Effect of agricultural management practices on soil structural stability and organic matter deprotection during drying-rewetting cycles

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Abstract:

Increasing drought conditions, as a result of climate change are expected to cause more frequent and intense drying-rewetting cycles in soils. Peaks of CO_2 emissions released from the soil to the atmosphere during the rewetting phase have been well documented. One hypothesis for this carbon release is the physical deprotection of organic matter in soils due to modifications in the soil structure, particularly regarding the pore network morphology. The morphological stability of the soil during drying-rewetting cycles depends of the soil properties (e.g. texture, carbon content), but is also expected to depend on soil management practices in agroecosystems.

This work aims to reveal for the first time the physical deprotection of organic matter in natural soils. We used synchrotron-based X-ray imaging to measure the temporal evolution of the 3D spatial distribution of organic matter in soil samples during drying-rewetting cycles. Soil samples were collected from the 2-5 cm layer of two Luvisols under conventional and conservation agriculture respectively. The samples were air-dried and broken manually into aggregates of 2-3 mm, and their organic matter was stained with Osmium. Then, 18 aggregates were subjected to 3 drying-rewetting cycles and scanned at 1.3 µm resolution before and after rewetting. The rewetting phase was also captured using 1 second fast scans performed at regular intervals over 10 minutes at 2.2 µm resolution.

The visualisation of short-time soil structure dynamics during the rewetting period allows us to observe the formation of microcracks during drying and wetting events. Soil structure deformation is affected by agricultural practices: more intense deformation occurs under conventional agriculture compared to conservation agriculture, especially during the second and third drying-wetting cycles. Aggregates from conservation agriculture show less swelling, thinner cracks, and better structural recovery upon drying. Aggregates from conservation agriculture contain more Osmium-stained organic matter. Further steps of this project will quantify interactions between the organic matter and the changing pore network during drying-rewetting cycles, and infer new relationships between soil organic matter decomposition and soil structure dynamics.

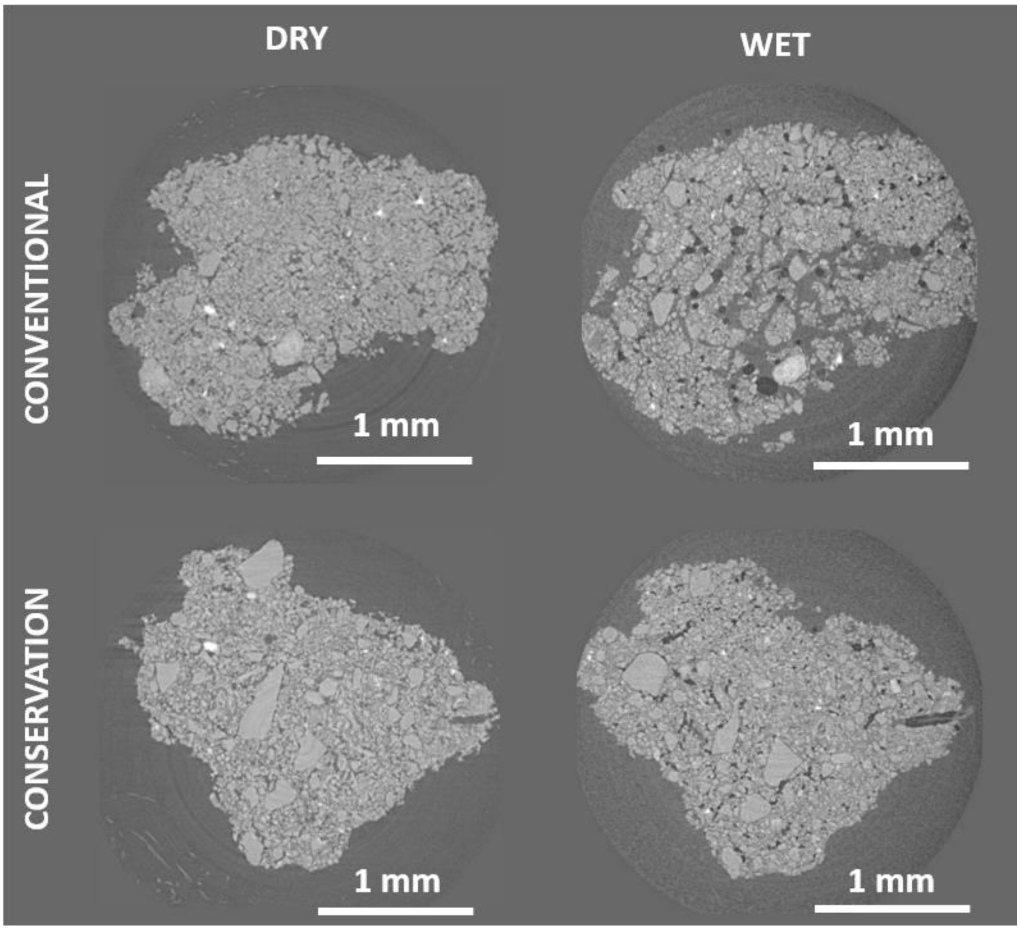

Figure: Visualisation of aggregate structure before and after rewetting for conventional and conservation agriculture

<u>+ 1 annex accepted: image, graph or table</u>