



Kairei Cruise Report

KR14-10



New phase of Ocean Hemisphere Project: Imaging the normal oceanic mantle by advanced ocean bottom observations (Northwest Pacific Ocean)

Sep. 09, 2014 - Oct. 02, 2014

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

Contents

1. Cruise Information
2. List of participants
3. Observation
 - 3.1 Purpose and background
 - 3.2 Research areas in plan
 - 3.3 Instruments used for observation
 - 3.4 Instrument photos
 - 3.5 Cruise log
 - 3.6 Dive information
 - 3.7 Summary of Recovery and bathymetric survey
 - 3.8 Summary of deployment
 - 3.9 Overview of the result
4. Notice for data users
5. Acknowledgments

Photo in the front page: Recovery of EFOS recorder (above), and the pressure case (lower right) and the sensor (lower left) of BBOBS-NX at NM01 on Sep. 13, 2014. These instruments were suspended by rope under the Kaiko vehicle and retrieved after Kaiko-7000II system had been settled on deck.

1. Cruise Information

● Cruise ID KR14-10

● Name of vessel Kairei

● Title of the cruise

 New phase of Ocean Hemisphere Project: Imaging the normal oceanic mantle by advanced ocean bottom observations

● Title of the proposal

 New phase of Ocean Hemisphere Project: Imaging the normal oceanic mantle by advanced ocean bottom observations

● Cruise period Sep. 9 – Oct, 2, 2014

● Ports of departure / call / arrival Shiogama to JAMSTEC Yokosuka

● Research area Northwest Pacific Ocean (Northwest and southeast areas of the Shatsky Rise) and three areas near the Japan trench

● Research Map See Fig. 1 in Section 3.2

2. List of participants

2.1 Researchers

Chief scientist Hisashi Utada [ERI, Univ. Tokyo]

Co-chief Scientist Hajime Shiobara [ERI, Univ. Tokyo]

Science party

 On board Kiyoshi Baba [ERI, Univ. Tokyo]

 Takehi Isse [ERI, Univ. Tokyo]

 Tetsuo Matsuno [ERI, Univ. Tokyo]

 Yuki Abe [ERI, Univ. Tokyo]

 Noriko Tada [JAMSTEC]

 Taro Kitamura [WAC Inc.]

 Toshimasa Nasu [NME ltd]

 Not on board Hitoshi Kawakatsu [ERI, Univ. Tokyo]

 Daisuke Suetsugu [JAMSTEC]

2.2 Operation team of the KAIKO

Operation Manager Atsumori Miura

2nd ROV Operater Junya Niikura

2nd ROV Operater Kiyoshi Takishita

2nd ROV Operater Tetsuya Ishitsuka

2 nd ROV Operater	Seiji Shigetake
2 nd ROV Operater	Shota Ihara
3 rd ROV Operater	Takuma Goto
3 rd ROV Operater	Yoichi Yasue

2.3 Captain and crew of the R/V KAIREI

Captain	Shinya Ryono
Chief Officer	Naoto Kimura
2 nd Officer	Kazuki Miyake
3 rd Officer	Akira Suzuki
Chief Engineer	Koji Hunae
1 st Engineer	Kenzo Kato
Jr.1 st Engineer	Takashi Ota
2 nd Engineer	Kenichi Shirakata
3 rd Engineer	Kota Kataoka
Chief Radio officer	Masamoto Takahashi
2 nd Electronic Operator	Misato Hata
3 rd Electronic Operator	Toshihiko Yuasa
Boat Swain	Kazuo Abe
Able Seaman	Shuichi Yamamoto
Able Seaman	Saikan Hirai
Sailor	Kosei Kawamura
Sailor	Toru Nakanishi
Sailor	Yosuke Horii
Sailor	Shinya Kojima
No.1 Oiler	Junji Mori
Oiler	Sota Misago
Oiler	Taijun Iwao
Oiler	Ryo Sato
Assistant Oiler	Shota Shimohata
Chief Steward	Isao Matsumoto
Steward	Toru Wada
Steward	Shinobu Ohyu
Steward	Kana Yuasa

3. Observation

3.1 Purpose and background

We proposed and got funded by Grant-in-aid for specially promoted research (JSPS) to conduct a research program in 5 years toward understanding of the mantle dynamics from an innovative observational approach by answering two fundamental questions in Earth science:

(a) *What is the physical condition for the lithosphere-asthenosphere boundary (LAB)?*

(b) *Is the mantle transition zone (MTZ) a major water reservoir of the Earth?*

The “normal” ocean floor is the best window to approach these questions as it allows us to see the inside of the Earth through it without the disturbance due to the thick and heterogeneous continental crust. However, any approach, if ever attempted, has not yet been successful because of technological difficulties in obtaining high-quality geophysical data in the ocean.

The present investigators had conducted the Ocean Hemisphere network Project (OHP) in 1996-2001, in which a network of geophysical observatories was built in the western Pacific region. Data from the OHP network, especially from broadband seismographs on land and under water, precise magnetometers, submarine cables to measure electric field, successfully provided improved global images of the Earth’s interior in terms of seismic velocities and electrical conductivity (e.g., Utada et al., *GRL*, 2003). During the OHP project, we had also developed a set of new portable ocean bottom instruments, broadband ocean bottom seismometers (BBOBSs) and ocean bottom electro-magnetometers (OBEMs).

These new observation technologies have been fully utilized in the 5-year Stagnant Slab Project (SSP) that succeeded the OHP since 2004. In the SSP, we have carried out a long-term (3 years in total) joint observation of BBOBSs and OBEMs in the Philippine Sea (Shiobara et al., *EOS*, 2009) to study the upper mantle and the MTZ where the subducted Pacific slab appears to be stagnating. We have made significant contributions to the SSP by obtaining results such as the estimation of water content in the MTZ by joint interpretation of seismic and electromagnetic tomography (Koyama, Utada et al., *AGU Monograph*, 2006; Utada et al., *EPSL*, 2009) and the seismic evidence for water transportation deep into the mantle by subducting slab (Kawakatsu & Watada, *Science*, 2007). We also revealed the upper mantle structure in this region by analyzing BBOBS data (Isse et al. *PEPI*, 2010) and OBEM data (Baba et al., *PEPI*, 2010). From the northwest Pacific Ocean, Kawakatsu et al. (*Science*, 2009) presented seismic evidence that indicates the lithosphere-asthenosphere boundary to be a sharp seismic discontinuity. Integration of these pieces of evidence obtained by existing technology is undoubtedly useful to solve two questions, but it is not enough.

Recently, we developed (e.g. Shiobara et al. 2011) further innovative instruments (BBOBS-NX: broadband ocean bottom seismometer next generation; EFOS: Earth electric field observation system). By improving the mechanical coupling between the sensor housing and seafloor sediments, the BBOBS-NX enables us to record horizontal seismic motions, as well as vertical ones, with a typical noise level comparable to land observations. This gives us a strong advantage over other OBS’s because it allows us

to apply station-based powerful seismic analysis methods commonly used on land, such as the receiver function and shear-wave splitting analyses, for ocean bottom data. The EFOS, on the other hand, measures the electric voltage difference at the seafloor by using a 10 km long cable. Compared to the OBEM measuring the electric field with a spacing of only 5 m, it successfully reduces the noise level to 1/10 or lower so as to provide reliable estimates of electromagnetic responses in a wide period range (1,000-500,000 s) that have high sensitivity to the electrical conductivity in the upper mantle and in the MTZ. Therefore, we are now capable of providing strong constraints to answer the two questions (a) and (b) listed above by applying our advanced observational technologies to the “normal oceanic mantle” (as opposed to the mantle beneath subduction zones, hot spots or mid-oceanic ridges). Therefore we call the project as **the NOMan project**.

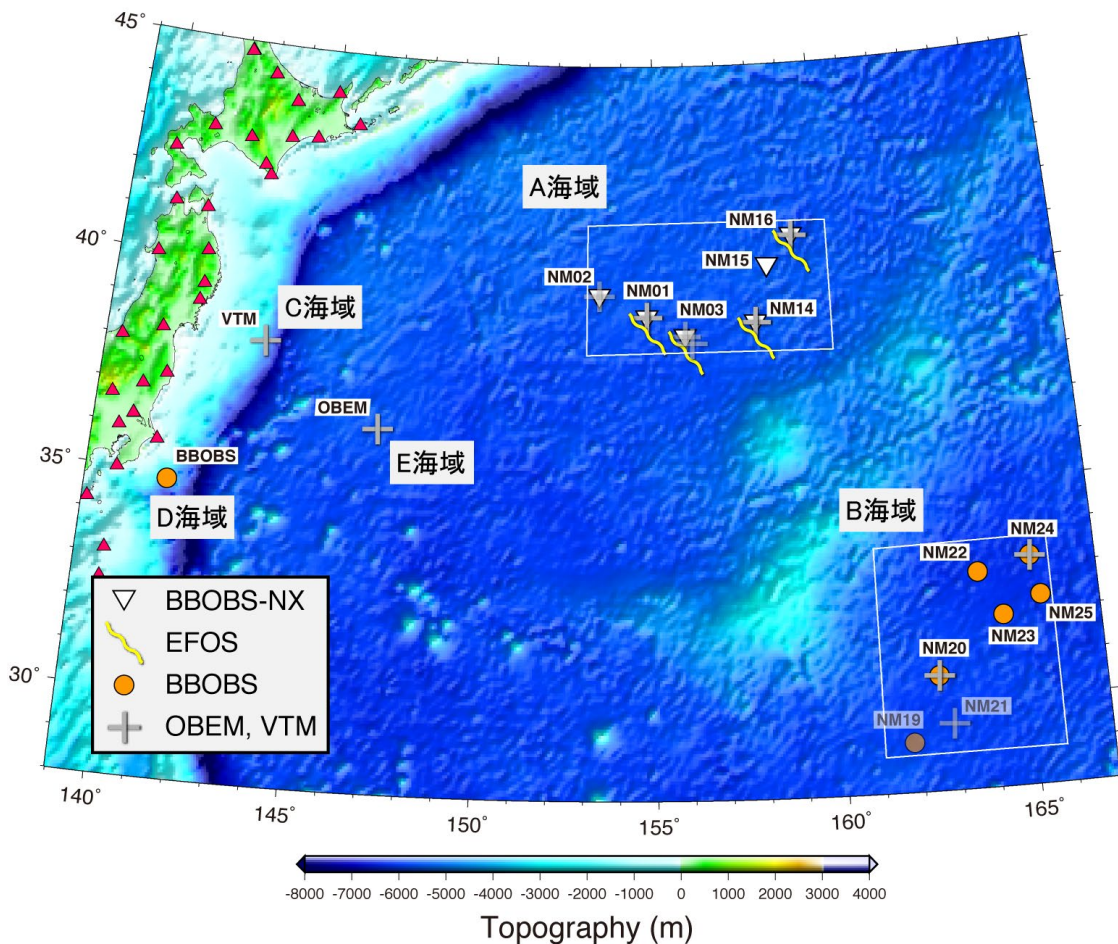


Fig. 1 Map of observation sites to be visited in the present cruise. Areas A and B are the main study areas of the NOMan project. Areas C, D and E are additional sites to recover instruments that were left there due to some trouble in releasing anchor.

In KR10-08 conducted in June 2010, we started a pilot experiment of the NOMan project, in which two BBOBS-NX's and one EFOS are deployed together for the first time in our experience, as well as 3 BBOBS's and 5 OBEM's of conventional type. We expected this pilot experiment would provide us a good opportunity to train ourselves for instrumentations, observations, data processing and analyses.

The second cruise of the NOMan project, KR11-10 was planned as the first phase of the main observation of the project, recovering instruments deployed in the pilot experiment, and deploying more number of BBOBS-NX's and EFOS's as well as BBOBS's and OBEM's. However, we had to change our cruise plan so that only conventional instruments (BBOBS's and OBEM's) which do not need KAIKO 7000-II dive operation are going to be recovered and deployed. The recovery and deployment of advanced instruments (BBOBS-NX's and EFOS's) are postponed to be conducted in the summer of 2012, which is KR12-14. The KR11-10 cruise was carried out from November 16 to 30, 2011. Due to a bad weather condition, we recovered only one BBOBS and one OBEM at the site NM04, and re-installed them in the area A. In the area B, we successfully deployed 8 BBOBS's and 8 OBEM's, respectively. Every instrument was equipped with batteries sufficient for two-year deployment, so as to be recovered in the summer of 2013. In KR12-14, we recovered 2 BBOBS's, 2 BBOBS-NX's, 1 EFOS recorder and 4 OBEM's from the pilot and 1st experiments, and deployed 6 BBOBS-NX's and 4 EFOS's (one replacement and three new installations), as well as 5 BBOBS's and 8 OBEM's.

In the summer of 2013 and in June of 2014, we have carried out two cruises by using a chartered vessel, Kaiyu (OOC) to maintain the observation array. In the 2013 cruise, most of BBOBSs and OBEMs installed in previous cruises were recovered or replaced. In the 2014 cruise, a controlled source seismic experiment was conducted to reveal shallower structures with high resolution. After this experiment, all BBOBSs and OBEMs, except OBEMs collocated with EFOS, were retrieved from area A.

The present cruise is the most important one in the NOMan Project in which we plan to recover all remaining instruments (6 BBOBS-NXs, 4 EFOSs, 7 BBOBSs, 6 OBEMs and 1 VTM) from whole study area. Data retrieved by this cruise will make a significant contribution for the fulfillment of the scientific purposes of the NOMan project.

3.2. Research Areas in plan

This cruise has 5 research areas including two target areas A and B in the northwest Pacific Ocean and three additional areas C, D, and E (Fig. 1). The area A (northwest of the Shatsky Rise) is the main target of the project where the sea floor is considered as 'normal'. The area B (southeast of the Shatsky Rise) is the second target, selected for testing generality of the result. In the areas C, D, and E, we plan to recover one vector tsunami meter (VTM), one BBOBS and one OBEM, respectively, all of which includes long-term observation data useful for the present purpose. Locations of observation sites in plan to be visited in KR12-14 cruise are summarized in Table 1a.

In area A, we plan to recover BBOBS-NX at 6 sites (NM01, NM02, NM03, NM14, NM15 and NM16) and EFOS at 4 sites (NM02, NM03, NM16, NM14). We also recover OBEM at 5 sites (NM01, NM02, NM03, NM14 and NM16) and BBOBS at NM01. Recoveries at these sites in the area A all include ROV/Kaiko7000-II operation. In the area B, we plan to recover BBOBS at 5 sites (NM20, NM22, NM23, NM24 and NM25) and OBEM at 2 sites (NM20 and NM24). NM19 and NM21 are

substitute sites where BBOBS and OBEM have to be recovered by Kaiko-7000II, respectively.

Table 1a. Locations of observation sites in plan of the KR12-14 cruise. Sites from NM01 to NM16 belong to the area A, while those from NM19 to NM25 belong to the area B

Site	Lat. (N)	Lon. (E)	Site	Lat. (N)	Lon. (E)	Site	Lat. (N)	Lon. (E)
NM01	39 12.06	154 47.04	NM16	41 13.98	159 03.00	NM23	33 13.02	164 24.42
NM02	39 42.06	153 21.30	NM19	29 09.00	161 46.44	NM24	33 13.02	165 15.72
NM03	38 45.72	155 54.60	NM20	30 38.46	162 33.00	NM25	32 18.96	165 26.64
NM14	39 02.70	158 00.53	NM21	29 32.51	162 51.55			
NM15	40 16.98	158 27.00	NM22	32 57.12	163 48.66			
C-VTM	38 13.68	143 34.28	D-BB	34 54.45	141 15.59	E-EM	36 26.02	147 01.13

3.3 Instruments used for the observation

3.3.1 BBOBS

BBOBS's have been used in many of our previous projects, and are to be used in the present project. It consists of a pressure housing, hydrophone for acoustic release system, and an anchor. A broadband sensor, batteries and recording unit are contained in the pressure case (a 65 cm diameter sphere) made of titanium alloy (Fig. 2). It is deployed by free-fall and recovered by self pop-up system. However, one BBOBS at NM01 is recovered by Kaiko-7000II operation, because its recovery by self pop-up was failed in a previous cruise.

3.3.2 OBEM

OBEM's have also been used in our previous projects together with BBOBS's. It consists of two grass spheres, frame made of titanium, an acoustic release system, and an anchor. There two types of OBEM deployed in this cruise. One is ERI type (OBEM-ERI) and the other is JAMSTEC type (OBEM-JM). OBEM-ERI is equipped with a three-component fluxgate sensor and recording unit are installed in one sphere and batteries in the other (Fig. 3a), while OBEM-JM is equipped with a fluxgate sensor in a titanium cylinder and recording unit and batteries in a glass sphere (Fig. 3b). Either OBEM is deployed by free-fall and recovered by self pop-up system. However, some of OBEMs (at NM01 and NM03) must be recovered by Kaiko-7000II operation because recovery by self pop-up was failed in previous cruises.

3.3.3 BBOBS-NX

BBOBS-NX (Fig. 4) is an advanced ocean bottom seismometer newly developed by our group (Shiobara et al., 2011). It is deployed by free-falling with the recording unit temporarily fixed above the sensor unit. After confirming that the sensor unit is penetrated into the sediment deeply enough, the recording unit is released from the sensor unit, and it is replaced on the seafloor nearby the sensor unit by

ROV KAIKO 7000-II. This operation enables us to make seismic noise level as low as those at normal land observatories at the period band (10-1000 seconds) important for the present purpose. During KR12-14 cruise, we recovered two BBOBS-NX (NM02 and NM03) and replaced new one by KAIKO 7000-II operation. In addition, we installed four more BBOBS-NX's at NM01, NM14, NM15, and NM16.

3.3.4 EFOS

EFOS (Earth's electric field observation system) is an advanced ocean bottom instrument for measuring the electric field by using a long cable. It consists of a cable bobbin and data recorder which are deployed from the ship by a buoy system with an acoustic release system. The buoy is released after landing the ocean bottom. Then KAIKO 7000-II picks up and tow the cable bobbin to lay a cable in a particular direction. The electrical potential difference between electrodes at the end of the cable and near the recorder is measured and recorded at a sampling interval of 1 s. In the pilot experiment, we tried to deploy a system with 6 km long cable (EFOS-6) at site NM03 but had to terminate the installation at the cable length of 3 km due to the weather condition. In KR-12-14 cruise, the recording unit at NM03 was replaced for further two-year long observation, and 3 more sets of EFOS with 2 km cable (EFOS-2) were installed at NM01, NM14 and NM16.

3.4 Instrument photos

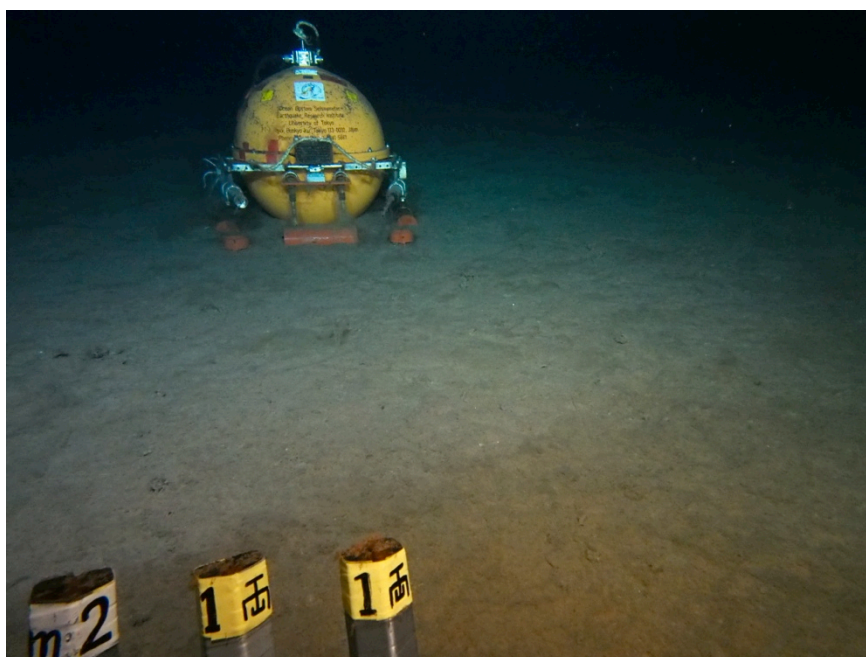


Fig. 2 BBOBS deployed at the seafloor site NM01 in June 2010 and recovered during this cruise after 4 years. The photo was taken from Kaiko 7000II as she approaches the instrument.

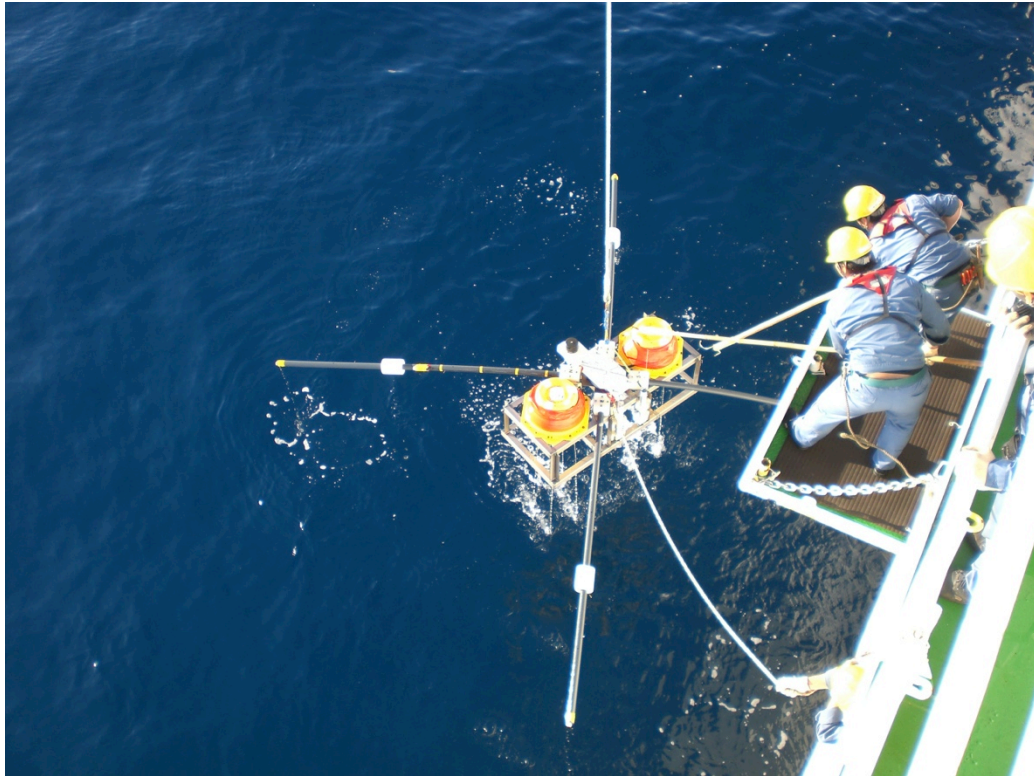


Fig. 3a OBEM-ERI recovered and deployed in the present cruise. The photo was taken at the recovery to Kairei at site NM16.



Fig. 3b OBEM of one-sphere type recovered at NM02 in the present cruise. The photo was taken at the deployment during the KR12-14 cruise.

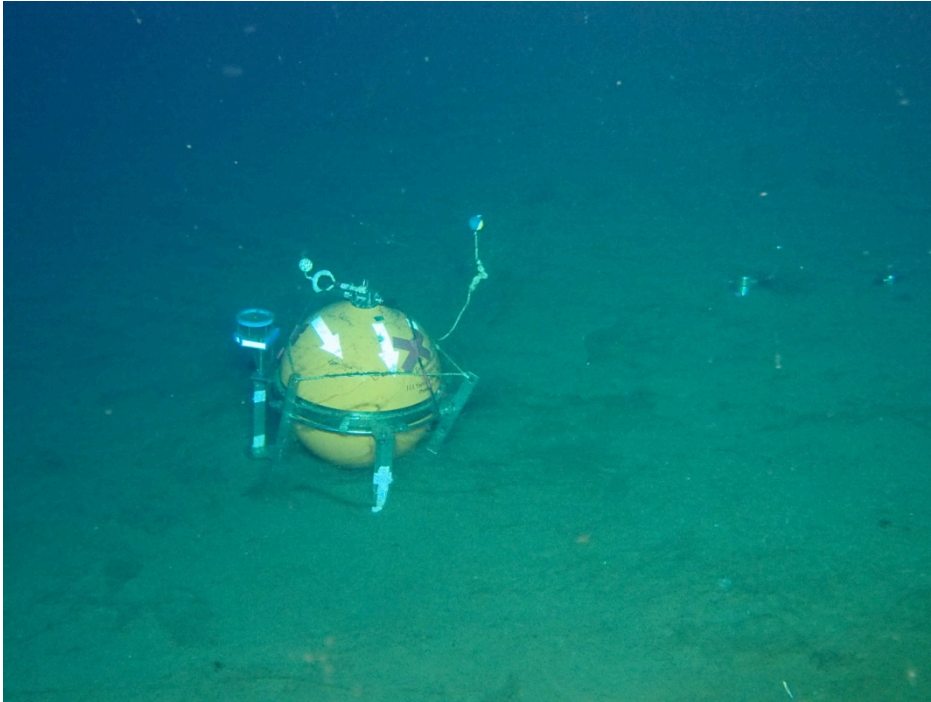


Fig. 4 BBOBS-NX at seafloor site NM14, which consists of the titanium sphere containing data recorder and batteries (left) and 3-component sensor (right, half buried in the sediment). This picture was taken by KAIKO 7000-II as she approaches the site.

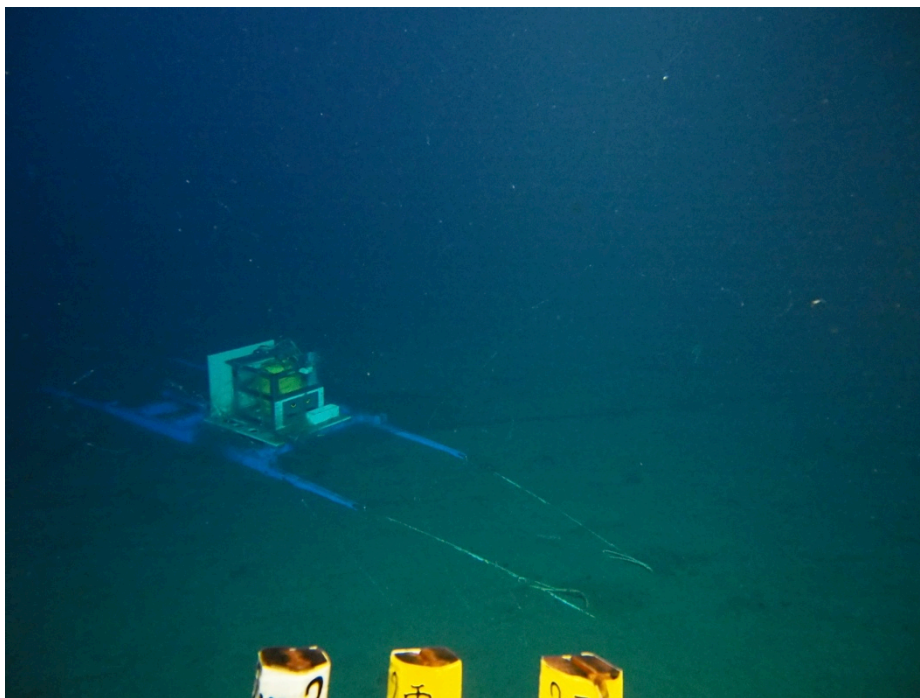


Fig. 5. EFOS recorder (with yellow hat) on anchor frame at the seafloor viewed down from KAIKO 7000-II when she approaches the site NM14.

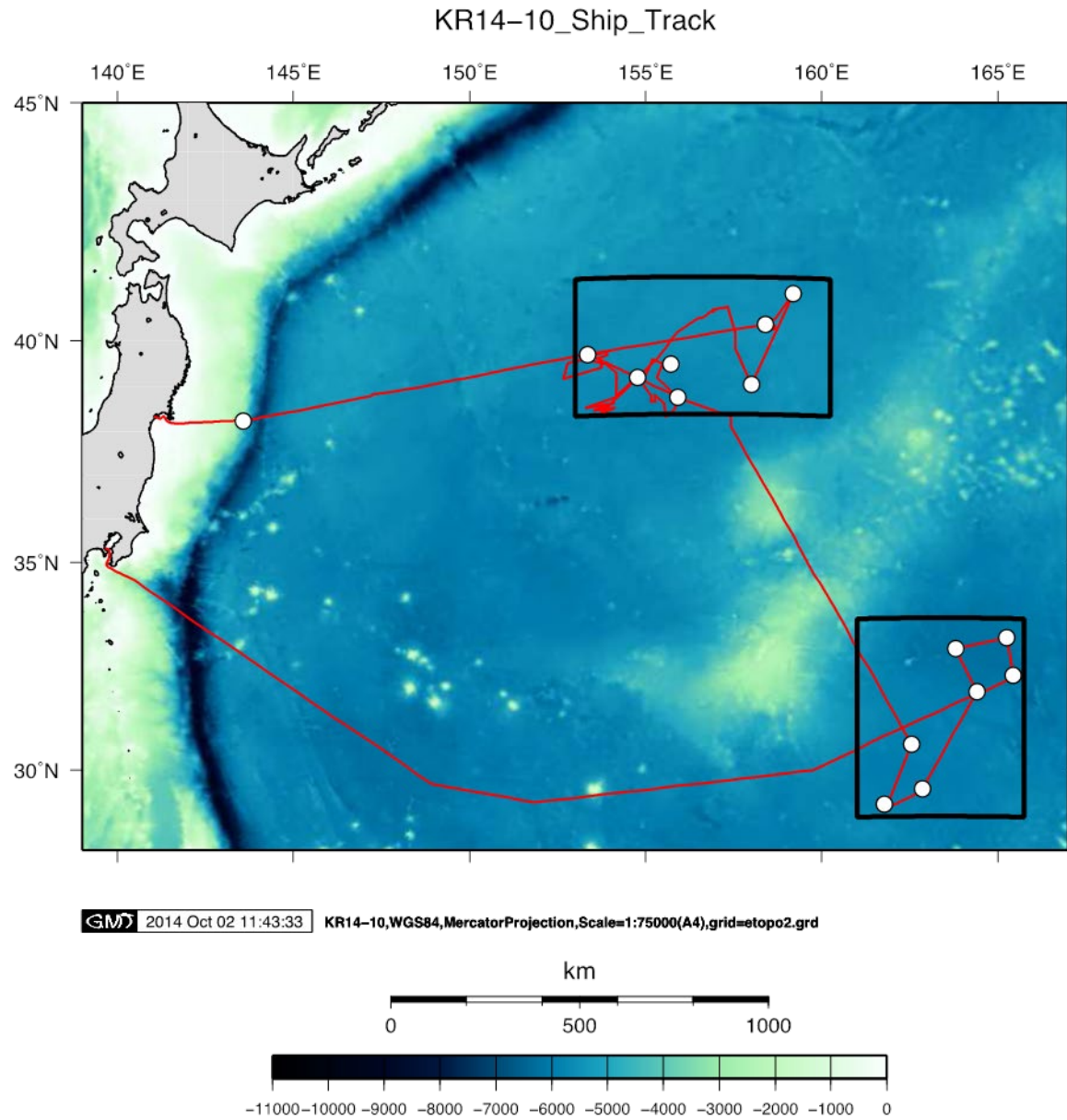


Fig. 6 Ship's track.

3.5.2 Shipboard Log

Date	Local Time	Note	Description	Position/Weather/Wind/Sea condition
9-9-2014		Let go all shore lines & left SHIOGAMA for Research area.		9/9 12:00(UTC+9h)
	08:00	Scientists onboarded.		OFF ISHINOMAKI WAN
	09:00	Let go all shore lines , & left SHIOGAMA for OFF ISHINOMAKI WAN.		38-20.4N,141-18.3E Fine but cloudy
	11:30-12:00	Carried out shipboard education & training for scientists.		EAST-3(Gentle breeze)
	13:00-14:00	KR14-10 Cruise meeting.		2(Sea smooth)
	14:10-14:30	"KAIKOU 7000 II" operation briefing.		1(Low swell sea)
	16:40-17:00	Carried out KONPIRA pray.		Visibly:7
	18:00-18:30	Scientists meeting.		
10-9-2014		Recovered VTM, Area C.		9/10 12:00(UTC+9h)
	06:06	Proceeded to research area (Area C).		OFF East KINKAZAN
	15:30	Arrived at research area (Area C).		38-12.5N,142-41.6E
	15:51	Sent out released command to VTM.		Fine but cloudy
	15:59	VTM left sea bottom.	Depth=3,353m	ESE-3(Gentle breeze)
	18:11	Recovered VTM on deck.		3(Sea slight)
	18:30	Left Research area C for next research area (Area A).		3(Moderate short)
	19:30-19:50	Scientists meeting.		Visibly:8
	24:00	Ship Local time + 1 hour.	UTC+10 hour	
11-9-2014		Proceeded to research area.		9/11 12:00(UTC+10h)
	18:00-18:30	Scientists meeting.		OFF East

				KINKAZAN
				38-55.5N,148-09.0E
				Fine but cloudy
				ESE-3(Gentle breeze)
				3(Sea slight)
				4(Moderate average)
				Visibly:8
12-9-2014		Recovered OBEM (ERI100 & ERI12), NM01.		9/12 12:00(UTC+10h)
	06:30	Arrived at research area (Area A, NM02).		North-West Pacific Ocean
	06:33	Released XBT.	39-42.0673N,1 53-16.7949E	39-16.2N, 154-34.5E
	07:40	Suspended "KAIKO 7000 II" dive operation due to rough sea.		Rain
		then proceeded to next site (NM01).		SE-6(Strong breeze)
	12:40	Arrived at research site (NM01).		5(Sea rough)
	13:10	Sent out released command to OBEM (ERI100).	Depth=5,730.6 m	3(Moderate short)
	13:21	OBEM (ERI100) left the sea bottom.		Visibly:7
	13:40	Sent out released command to OBEM (ERI12).	Depth=5,722.4 m	
	13:43	OBEM (ERI12) left the sea bottom.		
	15:29	Recovered OBEM (ERI100).		
	16:59	Recovered OBEM (ERI12).		
	17:17	Com'ced MBES mapping survey (NM01 to NM03).		
	19:30-19:50	Scientists meeting.		
13-9-2014		"KAIKO 7000 II"#629 Dive (Recovered EFOS &		9/13 12:00(UTC+10h)

		BBOBS-NX) ,NM01.		
	03:54	Finished MBES mapping survey (NM01 to NM03).		North-West Pacific Ocean
	04:00	Arrived at Dive area (NM03).		39-12.0N,154-45.9E
	06:00	Changed dive area, for avoiding fishing activity.		Fine but cloudy
		then proceeded to next dive site (NM01).		WSW-5(Fresh breeze)
	10:10	Arrived at Dive site (NM01).		4(Sea moderate)
	10:13	Released XBT.	39-11.6818N,154-47.3326E	3(Moderate short)
	11:27	Hoisted up "KAIKO 7000 II".		Visibly:7
	11:33	Launched "KAIKO 7000 II", then it dove & com'ced her operation.	Dive No.629	
	13:59	"KAIKO 7000 II" landed on the sea bottom.	Depth=5,748m	
	16:23	"KAIKO 7000 II" left the sea bottom.	Depth=5,748m	
	18:00-18:20	Scientists meeting.		
	19:26	Hoisted up "KAIKO 7000 II".		
	19:41	Recovered "KAIKO 7000 II" & finished the operation.		
	20:22	Recovered EFOS (EFOS6) & BBOBS (NX-D).		
	20:47	Com'ced MBES mapping survey (NM01 to NM02).		
14-9-2014		MBES mapping survey.		9/14 12:00(UTC+10h)
	04:27	Suspended MBES mapping survey, due to rough sea.		North-West Pacific Ocean
	08:00	Suspended "KAIKO 7000 II" dive operation, due to rough sea.		39-33.8N,153-23.5E
		then com'ced heave to.		Fine but cloudy
	18:00-18:20	Scientists meeting.		WEST-7(Naer gale)

	18:28	Restarted MBES mapping survey.		6(Sea rough)
				6(Heavy swell short)
				Visibly:7
15-9-2014		"KAIKO 7000 II"#630 Dive(Recovered OBEM & BBOBS-NX), NM02.		9/15 12:00(UTC+10h)
	05:37	Finished MBES mapping survey, then proceeded to next area.	Next area=NM02	North-West Pacific Ocean
	10:10	Arrived at Dive point.	NM02	39-42.7N,153-21.1E
	07:37	Hoisted up "KAIKO 7000 II".		Fine but cloudy
	07:43	Launched "KAIKO 7000 II", then it dove & com'ced her operation.	Dive No.630	NNW-4(Moderate breeze)
	09:57	"KAIKO 7000 II" landed on the sea bottom.	Depth=5,726m	4(Sea moderate)
	15:16	"KAIKO 7000 II" left the sea bottom.	Depth=5,730m	3(Moderate short)
	17:25	Hoisted up "KAIKO 7000 II".		Visibly:8
	17:37	Recovered "KAIKO 7000 II" & finished the operation.		
	18:16	Recovered OBEM (JM104) & BBOBS-NX (NX-B).		
	18:30	Left NM02 for next area.		
	20:00-20:15	Scientists meeting.		
16-9-2014		"KAIKO 7000 II"#631 Dive (Recovered BBOBS-NX), NM15.		9/16 12:00(UTC+10h)
	09:50	Arrived at dive site (NM15).		North-West Pacific Ocean
	09:56	Released at XBT.	40-20.7270N,158-23.2572E	40-21.8N,154-24.2E
	11:27	Hoisted up "KAIKO 7000 II".		Fine but cloudy
	11:33	Launched "KAIKO 7000 II", then it dove & com'ced her operation.	Dive No.631	WNW-4(Moderate breeze)
	13:41	"KAIKO 7000 II" landed on the sea	Depth=5,575m	3(Sea slight)

		bottom.		
	14:57	"KAIKO 7000 II" left the sea bottom.	Depth=5,577m	2(Low swell long)
	17:02	Hoisted up "KAIKO 7000 II".		Visibly:8
	17:12	Recovered "KAIKO 7000 II" & finished the operation.		
	17:19	Recovered BBOBS-NX (NX-F).		
	18:00	Left NM15 for next area (NM16).		
	18:00-18:15	Scientists meeting.		
	18:10	Com'ced MBES mapping survey (NM15 to NM16).		
17-9-2014		Recovered OBEM & "KAIKO 7000 II"#632 & #633 Dive(Recovered EFOS & BBOBS-NX) ,NM16.		9/17 12:00(UTC+10h)
	03:00	Arrived at dive point & finished MBES mapping survey (NM15 to NM16).		North-West Pacific Ocean
	03:06	Sent out released command to OBEM (ERI14).	Depth=5,551m	41-01.3N,159-11.3E
	03:14	OBEM (ERI14) left the sea bottom.		Fine but cloudy
	06:24	Recovered OBEM (ERI14).		ENE-2(Light breeze)
	08:23	Hoisted up "KAIKO 7000 II".		1(Calm)
	08:28	Launched "KAIKO 7000 II", then it dove & com'ced her operation.	Dive No.632	2(Low swell long)
	10:43	"KAIKO 7000 II" landed on the sea bottom.	Depth=5,575m	Visibly:8
	11:08	Suspended "KAIKO 7000 II" operation, due to trouble of her manipulator,		
		then "KAIKO 7000 II" left the sea bottom.	Depth=5,575m	
	13:19	Hoisted up "KAIKO 7000 II".		
	13:27	Recovered "KAIKO 7000 II" &		

		finished the operation.		
	14:39	Hoisted up "KAIKO 7000 II".		
	14:45	Launched "KAIKO 7000 II", then it dove & com'ced her operation.	Dive No.633	
	16:52	"KAIKO 7000 II" landed on the sea bottom.	Depth=5,576m	
	18:03	"KAIKO 7000 II" left the sea bottom.	Depth=5,575m	
	18:30-18:50	Scientists meeting.		
	20:10	Hoisted up "KAIKO 7000 II".		
	20:21	Recovered "KAIKO 7000 II" & finished the operation.		
	20:59	Recovered EFOS (EFOS7) & BBOBS-NX (NX-A).		
	21:10	Left NM16 for next dive site (NM14).		
18-9-2014		"KAIKO 7000 II"#634 Dive(Recovered EFOS & BBOBS-NX) & Recovered OBEM(ERI10),NM14.		9/18 12:00(UTC+10h)
	06:00	Arrived at dive area(NM14).		North-West Pacific Ocean
	06:06	Released at XBT.	39-04.3198N,1 58-01.3430E	39-02.7N,158-00.6E
	07:24	Hoisted up "KAIKO 7000 II".		Cloudy
	07:29	Launched "KAIKO 7000 II", then it dove & com'ced her operation.	Dive No.634	ESE-5(Fresh breeze)
	09:49	"KAIKO 7000 II" landed on the sea bottom.	Depth=5,506m	3(Sea slight)
	11:18	"KAIKO 7000 II" left the sea bottom.	Depth=5,507m	2(Low swell long)
	12:04	Sent out released command to OBEM(ERI10).		Visibly:7
	13:31	Hoisted up "KAIKO 7000 II".		

	13:41	Recovered "KAIKO 7000 II" & finished the operation.		
	13:49	Recovered EFOS (EFOS5) & BBOBS-NX (NX-C).		
	15:13	Recovered OBEM (ERI10).		
	15:21	Com'ced MBES mapping survey.		
19-9-2014		Suspended "KAIKO 7000 II" Dive.		9/19 12:00(UTC+10h)
	03:04	Suspended MBES mapping survey, due to rough sea.		North-West Pacific Ocean
	08:00	Suspended "KAIKO 7000 II" Dive, due to rough sea.		40-29.5N,156-30.3E
	18:00-18:15	Scientists meeting.		Fine but cloudy
				WEST-7(Near gale)
				5(Sea rough)
				5(Moderate long)
				Visibly:7
20-9-2014		Suspended "KAIKO 7000 II" Dive.		9/20 12:00(UTC+10h)
	07:00	Arrived at dive area (NM01), then suspended "KAIKO 7000 II" Dive. Due to rough sea.		North-West Pacific Ocean
	13:37	Com'ced MBES mapping survey.		38-35.4N,156-58.4E
	18:00-18:10	Scientists meeting.		Fine but cloudy
				WEST-5(Fresh breeze)
				4(Sea moderate)
				4(Moderate average)
				Visibly:8
21-9-2014		"KAIKO 7000 II"#635 Dive(Recovered BBOBS),NM01.		9/21 12:00(UTC+10h)
	03:05	Finished MBES mapping survey.		North-West Pacific

				Ocean
	07:00	Arrived at dive area (NM01).		39-12.0N,154-47.1E
	11:12	Hoisted up "KAIKO 7000 II".		Overcast
	11:16	Launched "KAIKO 7000 II", then it dove & com'ced her operation.	Dive No.635	NORTH-3(Gentle breeze)
	13:41	"KAIKO 7000 II" landed on the sea bottom.	Depth=5,748m	2(Sea smooth)
	14:24	"KAIKO 7000 II" left the sea bottom.	Depth=5,748m	3(Moderate short)
	16:35	Hoisted up "KAIKO 7000 II".		Visibly:7
	16:44	Recovered "KAIKO 7000 II" & finished the operation.		
	16:50	Recovered BBOBS (B).		
	17:30	Left NM01 for next dive site (NM03).		
	18:00-18:15	Scientists meeting.		
	18:34-23:05	Carried out MBES mapping survey.		
22-9-2014		"KAIKO 7000 II"#636 Dive (Recovered BBOBS-NX) & Deploy OBEM (ERI2) ,NM03.		9/22 12:00(UTC+10h)
	01:40	Arrived at dive site (NM03).	NM03	North-West Pacific Ocean
	02:56-03:30	Sent out released command to OBEM (ERI3).		38-45.1N,155-54.0E
	06:00-06:50	Searched OBEM (ERI3).		Fine but cloudy
	06:55	Suspended search for OBEM (ERI3) ,due to OBEM(ERI3) was missing.		NE-2(Light breeze)
	07:51	Hoisted up "KAIKO 7000 II".		2(Sea smooth)
	07:56	Launched "KAIKO 7000 II", then it dove & com'ced her operation.	Dive No.636	2(Low swell long)
	10:16	"KAIKO 7000 II" landed on the sea bottom.	Depth=5,752m	Visibly:8

	16:35	"KAIKO 7000 II" left the sea bottom.	Depth=5,758m	
	18:00-18:15	Scientists meeting.		
	18:43	Hoisted up "KAIKO 7000 II".		
	18:52	Recovered "KAIKO 7000 II" & finished the operation.		
	18:59	Recovered BBOBS-NX (NX-D).		
	20:15	Deployed OBEM (ERI2).		
	23:15-23:58	Carried out calibration OBEM (ERI2).	Depth=5,763m	
23-9-2014		Proceeded to next research area (Area B).		9/23 12:00(UTC+11h)
	00:00	Left NM03 for next research area (Area B, NM20).		North-West Pacific Ocean
	04:32-05:36	Carried out MBES mapping survey.		36-41.5N,158-26.0E
	18:00-18:15	Scientists meeting.		Cloudy
	24:00	Ship Local time + 1hour.	UTC+11 hour	NE-4(Moderate breeze)
				3(Sea slight)
				2(Low swell long)
24-9-2014		Recovered BBOBS & OBEM, NM20.		9/24 12:00(UTC+11h)
	09:30-10:00	Practiced boat & water proof station drill.	32-10N,161-34 E	North-West Pacific Ocean
	16:30	Arrived at Research site (NM20).		31-35.0N,161-55.0E
	16:32	Sent out released command to BBOBS (13B).	Depth=5,915m	Fine but cloudy
	16:38	BBOBS (13B) left the sea bottom.		NORTH-5(Fresh breeze)
	16:44	Sent out released command to OBEM (TT1).	Depth=5,922m	4(Sea moderate)
	16:50	OBEM (TT1) left the sea bottom.		3(Moderate short)

	18:23	Recovered BBOBS (13B).		Visibly:8
	18:30-18:45	Scientists meeting.		
	20:08	Recovered OBEM (TT1).		
	20:40	Left NM20 for next dive site (NM19).		
25-9-2014		"KAIKO 7000 II"#637 Dive(Recovered BBOBS), NM19.		9/25 12:00(UTC+11h)
	03:18-06:31	Carried out MBES mapping survey.		North-West Pacific Ocean
	04:48	Released XBT.	29-14.9734N,1 61-34.5331E	29-09.0N,161-46.5E
	06:00	Arrived at dive area (NM19).		Cloudy
	08:41	Hoisted up "KAIKO 7000 II".		NE-5(Fresh breeze)
	08:46	Launched "KAIKO 7000 II", then it dove & com'ced her operation.	Dive No.637	4(Sea moderate)
	11:39	"KAIKO 7000 II" landed on the sea bottom.	Depth=5,917m	3(Moderate short)
	12:54	"KAIKO 7000 II" left the sea bottom.	Depth=5,917m	Visibly:8
	15:15	Hoisted up "KAIKO 7000 II".		
	15:25	Recovered "KAIKO 7000 II" & finished the operation.		
	15:31	Recovered BBOBS (NMPC).		
	16:10	Left NM19 for next dive area (NM21).		
	16:22	Com'ced MBES mapping survey (NM19 to NM21).		
	18:00-18:15	Scientists meeting.		
26-9-2014		"KAIKO 7000 II"#638 Dive (Recovered OBEM anchor), NM21.		9/26 12:00(UTC+11h)
	04:47	Finished MBES mapping survey.		North-West Pacific Ocean

	04:52	Released XBT.	29-35.9858N,1 62-50.9015E	29-32.5N,161-51.6E
	05:14-05:58	Carried out MBES mapping survey.		Rain
	06:15	Arrived at dive site (NM21).		SE-5(Fresh breeze)
	07:25	Hoisted up "KAIKO 7000 II".		4(Sea moderate)
	07:30	Launched "KAIKO 7000 II", then it dove & com'ced her operation.	Dive No.638	3(Moderate short)
	10:14	"KAIKO 7000 II" landed on the sea bottom.	Depth=5,978m	Visibly:5
	11:12	"KAIKO 7000 II" left the sea bottom.	Depth=5,977m	
	13:42	Hoisted up "KAIKO 7000 II".		
	13:52	Recovered "KAIKO 7000 II" & finished the operation.		
	13:55	Recovered OBEM anchor (OBEM:TT7).		
	14:40	Left NM21 for next site (NM23).	Next area=NM23	
	18:00-18:15	Scientists meeting.		
27-9-2014		Recovered BBOBS (NM23, NM22, NM24) & OBEM (NM24).		9/27 12:00(UTC+11h)
	03:40	Arrived at research site (NM23).		North-West Pacific Ocean
	03:50	Sent out released command to BBOBS (13L).	Depth=6,017m	32-57.3N,163-48.0E
	03:56	BBOBS (13L) left the sea bottom.		Fine but cloudy
	05:40	Recovered BBOBS (13L).		SW-2(Light breeze)
	05:50	Left NM23 for next research site (NM22).		2(Sea smooth)
	10:40	Arrived at research site (NM22).		3(Moderate short)
	10:46	Sent out released command to BBOBS (13E).	Depth=6,132m	Visibly:5

	10:51	BBOBS (13E) left the sea bottom.		
	12:27	Recovered BBOBS (13E).		
	12:30	Left NM22 for next research site (NM24).		
	17:50	Arrived at research site (NM24).		
	18:05	Sent out released command to BBOBS (13J).	Depth=6,072m	
	18:10	BBOBS (13J) left the sea bottom.		
	18:21	Sent out released command to OBEM (ERI8).	Depth=6,119m	
	19:52	Recovered BBOBS (13J).		
	21:48	Recovered OBEM (ERI8).		
	22:00	Left NM24 for next site (NM25).		
28-9-2014		Recovered BBOBS,NM25.& Left research area for YOKOSUKA.		9/28 12:00(UTC+11h)
	04:15	Arrived at research site (NM25).		North-West Pacific Ocean
	04:25	Sent out released command to BBOBS (13K).	Depth=6,064m	31-37.0N,163-47.5E
	04:32	BBOBS(13K) left the sea bottom.		Fine but cloudy
	06:11	Recovered BBOBS (13K).		ENE-6(Strong breeze)
	06:20	Left research area for YOKOSUKA.		4(Sea moderate)
	18:00-18:10	Scientists meeting.		4(Moderate average)
	24:00	Ship Local time — 1hour.	UTC+10 hour	Visibly:8
29-9-2014		Proceeded to YOKOSUKA.		9/29 12:00(UTC+10h)
	18:00-18:10	Scientists meeting.		North-West Pacific Ocean
				29-40.0N,156-31.0E
				Fine but cloudy

				SE-4(Moderate breeze)
				3(Sea slight)
				4(Moderate average)
				Visibly:8
30-9-2014		Proceeded to YOKOSUKA.		9/30 12:00(UTC+10h)
		Scientists meeting.		OFF EAST OGASAWARA islands
	24:00	Ship Local time — 1hour.	UTC+9 hour	29-24.1N,150-33.7E
				Fine but cloudy
				WSW-4(Moderate breeze)
				3(Sea slight)
				4(Moderate average)
				Visibly:8
1-Oct-14		Proceeded to YOKOSUKA.		10/1 12:00(UTC+9h)
	09:00-10:00	Scientist seminar.		OFF ESE HACHIJO-JIMA
	18:00-18:30	Scientists meeting.		32-17.8N,144-24.2E
				Fine but cloudy
				East-4(Moderate breeze)
				3(Sea slight)
				3(Moderate short)
				Visibly:8
02-Oct-14		Arrived at YOKOSUKA		10/2 11:00 (UTC+9h)
	11:00	Sent out 1st shore line, arrived at YOKOSUKA,completed KR14-10.		YOKOSUKA

3.6 Dive information

Dive #629 (Site NM01)

Sep. 13, 2014

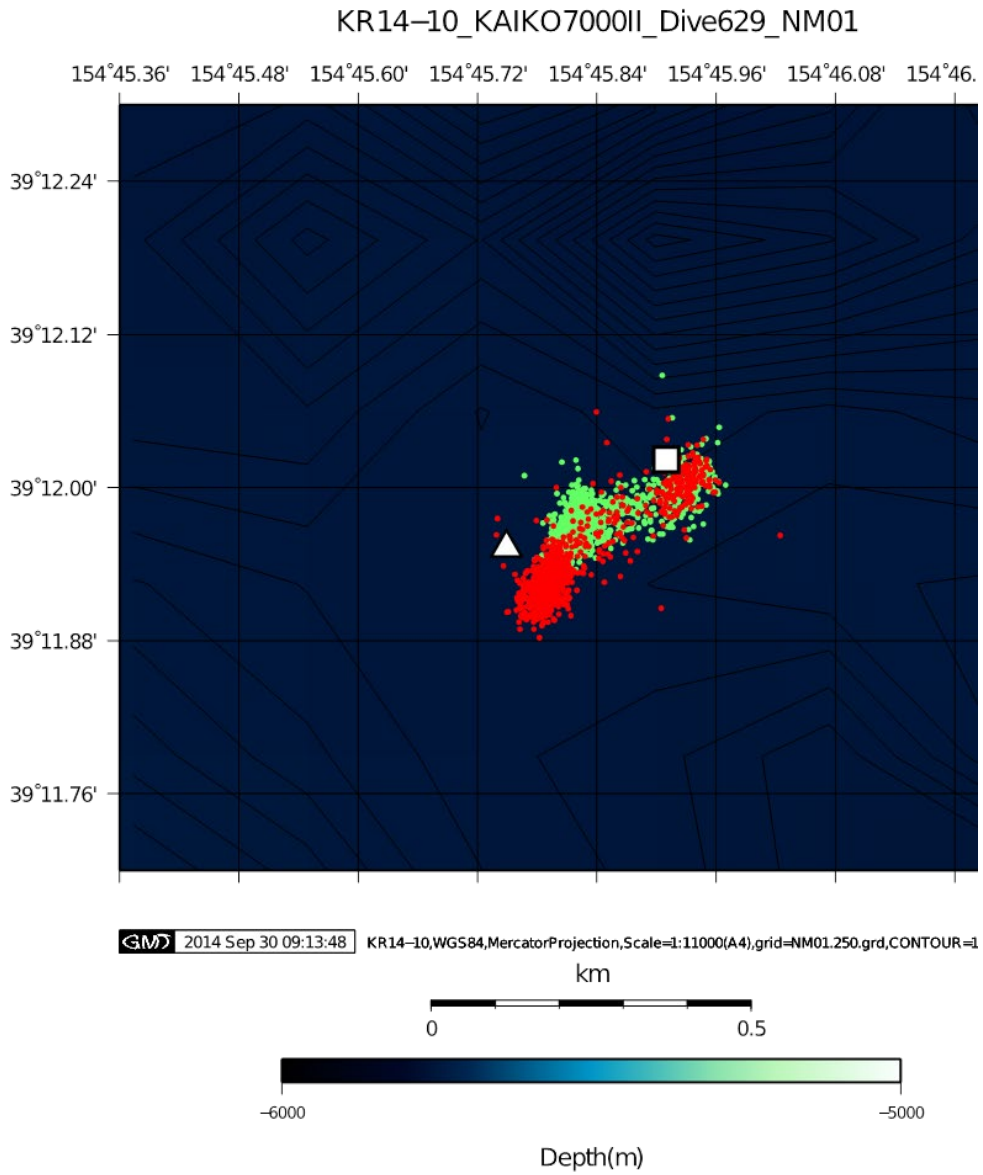


Fig. 7 Track of the vehicle (red) and launcher (green) at NM01 to recover BBOBS-NX (triangle) and EFOS recorder (square).

Dive #630 (Site NM02)

Sep. 15, 2014

KR14-10_KAIKO7000II_Dive630_NM02

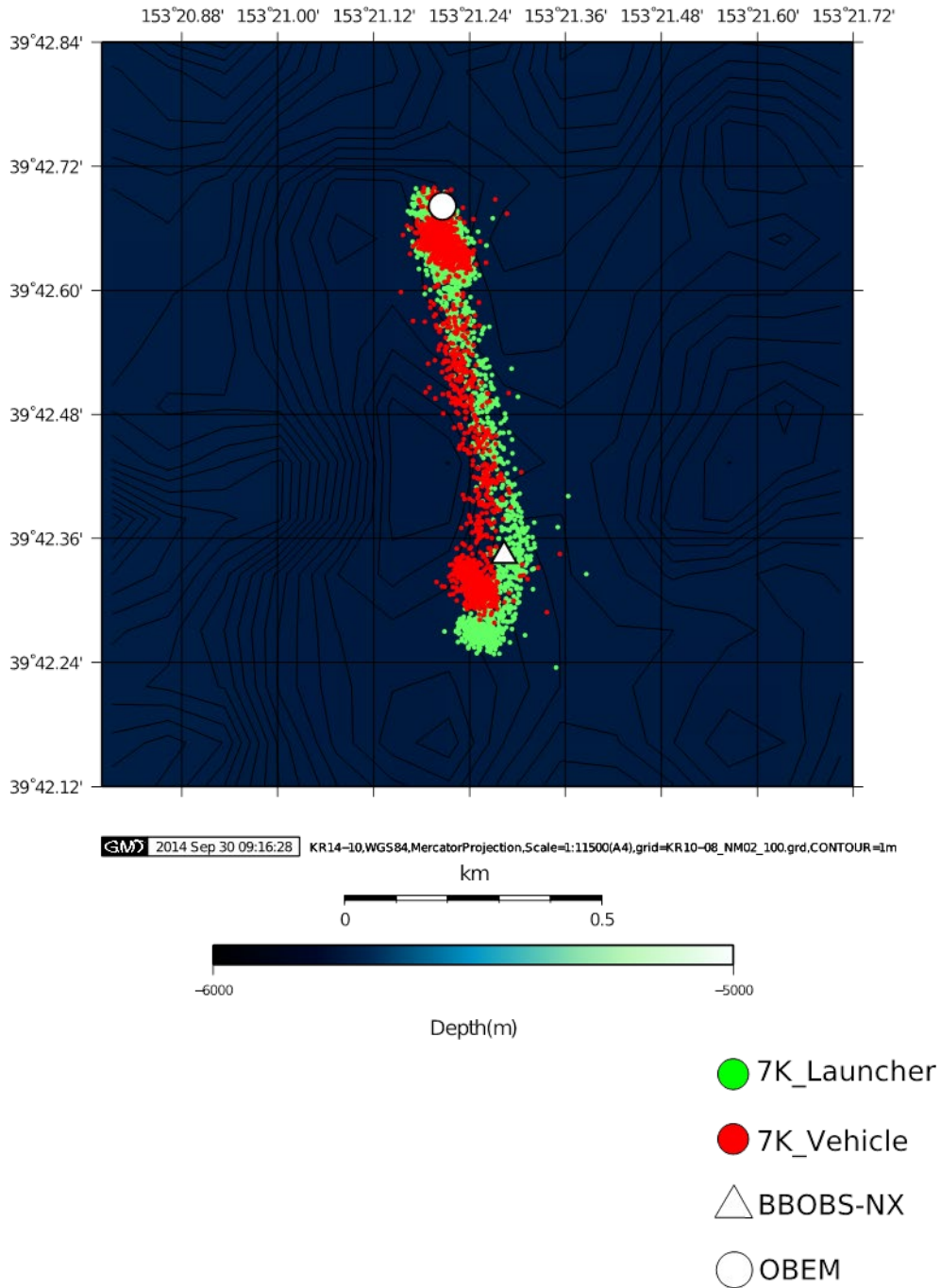


Fig. 8 Track of vehicle (red) and launcher (green) at NM02 to recover BBOBS-NX (triangle) and OBEM (circle).

Dive #631 (Site NM15)

Sep. 16, 2014

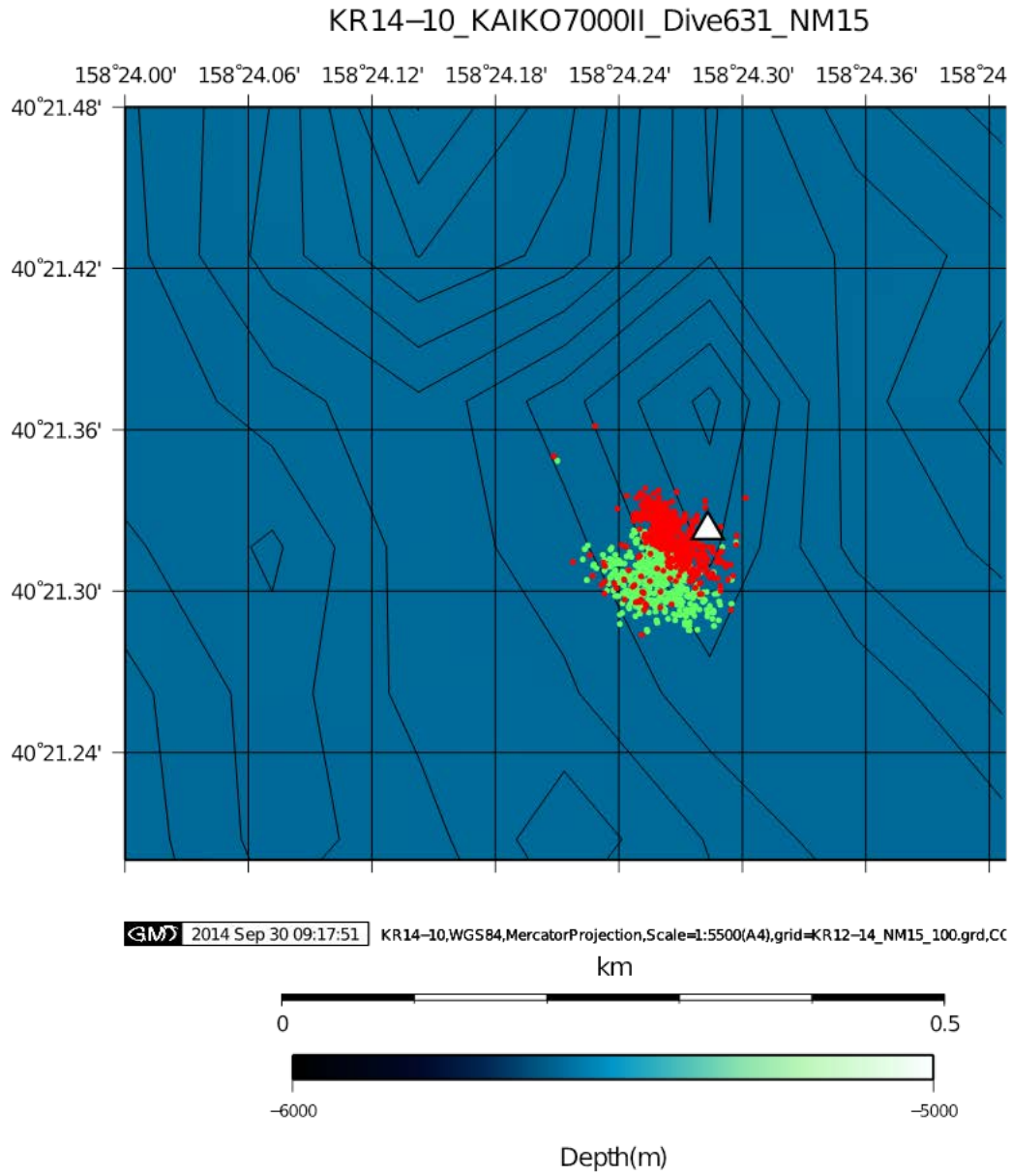


Fig. 9 Track of vehicle (red) and launcher (green) of Kaiko 7000II at NM15 to recover BBOBS-NX (triangle).

Dive #633 (Site NM16) Sep. 17, 2014

* Dive #632 was cancelled due to a trouble in the manipulator

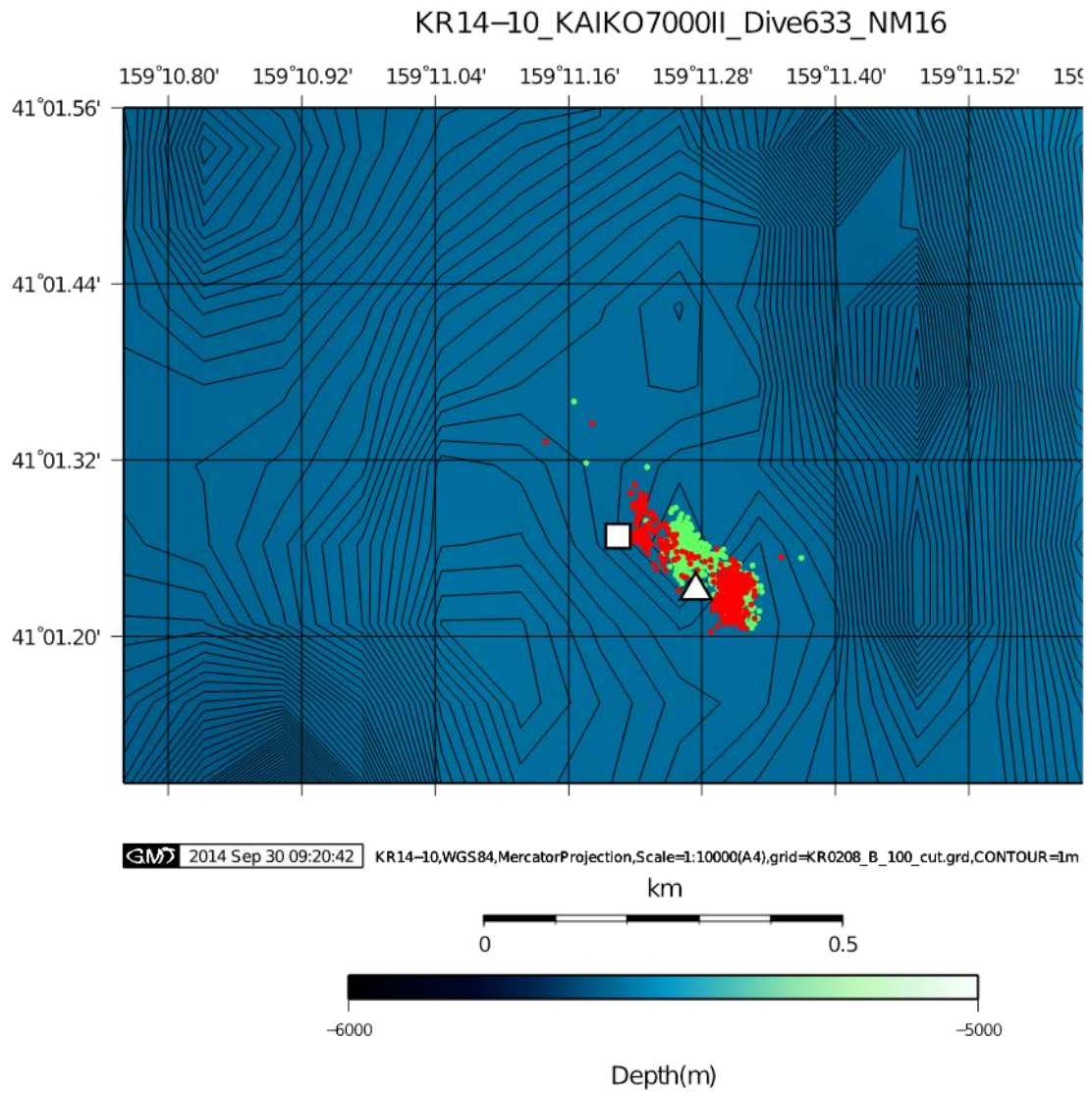


Fig. 10 Track of the vehicle (red) and launcher (green) at NM16 to recover BBOBS-NX (triangle) and EFOS recorder (square).

Dive #634 (Site NM14)

Sep. 18, 2014

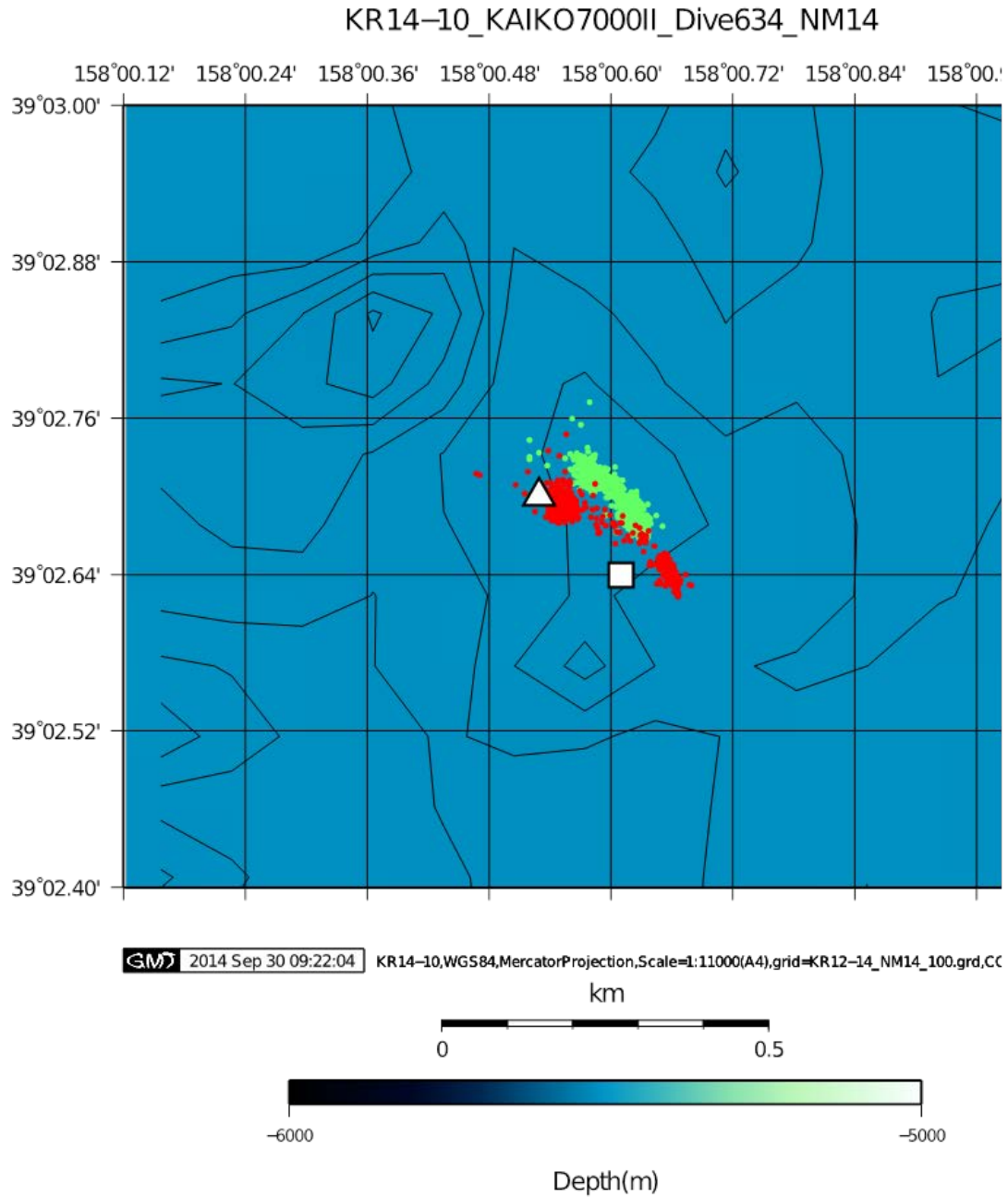


Fig. 11 Track of the vehicle (red) and launcher (green) at NM14 to recover BBOBS-NX (triangle) and EFOS recorder (square).

Dive #635 (Site NM01)

Sep. 21, 2014

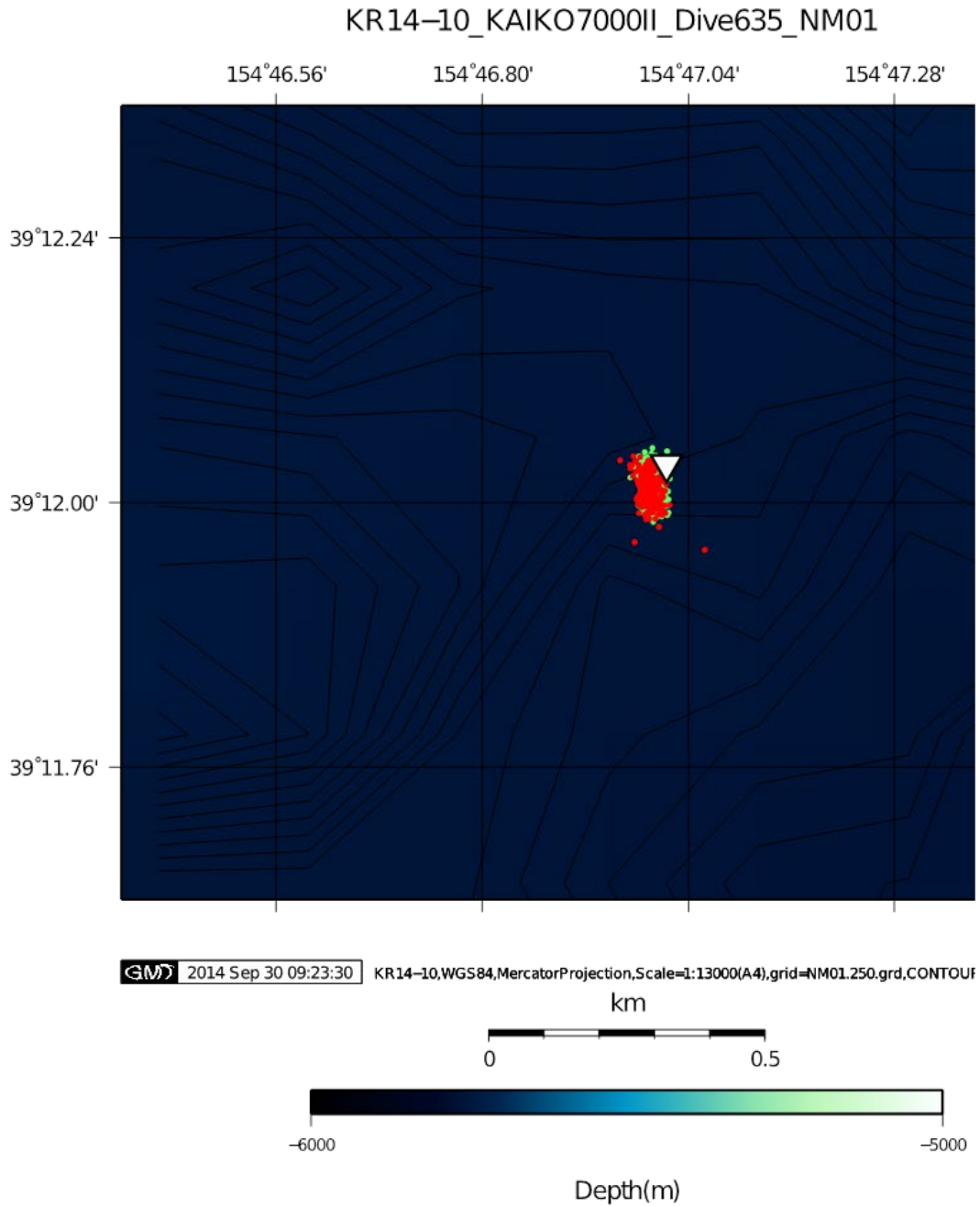


Fig. 12 Track of the vehicle (red) and launcher (green) at NM01 to recover BBOBS (reverse triangle).

Dive #636 (Site NM03)

Sep. 22, 2014

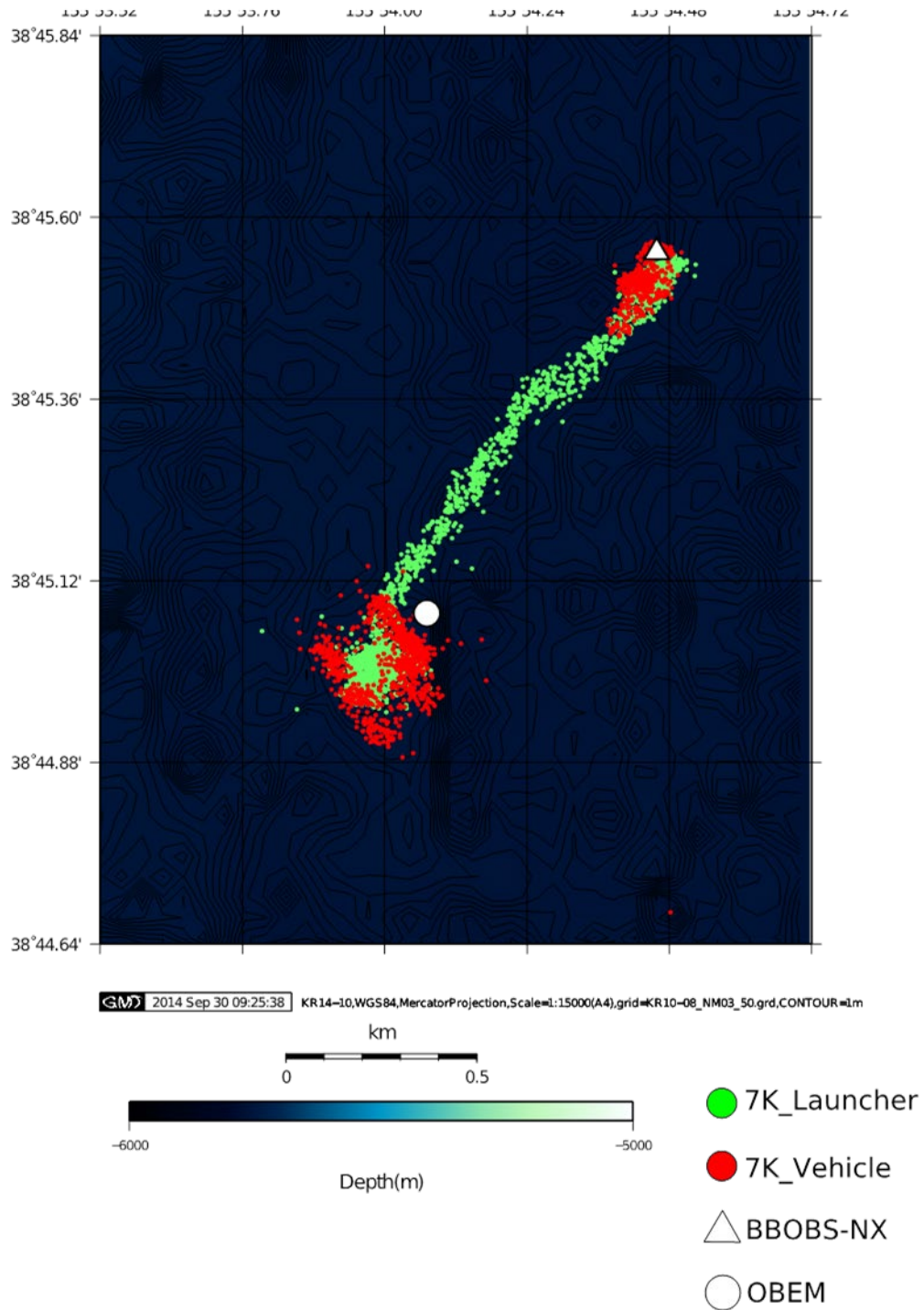


Fig. 13 Track of the vehicle (red) and launcher (green) at NM03 to recover BBOBS-NX (triangle) and OBEM (circle). OBEM was not found.

Dive #637 (site NM19)

Sep. 25, 2014/09/26

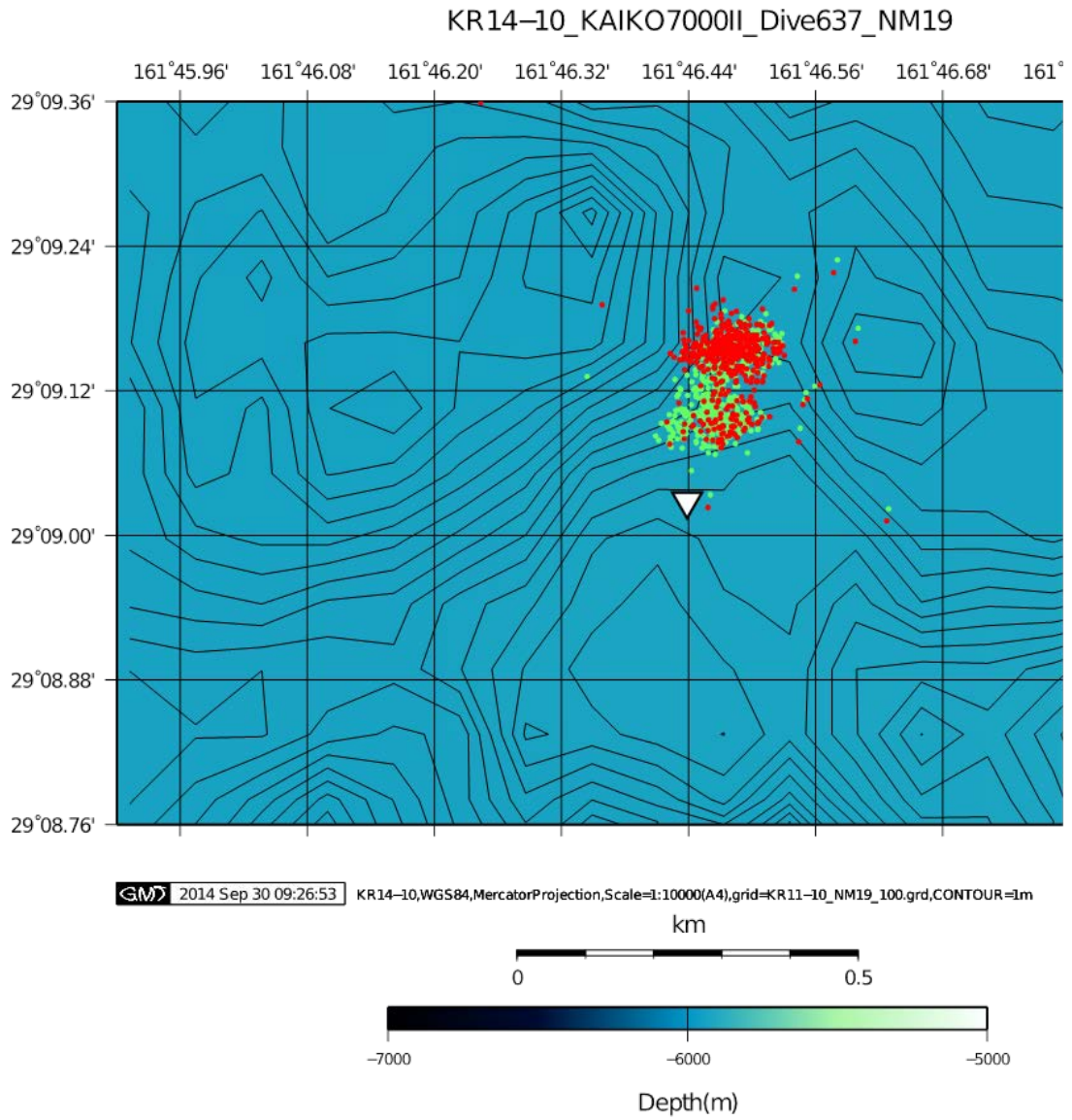


Fig. 14 Track of the vehicle (red) and launcher (green) at NM19 to recover BBOBS (reverse triangle).

Dive #638 (site NM21)

Sep. 26, 2014

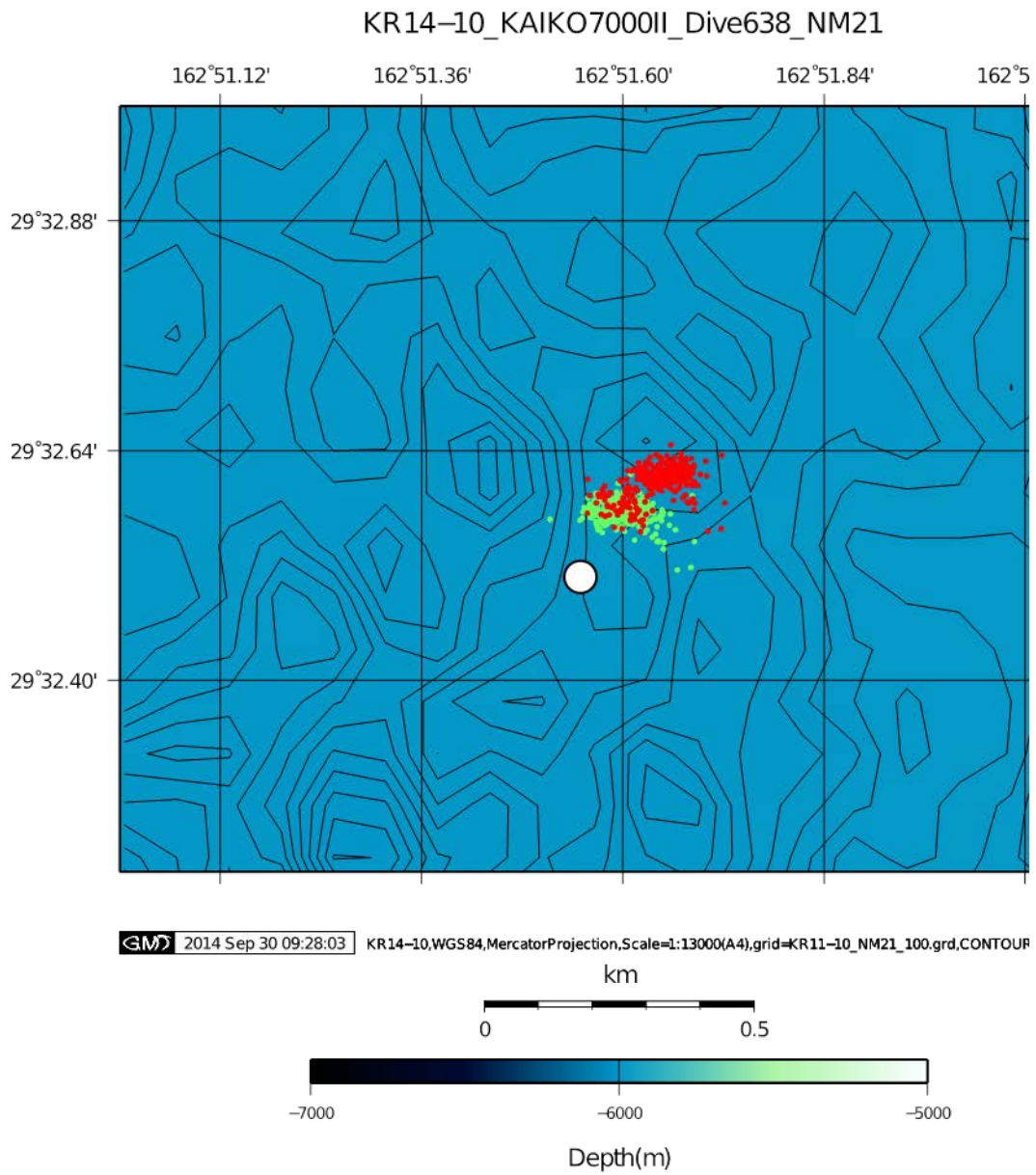


Fig. 14 Track of the vehicle (red) and launcher (green) at NM21 to recover OBEM (circle). OBEM was not found. Only its concrete anchor was found and retrieved.

3.7 Summary of Recovery and bathymetric survey

In the following, results of recovery operations and bathymetric surveys in this cruise are summarized in the order of completion.

Sep. 10 (Area C) Recovery of VTM.

Sep. 12 (Area A, site NM02) Call OBEM (with answer) and BBOBS-NX (without answer).

Sep. 12 (Area A, site NM01) Recovery of OBEMs of one-sphere and two-sphere type. Bathymetric survey between sites NM01 and NM03 at night.

Sep. 13 (Area A, site NM01) Recovery of BBOBS-NX and EFOS recorder by Kaiko-7000II dive operation (#629). Bathymetric survey between sites NM01 and NM02 at night.

Sep. 15 (Area A, site NM02) Recovery of BBOBS-NX and OBEM-JM104 by Kaiko-7000II dive operation (#630).

Sep. 16 (Area A, site NM15) Recovery of BBOBS-NX by Kaiko-7000II dive operation (#631).

Sep. 17 (Area A, site NM16) Recovery of OBEM of two-sphere type. Recovery of BBOBS-NX and EFOS by Kaiko-7000II dive operation (#632).

Sep. 18 (Area A, site NM14) Recovery of BBOBS-NX and EFOS by Kaiko-7000II dive operation (#634). Recovery of OBEM of two-sphere type. Bathymetric survey between sites NM14 and NM01.

Sep. 19 (Area A, between sites NM14 and NM01) Bathymetric survey.

Sep. 20 (Area A, west of site NM01) Bathymetric survey.

Sep. 21 (Area A, site NM01) Recovery of BBOBS with a trouble in the acoustic release system by Kaiko-7000II dive operation (#635).

Sep. 22 (Area A, site NM03) Search for OBEM by Kaiko-7000II, unsuccessful. Recovery of BBOBS-NX by Kaiko-7000II dive operation (#636).

Sep. 24 (Area B, site NM20) Recovery of BBOBS and OBEM of two-sphere type.

Sep. 25 (Area B, site NM19) Recovery of BBOBS by Kaiko-7000II dive operation (#637). Bathymetric survey at night.

Sep. 26 (Area B, site NM21) Search for OBEM but recovery only the anchor frame by Kaiko-7000II dive operation (#638).

Sep. 27 (Area B, site NM23) Recovery of BBOBS.

Sep. 27 (Area B, site NM22) Recovery of BBOBS.

Sep. 27 (Area B, site NM24) Recovery of BBOBS and OBEM.

Sep. 28 (Area B, site NM25) Recovery of BBOBS.

3.8 Summary of deployment

Sep. 22 (Area A, site NM03) Installation of OBEM of two-sphere type

Installation point information is provided in attached figure.

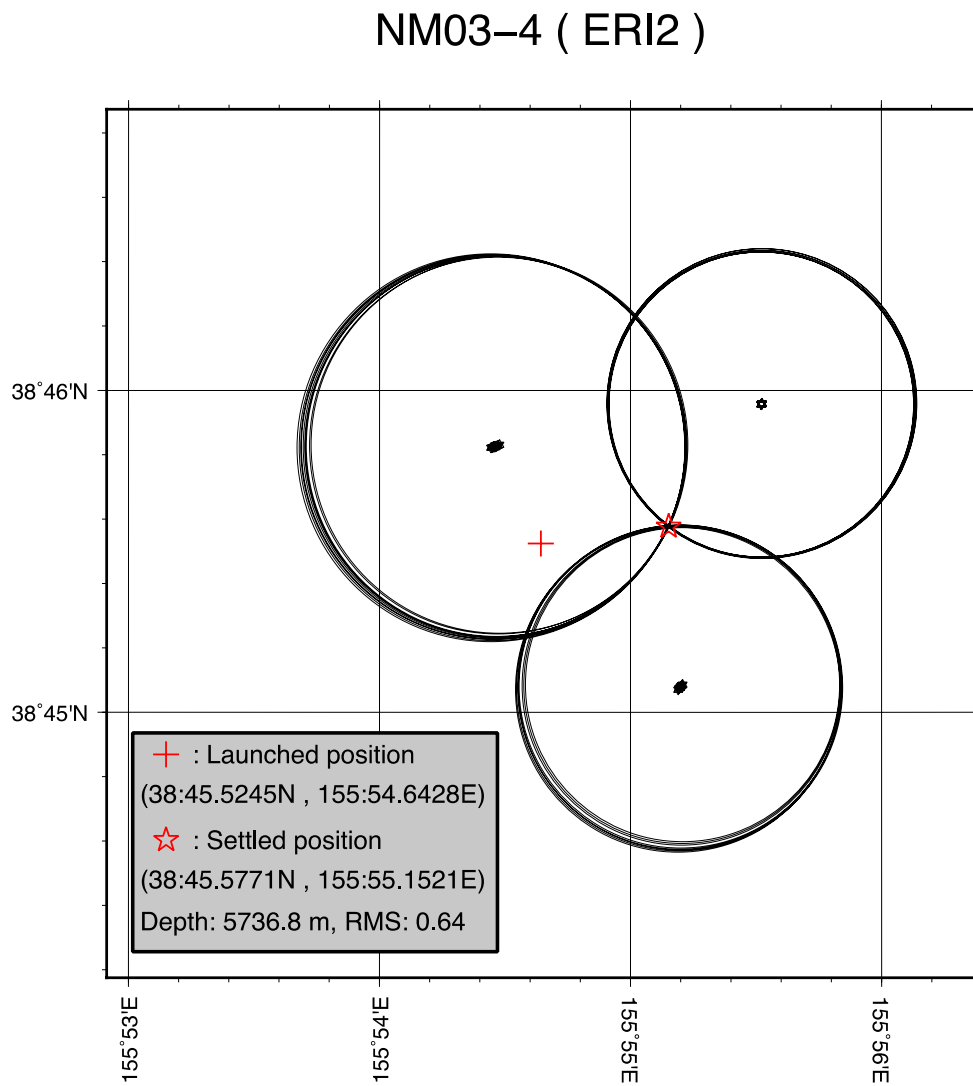


Fig. 15 Positioning results for launching and settling of OBEM at NM03.

3.9 Overview of the result

Due to unusually good sea condition for this season, we have completed planned operations at most of observation sites, except those at site NM03 where observations by EFOS and OBEM are continued till next recovery opportunity and OBEM with imploded glass spheres is left. As summarized in Table 1, we successfully retrieved 25 instruments from seafloor of the study areas and installed one instrument for further observation. We confirmed that most of retrieved instruments have recorded data, which will be analyzed to solve major scientific questions of the NOMan Project.

Table 1 Number of instruments recovered/installed in the present cruise.

	BBOBS-NX	EFOS	BBOBS	OBEM, VTM	Others
Recovery by dive	6	3	2	1*	1**
Recovery by self pop-up			5	7	
Installation				1	

* Titanium case imploded

** Only concrete anchor

4. Notice on Data usage

Notice on using: Insert the following notice to users regarding the data and samples obtained.

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. Acknowledgment

Onboard scientists would like to thank Captain S. Ryono and all officers, engineers and crews of R/V Kairei and Chief A. Miura and all operators of ROV Kaiko-7000II for their tremendous efforts in the performance of this cruise and dive operations. They are also grateful to all support staffs of JAMSTEC

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