

Coupled modelling of speleothem major isotope systems

R.A. OWEN*¹, C.C. DAY¹, G. M. HENDERSON¹

¹Department of Earth Sciences, University of Oxford, UK (*correspondence: robert.owen@earth.ox.ac.uk)

Speleothem geochemical proxies are widely used to infer past changes in rainfall and other environmental parameters. However, the processes controlling these proxies are complex and render detailed interpretation difficult. Recent progress in understanding proxy controls has been made through cave monitoring studies, laboratory simulations of speleothem growth, and geochemical modelling. Nevertheless, a unified interpretive framework remains elusive.

Previous modelling efforts focus either on carbon and oxygen isotope incorporation [1], or the trace element content of speleothems [2]. Such studies have delivered insights into the controls on speleothem chemistry. However, their focus on single components of the chemical system limits our ability to quantitatively interpret multi-proxy datasets.

Here we present a chemical model to address this concern. Based on the geochemical software PHREEQC [3], our one-dimensional model tracks dripwater chemistry from soil to cave. The model couples an isotope-enabled carbon system with Group II metal chemistry (Ca, Mg, Sr, Ba) and may be used to forward-model dripwater and speleothem chemistry including the proxies $\delta^{13}\text{C}$, $\delta^{18}\text{O}$, $\delta^{44}\text{Ca}$, Mg/Ca, Sr/Ca and Ba/Ca. Controls considered include soil chemistry, bedrock chemistry, open versus closed system dissolution, prior calcite precipitation and cave air pCO_2 .

The model is tested against existing and new isotope and trace element data. It may be expanded to include radiocarbon and other tracers, as well as kinetic considerations.

[1] Mühlinghaus et al. (2009) *Geochim. Cosmochim. Acta* **73**, 7275-7289.

[2] Sinclair (2011) *Chem. Geo.* **283**, 119-133.

[3] Parkhurst & Appelo (2013) *U.S. Geological Survey Techniques and Methods* **6**, 497.