Thallium isotopic analysis of microcline by laser ablation-inductively mass spectrometry with application to granite pegmatite petrogenesis

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Rare element granitic pegmatites are divided into two groups: Lithium, Cesium, Tantalum (LCT) type and Niobium, Yttrium, Fluorine (NYF) type based on their enrichment in these elements. In general, NYF pegmatites are related to anorogenic magmatism where as LCT pegmatites are related to peraluminous granites in orogenic settings. Previously, trace element geochemistry of various minerals has been used to identify LCT and NYF pegmatites, however the source of the magma is still uncertain. In an attempt to characterize the specific sources of these pegmatite types the thallium isotopic ratios of primary microcline from fourteen major pegmatites located around the world were determined by laser ablation inductively coupled mass spectrometry. Thallium was selected to be analyzed for because it is very enriched in highly fractionated granites and because its isotopic signature in crustal rocks show a small, but measurable, range which has been attributed to specific sources in the mantle or crust. The structural state of all microcline samples was determined by powder X-ray diffraction and the major as well as trace element content was measured by electron microprobe analysis and laser ablation inductively coupled mass spectrometry, respectively. The relative abundance of Ga, Rb and Pb found in the microcline clearly separates LCT and NYF type pegmatites as previous work has suggested. The $^{205}Tl/^{203}Tl$ ratios of microcline samples, which contain between 20 and 300 ppm Tl, was measured for the first time by Laser Ablation Inductively Coupled Mass Spectrometry. All the $^{205}Tl/^{203}Tl$ ratios were around 2.395 except for a rare alkali-enriched microcline from the core of the Tanco pegmatite. In conclusion, the $^{205}Tl/^{203}Tl$ ratios obtained by laser ablation inductively coupled mass spectrometry do not discriminate the different sources for NYF and LCT pegmatites, however, the results do indicate significant fractionation of thallium isotopes within the highly evolved Tanco pegmatite in Manitoba.

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