Combined Sr-Nd-Pb isotope data on individual melt inclusions from Italy record extreme mantle heterogeneity induced by complex geodynamics

JANNE KOORNNEEF[1], IGOR NIKOGOSIAN[1,2], LISA HAGEMAN[1]; MAXIMILIAN BERNDSEN[1]; MANFRED VAN BERGEN[2], PIETER VROON[1], GARETH DAVIES[1]

[1] VU Amsterdam, The Netherlands (j.m.koornneef@vu.nl)
[2] Utrecht University, The Netherlands

Recycling of Earth's crustal components through subduction or delamination processes, contributes to the observed geochemical heterogeneity in worldwide lavas. Melt inclusions in high Fo-olivine record greater geochemical variability than host lavas and more fully reflect the heterogeneity of magma sources. To date, use of multiple isotope systems on small (<300 μm) melt inclusions was hampered by analytical limitations. Here we report coupled Sr-Nd-Pb isotope data on individual melt inclusions from Italy's complex subduction setting and confirm that we can discriminate the presence of source components that are not resolved by bulk lava compositions.

Combined Sr-Nd-Pb isotopes were determined in ~80 melt inclusions from three localities in the Roman Magmatic Province (Latera, Roccamonfina and Ernici) and three Aeolian Islands (Vulcano, Stromboli, Filicudi). Combined wet chemistry techniques and TIMS analysis using 10^{13} Ω resistors mounted in the feedback loop of Faraday cup amplifiers, allow isotope analyses of 2 ng Sr, 100 pg Pb and 30 pg Nd. Compared to default 10^{11} Ω, use of 10^{13} Ω resistors results in a 10-fold improvement of the signal-to-noise ratio and more precise data for small ion beams (< 20 mV).

Where Sr and Nd isotope compositions largely overlap with the host lava compositons, Pb isotope compositions show extreme variability towards two different unradiogenic end-members. The most extreme unradiogenic inclusion in the Roccamonfina-Ernici trend has $^{206}Pb/^{204}Pb$ 17.8 $^{207}Pb/^{204}Pb$ 15.5, and $^{208}Pb/^{204}Pb$ 37.5 compared to its host with $^{206}Pb/^{204}Pb$ 18.8 $^{207}Pb/^{204}Pb$ 15.7, and $^{208}Pb/^{204}Pb$ 39.1. The most extreme inclusion in the Vulcano-Stromboli trend has $^{206}Pb/^{204}Pb$ 18.5 $^{207}Pb/^{204}Pb$ 15.4, and $^{208}Pb/^{204}Pb$ 38.0 compared to the host that has $^{206}Pb/^{204}Pb$ 19.4 $^{207}Pb/^{204}Pb$ 15.7, and $^{208}Pb/^{204}Pb$ 39.3.

To explain the unradiogenic Pb compositions we infer the presence of components from Hercynian and/or older lower continental crust in the Italian magma sources, emplaced by sediment subduction, subduction erosion, delamination, or slab detachment processes that acted during the complex geodynamic evolution of the Western Mediteranean.