

The application of ultrafast laser ablation to ultrafast geochemical mapping

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Since its debut, femtosecond laser ablation inductively coupled plasma mass spectrometry (fs-LA ICP-MS) has been recognized for its superior analytical performance in elemental and isotopic fractionation compared to nanosecond laser ablation. Peer-reviewed studies have extensively explored the effects of ultrashort femtosecond laser pulses on reducing matrix effects, particle size and distribution, transport efficiency, and other parameters that boost the accuracy and precision of spatially resolved, unidimensional isotope measurement [1,2,3]. Comparatively, the capabilities of high repetition femtosecond lasers for elemental and isotopic imaging have remained largely underexplored and remain largely untapped.

In this contribution, we look at the characteristics of a new femtosecond laser ablation system, the Iridia Femto, equipped with an ablation chamber capable of generating ultra-fast transient signals (ranging from single-digit milliseconds to sub-millisecond durations, depending on the configuration). We explore the imaging capabilities of the system when ablating challenging matrices as well as how it can be optimized for cutting edge applications. Crater morphology, ablation rates of various matrices as well as various standardization approaches are explored to offer a comprehensive overview of the capabilities of high repetition rate femtosecond lasers for elemental and isotopic imaging.

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[2] J.J. Gonzalez, A. Fernandez, D. Oropeza, X. Mao, R.E. Russo, Femtosecond laser ablation: Experimental study of the repetition rate influence on inductively coupled plasma mass spectrometry performance, *Spectrochim. Acta - Part B At. Spectrosc.* 63 (2008) 277–286.

[3] M.E. Shaheen, J.E. Gagnon, B.J. Fryer, Femtosecond (fs) lasers coupled with modern ICP-MS instruments provide new and improved potential for in situ elemental and isotopic analyses in the geosciences, *Chem. Geol.* 330–331 (2012) 260–273.