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STXM analysis of fungal soil aggregation

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Understanding soil's C sink potential is crucial to support soil management that increases its long-term carbon storage. Soil aggregate formation is known to be a main factor for long-term C sequestration, as C becomes physically protected, or "hidden", within an increasingly complex three-dimensional structure.

The dynamic process of soil aggregation is however not yet clearly understood. Soil (micro) organisms are thought to play a decisive role in "gluing together" and redistributing particles. They also move existing organic material, and include own exudates and dead cells into aggregates. Fungi, and especially mycorrhizal fungi play a key role in physical organic matter stabilization as they transport carbon compounds over long distances and into narrow soil pores, but little is known about the chemical remnants they leave to soil aggregates.

We investigated the exudates of single hyphae of two saprotrophic and two mycorrhizal fungi (G. confluens, P. subvisciva, P. involutus, R. irregularis), with and without contact to three types of minerals (quarts, goethite, muscovite). We grew them in sterile cultures on Si_3N_4 windows and analysed hyphae, their exudate layers and the organo-mineral interfaces. STXM analysis was performed at CLS, Canada, Diamond, UK, at the C(K), K(L), N(K) and Fe(L) absorption edges, and we made complementary measurements with photothermal IR microspectroscopy at Soleil, France. We found differential composition of the exudates depending on fungal species and environmental conditions. In some cases, we could identify spatially resolved oscillating plumes of K exudates emitted from the hyphae, indicating possible exudation channels. Goethite particles in close vicinity to a hypha showed reduced Fe(2+) compounds, suggesting that oxidative processes may take place. We further investigated thin-polished samples of AMF hyphae grown in a sterile soil, and located polysaccharide-, lipid- and protein-compounds in the surrounding soil matrix.

Our results will help to better understand the processes of fungal soil aggregation and physical organic matter stabilization.