Crystals with 4D and physicochemical context reveal a complete magma pathway, and eruption phenomena linked to mantle magma supply and shutdown, throughout the entire 2010 eruption of Eyjafjallajökull, Iceland

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Pankhurst et al. (2018) [1] presented a crustal scale model for magmatic system behaviour prior to the 2010 flank eruption of Eyjafjallajökull, Iceland, using integrated chemical, zonation and diffusion chronological data from 236 olivine crystals. Magma-mixing and recharge could not account for the patterns observed. Central to their interpretation was the concept of crystal-rain, which combines classic petrogenetic mechanisms (equilibrium, fractionation, and crystal settling) into a continuum model. The three function together in a self-regulated manner which is driven by the cooling regime experienced by the magma during its passage through the crust. The dynamic petrological model is a remarkable, detailed, match with interpretations of geophysical monitoring data.

Here we extend the dataset across the subsequent summit eruption phases. We show further high-order patterns in disequilibria data and for the first time also integrate volatile-in-melt-inclusion data (synchrotron FTIR) with time-and-space-stamped crystallisation. A number of new insights of non-equilibrium dynamic behaviour are revealed, including the date the mantle supply shut down, which in this case appears to have heralded the cessation of eruption weeks later. The interpretation involves only one magma, and minor interaction with the crust. This type of insight to the detailed physical evolution of the plumbing system is potentially recoverable from numerous previous eruptions, and support the implication that proxy volcano monitoring records are tractable using petrology.

[1] Pankhurst et al. (2018) *EPSL* **493**, 231-241.