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KR11-08 Cruise Report

Intensive seismic study around the deformed zone in the eastern margin of the Japan Sea

(Marine seismic exploration survey)

Aug. 5, 2011 – Aug. 27, 2011

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

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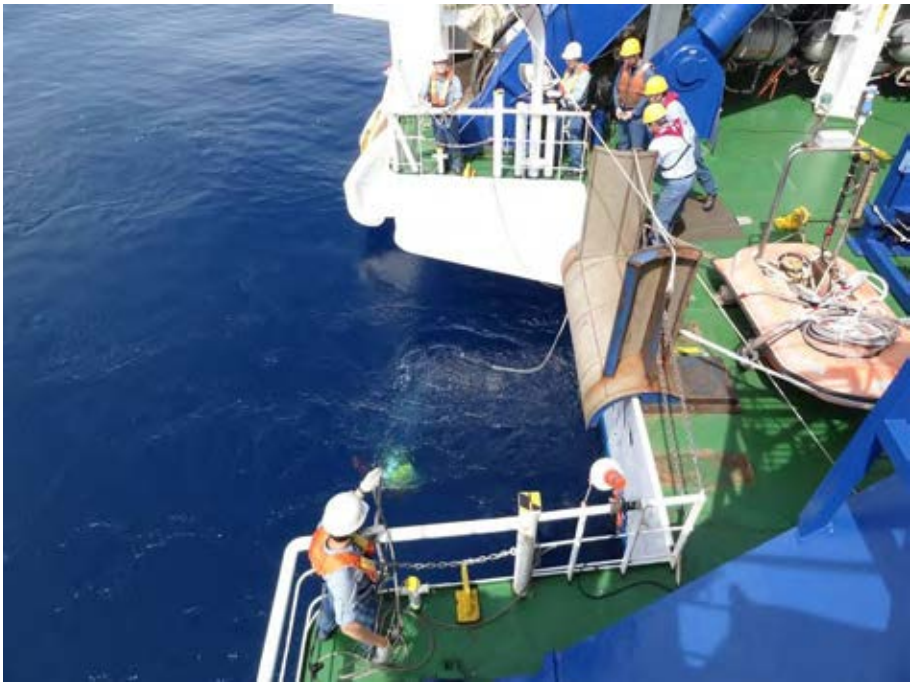

1. Cruise Information:

(1) **Cruise ID, Ship name:** KR11-08, R/V Kairei
(2) **Title of the cruise:** 2011FY "Seismic intensive study around the deformed zone in the eastern margin of the Japan Sea"
(3) **Title of proposal:** Seismic intensive study around the deformed zone in the eastern margin of the Japan Sea
(4) **Cruise period, Port call:** 2011/8/5-8/27, Yokohama port to Hakodate port
(5) **Research Area:** The eastern margin of the Japan Sea and the Japan Trench
(6) **Research Map:** Fig. 1

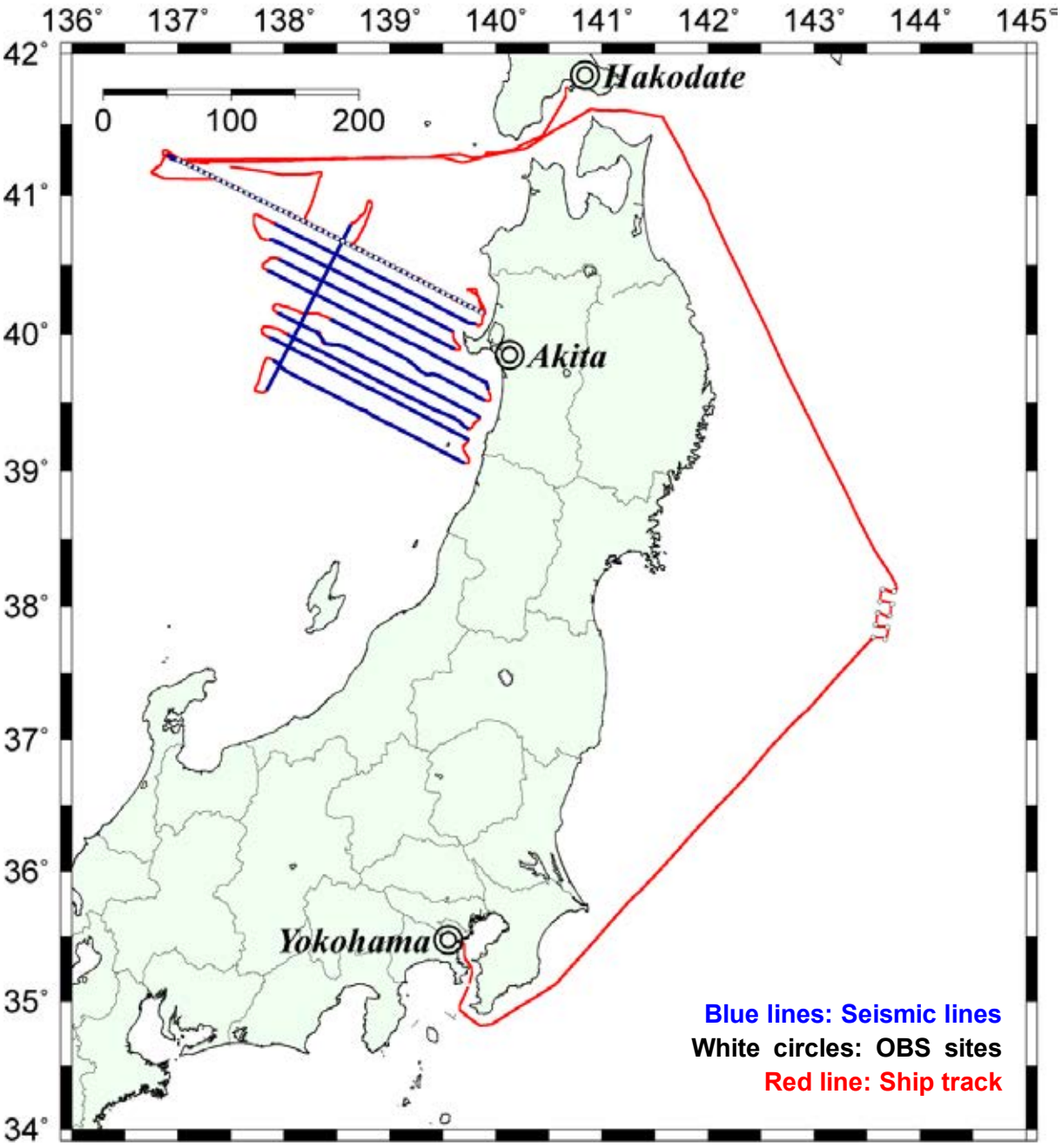

Fig. 1 Ship track during KR11-08 cruise.

2. Researchers:

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Kimiko SERIZAWA [NME]: Technician (Seismic navigator)
Kiyoshi SHIONO [NME]: Technician (Seismic observer)
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3. Overview of Observations:

(1) Objectives:

Large earthquakes have frequently occurred on the eastern margins of the Japan Sea (e.g., the 1964 Niigata earthquake (M_{JMA} 7.5), 1983 Nihonkai–Chubu earthquake (M_{JMA} 7.7), 1993 Hokkaido–Nansei–Oki earthquake (M_{JMA} 7.8)), and these earthquakes have caused very strong vibrations, large tsunamis, and serious damage across the coastline of the Japan Sea. However, this area has not been identified as a priority area for investigation. Therefore, we have collaborated with other Japanese research institutions in "Priority Investigations of Strain Concentration Areas" (using part of the Special Coordination Funds for Promoting Science and Technology), and have been performing seismic surveys from the R/V KAIREI at the eastern margins of the Japan Sea since 2008.

In August 2011, we conducted a marine seismic exploration survey around areas off Akita and Yamagata. There are two lines of strain concentration in the survey area (Okamura et al., 2007). Moreover, the survey area is located in the southern hypocentral region of the 1983 Nihonkai–Chubu earthquake. Within the aftershock area of this earthquake, there was a M_{JMA} 6.4 earthquake in March 2011 following the 2011 off the Pacific Coast of Tohoku Earthquake. The western part of the survey area is the transition zone of the Yamato Basin and the Japan Basin. It is very important to study the crustal structure of the Japan Sea in seismotectonic studies of the eastern margins of the Japan Sea. We can understand these crustal structures from the seismic exploration data of this survey; besides, we carry out seismotectonic and growth structure studies off the shore of Akita and Yamagata.

On the way to the Japan Sea from Yokohama, ten OBSs (Ocean Bottom Seismographs) were deployed for aftershock observations around the rupture zone in the offshore area of Miyagi prefecture. The aim was to record aftershocks from the 2011 off the Pacific Coast of Tohoku Earthquake.

(2) List of observation instruments:

1) Multichannel seismic reflection survey (MCS)

We conducted a MCS survey around the areas off Akita and Yamagata in the eastern margins of the Japan Sea using the R/V KAIREI (Fig. 2). MCS data were acquired along 11 lines (EMJS1101, EMJS1102, EMJS1103, EMJS1104, EMJS1105, EMJS1106, EMJS1107, EMJS1108, EMJS1109, EMJS1110, and EMJS11B) with a total length of approximately 1,924 km. Survey lines were crooked to avoid the many fishing operations and equipment in the survey area.

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 a spacing of 20–30 s, depending on the vessel speed (average 3.5–5 knots). The tuned airgun array has a total capacity of 7,800 cubic inches (about 130 liters), and consists of 32 Bolt Annular Port airguns. The standard air pressure was 2,000 psi (about 14 MPa). The airgun array was maintained at a depth of 10 m below the sea surface throughout the experiment. Fig. 3 shows four strings of sub-arrays 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 that of the ship's antenna.

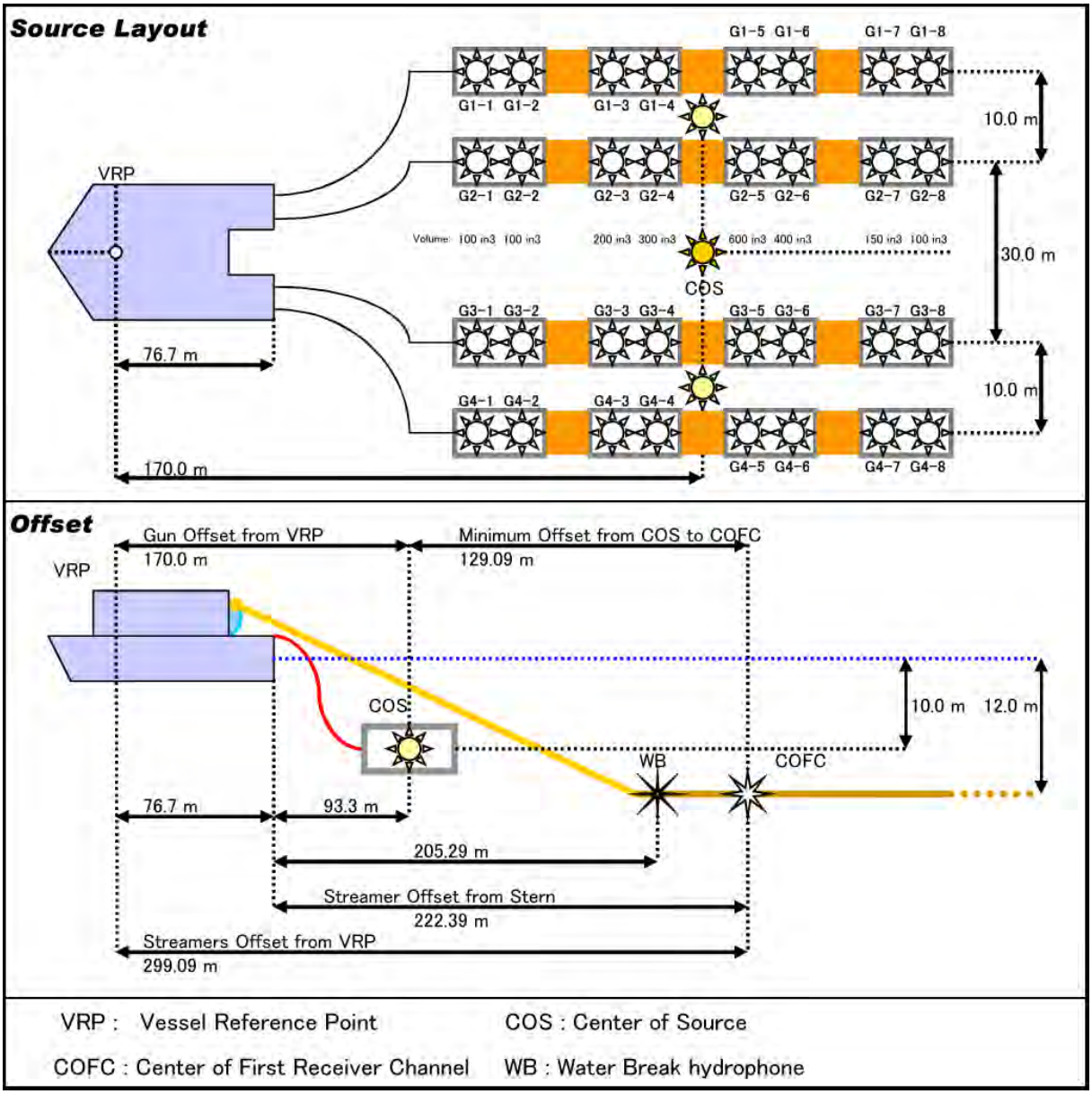

Fig. 3 Vessel towing geometry. Top figure shows the source (airgun system) layout, bottom figure represents source–receiver depth and position, and navigation offsets.

b) Receiver:

During the airgun shooting, we towed a 444-channel hydrophone streamer cable (Sentinel Digital Streamer System, Sercel Inc.) (see Fig. 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 A/D conversion. The interval of each group is 12.5 m. The length of the cable was about 6 km. The towing depth of the streamer cable was maintained at 12 m below the sea surface by the depth controller called Bird (I/O DigiCOURSE streamer depth controllers).

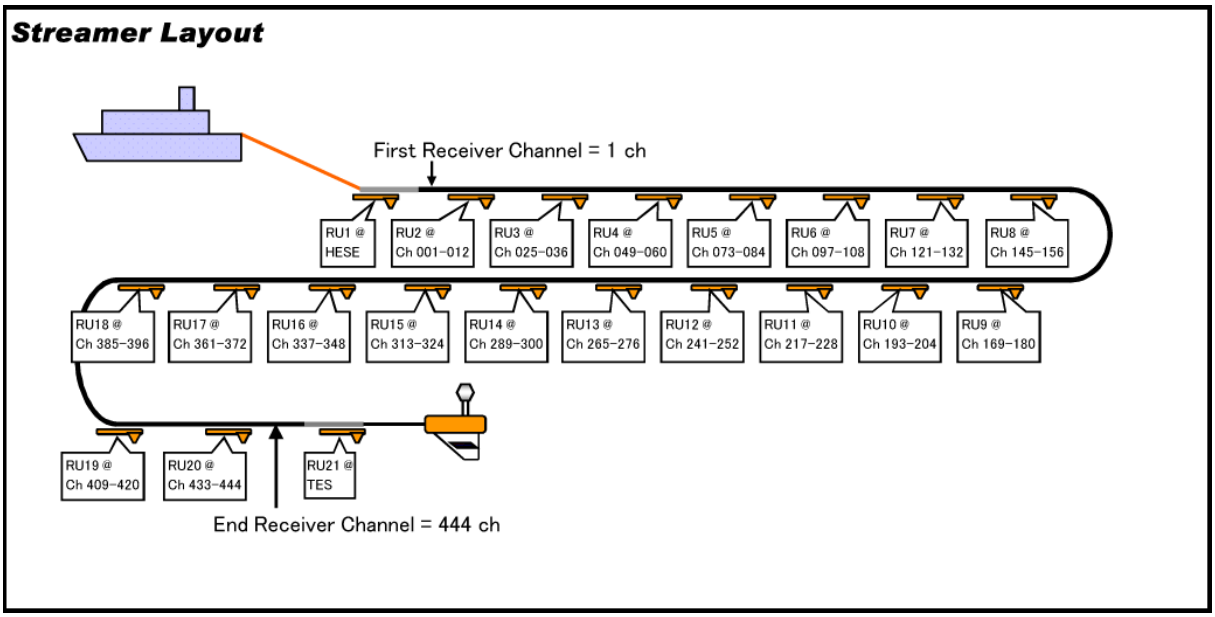

Fig. 4 Streamer cable configuration during the survey.

c) Recording and navigation systems

A Sercel Seal System Ver.5.2 recording system, made by Sercel Inc., was used in the survey; this collected seismic data on 3590E tapes in the SEG-D 8058 Rev.1 format. The system delay was set to 200 ms, the sampling rate was 2 ms, and the recording length was 16 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 the backup. The accuracy was reported to be about 0.4 m in StarFire and 5 m in SkyFix. We used SPECTRA 2D (Concept Systems Ltd.) as our navigation software for 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: survey datum was WGS84; map projection was UTM; UTM zone parameter was 54N.

d) Onboard processing of MCS data:

Raw MCS reflection data were processed on board for the purpose of quality control in the study areas. Onboard data processing was conducted by preserving 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 (3–250 Hz), datum correction, amplitude compensation, predictive deconvolution, velocity analysis, normal moveout correction, a radon filter for multiple suppression, mute, CMP stack, F-K migration, and a bandpass filter (Figs. 5 and 6).

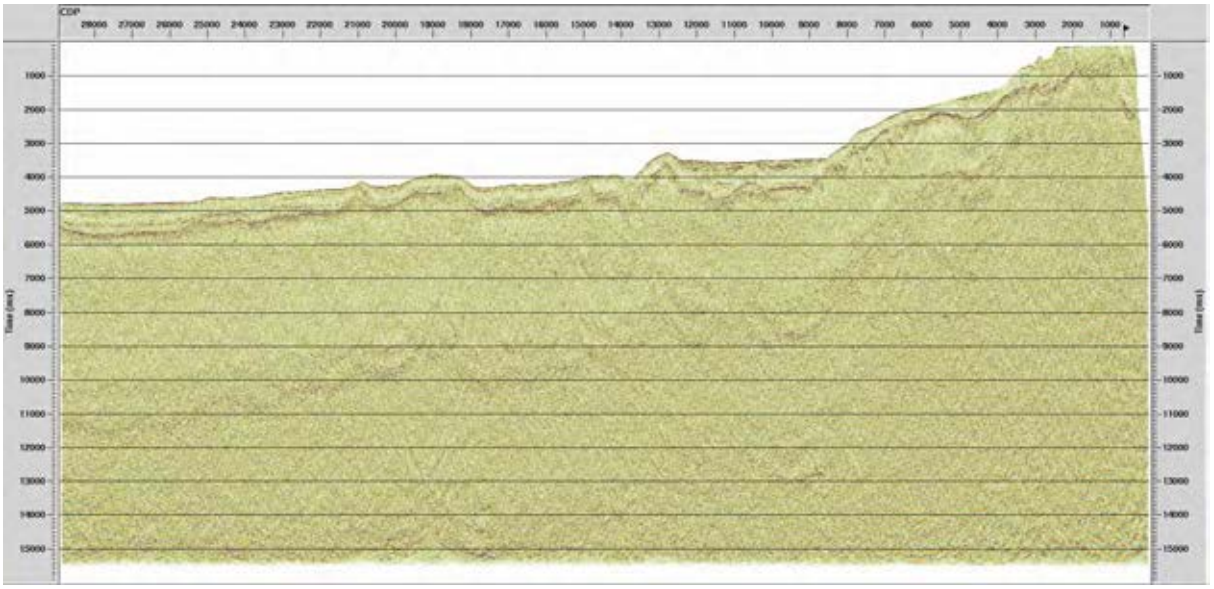

Fig. 5 Example of MCS profile with onboard processing (EMJS1109).

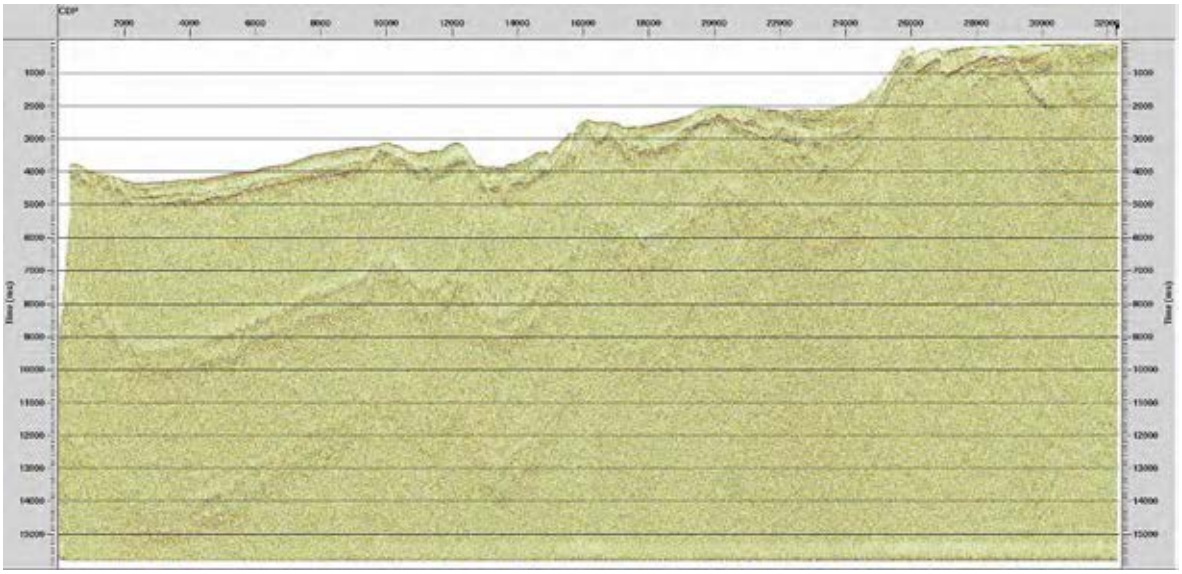

Fig. 6 Example of MCS profile with onboard processing (EMJS1106).

2) Refraction survey using ocean bottom seismographs (OBSs)

We deployed 55 OBSs at the EMJS1110, and performed a refraction survey using an airgun array with a spacing of 200 m. The airgun array in the OBS survey used the same configuration as in the MCS survey. The interval of the OBS deployment was about 5 km. An OBS is deployed by freefall and retrieved by melting releaser composed of stainless steel plates connecting the OBS with a weight when a transponder system receives acoustic signal sent from a vessel. This acoustic communication between the OBS and the vessel was performed using transducers installed on the vessel. The position of OBSs on the seabed was estimated by a SSBL (Super short base line acoustic system) of the vessel's positioning system during the cruise. We edited the continuous OBS data to a length of 70 s and the SEG-Y format. At the same time, calibration of the OBS clock for GPS time was carried out using difference times between the OBS clock and GPS time, which were measured just before OBS deployment and just after OBS retrieval. Fig. 6 shows examples of two OBS record sections (OBS10 and 40).

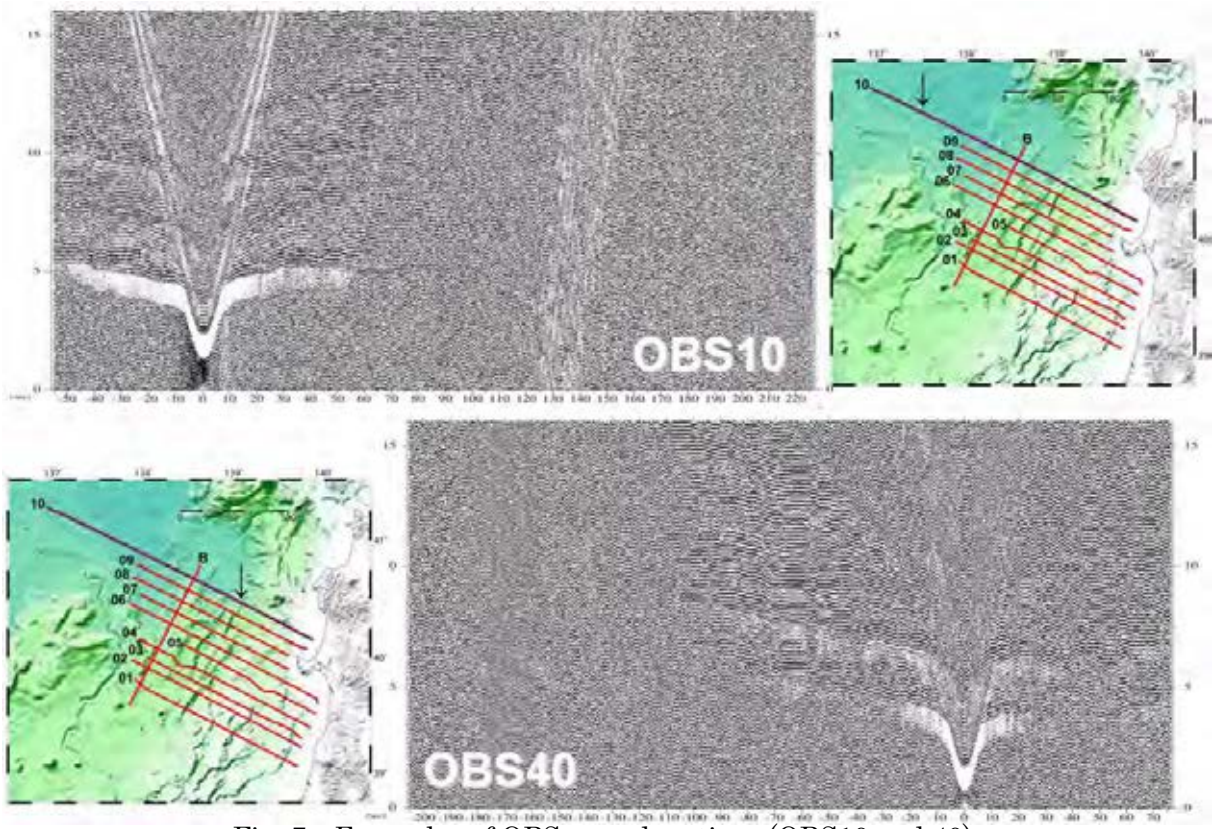

Fig. 7 Examples of OBS record sections (OBS10 and 40).

3) Deployment of OBSs off Miyagi

We deployed ten OBSs for aftershock observations around the rupture zone in the offshore area of Miyagi prefecture on the way to the Japan Sea (Fig. 8). These OBSs were deployed to observe the aftershocks of the 2011 off the Pacific Coast of Tohoku Earthquake. All OBSs will be retrieved in October, during the KAIYO cruise.

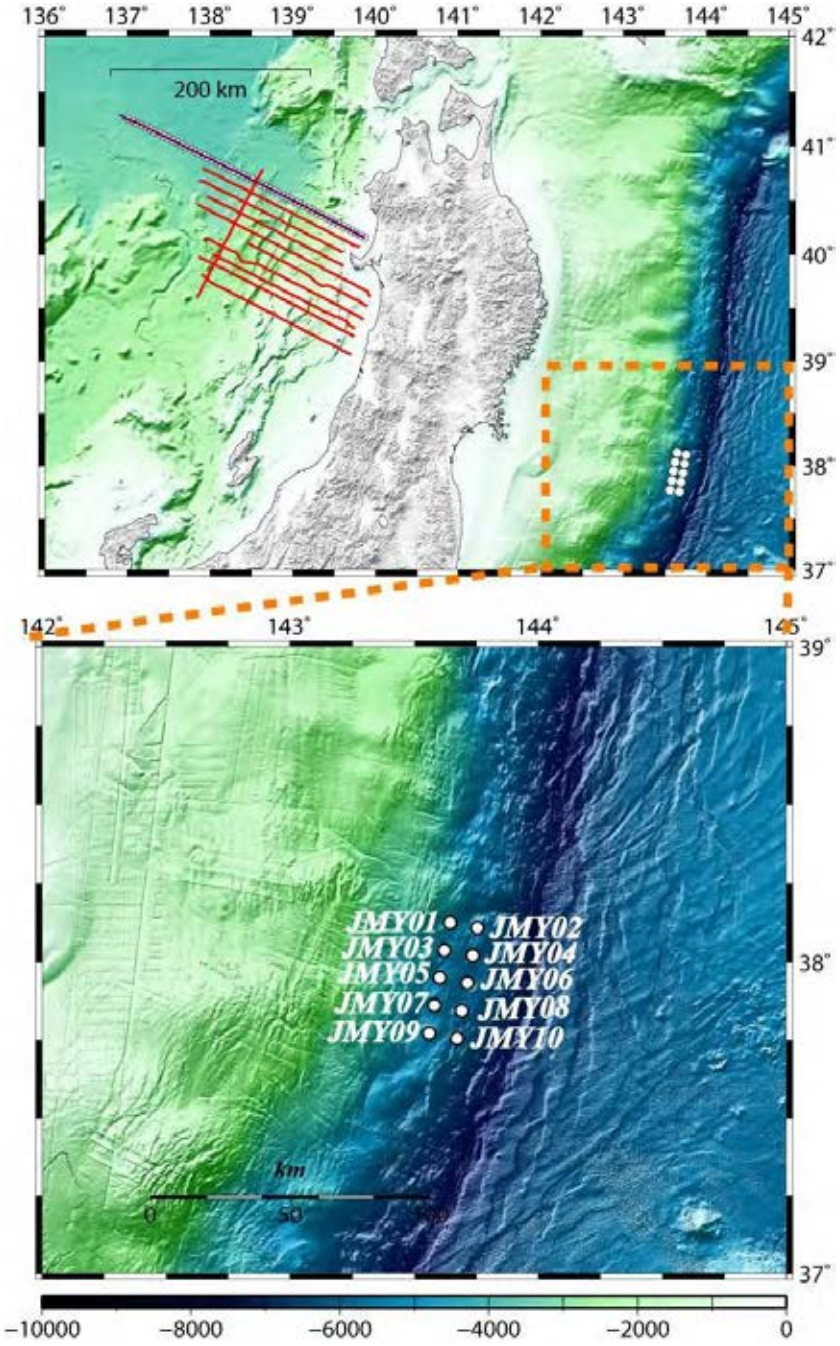

Fig. 8 Bathymetry and location maps of aftershock observations off Miyagi. White circles denote OBS sites.

4) Bathymetry, magnetic, and gravity observations:

Bathymetry, magnetic, and gravity data were recorded continuously during the survey. The bathymetry survey on R/V KAIREI used a multi-narrow beam echo sounder (Sea Beam 2112.004, SeaBeam Instruments) (Fig. 9). Gravity data was obtained by a shipboard gravimeter (BODESEEWERK KSS31, Fugro Co. Ltd.). The magnetic survey used a three-component magnetometer (SFG1214, Tiera Technica Corporation).

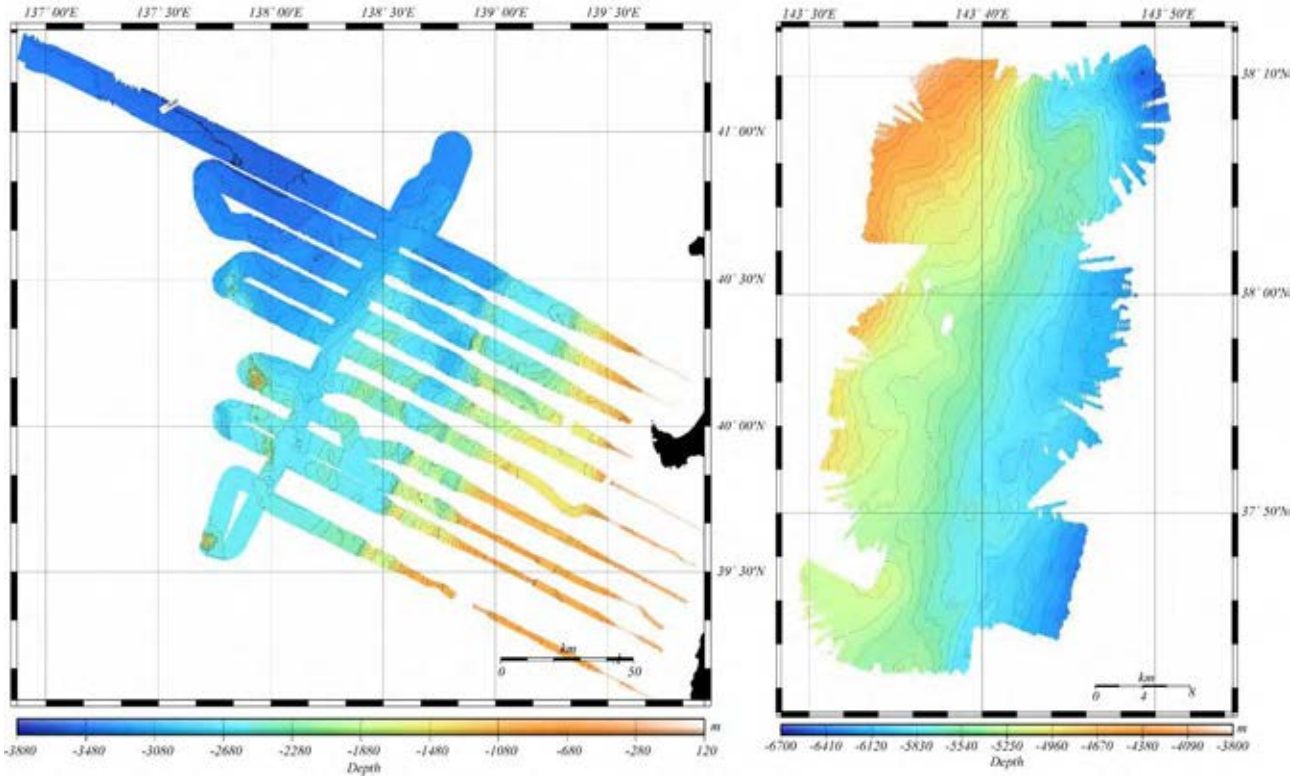

Fig. 9 Results of the bathymetric survey in this cruise. (Left) Bathymetric map of the eastern margins of the Japan Sea. (Right) Bathymetric map off Miyagi.

(3) **Cruise log:** Table 1

Date		Remarks
2011/8/5	Fri.	Departure from Yokosuka, transit to survey area of Japan Trench.
2011/8/6	Sat.	OBS deployment (JMY01-10), transit to survey area of Japan Sea.
2011/8/7	Sun.	Transit to survey area of Japan Sea, OBS deployment (OBS#1-#9).
2011/8/8	Mon.	OBS deployment (OBS#10-#48)
2011/8/9	Tue.	OBS deployment (OBS#49-#55), airgun shooting (EMJS1110, 200 m shot interval).
2011/8/10	Wed.	Airgun shooting (EMJS1110, 200 m shot interval).
2011/8/11	Thu.	OBS retrieval (OBS#55-#40).
2011/8/12	Fri.	OBS retrieval (OBS#39-#25).
2011/8/13	Sat.	OBS retrieval (OBS#24-#9).
2011/8/14	Sun.	OBS retrieval (OBS#8-#1), MCS survey (EMJS1110).
2011/8/15	Mon.	MCS survey (EMJS1110, EMJS1109)
2011/8/16	Tue.	MCS survey (EMJS1109, EMJS1108)
2011/8/17	Wed.	MCS survey (EMJS1108, EMJS1107)
2011/8/18	Thu.	MCS survey (EMJS1107, EMJS1106)
2011/8/19	Fri.	MCS survey (EMJS1106, EMJS1105)
2011/8/20	Sat.	MCS survey (EMJS1105, EMJS1104)
2011/8/21	Sun.	MCS survey (EMJS1104, EMJS1103)
2011/8/22	Mon.	MCS survey (EMJS1103, EMJS1102)
2011/8/23	Tue.	MCS survey (EMJS1102, EMJS1101)
2011/8/24	Wed.	MCS survey (EMJS1101, EMJS11B)
2011/8/25	Thu.	MCS survey (EMJS11B, EMJS1110)
2011/8/26	Fri.	MCS survey (EMJS1110), Transit to Hakodate port
2011/8/27	Sat.	Arrival at Hakodate port

Table 1　Cruise log during the survey.

(4) **Seismic lines** : Fig. 10

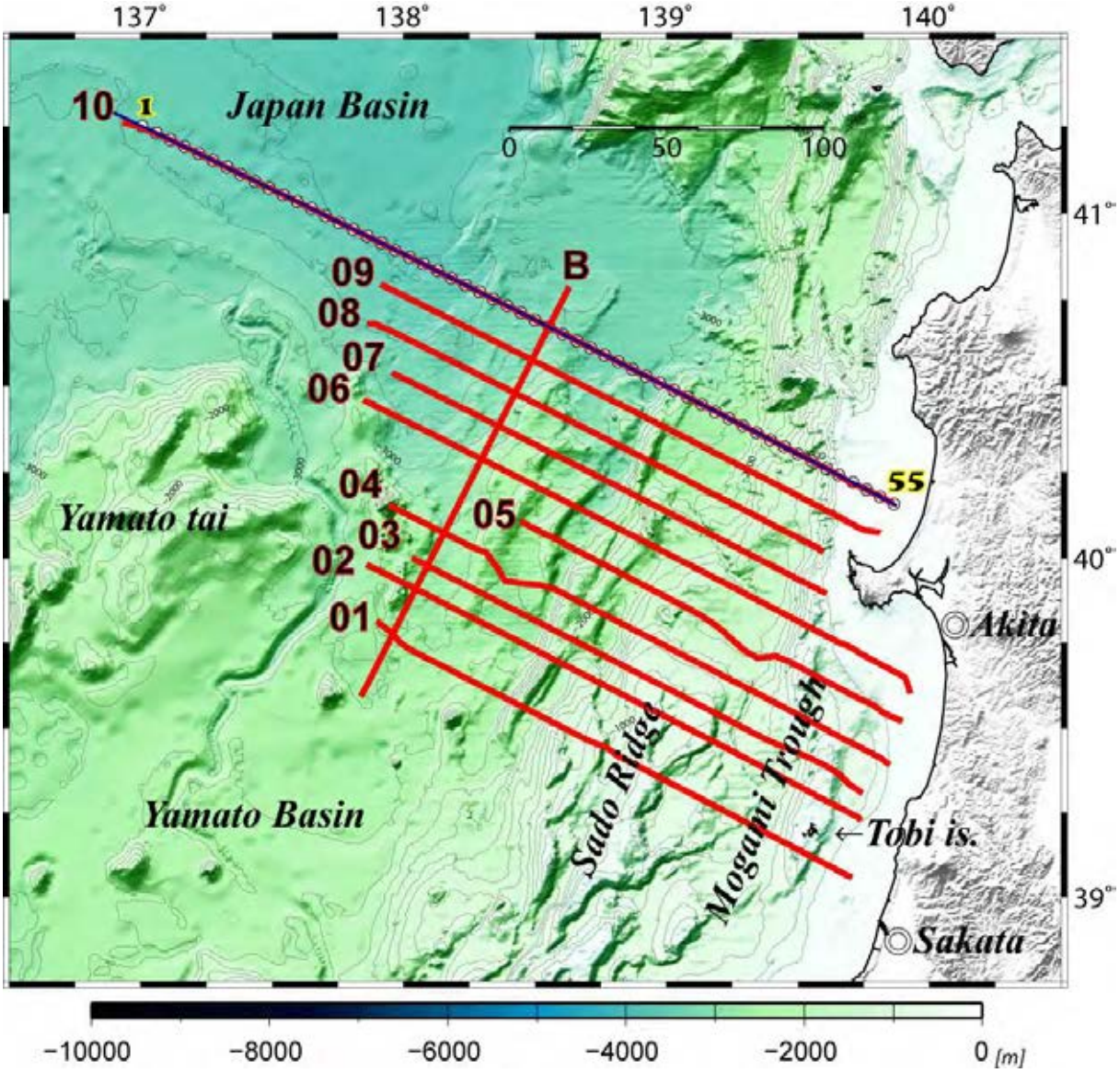

Fig. 10 Bathymetry and location maps of the survey area in the eastern margins of the Japan Sea. Red lines are the MCS lines of this survey, blue line is the shooting line of OBSs, and white circles are the positions of the OBS sites.

(5) Seismic line list: Table 2

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 (°)
EMJS11B_0	24/08/2011	08:54:49	1500	39_35.63766'N	137_50.29291'E	2608	142.3	28.682
	24/08/2011	09:34:51	1635	39_38.85088'N	137_52.51480'E	2624		
	25/08/2011	01:00:43	4480	40_47.37522'N	138_37.88190'E	3346		
	25/08/2011	01:00:43	4480	40_47.37522'N	138_37.88190'E	3346		
EMJS1101_0	23/08/2011	07:47:56	1070	39_03.48759'N	139_42.15727'E	-	164.5	298.696
	23/08/2011	08:26:53	1192	39_04.98396'N	139_38.38601'E	120		
	24/08/2011	02:24:02	4481	39_46.72427'N	137_57.26186'E	2562		
	24/08/2011	03:01:17	4607	39_48.80539'N	137_53.71443'E	2650		
EMJS1102_0	22/08/2011	07:34:20	1681	39_58.69094'N	137_51.62020'E	2655	180.4	118.650
	22/08/2011	07:42:41	1704	39_58.43346'N	137_52.35684'E	2658		
	23/08/2011	04:35:13	5312	39_13.49771'N	139_44.18423'E	252		
	23/08/2011	04:36:30	5313	39_13.43076'N	139_44.17690'E	246		
EMJS1103_0	21/08/2011	07:19:10	1106	39_18.50370'N	139_44.56380'E	435	160.9	298.613
	21/08/2011	07:59:04	1209	39_20.07363'N	139_41.58357'E	431		
	22/08/2011	02:16:11	4426	40_00.00568'N	138_01.68494'E	2558		
	22/08/2011	02:16:11	4426	40_00.00568'N	138_01.68494'E	2558		
EMJS1104_0	20/08/2011	08:51:06	1600	40_09.13234'N	137_56.73742'E	1273	179.6	118.575
	20/08/2011	09:13:51	1678	40_08.18799'N	137_59.19095'E	2426		
	21/08/2011	04:50:09	5270	39_23.63485'N	139_50.91907'E	165		
	21/08/2011	04:56:02	5274	39_23.36010'N	139_50.88506'E	165		
EMJS1105_0	19/08/2011	06:31:26	1070	39_31.19016'N	139_53.71923'E	86	133.2	298.899
	19/08/2011	07:19:54	1219	39_32.94540'N	139_49.03046'E	232		
	19/08/2011	23:00:26	3882	40_06.45467'N	138_26.43891'E	2321		
	19/08/2011	23:00:26	3882	40_06.45467'N	138_26.43891'E	2321		
EMJS1106_0	18/08/2011	05:33:33	2250	40_27.56774'N	137_50.91725'E	2770	197.3	118.495
	18/08/2011	05:46:57	2292	40_27.06486'N	137_52.24823'E	2811		
	19/08/2011	04:17:18	6238	39_37.92413'N	139_55.34210'E	64		
	19/08/2011	04:43:57	6280	39_36.00857'N	139_55.66893'E	65		
EMJS1107_0	17/08/2011	07:16:47	1060	39_53.72208'N	139_36.29831'E	202	146.6	298.459
	17/08/2011	08:34:39	1283	39_56.40940'N	139_29.28904'E	-		
	18/08/2011	02:30:03	4214	40_32.37309'N	137_57.23567'E	3284		
	18/08/2011	02:30:03	4214	40_32.37309'N	137_57.23567'E	3284		
EMJS1108_0	16/08/2011	10:01:16	2056	40_40.84306'N	137_51.89675'E	3385	158.7	118.421
	16/08/2011	10:31:43	2144	40_40.36637'N	137_55.10511'E	3449		
	17/08/2011	04:08:55	5317	40_01.47150'N	139_34.94627'E	645		
	17/08/2011	04:22:42	5350	40_00.89202'N	139_35.85709'E	627		
EMJS1109_0	15/08/2011	08:21:03	1096	40_04.40922'N	139_48.53846'E	57	173.3	298.380
	15/08/2011	09:12:23	1227	40_05.26229'N	139_43.90134'E	67		
	16/08/2011	04:00:07	4693	40_47.72124'N	137_54.66802'E	3533		
	16/08/2011	04:00:07	4693	40_47.72124'N	137_54.66802'E	3533		

EMJS1110_0	14/08/2011	10:58:45	3480	40_46.64268'N	138_16.43800'E	3595	7.9	118.346
	14/08/2011	10:59:28	3482	40_46.62377'N	138_16.50498'E	3518		
	14/08/2011	11:54:53	3640	40_44.74214'N	138_21.54241'E	3327		
	14/08/2011	11:55:14	3641	40_44.72970'N	138_21.57490'E	3338		
EMJS1110_1	14/08/2011	13:27:21	3900	40_41.57061'N	138_29.81482'E	3258	130.3	118.346
	14/08/2011	13:28:05	3902	40_41.54607'N	138_29.87798'E	3249		
	15/08/2011	05:50:20	6508	40_09.43277'N	139_51.87437'E	59		
	15/08/2011	05:50:20	6508	40_09.43277'N	139_51.87437'E	59		
EMJS1110_2	25/08/2011	11:30:34	4130	40_38.93411'N	138_36.94032'E	3143	149.8	298.346
	25/08/2011	11:51:28	4069	40_39.60207'N	138_34.95604'E	3150		
	26/08/2011	03:58:50	1074	41_14.84187'N	136_58.90822'E	3463		
	26/08/2011	04:30:34	980	41_15.79206'N	136_55.73862'E	3464		
EMJS1110obs_0	09/08/2011	01:49:53	996	40_09.21737'N	139_52.38945'E	56	281.2	298.348
	09/08/2011	01:52:28	998	40_09.30883'N	139_52.13386'E	57		
	10/08/2011	07:26:26	2404	41_17.40519'N	136_53.65548'E	3458		
	10/08/2011	07:26:26	2404	41_17.40519'N	136_53.65548'E	3458		
					Total		2205.7	

Table 2　List of seismic survey lines.

(6) **OBS position list:** Table 3

Site	Lat(N)	Lon(E)	Depth(m)	Site	Lat(N)	Lon(E)	Depth(m)
1	41_15.0375	137_00.3201	3475	29	40_41.5056	138_30.0082	3255
2	41_13.8015	137_03.5563	3463	30	40_40.2793	138_33.1834	3228
3	41_12.6285	137_06.7729	3460	31	40_39.0583	138_36.3568	3157
4	41_11.4570	137_09.9987	3455	32	40_37.8459	138_39.5272	3164
5	41_10.2706	137_13.2228	3501	33	40_36.6276	138_42.6968	3281
6	41_09.0857	137_16.4449	3521	34	40_35.3992	138_45.8597	3284
7	41_07.9155	137_19.6661	3534	35	40_34.1719	138_49.0261	3285
8	41_06.7138	137_22.8772	3543	36	40_32.9490	138_52.1939	3259
9	41_05.5423	137_26.1007	3533	37	40_31.7265	138_55.3566	3261
10	41_04.3462	137_29.2975	3545	38	40_30.4970	138_58.5144	3190
11	41_03.1636	137_32.5157	3571	39	40_29.2670	139_01.6727	2881
12	41_01.9774	137_35.7190	3558	40	40_28.0368	139_04.8254	2577
13	41_00.7819	137_38.9409	3562	41	40_26.7969	139_07.9668	2679
14	40_59.5824	137_42.1501	3589	42	40_25.5532	139_11.1241	2660
15	40_58.3843	137_45.3515	3599	43	40_24.3173	139_14.2652	2622
16	40_57.1934	137_48.5482	3598	44	40_23.0838	139_17.4093	2520
17	40_55.9905	137_51.7571	3601	45	40_21.8535	139_20.5753	2289
18	40_54.7904	137_54.9540	3614	46	40_20.6223	139_23.7139	1799
19	40_53.5932	137_58.1466	3629	47	40_19.3910	139_26.8555	1546
20	40_52.3952	138_01.3441	3622	48	40_18.1399	139_29.9970	1181
21	40_51.1901	138_04.5355	3620	49	40_16.8918	139_33.1342	1021
22	40_49.9879	138_07.7318	3564	50	40_15.6167	139_36.4548	642
23	40_48.7728	138_10.9083	3566	51	40_14.3897	139_39.3998	115
24	40_47.5686	138_14.1020	3534	52	40_13.1356	139_42.5388	95
25	40_46.3546	138_17.2802	3457	53	40_11.8919	139_45.6840	80
26	40_45.1455	138_20.4692	3291	54	40_10.6437	139_48.8126	70
27	40_43.9383	138_23.6604	3371	55	40_09.3583	139_51.9951	58
28	40_42.7171	138_26.8229	3341				

Site	Lat(N)	Lon(E)	Depth(m)	Site	Lat(N)	Lon(E)	Depth(m)
JMY01	38_07.5606	143_38.6859	4646	JMY06	37_55.9502	143_42.9142	5908
JMY02	38_06.5793	143_45.3383	5472	JMY07	37_51.7063	143_34.8111	5291
JMY03	38_02.2288	143_37.3149	5123	JMY08	37_50.6600	143_41.4567	5786
JMY04	38_01.2340	143_44.1290	5713	JMY09	37_46.3190	143_33.5451	5195
JMY05	37_57.0255	143_36.1220	5221	JMY10	37_45.3042	143_40.2673	5854

Table 3 List of OBS position (1-58:the eastern margin of the Japan Sea, JMY01-JMY10: the Japan Trench).

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.

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