The origin and significance of zabuyelite (Li_2CO_3)-bearing fluid inclusions in spodumene from granitic pegmatites

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Liquid-vapour-solid phase inclusions in spodumene ($LiAlS_2O_6$) have been interpreted to be the products of a hydrous silicate melt that was entrapped during crystallization. However, recent laser Raman spectroscopic analyses indicate that lithium carbonate is a major component of the entrapped fluid, as shown by the presence of the mineral zabuyelite (Li_2CO_3) in the inclusions. The high carbonate content of these inclusions is inconsistent with previous estimates of fluid composition and is typical of fluid inclusions trapped during a lower temperature hydrothermal stage in granitic rocks. In this study, the bulk composition and origin of fluid inclusions in spodumene from the Tranco pegmatite, Manitoba, were re-evaluated on the basis of (1) new petrographic data, (2) laser Raman spectroscopic analyses of solid phases in 300 separate fluid inclusions, and (3) thermodynamic analysis of the stability of the inclusion constituents in the system Li_2O-

Al_2O_3-SiO_2-H_2O-CO_2.

Petrographic evidence, such as the occurrence of fluid inclusions in healed microfractures that cross cut spodumene laths, indicate a secondary or pseudo-secondary origin. Of the 300 fluid inclusions examined, zabuyelite and quartz are the most common and widespread mineral constituents. Other solids, which were found less frequently, include cookeite, and three unidentified minerals. Thermodynamic analyses of the phases identified in these fluid inclusions were performed using the computer program *PTAX* (Berman et al., 1988). The analyses show that the following reactions:

5 spodumene + H_2O + 2 CO_2 = zabuyelite + 7 quartz + cookeite

2 spodumene + K-feldspar + H_2O + CO_2 = zabuyelite + muscovite + 4 quartz

can occur at the P and T trapping conditions for secondary fluid inclusions in the associated quartz.

Rather than the precipitation of daughter minerals from a trapped hydrous silicate melt, the results of this study suggest that a late aqueous carbonic fluid reacted with spodumene to give rise to the observed inclusion assemblage. An alternate mechanism for the precipitation of zabuyelite and quartz involves boiling of the hydrothermal fluids and the partial loss of CO_2 from the system. Such boiling could result in simultaneous precipitation of zabuyelite and quartz and subsequent closure of fluid inclusions by healing of the microfractures.