The architecture of soil micro-aggregates investigated by 3D X-ray microscopy

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Soil structure reflects the spatial arrangement of mineral and organic soil components. It is therefore of central importance for many biological, physical and geochemical processes, such as the ability of the soil to act as a carbon sink or the development and distribution of habitats for micro-organisms, which in turn also regulate important microbial processes (eg. the N cycle). Soil structure is a dynamic soil characteristic meaning that it is in a state of constant change and development. On the one hand the architecutre of soil micro-aggregates (SMAs), which are the core unit of soil structure, are influenced by multiple factors, such as texture, age, swelling and shrinking, as well as biological activity. On the other hand the spatial arrangement of solids and pores control the dynamics of SMAs by mediating physical, chemical and biological processes leading to the building and decay of SMAs. Hence it is of pivotal importance to analyse the internal microstructural characteristics to better understand the underlying mechanicsm and their interaction in SMA formation and to provide a basis for the development of new mechanistic modelling approaches that are able to functionally link aggregate architecture with processes.

In this presentation we will first introduce a new method to separate SMAs in dry conditions with the goal to preserve the internal structures in its most native state without risking the generation of “architectural artifacts” that may arise by re-aggregation after commonly applied wet seperation techniques. Second we will show ways on how to non-invasively image the internal structures of separated SMAs by modern 3D X-ray microscopy and how to derive quantitative morphological and topological characteristics of SMAs using 3D image analysis in order to compare them with respect to differences in environmental conditions during SMA formation (eg. soil texture, soil age). Finally, we will present some first results on the potential of 3D X-ray microcopy combined with novel staining techniques to study the spatial arrangement of soil organic matter within soil aggregates which is an important factor in SMA formation.