Investigating the evolution of the chemical nature of persistent soil organic carbon thanks to state-of-the-art synchrotron-based NEXAFS spectroscopy

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Though it is of crucial importance in order to better understand carbon persistence in soils, the chemical nature of stable soil organic matter (SOM) is poorly characterized. This is explained by two major difficulties: (1) there is still no successful experimental way to isolate the pool of SOM that has a pluri-decennial residence time and (2) SOM with high residence time is often associated to minerals, which complicates its characterization.

In this work, we overcame these two major difficulties by characterizing samples from long term bare fallow (LTBF) experiments using the state-of-the-art synchrotron-based NEXAFS spectroscopy (Canadian Light Source, Saskatoon, Canada). Firstly, LTBF experiments offer a unique opportunity to study stable SOM, as without carbon inputs and with continuing biodegradation and mineralization, SOM becomes progressively enriched in its most stable components. Secondly, NEXAFS technique allows the characterization of Carbon speciation with no sample pre-treatments and little to no noise induced by the mineral part of the samples. In this work, the fluorescence emission spectra at the Carbon K-edge threshold (280 eV) were measured for samples taken up at the initiation of 5 different european LTBF experiments and several decades later.

Results show that differences in chemical composition between different dates are subtle but significant and spectra are highly reproducible between field replicates. More advanced data treatment is ongoing and will be presented at the Goldschmidt conference.