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Development of marine magnetic vector measurement system using AUV and deep-towed vehicle

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Marine magnetic survey is one of useful methods in order to investigate the nature of the oceanic crust. Most of the data are, however, intensity of the geomagnetic field without its direction. Therefore we cannot properly apply a physical formula describing the relation between magnetic field and magnetization to analyses of the data. With this problem, Isezaki (1986) developed a shipboard three-component magnetometer which measures the geomagnetic vector at the sea. On the other hand, geophysical surveys near the seafloor have been more and more necessary in order to show the details of the oceanic crust. For instance, development of seabed resources like hydrothermal deposits needs higher resolution surveys compared with conventional surveys at the sea for accurate estimation of abundance of the resources. From these viewpoints, we have been developing a measurement system of the deep-sea geomagnetic vector using AUV and deep-towed vehicle.

The measurement system consists of two 3-axis flux-gate magnetometers, an Overhauser magnetometer, an optical fiber gyro, a main unit (control, communication, recording), and an onboard unit. These devices except for the onboard unit are installed in pressure cases (depth limit: 6000m). Thus this measurement system can measure three components and intensity of the geomagnetic field in the deep-sea.

In 2009, the first test of the measurement system was carried out in the Kumano Basin using AUV Urashima and towing vehicle Yokosuka Deep-Tow during the R/V Yokosuka YK09-09 cruise. In this test, we sank a small magnetic target to the seafloor, and examined how the system worked. As a result, we successfully detected magnetic anomaly of the target to confirm the expected performance of that in the sea.

In 2010, the measurement system was tested in the Bayonnaise Knoll area both using a titanium towing frame during the R/V Bosei-maru cruise and using AUV Urashima during the R/V Yokosuka YK10-17 cruise. The purpose of these tests was to evaluate the performance of the system in an actual hydrothermal deposit area for practical applications of that. The Bayonnaise Knoll is a submarine caldera with an outer rim of 2.5-3 km and a floor of 840-920 m, which is located in the Izu-Ogasawara arc. A large hydrothermal deposit, Hakurei deposit lies in the southeast part of the caldera. In the R/V Bosei-maru cruise, we observed three components of magnetic anomalies at depths of 400-570 m along SE-NW and WE tracks across the caldera. In the R/V Yokosuka YK10-17 cruise, we observed three components and intensity of magnetic anomalies at altitudes of 60-100 m around the Hakurei deposit and at depth of 500 m above the caldera.

From these tests, we have succeeded in measuring the geomagnetic vector and intensity using the AUV and the deep-towed vehicle, and also have obtained detailed magnetic anomaly in the Hakurei deposit area. We will here present the outlines of the measurement system and the tests in the sea. Note that this study has been supported by the Ministry of Education, Culture, Sports, Science & Technology (MEXT).