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Visualization with X-ray microtomography of soil samples under a growing draining pressure

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Despite its generalized use, the concept of capillary law applied to water movement through the soil is far from representing the real occurring processes. Beside individual pores volume (or size), should the connectivity and tortuosity of the complete pore network be part of any calculation regarding soil-water fluxes. We aimed at demonstrating that statement through the visualization of 20 agricultural soil samples (3 x 5 cm) at various water matric potentials. The samples were firstly saturated with water and then a specified negative pressure was applied to the bottom of the samples through the use of pressure plates in order to reach an internal water matric potential. At equilibrium, the samples were scanned with an X-ray microtomograph (micro-CT system Skyscan-1172) which produces 3D images where the air phase is distinguishable from the water phase and soil matrix. That procedure was applied after reaching water matric potential of -4 kPa, -7 kPa, -10 kPa, and -30 kPa. For each soil samples, we had then four 3D X-ray μCT images to compare.

On one hand, we visually analyzed the differences between the grayscale images. According to capillary law and from the used voxel size (21.5 μm resampled to 43 μm), we shouldn't have observed differences between the X-ray μCT images of the same soil samples at different water matric potential, but we did. We observed air-filled pores growing in volume with a growing negative pressure but also new air-filled pores with growing negative pressure.

On the other hand, the X-ray μCT images were binarized with a global segmentation method from which individual, and global, geometrical, and morphological, microscopic parameters were calculated. Analyses are still ongoing and we aim at evaluating the evolution of the microscopic parameters values with growing negative water matric potential. The microscopic parameters are calculated for all the pores taken together, but also by specific volume ranges.

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