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Contrasting forms of magma mixing on Methana and Santorini, Aegean Arc, Greece

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Magma mixing and mingling, rather than classical fractional crystallisation processes, may be the most important processes contributing to within-suite chemical variability in subduction-related magmas. The way in which the different magmas interact with each other varies, ranging from mingling, recognisable in the field by mafic enclaves within more evolved magmas, to true mixing of magmas, or mixing of magmas with phenocrysts ('antecrysts') from older batches of magma.
The islands of Santorini and Methana (Aegean Arc, Greece) display contrasting patterns of magma mixing. Methana is on the western side of the arc, where the overriding continental plate is thinned to a lesser degree than underneath Santorini, in the central part of the arc.
Methana is characterised by small lava domes, containing frequent mafic enclaves. The lavas are very crystal-rich, with ubiquitous disequilibrium assemblages, juxtaposing e.g. hornblende+zircon with olivine.
Lavas from Santorini are less phyric, and generally do not contain hydrous phases or zircon. Previous workers have documented mineralogical evidence for magma mixing (e.g. Martin et al., 2010, Geology 38, 539-542), but disequilibrium assemblages are far less conspicuous than on Methana.
Whole rock Harker diagrams for the two islands show that Santorini displays curved trends for at least some elements, such as TiO2, whereas (scattered) straight trends are the norm for Methana.
Volcanism on Methana resulted from remobilisation of largely crystallised felsic to intermediate crystal mushes by more mafic magmas, whereas the shallower volcanic system at Santorini is kept alive by the continual input of magma batches of only slightly more mafic composition. The greater thickness of the continental crust at Methana causes the magma to stall at greater depths, allowing amphibole to crystallise, leading to a great increase in viscosity and uneruptibility. Such mushes can only erupt when remobilised by the intrusion of a magma that is significantly more mafic. This results in magma mixing over a larger SiO2 span than at Santorini, where amphibole crystallisation does not take place.