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Student Section

Possible extension of Proterozoic sediments beneath Eastern Ghats Belt: A case study of Bastar Craton

Ankita Roy[1], Swarnapriya Chowdari[2] and A. Vasanthi [2]*
[1]Department of Earth Sciences, Pondicherry University, Puducherry-605014, India
[2]CSIR-National Geophysical Research Institute, Hyderabad-500007, India
*Corresponding author: vasanthi99ngri@gmail.com

ABSTRACT

The eastern margin of the Indian shield presents a geologically and geotectonically intricate zone where Proterozoic sedimentary basins and the high-grade metamorphic Eastern Ghats Belt (EGB), are juxtaposed along a broad, shear-dominated contact stretching from Odisha in the north to northern Tamil Nadu in the south. The tectonic relationship between the Bastar craton and the Eastern Ghats Belt in eastern India, has been the subject of considerable geological interest due to its implications for Proterozoic crustal evolution, basin development, and the assembly of ancient continental blocks. In this study, satellite-derived gravity data over Bastar craton and adjoining regions have been analysed to explore the possible extension of Proterozoic sedimentary sequences of this craton beneath EGB. The presence of a prominent residual gravity low of the order of -50 mGal on the SE part of the study area has been delineated below the EGB terrain, indicating possible presence of Mesoproterozoic to early Neoproterozoic sedimentary sequences. Further, gravity modelling across the Bastar craton and EGB, reveals steep crustal-scale contacts and high-density zones that are consistent with a under-thrust geometry. The underthrusting of Bastar sediments beneath the EGB likely occurred during the Mesoproterozoic collisional events, linked to the Rodinia supercontinent assembly. These findings not only enhance our understanding of the tectono-thermal history of the Bastar craton and EGB interface, but also provide a framework for re-evaluating crustal accretion processes along the cratonic margins in the Indian shield.

Key Words: Proterozoic sediments, Eastern Ghats Belt (EGB), Satellite gravity, Finite Element Method, Bastar craton, Bastar-EGB interface

INTRODUCTION

The Indian peninsular shield predominantly comprises Precambrian crustal blocks that formed approximately 3.6 to 2.6 billion years ago during the Archean Eon, representing some of the earliest solidified portions of the Earth's lithosphere (Sarkar et al., 1990; Sharma, 2010). These stable crustal blocks, commonly known as cratons, form the foundational cores of continental plates and are the key to understanding early Earth processes (Smithies et al., 2009). The tectonic framework of the Indian shield is well characterized by five major cratons, the Aravalli, Bundelkhand, Singhbhum, Bastar, and Dharwar, each exhibiting distinct geological histories and tectono-thermal events (Naqvi and Rogers, 1987; Ramakrishnan and Vaidyanadhan, 2010) (Figure 1). These Archean cratonic blocks are bounded and separated by various Proterozoic mobile belts, rift zones, grabens, and the shear zones, reflecting a complex and prolonged tectonic evolution marked by episodic collisions, accretions, and crustal reworking (Meert, 2003).

This study principally focuses on the Bastar craton, a significant Archean cratonic block situated in central India, renowned for its preserved ancient crust and tectono-thermal history that provide invaluable insights into the geodynamic evolution of the Indian Shield (Asokan et al., 2020; Mohanty, 2021), which in turn has implications for global tectonics, including supercontinent cycles such as Columbia and Rodinia (Satpathi et al., 2022). However, the intricate and heterogeneous litho-tectonic configuration within the Bastar region, characterized by a mosaic of metavolcanic, metasedimentary and granitic units, renders lithological correlations speculative and complex.

Multiple geological and geophysical investigations have been conducted to unravel the crustal and lithospheric architecture of the Bastar craton. Seismic wave dispersion studies reveal a lithospheric thickness of approximately 140 km beneath this region (Mitra et al., 2006). Complementary seismological analyses estimate the crustal thickness of Bastar craton to be in the range of 35–40 km, consistent with the other ancient continental crusts worldwide (Jagadeesh and Rai, 2008). Heat flow measurements carried out by Gupta et al. (1993) have documented relatively high surface heat flow in Bastar craton compared to the Dharwar craton, which has been attributed to spatial variations in upper crustal radiogenic heat production and possibly localized tectono-thermal activity.

In addition, several studies were also carried out to understand the tectonic relationship between the Bastar craton and the Eastern Ghats Belt (EGB) in eastern India. The southeastern margin of the Bastar craton is structurally juxtaposed against the high-grade Proterozoic EGB, forming a tectonically complex and thermally contrasting boundary in eastern Peninsular India. Proterozoic sedimentary basins, such as the Chhattisgarh Supergroup (~1.4–1.0 Ga), Khariar, Indravati, Sabari, Abujhmar and Amphani groups, lie along the Bastar craton's fringe and are interpreted as rift-related intra-basinal sequences. Gravity studies highlight the presence of tectonically active contact between Bastar craton and the EGB (Subramanyam and Verma, 1986; Kumar et al., 2004; Valdiya, 2015). Moreover, thermal (Bhadra et al., 2004), geochemical and geochronological studies have identified successive mafic magmatic events that have profoundly reshaped the lithosphere of the Bastar craton, evidencing sustained crust-mantle interactions that may have influenced its present-day geodynamic character (Rao et al., 2023).