Applying exhaustive crustal xenolith petrology to test fluid dynamic simulations in the magma conduit

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The importance of the interactions of thermal and mechanical processes during silicic magma ascent, and the relationships between wall-rock and magma within the conduit, are explored through the integration of (i) crustal xenolith petrology (foliation, equilibrium mineral assemblages and thermodynamic modelling, the size, abundance, distribution and age of minerals), and (ii) fluid dynamics.

We examine two-dimensional thermal models of dacitic magma injection and flow in a 200 m wide magma conduit - that caused their wall-rock to undergo partial melting. The case study selected is the Neogene Volcanic Province (SE Spain), where rapidly erupted crustal xenoliths had been previously incorporated into dacitic lava by rooting up from the wall-rock and/or dropping into the magma conduit at 13-18 km depth. These partial melt zones record the thermal history of magma flow in the conduit and, consequently, both the emplacement behaviour of the flow it fed, and the xenolith history before (and during?) the eruption event.

The results reveal important information on (i) the circulation and transport of xenoliths at depth by relating the textures and pressure-temperature conditions of the xenoliths to their position in a transient thermal regime in the wall-rock of the magma conduit; (ii) the time spent as a xenolith immersed in magma; and (iii) the magma ascent process by their interactive integration to fluid dynamics models and vesicles evolution within the magma conduit. They may also help to link observations on xenoliths and xenocysts to eruption style and intensity.