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Analysis of light lithophile elements (Li, Be, B) by laser ablation ICP-MS: Comparison between magnetic sector and quadrupole ICP-MS

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ABSTRACT

We report techniques for in-situ abundance measurements of the light-lithophile elements (LLE; Li, Be, and B) in silicate glasses by laser-ablation inductively coupled mass spectrometry (LA-ICP-MS), and compare the analytical performance of a sector field and quadrupole mass analyzer for these measurements. LA-ICP-MS is shown to be an effective means of determining LLE abundances at spatial scales between 25 and 100 μm. Detection limits depend on instrumental sensitivity and ablation rate, but can be in the low- to sub-ng/g range. Measured ion yields for ^{7}Li, ^{9}Be, and ^{11}B ion, normalized to ^{43}Ca as an internal standard, remain largely constant during ablation, although ^{11}B shows a relative increase once the ablation crater aspect ratio exceeds ~1. Surficial contamination, particularly of B, can be removed rapidly via a short pre-ablation (~20 pulses) immediately prior to analysis. The sector field ICP-MS provided considerable improvements in analytical performance over the quadrupole mass analyzer, although longer magnet settling times result in greater duty cycle losses. Calculated detection limits for a given set of ablation conditions are 20–90 times lower, and useful yields (the ratio of atoms ablated to counts detected) are 20–75 times greater for the sector field instrument. Analysis of reference glasses shows that LA-ICP-MS provides accurate measurements of Li, Be, and B contents in silicate glasses over a range of compositions (komatiite to rhyolite). LA-ICP-MS also offers similar accuracy and precision and marked improvements in sample throughput compared to secondary ion mass spectrometry (SIMS) analysis of LLE abundances, although SIMS has higher useful yield and thus provides better spatial resolution.

Keywords: Light-lithophile elements (Li, Be, B), laser ablation ICP-MS, SIMS, geochemical reference standards