Santorini volcano magma plumbing system: constraints from a combined experimental and natural products study

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Santorini Volcano constitutes a serious hazard in the Aegean region of Greece. The recent 2011-2012 episode of caldera unrest has focussed attention on the magma plumbing system of the volcano, and notably on the depths of storage of different magma batches. We investigated the differentiation conditions of mafic-intermediate magmas, as well as the pre-eruptive storage conditions of dacitic-rhyodacitic magmas prior to the four largest Plinian eruptions of the volcano over the last 200 ka (Minoan, Cape Riva, Lower Pumice 2, Lower Pumice 1). The intensive variables (P, T, fO_2, volatiles content) were determined by combining laboratory crystallization experiments with study of the natural products (including volatiles in melt inclusions). Our results show that the magma plumbing system is dominated by a large, long-lived ($\geq$ 200 ka) storage region at about 8 km depth (2 kb), from which the silicic magmas are derived. This region is fed by injections from a deeper, mafic reservoir located at the boundary between the upper and lower crust ($\sim$15 km; 4 kb). Mantle-derived basalts stall in the 15 km storage region, where they fractionate to basaltic andesite (55 to 58 wt.% SiO_2) with 2-3 wt.% H_2O through crystallization of about 60 wt.% of oliv, cpx, plag, mt/ilm and opx, at 1040-1000°C, 4 kbar, fO_2 = FMQ-0.5. The basaltic-andesitic magmas then ascent to about 8 km where they either (1) experience a last episode of equilibration prior to eruption, or (2) fractionate to produce dacitic to rhyodacitic liquids.

Prior to the major Plinian eruptions, the silicic magmas were stored at T = 850-900°C, under relatively reduced conditions ($\sim$FMQ or, ΔNNO = -0.9 to -0.1), with melts depleted in fluorine ($\sim$500-700 ppm) and particularly in sulphur (<100 ppm) but rich in water and chlorine (5-6 wt.%, ca. 2500-3500 ppm, respectively) probably co-existing with a hydrosaline liquid, at pressure $\geq$ 2 kbar. The fact that Santorini dacites-rhyodacites have high enough dissolved Cl for the melts to be saturated with hydrosaline liquid (and maybe vapor) before Plinian eruptions has significant consequences on the Cl degassing budget, which was previously estimated as insignificant. A re-evaluation is under progress and the results will be presented in our communication.