Studies of the source of laser-induced isotopic bias in LA-MC-ICP-MS

S. E. JACKSON, AND D. GÜNTHER

GEMOC National Key Centre, Department of Earth and Planetary Sciences, Macquarie University, N. Ryde, Australia (sjackson@els.mq.edu.au)

Laboratory for Inorganic Chemistry, ETH Hönggerberg, Zurich, Switzerland (guenther@inorg.chem.ethz.ch)

Coupling laser ablation sampling with MC-ICP-MS analysis allows Cu and Fe isotopic compositions to be measured rapidly in sulphide minerals with 2_ precision as low as 1 part per 10,000 (1 epsilon unit). This precision is much smaller than the variation typical in many sulphide ore deposits, allowing isotopic variations to be detected in a wide variety of mineralised systems on single-grain to deposit-wide scales [1,2,3]. These data offer, for the first time, a direct approach to identifying the source of metals in hydrothermal deposits. Potentially, they also allow isotopic fingerprinting of particular ore depositional environments, which may possess important exploration significance.

A major obstacle to performing laser-based metal isotopic analyses is a systematic and ablation-time-dependent bias (up to 40 _) in the isotopic measurements. Correcting this bias can be achieved by referencing to analyses of an isotopically homogeneous, matrix-matched standard. However, the requirement for isotopic mineral standards severely limits the applicability of the technique, and frequent external standardisation reduces sample throughput

To determine whether the bias in the laser-based analyses occurs during ablation (i.e., non-isotopically stoichiometric ablation) and/or during post-ablation processes occurring in the ICP, a copper target was ablated under a range of analytical conditions (wavelength, pulse energy, ablation gas). The ablated particulates were filtered from the gas stream, dissolved and analysed on a Neptune MC-ICP-MS, employing external normalisation using Ni to correct instrumental mass bias. Biases in the measured isotopic composition of the dissolved particles relative to the target material indicate that isotopic fractionation occurs during the ablation process, but only to a small extent. This leaves open the possibility that isotopic fractionation takes place to a significant degree in the ICP, as demonstrated for elemental fractionation [4], perhaps through the interplay of incomplete ionisation of ablated particulates and a systematic change in ablated particle size distribution during ablation.

References

[1] Botfield, A., 1999, *Unpubl. Honours Thesis*, Macquarie University.

[2] Doyle, S., 2001, *Unpubl. Honours Thesis*, Macquarie University.

[3] Graham, S., Griffin, W.L., Jackson, S.E., Walter, M.R., and Pearson, N.J., *V.M. Goldschmidt Conference*, 2002.

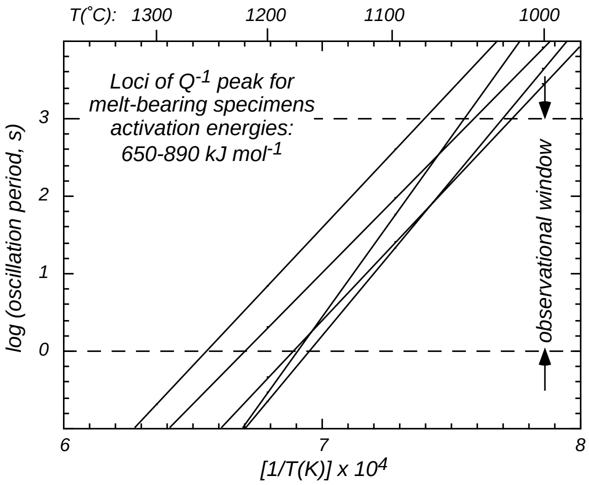
[4] Guillong, M., and Günther, D., *J. Anal. Atom. Spectrom*, in press.

Systematics in the seismic wave attenuation of partially molten olivine aggregates

I JACKSON, U FAUL, J FITZ GERALD AND B TAN

Research School of Earth Sciences, Australian National University, Canberra, Australia (uli.faul@anu.edu.au)

A suite of melt-bearing olivine specimens has been prepared by hot-isostatic pressing of natural or synthetic Fo_{90} powders mixed with powdered basaltic glass. The resulting specimens have been tested with torsional forced oscillation/ microcreep methods at 50°C intervals during staged cooling. Relatively narrow grain-size distributions determined after testing by EBSD indicate a generally high degree of textural equilibrium with mean grain sizes of 9-52 µm. Melt fractions vary from 0.4 to 3.7% at the highest temperatures (1240-1300˚C) reached during hot-pressing and mechanical testing. SEM and TEM observations indicate that the melt is distributed throughout an interconnected network of grain-edge tubules, some larger pockets and wetted grain boundaries – in accord with previous observations. Re-equilibration of one sample after testing showed that between 1300°C and 1200°C the melt distribution survives largely unaltered, most of the crystallisation occurring between 1200°C and ~1130°C.



The dissipation (Q^{-1}) measured at high temperatures on each of these specimens consists of a broad peak superimposed upon a monotonic background that is enhanced relative to that for melt-free materials. The peak moves across the observational window from 1 to 1000 s period without changing its shape as T decreases from 1170-1260°C (specimen dependent) to 1020-1080°C (Figure). The peak height is positively correlated with melt fraction, whereas its width remains essentially constant. Such systematics allow evaluation of alternative microscopic models for the melt-related enhancement and localisation of attenuation - including stress-induced melt redistribution and melt-facilitated grain-boundary sliding.