American Mineralogist, Volume 107, pages 239–247, 2022

Peralkalinity in peraluminous granitic pegmatites. II. Evidence from experiments on carbonate formation in spodumene-bearing assemblages

Yongchao Liu[1,2], Christian Schmidt[2,*], and Jiankang Li[1]

[1]MNR Key Laboratory of Metallogeny and Mineral Assessment, Institute of Mineral Resources, Chinese Academy of Geological Sciences, Beijing 100037, China
[2]GFZ German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, Germany

Abstract

Carbonate has often been identified in aqueous carbonic inclusions in spodumene-bearing and other pegmatites, but its origin remains unclear. Here, the conditions at which carbonate and hydrogen carbonate can be generated from spodumene, CO_2 and H_2O, were studied using a hydrothermal diamond-anvil cell (HDAC) and Raman spectroscopy. In all experiments, spodumene persisted in aqueous carbonic solution up to the maximum temperature (600 to 800 °C). Heating of hydrogen carbonate/oxalate solutions produced CO_2- and HCO_3^--rich peralkaline fluids, which resulted in strong corrosion of spodumene (and polylithionite-trilithionite) and, in one run, formation of zabuyelite [$Li_2(CO_3)$] crystals at low temperatures. The experiments indicate that the reaction of spodumene with CO_2 and H_2O requires a peralkaline fluid to proceed rapidly. In addition, they show that spodumene crystallizes upon the heating of quartz, muscovite, and aqueous lithium carbonate solution. We conclude that if the aqueous fluid was rich in alkali hydrogen carbonate, zabuyelite in fluid inclusions in pegmatites can form both via a subsolidus reaction of CO_2-bearing fluid inclusion with the spodumene host or by trapping a peralkaline fluid early in the evolution of simple or complex pegmatites. The results of our experimental study strengthen the conclusion that, although counterintuitive, hydrogen carbonate-rich peralkaline fluids may be involved in the evolution of peraluminous granitic pegmatites, in which peralkaline minerals are normally absent or very rare.

Keywords: Zabuyelite, carbonate, hydrogen carbonate, CO_2, pegmatite, spodumene, hydrothermal diamond-anvil cell