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Improved accuracy and precision of in-situ Sr isotope measurements by LA-MC-ICP-MS: New insights into magma histories

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Radiogenic Sr isotope ratios can be measured in common igneous minerals and glasses and offer the potential to gain a detailed insight into the evolution of magmatic systems across a diverse range of bulk rock compositions. Laser ablation multi-collector mass spectrometry (LA-MC-ICP-MS) has emerged as the technique of choice for in situ Sr isotope measurements as it is significantly faster and can achieve greater spatial resolution compared to traditional micro-milling and solution-based analyses. However, numerous elemental and molecular inferences on Sr isotopes pose analytical challenges and there are still no widely adopted standard analytical protocols.

Here, we outline a series of guidelines for improving the accuracy and precision of Sr isotope measurements in plagioclase and glassy to microcrystalline matrix by LA-MC-ICP-MS. The guidelines are derived from analyses of a newly characterised set of plagioclase reference materials and previously characterised rock glass reference materials. Our tests show that a combination of Kr-baseline subtraction, Rb-peak stripping using βRb derived from a bracketing glass standard, and a CaCa/CaAr correction for plagioclase and CaCa/CaAr + REE2+ correction for low Rb/Sr rock glasses, yield the most accurate and precise 87Sr/86Sr. Using our guidelines, static spot analyses with a beam diameter of 100 µm achieve <100 ppm 2SE internal precision for 87Sr/86Sr in materials with <1000 ppm Sr. Comparable precision can also be achieved at beam diameters of 65 and 50 µm by rastering the laser beam across the sample, providing new opportunities to analyse small sample features.

We apply the method to plagioclase phenocrysts and microcrystalline matrix from the 23-24 Ma Tweed volcano, the largest continental shield volcano in the Cenozoic hotspot province of Eastern Australia. 87Sr/86Sr ratios show sharp variations between 0.7038 and 0.7060 across volcanic units, tracking discrete events of crustal assimilation with time. Individual plagioclase zones and their host matrix yield similar results, indicating well homogenised interaction between mafic replenishment and the crust. Together with major and trace element variations in plagioclase, 87Sr/86Sr data suggest punctuated assimilation-fractional crystallisation events characterised bursts of volcanic activity throughout the lifespan of volcanism.