American Mineralogist, Volume 105, pages 255–261, 2020

Cl-bearing fluorcalciobritholite in high-Ti basalts from Apollo 11 and 17: Implications for volatile histories of late-stage lunar magmas.

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Abstract

We report the occurrence of a previously unidentified mineral in lunar samples: a Cl-,F-,REE-rich silico-phosphate identified as Cl-bearing fluorcalciobritholite. This mineral is found in late-stage crystallization assemblages of slowly cooled high-Ti basalts 10044, 10047, 75035, and 75055. It occurs as rims on fluorapatite or as a solid-solution between fluorapatite and Cl-fluorcalciobritholite. The Cl-fluorcalciobritholite appears to be nominally anhydrous. The Cl and Fe^{2+} of the lunar Cl-fluorcalciobritholite distinguishes it from its terrestrial analog. The textures and chemistry of the Cl-fluorcalciobritholite argue for growth during the last stages of igneous crystallization, rather than by later alteration/replacement by Cl-, REE-bearing metasomatic agents in the lunar crust. The igneous growth of this Cl- and F-bearing and OH-poor mineral after apatite in the samples we have studied suggests that the Lunar Apatite Paradox model (Boyce et al. 2014) may be inapplicable for high-Ti lunar magmas. This new volatile-bearing mineral has important potential as a geochemical tool for understanding Cl isotopes and REE chemistry of lunar samples.

Keywords: Moon lunar volatiles, apatite, britholite, mare basalt, apollo, phosphate, chlorine