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KR10-10 Cruise Report

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

(Marine seismic exploration survey)

Aug. 3, 2010 – Sep. 6, 2010

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

Contents:

1. Cruise Information:

(1) **Cruise ID, Ship name:** KR10-10, R/V Kairei
(2) **Title of the cruise:** 2010FY "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:** 2010/8/3-9/6, Yokosuka port to JAMSTEC port (Yokosuka)
(5) **Research Area:** The eastern margin of the Japan Sea
(6) **Research Map:** Fig.1

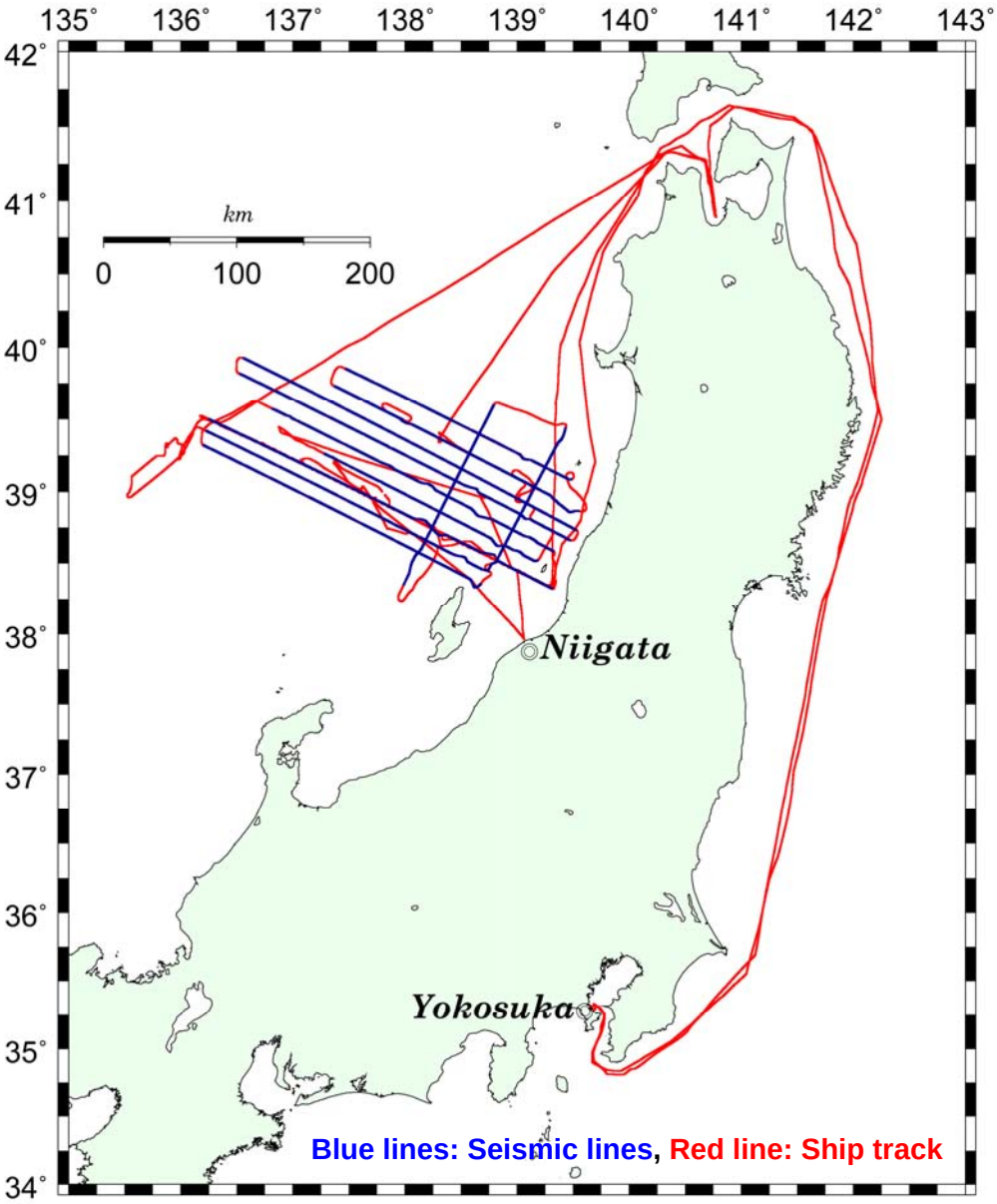

Fig.1 Ship track during KR10-10 cruise.

2. Researchers:

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(2) Representative of Science Party [Affiliation]:
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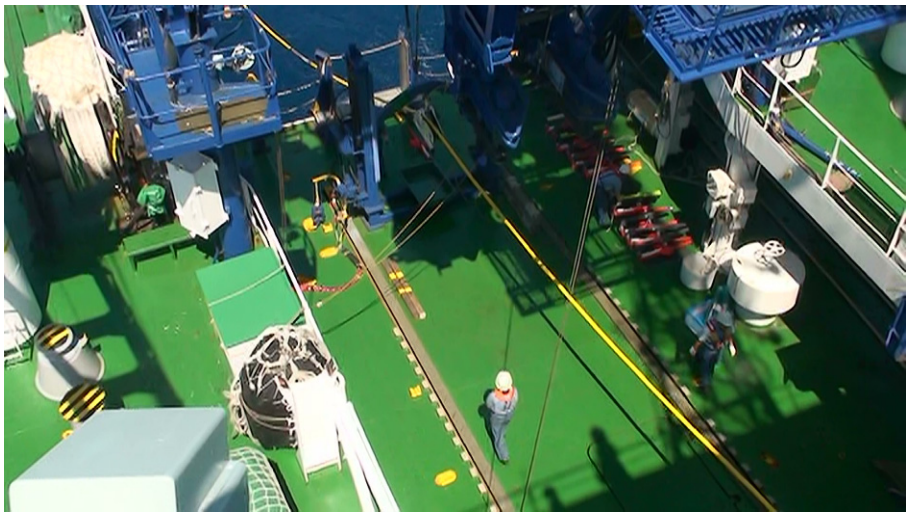


3. Overview of Observations:

(1) Objectives:

Recently, large earthquakes of magnitude M7 have occurred along the "strain concentration areas" located at the eastern margin of the Japan Sea. For example, the 1964 Niigata earthquake (M_J 7.5), the 1983 Nihonkai-Chubu earthquake (M_J 7.7), the 1993 Hokkaido-Nansei-Oki earthquake (M_J 7.8), the 2004 Mid-Niigata Prefecture earthquake (M_J 6.8), and the 2007 Niigata-ken Chuetsu-oki earthquake (M_J 6.8) caused great damage along the strain concentration areas. However, this area has not been identified as one of the priority areas to be investigated. Therefore, we have joined as a member of the strain concentration areas study in collaboration with other Japanese research institutions using part of the Special Coordination Funds for Promoting Science and Technology, "priority investigations of strain concentration areas", and performed seismic surveys using R/V KAIREI at the eastern margin of the Japan Sea since 2008. Objectives of this cruise are to reveal structural characteristics of the strain concentration areas, which are active faults and fold structures. In particular, one of the main targets is to clarify crustal structure showing mechanism of the 1964 Niigata earthquake and understand the tectonics as the geologic background.

(2) List of observation instruments:

1) Multichannel seismic reflection survey (MCS)

We conducted a MCS survey around the area near Sado Island and off Sakata in the eastern margin of the Japan Sea using the R/V KAIREI (Fig.2). MCS data was acquired along 11 lines (EMJS1001, EMJS1002, EMJS1003, EMJS1004, EMJS1005, EMJS1006, EMJS1007, EMJS1008, EMJS1009, EMJS10A, and EMJS10B) with a total length of approximately 2,680 km. Survey lines were crooked to avoid the many fishing operations and equipment in the survey area.

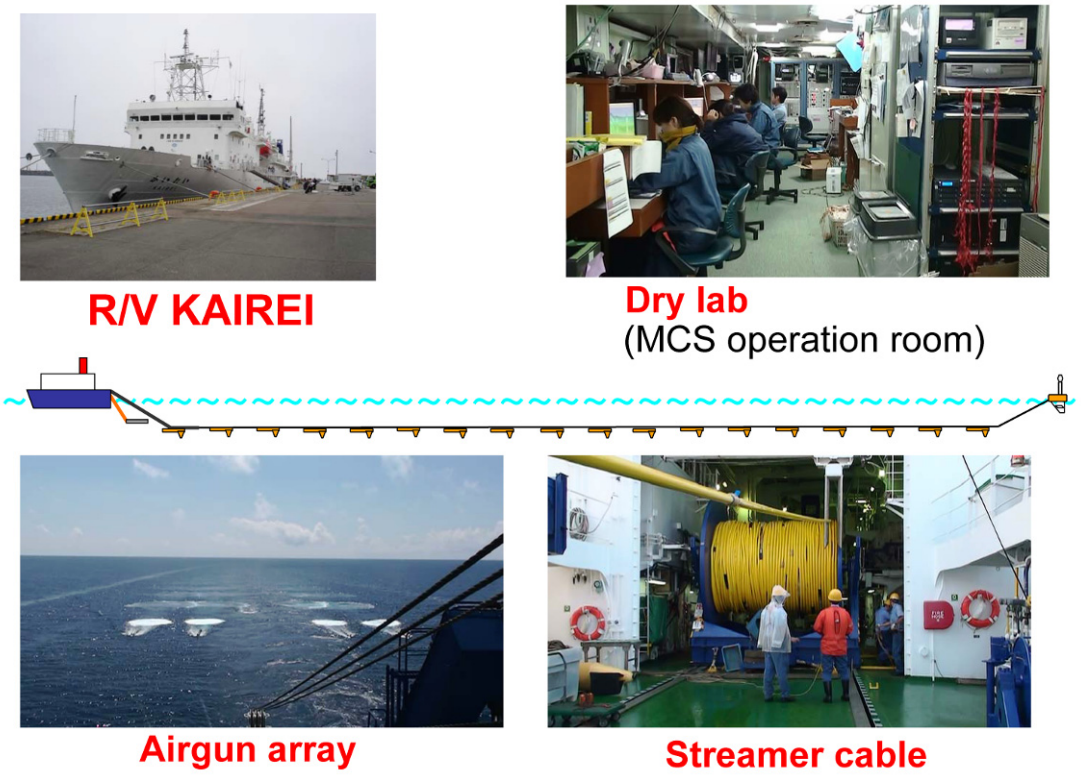
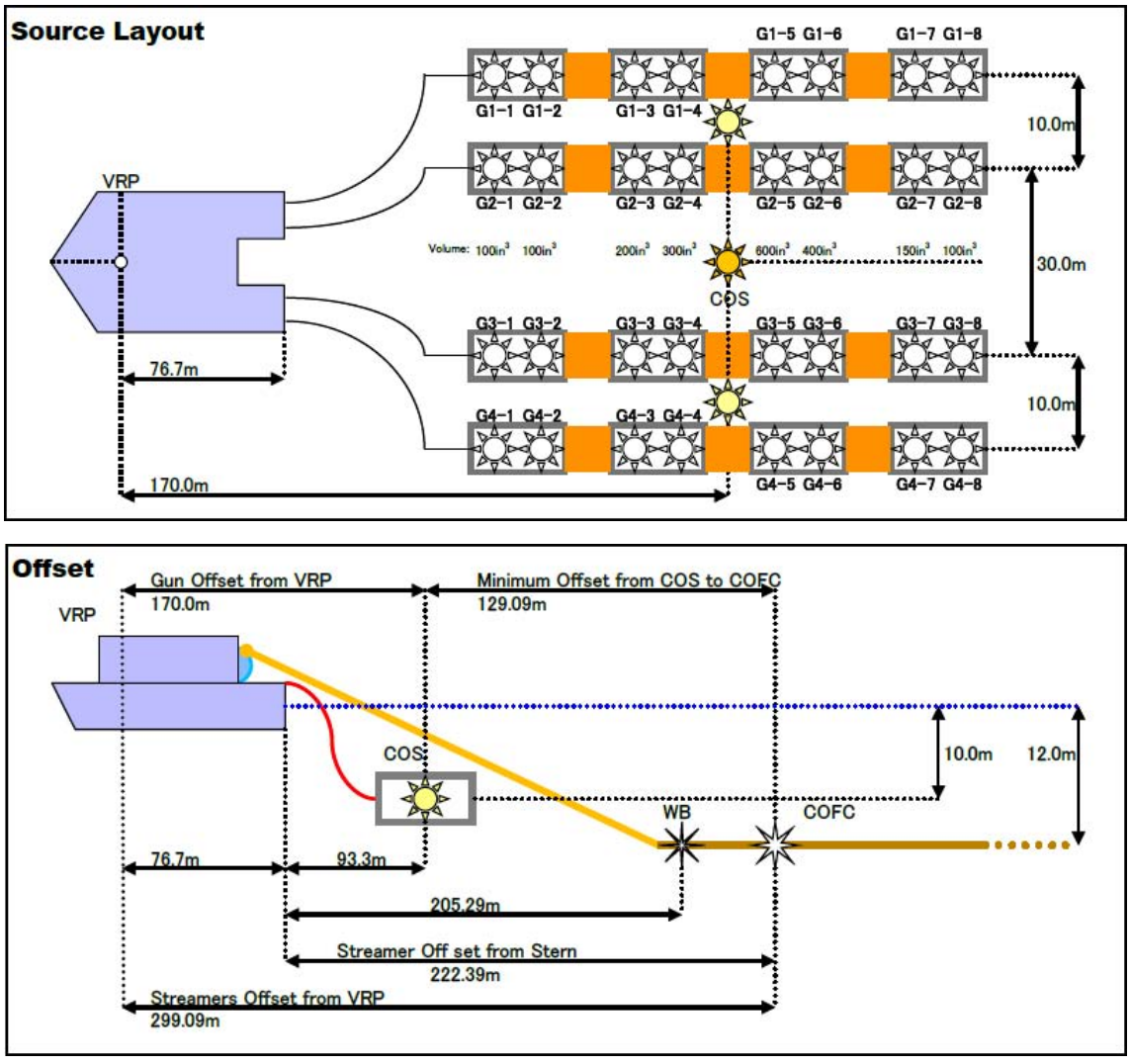


Fig.2 MCS system on R/V KAIREI.

a) Source:

To obtain MCS data of good quality, we shot an airgun array with a spacing of 50 m, which corresponds to 20–30 s in time 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 depth of the airgun array during the experiment was kept at 10 m below the sea surface. The following figure 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 antenna (Fig.3).



VRP : Vessel Reference Point	COS : Center of Source
COFC : Center of First Receiver Channel	WB : Water Break hydrophone

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

b) Receiver:

During shooting, we towed a 444-channel hydrophone streamer cable (Sentinel Digital Streamer System, Sercel Inc.)(Fig.4). Hydrophone sensors (Benthos Reduced Diameter

Array hydrophone) with 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 total active section is 5,550 m. The towing depth of the streamer cable was maintained at 12 m below sea surface by the depth controller called Bird (I/O DigiCOURSE streamer depth controllers).

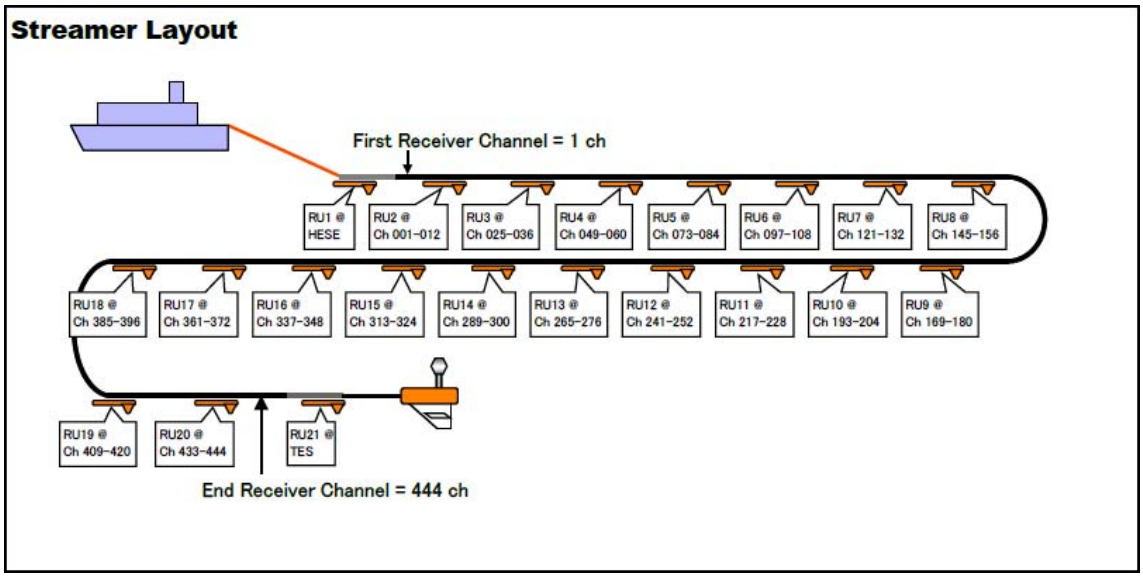


Fig.4 Streamer cable configuration in this survey.

c) Recording and navigation systems

The recording system is Sercel Seal System Ver.5.2, made by Sercel Inc.; it collected seismic data onto 3590E tapes with SEG-D 8058 Rev.1 format. We set the system delay to 200 msec. The sampling rate was 2 msec, and the record length was 16 sec.

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

d) Onboard processing of MCS data:

Raw MCS reflection data are processed on board for the purpose of quality control in the study areas. Onboard data processing was conducted 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 (4–120 Hz) (Fig. 5).

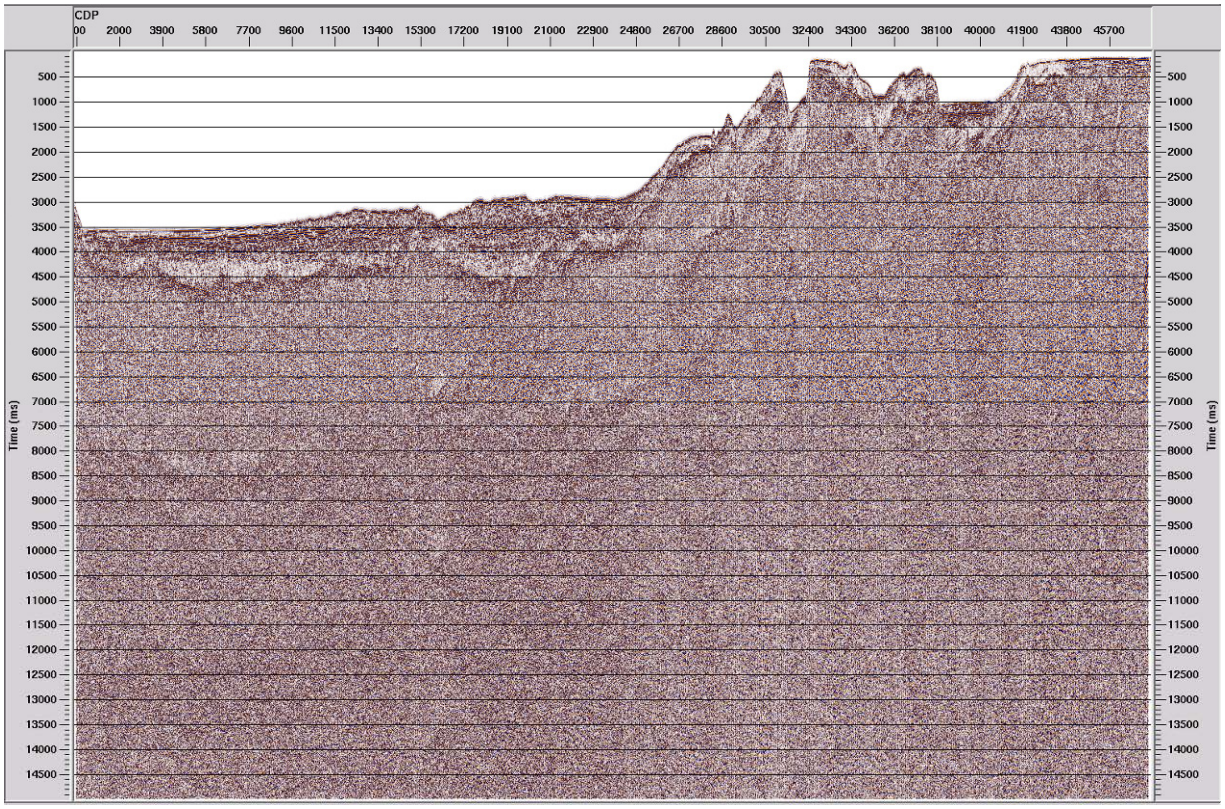


Fig.5 Example of MCS profile with onboard processing (Line EMJS1003).

2) Refraction survey using ocean bottom seismographs (OBSs)

We deployed 58 OBSs at the Line EMJS1003, and a refraction survey using an airgun array with a spacing of 200 m. An airgun array in OBS survey used the same configuration as MCS survey. The interval of the OBS deployment was about 5 km. An OBS is deployed by free fall 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. Positions of OBSs on sea bottom are estimated by SSBL of the vessel's positioning system during the cruise. We edited the continuous OBS data with length of 60 sec and SEG-Y format. At the same time, calibration of the OBS clock for GPS time was carried out using difference times between OBS clock and GPS time, which measured just before OBS deployment and just after OBS retrieval. Fig.6 shows examples of OBS record section (OBS30 and 40).

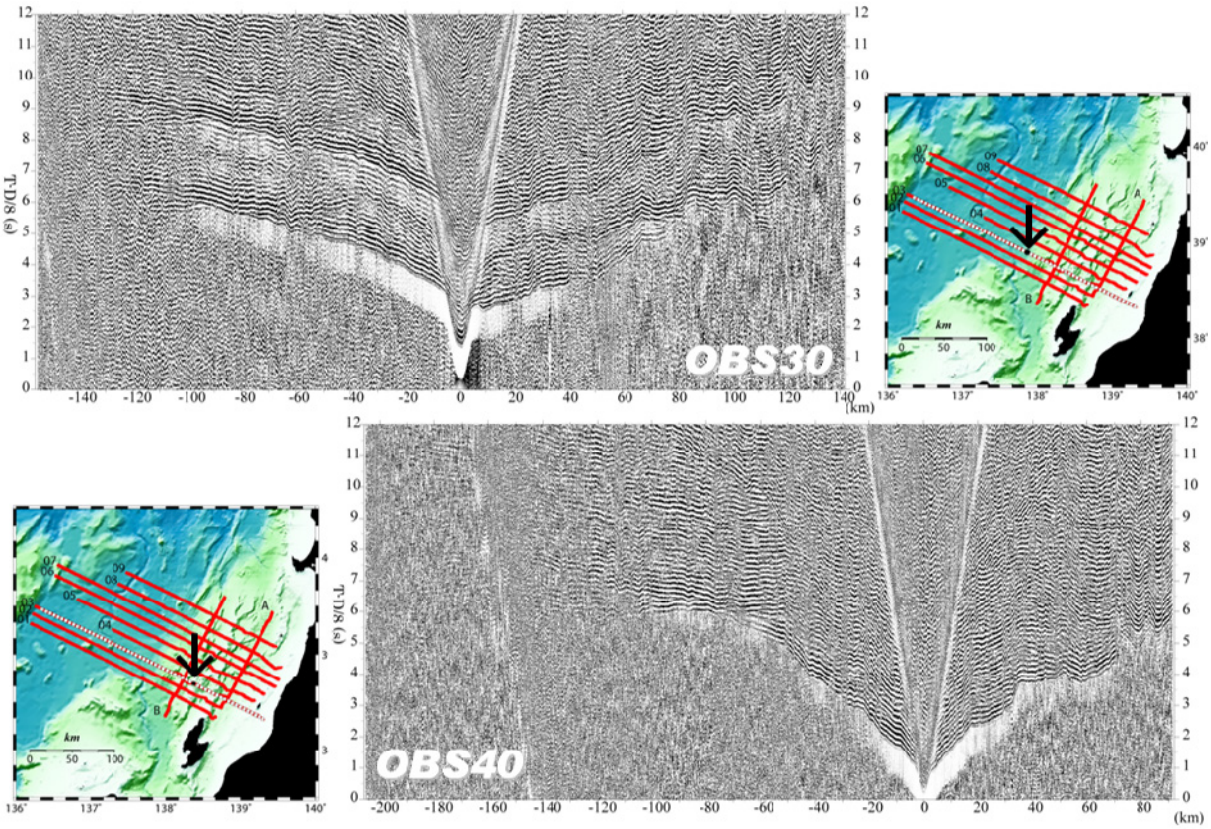


Fig.6 Example of OBS record section (OBS30 and 40).

3) Bathymetry, magnetic, and gravity observations:

Bathymetry, magnetic, and gravity data were recorded continuously during the survey. The bathymetry survey on R/V KAIREI uses a multi-narrow beam echo sounder manufactured by SeaBeam Instruments (type: Sea Beam 2112.004)(Fig.7). Gravity data is obtained by a shipboard gravimeter manufactured by Fugro Co., Ltd. (type: BODESEEWERK KSS31). The magnetic survey uses a three-component magnetometer manufactured by Tiera Technica Corporation (type: SFG1214).

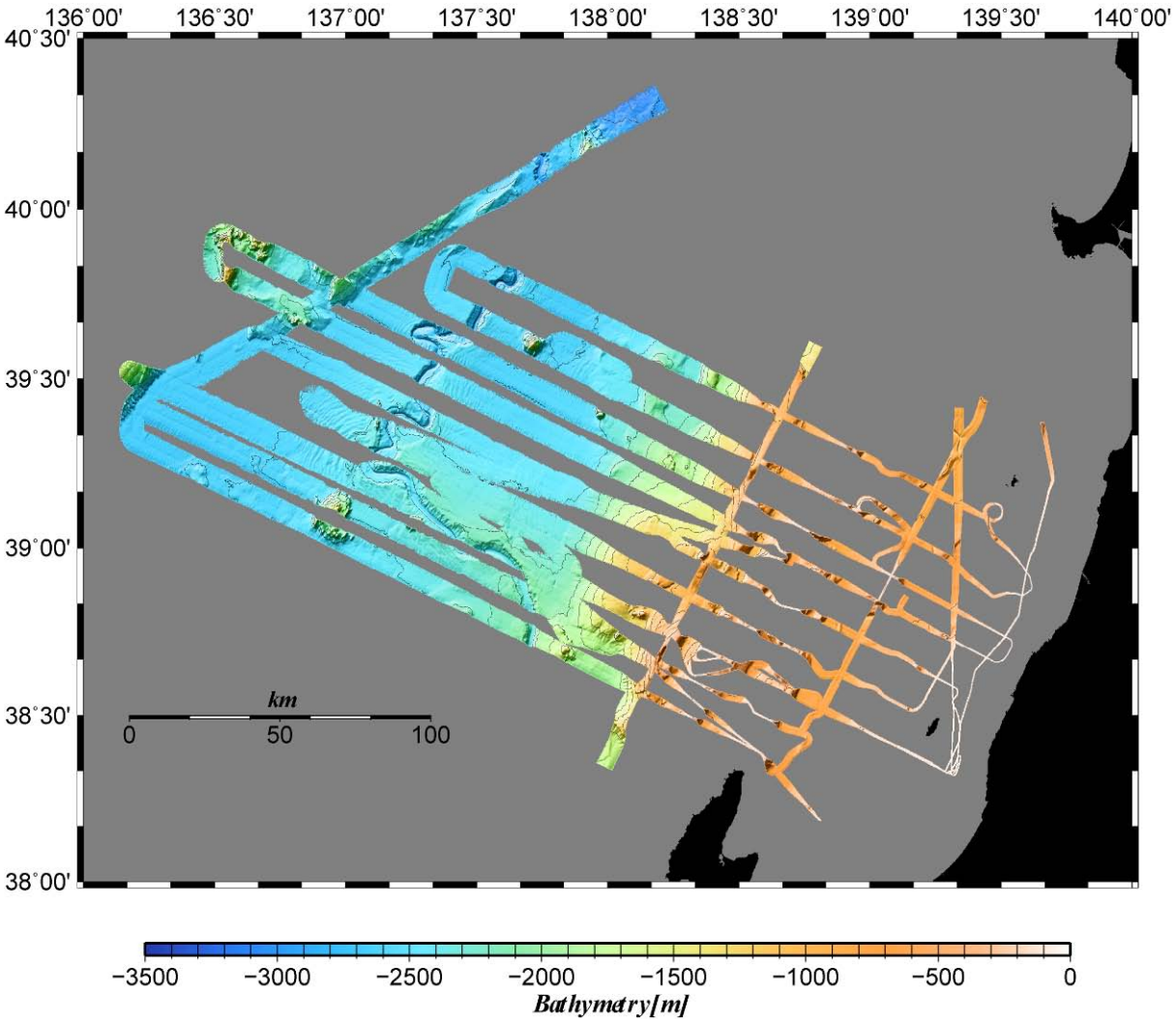


Fig.7 Results of bathymetric survey in this cruise.

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

Date		Remarks
2010/8/3	Tue.	Departure from Yokosuka, transit to survey area of Japan Sea.
2010/8/4	Wed.	Transit to survey area of Japan Sea.
2010/8/5	Thu.	Transit to survey area of Japan Sea, OBS deployment (OBS#51-#38).
2010/8/6	Fri.	OBS deployment (OBS#37-#30), MCS survey (EMJS1003)
2010/8/7	Sat.	MCS survey(EMJS1003, EMJS1005)
2010/8/8	Sun.	MCS survey(EMJS1005)
2010/8/9	Mon.	MCS survey(EMJS1001)
2010/8/10	Tue.	MCS survey(EMJS1001, EMJS1002)
2010/8/11	Wed.	OBS deployment (OBS#28, #29, #40, #52-#58).
2010/8/12	Thu.	Stand by all day in the Mutsu Bay due to a tropical cyclone.
2010/8/13	Fri.	Stand by all day in the Mutsu Bay due to a tropical cyclone.
2010/8/14	Sat.	OBS deployment (OBS#1-#27), airgun shooting (EMJS1003, 200 m shot interval).
2010/8/15	Sun.	Airgun shooting (EMJS1003, 200 m shot interval), OBS retrieval (OBS#58). Call at Noogata port (Leg. 1 ended and Leg 2 started)
2010/8/16	Mon.	OBS retrieval (OBS#57-#52), change of a chief scientist (the Niigata port), airgun shooting (EMJS1003, 200 m shot interval)
2010/8/17	Tue.	Airgun shooting (EMJS1003, 200 m shot interval), OBS retrieval (OBS#1-#9).
2010/8/18	Wed	OBS retrieval (OBS#10-#31).
2010/8/19	Thu.	OBS retrieval (OBS#32-#51).
2010/8/20	Fri.	MCS survey(EMJS1004)
2010/8/21	Sat.	MCS survey(EMJS1004, EMJS1006)
2010/8/22	Sun.	MCS survey(EMJS1006)
2010/8/23	Mon.	MCS survey(EMJS1007)
2010/8/24	Tue.	MCS survey(EMJS1007, EMJS1006)
2010/8/25	Wed	MCS survey(EMJS1008)
2010/8/26	Thu.	MCS survey(EMJS1008, EMJS1009)
2010/8/27	Fri.	MCS survey(EMJS1009, EMJS1008, EMJS10A)
2010/8/28	Sat.	MCS survey(EMJS10A, EMJS1003)
2010/8/29	Sun.	MCS survey(EMJS1003)
2010/8/30	Mon.	MCS survey(EMJS1002)
2010/8/31	Tue.	MCS survey(EMJS1002, EMJS10B)
2010/9/1	Wed	MCS survey(EMJS10B, EMJS10A)
2010/9/2	Thu.	MCS survey(EMJS10A, EMJS1008), retrieve all investment equipments
2010/9/3	Fri.	Stand by all day in the Mutsu Bay due to a typhoon
2010/9/4	Sat.	Stand by all day in the Mutsu Bay due to a typhoon, transit to JAMSTEC port (Yokosuka).
2010/9/5	Sun.	Transit to JAMSTEC port (Yokosuka)
2010/9/6	Mon.	Arrival at JAMSTEC port (Yokosuka)

Table 1　Cruise log during this survey.

(4) Seismic lines (Black lines: MCS lines): Fig.8

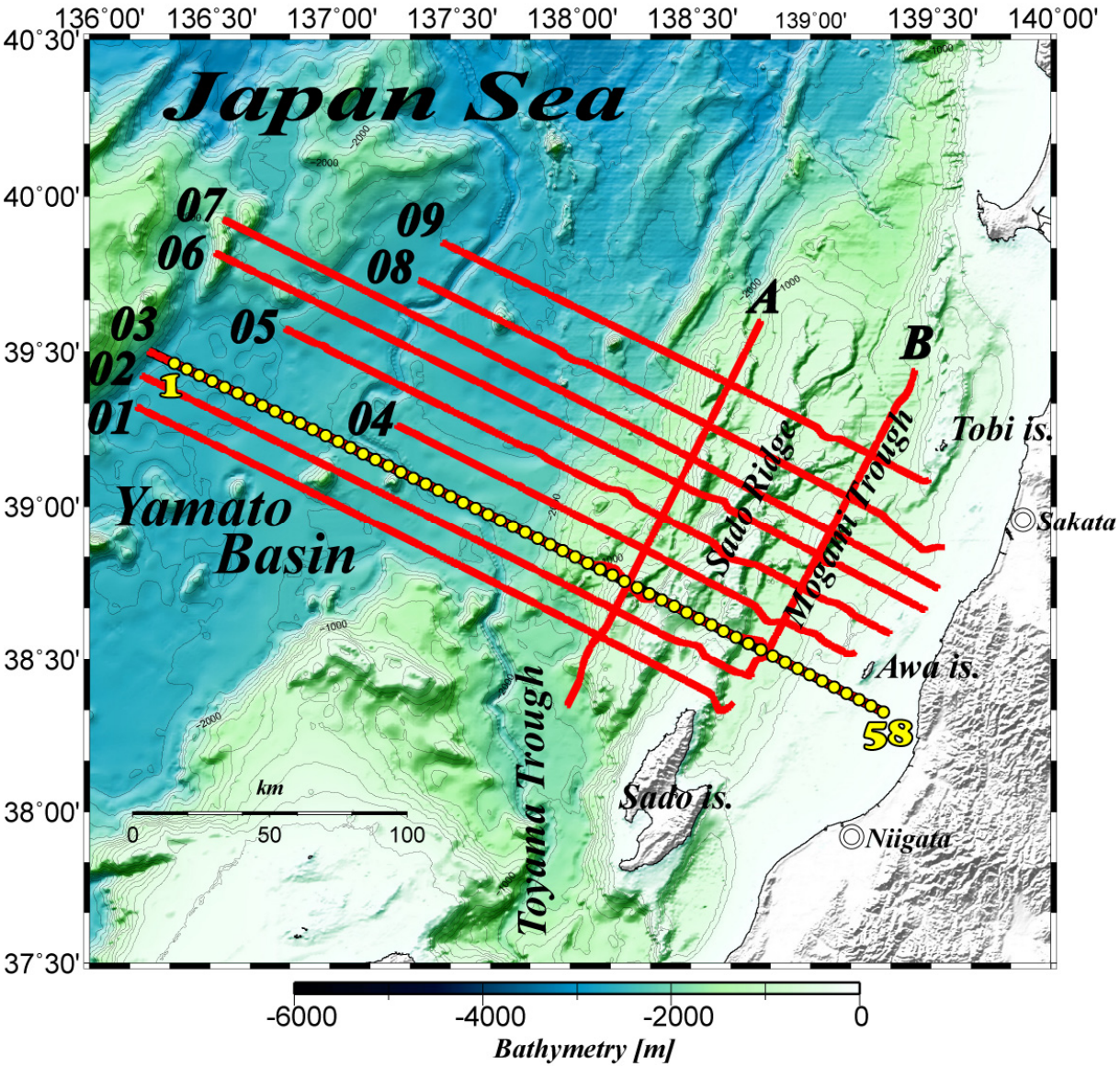


Fig.8 Bathymetry and location maps of the survey area. Red lines are the MCS lines of this survey, yellow circles are the position of the OBS site.

(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.	S.P. POSITION Lat.	S.P. POSITION Lon.	Depth (m)	LENGTH FGSP - LGSP (km)	DIRECTION (°)
EMJS1001_0	08/08/2010	21:10:43	1065	39_19.33338'N	136_11.92126'E	2658	240.5	118.891
	08/08/2010	21:11:33	1067	39_19.30295'N	136_11.97881'E	2657		
	10/08/2010	00:19:57	5877	38_21.61283'N	138_40.79844'E	698		
	10/08/2010	00:19:57	5877	38_21.61283'N	138_40.79844'E	698		
EMJS1002_0	10/08/2010	01:43:00	2076	38_26.12245'N	138_45.84560'E	650	57.6	298.796
	10/08/2010	01:51:21	2100	38_26.55383'N	138_45.20657'E	661		
	10/08/2010	08:30:13	3251	38_40.22788'N	138_09.60309'E	647		
	10/08/2010	08:30:13	3251	38_40.22788'N	138_09.60309'E	647		
EMJS1002_1	30/08/2010	05:17:10	7015	39_25.37337'N	136_13.11447'E	2642	198.1	118.859
	30/08/2010	05:17:49	7013	39_25.34908'N	136_13.17651'E	2641		
	31/08/2010	01:51:29	3051	38_37.67969'N	138_15.94301'E	740		
	31/08/2010	01:51:29	3051	38_37.67969'N	138_15.94301'E	740		
EMJS1003_0	06/08/2010	04:30:51	3780	38_58.73158'N	137_38.68640'E	2155	162.8	118.295
	06/08/2010	04:31:39	3782	38_58.70736'N	137_38.74823'E	2155		
	07/08/2010	02:37:34	7037	38_19.75311'N	139_19.32464'E	73		
	07/08/2010	02:37:34	7037	38_19.75311'N	139_19.32464'E	73		
EMJS1003_1	28/08/2010	00:54:06	6040	38_31.94950'N	138_48.51529'E	766	246.0	298.235
	28/08/2010	01:04:25	6021	38_32.80603'N	138_48.35934'E	773		
	29/08/2010	07:35:25	1101	39_30.17788'N	136_14.68593'E	2253		
	29/08/2010	07:35:25	1101	39_30.17788'N	136_14.68593'E	2253		
EMJS1003obs_0	14/08/2010	12:33:48	2961	39_08.42749'N	137_13.19267'E	2335	203.2	118.297
	14/08/2010	12:38:04	2973	39_08.28230'N	137_13.56438'E	2329		
	15/08/2010	11:52:04	7037	38_19.23147'N	139_18.96920'E	73		
	15/08/2010	11:52:04	7037	38_19.23147'N	139_18.96920'E	73		
EMJS1003obs_1	16/08/2010	11:47:36	3405	39_03.26019'N	137_26.81301'E	2231	114.8	298.232
	16/08/2010	11:51:09	3397	39_03.35773'N	137_26.56598'E	2249		
	17/08/2010	01:24:50	1101	39_30.18117'N	136_14.68810'E	2250		
	17/08/2010	01:24:50	1101	39_30.18117'N	136_14.68810'E	2250		
EMJS1004_0	20/08/2010	04:05:17	3007	39_15.75554'N	137_16.75559'E	2288	184.7	118.789
	20/08/2010	04:05:59	3009	39_15.73203'N	137_16.81813'E	2287		
	21/08/2010	01:47:17	6703	38_31.53603'N	139_11.35908'E	159		
	21/08/2010	01:47:17	6703	38_31.53603'N	139_11.35908'E	159		
EMJS1005_0	07/08/2010	05:31:20	1223	38_34.17616'N	139_20.12485'E	76	243.9	298.686
	07/08/2010	05:44:11	1250	38_34.98686'N	139_19.63032'E	71		
	08/08/2010	10:53:58	6127	39_34.49149'N	136_48.83179'E	2606		
	08/08/2010	10:53:58	6127	39_34.49149'N	136_48.83179'E	2606		
EMJS1006_0	21/08/2010	05:02:30	1422	38_44.80958'N	139_15.54454'E	424	264.6	298.647
	21/08/2010	05:03:18	1424	38_44.82877'N	139_15.47929'E	427		
	22/08/2010	14:11:07	6715	39_49.11898'N	136_31.25717'E	2178		
	22/08/2010	14:11:07	6715	39_49.11898'N	136_31.25717'E	2178		
EMJS1006_1	24/08/2010	01:41:47	1660	38_47.77307'N	139_08.51882'E	625	31.2	118.707
	24/08/2010	01:54:57	1624	38_47.32166'N	139_09.62002'E	616		
	24/08/2010	05:39:35	1001	38_39.53976'N	139_28.68242'E	81		
	24/08/2010	05:39:35	1001	38_39.53976'N	139_28.68242'E	81		

EMJS1007_0	22/08/2010	16:07:03	1265	39_55.64973'N	136_32.93458'E	1719	249.8	119.274
	22/08/2010	16:13:00	1280	39_55.49680'N	136_33.42511'E	1711		
	23/08/2010	23:55:21	6276	38_53.76383'N	139_08.09772'E	647		
	23/08/2010	23:55:21	6276	38_53.76383'N	139_08.09772'E	647		
EMJS1007_1	24/08/2010	06:51:50	7060	38_43.84913'N	139_31.76797'E	93	49.1	299.216
	24/08/2010	06:52:31	7058	38_43.87289'N	139_31.70583'E	95		
	24/08/2010	12:35:01	6076	38_56.39562'N	139_01.78689'E	352		
	24/08/2010	12:35:01	6076	38_56.39562'N	139_01.78689'E	352		
EMJS1008_0	24/08/2010	15:04:06	1972	39_03.08096'N	139_06.13336'E	640	119.2	298.579
	24/08/2010	15:21:14	2019	39_03.66706'N	139_04.68813'E	621		
	25/08/2010	06:19:24	4402	39_32.87671'N	137_50.84000'E	2599		
	25/08/2010	06:27:15	4423	39_33.12883'N	137_50.18367'E	2600		
EMJS1008_1	25/08/2010	11:40:08	4130	39_29.60106'N	137_59.33122'E	2440	58.9	298.579
	25/08/2010	11:46:33	4145	39_29.76439'N	137_58.85089'E	2450		
	25/08/2010	19:00:13	5323	39_43.95384'N	137_22.04021'E	2565		
	25/08/2010	19:00:13	5323	39_43.95384'N	137_22.04021'E	2565		
EMJS1008_2	27/08/2010	03:39:42	1080	38_51.85711'N	139_33.45858'E	116	52.8	298.579
	27/08/2010	03:40:57	1083	38_51.87077'N	139_33.34982'E	118		
	27/08/2010	10:16:13	2139	39_05.15390'N	139_00.99080'E	632		
	27/08/2010	10:16:13	2139	39_05.15390'N	139_00.99080'E	632		
EMJS1008D_0	01/09/2010	21:46:26	2040	39_03.80009'N	139_03.95232'E	642	43.5	298.579
	01/09/2010	21:47:38	2043	39_03.85773'N	139_03.87420'E	647		
	02/09/2010	04:00:27	2912	39_14.70340'N	138_37.12739'E	769		
	02/09/2010	04:00:27	2912	39_14.70340'N	138_37.12739'E	769		
EMJS1009_0	25/08/2010	21:24:34	2660	39_51.72180'N	137_26.39545'E	2609	193.6	118.088
	25/08/2010	21:45:21	2717	39_51.06937'N	137_28.20527'E	2614		
	26/08/2010	21:45:54	6589	39_05.24902'N	139_29.56084'E	261		
	26/08/2010	21:45:54	6589	39_05.24902'N	139_29.56084'E	261		
EMJS10A_0	27/08/2010	14:06:40	2600	39_01.06365'N	139_08.95358'E	696	72.1	208.782
	27/08/2010	14:07:51	2603	39_00.99169'N	139_08.90567'E	696		
	27/08/2010	23:17:40	4045	38_27.28626'N	138_43.93740'E	710		
	27/08/2010	23:17:40	4045	38_27.28626'N	138_43.93740'E	710		
EMJS10A_1	01/09/2010	10:14:04	1540	39_26.43147'N	139_26.06654'E	797	62.4	208.782
	01/09/2010	10:15:39	1544	39_26.33375'N	139_26.00641'E	799		
	01/09/2010	17:52:38	2792	38_56.46549'N	139_05.87319'E	222		
	01/09/2010	17:52:38	2792	38_56.46549'N	139_05.87319'E	222		
EMJS10B_0	31/08/2010	09:32:04	1085	38_20.91862'N	137_59.22932'E	1719	155.6	28.324
	31/08/2010	09:33:08	1088	38_20.99131'N	137_59.27483'E	1723		
	01/09/2010	03:30:12	4199	39_36.07978'N	138_47.65741'E	1369		
	01/09/2010	03:30:12	4199	39_36.07978'N	138_47.65741'E	1369		
					Total		3004.0	

Table 2　List of seismic survey lines.

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

SITE	Lat.	Lon.	Depth (m)
1	39_27.8278'N	136_21.1331'E	2656.0
2	39_26.6718'N	136_24.2924'E	2657.0
3	39_25.4989'N	136_27.4230'E	2653.0
4	39_24.3431'N	136_30.5965'E	2649.0
5	39_23.1727'N	136_33.7394'E	2649.0
6	39_22.0188'N	136_36.8770'E	2641.0
7	39_20.8502'N	136_40.0188'E	2628.0
8	39_19.6848'N	136_43.1681'E	2610.0
9	39_18.5192'N	136_46.3160'E	2585.0
10	39_17.3463'N	136_49.4567'E	2570.0
11	39_16.1703'N	136_52.5961'E	2522.0
12	39_14.9905'N	136_55.7402'E	2482.0
13	39_13.8258'N	136_58.8760'E	2446.0
14	39_12.6398'N	137_02.0029'E	2388.0
15	39_11.4675'N	137_05.1426'E	2356.0
16	39_10.2872'N	137_08.2727'E	2360.0
17	39_09.1026'N	137_11.4070'E	2334.0
18	39_07.9245'N	137_14.5305'E	2311.0
19	39_06.7397'N	137_17.6566'E	2499.0
20	39_05.5227'N	137_20.7873'E	2387.0
21	39_04.3574'N	137_23.9226'E	2234.0
22	39_03.1673'N	137_27.0338'E	2209.0
23	39_01.9844'N	137_30.1409'E	2173.0
24	39_00.7859'N	137_33.2847'E	2201.0
25	38_59.5966'N	137_36.3823'E	2219.0
26	38_58.4140'N	137_39.4927'E	2155.0
27	38_57.2191'N	137_42.5966'E	2174.0
28	38_56.0445'N	137_45.7043'E	2188.0
29	38_54.8493'N	137_48.8088'E	2183.0

SITE	Lat.	Lon.	Depth (m)
30	38_53.6395'N	137_51.9139'E	2077.0
31	38_52.4392'N	137_55.0174'E	1813.0
32	38_51.2419'N	137_58.1137'E	1460.0
33	38_50.0448'N	138_01.2209'E	1274.0
34	38_48.8382'N	138_04.3213'E	1252.0
35	38_47.6334'N	138_07.4140'E	1103.0
36	38_46.4279'N	138_10.5161'E	948.0
37	38_45.2199'N	138_13.5722'E	550.0
38	38_44.0050'N	138_16.6981'E	401.0
39	38_42.8034'N	138_19.7850'E	785.0
40	38_41.5865'N	138_22.8834'E	123.0
41	38_40.3743'N	138_25.9681'E	170.0
42	38_39.1595'N	138_29.0566'E	274.0
43	38_37.9479'N	138_32.1303'E	656.0
44	38_36.7311'N	138_35.2231'E	497.0
45	38_35.5043'N	138_38.3069'E	342.0
46	38_34.2836'N	138_41.3858'E	336.0
47	38_33.0680'N	138_44.4656'E	773.0
48	38_31.8470'N	138_47.5324'E	749.0
49	38_30.6208'N	138_50.6054'E	749.0
50	38_29.3979'N	138_53.6688'E	657.0
51	38_28.1700'N	138_56.7456'E	313.0
52	38_26.9537'N	138_59.7722'E	172.9
53	38_25.7397'N	139_02.8317'E	132.4
54	38_24.5190'N	139_05.9168'E	114.6
55	38_23.3003'N	139_08.9811'E	102.7
56	38_22.0395'N	139_12.0444'E	100.5
57	38_20.8036'N	139_15.0922'E	93.8
58	38_19.5766'N	139_18.1590'E	83.3

Table 3　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.

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