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3D Inversion of Gravity Anomalies for the Interpretation of Sedimentary Basins using Variable Density Contrast

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Concern about sedimentary basins is generally related to their genetic and economic significance. Analysis of sedimentary basins requires the acquisition of data through outcrop studies and subsurface investigations that encompass drilling and geophysics. These data are commonly analysed by computer-assisted techniques. One of these methods is based on analysing gravity anomalies to compute the depth of sedimentary basin-basement rock interface. Sedimentary basins produce negative gravity anomalies, because they have mostly lower densities than that of the surrounding basement rocks. Density variations in a sedimentary fill increase rapidly at shallower depths then gradually reach the density of surrounding basement rocks due to the geostatic pressure i.e. compaction. The decrease of the density contrast can be easily estimated by a quadratic function. Hence, if the densities are chosen properly and the regional background is removed correctly, the topographical relief of the sedimentary basin-basement rock interface might be estimated by the inversion of the gravity data using an exponential density-depth relation. Three dimensional forward modelling procedure can be carried out by introducing a Cartesian coordinate system, and placing vertical prisms just below observation points on the grid plane. Depth to the basement, namely depths to the bottom of the vertical prisms are adjusted in an iterative manner by minimizing the differences between measured and calculated residual gravity anomalies.

In this study, we present a MATLAB-based inversion code for the interpretation of sedimentary basins by approximating the topographical relief of sedimentary basin-basement rock interfaces. For a given gridded residual gravity anomaly map, the procedure estimates the bottom depths of vertical prisms by considering some published formulas and assumptions. The utility of the developed inversion code was successfully tested on theoretically produced gridded gravity data set. Additionally, some applications with real residual gravity data sets from Los Angeles Basin (California, USA), Pannonian Basin (East-Central Europe), Saros Bay (Thrace, Northwestern Turkey) and the Aegean Graben System (Western Anatolia, Turkey) have produced geologically reasonable results which are in close agreement with those of previously published studies in the literature. Therefore it is mentioned here that the developed MATLAB-based inversion code is suitable to estimate the depths to the basement of sedimentary basins.

Keywords: Sedimentary basins, Gravity anomalies, Inversion, Variable density contrast