Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35364

Geodynamic significance of mafic granulites from the Angul Domain, Eastern Ghats Belt, India: Implications for arc-related crustal assembly and metamorphic evolution.

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The Eastern Ghats Belt (EGB) preserves critical records of Proterozoic orogenesis associated with several supercontinent assemblies. However, unlike the extensively studied ultrahigh-temperature (UHT) domains in the central and southern EGB, the metamorphic evolution and tectonic affinity of mafic granulites from the Angul Domain remain poorly constrained. This study integrates whole-rock geochemistry, tectonic discrimination diagrams, and metamorphic *P–T* estimates to evaluate the petrogenesis and geodynamic significance of mafic granulites from this domain.

Major-element classification using the TAS diagram places the protolith compositions in the basalt field, consistent with mafic igneous precursors. AFM and FeO/MgO–SiO_2 systematics indicate a dominantly tholeiitic affinity, with limited calc-alkaline influence. TiO_2–FeO/MgO relations further confirm tholeiitic differentiation trends rather than alkaline enrichment. The MnO–TiO_2–P_2O_5 and discriminant function diagrams collectively indicate that the mafic granulite protoliths were derived from a subduction-modified mantle source within an island arc to arc-extensional tectonic setting. Transitional MORB–OIT and minor within-plate signatures suggest involvement of depleted mantle with limited enrichment, consistent with magma generation in an arc-proximal extensional or back-arc environment rather than a purely mid-ocean ridge or intraplate setting.

Conventional mineral thermobarometry indicates peak metamorphic conditions of ~800 °C and 8–9 kbar, corresponding to mid- to lower-crustal granulite facies conditions. Retrograde equilibration occurred at ~600 °C and 4–5 kbar, reflecting decompression and cooling during exhumation. These *P–T* estimates are significantly lower than the extreme UHT conditions (>900 °C) reported from other parts of the EGB, indicating spatial heterogeneity in thermal structure and metamorphic intensity.

The combined geochemical and metamorphic evidence suggests that the Angul Domain represents an arc-related crustal segment that underwent moderate crustal thickening and subsequent exhumation without experiencing UHT metamorphism. This implies that UHT conditions in the EGB were not regionally uniform, likely controlled by spatial variations in heat input, magmatic underplating, and crustal architecture during Proterozoic collision and accretion. The Angul Domain therefore preserves a distinct tectono-metamorphic record that bridges arc magmatism and lower crustal reworking, providing new constraints on the geodynamic evolution and thermal regime of the Eastern Ghats Belt during supercontinent assemblies.