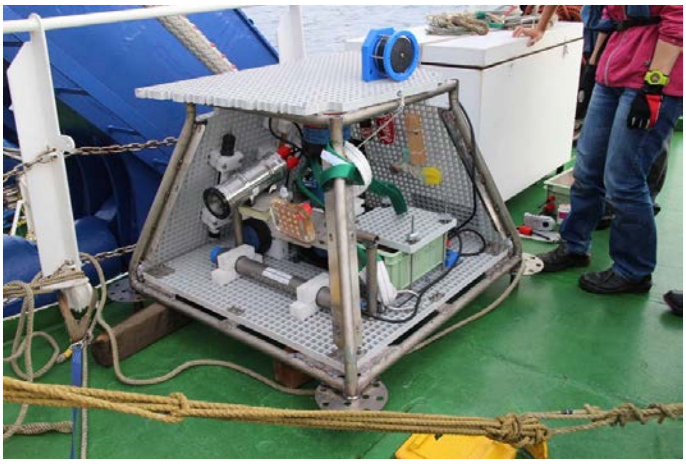


Fig 7.1.1 Lander system. Plastic guard was removed to show inside the lander.

Fig. 7.1.2. Photo taken from the top part of the lander. Green belt was connected with the transponder of the mooring system with a titanium ring.

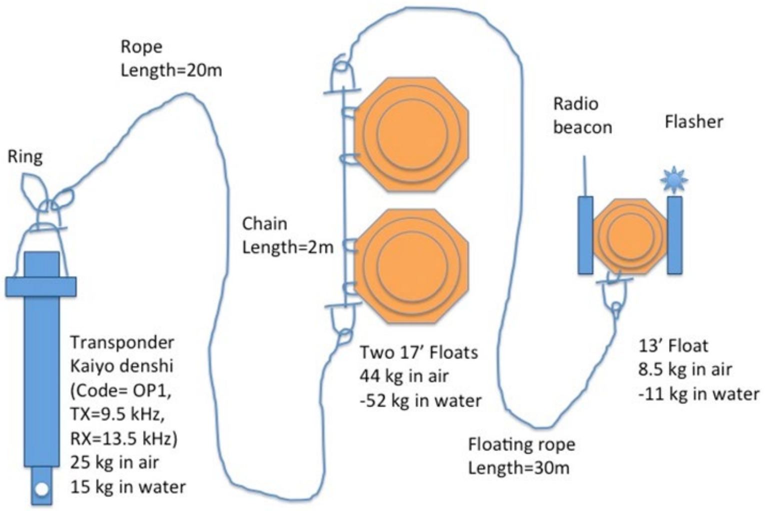


Fig. 7.1.3. Mooring system used for the deployment of the lander system.

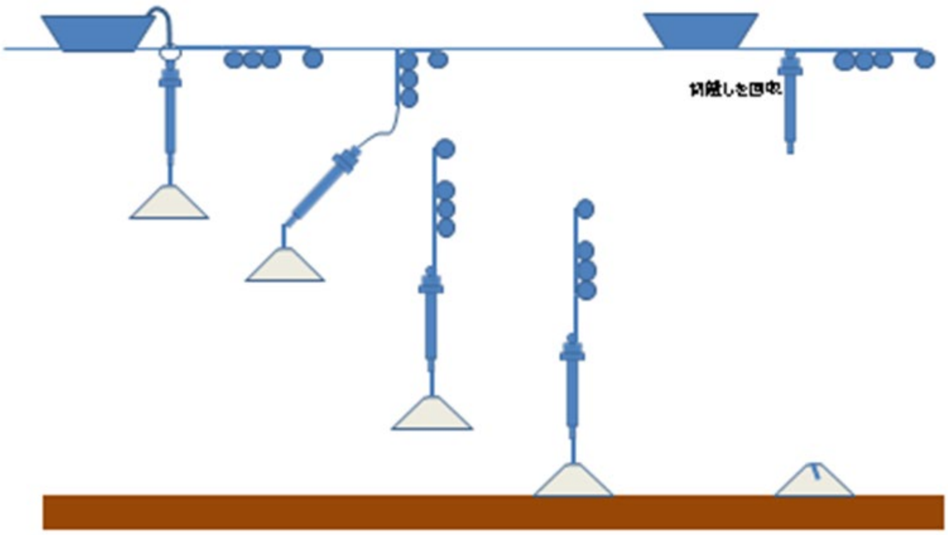


Fig. 7.1.4. Schematic illustration of the lander deployment and the recovery of the mooring system.

Table 7.1.1. Date and time of the deployment, location and water depth of the site deployed.

Date of deployment	Landed time (JST)	Latitude (N)	Longitude (E)	Depth (m)
2014/6/24	7:27	39° 19.9430'	142° 26.9720'	1001

Table 7.1.2. Instruments and measurement features of the lander system.

Instruments	RDCP600 (Serial No. 1001)	Camera (Serial No. 04)	LED Light	Lithium-Ion battery	ARGOS beacon	ROV Homer	Transponder
	Current direction, intensity, temperature, conductivity, turbidity and dissolved oxygen	Still and HDTV recordings.	14.8W	14.8V/40Ah	ID=136037 HEX=BF9D58B Serial=136037	ID=33	Code= OP1 TX= 12.0kHz RX= 13.5kHz

[

Table 7.1.3. Measurement interval

Instruments	RDCP600	Still image	HDTV VIDEO
Interval	1 hour	4 times/day (0, 6, 12 and 18 hour)	5 minutes/week

Table 7.1.4. Settings of the ADCP in RDCP600.

Power	Pulse type	Column height	Cell size	Overlap	Timing	Ping (times)
Low	Auto	3 - 83.4m	2m	20%	Burst	200

7.1.2 Recovery of the lander system deploying at 300 m depth

On 24th/Jun., the lander deployed on 1st/Nov. 2013 by R/V Bosei-maru was tried to the recovery. However, the acoustic signal from the lander could not detected even wake up signal was sent at the appropriate code and the frequency (Code= OP1 and TX= 11.5 kHz). At dive #1664, ROV *HYPER-DOLPHIN* was submerged at the initially-deployed site (39°19.859’ N, 142°10.032’ E). However, any artificial objects were not seen. Confirmation of the acoustic response from ROV homer (ID= 32) installed on the lander was also tried, and the response was not detected. *HYPER-DOLPHIN* continued to search the lander with acoustic sonar with moving the position, but any signals were eventually obtained.

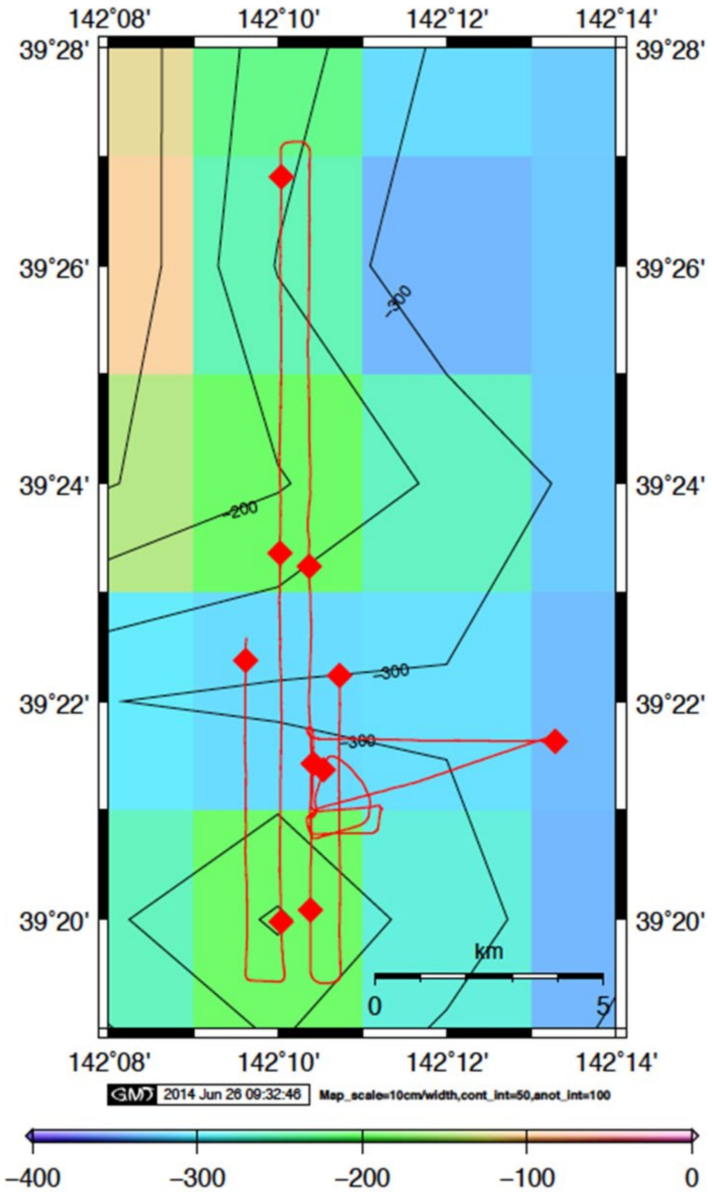


Fig. 7.1.5. Transect line in search for the response from the lander transponder.

From evening on 24th, the R/V Natsushima started the search the response from the lander transponder to send wakeup signals. The transect lines are shown in Fig. 7.1.5. Throughout the survey, obvious responses were not confirmed. Sometimes, response-like signal was received, but slant ranges were random and the signal was received even if the transmitting frequency was changed. Therefore, such signals were regarded as noise.

From 27th evening to 28th morning, the search of the 300 m lander was attempted again. The search transect is shown in the blue line in the Fig. 7.1.6. Unfortunately, obvious response from the lander was not recognized. Although we could not get any signals throughout the two surveys, we estimate the lander was still lying at the sea bottom because the signals from ARGOS satellites have not yet arrived. To think of the battery capacity of the transponder (guaranteed for more than 1 year), the lander might have still respond from the wakeup command. The lander are possibly moved by trawling activities and it must be still alive and waiting the command at the sea bottom.

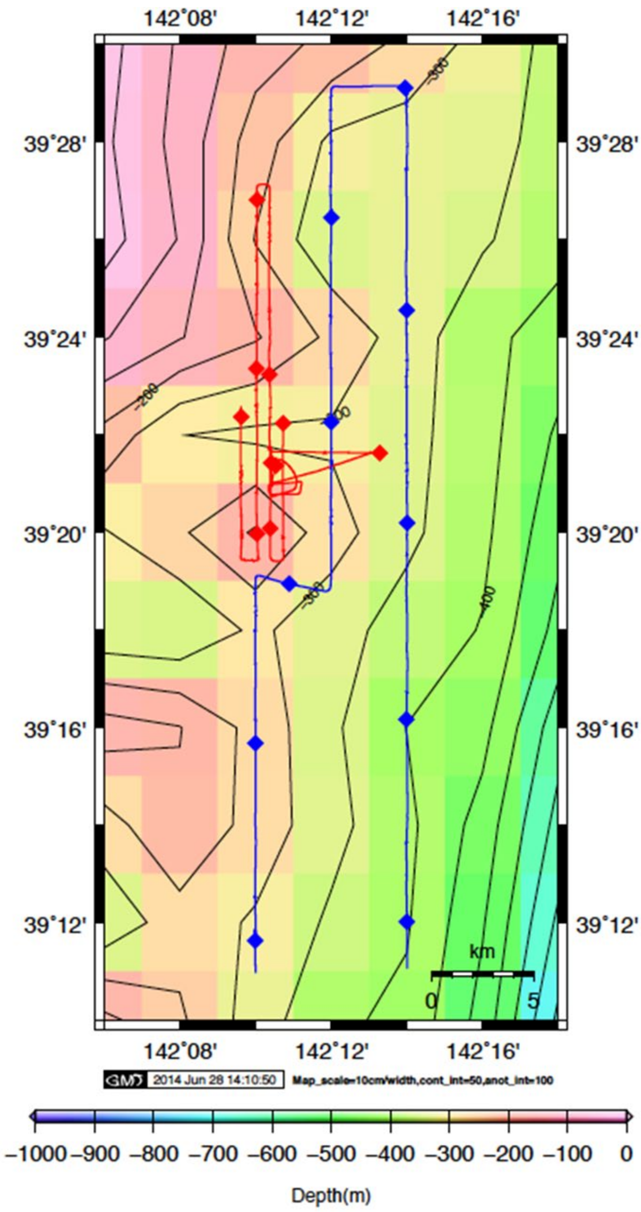


Fig. 7.1.6 Transect line (blue) in search for 300 m lander. Red line represents search transect carried out on 24th/Jun.

7.2 XCTD, XBT

In this cruise, water temperature measurements were conducted at many point (total 69 points, Table 7.2.1) using XBT (Fig. 7.2.1). These water temperature data are used for sound speed correction such as a distance measurement by SSBL and the bottom topography survey by the MBES. Moreover, these are important data to understand fluctuation of the hydrographic condition (marine environment) in Sanriku offshore area as well as sound speed correction.

Grid surveys of water temperature and salinity using XCTD (total 30 points, Table 7.2.2) also conducted it to understand marine environment in Sanriku offshore area during a research period (Fig. 7.2.1). The survey lines were made for East-West lines in the Otsuchi offshore area (39-20') and the south side (39-10'). In this sea area, Kuroshio Current, Oyashio and Tsugaru warm water mix together and cause complex hydrographic condition. As well as information in the sea surface such as the satellite image (Fig. 7.2.2), the vertical measurement of water temperature and salinity is important to know the fishing ground environment in Sanriku offshore area. Each data are analyzed to understand marine structure.

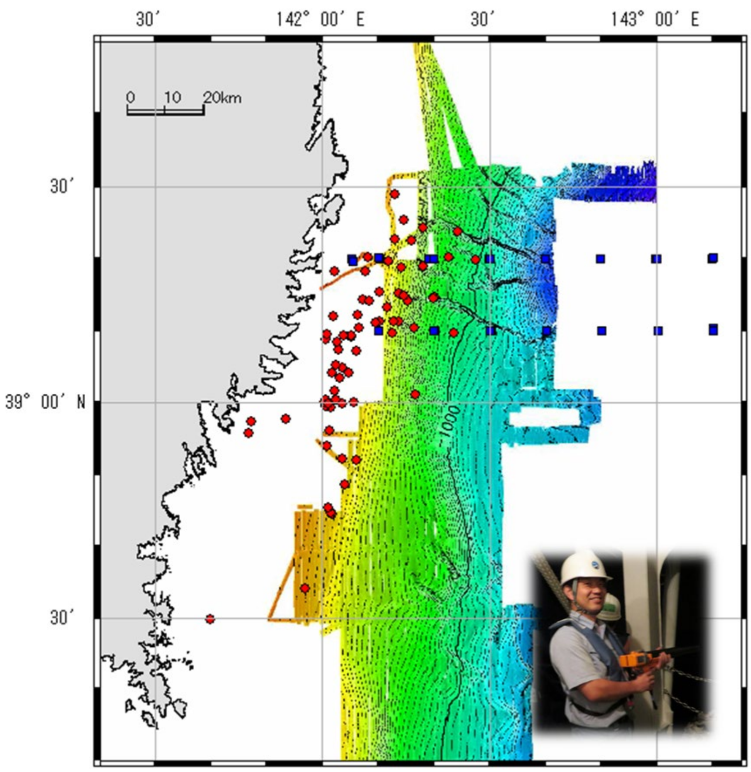


Fig.7.2.1 Observation points of XBT and XCTD

Red dots are XBT point and blue squares show XCTD points.

Table 7.2.1 Observation points of XBT

St_No	Day	Time	Lat_deg	Lat_min	Long_deg	Lat_min
XBT131	20140623	210605	39	19.9207	142	27.2136
XBT132	20140624	23118	39	19.7353	142	11.7163
XBT133	20140624	214015	38	55.8671	141	46.6428
XBT134	20140625	85939	39	0.1721	142	5.3652
XBT135	20140625	100100	38	52.1634	142	5.8228
XBT136	20140625	191649	38	48.748	142	3.7493
XBT137	20140626	82344	39	0.0894	142	3.2867
XBT138	20140626	92210	38	52.416	142	3.3475
XBT139	20140626	190234	38	44.7195	142	1.62
XBT140	20140626	232132	38	30.0012	141	39.7607
XBT141	20140627	115610	39	11.3745	142	9.9947
XBT142	20140627	191650	39	19.0016	142	13.9905
XBT143	20140628	5417	39	20.4047	142	8.0008
XBT144	20140628	101129	38	59.5095	142	1.2644
XBT145	20140628	123504	38	44.8302	142	1.3824
XBT146	20140628	150905	39	7.3986	142	5.8541
XBT147	20140628	190905	39	9.2491	142	5.018
XBT148	20140628	214305	38	57.9126	141	53.2603
XBT149	20140629	223243	38	57.5826	141	47.0008
XBT150	20140630	74708	38	59.6036	142	0.4397
XBT151	20140630	95556	38	45.5829	142	0.8629
XBT152	20140701	91939	39	0.2655	142	0.0206
XBT153	20140701	114633	39	9.4722	142	5.0278
XBT154	20140701	150716	39	4.2582	142	4.4693
XBT155	20140701	184858	39	9.5219	142	3.6698
XBT156	20140701	220214	39	23.9516	142	24.135
XBT157	20140702	225224	39	14.7866	142	19.9455
XBT158	20140703	95502	39	0.5186	142	0.3079
XBT159	20140703	110219	39	8.9965	142	0.3919
XBT160	20140703	213303	39	11.4284	142	13.5366
XBT161	20140704	84642	39	9.8645	142	12.3183
XBT162	20140704	120700	39	15.3576	142	13.46

XBT163	20140705	64737	39	9.639	142	0.5817
XBT164	20140705	83139	39	0.0895	142	0.8555
XBT165	20140705	125155	39	4.2949	142	1.4098
XBT166	20140706	81524	39	11.2168	142	9.259
XBT167	20140706	150608	39	22.8123	142	12.7877
XBT168	20140706	191723	39	14.2008	142	15.1358
XBT169	20140707	81151	39	29.03	142	12.7915
XBT170	20140707	110926	39	10.5233	142	16.2521
XBT171	20140707	150607	39	19.0395	142	17.7859
XBT172	20140707	210136	39	20.3595	142	22.3993
XBT173	20140707	222155	39	9.753	142	23.3169
XBT174	20140709	83658	39	18.3307	142	1.9725
XBT175	20140709	104302	39	1.7433	142	1.9714
XBT176	20140713	100318	39	0.5065	142	2.2627
XBT177	20140713	115810	39	3.5252	142	2.8036
XBT178	20140713	141630	39	4.9648	142	3.3623
XBT179	20140713	215025	39	14.9158	142	14.3664
XBT180	20140714	193549	39	5.3926	142	2.1214
XBT181	20140714	221859	39	25.5216	142	14.3172
XBT182	20140715	190600	39	12.0895	142	1.7171
XBT183	20140717	193120	39	7.5677	142	2.7661
XBT184	20140717	222202	39	14.6767	142	19.7689
XBT185	20140719	11631	39	11.3906	142	12.5039
XBT186	20140719	103732	39	12.3031	142	6.1425
XBT187	20140719	150024	39	13.4699	142	11.4397
XBT188	20140719	233943	39	8.5122	142	2.3243
XBT189	20140720	10525	39	10.5143	142	6.4124
XBT190	20140720	42711	39	14.5422	142	6.9715
XBT191	20140720	212452	38	34.2896	141	56.6377
XBT192	20140721	100554	38	54.085	142	0.648
XBT193	20140721	112859	38	56.2738	142	1.045
XBT194	20140721	150335	39	15.5128	142	9.9763
XBT195	20140722	90026	39	18.4252	142	7.5301
XBT196	20140722	121559	39	14.2477	142	8.0906

XBT197	20140723	113526	39	22.6337	142	15.6998
XBT198	20140723	131958	39	24.4789	142	17.7894
XBT199	20140723	235615	39	1.2438	142	16.5311

Table 7.2.2 Observation points of XCTD

St_No	Day	Time	Lat_deg	Lat_min	Long_deg	Lat_min
XCTD136	20140708	94348	39	19.9917	142	10.1626
XCTD137	20140708	103149	39	19.9943	142	18.9279
XCTD138	20140708	112035	39	20.0224	142	29.8253
XCTD139	20140708	120939	39	20.0067	142	39.832
XCTD140	20140708	130313	39	19.9953	142	49.7591
XCTD141	20140708	135845	39	20.0046	142	59.7598
XCTD142	20140708	145539	39	19.9946	143	9.8834
XCTD143	20140708	161405	39	10.3526	143	10.024
XCTD144	20140708	172321	39	10.0035	143	0.1547
XCTD145	20140708	182718	39	9.9991	142	50.1106
XCTD146	20140708	192524	39	10.0105	142	40.0417
XCTD147	20140708	202211	39	10.0104	142	30.196
XCTD148	20140708	211645	39	10.0188	142	20.0328
XCTD149	20140708	222334	39	9.9662	142	10.0599
XCTD150	20140709	80347	39	19.9483	142	5.2886
XCTD151	20140718	83429	39	19.9923	142	19.9525
XCTD152	20140718	92646	39	19.9825	142	30.0001
XCTD153	20140718	101741	39	20.0004	142	39.984
XCTD154	20140718	110939	39	20.0102	142	49.8517
XCTD155	20140718	120147	39	20.0035	142	59.9536
XCTD156	20140718	125634	39	20.1522	143	10.1401
XCTD157	20140718	141015	39	10.0106	143	10.1591
XCTD158	20140718	151024	39	9.9882	143	0.11
XCTD159	20140718	161059	39	9.9975	142	50.0471
XCTD160	20140718	170756	39	10.0022	142	40.1108
XCTD161	20140718	180236	39	10.0081	142	30.0021
XCTD162	20140718	185436	39	10.006	142	19.9814
XCTD163	20140718	194208	39	10.0038	142	10.0365

XCTD164	20140719	85902	39	20.1533	142	10.0219
XCTD165	20140719	92830	39	19.6875	142	5.3456

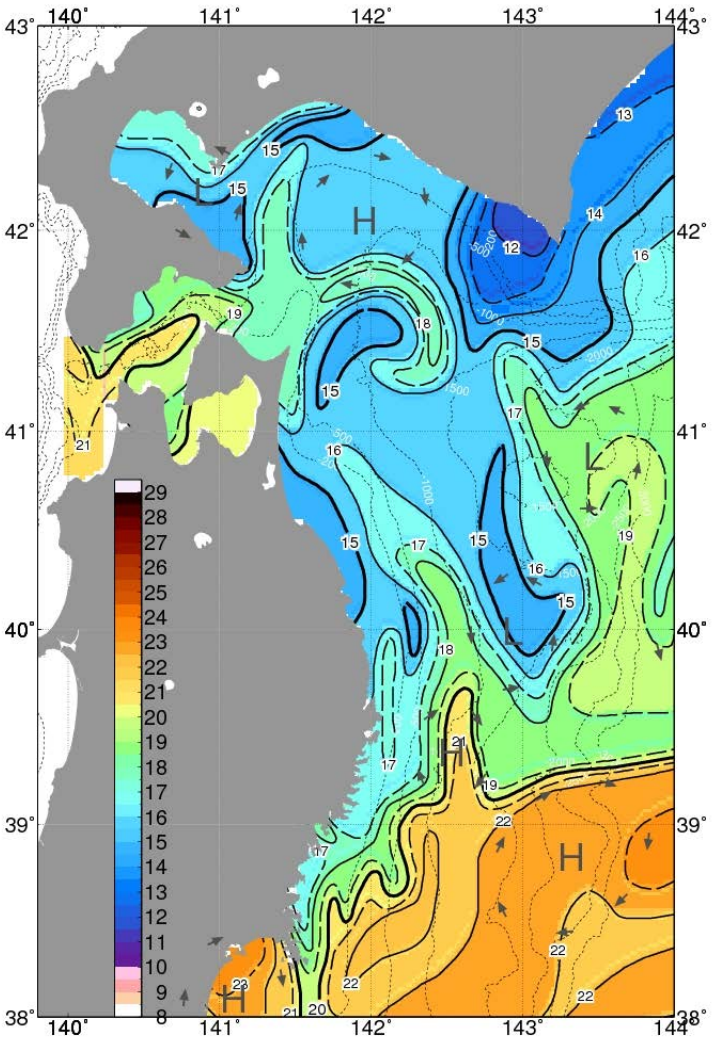


Fig.7.2.2 SST (sea surface temperature) distribution on July 8th, 2014.

(From Iwate Tairyo Navi : JAFIC image)

7.3 CTD of *HYPER-DOLPHIN*

HYPER-DOLPHIN is equipped with CTD for a marine environment measurement. In this CTD, water temperature, salinity, dissolved oxygen and depth data were measured in each dive respectively (measurement interval is one second). In this cruise, 22 times of dive surveys were carried out with *HYPER-DOLPHIN* (Fig.7.3 and Table 7.3). *HPD* started diving, and the CTD data determined grounding as vertical data for marine environment monitoring. The CTD data during bottom survey were also selected as horizontal marine environment data. The CTD data at the dive survey of *HPD* are important as marine environment information of the survey period. Therefore, in the Sanriku offshore area survey after the earthquake, conduct similar environmental monitoring analysis continuously. About the CTD data, be analyzing now.

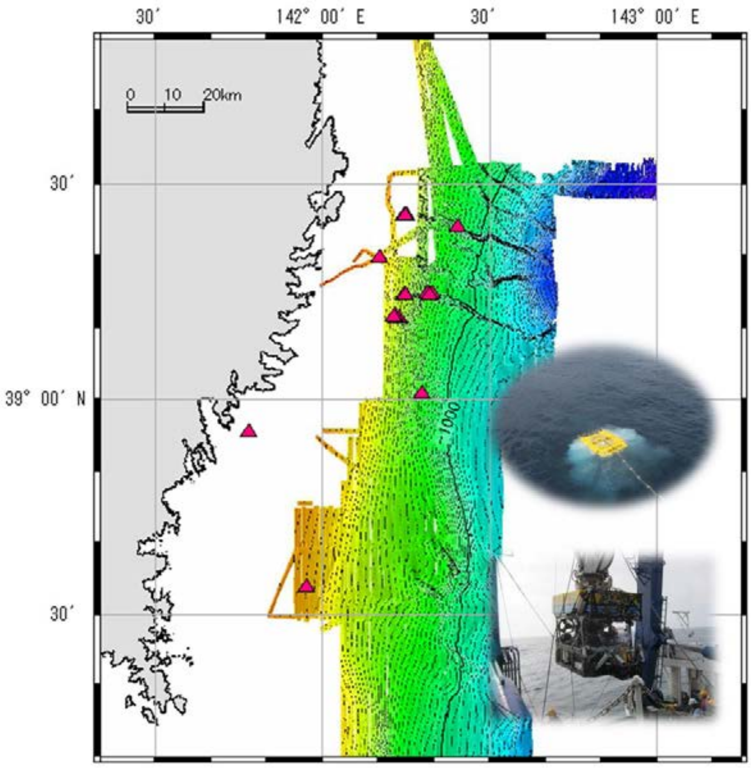


Fig.7.3 Observation points of CTD.

Table 7.3 Observation points of CTD (same as HDP dive points)

Dive No.	Date	Time	Lat-deg	Lat-min	Long-deg	Long-min	Depth
1664	2013/6/24	13:31	39	19.844	142	10.016	293
1665	2014/7/1	10:27	38	55.579	141	46.498	114
1666	2014/7/2	9:35	39	23.994	142	23.994	911
1667	2014/7/3	9:49	39	14.771	142	18.508	787
1668	2014/7/4	8:50	39	11.485	142	13.420	569
1669	2014/7/5	8:58	39	11.399	142	12.945	508
1670	2014/7/8	9:37	39	11.637	142	12.563	487
1671	2014/7/9	9:42	39	14.766	142	19.553	846
1672	2014/7/13	9:06	39	11.544	142	12.739	495
1673	2014/7/14	9:03	39	14.683	142	14.352	518
1674	2014/7/15	14:07	39	25.704	142	14.825	408
1675	2014/7/16	8:52	39	25.619	142	14.543	395
1676	2014/7/16	14:24	39	25.623	142	14.493	395
1677	2014/7/17	8:46	39	25.610	142	14.537	396
1678	2014/7/18	8:59	39	14.672	142	19.092	823
1679	2014/7/19	11:31	39	11.561	142	12.648	490
1680	2014/7/21	8:37	38	33.941	141	56.907	285
1681	2014/7/22	8:51	39	11.845	142	12.690	495
1682	2014/7/22	14:02	39	11.561	142	12.648	492
1683	2014/7/23	7:41	39	11.576	142	12.458	480
1684	2014/7/23	11:49	39	14.663	142	14.540	535
1685	2014/7/24	10:34	39	0.971	142	17.613	804

7.4 Environmental measurement near the bio-tracking system

The fluid measurement in the multi-layer using the ADCP (Acoustic Doppler Current Profiler, Teledyne RD Instruments, Inc. Workhorse Sentinel 300 kHz) was conducted in Bio-Tracking System survey area from July 8th, 2014 to July 22 (fig.7.4). The ADCP established it near the central Bio-Tracking basis station. T-S sensor (JFE Advantech Co., Ltd., INFINITY-CT) and ADP (Nortek AS, Aquadopp2000) were also attached to an ADCP mounting frame. Compact memory-type water temperature center (JFE Advantech Co., Ltd., DEFI-T) was attached to the other bases station. Fluid data and the environmental data such as a water temperature or the salinity are analyzed in conjunction with a result due to bio-tracking system.

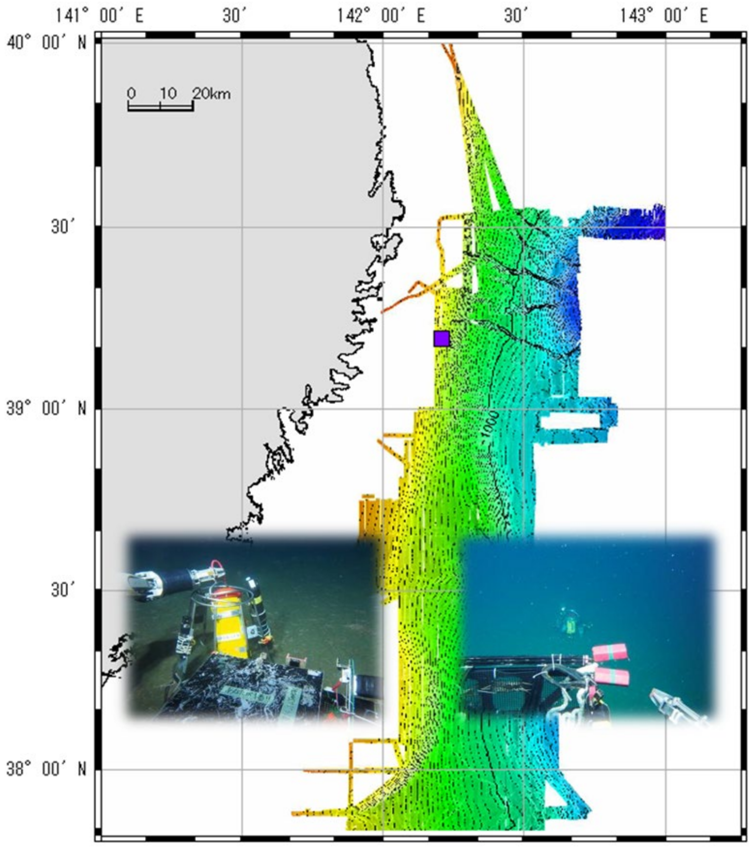


Fig.7.4 Observation points of ADCP.

7.5 Fluctuation of sea surface chlorophyll and CTD

This study was conducted to elucidate the relationship between water mass structure and the primary productivity of phytoplankton. To evaluate the potential as fishing grounds can contribute to support re-establishment of Sanriku offshore area fisheries.

Through Leg.1 and Leg.2, surface water was continuously monitored. The R/V Natsushima ordinarily do not monitor the surface sea water quality. Therefore, we set the Rinko-profiler (JFE Advantech Co., Ltd.) at Lab 3 sink (Fig. 1), to monitor mainly temperature, salinity and chlorophyll contents. Fast repetition rate fluorometer (FRRF, Kimoto Electric Co., Ltd.) was also set at Lab 3to monitor the chlorophyll fluorescence as the index of the primary productivity of phytoplankton. Collaterally, 500 ml of surface sea water was collected and fixed by formalin to observe the phytoplankton species composition under an optical microscope. Now the data and samples are under analyses, then the results will be compared and discussed with those of prior cruise conducted around Sanriku offshore area such as Bosei-maru cruise (BO13-20) and SHINSEI-maru cruise (KS14-3). All data will be submitted to JAMSTEC Data Management Office (DMO) within 2 years.

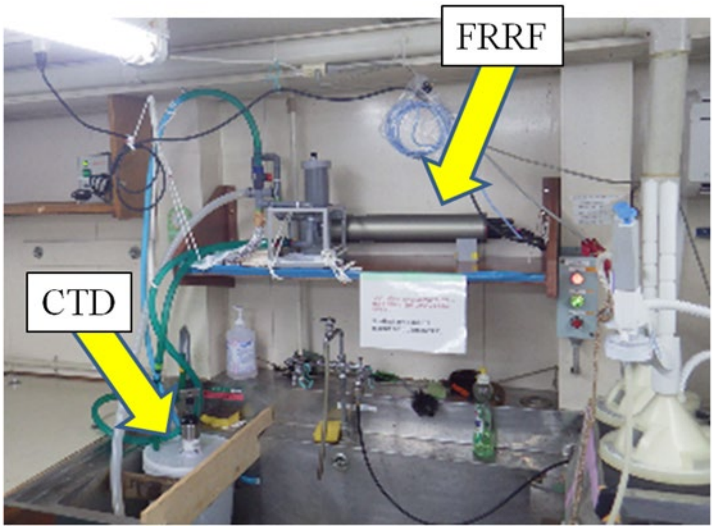


Fig.7.5.1 The instruments (FRRF & CTD) set at the Lab. No.3

7.6 DO and REDOX potential measurements near the seafloor

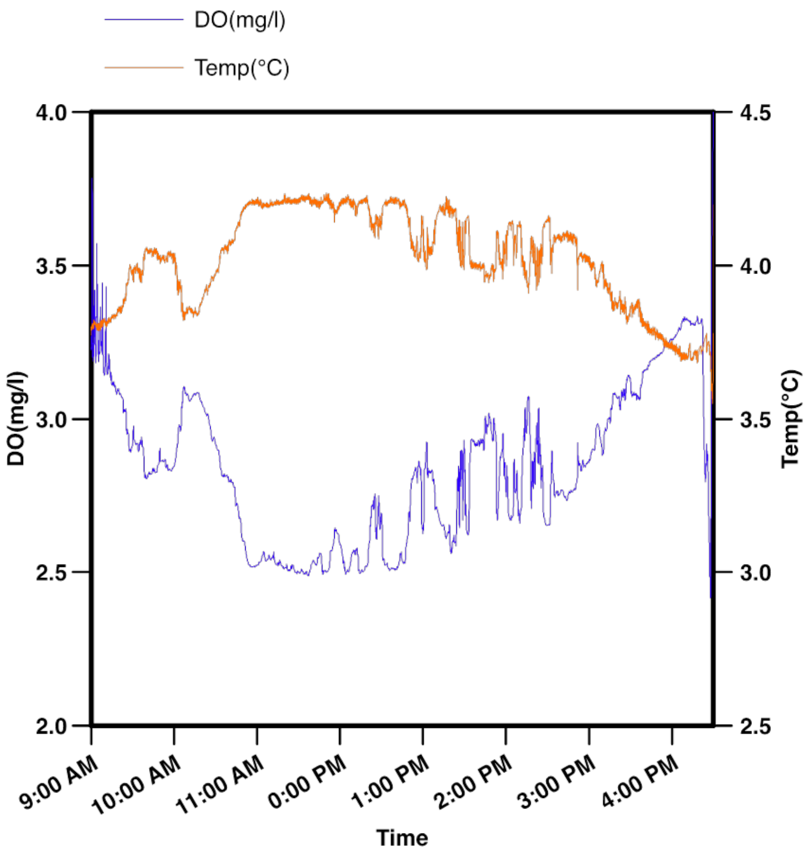
DO and REDOX potential measurements were conducted near the seafloor.

- DO measurements: HD1672, HD1678, HD1680, H1684
- REDOX potential measurements: HD1677, HD1678

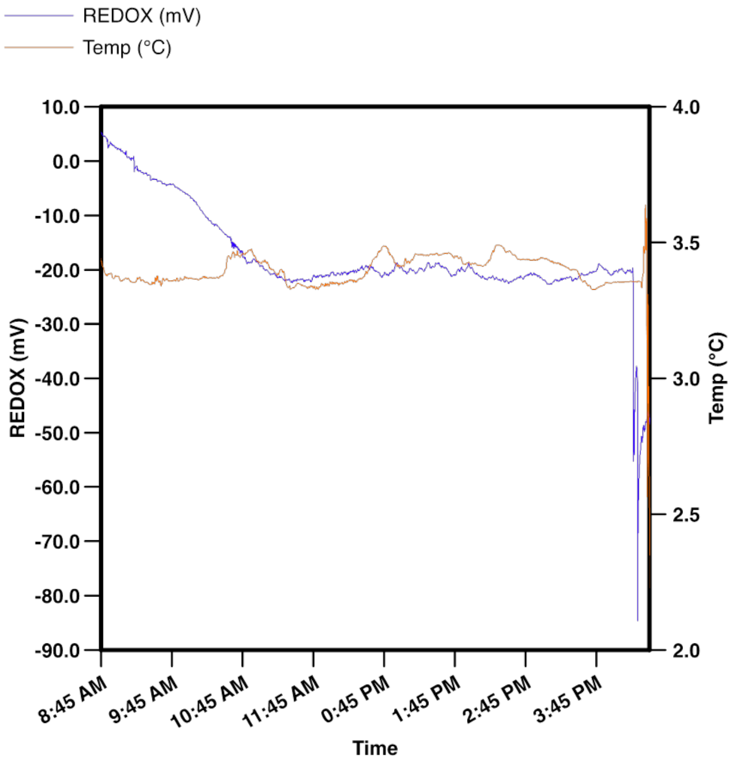
*Remarks:

DO and REDOX potential were very low at the bacterial mat area during HD#1678. Temperature in the sediments underneath the bacterial mats were slightly higher than that of ambient seawater.

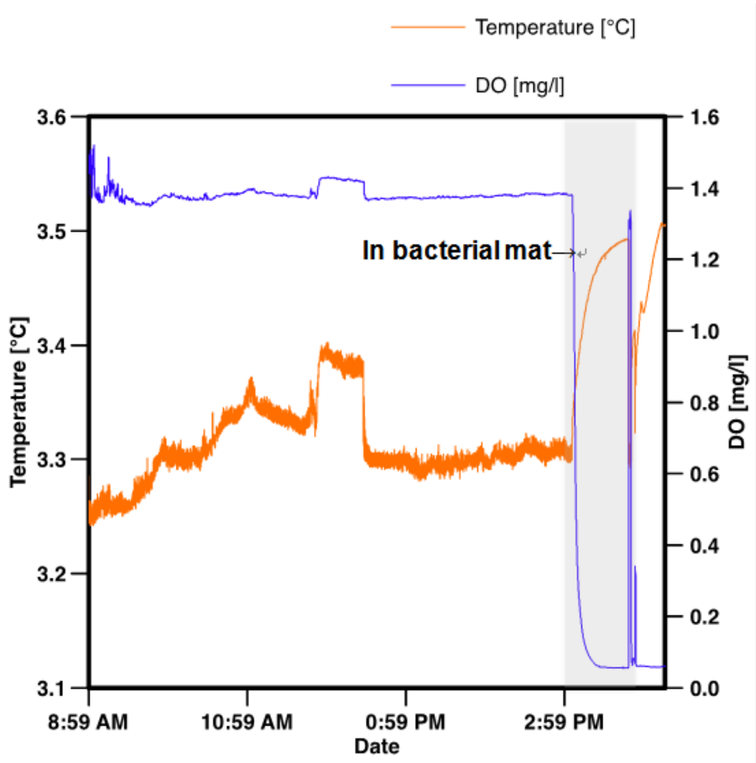
HD1672-DO



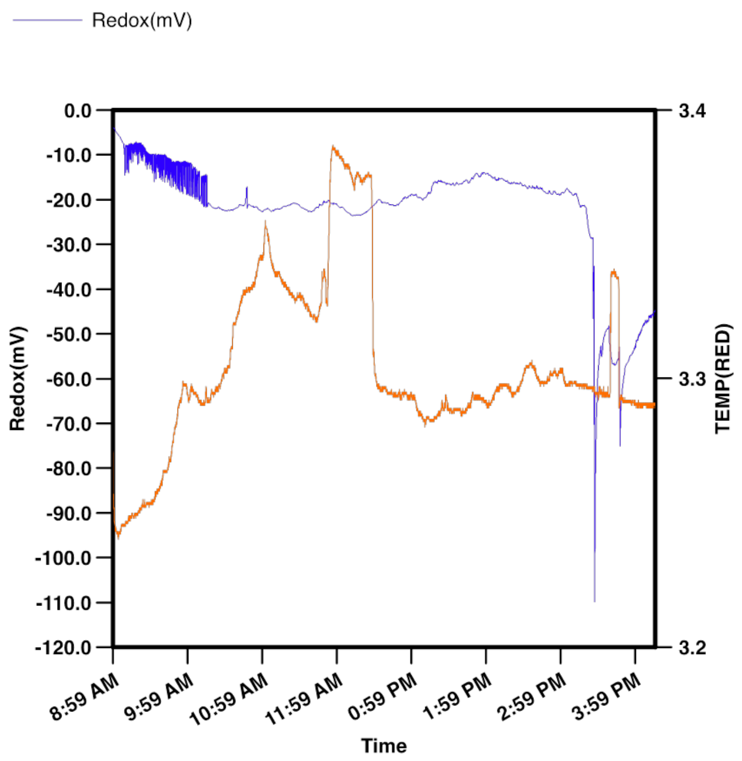
HD1677-REDOX



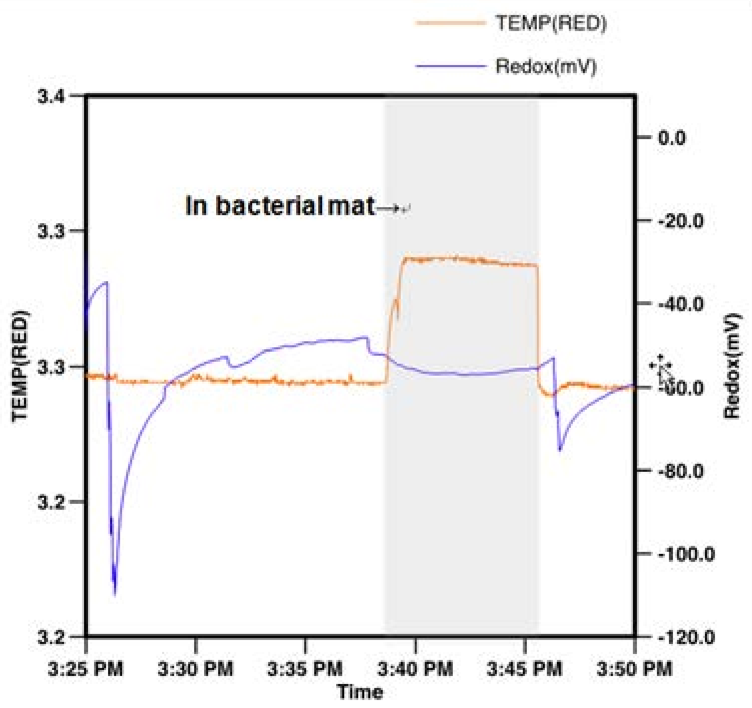
HD1678-DO



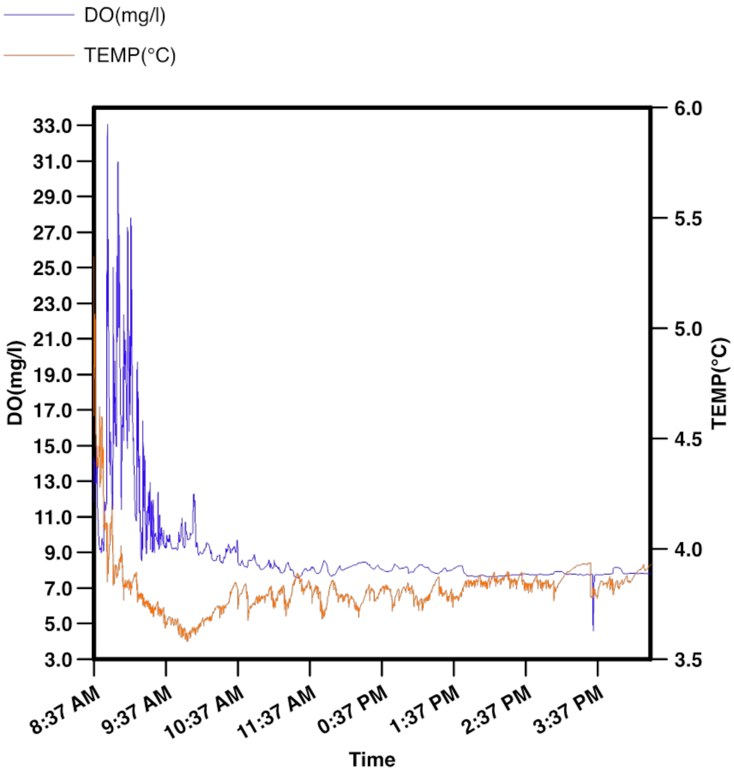
HD1678-REDOX



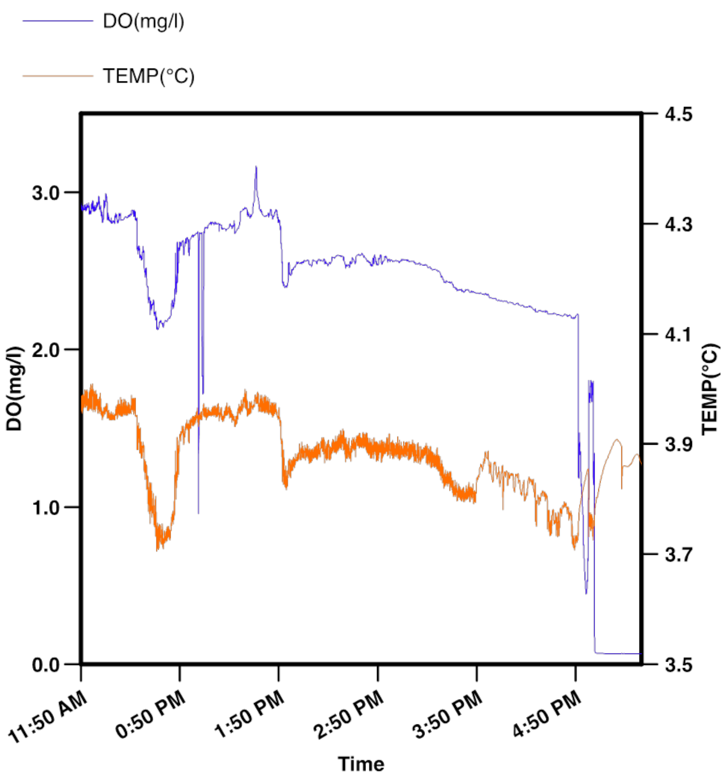
HD1678-REDOX (shorter period: 15:25-15:50)



HD1680 (Incorrect data)



HD1684 (Incorrect data after 16:50)



7.7 Sediment-trap

The sediment-trap was deployed as mooring in 1,868m depth on KS14-3 cruise. Deployment point was 39-19.86’ N, 143-10.00’ E. It set 24 bottles replaced 4 days interval, deployment term is March 26 - June 29 in 2014.

The mooring was recovered in July 6. As result, the sediment-trap could get several samples. They will be analyzed by MIO.

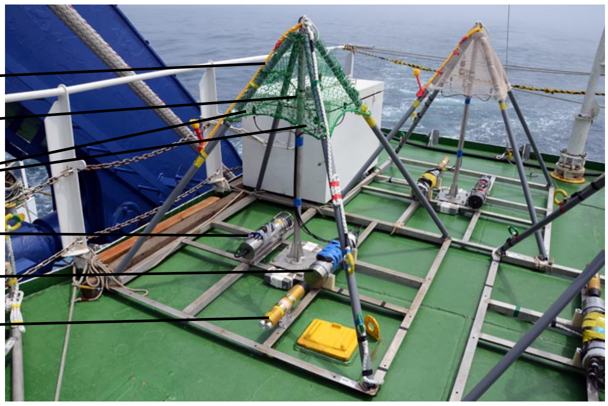
8. Observation with Bio-tracking System

8.1 Installation and recovery of the Bio-tracking System

We examined to develop the Bio-Tracking System to trace benthic animals such as snow crabs and stone fish in the deep-sea Off Kamaishi to know the distribution and behavior patterns.

Bio-Tracking Base Station

1. Frame
2. Thermometer
3. Acoustic transducer 4ch
4. Transponder
5. Control unit
6. ROV Homer



8.2 Pinger attachment experiment in in-situ

Snow Crab *Chionoecetes opilio*

No.	Pinger ID	Sex	Carapace Width（mm）	Abdomen Width (mm)	Lost of legs	Sampling Dive
1	8G080808	♂	85.05	30.90	R1,2,4	HD#1669
2	9G090909	♂	88.25	32.15		HD#1669
3	6G060606	♀(ovigerous)	78.05	50.85	R3,L2	HD#1669
4	18G181818	♀(ovigerous)	76.50	56.00		HD#1669
5	17G171717	♂	79.55	29.15	L2	HD#1669
6	1G010101	♀(ovigerous)	71.45	48.20	L1	HD#1669
7	13G131313	♂	76.00	28.10		HD#1669
8	15G151515	♂	93.30	34.05	RC,3,4	HD#1668
9	20G202020	♂	83.50	30.25		HD#1668
10	7G070707	♀(ovigerous)	76.20	48.85		HD#1668
11	6C050711 1406023	♂	82.70	30.25		HD#1668
12	6C313201 1406021	♂	90.50	31.65		HD#1668
13	6C020408 1406022	♂	70.95	29.00	L1	HD#1668
14	6C081014 1406024	♂	72.00	25.15		HD#1668
15	6C111317 1406025	♀(ovigerous)	67.45	44.50		HD#1668

Stone Fish *Sebastolobus macrochir*

No.	Pinger ID	Total Length	Sampling Dive
1	28G282808	25cm	HD#1668
2	36G272716	21.5cm	HD#1669
3	30G303010	22.5cm	HD#1669

8.3 Deploy and Recovery of the Bio-Tracking Base Station

Deployed Date: July 5th 2014 Free fall from R/V Natsushima

Recovery Date: July 22th 2014 (#1, #3, #4, and #5) and July 23rd 2014 (#2 and #6)

8.4 In-situ pinger attachment by PINGU (PINger attachment GUn)

We examined in-situ tagging of the acoustic pinger on the dorsal carapace of snow crabs. During the dive#1679, we successfully attached tow pingers on the snow crabs respectively.

PINGU

Pinger attached on the crab

9. 3D mapping survey

9.1 High altitude 3D mapping using Sea Xerocks

SeaXerocks is a mapping system for collecting high quality image data of the seafloor from altitudes of up to 10m, which are then processed to generate a 3D reconstruction of the mapped area in its actual colours.

It consists of multiple cameras, four synchronised flashes, a sheet laser and navigation sensors. Fig. 1 shows the equipment mounted on a payload skid, which was fixed in *HYPER-DOLPHIN*'s payload bay.

3D bathymetry information is measured using a laser scanning system, where a sheet laser projects a line onto the seafloor, and a camera (Fig. 1 Firefly) records images of it at a rate of 15 fps. Flashed images are taken with high-sensitivity cameras (Fig. 1 ExiAqua cameras) at an interval of 6s. The combination of high sensitivity cameras, strong illumination from the flashes (mounted at the front and the back of *HYPER-DOLPHIN*) and a long baseline between them make it possible to perform colour imaging of the seafloor from altitudes of up to 10 m, which, to our knowledge, is the longest range achieved for colour imaging underwater. This leads to a large covered area per photo and allows for nearly 10 times the acquisition rate at over 8000 m2 per hour (A. Bodenmann, B. Thornton et. al.: "Wide area 3D seafloor reconstruction and its application to sea fauna density mapping." in Proc. Oceans International Conference, IEEE , San Die go, 2013.). Navigation data is recorded from a DVL and depth sensor, as well as *HYPER-DOLPHIN*s' PHINS DVL and an SSBL.

The image and navigation data is transformed in post-processing into a coloured 3D reconstruction. The laser line projection is extracted in a set of images to calculate a bathymetry map with sub-centimetre resolution. The colour information is matched with an algorithm that is aware of the lighting system and models the beam pattern of all flashes to correct for differences in illumination. The colour-balance is corrected for attenuation in water separately for every mapped point on the seafloor as a function of the distance from that point to the camera. The result is a highly resolved and dimensionally accurate 3D map in actual colours.

Fig. 2 shows two images taken by the mapping system, which will be used to generate 3D reconstructions of the scanned area. This will allow dimensions to be measured and number of sea animals (e.g. sea stars) related to a population density.

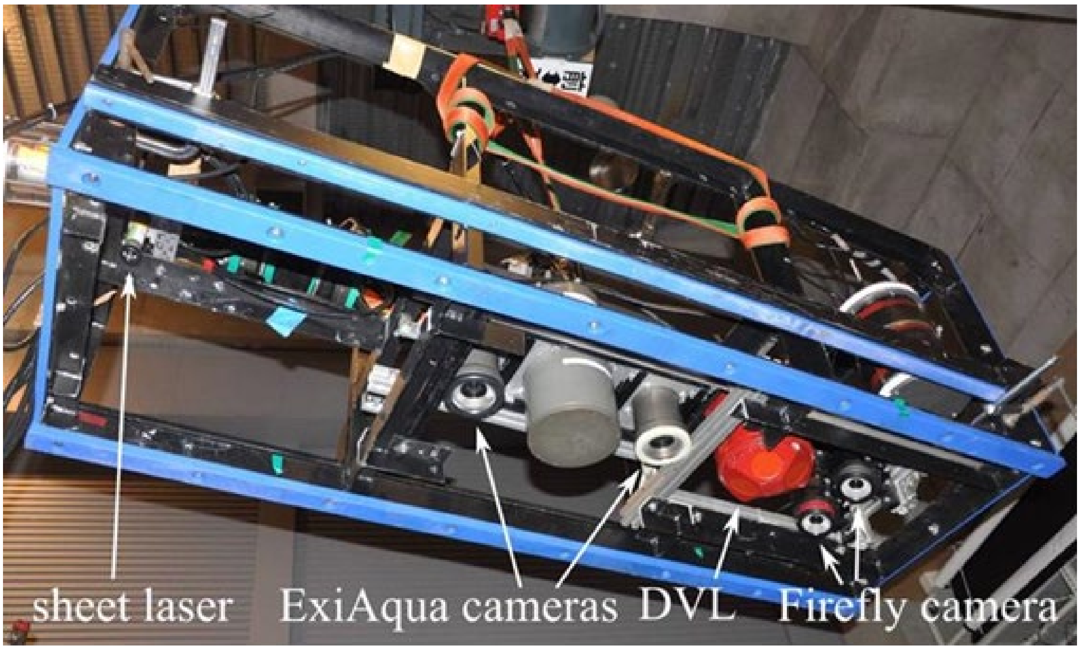


Fig. 9.1.1 SeaXerocks mapping system mounted on payload skid.


Fig. 9.1.2 Photos taken with the SeaXerocks 2 mapping system showing debris populated by seastars. The plastic box in the image to the left and the car bumpers and the fish trap were found at the entrance of an underwater valley at a depth of approximately 550m.

9.2 High resolution 3D mapping using Serpent

The serpent camera, a 3D imaging stereo deep rated camera, will fitted to the *HYPER-DOLPHIN* ROV. We aim to be able to demonstrate the use of the techniques we employ to capture high resolution 3D meshes of benthic marine environments. This is in collaboration with the University of Tokyo where we will produce data that is higher resolution but smaller scale than their SeaXerocks system. The survey style will be in two formats: one of dense grid which require maneuvering the ROV in a “mowing the lawn” pattern of around 25/25m square boxes to produce 3D imaging that can be used to get an accurate estimate of population densities for a give site; The other “long line” transects that are effective in indicating the change of habitat and diversity of life over larger scale geological features and other influences. We hope that after the ability of our imaging software and imaging systems will lead to a long term collaboration

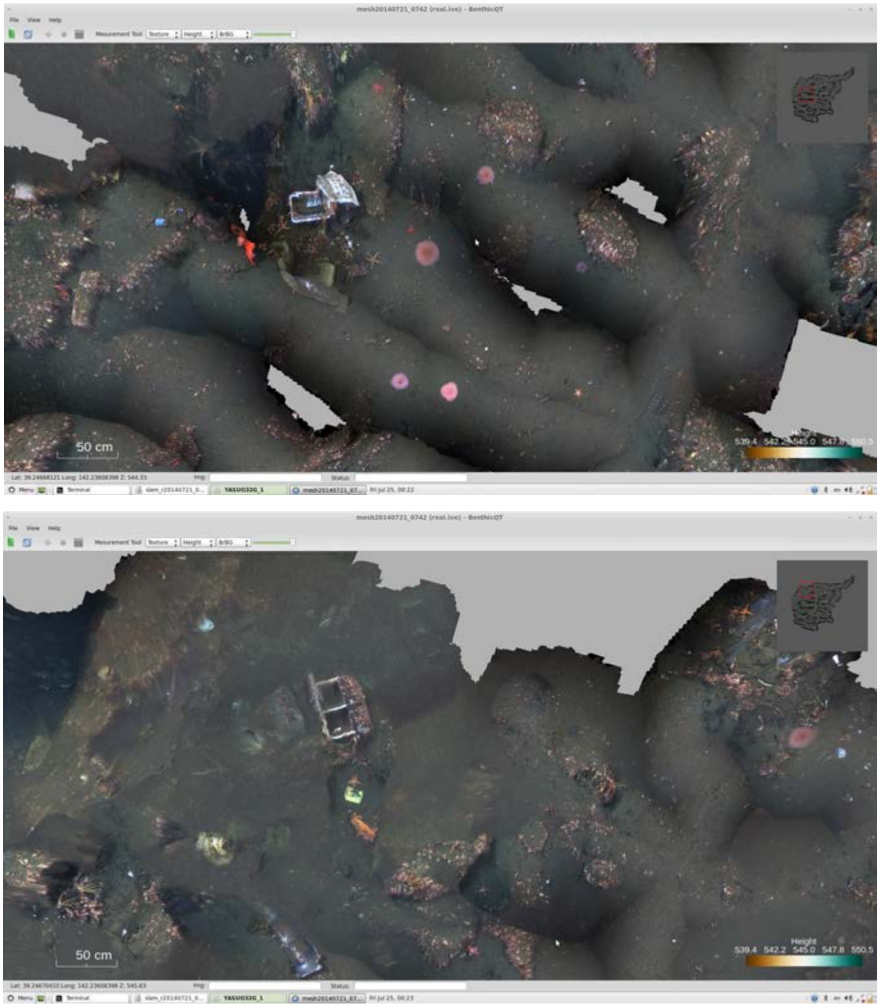


Fig. 9.2.1 The example of the initial processing 3D imaging using Serpent camera.

Notice on Using

This cruise report is a preliminary documentation as of the end of the cruise. This report may not be corrected even if changes on contents (i.e. taxonomic classifications) may be found after its publication. This report may also be changed without notice. Data on this cruise report may be raw or unprocessed. If you are going to use or refer to the data written on this report, please ask the Chief Scientist for latest information.

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