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Exploration of lithium pegmatites using portable XRF: Assessing the impact of sodic alteration on K-Feldspar chemistry

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Granitic pegmatites represent an important source of lithium whereby enrichment of Be, Li, Cs and Ta occurs during fractional crystallization. The chemistry of K-feldspar can trace fractional crystallization using Rb and Cs, which increase, whereas K and Sr remain constant. Thus, ratios of K/Rb, K/Cs and Rb/Sr are used to distinguish fertile from barren lithium-cesium-tantalum (LCT) pegmatites. In situ analysis of these elements in K-feldspar in the field using a portable X-ray fluorescence spectrometer (pXRF) is employed by exploration companies. However, K-Feldspar can commonly alter to albite, but as the pXRF cannot detect Na the impact of albitization on the utility of these diagrams is not well constrained.

A study was conducted on the Brazil Lake spodumene pegmatite (Nova Scotia, Canada), which is characterized, in parts, by intense sodic alteration to albite/cleavelandite. Detailed mapping was combined with pXRF and LA-ICP-MS analysis on K-feldspar with varying degrees of alteration. Application of QA/QC procedures (using reference materials, including K-feldspar) during pXRF analyses demonstrates good precision and accuracy (<6%) for K, Cs, Rb, Sr, Fe, and P in K-feldspar on cut blocks. The results show that progressive alteration of K-feldspar to albite leads to a significant decrease in K, Rb, and Cs, whereas Sr and P remain relatively unchanged. Therefore, the K/Rb and K/Cs ratios are independent of alteration, whereas the Rb/Sr ratio decreases. Geochemical diagrams available in the literature thus present certain limitations related to the sodic alteration of K-feldspar. On the diagrams K/Cs vs. Rb and K/Rb vs. Cs, alteration shifts the data outside the Li field into the sterile/Be field, due to the low Rb and Cs contents of altered K-feldspar. The K/Rb vs. Rb/Sr diagram provides the best results: 1) it distinguishes highly altered K-feldspar/albite from the sterile and the rare metal fields and 2) the pXRF data of partially altered and unaltered K-feldspar plot correctly in the Li field. Therefore, pXRF analysis of K-feldspar is a robust tool for evaluating the economic potential of LCT pegmatites, even when partially altered, provided that appropriate classification diagrams are used.