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Multi-Element Trace Element Proxies in Speleothems

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The potential of speleothems as palaeoenvironmental indicators is developing rapidly, both in terms of the recognition and calibration of new proxies and the separation of general ground rules for their interpretation from site-specific effects. In the case of trace element proxies, their variation is now understood primarily to reflect palaeohydrological modification of a basic level set by the composition of karstic host rock composition and overlying weathering mantle (Fairchild et al., 2000). In some cases, crystal growth factors also need to be considered (Huang and Fairchild, in press). Since longer term changes in weathering mantle are expected to occur, the use of trace elements can be considered to be optimal over shorter time frames of rapid climatic change. The ion microprobe instrument (Roberts et al., 1998; Huang et al, in press) in particular offers a blend of low detection limits and high spatial resolution to allow the seasonal response to water availability to be determined and tracked across such interesting time intervals.

Preliminary studies of 20th century speleothems from a number of sites in western Europe (Ernesto, Italian Alps; Pere-Noel, Belgium; Uamh am Tartair, Sutherland, Scotland; Crag Cave, Ireland; Ballymaintra, Ireland) have shown appreciable and systematic variations in trace elements within an annual timescale. Since most speleothems are not visibly annually banded, chemical indicators of the annual timescale and hence growth rates are valuable. P has most promise of all the trace elements in this respect with up to an order of magnitude variations (c. 10-100ppm). Where the time frame of these variations are known a broad autumnal peak in P is displayed which is explicable in terms of an autumnal peak in P release (as orthophosphate primarily) from decay of vegetation, coupled with an enhanced water infiltration rate. Variations also occur in Mg (which is a key indicator of palaeohydrology), Sr (likewise, but modified by growth rate and other crystal chemical effects), Ba, F, H and Na.

Work is in progress to collect a record of continuous variation from the Ernesto and Uamh am Tartair sites backwards from the 1990's for comparison with weather records. The Ernesto record for example displays a clear change in the pattern of trace element response coinciding with a significant reduction in autumnal rainfall between the 1960's and the 1980's-1990's.

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