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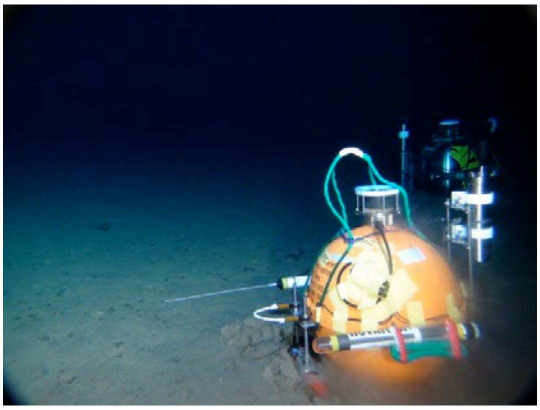
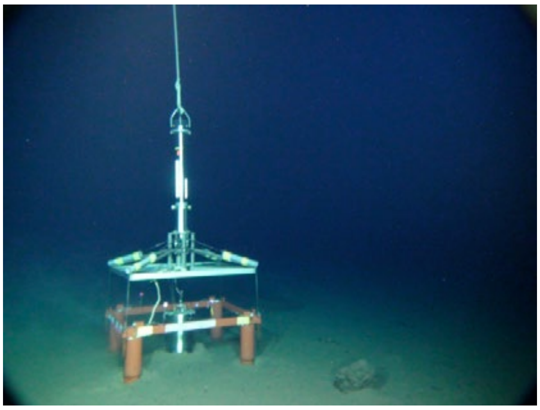
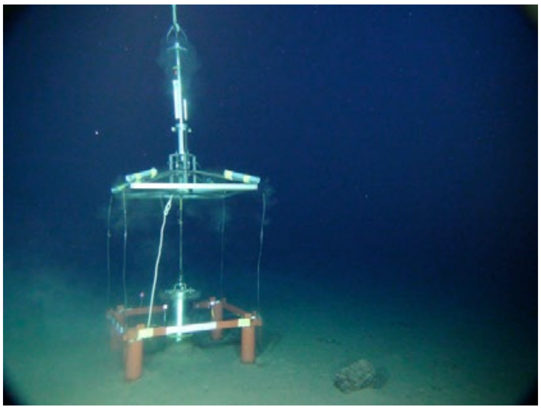
KAIREI Cruise Report

KR13-03

Research Dives by KAIKO-7000II

Philippine Sea

Feb., 4 – 11, 2013

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

Content

Cover photos (from upper left to lower right):
One scene of a sunset in this cruise, the OBEMC and the OBDC on the seafloor, the NUDOBS in the observation state and in beginning of the recovery state.

1. Cruise Information

1.1. Cruise Number

KR13-03

1.2. Ship Name

KAIREI

1.3. Title of the Cruise

Research dives by KAIKO7000II

1.4. Title of Proposals

Experimental studies for development of ocean bottom instruments in the next generation

1.5. Cruise Period

Feb., 4 – 11, 2013

1.6. Port Call

JAMSTEC, Yokosuka – JAMSTEC, Yokosuka

1.7. Research Area

Philippine Sea

1.8. Research Map

Refer to Figure 1.

2. Researchers

2.1. Chief Scientist

Hajime Shiobara [ERI, Univ. Tokyo]

2.2. Representative of Science Parties

Hajime Shiobara [ERI, Univ. Tokyo]

2.3. Science Parties

Hajime Shiobara [ERI, Univ. Tokyo, chief]

Kiyoshi Baba [ERI, Univ. Tokyo, co-chief]

Hiroko Sugioka [IFREE, JAMSTEC, support]

Aki Ito [IFREE, JAMSTEC, support]

Masanao Shinohara [ERI, Univ. Tokyo, land support]

Takehi Isse [ERI, Univ. Tokyo, land support]

2.4. Captain, crew and KAIKO operation team

2.4.1. Captain and crew of the R.V. KAIREI

Captain	MASAYOSHI ISHIWATA
Chief Officer	HIROAKI MASUJIMA
2nd Officer	MOTOI KATSUMATA
3rd Officer	YUKI DEGURA
Chief Engineer	TADASHI ABE
1st Engineer	KAZUNORI NOGUCHI
2nd Engineer	TAKAHIRO MORI
3rd Engineer	SHOGO YOSHIMURA
Jr.3rd Engineer	KOTA KATAOKA
Jr.3rd Engineer	YOICHI YASUE
Chief Electronics Operator	TOKINORI NASU
2nd Electronics Operator	MICHIYASU KATAGIRI
3rd Electronics Operator	TAKAYUKI MABARA
Boat Swain	TADAHIKO TOGUCHI
Able Seaman	YASUO KONNO
Able Seaman	YUKI YOSHINO
Able Seaman	HIROAKI MURASE
Sailor	SHUN ABE
Sailor	SHUN MIURA
Sailor	YASUNOBU KAWABE
Sailor	SHINYA KOJIMA
No.1 Oiler	HIROYUKI OISHI
Oiler	KAZUO SATO
Oiler	SHINYA SUGI
Oiler	MASANORI UEDA
Assistant Oiler	SHOTARO SUMITOMO
Chief Steward	TERUYUKI YOSHIKAWA
Steward	YOSHINOBU HASATANI
Steward	TORU WADA
Steward	KIYOTAKA KOSUJI
Steward	KANA YUASA

2.4.2. KAIKO operation team

Operation Manager	ATSUMORI MIURA
2^{nd} ROV Operator	KIYOSHI TAKISHITA
2^{nd} ROV Operator	TOMOE KONDO
2^{nd} ROV Operator	TETSUYA ISHIZUKA
2^{nd} ROV Operator	ATSUSHI TAKENOUCHI
2^{nd} ROV Operator	SEIJI SHIGETAKE
3^{rd} ROV Operator	RYU ASAI
3^{rd} ROV Operator	TAKUMA GOTO

2.5. Marine Technician

Satomi MINAMIZAWA [Nippon Marine Enterprises, LTD]

3. Observation

3.1. Purpose and background

The general purpose of this cruise is the practical test observation of our newly developed instruments, the broadband ocean bottom seismometer of the next generation with tilt measurement (BBOBST-NX), the new ultra deep ocean bottom seismometer (NUDOBS), and the vector tsunami meter (VTM). The BBOBST-NX has the same construction of the BBOBS-NX, which is already in practical use, except for the additional function to obtain mass position signals from two horizontal components of the broadband sensor. The NUDOBS is the OBS of a completely new concept design that can be deployed up to 10000 m depth without using any underwater cables and the traditional anchor releasing system. Some experimental OBSs in such deep water had been tried several times since 1989, but there were no good results from the viewpoint of the instrumental development. The VTM is a combination of the ocean bottom electro-magnetometer (OBEM) and the differential pressure gauge (DPG) as the new integrated instrument, which is aimed to detect the tsunami's direction and strength by using the pressure signal of the DPG and the magnetic field signal of the magnetometer, which is induced by the long wave of the tsunami. To know the environment around these instruments, the ocean bottom Doppler current profiler (OBDC) is also used.

Demands for array observation of the electric and magnetic (EM) field on seafloor have been increasing recently with recognitions, e.g., that electrical conductivity imaging can contribute to constrain water distribution in crust and mantle. To respond this demands, we have developed a new ocean bottom electro-magnetometer (NOBEM), which has higher data quality, lower power consumption, and downsized package compared with conventional instruments. In this cruise, we tested the NOBEM in practical environment in the first time to check the deployment and recovery works and the data quality.

3.2. Observations

The BBOBST-NX, the OBDC, the NUDOBS and the VTM were already deployed closely each other at the T08 site (about 4900m depth) in the southwestern tip of the Shikoku Basin (Fig. 1), since November 2012 during the KR12-18 cruise. Additionally, the ocean bottom electro-magnetic current profiler (OBEMC) for comparison with the OBDC and the NOBEM for the first in-situ observation were deployed during this cruise.

3.3. Method and Instruments

Although the BBOBS-NX has been applied for our large-scale research project, the goal of the development is still far away, because the goal is the BBOBS-NX of capability to operate without the ROV, like as the self pop-up type OBS. In this observation, as the first step to realize it, the effect of existing a large object, the recording unit, upper inside of the sensor unit was examined. The OBDC was also deployed to measure the environmental condition, mainly to record the bottom current data. As it is the first test for the NUDOBS that is designed as the free-fall deployment and self pop-up recovery type OBS, all its function at the seafloor should be checked from the ROV through the dive in the KR12-18 cruise and the recovery dive of this cruise. This time, the second function, releasing the anchor, was observed. For the VTM, it was the first observation to examine its function, too. With the BBOBST-NX and the OBDC deployed nearby, seismic and tilt signals in a long period range and the bottom current data will be used to examine the VTM data to understand its performance in detail. To measure the slow bottom current as less than 10 cm/s, the OBDC is not adequate due to its principle, especially in the seawater with less suspended substance. The OBEMC for the deep water is based on the current profiler recently developed, which can detect slow water movement well less than 1 cm/s.

NOBEM is a pop-up type marine instrument to measure time variations of the EM field. The instrumental tilt and temperature on the flux-gate sensor and the electric circuit are also measured for correction of the data. We adopted two titanium pressure cases for housing electro-magnetometer, acoustic transponder, and battery packs and a 17 inch glass sphere and two 10 inch glass sphere floats. Ag-AgCl electrodes are mounted on the tip of pipes elongated to lateral four directions. The dipole length is 4.75 m. The pipes are holed to vertical downward when the instrument is ascending from seafloor. The weight release system is electric corrosion of a stainless thin plate. A radio beacon and a flash light are also mounted, which are smaller than conventional ones.

3.4. Research Result

On February 6th, 2013, we deployed the NOBEM and the OBEMC at station T08 in the Shikoku Basin. Including instruments previously deployed, all units were located within about 500 m of distance as shown in Fig. 2a. The NOBEM descended to 4900 m deep seafloor with speed of -42.2 m/min, drifting about 420 m in N68W direction from the launched point. Most of drift was occurred by surface water current. The settled position was estimated by triangulations. The coordinate of NOBEM is shown in Table 1. Estimated coordinates with the constant velocity of 1500 m/s and measurement positions of slant ranges for the BBOBST-NX, the NUDOBS, the OBDC, the OBEMC, and the VTM are shown in Fig. 3. For the NUDOBS and the VTM, there was no additional measurement in this cruise.

On February 7th, the KAIKO7000II dive (#590) was performed. At first, the OBEMC was found and moved close to the OBDC (Fig. 2b). Next, at the BBOBST-NX, the recording unit was settled at the above position of the sensor unit (Fig. 4). The recording was already activated when the ROV was approaching to it via the underwater acoustic communication. Finally, the ROV visited the NUDOBS, and watched the second function of the new acoustic transponder, releasing the anchor. This time, between the main part of the NUDOBS and the anchor, there was a thin rope not to start ascending. Then, it started to recover the NUDOBS attaching a hook at the top of the float section. The data of the NUDOBS was completely obtained. The NOBEM was recovered in the same day, too. It started ascending 9.5 minutes after we sent acoustic release command from the vessel and then reached to the surface with the speed of - 50.2 m/min. The NOBEM was caught at the starboard side of the vessel by crew and hoisted up to working deck. Fig. 5 shows the NOBEM when it was deployed and recovered. NOBEM successfully recorded the data. The observed raw time series data are shown in Fig. 6. From the data during the descending, the attitude of the NOBEM was calculated. The NOBEM was slightly inclined (7–8º) to the side of smaller titanium case and horizontally rotated about 360º by reaching to the seafloor (Fig. 7). The magnetic field data are well correlated with those observed by the VTM. Further detailed analysis is necessary to assess the quality of NOBEM data.

On February 8th, the second KAIKO7000II dive (#591) was performed. The BBOBST-NX was recovered with additional equipment for the test observation. Before the recovery, it was stopped the recording, and the measurement of the force to extract the sensor unit from the sediment was conducted, which required about 80 kgw in maximum. During the dive we should wait more than 2.5 hours due to invisibility, it made us to postpone the recovery of the OBDC and the OBEMC in the same day. The BBOBST-NX worked well as we expected.

From the early morning of February 9th, self pop-up recoveries of the OBDC, the OBEMC and the VTM were performed and completed without any problem. All of them worked well during their observation periods. Signals associated with the tsunami occurred near the Saint Cruz Islands on February 6th were recorded by the VTM, the OBEMC and also by the NOBEM, but not by the OBDC due to its resolution limit of current and pressure measurements.

3.5. Cruise Log

Date	Local Time	Note	Description	Position/Weather/ Wind/Sea condition
04-Feb-13		**Sail out, proceeding to research area**		02/04 12:00 (UTC+9h)
	08:00	boarded		34-45.3N, 139-34.7E
	09:00	let go all shore line, left YOKOSUKA	for Shikoku basin	East off IZU-OHSHIMA
	10:30-10:35	carried out onboard education & training for scientists		Overcast
	13:00-13:25	practiced Life boat, fire and collision station drill		SW-5 (Fresh breeze)
				3 (Sea slight)
				1 (Low swell shot)
				Visibly: 8'
05-Feb-13		**Proceeding to research area**		02/05 12:00 (UTC+9h)
	10:00-10:30	meeting with officer, operation manager, and scientist		29-34.5N, 138-34.0E
				Southeast off TORI-SHIMA
				Overcast
				NE-2 (Light breeze)
				2 (Sea smooth)
				2 (Low swell log)
				Visibly: 8'
06-Feb-13		**Deploy OBEMC / NOBEM**		02/06 12:00 (UTC+9h)
	06:50	arrived at research area		25-46.0N,137-00.5E
	06:57	deployed XBT @ 25-45.6147'N, 137-00.1338'E		Shikoku basin
	08:16	deployed NOBEM @ 25-45.9189'N, 137-00.4865'E	Depth = 4907m	Fine but cloudy
	09:32	deployed OBEMC @ 25-45.8737'N, 137-00.6195'E	Depth = 4906m	SW-5 (Fresh breeze)
	11:00-12:02	carried out SSBL calibration		3 (Sea slight)

	12:20-12:45	carried out figure eight turning		2 (Low swell log)
				Visibly: 2'
07-Feb-13		**ROV KAIKO7000II dive 590**		02/07 12:00 (UTC+9h)
	07:42	hoisted up KAIKO 7000II		25-45.9N, 137-00.6E
	07:47	launched KAIKO 7000II, and started 7K#590 dive operation		Shikoku basin
	10:32	landed at sea bottom	Depth = 4917m	Rain
	12:46	left bottom	Depth = 4921m	NE-2 (Light breeze)
	15:14	hoisted up KAIKO 7000II		2 (Sea smooth)
	15:28	recovered KAIKO 7000II		2 (Low swell log)
	16:19	recovered NUDOBS		Visibly: 5'
	16:37	recovered NOBEM		
	18:38-19:00	carried out figure eight turning		
08-Feb-13		**ROV KAIKO7000II dive 591**		02/08 12:00 (UTC+9h)
	07:26	hoisted up KAIKO 7000II		25-46.0N, 137-00.5E
	07:31	launched KAIKO 7000II, and started 7K#591 dive operation		Shikoku basin
	10:09	landed at sea bottom	Depth = 4916m	Cloudy
	14:06	left bottom	Depth = 4917m	NW-4 (Moderate breeze)
	16:28	hoisted up KAIKO 7000II		3 (Sea slight)
	16:38	recovered KAIKO 7000II		2 (Low swell log)
	17:15	recovered BBOBST-NX		Visibly: 8'
09-Feb-13		**Recover OBEMC, OBDC, and VTM**		02/09 12:00 (UTC+9h)
	06:50	recovered OBEMC @ 25-45.7713'N, 137-00.2947'E	Depth = 4780m	26-23.8N, 137-05.0E
	08:06	recovered OBDC @ 25-45.9500'N, 137-00.2842'E	Depth = 4780m	Shikoku basin
	08:59	recovered VTM @ 25-46.0083'N, 137-00.0772'E	Depth = 4780m	Overcast
	09:00	commenced proceeding to YOKOSUKA-SHIN-KO		NNE-5 (Fresh breeze)

				4 (Sea moderate)
				4 (Moderate average)
				Visibly: 8'
10-Feb-13		**Proceeding to YOKOSUKA-SHIN-KO**		02/10 12:00 (UTC+9h)
				32-05.0N, 137-51.1E
				Southwest off AOGASHIMA
				Fine but cloudy
				West-4 (Moderate breeze)
				3 (Sea slight)
				2 (Low swell log)
				Visibly: 8'
11-Feb-13		**Arrived at YOKOSUKA-SHIN-KO**		02/11 12:00 (UTC+9h)
	09:00	Arrived at YOKOSUKA-SHIN-KO		
	10:00	disembarked from KAIREI		
		finished KR13-03 cruise		

3.6. Dive Information

3.6.1. Dive Numbers

590 and 591

3.6.2. Payloads

The remote commander for the acoustic transponder (590 and 591)
Hooks for recovery the NUDOBS (590)
The plate for the recording unit of the BBOBST-NX (590 and 591)
The base for the test of the BBOBST-NX (591)
Hooks for recovery the BBOBST-NX (591)
The spring scale for the sensor unit of the BBOBST-NX (591)

4. Acknowledgements

We thank for the captain and crew of R.V. KAIREI, the KAIKO operation team and a scientific support staff of NME. This study is partly supported by KAKENHI (23540489).

5. Notice on using

This cruise report is a preliminary documentation as of the end of the cruise. It may not be corrected even if changes on content (i.e. taxonomic classifications) are found after publication. It may also be changed without notice. Data on the cruise report may be raw or not processed. Please ask the Chief Scientist for the latest information before using.

Users of data or results of this cruise are requested to submit their results to Data Integration and Analysis Group (DIAG), JAMSTEC.

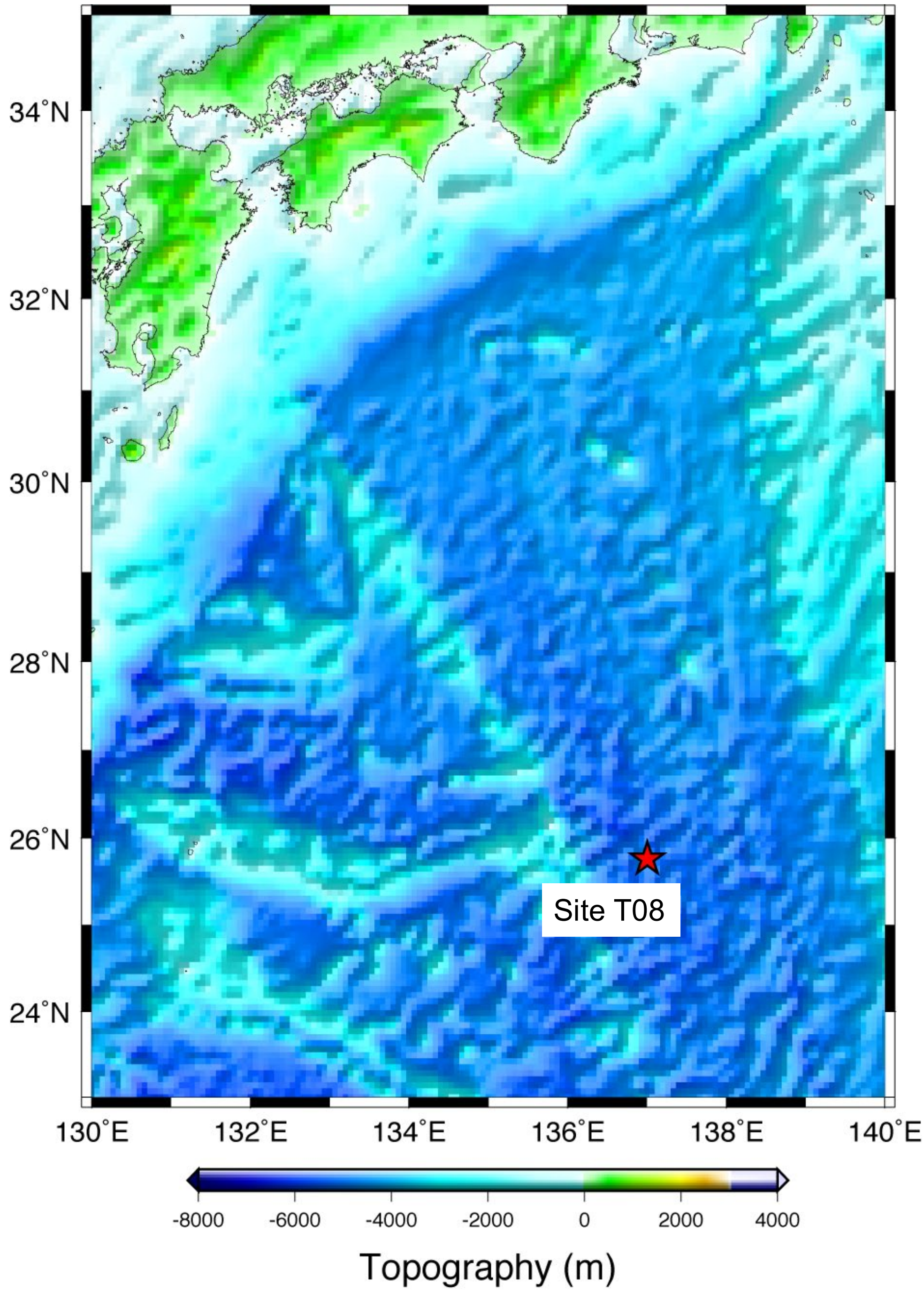
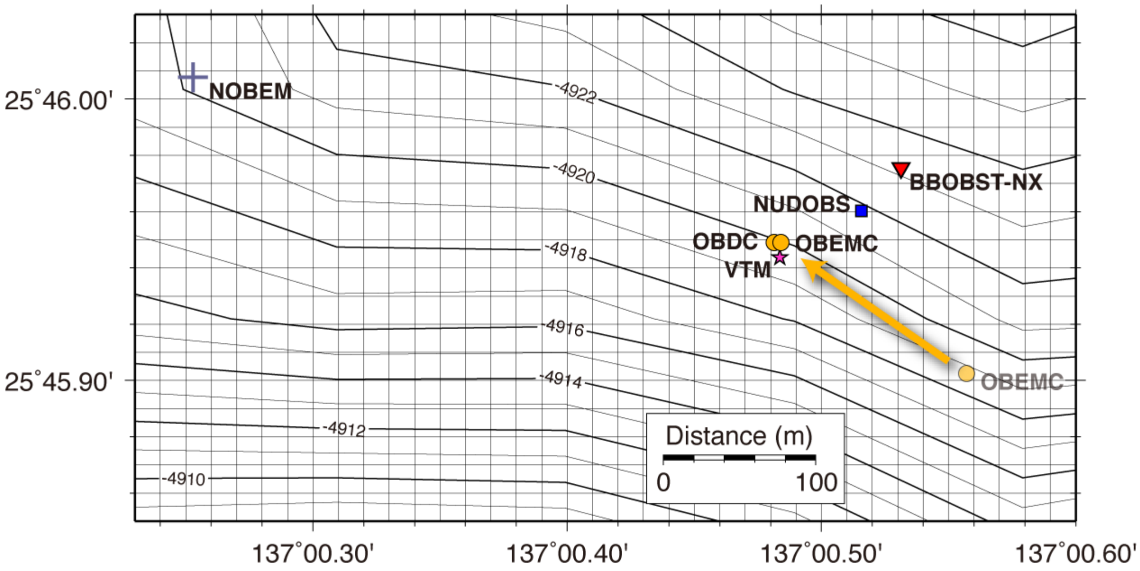
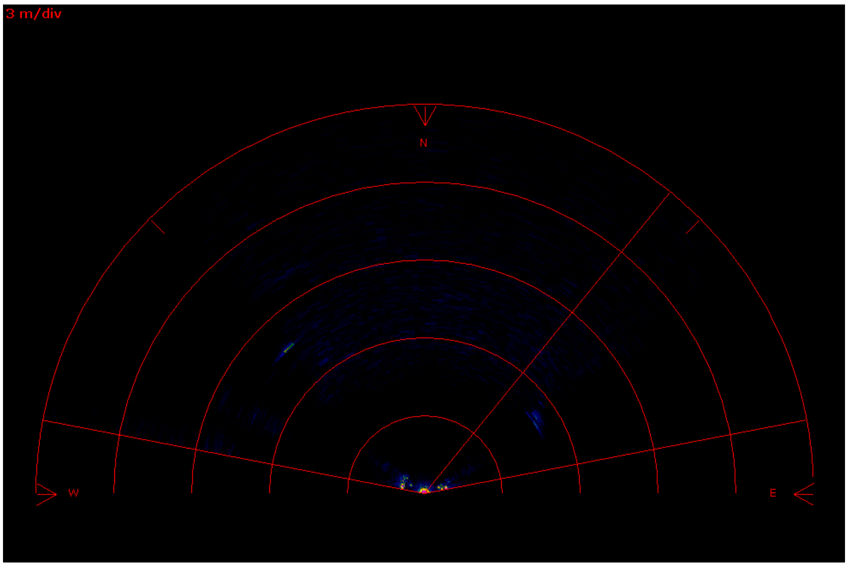


Figure 1. Research map.

Site T08: Broadband seismic observation station (depth: 4900 m)



(a)



(b)

Figure 2. Location of instruments.

(a) The map of the BBOBST-NX, the NUDOBS, the OBDC and the VTM were deployed in the KR12-18 cruise. The OBEMC was landed about 140 m southeastward from the VTM, and it was moved to nearby the OBDC, about 4 m of distance as shown in (b). The NOBEM was gliding away about 400 m during the descending. All instruments were recovered in the KR13-03 cruise by the KAIKO7000II or self-popup operations.
(b) The sonar display capture of the KAIKO7000II, when it was at the side of the OBEMC about 1 m of distance with heading to 279°N, and the range is 3 m/div. Echoes at the right side is the OBDC and the other in the left side is the VTM.

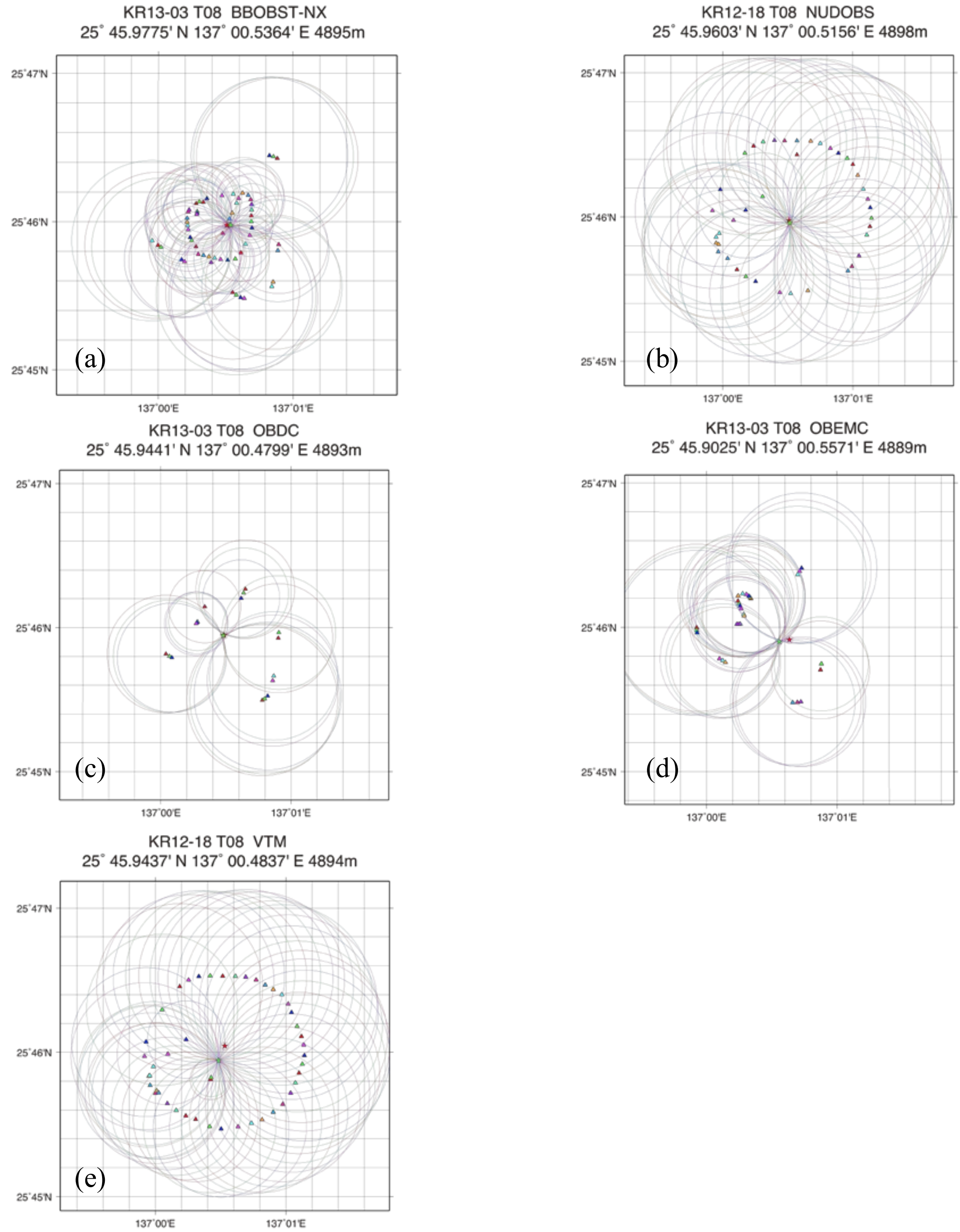


Figure 3. Results of instrument positioning except for the NOBEM.

At the top of each figure, the cruise name of which the positioning was performed, the name of the instrument and the position determined are shown for (a) the BBOBST-NX, (b) the NUDOBS, (c) OBDC, (d) OBEMC before moving, and (e) the VTM. Due to the positioning error, relative positions between the OBDC and the VTM were not the true when we found them at the seafloor.

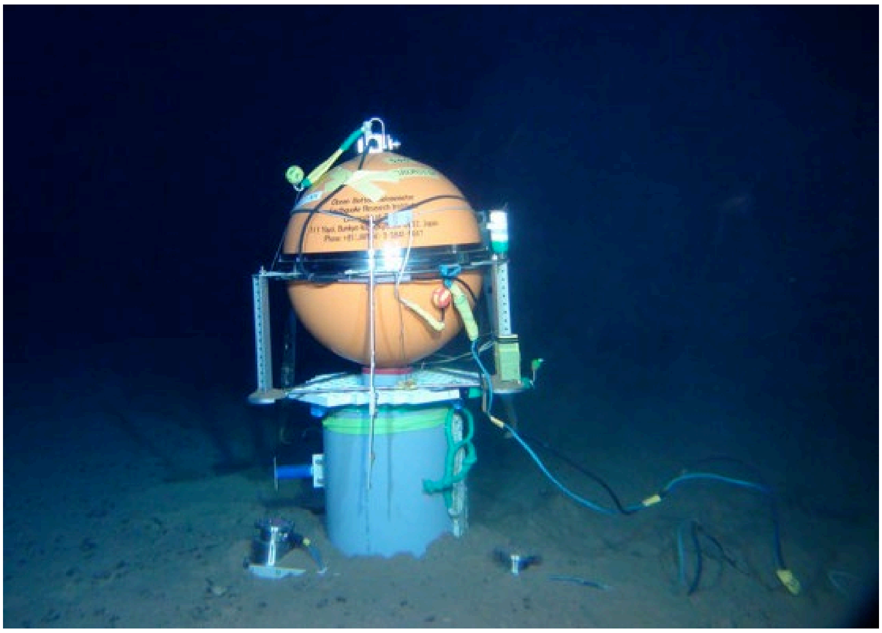
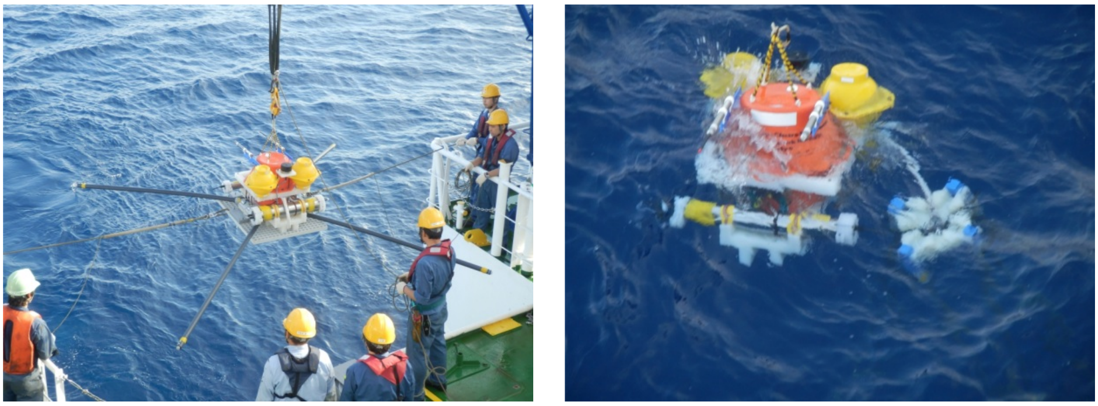


Figure 4. The BBOBST-NX during the test for the next stage.

To realize the self pop-up function for the BBOBS-NX, the effect of a large object at the center of the sensor unit on the noise level was examined. Of course, there was no mechanical connection between the object and the sensor unit, which should become a source of the noise induced by the bottom current.



(a) (b)

Figure 5. The NOBEM in (a) deployment and (b) recovery.

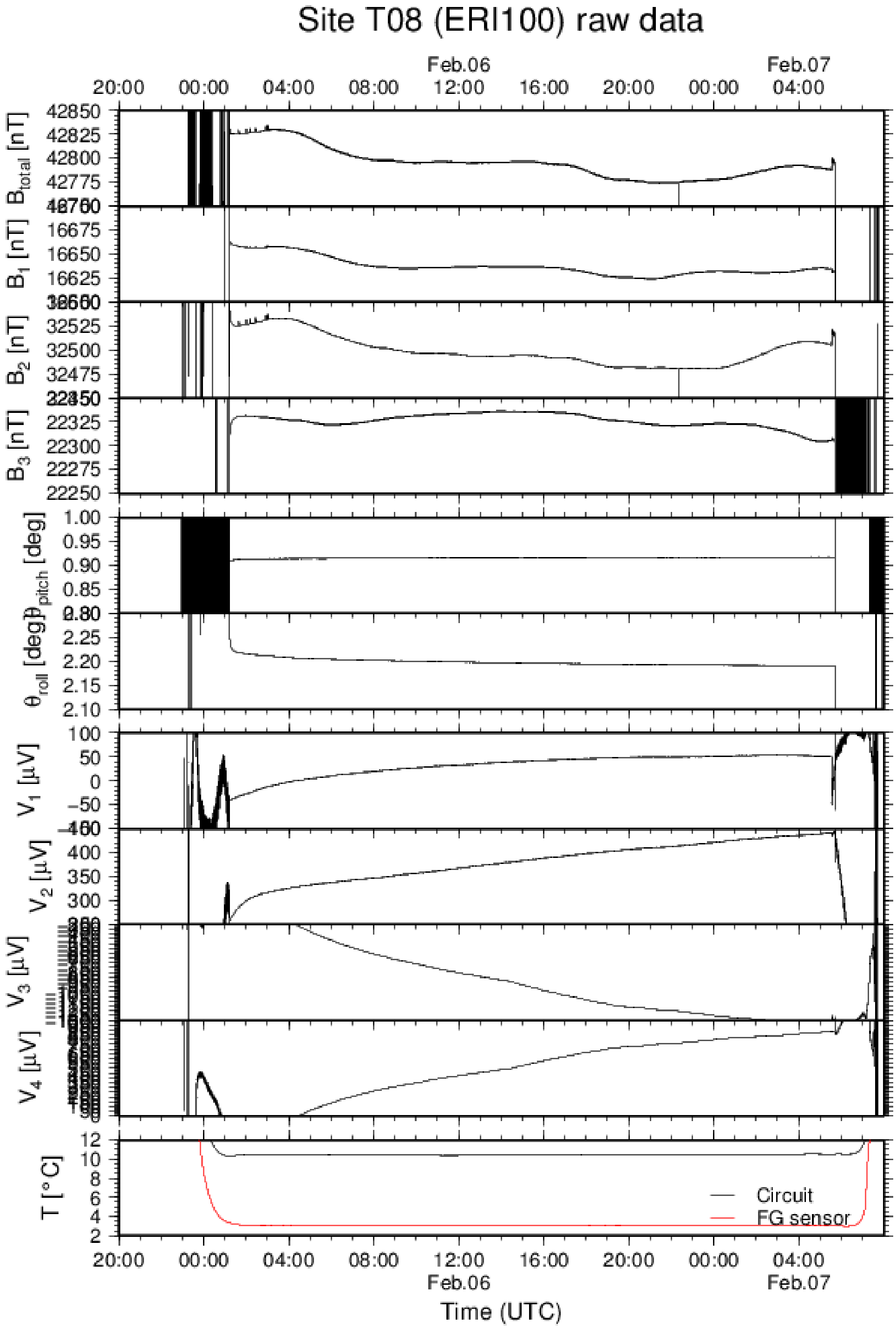


Figure 6. Raw time series recorded in the NOBEM.

From the top to the bottom, total magnetic field intensity, three components of the magnetic field, two components of the instrumental tilt, four components of the voltage difference, and temperature, are plotted.

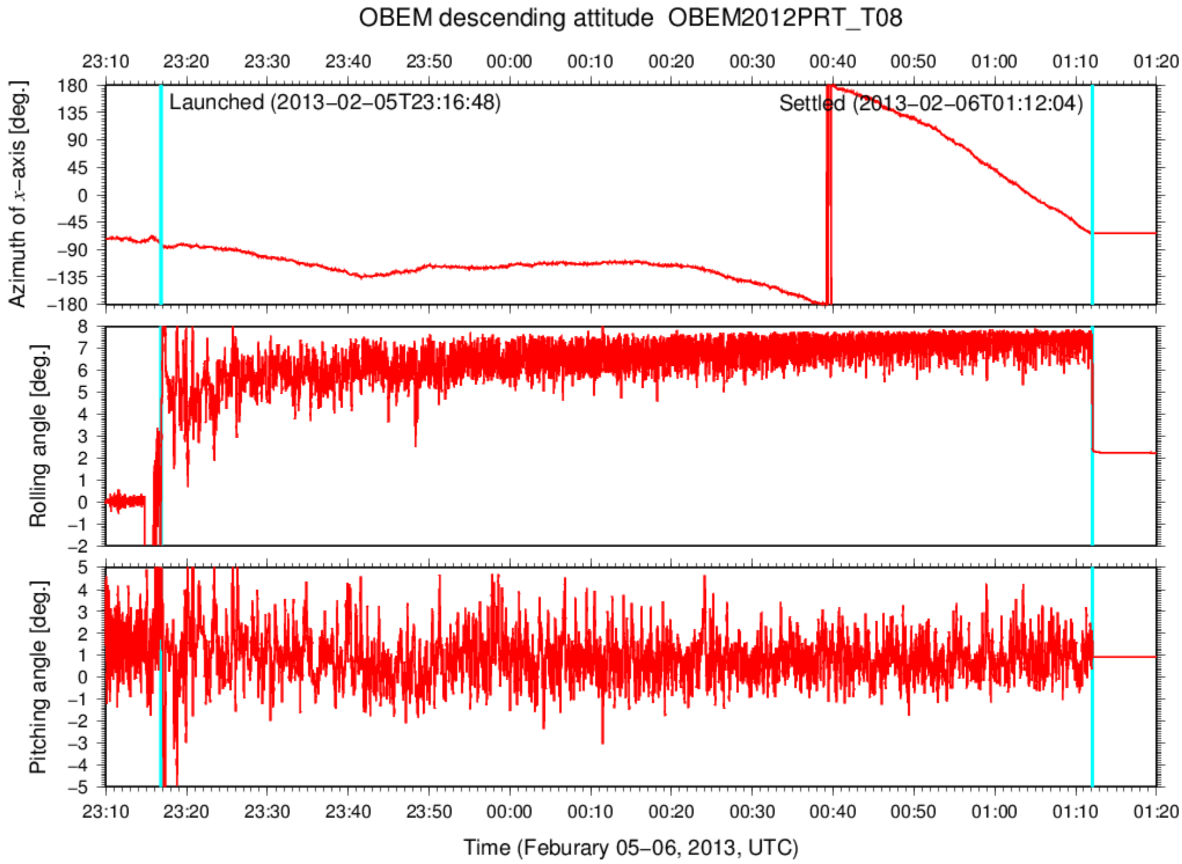


Figure 7. Attitude of the NOBEM during descending.

Table 1. Coordinate of the NOBEM.

Launched position		Settled position		
Lat.	Lon.	Lat.	Lon.	Depth (m)
25° 45.919' N	137° 00.487' E	25° 46.005' N	137° 00.251' E	4896