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Triangular grid-based common inversion framework for different geophysical data to improve subsurface imaging

Vishnu Kant Verma and Anand Singh
IIT Bombay, Indian Institute of Technology Bombay, Mumbai, India (vishnu.kant.verma1@gmail.com)

A Geophysical model (subsurface imaging) is built up by a combination of many units that reflect the distribution of a certain physical property in the earth subsurface. The physical property can be any type like density, magnetic susceptibility, velocity, resistivity, or other properties. All the quantities which describe a geophysical model are termed as 'model parameters.' A geophysical model should explain the set of measurements recorded on the earth's surface to understand the subsurface structures. The set of all measurements is termed as 'data vector.' The present work deals with the inversion procedure to obtain a reliable model from the measured data sets. Regular grid discretization is an obstacle to define complex geological models and topography as well. In this context complex geological model can be generated through a triangular grid. Also, any type of complex geological model can be represented using triangular grids, which are difficult using a common discretization approach. In the present work, we have used Delaunay triangulation to discretize the subsurface to overcomes the problems encountered by the regular grid discretization. We have coded our forward formulation in such a way that multiple geophysical datasets can be generated on the same setup. Further, we have developed a common inversion framework to handle many geophysical datasets like Gravity, Magnetic, and VLF EM methods. This framework is utilizing the optimization scheme of the Conjugate Gradient Method. Since potential field anomalies decay with increasing depth of source, we have provided preconditioning to our kernel matrix to counteract the decay effect. We also noted that the preconditioned conjugate gradient method effectively deals with large matrices as it reduces the storage space and computation time. We demonstrated the developed approach using synthetic and real field data sets.

Keywords: Gravity, Magnetic, VLF EM, Geophysical inversion**;** Subsurface discretization, Delaunay triangulation, Preconditioned Conjugate Gradient method