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Modeling of vertical density distribution in a normal geological fault by the Backus and Gilbert method

P Y A G S Yapa and D A Tantrigoda

Department of Mathematics and Philosophy of Engineering, The Open University of Sri Lanka, Nugegoda

Modeling of gravity anomalies by the powerful Backus and Gilbert method was so far limited to modeling of bodies with constant densities and in this study, the possibility of extending the Backus and Gilbert method to model gravity anomalies due to bodies with increasing density and applying it for a special case of a geological fault was investigated.

A normal geological fault is formed as a result of breaking of a large earth structure into two blocks and subsidence one relative to the other. The void created by the subsidence of the block will normally be filled with sediments. The density contrast between the sediments (ρ_s) and the block that did not subside (ρ_c) produces a gravity anomaly. The feasibility of modeling a normal geological fault with increasing densities with depth by the Backus and Gilbert method was examined by inverting gravity anomaly data obtained from an artificially simulated hypothetical geological fault of known dimensions and a known density distribution. It was then compared with the results obtained for the relevant features of the hypothetical fault. For the numerical study, the anomaly was first modeled in terms of a body of constant density by the inversion of the Backus and Gilbert method for gravity modeling. The following steps were then carried out.

1. In the initial trial, the rectangular cross sectional shape was divided into a number of semi-infinite slabs.
2. The density contrast of each slab was determined by the Backus and Gilbert method, together with the singular value decomposition method.
3. The semi-infinite slabs having positive density values or density values close to zero were neglected by taking their thickness equal to zero.
4. A value for the density of remaining semi-infinite slabs was assigned and the gravity anomaly due to the new body was calculated and compared with the "observed anomaly". If the agreement was not acceptable, steps 2 and 3 above were repeated until a suitable agreement was obtained.

For the test example, the model obtained by the use of the above method consisted of five consecutive slabs of equal density contrast of -0.3 g/cm^3. To model a body with increasing densities, each slab of the model was divided into five horizontal strips so that the whole model was divided into 25 strips. The density for each strip was assigned a value assuming a linear increase of density with depth. The results indicate that the Backus and Gilbert method can be used to successfully model gravity anomalies caused by geological faults.

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gayani21@yahoo.com Tel: +94714433551