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Bimodality of lavas in the Teide–Pico Viejo succession in Tenerife – The role of crustal melting in the origin of recent phonolites

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In Tenerife, the composition of lavas at the recent Teide–Pico Viejo central complex show a marked bimodality in composition from initially mafic lava (200ka – 30ka) to highly differentiated phonolite (30ka – recent). After this abrupt change, the bimodality of lavas continued to manifest itself between the now-felsic Teide–Pico Viejo and the adjacent, exclusively mafic rift zones.

Whole-rock trace element fingerprinting distinguishes three compositional groups (mafic, transitional, felsic). Groundmass Sr-Nd-Pb-O and feldspar δ^{18}O data demonstrate open system for the petrogenesis of Teide–Pico Viejo by unusually high ^{87}Sr/^{86}Sr ratios in Teide phonolites ($<$0.7049). Additionally, the felsic lavas possess a tightly confined range of ^{206}Pb/^{204}Pb and a larger range of ^{207}Pb/^{204}Pb ratios, compared to mafic lavas. However, ocean sediment contamination can be excluded due to the low ^{206}Pb/^{204}Pb ratios of North Atlantic sediment.

Isotope mixing hyperbolae indicate a strong petrogenetic kinship for the entire Teide–Pico Viejo succession and show that assimilants of predominantly felsic composition are required. Rare earth element modelling indicates that nepheline syenite needs to be melted in bulk to form a suitable end-member composition. Nepheline syenite blocks occur as fresh or altered lithic blocks in voluminous pre-Teide ignimbrite deposits and represent deep left-overs of associated earlier eruptions. Energy constrained, assimilation fractional crystallisation (EC-AFC) modelling reproduces the bulk of the succession with this assimilant, which leads us to suggest that Teide–Pico Viejo petrogenesis is governed by assimilation and fractional crystallisation. Both, mixing hyperbolae and EC-AFC models, indicate that assimilation is more dominant for more felsic lavas. Large amounts of nepheline syenite bulk melts must have been recycled during phonolite petrogenesis.

The maximum assimilation is yielded in the strongest differentiated (and most radiogenic) lava and computes to $>$97.8% of assimilant. In this most evolved eruption, lenses of nepheline syenite bulk melts may have formed and been spatially decoupled from juvenile material. This study therefore recognises a wider variability of magmatic differentiation processes at Teide–Pico Viejo than previously thought.