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Quantitative approach of speleothems fluorescence

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In this study, we propose a framework to interpret quantitatively the fluorescence of speleothems organic matter (OM) by the way of a bank of water-extracted organic matter.

Due to its efficiency to described dissolved organic matter (DOM) characteritics, fluorescence has been used to determined DOM signatures in natural systems, water circulations, OM transfer from soils, OM evolution in soils or recently, DOM changes in engineered treatment systems.

Fluorescence has also been used in speleothems studies, mainly as a growth indicator. Only few studies interpret it as an environmental proxy.

Indeed, the fluorescence of OM provides information on the type of organic molecules trapped in speleothems and their evolutions. But the most direct information given by fluorescence is the variation of OM quantities. Actually, increase of fluorescence intensity is generally related to an increase in OM quantity but may also be induced by calcite optical effect or qualitative change of OM. However, analytical technics used in water environments cannot be used for speleothem samples.

In this study we propose to give a frame to interpret quantitatively the fluorescence signal of speleothems. 3 different samples of stalagmites from french northern Prealps were used. To allow the quantification of the fluorescence signal, we need to measure the fluorescence and the quantity of organic matter on the same sample. OM of speleothems was extracted by an acid digestion method and analysed with a spectrofluorimeter. However, it was not possible to quantify directly the OM, as the extract solvant was a high-concentrated acid. To solve this problem, a calibration using soil extracts was realised. Soils were chosen in order to represent the diversity of OM present in the environment above the caves. Attention was focused on soil and vegetation types, and landuse. Organic material was water extracted from soils and its fluorescence was also measured. Total organic carbon was performed on the same samples. This allow to compare the two fluorescence signals. A range of OM concentrations can be then attributed to the speleothem signal. Fluorescence measurements were also realised on solid samples, using the MUESLI (Muesli Uses Emission Fluorescence for Line scanning and Imaging). Comparison with the two fluorescence signals, will evaluate the adaptability of the concentrations range for solid measurements, generally used.

This method offers the possibility to associate a fluorescence signal on solid speleothem, with a non-destructive method, to an environmental range of organic carbon quantities.