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Magma evolution and volatile behaviour prior to and during the Plinian Lower Pumice 2 eruption, Santorini, Greece

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The Plinian Lower Pumice 2 (LP2) eruption (c. 180 ka) was the first major caldera-forming eruption of the Santorini volcanic complex (Greece). The eruption shows some striking similarities to the caldera-forming Late Bronze Age (Minoan) eruption in terms of field, petrological and geochemical characteristics of its eruptive products, which are discussed here to reveal the storage conditions of the LP2 magmas, pre-eruptive magmatic processes and the behaviour and degassing of volatiles prior to and during eruption. The LP2 eruption consists of four discrete eruption phases that produced pyroclastic fall and flow deposits of predominantly rhyodacitic composition [Druitt et al., 1999, Geol. Soc. Lond. Mem., 19]. A subordinate basaltic to andesitic juvenile component, represented by grey, quench-textured scoriae, occurs mainly in the Plinian airfall deposits of the first eruption phase. Petrological and geochemical data indicate that the main volume of rhyodacitic LP2 magma formed by fractionation of olivine, clinopyroxene, orthopyroxene, plagioclase, amphibole, Fe-Ti oxides, pyrrhotite and apatite from basaltic magma with compositional characteristics similar to the most mafic scoriae and assimilation of small amounts of crustal rocks. The magma was stored at mid-crustal levels, magmatic temperatures of 831 $\pm$ 12°C and an oxygen fugacity slightly above the fayalite-magnetite-quartz (FMQ) oxygen buffer. Injection of c. 200°C hotter mafic magma into the rhyodacitic reservoir and subsequent mingling and minor hybridisation with the resident magma helped remobilising the rhyodacitic host magma and ultimately determined the observed compositional range of the erupted products. Melt inclusion data show that sulphur concentrations were reduced to less than 200 ppm in the rhyodacite, primarily due to partitioning of sulphur into a crystallising sulphide phase (pyrrhotite) during magmatic differentiation at oxygen fugacities around the FMQ oxygen buffer. Sulphur concentrations in groundmass glasses of the LP2 pumices suggest that c. 60% of the remaining sulphur was released into the atmosphere during the LP2 eruption, the climatic effects of which are considered minor when compared to eruptions of more oxidised silicic arc magmas. Chlorine remained dissolved in the melt during magmatic differentiation prior to and during the LP2 eruption, indicating that chlorine emissions to the atmosphere were negligible.