磁気および電気探査による海底熱水鉱床の検出可能性

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Modeling of electric and magnetic field anomalies for the exploration of seabed resources

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Recent geophysical studies have revealed that huge amount of mineral and energy resources may be buried in the exclusive economic zone (EEZ) of Japan. To realize the commercial mining of these resources, detailed information on subsurface structure under seafloor is necessary for the estimation of seabed resources. Although advantages of geophysical exploration near seafloor are expected for the seabed resource survey, efficient method has not been well-established.

The authors started a project to develop exploration tools for seabed resources under the financial support of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan (Sayanagi et al., 2008). In this project, we carry out research and development mainly regarding measurement of the magnetic field with high-resolution and high sampling rate electric exploration device with accurately controlled active source signals. Developed tools will be mounted on the underwater platforms such as deep-tow system, ROV (remotely operated vehicle), and AUV (automated underwater vehicle).

To detect the seabed resource precisely, we should investigate the optimum specification of sensors and their effective operation methods. We study the feasibility of the detection of underground magnetically and electrically anomalous bodies by using forward modeling algorithms (Bhattacharyya, 1964; Spitzer, 1995). We test for the cases of shallow (depth ~20m) and deep (depth ~100m) bodies, of which shape are assumed as prism. In the test, we change parameters such as size, magnetization and conductivity of the anomalous body, and calculated the three-dimensional distribution of electric and magnetic field anomalies.

The results of magnetic field indicate that the amplitude of magnetic anomaly decreases rapidly with height from the seafloor. Expected amplitude at a height of 10 m is 1/3 of those at seafloor, therefore, 'How to navigate underwater robot near the sea bottom?' should be very important problem for our subject. Deep-tow system has been applied to map geophysical parameters over a very wide area. They are generally towed with keeping at height of greater than several tens meters to avoid running into a mound. Other underwater vehicles such as ROV and AUV can be navigated near the sea bottom, on the other side the effect of noise from vehicle must be large. In this case, development of a method to remove such noise component becomes important problem. To evaluate the spatial resolution of the detected magnetic prism, we have to check whether the original shape, magnetization, and other features are reconstructed by using an inversion technique. Variation of the density of the measurement points in the two- and three-dimensional space may affect the resolution of the detected body. This probably corresponds to the sampling frequency of the magnetic field, height from the bottom and velocity of the vehicle. These studies may provide us the information on the optimum specification and operation of the tools to detect the target bodies with desired resolution.

References

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