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Aeromagnetic 3D subsurface imaging and its application to the data of Otoge Cauldron, Shitara area, Central Japan

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In survey methods using potential field such as in aeromagnetics, there is a theoretical difficulty of non-unique source solution for the observation, whereas data includes structural information of wide depth range. In order to overcome this difficulty, the analysis methods with any structural regularization have been developed, and the validity of the strategic regularization would be a primary concern in practice.

We have developed a software of aeromagnetic 3D subsurface imaging, which is applicable to helicopter-borne magnetic (total force) surveys in mountainous regions, and based on the compact regularization to constrain source magnetization succeeding the idea developed by Last and Kubik (1983), Portniaguine and Zhdanov (2002). Our method accepts the surface undulation and variable thickness slicing of model layers, and the regularization criterion of minimum effective source volume is adopted.

The software was first applied to synthetic and geologic models to evaluate its characteristic ability of recovering source structure and to examine the efficiency of the method. In spite of the intrinsic difficulty of the non-unique problem, the results revealed that good recovery of subsurface image can be achieved by a proper choice of trade-off parameter to assure the compactness, and it was proven that the compact regularization is useful to interpret magnetic anomaly data in terms of 3D source configuration.

The helicopter-borne magnetic survey data in the Shitara area was put into analysis by this 3D imaging software. The geology of Shitara area is characterized by middle Miocene Otoge and Shitara igneous complexes, the Otoge Cauldron structure with stock, and post-cauldron intrusions of dike swarms (Otoge cone sheets and Shitara central dike swarm). The 3D imaging analysis of magnetic anomalies revealed the magnetization structure (to the depth of 3000m) of the magma reservoir of Otoge Cauldron, the Otoge cone sheets, and Otoge stock, to be consistent with existing studies from surface geology.

キーワード: aeromagnetic, 3D imaging, compact inversion, source volume minimization, helicopter survey, Otoge Cauldron
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