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# Insights into Stromboli's plumbing system using a unified model of magma crystallization, degassing and multiphase flow

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Volcanic activity is driven by the strongly coupled processes of volatile exsolution and crystallisation. The dynamics of magma ascent are recorded as heterogeneities in crystal composition, texture, and size distribution, allowing forensic reconstruction of magma dynamics from petrological measurements. This reconstruction could be greatly enhanced if gas emissions and quantitative volcanological features associated with an eruption were also taken into consideration.

Modern gas geochemistry has made great progress in recent years, and now offers $\sim$1 Hz frequency measurements of magmatic gas compositions and fluxes. Advances in crystal analysis allow internal mapping of compositions, which record changes in melt pressure, temperature and volatile content during ascent. These empirical advances have outstripped progress in unified numerical modelling of degassing and crystallisation.

Here we present a new numerical model that calculates crystal growth and composition, non-ideal gas dynamics and multiphase magma / gas flow in a fully integrated and thermodynamically rigorous framework. We apply the model to the effusive 2007 Stromboli eruption, and are able to accurately reproduce many features, including gas composition, gas flux, lava flux, lava vesicularity, crystal content and plagioclase zonation when a plumbing system consisting of dikes and sills is used.

The numerical unification of petrology, volcanology and gas geochemistry opens the door to major new insights into the magma dynamics driving volcanic activity during an eruption, thereby improving our ability to forecast the evolution of an eruption.