



“KAIYO” Cruise Report

KY15-15

Experiments of Underwater Acoustic Technology

and

Site Survey for IODP (Recovery of Mooring Systems)

Suruga-Bay and Northern Izu-Ogasawara

Oct./4/2015 – Oct./11/2015

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

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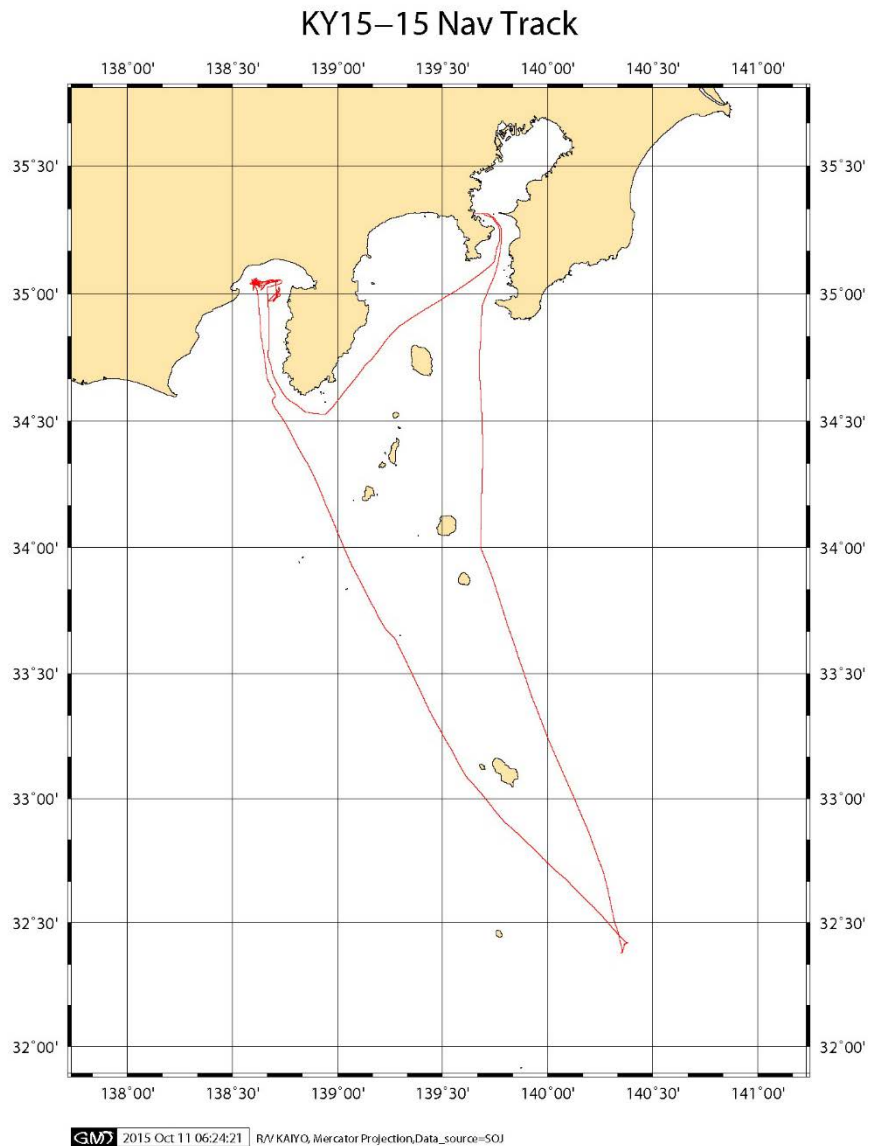
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1. Cruise Information

- Cruise ID: KY15-15
- Name of vessel R/V KAIYO
- Title of the cruise Experiments of Underwater Acoustic Technology and Site Survey for IODP (Recovery of Mooring Systems)
- Title of proposal 1 Research on time-reversal communication, real time source tracking and deep sea seismic.
- Title of proposal 2 Site survey for a drilling project of IODP in the northern Izu-Ogasawara arc
- Cruise period 4/Oct./2015 – 11/Oct./2015
- Ports of call Yokosuka JAMSTEC Headquater
- Research area Izu-Ogasawara, Suruga-Bay
- Research Map



2. Researchers

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3. Preliminary report of experiments for underwater acoustic technology

In marine technology department of JAMSTEC, research on long-range acoustic communication with time-reversal in deep ocean, real time source tracking with particle filter, and deep sea seismic has been conducted. In this cruise, due to heavy weather, it was impossible to execute long-range experiments in Izu-Ogasawara area as planned. Thus, basic experiments were carried out in the spare area, Suruga-bay, for acoustic communication and source tracking.

Time reversal is an attractive solution, originally, for single user communication. It is suitable for underwater acoustic communication in terms of countermeasure to intersymbol interference (ISI) due to rich multipath environment inherent in the ocean acoustic propagation. Spatial and temporal focusing of time reversal removes such ISI by collecting multipath signals. Additionally, time reversal can be easily extended to multiuser communication by the same processing in the single user case without sacrificing throughput.

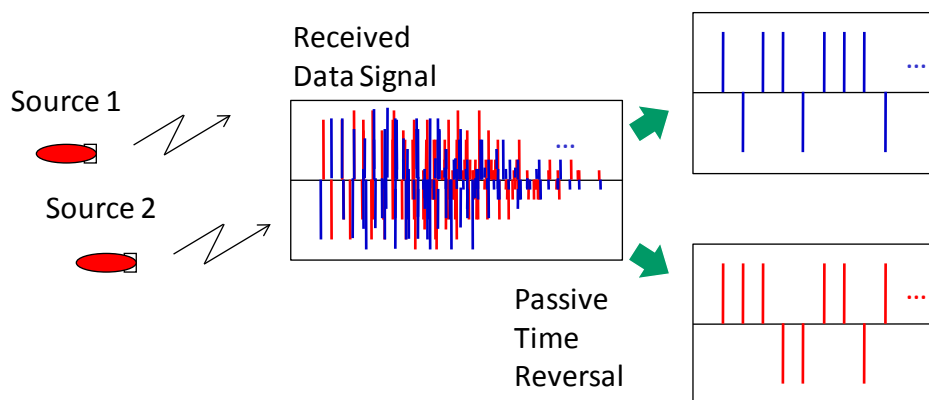


Fig. 1 Schematic of multi-user communication by passive time reversal.

In the experiment, acoustic signals were transmitted from a low-frequency (500 Hz $\pm$ 50 Hz) source suspended from R/V Kaiyo. The signals were measured by a 20-channel receiver array which

was moored at the range of 10 km from the source. The depth of the source was change at each transmission to simulate transmission from multiple sources or a moving target source.

Figure 2 shows channel response obtained by correlation of LFM chirp signal. As shown in this figure, many multipath waves are observed.

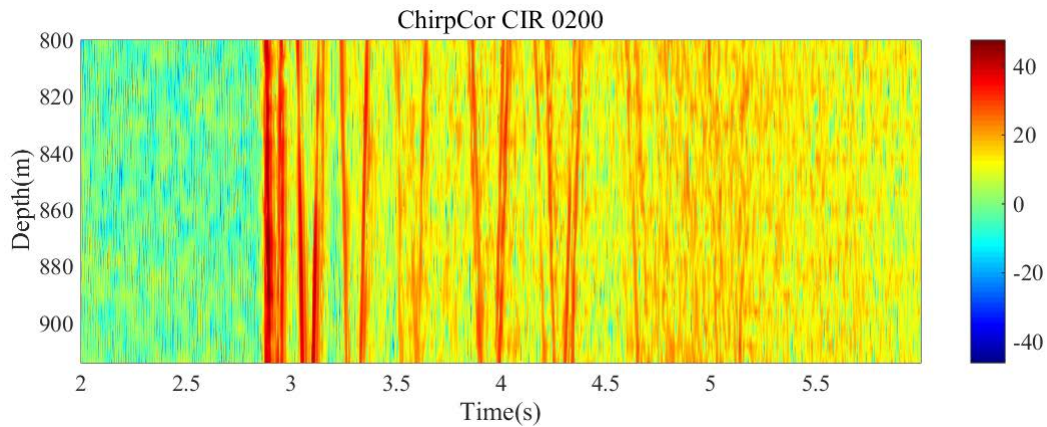


Fig.2 An example of channel responses.

Figure 3 shows output SNRs of demodulation results by passive time reversal for binary phase shift keying (BPSK) packets. It is shown that the demodulation with no error can be achieved for all packets. Performance analysis with time reversal for multiple-input-multiple-output communication at higher data rate will be carried out by synthesizing these real data. And analysis for a moving source tracking with real time inversion using particle filter will also be executed.

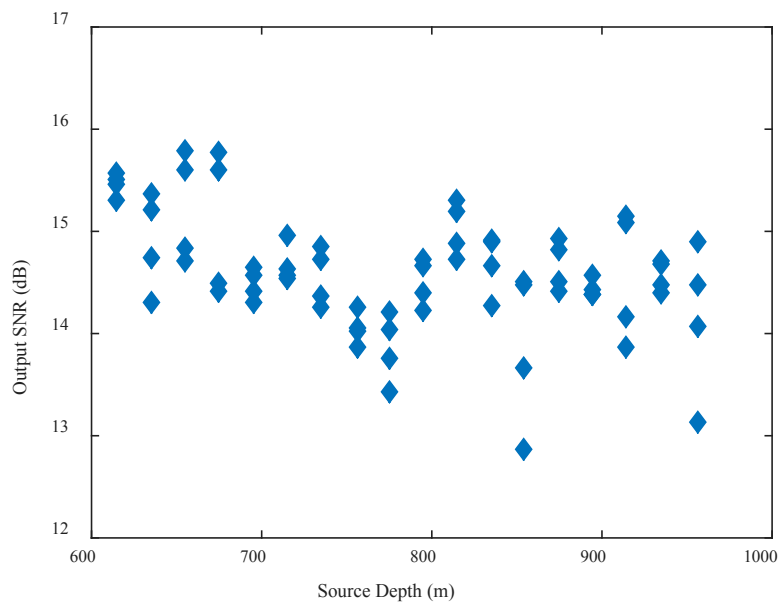


Fig. 3 Demodulation results by passive time reversal.

4. Preliminary report of the site survey for IODP (recovery of mooring systems)

4.1. Objectives

This survey is aimed mainly at retrieving two mid-depth subsurface mooring systems, CM-07 and CM-08, for long term sea current observation installed to Site IBM-4 off the east of Aogashima Island in June 2014 during the YK14-10 cruise (Fig. 4). Site IBM-4 is a deep riser drilling site proposed in the International Ocean Discovery Program (IODP), about 1800 m in water depth, potentially drilled by D/V Chikyu in near future. Long term sea current observation data is one of operational site survey data required for safety assessment of riser drilling, especially for assessment of riser behavior in high current conditions (riser analysis). Since the IBM-4 is located in an area where the Kuroshio Current passes sometimes according to its meandering patterns, we planned to install the mooring systems for more than a year (up to two years) to obtain data for the riser analysis. The mooring systems are about 1500 m in length and the designed depth of the top buoys is about 300 m under low current conditions (Fig. 5). In this cruise, one main and two supplemental surveys were planned for this survey as follows:

[Main]

- 1) To recover the two subsurface mooring systems,

[Supplemental]

- 2) To fill in gaps of the preexisting multibeam bathymetry map around the IBM-4 obtained by JAMSTEC vessels if time allows, and
- 3) To obtain vertical sea current profiles with the hull-mounted ADCP during the vessel stays in the survey area (.

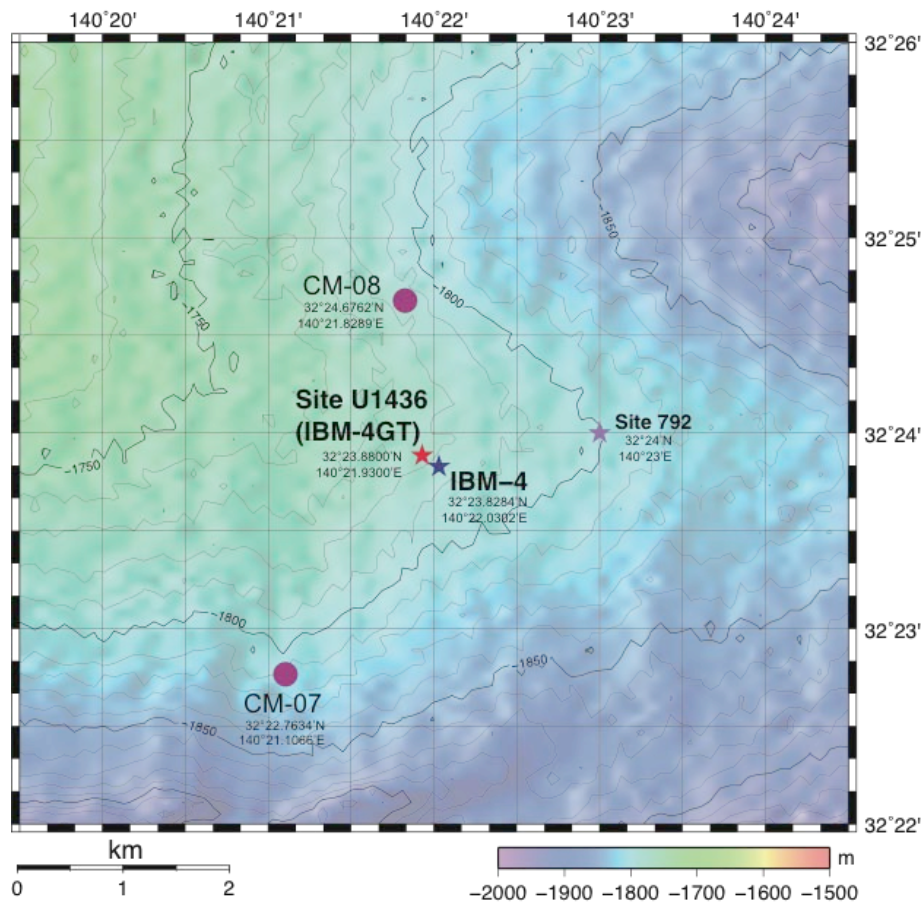


Figure 4. Close-up bathymetry map around Sites IBM-4 and U1436 (IBM-4GT), showing the expected positions (releaser positions) of the mooring systems, CM-07 and CM-08, which were installed during YK14-10 cruise. The bathymetry is based on the existing multibeam bathymetry data obtained by the JAMSTEC fleet.

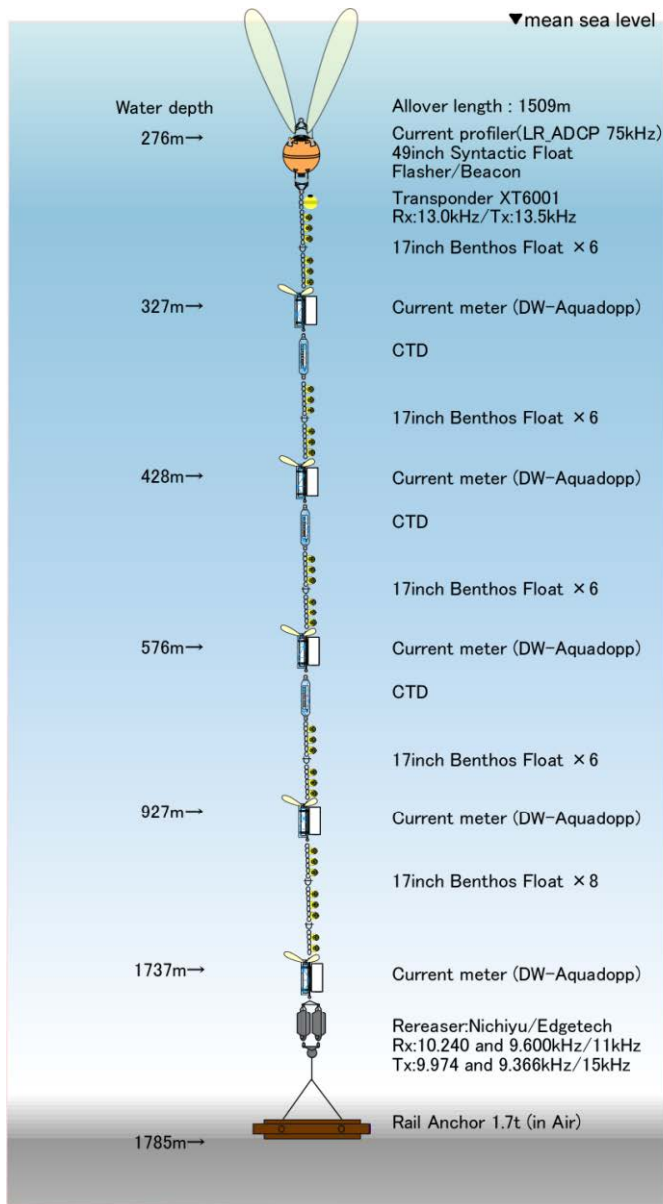


Figure 5. Cartoon of the CM-08 subsurface mooring system.

4.2. Results

4.2.1. Recovery of mooring systems

After the experiments carried out in the Suruga Bay, the vessel left there in the morning (06:00) of October 9 and arrived at the site before dawn (04:00) on the following day, October 10 (see the ship track in the Research Map). The preparation for the mooring recovery operations commenced in the early morning (06:30) at the site of CM-08 under a calm sea state, however, the sea state got rapidly worse beyond that for landing the work boat on the sea (wind speed: 10-13 m/sec, 1/3 significant wave height: 1.7-1.9 m, maximum wave height: 3 m) before releasing the mooring. Although we

waited for a sea state restoration, it was unlikely to restore according to the forecast. Finally, we abandoned to retrieve the mooring systems in this cruise (09:40). Instead, we confirmed that both the two mooring systems were there as expected by measuring the slant ranges with the transponders below the top buoys and by awakening the releasers. After confirming that the CM-07 mooring was alive (11:45), we left the site and started back to Yokosuka.

In the operations for the CM-08 mooring system recovery, the vessel approached the mooring location from the downstream of the Kuroshio (2~2.4 kt ENE) and we tried to send the release command before the vessel reached the location in expectation of catching the mooring surfaced in the downstream side. Transducers of the transponder and the releasers were lowered by hand at the bow. However, this approach might not bring a good result because the vessel needed to keep the thrusters active under high current and wind conditions while sending the enable and release commands. While the transponder successfully responded, one of the releasers (the releaser assembly consists of two different releasers assembled in parallel) showed no response and the other releaser did not accept the release command probably due to the high thruster noise. In addition, the vessel was drifted down with the Kuroshio and distanced from the site while sending commands. We tried several times, but after all we lost a small chance to retrieve the first mooring.

We positioned the both mooring systems by tracking the transponder with the vessel's SSBL and confirmed that they were located almost as expected with small deviations about 5 m and 7 m east-northeastward in CM-07 and CM-08, respectively. These deviations, however, are acceptable within the accuracy of SSBL positioning. The results of positioning are shown in Table 1.

Table 1. Results of positioning of each transponder below the top buoy

Mooring System	Number of Positioning	Depth of Transponder	Horizontal Distance from Installed Location	Expected System Tilt	Direction of Deviation	Horizontal Deviation
CM-07	1	343 m	394 m	17.3°	72°	4.9 m
CM-08	9	328 m	454 m	15.0°	62°	6.6 m

Note: Each transponder is located 5 m below the top buoy.

4.2.2. Supplemental surveys

The sea current data with the vessel's ADCP was collected during the vessel was staying in the site. On the other hand, the multibeam bathymetry survey was cancelled due to the tight cruise schedule and the rough sea conditions.

5. Notice on Using

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.