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A first convincing step towards the application of dissolved noble gases in speleothem fluid inclusions to determine local meteorological conditions in caves

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In aquatic systems concentrations of dissolved atmospheric noble gases in water reflect the physical conditions that prevailed during air / water partitioning. This simple principle has been successfully applied to reconstruct palaeoenvironmental conditions from groundwater or from pore water of lake sediments.

It seems obvious to apply the same physical concepts to the fluid inclusions in speleothems, because it is expected that growing speleothemes incorporate drip water in equilibrium with the local air. However, earlier attempts to apply the noble gas systematics on fluid inclusions in speleothemes failed because large amounts noble gases from 'excess air' entirely masked the noble gases being dissolved in water (Mc Dermott et al., 2005).

We developed a crushing method that overcomes the former experimental limitations. In contrast to common techniques our method allows to crush speleothem samples into single grains leaving the individual crystals intact. Microscopic analyses and noble gas results from crushing and subsequent gas extraction by thermal decrepitation demonstrate that spelethems contain different types of fluid inclusions (see also Kendall, 1978) that contain distinct noble gas components. The larger inclusions between the calcite crystals seem to contain free air, whereas the much smaller water inclusions within the minerals seem to carry a noble gases component similar to that of air-saturated water.

Our results are the first clear evidence that noble gases in the water inclusions in speleothemes are experimentally accessible. Although very preliminary, our work backs the idea of using noble gases in fluid inclusions in speleothems as new and emerging palaeoenvironmental proxies.

Literature. Kendall, A. (1978). Origin of fabrics in speleothems composed of columnar calcite crystals. Journal of Sedimentary Petrology, 48:519-538. McDermott, F., Schwarcz, H., and Rowe, P. (2005). Isotopes in speleothems. in Leng, M. (editor), Isotopes in Palaeoenvironmental Research, 10, pages 185-225. Springer.