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A 3-D gravity inversion tool based on exploration of model possibilities☆

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Abstract

A computational tool for the development and implementation of a recently published method of 3-D (three dimensional) inversion for gravity data is presented. This method seeks to determine the geometry of an indefinite number of anomalous bodies with prescribed (fixed or variable) density contrasts, positive and negative values being indiscriminately accepted in the model. The approach is based on a prismatic partition of the subsurface and attempts to determine the anomalous bodies by means of a "growth" sequence, analysing (systematically or randomly) the several model possibilities and from that choosing the best for the growth progress. Moreover, a regional trend for the gravity data can be simultaneously adjusted. The non-uniqueness of the gravity inversion is avoided by means of a mixed condition about the residuals and the whole body anomalous mass. This inversion method has been applied with good results to simulation tests and to several real examples. Here, we present a main program that realises the inversion according to several possibilities for general application (scale of the survey, fixed or variable density contrasts, optional smoothing, optional trend adjustment, systematic or random exploration, optional a priori information, weighting, etc.). This program is presented along with a previous program for selection of unknowns and parameters and another program for visual presentation of the results. All three programs are written in Fortran 77 and completes the inversion tool.

Keywords: Gravity inversion; Three-dimensional models; Model exploration; Gravity anomaly; Anomalous density contrast

1. Introduction

The gravity inversion problem usually deals with discrete, inaccurate and irregularly sampled data of some gravity anomaly with the aim of obtaining information about the distribution of the subsurface anomalous masses that are the source of the detected gravity anomaly. The non-uniqueness of solution is characteristic of this inversion problem. This demands a geological or mathematical hypothesis that constrain the problem and allow to obtain realistic results. For instance, a usual approach consists of constraining the possible density contrasts of the anomalous structures and then looking for the geometry of these anomalous bodies. The above procedure corresponds to a non-linear context. In this case, the traditional methods for non-linear approach work iteratively, for instance by means of gradient calculations (e.g., Farquharson and Oldenburg, 1998), starting from an approximate initial solution. These methods are dependent on the quality of the initial model to define the unknown geometrical parameters and to assure the convergence of the non-linear process. In Camacho et al. (2000), we propose a method of 3-D (three dimensional) gravity inversion inspired by the method of René (1986) and based on a "growth" process that works by means of exploration of the model possibilities (see Tarantola, 1987 for general

☆Code available from server at http://www.iamg.org/CGEditor/index.htm

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