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Improving X-ray CT based visualization of particulate organic matter in soil

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Soil pore network structure can have a significant impact on microbial utilization of soil organic matter and hence its stability. This stabilization is essentially the result of suboptimal conditions for substrate and metabolite diffusion connected to moisture distribution and aeration. All these factors depend on the spatial organization of the pore network. Because of the small dimensions of the soil pores, X-ray Computed Tomography (CT) is commonly used to study the soil pore network. This non-destructive technique allows to visualize the 3D architecture of soils at scales relevant for microbial activity.

Despite recent advances in software development, a main constraint on the use of X-ray CT visualization for soil applications is the limited soil phase differentiation, largely due to a low X-ray attenuation contrast. Application of heavy element contrast stains that enhance X-ray attenuation of targeted structures could facilitate phase determination. Recently, the effectiveness and selectivity of different staining agents towards water, SOM and mineral matter (MM) has been investigated. Subsequent staining of water and SOM resulted in the selection of four staining agents that successfully increased the attenuation of SOM. The potential of these agents (lead nitrate, lead acetate, silver nitrate and phosphomolybdenic acid) to selectively stain OM was further tested in MM/OM mixtures. Among the tested staining agents different selectivity towards the mineral sand fraction was observed. This suggests that soil matrices of different mineral compositions probably require specific selection of compatible staining agents. Therefore, it is important to test the selectivity of staining agents towards different mineral soil fractions. A study concerning the compatibility of four staining agents towards silt and clay will be presented.

Finally, improved visualization of organic matter and other soil fractions will contribute to more accurate and efficient processing of the X-ray CT images. The combination of this technique with measurements of the microbial community and activity could result in new insights in small scale carbon cycling.