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MODELING ZIRCON GROWTH DURING OPEN-SYSTEM CRYSTALLIZATION

TAVAZZANI, Lorenzo¹, ECONOMOS, Rita¹, WOTZLAW, Jörn-Frederik², LAURENT, Oscar³, CHELLE-MICHOUE, Cyril⁴ and BACHMANN, Olivier²

(1)Southern Methodist University, Earth Sciences, 3225 Daniel Ave, Heroy 207, Dallas, TX 75275, (2)Institute of Geochemistry and Petrology, Department of Earth Sciences, ETH Zurich, Clausiusstrasse 25, Zurich, 8092, Switzerland, (3)ETH, Zürich, Zürich, 8092, Switzerland, (4)Department of Earth Sciences, ETH Zurich, Clausiusstrasse 25, Zurich, 8092, Switzerland

Recent advances in zircon geochronology by isotope dilution thermal-ionization mass spectrometry (ID-TIMS) techniques allow for age precision beyond the 0.02 % level for single zircon $^{206}\text{Pb}/^{238}\text{U}$ dates [1] and can resolve zircon crystallization heterogeneities in a dispersed age population. As zircon saturation is dependent on melt temperature and composition, quantitative analysis of dispersed zircon age populations can provide insight into the timing and magnitude of intensive parameter variations during the lifetime of magma reservoirs.

In order to interpret heterogeneously dispersed zircon ages collected in volcanic and plutonic products of large silicic systems (e.g. Yellowstone Plateau volcanic field, Mogollon–Datil volcanic field, Sesia magmatic system) we developed a stochastic zircon saturation model based on the software Magma Chamber Simulator [2], which accounts for fractional crystallization, recharge and cumulate melting effects on zircon growth and stability in a rhyolitic magma body. Model results show that open-system processes operating in crystallizing magma reservoirs produce zircon crystallization gaps, non-linear increase in zircon mass with time and fluctuations in zircon crystallization temperature. These observations suggest a connection between zircon crystallization age heterogeneities characteristic of large rhyolitic centers and open-system dynamics of upper crustal magma reservoirs, where increase in heat supply can produce system-wide crystallinity variations conducive to evacuation of large volumes of magma in a single, catastrophic eruption.

This study demonstrates that quantitative analyses of dispersed zircon crystallization age distributions obtained with high-precision, ID-TIMS techniques can be applied to the plutonic and volcanic record to identify mature silicic magma reservoirs, whose properties and storage conditions allow for catastrophic caldera-forming eruptions to occur. Ultimately, this modeling framework provide the petrologic community with a new tool to investigate the genesis and evolution of caldera-forming volcanism through time and tectonic settings.

[1] Szymanowski, D. and Schoene, B., 2020. *J. Anal. At. Spectrom.* 35, 1207–1216.

[2] Bohron et al., 2020. *Contrib. Mineral. Petrol.* 175, 104.