The 19 July 2020 eruption at Stromboli: insights into the magmatic system feeding high-energy activity at an open-conduit basaltic volcano

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Stromboli is well-known for its periodic, ordinary activity that has been persistent for the past 1400-1800 years. On sporadic occasions however, Stromboli's ordinary activity is interrupted by more violent events that are characterised by higher erupted mass and energy and pose a threat to the island's population and tourists. Those eruptions involve the highest duration, mass and energy and are generally classified as paroxysms, with the most recent events that occurred in 2003, 2007 and 2019. Eruptions with characteristics intermediate between paroxysms and ordinary activity are commonly termed major explosions. While there is abundant literature discussing the mechanisms, dynamics and source regions that underlie both paroxysms and ordinary activity, these factors remain poorly constrained for major explosions. This is particularly crucial with regards to key parameters such as source region, dynamics that lead up to the eruption as well as the associated timescales, which constitute fundamental information when it comes to improving existing early-warning systems.

The 19 July 2020 eruption provides an excellent case study to discuss the processes that control major explosions and paroxysmal activity given that it was characterised by the emission of an important amount of juvenile products. Here we focus on the low porphyritic ejecta that represent the contribution of the deep magmatic component. We provide a detailed geochemical characterisation of melt inclusions, olivine crystals and matrix glass, which is subsequently integrated with data from the monitoring network. Major element data on melt inclusions and matrix glass is combined with olivine compositions to constrain magma source and ascent dynamics, suggesting that both differ from typical paroxysms. Water and carbon contents in melt inclusions and embayments are combined with sulphur and chlorine compositions and are used to estimate entrapment pressures, allowing to constrain the source region as well as the degassing history of the feeding magma. Furthermore, modelling of Fe-Mg diffusion in olivine zoning profiles provides time constraints that are coherent with observations from the degassing regime of the plume.

The integration of this geochemical-petrological dataset with observations from the monitoring network provides new insights into the source and ascent dynamics of the magma feeding major explosions at Stromboli and adds further understanding to the fundamental discussion on magma systems that feed paroxysmal activity at open-conduit basaltic volcanoes.