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FCM クラスタリングを用いた重力・磁気探査データのジョイントインバージョン
Three-dimensional joint inversion of gravity and magnetic anomalies using fuzzy c-means clustering

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The gravity and magnetic surveys have been widely carried out over the years, especially for the exploration of metallic mineral deposits and geothermal resources. These intensity data of gravity and magnetic fields could be acquired in much quicker and simpler ways than the other geophysical or geological surveys. The inversion of such potential field data, however, has been known as a non-uniqueness problem expressed in the Green's equivalent layer theory. Because of this problem, gravity and magnetic data have no inherent resolution in depth. We, therefore, would like to develop a way to make use of high exploration efficiency that takes the advantages of the convenience to conduct gravity and magnetic surveys.

We present a 3D joint inversion method to estimate two physical parameters, density and magnetization of subsurface materials. In the method, we introduce the fuzzy c-means (FCM) clustering technique in our joint inversion algorithm to consider the petrophysical relation between density and magnetization of subsurface materials. The fuzzy c-means clustering technique we introduce does not necessitate any empirical equations but deals with a linear combination of the influence from multiple clusters given a piece of data to belong to plural clusters in the parameter space formed by the petrophysical parameters. Adding the simple FCM clustering scheme, we introduced the smoothness constraint to a weight for membership to each clusters, instead of the conventional smoothness constraint to model parameters. Numerical studies using synthetic data indicate the effectiveness of FCM clustering in the joint inversion: the joint inversion results using gravity and magnetic data sets show higher accuracy and resolution than the individual ones.

As the field example, we focus on submarine volcanoes located at Mozambique Channel, because the world-class gas fields were discovered around that area and it is necessitated to estimate structure of submarine volcanoes near gas fields. We apply our inversion method to the real field gravity and magnetic data of the submarine volcanoes at Mozambique Channel. We conclude that our joint inversion method gives the reliable and detailed density/magnetization structures inside the submarine volcanoes in term s of the gravity and magnetic anomalies.

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