Micron-scale chronochemical zoning in zircon from Tarawera volcano

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Tarawera volcano (Okataina, Taupo Volcanic Zone, New Zealand) was formed during four major rhyolite eruptions over the past ~22 ka, the youngest of which (the 0.7 ka Kaharoa event) also erupted granodioritic xenoliths from the volcano's intrusive underpinnings. We have combined U-Th zircon geochronology with zicon trace element analysis at the highest achievable (μm-scale) spatial resolution afforded by Secondary Ionization Mass Spectrometry (SIMS) depth profiling of unsectioned crystals from Tarawera volcanic and plutonic rocks [1-3]. Zircon rim ages are heterogeneous at hand-sample scale, implying that individual crystals experienced different thermal histories. Arrested zircon crystallization is often indicated by age hiatuses and trace element reversals that mark deviations from a dominant pattern of retrograde crystallization indicated by a rimward decrease in Ti correlating with Zr/Hf. Moreover, zircon age distributions for sequential eruptions become progressively younger, with rim ages of preceding eruptions resembling interiors ages of the subsequent event. By contrast, granodiorite zircons in Kaharoa rhyolite have ages up to ~750 ka which differ from the dominantly young (<45 ka) zircon population in the host rhyolite. Zircon data for Tarawera rhyolites and granodiorites underscore that (1) the zircon record becomes gradually biased towards younger magmatic episodes; (2) zircon crystallization may not always track monotonic magma cooling, but can be interrupted by episodes of thermal and compositional rejuvenation; (3) marginal parts of the intrusive magma system can escape subsequent reprocessing, and thus plutonic rocks may only portray a partial picture of magmatic longevity; and (4) the zircon 'cargo' in volcanic rocks reflects thermally and compositionally divergent processes acting near-simultaneously in a crystal-rich magma storage region, rather than the conditions in the eruptible magma.

[1] Storm, Shane, Schmitt & Lindsay (2011). *Earth Planet. Sci. Lett.* **301**, 511-520; [2] Shane, Storm, Schmitt & Lindsay (2012). *Lithos*, **140**, 1-10; [3] Storm, Shane, Schmitt & Lindsay (2013). *Contributions to Mineralogy and Petrology*, **163**, 505-519.