Constraining magma residence timescales by coupling ID–TIMS U–Pb dating of zircon and titanite

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Clues about the timescales and thermal conditions associated with the growth and evacuation of large silicic magma reservoirs are frequently drawn from radiometric dating, diffusion modelling, thermomechanical modelling or crystal size distribution analyses [1]. A growing amount of petrological and geochronological evidence, supported by thermal modelling, suggests that many silicic magma reservoirs may exist for some 10^4–10^6 years in the form of high-crystallinity mushes at relatively low temperatures (~700-750°C, [2–4]). Geochronological studies addressing this issue typically utilise the U–Pb system in zircon capable of recording extended periods of crystallisation, particularly in evolved calc-alkaline systems that spend most of their lifetime zircon-saturated.

In this study, we integrate U–Pb dating of zircon and titanite to investigate the longevity of the magma reservoir that produced the Kneeling Nun Tuff, a ~35 Ma, > 900 km^3 crystal-rich rhyolitic super-eruption erupted within the Mogollon–Datil volcanic field in New Mexico (USA). High-precision ID–TIMS U–Pb dating of single zircon crystals displays a ~200,000 year crystallisation history and provides the temporal framework for our petrologic studies. We explore the use of titanite petrochronology as an additional time-resolved archive of magma evolution that may record different crystallisation conditions than zircon [5]. Dating of both accessory phases is combined with textural, major (EPMA) and trace (LA–ICPMS) element studies revealing the thermal conditions, differentiation processes and a mush rejuvenation event responsible for the growth of Ba+Sr+REE-enriched rims in sanidine and titanite. These preliminary results suggest a protracted upper-crustal storage of magma prior to the Kneeling Nun Tuff eruption followed by a melting event which reduced the magma crystallinity and conditioned it for eruption.

[1] Costa (2008), *Dev. Volcanol.* **10**, 1–55. [2] Bachmann & Bergantz (2004), *J. Petrol.* **45**, 1565–1582. [3] Gelman et al. (2013), *Geology* **41**, 759–762. [4] Cooper & Kent (2014), *Nature* **506**, 480–483. [5] Xirouchakis & Lindsley (1998), *Am. Mineral.* **83**, 712–725.