Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.16198

Evidence of bubble-assisted magma mixing in the early stage of the Cumbre Vieja 2021 eruption, La Palma, Canary Islands

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The interaction between different magmas at various levels is a common phenomenon in ocean island volcanic plumbing systems, modulating melt compositions and influencing eruption dynamics. However, evidence of magma mixing in basaltic systems is mostly cryptic and it is usually limited to mineral disequilibrium features (zoning, resorption). Here we show direct evidence of the syneruptive interaction between basanitic and tephritic magmas in tephras erupted in the early stages of the Cumbre Vieja 2021 eruption, La Palma, Canary Islands. Throughout the eruption, lavas varied from a kaersutite-clinopyroxene tephrite (first week) to olivine-clinopyroxene basanite, and tephra glass evolved from tephritic-phonotephritic (49.5 wt.% SiO_2, 3.6 wt.% MgO) to basanitic-like (44 wt.% SiO_2, 4.5 wt.% MgO). However, groundmass glasses from tephras erupted on 23 September (eruption day 4) are locally inhomogeneous and show small-scale filamentary structures, frequently associated to bubbles, of more primitive glass which are reminiscent of incomplete magma mixing. Although volumetrically minor, the major element distribution observed in these structures attests the presence of primitive magma, similar to melts erupted later in the eruption, interacting with an evolved tephritic melt during the first week of the event. Semi-quantitative diffusion modelling suggests that the observed structures are short-lived at magmatic conditions (survival timescales in the order of tens of seconds to minutes) and arise from bubble growth and/or migration in an inhomogeneous ascending magma. Combining this with mineral-melt thermobarometry, we propose that a tephritic, crystal-rich magma stored at sub-Moho depth was remobilized by the basanitic magma coming from deeper levels of the system (ca. 1140 °C, 800-1000 MPa), carrying a mingled, inhomogeneous melt towards the surface and potentially enhancing bubble growth and further melt phase mixing in the shallow conduit.