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# Crustal reworking and magmatic evolution in the northeastern Dharwar craton: evidence from geochemistry and zircon U-Pb geochronology of Ghanapur granitoids

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**ABSTRACT**

The widespread occurrence of granitoids in Precambrian terranes provides crucial insights into crustal processes and geochemical evolution within cratonic blocks. The Eastern Dharwar Craton (EDC) of southern India, records extensive granitic magmatism during the late Archean, a transformative period in Earth's history marked by significant geological and geochemical shifts. This study presents a comprehensive, first-hand investigation of granitoids from the Ghanapur area in the underexplored north-eastern EDC, using integrated fieldwork, petrography, geochemistry, and zircon U-Pb geochronology, to provide new insights into the evolutionary history of granitic crust. The granitoids of Ghanapur are categorized into three suites: granitic gneisses, granodiorite gneisses and leucogranites. Zircon U-Pb dating reveals two distinct magmatic episodes: granitic gneisses at ca. 2697–2607 Ma, while granodiorite gneisses formed at ca. 2560–2545 Ma. Granitic gneisses are silica rich, weakly metaluminous to slightly peraluminous, and show high-K calc-alkaline to shoshonitic affinity, with magnesian character. They show variable Eu anomaly and REE fractionation. Their ages and geochemistry together suggest repeated crustal reworking and mixed origin. The granodioritic gneisses are weakly peraluminous and moderately silicic, with elevated Mg# and enriched in incompatible elements. They resemble Archean sanukitoids and suggest their origin from a metasomatized mantle wedge. These rocks record a two-stage evolutionary history: initial sanukitoid magmatism driven by partial melting of the enriched mantle wedge, followed by a younger migmatitic episode, resulting in their preservation as mesosome within the migmatitic complex. Leucogranites are garnet- or magnetite- bearing, silica-rich, peraluminous to strongly peraluminous, high-K calc-alkaline, ferroan rocks, likely reflecting the waning stages of late Archean crustal thickening. Taken together, the geochemistry and geochronology suggest progressive crustal reworking and differentiation over a period of at least 150 Ma during the late Archean in the Ghanapur region.

**Keywords:** Ghanapur granitoids, NE Dharwar craton, U-Pb Zircon dating, Sanukitoid, Crustal evolution, Leucogranites, Gneisses

## INTRODUCTION

The late Archean (2.8–2.5 Ga) was a transformative period in Earth's history, marked by rapid continental growth and fundamental changes in tectonic style (Hawkesworth et al., 2020). While the precise volume of crust generated remains debated (e.g., Dhuime et al., 2012; Rosas and Korenaga, 2018), there is a broad consensus that this interval witnessed a compositional shift from sodic tonalite-trondhjemite-granodiorite (TTG) suites toward more potassic granitoids (Moyen, 2011; Laurent et al., 2014). The late Archean potassic granitoids are petrogenetically diverse, encompassing sanukitoids, two-mica granites, biotite granites, and hybrid varieties, each recording different source contributions and melt-generation processes (Laurent et al., 2014). Their appearance in the late Archean record is commonly linked to the progressive evolution of source compositions (Johnson et al. 2019) together with changing mantle thermal conditions and evolving subduction dynamics (Dash et al., 2025). Understanding their petrogenesis and relative timing provides important constraints on how Archean crust matured from juvenile additions to stabilized cratonic lithosphere.

The Eastern Dharwar Craton (EDC) of southern India, preserves an excellent record of the late Archean magmatism. The EDC is considered to have been accreted mostly during the late Neoarchean (2.7-2.5 Ga) (Peucat et al., 1993; Jayananda et al., 2000, 2013), and is characterized by numerous NW-SE trending linear volcano-sedimentary sequences of Neoarchean with volumetrically dominant 2.57-2.50 Ga K-rich granitoids, and 2.67-2.58 Ga transitional TTGs (Jayananda et al., 2013, 2018; Dey et al., 2017). Various tectonic models, such as subduction-driven accretion, mantle plume-derived crustal growth, and accretion via combined plum-arc processes are used to explain crustal accretion in EDC (Chadwick et al., 2000; Manikyamba and Kerrich, 2012; Dey et al., 2017; Jayananda et al., 2018).

However, the current understanding of crust formation and tectonic evolution of EDC is mostly restricted to the southern and western parts of the craton whereas the northern part of the craton largely remains underexplored with limited comprehensive geochemical and geochronological studies. This study presents field, petrographic, geochemical, and zircon U-Pb geochronological data from granitoids of the Ghanapur area in the north-eastern EDC. We document three granitoid suites, granitic gneiss, granodiorite gneiss and leucogranite and constrain their petrogenesis, age relationships, and tectonic significance. The results provide new insights into late Archean sanukitoid magmatism, crustal anatexis, and the role of migmatization in crustal reworking within this underexplored segment of the craton.