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Pan-African granulite facies reworking along Moyar shear zone, south India: Implications for Gondwanaland assembly

Subhadip Bhadra (1) and Pritam Nasipuri (2)

(1) Department of Earth Sciences, Pondicherry University, Kalapet, Puducherry , (2) Department of Earth and Environmental Sciences, Indian Institute of Science Education and Research, Bhopal, India

The present study documents metamorphic evolution of garnetiferrous quartzo-feldspathic gneiss from the Moyer shear zone (MSZ), southern granulite terrain (SGT). Quartz (Qtz), plagioclase feldspar (Pl) and biotite ($\mathbf{Bt}_1$) constitute the pre-metamorphic mineral assemblage in the rock, where as porphyroblastic garnet (Grt) and second generation biotite ($\mathbf{Bt}_2$) characterize the metamorphic mineral paragenesis. Mylonitic fabric in the rock is defined by biotite ($\mathbf{Bt}_1$) and poly-crystalline quartz ribbons that wraps garnet porphyroblast. Core compositions of the porphyroblastic garnets lie in almandine-pyrope-grossular ternary ($Alm_{62}Prp_{23}Grs_{14}Spss_{01}$). In the core to rim traverses within the garnet display variation in major element zoning patterns that depend on the neighboring mineral phase/phases. Along traverses where garnet rim shares contact with quartz, a flat Fe, rimwardly decreasing Mg, flat Mn and rimwardly increasing Ca (referred as $Fe^0Mg^-Ca^+Mn^0$) profile was observed. Embayed garnet sharing boundary with randomly oriented $\mathbf{Bt}_2$, displays rimwardly increasing Fe, rimwardly-decreasing Mg, rimwardly increasing Ca and flat Mn (referred as $Fe^+Mg^-Ca^+Mn^0$) profile. $\mathbf{Bt}_2$ shows complementary decrease of Fe and increase of Mg towards the interface with garnet. Garnet sharing contact with both $\mathbf{Bt}_1$ and plagioclase-feldspar displays rimwardly increasing Fe, rimwardly decreasing Mg, rimwardly increasing Ca and rimwardly increasing Mn (referred as $Fe^+Mg^-Ca^+Mn^+$) profile. Adjacent biotites show an increase of Fe and Mg towards the interface with garnet. Anorthite content of plagioclase decreases towards the interface. While $Fe^0Mg^-Ca^+Mn^0$profile can be interpreted with garnet growth (Bt_1 + Pl → Grt) and compositional homogenization (flat Fe, Mn) during peak metamorphism, $Fe^+Mg^-Ca^+Mn^+$*and* $Fe^+Mg^-Ca^+Mn^0$ profiles can be linked with post-peak compositional modifications respectively via retrograde net-transfer (ReNTR: Grt + Ca-rich ± Qtz → Bt_{II} + Ca-poor Plag) and retrograde exchange (ReER: Fe-Bt + Mg-Grt → Mg-Bt + Fe-Grt) equilibria.

Mineral and isopleth thermobarometry constrain the peak metamorphic condition at 900 ^{o}C, 9.5 kbar implying high pressure granulite facies metamorphism. ReNTR and ReER equilibria were constrained to be closed respectively at 740 ^{o}C, 8 kbar and 650 ^{o}C, 7 kbar. Geo-speedometric analyses reveal very rapid cooling in the order of >150 ^{o}C/Ma, at least during the initial stages of retrograde metamorphism. This estimate is commensurate with strong Mn kick up near the garnet rim along $Fe^+Mg^-Ca^+Mn^+$profiles and absence of any symplectectic phases through break down of porphyroblastic garnet.

High-P granulite facies metamorphism and subsequent cooling decompression path, documented in this study, in conjugation with reported Neoproterozoic Sm-Nd garnet ages (624-591 Ma) from the quartzo-feldspathic gneiss bear semblance with Pan-African HT-UHT reworking along Palghat-Cauvery Shear Zone (521 Ma) that was culminated with the closure of Paleo-Mozambique ocean during east and west Gondwanaland assembly. We envisaged that peak granulite facies metamorphism in MSZ marks the onset of paleo-Mozambique ocean closure in the northern part of SGT. Rapid exhumation along MSZ was possibly engineered by early Paleozoic tectonic extrusion related processes during final assembly of the Gondwanaland.