A super-volcanic magma reservoir at high temporal resolution

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Mineral chemistry, thermobarometry and other classic tools of magmatic petrology give us snapshots of the conditions in a magma reservoir, typically with only the last 'magmatic event' available for interpretation. While individual crystals often preserve complex, high-resolution records of compositional changes within the surrounding magma, their relation to an absolute timescale is typically undefined. In contrast, accessory mineral petrochronology allows tracking the evolution of a magma body through time by integrating an absolute chronometer (U–Th–Pb) with the corresponding compositional information.

We present a study that combines the power of high-precision zircon U–Pb geochronology with the ability of zircon compositions to trace chemical changes in the surrounding melt. A large-*n* ID-TIMS U–Pb dataset of zircon from different facies of the 35 Ma Kneeling Nun magmatic system in New Mexico [1,2] enables us to tie the high-resolution time information to compositional variations in the dated crystals. Our data allow a discussion of the timescales and the character of changes occurring in the buildup to eruption, in particular the relative importance of variations in crystallinity (crystallisation vs. cumulate melting), temperature, and the influx of recharge magma. We also compare the records preserved by zircons in regions of the magmatic system of contrasting thermal histories to address the scales of heterogeneity in the magma reservoir. Zircons from holocrystalline plutonic and from porphyritic clasts significantly pre-date the eruption while zircons from pumice clasts and bulk ignimbrite samples yield complex age populations ranging from ~700 ky before eruption to ones indistinguishable from the $^{40}Ar/^{39}Ar$ eruption age. Taken together, a remarkably high resolution in a study of the time–temperature evolution of a fossil magma chamber is achieved, providing new insights into the timescales of storage and pre-eruptive rejuvenation of high-crystallinity super-eruptive systems.

[1] Elston, Seager & Clemons (1975) *New Mexico Geol. Soc. Guidebook* 26, 283–292. [2] Szymanowski, Wotzlaw, Ellis, Bachmann, Guillong & von Quadt (2017), *Nat. Geosci.* 10, 777–782.