Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.31857

# Method Development and Applications for *In Situ* Rb-Sr Isotopic Analyses by Femtosecond LA-MC-ICPMS/MS

**HAYWARD MELTON**[1], TENG EE (TONY) YAP[1], ALICIA MARIE CRUZ-URIBE[2] AND FRANÇOIS L.H. TISSOT[1]

[1]California Institute of Technology
[2]University of Maine

The Rb-Sr beta-decay system is a fundamental tool in geochronology and geoforensics, widely applied to terrestrial, lunar, and Martian samples [1–3]. This technique is based on the radioactive decay of $^{87}$Rb to $^{87}$Sr and takes advantage of the substitution of Rb and Sr for K and Ca in rock-forming minerals which often have a range of Rb/Sr ratios. Over time, the decay of $^{87}$Rb to $^{87}$Sr increases the $^{87}$Sr/$^{86}$Sr ratio, allowing us to construct an isochron and determine the crystallization age of a sample and its initial $^{87}$Sr/$^{86}$Sr ratio.

Traditional Rb-Sr dating requires sample processing to mitigate the $^{87}$Rb-$^{87}$Sr isobaric interference before analysis [4]. We develop a method integrating a femtosecond (fs) ESL NWRFemto 257nm LA system with a Thermo Fisher Scientific™ Neoma MC-ICPMS/MS, featuring a dual Wien mass filter and a collision-reaction cell for online Rb-Sr separation [5-7]. Using $SF_6$ gas, we selectively fluorinate Sr, shifting it by +19 m/z, and optimize key laser parameters.

We analyze reference glasses from NIST, MPI-DING, and USGS, covering a broad range of Rb-Sr compositions. Our results show $^{87}$Sr/$^{86}$Sr accuracies exceeding 0.03% and 87Rb/86Sr accuracies within 5%, with precisions of ~1‰ and ~3% (2SE), respectively. Even with the benefits of an fs-LA system [8] this is still an unexpected degree of elemental fractionation which is likely attributable to transport effects.

Our method advances high-precision *in situ* Rb-Sr dating with broad applicability across geologic and planetary sciences. We demonstrate its potential for dating terrestrial feldspars and micas, tracing turquoise trade routes, and analyzing Martian meteorites, a subset of which will be presented.

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