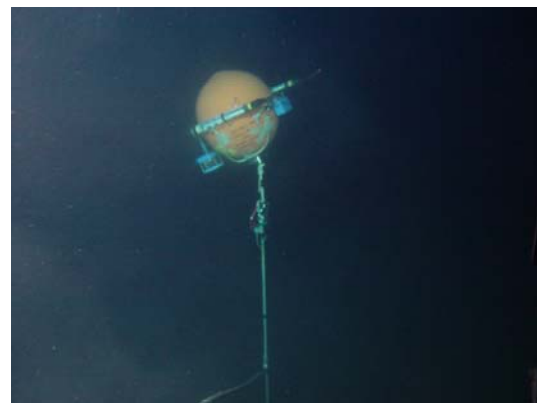
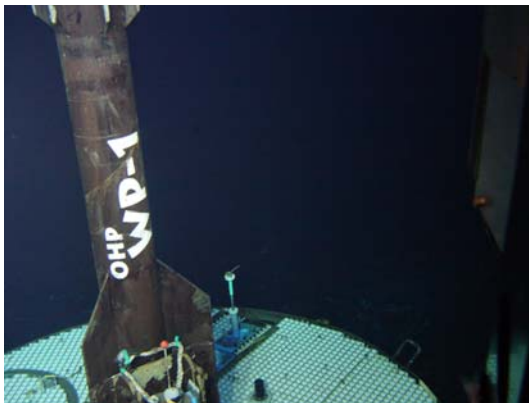
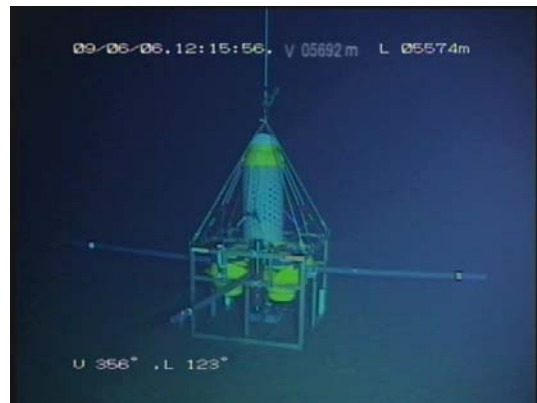
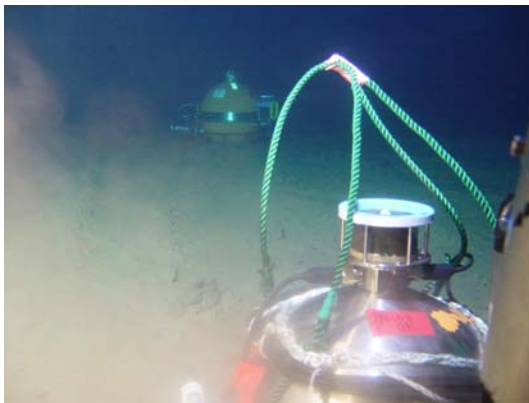


KAIREI Cruise Report

KR09-05

Research Dives by KAIKO-7000II

Philippine Sea



June, 1 – 15, 2009

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

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1. Cruise Information

1.1. Cruise Number

KR09-05

1.2. Ship Name

KAIREI

1.3. Title of the Cruise

Research dives by KAIKO7000II

1.4. Title of Proposals

1. Study for mobile ocean bottom broadband seismic observation of the next generation
2. Imaging the Earth's deep interior by seafloor long-term broadband seismic and EM observation

1.5. Cruise Period

June, 1 – 15, 2009

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

1. Hajime Shiobara [ERI, Univ. Tokyo]

2. Yuzo Hamano [IFREE, JAMSTEC]

2.3. Science Parties

1. Hajime Shiobara [ERI, Univ. Tokyo, chief]

Toshihiko Kanazawa [ERI, Univ. Tokyo, land support]

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

Hiroko Sugioka [IFREE, JAMSTEC, land support]

Aki Itoh [IFREE, JAMSTEC, support]

Takehi Isse [ERI, Univ. Tokyo, support]

2. Yuzo Hamano [IFREE, JAMSTEC, co-chief]

Hisashi Utada [ERI, Univ. Tokyo, land support]

Toshihiko Kanazawa [ERI, Univ. Tokyo, land support]

Hiroaki Toh [Graduate School of Science, Kyoto Univ., support]

Hajime Shiobara [ERI, Univ. Tokyo, support]

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

Tadanori Goto [Kyoto Univ., land support]

Hiromichi Nagao [IFREE, JAMSTEC, land support]

Eiichiro Araki [JAMSTEC, land support]

Kimihiro Mochizuki [ERI, Univ. Tokyo, land support]

Tomoaki Yamada [ERI, Univ. Tokyo, land support]

Takuto Minami [Graduate School of Science, Kyoto Univ., support]

Shinnichi Hosoya [NME, scientific support staff]

2.4. Captain, crew and KAIKO operation team

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

Captain	SUSAMI SATOSHI
Chief Officer	KIMURA NAOTO
2nd Officer	MAEDA ISAO
3rd Officer	FUJII SHOZO
Chief Engineer	SHIBATA HIROYUKI
1st Engineer	KANEDA KAZUHIKO
2nd Engineer	KATO KENZO
3rd Engineer	SHIRAKATA KENICHI
Chief Electronics Operator	AKAMA HIDEYUKI
2nd Electronics Operator	INOUE YOICHI
3rd Electronics Operator	KOMAKI YOSUKE
Boat Swain	ABE SHOICHI
Able Seaman	KAWAMURA YOSHIAKI
Able Seaman	KONNO YASUO
Able Seaman	CHIMOTO TSUYOSHI
Able Seaman	OHATA MASANORI
Sailor	HIRAI SAIKAN
Sailor	ITO HIDEO
No.1 Oiler	MIURA KOZO
Oiler	SHIINO MASANORI
Oiler	INOMOTO TAKAATSU
Oiler	FUJIWARA MASAYUKI
Oiler	SATO RYO
Chief Steward	TAKASHIMA
Steward	TAKEMURA RYUEI
Steward	FUKUMURA HIDEO
Steward	MIKAMI RIKAKO
Steward	ITO KEI
Trainee	Michiyasu KATAGIRI
	Shin TORAO
	Kosei KAWAMURA
	Kana YUASA
	Hideaki NAKATA
	Kouji FUNAE
	Fumihiro UEKI
	Daishuke MATSUSHITA

2.4.2. KAIKO operation team

Operation Manager “KAIKO”	HIRATA KAZUYOSHI
Operation “KAIKO”	NAMBU YOSHINOBU
Operation “KAIKO”	MIURA ATSUMORI
Operation “KAIKO”	UEKI MITSUHIRO
Operation “KAIKO”	TAKISHITA KIYOSHI
Operation “KAIKO”	WAKAMATSU HOMARE
Operation “KAIKO”	KONDO TOMOE
Operation “KAIKO”	SHIGETAKE SEIJI
Operation “KAIKO”	SAIGO RYO
Operation “KAIKO”	ASAI RYU

3. Observation

3.1. Proposal 1.

“Study for mobile ocean bottom broadband seismic observation of the next generation”
(at site 1)

3.1.1. Purpose and background

We have already developed the mobile broadband ocean bottom seismometer (BBOBS), and many practical observations and the result have been achieved since 1999. But, through the evaluation of the broadband seismic data, the noise level of horizontal components those are important in data analyses, is rather high in average and its variation in time is also large. The reason of this is assumed as the small tilt variation of the large housing sphere due to a tidal bottom current. To clear this problem, one idea of observation without tilt variation due to the bottom current is the use of small and low profile broadband sensor that enables to intrude into the sediment. Now, we are on the way to develop this new generation BBOBS (BBOBS-NX) under support of Grant-in-Aid for Scientific Research (B) during 2007–2010. Its final goal is the free fall deployment and self pop-up recovery system as same as the BBOBS in present.

3.1.2. Observations

We recover the BBOBS-NX deployed in the KR08-06 cruise, and we deploy the BBOBS-NX2 (BBOBS-NX modified for free-fall deployment), BBOBS-NA (BBOBS using a new style anchor) and ocean bottom doppler current meter (OBDC) under support of the ROV, KAIKO-7000II. It is impossible to do this kind of test on the land, because there is almost no low noise station similar to the deep sea floor and the condition of solid-liquid interface and the existence of the bottom current.

3.1.3. Method and Instruments

The BBOBS-NX2, the BBOBS-NA and the OBDC are deployed by free-falling nearby the BBOBS-NX. The BBOBS-NA and the OBDC are moved to nearby of the BBOBS-NX2. The recording unit of the BBOBS-NX2 is moved from the top of the sensor unit and is put on the sea floor. The BBOBS and the ocean bottom electro-magneto meter (OBEM) deployed in the KR08-15 cruise are also targets to observe at the sea floor. Finally, the BBOBS-NX is recovered by the ROV.

3.1.4. Research Result

All operations planned at this site were completed during a single dive (#453) of the ROV. The BBOBS-NX2 and the BBOBS-NA were closely landed about 20 m of distance (Figure 2). The OBDC was moved to nearby the BBOBS-NA. The BBOBS-NX2 intruded to the sediment well, and the observation has been started as we planned. The BBOBS and the OBEM were found at calculated positions relative to others. Absolute values between calculated positions by a LBL and positions of the ROV system by a SSBL were slightly different systematically, about 80 m toward the

east. The BBOBS-NX (Figure 3) was recovered by the ROV, and the data is sufficiently recorded. We will recover these instruments, now operating, in the KR09-11 cruise.

3.2. Proposal 2.

“Imaging the Earth’s deep interior by seafloor long-term broadband seismic and EM observation” (at site 2 and site 3)

3.2.1. Purpose and background

The objective of this proposal is to yield an image of the Earth’s deep structure beneath the western Pacific with high resolution that has never reached before. To achieve this, efforts have been made for more than 10 years in order to maintain a seismic and geoelectromagnetic observation network over the western Pacific. These efforts have been a fruitful product of collaboration among Graduate School of Science, Kyoto University, IFREE, JAMSTEC and ERI, University of Tokyo so far. Since the key to the enhanced resolution is long-term geophysical observation at the seafloor, use of the ROV is essential and indispensable as in this research cruise.

3.2.2. Observations

Not only the geomagnetic field but also the geoelectric field should be monitored over a significantly long duration of time in order to image the Earth’s deep interior in a geoelectromagnetic sense. The geoelectric measurement will be combined with that of the geomagnetic field to give the so-called ‘magnetotelluric impedance’, which is representative of the Earth’s electrical property. In the period range further out of the magnetotelluric band, the ratios of vertical to horizontal components are of particular interest here, which is representative of the Earth’s electromagnetic response to the axial dipole excitation. Furthermore, the smooth and gradual change of the geomagnetic field, i.e., the geomagnetic secular variation, is to be detected. This phenomenon conveys information of dynamics in the Earth’s outer core. The seismic data from the borehole site and the free-fall site will provide us the information of the Earth’s elastic property ranging from regional to global scale. The seismic and geoelectromagnetic observation will be jointly interpreted to give a clearer image of the Earth’s deep interior.

3.2.3. Method and instruments

At the site 2, there are two aims. The first one is about the SeaFloor ElectroMagnetic Station (SFEMS). The final version SFEMS is deployed in place of the already installed SFEMS that is a bit older version of SFEMS. A buoy system is attached to the new SFEMS so as to give it sufficient buoyancy for the ROV, KAIKO-7000II to handle it easily in seawater. In addition, a ROV homer (acoustic responder) is specially arranged and equipped with the new SFEMS in order to guarantee quick spotting of the SFEMS at the seafloor. The second one is a recovery of two Li battery units used to operate the WP-1 sea floor borehole seismic observatory, those are necessary to restart future observation there. And more, at the site 3, a long-term OBS (LTOBS) deployed in July,

2006 is a target to search and recover by the ROV.

3.2.4. Research result

Thanks to the magnificent capability of the ROV and excellent navigation by R.V. KAIREI, the two SFEMSs conducted an overnight side-by-side simultaneous geoelectromagnetic measurements within a distance of 10 m at the seafloor. After the simultaneous measurements, the old SFEMS was successfully retrieved by acoustic release. Furthermore, two Li battery units (Figure 4) were recovered by the ROV from the WP-1 sea floor borehole seismic observatory in two dives (#455 and #456). Although more than 8 years deployment there, PP ropes and O-rings used in these units have no damage. At the site 3, the LTOBS was found close to the calculated position with malfunction of one of two releasing units in a dive (#457). As the underwater cable was good in the later inspection on the land, so the reason seemed in the incorrect preparation of the cable connection or the quality control of this releasing unit.

3.3. Cruise Log

2009/06/01

09:00 Onboard

10:00 Departure from Yokosuka (JAMSTEC)

11:00-11:40 Briefing about ship's life and safety

Weather: fine but cloudy/ Wind direction: NNE/ Wind force: 4/ Wave: 3 m/ Swell: 1 m/

Visibility: 6 nautical miles (12:00 JST)

2009/06/02

Transit to survey area "1"

09:00-10:30 Cruise Meeting

Weather: fine but cloudy/ Wind direction: ENE/ Wind force: 3/ Wave: 2 m/ Swell: 1 m/

Visibility: 8 nautical miles (12:00 JST)

2009/06/03

06:00 Arrive at survey area "1"

07:57 XBT

08:52 Release the BBOBS-NA

08:57 Release the BBOBS-NX2

09:02 Release the OBDC

10:10-12:16 Calibration the BBOBS-NA, BBOBS-NX2 & OBDC

Weather: fine but cloudy / Wind direction: ENE/ Wind force: 3/ Wave: 2m/ Swell: 1 m/

Visibility: 8 nautical miles (12:00 JST)

2009/06/04

08:38 Launch KAIKO (7K#453dive)

10:39 KAIKO lands (4,909m)

14:57 KAIKO leaves the bottom (4,909m)

16:47 KAIKO on deck

00:00 Transit to survey area "2"

Weather: fine but cloudy / Wind direction: SSE Wind force: 4/ Wave: 3 m/ Swell: 1 m/

Visibility: 9 nautical miles (12:00 JST)

2009/06/05

19:25 XBT

20:00 Arrive at survey area "2"

20:30 Deployed the SFEMS

Weather: fine but cloudy / Wind direction: West/ Wind force: 3/ Wave: 2 m/ Swell: 1

m/ Visibility: 9 nautical miles (12:00 JST)

2009/06/06

00:11-01:27 Calibration the SFEMS

08:35 Launch KAIKO (7K#454dive)

10:45 KAIKO lands (5,693m)

12:26 KAIKO leaves the bottom (5,693m)

14:22 KAIKO on deck

Weather: fine but cloudy / Wind direction: SSW / Wind force: 4/ Wave: 3 m/ Swell: 1 m/ Visibility: 8 nautical miles (12:00 JST)

2009/06/07

08:11 Release the SFEMS

11:16 Surface the SFEMS

11:41 SFEMS on deck

13:00 Release the Transponder

14:11 Surface the Transponder

14:18 Transponder on deck

Weather: cloudy / Wind direction: SW/ Wind force: 5/ Wave: 3 m/ Swell: 1 m/ Visibility: 8 nautical miles (12:00 JST)

2009/06/08

Suspended 'KAIKO7000II' diving operation due to rough sea

Weather: cloudy / Wind direction: WSW/ Wind force: 5/ Wave: 4 m/ Swell: 3 m/ Visibility: 9 nautical miles (12:00 JST)

2009/06/09

08:38 Launch KAIKO (7K#455dive)

10:54 KAIKO lands (5,706m)

11:04 KAIKO leaves the bottom (5,706m)

13:41 KAIKO on deck

14:28 Recovered Li battery units

Weather: fine but cloudy / Wind direction: WSW/ Wind force: 3/ Wave: 2 m/ Swell: 1 m/ Visibility: 9 nautical miles (12:00 JST)

2009/06/10

08:30 Launch KAIKO (7K#456dive)

10:43 KAIKO lands (5,705m)

10:52 KAIKO leaves the bottom (5,705m)

13:31 KAIKO on deck

14:07 Recovered Li battery units

14:30 Transit to survey area "1"

Weather: fine but cloudy / Wind direction: SE/ Wind force: 3/ Wave: 2 m/ Swell: 1 m/
Visibility: 10 nautical miles (12:00 JST)

2009/06/11

Transit to survey area "1"

Weather: fine but cloudy / Wind direction: SSW/ Wind force: 3/ Wave: 3 m/ Swell: 1
m/ Visibility: 10 nautical miles (12:00 JST)

2009/06/12

06:00 Arrive at survey area "1"

05:50-08:10 Acoustic Communication with the BBOBS-NA and the BBOBS-NX2

08:15 Transit to survey area "3"

Weather: Cloudy / Wind direction: SW/ Wind force: 5/ Wave: 3 m/ Swell: 1 m/
Visibility: 8 nautical miles (12:00 JST)

2009/06/13

12:00 Arrive at survey area "3"

12:54-14:23 Acoustic Communication with the LTOBS

14:44 XBT

Weather: Overcast / Wind direction: SW/ Wind force: 5/ Wave: 3 m/ Swell: 1 m/
Visibility: 5 nautical miles (12:00 JST)

2009/06/14

08:36 Launch KAIKO (7K#457dive)

10:10 KAIKO lands (3,421m)

10:50 KAIKO leaves the bottom (3,423m)

12:21 Recovered the LTOBS

12:30 KAIKO on deck

13:20 Transit to Yokosuka (JAMSTEC)

Weather: Overcast / Wind direction: SW/ Wind force: 5/ Wave: 3 m/ Swell: 1 m/
Visibility: 5 nautical miles (12:00 JST)

2009/06/15

09:00 Arrival at Yokosuka (JAMSTEC), KR09-05 finish and disembarkation

3.4. Dive Information

3.4.1. Dive Number

- | | |
|-------------|----------------------------------|
| Proposal 1. | 453 (site 1) |
| Proposal 2. | 454 – 456 (site 2), 457 (site 3) |

4. Acknowledgements

We thank for the captain and crew of R.V. KAIREI, the KAIKO operation team and a scientific support staff of NME in their correct work and warm support during this cruise. This study is supported by KAKENHI (19340121).

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.

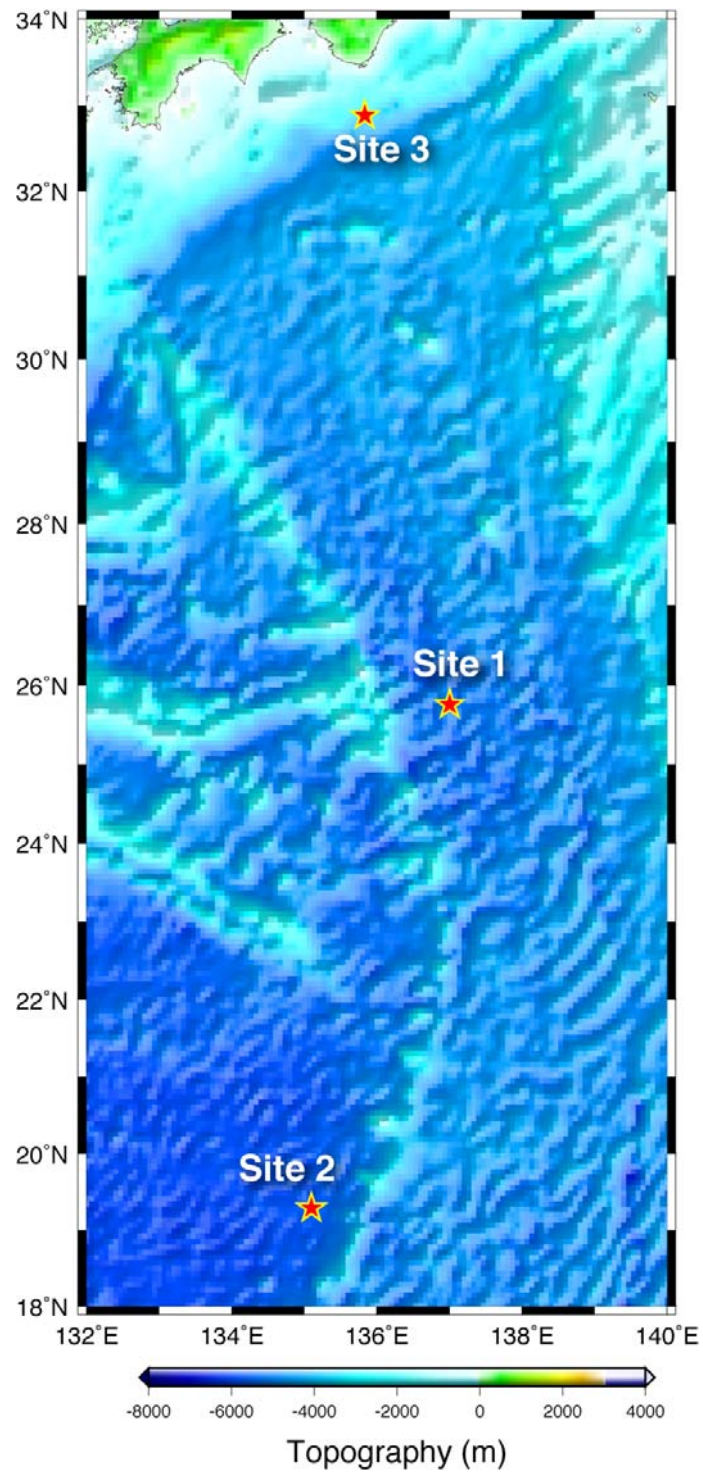


Figure 1. Research map.

- Site 1: T08 broadband seismic observation station (depth: 4920 m)
- Site 2: WP-1 sea floor borehole seismic observatory (depth: 5710 m)
- Site 3: LS14 long-term seismic observation station (depth: 3430 m)

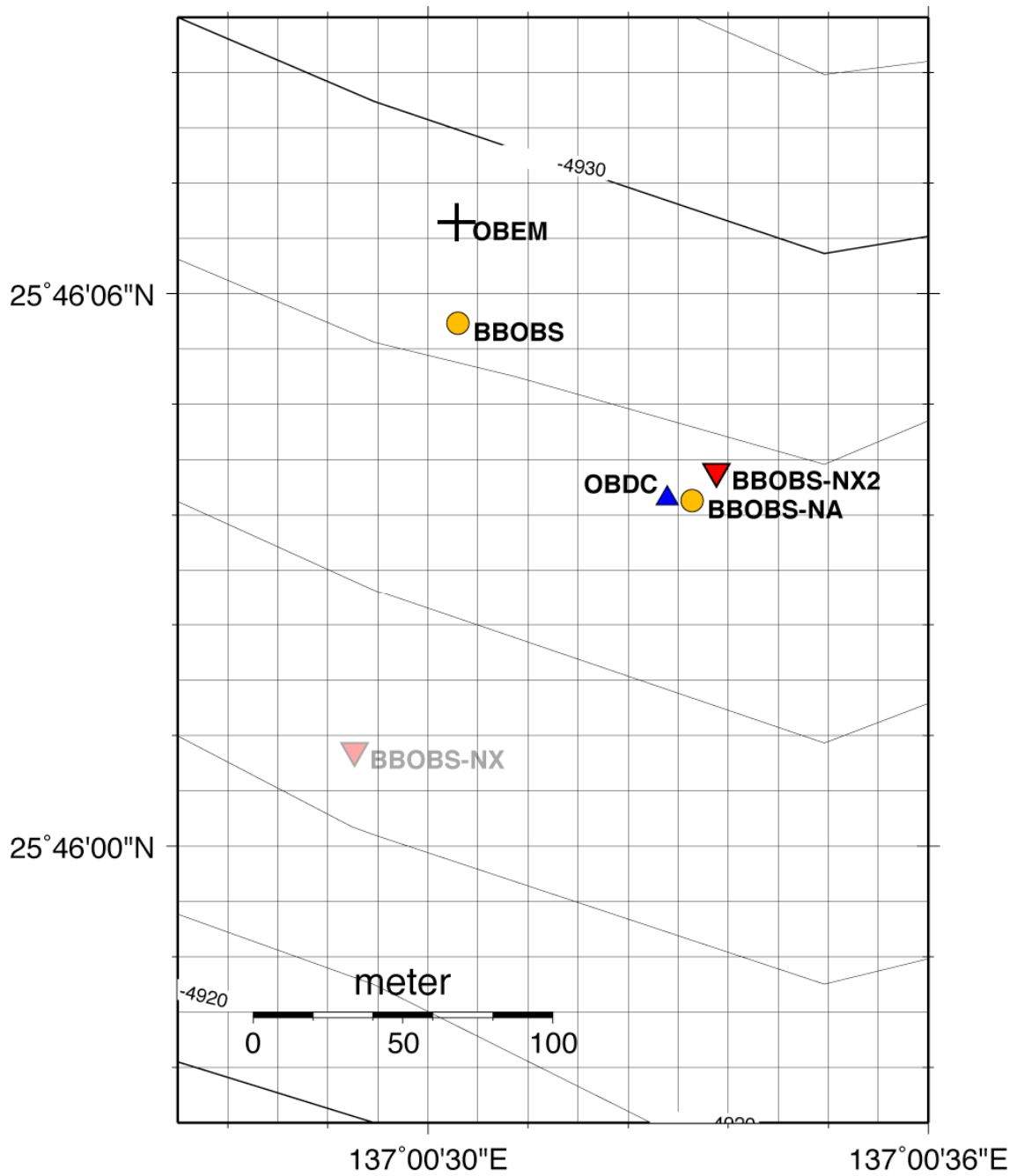


Figure 2. Location map of equipments at the site 1.

The BBOBS-NX was recovered in the #453 dive. BBOBS and OBEM were deployed in the KR08-15 cruise. The OBDC was moved from the landed position by the ROV. These 5 equipments now operating are recovered in the KR09-11 cruise.

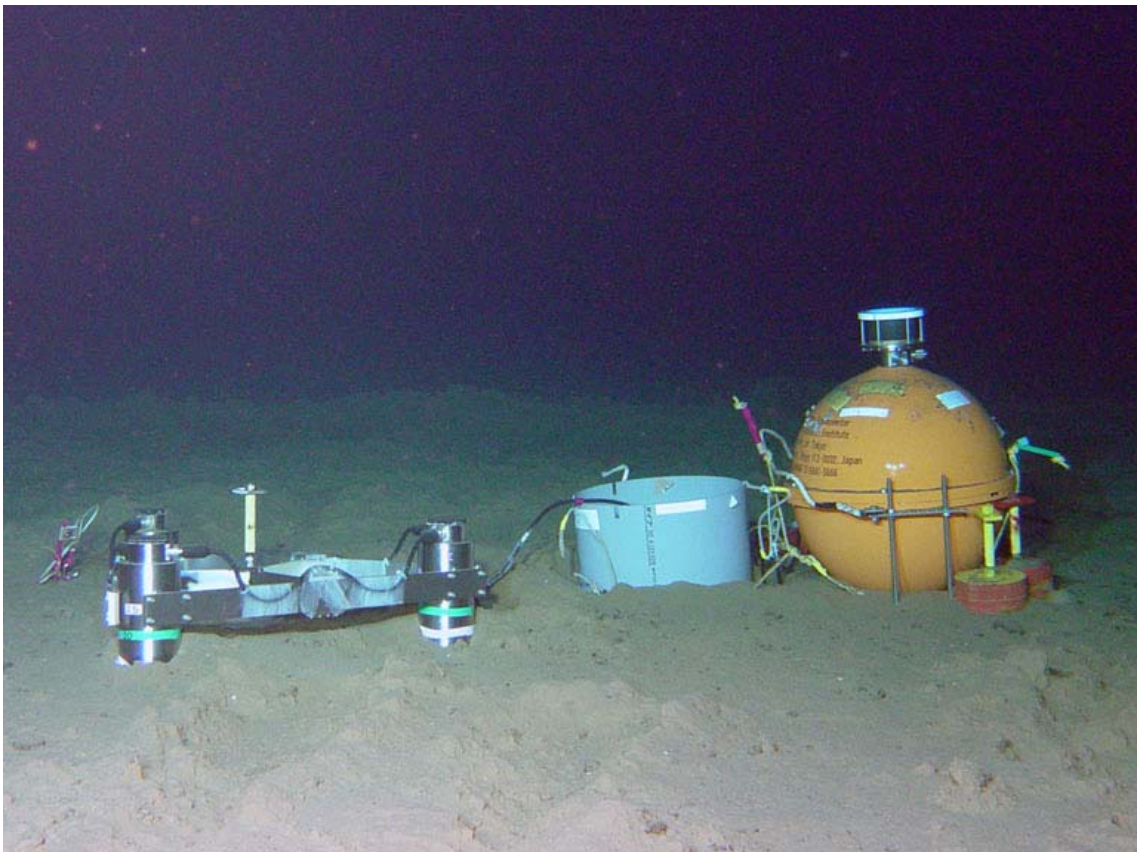
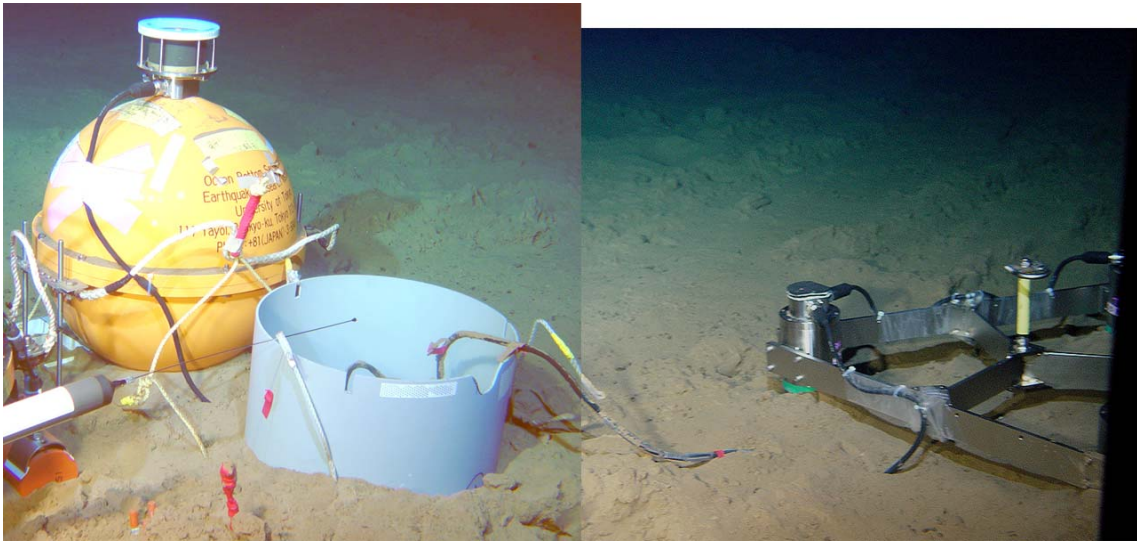


Figure 3. The BBOBS-NX. In the deployment during the KR08-06 cruise (upper), and the recovery in this cruise (lower). Due to several limits and conditions, this BBOBS-NX was brought as a payload of the ROV. The metallic unit is the seismic sensor, and the orange color sphere is the recording unit including the battery.



Figure 4. Two lithium battery frames recovered from the WP-1 sea floor borehole seismic observatory at the site 2 by two KAIKO-7000II dives (#455 and #456).