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Cruise Report

YK12-13

Off Sanriku - Japan Trench

Impact by the mega-earthquake on marine ecosystem including chemical, physical, geology and geophysics in the Japan Trench

R.V. Yokosuka/H.O.V. Shinkai 6500

August 11, 2012-August 24, 2012

Contents

1. Cruise Information

1-1. Cruise ID: YK12-13

1-2. **Name of vessel:** R/V Yokosuka

1-3. Title of the cruise: Impact by the huge earthquake on marine ecosystem including chemical, geology and geophysics in the Japan Trench

1-4. Title of proposal:

Impact by the huge earthquake on marine ecosystem including chemical, ocean physics, geology and geophysics in the Japan Trench (K. Fujikura: JAMSTEC)

1-5. Cruise period: August 11, 2012-August 24, 2012

1-6. Ports of call: Yokosuka, JAMSTEC August 11, 2012 - Yokosuka, JAMSTEC August 24, 2012

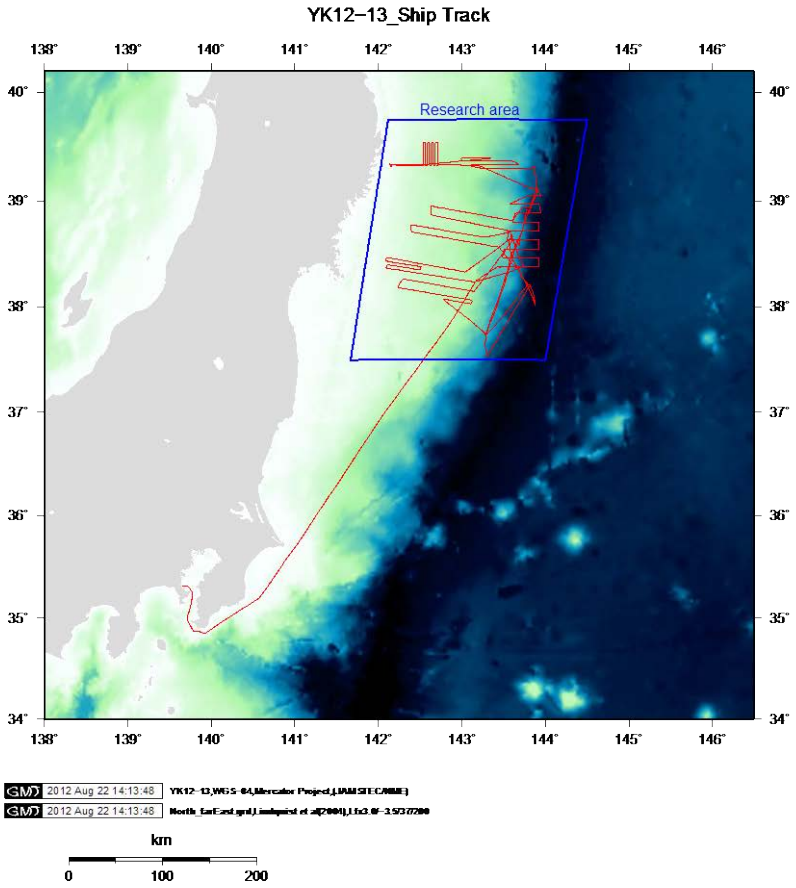
1-7. Research area:

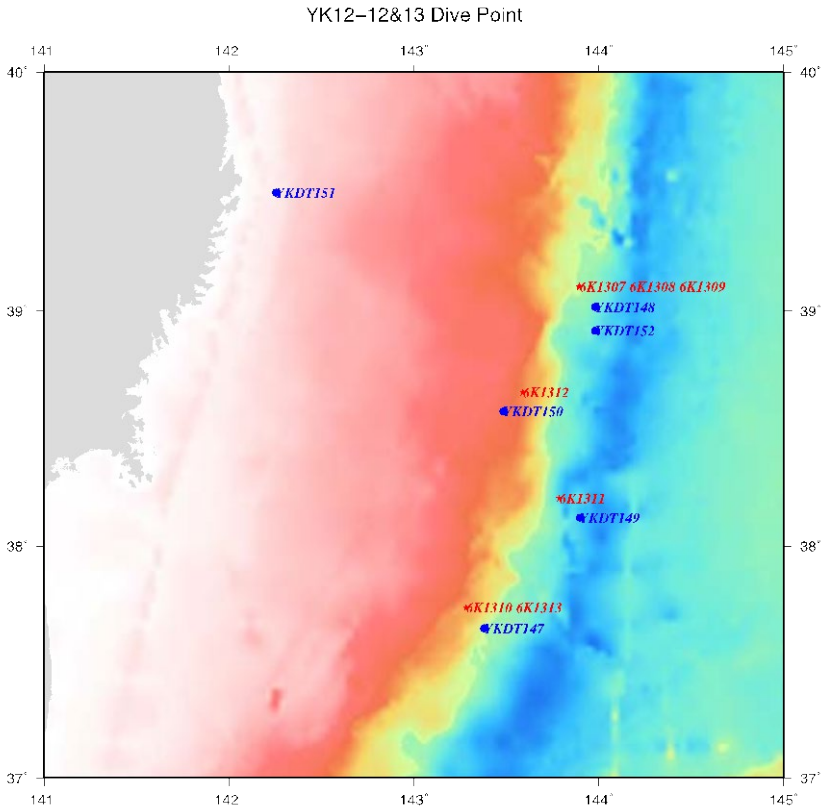
General survey area, Off Sanriku-Japan Trench

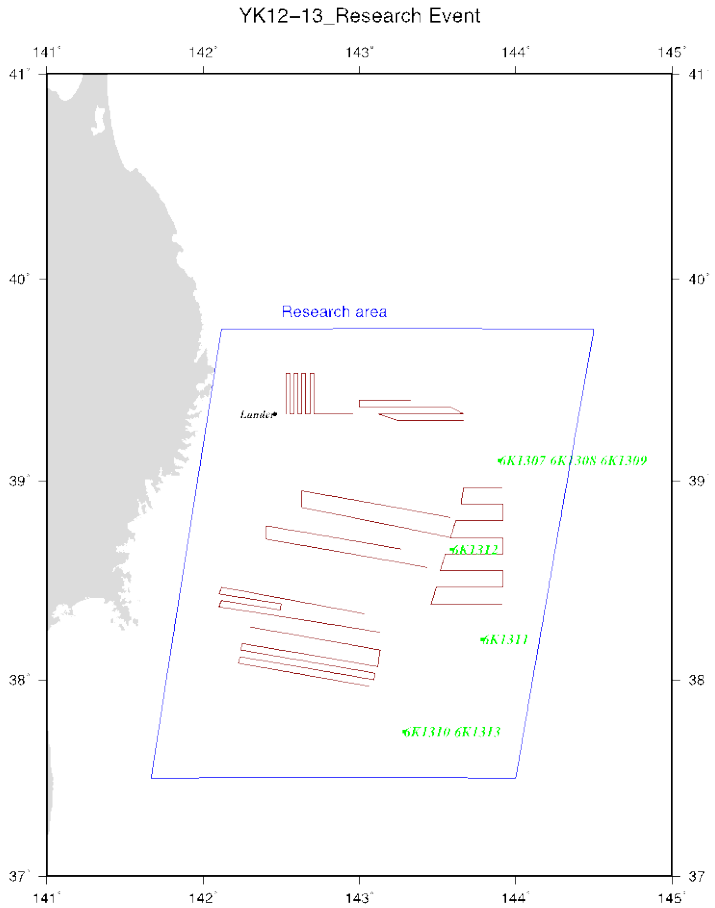
Water depth range：200m～8,000m

Area surrounded by following 4 points, 37°30'N : 141°40'E, 37°30'N : 144°00'E, 39°45'N : 144°30'E, 39°45'N : 142°07'E.

1-8.Research map







Topographic survey areas (blue line). Landers deployment sites (black circles)

2. Participants

2-1. **Chief scientist:**

藤倉克則 FUJIKURA, Katsunori; Principal Scientist, Biodiversity Research Program, Institute of Biogeosciences, JAMSTEC 2-15, Natsushima-cho, Yokosuka 237-0061 Japan

2-2. **Science party** (List)

名前	Name	Position	Affiliation
藤倉克則（首席研究員）	FUJIKURA, Katsunori	Principal Scientist	Biodiversity Research Program, Institute of Biogeosciences, JAMSTEC
野牧秀隆（次席研究員）	NOMAKI, Hidetaka	Scientist	BioGeos3, JAMSTEC
新井和乃	ARAI, Kazuno	Ph.D. student	Graduate School of Science, Chiba University
古島靖夫	FURUSHIMA, Yasuo	Research Scientist	Biodiversity Research Program, Institute of Biogeosciences, JAMSTEC
生田哲朗	IKUTA, Tetsuro	Research Scientist	Biodiversity Research Program, Institute of Biogeosciences, JAMSTEC
伊藤雅志	ITO, Masashi	Marine Technician	Nippon Marine Enterprises, Ltd.
今野祐多	KONNO, Yuta	Research Scientist	Extremobiosphere Research Program, Institute of Biogeosciences, JAMSTEC
長井裕季子	NAGAI, Yukiko	Research Technician	Biodiversity Research Program, Institute of Biogeosciences, JAMSTEC
布浦拓郎	NUNOURA, Takuro	Senior Scientist	Extremobiosphere Research Program, Institute of Biogeosciences, JAMSTEC
小栗一将	OGURI, Kazumasa	Scientist	BioGeos3, JAMSTEC
柴田晴佳	SHIBATA, Haruka	Ph.D. student	Graduate School of Fisheries Science, Kitasato University
砂村倫成	SUNAMURA, Michinari	Assistant Professor	Graduated school of Science, University of Tokyo
田角栄二	TASUMI, Eiji	Scientist	Extremobiosphere Research Program, Institute of Biogeosciences, JAMSTEC
土岐知弘	TOKI, Tomohiro	Assistant Professor	Faculty of Science, University of the Ryukyus
辻 健	TSUJI, Takeshi	Associate Professor	WPI-I2CNER, Kyushu University

2-3.Shinkai 6500 operation team

Operation Manager	Satoshi Ogura	1st Submersible Staff	Kazuki Iijima
1st Submersible Staff	Masanobu Yanagitani	1st Submersible Staff	Keita Matsumoto
2nd Submersible Staff	Hirofumi Ueki	2nd Submersible Staff	Yosuke Chida
2nd Submersible Staff	Fumitaka Saito	2nd Submersible Staff	Takuma Onishi
3rd Submersible Staff	Hitomi Ikeda	3rd Submersible Staff	Yudai Tayama

2-4.Ship crews

Captain	Kouji Sameshima	Chief Officer	Yasuhiko Sammori
2nd Officer	Shozo Fujii	3rd Officer	Hiroharu Omae
Chief Engineer	Eiji Sakaguchi	1st Engineer	Kimio Matsukawa
2nd Engineer	Daisuke Gibu	3rd Engineer	Kota Kataoka
Chief Electronic Operator	Fukuo Suda	2nd Electronic Operator	Yosuke Komaki
Jr.2nd Electronic Operator	Takehito Hattori	3rd Electronic Operator	Takatomo Shirozume
Boat Swain	Yoshiaki Kawamura	Able Seaman	Kazumi Ogasawara
Able Seaman	Masanori Ohata	Able Seaman	Yuki Yoshino
Able Seaman	Takuya Miyashita	Sailor	Shinya Ueno
Sailor	Toru Nakanishi	No.1 Oiler	Kozo Miura
Oiler	Yoshinori Kawai	Oiler	Sota Misago
Assistant Oiler	Eiji Aratake	Assistant Oiler	Toru Hidaka
Chief Steward	Sueto Sasaki	Steward	Shigeto Ariyama
Steward	Yoshinobu Hasatani	Steward	Tatsunari Onoue
Steward	Toru Wada		

3. Investigations

3-1. Introduction

The purpose of this cruise is to estimate how impact by the mega-earthquake on marine ecosystem in the Japan Trench. The tremendous March 2011 Tohoku earthquake (Mw 9.0) ruptured a wide area along the plate interface off the Pacific coast of Tohoku, Japan. The tsunami induced by earthquake was extremely huge. Earthquake, after shocks and tsunami have been variously affected to not only coastal marine ecosystems but also deep-sea ecosystems. To estimate and make clear for above expected impacts by the earthquake, we conducted deep-sea investigations using the HOV Shinkai 6500 in the Japan Trench from 2011. We could observed several fissures on the seafloor, occurrences of bacterial mats associated with CH_4 and H_2S seepages, other bacterial mats associated with decay of dead benthic organisms aggregations and decreasing of *Calyptogena phaseoliformis* colonies were observed same as the last year. We believe, to describe these impacts by the huge earthquake is our important task.

3-2. Facilities

3-2-1. HOV Shinkai 6500

システムの特徴
潜水調査船「しんかい 6500」
全長：9.5m

巾　：2.7m
高さ（着底脚下面から上構上面）：3.2m
空中重量：約 26 トン
潜航最大深度：6,500m
乗員：3 名
耐圧殻径：　2.0m
最大潜航時間（潜航開始から浮上まで）：8 時間
ライフサポート時間：129 時間
ペイロード：150 kg（空中重量）
水中速力：0～2.0Kt　乗　員
3 名の乗員の内訳は、パイロットが 2 名と研究者が 1 名。 (3)　潜航時間最大潜航深度(6,500m)での潜航作業の場合は、最大潜航時間を 8 時間

3-2-2. Lander: Long term environmental observatory　Oguri

As a part of a long term monitoring of marine environments concerning Tohoku Marine Science project, a lander system was deployed off Sanriku. ADCP, CTD, turbidity and dissolved oxygen sensors (RDCP600, Aanderaa Data Instruments) and time lapse video camera system with two LED lights (handmade), Acoustic transponder (Kaiyo Denshi) and ARGOS satellite communication system (ID= 109220, HEX=44F5C4C, Serial=B1700043, Kenwood) were mounted on the lander (Fig. 1). The ARGOS system was set to emit radio signal if the lander was accidentally captured by trolling. To avoid biofouling at a window of the camera cylinder, copper foil was placed on the side of the window. The measurements in each sensor were started on board and the respective functions were confirmed prior to the deployment. On 13th/Aug., the lander was released from the ship and the landing was confirmed with the acoustic signal from the transponder. The weight in the air was 270 kg and that in freshwater was 40 kg. The descending speed at actual deployment was 60.8 m/minute. The date, time and the location of the deployed site and each interval for the data acquisition were shown in the following tables 1 and 2, respectively. At first plan, another deployment for similar lander at 300 m depth was planned. However, due to the mechanical accident, the deployment was cancelled. The recovery of the lander is scheduled at a cruise on Tohoku Marine Science in 2013.

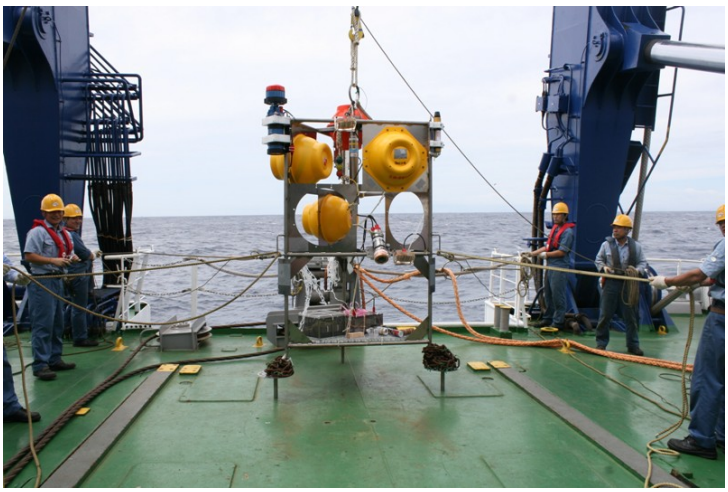


Fig. 1: The lander system.

Table 1: Deployed date, time and the site information of the site deploying the lander system.

Date	Landing time (JST)	Latitude (N)	Longitude (E)	Depth (m)
2012/8/13	13:28	39°19.9775	142°27.5189	998

Table 2: Intervals of the data, photo and movie acquisitions.

Instruments	RDCP600	Still image at sea floor	5 minutes movie at sea floor
Interval	1 hour	1 day	1 week

3-2-3. Dissolved Oxygen Concentration and Turbidity meter: Furushima

We installed Dissolved Oxygen meter and Turbidity meter in a Shinkai 6500 (photo 1) and carried out environmental monitoring with CTD. The environmental data were measured every one second. We conducted similar survey of Sanriku offing cruise of last year. We showed environmental data before Shinkai 6500 arriving at the seabed in vertical profile. In addition, the environmental data when Shinkai 6500 carried out investigation in the seabed represented in Horizontal profile. We included the measurement results in each general investigation report.

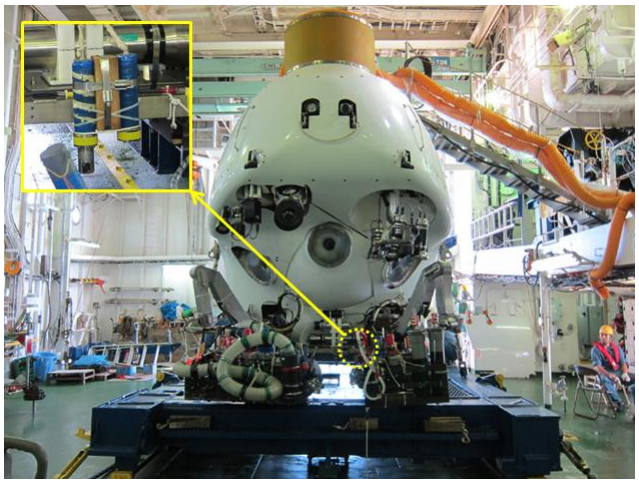


Photo 1 Dissolved Oxygen meter and Turbidity meter in a Shinkai 6500. Dissolved Oxygen: Compact Optode JFE Advantech. Turbidity meter: Compact-LT(ATU6-CMP) JFE Advantech.

3-3. Cruise log

日付 Date	時間 Local Time	内容 Note	本船位置／気象／海象 Position/Weather/Wind/Sea condition
11-Aug-16		Sail out, proceeding to research area	08/11 12:00 (JST)
	09:00	Onboad	34-57.6N 139-43.4E
	10:00	Let go all shore lines,left YOKOSUKA for research area (off SANRIKU).	off Suzaki
	10:15- 11:00	Scientific meeting	Weather: Cloudy
	13:00- 13:30	Carried out shipboard education & training for scientists.	Wind direction: SSW
	13:30- 14:00	General Briefing about Shinkai6500	Wind scale: 3 (Gentle breeze)
	14:30- 15:00	Scientific meeting	Wave scale: 2 (Smooth)
	16:40- 17:00	Praying for the safety of this cruise (Konpira ceremony)	Swell scale: 1 (Low swell, short) Visibly: 8 miles
12-Aug-16		Arrived at research area	08/12 12:00 (JST)
	08:30	Arrived at research area.	38-28.0N 143-49.5E
	08:33	Released XBT at <38-22.4445N, 143-24.5858E>	off Sanriku
	09:00	Briefing about Shinkai6500 for observers	Weather: Cloudy
	09:27	Comiced MBES mapping survey.	Wind direction: SSE

	19:00- 19:30	Scientific meeting	Wind scale: 4 (Moderate breeze) Wave scale: 3 (Slight) Swell scale: 1 (Low swell, short) Visibly: 8 miles
13-Aug-16		6K#1307@off Sanriku	08/13 12:00 (JST)
	06:14	Let go XBT at <39-07.0920N, 143-53.7190E>	39.06.2N 143-53.6E
	09:21	Launched work boat	off Sanriku
	09:49	Hoisted up SHINKAI6500	Weather: Cloudy
	09:56	Lauched SHINKAI6500	Wind direction: South
	10:06	SHINKAI6500 dove and started her operation #1307	Wind scale: 4 (Moderate breeze)
	10:14	Hoisted up work boat	Wave scale: 3 (Slight)
	12:26	SHINKAI6500 launded on sea bottom (D=5351m)	Swell scale: 1 (Low swell, short)
	15:08	SHINKAI6500 left the sea bottm (D=5337m)	Visibly: 8miles
	16:40	Launched work boat	
	16:59	SHINKAI6500 relfoated	
	17:17	Hoisted up SHINKAI6500	
	17:26	Recovered SHINKAI6500 and finished her operation	
	17:33	Hoisted up work boat	
	18:00	S/H eng's and proceed to MBES mapping survey area	
	19:00- 19:30	Scientific meeting	
	19:26	Arrived at above site, com'ced MBES mapping survey	
14-Aug-16		Deployed Lander	08/14 12:00 (JST)
	03:53	Finished MBES mapping survey and proceeded to Tohoku Marine Science Site	39.19.6N 142-27.4E
	06:50	Arrived at above site	off Sanriku
	06:54	Let got XBT at <39-20.2775N, 142-35.3314E>	Weather: Overcast
	07:24	Com'ced MBES mapping survey (pre-deploy survey)	Wind direction: North
	08:55	Finished MBES mapping survey	Wind scale: 5 (Fresh breeze)
	11:09	Released Lander (1000m Ver- L2)	Wave scale: 4 (Moderate)
	11:30	Deployed Lander	Swell scale: 1 (Low swell, short)
	12:41- 13:54	Carried out calibulation lander system	Visibly: 7miles
	15:30- 16:30	Scientific meeting	
15-Aug-16		6K#1308@off Sanriku	08/15 12:00 (JST)
	00:19	Finished MBES mapping survey and comiced proceeding to 39N site.	36-06.1N 143-53.4E
	03:30	Arrived at above site.	off Sanriku
	08:20	Launched work boat	Weather: Fine but Cloudy
	08:48	Hoisted up SHINKAI6500	Wind direction: SE

	08:54	Lauched SHINKAI6500	Wind scale: 2 (Light breeze)
	09:01	SHINKAI6500 dove and started her operation #1308	Wave scale: 2 (Smooth)
	09:06	Hoisted up work boat	Swell scale: 1 (Low swell, short)
	11:21	SHINKAI6500 launded on sea bottom (D=5342m)	Visibly: 8miles
	15:07	SHINKAI6500 left the sea bottm (D=5342m)	
	16:39	Launched work boat	
	17:01	SHINKAI6500 refloated	
	17:18	Hoisted up SHINKAI6500	
	17:29	Recovered SHINKAI6500 and finished her operation	
	17:33	Hoisted up work boat	
	17:50	S/H eng's and proceeded to Bacteria mat site.	
	19:00- 19:30	Scientific meeting	
16-Aug-12		Suspended SHINKAI6500 operation	08/16 12:00 (JST)
	06:30	Arrived at "Bacteria Mat" site	38-35.9N 143-09.9E
	06:48	Let go XBT at <37-44.8252N, 143-17.6994E>	off Sanriku
	07:00	Suspended SHINKAI6500 operation due to bad sea condition	Weather: Fine but cloudy
	07:25	Proceeded MBES mapping survey area	Wind direction: SSW
	08:00	Scientific meeting	Wind scale: 5 (Fresh breeze)
	10:55	Com'ced MBES mapping survey	Wave scale: 4 (Moderate)
	17:30	Scientific meeting	Swell scale: 1 (Low swell, short) Visibly: 8miles
17-Aug-12		6K#1309@off Sanriku	08/17 12:00 (JST)
	03:39	Finished MBES mapping syrvey and comiced proceeding to 39N site.	39-06.5N, 143-53.3E
	05:20	Arrived at 39N site.	off Sanriku
	08:15	Launshed work boat.	Weather: Fine but Cloudy
	08:44	Hoisted up SHINKAI6500.	Wind direction: SW
	08:51	Launched SHINKAI6500.	Wind scale: 3 (Gentle breeze)
	08:59	SHINKAI6500 dove and started her operation #1309	Wave scale: 2 (Smooth)
	09:06	Hoisted up work boat.	Swell scale: 1 (Low swell, short)
	11:10	SHINKAI6500 landed on sea bottom (D-5350m).	Visibly: 8miles
	15:10	SHINKAI6500 left the sea bottom (D=5347m).	
	16:36	Launched work boat.	
	16:58	SHINKAI6500 refloated.	
	17:15	Hoisted up SHINKAI6500.	
	17:23	Recovered SHINKAI6500 and finished her operation.	
	17:28	Hoisted up work boat.	
	17:42	S/H eng's and proceeded to 'Bacteria mat' site.	

	19:00 - 19:30	Scientific meeting	
18-Aug-12		6K#1310@off Sanriku	08/18 12:00 (JST)
	05:00	Arrived at "Bacteria Mat" site	37-44.2N 143-17.0E
	06:12	Let go XBT at <37-44.5033N, 143-16.4599E>	off Sanriku
	09:36	Launched work boat	Weather: Fine but cloudy
	10:03	Hoisted up SHINKAI6500	Wind direction: SSW
	10:10	Launched SHINKAI6500	Wind scale: 4 (Moderate breeze)
	10:19	SHINKAI6500 dove and started her operation #1310	Wave scale: 3 (Slight)
	10:24	Hoisted up work boat	Swell scale: 1 (Low swell, short)
	12:02	SHINKAI6500 landed on sea bottom (D=3585m)	Visibly: 8miles
	16:06	SHINKAI6500 left sea bottom (D=3510)	
	16:05	Launched work boat	
	17:17	SHINKAI6500 refloated	
	17:34	Hoisted up SHINKAI6500	
	17:43	Recovered SHINKAI6500 and finished her operation	
	17:48	Hoisted up work boat	
	19:00- 19:30	Scientific meeting	
19-Aug-12		6K#1311@off Sanriku	08/19 12:00 (JST)
	00:45	Arrived at KAIREI site.	38-12.2N 143-47.1E
	06:09	Let go XBT at <38-12.5333N, 143-47.9841E>	off Sanriku
	09:16	Launched work boat	Weather: Fine but cloudy
	09:37	Hoisted up SHINKAI6500	Wind direction: SSW
	09:45	Launched SHINKAI6500	Wind scale: 5 (Fresh breeze)
	09:52	SHINKAI6500 dove and started her operation #1311	Wave scale: 3 (Slight)
	09:57	Hoisted up work boat	Swell scale: 1 (Low swell, short)
	12:20	SHINKAI6500 landed on sea bottom (D=5798m)	Visibly: 8miles
	15:29	SHINKAI6500 left sea bottom (D=5723)	
	17:04	Launched work boat	
	17:24	SHINKAI6500 refloated	
	17:43	Hoisted up SHINKAI6500	
	17:52	Recovered SHINKAI6500 and finished her operation	
	17:58	Hoisted up work boat	
	19:00- 19:30	Scientific meeting	
20-Aug-12		Suspended SHINKAI6500 operation	08/20 12:00 (JST)
	02:45	Arrived at "Seibutsu" site	38-33.4N 143-38.7E
	06:32	Let go XBT at <38-39.6315N, 143-36.1971E>	off Sanriku

	10:00	Suspended SHINKAI6500 operation due to mechanical trouble (TV camera Pan/Tilt)	Weather: Fine but Cloudy
	16:00	Scientific meeting	Wind direction: SSW
	17:50	Com'ced MBES mapping survey	Wind scale: 3 (Gentle breeze)
			Wave scale: 2 (Smooth)
			Swell scale: 1 (Low swell, short) Visibly: 8miles
21-Aug-12		6K#1312@off Sanriku	08/21 12:00 (JST)
	05:09	Finished MNBES mapping survey, then proceeded to SEIBUTSU site.	38-39.2N 143-36.2E
	07:10	Arrived at above site.	off Sanriku
	09:22	Launched work boat	Weather: Fine but Cloudy
	09:45	Hoisted up SHINKAI6500.	Wind direction: WSW
	09:53	Launched SHINKAI6500.	Wind scale: 2 (Light breeze)
	10:01	SHINKAI6500 dove and started her operation #1312.	Wave scale: 2 (Smooth)
	10:08	Hoisted uo work boat.	Swell scale: 1 (Low swell, short)
	11:29	SHINKAI6500 landed on the sea bottom (D=3262m).	Visibly: 8miles
	15:58	SHINKAI6500 left the sea bottom (D=3226m).	
	16:45	Launched work boat.	
	17:11	SHINKAI6500 refloated.	
	17:26	Hoisted up SHINKAI6500.	
	17:41	Recovered SHINKAI6500 and finished above operation.	
	17:47	Hoisted up work boat.	
	18:15	Proceeded to MNBES mapping survey area.	
	20:37	Com'ced MBES mapping survey.	
	19:00- 19:30	Scientific meeting	
22-Aug-12		6K#1313@off Sanriku	08/22 12:00 (JST)
	05:15	Finished MNBES mapping survey, then proceeded to "Bacteria Mat" site.	37-44.2N 143-17.0E
	07:20	Arrived at above site.	off Sanriku
	09:15	Launched work boat	Weather: Fine but cloudy
	09:47	Hoisted up SHINKAI6500.	Wind direction: SSW
	09:55	Launched SHINKAI6500.	Wind scale: 4 (Moderate breeze)
	10:04	SHINKAI6500 dove and started her operation #1313	Wave scale: 3 (Slight)
	10:08	Hoisted uo work boat.	Swell scale: 1 (Low swell, short)
	11:41	SHINKAI6500 landed on the sea bottom (D=3585m).	Visibly: 8miles
	15:46	SHINKAI6500 left the sea bottom (D=3414m).	
	16:37	Launched work boat	
	17:03	SHINKAI6500 refloated.	

	17:21	Hoisted up SHINKAI6500.	
	17:30	Recovered SHINKAI6500 and finished above operation.	
	18:05	Proceeded to MNBES mapping survey area.	
	19:00- 19:30	Scientific meeting	
	20:07	Com'ced MBES mapping survey.	
22-Aug-12		Left research area	08/23 12:00 (JST)
	05:30	Finished MNBES mapping survey. Left survey area for YOKOSUKA.	37-03.4N 141-35.4E off Sshioiyazaki Weather: Fine but cloudy Wind direction: South Wind scale: 4 (Moderate breeze) Wave scale: 3 (Slight) Swell scale: 1 (Low swell, short) Visibly: 8miles
24-Aug-12	09:00	Arrival at the JAMSTEC pier, end of cruise	

4. Diving Investigations by the Shinkai 6500

4-1. Shinkai 6500 #1307 Nomaki

Observer: Hidetaka Nomaki (JAMSTEC)
Pilot: Hirofumi Ueki
Co-pilot: Fumitaka Saito
Diving point: 39N site (Water depth: ~5350 m)
Landing point: 39°6.1915N, 143°53.7217E, Depth = 5351 m, time = 12:25
Dive summary

Dive #1307 investigated geological, chemical, and biological changes at 39N site after YK11-E06 cruise, which had investigated impacts by 2011 Tohoku-earthquake and tsunami. Faunal composition was different from last year, but was similar to those observed in 2009, which is characterized by less abundant holothurians and abundant sea anemones. Bacterial mats were probably fewer than last year, although the diving course was different from each other.

We made following observations, measurements, and samplings during this dive.
Observation of quadrates (#1263).
Samplings of C*alyptogena* clam.
Sampling of sediments from bacterial mat (near 1263 quadrate).
Sampling of sediments from normal sediments (new #1307 quadrate).
Measurements of heat-flow using SAHF at bacteria mat (near 1263 quadrate) and deployment at the normal sediments (#1307 quadrate).
Deployment of in situ incubation core (near #1307 quadrate).
Seawater sampling at the normal sediments (landing point).

4-2. Shinkai 6500 #1308 Sunamura

2012/8/15
Observer: Michinari SUNAMURA (Univ. Tokyo)
Survey site: Off Sanriku, Japan Trench
Landing Point: 39-06.0834'N 143-53.6962'E, 5353m
Leaving Point: 39-06.3843'N 143-53.7975'E, 5342m

Dive Summary:
The purpose of Shinkai6500 #1308 was to investigate the geological, chemical, and biological changes in time series after the 2011 Tohoku earthquake. The dive was planned to visit the *Calyptogena phaseoliformis* colonies site. This site was observed at #1161 dive before the earthquake, and visited at #1254, #1255, and #1256 dive in 2011 during YK11-E06 cruise after the earthquake. The objectives of this dive was
-to find the markers settled in the 2011 dives
-to recover the ROC homer, SAHF, and the in situ incubation core settled at the #1307 dive.
-to collect sediment, *Calyptogena*, and water samples around the seafloor
-to collect water sample by ANEMONE sampler for the high resolution mapping of chemical components and microbial cell densities.

4-3. Shinkai 6500 #1309 Konno
Observer: Yuta Konno (JAMSTEC)
Pilot: Masanobu Yanagitani
Co-pilot: Yudai Tayama
Diving point:
39N site (Water depth: ~5350 m)
Landing point:
39°6.2085N, 143°53.5938E, Depth = 5350 m, time = 11:00
Dive summary
Dive #1309 investigated geological, chemical, and biological changes at 39N site after YK11-E06 cruise, which had investigated impacts by 2011 Tohoku-earthquake and tsunami. This dive was planned to visit large bacterial mat site observed by 6.5K#1255 in 2011. However, we could not find the remarkable bacterial mats at this dive. We recovered homer, measured heat flow by using SAHF (near quadrates #1255-3), and collected water, sediments and rocks.
Observation of quadrates (#1255-3)
Measurements of heat-flow using SAHF near quadrates #1255-3
Sampling of sediments near quadrates #1255-3
Sampling of rocks
Seawater sampling (above landing point)

4-4. Shinkai 6500 #1310 Nunoura
Observer: Takuro NUNOURA (JAMSTEC)
Pilot: Yosuke Chida
Co-pilot: Takuma Onishi
Survey site: Off Sanriku, Japan Trench
Landing Point: 37-44.2364'N 143-16.9700'E, 3585m
Leaving Point: 37-44.8174'N 143-44.8174'E, 3510m (A=40m)
Dive Summary:
The objective of Shinkai6500 #1310 was to know chemical and biological changes on and under the "bacterial mats" after the 2011 observation (YK11-E06 cruise). The bacterial mats have been revealed to be the result of the animal bodies deposition under turbidite occurred by the earthquake. The major tasks of this dive described below and were completed during the dive.
1. At the marker #127 site where a quadrat (1260-3) was settled in dive #1260 (YK11-E06), collecting sediment cores and deploying in situ cultivation systems.
2. At the marker #128 (dive #1260 (YK11-E06)) site, taking a sediment core.
3. At the site marker # 129 (dive #1260 (YK11-E06)), observation of the seafloor around the marker.
4. At the site #123 marker where quadrats (1257-1, 2) were settled in dive #1257 (YK11-E06), taking sediment cores and deploying in situ cultivation systems.

4-5. Shinkai 6500 #1311 Tsuji
Date: 2012/8/19

Observer: Takeshi Tsuji (WPI-I2CNER, Kyushu University)
Survey site: Off Miyagi, Japan Trench
Landing Point: 38-12.2637'N 143-47.1581'E, 5798m
Leaving Point: 38-12.6299'N 143-47.0452'E, 5723m
Dive Summary:
The purpose of Shinkai6500 #1311 was to investigate the geological, chemical, and biological changes in time series after the 2011 Tohoku earthquake. Four Shinkai 6500 dives had been conducted in this site before the 2011 Tohoku earthquake (Dive #1069, #1072, #1073, and #1074 in YK11-06E). These previous Shinkai dives revealed *Calyptogena* colonies at some areas along a steep cliff, where the reverse fault was expected from seismic profiles (Tsuji et al., 2011). In the 2008 cruise, furthermore, we deployed CAT-meters and several makers on the seafloor. By comparing the seafloor environments and morphology before and after the 2011 earthquake, we can evaluate dynamic change of seafloor environments due to the earthquake. In the Deep-tow dive after the earthquake (Dive #95 and #96 in YK11-04E), we revisited the steep cliff and found several open fissures along the steep cliff. However, we could not dive to this site using manned submersible Shinkai 6500 after the cruise, because aftershocks were frequently generated in 2011 cruise (YK11-06E).
The Shinkai #1311 is first dive to this site using manned submersible. The dive was planned to visit the (1) open fissures observed in the 2011 deep-tow survey and (2) Calyptogena phaseoliformis colonies observed in 2008.
The objectives of this dive were
-to observe open fissures as well as bacterial mats
-to find the markers settled in the 2008 dives
-to measure heat flow
-to collect sediment, *Calyptogena*, and water samples around the seafloor
-to collect water sample by ANEMONE sampler for the high resolution mapping of chemical components and microbial cell densities.

4-6. Shinkai 6500 #1312 Furushima
Date: 2012/8/21
Observer: Yasuo Furushima (JAMSTEC)
Pilot: Masanobu Yanagitani
Co-pilot: Masaya Katagiri
Survey site: Deep Sea Biology Site (off Sanriku)
Landing Point: 38-39.2654'N 143-36.1742'E, 3262m
Leaving Point: 38-39.3566'N 143-35.3465'E, 3226m
Dive Summary:
An aim of a survey with Shinkai 6500 (Dive #1312) in this site is to investigate time series fluctuation of deep sea ecosystem after the 2011 Tohoku earthquake. Observation is carried out in last year (Dive #1259 with Shinkai 6500 at dive in 2011 during YK11-E06 cruise), and this site understands that many organisms inhabit the seabed. In addition, discoloration area (bacteria mat) is confirmed around a fissure, too. Thus, we call this survey spot "biology site".
The objectives of a dive here is to observe along a trail last year. Especially, several core sampling and biology samplings etc. are carried out while searching a marker installed in two points of fissure sites last year (fissure site 1: quadrat-1259-1, marker #125, fissure site 2: quadrat-1259-2, marker #126).
Investigation missions are as follows.
-NISKIN (before landing, fissure site 1)
-Syringe water sampling (before landing)
-Collecting sediment cores (around fissure site 1 and 2, using H-core sampler, H-core sampler, MT-core sampler, MBARI-core sampler)
-WHATS water sampler (fissure site 1)
-Heat flow measurement with SHAF (around fissure site 1 and 2, mount area)
-Sampling of snails and other organism (appropriately, using suction sampler)
-Sampling of debris at the bottom (appropriately)

-Installed marker and quadrat (fissure site 1 and 2, mount area)
Seafloor covered by mud in flat areas. We were able to confirm markers and quadrats installed in fissure area last year. However, a crack of crack site 2 was covered with sediment, and we were not able to confirm a crack. In addition, the discoloration area assumed to be bacteria mat decreased in comparison with last year. Furthermore, there seemed to be few populations of biology such as sea cucumbers in comparison with last year.

4-7. Shinkai 6500 #1313 Toki
Observer: Tomohiro Toki (University of the Ryukyus)
Pilot: Fumitaka Saito
Co-pilot: Keita Matsumoto
Diving point:
Bacteria site (Water depth: ~3,600 m)
Landing point:
37°44.2260N, 143°16.9315E, Depth = 3,585 m, Time = 11:41
Objectives:
1) Recovery of the in-situ cores deployed during dive #1310 in Bacteria site
2) Measurement of heat flow in Bacteria site where the normal fault would slip during 2011 Tohoku earthquake based on seismic data
3) Sampling sediment from the same area as sampled during YK11-E06 to compare population of benthic fauna between 2011 and 2012
4) Sampling sediment from the discolored area on the seafloor found during dive #1310
5) Observation of outcrop off northeast corresponding to the normal fault that would slip during 2011 Tohoku earthquake
Dive summary:
All in-situ cores deployed during dive #1310 was recovered. Heat flow was measured at Marker #128, #129, #123, and #141. Sediment was sampled at Marker #128, #129, #123, and #141. Fresh dead animals were found in the sediment taken from discolored area at Marker #141. The gap was observed along 60°, and basement was covered by thin sediment.

5. Results and discussions (summary)
5-1. Mega-benthic biology Ikuta et al.
2011 Tohoku earthquake and subsequent Tsunami on 11 March had heavily damaged the coastal area of northeastern Japan. In the present study, recovering processes of benthic fauna from the earthquakes and tsunami will be evaluated, through comparison of the video images and faunal samples obtained before and after the earthquakes.

5-2. Biogeochemical cycle on the seafloor Nomaki et al.
2011 Tohoku earthquake and subsequent Tsunami had largely affected the benthic ecosystem of northeastern Japan. In the present study, faunal changes in deep-sea areas off Tohoku caused by the earthquakes and tsunami and recovering processes will be monitored through comparison of faunal samples obtained before and after the earthquakes. We also carried out *in situ* incubation experiments to evaluate POC degradation and ammonia oxidation rates by adding stable isotope-labeled substrate.
5-2.1. Sediment organic geochemistry and meiofaunal analysis: Hidetaka Nomaki, Tomo Kitahashi, Kazuno Arai, Akira Tsujimoto, Ritsuo Nomura, Motohiro Shimanaga
We collected sediment samples using a H-type push corer to investigate a) faunal analyses of metazoan meiofauna and benthic foraminifera, b) foraminiferal population changes over 100 years, and c) organic geochemical analyses of sediments.
a) faunal analyses of metazoan meiofauna and benthic foraminifera
We collected 7 sediment cores from 4 different sites; bacterial mat site, Seibutsu site, and Kiretsu site. Sediment cores were sliced vertically down to 5 or 15 cm depths in sediments. Approximately 1 cm of overlying water was also sampled and pooled into 0-1 cm sediment samples. Rose-Bengal formalin was

added into the sliced sediments to fix and stain meiobenthos.

b) foraminiferal population changes over 100 years

We collected 3 sediment cores from 3 sites; 39N site, bacteria mat site, and Seibutsu site, where we also collected sediments for these analyses last year. Sediment cores were vertically sliced into every half cm down to 20 cm depth if possible, and were equally split into two parts. First half were kept frozen for b) foraminiferal population changes over 100 years, and the second half were kept cool for determination of sedimentation rates (see cruise report by Arai).

c) organic geochemical analyses of sediments

We collected 11 core samples for the analysis of TOC, TN, and their isotopic compositions. They were sampled into glass bottles and kept frozen on board.

5-2.2. In situ incubation experiments to evaluate phytodetritus consumption rates and ammonia oxidation rates on the seafloor: Hidetaka Nomaki, Takuro Nunoura, Manabu Nishizawa, Eiji Tasumi, Yuta Konno, Tomohiro Toki

We carried out several in situ incubation experiments to investigate carbon and nitrogen cycling at the sediment-water interface off Tohoku area. Isotope labeled algae were added onto the seafloor to see the degradation rate of particulate organic matter derived from water column. Ammonia oxidation rate will also be evaluated by injecting substrate into sediments and subsequent on-shore geochemical analyses.

5-3. Microbiology & Geochemistry (Sediment) Tasumi, Nunoura, Toki, Konno

Significant impacts on the deep-seafloor ecosystem by the 2011 Tohoku earthquake were observed in the last-year cruise, YK11-E06-Leg2. One of the significant features after the earthquake was the occurrence of heterotrophic bacterial mats (hetero-mats) on the deep-seafloor. Our onshore studies also suggest that methyl-compounds dependent methanogenesis occurred below the mat formation. One of our major objectives of this cruise is to know the in situ microbial activity under the bacterial mat formation. Another objective in this cruise is to know the impact of the seafloor including hetero-mats and methane-seep on the deep-sea microbes in the water column through produced reduced chemicals, e.g. methane, ammonium, and sulfide.

5-4. Geology and sedimentlogy Tsuji and Arai

In YK12-13, we observed seafloor environment and morphology at the seafloor traces of fault system in the 2011 Tohoku earthquake using the manned submersible Shinkai 6500. Before the earthquake, we dived some of these observations sites using submersible. After the earthquake, furthermore, we observed seafloor environment using Deep-tow survey (YK11-04E) and Shinkai 6500 (YK11-06E). We examine dynamic changes of fault traces on the seafloor by comparing observations made by submersible before and after the earthquake. In YK12-13, we mainly (1) obtained core samples for sedimentological studies and (2) measured heat flow for evaluation of fault activities of the 2011 earthquake.

5-4-1 Seafloor and core observations

Seafloor observation (four sites) and core sediment sampling (four sites, 12 samples) were conducted using the HOV Shinkai6500 to investigate events associated with this earthquake, aftershock and tsunami. As a result, aspect of sea floor and core sediments are different from that of YK11-E06 leg2. New soft sediments associated with aftershocks are seen at 39N, bacteria mat site etc. These core samples will be analysized by description, smearslides, X-ray CT, XRD etc.

5-4-2 Age determination of sediments and evaluation of bioturbation using radio nuclides

We collected 3 sediment cores from 3 sites, where we also collected sediments for these analyses last year. Sediment cores were vertically sliced into every half cm down to 20 cm depth if possible, and were equally split into two parts. First half were kept frozen for foraminiferal sample, and the second half were kept cool for age determinations of sediments and evaluation of bioturbation using radio nuclides.

5-4-3 Heat flow measurements

Heat flow can be considered as important information in order to evaluate dynamic fault activity. Because deep fluid passes through the fault plane (fracture) generated by dynamic fault rupture, the degree of fault activity as well as rupture mechanics directly influence to the heat flow value measured on the seafloor. If the fault activities are decreased after the earthquake, the heat flow value would be also decreased. Furthermore,

since we measured heat flow at same places in 2011 and 2012, we can evaluate fault activity from the heat flow variation after the 2011 earthquake.
By vertically inserting Stand-Alone Heat Flow meter (SAHF) probe to the seafloor, we measured temperature gradient for depth direction. SAHF probe is 60 cm long with 5 thermistors mounted at 11-12cm spacing. We usually measured temperature gradient during ~20 minutes for each measurement point. At one measurement points, we measured temperature gradient during ~48 hours and obtained accurate value. For the heat flow calculation, we measured thermal conductivity of the mudstone and core samples obtained from almost all heat flow measurement points. From the temperature gradient (mK/m) and the laboratory-derived thermal conductivity (W/mK), we calculated heat flow values (mW/m2) for each measurement point.

5-5. Physical environment and drift litter Furushima et al.

With dissolved oxygen meter and turbidity meter and CTD equipped with to Sinkai 6500, we carried out vertical and horizontal measurement of water temperature, salinity, turbidity and dissolved oxygen (DO) to obtain oceanographic fluctuation data of each observation area. In 39N site, a fissure site and biology site, thermocline was formed to 200m and 400m depth. This result suggested that these sites were affected by Oyashio. On the other hand, thermocline of bacteria site was formed by 500m depth, and it was shown that a water mass was different from other sites clearly. Probably this result will depend on influence of the Kuroshio Current. In comparison with data of last year and other oceanographic conditions data, we want to examine more.
We established a video camera in bridge at R/V Yokosuka to carry out search of drifting liter and obtained a movie of the sea surface from 6:00 to 18:00 every day. There is clearly little drifting liter when we compare with observation of last year. The drifting liter was plastic garbage mainly. We were not able to distinguish whether these liter drifted by influence of a tsunami.

5-6. Long time environmental observatory Oguri et al.

On 13th/Aug., the lander was released from the ship and the landing was confirmed with the acoustic signal from the transponder. The weight in the air was 270 kg and that in freshwater was 40 kg. The descending speed at actual deployment was 60.8 m/minute. The date, time and the location of the deployed site and each interval for the data acquisition were shown in the following tables 1 and 2, respectively. At first plan, another deployment for similar lander at 300 m depth was planned. However, due to the mechanical accident, the deployment was cancelled. The recovery of the lander is scheduled at a cruise on Tohoku Marine Science in 2013.

Table 1: Deployed date, time and the site information of the site deploying the lander system.

Date	Landing time (JST)	Latitude (N)	Longitude (E)	Depth (m)
2012/8/14	13:28	39°19.9775	142°27.5189	998

Table 2: Intervals of the data, photo and movie acquisitions.

Instruments	RDCP600	Still image at sea floor	5 minutes movie at sea floor
Interval	1 hour	1 day	1 week

6. Future plan

Katsunori Fujikura

Based on collected data and sample during this cruise, I will present about cruise summary and impact by mega-earthquake on the deep-sea ecosystems in the symposiums and workshops with cruise participants. We found unique or new setting potential of deep-sea chemosynthetic communities, such as mixture methane seeps and organism decomposition. I will study about succession of this biological community. Additionally, I will investigate comparison of benthic faunal composition and distribution between before and after the mega-earthquake.

Takeshi Tsuji (I2CNER, Kyushu University)
I compare seafloor morphology (i.e., fracture) before and after the 2011 Tohoku earthquake (YK0806, YK1104E, YK1106E and YK1213), in order to discuss the dynamic fault activities during the earthquake. I further compare the heat flow variation measured after the earthquake (YK1106E and YK1213). In this study, we use the following dataset; (1) seafloor pictures of fractures and clam colony, (2) heat flow value calculated from thermal conductivity and thermal gradient, and (3) dive tracks. I collaborate with several scientists from 2008 diving cruise.

Haruka Shibata (Kitasato Univ.)
We would like to investigate distribution and composition of deep-sea litter from video footages that recorded by *Shinkai6500* camera. We will discuss transportation of marine litter to deep-sea floor and relation to attached organisms.

Kazumasa Oguri (BioGeos/MARITEC, JAMSTEC)
The lander system deployed during this cruise will be recovered in the next year in the cruise by R/V Natsushima and ROV Hyperdolphin. The physical and chemical environmental data will be analyzed to assess yearly or seasonal changes in the sea bottom at the site. As well, photo taken on the sediment surface will provide information on biomass and the changes related to the chemical environments. Especailly, temperature, turbidity and dissolved oxygen will influence to the biological activities. These data will be summarized and provided to the people especially for the fisheries activities as one of the results of Tohoku Marine Science studies.

Hidetaka Nomaki (BioGeos JAMSTEC)
Faunal and molecular analyses of metazoan meiofauna (Kitahashi and Shimanaga)
Faunal analyses of benthic foraminifera (Nomaki et al.)
Long term foraminiferal population changes (Nomura and Tsujimoto)
Age determination of sediments and evaluation of bioturbation using radionuclides (Nomura)
Organic geochemical analyses of sediments (Nomaki)
Phytodetritus degradation rate (Nomaki et al.)
Ammonia oxidation rate (Nishizawa et al.)

Michinari SUNAMURA (Univ. Tokyo, Earth & Planet. Science)
In this cruise, we collected seawater samples using 128 bottles ANEMONE water sampler and Niskin sampler. Microbial cell densities in these samples were determined by flow-cytometry on board. Further analysis of water samples will be conducted for water densities, nutrients, pH, and alkalinities by K. Okamura and T, Noguchi. After the quality check with these chemical data, the microbial cell densities and chemical concentrations will be compared with geological structures. In addition, microbial community structures will be determined by DNA and cell analysis using Niskin samples.

Microbiology & Geochemistry (Sediment) E. Tasumi, T. Nunoura, T. Toki, U. Konno
During this cruise, we took sediment cores from bacterial mat sites and methane seep sites, and assessed in situ microbial activity under bacterial mats. We will conduct chemical analysis on these cores including isotopic compositions of CH_4 and CO_2 to clarify pathways of CH_4 generation, and determine microbial community structures in these sediment cores.

Kazuno Arai (Chiba Univ.)
We attempt to reconstruct the events due to the earthquake, aftershock and tsunami. As a result of the investigations of YK12-13, aspect of sea floor and core sediments are different from that of YK11-E06 leg2. New soft sediments associated with aftershocks are seen at 39N, bacteria mat site etc. In this study, first, the detailed characteristics of sediments (such as aspect of seafloor, sediment structure, and grain-size distribution) are investigated. Second, inverse analysis of hydraulic conditions of turbidity currents based on

the characteristics of the soft sediments layers is conducted. Reconstructions of flow processes of the turbidity currents will become an important data of the earthquake and tsunami-generated turbidity currents.

Yasuo Furushima (BioGeos JAMSTEC)
Continuous investigation is necessary to monitor physical environment around a focal region off Sanriku. Therefore, we will carry out a similar survey in future and examine physical environment fluctuation for time series. Furthermore, we investigate an event (bacteria mat, distribution of organisms) in the bottom and relationship with physical environment fluctuation.
In addition, in this cruise, we established the lander system which put ADCP on the bottom of Sanriku offing 1,000m depth, and long-term environmental monitoring was started. Therefore, in the next fiscal year, we analyze long-term environmental data and understand characteristics of environmental fluctuation off the Sanriku deep sea bottom. At the same time, we want to proceed with information disclosure as fisheries oceanographically environmental data to fishermen.
We analyze distribution conditions and a kind of litter continuously to examine influence to marine ecosystem. In addition, we want to establish a method to guess a route of drifting litter from oceanography data.

Tetsuro Ikuta (BioGeos JAMSTEC)
In order to evaluate recovering processes of benthic fauna from the 2011 Tohoku Earthquake and subsequent Tsunami, quantitative core samples obtained in the present cruise will be utilized for population dynamics and population genetics study. We will also analyze mechanism of symbiosis between symbiotic bacteria and host bivalves using Calypogena samples obtained in this cruise.

7. About data
Include any information that may be necessary for analysis and QC planning and secondary use (publications, provisions, etc.)
Notice on Using
Notice on using: Insert the following notice to users regarding the data and samples obtained.
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.