

Controls on Eruption Style at La Soufrière de Guadeloupe from Melt Inclusions and Mineral Diffusion Timescales

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Signals of volcanic unrest do not usually provide insights into the timing, size and style of future eruptions. However, analysis of past eruptions provides data helping us to understand the evolution, magma storage and onset of future eruptions. Unrest at La Soufrière de Guadeloupe has increased over the last 25 years, with a potential eruption capable of impacting ~70,000 people, making our work timely. Here, we present the geochemistry of pre-eruptive magmas and timescales of magmatic processes preceding four La Soufrière de Guadeloupe eruptions including: 1657 CE (Vulcanian), 1010 CE (Plinian), 341 CE (Strombolian) and 5680 BCE (Plinian).

Using diffusion timescale studies of orthopyroxene phenocrysts, we constrain magma injections into the magmatic reservoir ranging from 35 ± 0.37 to 848 ± 0.4 days before eruption. Diffusion timescales do not appear to correlate with eruption style/size, but may correlate with other parameters (e.g., magma interactions in the reservoir and/or volatile content of the magma).

Major element concentrations of melt inclusions reveal a relatively homogenous dacitic to rhyolitic (63.6 – 78.7 wt% SiO₂) composition, suggesting this is not a main control on eruptive style. Melt inclusions also reveal a narrow range of pre-eruptive volatile contents, with a notable difference between eruptions only observed in CO₂ contents. However, the difference does not relate to eruptive style (e.g., 131 ppm for 1010 CE Plinian, 866 ppm for 5680 BCE Plinian and 674 ppm for 1657 CE Vulcanian eruptions).

The syn-eruptive crystal fraction in the groundmass glass varies between the eruptions with both microlite rich (>40 vol% crystals, e.g., 5680 BCE and 341 CE) and microlite poor (<20 vol% crystals, e.g., 1657 CE and 1010 CE) glasses. This variation corresponds to differences in viscosity after syn-eruptive crystallisation and in magma ascent rate. Again, these parameters do not appear to correlate with eruption style/size, suggesting eruption style at this system is instead modulated by both ‘top-down’ and ‘bottom-up’ controls. Sealing of the conduit by lava dome and hydrothermal activity may control the transitions in explosive behaviour in the absence of any major changes in the deeper reservoir, which makes La Soufrière de Guadeloupe a particularly hazardous volcano.