Understanding the link between timescales of magmatic processes and unrest at La Soufrière de Guadeloupe.

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Using petrology to constrain the pre-eruptive crystal storage timescales gives an insight into the magmatic mush system. Observing how timescales vary with eruption style is important for understanding volcanic unrest. We focus our work on La Soufrière de Guadeloupe, which in the last 9150 years has exhibited a variety of magmatic explosive eruption styles from Vulcanian to Plinian style eruptions. Unrest at La Soufrière has increased gradually over the last 25 years, with the strongest seismic event since the 1976-77 volcanic crisis recorded in 2018. Relating unrest to magmatic recharge timescales and eruptible melt production may help us understand what eruption style the unrest could be building to.

Using Fe-Mg diffusion in pyroxenes from juvenile eruptive products, we modelled pre-eruptive crystal storage timescales for the last magmatic eruption in 1657CE (Vulcanian), 1010CE (Plinian), 720BCE (Strombolian) and the first explosive eruption 5680BCE (Plinian). By using greyscale backscattered electron images (BSE) as a proxy for Fe-Mg composition, which varies due to crystal-melt diffusion, we demonstrate timescales between recharge and eruption range from days to years at La Soufrière.

Preliminary results indicate the 1657CE began with recharge six months before the eruption; beginning the mush unlocking process. In comparison, the 5680BCE Plinian eruption shows rapid timescales ranging from days to weeks. We are developing a probability density function to better constrain the timescales and statistically estimate the timescale error. These results show that the La Soufrière mush system produces eruptible magma quickly and that large explosive eruptions can have a rapid onset. Linking magmatic timescales to observable unrest monitoring, such as seismic swarms, deformation and magmatic gas emissions, will indicate for each eruption style, timescales for recharge magma arrival and eruptible magma production. This has important implications for detecting precursory activity, early warning systems and crisis response and management.