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Isostatic Compensation below the Arabian Shield and Platform: Distant effects caused by Red Sea Spreading

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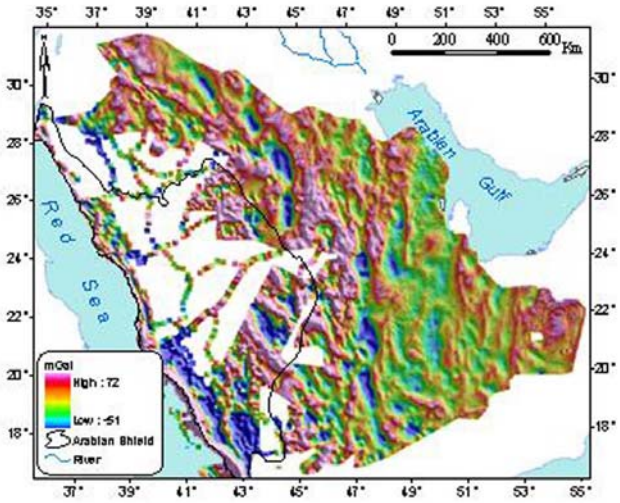

Configuration and the overall mass distribution both in crust as well as in top most part of upper mantle below the Arabian Shield and Platform (ASP) are of much geodynamic significance from the viewpoint of effects due to Red Sea spreading below these areas. Deep Seismic refraction profiling (by USGS and Saudi Directorate of Mines and Geology) and seismological wave propagation studies (by King Saud University) have delineated the gross differences in crust and upper mantle configuration below ASP and southern Red Sea. These results have also brought out general consensus on a plausible tectonic model where passive spreading effects below the southern Red Sea are held responsible for large-scale igneous activity in the Asir Igneous Province and structural uplift of the Arabian Shield at the Red Sea coast and downfaulting and subsidence of the Arabian Platform within the continental interior. In the backdrop of such basic model, the isostatic compensating mechanism for the ASP is investigated here by an analysis of the gravity field for the uplifted terrains of the Arabian Shield and other prominent geologic belts and crustal sutures. For this purpose, a large volume of new gravity stations was established in the region by combining GPS and gravity field surveys. The study also takes help of an enormous volume of gravity exploration data already collected since 1940s by oil companies over the basins of the Arabian Platform and the southern Red Sea. The composite terrain-corrected Bouguer anomaly and Airy-Heiskanen Isostatic anomaly maps for ASP are prepared using these data sets. The gravitational attraction of the Moho was determined from the 30 arc-seconds topography data; calculation of isostatic correction was done by grid-based Fast Fourier Transform (GRIDFFT) by utilizing Generic Mapping (software) Tools, assuming 2.67 g/cm-3 and 3.3 g/cm-3 densities for the crust and mantle respectively. A mean thickness of 40 km was used for isostatic data reduction. Decompensated Isostatic residual anomaly map is next prepared and its correlation to digital elevation data is examined in details to look for geological mass anomalies in upper crust. Once these effects are isolated, the long wavelength isostatic anomalies are ascribed to crust-mantle configuration below the ASP. The results suggest that the Asir Igneous Province and the regions of higher elevation in the Arabian Shield are largely uncompensated, whereas, the isostatic compensation status for the Arabian Platform is more complete. Mass/unit area under the crustal columns at the assumed level of compensation at 40 km depth for ASP is constructed and compared with those for other shield regions in the world.

For correlation purpose, the available deep crustal seismic results are used as constraints. Finally; tectonic significance of the isostatic status is discussed.

Keywords: decompensative, Isostatic, geodynamic, Gravity, Saudi, Arabian