The melt inclusion record of mantle source heterogeneity under Iceland

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While it is well-established that the mantle source regions of Icelandic basalts are heterogeneous, there remains substantial uncertainty regarding key characteristics of this heterogeneity. The present-day spatial distribution of compositions in the mantle under Iceland needs to be understood as part of a broader investigation of the origins and evolution of mantle variability. Melt inclusions hosted in forsteritic olivines in single specimens provide an opportunity to constrain the distribution of mantle melt compositions produced over limited temporal and spatial scales.

The focus of this study is the ~8 kyr Borgarhraun eruption from the Theistareykir volcanic system in NE Iceland. This eruption carried $Fo_{\sim 90}$ olivines in a ~10 wt% MgO liquid that is preserved in tephra glass. Previous studies have reported the trace element composition of 168 ol-hosted inclusions from Borgarhraun; 72 inclusions have also been characterised for volatile trace elements (CO_2-H_2O-S-Cl-F). This study presents Pb-isotope data for 35 of these inclusions and shows systematic correlations between $^{208}Pb/^{206}Pb$, $^{207}Pb/^{206}Pb$ and the concentrations of incompatible trace elements (including CO_2). The spread and covariation of Pb isotope ratios with incompatible trace element ratios in the melt inclusion suite is similar to that observed in Theistareykir whole-rock samples. The whole-rock compositions are influenced by variable extents of fractional crystallisation, crystal accumulation and degassing, processes which obscure the relationship between isotopic compositions and elemental concentrations in mantle-derived melts. The covariance between Pb-isotopes and trace element concentrations in the inclusions demonstrates a strong association between isotopic enrichment and a trace element signature derived from mantle melting in the presence of garnet.