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Computation of gravity effect of a two-dimensional body with arbitrary cross-section and linear density variation in horizontal and vertical directions and its comparison with the case of constant density

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Extended Abstract

Summary

We present a formula for computing the horizontal and vertical gravitational anomalies due to an arbitrary n-sided polygon in a two-dimensional (2D) space with a linear density variation in horizontal and vertical directions. In the analysis of gravity data over thick sedimentary basins or lithospheric scale studies, density contrast can sometimes be approximated by a continuous function decreasing or increasing linearly with depth. We developed a MATLAB code to calculate the gravitational anomaly of an n-sided polygon having linear density variation and compare the anomaly with that of a same n-sided polygon having mean constant density. There is a significant difference in the amount of anomalies that cannot be ignored.

Introduction

When we face geological structures, which are approximately linear, the problem can be solved by analysis of 2D forms. Any 2D body of irregular cross section can be approximated by a polygon and for gravity modeling, an algorithm can be developed based on this polygon. It is well recognized that density of sedimentary rocks increases with depth, and also, there is a linear density decreasing with depth in mantle structure. We present a modified algorithm for computing the gravitational acceleration due to a polygon with linear density variation in horizontal or vertical directions. Considering some geological assumptions, a theoretical geometrical model will be constructed. 2D models are constructed in (X,Z) coordinates and are composed of a series of polygons whose apices define the model geometrically. This is the first stage in the modeling process. The second stage is to modify the shape of the body until a best fit is obtained between the theoretical and observed anomalies. A change in the shape of the body is easily accomplished by computer in the polygon method by changing the coordinates of the vertices.

Methodology and Approaches

It is known that the vertical and horizontal component of gravitational attraction due to a 2D body is equal to the line integral being taken along its perimeter. Using this method, it is possible to model the geological structures by polygons. If we assume a constant amount for the density contrast, the density gets out from the integration but if there is a variable density, it should be taken into account in the integration. Many methods have been suggested for calculation of gravity anomalies due to irregular 2D bodies having a uniform density contrast. In this paper, we solve the line integral with linear density variation in horizontal or vertical directions and use these results in a MATLAB code in order to compute the vertical and horizontal gravitational anomalies.

Results and Conclusions

To compare the differences in gravitational anomalies due to a model having linear density variation in horizontal or vertical directions and a model having mean uniform density, we construct a 2D synthetic model containing arbitrary cross section. The results show that the differences are noticeable in both horizontal and vertical gravity attraction. A similar method can be developed for computation of magnetic anomalies of a body having linear magnetic susceptibility variations in horizontal or vertical directions.