Optimised techniques to determine coupled trace element and Sr-Nd-Pb isotope ratios in olivine-hosted melt inclusions

J.M. KOORNNEEF[1]*, A.J.J. BRACCO GARTNER[1], I.K. NIKOGOSIAN[1], M. KLAVER[2], P.Z. VROON[1] AND G.R. DAVIES[1]

[1] Faculty of Science, Vrije Universiteit Amsterdam, The Netherlands (*correspondence: j.m.koornneef@vu.nl)
[2] School of Earth Sciences, University of Bristol, Bristol, UK

Melt inclusions (MIs) in deeply formed magmatic minerals are typically characterised by larger variability in major and trace element- and isotope compositions compared to bulk lavas. The larger geochemical variability reflects that MIs represent partial melts that have escaped post-entrapment melt mixing that homogenises bulk lava compositions. Thus melt inclusions more realistically record the compositional heterogeneity of a mantle source and can be used to infer the presence of enriched or depleted source components in various tectonic settings.

Recent development of 10^{13} Ω resistors in the feedback loop of Faraday cup amplifiers used in thermal ionisation mass spectrometry (TIMS) [1] now allows determining combined Sr-Nd-Pb isotopes in individual melt inclusions (<300 μm). Data on MIs from peninsular Italy confirm the strength of these techniques to identify source components previously unresolved by bulk lava geochemistry [2, 3].

We further optimised the combined wet chemistry and TIMS analytical techniques applied to individual olivine-hosted melt inclusions to determine coupled 1) trace element ratios by ICPMS; 2) Sr-Nd-Pb concentrations by isotope dilution; and 3) isotopic compositions by TIMS. For Pb isotope analyses we use an optimised ^{207}Pb–^{204}Pb double spike technique [4]. Total procedural blanks (<20 pg Sr; <1 pg Nd; <10 pg Pb) can be corrected for using the analysed isotope compositions, but currently are the main limiting factor for application to tectonic settings that generate more depleted magma compositions.

The improved procedures along with data on reference materials and melt inclusions from the Roman Magmatic Province in Italy are presented to evaluate the accuracy and reproducibility as a function of the amount of material analysed.

[1] Koornneef et al., 2014, Anal. Chim. Acta 819, 49-55.
[2] Koornneef et al., 2018, Goldschmidt Abstracts 1335.
[3] Koornneef et al., 2015, Chem. Geol. 397, 14-23.
[4] Klaver et al., 2016, J. Anal. At. Spectrom. 31, 171-178.