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R/V Kaiyo Cruise Report

KY14-08

Recovery of the prototype buoy for tsunami and crustal movement.

Jun.14.2014 - Jun.17.2014

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

Table of contents

Note

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1. Cruise Information

1.1. Cruise ID

KY14-08

1.2. Ship

R/V Kaiyo (Captain: Eiko Ukekura)

1.3. Title of cruise

Recovery of the prototype buoy for tsunami and crustal movement.

1.4. Title of Proposal

Development of the buoy observation system for tsunami and crustal movement.

1.5. Period

Jun. 14, 2014 – Jun. 17, 2014

1.6. Research area

Kumano basin

2. Introduction and experiments summary

2.1. Introduction

Regarding the urgent research for 2011 Off Tohoku Earthquake, It was approved based on the results of the director discussion which is held at 14th June 2012 to develop the Tsunami detection system around strong current area. The buoy observation system for tsunami and crustal movement consist of two subsystem which are an ocean bottom unit located at seafloor and a surface buoy mooring. The water pressure data from the ocean bottom unit are transmitted using acoustic pulse, and the pulse signal are received at wire-end station which are located at 1000m below water surface. The received data are transferred to the surface buoy using inductive modem or metal cable and the data are transmitted by satellite communication. And there are also another four systems on the surface buoy. They are GNSS antenna and receiver by JAXA, backup GPS receiver by Tohoku University, ETS-8 (KIKU No.8) transmitter by JAXA, GPS/Acoustic surface unit by Tohoku University. These purpose are tsunami monitoring and satellite communication and seafloor crustal deformation precise acoustic ranging.

The main mission of this cruise is to recovery the prototype buoy for tsunami and crustal movement.

2.2. Experiments summary

Surface buoy recovery:	1 mooring
Ocean Bottom Unit recovery:	1 mooring
XBT (to correction of sound velocity for SSBL):	1 cast
Acoustic signal monitor on KAIYO	3 times

We successfully recovered a prototype buoy mooring and an ocean bottom unit during this cruise.

We conducted acoustic signal monitor around the deployed site. These measurements were conducted to investigate acoustic data communication for the buoy.

3. Cruise period, ports of call, cruise log and cruise track

3.1. Cruise period

Jun. 14, 2014 – Jun. 17, 2014

3.2. Ports of call

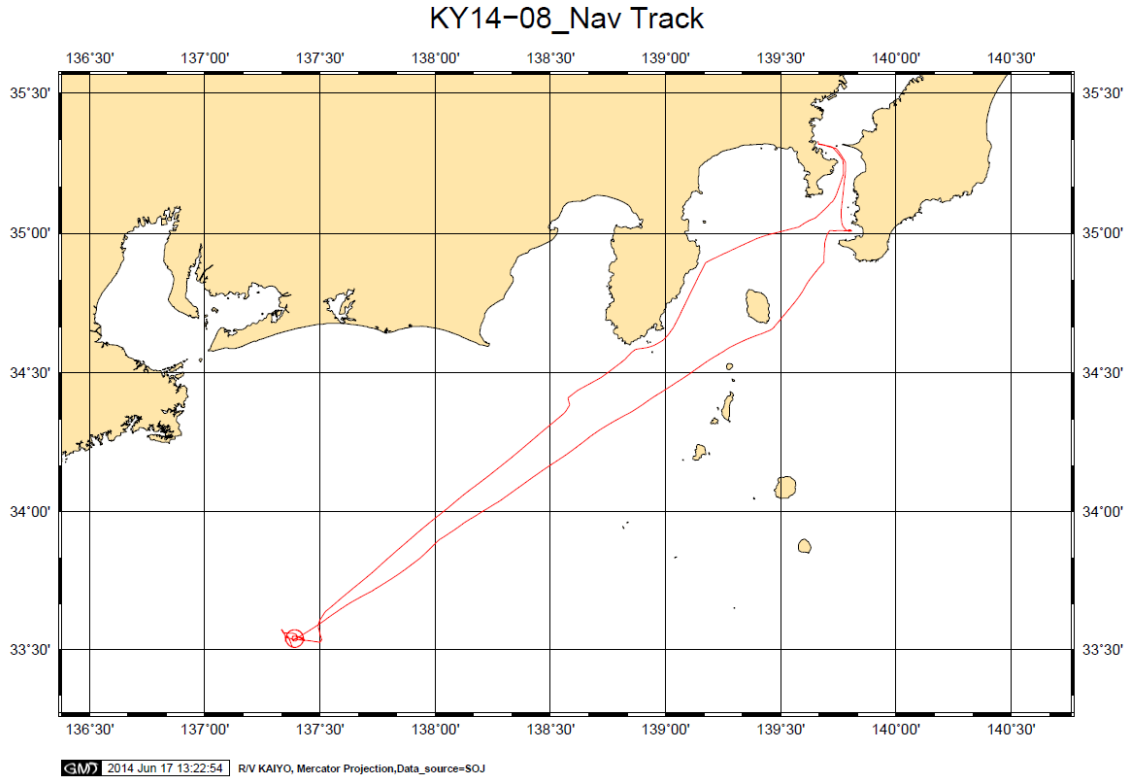
Yokosuka, Japan (Departure: Jun. 14, 2014)

Yokosuka, Japan (Arrival: Jun. 17, 2014)

3.3. Cruise log

SMT	UTC	Event
Jun. 14, (Sat.) 2014		
10:00	01:00	Departure from Yokosuka, Japan
10:30	01:30	Safety Lecture
13:00	04:00	Meeting for recovery operation
Jun. 15, (Sun.) 2014		
02:45	17:45	Arrive at Kumano Basin
02:59-07:00	17:59-22:00	Acoustic signal monitor #1 (point #1)
06:40	21:40	XBT-1 (33-31.9458N 137-25.9301E)
07:53-09:02	21:53-00:53	Position calibration of Tsunami Monitoring mooring and Ocean Bottom Unit
09:07-13:22	00:07-04:22	Recovery of prototype Tsunami Monitoring mooring (Anchor position: 33-32.33N 137-23.24E Depth: 2972m)
19:00-04:00	10:00-19:00	Acoustic signal monitor #2 (line #1)
Jun. 16, (Mon.) 2014		
04:00-09:10	19:00-00:10	Acoustic signal monitor and communication test using wire rope #3 (Area #1)
09:32-11:20	00:32-02:20	Recovery of prototype Ocean Bottom Unit (position: 33-32.43N 137-23.41E Depth: 2973m)
11:30	02:30	Departure from Kumano Basin
Jun. 17, (Tue.) 2014		
13:15	04:15	Arrive at Yokosuka, Japan

3.4. Cruise track



4. Researchers

4.1. Chief scientist

Chief Scientist

Tatsuya Fukuda

Engineer

Marine Technology and Engineering Center (MARITEC)

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

Co - Chief Scientist

Hiroshi Ochi

Engineer

Marine Technology and Engineering Center (MARITEC)

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

4.2. Science Party

4.2.1. Buoy System Engineer

Yasuhisa Ishihara (not on board)

Junichirou Tahara

Tatsuya Fukuda

Yosaku Maeda (not on board)

4.2.2. Underwater Acoustic Engineer

Hiroshi Ochi

Takami Mori

Mitsuyasu Deguchi

4.2.3. Earthquake and tsunami Study

Narumi Takahashi

4.2.4. GPS/Acoustic Study

Motoyuki Kido (not on board)

Yusaku Ohta

Misae Imano

Yuichiro Hirata

4.2.5. GNSS System Study

Katsuhiko Mutoh (not on board)

Yasuyoshi Hisamoto

Osamu Motohashi

4.2.6. ETS-8 Communication Engineer

Gousei Hashimoto

4.3. R/V Kaiyo Scientist and technical stuff

Tatsuya Fukuda	JAMSTEC	Yokosuka - Yokosuka
Narumi Takahashi	JAMSTEC	Yokosuka - Yokosuka
Hiroshi Ochi	JAMSTEC	Yokosuka - Yokosuka
Junichirou Tahara	JAMSTEC	Yokosuka - Yokosuka
Takami Mori	JAMSTEC	Yokosuka - Yokosuka
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Rei Itoh	MWJ	Yokosuka - Yokosuka
Takatoshi Kiyokawa	MWJ	Yokosuka - Yokosuka

JAMSTEC: Japan Agency for Marine-Earth Science and Technology

JAXA: Japan Aerospace Exploration Agency

Tohoku Univ.: Tohoku University

MWJ: Marine Works Japan, Ltd.

5. Experiments

5.1. Operation of the prototype buoys for tsunami and crustal movement

5.1.1. Personnel

Tatsuya Fukuda	(JAMSTEC): Principal Investigator
Hiroshi Ochi	(JAMSTEC): Engineer
Narumi Takahashi	(JAMSTEC): Researcher
Junichirou Tahara	(JAMSTEC): Engineer
Takami Mori	(JAMSTEC): Engineer
Mitsuyasu Deguchi	(JAMSTEC): Engineer
Gousei Hashimoto	(JAXA): Engineer
Osamu Motohashi	(JAXA): Engineer
Yasuyoshi Hisamoto	(JAXA): Engineer
Yusaku Ohta	(Tohoku Univ.): Researcher
Misae Imano	(Tohoku Univ.): Student
Yuichiro Hirata	(Tohoku Univ.): Student
Keisuke Matsumoto	(MWJ): Operation Leader
Hiroki Ushiromura	(MWJ): Technical Staff
Rei Itoh	(MWJ): Technical Staff
Takatoshi Kiyokawa	(MWJ): Technical Staff

5.1.2. Objectives

The buoy observation system for tsunami and crustal movement consists of two subsystems which are an ocean bottom unit located at seafloor and a surface buoy mooring. The water pressure data from the ocean bottom unit are transmitted using acoustic pulse, and the pulse signal are received at wire-end station which are located at 1000m below from the water surface. The received acoustic pulse data are transferred to the surface buoy through the inductive modem or conducting wire and the data are transmitted by Iridium satellite communication system. And there are also another three systems on the surface buoy. First one is a GNSS system which is supplied by JAXA, ETS-8 (KIKU No.8) satellite communication system which is also supplied by JAXA, GPS/Acoustic surface unit which is supplied by Tohoku University. These purposes are tsunami monitoring and satellite communication and seafloor crustal deformation precise acoustic ranging.

The purpose of this cruise is to recover the prototype buoy and the ocean bottom unit. A prototype of tsunami monitoring buoy and an ocean bottom unit have been successfully recovered during this cruise.

5.1.3. Measured parameters

The prototype buoy for tsunami and crustal movement observes engineering parameters as follows:

Engineering parameters:	water depth at 1.5m and 1000m
	currents at 1.5m
	accelerometer at surface and 1000m
	magnetic compass at 1000m

Details of the instruments used on the prototype buoy are summarized as follows:

(1) Data logger and Satellite transmitter

1) Data logger

Most of equipments are controlled by RS232C.

2) Iridium transmitter

The data in the interval of 60 minutes are being transmitted through Iridium transmitter.

3) ETS-8 transmitter (JAXA)

The data in the interval of 60 minutes are being transmitted through ETS-8 transmitter.

4) GNSS receiver and logger (JAXA)

Using 4 antennas, the attitude and NMEA data are stored itself.

5) Backup GPS receiver and logger (Tohoku Univ.)

Using an antenna, the NMEA data are stored itself.

6) GPS/Acoustic surface unit and transducer (Tohoku Univ.)

Using a transducer, the GPS/Acoustic seafloor geodetic observation data are stored itself.

(2) Engineering Sensor

1) CRN (at 1.5m, Current meter, Nortek AS)

Aquadopp IM400

Sampling interval:	600sec
Sensor frequency:	2MHz
Velocity Range:	±5m/s

2) D Sensor (at 1000m, Depth, Sea-bird electronics)

SBE37CTD-IM

Sampling interval:	600sec

Only using D sensor

Table 5.1-1 SBE37 specification

	Range	Accuracy	Resolution
Conductivity (S/m)	0-7	+/-0.0003	+/-0.00001
Temperature (degC)	-5-+35	+/-0.002	+/-0.0001
Pressure	0-7000meter	+/- 0.1%FS	+/- 0.002%FS

3) Accelerometer (MEMS Gyro)#1 (at Surface, xsens)

MTi-G GPS-aided AHRS

Sampling interval: 7days

4) Accelerometer #2 (at 1000m, Sumitomo Seimitsu Kogyo)

AMU-1802BR

Sampling interval: On Demand

Continuous record time 50min

Max number of recording 8times

5) Magnetic Compass (at 1000m, Honeywell)

HMR3400

Sampling interval: 600s

5.1.4. Mooring Configuration

(1) The prototype buoy for tsunami and crustal movement

Mooring configuration of the prototype buoy is shown in Fig. 5.1-1.

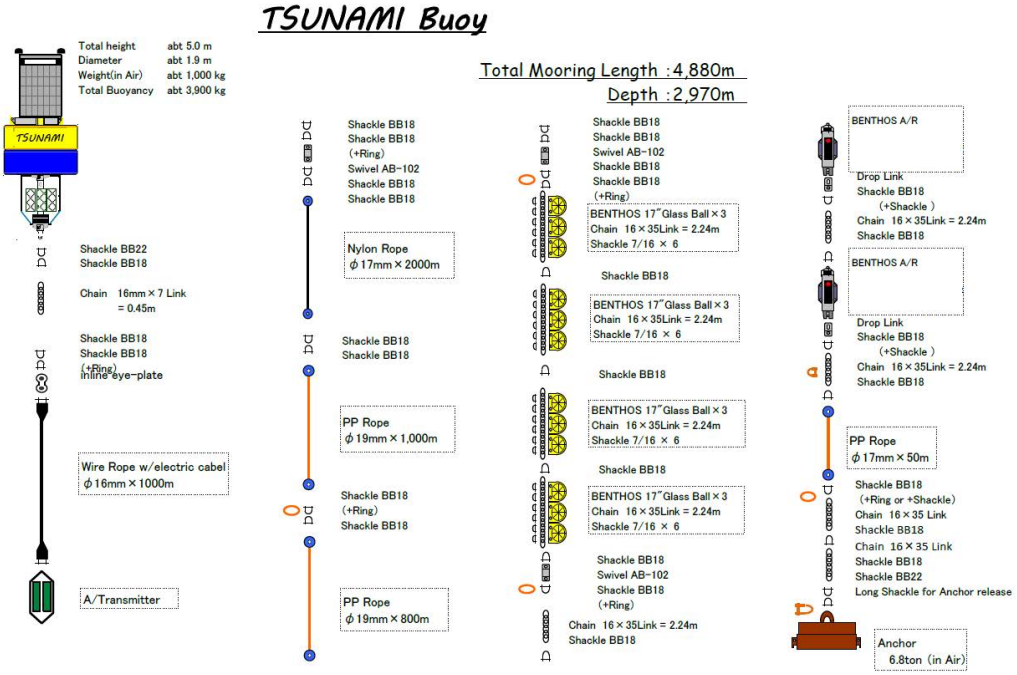

Fig. 5.1-1 Mooring Configuration of the prototype buoy

(2) Ocean Bottom Unit

Mooring configuration of the ocean bottom unit is shown in Fig. 5.1-2.

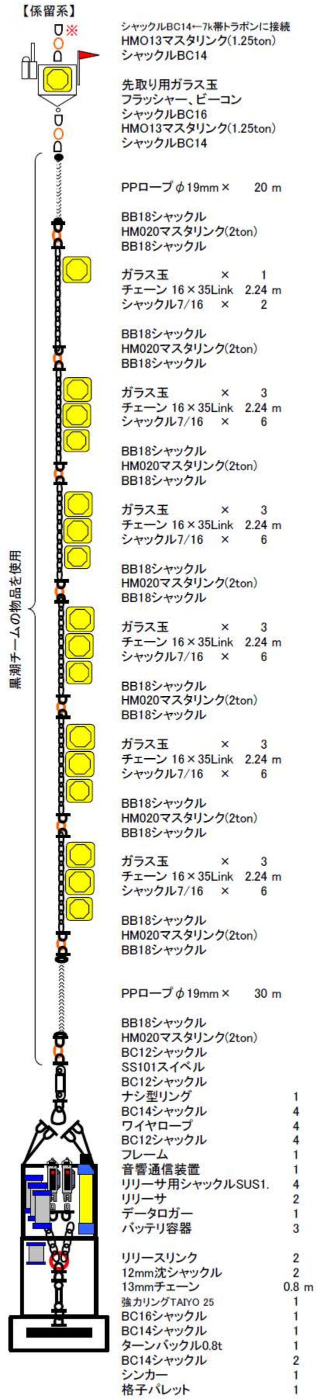

Fig. 5.1-2 Configuration of the ocean bottom unit

5.1.5. Results

Locations of recovery and deployment are as follow:

(1) Locations of Deployment

1) The prototype buoy for tsunami and crustal movement

ARGOS backup PTT number	121999
Deployed date (UTC)	12 Jan. 2014 02:49
Recovered date (UTC)	15 Jun. 2014 01:16
Exact location	33 - 32.33N, 137 - 23.24E
Depth	2,972 m

2) The prototype Ocean Bottom Unit

Deployed date (UTC)	12 Jan. 2014 07:25
Recovered date (UTC)	16 Jun. 2014 01:20
Exact location	33 - 32.43N, 137 - 23.41E
Depth	2,973 m

(2) Hardware Failures

There were some hardware failures.

1) Wire rope

The wire rope from top to 75m and 190m depth was injured by fishery line. And there were many pin holes.

2) Electric Tube at buoy

There were some crevice corrosions.

3) Wire-end station

There was a scuff at frame.

5.1.6. Data archive

The data in the interval of 60 minutes were transmitted via Iridium satellite system and ETS-8 communication system in real time during mooring period. Because the main battery was decreased last 3 weeks of mooring period, the observation of buoy was limited. All data which was installed on buoy were stored in each system.

5.2. Acoustic signal monitor and communication test using wire rope

5.2.1. Personnel

Tatsuya Fukuda	(JAMSTEC): Principal Investigator
Hiroshi Ochi	(JAMSTEC): Engineer
Takami Mori	(JAMSTEC): Engineer
Mitsuyasu Deguchi	(JAMSTEC): Engineer
Narumi Takahashi	(JAMSTEC): Researcher

5.2.2. Objectives

The measurements of acoustic signal monitor were conducted to investigate acoustic data communication for our buoy.

A wire-end station and surface buoy are connected by wire rope. Communication between them is used this wire rope with RS232-C protocol on inductive modem (IM). Whilst mooring period, this wired communication was very noisy. So, the communication test using wire rope between on board PC and wire-end station was conducted to investigate IM communication at real observation area.

5.2.3. Methods

For observing the acoustic signal from ocean bottom unit (OBU), we used hydrophone array of acoustic navigation system which is installed on the bottom of the ship. By moving ship position, various data were recorded on the ship.

Wired communication test was carried out after recovering buoy system. Regarding communication test, we used recovered wire rope and recovered wire-end station. To investigate the effect of inductance of the wire rope, communication behavior was measured at several depths.

5.2.4. Preliminary results

The acoustic signal from OBU were measured at almost fixed position (Point #1) and along with circle line (Line #1). The wired communication test were carried out at area of surface buoy drifted area during mooring (Area #1). Those are shown in Fig. 5.2-1 - Fig. 5.2-3.

- Point #1 near buoy
- Line #1 Circle Radius 3.55km Center: 33-32.43N, 137-23.41E
- Area #1 Circle Radius 3.0 ~ 3.9km Center: 33-32.43N, 137-23.41E

5.2.5. Data archives

These data will be archived at the JAMSTEC Yokosuka Headquarters.

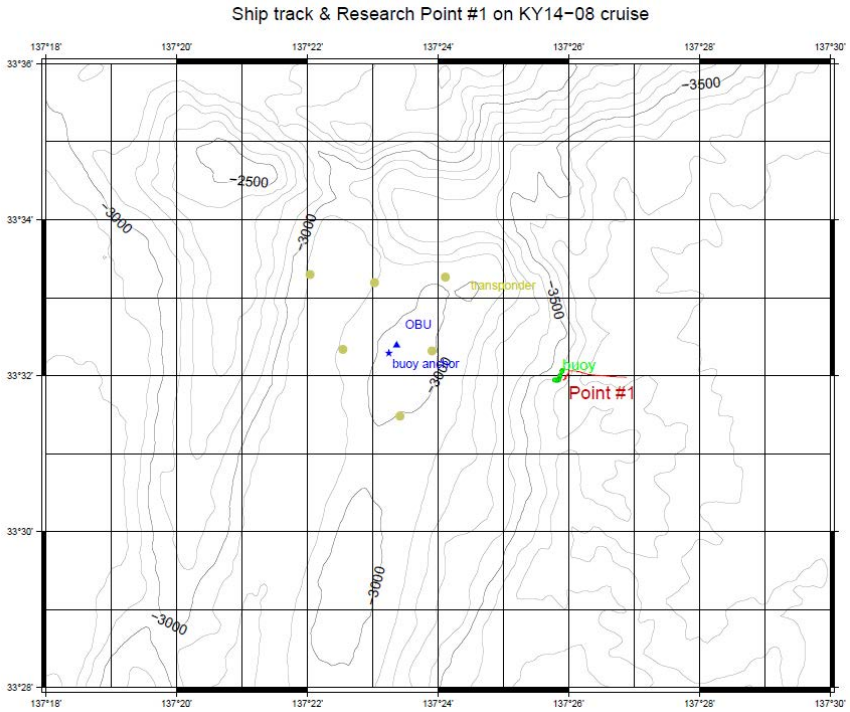

Fig. 5.2-1 Obervation #1 (Point #1)

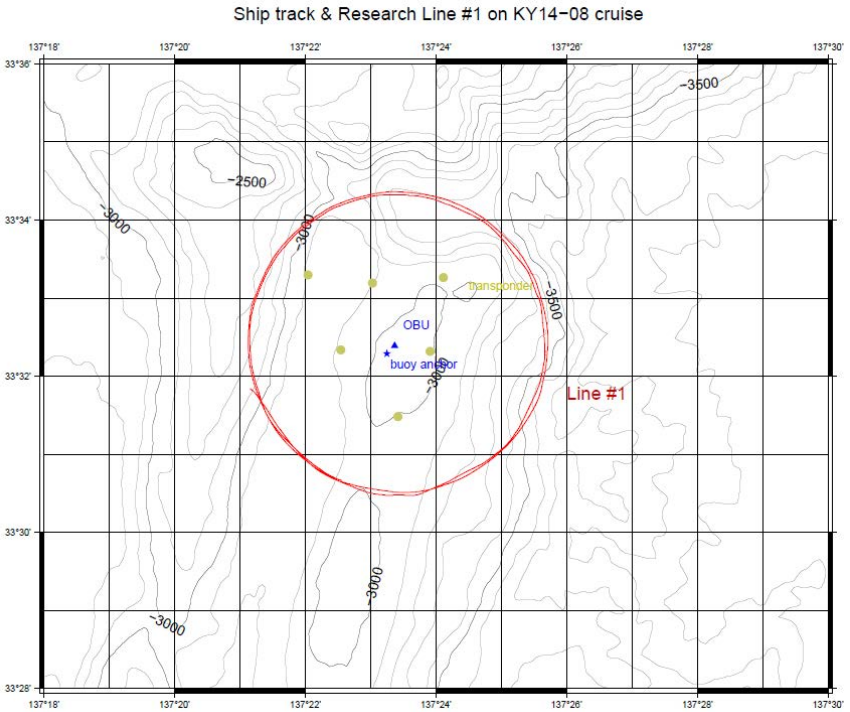

Fig. 5.2-2 Obervation #2 (Line #1)

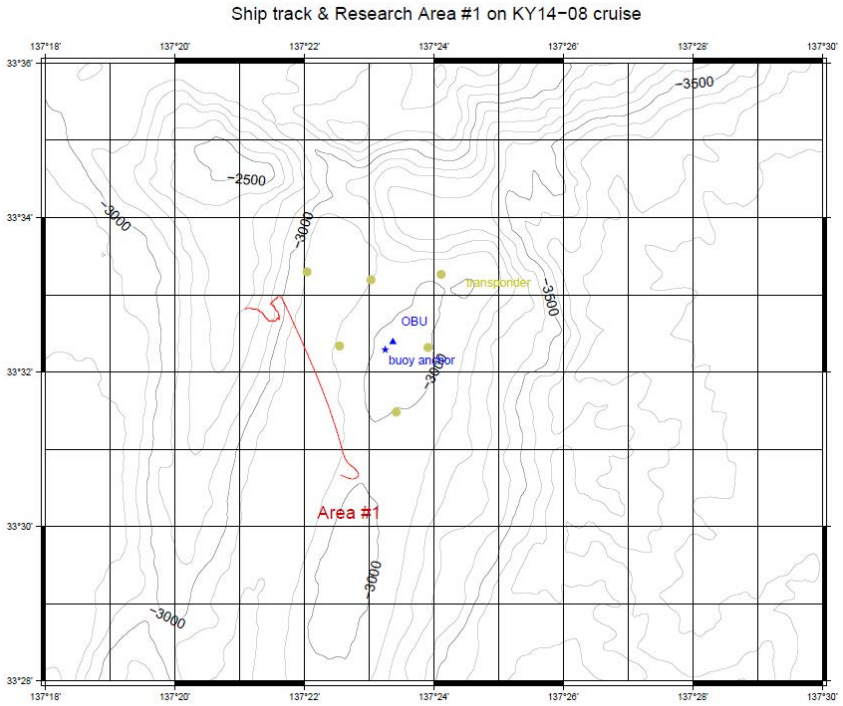

Fig. 5.2-3 Observation #3 (Area #1)