Fully quantifyed crystal populations? Combining CSD and microanalysis to constrain timescales and contamination in magmas

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Crystal populations provide important information about magma histories as they can capture vital geochemical and timescale signals during their growth. A crystal size distribution (CSD) analysis allows the quantification of the crystal population in 3D and helps provide a framework to understand the populations evolution through time. Isotopic microanalysis[1], on the other hand, has undergone rapid development in recent years, detailing magmatic processes through information stored at the sub-grain scale[2]. If we can investigate the information at the sub-grain scale and transfer this through the whole crystal population we would have the potential to map out the true isotopic distribution of the rock and place timescale constraints on this data to reveal recharge dynamics at volcanoes, and thus aid predictive modelling.

Here we introduce the methodology to construct a 3D crystal population and how to transpose micro-isotopic analysis into the resulting CSD plot to fully quantify the texture. The combined approach is powerful, allowing investigation of the magma supply, mixing, crystallisation and contamination processes involved in prior to eruption of a volcanic sample. We present the method and demonstrate its use on a 26,000 year old sample from Stromboli Volcano, showing that the change in magma type following a sector collapse took between 20 and 100 years to complete, similar to the timescale of changes seen in recent decades. This implies that current volcanic activity may be reasonably expected to follow a similar path to the activity of 26,000 years ago.

References

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