doi : 10.17596/0003193

KR09-09 Cruise Report

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

(Multichannel seismic reflection survey)

Jul. 25, 2009 – Aug. 7, 2009

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

Contents:

1. Cruise Information:

(1) **Cruise ID, Ship name:** KR09-09, R/V Kairei

(2) **Title of the cruise:** 2009FY "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:** 2009/7/25-8/7, off Shingu port (Wakayama) to Sekinehama port (Mutsu, Aomori)

(5) **Research Area:** The eastern margin of the Japan Sea

(6) **Research Map:** Fig.1

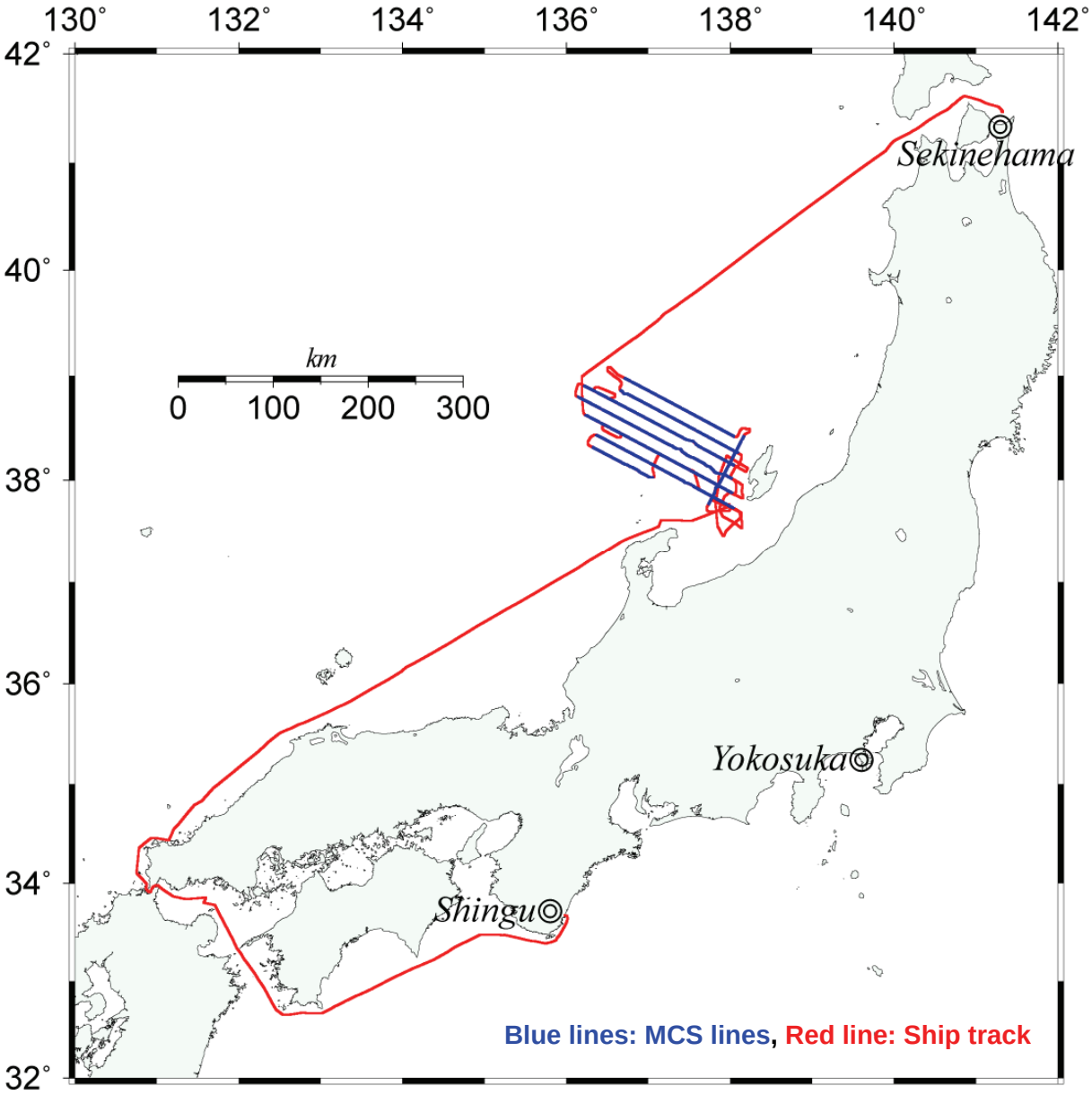


Fig.1 Ship track during KR09-09 cruise.

2. Researchers:

(1) Chief Scientist [Affiliation]:

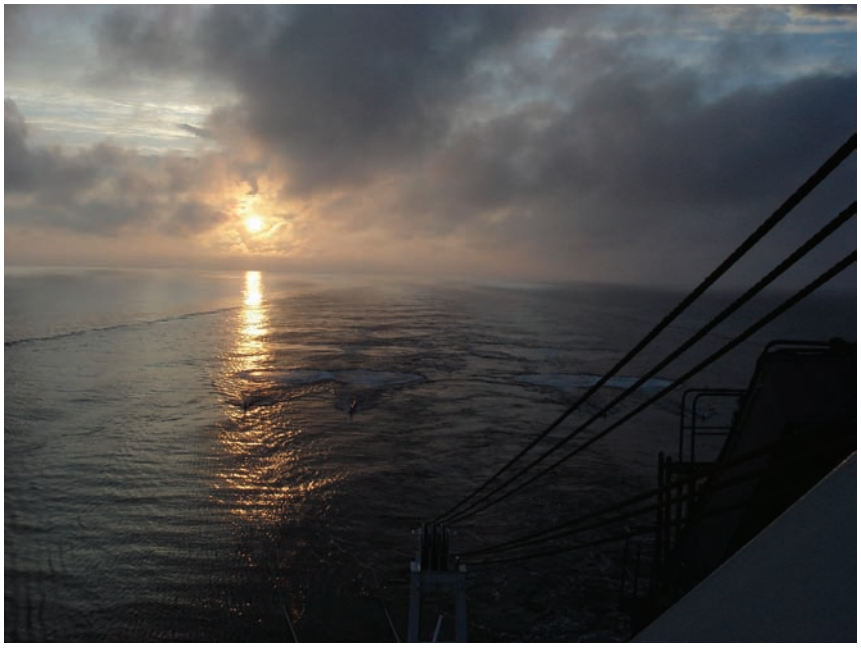
Tetsuo NO [JAMSTEC]

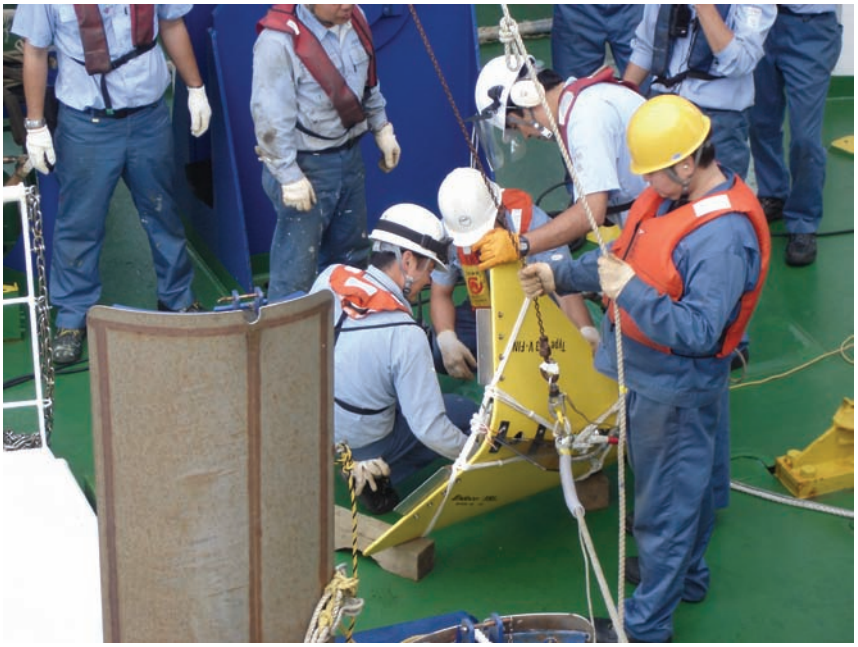
(2) Representative of Science Party [Affiliation]:

Yoshiyuki KANEDA [JAMSTEC]

(3) Science party list:

Yoshiyuki KANEDA [JAMSTEC]
Shuichi KODAIRA [JAMSTEC]
Narumi TAKAHASHI [JAMSTEC]





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 and the western part of the Tohoku region. For example, the 1983 Nihonkai-Chubu earthquake (M 7.7), the 1993 Hokkaido-Nansei-Oki earthquake (M 7.8), the 2004 Mid-Niigata Prefecture earthquake (M 6.8), the 2007 Niigata-ken Chuetsu-oki earthquake (M 6.8), and the 2008 Iwate-Miyagi Nairiku earthquake (M 7.2) 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, seismic studies have been performed to understand active faults and fold structures at the eastern margin of the Japan Sea and the western part of the Tohoku region in collaboration with Japanese research institutions as part of the Special Coordination Funds for Promoting Science and Technology, "priority investigations of strain concentration areas", since 2008. The objectives of this cruise are to reveal the structural characteristics of the strain concentration areas using a multichannel seismic reflection survey system (MCS) on R/V KAIREI.

(2) List of observation instruments:

1) Multichannel seismic reflection survey (MCS)

In July–August 2009, we conducted a MCS survey around the area off Noto peninsula and near Sado Island in the eastern margin of the Japan Sea using the R/V KAIREI (Fig.2). MCS data was acquired along eight lines (EMJS0902, EMJS0903, EMJS0904, EMJS0905, EMJS0906, EMJS0907, EMJS0908, and EMJS09B) with a total length of approximately 1,189 km. Survey lines were crooked to avoid the many fishing operations and equipment in the survey area.

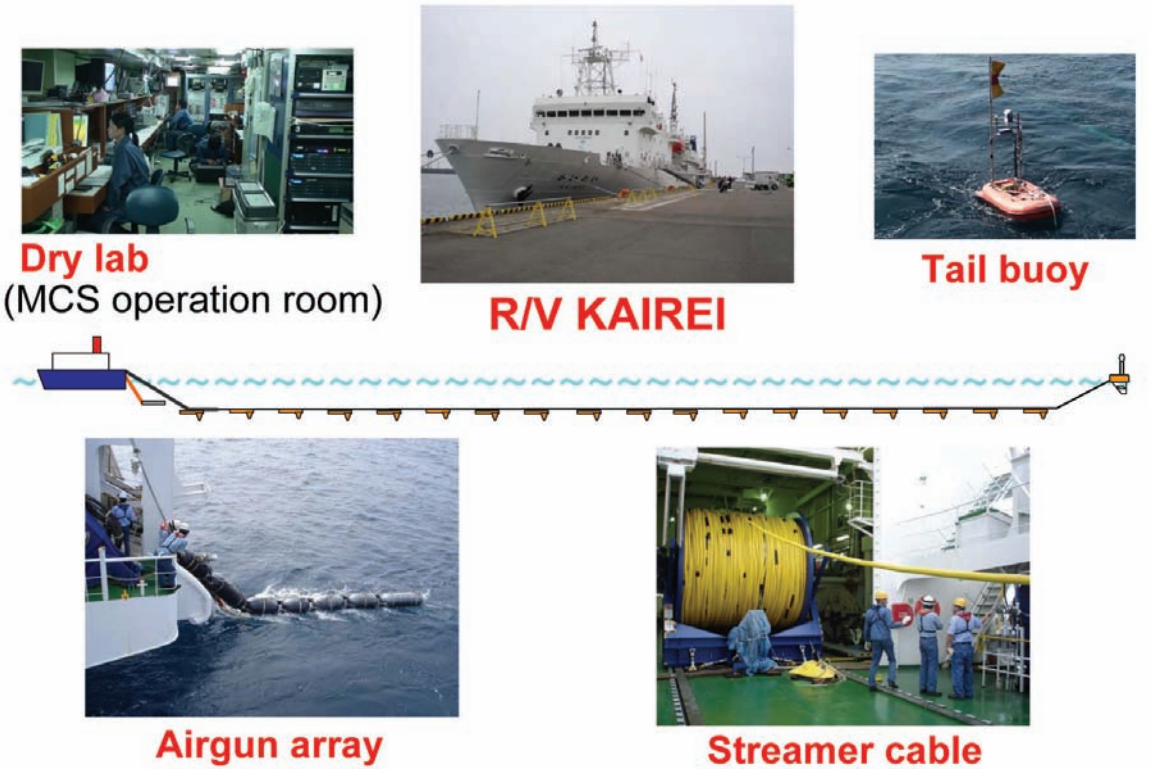


Fig.2 MCS system on R/V KAIREI.

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 4.5–5 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 25.0 m by a paravane system, and the central position of the array was set 170 m behind that of the ship antenna (Fig.3).

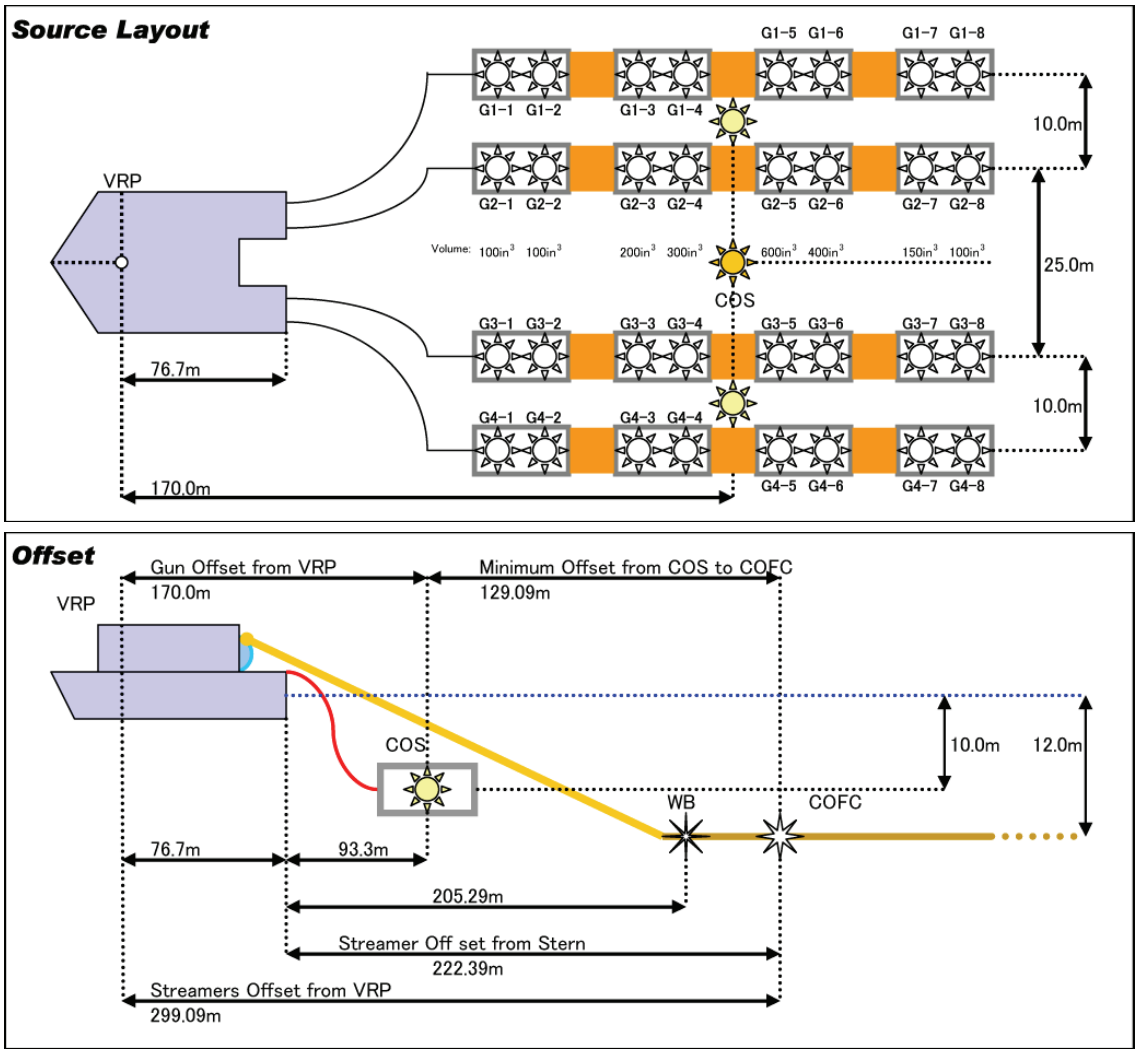


Fig.3 Vessel towing geometry. Top figure shows the source (airgun system) layout, bottom one represents source-receiver depth and position, and navigation offsets.

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 lengths of total active section and lead-in cable are 5,500 m and 110 m, respectively. 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).

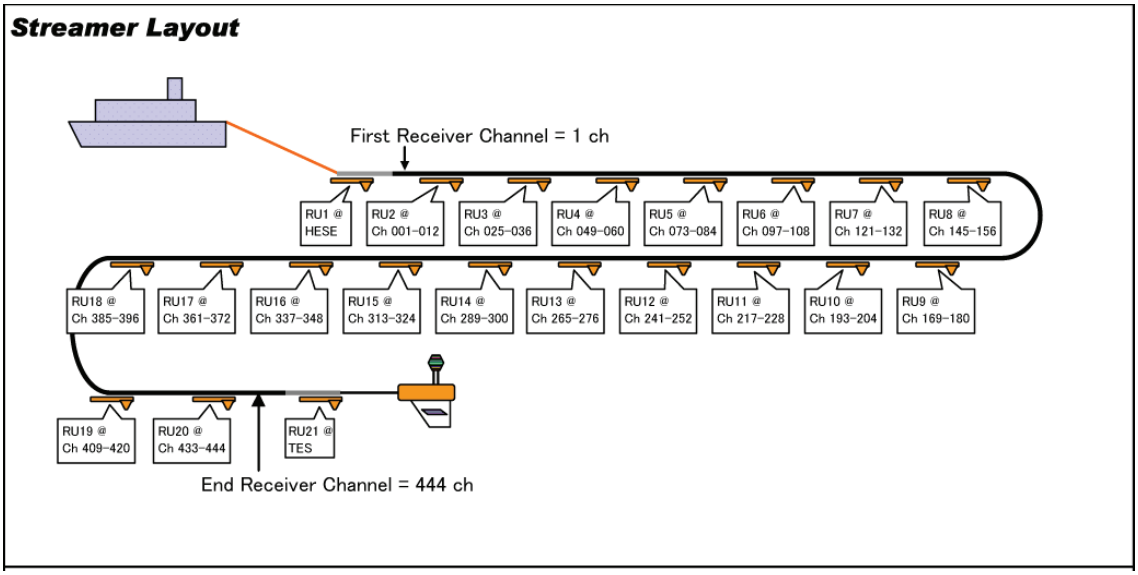


Fig.4 Streamer cable configuration in this survey.

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 53N.

2) 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.5). 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).

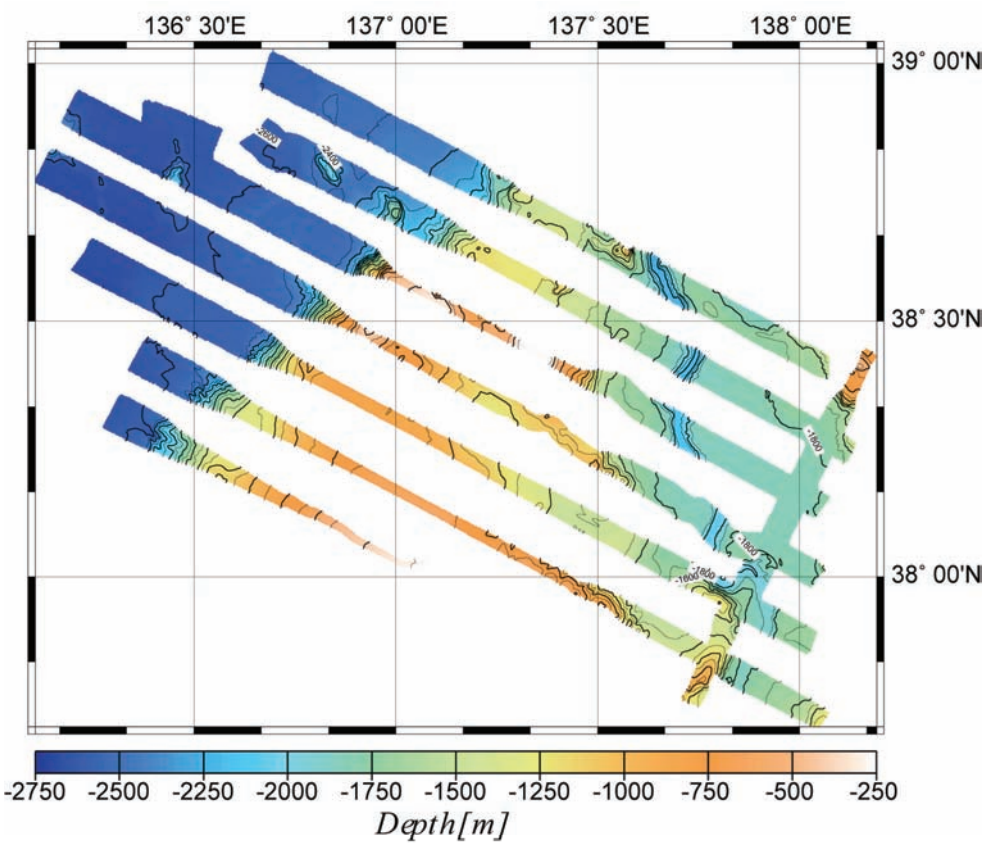


Fig.5 Results of bathymetric survey in this cruise.

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

Date		Remarks
2009/7/25	Sat.	Departure from Shingu, transit to survey area of Japan Sea.
2009/7/26	Sun.	Transit to survey area of Japan Sea.
2009/7/27	Mon.	Transit to survey area of Japan Sea.
2009/7/28	Tue.	Transit to survey area of Japan Sea, Far field signature test.
2009/7/29	Wed.	MCS survey (EMJS0903)
2009/7/30	Thu.	MCS survey (EMJS0903, EMJS0902, EMJS0904)
2009/7/31	Fri.	MCS survey (EMJS0904, EMJS0905)
2009/8/1	Sat.	MCS survey (EMJS0905, EMJS0906)
2009/8/2	Sun.	MCS survey (EMJS0906, EMJS0907)
2009/8/3	Mon.	MCS survey (EMJS0907, EMJS0908)
2009/8/4	Tue.	MCS survey (EMJS0908, EMJS09B, EMJS0903)
2009/8/5	Wed.	MCS survey (EMJS0903, EMJS0904)
2009/8/6	Thu.	MCS survey (EMJS0904), retrieve all equipments, and transit to Sekinehama port
2009/8/7	Fri.	Arrival at Sekinehama port

Table 1 Cruise log during this survey.

(4) **Seismic lines (Black lines: MCS lines):** Fig.6

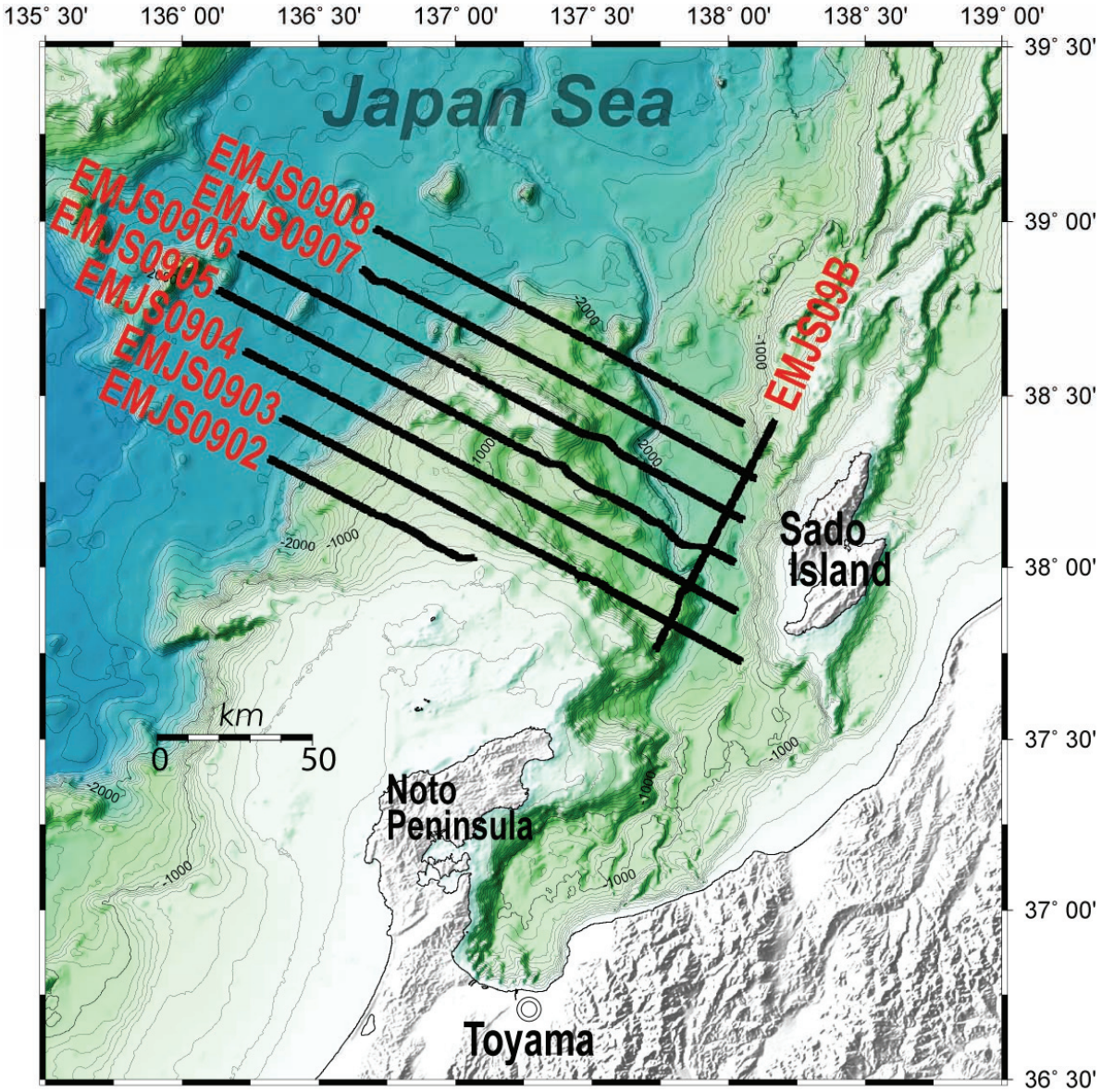


Fig.6 Bathymetry and location maps of the survey area. Black lines are the MCS lines of this survey.

(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)	DIRECTION (°)
EMJS0903_0	29/07/2009	02:41:10	881	37_43.62081'N	138_02.74198'E	1332	296.7
	29/07/2009	02:41:52	883	37_43.64738'N	138_02.68269'E	1333	
	29/07/2009	22:11:55	4226	38_26.19654'N	136_21.84807'E	2623	
	29/07/2009	22:11:55	4226	38_26.19654'N	136_21.84807'E	2623	
EMJS0902_0	30/07/2009	00:36:51	881	38_19.42634'N	136_18.30522'E	2638	116.8
	30/07/2009	00:46:45	909	38_19.08203'N	136_19.16076'E	2632	

	30/07/2009	08:53:29	2374	38_01.82466'N	137_04.30100'E	275	
	30/07/2009	08:55:19	2375	38_01.93303'N	137_04.40862'E	272	
EMJS0904_0	30/07/2009	13:27:18	2260	38_14.12855'N	137_10.73788'E	1084	116.7
	30/07/2009	13:42:24	2310	38_13.49605'N	137_12.25162'E	1095	
	30/07/2009	22:00:04	3957	37_52.38722'N	138_01.79663'E	1689	
	30/07/2009	22:00:04	3957	37_52.38722'N	138_01.79663'E	1689	
EMJS0905_0	31/07/2009	00:02:47	1222	38_00.22513'N	138_02.70674'E	1797	296.7
	31/07/2009	00:18:32	1269	38_00.85883'N	138_01.31418'E	1815	
	31/07/2009	21:57:55	5008	38_48.28209'N	136_07.90923'E	2675	
	31/07/2009	21:57:55	5008	38_48.28209'N	136_07.90923'E	2675	
EMJS0906_0	31/07/2009	23:58:51	881	38_54.87240'N	136_11.86714'E	2635	116.7
	01/08/2009	00:08:49	909	38_54.52253'N	136_12.72621'E	2636	
	01/08/2009	03:04:13	1408	38_48.29113'N	136_28.02544'E	2424	
	01/08/2009	03:18:09	1450	38_47.77064'N	136_29.31461'E	2607	
EMJS0906_1	01/08/2009	08:54:58	1280	38_49.89113'N	136_24.10430'E	2661	116.7
	01/08/2009	08:55:40	1282	38_49.86556'N	136_24.16521'E	2661	
	02/08/2009	02:24:27	4545	38_08.41368'N	138_03.18403'E	1787	
	02/08/2009	02:24:27	4545	38_08.41368'N	138_03.18403'E	1787	
EMJS0907_0	02/08/2009	04:36:00	1250	38_15.22702'N	138_06.77064'E	1624	296.6
	02/08/2009	04:44:46	1277	38_15.57197'N	138_05.95583'E	1690	
	02/08/2009	20:45:16	4130	38_51.96172'N	136_39.39091'E	2602	
	02/08/2009	20:45:16	4130	38_51.96172'N	136_39.39091'E	2602	
EMJS0908_0	03/08/2009	04:33:01	1050	38_58.84432'N	136_42.44804'E	2579	116.6
	03/08/2009	04:33:21	1051	38_58.83099'N	136_42.47823'E	2580	
	03/08/2009	18:46:52	3713	38_24.98614'N	138_03.47174'E	1595	
	03/08/2009	18:46:52	3713	38_24.98614'N	138_03.47174'E	1595	
EMJS09B_0	03/08/2009	22:16:03	950	38_26.35308'N	138_10.69559'E	806	205.5
	03/08/2009	22:28:43	980	38_25.66333'N	138_10.14244'E	744	
	04/08/2009	09:14:57	2648	37_45.63751'N	137_43.94661'E	1237	
	04/08/2009	09:14:57	2648	37_45.63751'N	137_43.94661'E	1237	
EMJS0903D_0	04/08/2009	13:57:46	1040	37_45.67767'N	137_57.99278'E	1669	296.7
	04/08/2009	13:58:40	1042	37_45.70173'N	137_57.93187'E	1669	
	04/08/2009	19:20:17	1700	37_54.17441'N	137_38.22515'E	1493	
	04/08/2009	19:20:17	1700	37_54.17441'N	137_38.22515'E	1493	
EMJS0904_1	05/08/2009	02:39:23	2370	38_12.81385'N	137_13.85606'E	1124	296.7
	05/08/2009	02:39:23	2370	38_12.81385'N	137_13.85606'E	1124	
	05/08/2009	09:43:49	1135	38_28.43028'N	136_36.39690'E	2575	
	05/08/2009	09:43:49	1135	38_28.43028'N	136_36.39690'E	2575	
EMJS0904_2	05/08/2009	16:46:27	11140	38_28.36477'N	136_36.54731'E	2574	296.7
	05/08/2009	16:47:05	11138	38_28.39035'N	136_36.48670'E	2573	
	05/08/2009	20:30:20	10393	38_37.72523'N	136_13.76342'E	2679	
	05/08/2009	20:30:20	10393	38_37.72523'N	136_13.76342'E	2679	

F.S.P: First shot point, F.G.S.P: First good shot point, L.G.S.P: Last good shot point, L.S.P: Last shot point

Table 2　List of MCS survey lines.

(6) 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. 7).

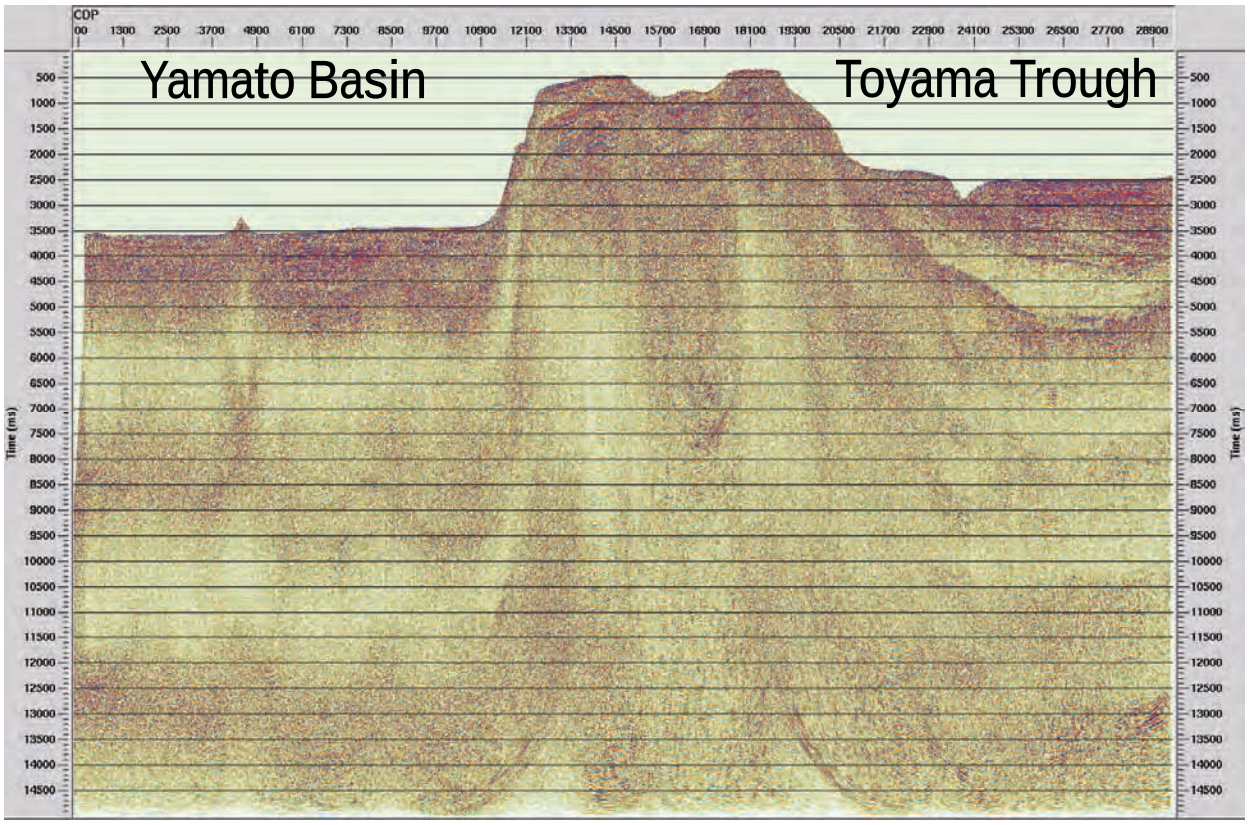


Fig.7 Example of MCS profile with onboard processing (Poststack time migration section of Line EMJS0906).

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 thank to the captain Satoshi Susami and the crews (Nippon Marine Enterprises, Ltd.) of R/V KAIREI for their efforts in obtaining MCS data and other geophysical data. We are grateful to the following members of the MCS technician team (Nippon Marine Enterprises, Ltd.): Masayuki Toizumi (Party chief), Yuki Ohwatari (Seismic observer and navigator), Morifumi Takaesu (Seismic navigator and observer), Ayumi Mizota (Seismic data processor), Yuta Watarai (Seismic navigator and observer), Mitsuteru Kuno (Seismic source technician), Ryo Miura (Seismic data processor), Kyoko Tanaka (Seismic observer and navigator), Masashi Kawahara, Gensaku Miyamura, Ryuichi Ohtsuka, Satoru Yamazaki (Technician). We are also grateful to participants of Leading Project (Earthquake and Tsunami research project for Disaster Prevention), Institute for Research on Earth Evolution, and Marine Technology Center in JAMSTEC for great supporting in this cruise. We used "The Generic Mapping Tools" (Wessel and Smith, 1991) to make figures. This project is funded by a program called "the priority investigations of strain concentration areas" which is a part of the Special Coordination Funds for Promoting Science and Technology by the Ministry of Education, Culture, Sports, Science, and Technology.