Volcano plumbing from microspatial analysis of clinopyroxene megacrysts

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Lavas from Heard Island display extreme isotopic variations (e.g. $^{87}Sr/^{86}Sr$ .0.7047-0.7079) and whole rock-clinopyroxene isotopic disequibrium [1]. The presence of large (5-15mm), euhedral clinopyroxene megacrysts in some lavas provides an opportunity to investigate magma chamber processes via microspatial analysis. Megacrysts, megacryst inclusions and matrix glass were analysed from one such flow. Major and trace element concentrations were determined using SEM and LA-ICP-MS and $^{87}Sr/^{86}Sr$ was determined by microdrilling and subsequent MC-ICP-MS analysis of core and rim samples from two megacrysts. Megacrysts in this flow are characterised by large, glass inclusion-rich cores and narrow normally-zoned Ti-rich rims. Detailed SEM and LA-ICP-MS traverses across one megacyst reveal that across the core-rim interface there is an increase in Mg# (81.6 to 84.7) and compatible trace element concentrations (e.g. Cr) coupled with a decrease in incompatible trace elements (e.g. Sr, Nb and Al). These features provide evidence of a mafic recharge event. Pre-eruptive magma temperatures were estimated from glass geothermometry at ~1112 °C [2]. This temperature was combined with a lattice strain model evaluation of the systematic variations in the apparent partition coefficients calculated between the megacryst rim and matrix glass which enabled us to estimate a pre-eruptive magma storage depth of ~9km (250MPa) [3, 4]. $^{87}Sr/^{86}Sr$ data for the two megacryst cores (0.705437-0.705480) and matrix glass (0.705447) are identical, the rims however are less radiogenic (0.705303-0.705318). The isotopic disequilibrium between the megacryst rims and matrix glass is in constrast to the chemical equilibrium implied by the systematic behaviour of the calculated partition coefficients. The isotopic data, together with petrographic and geochemical data, provide evidence of a multi-stage, open-system polybaric plumbing system with a final magma chamber at ~9km. Here isotopically distinct magmas supplied from at least two, presumably deeper, chambers mix prior to eruption.

[1] Barling *et al* (1994) *J. Pet.* **35,** 1017-1053. [2] Putirka (2008) *Rev. Min. & Gechem.* **69,** 61-120. [3] Wood & Blundy (1997) *CMP* **129,** 166-181. [4] Wood & Blundy (2003) *Treatise on Geochem.* **2,** 395-424.