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Microbial soil aggregation and their gluing agents

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Carbon (C) sequestration from the atmosphere and long-term storage in soil has potential to counterbalance the excessive CO_2 emissions and mitigate effects of the global climate change. Under physical stabilization, soil organic matter (SOM) is hidden from its decomposers within soil aggregates and C is prevented from being released back to the atmosphere through their catabolic activities. Thus, aggregate formation has been recognized to play a major role in soil C stabilization, but the related processes are not well understood. Soil (micro)organisms are thought to play a decisive role in gluing together and redistributing mineral particles. Mycorrhizal fungi in particular can be responsible for transporting carbon into soil spaces that are less attractive to other soil organisms and their hyphal exudates – for gluing together mineral particles.

Increasing our understanding of the processes leading to physical C stabilization in soils is the prerequisite to identify soil cultivation practices that can support those processes. Thus, the aim of this project is to study the dynamic processes of soil aggregate formation by means of different spectroscopic techniques including synchrotron radiation based X-ray microspectroscopy (STXM, XRF, XANES/EXAFS) which provide chemically specific information about samples at micro- to nano-scale. The role of microbial necromass and fungal exudates to the formation of aggregates will be specifically monitored by growing different, initially defined soil organisms such as bacterial populations or saprotrophic and arbuscular mycorrhizal fungi in contact with different principal soil components (pure compounds in form of mineral types and organic matter types) within a microfluidic platform. Such an approach enables us to monitor the aggregation process under the microscope in real time and allows manipulating physical structure and chemical availability of nutrients to microorganisms at micrometer scale. The effects of such manipulations on the fungal hyphae and their exudates, and chemical alterations in newly formed aggregates will be monitored through scanning transmission X-ray microscopy. We anticipate the overall results will provide new insights into processes of soil aggregate formation and their role in physically stabilizing carbon.