Constraining heterogeneity in the upper mantle using Ocean Island Basalts

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Major-, trace elements and isotopic compositions reveal the presence of recycled heterogeneities in the sources of Ocean Island Basalts (OIBs). However, the lithology, compositions and proportions in the upper mantle are debated. The high Mg# in primary OIBs require contributions of peridotite along with recycled non-peridotitic heterogeneites [1,2]. Here we estimate the proportion of recycled heterogeneites in the sources of primary OIBs globally, to illustrate both the importance of the melting model and the role of the lithology and composition of the heterogeneites.

We constrain the proportion of heterogeneity in the OIB sources for two distinct pyroxenite compositions, using two melting models for primary OIB formation – (a) simple mixing model between pyroxenite- and peridodite-derived melts [3]; (b) a reactive crystallization model of the pyroxenite-derived melt during its ascent through a peridotitc mantle [4]. We use the parameterizations of [3], [4], [5] and [6] in our calculations.

We show that (a) proportions of constrained heterogeneity under the same ocean island are very dependent on the melting model and composition of heterogeneity; (b) irrespecive of the choice of model or composition, a significantly heterogeneous source is found beneath all ocean islands; (c) proportion of heterogeneity in the source has no correlation with mantle potential temperature or final pressure of melting, implying a decoupling between the thermal state and chemical heterogeneity in the upper mantle. We discuss how such a decoupling has implications for why OIBs display greater heterogeneity in major element compositions than mid-ocean ridge basalts.

[1] Sobolev *et al.* (2005) *Nature* **434**, 590–597. [2] Mallik & Dasgupta (2012) *EPSL* **329–330**, 97–108. [3] Lambart *et al.* (2016) *JGR* **121**, 5708–5735 [4] Mallik & Dasgupta (2014) *G3* **15**, 1533–1557. [5] Sobolev *et al.* (2007) *Science* **316**, 412–417. [6] Herzberg & Asimow (2015) *G3 16*, 563–578.