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Plutonic xenoliths reveal open system magma evolution processes beneath St Vincent, Lesser Antilles arc

Joshua Brown[1], Julie Prytulak[1], George Cooper[2], Madeleine Humphreys[1], and Alexander Iveson[1]
[1]Department of Earth Sciences, Durham University, Durham, United Kingdom of Great Britain – England, Scotland, Wales (joshua.r.brown@durham.ac.uk)
[2]School of Earth and Environmental Sciences, Cardiff University, Cardiff, United Kingdom of Great Britain – England, Scotland, Wales

Volcanic arc lavas often carry mushy rocks from deeper levels of magma plumbing systems, termed "plutonic xenoliths", to the surface. These xenoliths offer the opportunity to study magma evolution in the crust. Here we focus on the Lesser Antilles island arc, known for its abundance of plutonic xenoliths, and describe a new suite of plutonic xenoliths from St Vincent.

The whole rock chemical compositions of erupted lavas from St Vincent are consistent with *closed system fractionation* as the dominant magma evolution process [1,2]. However, the chemical compositions of crystals in plutonic xenoliths, which record magmatic processes and the composition of melts present during crystal growth in mushes at depth in the crust, are commonly more complex. Thus, plutonic xenoliths provide a more detailed picture of magma plumbing system processes and geochemical diversity than is available from the chemical compositions of erupted lavas alone.

The new St Vincent plutonic xenoliths show intriguing textural features such as centimetre scale mineralogically distinct bands and amphibole replacement rims on clinopyroxene. Similar textures in plutonic xenoliths elsewhere have been attributed to open system processes such as reactive porous melt flow [3,4].

We use the major and trace element compositions of clinopyroxene and amphibole from St Vincent plutonic xenoliths to assess evidence for reactive flow and open system processes in the St Vincent magma plumbing system. A distinctive hornblende-olivine gabbro xenolith contains two clinopyroxene populations (Mg# 82-89 and Mg# 77-79, < 1.5 mm) and pervasive poikilitic amphibole texturally associated with clinopyroxene. Both the lower Mg# (77-79) clinopyroxene and amphibole are enriched in LREE, Zr, Nb (amphibole), Ni and Cr. Modelling of closed system fractionation of primitive St Vincent basalt fails to reproduce these enrichments. Instead, the chemical data and textural characteristics suggest that the lower Mg# (77-79) clinopyroxene and amphibole formed via reactive melt flow. In contrast with the closed system fractionation trends displayed by whole rock lava compositions, this study provides strong evidence that open system reactive melt flow operates in the St Vincent magma plumbing system, modifying mineral

assemblages and compositions. Thus, reactive melt flow may (cryptically) contribute to magma chemical evolution on St Vincent.

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