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KR13-07 Cruise Report

Seismic reflection study off the Boso Peninsula and in the Ogasawara region

Apr. 4, 2013 – Apr. 17, 2013

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

Contents:

1. Cruise Information:

(1) **Cruise ID, ship name:** KR13-07, R/V KAIREI
(2) **Cruise title:** 2013FY "Seismic study off the Boso Peninsula and in the Ogasawara region"
(3) **Proposal title:** Seismic study related to the site surveys of the IODP proposal
(4) **Cruise period, port call:** 2013/4/4–4/17, Yokosuka port (Yokosuka shinko) to Yokosuka port (JAMSTEC)
(5) **Research Area:** Off the Boso Peninsula and the Ogasawara regions
(6) **Research Map:** Fig. 1

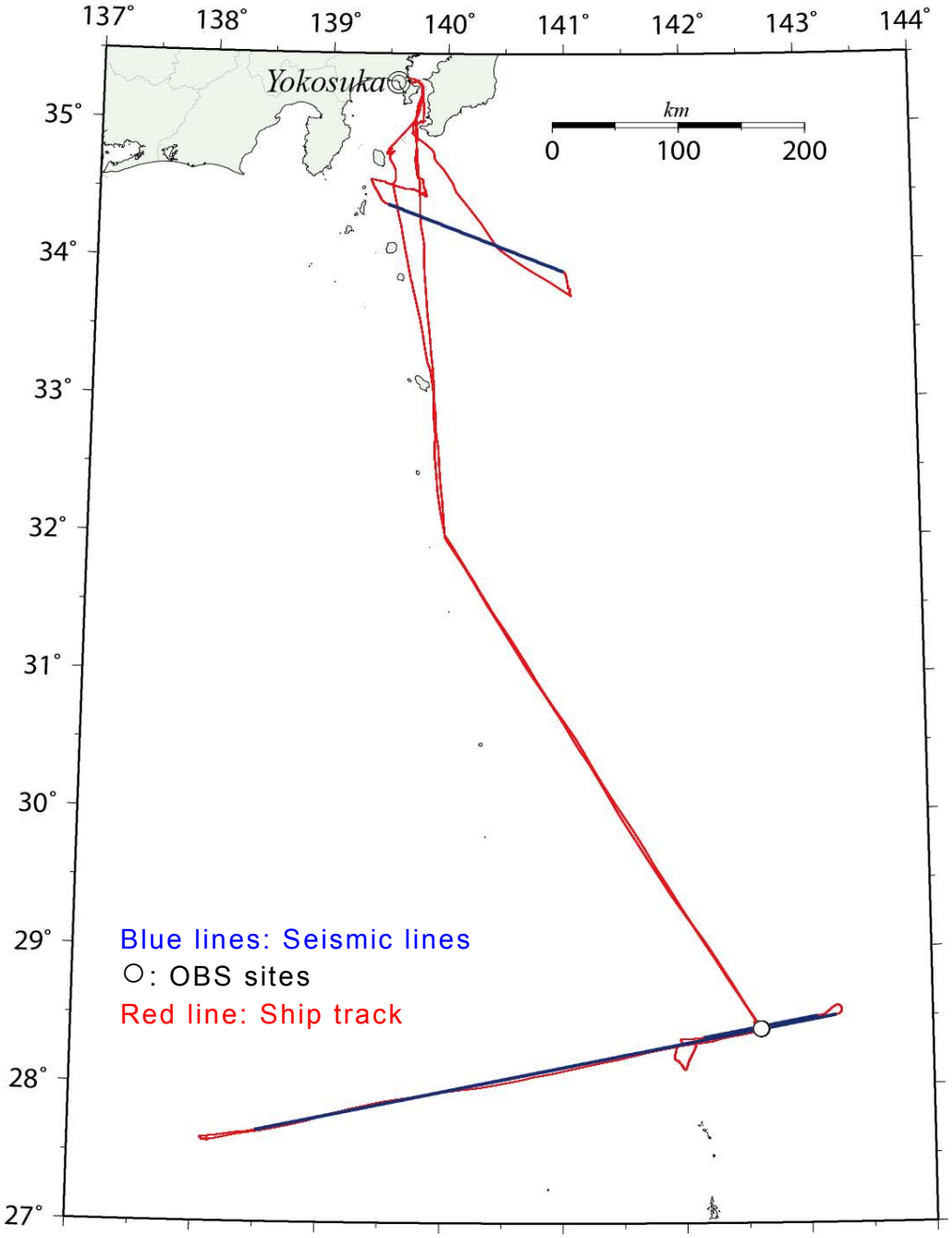

Fig. 1 Ship track during KR13-07 cruise.

2. Researchers:

(1) Chief Scientist [Affiliation]:

Tetsuo NO [JAMSTEC]

(2) Representative of Science Party [Affiliation]:

Shuichi KODAIRA [JAMSTEC]

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Tetsuo NO [JAMSTEC]: Chief Scientist
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Hideki SHIBATA [NME]: Technician (Seismic source technician)
Atsushi ISOGAI [NME]: Technician (Seismic navigator)
Yuta WATARAI [NME]: Technician (Seismic observer)
Takuya MAEKAWA [NME]: Technician (Chief OBS technician)
Ryo MIURA [NME]: Technician (Seismic data processor)
Kyoko TANAKA [NME]: Technician (Seismic navigator)
Taro SHIRAI [NME]: Technician (Seismic data processor)
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3. Overview of observations:

(1) Objectives:

As part of the site surveys of the IODP proposal, we conducted a multichannel seismic reflection survey using the R/V KAIREI around areas off the Boso Peninsula and in the Ogasawara region.

The seismic survey off the Boso Peninsula was part of the site survey of the "Kanto Asperity Project (KAP)," which concerns the understanding of three types of great earthquakes (e.g., the 1923 Great Kanto earthquake, the 1703 Genroku earthquake) near the Sagami trough. This trough is located along the boundary between the Philippine Sea Plate and the Northeast Honshu arc. Because of the heterogeneous structure of the Philippine Sea Plate, it is important to understand how this affects the seismogenic zone around the Sagami trough.

Moreover, the survey in the Ogasawara region acquired seismic reflection data for site characterization around the proposed drilling sites (IBM-2) for "Project IBM." Because the drilling schedule of IBM-2 is already decided, seismic data acquisition is required for the site evaluation. In addition, we would like to study the whole crustal structure of the island arc and basin in the survey area. In the vicinity of IBM-2, we deployed four OBSs, including a new type of OBS for performance comparison testing, and performed a refraction survey using an airgun array with a spacing of 200 m.

(2) List of observation instruments:

1) Multichannel seismic reflection survey (MCS)

We conducted the MCS survey around the areas off the Boso Peninsula and the Ogasawara region using the R/V KAIREI (Fig. 2). The MCS data were acquired along three lines (Line 6, IBr11, and IBr11n) with a total length of approximately 719 km.

Fig. 2 MCS system on R/V KAIREI.

a) Source:

To obtain good quality MCS data, we shot an airgun array at a spacing of 50 m. This corresponds to an interval of 20–30 s, depending on the vessel speed (average 3.5–5 knots). The tuned airgun array has a maximum capacity of 7,800 in^3 (about 130 L) and consists of 32 Bolt Annular Port airguns. The standard air pressure was 2,000 psi (about 14 MPa). Throughout the experiment, the airgun array was maintained at a depth of 6 m below the sea surface. Figs. 3 and 4 show four strings of subarrays deployed at the port and starboard sides of the vessel. Their width was expanded to 30.0 m by a paravane system, and the central position of the array was set 170 m behind the ship's antenna.

b) Receiver:

During the airgun shooting, we towed a 444-channel hydrophone streamer cable (Sentinel Digital Streamer System, Sercel Inc.) (Figs. 3 and 4). Hydrophone sensors (Benthos Reduced Diameter Array hydrophone) with a sensitivity of 19.7 V/bar were used. The signals from eight sensors in the same group (channel) were stacked before the A/D conversion. The interval of each group was 12.5 m. The cable was about 6 km long. The towing depth of the streamer cable was maintained at 10 m (Line 6) and 6 m (IBr11 and IBr11n) below the sea surface by a depth controller, the so-called bird (I/O DigiCOURSE streamer depth controllers).

c) Recording and navigation systems

A Sercel Seal System Ver.5.2 recording system, made by Sercel Inc., was used in the survey. The seismic data were collected on 3590E tapes in the SEG-D 8058 Rev.1 format. The system delay was set to 200 ms, the sampling rate was 1 ms, and the recording length was 15–17 s.

The Differential Global Positioning System (DGPS) was used for positioning. We adopted NAVCOM's StarFire as the main positioning system and used Fugro's SkyFix as backup. The accuracy was reported to be about 0.4 m for StarFire and 5 m for SkyFix. We used SPECTRA 2D (Concept Systems Ltd.) as our navigation software during the seismic data acquisition. Positioning data collected from both StarFire and SkyFix were sent to the Power Real Time Navigation Unit (PowerRTNU) (Concept Systems Ltd.) via a terminal server connected to a LAN in the vessel. Shot times and shot points (SPs) were set on SPECTRA, and then a trigger signal was sent to the recording system and the gun controller (ION DigiSHOT Ver.3.1). The main navigation parameters were as follows: the survey datum was WGS84, the map projection was UTM, and the UTM zone parameter was 54N.

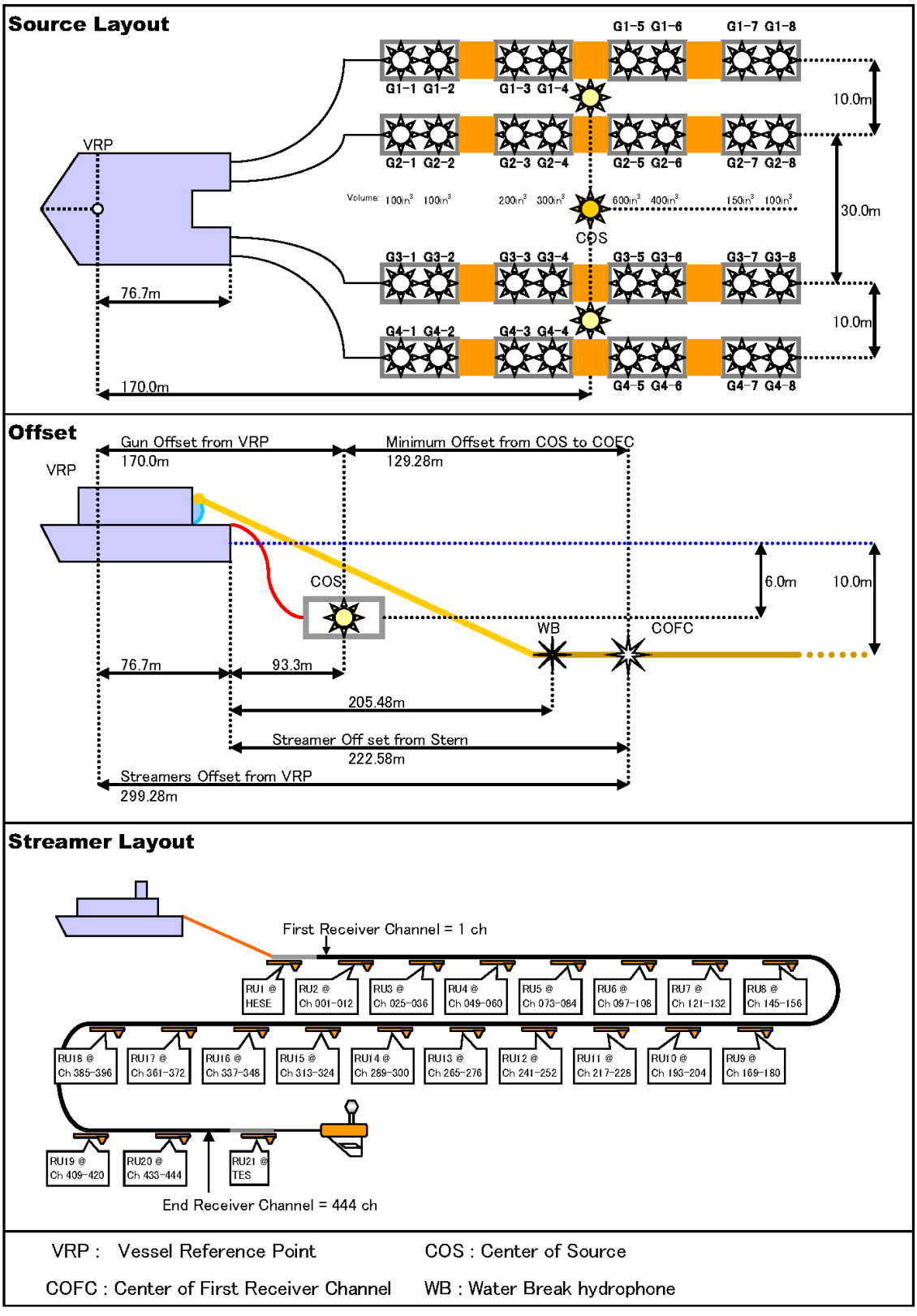

Fig. 3 Vessel towing geometry during the MCS survey (Line 6).

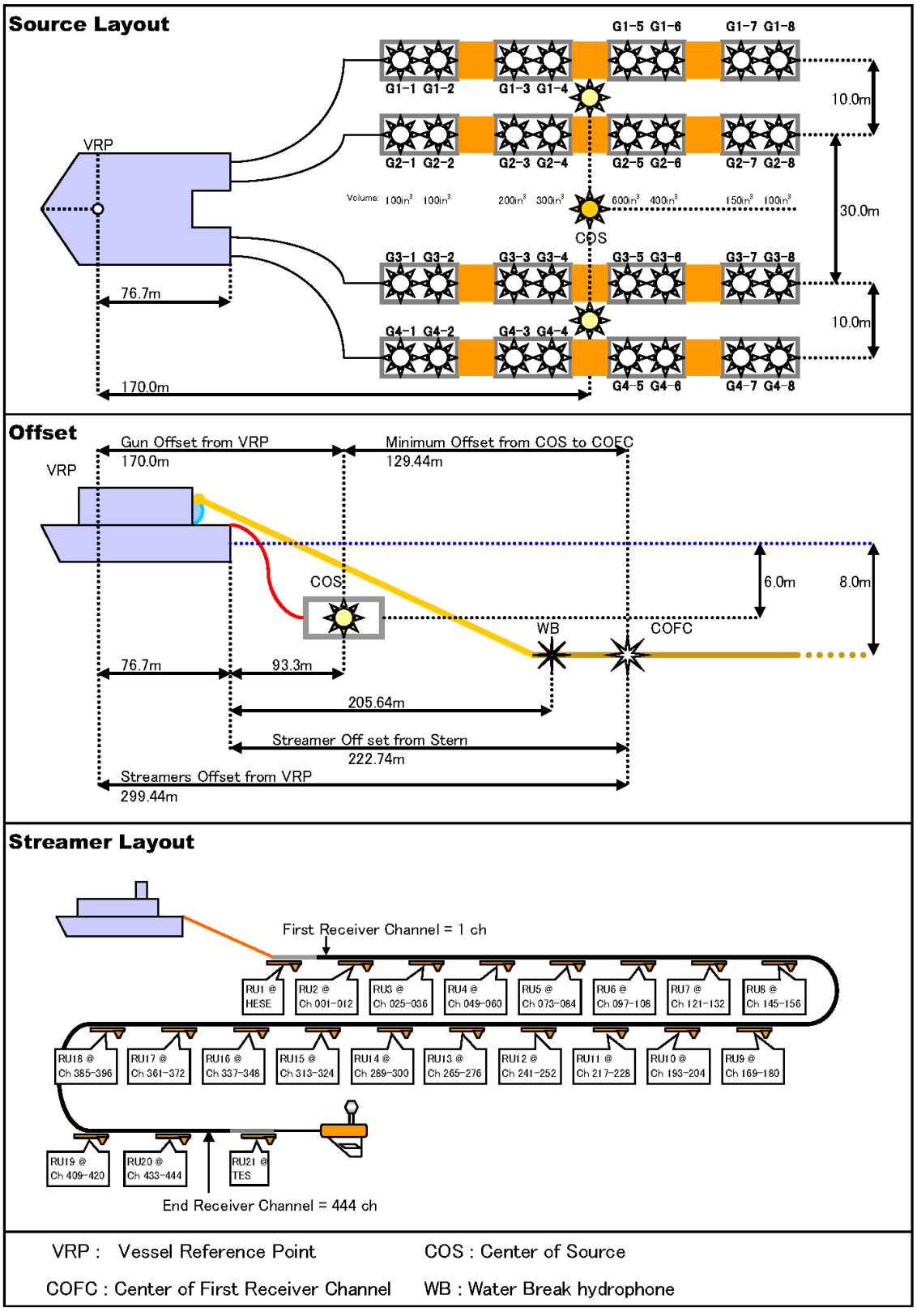

Fig. 4 Vessel towing geometry during the MCS survey (IBr11 and IBr11n).

d) Onboard processing of MCS data:

Raw MCS reflection data were processed on board for quality control. Onboard data processing was conducted by preserving the relative amplitudes under the conventional processing scheme, which includes trace header edit, trace edit, common midpoint (CMP) binning with an interval of 6.25 m, a bandpass filter, datum correction, amplitude compensation, predictive deconvolution, velocity analysis, normal moveout correction, a radon filter for multiple suppression, mute, CMP stack, F–K migration, and so on (Figs. 5, 6, and 7).

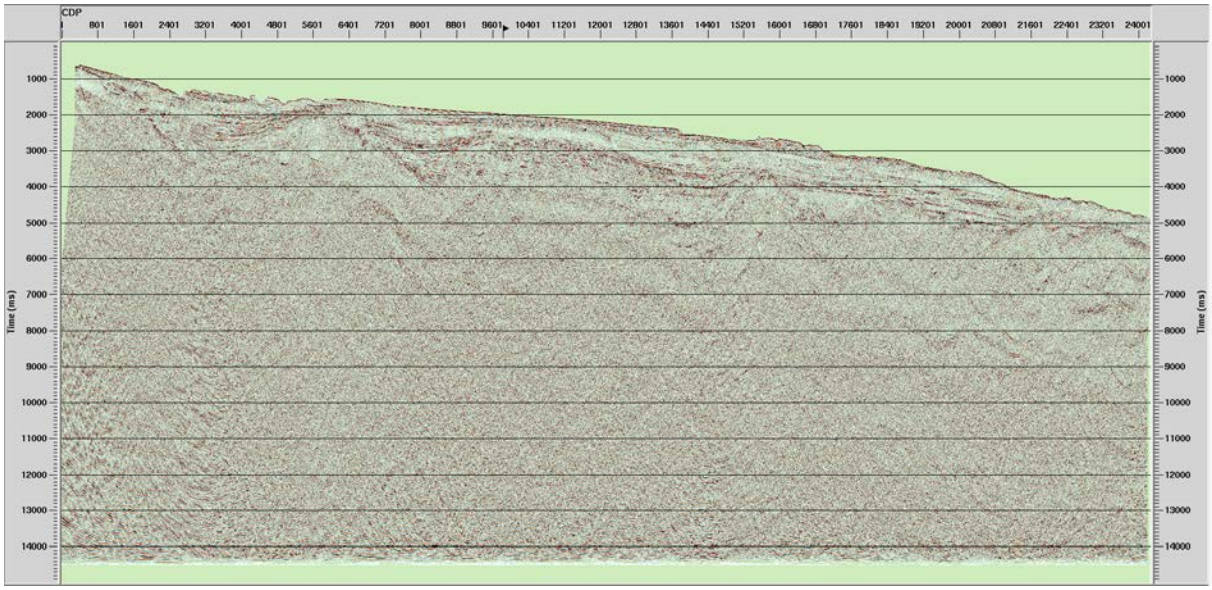

Fig. 5 Example of MCS profile with onboard processing (Line6).

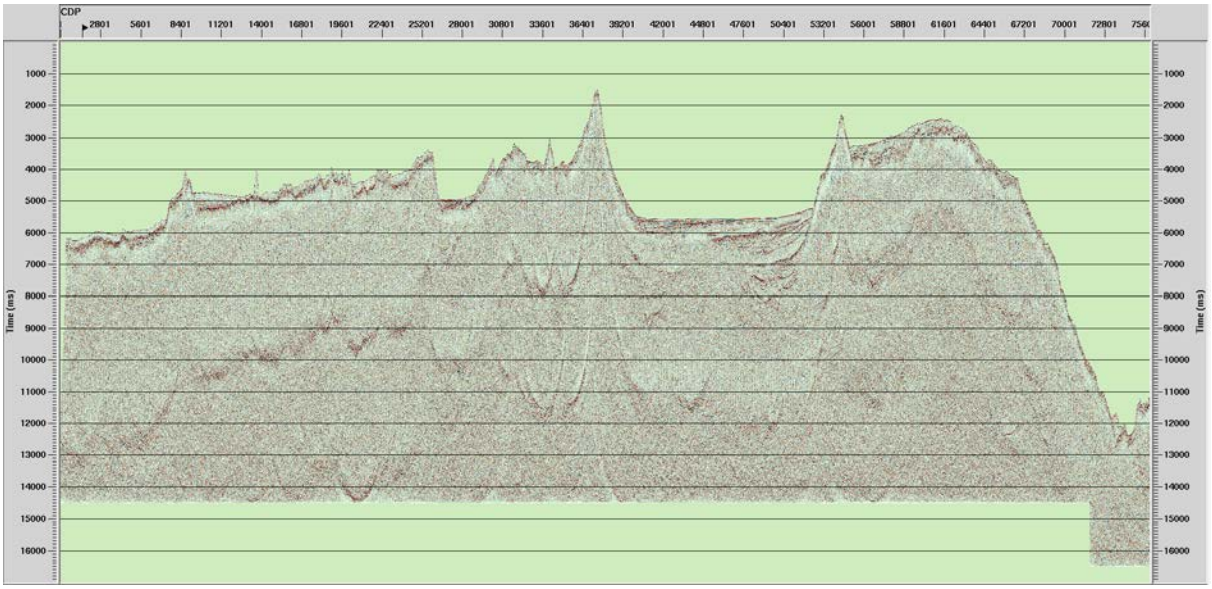

Fig. 6 Example of MCS profile with onboard processing (IBr11).

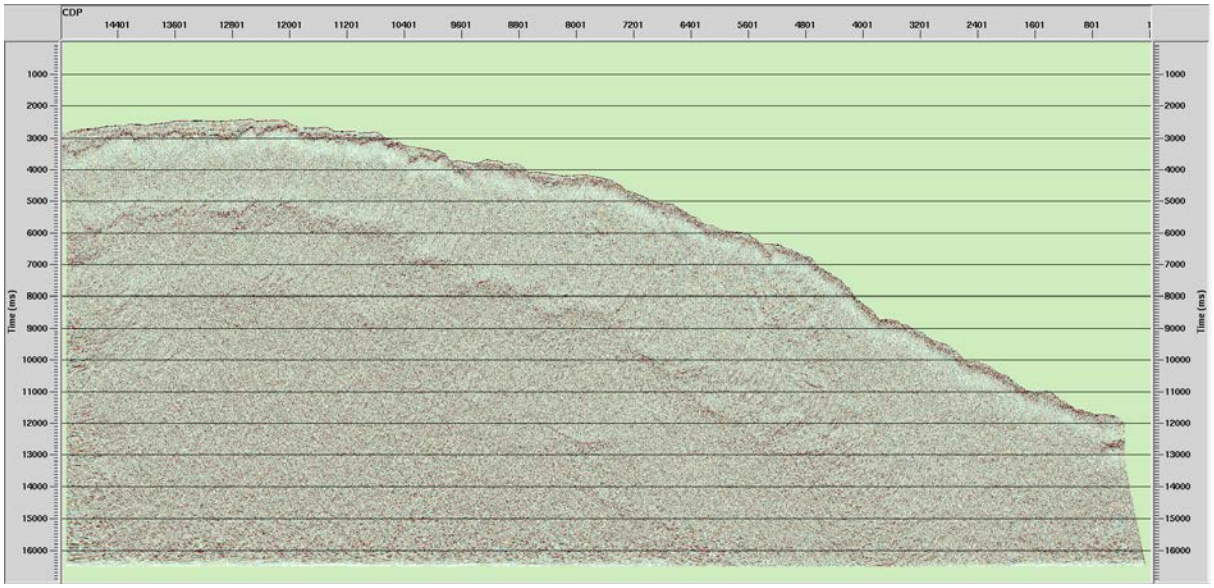

Fig. 7　Example of MCS profile with onboard processing (IBr11n).

2) Seismic refraction survey and performance comparison test of OBS:

In the vicinity of IBM-2, we deployed four OBSs including the new type of OBS for performance comparison testing, and performed a refraction survey using an airgun array with a spacing of 200 m. Each OBS has different system specifications. The detailed system specifications of the OBSs are listed in Tables 1–4. The airgun array in the OBS survey used almost the same configuration as in the MCS survey, though their width was expanded to 30.0 m by a paravane system, and the central position of the array was set 170.0 m behind the ship's antenna (Fig. 8). The OBSs' position on the seabed was estimated by a super short baseline (SSBL) acoustic system from the vessel's positioning system during the cruise. We edited the continuous OBS data to a length of 80 s in the SEG-Y format. At the same time, the calibration of the OBS clock according to the GPS time was carried out using the difference times between the OBS clock and the GPS time, which were measured just before the OBS deployment and just after the OBS retrieval. Figs. 9–12 show examples of the four OBS record sections.

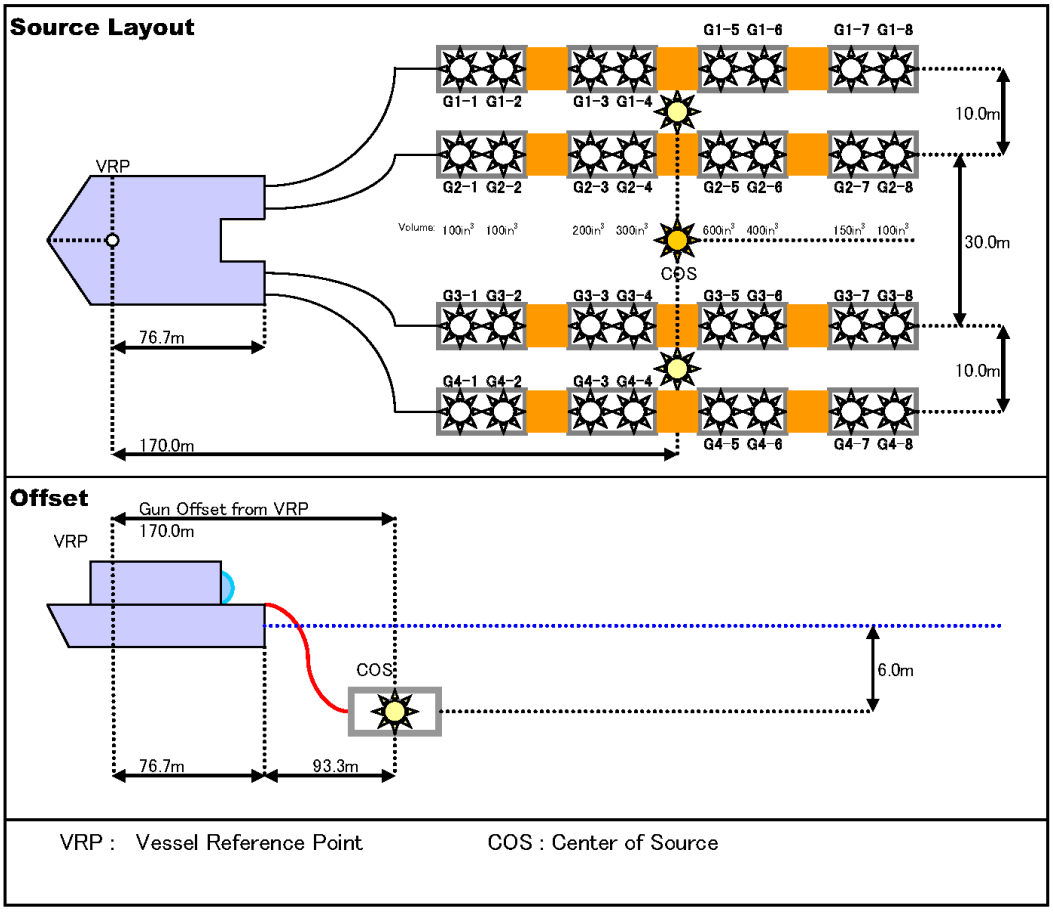

Fig. 8 Vessel towing geometry during the refraction survey.

OCEAN-BOTTOM SEISMOMETER	
Type	NME OBS2G
Number of Channel	4
ch1	Vertical sensor
ch2 / ch3	Horizontal sensor (two directions)
ch4	Hydrophone
SENSOR	
Type	735T-NME
Sensitivity	10V/g (±10%　25℃)
Amplitude Nonlinearity	80%
Resonance Frequency	700Hz
Frequency Response	0.01～350Hz（±3dB)
Self Noise Density	20ng/√Hz（2Hz）、7ng/√Hz（10Hz）、3.5ng/√Hz（100Hz）
Output Impedance	600Ω@1mA
HYDROPHONE	
Type	NME
Sensitivity	163dBV/uPa
Frequency Response	3～500Hz
RECORDER	
Type	NME-SPM2
Sample Rate	4.0 msec
A/D Converter	24 Bit
Frequency Response	ch0-2：0-103.25 Hz (ch3：0.1-103.25 Hz)
Pre Amplifier Gain	
ch1/ch2/ch3/ch4	8x / 8x / 8x / 1x
Digital Filter	Sinc Filter + FIR-LPF
Width of quantization step	0.298 μV
Recording Media	SDHC 32 GB ×4
Clock Type	VC-TCXO
Clock　Frequency	16.384 MHz
Clock　Accuracy	0.1 ppm (-10～50degC)
Time Reference	GPS

Table 1　OBS specifications of site BON2_1.

OCEAN-BOTTOM SEISMOMETER	
Type	NME OBS2G-17inch
Number of Channel	4
ch1	Vertical sensor
ch2 / ch3	Horizontal sensor (two directions)
ch4	Hydrophone
SENSOR	
Type	735T-NME
Sensitivity	10V/g (±10%　25℃)
Amplitude Nonlinearity	80%
Resonance Frequency	700Hz
Frequency Response	0.01～350Hz （±3dB)
Swlf Noise Density	20ng/√Hz (2Hz)、7ng/√Hz (10Hz)、3.5ng/√Hz (100Hz)
Output Impedance	600Ω@1mA
HYDROPHONE	
Type	HIGH TECH HTI-90-DY
Sensitivity	-170 dB re:1 V/uPa
Frequency Response	2 - 15 kHz
RECORDER	
Type	NME-SPM2
Sample Rate	4.0 msec
A/D Converter	24 Bit
Frequency Response	ch0-2 : 0-103.25 Hz (ch3 : 0.1-103.25 Hz)
Pre Amplifier Gain	
ch1/ch2/ch3/ch4	8x / 8x / 8x / 1x
Digital Filter	Sinc Filter + FIR-LPF
Width of quantization step	0.298 μV
Recording Media	SDHC 32 GB ×4
Clock Type	VC-TCXO
Clock　Frequency	16.384 MHz
Clock　Accuracy	0.1 ppm (-10～50degC)
Time Reference	GPS

Table 2　OBS specifications of site BON2_2.

OCEAN-BOTTOM SEISMOMETER	
Type	NME OBS2G
Number of Channel	4
ch1	Vertical sensor
ch2 / ch3	Horizontal sensor (two directions)
ch4	Hydrophone
SENSOR	
Type	Geo Space Technologies HS-1LT
Sensitivity	- *1
Damping	80%
Natural Frequency	4.5 Hz
Frequency Tolerance	±0.75 Hz
Coil Resistance	1460 Ω
Coil Current Damping	1910 Ω
HYDROPHONE	
Type	NME
Sensitivity	163dBV/uPa
Frequency Response	3～500Hz
RECORDER	
Type	NME-SPM2
Sample Rate	4.0 msec
A/D Converter	24 Bit
Frequency Response	ch0-2 : 0-103.25 Hz (ch3 : 0.1-103.25 Hz)
Pre Amplifier Gain	
ch1/ch2/ch3/ch4	8x / 8x / 8x / 1x
Digital Filter	Sinc Filter + FIR-LPF
Width of quantization step	0.298 μV
Recording Media	SDHC 32 GB ×4
Clock Type	VC-TCXO
Clock Frequency	16.384 MHz
Clock Accuracy	0.1 ppm (-10～50degC)
Time Reference	GPS
*1	Damping 70%:0.78 V/inch/sec Open :1.22 V/inch/sec

Table 3 OBS specifications of site BON2_3.

OCEAN-BOTTOM SEISMOMETER	
Type	NME OBS2G-17inch
Number of Channel	4
ch1	Vertical sensor
ch2 / ch3	Horizontal sensor (two directions)
ch4	Hydrophone
SENSOR	
Type	SERCEL L-28LB.H.V
Sensitivity	0.68 V/inch/sec
Sensitivity (OPEN)	0.8 V /inch/sec
Natural Frequency	4.5 Hz
Frequency Tolerance	±0.5 Hz
Coil Resistance	395 Ω
Shunt Resistance	2490 Ω
HYDROPHONE	
Type	HIGH TECH HTI-90-DY
Sensitivity	-170 dB re:1 V/uPa
Frequency Response	2 - 15 kHz
RECORDER	
Type	NME-SPM2
Sample Rate	4.0 msec
A/D Converter	24 Bit
Frequency Response	ch0-2 : 0-103.25 Hz (ch3 : 0.1-103.25 Hz)
Pre Amplifier Gain	
ch1/ch2/ch3/ch4	8x / 8x / 8x / 1x
Digital Filter	Sinc Filter + FIR-LPF
Width of quantization step	0.298 μV
Recording Media	SDHC 32 GB ×4
Clock Type	VC-TCXO
Clock　Frequency	16.384 MHz
Clock　Accuracy	0.1 ppm (-10～50degC)
Time Reference	GPS

Table 4　OBS specifications of site BON2_4.

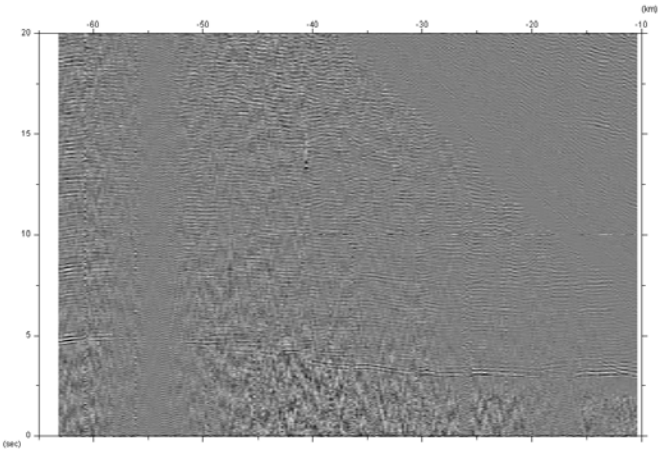

Fig. 9　Example of OBS record sections (BON2_1).

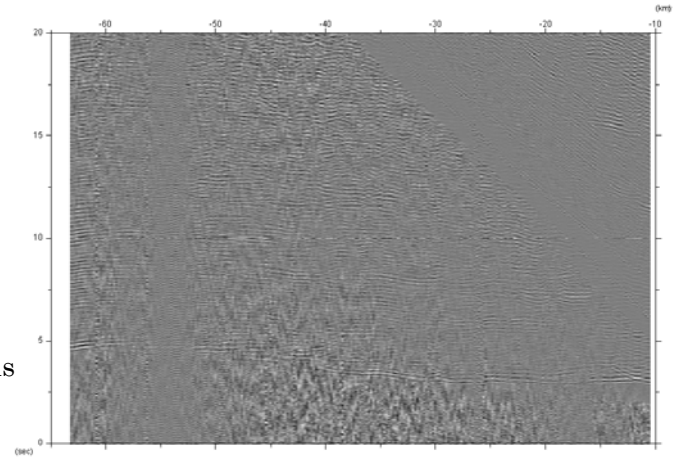

Fig. 10　Example of OBS record sections (BON2_2).

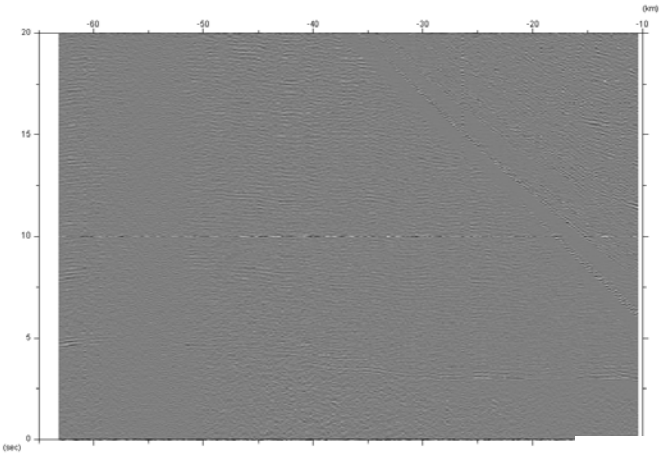

Fig. 11　Example of OBS record sections (BON2_3).

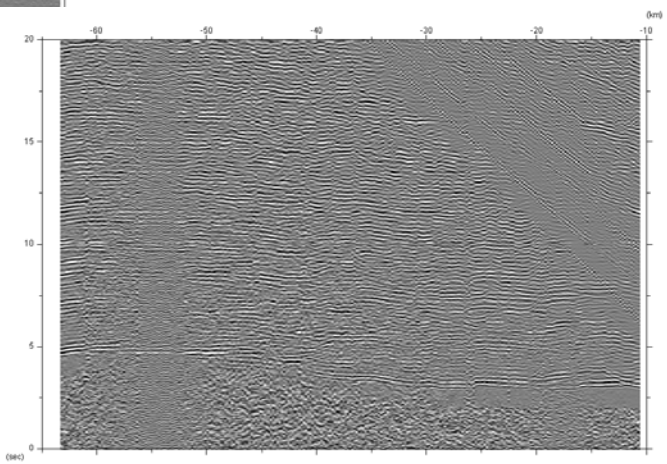

Fig. 12　Example of OBS record sections (BON2_4).

3) Bathymetry, magnetic, and gravity observations:

Bathymetry, magnetic, and gravity data were continuously recorded during the survey. For the bathymetry survey on R/V KAIREI, we used a multinarrow beam echo sounder (Sea Beam 2112.004, SeaBeam Instruments) (Fig. 13). Gravity data were obtained using a shipboard gravimeter (BODESEEWERK KSS31, Fugro Co. Ltd.). For the magnetic survey, we used a three-component magnetometer (SFG1214, Tiera Technica Corporation).

Occasionally, the SeaBeam system could not acquire bathymetry data because of system malfunction of unknown origin since April 9.

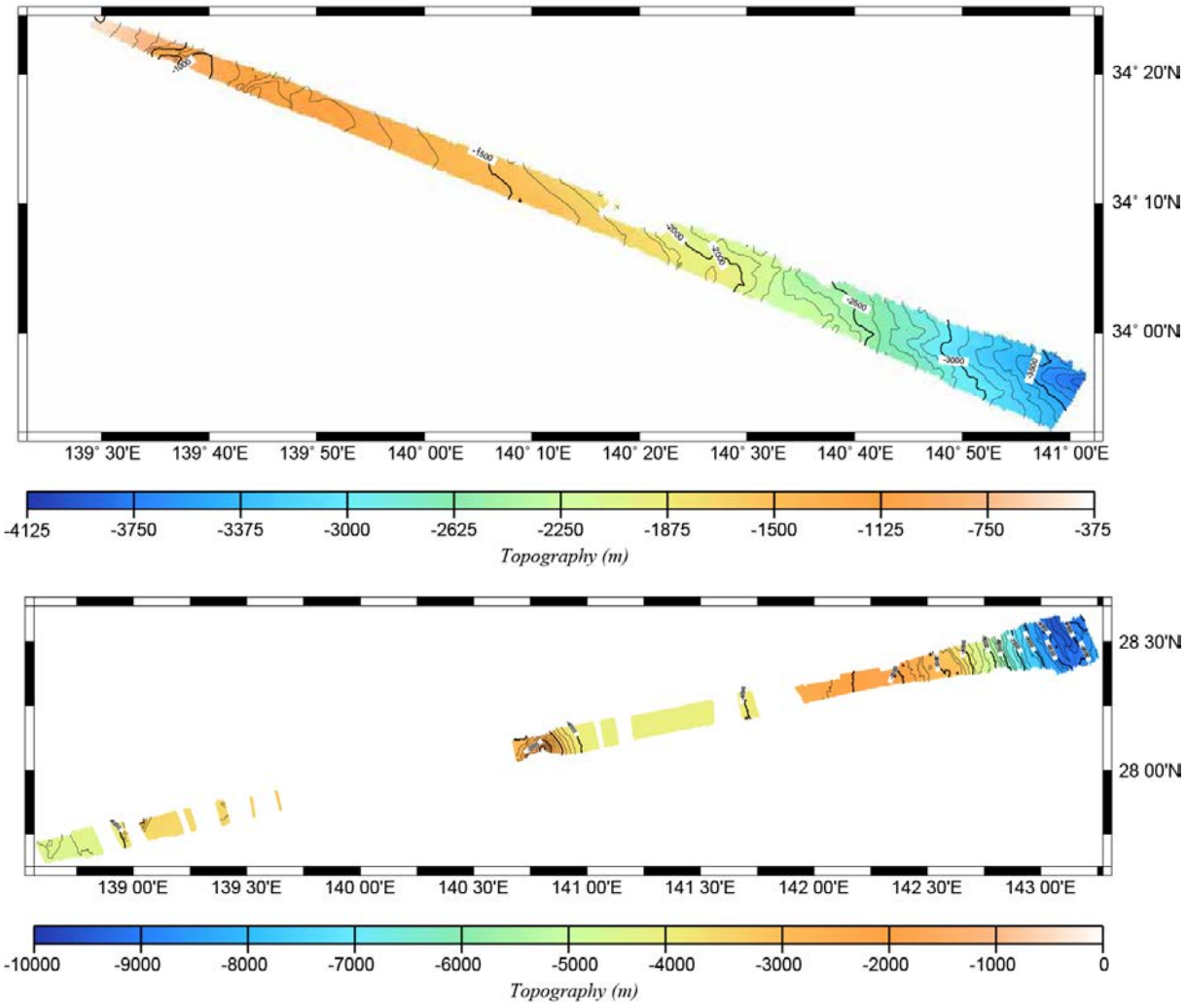

Fig. 13 Results of the bathymetric survey. (Upper) Off the Boso Peninsula, (Under) the Ogasawara region.

(3) **Cruise log:** Table 5

Date		Remarks
2013/4/4	Thu.	Departure from Yokosuka port (Yokosuka shinko), transit to the survey area off the Boso Peninsula. Airgun system deployment.
2013/4/5	Fri.	Streamer cable system deployment. MCS survey (Line 6).
2013/4/6	Sat.	MCS survey (Line 6). Stop shooting due to bad weather and sea condition, and retrieve all equipments. Transit to the Tokyo Bay
2013/4/7	Sun.	Stand by all day in the Tokyo Bay due to bad weather and sea condition.
2013/4/8	Mon.	Stand by all day in the Tokyo Bay due to bad weather and sea condition.
2013/4/9	Tue.	Transit to the survey area of the Ogasawara region
2013/4/10	Wed.	4 OBSs deployment (Site BON2_1, BON2_2, BON2_3, and BON2_4)
2013/4/11	Thu.	MCS system deployment. MCS survey (IBr11).
2013/4/12	Fri.	MCS survey (IBr11).
2013/4/13	Sat.	MCS survey (IBr11). Maintenance of airgun system.
2013/4/14	Sun.	MCS survey (IBr11, IBr11n). Retrieve streamer system.
2013/4/15	Mon.	Airgun shooting (IBr11, 200 m shot interval). Retrieve airgun system and all OBSs.
2013/4/16	Tue.	Transit to Yokosuka port (JAMSTEC).
2013/4/17	Wed.	Arrival at Yokosuka port (JAMSTEC).

Table 5　Cruise log during the survey.

(4) **Seismic lines** : Fig. 14

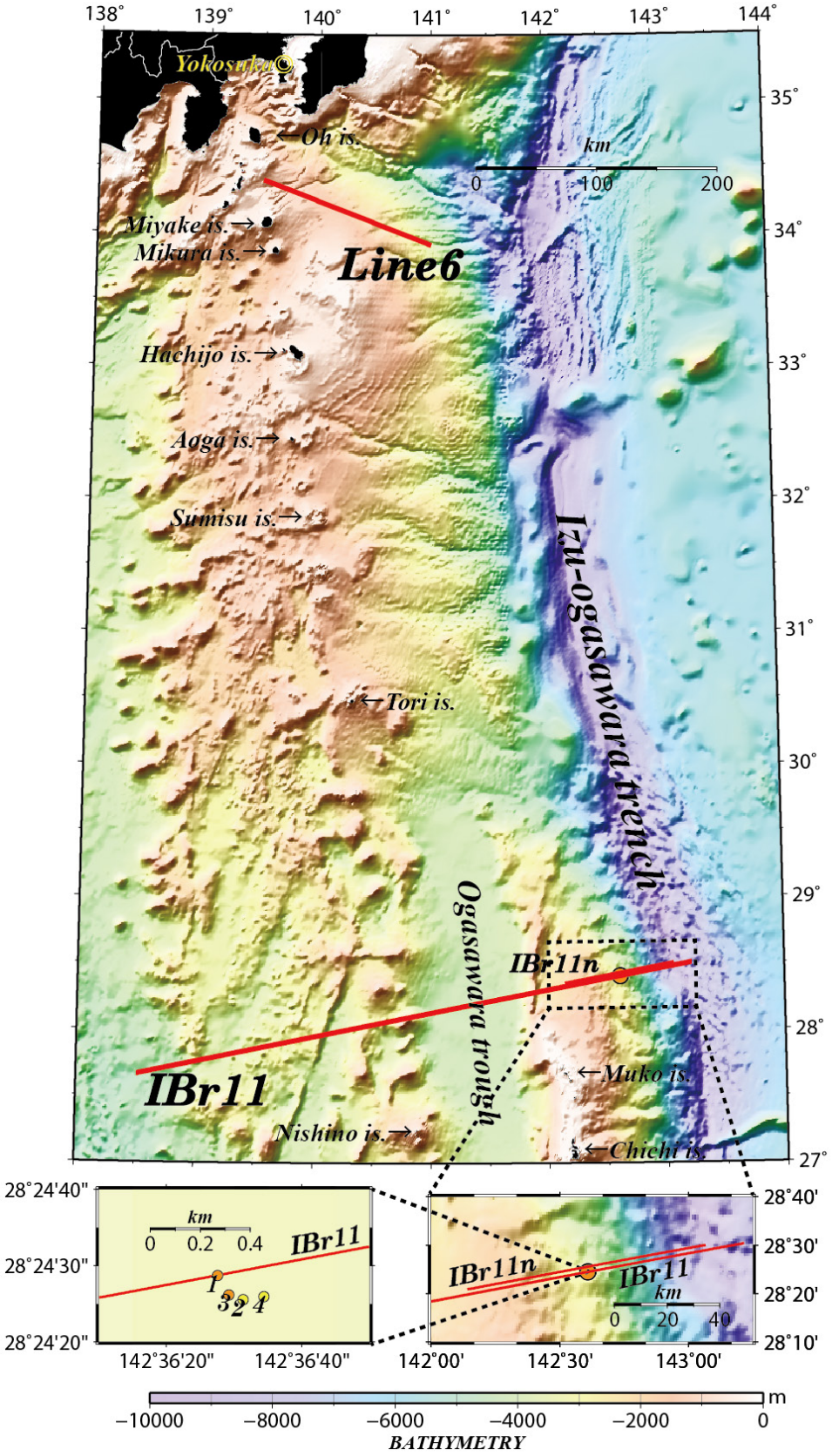

Fig. 14 Bathymetry and location maps of the survey area. Red lines are the MCS lines of this survey, and circles are the positions of the OBS sites.

(5) **Seismic line list:** Table 6

LINE NAME	DATE (UTC)	TIME (UTC)	F.S.P. / F.G.S.P. / L.G.S.P. / L.S.P.	VESSEL POSITION Lat.	VESSEL POSITION Lon.	Depth (m)	LENGTH FGSP - LGSP (km)	DIRECTION (°)	Mode (m)
IBr11_0	11/04/2013	03:26:31	10315	27_39.86503'N	138_30.67357'E	-	354.2	78.6	Distance (50.0m)
	11/04/2013	03:27:08	10313	27_39.87757'N	138_30.73262'E	-			
	12/04/2013	21:00:15	3230	28_18.76704'N	142_02.30593'E	-			
	12/04/2013	21:00:15	3230	28_18.76704'N	142_02.30593'E	-			
IBr11_1	13/04/2013	07:59:04	3355	28_18.12775'N	141_58.55033'E	-	122.4	78.6	Distance (50.0m)
	13/04/2013	08:09:59	3328	28_18.26022'N	141_59.36274'E	-			
	13/04/2013	23:17:47	881	28_30.45400'N	143_13.00425'E	8543			
	13/04/2013	23:17:47	881	28_30.45400'N	143_13.00425'E	8543			
IBr11n_0	14/04/2013	02:36:27	881	28_30.04567'N	143_03.78933'E	9166	92.1	258.6	Distance (50.0m)
	14/04/2013	02:37:03	883	28_30.03682'N	143_03.72889'E	9117			
	14/04/2013	12:15:14	2724	28_20.86173'N	142_08.31525'E	2107			
	14/04/2013	12:15:14	2724	28_20.86173'N	142_08.31525'E	2107			
IBr11obs_0	14/04/2013	15:59:39	2741	28_18.13727'N	141_58.54827'E	2398	52.4	78.6	Distance (200.0m)
	14/04/2013	16:03:06	2743	28_18.17116'N	141_58.79001'E	2393			
	14/04/2013	23:01:23	3005	28_23.47976'N	142_30.29772'E	2808			
	14/04/2013	23:01:23	3005	28_23.47976'N	142_30.29772'E	2808			
Line6_0	05/04/2013	00:14:58	981	34_24.15406'N	139_29.49114'E	536	149.2	111.5	Distance (50.0m)
	05/04/2013	00:15:17	982	34_24.14446'N	139_29.52168'E	532			
	05/04/2013	16:28:23	3966	33_55.09485'N	141_00.13088'E	3634			
	05/04/2013	16:28:23	3966	33_55.09485'N	141_00.13088'E	3634			

Table 6 List of seismic survey lines.

(6) **OBS position list:** Table 7

Site	Lat (N)	Lon(E)	Depth (m)	Type
BON2_1	28_24.4787	142_36.4594	3132	See Table 1
BON2_2	28_24.4256	142_36.5227	3131	See Table 2
BON2_3	28_24.4357	142_36.4871	3133	See Table 3
BON2_4	28_24.4318	142_36.5737	3135	See Table 4

Table 7 List of OBS position.

4. Notice on use:

This cruise report is a preliminary document as of the end of the cruise. It may not be corrected even if changes in content (i.e., taxonomic classifications) are found after publication. It may also be changed without notice. Data in the cruise report may be raw or unprocessed. Please ask the PI for the latest information before using. Users of data or results of this cruise are requested to submit their results to the Data Integration and Analysis Group (DIAG), JAMSTEC.

Acknowledgement:

We would like to thank the captain, Hitoshi Tanaka, and crew of the R/V KAIREI, and Makoto Ito and the marine technician team (Nippon Marine Enterprises, Ltd.), for their efforts in obtaining MCS data, OBS data, and other geophysical data. We are grateful to participants of MARITEC (Marine Technology Center), Research Support Department, and IFREE (Institute for Research on Earth Evolution) in JAMSTEC for their great support in this cruise. We used "The Generic Mapping Tools" (Wessel and Smith, 1991) to make figures.