None of us belong: crystal chemistry of andesites in Dominica, Lesser Antilles

Tracy M Howe[1], Jan M Lindsay[1], Phil A Shane[1], Axel K Schmitt[2], Danny Stockli[3]

[1]University of Auckland, New Zealand, [2]University of California, Los Angeles, United States, [3]University of Texas, Austin, United States

E-mail: t.howe@auckland.ac.nz

As the simplest subduction setting, island arcs provide a unique chance to study the magmatic processes involved in andesitic eruptions. Located in the centre of the Lesser Antilles arc, Dominica has been the site of andesitic volcanism for >500,000 years. Eruptions from the island produce dominantly porphyritic andesite with a phenocryst assemblage of plagioclase (An54-92), clinopyroxene (En64-69), orthopyroxene (En52-58) and Fe-Ti oxides with less common amphibole and olivine. Microprobe spot and profile analyses were undertaken on all phenocryst phases in order to constrain petrogenetic and ascent processes. While single plagioclase and amphibole profiles within individual units lack core to rim zonation, each mineral population within the units displays significant chemical variability. Combined with the lack of equilibrium between phenocrysts and melt, this indicates a mineral-melt decoupling which may be the result of magma mixing or the accumulation of crystal cargo during ascent from source to surface. The homogenous crystal profiles seen in all mineral phases across all units suggest the existence of locally homogeneous magma reservoirs in the crust. Amphibole pressures and the rhyolitic nature of matrix glass suggest that such reservoirs were relatively shallow (3-5 km). Model temperatures calculated for individual phases and equilibrium phase pairs also support mineral-melt decoupling, with Fe-Ti oxides (avg. 800℃), amphiboles (avg. 750℃), and high-An plagioclase (avg. 950℃) displaying different temperatures. Our findings suggest that the phenocryst assemblage in the Dominican andesites is the result of near-equilibrium crystallization in evolved and primitive melts, followed by subsequent mixing which resulted in a non-equilibrium crystal cargo. U-Th zircon geochronology provides further evidence for recycling, with most lava samples showing multiple crystallization events prior to eruption. This work provides evidence for widespread disequilibrium between magmas and their crystal cargo, which can be explained by a long-lived crystal mush beneath the silicic centers in Dominica. These centers, which only recently emerged compared to the overall longevity of the arc, thus may indicate the initiation of a batholithic crust of continental affinity in an island arc.