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Fluorine behavior during experimental muscovite dehydration melting and natural partitioning between micas: Implications for the petrogenesis of peraluminous leucogranites and pegmatites

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Abstract

Fluorine behavior during the partial melting of two mica-bearing protoliths has been experimentally investigated at 700 to 930 °C and 0.4 and 0.6 GPa. Muscovite dehydration and H_2O-HF fluid-assisted partial-melting experiments were carried out using both a natural and synthetic two-mica schist made of natural micas. The mineral composition of the experiments was assessed by BSE imaging and EDS analyses. The F, Cl, and major elements contents of the glass and micas were determined by EPMA.

The muscovite dehydration melting reaction is muscovite + quartz + plagioclase = peraluminous melt + biotite + sillimanite + potassic feldspar ± hercynite. The starting biotite stays largely stable, showing only minor melt + ilmenite and trace magnetite formation in the cleavages. The newly formed biotite shows similar F contents and a slightly higher X_{Sid} component when compared to the starting biotite. HF-added experiments yield F-rich newly formed biotite.

The experimentally produced melts were of a peraluminous leucogranitic composition with F contents increasing with F-rich protoliths. The bulk partition coefficient $D_F^{schist/melt}$ increases from 0.5 to 3.0 when the F content of the protolith rises from 0.05 to 1.2 wt%. The partition coefficient, $D_F^{Bt/melt}$, increases from 2.0 to 6.0 where the biotite MgO content increases from 5 to 18 wt%. The natural partition coefficient $D_F^{Bt/Ms}$, measured for a set of rocks with a varied lithology from the Seridó Belt, northeastern Brazil, was 2.7 ± 0.5.

The F partition coefficients measured in this study, along with published F partition coefficients between biotite and melt, biotite and muscovite, and fluid and melt, allow for the modeling of F behavior during muscovite dehydration and fluid-present melting. F-rich, two-mica protoliths will increase F partitioning in favor of the micaceous anatectic residue compared to the peraluminous melt. Furthermore, the model indicates that the more Fe-rich the schist and its residual biotite are, the higher the F content of the melt and the fluid. Fluorine-rich peraluminous leucogranites and related fluids may be generated by the anatexis of F- and Fe-rich, two-mica protoliths. As F can be a complexing ligand for Li, Be, Cs, Nb, Ta, W, Sn, and U, muscovite dehydration could potentially be associated with metallic occurrences associated with peraluminous melts.

Keywords: Anatexis, peraluminous leucogranite, micas, fluid, fluorine partition; Experimental Halogens in Honor of Jim Webster