

## **Organo-mineral associations in form of co-precipitates stabilize soil carbon, but these associations are less stable in contact to root exudates.**

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Soils contain a large amount of C, in the form of organic matter (OM). Maintaining this amount of OM is important for food security but also for the climate. Soil OM stabilization is mainly provided by its association with mineral phases. And a large part of these associations is in form of co-precipitates [1], which bind OM with elements from weathered primary minerals. The importance of these co-precipitates is quantified using chemical extractions that destroy them [2]. Although co-precipitates are quantitatively important [1], their characterization and their fate in contact with soils living organisms remains unknown. Following this observation, we lab-synthesized co-precipitates with elements from weathered basalt, biotite or labradorite (minerals containing Fe, Si, Al, Mg, K, Na and Ca) and we isolated natural co-precipitates from a soil (andosol). In a first step, we characterized these synthetic and natural co-precipitates using transmission electron microscopy coupled with EDS and EELS to characterize the crystalline order and map the elemental composition from the micro to the nanoscale. In both the synthetic and natural coprecipitates, results showed that C is always detected with Al, Fe and Si in an electron-amorphous, gel-textured phase. These elemental colocalizations were detected down to 10 nm. These results suggest that the inorganic phase co-precipitated with OM is composed of a few oligomers with little or no crystalline order. This type of association is theorized and named “nanoCLICs” for Nanosized Co-precipitates of inorganic oLIgomers with organiCs [3]. In a second step, we tested the fate of these synthetic and natural nanoCLICs by exposing them to soil microorganisms and a root exudate in microcosms. This experiment showed that the C of nanoCLICs is mostly protected from microbial mineralization. However, the contact of a root exudate weakened the nanoCLICs and provide OM accessibility to microorganisms. Thus, mineral weathering in soils can generate nanoCLICs-co-precipitates. And while these nanoCLICs participate to the retention/stabilization of OM, they can themselves be weathered, in contact to the biological activity of the rhizosphere.

[1] Rasmussen et al. (2018), *Biogeochemistry*, 137.

[2] Rennert. (2018), *Soil Research*, 57.

[3] Tamrat et al. (2019), *Geochimica et Cosmochimica Acta*,