Submission date: 2012/01/06

Cruise Summary

1. Cruise Information

Cruise ID	YK11-10
Name of Vessel	S/V Yokosuka
Cruise Title	Development of Strategy for Finding and Observing Hydro-Thermal Vent Fields in West Part of Okinawa Trough such as No. 4 Yonaguni Knolls by Using Two Autonomous Underwater Vehicles
Chief Scientist	Tamaki Ura, Professor of Institute of Industrial Science, The University of Tokyo
Representative	Tamaki Ura, Professor of Institute of Industrial Science, The University of Tokyo
Proposal	Development of Strategy for Finding and Observing Hydro-Thermal Vent Fields in West Part of Okinawa Trough such as No. 4 Yonaguni Knolls by Using Two Autonomous Underwater Vehicles
Cruise Period	15 Nov. 2011 - 6 Dec. 2011
Ports of Call	Yokohama ~ Naha, Okinawa
Research Area	No.04 Yonaguni Knoll and Izena Site in Okinawa Trough (see Fig. 1.1)

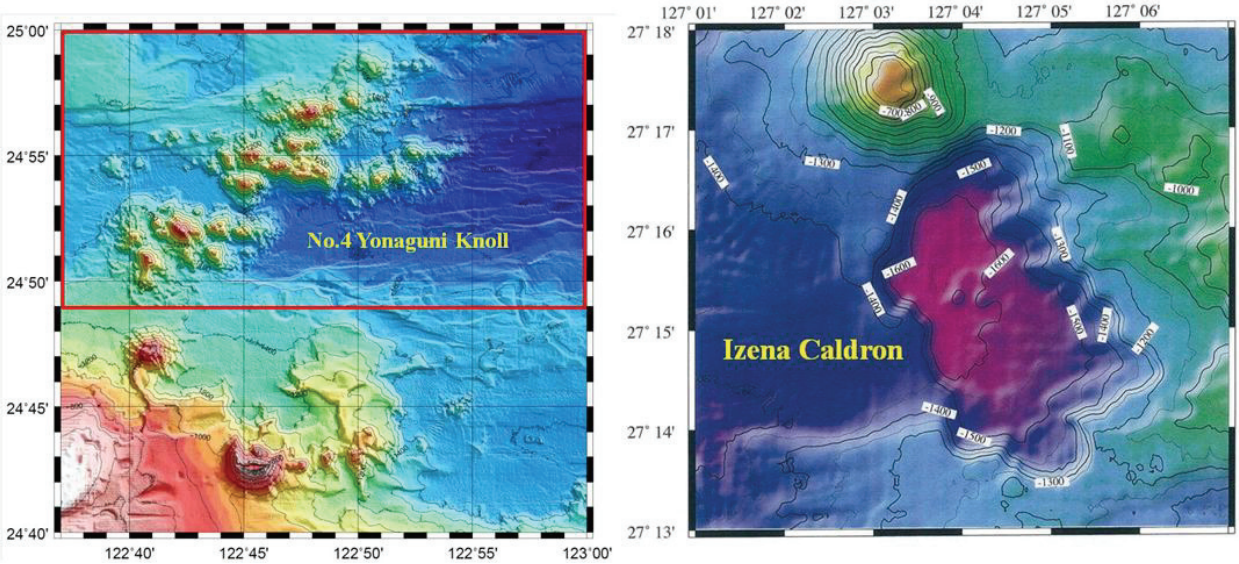

Fig. 1.1 YK11-10 survey areas (No.4 Yonaguni Knoll (left) / Izena Caldron (right)).

2. Overview of the Observation

2.1 Backgrounds

As the resource nationalism increases and spreads worldwide, hydrothermal vents which are to be served as a potential benthic deposit start to attract much attention in Japan. Recently, it has become apparent that there are a few potential and active undersea hydrothermal vents within and near Japanese waters. However, only a few hydrothermal vents have been found in Japanese waters yet. In the traditional approaches for discovering unknown hydrothermal vents, acoustic investigation using the multi-narrow beam sonar device installed on a surface vessel is carried out first. On the basis of the results from this shipborne survey offering the probable spots of hydrothermal activities, ROVs or manned submersibles are deployed to conduct the refined survey over the probable spots. As is well known, however, resolution of a bathymetric map generated by the shipborne acoustic investigation is restricted by the water depth resulting in the map of insufficient resolution to be used as a guidance for the deployment of ROVs or manned submersibles. As a result, the attempt for finding an unknown hydrothermal vent based on the shipborne acoustic surveys followed by the surveys using ROVs or manned submersibles seems to be neither efficient nor useful. Motivated by the problem in current approach for finding unknown undersea hydrothermal vents, we have proposed a new undersea survey strategy based on the cooperative deployment of two heterogeneous AUVs; the cruising AUVs and the hovering AUVs. Based on our new strategy, we try to find an unknown hydrothermal vent by the four structured survey stages as follows:

1) Determining the site of undersea survey using the bathymetric map taken from the shipborne acoustic survey.
2) Narrowing down the search area and detecting active undersea hydrothermal vent site. This stage is conducted by cruising AUVs based on the acoustic survey (using Side Scan Sonar (SSS), and/or Interferometry Sonar (IFS)) and the geophysical and geochemical sensing.
3) Generating the mosaic of seabed by deploying the hovering AUVs which takes the photo images of seabed over the narrowed search area maintaining the altitudes of few meters.
4) Final investigation and confirmation of the discovery of a new hydrothermal vent by deploying ROVs.

In this cruise, referring to the prior information obtained from the KR10-03 cruise conducted on January 2010, we have implemented our strategy by deploying a cruising AUV "Aqua-Explorer 2000a (AE2000a, for short)" and a hovering AUV "Tuna-Sand (TS, for short)", developed and owned by Institute of Industrial Science (IIS), the University of Tokyo.

2.2 Methods

The basic idea of putting into practice our strategy is shown in Fig. 2.1. In our survey strategy mentioned in 2.1, it is noted that by employing a cruising AUV in stage 2), we can obtain the bathymetric map of far more enhanced resolution. Moreover, due to the recent remarkable advances in the field technology of operating small hovering AUVs, by deploying a

hovering AUV instead of a ROV in stage 3), vast survey area can be covered within reduced survey time by the collaboration between cruising and hovering AUVs. This lets the ROV operation be concentrated on stage 4), realizing more effective utilization of ROVs. For the undersea investigation during YK11-10 cruise, AE2000a was deployed to fulfill the wide range survey mission explained in the stage 2). Meanwhile, for the image-based survey within an extracted area, followed by the wide range survey performed by AE2000a, TS was deployed.

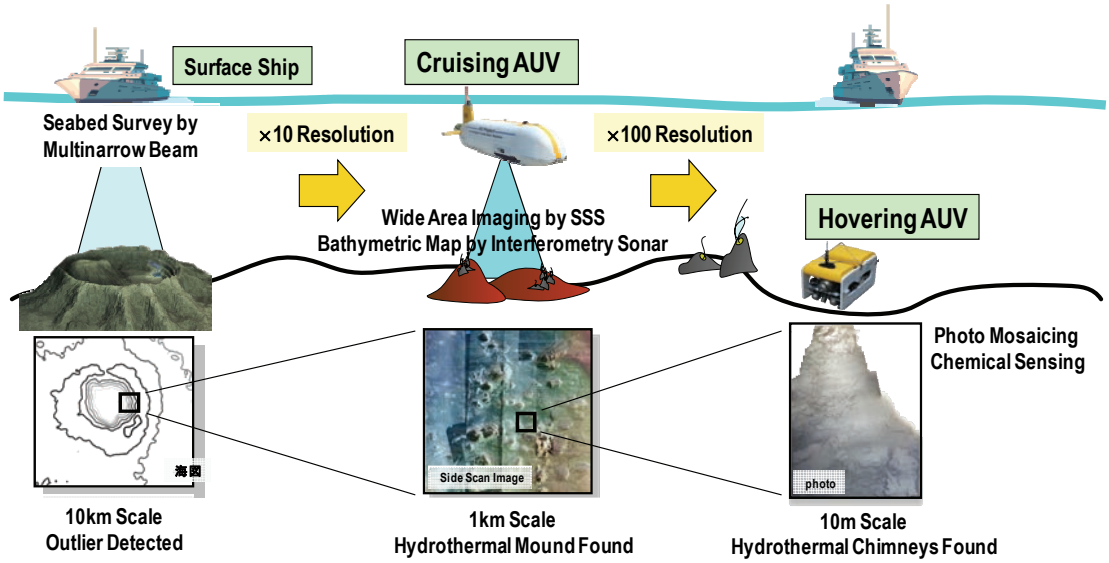

Fig. 2.1 Cooperative undersea survey by multiple heterogeneous AUVs.

2.3 Instruments

2.3.1 Cruising AUV Aqua-Explorer 2000a

Aqua-Explorer 2000a (AE2000a) is an evolved version of the Aqua-Explorer 2000 originally designed and constructed for the undersea cable inspection. By means of the full remodeling and redesign, AE2000a has been completed on November 2011. AE2000a is a small cruising AUV capable of working at the maximum depth of 2000 m from the surface. Overall feature of AE 2000a is shown in Fig. 2.2. Length, breadth, and height of AE 2000 are 3.0 m, 0.7 m, and 0.7 m, respectively. Total mass of it in air is 300 kg. Nominal and maximum cruising speeds of AE 2000 are 2.0 and 2.8 kts, respectively.

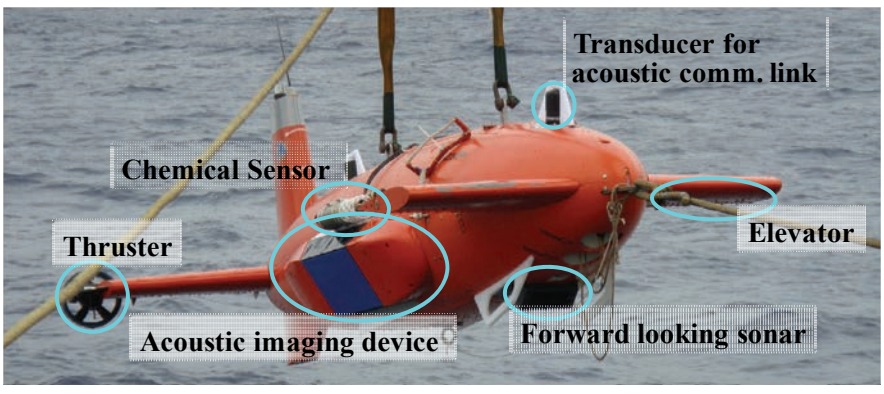

Fig. 2.2 Overall feature of Aqua-Explorer 2000a.

2.3.2 Hovering AUV Tuna-Sand

Tuna-Sand (TS) is a hovering AUV developed for the visual investigation of the seafloor features. Figures 2.3 show the general arrangement of TS.

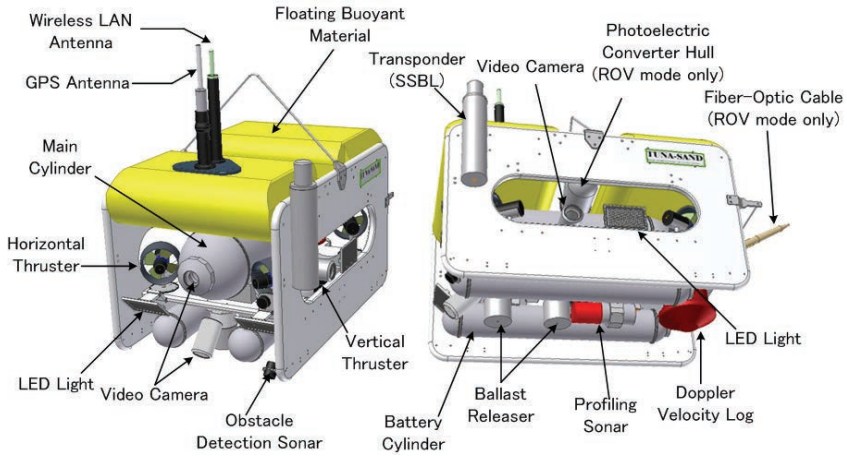

Fig. 2.3 General arrangement of Tuna-Sand.

2.4 Survey Results

Figure 2.4 shows the high-resolution bathymetry map and SSS image of the No.04 Yonaguni knoll site, taken during the AE dive #01. With the help of the fully automated vehicle operation based on the highly stable attitude control, considerably fine seabed images were obtained. By investigating these images, we could identify the potential locations where the unknown new hydrothermal vent exists.

AE dive #04 was conducted in the Izena Caldron (Fig. 1.1), known as one of the most active undersea hydrothermal sites in Japanese waters. During the dive, chemical sensor installed on AE2000a detected clear anomalies in pH and turbidity which are believed to come from the plumes issued from a hydrothermal vent of strong activity.

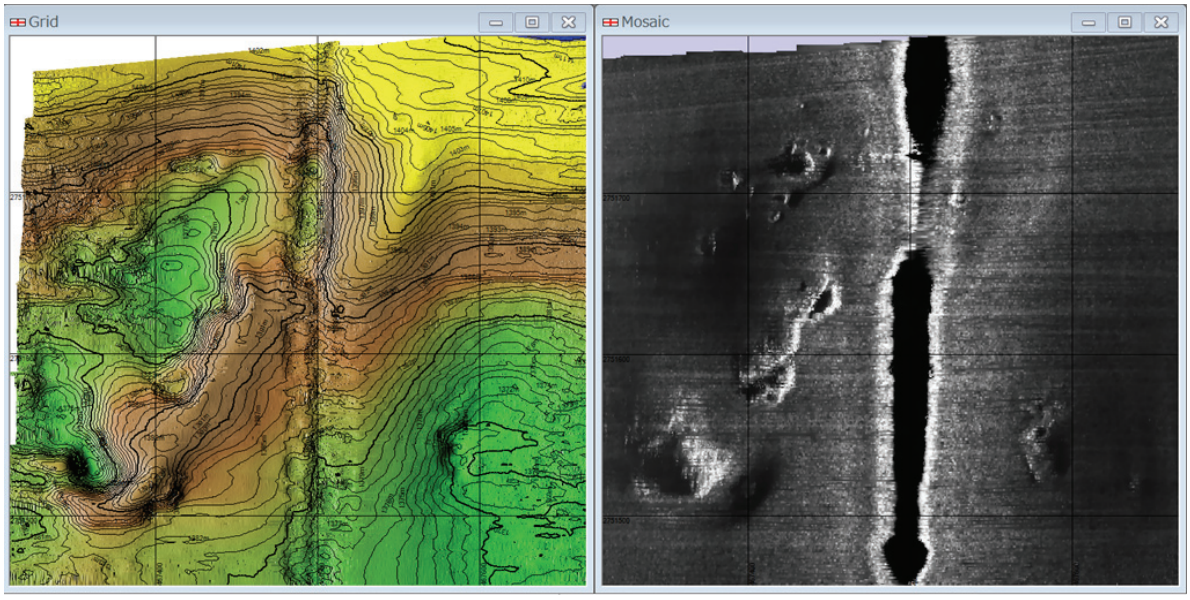

Fig. 2.4 Bathymetry map (left) and side scan sonar image taken during AE 2000 dive #01.