J. Ind. Geophys. Union, 30(1) (2026),21-34
https://doi.org/10.71122/JIGU.30(1)2026.003

Insights into crustal structure of Aravalli-Delhi Fold Belt and adjoining Bundelkhand craton-Marwar block from gravity models: Significance for Precambrian tectonics in NW India

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ABSTRACT

The 2.5D crustal density structure is modelled using complete Bouguer anomaly along two W-E profiles across the Marwar block, Aravalli-Delhi Fold Belt (ADFB), and the Bundelkhand craton, constituting the north-western edge of the Indian Shield. The rock density closely mimics the litho-tectonic units that preserve the Archean-Proterozoic evolutionary history. The Bouguer anomaly along the profiles, corresponds to significant variation in crustal structure, with Moho depth varying from 34 to 40 km under the Marwar block, ~45 km under high-relief ADFB and <42 km under the Bundelkhand craton. A high-density (2.78 g/cm^3) 6-8 km thick sill in the upper crust and a 10-12 km thick high-density (3.05 g/cm^3) body as the mantle underplating at the Moho, represent the source conduit of the Neoproterozoic Malani Igneous Suite in the Marwar block. The significant lithological variation within the 8-10 km thick upper crust with a 12-13 km thick elongated high-density (3.05 g/cm^3) basaltic body with a diffused Moho signature, possibly representing the mantle underplating due to orogenic root delamination under the ADFB. The lateral variation in the crustal structure across the craton suggests the orogenic reworking during the early-mid Proterozoic and mantle upwelling in an extensional regime during the Neoproterozoic in the ADFB and Marwar lock.

Keywords: Northwestern India, 2.5D Gravity modelling, Crustal density structures, Geodynamics, Aravalli-Delhi Fold Belt, Bundelkhand craton

INTRODUCTION

The Aravalli-Delhi Fold Belt (ADFB) together with the adjoining Bundelkhand craton towards the east and Marwar block towards the west, represents the north-western edge of the Indian shield (Figure 1), possessing a reasonably well-conserved rock record of nearly three billion years (~3.6 to ~0.75 Ga) of earth's evolutionary history (Deb and Sarkar, 1990; Bhushan, 1995; Sharma, 2009; Sharma and Mondal, 2019; Jain et al., 2020). The overlapping rock records, cryptic domain boundaries, and overprinted magmatic events make their spatiotemporal disposition enigmatic. Based on the accretion and reworking over time, the Precambrian tectonics and the crustal growth of the ADFB and adjoining regions are preserved. A knowledge of the crustal structure and reconstruction of spatiotemporal tectono-magmatic events enables detailed comparisons between models and observations. Some investigations using seismic (Rao et al., 2000; Krishna and Rao, 2010; Mandal et al., 2014, 2018), magnetic (Bansal and Dimri, 2005), and gravity methods (Mishra et al., 2000; Porwal et al., 2006; Naganjaneyulu and Santosh, 2012; Dwivedi et al., 2019) have been made to delineate the deep crustal structure across the central and northern part of the ADFB to speculate on the geodynamic evolution of northwestern India. In the southeastern part, the ADFB is bordered by the Bundelkhand massif basement, which is overlain by a sedimentary sequence of the Proterozoic Vindhyan Super Group. In certain parts, this sequence is covered by extensive Late Cretaceous Deccan volcanics. Whereas towards the west of ADFB, lies the Late Proterozoic Marwar Supergroup sequence of acidic volcanics, sedimentary succession, and the Mesozoic Jaisalmer sediments deposited in an extensional rift setting. The amalgamation of the complex geological setup is illuminated by pronounced seismicity, which is feeble in the central part and extensive towards the northern part of the ADFB (Figure 1). Unlike the central and northern parts, the southern part of the ADFB and its adjoining region lacks regional geophysical modelling of the crustal structure to understand the tectonic juxtaposition of syn- to post-tectonic orogenic events and, therefore, was chosen for the present study.

Unlike the seismic method, gravity models do not provide a unique solution. However, when constrained by seismic and other geophysical data, they yield a robust crustal structure that may represent a better litho-tectonic setup. We therefore modelled the high-resolution gravity data with constraints for the seismic structures that have been used to derive 2.5D density models of the deep crustal geometry of the southern ADFB and bordering geological units (Figure 1). We modelled the density structure of the crust across ADFB along two gravity profiles, where Profile 1 is constrained by the seismic structure of the region (Tewari et al., 1997; Krishna and Rao, 2010; Mandal et al., 2014, 2018). The crustal density structure along Profile 2 has been extended based on regional structures and the density interface from Profile 1. We aim to provide (i) a detailed 2.5D crustal density structure across the three tectonic domains, and examine a possible evolutionary and geodynamic link between the mafic and ultramafic rocks on the surface as well as in the deep crust.