



R/V Natsushima Cruise Report

NT13-18

Geofluid imaging of back-arc region based on ocean bottom
electromagnetic survey

Japan Sea

August 9, 2013 – August 13, 2013

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

Contents

1. Cruise Information	3
2. Researchers	4
3. Observation	6
3.1 Summary of Observations	6
3.2 Research Objectives	8
3.3 Instruments	8
3.4 Operation remarks	10
3.4.1 Recovery of OBEMs	10
3.4.2 Bathymetric survey	12
4. Notice on Using	13
5. Acknowledgements	13
6. References	13
7. Appendices (Cruise Log)	14

1. Cruise Information

Cruise ID:	NT13-18	
Name of vessel:	R/V NATSUSHIMA	
Title of the cruise:	2013 Deep Sea Research Cruise with NATSUSHIMA	
Title of proposal:	S13-50 “Understanding of dehydration and ascending processes of geo-fluid in the subduction zones based on ocean bottom electromagnetic surveys”	
Cruise period:	August 9, 2013 – August 13, 2013	
Ports of call:	August 9	Dept. from Niigata port
	August 13	Arrive. at Sekine-hama (JAMSTEC)
Research area:	Japan Sea	

2. Researchers and Crews

Science Party:

Hiroshi ICHIHARA IFREE, JAMSTEC (Chief Scientist)
Takafumi Kasaya IFREE, JAMSTEC

Technical Support Staff:

Hisanori Iwamoto Nippon Marine Enterprises, Ltd.

R/V NATSUSHIMA Crew

Captain	AOKI TAKAFUMI
Chief Officer	ADACHI TATSUO
2nd Officer	TAKAHASHI TOMOYUKI
3rd Officer	IJICHI KAKERU
Chief Engineer	SHIBATA HIROYUKI
1st Engineer	KUROSE WATARU
2nd Engineer	TADOOKA NAOHITO
Jr.2nd Engineer	IKUTA SHINITI
3rd Engineer	YOSHIMURA SHOGO
Chief Electronics Operator	SUDA FUKUO
2nd Electronics Operator	KATAGIRI MICHIIYASU
3rd Electronics Operator	TAKAKUWA TATSUHIRO
Boat Swain	HOSOKAWA SEIJI
Able Seaman	FUJII YOSHITSUGU
Able Seaman	KONNO YASUO
Able Seaman	NAGAI HIROAKI
Sailor	KAWAMURA KOSEI
Sailor	NAKANISHI TORU
Sailor	KAWABE YASUNOBU
Sailor	KOJIMA SHINYA
No.1 Oiler	OISHI HIROYUKI
Oiler	SATO KAZUO
Oiler	IKEDA TOSHIKAZU
Oiler	TANAKA MASAKI
Oiler	TANIGUCHI KEIYA

Oiler	SUMITOMO SHOTARO
Chief Steward	YOSHIKAWA TERUYUKI
Steward	KIRITA KOJI
Steward	WADA TORU
Steward	OHBA HIROYUKI
Steward	NAKANO MIZUKI

Hyper-Dolphin operation team (The team is for withdrawing HPD, not operating submersible dive in this cruise)

Operation Manager	KONDO TOMOE
2nd ROV Operator	CHIDA YOSUKE
2nd ROV Operator	TAKENOUCHI ATSUSHI
2nd ROV Operator	SAIGO RYO
2nd ROV Operator	ASAI RYU

3. Observation

3.1 Summary of Observations

1) Recovery of OBEMs

We successfully recovered 6 OBEMs that were deployed in the MR13-02A cruise. The SSBL system equipped by R/V Natsushima was used to track the position of OBEMs.

2) Multi-beam echo sounder (MBES) survey

In order to obtain the bathymetric data for resistivity imaging, bathymetric surveys were conducted using the “Seabat” system equipped by R/V Natsushima.

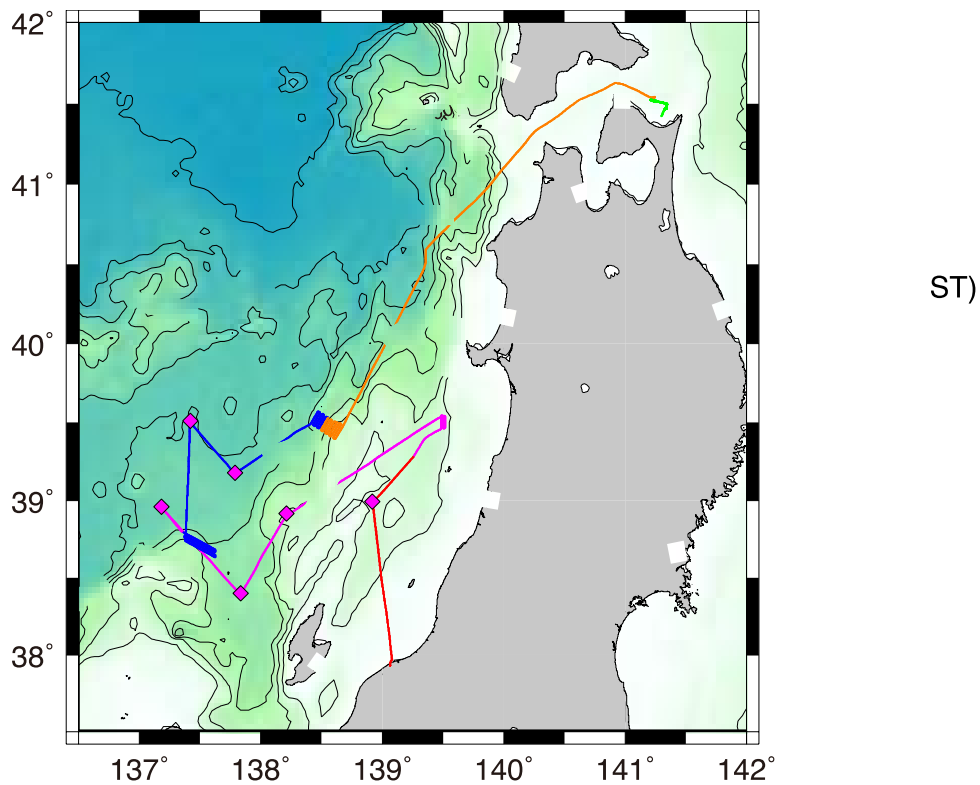


Fig. 3-1 Ship tracks of NT13-18. Purple diamonds denote OBEM sites.

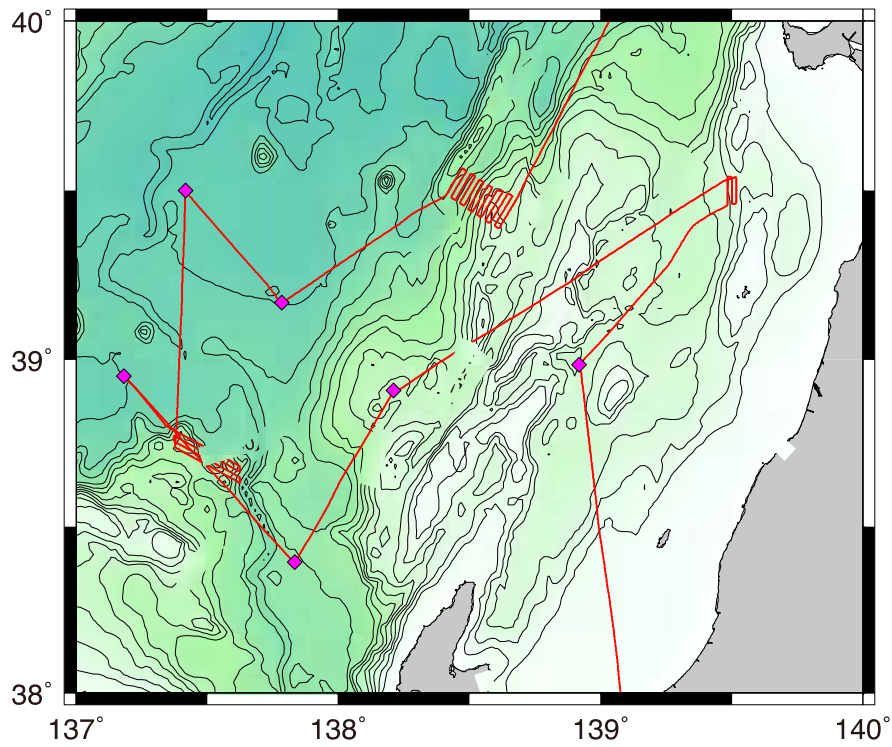


Fig. 3-2 Observation points of NT13-18 (Purple diamonds)

Table 3-1 Cruise schedule and operations

Date	Events, Operations
August 9	Departure from the Niigata port, Recovery of OBEM at site NK135
August 10	MBES survey Recovery of OBEMs at site NK134, NK137 and NK132
August 11	MBES survey Recovery of an OBEM at site NK131 and NK133
August 12	MBES survey, Transit to Yokosuka, JAMSTEC
August 13	Arrived at Yokosuka, JAMSTEC

3.2 Research Objectives

Electrical conductivity distribution gives us fundamental information to understand dynamics of subduction zone including inter-plate earthquakes and volcanic activities because it is sensitive to pore fluid and temperature in the crust and mantle. NE Japan arc is a typical field for the subduction studies. Because most of the subduction zone is located beneath the sea (**Fig. 3-3**), ocean bottom EM survey is important for our purpose. However, ocean bottom EM stations are not enough in the ocean. Especially in the eastern part of Japan Sea (back arc are of NE Japan arc), there are only four OBEM stations along latitude 39.5N (Toh et al., 2006). In this cruise, we conducted marine MT surveys with OBEMs in the eastern part of Japan Sea. In addition, we carried out multi-beam echo sounders (MBES) survey in order to obtain the data of conductive seawater distribution used for resistivity imaging.

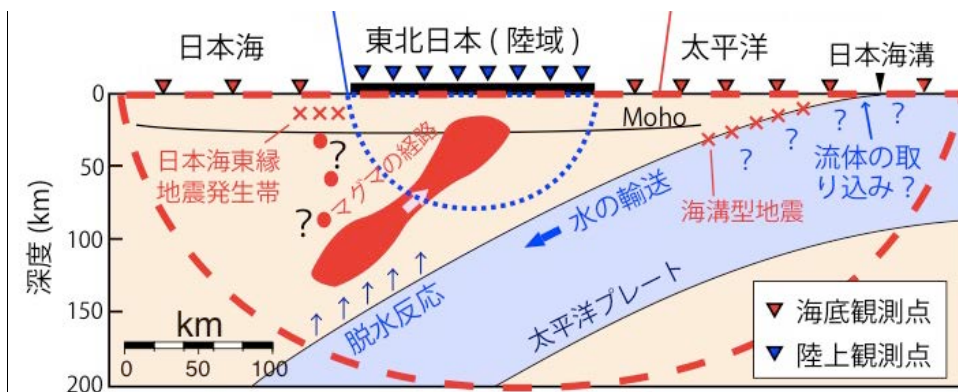


Fig. 3-3 Schematic illustration of OBEM observation and its targets

3.3 Instruments [small type ocean bottom electro-magnetometer (OBEM)]

The OBEM system can measure time variations of three components of magnetic field, horizontal electric field, the instrumental tilts, and temperature. It mainly consists of one 17-inch glass sphere, sensor unit in aluminum/titanium pressure housing and electrode arm unit with arm holding mechanism (Kasaya and Goto, 2009, **Fig. 3-4, 3-5**). The glass sphere involves data logger and a lithium battery pack. The sensor unit has a high-accuracy fluxgate magnetometer, tilt meter and thermometer. The electrodes are Ag-AgCl equilibrium type made by Clover Tech. For electric field, four voltage differences between the electrodes on the tip of the pipes and the ground electrode are measured. The electrodes were monitored their self-potentials in laboratory in advance of the seafloor observation and pairs that the coherence is high enough were selected, in order to reduce the noise due to the voltage drift of electrodes themselves. A transponder unit, radio beacon and a flashlight are also mounted on the OBEM. The acoustic system can communicate with the acoustic unit of Natsushima. Concepts of type the OBEM system are miniaturization, a high sampling rate, easy assembly and recovery

operations, and low costs of construction and operation. The arm holding mechanism, which electrode arm is folded when OBEM is in surfacing, enable recovery operation even by the small ship that do not equip A frame (**Fig. 3-6**).

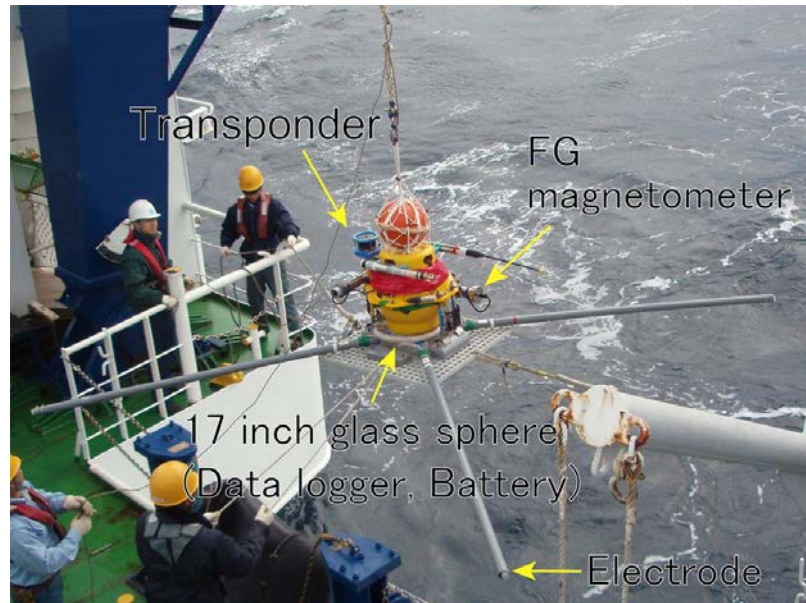


Fig. 3-4 OBEM (one glass-sphere type)

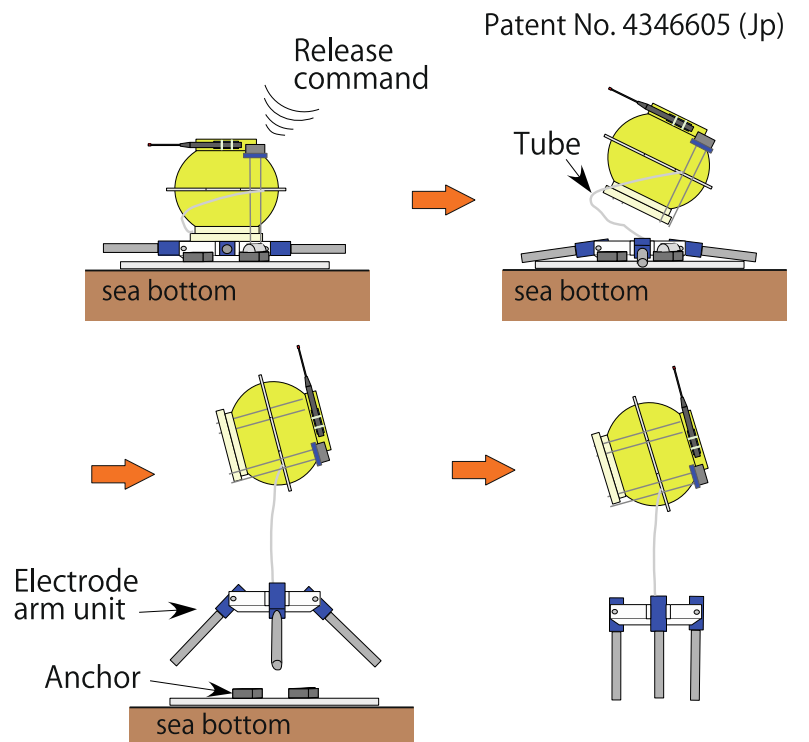


Fig. 3-5. Electrode arm-holding mechanism of the OBEM system

3.4 Operation remarks

3.4.1 Recovery of OBEMs

We retrieved six OBEMs at the sites NK131, NK132, NK133, NK134, NK135, and NK137 (**Fig. 3-2**). These OBEMs were deployed in the MR13-02A cruise. We sent the acoustic weight-release signal from the SSBL system equipped by R/V Natsushima. The OBEMs were started to ascend in the usual releasing time (16-20 minutes, **Table 7-3**). The ascent rates of the OBEMs were between 41 and 45 m/min. The OBEM was found with the ship looking and radio beacon signal soon after the surfacing. The OBEMs were hooked and lifted on deck from starboard (**Fig. 3-6**). The clock of each data logger was compared with the laptop PC synchronized by using NTP server unit connecting to GPS immediately after the boarding (**Table 3-4**). Then we removed the arm-unit, sensor unit and transponder, and checked conditions of the OBEMs. Then we opened the glass-spheres and collected the data and found about 100cc of seawater in glass-sphere of JM102. Although inside of data logger was not damaged, connectors of the logger were corroded and electrical field record of JM102 contained a lot of noises. Except for the electrical field record in JM102, high quality time series are recorded in most of the OBEM.



Fig. 3-6 Recovery of an OBEM in this cruise

Table 3-2 Positioning information of OBEMs

Site ID	OBEM ID	Acoustic code	Dipole length (m) (NS EW)		settled position		Depth (m) [※]
NK135	JM105	4B-1	4.46	4.46	38:58.9681N	138:55.0656E	807
NK134	JM102	5A-1	4.46	4.46	38:54.4343N	138:12.5884E	915
NK137	TIT02	3A-1	4.46	4.46	38:23.5722N	137:49.9874E	1832
NK132	JM101	4F-1	4.46	4.46	38:56.9633N	137:10.9157E	2412
NK131	JM100	6A-1	4.47	4.47	39:29.9978N	137:25.0496E	2482
NK133	TIT01	2B-1	4.44	4.46	39:10.0958N	137:47.1293E	2430

※ based on MBES data

Table 7-3 Recovery information

Site ID	OBEM ID	Arrived time to the site (JST)	Releasing duration (min)	Ascent rate (m/min)	On deck time (JST)
NK135	JM105	13/8/9 15:02	16	45	13/8/9 15:51
NK134	JM102	13/8/10 5:26	17	42	13/8/10 6:07
NK137	TIT02	13/8/10 9:41	16	41	13/8/10 10:50
NK132	JM101	13/8/10 15:02	20	42	13/8/10 16:28
NK131	JM100	13/8/11 5:21	16	42	13/8/11 6:41
NK133	TIT01	13/8/11 9:05	17	45	13/8/11 10:23

Table 3-4 Clock information

Site ID	OBEM ID	Clock set time (JST)	Clock compared time (JST)	Time difference (OBEM-NTP, sec)
NK135	JM105	2013-04-02T07:04:25	2013-08-09T16:04:00	+12.278
NK134	JM102	2013-04-02T09:42:29	2013-08-10T06:22:50	+15.918
NK137	TIT02	2013-04-02T13:52:18	2013-08-10T10:58:50	+17.077
NK132	JM101	2013-04-04T06:43:01	2013-08-10T18:02:29	+25.881
NK131	JM100	2013-04-03T13:40:28	2013-08-11T06:58:31	+6.307
NK133	TIT01	2013-04-03T06:50:19	2013-08-11T10:30:22	+15.679

3.4.2 Bathymetric survey

In order to obtain the data of conductive seawater distribution used for resistivity imaging, we carried out multi-beam echo sounders (MBES) survey by Seabat system equipped by R/V Natsushima. The obtained data were calibrated based on the velocity data based on expendable bathythermograph (XBT) that injected before the MBES survey around the MT stations. As a result, excellent bathymetric data were obtained (**Fig. 3-7**).

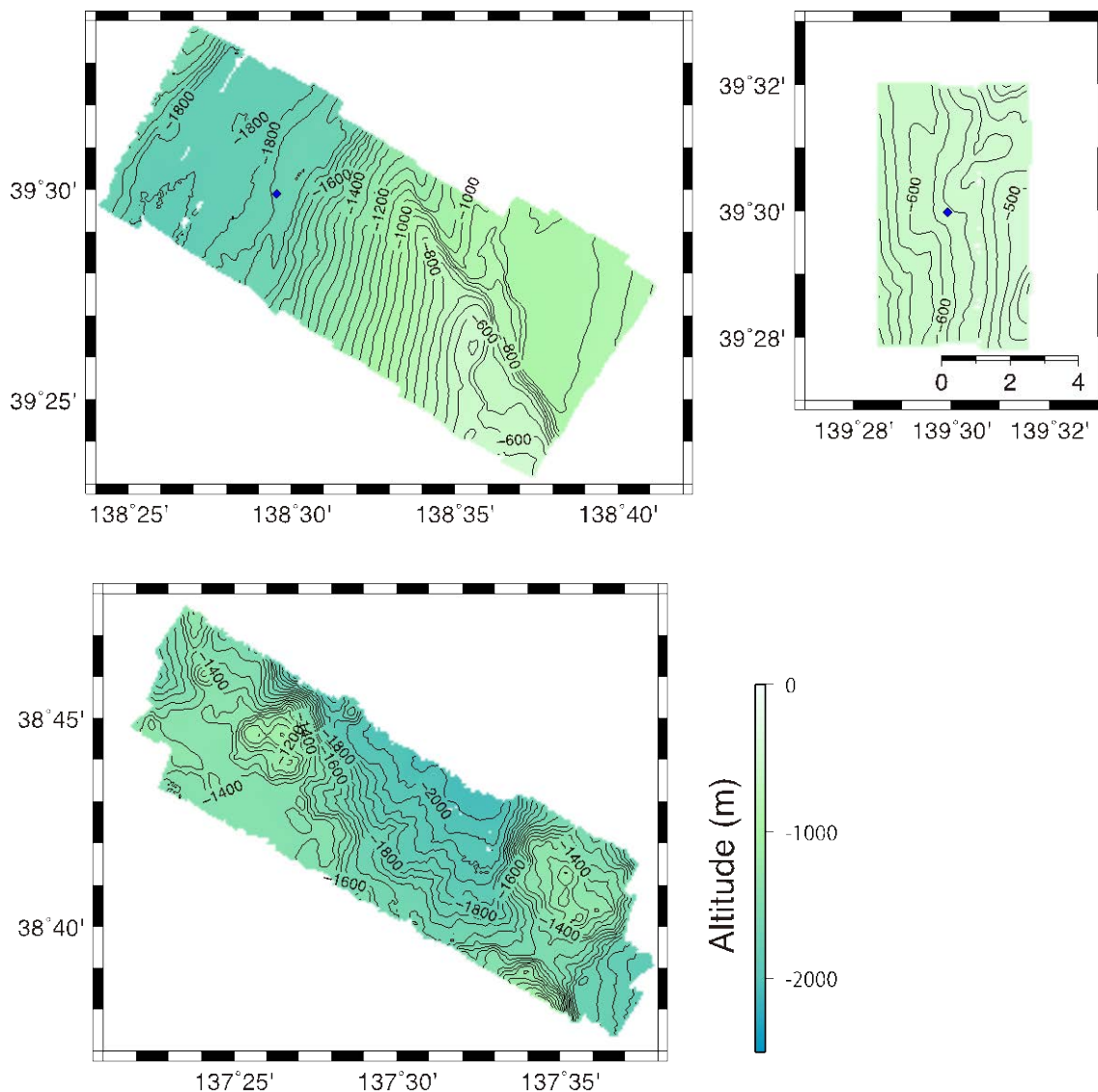


Fig. 3-7 Bathymetric map based on the MBES data acquired by NT13-18 cruise.

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.

5. Acknowledgements

We are grateful to Captain T. Aoki, the officers and the crews of the R/V Natsushima for skillful operations of the ship and research equipment. We also thank to Dr. H. Iwamoto for great assistance in research works throughout the cruise. The staff of the Operation Group, Research Vessel Management and Operations Department, Marine Technology Center, Mr. Y. Yamamuro made excellent arrangements for the cruise. Generic Mapping Tools software (Wessel and Smith, 1998) was used to draw some of the figures. The research conducted on this cruise was partly supported by Japan Society for the Promotion of Science and Ministry of Education, Culture, Sports, Science and Technology through Grant-in Aids for Scientific Research (24109707).

6. References

- Kasaya, T., and T. Goto, A small OBEM and OBE system with an arm folding mechanism, *Exploration Geophysics*, **40**, 41-48, 2009.
- Toh, H., K. Baba, M. Ichiki, T. Motobayashi, Y. Ogawa, M. Mishina and I. Takahashi, Two-dimensional electrical section beneath the eastern margin of Japan Sea, *Geophys. Res. Lett.*, **33**, 22, L22309, doi: 10.1029/2006GL027435, 2006.
- Wessel, P., and W. H. F. Smith, New, improved version of the Generic Mapping Tools released, *EOS Trans. AGU*, **79**, 579, 1998.

7. Appendix (Cruise log)

Date	Local Time	Description	Position/Weather/Wind/Sea condition
09-Aug-13	08:00	scientists onboard	8/9 12:00 (UTC+9h)
	08:55	departure from Niigata-ko port, Niigata	38-28.0N,139-00.0E
	14:45	arrive at research area	cloudy
	14:47	released XBT	SW-4 (moderate breeze)
	15:11	send release commamd to OBEM NK135	3 (sea slight)
	15:30	OBEM left bottom	2 (Low swell long)
	15:46	OBEM come up to the surface	Visibly: 6'
	15:51	OBEM on deck	
	19:23-21:24	MBES survey	
10-Aug-13	05:28	send release commamd to OBEM NK134	8/10 12:00 (UTC+9h)
	05:45	OBEM left bottom	38-32.0N,137-40.0E
	06:08	OBEM come up to the surface	cloudy
	06:14	OBEM on deck	WSW-4 (moderate breeze)
	09:43	send release commamd to OBEM NK137	3 (sea slight)
	10:00	OBEM left bottom	2 (Low swell long)
	10:45	OBEM come up to the surface	Visibly: 3'
	10:49	OBEM on deck	
	15:06	send release commamd to OBEM NK132	
	15:26	OBEM left bottom	
	16:22	OBEM come up to the surface	
	16:28	OBEM on deck	
	17:54	released XBT	
	18:07-	start MBES survey	
11-Aug-13	-00:57	finish MBES survey	8/11 12:00 (UTC+9h)
	05:25	send release commamd to OBEM NK131	39-19.0N,138-05.5E
	05:42	OBEM left bottom	fine but cloudy
	06:41	OBEM come up to the surface	West-3 (gentle breeze)
	06:46	OBEM on deck	2 (sea smooth)

	09:07	send release commamd to OBEM NK133	2 (Low swell long)
	09:25	OBEM left bottom	Visibly: 3'
	10:18	OBEM come up to the surface	
	10:22	OBEM on deck	
	13:48-23:52	MBES survey	
12-Aug-13		transit to Sekinehama	8/12 12:00 (UTC+9h)
			41-15.5N,140-11.2E
			fine but cloudy
			WSW-4 (moderate breeze)
			2 (sea smooth)
			2 (Low swell long)
			Visibly: 8'
13-Aug-13	10:30	arrive at JAMSTEC mutsu institute Sekinehama, AOMORI	8/7 12:00 (UTC+9h)
			Sekinehama