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The impact of rapid recharge events on the evolution of magma chambers: Case studies of Santorini Volcano (Greece) and Volcan Quizapu (Chile)

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Magma reservoirs in the crust are thought to be dominantly formed by episodic recharge events at rates that are much larger than the long-term average magma inflow rates. Hence, a better understanding of the evolution of a magma reservoir requires elucidating the mass change, pressurization, heating, deformation and the potential for an eruption associated with different recharge scenarios. Most importantly, the bifurcation in behavior between a recharge event that leads to eruption and one that will grow the chamber requires quantification for better volcanic hazard assessment. We use a numerical model to determine the change in pressure, temperature and volume of a magma chamber as it is exposed to a recharge event. The model is applied to the well-studied volcanic systems of Santorini Volcano (Greece) and Volcan Quizapu (Chile). We establish the rates and the duration of magma recharge events that will lead to an eruption. In doing so, we demonstrate the importance of the state of the magma chamber prior to the recharge event, i.e. its size and exsolved volatile content, on the subsequent evolution of the reservoir. In the case of Santorini, the model successfully reproduces the main features of the Minoan eruption and Nea Kameni activity, providing volume estimates for the active part of the current subvolcanic reservoir as well as information regarding the presence of exsolved volatiles. For Quizapu, we suggest that the change in eruptive style, from an effusive outpouring of lava in 1846-1847 to an explosive Plinian eruption in 1932, was controlled by a shift in the state of the magma chamber induced by the first eruption. These case studies show that thermo-mechanical models offer a new framework to integrate the historic eruption record with geodetic measurements and provide a context to understand the past, present and future of active volcanic centers.