Crustal Structure of the North Western Indian Shield: Preliminary Studies Based on Bouguer Gravity

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The crust of the north western Indian craton in Rajasthan comprises of the Archean Banded Gneissic Complex forming the basement, with Proterozoic igneous suites of Malani, Jalore and Siwana and Proterozoic Fold belts of Delhi and Aravalli, most of which is covered by Tertiary and Quaternary sediments. Seismic imaging of the crust along the 400 km Nagaur-Jhalawar deep seismic reflection profile provides information on the broad crustal structure of the region (Tewari H.C et al, 1997 and Reddy et al, 1995). A geoelectrical section is available along part of this profile (Kekri-Kota) (Rajendra Prasad et al, 1999), which sheds further light on the subsurface structure. Detailed geological mapping (Sinha-Roy et al, 1998) indicates the wide variation in spatial and temporal evolution of the region by means of different geodynamic processes. The studies of Gopalan et al (1990) provide constraints on the age of the cratonic rocks. The thickness of the magnetic crust in this area estimated from the MAGSAT data for ADFB is around 36-40 km (Mishra, 1987); Singh & Rajaram (1990) have shown positive magnetization. Thus the general geology and tectonics of Rajasthan is well studied (Sinha-Roy et al 1998), particularly across the Aravalli-Delhi-Fold Belt (ADFB), however no such detailed geophysical study is available farther west in the trans-Aravalli area. Recent production of hydrocarbons from the Jaisalmer and Barmer basins has generated fresh interest in this area. The formations in adjacent areas of Pakistan across the national border are also producing oil and natural gas.

Regional studies are planned in this area with the dual objectives of tracing the configuration of deeper crustal features, specially the crust-mantle boundary as well as map the basement to the west of the Aravallis for identification of potential basins which might host hydrocarbons. In this work, an attempt is being made to examine the regional gravity data for deciphering the signatures of sub-surface geology. First order crustal models along selected profiles are generated from a compilation of existing geological knowledge of this area based on the observed Bouguer gravity map (from Gravity Map of India, 2006). Such a study would provide important information regarding the effects of continental collision at the Himalayan front and subsequent isostatic adjustment mechanisms on the northwestern Indian Shield from the geometry of the crust and Moho.

The initial model configuration is based on the overall geometry provided by the Nagaur-Jhalawar velocity information from the Delhi-Aravalli Fold Belt (ADFB) in the east to the Quaternary formations in the west (Satyavani, 2004), which is located in the northern part of Rajasthan. We have incorporated in the models the sediment formations of Quaternary (density 1800 kg/m3), Tertiary (2200 kg/m3) and Mesozoic (2400 kg/m3) overlying the basement, which itself is represented by the

Late Proterozoic formations (density 2700 kg/m3) and Early Proterozoic formations (2750 kg/m3). Spectral analysis of the gravity signal has aided in defining average depth boundaries of the layers, particularly in the west, where no other data are available. A first-order fit between observed and computed gravity anomalies suggests a model configuration which depicts the sedimentary formations in the northwestern part upto 5 km in depth. These depths may be better resolved with seismic information. The basement layers show undulations, which correspond to the positive gravity anomalies. The basement shows a rise in the west and shallows to the surface in the east where the sediment cover is absent. The Moho dips gently from about 32 km in the north-west to 40 km below the Fold Belts in the south-east. The above exercise reveals the broad crustal structure of the southern part of the Rajasthan Shield region. The models are compared to published results from other crustal models at similar distances from the Himalayan front. Close-spaced gravity data as well as constraining geophysical information are necessary for the development of a more robust model.

Key words: crustal features, ADFB, potential basins, Himalayan.

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