Dykes, crystals, and seismic unrest of monogenetic eruptions

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Eruptions from monogenetic volcanoes tend to be small but are particularly difficult to anticipate since they occur at unexpected locations and there is very limited instrumental monitoring data. Many monogenetic volcanic fields occur in high-density, populated areas and/or tourist destinations, and thus even a small eruption can have a major economic and societal impact. Here we use the results of petrological studies with historical accounts of seismicity for several monogenetic eruptions from Tenerife Island (Canaries), and combine them with literature data to propose a general model for the plumbing system, magmatic processes, and times scales of unrest.

We find that the olivine crystals from deposits of mafic eruptions from Siete Fuentes, Fasnia and Arafo (1704-5) show evidence for open system, including three different mixing events. Results from studies of other monogenetic eruptions (e.g. Paricutin 1943, El Hierro 2011) also show evidence for open system involving magma mixing and/or crustal assimilation. Thus, these eruptions were fed by relatively complex plumbing systems involving one or more magma reservoirs, and the magma did not directly travel from the mantle to the surface. Modelling the Fe-Mg zoning of olivine indicates that the times since magma mixing, transport to the surface and eruption vary between a few months and a few days. Historical accounts of seismicity also vary between about several months and a few days and are likely related to shallow intrusions (e.g. failed eruptions) and transport recorded by the olivine crystals. We propose that early dike intrusions in the crust do not erupt (e.g., stalled intrusions) and make small plumbing systems, but they probably are key in creating a thermal and rheological pathway for later dikes to be able to reach the surface [1]. These observations provide a conceptual framework for better anticipating monogenetic eruptions in similar settings and magmatic fluxes and should lead to improved strategies for mitigation of their associated hazards and risks.

[1] Albert, Costa & Marti (2006), *Geology* **44**, 211-214.