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Reconstruction of lake history using nondestructive methods. A first record of organic endmember in sediments using solid phase fluorescence (Lake Noir Inférieur, Aiguilles Rouges Massif, France)

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Mountain areas are known to be highly sensitive to environmental perturbations driven by climate changes and human activities. Thus, high altitude lake sediments represent interesting archives to reconstruct past environmental variations. Because of their difficult access and their low sedimentation rate, high resolution nondestructive methods are required to limit the loss of information induced by the use of destructive analyses. Moreover, when they are located at the top of drainage basins, their reduced catchment area leads to the dominance of organic matter in the sediment which would make interesting to complete the use of traditional high resolution sedimentary geochemistry tools, such as X-ray fluorescence (XRF) logging, by organic matter-borne high resolution signals.

Here we attempt to use UV-induced solid phase fluorescence (SPF) as a promising way to analyze the organic component of environmental archives as we already showed on speleothem records.

A 70cm-long core was retrieved in 2012 from the high altitude Lake Noir Inférieur (2495 a.s.l.), located in the Aiguilles Rouges Massif (Northern French Alps). The catchment area, made by gneiss and amphibolites, is almost devoid of vegetation. Thus, the high OM content (up to 23.6%) of the homogenous dark brown sediments is assumed to be essentially related to autochtonous production. The preliminary age model suggests that the core spans the last 8000 yrs.
In this work, we investigated the upper 15 cm of the core which represents the last 1300 yrs. We combined the two spectroscopic methods (XRF and SPF) at a 100μm step, in order to provide a high resolution overview of both mineral and organic endmembers. The XRF core scanner analytical settings were adjusted at 10 kV and 30kV in order to detect elements from Al to Pb. SPF measurements were performed with a spectrofluorimeter and emission spectra were recorded at 256 nm and 325 nm excitation wavelengths. Different organic matter types (chlorophyll-like, protein-like or humic-like compounds) are detected and their relative concentration is assessed by a curve fitting procedure.

XRF results show a clear mineralogical signal tracing anthropogenic and climatic changes in time over the Medieval Warm Period, Little Ice Age and the last Century. As suspected, due to the absence of soil in the catchment, SPF signal of humic-like compounds is very low whereas autochthonous products (chlorophyll-like and protein-like compounds) present important variations. Despite some uncertainties induced by the sediment matrix changes, these results present a concordant signal with the XRF measurements. Although the sediment matrix effects need to be corrected, this work suggests that fluorescence signal of chlorophyll-like and protein-like compounds could be used as proxies of organic productivity. SPF logging combined with X-Ray fluorescence is a promising tool to interpret, in a nondestructive manner, climate and environmental changes.