

Diffusion-controlled reactions from the Archean Sittampundi Layered Complex, India

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The Archean chromite-layered anorthosite of the Sittampundi Complex, Tamil Nadu, India is bordered by a layer containing peraluminous corundum, spinel, sapphirine, sillimanite, staurolite and högbomite all set in a matrix of plagioclase. A similar sapphirine-bearing assemblage has prompted many workers to infer ultrahigh-temperature (UHT) metamorphism from the same location. However, our detailed petrological investigations demonstrate that diffusion-controlled metasomatic reactions were responsible for formation of the high-temperature sapphirine, spinel, corundum etc. There are two types of spinel: Fe-Mg ($X_{Mg}=0.4$) and Cr-rich (Cr_2O_3 12wt%) in the same sample; nevertheless, chromite is not present in this layer. Fe-Mg-spinel is associated with Ti-bearing högbomite ($TiO_2 \sim 5wt\%$), which are indistinguishable under transmitted light. Sapphirine (7:9:3 polytype) occurs along the grain boundaries of Fe-rich staurolite ($X_{Fe}=0.64$), sapphirine and staurolite are mostly along the dihedral grain boundaries of plagioclase ($X_{An}=0.92$), and corundum forms a thin film along plagioclase-gedrite grain boundaries. Ca-rich plagioclase inclusions are in gedrite, sapphirine, and cordierite, suggesting an early-stage formation of plagioclase. Ca-amphibole forms inclusions in cordierite that has up to $\sim 2wt\%$ Cr_2O_3 . Also, sapphirine, corundum, gedrite, sillimanite, högbomite and staurolite have significant contents of Cr_2O_3 , indicating mobility of chromium derived from nearby chromitite layers in the anorthosite. The textures and mineral chemistry indicate a diffusion-driven alteration of an anorthosite layer close to chromitite. Similar unusual mineral assemblages are reported in metasomatic sapphirine-bearing rocks of the Fiskenaesset complex, Greenland, and in the Limpopo belt, South Africa. These assemblages are indicative of cm-scale metasomatic reactions between two distinct lithologies driven by a significant chemical potential gradient.

Keywords: Chromite, Metasomatism, Archean Layered Complex