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Modeling of gravity anomalies over a sedimentary basin having intruded horizontal Indigneous layer

P Y A G S Yapa[1*] and D A Tantrigoda[2]

[1]*Department of Mathematics and Philosophy of Engineering, The Open University of Sri Lanka, Nawala*
[2]*No.50, Wijerama Lane, Gangodawila, Nugegoda*

In certain places sedimentary basins have layers of high dense igneous intrusions emplaced as almost horizontal thick sheets. Very often such igneous layers are misinterpreted as basement rock when drilling test wells for oil exploration resulting in abandonment of the drilling process unaware of the fact that the sedimentary basin continues below the igneous rocks. Igneous layers of this nature have been reported in the Mannar Basin in the North Western off shore regions of Sri Lanka. It is worthwhile to have a method of ascertaining whether the igneous rocks encountered in the drilling process belong to the actual basement or to a sheet of igneous rocks intruded into the sedimentary basin. An attempt was made to examine whether the modeling of gravity anomalies caused by a sedimentary basin having an igneous layer intruded into it using the Backus and Gilbert method can be used for this purpose.

A mathematically rigorous approach of solving the inverse problem in geophysics for the under-determined case is described by Backus and Gilbert. This inversion method is based on a mathematical abstraction called an "Earth Model". An idealized model known as an "n-dimensional Earth model" can be considered as a point in an infinite dimensional linear space of all conceivable Earth models. In this method, a model that satisfies a set of observations is created by minimizing the distance between an initial model and the real Earth model in the parameter space, subject to the constraints imposed by observations.

In this study, it was been assumed that the igneous layer is of infinite extension and the density contrast of sedimentary rocks is -0.3 g/cm^3 and that of the igneous intrusion is 0.3 g/cm^3. Gravity anomaly due to this model structure was calculated and the results were used as observations to solve the inverse problem. Gravity anomaly was first modeled in terms of a body with single density contrast -0.3 g/cm^3. Then an igneous layer of thickness 0.2 km and density contrast of 0.3 g/cm^{3}is introduced at a depth of 1.0 km to this model and divided into 22 strips of thickness 0.1 km.

The numerical experiment was repeated for two different values of thicknesses of the igneous layer (0.5 km, and 1.0 km) and results obtained for these two cases were not as consistent as the density distribution obtained for the case where the thickness of the igneous layer is 0.2 km. The results conclusively showed that modeling of gravity anomalies using the Backus and Gilbert method can be used to determine whether the igneous rocks encountered in the drilling process belong to the actual basement or to a sheet of igneous rocks intruded into the sedimentary basin.

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gayani21@yahoo.com Tel:+94 714433551