Petrophysical-based constrained and joint inversions of magnetotelluric (MT) and gravity data-sets on unstructured tetrahedral meshes

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SUMMARY

Geophysical inverse problems can identify significant subsurface features by the means of measured physical quantities such as gravity, magnetic, electric, and electromagnetic (EM) fields. The minimum-structure algorithm, or Occam's style, is one of the most common inversion methods that has been extensively employed for the inversion of geophysical data due to its robustness and reliability. This method can be adapted and extended in many ways. Perhaps the two most important of which are constrained and joint inversion methods, and on which this study focusses. The geophysical Earth models constructed from multiple, complementary geophysical survey types or constrained independent inversions are more likely to represent the true subsurface than a model constructed from an independent unconstrained inversion.

Joint inversion methods can be divided into two main types, structural-based and petrophysical-based joint inversion methods, depending on the type of coupling measure used between physical property models. This study develops a joint MT and gravity inversion methodology based on a petrophysical-based approach. Petrophysical-based joint inversions result in a less challenging, although not easy, optimization problem compared with the structural-based approaches. The fuzzy *c*-means clustering technique (FCM) is the petrophysical-based joint inversion method that this studying uses as a coupling measure. Also, independent constrained MT and gravity inversions using the FCM method are compared with the joint inversion results.

The capability of the joint and constrained MT and gravity inversions are investigated using synthetic and real-data examples. The conductivity and density models constructed by the clustering method represent a reasonable definition of the anomaly's boundaries and a reasonable range of the recovered physical property values of the true model compared to the models constructed by the independent MT and gravity inversions.

Keywords: Constrained inversion, Gravity method, Joint inversion, Magnetotelluric method