Thermochemical diversity of zircon crystallizing from the Youngest Toba Tuff, Indonesia

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Eruption of the 74 ka Youngest Toba Tuff (YTT) of northern Sumatra produced an extraordinary 2800 km^3 of compositionally-zoned welded ignimbrite and co-ignimbrite ash-fall. Spatially selective chemical analyses of zircons from dacite to high silica rhyolite represent "rim" (unpolished rims), "near-rim" (at ~5 μm depth or ~50% of volume) and "interior" (sectioned grains) domains, offering systematic new insights into assembly of a giant magma chamber. Trace element ratios in zircon overall (e.g., Zr/Hf, Eu/Eu*, Nd/Yb) vary significantly (factors of 2, 7, >10, respectively) and co-variations mirror those observed in host rocks. Titanium concentrations in zircon (1-10 ppm) generally vary as expected with interelement ratios and translate to a large T_{ZirXl} range of 650 to 860°C at a_{TiO2} = 0.3 [1], as calibrated at 1 GPa [2]. Likely crystallization of YTT zircon at <0.2 GPa, as judged by chemical affinities with quartz-hosted melt inclusions, could reduce apparent T_{ZirXl} by ≥40°C.

Spatially resolved YTT dating shows that zircon crystallization extended to >400 ka before eruption [3]. Similarly high maximum Ti and Zr/Hf contents in zircon now hosted in diverse rhyolitic melts suggest periodic growth from dacitic melts. Subsequent growth from generally cooling melts is suggested by average Ti contents that decrease from interiors to near-rims to rims. Differences in average Ti contents between near-rim and rim zircon domains suggest thermal zonation of the magma reservoir (by ~30°C). Nonetheless, extensive overlap in zircon compositions indicate that conditions experienced by individual zircon were highly variable. Additionally, the Ti decrease from near-rims to rims (potentially equivalent to ~40°C) is not accompanied by clear evidence of normal trace element zoning. This decoupling could be explained by a decrease in a_{TiO2} (contraindicated by high a_{TiO2} inferred from FeTi-oxides) or by a decrease in pressure before eruption.

[1] Kularatne and Audétat (2014) *Geochim. Cosmochim. Acta* **125**, 196-209. 2014. [2] Watson *et al* (2006) *Contrib. Mineral. Petrol.* **151**, 413–433. [3] Reid and Vazquez (2013) *Goldschmidt Conference Abstracts*, 2042.