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MR13-02A Cruise Report

R/V "MIRAI"

Geofluid imaging of subduction zone based on ocean bottom electromagnetic survey

Japan Sea
April 1 – April 6, 2013

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

Contents

1. Cruise Information

Cruise ID: MR13-02A

Name of vessel: R/V MIRAI

Title of the cruise: 2013 Research Cruse with MIRAI

Chief scientist: Hiroshi ICHIHARA [JAMSTEC]

Representative of the Science Party:
Hiroshi ICHIHARA [JAMSTEC]

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: April 1, 2013 – April 6, 2013

Ports of call: April. 1 Dept. from Sekinehama (JAMSTEC)
April. 6 Arriv. at Shimonoseki (MHI)

Research area: East part of Japan sea

2. Researchers

Chief Scientist / Representative of the science party:

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Science Party:

Hiroshi ICHIHARA	IFREE, JAMSTEC
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Yuuki Ohwatari	MARITEC , JAMSTEC

Technical Support Staff:

Toshimitsu Goto	Global Ocean Development

3. Observation

3.1 Summary of Observations

1) Bathymetry survey

In order to confirm the sea floor condition of OBEM settled point and to obtain the bathymetric data for resistivity imaging, bathymetric surveys were conducted using the "Seabeam" system equipped by R/V MIRAI.

2) Deployment of OBEMs

We deployed OBEMs at six stations on the east part of Japan Sea. Using the acoustic system equipped by R/V Mirai, we determined settled position of OBEMs.

3) Measurement of acoustic noise

We took down hydrophone and measured acoustic noise emitted from the ship to investigate source of noise contaminated in the streamer cable of Portable type Multi Channel Seismic Survey (PMCS).

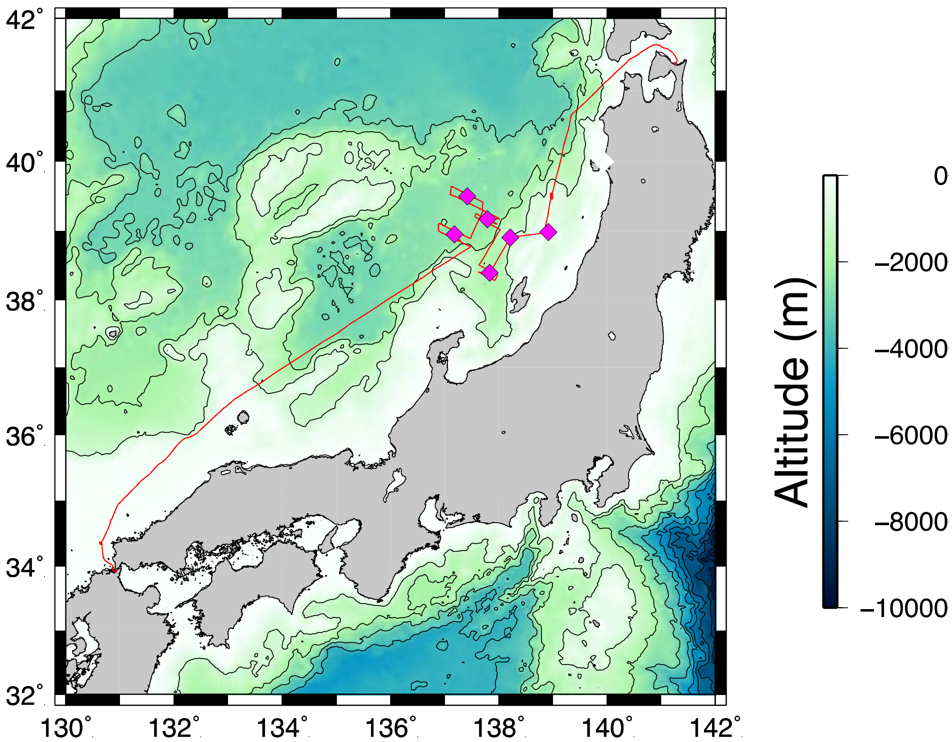


Fig. 3.1.1 Ship tracks of MR13-02A. Purple diamonds denote OBEM sites.

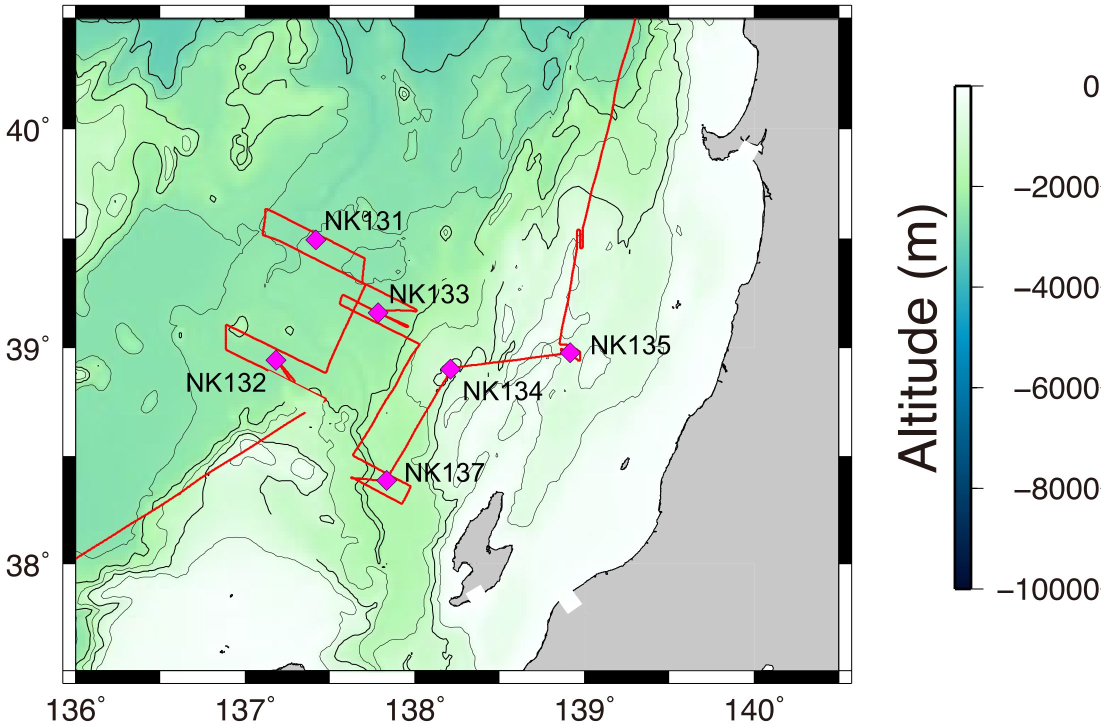


Fig. 3.1.2 Observation points of MR13-02A (Purple diamonds)

Table 3.1.1. Cruse schedule and operations

Date	Events, Operations
April 1	Departure from JAMSTEC (Sekinehama)
April 2	Arrived at research area Carried out MBES mapping survey. Deployed OBEMs at sites NK135, NK134 and NK137
April 3	Deployed OBEMs at sites NK133 and NK131
April 4	Deployed OBEMs at site NK132
April 5	Transit to Yokosuka, JAMSTEC
April 6	Arrived at MHI (Shimonoseki)

3.2 Research Objectives

3.2.1 Electirical resistivity distribution in the back arc region in NE Japan arc

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 covered with seawater (**Fig. 3.2.1**), 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 cruse, we conducted marine MT surveys with OBEMs in the eastern part of Japan Sea. In addition, we carried out multi-beam echosounders (MBES) survey in order to confirm whether the topography is suitable for deployment of OBEM and to obtain the data of conductive seawater distribution used for resistivity imaging,

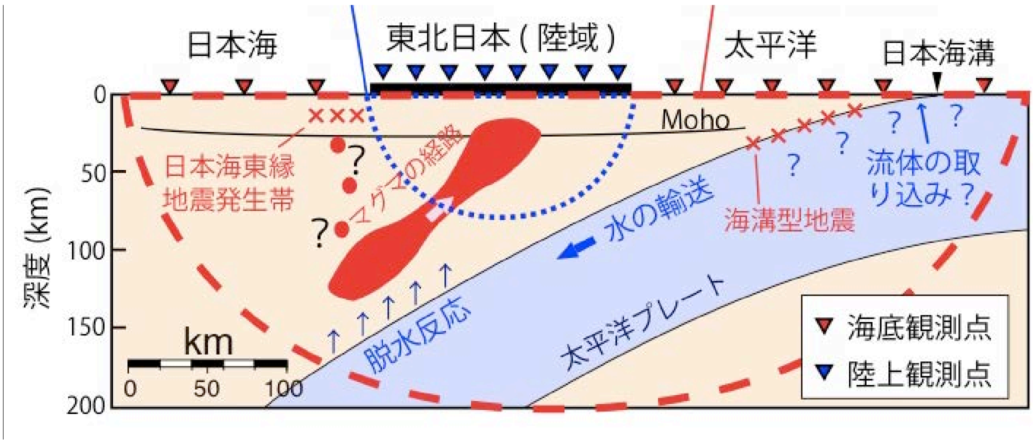


Fig. 3.2.1. Schematic illustration of OBEM observation and its targets

3.2.2 Acoustic noise measurement

Acoustic noise emitted from the R/V Mirai is possibly contaminated in the streamer cable of Portable type Multi Channel Seismic Survey (PMCS). Thus we measured acoustic noises in a few part of "Mirai" using a hydrophone.

3.3 Instruments (Ocean bottom electro-magnetometers)

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 (**Fig. 3.3.1**). 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 flash light are also mounted on the OBEM. The acoustic system can communicate with the acoustic unit of Mirai. 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. 3.3.2,** Kasaya et al., 2006; Kasaya and Goto, 2009).

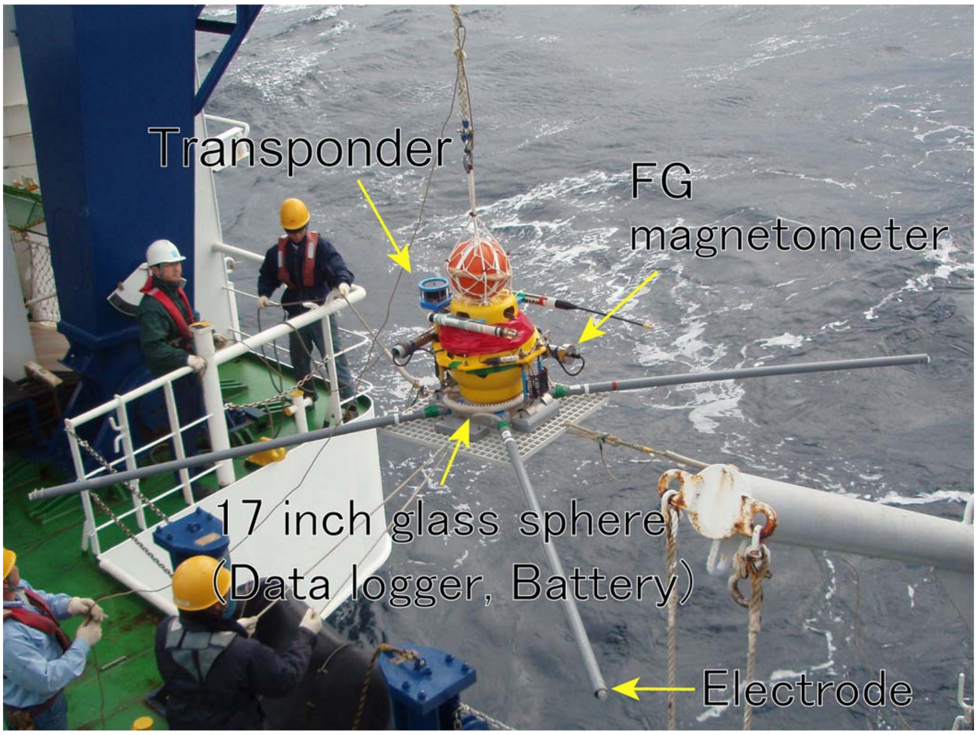


Fig. 3.3.1 OBEM (deployment)

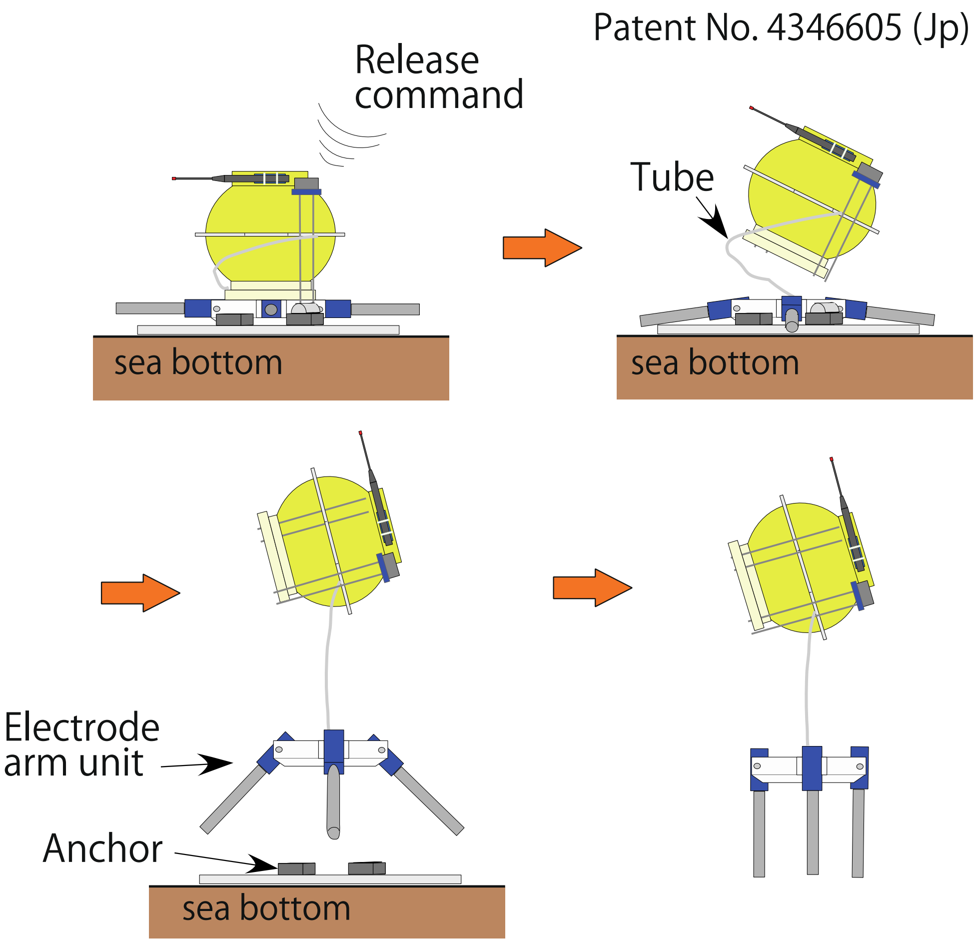


Fig. 3.3.2. Electrode arm-holding mechanism of the OBEM

3.4 Operations and preliminary results

3.4.1 Bathymetric survey

In order to confirm whether the topography is suitable for deployment of OBEM and to obtain the data of conductive seawater distribution used for resistivity imaging, we carried out multi-beam echosounders (MBES) survey by Seabeam system equipped by R/V Mirai. 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. 3.4.1**).

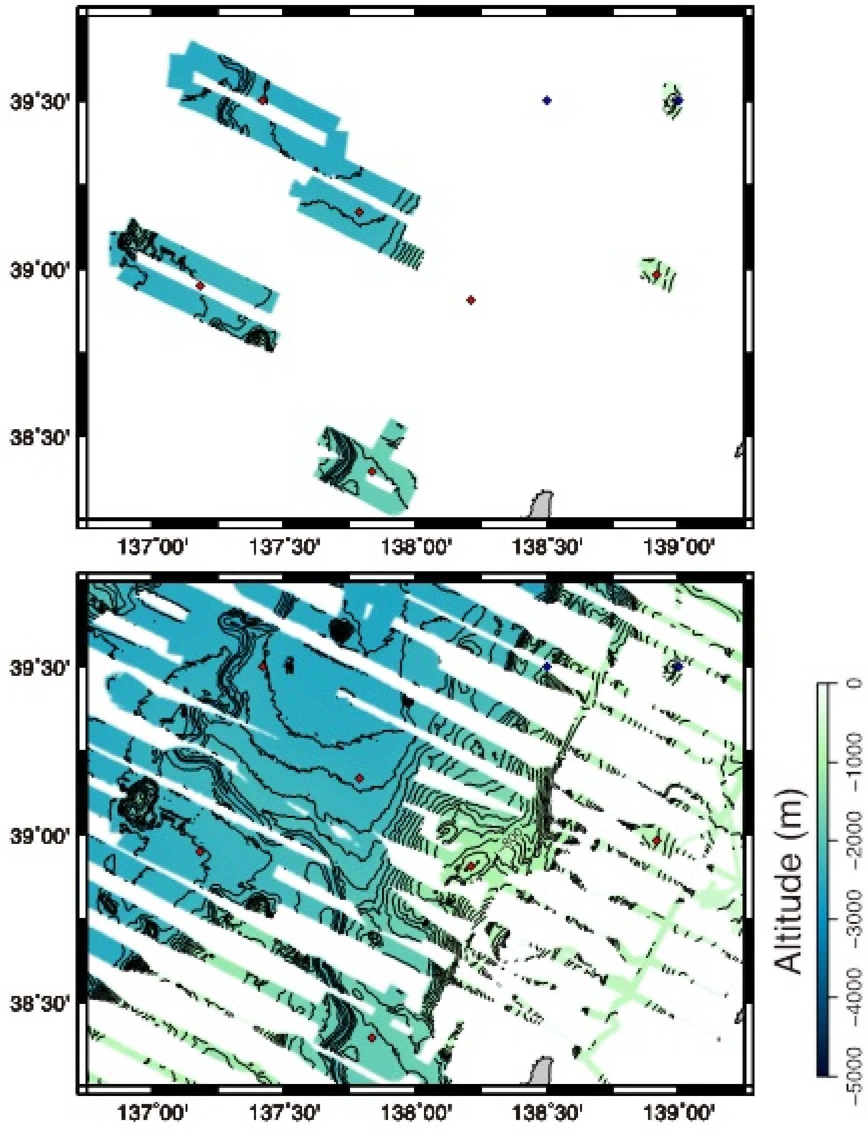


Fig. 3.4.1 (above) Bathymetric map based on the MBES data acquired by MR13-02A cruise. The red diamonds denote OBEM stations. (below) Bathymetric map based on MR13-02A cruise and existing data.

3.4.2 Deployment of OBEM

We deployed six OBEMs in this cruse in the eastern part of Japan Sea. The OBEM sites are located on west extension of the land MT sites by the “Geofluid” project. Specifications of OBEMs (acoustic code, the beacon frequency, and the electric dipole length) are listed in **Table 3.4.1**. JM105, JM102 and TIT02 were deployed on April 2 at site NK135, NK134 and 137, respectively. TIT01 and JM100 were deployed on April 3 at site NK133 and NK131, respectively. JM101 was deployed on April 4 at site NK132. All of the OBEMs were successfully deployed without any trouble. The clocks of OBEM were synchronized before deployment by using laptop PC using USB communication. The laptop PC is synchronized NTP server unit connecting to GPS immediately before setting of the OBEM system (**Table 3.4.2**). After we settled OBEM (e.g. the sampling schedules, **Table 3.4.3**), the OBEMs were launched from the stern using A-frame (**Fig. 3.4.2**). We tracked distance of OBEM from the ship using acoustic system equipped by R/V Mirai. Descend rates were between 43 and 49 m/min (**Table 3.4.2**). These OBEMs will be recovered by R/V Natsushima cruse planed in August 2013.

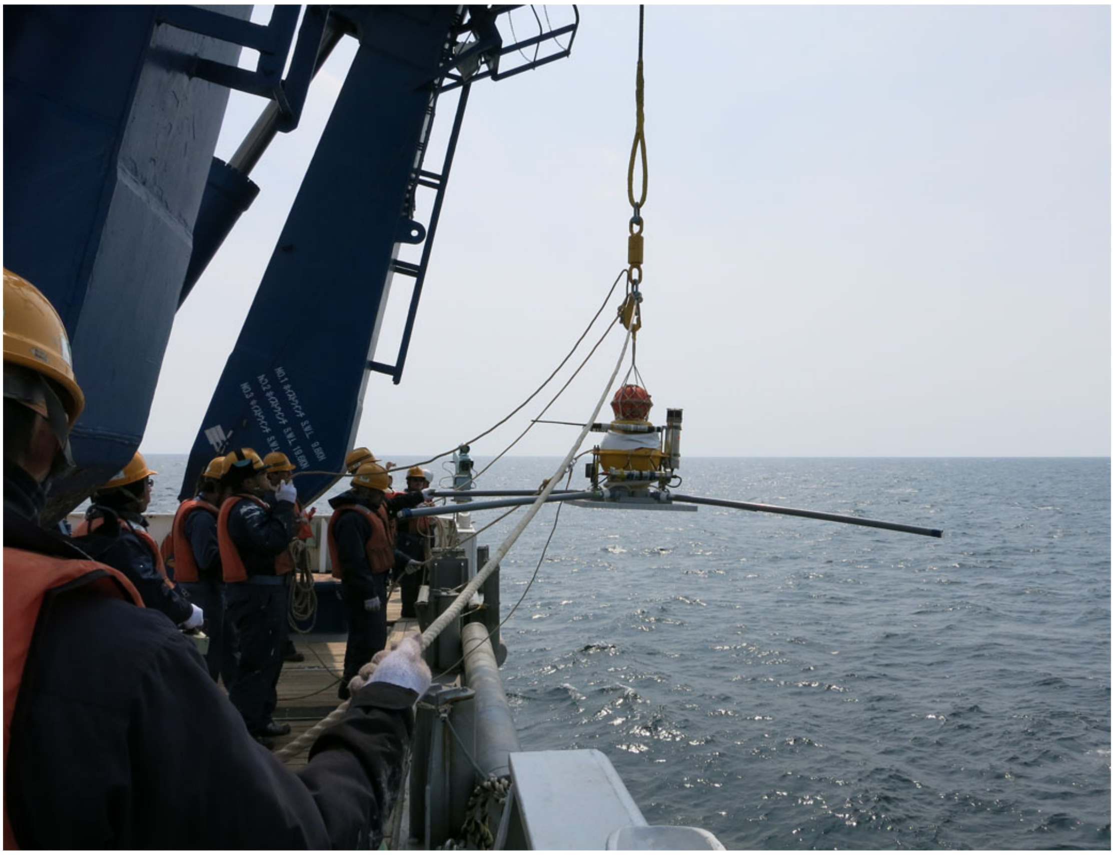


Fig. 3.4.2 Launching of OBEM using A-frame

Table 3.4.1 Specification of OBEMs

site ID	OBEM ID	T/P code	T/P ID	Becon ID	Becon Freq.	Becon code	Flasher ID	Dipole length(m) NS	EW
NK135	JM105	4B-1	JX1168	J?08-009	43.528MHz	JS142	S12-020	4.46	4.46
NK134	JM102	5A-1	JX1190	S12-028	43.528MHz	JS1363	W09-010	4.46	4.46
NK137	TIT02	3A-1	JX1196	T02-291	43.528MHz	JS1399	T02-478	4.46	4.46
NK133	TIT01	2B-1	JX1195	U02-098	159.250MHz	-	U03-060	4.44	4.46
NK131	JM100	6A-1	JX1191	S11-038	159.200MHz	-	S11-021	4.47	4.47
NK132	JM101	4F-1	JX1189	T12-022	159.150MHz	-	S12-019	4.46	4.46

Table 3.4.2 Deployment information of OBEMs

site ID	OBEM ID	clock set time (JST)	Launched time (JST)	Settled time (JST)	descent rate (m/min)
NK135	JM105	2013-04-02T07:04:25	2013-04-02T08:05	8:22	48.5
NK134	JM102	2013-04-02T09:42:29	2013-04-02T12:02	12:22	46.9
NK137	TIT02	2013-04-02T13:52:18	2013-04-02T16:04	16:46	45.6
NK133	TIT01	2013-04-03T06:50:19	2013-04-03T08:00	8:53	48.1
NK131	JM100	2013-04-03T13:40:28	2013-04-03T14:36	15:30	47.1
NK132	JM101	2013-04-04T06:43:01	2013-04-04T08:01	8:58?	43.6?

Table 3.4.3 Sampling Schedules of OBEMs

site ID	Obs start time1	Obs end time1	smpl. Rate1	Obs start time2	Obs end time2	smpl. Rate2	Obs start time3	Obs end time3	smpl. Rate3
NK135	13-04-04 09:00:00	13-04-11 08:59:00	30s	13-04-11 09:00:00	13-05-12 08:59:00	8Hz	13-05-12 9:00:00	99-99-99 99:99:99	30s
NK134	13-04-04 09:00:00	13-04-11 08:59:00	30s	13-04-11 09:00:00	13-05-12 08:59:00	8Hz	13-05-12 9:00:00	99-99-99 99:99:99	30s
NK137	13-04-04 09:00:00	13-04-11 08:59:00	30s	13-04-11 09:00:00	13-05-11 08:59:00	8Hz	13-05-11 9:00:00	99-99-99 99:99:99	30s
NK133	13-04-04 09:00:00	13-04-11 08:59:00	30s	13-04-11 09:00:00	13-05-12 08:59:00	8Hz	13-05-12 9:00:00	99-99-99 99:99:99	30s
NK131	13-04-04 09:00:00	13-04-11 08:59:00	30s	13-04-11 09:00:00	13-05-11 08:59:00	8Hz	13-05-11 9:00:00	99-99-99 99:99:99	30s
NK132	13-04-04 10:00:00	13-04-11 08:59:00	30s	13-04-11 09:00:00	13-05-12 08:59:00	8Hz	13-05-12 9:00:00	99-99-99 99:99:99	30s

3.4.3 Positioning of OBEM

After we confirmed setting of OBEMs on the seafloor, distances from ship to OBEM were measured in three directions. Then we estimated settled positions based on the distances using least squared method. The location seems to be determined precisely because RMS of the position is less than 1 m for all the site (**Fig. 3.4.3**). Note that we did not used SSBL system equipped by R/V Mirai in this cruise.

(a) site NK131 **(b) site NK132**

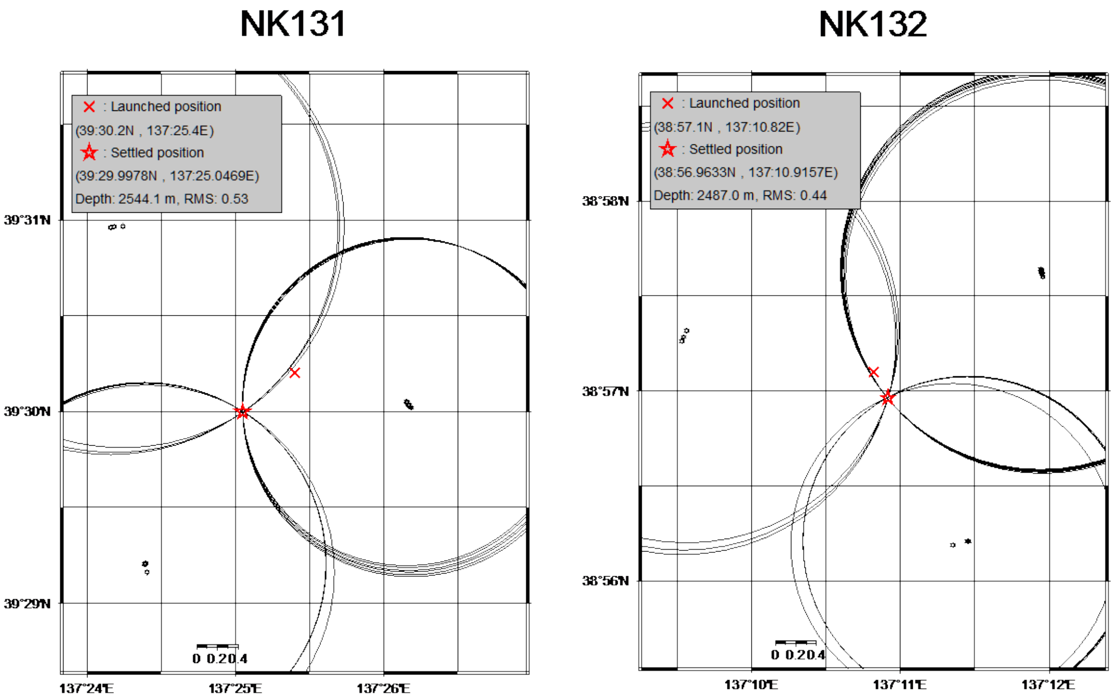
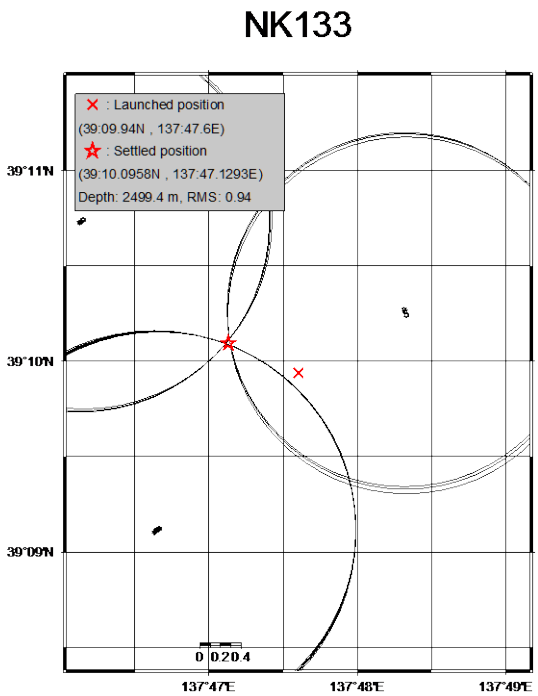
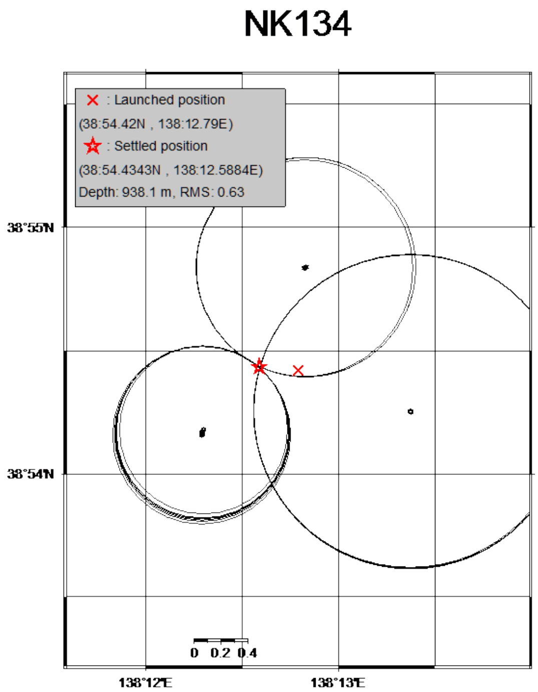


Fig. 3.4.3 Launched and settled locations of OBEMs.

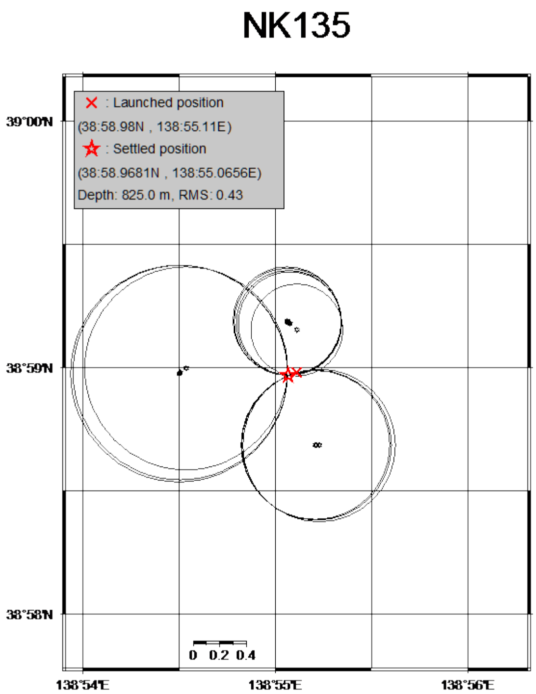
(c) site NK133



(d) site NK134



(e) site NK135



(f) site NK137

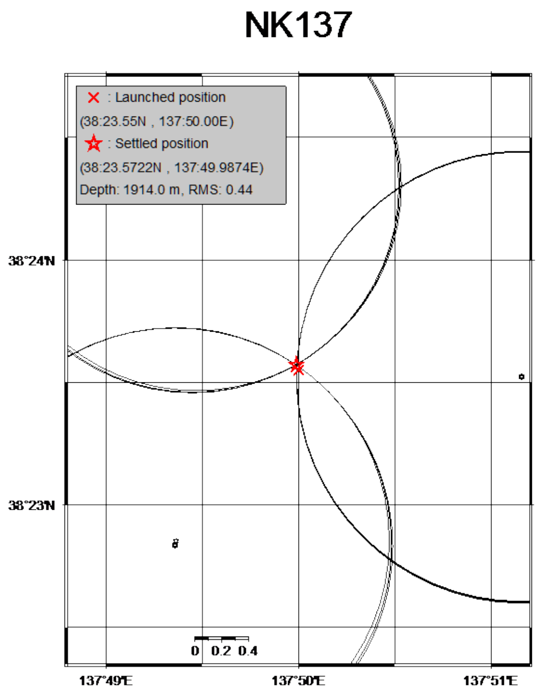


Fig. 3.4.3 Launched and settled locations of OBEMs (continued).

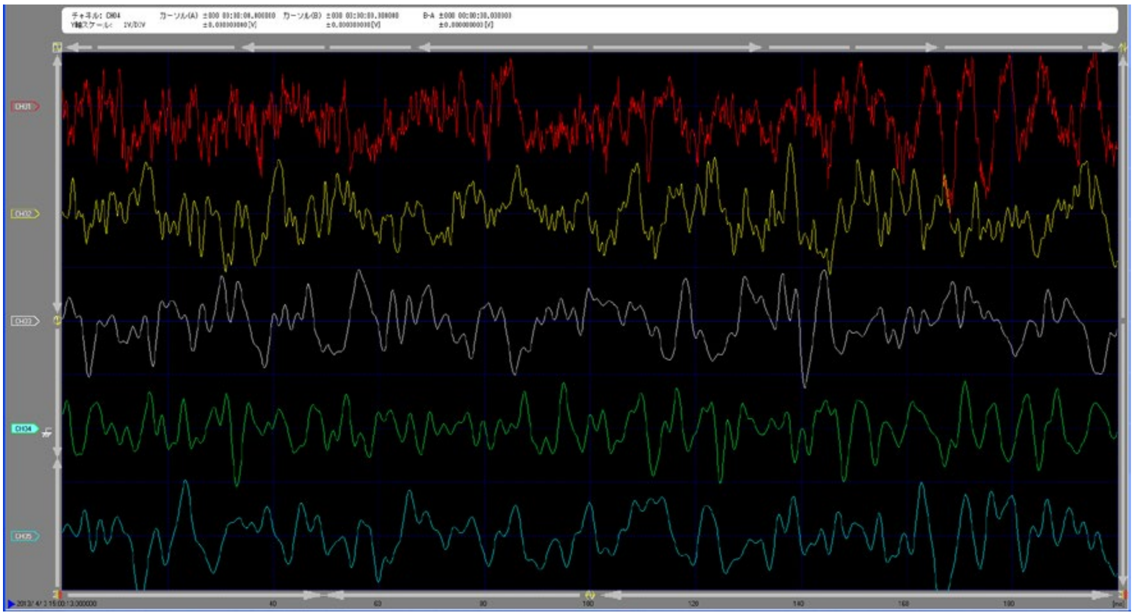
3.4.4 Acoustic noise measurement

While acoustic position of OBEM were measured, we taken down a hydrophone from the sides of ship and put it at 20 m deep (**Fig. 3.4.4**). Then we measured acoustic noise emitted from the ship. The acquired noise data serves as reference for determine source of noise mixed in the streamer cable of Portable type Multi Channel Seismic Survey (PMCS) (**Fig. 3.4.5**).

(a) (b)

Fig. 3.4.4. (a) Falling of the hydrophone (b) Towing of the hydrophone.

(a)



(b)

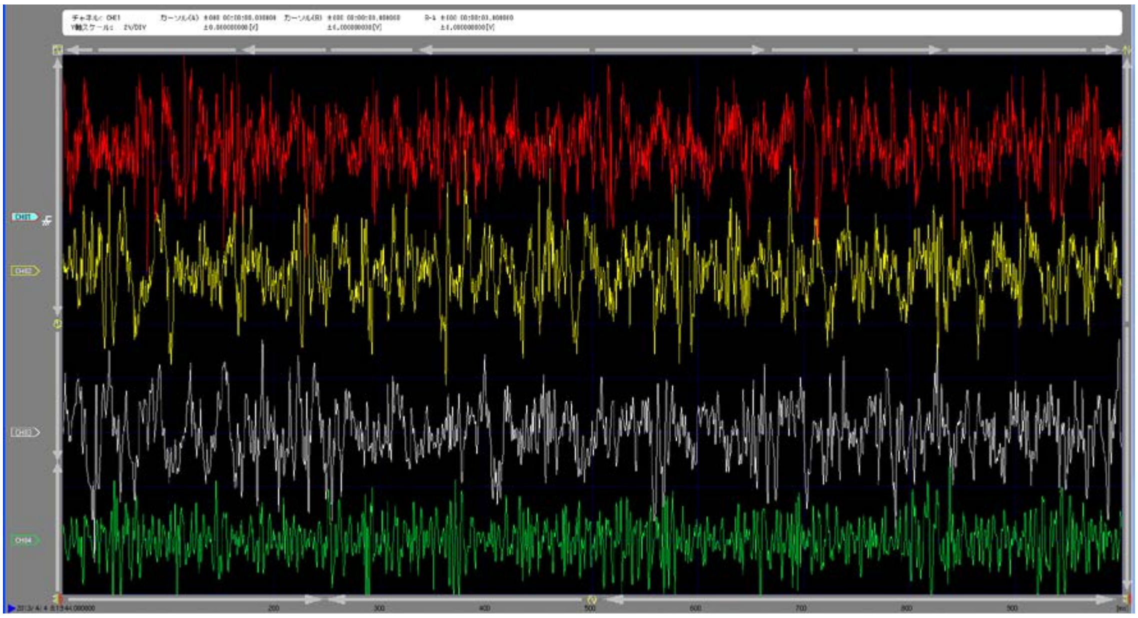


Fig. 3.4.5 (a) Sample of noise data (OKI) acquired at center of portside of Mirai. (b) Sample of noise data (HTI) acquired at centrer of stern (towed at 2knt).

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 Y. Ishioka and the crews of the R/V Mirai for skillful operations of the ship and research equipment. We also extend our thanks to T. Goto and Mr. Furuta from GODI, Dr. H. Iwamoto and Ms. Serizawa from NME for giving us great assistance in research works throughout the cruise and preparation of the observation. We also thank Ms. M. Inada and other staffs from MARITEC, JAMSTEC to arrange 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

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