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Evaluation of a novel femtosecond laser for in-situ analysis based on a two-dimensional galvanometer scanning system

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Uneven energy distribution of femtosecond lasers presents a significant challenge for single-spot analysis, which often leads to concave ablation craters. This study assesses the performance of a femtosecond laser for in-situ analysis using a novel galvanometer scanning system. A galvanometer rapidly moves the laser beam focus to create craters with a small beam spot. We first examined the ICP-MS signal sensitivity to laser parameters, establishing a strong linear correlation with laser energy, repetition rate, spot size, and galvanometer scanning frequency. Elemental fractionation analysis of NIST SRM 610 suggests minimal bias, with fractionation indices of different elements approaching unity. Subsequently, the elemental content of six reference material glass was measured by fsLA-ICP-MS to evaluate the elemental quantification capabilities of the Galvo-femtosecond laser (Galvo-fsLA). The laser's capability for in-situ U-Pb dating was demonstrated by concordant U-Pb ages of six zircon reference materials that are highly consistent with the ID-TIMS ages reported previously. Finally, the reliability of the new laser for isotope analysis was verified by accurate determination of radiogenic Hf, Pb isotopes, and stable Cu isotopes, all agreeing well with their reference values within uncertainties. These assessments underscore the significant potential of the Galvo-fsLA for enhanced accuracy and precision of single-spot in-situ analysis.