Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.36519

Lithium isotopes in speleothems: weathering versus hydrological controls

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The lithium isotope composition (^{7}Li) of speleothems reflects past drip water compositions and thereby provides a promising proxy for reconstructing changes in chemical silicate weathering at a regional scale. Shifts towards higher ^{7}Li values can be expected to arise from enhanced secondary mineral formation relative to silicate rock dissolution, while lower ^{7}Li values should indicate more efficient rock dissolution. In turn, such changes may reflect shifts in weathering congruency related to landscape evolution (e.g. fresh mineral supply, soil formation), or more direct climate controls that affect the fluid residence time in the overlying soil and epikarst (e.g. precipitation, effective infiltration). However, which of these controls is dominant may be a function of the geological, hydrological, and climatic setting, and potentially also the timescale under consideration.

Here we explore several case studies of speleothem ^{7}Li records we have been developing, including (i) Holocene stalagmites from the Yorkshire Dales, UK; (ii) Holocene and Late Pleistocene stalagmites from Central and Northeast Brazil; (iii) Middle Pleistocene speleothems from Siberia; and (iv) an Early Pleistocene flowstone record from Buffalo Cave, South Africa. In the case of the Yorkshire Dales, positive correlations between elevated ^{7}Li, ^{13}C, Mg/Ca, and Sr/Ca values provide a signature of increased fluid residence times, which may relate to a combination of regional changes in effective infiltration and local changes in fluid pathways. In addition, some longer term trends within those Holocene ^{7}Li records appear decoupled from the hydrological tracers, and may instead relate to changes in the vegetation succession and soil formation in this temperate moorland setting. The other examples span a range of climate zones and vegetation types, enabling us to test the wider applicability of those findings, and in particular to investigate other potential environmental controls on speleothem ^{7}Li records from permafrost and savannah settings.