Origin of ruby in chromiferous anorthosites, from the Sittampundi Layered Complex, India

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The origin of colourless and pink corundum (ruby) is a subject of significant interest to petrologists and gemologists. Studies have shown that economically viable ruby is associated with colluvial deposits and hence genesis of this gem mineral is the subject of considerable debate. Corundum / ruby is rarely found in mafic-ultramafic / anorthositic rocks. A number of diverse petrogenetic models have been proposed to explain the formation of corundum in mafic-ultramafic rocks and anorthosites (extremely rare). These are (1) as a liquidus phase during magmatic crystallization; (2) as a product of high- to ultra-high pressure metamorphism; (3) through anatexis of anorthositic rocks; (4) as a metasomatic mineral that formed by desilification of rocks. The ~2.9 Ga old metamorphosed layered magmatic complex of Sittampundi (SLC) developed ruby (with up to 2.2 wt% Cr_2O_3) in anorthosite (with highly calcic anorthite, >An96) proximal to chromitite layers. Textural features and numerically computed phase diagrams in the systems NCASH (Na_2O-CaO-Al_2O_3-SiO_2-H_2O) and CASH suggest that melting of anorthite in highly calcic anorthosite requires metamorphic temperature in excess of 1000°C at 9 kbar. Presence of Na (albite content in plagioclase) lowers the solidus of anorthite melting by more than ~150°C at the same pressure. Amount of H_2O has practically no effect on the solidus temperature, whereas a drop in pressure drastically raises the temperature of melting (15-20°C/kbar). Integrating all the geological features it is proposed that aqueous fluid assisted partial melting of anorthosite of the SLC at >900°C and at ~9 kbar, thereby producing ruby prior to the onset of high pressure metamorphism of the complex (11±2 kbar, 750±50°C). A close match between $\delta^{18}O$ values of ruby (+4.56-5.18‰) and anorthite (+6.24-6.68‰) supports the derivation of ruby from anorthite. The Cr_2O_3 that renders the pink color of the ruby was presumably derived from the adjoining chromite band during partial melting. This study offers a new petrogenetic model for the origin of ruby in nature.