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Evolution of mass discharge and decompression rates during the Plinian phase of the Bronze-Age eruption of Santorini

Madison Myers (1,2), Tim Druitt (2), Lucia Gurioli (2), Federica Schiavi (2), and Taya Flaherty (2)

(1) Montana State University, Department of Earth Sciences, Bozeman, United States , (2) Université Clermont Auvergne, CNRS, IRD, OPGC, Laboratoire Magmas et Volcans, F-63000 Clermont-Ferrand, France

We have used multiple independent methods to investigate the time-evolution of eruptive intensity during the Plinian phase of the 3600 y BP Bronze-Age eruption of Santorini Volcano: mass discharge rate based on new lithic isopleth maps for multiple sub-levels in the deposit, and magma decompression rate based on (1) pumice vesicle number densities, and (2) volatile gradients in plagioclase/pyroxene-hosted melt re-entrants. Using lithic data collected at 44 sites around the caldera rim, the main Plinian phase began with a 13.5 $\pm$ 3 km high plume that grew to the peak height of 27 $\pm$ 5 km, before then decreasing to 17 $\pm$ 3 km. This final decrease in plume height coincides with the first appearance of pyroclastic surge deposits in the eruption sequence. Two independent estimates for decompression rate were derived from the same pumice clast collected from each Plinian sub-level. Preliminary results from both techniques exhibit an increase in decompression rate towards the peak in plume height, followed by a sudden decrease, suggesting a positive correlation with mass discharge rate. However, the decompression rates determined from vesicle number densities (2-20 MPa/s) are two orders of magnitude higher than those obtained from melt reentrants (0.01-0.3 MPa/s). This difference suggests that the two methods may be recording decompression rates at different levels of the conduit. Melt re-entrants likely record a time-averaged integration of decompression rate between the magma reservoir and the fragmentation level, whereas vesicle number densities probably record decompression rate as the ascending magmatic foam travels through the steep pressure gradient just below the fragmentation level. These results, combined with lithic evidence for a falling fragmentation level with time during the Plinian eruption phase, provide quantitative constraints for future development of a numerical conduit model aimed at reconstructing the progression of a Plinian eruption.