



# KAIYO Cruise Report

KY13-18

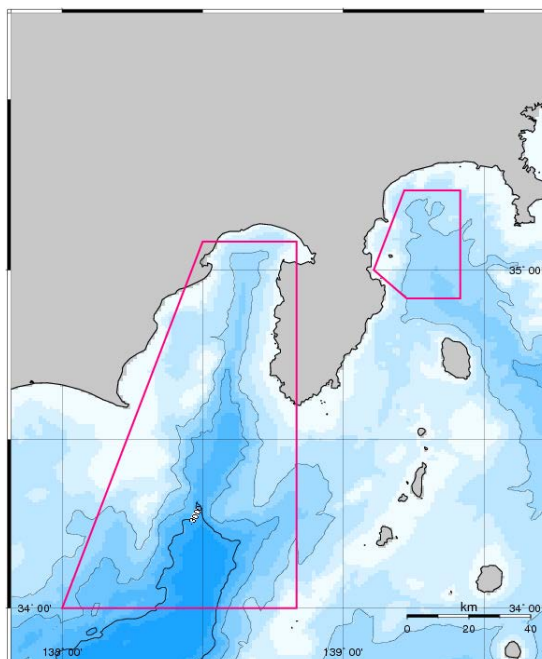
Operation training and test cruising of the AUV;  
Yumeiruka for enabling underwater resources observation  
Sagami-Bay

December 9, 2013 – December 26, 2013

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

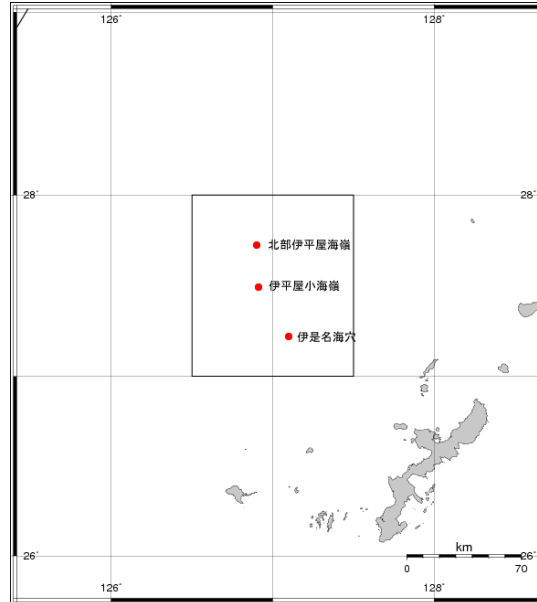
## 1. Cruise Information

- ✓ Cruise ID KY13-18
- ✓ Name of vessel KAIYO
- ✓ Title of the cruise Operation training and test cruising of the AUV; Yumeiruka for enabling underwater resources observation.
- ✓ RePresentative of Science Party Hiroshi Yoshida [JAMSTEC]
- ✓ Title of proposal Operation training and test cruising for underwater resources observation of the AUV; Yumeiruka.
- ✓ Cruise period Dec. 9, 2013 – Dec. 26, 2013
- ✓ Ports of departure / call / arrival Yokosuka ~ Yokosuka
- ✓ Research area Sagami-Bay, Suruga-Bay, and Iheya-Knoll
- ✓ Research Map
  - (1) Area #1: Sagami-Bay  
Sea-trial was carried out in the area bounded by [34° 55.0' N, 139° 13.5' E], [35° 00.0' N, 139° 06.5' E], [35° 14.0' N, 139° 13.0' E], [35° 14.0' N, 139° 25.0' E], [34° 55.0' N, 139° 25.0' E], 80 m ~ 1,500 m in depth.
  - (2) Area #2: Suruga-Bay  
Sea-trial was carried out in the area bounded by [35° 05.0' N, 138° 30.0' E], [35° 05.0' N, 138° 50.0' E], [34° 00.0' N, 138° 50.0' E], [34° 00.0' N, 138° 00.0' E], 200 m ~ 3,000 m in depth.



(3) Area #3: Iheya Knoll in Okinawa

27° 00.0' N、28° 00.0' N, 126° 30.0' E、127° 30.0' E



## 2. Researchers

| Name               | Affiliation                                   | Job Title             |
|--------------------|-----------------------------------------------|-----------------------|
| Hiroshi Yoshida    | Maritec, JAMSTEC                              | Chief Scientist       |
| Shojiro Ishibashi  | Maritec, JAMSTEC                              | Scientist             |
| Makoto Sugasawa    | Maritec, JAMSTEC                              | Scientist             |
| Yutaka Ohta        | Maritec, JAMSTEC                              | Scientist             |
| Hiroshi Ochi       | Maritec, JAMSTEC                              | Scientist             |
| Yoshitaka Watanabe | Maritec, JAMSTEC                              | Scientist             |
| Takao Sawa         | Maritec, JAMSTEC                              | Scientist             |
| Yoshiyuki Nakano   | Maritec, JAMSTEC                              | Scientist             |
| Masayuki Watanabe  | R&D Center for Submarine Resorces,<br>JAMSTEC | Assistant to director |
| Takafumi Kasaya    | R&D Center for Submarine Resorces,<br>JAMSTEC | Scientist             |
| Yoshiaki Yamauchi  | Mitsubishi Heavy Industry                     | Chief Engineer        |
| Kazuki Eguchi      | Mitsubishi Heavy Industry                     | Engineer              |
| Yoshimi Kaneko     | Mitsubishi Heavy Industry                     | Technician            |
| Takasumi Matsuoka  | Mitsubishi Heavy Industry                     | Technician            |
| Yusuke Nagata      | Mitsubishi Heavy Industry                     | Technician            |
| Kazuhiro Kanayama  | Mitsubishi Heavy Industry                     | Technician            |
| Mutsuo Takashima   | Mitsubishi Heavy Industry                     | Technician            |
| Hiroyuki Miyake    | Ryoyu System Giken                            | Engineer              |
| Kazunari Takahashi | Oki Seatech                                   | Engineer              |

### 3. Engineering Test

#### 1) Overview

Operation training and observation performance check of the Autonomous underwater vehicle (AUV), Yumeiruka, were main purpose of this sea trial but its electronic system failed in the first launch/ recovery test and had not worked through the scheduled period. Acoustic communication test including signal level measurement was only done. During the sea trial, the trouble was focused with cooperation of crew of R/V Kaiyo.

After the trial, we have fixed the problems and tried to improve the system reliability since Jan. 2014.

Table 1: List of results in the Leg #1.

| Date          | Action/Place (planned) |                             | Planned                                    | Actuals                                 |
|---------------|------------------------|-----------------------------|--------------------------------------------|-----------------------------------------|
| Dec. 9, Mon.  | Pre-testing            | Pear of SHI                 | Launch/Recover Test@Pier                   | Pier<br>(Fixing of the fault)           |
| Dec. 10, Tue. | Departing              | Sagami-Bay                  | Acoustic system check                      | Pier<br>(Fixing of the fault)           |
| Dec. 11, Wed. | Sea trial              | Sagami-Bay                  | Acoustic system check                      | Pier<br>(Fixing of the fault)           |
| Dec. 12, Thu. | Sea trial              | Sagami-Bay<br>Nankai Trough | Dive #1<br>(~3,000m)                       | Loading                                 |
| Dec. 13, Fri. | Sea trial              | Sagami-Bay<br>Nankai Trough | Dive #2<br>(~3,000m)                       | Test at the Pier<br>Remaining the fault |
| Dec. 14, Sat. | Sea trial              | Sagami-Bay<br>Nankai Trough | Dive #3<br>(Evaluation of maneuverability) | Pier<br>(Fixing of the fault)           |
| Dec. 15, Sun. | Sea trial              | Sagami-Bay<br>Nankai Trough | Dive #4<br>(Evaluation of maneuverability) | Test at the Pier                        |
| Dec. 16, Mon. | Sea trial              | Sagami-Bay                  | Dive #5<br>(Evaluation of maneuverability) | Test at the Pier                        |
| Dec. 17, Tue. | Sagami-Iheya           |                             |                                            | Test at the Pier<br>Left the pier       |
| Dec. 18, Wed. | Sagami-Iheya           |                             |                                            | Acoustic test@<br>Suruga-bay            |
| Dec. 19, Thu. | Sagami-Iheya           |                             |                                            | Acoustic test@<br>Suruga-bay            |
| Dec. 20, Fri. | Sea trial              | Iheya                       | Dive#6<br>(Observation tests)              | Bad weather                             |
| Dec. 21, Sat. | Sea trial              | Iheya                       | Dive#7<br>(Observation tests)              | To the pier                             |
| Dec. 22, Sun. | Sea trial              | Iheya                       | Dive#8<br>(Observation tests)              | Fixing of the faults                    |

|                  |               |      |  |           |
|------------------|---------------|------|--|-----------|
| Dec. 23,<br>Mon. | Iheya-JAMSTEC |      |  | Test@Pier |
| Dec. 24, Tue.    | Iheya-JAMSTEC |      |  | Test@Pier |
| Dec. 25, Wed.    | Iheya-JAMSTEC |      |  |           |
| Dec. 26, Thu.    | unloading     | Pier |  | Unloading |

## 2) Result

We only carried out a test on acoustic communication between AUV Yumeiruka and R/V Kaiyo. Figure 1 shows raw data of a noise spectrum measured. We estimate maximum communication range from carrier-to-noise ratio as shown in Figure 2. From the figure we obtain that maximum range is about 4,600 m.

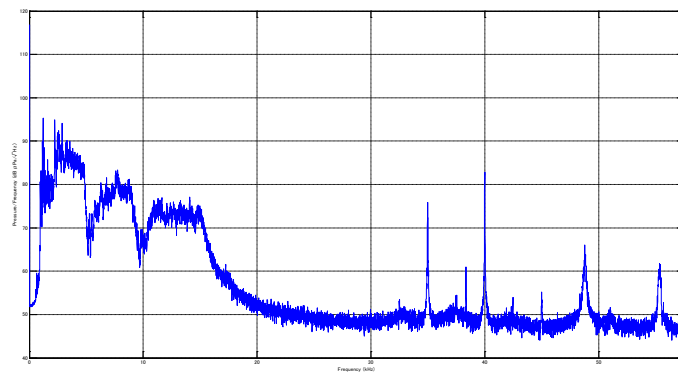


Figure 1. Noise spectrum measured at the receiver of Yumeiruka.

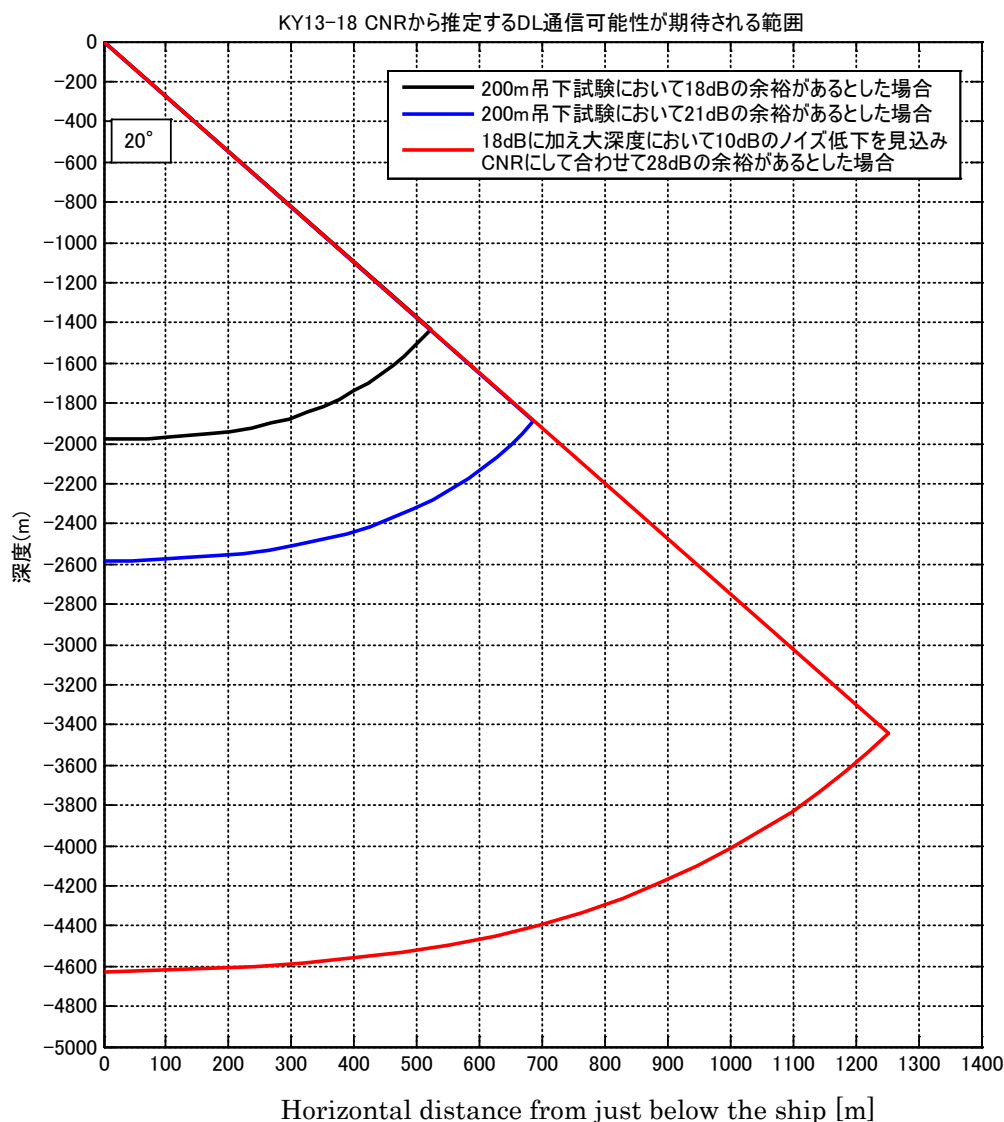


Figure 1 : Communication range estimated from the data measured.

### 3) Specifications of Yumeiruka

Yumeiruka is the AUV equipped with a canard-X rudder. The highly maneuverable AUV will be utilized for underwater resources exploration. Its constant motion control allows a magnetic sensor and/or synthetic aperture sonar to enhance performance. Table 2 shows its specifications.

Yumeiruka has a streamline shape to reduce hydro resistance. Its frame is made from aluminum alloy. The mechanically-formed syntactic forms attached into the frame make the vehicle buoyant. The syntactic forms also form vehicle outer shape. Its whole surface is covered with separated thin fiber-reinforced plastics (FRPs). Cross arranged four 400 Watts direct drive thrusters at rear make

propulsion. The thrusters generate maximum speed of 3 knots. Two X-rudders are mounted on the bow and the stern to control the vehicle highly maneuverable. Its controllable speed with the rudders is between 2 and 3 knots. The rudder area and aspect ratio were optimized by the balance between the control range of the simultaneous heading and course control and the rudder overhang length from the body. Fig. 1 shows the device arrangement of Yumeiruka. A buoyancy compensator adjusts the vehicle weight to near-neutral. The compensator consists of a pressure hull with capacity of 30 liters, an oil bladder, a pump and valves. Its buoyancy is adjusted by transferring the oil between the pressure hull and the bladder. It can be automatically controlled by a mission scenario. A small inertial navigation system (INS) consisting of three ring laser gyros developed by Japan Aviation Electronics Industry, Ltd. and JAMSTEC enables high accuracy positioning of the vehicle with a 300 kHz Doppler velocity log (DVL), a global positioning system (GPS) and acoustic navigation systems (ANSs). Its navigation modes, a DVL-INS hybrid mode and so on, are automatically or manually selected. The AUV system has a super short base-line (SSBL) acoustic positioning system. Other sensors for navigation are an altimeter and a depth meter. The vehicle is equipped with a depth meter, model 8B and a CTD, SBE49 but the vehicle system gives priority to the model 8B as depth data measured. Both the DVL and an altimeter measure altitude and the DVL has priority as well. These pair sensors constitute a redundancy system.

Table 2: Specifications of *Yumeiruka*

| ITEMS                | VALUES                                                                                 |
|----------------------|----------------------------------------------------------------------------------------|
| Maximum depth rating | 3,000 m                                                                                |
| Cruising speed       | 2 knot                                                                                 |
| Length               | 5.0 m                                                                                  |
| Weight               | 2.7 tons                                                                               |
| Endurance            | 16 hours                                                                               |
| Scientific payload   | 70 liters (100 kg)                                                                     |
| Observation items    | IF sonar, Synthetic Aperture Sonar, SBP, CTD meter, Fluoro & turbidity meter, pH meter |

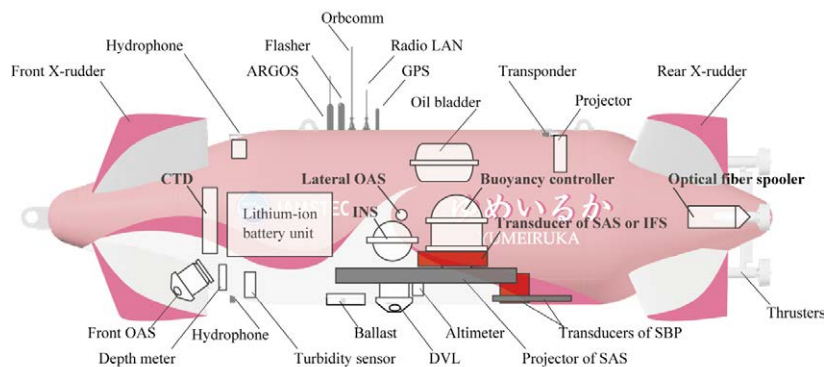


Fig. 5: System arrangement.

#### **4. Notice on Using**

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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.