

Two-Dimensional Inversion of Marine DC Resistivity Survey using FCM Clustering Constraint

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SMS (Seafloor Massive Sulfide) deposits, including rare and precious metals, have been often found in the vicinity of hydrothermal active areas: for example in the Okinawa Trough, Izu-Bonin arc, and Azores triple junction in the mid-Atlantic ridge. Geophysical explorations with electromagnetic (EM) methods are recently carried out around the SMS deposits in Papua New Guinea because the SMS deposits are known as low resistivity material. The resistivity distribution below the seafloor can be a good indicator for the buried SMS deposits. However, the resistivity structure below hydrothermal active areas has not been clearly investigated. In this study, we developed a 2D inversion of a marine deep-towed DC resistivity survey as an effective tool to the exploration of SMS deposits. The finite-difference method is applied in the forward modeling calculation to solve potential difference between the electrodes at the electric current injection to the seawater. The real distributions of SMS deposits are concentrated at narrow (thin) zones. Therefore, we add a guided Fuzzy C-Means (FCM) clustering constraint into the objective function in the inversion procedure in order to obtain sharp-change of resistivity matching the petrophysical information. Although the two balance parameters in this objective function should be controlled in the inversion, the optimal ways to adjust these parameters have not been proposed. Therefore, we propose an algorithm to choose these parameters properly. The new algorithm is based on the two stages; the first stage with the ordinary Occam scheme, then the second stage with the FCM clustering constraint where the inverted model in the first stage is used as the initial model in the second stage. The other parameters are decided with the searching scheme. The refined inversion results show that the inversion can produce sharp boundaries in resistivity structure, which can also handle with the realistic petrophysical information. Finally, we applied the inversion code to the field data obtained at the Okinawa Trough; the inverted resistivity anomalies are consistent with the known geological investigations of hydrothermal fluid flows and the observed distributions of seafloor venting sites.