Effect of episodic recharge on the evolution of upper crustal magma chambers

WIM DEGRUYTER[12*], CHRISTIAN HUBER[1], KARI M. COOPER[3], ADAM J. R. KENT[4] AND OLIVIER BACHMANN[2]

[1]Georgia Institute of Technology, Atlanta, GA, USA (*correspondence: wim_degruyter@msn.com)
[2]ETH Zurich, Switzerland
[3]University of California Davis, CA, USA
[4]Oregon State University, Corvallis, OR, USA

The occurrence of large explosive volcanic eruptions depends on the evolution of magma reservoirs in Earth's upper crust. In order for such a system to produce an eruption (i) large batches of magma need to be mobile and (ii) sufficient overpressure needs to be generated to trigger an eruption. The circumstances that lead up to such conditions are controlled by magma inflow rate, chamber size, crystallization, volatile exsolution, heat flow out to the crust, and the rheological response of the crust. The feedbacks between these processes requires better understanding if one wants to predict the overall evolution of shallow magma bodies. Here we use a numerical model that incorporates the coupling between these processes [1]. New calculations highlight how pulsating inflow can generate both plutonic bodies and volcanic eruptions for the same long-term average inflow of magma, but different recharge frequency. We also study how large eruptions can be triggered by a late stage pulse that will reheat and pressurize the system simultaneously. We apply these results to the eruptive history of Santorini Volcano [2-4]. The long-term average inflow rate at Santorini is on the order of 0.001 km^3/yr, which is similar to rate inferred for the Tuolomne Intrusive Suite [5], a large plutonic body with little to no known volcanic outputs. We suggest that the divergent evolution of these magmatic systems is due to a difference in the nature of fluctuations of the supply rate. Our results are also consistent with the recharge event preceding the Minoan eruption, which lasted about 100 yrs at a rate of >0.05 km^3/yr, which is believed to have emplaced ~10% of the erupted volume, and possibly triggered the eruption. Based on eruption frequency over the last 3600 yrs, we hypothesise that the current magma chamber is significantly smaller than the one that produced the Minoan eruption and that recent unrest at Santorini was sufficient to build up overpressure, but did not last long enough to reach the critical overpressure needed for an eruption.

[1]Degruyter and Huber (2014), *EPSL* **403** p. 117-130. [2]Druitt et al. (2012), *Nature* ***482*** p. 77-80. [3]Newmann et al. (2012), *GRL* ***39*** L06309. [4]Parks et al. (2012), *Nature Geosci* ***5*** p. 749-754. [5]Schöpa and Annen (2013), *JGR*, 118, 926-942.