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Vapor-phase cristobalite and halogens in glass: Insights into fluid fluxes and outgassing dynamics in silicic submarine lavas

SAMUEL J MITCHELL[1], ACACIA CLARK[2] AND REBECCA CAREY[2]

[1]University of Bristol

[2]University of Tasmania

Presenting Author: sam.mitchell@bristol.ac.uk

Vapor-phase, or metastable/secondary, cristobalite (VPC) is a silica polymorph commonly found in silicic lava domes with an outgassing hydrothermal system containing halogen-rich fluids. Observations of VPC have been made in many dome systems, but there is still relatively little known about the exact temperatures and kinematics of cristobalite growth. In this study, we analysed 14 VPC-bearing samples acquired from a submarine rhyolitic lava dome and separate lava flow at Havre volcano in the Kermadec Arc, New Zealand – erupted in 2012. Samples acquired from *in-situ* carapace and scarps, and talus on the lava flanks show a variety of VPC-bearing groundmass textures, where *in-situ* samples from the top of the dome exhibit some of the most evolved VPC textures observed in any subaerial lava literature. Analysis of Cl and H_2O in melt inclusions and matrix glasses from this eruption indicate a large amount of Cl degassing being fed into the lava dome that characterized the end of the eruption. Low crystallinity did not permit Cl-enrichment within the glass, as seen commonly elsewhere in crystal-rich silicic melts. For each sample, we determined: bulk porosity, DRE density and pore space connectivity through He-pycnometry; VPC area fractions, size distributions and number densities through SEM image analysis; and VPC impurity measurements (Na, K, Cl) through EPMA analysis. The most evolved VPC-bearing samples have many, large vesicle-infilling VPC crystals, and in some cases, VPC re-filling diktytaxitic void space between microlites from prior glass dissolution. The extremely evolved VPC textures in a submarine dome may reflect the different cooling rates and outgassing environment in a more pressurized, fluid-rich, submarine system. The interior of the submarine lava dome can remain hotter for longer with high-density, Cl-rich fluids trapped within the dome, creating an ideal environment for efficient glass dissolution and subsequent VPC precipitation.