Plutonic xenoliths from the Lesser Antilles: A window into the plumbing systems of volcanic arcs

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The Lesser Antilles Volcanic Arc is exceptional globally in respect to the abundance and variety of erupted plutonic xenoliths. These samples provide a window into the deeper crust and an earlier crystallisation history than is possible from lavas alone.

Here, we use petrological, in-situ geochemical, and isotopic data of xenoliths from Martinique and St. Eustatius in order to establish their petrogenesis, storage conditions and the components which build the Lesser Antilles crust. The lavas from both islands are controlled by crystal-liquid differentiation, driven largely by amphibole, plagioclase and magnetite fractionation [1]. Amphibole is rarely present in the erupted lavas but it is a very common component in plutonic xenoliths, allowing us to directly test the involvement of amphibole and 'cryptic' fractionation on the petrogenesis of arc magmas.

The plutonic xenoliths provide both textural and geochemical evidence of open system processes and crystal 'cargos'. All xenoliths are plagioclase bearing with variable proportions of ol, spl, cpx, opx and amph, commonly with interstitial melt. The sequence of crystallisation varies in sample type and between islands. Amphibole may either be equant, crystallising early in the sequence or interstitial (late stage). Interstitial amphibole is enriched in Ba and LREE compared with early-crystallised amphibole and does not follow typical fractionation trends, suggesting the involvement of a reactive melt or fluid, which causes the breakdown of cpx and the crystallisation of amphibole.

A compositional offset between plagioclase (~An_{90}) and olivine (~Fo_{75}), suggests crystallisation under high water contents and low pressures from an already fractionated liquid. Geothermobarometry estimates and comparisons to experimental studies imply the majority of xenoliths formed at relatively low pressures (0.2-0.4 GPa) in the mid-crust. These xenoliths are inferred to represent crystal mushes within an open system, through which melt can both percolate and be generated.

[1] Davidson & Wilson (2011) *J. Petrol* **52**, 1493-1531.