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Plutonic Xenoliths from Santorini Volcano, Aegean Arc, Greece

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Plutonic xenoliths provide a means to explore the plumbing systems of volcanoes, representing snapshots of processes not clearly resolvable in the lava and pyroclastic rock record. Santorini volcano, situated in the South Aegean volcanic arc, has produced 12 major explosive eruptions within the last 360 ky, including the most recent ∼1600 B.C. eruption that is amongst the most powerful in the recent recorded history. An abundance of plutonic xenoliths within the deposits of the major explosive eruptions provides an opportunity to gain a detailed insight into magma genesis and the plumbing system of Santorini. We use geothermobarometry and insitu Laser Ablation ICPMS trace element data to decipher storage depths and fractionation trends.

The xenolith lithologies range from troctolite, through olivine gabbros and gabbro, to gabbronorites. Texturally, many can be described as 'cumulate', exhibiting a network of interlocking crystals with an intercumulus assemblage comprising quartz, alkali feldspar and glass. Mineral core and rim compositions vary between the xenoliths: plagioclase An_{9286} in troctolite to An_{80-1} in gabbronorites, olivine Fo_{84-77} in troctolite to Fo_{6947} in gabbronorites, and clinopyroxene $Mg\#_{85-64}$ in olivine gabbros to $Mg\#_{79-54}$ in gabbronorites. Intercumulus alkali feldspars reach Or_{87}. Interstitial glass and melt inclusion compositions range from basaltic to rhyolitic, spanning the full range of published Santorini melt compositions, with interstitial glasses generally being more SiO_2-rich than melt inclusions.

Mineralmelt thermometry estimates span a wide range of temperatures from 1150˚C in the olivinegabbro olivines to 800˚C for plagioclase crystal rims and intercumulus crystals in the gabbronorites. Pressure estimates from mineral-melt equilibria and experimental comparisons suggest mafic to silicic magma differentiation at $\leq 3 \pm 1$ kbar, which generally concurs with current models of magma storage and genesis. Unlike many arc volcanoes, including those within the Aegean arc, Santorini volcanic wholerock trace element data and equilibrium melt compositions calculated from cumulate clinopyroxenes point towards only a modest role of amphibole fractionation, which is most prominent at late stages of evolution. This is corroborated by the presence of amphibole restricted to the cumulate late evolutionary stages.