Relationship between Resistivity Characteristics and Mineral Species of Rock Samples in the Seafloor Hydrothermal Area

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Geophysical surveys around seafloor hydrothermal areas are conducted for the purpose of metal resources development. However, the information from geophysical survey is limited so that new technology developments are necessary for quantitative interpretation of grade and spatial distribution of mineral resources. To solve this problem, rock physics model incorporating correlations of physical properties and chemical composition of target area is helpful. This is known as concept of multidisciplinary analysis based on the rock physics (e.g., Suzuki, 2013) that estimate geological information hardly obtained only from the physical properties. In this research, we measured and analyzed both physical properties and chemical composition of the rock samples obtained from seafloor hydrothermal areas. Based on them, we suggest a rock physics model, useful for our final goal; evaluation of amount of mineral resource by combined analysis of geophysical explorations.
The rock physics model constructed in this research gives the predicted resistivity of rock based on assumption of porosity and other parameters. The reason why we focus on resistivity comes from the previous researches that resistivity structure is useful for the investigation of metal resources in the seafloor hydrothermal area (e.g. Kowalczyk, 2008). Moreover, it is known that sulfide minerals such as pyrite (abbreviated in seafloor hydrothermal area) are exerting high electrical conductivity.
In order to construct an appropriate model, it is necessary to clarify the physical and chemical characteristics of the rock sample. Therefore we first measured several physical properties and analyzed the chemical composition of rock samples obtained from the Noho-site, Izena Caldron and Iheya North Knoll known as seafloor hydrothermal area in the Okinawa Trough, Japan. The measurement properties are resistivity, porosity, grain density, natural remnant magnetization, together with metal element content. Particularly in the measurement of resistivity, in order to reveal the formation factors and electrical conduction of solid rock matrix, we conducted resistivity measurements with changing concentrations of NaCl solution in pore water (such as in Suzuki, 2003). After these measurement and analysis, we applied our new model to determine the each parameter of the model.
As a result, obvious correlation was confirmed between each parameter of our new model and the specific chemical elements of rock samples. This suggests that the model constructed in this study is useful to extract chemical information such as mineral species from physical properties such as resistivity. In the future, we will develop this detailed resistivity model, then quantitatively incorporate other physical properties and chemical composition for further discussion.

Keywords: seafloor massive sulfides, Archie's law, electrical conductivity, rock physics model

