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Development of electrical and magnetic exploration tools for seabed resources: tests using ROV, AUV and deep-tow system

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Sea-floor hydrothermal deposits including copper, lead, zinc, gold, silver, germanium etc. have recently focused renewed attention behind rapid changes in the international situation for natural resources (e.g., increased competition of resources development) in order to maintain a stable supply of the resources. It is, however, difficult to estimate accurate abundance of those resources. Conventional investigations of the sea-floor hydrothermal deposits are geophysical surveys on the sea and a sea-floor drilling. The former could not give sufficient information for estimation of the sea-floor hydrothermal deposits with a resolution of several to several tens meters, because they usually exist at a depth of 500 m to 3,000 m. The latter needs much time and labor, and does not always reach the bottom of the deposit. The most promising solution to those problems is considered to be geophysical surveys near the sea floor. With these points as a background, a development program of fundamental tools for exploration of deep seabed resources was started with the financial support of the Ministry of Education, Culture, Sports, Science & Technology (MEXT) in 2008. Our project has carried out as a part of the program. In this project, we are developing new electrical and magnetic exploration tools for sea floor resources using AUV (Autonomous Underwater Vehicle), ROV (Remotely Operated Vehicle), and deep-tow system in order to estimate sea-floor structure precisely.
The magnetic exploration system contains three-component magnetometers and total intensity magnetometers. The main features of the system are measurement of three components, total intensity and gradient of the magnetic field with high resolution and high sampling rate, and a versatile system that are available on multi-platforms like AUV and deep-tow system. The electrical exploration system consists of a transmitter and receivers. The latter ones have an on-line type that is connected to the transmitter through a cable and an off-line type that is independently deployed on the sea-floor. The transmitter and the on-line type receiver are mounted on the ROV, and the cables with current and potentiometric electrodes are towed behind the ROV. Those two types of receivers can provide information on a shallower part (a few meters) to a deeper part (100-200m) of the sea-floor. In addition, the ROV supplies stable power (2kW), and it allows us to monitor data of the transmitter and the receiver on board.
The present stage of the development has been tests of basic performance for each exploration system after manufacturing a prototype one. The magnetic exploration system was tested in the Kumano Basin during the R/V Yokosuka cruise in July, 2009, and above Aogashima volcano in October, 2009. AUV "Urashima" and towing vehicle "Yokosuka Deep-Tow" (both are JAMSTEC vehicles) were used in the former test, and a helicopter (Nakanihon Air Service) was done in the latter one. The electrical exploration system was tested off Miho in Suruga Bay in September and December, 2009, and in Japan trench during the R/V Kairei cruise in November, 2009. The R/V Hokuto of Tokai University was used in the first and second tests, and ROV "Kaiko 7000II" was used in the last one. These tests gave us basic data of the systems for the platforms and the confirmation of their performance. We will introduce the present state of the development

centered on the outline of the tests. Details of the tests will be reported in other papers by Isezaki et al. and Harada, M. et al. in this meeting.

Keywords: seabed resources, sea-floor hydrothermal deposits, geophysical exploration, electrical, magnetic, instruments