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Micas from lithium-cesium-tantalum pegmatites: what are they really telling us?

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Granitic pegmatites of the Li-Cs-Ta (LCT) family are an important source of hard rock Li and currently account for the majority of global Li production. This demand is anticipated to continue to grow well into the future in part because LCT granitic pegmatites have a worldwide distribution and are less vulnerable to supply chain disruptions.

Despite their economic importance, many scientific questions remain unresolved such as pegmatite textures, internal and regional zonation, incompatible element and volatile enrichments, to cite a few. For these reasons, interest in pegmatite research, particularly of the LCT family is very timely.

Many of the large and extremely fractionated known LCT pegmatites formed late in Archean terranes, including the Greenbushes pegmatite in Australia, the Tanco pegmatite in Manitoba, Canada and several others in the Canadian Superior Province. The evolution of pegmatites has traditionally been evaluated using changes in the concentrations of incompatible trace elements (*e.g.*, Li, Rb, Cs, Sn, Nb, and Ta) in several minerals such as K-feldspar, garnet, and tourmaline. White mica has been seen by many as a robust mineral to study these changes in pegmatite systems as micas have the ability of capturing physicochemical changes in pegmatite melts. Furthermore, white mica melt chemical equilibrium is typically preserved under near-liquidus conditions such that the trace-element concentrations of this mineral should provide a robust record of near-solidus melt chemistry.

Recent advances in microbeam analytical techniques, such as laser ablation, now allow high-resolution characterization of trace element distribution within individual white mica grains and across large datasets. Using examples from various LCT pegmatites we document extreme intra- and inter-grain compositional variability. Statistical and machine learning tools are applied to these datasets to provide insights of what the white micas can tell us about LCT pegmatite evolution.