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In Situ Geochemistry of Mica in Exomorphic Spodumene Pegmatite Halos: Implications for Mineral Exploration

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Spodumene pegmatites intrude peraluminous granite of the Ordovician-Devonian Leinster Batholith and its immediate mica schist country rocks within the East Carlow Deformation Zone in South Leinster, Ireland. Pegmatites are often surrounded by exomorphic metasomatic halos formed by magmatic hydrothermal fluids expelled from crystallizing pegmatite. Some halos are detectable by whole-rock analysis 10s to 100s of metres from pegmatite contacts, making them useful exploration vectors, but others are much more spatially restricted. Micas are ideal for monitoring hydrothermal processes related to granitic pegmatite systems, as they can incorporate a wide range of halo elements. This work investigates the viability of using mica geochemistry in restricted halos surrounding spodumene pegmatites in South Leinster to spatially extend halo detectability and to better understand pegmatite crystallization.

White mica is the main metasomatic phase identified in the Leinster halos. It was characterized by quantitative SEM analysis and LA-ICP-MS chemical mapping and spot analysis. The compositional series ranges from muscovite in the unaltered granite to lithian ferroan muscovite in the halo. Intermediate compositions are found within structures interpreted as closed fractures several meters away from the pegmatite. Although white mica appears homogeneous, LA-ICP-MS mapping reveals two distinct types with complex zoning patterns. The first is proposed to represent altered original muscovite with a pristine core zone; the second newly formed mica with core zones enriched in Cs, Li, and Rb. Whereas Cs and Li concentrations decrease with distance, Ta and Nb are concentrated in distant halo mica. These observations have implications for exploration purposes. Methods like LIBS, able to measure element concentrations or ratios in individual crystals, can use the abundances of Li, Cs, Ta, and Nb to vector towards nearby pegmatite. However, the compositional heterogeneity of the mica could cause a problem if depleted core zones are analysed and mistakenly classified as background.