

## ABSTRACT

The timing of assembly into India by amalgamation of cratonic fragments, is controversial with Tonian, earliest Mesoproterozoic or late Neoarchean ages being proposed. All models have the South Indian Block, comprising the Dharwar, Bastar and Singhbhum cratons, as one of the nuclei, which amalgamated with the North Indian Block comprising Aravalli-Banded Gneiss Complex- and the Bundelkhand cratons. Here, the timing of amalgamation between Bastar and Eastern Dharwar cratons being critical to understand if there was any sequential amalgamation process is, therefore, addressed in this study.

The NW-SE trending Pranhita Godavari Valley (PGV) occurs between these two cratons flanked by two granulite-facies belts, the Neoarchean Karimnagar granulite zone at the NE margin of the EDC and the linear NW-SE trending Proterozoic Bhopalpatnam granulite belt on the SW margin of the Bastar craton. Although the Late Neoarchean Karimnagar granulite belt has been correlated with the Bhopalpatnam granulite-facies belt the 1.7-1.6 Ga ages reported from the Bhopalpatnam granulite belt imply that there were two granulite-facies events which were not coeval but rather developed by two different tectonothermal events related to different orogenies, an older Early Neoarchean and a younger Mesoproterozoic event. Therefore, the paleogeographic positions of these two cratons must have been distinct and they likely amalgamated only during the Mesoproterozoic Era. This implies that these cratons underwent significant movement and can be reconstructed using both geologic and paleomagnetic constraints.

Therefore, I have approached the problem by attempting to constrain the P-T-t evolutionary histories of the Karimnagar granulite enclaves (and its tectonic setting) and that from the >300 km Bhopalpatnam granulite belt. This was done by fieldwork, sampling, petrological studies and direct dating of selected metamorphic phase garnet for the Karimnagar and Bhopalpatnam granulites. I have relied upon the existing recent constraints from paleomagnetic pole data, analogous numerical geodynamic models for continent-continent collision or reactivation to support my argument to explain the sequential development of the Karimnagar high-temperature granulite-facies enclaves and those from the Bhopalpatnam high-grade belt (high pressure amphibolite- and granulite-facies rocks).

A clockwise P-T path was reconstructed for Bhopalpatnam tectonites as high-pressure amphibolite-facies stage M1a  $P \geq 10$  kbar at  $\sim 750$  °C, followed by M1b granulite-facies stage with  $T \geq 850$  °C at lower pressures; the path segments were constrained with garnet Lu-Hf and Sm-Nd isochron weighted mean ages. High-grade tectonite formation was interpreted as a

response to crustal thickening during Mesoproterozoic continental collision. An orogenic duration of  $38 \pm 19$  Myr was inferred between the high-pressure amphibolite-facies through to granulite-facies event at  $1721 \pm 14$  Ma and a post-peak cooling to  $\leq 650$  °C at  $1683 \pm 6$  Ma, being the Sm-Nd garnet weighted mean age. Archean two-stage depleted mantle model ages (at 1.7 Ga) of tectonites and rotated dyke swarm orientations further support the reactivation and reworking of the Paleo- to Neoarchean Bastar craton marginal rocks being underthrust beneath the Eastern Dharwar craton in response to the early Mesoproterozoic orogeny. As paleomagnetic data support proximity of Bastar and Eastern Dharwar cratons by 1.79-1.77 Ga, the Bhopalpatnam orogen possibly represents the site of early Mesoproterozoic cratonic collision or locus of post amalgamation reactivation due to convergence.

The Karimnagar garnet-bearing granulite enclaves record a clockwise P-T path with peak metamorphic conditions,  $\sim 850$  °C and  $\sim 8.5$  kbar (M1a), followed by near isothermal decompression to 5–6 kbar (M1b) and isobaric cooling to  $\sim 800$  °C (M1c). A garnet Lu-Hf weighted mean age for the porphyroblastic garnet suggests growth at  $2725 \pm 12$  Ma during the M1a-M1b stages. The garnet Sm-Nd weighted mean age at  $2692 \pm 8$  Ma constrains the later M1b-M1c stages. I proposed that the protoliths to these supracrustal enclaves were deposited in an arc tectonic setting and underwent thickening followed by heating during peeled-back lithospheric convergence. Therefore, the earliest of the Eastern Dharwar craton-forming accretionary stages is preserved as the  $\sim 2.73$  Ga granulite-facies enclaves and are marginally older than the 2.70–2.65 Ga cratonic greenstone volcanism. Tectonic exhumation of these mid-crustal granulite enclaves was in response to the late Proterozoic ( $\sim 1.7$  Ga) Bhopalpatnam orogeny.

**Keywords:** Bhopalpatnam orogen, Petrochronology, Geochronology, Garnet, Lu-Hf Sm-Nd garnet chronology, Karimnagar Granulite enclaves, Bastar craton reworking