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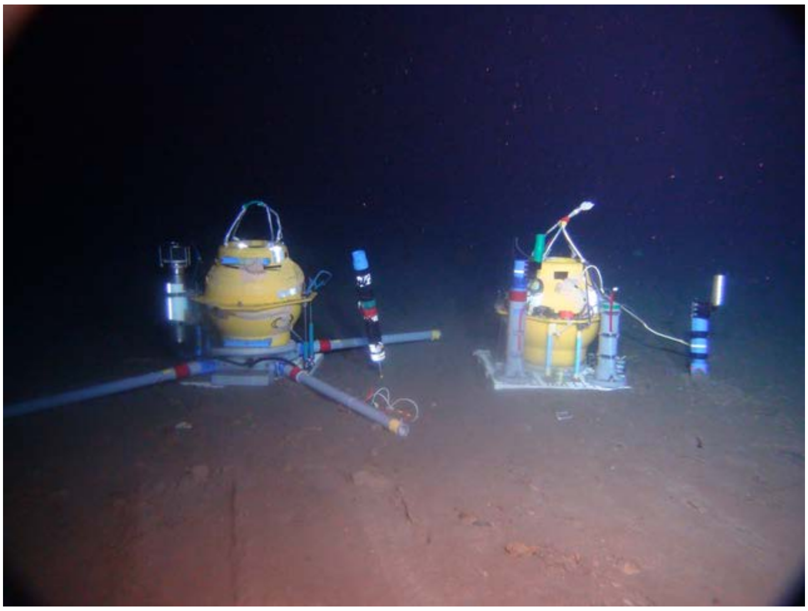
R/V Kairei Cruise Report
KR12-16



Cruise Proposal 1
"The fluid detection using the electro-magnetic survey method and the chemical anomaly"

Cruise Proposal 2
"Research of the fault slip process using the temperature and pressure observation at the J-FAST site"

16 Oct. 2012 (Sendai) – 28 Oct. 2012 (Yokosuka)

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

Acknowledgements

We would like to thank Captain Mr. Ishiwata and all ship crew of R/V KAIREI for their safe cruise. We are grateful to Commander Mr. Miura and the operation team of a ROV KAIKO7000 II for their operations in serious condition. We are pleased to MARITEC/JAMSTEC staff for their supports during our cruise. This cruise is supported by a research program "The Survey and Observation for Earthquakes and Tsunamis off the Pacific Coast of Tohoku" by MEXT.

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.
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KR12-16 Cruise report contents

1. Objectives and Cruise summary of KR12-16 cruise

Cruise information

Cruise number	KR12-16
Name of the cruise	R/V KAIREI
Chief scientist	Takafumi Kasaya (IFREE, JAMSTEC)
Representative of the Science Party 1	Takafumi Kasaya (IFREE, JAMSTEC)
Title of the cruise 1	The fluid detection using the electro-magnetic survey method and the chemical anomaly
Representative of the Science Party 2	Yasuyuki Kano (DPRI, Kyoto univ.)
Title of the cruise 2	Research of the fault slip process using the temperature and pressure observation at the J-FAST site
Cruise period	16 Oct. 2012 – 28 Oct. 2012
Ports of call	Sendai-Shiogama – Yokosuka (JAMSTEC)
Research Area	Off Sanriku Fig.1

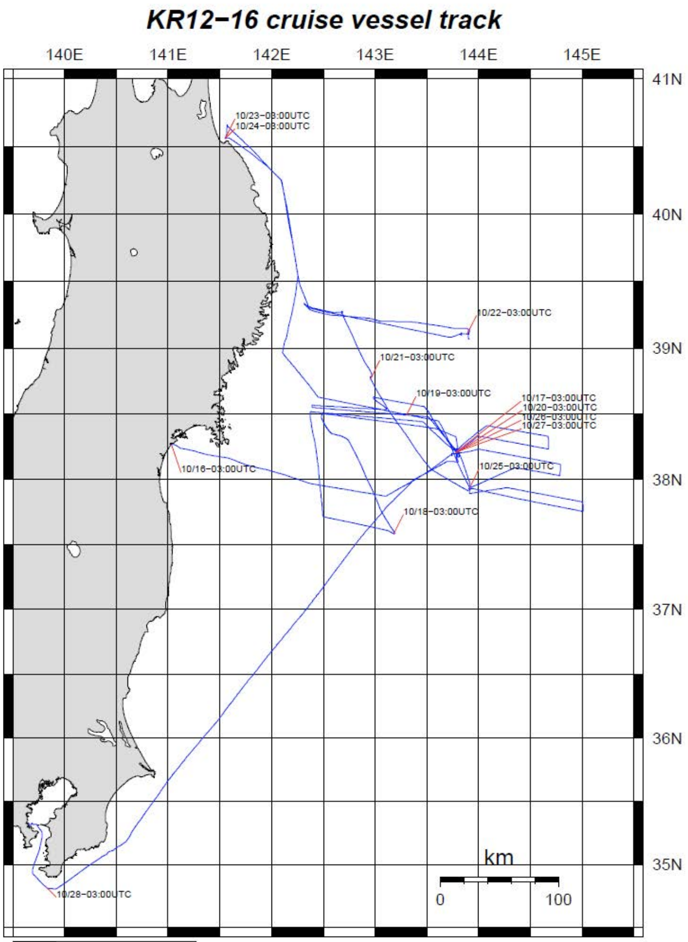


Fig.1 Ship track of this cruise.

Summary

Cruise proposal 1

Electrical resistivity is a very sensitive parameter for the water. Therefor we have conducted to survey using ocean bottom electro-magnetometers (OBEMs) around the subduction zone to investigate the relationship between fluid and earthquake occurrence.

In this cruise, we carried out conventional OBEM operation at eight sites to obtain the resistivity structure. Moreover, we planned two newly observation. One is a DC resistivity survey around the cold water seep area related with the fault system. During the Dive 578 and 581, we could obtain good data of the DC resistivity meter. Other newly observation is a setup of long term OBE system to observe the natural electrical potential data near the cold seep area. This newly system can observe horizontal and vertical components. We succeeded the setup of this system and heat flow probe (SAHF). These will be recovered at KR 13-04 cruise.

Cruise proposal 2

Primary objective of second proposal is to locate the wellhead drilled by the Japan Trench Fast Drilling Project (JFAST) and to obtain sufficient information to facilitate future retrieval of the autonomous observatory installed in the borehole.

The main science goal of the JFAST is to understand the physical mechanisms and dynamics of large slip earthquakes (Chester et al., 2012). The site for JFAST is chosen to penetrates plate boundary with large slip during the 2011 off the Pacific coast of Tohoku earthquake. One of the objectives of JFAST is estimating the frictional heat and stress within and around the fault zone by measurement of temperature across the fault. During the JFAST expeditions (Integrated Ocean Drilling Program [IODP] Expedition 343 in April and May 2012 and IODP Expedition 343T), five holes are drilled using the D/V Chikyu. Three holes penetrates plate boundary. In Hole C0019D, the miniature temperature logger (MTL) autonomous observatory is installed. The wellhead is installed on seafloor close to Japan trench at depth of about 6900 m. The ROV KAIKO 7000 II is scheduled for later retrieval of the MTL observatory.

In the original plan of JFAST, the MTL observatory should have been installed on April or May, 2012 and retrieved in this cruise (KR12-16). The preparatory calculations show that recorded data for at least 6 month is desirable to avoid the disturbance of temperature field circulation during drilling and to precisely distinguish the temperature anomaly caused by fault slip from other sources, such as fluid motion. The delay in installation of the MTL observatory until July 2012 reduces the length of observation period to only three months. So, the JFAST observatory group requested retrieval of the MTL observatory in February 2013 to have the needed time for data recording. Considering expected severe weather conditions in February 2013, we need precise location of the wellhead and confirmation of procedure of retrieval, which will be done on this cruise.

During Dive 579 of KR12-16 cruise, we located the wellhead of Hole C0019D and obtained data on vertical motions of the KAIKO vehicle and launcher. During Dive 578 and 579, we tested the obstacle avoidance sonar (OAS) directed to the seafloor as an indicator of the permissible range of motion of KAIKO during retrieval.

2. List of Participant

Chief Scientist:

TAKAFUMI KASAYA	IFREE, JAMSTEC

Onboard Scientists:

HIROSHI ICHIHARA	IFREE, JAMSTEC
YOSHIHIRO ITO	Tohoku University
YASUYUKI KANO	DPRI, Kyoto University
YASUHIRO NAMBA	CDEX, JAMSTEC
SHOICHI SHIOZAKI	Yamaguchi University

Marine Technician:

HIKARU IWAMARU	Nippon Marine Enterprises, LTD.

KAIKO Operation team

Operation Manager:	ATSUMORI MIURA
2nd ROV Operator:	KIYOSHI TAKISHITA
	TOMOE KONDO
	TETSUYA ISHIZUKA
	RYO SAIGO
	SEIJI SHIGETAKE
3rd ROV Operator:	SHOTA IHARA
	TAKUMA GOTO

R/V KAIREI Officers and Crew

Captain:	MASAYOSHI ISHIWATA
Chief Officer:	AKIHISA TSUJI
Jr.Chief Officer:	HIROAKI MASUJIMA
2nd Officer:	ISAO MAEDA
3rd Officer:	HIDEHIKO KONNO
Chief Engineer:	TADASHI ABE
1st Engineer:	KAZUNORI NOGUCHI
2nd Engineer:	RYUZO MIKAMI
3rd Engineer:	YOSHIHIRO OTSUGA
Chief Radio Operator:	TOKINORI NASU

2nd Radio Operator:	SHUNSUKE FUKAGAWA
3rd Radio Operator:	TAKAYUKI MABARA
Boat Swain:	YOSHIAKI KAWAMURA
Able Seaman:	TAKAO KUBOTA
	YOSHIAKI MATSUO
	SAIKAN HIRAI
Sailor:	HIROTAKA SHIGETA
	YOSHIHIRO OGAWA
	YASUNOBU KAWABE
No1. Oiler:	KAZUAKI NAKAI
Oiler:	MASANORI UEDA
	MASAKI TANAKA
Assistant Oiler:	DAIKI IGARASHI
	AOI TAKAMIYA
Chief Steward:	ISAO MATSUMOTO
Steward:	HIDEO FUKUMURA
	KAZUHIRO HIRAYAMA
	NAKAMICHI KANDA
	MANAMI TAKAHASHI

3. Ship Log

Date	Local Time	Description	Ship position / Weather / Sea condition (Noon@JST)
16-Oct	13:00	Scientists party on board a ship	38-16.0N, 141-01.9E
	13:30-14:30	Briefing about ship's life and safety	Fine but cloudy
		Briefing about KAIKO 7000II operation	Wind:NW-Light breeze
	15:00	Departure from SENDAI Buey	Wave:1 (Sea calm)
	16:00-17:00	Carried out boat station drill	Swell:0 (No swell)
	19:31-23:43	MBES survey	Visibly: 7'
17-Oct	5:00	Arrived at research area	38-12.6N, 143-46.8E
	07:26	Start dive #576	Fine but cloudy
	10:14	Landed at sea bottom (Depth=5783m)	Wind:SE-Fresh breeze
	12:31	Left sea bottom (Depth=5588m)	Wave:3 (Sea slight)
	15:12	Recovered KAIKO 7000II	Swell:2 (Low swell long)
	17:50-23:04	MBES survey	Visibly: 8'
18-Oct	10:17	Deployed XBT sensor	37-35.3N, 143-11.0E
	10:41	Deployed OBEM (SiteD33)	Overcast
	11:59	OBEM landed at sea bottom	Wind:NW-Strong breeze
	13:32-02:41	MBES survey	Wave:4 (Sea moderate)
			Swell:4 (Moderate average)
			Visibly: 7'
19-Oct	08:30	Suspended KAIKO 7000Ⅱ operation due to heavy sea condition.	38-29.3N, 143-18.0E
	11:08-00:15	MBES survey	Cloudy
			Wind:NNW-Moderate breeze
			Wave:3 (Sea slight)
			Swell:4 (Moderate average)
			Visibly: 7'
20-oct	08:34	Start dive #577	38-12.6N, 143-47.5E
	11:23	Landed at sea bottom (Depth=5779m)	Fine but cloudy
	13:57	Left sea bottom (Depth=5780m)	Wind:West-Gentle breeze
	16:10	Recovered OBE(JF3_horizontal)	Wave:2 (Sea smooth)
	16:41	Recovered KAIKO 7000II	Swell:2 (Low swell long)
	18:14	Deployed XBT sensor	Visibly: 8'

	20:52-03:35	MBES survey	
21-oct	07:00	Suspended KAIKO 7000Ⅱ operation due to heavy sea condition.	38-47.0N, 142-57.0E
	13:13	Recovered OBEM(siteF31)	Fine but cloudy
	16:59	Recovered OBEM(siteB31)	Wind:West-Strong breeze
			Wave:4 (Sea moderate)
			Swell:3 (Moderate short)
			Visibly: 8'
22-oct	07:32	Start dive #578	39-06.2N, 143-53.4E
	10:10	Landed at sea bottom (Depth=5358m)	Fine but cloudy
	12:21	Left sea bottom (Depth=5340m)	Wind:West-Gentle breeze
	15:16	Recovered KAIKO 7000II	Wave:3 (Sea slight)
	16:53-20:38	MBES survey	Swell:2 (Low swell long)
			Visibly: 8'
23-oct	6:00	Anchored at HACHINOHE	40-34.0N, 141-33.2E
			Cloudy
			Wind:SW-Strong breeze
			Wave:3 (Sea slight)
			Swell:2 (Low swell long)
			Visibly: 7'
24-oct	13:15	Com'ced heaving in anchor	40-33.9N, 141-33.4E
	22:20-02:29	MBES survey	Fine but cloudy
			Wind:WNW-Near gale
			Wave:4 (Sea moderate)
			Swell:3 (Moderate short)
			Visibly: 8'
25-oct	5:30	Arrived at research area	37-56.4N, 143-54.8E
	07:30	Start dive #579	Fine but cloudy
	15:35	Landed at sea bottom (Depth=6902m)	Wind:West-Gentle breeze
	16:35	Left sea bottom (Depth=6903m)	Wave:2 (Sea smooth)
	19:45	Recovered KAIKO 7000II	Swell:2 (Low swell long)
	22:06-05:34	MBES survey	Visibly: 8'

26-oct	08:27	Start dive #580	38-12.4N, 143-47.0E
	11:28	Landed at sea bottom (Depth=5785m)	Fine but cloudy
	11:45	Deployed OBE(Vertical)	Wind:North-Moderate breeze
	11:57	Deployed OBE (Horizontal)	Wave:3 (Sea slight)
	12:03	Deployed SAHF	Swell:2 (Low swell long)
	13:30	Left sea bottom (Depth=5695m)	Visibly: 8'
	16:13	Recovered KAIKO 7000II	
	21:00-04:44	MBES survey	
27-oct	07:29	Start dive #581	38-12.4N, 143-47.0E
	10:30	Landed at sea bottom (Depth=5785m)	Fine but cloudy
	12:32	Left sea bottom (Depth=5730m)	Wind:East-Fresh breeze
	15:28	Recovered KAIKO 7000II	Wave:4 (Sea moderate)
			Swell:3 (Moderate short)
			Visibly: 8'
28-oct	15:15	Anchored at YOKOSUKA port	34-48.4N, 139-50.0E
			Overcast
			Wind:SE-Fresh breeze
			Wave:3 (Sea slight)
			Swell:3 (Moderate short)
			Visibly: 6'
29-oct	07:45	Com'ced heaving in anchor.	
	09:00	Arrived at JAMSTEC	
		The KR12-16 cruise end.	

4. Instruments

4.1 DC resistivity system

In this cruise, we used a DC resistivity system operated by the ROV Kaiko to detect the detailed resistivity structure related with the fault system. The transmitter and receiver control unit were mounted on the payload space of the Kaiko vehicle. The transmitter unit sends the artificially controlled electric current using an electrode cable. Since we the seawater conductivity is measurable with the CTD sensor attached to the vehicle, we can calibrate the DC resistivity system. We tested two electrode configurations (Fig. 4.1.1).

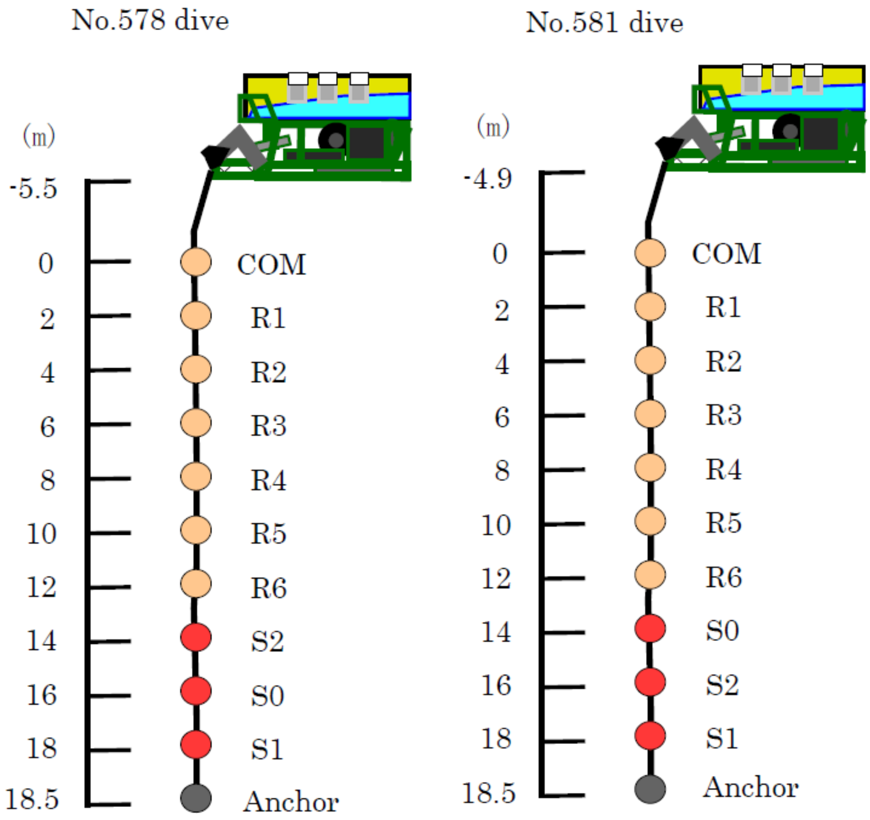


Fig. 4.1.1 Electrode configuration of Kaiko dives.

4.2 OBEM and long term OBE system

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. 4.2.1). The glass sphere involves data logger and a lithium battery pack. The sensor unit has a high-accuracy fluxgate magnetometer, tiltmeter 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 Kairei's SSBL system and it is easy for us to detect its position in the sea or on the seafloor.

There are two types of transponder units mounted on the OBEM system (type A and type B). The type A transponder unit has 6-month battery life. Acoustic unit of it is separated from a pressure case which contains circuit board and battery. The type B transponder unit, of which the acoustic and the pressure case units are combined, has 2-years battery life. 4 type A units and 2 type B units are used in this operation.

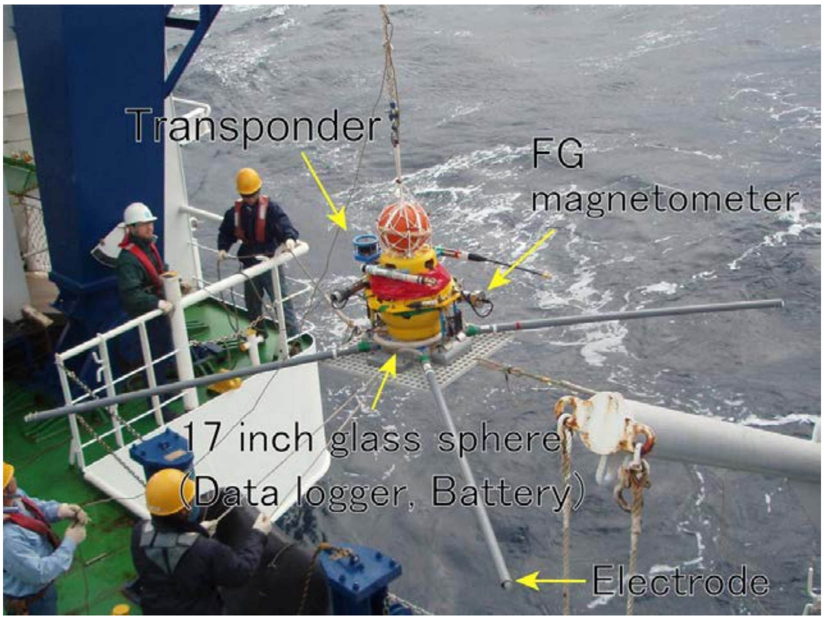


Fig. 4.2.1 OBEM system

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 (Fig. 4.2.2), enable recovery operation even by the small ship that do not equip A frame (Kasaya et al., 2006; Kasaya and Goto, 2009).

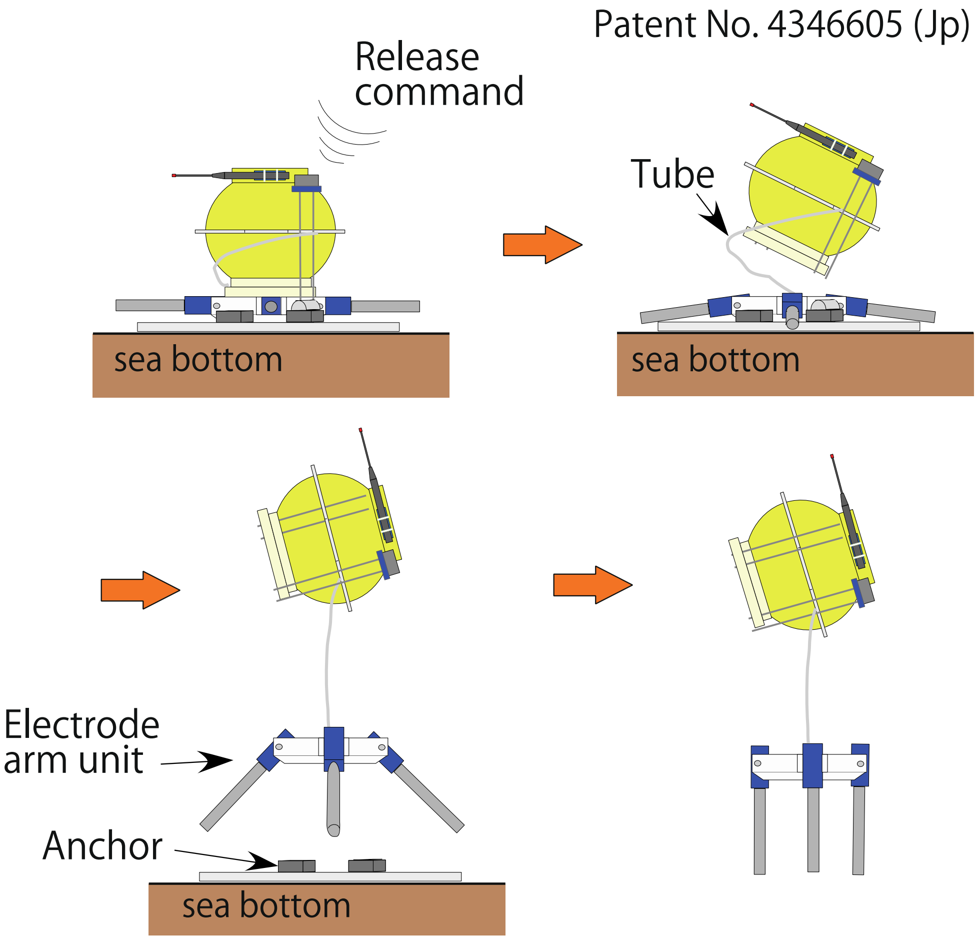


Fig. 4.2.2 Electrode arm-holding mechanism of type A OBEM

Table 4.2.1 Specification of OBE system

Sampling rate	1Hz
AD converter	24bit
Resolution	0.0000019mV/LSB
Memory	Compact flash memory (Max 1GB)
Communication port	RS-232C

Long term OBE system was based the pop up type OBE system (Kasaya et al., 2006; Kasaya and Goto, 2009). Tab;e 4.2.1 shows a their specifications. To detect an anomalous change of a cold water seep, we used a horizontal and vertical electrode configuration, , in this cruise (show Fig. 5.2.).

References

Kasaya, T., T. Goto, and R. Takagi, Marine electromagnetic observation technique and its development –For crustal structure survey-, *BUTSURI-TANSA*, **59**, 585-594 (in Japanese with English abstract), 2006.

Kasaya, T., and T. Goto, A small OBEM and OBE system with an arm folding mechanism, *Exploration Geophysics*, **40**, 41-48, 2009.

4.3 JFAST site

Shown in Fig.4.3.1 is a schematic diagram of an observatory system being constructed during Expedition 343T at the JFAST site, Hole C0019D. An 8.5” open hole was drilled to a total depth of about 850 meters below seafloor (mbsf) to across two fault zones. A 4.5” tubing was installed in the 8.5” hole with containing the observatory system.

The observatory system consists of a sinker bar, 8 ropes, 55 sensors, so called miniature temperature loggers (MTL), 3 weak links, an MTL hanger and an ROV hook ring. The sensors are represented with several marks in this figure and are listed in Table 4.3.1.. There are two kinds of temperature sensors, expressed as “Temperature-1” and “Temperature-2” in the figure and the number of these sensors is totally 45. The remaining 10 sensors can measure not only the temperature but also the pressure. The wet weight of the whole observatory system is about 80 kg. Measured data are being stored in the sensors and the whole observatory system is planned to be recovered in the next February. As shown in the right-upper figure in Fig.4.3.1, there exist an upper end of 20” casing and a running tool connector on the seafloor. the The observatory system has an ROV hook ring at its most upper end and the system will be retrieved by pulling up this ring.
It is possible that the faults are still slipping and therefore three weak links were employed to avoid the whole system stacked in the hole during retrieving.

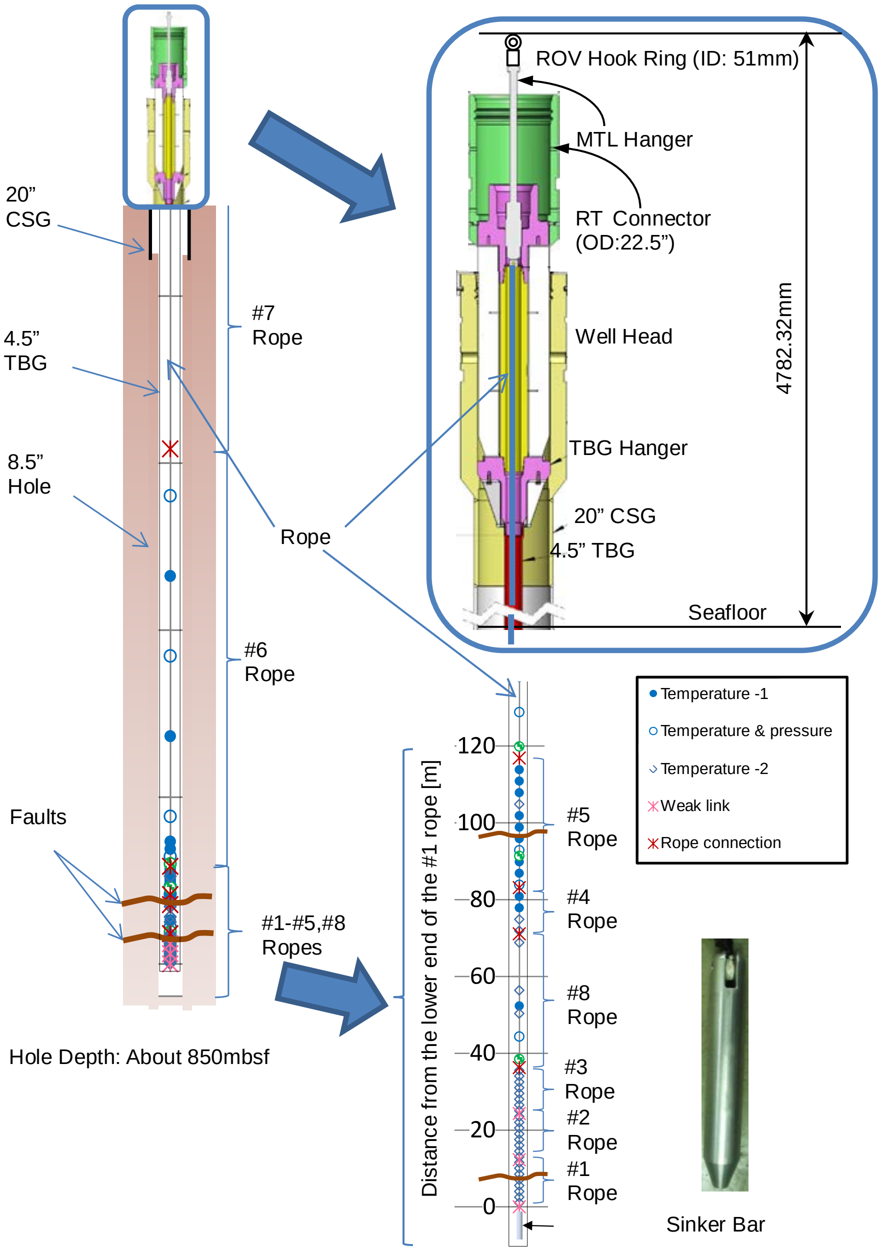


Fig.4.3.1: A schematic diagram of the observatory system being constructed during Expedition 343T at the JFAST site. CSG=Casing, TBG=Tubing, MTL=Miniature Temperature Logger, RT=Running Tool and mbsf=meters below seafloor.

5. Dive summary

5.1 Dive 576

The objective of this dive is to set up the horizontal type OBE system on the seafloor (Fig. 5.1.1). An acoustic release system was attached to this OBE system. We set up the OBE system on the seafloor temporary around the first landing position because we had a plan to set up OBE system near the some bacterian mud or other cold water seep in a successive dive. Then we carried out a seafloor observation around a western slope. Some massive outcrops were observed at the upper portion of the slope. Figure 5.1.2 shows dive tracks of vehicle and launcher of R/V Kaiko of this dive.

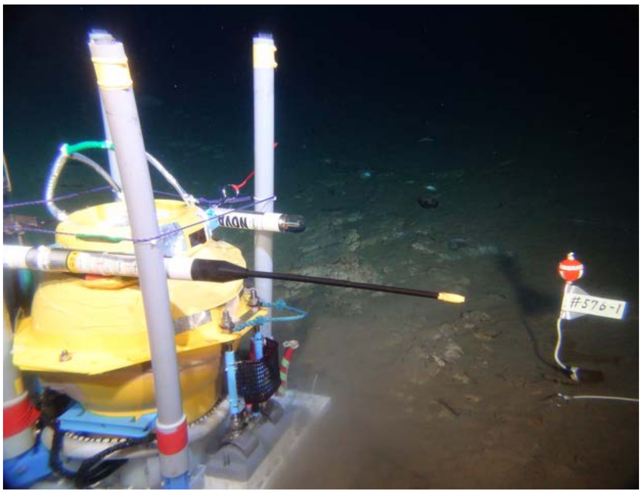


Fig.5.1.1 Horizontal OBE system on the seafloor.

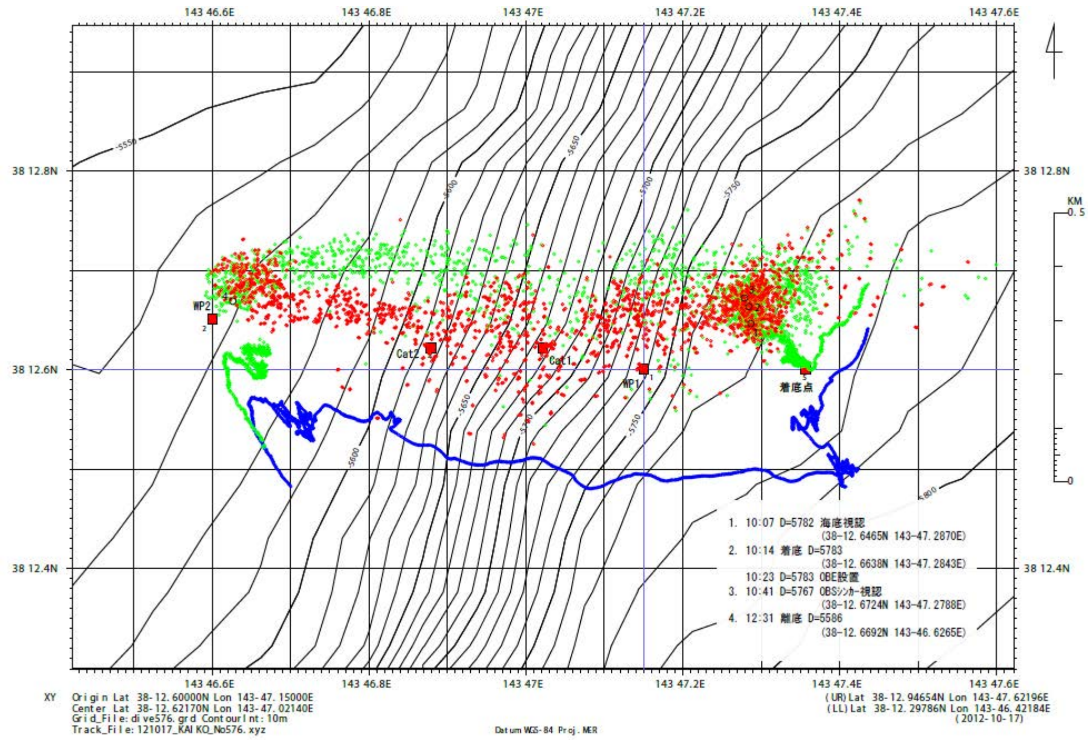


Fig. 5.1.2 Tracks of ship, vehicle and launcher of R/V Kaiko of dive #576. Blue, green and red dots show the position of ship, launcher and vehicle, respectively.

5.2 Dive 577

In this dive, we tried to setup the vertical type OBE system. At first, we approached the horizontal type OBE system that put on in a previous dive. After picking up the horizontal type OBE, we started to move both systems to the water seep area. However, the anchor was suddenly detached from the horizontal OBE system. We necessarily decided to release it from manipulator. This OBE popped up at 15:55, and was recovered using the working boat.

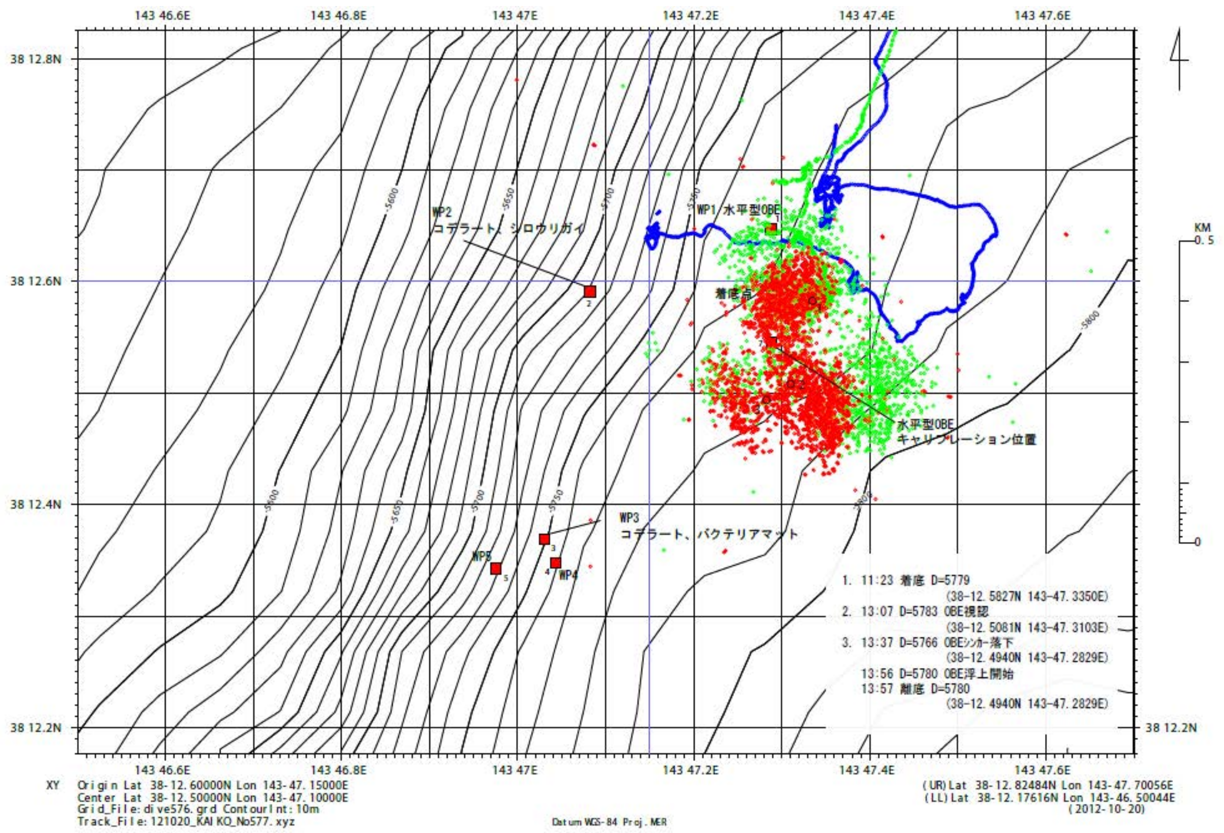


Fig. 5.2.1 Tracks of vehicle and launcher of R/V Kaiko of dive #577. Blue, green and red dots show the position of ship, launcher and vehicle, respectively.

5.3 Dive 578

The objective of this dive was to obtain the detailed resistivity survey at the shallower structure related with the cold water seep using the DC resistivity sounding system. Figure 5.3.1 shows the survey system and the electrode cable that were loaded on the payload space of the R/V Kaiko. The electrode configuration is shown in Fig. 4.1.1. After landing on the seafloor, electrode cable was let out from payload basket. We planned to approach the slope, but we finished this dive before reaching the slope.

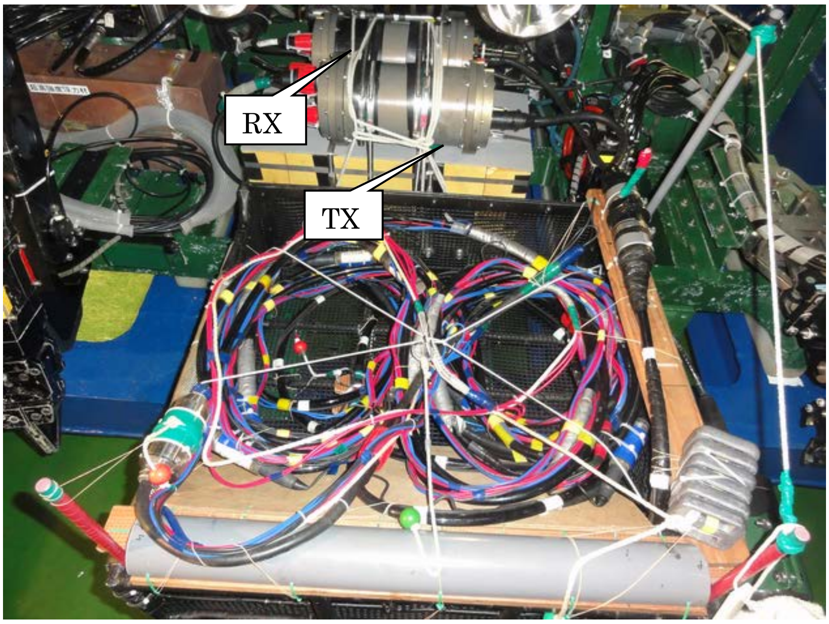


Fig. 5.3.1 DC resistivity sounding system and electrode cable loaded on the payload space of R/V Kaiko. Tx and Rx shows the transmitter unit and receiver unit, respectively.

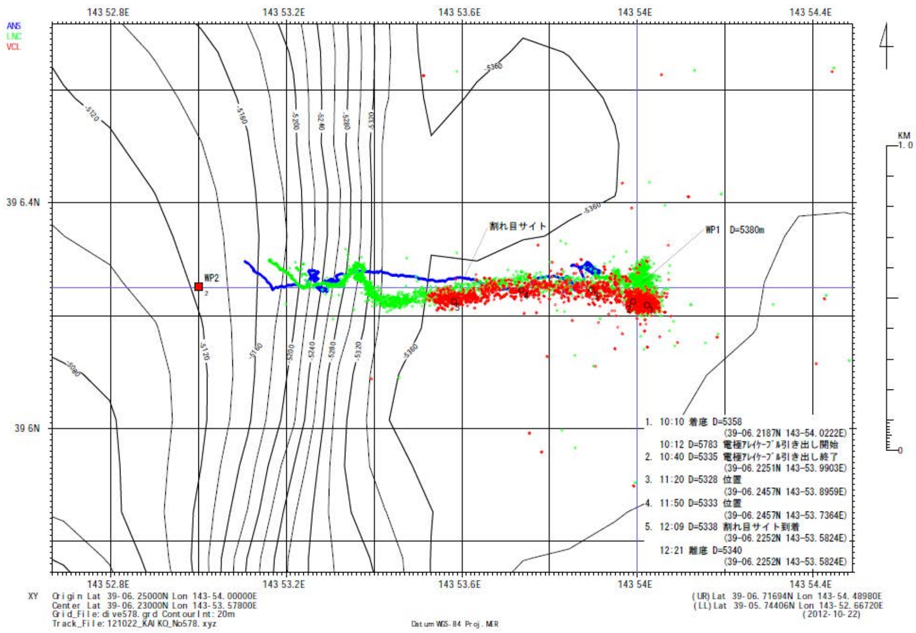


Fig. 5.3.2 Tracks of of vehicle and launcher of R/V Kaiko of dive #577. Blue, green and red dots show the position of ship, launcher and vehicle, respectively.

5.4 Dive 579

We searched for the wellhead of Hole C0019D which was installed by D/V Chikyu during IODP Expedition 343 and 343T. The tracks of the R/V KAIREI and ROV KAIKO 7000II are shown in Figure 4.2.4.1. The wellhead was found on the slope dipping to south or southwest (Figure 4.2.4.2, Table 4.2.4.1). There were thick sediments accumulated on the surrounding sea floor. The current was weak and flowed toward the southwest. The soft sediments and weak current caused poor visibility. For the best visibility during retrieval of the MTL observatory, it is recommended to approach from the south.

The wellhead including the MTL hanger and top of the 20” casing was detected by the Obstacle Avoidance Sonar (OAS) (Figure 4.2.4.3) and visually confirmed (Figure 4.2.4.2). A strong response appeared on OAS about 30 m behind C0019D, in the direction of about N220E, which may correspond to the wellhead at Hole C0019C (Figure 4.2.4.3).

We need to keep the MTL instrument string close to vertical during the retrieval from hole, because it may become stuck if the angle is too large.. KAIREI, launcher and vehicle should be aligned as close as possible to the vertical, so that all the components can be smoothly raised in a straight line. To confirm this procedure for the future retrieval of MTL observatory, we tried raising the ROV KAIKO 7000II as vertically as possible. Figure 4.2.4.4 shows the track of the launcher and vehicle determined by SSBL (Super Short Base Line).

We tested the OAS as an indicator of the position of the vehicle relative to the wellhead. An additional OAS was placed on the sample basket of the vehicle and directed to the seafloor (Figure 4.2.4.5). We also attempted to use the ROV homing to obtain the position of the vehicle relative to the wellhead. A miniature transponder could not be placed because of the thick soft sediments. There also was communication error of the ROV homing system.

Table5.4.1 Location of Hole C0019D.

Cruise	Latitude	Longitude	Water depth mbsl
KR12-16	37-56.1886 N	143-54.7827E	6903

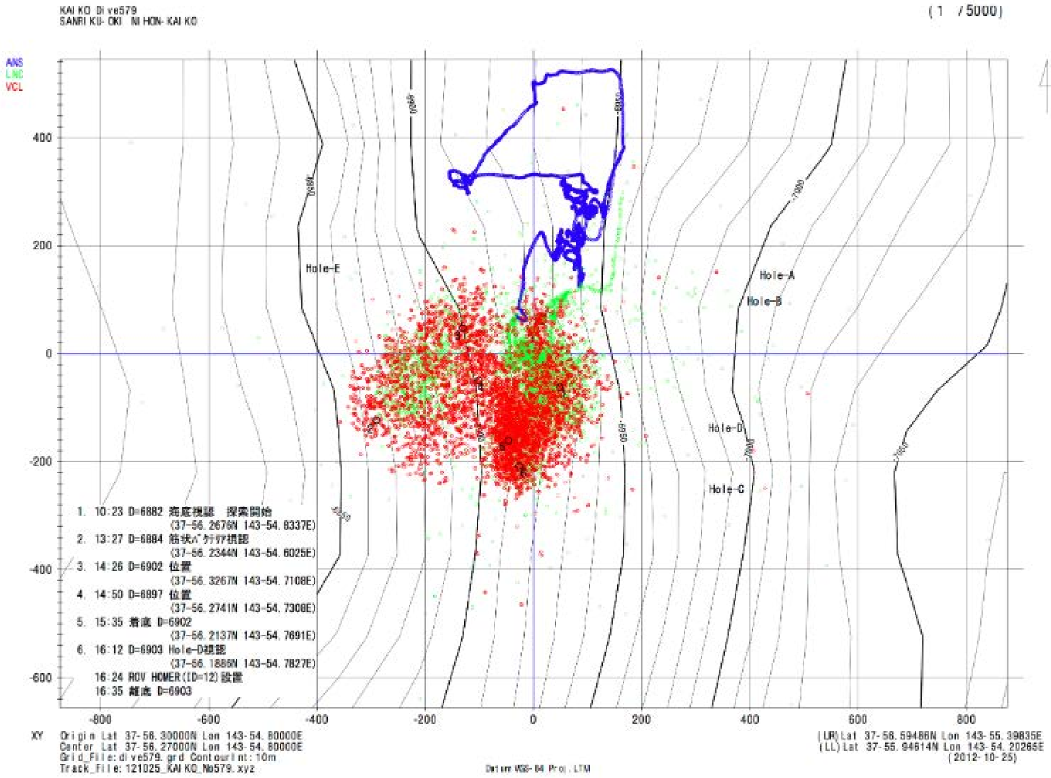


Figure 5.4.1. Map shows track of R/V KAIREI, ROV KAIKO launcher and vehicle.

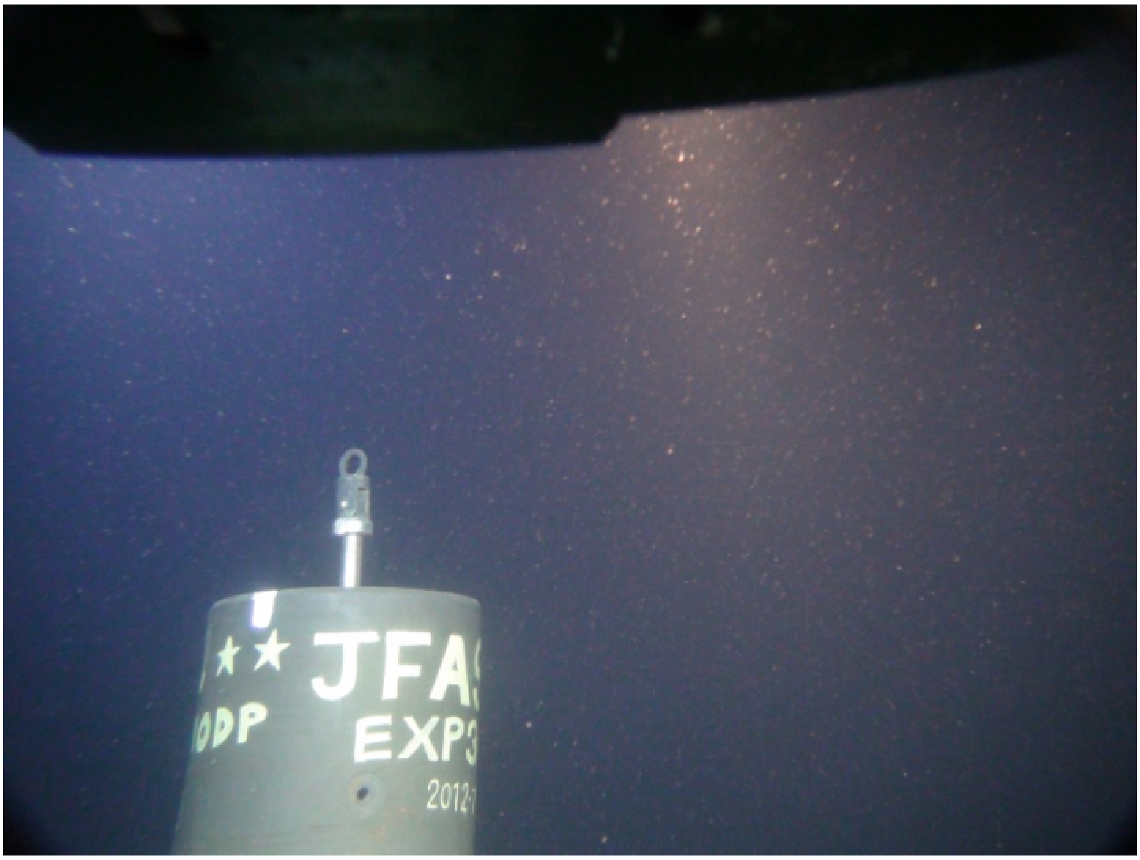


Figure 5.4.2. Photo of wellhead of Hole C0019D.

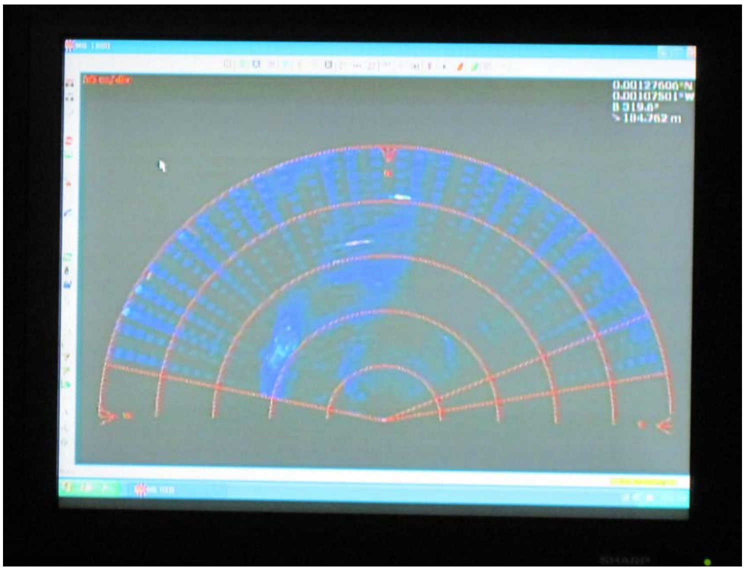


Figure 5.4.3. Photo of OAS display with 150 m range. The heading of the vehicle was south. The strong response appeared at distance of 100 m is wellhead of Hole C0019D, which visually confirmed later. Another strong response at 120 m should be Hole C0019C.

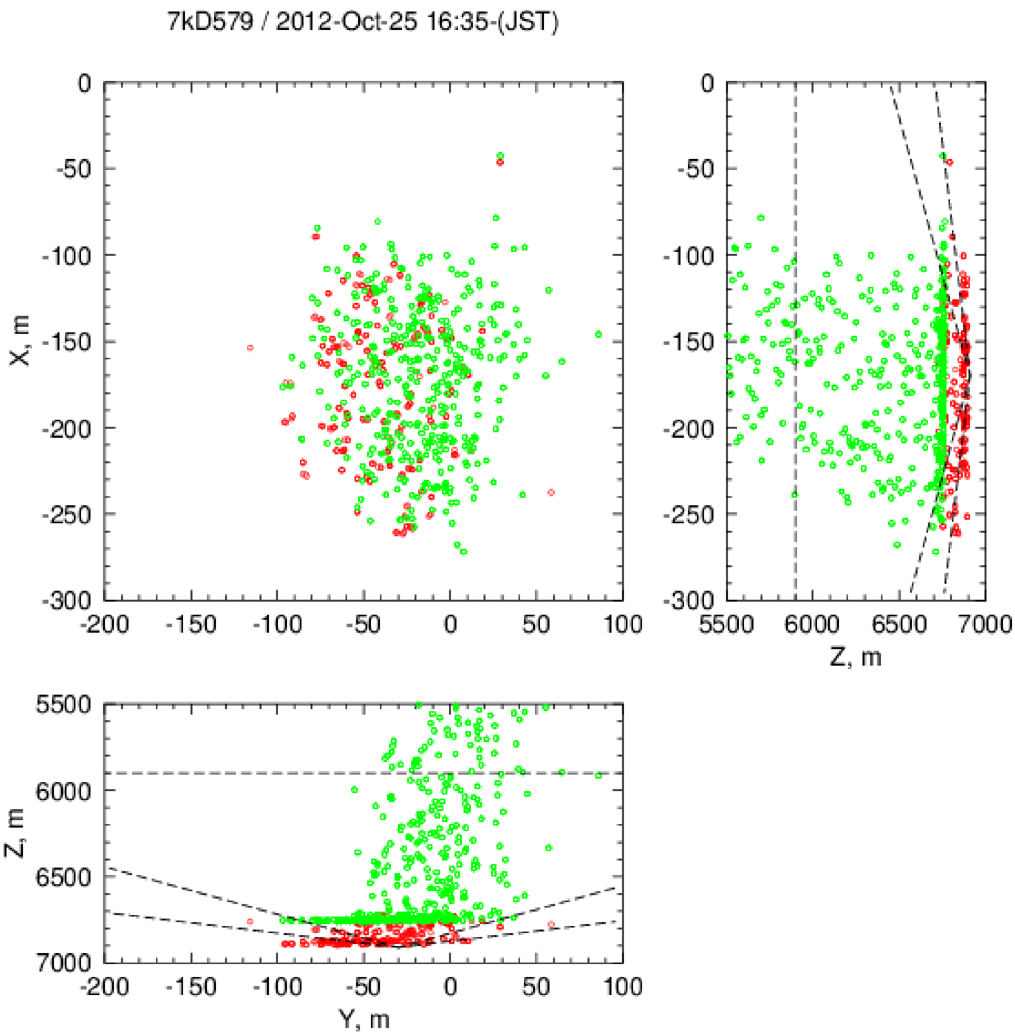


Figure 5.4.4. Position of vehicle (red) and launcher (green) during asending. Note that the accuracy of SSBL (Super Short Base Line) is about 2% of the depth, that is about 150 m for this case.

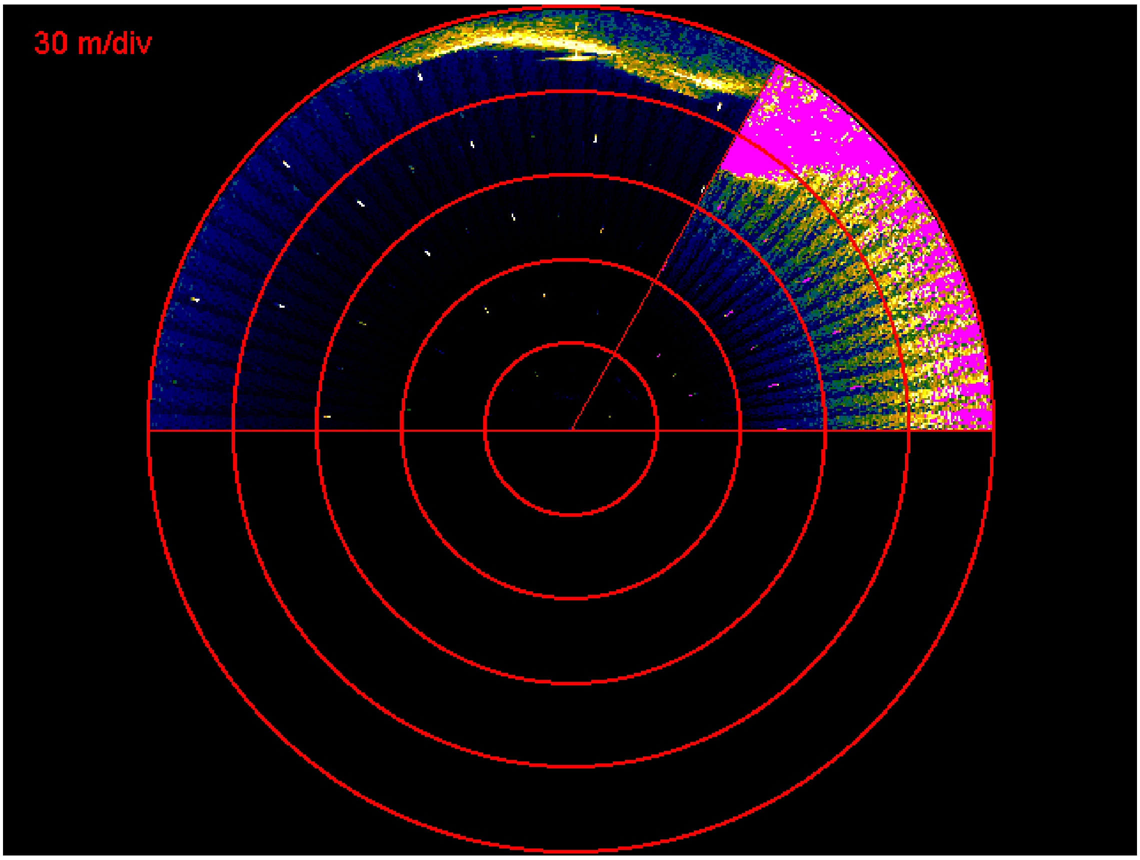


Figure 5.4.5. Capture of OAS directed to seafloor. The seafloor and wellhead of Hole C0019D is clearly appeared.

5.5 Dive 580

The objective of this dive was to install both type OBE systems at once. We carried out the weight reduction of them because of the weight limitation of the payload. Figure 5.5.1 shows OBE systems on the payload space. After landing on the seafloor, we installed both system and a heat flow meter (SAHF). We were successful in the unfolding operation of the horizontal electrode and installation of two vertical electrode bars (Fig. 5.5.2). Finishing OBE operation, we carried out the seafloor observation toward the western slope. We could find a marker and a quadrart.

Fig. 5.5.1 Horizontal and vertical OBE systems on the payload space of R/V Kaiko.

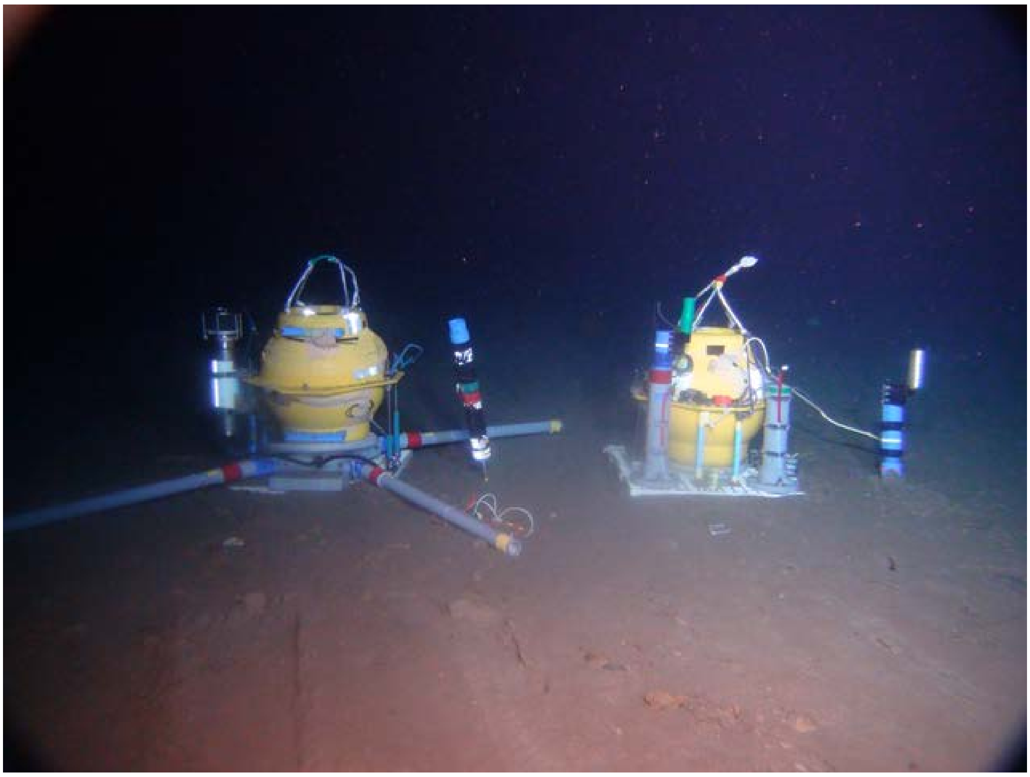


Fig. 5.5.2 OBEs and heat flow measurement system (SAHF) were set up on the seafloor.

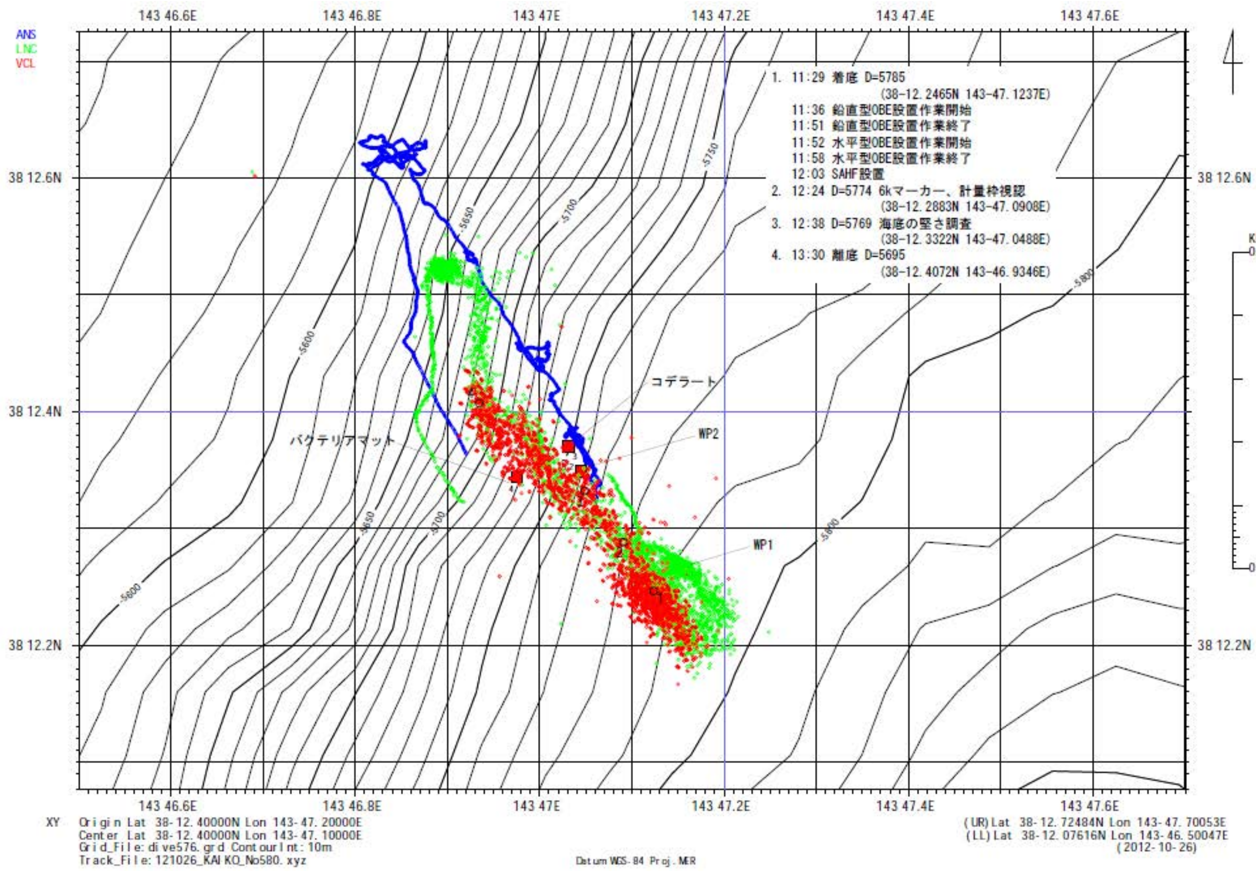


Fig. 5.5.3 Tracks of ship, vehicle and launcher of R/V Kaiko of dive #580. Blue, green and red dots show the position of ship, launcher and vehicle, respectively.

5. 6. Dive 581

This dive objective was also to obtain the detailed structure related with the cold water seep. We could not approach the slope closely at the previous dive. Therefore, we started this dive nearby the slope of this survey area. The resistivity survey carried out as same procedure as previous dive. The electrode configuration shows in Fig. 4.1.1. System worked well, and enough data were obtained through this dive.

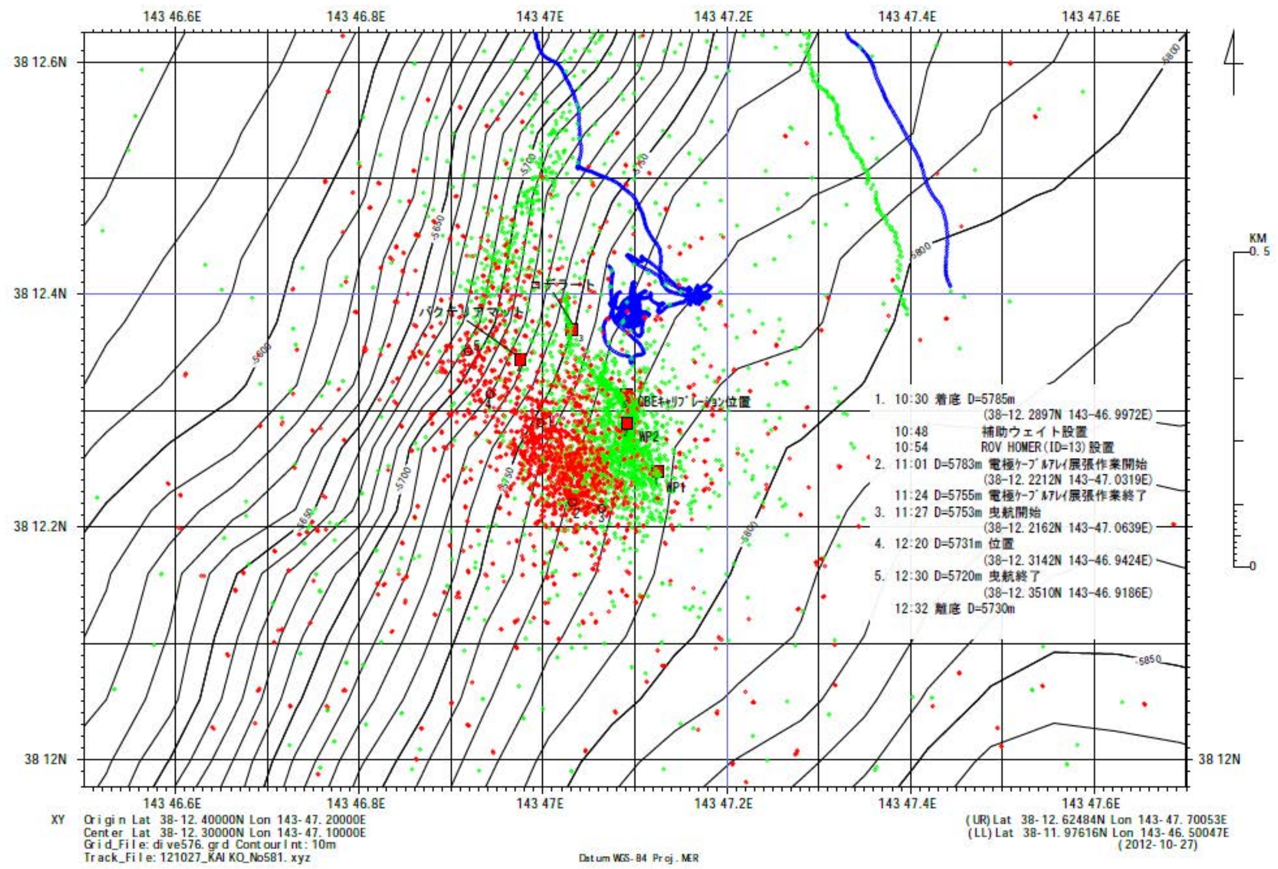


Fig. 5.6.1 Tracks of ship, vehicle and launcher of R/V Kaiko of dive #581. Blue, green and red dots show the position of ship, launcher and vehicle, respectively.

6. Shipboard data

Bathymetric data are obtained by SEABEAM2112 system with an array of transducers and hydrophones installed along and across keel of the R/V Kairei. The system transmits a 12 kHz sonar pulse at 2° x2° resolution for fore/aft direction, and records the travel time and amplitude of the returning echoes. The number of beams for this cruise is fixed in 121, thus there are overlap of beams in 1°. The swath range is changeable between 90 – 150°, and we fixed the range 120° during this cruise. Sound velocity profiles were obtained from ship-launched XBT measurements, and were updated into the SEABEAM system. Ship speed is 8 or 10 knots for all survey lines. We have two objectives of MBES survey in this cruise. This MBES system has sub-bottom profiler with 4 kHz frequency. We could also obtain the SBP data during day time survey at 6th June. Table 6.1 shows the survey line list of this cruise. Figure6.1 shows the bathymetric map used by this data.

Specification of SEABEAM2112.004 on R/V Kairei

Depth range; 50-11000 m
Frequency; 12 kHz
Number of beams; 151 max
Beam resolution; 2° ×2°
Beam spacing; 1°
Maximum speed; 12 knot (8 knot fix during this cruise)
Accuracy of measurement; 0.5% of depth
Swath range; 90-150 (150° for ~300m, 140° for ~1500m, 120° for ~4500m, 100° for 8000m, and 90° for 11000m in depth. 120° fix in this cruise)

Specification of sub-bottom profiler system

Frequency; 4 kHz
Beam width; 45° ×5°
Profiling limit; 75mbsf
Number of pixels; 1000 pix. each for port and stbd

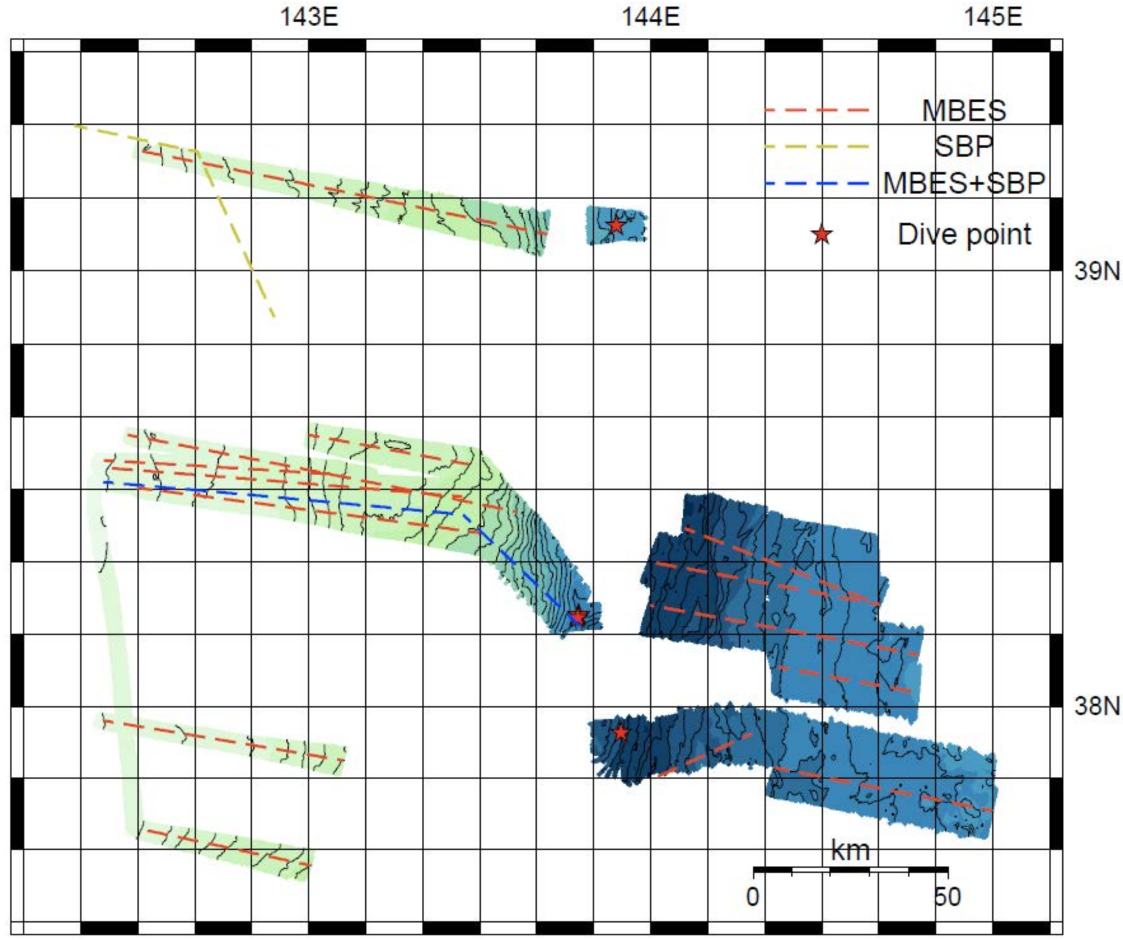


Figure 6.1 Bathymetric map of this cruise.

Table 6.1 List of MBES survey lines.

Line Name		Start				End			
		Date	Time (UTC)	Latitude	Longitude	Date	Time (UTC)	Latitude	Longitude
Line1	MBES	10/16	10:31	37-58.0065N	142-23.9969 E	10/16	14:43	37-52.4755N	143-06.0592 E
Line2	MBES	10/17	08:50	38-24.0119N	143-29.9232 E	10/17	14:04	38-30.2070N	142-29.9271 E
Line3	MBES	10/18	04:32	37-37.8838N	143-00.1473 E	10/18	07:34	37-42.9999N	142-29.9793 E
Line4	MBES	10/18	11:32	38-31.0029N	142-23.9940 E	10/18	17:41	38-26.5199N	143-27.0927 E
	SBP	10/18	12:45	38-30.1238N	142-36.6080 E	10/18	20:30	38-11.1563N	143-47.5322 E
Line5	MBES	10/19	02:08	38-29.0031N	143-26.9743 E	10/19	08:10	38-32.9921N	142-23.9335 E
Line6	MBES	10/19	08:22	38-33.9956N	142-24.0365 E	10/19	11:52	38-32.0123N	143-05.9907 E
Line7	MBES	10/19	12:49	38-37.5015N	143-00.0302	10/19	15:15	38:33.4581N	143-28.0647

					E				E
Line8	MBES	10/20	11:52	37-56.1943N	144-17.7483 E	10/20	15:09	37-49.7922N	144-00.0795 E
Line9	MBES	10/20	15:37	37-45.4728N	144-59.9642 E	10/20	18:35	37-51.4328N	144-21.8412 E
Line10	SBP	10/21	04:55	38-53.6537N	142-53.9619 E	10/21	09:43	39-19.8685N	142-18.9016 E
Line11	MBES	10/22	07:53	39-05.0310N	143-41.8574 E	10/22	11:38	39-16.5158N	142-29.8491 E
Line12	MBES	10/24	13:20	38-37.5049N	142-28.2335 E	10/24	17:29		
Line13	MBES	10/25	13:06	38-05.4091N	144-22.4276 E	10/25	15:30	38-01.8961N	144-46.8722 E
Line14	MBES	10/25	16:02	38-07.1494N	144-46.9045 E	10/25	20:34	38-14.0003N	143-59.9676 E
Line15	MBES	10/26	12:00	38-24.6092N	144-06.0208 E	10/26	15:18	38-14.1055N	144-40.1217 E
Line16	MBES	10/26	15:55	38-14.1055N	144-40.1217 E	10/26	19:44	38-20.0006N	143-59.9404 E
Line17	8 shape Track	10/22	1603				1623		
Line18	8 shape Track	10/26	1720				1740		

7. OBEM deployment and recovery

We deployed one OBEM (TIT01, site D33) in this cruse. The acoustic code, the beacon frequency, and the electric dipole length are listed in Table 7. 1. 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. Because the communication frequency of our acoustic system matched a SSBL system of R/V Kairei, we tracked the OBEM's positions by the SSBL system. Landing positions of each OBEM were determined by SSBL system (Table. 7.2, Fig. 7.1).

Two OBEMs (JM103, site F31 and KYT01, site B31, Fig. 7.2) settled in KR12-15 were recovered in this cruise without any trouble. The OBEMs started to ascend about 14-16 minutes after we sent the acoustic weight-release signal by the SSBL system equipped by R/V "Kairei", (Table 7.2.3). The ascent rates were about 40 m/min based on the SSBL system. The OBEM was found with the ship looking and radio beacon signal soon after the surfacing. The OBEMs were hooked and lifted on deck at starboard. Because the main batteries were exhausted for the all OBEM, we could not check clock of OBEMs. Thus we opened glass-spheres and took out the data logger units after 1-2 days from the recovery. Then the clock of each data logger was compared with the laptop PC synchronized by using NTP server unit connecting to GPS (Table 6.3).

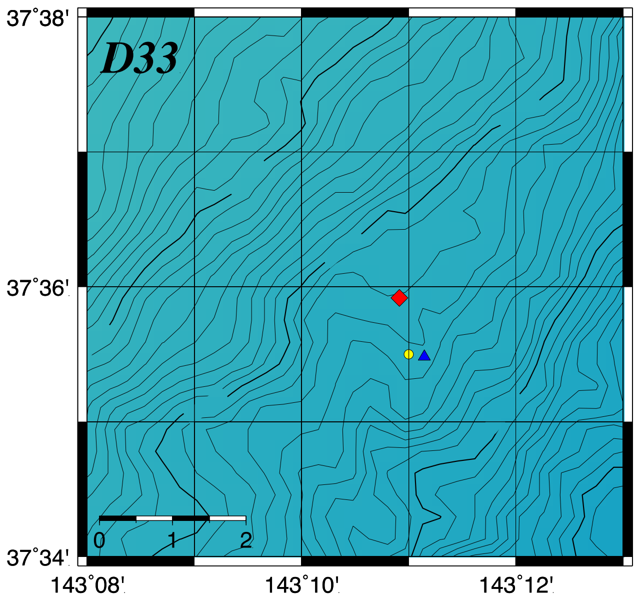


Fig. 7.1 Deployed and settled locations of the OBEM. Yellow, blue and red symbols denote planned, launched and settled position of OBEM, respectively. Contour interval is 10 m.

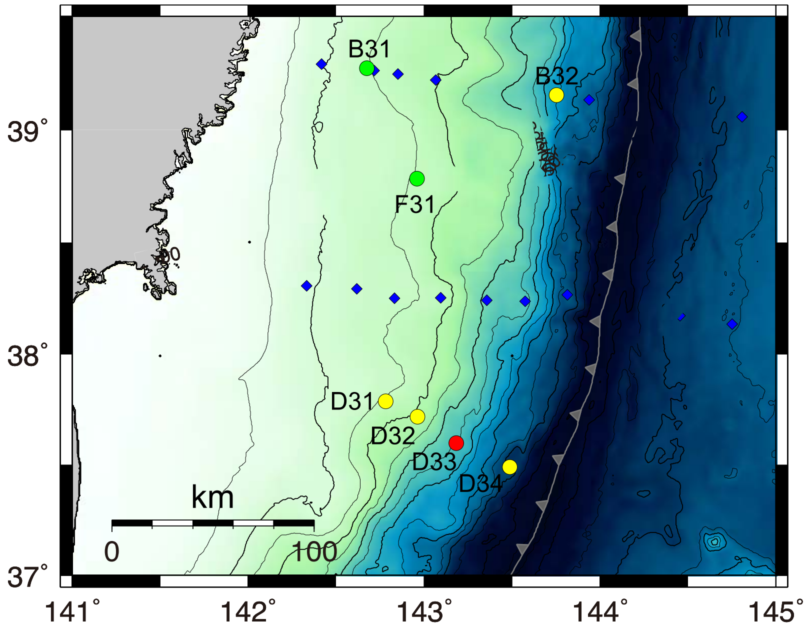


Fig. 7.2 Deployed and Recovered OBEM locations in this cruise and KR12-16. Red, green circles denote deployed and recovered OBEMs in this cruise. Yellow circles denote OBEMs deployed in KR12-15. Blue diamond denote past OBEM sites.

Table 7.1 Specification of OBEMs

Site ID	OBEM ID	Type of Transponder unit	Acoustic code	Beacon freq. (MHz)	Sampling rate (Hz)	Measurement start time (JST)	Dipole length (m)
D33	TIT01	A	4B-1	159.150	8.0	‘12/10/20 0:00:00	4.44

Table 7.2 Positioning information of OBEMs

Site ID	Date	launched time (JST)	settled time (JST)	settled position		settled depth (m)	Averaged descent rate (m/min)
D33	‘12/10/18	10:41	11:59	37-35.9183N	143-10.9122E	3463.6	45.6

Table 7.3 Recovery information

Site ID	OBEM ID	Releasing duration (min)	Ascent rate (m/min)	On deck time (JST)	Clock set time (JST)	Clock compared time (JST)	Time diff. (sec)
B31	KYT01	14	38.6	‘12/10/21 16:58	‘12/10/11 12:17:52	‘12/10/21 17:06:28	+0.375
F31	JM103	16	40.9	‘12/10/21 13:12	‘12/10/11 15:38:37	‘12/10/21 13:21:28	+0.393

Appendix

A.1 R/V KAIREI

The deep sea research vessel "KAIREI" is designed to survey deep sea floor and sub-seafloor structures of arc-trench-backarc systems, ridge systems and basic oceanic crustal structure. R/V KAIREI is the exclusive mother vessel for “KAIKO 7000 II”.

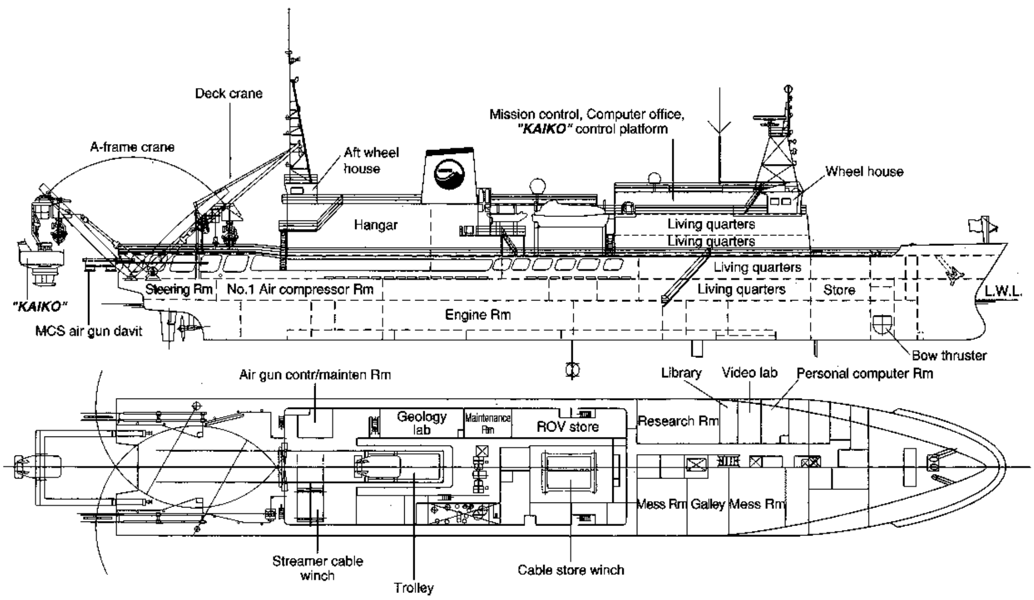
In addition, R/V KAIREI is equipped with various kinds of geophysical equipment; a multi narrow beam echo sounder and a sub bottom profiler (Sea Beam 2112.004, Sea Beam Instruments, Inc.), a gravity meter (Marine Gravity meter System type KSS 31, BODENSEEWERK PERKIN-ELMER), a three axis magnetometer (Type SFG-1212, Tera Technica Inc.), and a proton magnetometer (Type PM-217, Kawasaki Geological Engineering Co., Ltd.). The specifications of R/V KAIREI are listed below.

<u>The general specifications of R/V KAIREI</u>

Nationality	JAPAN
Owner	JAMSTEC
Operator	Nippon Marine Enterprises, Ltd
Length overall	106.0 m
Beam overall	16.0 m
Draft	4.5 m
Gross tonnage	4,517 tons
Maximum speed	16.7 knots
Main propulsion system Diesel engines	2,206kW x 2
Main propulsion method	Controllable pitch propeller x 2

<u>Complement</u>

Crew / Submersible operation staff	38 persons
Researchers	22 persons
	Total 60 persons



A.2 KAIKO 7000 II System

The 7,000m-class ROV "*KAIKO 7000 II*" system has been developed for use in deep-sea research that has not been possible by existing manned submersible for reason of ocean depths or sea floor topographies.

The specifications of Launcher

Dimensions	5.2m (Length) x 2.6m (Wide) x 3.2m (Hight with fin)
Weight	5.8 tons in air / 3.5 tons in water
Tow speed	MAX 1.5 knots
Operating depth	MAX 11000m
Equipment	
Side Scan Sonar (SSS)	Frequency ：42kHz, 38kHz Range ：1000m in each side
Sub Bottom Profiler (SBP)	Parametric method Frequency ：60kHz (Primary wave) 2.5, 3.5, 5.0kHz (Secondary) Pulse level ：235dB
CTD, Gyro compass, Obstacle avoidance sonar, Acoustic positioning system, Monitoring camera, Pitch / roll sensor,	

The specifications of Vehicle

Dimensions	3.0m (Length) x 2.0m (Wide) x 2.1m (Hight)
Weight	4.0 tons in air / 0.0 tons in water
Speed	0 – 0.5 knots
Propulsion	4 horizontal thrusters / 6 vertical thrusters
Operating depth	MAX 7000m
Equipment	
CTD, Gyro compass, Obstacle avoidance sonar, HDTV camera x2, Color TV camera x2 (with Pan &Tilt), Digital still camera, manipulators x2, Sample basket (Payload:100kg in air, 50kg in water)	