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Corundum–leucosome-bearing aluminous gneiss from Ayyarmalai, Southern Granulite Terrain, India: A textbook example of vapor phase-absent muscovite-melting in silica-undersaturated aluminous rocks

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Abstract

An aluminous gneissic rock associated with high-pressure mafic and felsic granulites in the Palghat-Cauvery Shear Zone of southern India provides a classic example of quartz-absent muscovite melting. The anatectic gneiss shows a conspicuous migmatitic structure defined by closely spaced centimeter to decimeter sized, corundum-bearing leucosomes developed in a weakly foliated mesosome of plagioclase ($An_{21}Ab_{77}Or_2$) and biotite (4.9 wt% TiO_2, X_{Mg} = 0.51–0.47). The boundaries between leucosome and mesosome domains are sharp, and no melanosome selvages are developed at the interface. Corundum occurs as euhedral crystals up to 2 cm in diameter, typically centered in the leucosome matrix of coarse-grained perthitic alkali feldspar (integrated composition: $An_2Ab_{35}Or_{63}$), minor relict biotite (4.2–5.1 wt% TiO_2, X_{Mg} = 0.48–0.46) and plagioclase ($An_{21}Ab_{78}Or_1$). In some domains, the mesosomes also contain elongate clusters of similarly oriented smaller corundum plates that are intergrown with perthitic alkali feldspar, presumably replacing former kyanite blades.

The textural and mineralogical characteristics and petrogenetic grid considerations indicate breakdown of muscovite through two successive dehydration-melting reactions: (1) formation of corundum+K-feldspar-clusters via the reaction muscovite+aluminosilicate → corundum+liquid at the sites of kyanite/sillimanite, and (2) development of corundum-bearing leucosomes through the reaction muscovite → corundum+K-feldspar+liquid, focused around the sites of nucleation and growth of peritectic corundum. *P-T* pseudosection modeling in the Na_2O-CaO-K_2O-FeO-MgO-Al_2O_3-SiO_2-H_2O-TiO_2 system locates the onset and completion of the muscovite-melting reaction 2 in the steep narrow quadrivariant field Ms+Bt+Pl+Kfs+Crn+Liq, which extends from ~6 kbar, 720 °C to higher pressures. Biotite remained stable and was not involved in the melting reactions. Two-feldspar thermometry gives peak-temperatures of 800 ± 50 °C. Combined with *P-T* estimates for metapelitic granulites in the area, these *P-T* constraints appear to be consistent with a clockwise *P-T* evolution of the eastern Palghat Cauvery shear zone with peak *P-T* conditions not exceeding ca. 800 °C and 10–12 kbar. The timing of partial melting and HT-metamorphism is constrained at ~529 Ma by U-Pb spot dating of oscillatory zoned individual grains and overgrowths on detrital zircon cores included in peritectic corundum of leucosome domains. The zircon cores indicate a Paleoproterozoic (2.5–2.0 Ga) provenance of the sedimentary protolith.

Keywords: Aluminous migmatite, silica-undersaturated muscovite melting, corundum-bearing leucosomes, Palghat-Cauvery shear zone system