Deconvolving laser-ablation profiles to resolve sharp compositional boundaries.

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Measurement of elemental diffusion in mineral lattices has provided a powerful tool for quantifying the timescales of magmatic processes [1]. However, this information comes at the price of costly and often time consuming analyses. The high spatial resolution required to constrain a diffusion profile requires a technique that can provide high analytical precision from a very small sample size. Historically diffusion studies, focussed on trace elements, have made use of the high sensitivity and small beam sizes of SIMS and nano SIMS. Whilst improvements in LA-ICPMS systems mean they are now used in diffusion studies [2], their application is limited to relatively fast diffusivities ($1x10^{-6}$ m^2/sec) due to the ablation area required to generate sufficient signal in the ICPMS [3]. Spatial resolution can be improved through depth profiling but this has the associated problem of down-hole fractionation.

Using a deep-UV 193 nm excimer laser-ablation system coupled to an Agilent 7500ce/cs quadrupole ICPMS described in [4] we have obtained data from laser tracks using both a standard circular laser mask and a rectangular mask over a range of custom-made sandwiched synthetic glass standards. Pulse rate was reduced to minimise mixing effects in the ablation plasma and the SQUID was removed, reducing travel time to the ICPMS. Data was deconvolved using a frequency domain Wiener Filter [5] after first estimating the impulse response and noise spectrum. Preliminary results suggest that it is possible to resolve sharp compositional boundaries at ~30% better spatial resolution, and with significant suppression of noise, compared to standard LA-ICPMS rastering. This suggests that it may be possible to successful resolve diffusion profiles for elements in minerals with $D \sim 1x10^{-18}$ m^2/s, i.e. Sr in plagioclase which has previously been shown to diffuse too slowly for magmatic timescales to be resolved by LA-ICPMS [6].

[1] Costa *et al* (2003) GCA **67**, 2189-2200 [2] Spandler *et al* (2007) *Nature* **447**, 303-306 [3] Chernaik *et al* (2010) RiMG **72** 107-170 [4] Muller *et al* (2009) *JAAS* **24**, 209-214 [5] Wiener (1942) Research Project DIC-6037 MIT [6] Saunders *et al* (2010) *J.Pet.* **51**, 2465-2488