Precision of *in situ* isotope ratio measurements by LAM-MC-ICPMS

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The coupling of a laser ablation microprobe (LAM) to a multi-collector ICP-MS has enabled the development of high-precision *in situ* isotope ratio analysis. Like other microanalytical techniques, laser ablation MC-ICPMS provides the benefit of high spatial resolution and produces data that can be integrated with microstructural and other geochemical datasets. Despite the advances in recent years there remains a perception that the accuracy and precision of the *in situ* measurements suffer in comparison to solution measurements because of matrix effects and isobaric interferences.

In addition to corrections for mass bias and isobaric/molecular interferences the precision of an individual measurement is primarily a function of the number of ions counted and therefore depends on the concentration of the element in the mineral, the size of the laser pit, the sensitivity of the mass spectrometer and the counting time. Signals produced by laser ablation are transient, but operating conditions for the laser can be chosen to achieve near steady-state signals. Frequency, laser fluence and spot size settings all contribute to signal stability and intensity. Instrument sensitivity is not a problem for isotopic systems where the element is a major constituent of the mineral (e.g. Mg in olivine, Fe in pyrite). Significant limitations remain in the measurement of isotopic ratios of trace elements in common minerals and in many cases the best precision has been obtained at the expense of spatial resolution (effectively using the laser as a solid sampling tool) or limited to minerals with very low parent/daughter ratios. Ablation time and hence counting time can be limited by the size of the mineral grain and the calculation of the precision of individual measurements should take this into account. The use of ion counters in combination with Faraday detectors or multiple-ion counting systems can extend the measurements to smaller ion beam intensities, thereby making it possible to use smaller spot sizes or measure lower concentrations. Although the precision of individual measurements using ion counters can approach the theoretical precision, external reproducibility is dependent on long-term detector stability and gain calibration.

Melt Inclusions as a recorder of crustal assimilation processes

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Theoretical models suggest that crustal assimilation and fractional crystallization processes should be closely linked, with the energy required to melt crustal rocks coming from cooling and crystallization of magma. The early stages of crystallization of basaltic magma, dominated by olivine, are predicted to be potentially associated with high rates of assimilation [1]. Thus, olivine-hosted melt inclusions might be expected to preserve a record of progressive stages of the assimilation process, as is seen in Yemen flood basalts [2]. We will present new compositional data for olivine-hosted melt inclusions to assess the timing of crustal assimilation relative to crystallization for two contrasting styles of magmatic systems (small-volume monogenetic eruptions and large-volume flood basalt sequences).

The monogenetic Ice Springs basalt flow (Utah) has two compositionally distinct flow lobes (49% & 51% SiO_2). All melt inclusions have similar compositions to the low-Si lobe, which implies that the assimilation responsible for the high-Si lobe occurred after olivine crystallization, and rapidly, most likely during eruption, given the small olivine phenocryst size (~0.5 mm). At Paricutin (Mexico), melt inclusions from the early stages and the more contaminated later stages of the eruption have similar compositions to their respective host lavas, perhaps indicating that in this case assimilation occurred prior to significant olivine crystallization [3]. In contrast, individual flood basalt samples (from Yemen, West Greenland, Etendeka, Karoo, Baffin Island) can contain melt inclusions with a diverse range in compositions, consistent with variable extents of crustal assimilation taking place as the olivine crystals were growing. The contrasting styles of compositional records shown by the melt inclusions require fundamental differences in the nature of magma transport and storage between these different magmatic systems, and allow us to make inferences about the likely locations and mechanisms by which crustal assimilation occurs.

[1] Reiners *et al.* (1995) *Geology* **23**, 563-566. [2] Kent *et al.* (2002) *EPSL* **202**, 577-594. [3] Rowe *et al.* (2008) *GCA*, this volume.