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# Joint Inversion of geophysical data around submarine hydrothermal deposits based on core samples

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Seafloor massive sulphides (SMS) around seafloor hydrothermal active zone are attractive due to the general growth trend of global economical activities. Since the SMS is located below the deep seafloor, which restricts a number of boreholes for land-based mineral explorations, deep seafloor geophysical surveys (e.g., electromagnetic, magnetic, gravity and seismic surveys) are conducted to image the detailed distribution of SMS below seafloor. However, the complicated lithological structure around SMS interrupts the good interpretation of sub-seafloor structure by using sole geophysical technique. For example, low resistivity value is expected for SMS (e.g., [1]), but the evaluation of amount of metal deposits is not enough only from the resistivity structure.

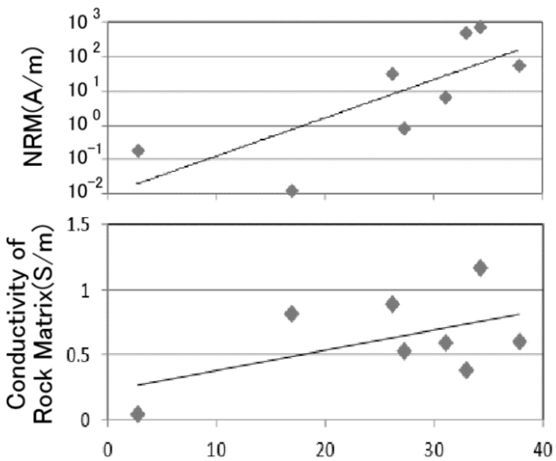


Fig.1. Relationship between Physical and chemical analysis of SMS samples

Joint inversion of multiple geophysical dataset can be a candidate to overcome the difficulty and to obtain the better interpretations related to the lithology. Such a new technique is widely applied to the real geophysical dataset. For example, on land, joint inversions using geostatistical method of multiple data sets have been proposed to estimate the major lithological properties of rocks (e.g., Bosch, 1999). Joint inversions using a cross-gradient function which measures structural similarity (Fregoso et al., 2009) increase the accuracy and resolution of three-dimensional (3D) geophysical models.

In this study, we try to include the physical properties (and amount of metal deposits) obtained from laboratory experiment using rock core samples to add better constraint to the joint inversion. The rock samples of SMS were obtained by ROV and submersible exploration around the hydrothermal active areas in the Okinawa Trough, Japan. From 21 core samples, resistivity, density, porosity, natural remanent magnetization (NRM) are measured. The chemical components are obtained by X-ray fluorescence (XRF) analysis. The result indicates a correlation between resistivity, NRM and concentration of metal (e.g. Fig.1). We conclude that the higher conductivity of rock matrix and higher NRM are possibly relates to the high metal contents and can be a good index for mineral deposits.

Based on the laboratory measurements, we carried out the 3D joint inversion to estimate the reasonable geological structures. Our method is based on the fuzzy c-means clustering technique [4]. Two different physical parameters such as resistivity and magnetization can be modelled simultaneously with guide of known (initial) end-members of parameters. The inversion solves the unknown physical parameters, which should have values near or between the end-members. We applied the method to a real dataset obtained around a SMS in the Okinawa Trough, Japan. The joint inversion results show better accuracy and resolution than the individual inversions. Thus, the combination of laboratory data and joint inversion of geophysical survey becomes a powerful tool for more reliable evaluation of mineral deposits below the seafloor.

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