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論文題目	Development of Resource Evaluation Technology by Integration of Geophysical Exploration Data and Rock Physics（物理探査データと岩石物理学の統合による資源評価技術の開発）		

（論文内容の要旨）

In recent years, seafloor massive sulfide (SMS) deposits have been attracting attention from the viewpoint of metal resource development. For the development, detailed information on the scale and grade of deposits is required and also, it is urgent to establish advanced survey and exploration methods. At present, a wide area survey by geophysical exploration is underway in seafloor hydrothermal vent areas. However, the information obtained by geophysical exploration is limited to several physical properties, and the shape of the seafloor hydrothermal deposit, especially the scale in the depth direction (thickness of the deposit), and metal grade distribution have not yet been sufficiently clarified. The current situation is that geophysical exploration alone cannot reach the stage of resource quantity evaluation. On the other hand, drilling surveys that can directly obtain information on materials under the seafloor are expensive, and the core recovery rate of subseafloor drilling is generally low.

This PhD dissertation aims to develop technology that acts as a ‘bridge’ between rock physical properties and metal-resource distribution on and beneath the seafloor. For this purpose, rock samples were obtained in a seafloor hydrothermal activity area at the middle Okinawa Trough, and their physical properties and chemical components were measured and analyzed by several methods. For evaluating the metal resource compositions, the electromagnetic properties of the rocks containing sulfide minerals were mainly targeted. The physical formula that links the electromagnetic properties of rocks and the content of sulfide minerals were newly constructed by this study. The rock electromagnetic model of the preceding studies and the rock model of this study were compared with the measured data to verify the consistency. Quantification of the base-metal amounts through applying the developed rock model to the cross-sectional area of electrical conductivity structure obtained by a geophysical exploration, seafloor electric survey, conducted in the seafloor hydrothermal activity area was implemented.

Chapter 1 is an introduction to summarize the content of this research with an overview of preceding, unsolved problems, and motivation for understanding the rock physics and chemical compositions of the deposits.

Chapter 2 is a review of previous studies that consists of geology of SMS deposits, physical explorations, and physical properties of sulfide minerals.

Chapter 3 provides a new measurement protocol and various measurement data with high value. Despite global demand of clarification and development of seafloor mineral deposits, the physical properties and chemical composition of massive sulfide ore are very complicated and it is not realistic to simplify the correlation between the physical properties

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and the chemical composition. From the characteristics of the physical properties and components of the rock samples obtained, this study revealed that it is appropriate to treat them as rocks in areas where hydrothermal activity occurs on the seafloor, especially in areas where hydrothermal alteration is actively generated. No effective law was found between the electrical conductivity, which was expected to have the highest correlation, and the metal element content. This is because the electrical conductivity is a secondary physical quantity calculated from various factors.

Chapter 4 provides the newly constructed rock physics model which combines electrical conductivity and metal-related properties. The models of previous studies were inadequate for the purpose of fully explaining the physical properties of rock samples obtained from the seafloor hydrothermal activity areas and accurately predicting their metal composition. This chapter proposed a new rock physics model for the conductivity of rocks by effectively integrating the two types of physical models constructed by previous studies. Not only did this new model reproduce the measured electrical conductivity well, but also a clear positive correlation was found between one of the parameters of the new model and the concentration of metal elements contained in the rocks.

Chapter 5 develops a new estimation technology for metal resources and suggested the existence of subseafloor metal resources. The total amount of base metals in the Iheya North hydrothermal activity area was estimated from the results of seafloor electric survey by assuming various lithology and thermal structure of the seafloor geology and giving various parameters to the rock physics model. Consequently, this study succeeded in suggesting and quantifying the existence of sulfide deposits under the seafloor by theoretical physical analysis.

Finally, Chapter 6 summarizes the concluding remarks, including the most important results from each chapter. Besides, essential future works to metal resources exploration researches are proposed.