Cruise Summary YK09-09

1. Cruise information

Cruise number	YK09-09
Ship name	R/V YOKOSUKA, Deep-tow and AUV URASHIMA
Chief scientist	Takafumi Kasaya (IFREE, JAMSTEC)
Proposal title 1	Research for the fluid distribution around the spray fault using the control source EM method (T. Kasaya)
Proposal title 2	Test of high precision magnetometer by deep-tow system and Autonomous Underwater Vehicle Urashima (K. Sayanagi)
Date	19 July 2009 – 29 July 2009
Ports of call	Wakayama port – Yokosuka(JAMSTEC)
Research Area	Kumano trough, off Kii peninsula (Fig.1)

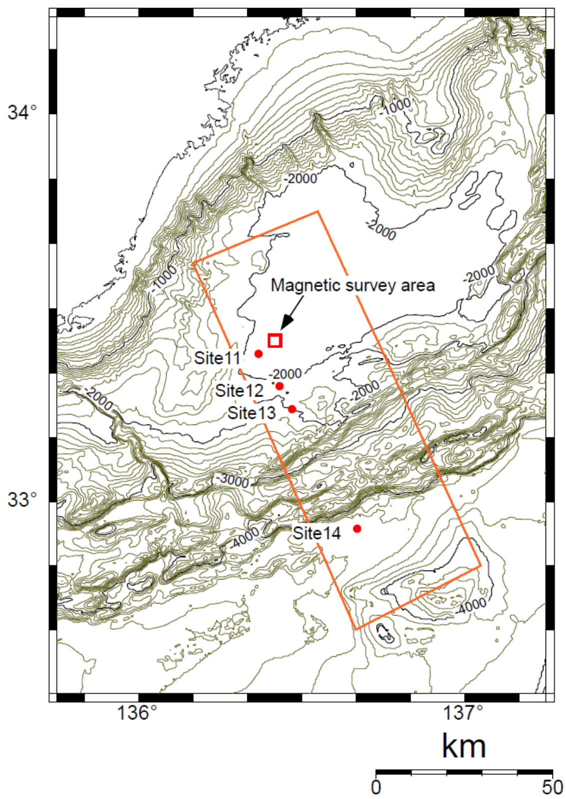

Fig.1 Research area of YK09-09 cruise. Red circles show OBEM positions. The towed electro-magnetic survey was conducted around Site11. A red square shows the magnetic survey area used by an AUV URASHIMA and Deep-tow.

2. Overview

2.1 Research for the fluid distribution around the spray fault using the control source EM method

Background and Objectives

The electro-magnetic survey method is an important technology to obtain the subsurface structure using resistivity. We carried out the EM survey around the mega-thrust earthquake zone, and obtained the resistivity image of the crust and upper mantle. Natural magnetic fields are attenuated by electrically conductive water. Therefore, it is difficult for magneto-telluric method to obtain the shallow structure in the deep sea. The control source EM method is very suitable to detect the shallow structure. Kumano area is over a water depth of 2000m, and there is a strong sea current. It is important matter to establish the technique of the towing survey tool.

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Outline of this survey

We use the towed DC resistivity survey system (Goto et al., 2008), called MANTA for the control source EM survey. Figure 2 shows the image of the control source EM survey. Two transponders were set up at the deep-tow system and the tail of a towed electrode cable to detect the position of them. The length of electrode cable is about 170 m. Four OBEMs were deployed for the receiver of the control source EM survey and the MT survey in Kumano area (see Fig.1). Field test of the control source EM survey was carried out around the Site 11. Two OBEMs at Site11 and 12 were recovered on this cruise.

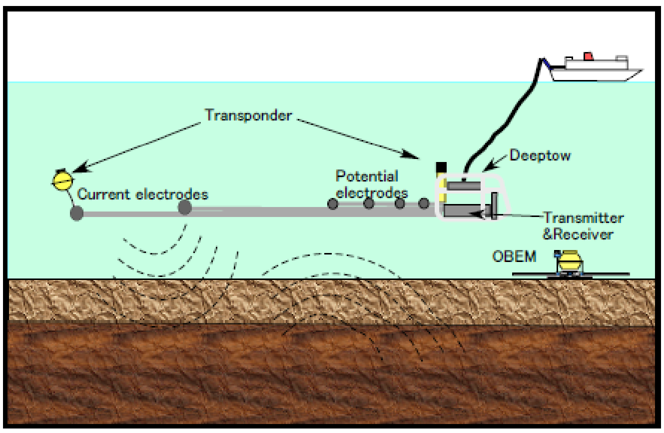

Fig.2 Survey image of the electro-magnetic survey.

Preliminary Results

Deployment of OBEMs was conducted at four sites (Fig.1). After deployment, acoustic measurement at each site was also carried out to settle the landing position of OBEM. Two OBEMs at Site11 and 12 were recovered on this cruise. Each recovered OBEM had a good quality EM data.

Field test of MANTA was carried out from 23th July to 26th July. As the result of the first dive, the wave form of the receiver was disturbed by high frequency noise. It is estimated that this noise is caused by the failure of receiver electric circuit. Therefore, we decided to conduct this field test around site 11. This circuit failure was already fixed after this cruise. Figure 3 shows the position of the deep-tow and the tail of towed electrode cable detected by SSBL (see Fig.2). Blue and red symbol shows the position of a deep-tow and a towed electrode cable, respectively. This figure presents that towing posture is very stable, even if the black current (Kuroshio) is over 3 knot. EM signal recorded by OBEM (Site11) was very clear. Analyzing these EM data, we will update the resistivity image around the Kumano area. The towing operation is generally of no matter. Because of the strong sea current, breaking of electrical cable occurred at the recovery operation of the electrode cable. We need to improve a towing electrode cable.

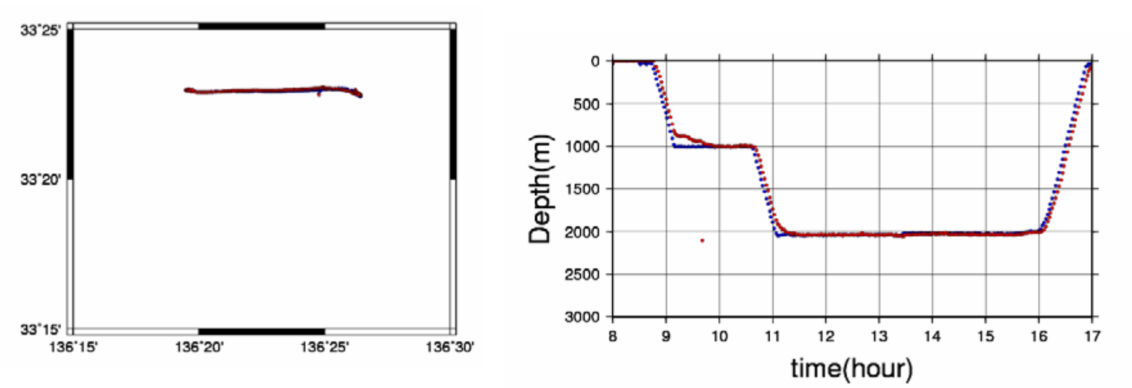

Fig.3 A deep-tow and a towed electrode cable position data deduced by SSBL system. Left panel is the horizontal projection, and right panel is the vertical one. Blue and red symbol shows the position of a deep-tow and a towed electrode cable, respectively.

2.2 Test of high precision magnetometer by deep-tow system and Autonomous Underwater Vehicle Urashima

Background and Objectives

Recently, sea-floor hydrothermal deposits including valuable metals like copper, lead, zinc, gold, silver, germanium have again become a subject of special interest in the world through intensifying competition of resource development for a stable supply of the resources. It is, however, difficult to develop the sea-floor hydrothermal deposits because there is no established method to estimate accurate abundance of them. Conventional marine (sea surface) geophysical explorations do not have enough resolution, and an exploratory drilling needs much time and money. Thus, new technology of geophysical exploration near the sea floor is required in order to discover and estimate the resources precisely. With these points as a background, a development program of fundamental tools for exploration of deep seabed resources was started in 2008 with financial support of the Ministry of Education, Culture, Sports, Science and Technology (MEXT). As a part of the program, we have developed new measurement systems for electrical and magnetic explorations by Autonomous Underwater Vehicle (AUV), Remotely Operated Vehicle (ROV) and deep-tow system.

Outline of the magnetic survey test

During this cruise, we carried out performance tests of a magnetic exploration system under development by "Yokosuka Deep-Tow" and AUV "Urashima" in the Kumano Basin area (water depth: 2000m). The tests contained 2 dives by the AUV on July 20 and 21, and 2 dives by the deep-tow system on July 27 and 28. Each dive had 6 to 9 hours. Figure 4 shows the configuration of the tests. The magnetic exploration system consists of two flux-gate magnetometers and an overhauser magnetometer. The flux-gate magnetometers were attached to the inside of the frame of the AUV or the deep-tow system. The overhauser magnetometer was mounted on the back of the AUV or suspended from the deep-tow system. The AUV or the deep-tow system moved 5 to 40 m above an artificial magnetic target while measuring the magnetic field.

In these tests, the flux-gate magnetometer on the AUV and the overhauser magnetometer of the deep-tow system clearly recorded expected magnetic anomalies caused by the magnetic target. The overhauser magnetometer on the AUV could, however, not measure the magnetic field, because the gradient of the ambient field was probably too large due to inappropriate position of the magnetometer. Although the flux-gate magnetometer on the deep-tow system detected the magnetic anomalies, they were not clear and noisy compared with those in the case of the AUV. The noise possibly arose from the following causes: (a) the power supply and (b) the induced magnetic field of the frame made of iron. Since the amplitude of the magnetic anomalies depend on a distance between the magnetometer and the magnetic target, it is necessary to determine positions of the AUV, the deep-tow system and the magnetic target for further discussion. From these tests, we could successfully obtain basic data for the measurement of our magnetic exploration system by the AUV and the deep-tow system. The results indicate that the system can be basically operated by the AUV and the deep-tow system with expected performance and practicality. We will improve the accuracy of measurement by fully analyzing the noise of data in future.

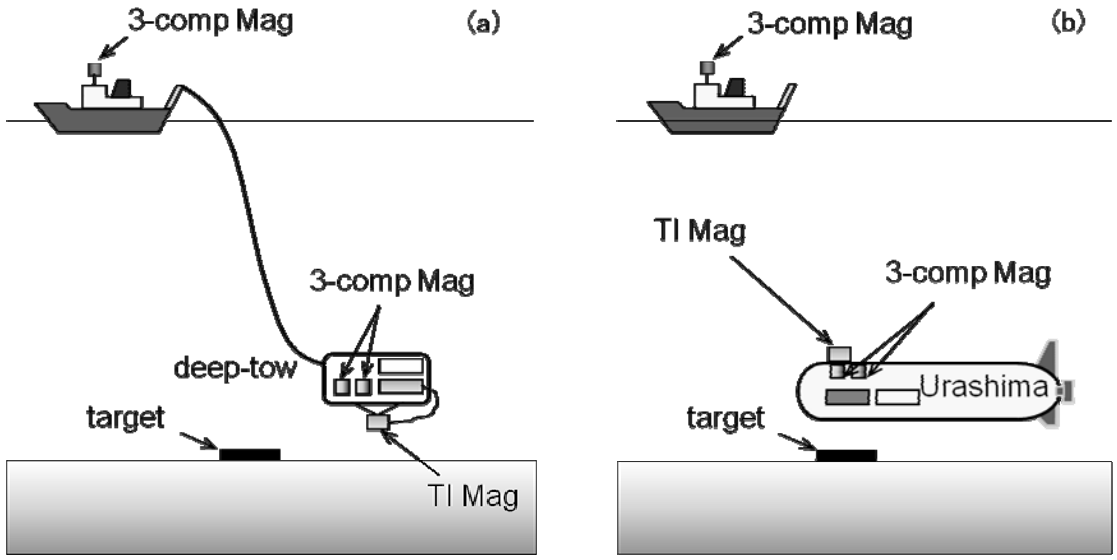

Fig. 4 A performance test of a magnetic exploration system using Yokosuka deep-tow (a) AUV Urashima (b) and a during the R/V Yokosuka YK09-09 cruise. 3-comp Mag: 3-component magnetometer, TI Mag: total intensity magnetometer.