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KR19-06C Cruise report

Integrated Research Project on Seismic and Tsunami Hazards Around the Sea of Japan

Aug. 5 - Aug. 24, 2019

Japan Agency for Marine-Earth Science and Technology
(JAMSTEC)

Contents:

1. Cruise Information:

(1) **Cruise ID, Ship name:** KR19-06C, R/V *KAIREI*

(2) **Title of the cruise:** 2019 FY "Integrated Research Project on Seismic and Tsunami Hazards Around the Sea of Japan"

(3) **Title of proposal:**

Integrated Research Project on Seismic and Tsunami Hazards Around the Sea of Japan

(4) **Cruise period, Port call:** Aug. 5 – Aug. 24, 2019, Miyako port to Hachinohe port

(5) **Research Area:** Off Yamagata, Japan Sea

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

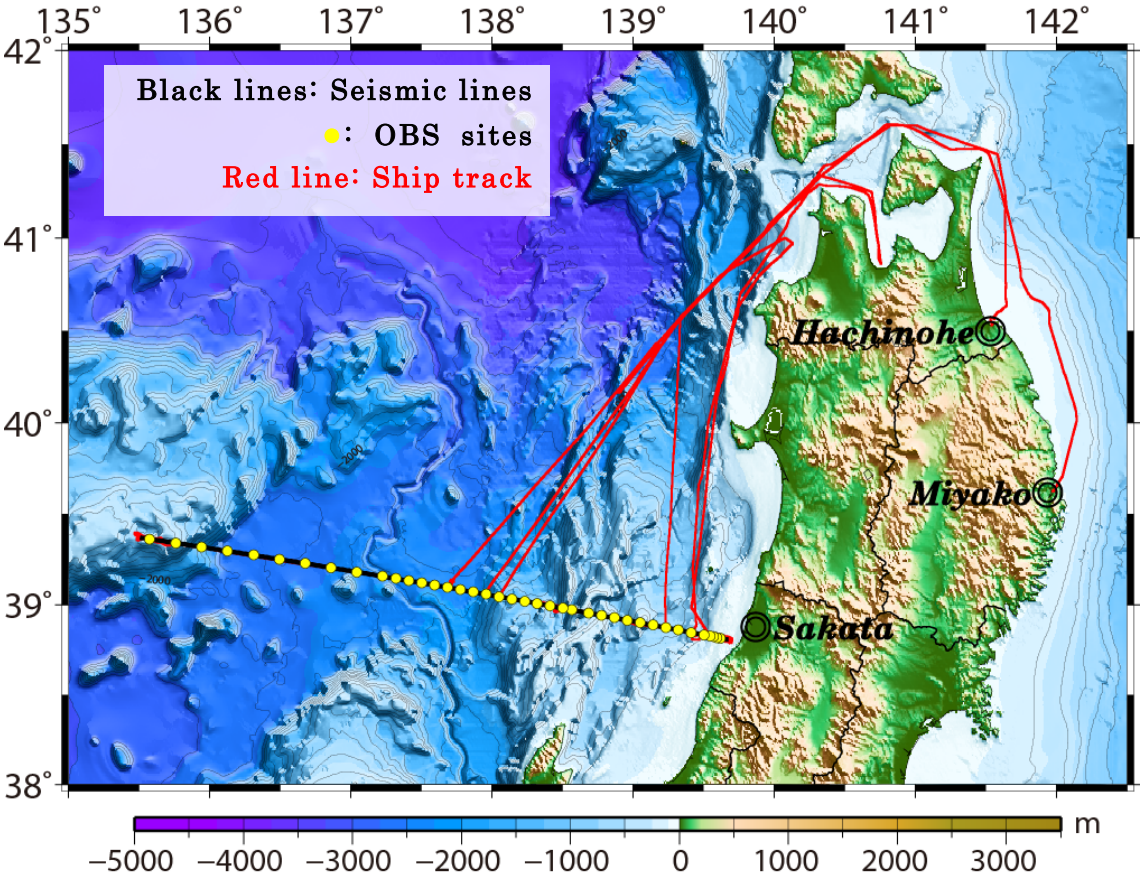


Fig. 1 Ship track during KR19-06C cruise.

2. Researchers:

(1) Chief Scientists [Affiliation]:

Tetsuo NO [Research Institute for Marine Geodynamics (IMG)/JAMSTEC]

(2) Representative of Science Party [Affiliation]:

Shuichi KODAIRA [IMG/JAMSTEC]

(3) KR19-06C Shipboard Science Party:

Tetsuo NO [IMG/JAMSTEC]: Chief Scientist
Ryo MIURA [IMG/JAMSTEC]: Vice-chief Scientist
Yuki OHWATARI [Nippon Marine Enterprises, Ltd. (NME)]: Chief marine technician
Naoto NOGUCHI [NME]: Marine technician
Takuya MAEKAWA [NME]: Marine technician
Akie SUZUKI [NME]: Marine technician
Hikaru IWAMARU [NME]: Marine technician
Keita SUZUKI [NME]: Marine technician
Waka KOMATSU [NME]: Marine technician
Miki TAWATA [NME]: Marine technician
Akinori MURATA [NME]: Marine technician
Misaki HORIUCHI [NME]: Marine technician
Tatsuya SUGIYAMA [NME]: Marine technician

(4) R/V *KAIREI* Crews:

Takafumi AOKI: Master
Takeshi EGASHIRA: Chief Officer
Takeshi MURAMATSU: 1st Officer
Shintaro KAN: 2nd Officer
Masaki OKADA: 3rd Officer
Takashi OTA: Chief Engineer
Daisuke GIBU: 1st Engineer
Yoshinobu HIRATSUKA: 2nd Engineer
Yuna KAINO: 3rd Engineer
Masakazu ISHIDA: Jr. 3rd Engineer
Yosuke KOMAKI: Chief Electronics Operator
Kazumi UGAJIN: 2nd Electronics Operator
Kohei MAEDA: 3rd Electronics Operator
Naoki IWASAKI: Boat Swain
Shuichi YAMAMOTO: Quarter Master
Daisuke YANAGITANI: Quarter Master
Sho SUZUKI: Quarter Master
Takumi MIURA: Sailor
Kodai KAKUBARI: Sailor
Yuki OISHI: Sailor
Junji MORI: No.1 Oiler
Makoto KOZAKI: Oiler
Aoi TAKAMIYA: Oiler
Masashi OE: Assistant Oiler
Keisuke ONUMA: Assistant Oiler
Kiyotaka KOSUJI: Chief Steward
Hideo FUKUMURA: Steward
Tuyoshi NAGATOMO: Steward
Takehiro NOJIRI: Steward
Yoshitatsu KUMAZAWA: Steward

3. Overview of Observations:

(1) Objective:

The relationship between crustal structure and earthquakes that have occurred along the eastern margin of the Japan Sea has been recently investigated via seismic surveys as part of the research project "Multidisciplinary research project for construction of fault model in the high strain rate zone" (Sato et al., 2014; No et al., 2014). However, other areas in the Japan Sea have not yet been surveyed to study crustal structures. Therefore, we participated in the "Integrated Research Project on Seismic and Tsunami Hazards Around the Sea of Japan", conducted by the Japanese Ministry of Education, Culture, Sports, Science, and Technology (MEXT). As a part of these efforts, we have performed seismic surveys in the Japan Sea since 2014; this survey was the final data acquisition activity of this project.

In August 2019, we conducted a marine seismic survey to study the crustal structure off Yamagata Prefecture. The survey covered the areas from the continental shelf to the Yamato Ridge. The specific area of this survey is located near the aftershock area of the Earthquake offshore Yamagata Prefecture (M_J 6.7), which occurred on June 18, 2019. The earthquake occurred on the continental shelf, which is shallower than 100 m. While it is difficult to explore the crustal structure in such a coastal area due to economic activity (e.g. the fishing industry), it is estimated that many active faults are also distributed in the coastal area and the land-sea boundary area in the Japan Sea (e.g. Okamura, 2019). Further, it has been pointed out that to improve the accuracy of the source fault model, it is necessary to promote deep seismic survey in many parts of the Japan Sea (Committee for Technical Investigation on Large-scale Earthquake in the Sea of Japan, 2014). Therefore, it is expected that this cruise will be important for studying the entire crustal structure related to the formation of earthquake source faults off Yamagata. In addition, as our survey line was connected to the land seismic survey line of the Earthquake Research Institute of the University of Tokyo which was located on the east extension. We will be able to obtain crustal structure images of the onshore-offshore seismic profile through further data analysis.

(2) List of observation instruments:

1) Refraction survey using OBSs

We deployed 39 ocean bottom seismographs (OBS) along the line SJ1901. Two types of OBS were used due to fishing activity constraints (Tables 1 and 2). Type "K" Katsujima OBSs were deployed at Sites 1–8; these were recovered all equipment including anchors (Table 1). Type "T" Tokyo Sokushin OBSs were deployed at Sites 9–48 (Table 2). In addition, due to the influence of three typhoons, we canceled the deployment of odd-numbered OBSs in Sites 30–48 as well as the multichannel seismic reflection (MCS) survey.

To conduct the seismic refraction/reflection survey using OBSs, we shot an air gun array with a spacing of 200 m. The tuned air gun array had a maximum capacity of 7,800 cu. in. (approximately 130 L) and consisted of 32 air guns. The standard air pressure was 2,000 psi (approximately 14 MPa). The air gun array was kept at 10 m below the sea surface throughout the experiment. The air-gun array configuration is shown in Fig. 1. We used TriggerFish (made by InProspect Limited) as our navigation software for the acquisition of seismic data. Shot times and shot points (SPs) were set on TriggerFish, and a trigger signal was sent to the gun controller (ION DigiSHOT). The main navigation parameters were as follows: the survey datum was WGS84, the map projection was UTM, and the UTM zone parameter was 54N.

All OBSs were retrieved by the deep sea research vessel *KAIREI*. Calibration of the OBS clock to GPS time was performed using the time difference between the OBS clock and GPS time, which was measured just before OBS deployment and just after OBS retrieval. Fig. 3 presents examples of record sections for OBSs (Sites 5 and 25).

Type	POBS-150, Katsujima Co., LTD.
Maximum Depth	6,000 m
Dimension (w/ anchor)	120 * 100 * 52 cm
Weight (w/ anchor)	113 kg in air, 48 kg in water (Site1-4) 120 kg in air, 48 kg in water (Site5-6) 131 kg in air, 50 kg in water (Site7-8)
Sensor	Three-component Geophone [One vertical and two horizontal components, Natural frequency: 4.5Hz, Sensitivity:0.8V/inch/s (OPEN)] & Hydrophone
Recorder	SPM2, Nippon Marine Enterprises, Ltd.
Recording System	Sampling continuously (Timer control is possible for start time)
Sampling Rate	24 bit, 250Hz
Power	Lithium Ion Rechargeable Battery
Acoustic Communication & Release System	Electric corrosion method
Attached Parts	Weight, Flash light, Radio beacon
Pressure Resistant Container	17-inch glass sphere

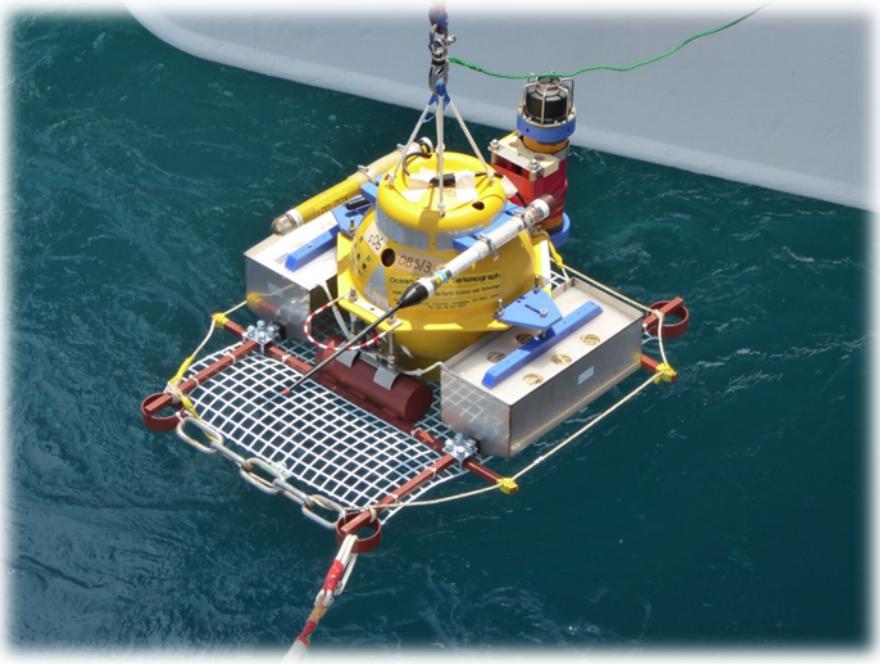


Table 1　Specifications of OBS of Katsujima type [Anchor retrieve type] (hereinafter referred to as "Type K").

Type	TOBS-24N, TOKYO SOKUSHIN CO., LTD.
Maximum Depth	6,700 m
Dimension (w/ anchor)	120 * 65 * 50 cm
Weight (w/ anchor)	105 kg in air, 50 kg in water
Sensor	Three-component Geophone & Hydrophone [One vertical and two horizontal components, Natural frequency: 4.5Hz, Sensitivity:0.78V/cm/s (damping 0.7)]
Recorder	DTC-6710, TOKYO SOKUSHIN CO., LTD.
Recording System	Sampling continuously (Timer control is possible for start time)
Sampling Rate	24 bit, 200Hz
Power	Lithium Ion Rechargeable Battery
Acoustic Communication & Release System	Electric corrosion method
Attached Parts	Weight, Flash light, Radio beacon
Pressure Resistant Container	17-inch glass sphere

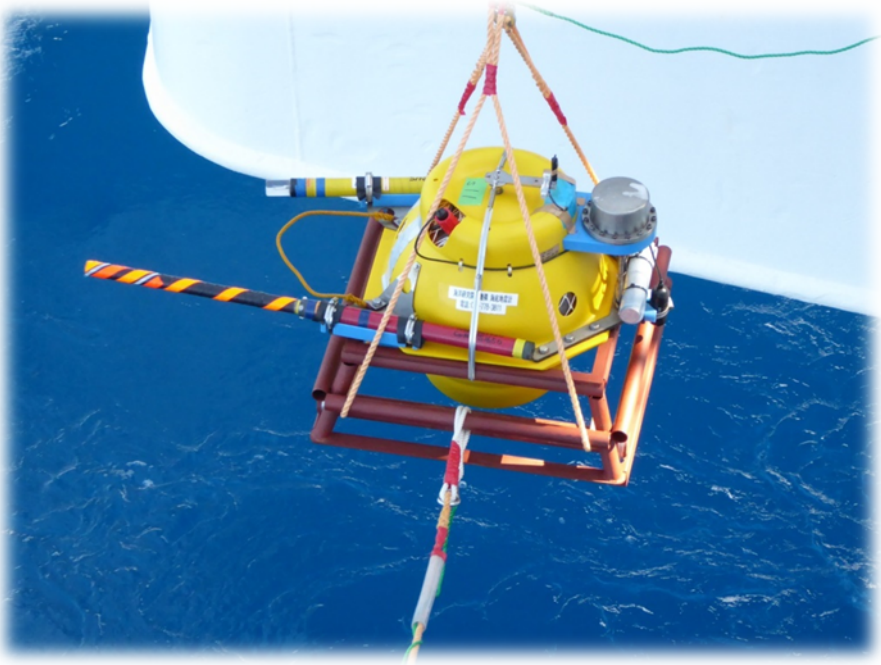


Table 2　Specifications of OBS of Tokyo Sokushin type [Normal type] (hereinafter referred to as "Type T").

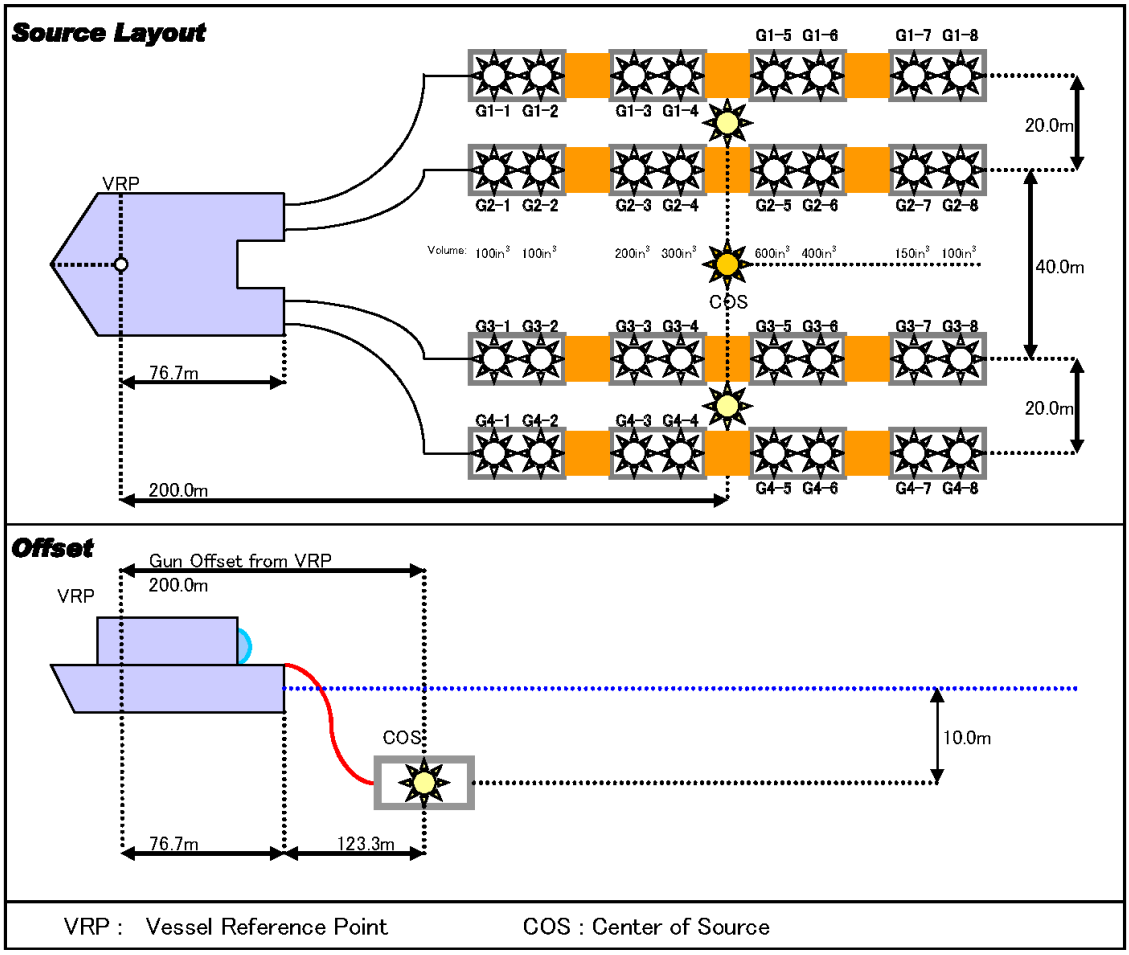


Fig. 3 Vessel towing geometry during the refraction survey of the line SJ1901. Top figure shows the source (airgun system) layout, bottom figure represents source depth and position, and navigation offsets.

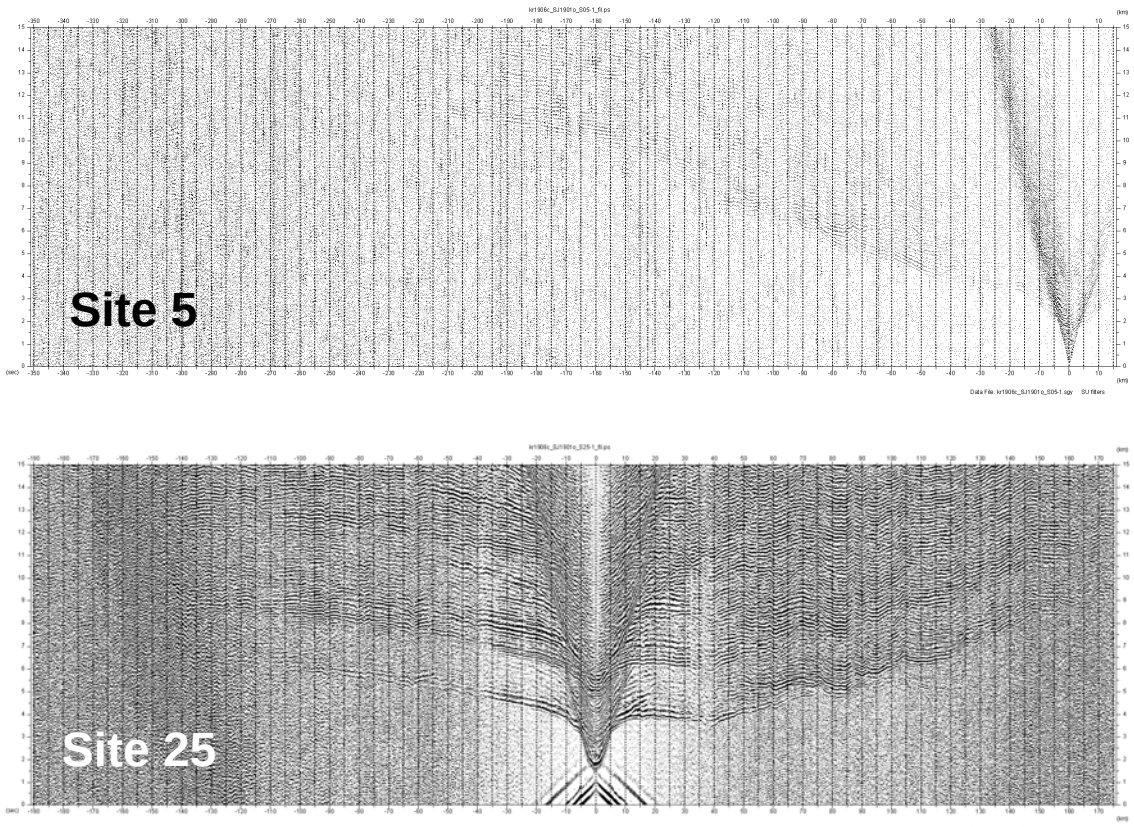


Fig. 3　Examples of record sections for OBSs on the vertical component (Site 5 [upper] and 25 [lower]).

2) Bathymetry, magnetic, and gravity observations

Bathymetry, geomagnetic, and gravity data were recorded continuously during the survey. The bathymetry survey on the R/V *KAIREI* used a multi-narrow beam echo sounder (SeaBeam 3012, L-3 ELAC Nautik GmbH) (Fig. 4). Gravity data was obtained by a shipboard gravimeter (KSS31, BODENSEEWERK PERKIN-ELMER). The geomagnetic survey used a three-component magnetometer (SFG-1214, Tierra Technica Inc.).

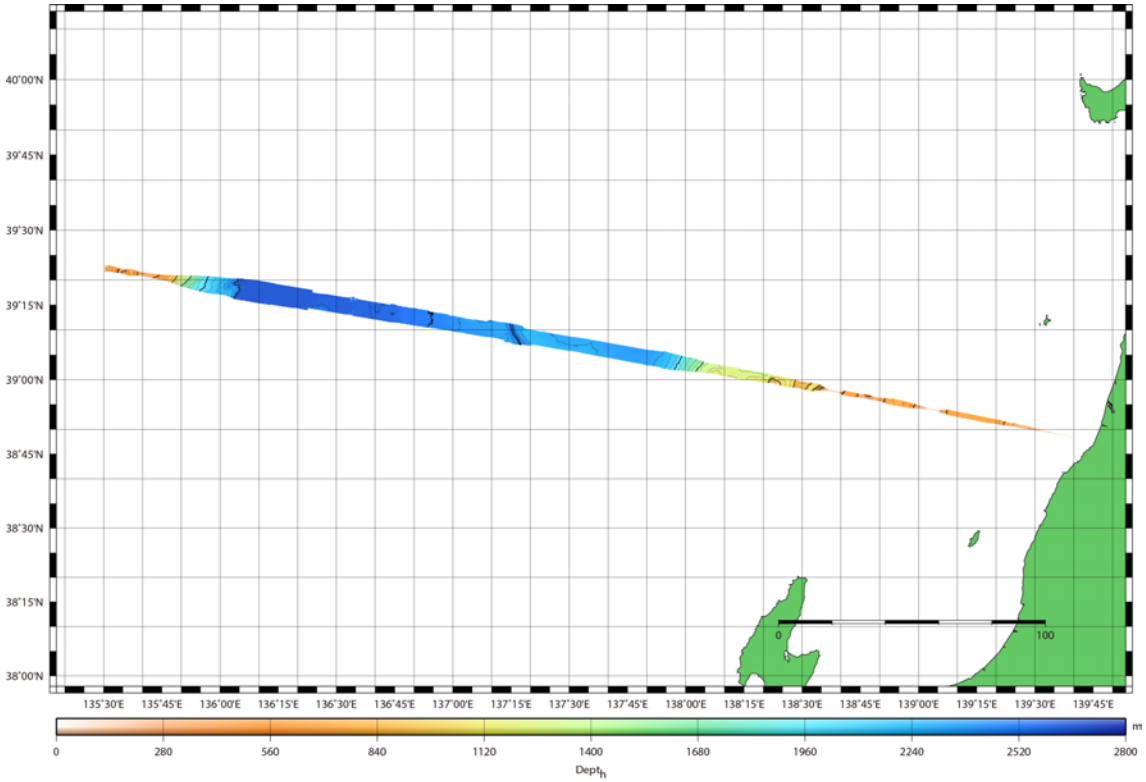


Fig. 4 Result of the bathymetric survey in this cruise.

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

Date		Remarks
2019/8/5	Mon	Departure from Miyako port and transit to the survey area
2019/8/6	Tue	OBS deployment.
2019/8/7	Wed	OBS deployment. Transit to the waiting area.
2019/8/8	Thu	Transit to the waiting area.
2019/8/9	Fri	Wait on weather off Sakata. Airgun system deployment.
2019/8/10	Sat	Airgun shooting (SJ1901[east to west], 200 m shot interval).
2019/8/11	Sun	Airgun shooting.
2019/8/12	Mon	Airgun shooting, retrieve airgun array system. OBS retrieval (Site48-34).
2019/8/13	Tue	OBS retrieval (Site32-22). Transit to the waiting area.
2019/8/14	Wed	Wait on weather in Mutsu Bay.
2019/8/15	Thu	Wait on weather in Mutsu Bay.
2019/8/16	Fri	Wait on weather in Mutsu Bay.
2019/8/17	Sat	Wait on weather in Mutsu Bay.
2019/8/18	Sun	Transit to the survey area. OBS retrieval (Site21-19).
2019/8/19	Mon	OBS retrieval (Site1-5).
2019/8/20	Tue	OBS retrieval (Site9-18).
2019/8/21	Wed	OBS retrieval (Site6-7).
2019/8/22	Thu	OBS retrieval (Site8). Transit to Hachinohe port.
2019/8/23	Fri	Arrival at Hachinohe port.
2019/8/24	Sat	End of KR19-06C cruise.

Table 3　Cruise log of KR19-06C.

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

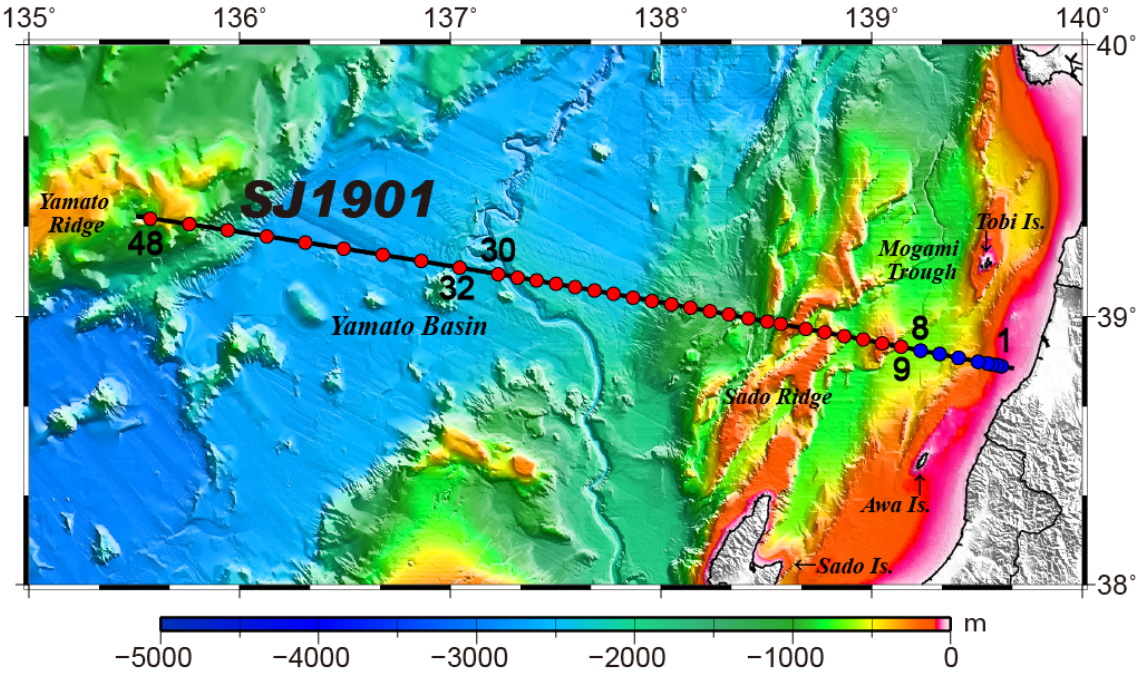


Fig. 4　Bathymetry and location maps of the survey area. Black line is the seismic line, and circles are the positions of the OBS sites (red: Type T, blue: Type K).

(5) **Seismic line list:** Table 4.

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)
SJ1901	2019/08/09	23:02:32	1001	38_48.46517'N	139_40.35133'E	53	365.0
	2019/08/09	23:02:32	1001	38_48.46517'N	139_40.35133'E	53	
	2019/08/11	15:15:11	2826	39_22.30800'N	135_30.34950'E	803	
	2019/08/11	15:15:11	2826	39_22.30800'N	135_30.34950'E	803	

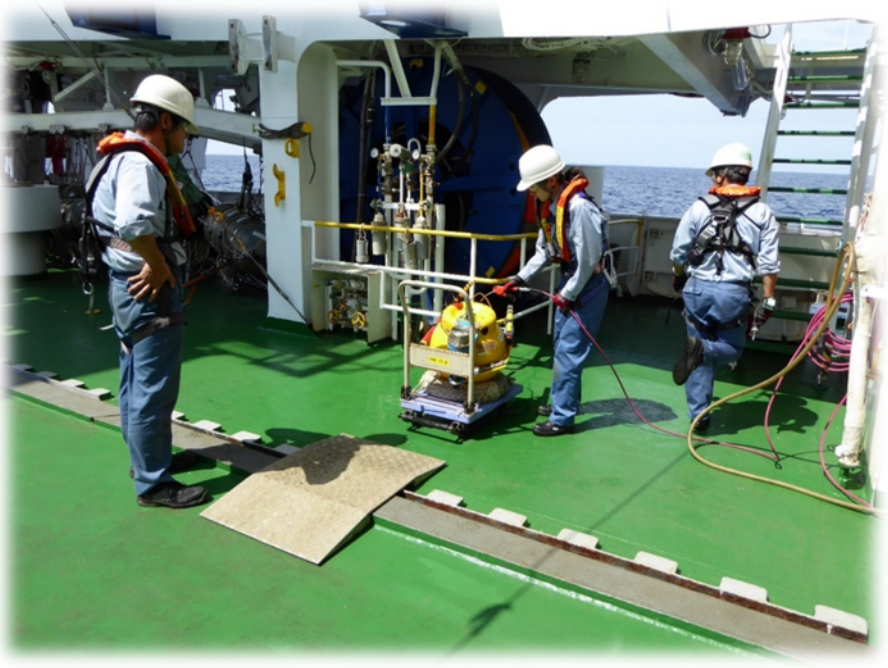
Table 4 List of seismic line.

(6) **OBS position list:** Table 5.

Type	Site No.	Lon.	Lat.	Depth (m)	Remarks
K	1	139 37.071	38 48.955	77	Positioning using SSBL
K	2	139 35.722	38 49.170	83	Positioning using SSBL
K	3	139 34.364	38 49.384	91	Positioning using SSBL
K	4	139 33.021	38 49.576	113	Positioning using SSBL
K	5	139 30.283	38 50.005	240	Positioning using SSBL
K	6	139 24.846	38 50.845	380	Positioning using SSBL
K	7	139 19.374	38 51.647	635	Positioning using SSBL
K	8	139 13.937	38 52.446	646	Positioning using SSBL
T	9	139 8.465	38 53.297	654	Location of deployment
T	10	139 3.030	38 54.108	142	Location of deployment
T	11	138 57.570	38 54.924	643	Location of deployment
T	12	138 52.112	38 55.720	652	Location of deployment
T	13	138 46.649	38 56.522	475	Location of deployment
T	14	138 41.217	38 57.318	669	Location of deployment
T	15	138 34.053	38 58.350	812	Location of deployment
T	16	138 30.293	38 58.889	851	Location of deployment
T	17	138 24.827	38 59.676	1075	Location of deployment
T	18	138 19.368	39 0.458	1205	Location of deployment
T	19	138 13.896	39 1.230	1262	Location of deployment
T	20	138 8.433	39 1.999	1242	Location of deployment
T	21	138 2.967	39 2.761	1576	Location of deployment

T	22	137	57.494	39	3.523	2055	Location of deployment
T	23	137	52.019	39	4.285	2327	Location of deployment
T	24	137	46.552	39	5.024	2367	Location of deployment
T	25	137	41.173	39	5.759	2342	Location of deployment
T	26	137	35.592	39	6.529	2296	Location of deployment
T	27	137	30.212	39	7.243	2319	Location of deployment
T	28	137	24.622	39	7.994	2277	Location of deployment
T	29	137	19.245	39	8.723	2244	Location of deployment
T	30	137	13.653	39	9.465	2318	Location of deployment
T	32	137	2.662	39	10.890	2377	Location of deployment
T	34	136	51.687	39	12.326	2528	Location of deployment
T	36	136	40.687	39	13.725	2607	Location of deployment
T	38	136	29.689	39	15.123	2619	Location of deployment
T	40	136	18.682	39	16.497	2658	Location of deployment
T	42	136	7.664	39	17.849	2658	Location of deployment
T	44	135	56.629	39	19.182	2035	Location of deployment
T	46	135	45.612	39	20.500	705	Location of deployment
T	48	135	34.577	39	21.807	459	Location of deployment

Table 5　List of OBS position.



4. Notice on using:

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.

Acknowledgement:

We thank the captain, Mr. Takafumi AOKI, and the crew of the deep sea research vessel *KAIREI*, and the marine technician team (Nippon Marine Enterprises, Ltd.) for their efforts in obtaining the OBS data, and other geophysical data. We are grateful to participants of Institute for Marine-Earth Exploration and Engineering (MarE3), Research Support Department, and Research Institute for Marine Geodynamics (IMG) in JAMSTEC for their great support in this cruise. This cruise is funded by programs called "Integrated Research Project on Seismic and Tsunami Hazards Around the Sea of Japan," which is part of the Special Coordination Funds for Promoting Science and Technology of the Ministry of Education, Culture, Sports, Science, and Technology. We used "The Generic Mapping Tools" by Wessel and Smith (1991) to construct the figures.

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