EUROPEAN WORKSHOP ON LASER ABLATION

Prospects and challenges for in situ beta decay geochronology by MC-ICP-MS/MS

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The development of tandem mass spectrometers equipped with collision cells has enabled online interference removal for ICP-MS, with special attention paid to beta decay systems used for geochronology (e.g., Rb-Sr, Lu-Hf). The addition of pre-cell mass filters and collision cells for multicollector mass spectrometry has recently been utilized to constrain single laser spot Rb-Sr isochron dates in biotite with unprecedented precision [1]. This technique opens up avenues for campaign-style Rb-Sr geochronology, and adds a powerful new tool for constraining the chronologic history of rocks in many tectonic settings over a broad range of spatial and temporal scales.

Static multicollection from ^{85}Rb to mass-shifted $^{88}Sr^{19}F$ utilizing the Thermo Scientific™ Neoma™ MC-ICP-MS/MS coupled to an ESL™ imageGEO™193 excimer laser-ablation system enables the recovery of significant age information from individual integrations within single laser spot analyses. These data reveal single spot isochrons - some with multiple isochronous populations - from multiple orogenic belts. The high-precision simultaneous isotope measurement approach on the Neoma™ enables determination of distinct initial $^{87}Sr/^{86}Sr$ ratios based on the fit of individual isochrons within single laser spots, which is assisted by the use of 10^{11} and 10^{13} ohm amplifiers on Faraday cups. The large range of Rb/Sr ratios in micas opens up a new microsampling frontier for isochron-based geochronology that will transform our approach to unraveling continent-scale tectonic processes over Earth's history. Two extensive datasets from these efforts demonstrate punctuated geochronologic events not captured by other chronometers, suggesting the ability to uncover previously hidden thermal and fluid events using our approach.

Looking toward the future, the prospects for utilizing LA-MC-ICP-MS/MS for geochronology will expand the geochronologic toolbox beyond traditional accessory phase geochronology. For example, initial successes employing single collector MS/MS machines for *in situ* Lu-Hf analyses open the door for vastly improved precision by LA-MC-ICP-MS/MS, particularly on the Hf isotope ratio in low-Hf phases such as apatite and garnet. In addition, simultaneous LIBS analyses have the potential to provide major and trace element information in real time, further augmenting the *in situ* approach to petrochronology.

[1] Cruz-Uribe *et al*. (2023) Geostandards and Geoanalytical Research. doi:10.1111/ggr.12518.