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Petrology, geochemistry and geochemical modelling of Neoarchean granitoids from Southern Granulite Terrane, India: Implications on Archean tectonics and melting processes

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Multiphase granitoid magmatism is present throughout the Southern Granulite Terrane of India. In the Nilgiri-Namakkal Block, granitoids have intruded several layered mafic-ultramafic complexes (oceanic crust), whose magmatic age have a peak at ca.2.5Ga. Subsequently, the regional granulite facies metamorphism took place at ca.2.47Ga. The magmatic age is generally related to the formation of the Archean supercratons and their metamorphic age is related to the breakdown of these supercratons. Therefore, REE and trace elements data of these rocks bear the signatures of Archean melting process and their metamorphism throws light on the Palaeoproterozoic crustal tectonics.

Petrologically these granitoids define two distinct clusters. First group have peak assemblage of Cpx-Opx-Grt-Pl-Qtz-Kfs with Hbl formed during retrogression. These rocks cluster within basaltic-andesite to andesite fields and are calcic to calc alkaline in nature. The second group is distinctly more leucocratic with high proportion of Kfs and Qtz. The peak assemblage shows Kfs-Qtz-Ab-Opx-Cpx-Grt with Bt and Chl as the retrograde phases. This group cluster within andesite to rhyolite fields with calc-alkaline nature. The overall composition is mostly magnesian with low to medium potassium content. Some of the samples are depleted and some are enriched in U, Th and Rb but these data cannot be corroborated with any particular cluster or the Ti content. Tectonic discrimination diagrams indicate ‘volcanic arc granites’ with amphiboles in the restite phase and plagioclase being part of the melt sourced from Archean Basalt.

The geochemical data does not indicate any clear melting and fractionation process. The protoliths of these granitoids could have formed due to (1) variable fractional crystallization of primary melts derived from Archean primitive mantle or (2) remelting of mafic lower crust or, (3) combination of the above two processes. To delineate these processes, forward modelling based on thermodynamic principles and trace element compositions were modelled through partitioning between melt and restitic phases. Suitable source rock compositions and variable melting and crystallization conditions were modelled to generate melts akin to the natural rocks. Subsequent high-pressure granulite facies metamorphism (11kbar and 750^{o}C) of these granitoids indicate low geothermal gradient which can be achieve only with thick crust subduction or collision.