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Mechanisms for strain localization within Archaean craton: A structural study from the Bundelkhand Tectonic Zone, north-central India

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The transformation of palaeo-continents involve breakup, dispersal and reassembly of cratonic blocks by collisional suturing that develop a network of orogenic (mobile) belts around the periphery of the stable cratons. The nature of deformation in the orogenic belt depends on the complex interaction of fracturing, plastic deformation and diffusive mass transfer. Additionally, the degree and amount of melting during regional deformation is critical as the presence of melt facilitates the rate of diffusive mass transfer and weakens the rock by reducing the effective viscosity of the deformed zone. The nature of strain localization and formation of ductile shear zones surrounding the cratonic blocks have been correlated with Proterozoic-Palaeozoic supercontinent assembly (Columbia, Rodinia and Gondwana reconstruction). Although, a pre-Columbia supercontinent termed as Kenorland has been postulated, there is no evidence that supports the notion due to lack of the presence of shear zones within the Archaean cratonic blocks. In this contribution, we present the detailed structural analysis of ductile shear zones within the Bundelkhand craton. The ductlile shear zone is termed as Bundelkhand Tectonic Zone (BTZ) that extends east-west for nearly 300 km throughout the craton with a width of two-three kilometer .
In the north-central India, the Bundelkhand craton is exposed over an area of 26,000 sq. The craton is bounded by Central Indian Tectonic zone in the south, the Great Boundary fault in the west and by the rocks of Lesser Himalaya in the north. A series of tonalite-trondjhemite-granodiorite gneiss are the oldest rocks of the Bundelkhand craton that also contains a succession of metamorphosed supracrustal rocks comprising of banded iron formation, quartzite, calc-silicate and ultramafic rocks. K-feldspar bearing granites intrude the tonalite-trondjhemite-granodiorite and the supracrustal rocks during the time span of 2.1 to 2.5 Ga.

The TTGs near Babina, in central part of Bundelkhand Craton are characterized by the development of at least three stages of folding. The penetrative foliation in the TTG is characterized by the parallel alignment of biotite and amphibole (S2). In the low-strain domains, the S2 foliation is axial planer to the small scale root less hinges (F2) of mafic boudins and anatectic leucosomes (S1). The presence of hook-shaped fold on the mafic and anatectic leucozomal layers indicates that co-axial nature of F1 and F2 folds. In general, the F2 axial planes (S2) are oriented in NNW-SSE direction. The F2 fold axes are generally north trending with sub-vertical plunge (550 -> 0060N). The intensity and tightness of last stage of folding is prominent in the leucocratic layers and is characterized by the development of open warps with E-W trending axial planes. However, the effect of F3 is not prominent in the mafic layers. Locally, small scale E-W displacement in the mafic bands corresponds to the E-W trending F3 axial plane in the leucosomes. In contrast to the TTGs, the supracrustal rocks are devoid of melting and compositional segregation. The supracrustal units are characterized by the development of E-W trending fabric.
The development of tight to isoclinal folds in the leucosomes of TTGs indicates the F1 folding in the partially molten TTG occurred in the anatectic conditions. The presence of melt decreases the effective viscosity of the rock and promotes the development of tight to isoclinal folds in the F1 and F2 phases. It is also suggested that the segregation of the melt during the first and second phases of folding again increases the strength of the restite and is manifested by the development of small scale E-W displacements. The study demonstrated the change in the strength of a segment of Archaean crust due to the limited availabiliy of melt during deformation.
The presence of three stages of deformation in the TTGs and E-W trending fabric in banded iron formation and quartzite indicate the opening of a palaeo-ocean after the F2 folding in the TTGs where the supracrustal sequences were deposited. The extensive lateral extent of BTZ and limited width indicate that the ductile shear zone may represent the contact domains of different fragments of pre-Bundelkhand craton that are amalgamated during N-S collisional orogeny. However, in the absence of radiometric dating, the exact timing of closure of palaeo-ocean remains elusive.