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Chemical and textural relations of britholite- and apatite-group minerals from hydrothermal REE mineralization at the Rodeo de los Molles deposit, Central Argentina

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Abstract

Britholite group minerals $(REE,Ca)_5[(Si,P)O_4]_3(OH,F)$ are widespread rare-earth minerals in alkaline rocks and their associated metasomatic zones, where they usually are minor accessory phases. An exception is the REE deposit Rodeo de los Molles, Central Argentina, where fluorbritholite-(Ce) (FBri) is the main carrier of REE and is closely intergrown with fluorapatite (FAp). These minerals reach an abundance of locally up to 75 modal% (FBri) and 20 modal% (FAp) in the vein mineralizations. The Rodeo de los Molles deposit is hosted by a fenitized monzogranite of the Middle Devonian Las Chacras-Potrerillos batholith. The REE mineralization consists of fluorbritholite-(Ce), britholite-(Ce), fluorapatite, allanite-(Ce), and REE fluorcarbonates, and is associated with hydrothermal fluorite, quartz, albite, zircon, and titanite. The REE assemblage takes two forms: irregular patchy shaped REE-rich composites and discrete cross-cutting veins. The irregular composites are more common, but here fluorbritholite-(Ce) is mostly replaced by REE carbonates. The vein mineralization has more abundant and better-preserved britholite phases.

The majority of britholite grains at Rodeo de los Molles are hydrothermally altered, and alteration is strongly enhanced by metamictization, which is indicated by darkening of the mineral, loss of birefringence, porosity, and volume changes leading to polygonal cracks in and around altered grains. A detailed electron microprobe study of apatite-britholite minerals from Rodeo de los Molles revealed compositional variations in fluorapatite and fluorbritholite-(Ce) consistent with the coupled substitution of $REE^{3+} + Si^{4+} = Ca^{2+} + P^{5+}$ and a compositional gap of ~4 apfu between the two phases, which we interpret as a miscibility gap. Micrometer-scale intergrowths of fluorapatite in fluorbritholite-(Ce) minerals and vice versa are chemically characterized here for the first time and interpreted as exsolution textures that formed during cooling below the proposed solvus.

Keywords: Britholite, apatite, exsolution textures, miscibility gap, compositional gap, REE, fenite, alkaline granites, hydrothermal alteration