Lecture Abstract:

The "Trace Element Geochemistry of Speleothems" Lecture

By Ian Fairchild[1]

Trace elements that are incorporated in speleothems are transported both in solution and as colloids. Ions in solution include the alkaline earths which classically substitute for Ca in a fairly systematic way and whose interpretation can be guided by first considering carbonate bedrock and atmospheric aerosol sources. Contributions from silicates for Sr can be assessed by Sr isotope analysis. The trace element to Ca ratio then shows characteristic variations seasonally or over longer periods of time in cave systems subject to strong seasonal variations in water flow rate or CO_2 degassing leading to changing flow paths (and hence sources) or changing amounts of prior calcite precipitation. These elements tend to be more abundant in dry periods, although at some sites seasonal dryness can compete with seasonal low PCO_2 as a driver for high trace element concentrations. Quantitative models of these processes are now well developed. Sulphate ions tend to substitute for carbonate and can reveal pollution or volcanic events, mediated by soil-ecosystem storage, and made more variable by in-cave pH effects.

Trace elements transported as colloids show different patterns. Where there is a seasonal flux of relatively coarse colloids, element enrichments associated with fluorescent organic matter can be found and provide a record of palaeohydrology. On the other hand some transition elements are characteristically enriched in association with ultrafine humic colloids that may form a year-round background. Enhanced colloidal enrichment may be associated with depressed Sr and assist the determination of annual chronology by counting chemical layers. Elemental enrichments at hiatuses may characteristically reflect the composition of cave aerosols combined with bacterial element fixation.

A succinct summary of trace element patterns is found in Fairchild & Treble (2009) with a comprehensive treatment in chapters 5 and 8 of Fairchild & Baker (2012). More recent work includes models and application of alkaline earth elements (Sinclair et al., 2012, Stoll et al., 2012, Wong et al., 2011), colloidal patterns (Hartland et al., 2012) and role of cave aerosols (Dredge et al., 2013).

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