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A new technique for trace elemental analysis of speleothems using microbeam xrf

J. Buckles (1), H. Rowe (1), Y. Gao (2), H. Cheng (3), R.L. Edwards (3), G. Springer (4), and B. Hardt (3)

(1) University of Texas at Arlington, Arlington, United States (jessica.buckles@mavs.uta.edu), (2) East Tennessee State University, Johnson City, United States (gaoy@etsu.edu), (3) University of Minnesota, Minneapolis, United States (cheng021@umn.edu; edwar001@umn.edu; bhardt@mail.utexas.edu), (4) Ohio University, Athens, United States (springeg@ohio.edu)

Trace element ratios in speleothems (Sr/Ca, Mg/Ca, Ba/Ca) have been used to interpret the hydrogeochemical processes in the epikarst zone as well as the partitioning that occurs at the calcite-water interface. During periods of low rainfall, trace element ratios generally increase as a result of the longer residence time of water in the soil and epikarst zones. High-resolution time series analyses of these elements in speleothems provide evidence for changing paleohydrological and geochemical conditions over time.

The conventional methods of trace metal analysis of speleothems- Laser Ablation Inductively-Coupled Plasma Mass Spectrometry (LA-ICPMS) and Inductively-Coupled Plasma Optical Emission Spectroscopy (ICP-OES) have yielded many high-quality data sets. However, these methods can be expensive, time-consuming, and require the destruction – either by ablation, micro-milling, or powdering of speleothem samples. The many caveats of these conventional methods have led to the search for a viable alternative – one that will provide the same high-resolution result, but that is affordable, rapid, and non-destructive.

Presented here are trace element analysis results using microbeam X-ray Fluorescence Spectrometry. The Brüker-AXS ARTAX microbeam XRF spectrometer permits a multi-element analysis from Na to U with a spatial resolution of 70 μm. The method is non-contact and non-destructive, therefore preserving the sample for additional analyses (e.g. stable isotopes). A simple calibration method for Sr/Ca using pressed mixed powders will be described.

It will be demonstrated that microbeam XRF is an important tool in trace element analysis of speleothems and a viable alternative to conventional methods. Sr/Ca ratios were obtained for multiple speleothems and serve as a preliminary test of microbeam XRF suitability. Analyses of variable count times, temporal and spatial reproducibility along transects, and a comparison between microbeam XRF spectra and ICP-OES spectra for the same transect of a speleothem growth axis will be presented. In addition, ARTAX multi-transect area-mapping will demonstrate trace element abundances along both calcite bands and the growth axis.