Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.32120

In-situ Stable Si Isotope Analysis of Zircons by Femtosecond Laser Ablation MC-ICP-MS

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Zircon ($ZrSiO_4$) preserves isotopic and geochemical signatures over geological timescales, acting as a critical archive of magmatic processes and a window onto their parental melts and crustal evolution. Silicon (Si) isotopes in zircon provide a novel tool for understanding magma evolution and crustal recycling, as Si is a major component of Earth's continental crust and exhibits measurable isotopic fractionation during fractional crystallization, and can be used to trace magma mixing and assimilation of surface materials into melts [1-3]. Previous studies have been limited to solution analyses requiring a time-consuming chemical process or Secondary ion mass spectrometry (SIMS) analyses using matrix-matched calibration method depending on availability and sustainability of zircon references. But due to less thermal effect, femtosecond laser ablation (fs-LA) analyses are suggested to be less sensitive to sample and standard mismatch, paving a way to in-situ techniques. Here, we report a non-matrix matched calibration method to measure Si isotope ratios in zircon using fs-LA coupled with multi collector inductively coupled plasma mass spectrometer (MC-ICP-MS).

We measured three natural zircon reference materials: Mud Tank, 91500 and Plešovice, together with BHVO-2 (basalt glass) and ML3B-G (andesite glass) using NIST612 glass as the bracketing standard. The obtained $\delta^{30}Si$ and $\delta^{29}Si$ values are reported relative to the delta-zero material NBS28, based on the Si isotope ratio offset between NIST612 and NBS28. The resulting $\delta^{30}Si$ values were -0.25 ± 0.09 ‰ (2SD) for Mud Tank, -0.19 ± 0.11 ‰ (2SD) for Plešovice and -0.20 ± 0.17 ‰ (2SD) for 91500. Despite being bracketed by the amorphous NIST612 standard, the zircon data agree well with values derived from solution analyses and with previously reported values using fs-LA [4]. The $\delta^{30}Si$ values of BHVO-2 (-0.22 ± 0.13) and ML3B (-0.32 ± 0.07) are likewise consistent with accepted values in the literature. This study highlights the potential of applying non-matrix matched calibration methods with fs-LA-MC-ICP-MS to analyse in-situ Si isotope ratios in zircons and other minerals.

References:

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