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Cryogenian tectonothermal events in the Madurai Block of the Southern Granulite Terrane, India: Characterization and implications.

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Over the last one decade, it has become increasingly clear that a distinct tectonothermal event has affected the entire Southern Granulite Terrane of India during the Cryogenian (850-635 Ma), however, the evidence is more predominant from the Madurai Block. Characterization of this tectonothermal event through multi-dimensional petrochronological studies is crucial in understanding the Proterozoic crustal evolution of southern India in particular, and the thermal evolution of continental crust, in general.

In the Madurai Block, the oscillatory-zoned elongated magmatic zircon grains, with unzoned metamorphic rims, from the porphyritic charnockites, intruding the massive mafic rocks and enderbites, yield a Cryogenian (~800 Ma) magmatic emplacement age and an Ediacaran-Cambrian metamorphic overprint (~570 Ma). Detailed geochemical study reveal that the precursors of these charnockites were ferroan A-type granite plutons that were most likely emplaced in a riftogenic setting. Texturally controlled in-situ dating of monazite grains from the associated garnet-biotite-sillimanite bearing metapelitic granulites, occurring north and west of the Sirumalai Hills near Dindigul city, yield weighted mean ages of 845-815 Ma from the core and mantle, dating the age of peak metamorphism. The chemically distinct, recrystallized thin rims, sometimes cutting across both core and mantle, yield a weighted mean age of ~615 Ma, signifying Ediacaran-Cambrian metamorphic overprint. Detailed petrological and thermobarometric study, complemented by thermodynamic modelling, constrain the peak P-T conditions of these rocks at ~800-850°C, 7.5-8.0 kbar. The age of the peak metamorphism, obtained from the monazite cores and mantles, is coeval with the extensive A-type felsic magmatism in the Madurai Block, suggesting that the metamorphic event was linked to the enhanced heat input through rift related felsic magmatism. However, the trigger behind the widespread Cryogenian thermal events needs to be ascertained to place them in context of the global tectonic framework.

The Mesoproterozoic supercontinent Rodinia, which assembled between 1300 and 900 Ma, broke apart during the Cryogenian between 830 and 650 Ma. The Indian continent, being an integral part of all Rodinia reconstructions, was largely affected by the magmatic and metamorphic events related to Rodinia breakup, and the Southern Granulite Terrane is no exception. In summary, we suggest that the pre-Cryogenian crust of the Madurai Block has been affected by widespread and

voluminous A-type magmatism and associated granulite facies metamorphism in response to rifting and crustal extension during the breakup of the Rodinia supercontinent. Subsequent compression and crustal thickening related to Gondwana amalgamation during Ediacaran-Cambrian resulted in high- to ultrahigh-temperature metamorphism. This metamorphic event was long and strong enough to overprint, and sometimes obliterate, the signals of the Cryogenian thermal event.

The Cryogenian thermal events have also been recorded from the Nilgiri-Namakkal Block, north of the Palghat Cauvery Shear Zone. The strikingly similar geochemical characteristic and close spatial association of the Cryogenian rocks across the perceived terrane boundary, i.e. the Palghat Cauvery Shear Zone, negates the hypothesis of Cambrian amalgamation of the Southern Granulite Terrane with the Dharwar craton along the Palghat Cauvery Shear Zone.