American Mineralogist, Volume 105, pages 1161–1174, 2020

Origin of corundum within anorthite megacrysts from anorthositic amphibolites, Granulite Terrane, Southern India

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Abstract

Growth of corundum in metamorphosed anorthosites and related basic-ultra-basic rocks is an exceptional feature, and its origin remains elusive. We describe the occurrence of and offer an explanation for the genesis of corundum in anorthositic amphibolites from ~2.5 Ga old basement of the Granulite Terrane of Southern India (GTSI). The studied amphibolites from two localities, Manavadi (MvAm) and Ayyarmalai (AyAm), contain anorthite lenses ($An_{90–99}$) with euhedral to elliptical outline set in a finer-grained matrix of calcic plagioclase ($An_{85–90}$) and aluminous amphibole (pargasite-magnesiohastingsite). The lenses, interpreted as primary magmatic megacrysts, and the matrix are both recrystallized under static condition presumably during the regional high pressure (HP) metamorphism (~800 °C, 8–11 kbar) at ~2.45 Ga. Corundum occurs in the core of some of the recrystallized anorthite lenses ($An_{95–99}$) in two modes: (1) Dominantly, it forms aggregates with magnetite (with rare inclusion of hercynite; in MvAm) or spinel (and occasionally hematite-ilmenite; in AyAm). The aggregates cut across the polygonal grain boundaries of the anorthite and contain inclusions of anorthite. (2) Corundum also occurs along the grain boundaries or at the triple junctions of the polygonal anorthite grains, where it forms euhedral tabular grains, sieved with inclusions of anorthite or forms skeletal rims around the recrystallized anorthite, such that it seems to be intergrown with anorthite. Combined petrological data and computed phase relations are consistent with growth of corundum in an open system during regional metamorphism in the presence of intergranular fluids. Two mechanisms are proposed to explain the formation of the corundum in the amphibolites: (1) corundum + magnetite/spinel aggregates formed dominantly by oxy-exsolution of pre-existing Al-Fe-Mg-(Ti)-spinel. This pre-existing spinel may be primary magmatic inclusions within the anorthite phenocrysts or could have formed due to reaction of primary magmatic inclusions of olivine with the host anorthite. Pseudosections of f_{O_2}-n_{H_2O}-*T*-*P* in the CaO–FeO–MgO–Al_2O_3–SiO_2–H_2O (CFMASH) system indicate that f_{O_2} and H_2O strongly influence the formation of corundum + amphibole from the initial magmatic assemblage of anorthite (phenocrysts) + spinel ± olivine (inclusions). (2) The corundum with anorthite presumably formed through desilification and decalcification of anorthite, as is indicated by computed phase relations in isobaric-isothermal chemical potential diagrams (μSiO_2-μCaO) in parts of the CASH system. Growth of corundum in this mode is augmented by high activity of anorthite in plagioclase, high pressure, and low-to-medium temperature of metamorphism. This study thus presents a new viable mechanism for the origin of corundum in anorthositic amphibolites, and basic-ultra-basic rocks in general, which should provide new insight into lower crustal processes like high-pressure metamorphism.

Keywords: Metasomatic corundum, chemical potential, desilification decalcification, anorthite phenocryst, Granulite Terrane of South India