Geological studies across the Singhbhum Craton-Rengali Province boundary: insights into continental crustal processes using novel petrofabric analytical techniques

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by

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Abstract

Precambrian shields around the world comprise an amalgam of cratons whose juxtaposition is a record of the geodynamic processes involved in continental crust construction. The Singhbhum Craton in India is one of the oldest components of the Indian Precambrian shield. The nature of amalgamation of the Archaean Singhbhum Craton with the Rengali Province to its south, in the eastern part of the Indian shield, has been investigated in this study. Two dominant views exist with regard to this juxtaposition – some workers consider the Rengali Province to be the exhumed root of the Singhbhum Craton that was thrust onto the cratonic interior, while other workers consider the Rengali Province to be a slice of the Bastar Craton that was juxtaposed with the Singhbhum Craton along a dilational strike-slip step-over zone. In this study, the Singhbhum Craton and the Rengali Province are discriminated based on the exclusive presence of a pervasive high-temperature (upper amphibolite-granulite) metamorphic imprint in the latter terrane. While the two terranes show differences in their deformation history, a final phase of dextral strike-slip shearing along sub-vertical, WNW-ESE striking shear planes is common to both. Microstructurally, the Singhbhum Craton does not preserve any evidence of high-temperature metamorphism, whereas the lithologies in the interior of the Rengali Province contain high-temperature textural domains with a limited low-temperature deformation overprint. Crystallographic Preferred Orientations (CPOs) of quartz indicate that deformation by basal <a> slip with a pronounced dextral asymmetry was dominant in the lithologies of the Singhbhum Craton and the marginal lithologies of the Rengali Province. Deformation temperatures estimated from quartz CPOs are consistent with thermobarometric estimates obtained from the Singhbhum Craton lithologies using chlorite thermometry and multiple-reaction thermobarometry. Penetrative shallow-dipping fabrics within the Singhbhum granite define trough cross-beds and are inferred to be of primary magmatic origin. CPOs of constituent minerals in this fabric coupled with modelling studies indicate an origin by convective material transport in a felsic magma chamber. This study also provides an insight into fluid percolation through quartz-rich rocks at different metamorphic grades. Grain boundary morphologies in quartzites deformed and metamorphosed under a range of metamorphic conditions (greenschist-granulite) were studied with an Atomic Force Microscope and integrated with grain boundary misorientation distributions. It is concluded that quartz-rich rocks deformed and metamorphosed under granulite facies conditions are likely to be significantly more resistant to fluid percolation compared to rocks deformed and metamorphosed under greenschist facies conditions. This study therefore demonstrates that the Singhbhum Craton-Rengali Province interface is a dextral strike-slip shear zone, and also provides an insight into processes occurring in the continental crust.

(423 words)