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Mineral-associated organic matter: Accumulation and destabilization potentials

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Mineral-associated organic matter (MAOM) is considered to represent an important pool of slow-cycling soil carbon, and its formation pathways and distribution have been extensively studied recently. However, the potentials and conditions for MAOM accumulation or destabilization remain poorly constrained, especially in the context of global changes that affect both organic matter inputs and soil physiochemical status. When organic matter inputs into the soil increase (e.g., under elevated plant productivity), will MAOM increase accordingly or remain constant? Alternatively, will MAOM be disrupted and decomposed when environmental changes make it accessible? To answer these questions, this talk showcases several studies that highlight the dynamic variations of MAOM under environmental changes.

In the first study, we investigate MAOM accumulation potentials by burying ^{13}C-labeled grass roots with soils at different depths in four grasslands in the field and trace the incorporation as well as the form (as plant or microbial inputs) of ^{13}C into MAOM in place of its native (old) carbon. We find that MAOM, both in terms of its carbon content or proportion of ^{13}C, did not change after the two years of root deposition. However, simulated warming significantly increased MAOM content without changing total soil carbon in the subsoil, indicating MAOM accumulation potentials with increased carbon inputs at depth but not the surface.

In the second study, we investigate changes in MAOM in relation to soil carbon mineralization in different grassland soils during substrate-amended incubations under various redox conditions. We find that labile carbon addition induced much stronger CO_2 production from native soil organic carbon under O_2-limited than aerobic conditions. Moreover, in contrast to oxic incubations, elevated anaerobic mineralization was accompanied by a significant decrease of iron-associated organic carbon, indicating anaerobic release and degradation of components that were originally protected by reactive metals in the soil. These findings reveal a substrate-induced hot moment for MAOM destabilization under anoxia. Collectively, our study calls for attention to the dynamic variations of MAOM during environmental changes. While increased carbon supply may enhance MAOM accumulation in grassland subsoils under warming, periodic anoxia may yield the opposite effect.