

Speleothem archives of volcanism: In search of the Taupō eruption

NICHOLAS GAMPELL^{1*}, SIMON BARKER², SILVIA FRISIA³, ANDREA BORSATO³, PAUL WILLIAMS¹, JOHN HELLSTROM⁴, RUSSELL DRYSDALE⁴, COLIN WILSON², ADAM HARTLAND⁵, JOEL BAKER¹

¹School of Environment, University of Auckland, New Zealand (*correspondence: ngam491@aucklanduni.ac.nz)

²School of Geography, Environment and Earth Sciences, Victoria University of Wellington, New Zealand

³School of Environmental and Life Sciences, University of Newcastle, Australia

⁴School of Earth Sciences, University of Melbourne, Australia

⁵Faculty of Science and Engineering, University of Waikato, New Zealand

Speleothems are cave deposits that can be dated using high-precision U-series methods. These archives contain multiple proxies (e.g. trace elements) that can be used to reconstruct the palaeoenvironment [1]. Previous studies have shown that volcanic eruption signals may be preserved in speleothems from either indirect or direct evidence, with S and other trace elements considered to be promising proxies [2]. A recent paper [3] challenged the accuracy of the ¹⁴C wiggle-match age of the Taupō eruption— 232 ± 10 CE [4]. It was proposed that the ¹⁴C ages from sources near the eruption were influenced by magmatic ¹⁴C-depleted CO₂, and that the eruption likely occurred decades to centuries after this date.

Here we present a multi-proxy petrographic and geochemical study on a well-dated New Zealand speleothem, with the objective to further constrain the timing of the Taupō eruption. Robust age–depth models were constructed using several U-series dates to identify the most likely sample depths of the event. Replicate LA-ICP-MS raster transects provided reproducible trace element maps. In one region, a significant increase in growth rates is coupled with increases in S, Ti, Y, Zr, Sr, Ba, and U and a decrease in Mg contents. These are also coincident with a porous speleothem fabric, FE-SEM particulate analyses showing the presence of S, K, and Ti, and initial stable isotope analyses that suggest likely higher influx of rainfall and vegetation loss. This depth in the speleothem has an age of 217 ± 27 CE, and is within uncertainties of 232 ± 10 CE. This suggests the Taupō eruption occurred close to the currently accepted age, and highlights that New Zealand speleothems are important archives of past volcanism.

[1] Fairchild & Baker (2012) *JW&S*. [2] Badertscher *et al.* (2014) *EPSL* **393**, 58–66. [3] Holdaway *et al.* (2018) *Nat. Commun.* [4] Hogg *et al.* (2012) *The Holocene* **22**, 439–449.