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Synchrotron X-ray Computed Microtomography of Soil Pore Characteristics Affected by Compaction

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Soil compaction modifies soil structure which affects gas and water movement in porous systems due to changes in density, porosity, and morphological pore characteristics. The objective of this study was to quantify changes in morphological pore characteristics at a micrometer resolution with x-ray computed microtomography as affected by differential density. Hamra soil (Redoxeralfs) from Israel was subjected to three levels of density (porosity = 0.44, 0.35, and 0.33) with triplicate 58.3 mm^3 cores which were imaged at 9.6 micrometer resolution at the computed microtomography facility of the advanced photon source in Argonne, Illinois, USA. Spatial distributions of pore path length, coordination numbers, pore area, pore throat, nodal pore volume, and tortuosity were analyzed using 3DMA computer software. Probability density distributions of coordination number, characteristics area, and throat area were explained by exponential functions. Coordination number and characteristic area increased with porosity while throat area decreased. This implies a greater range of throat areas at larger porosity. Compaction preferentially affected largest pores reducing them in size. Compaction reduced pore volume by 30% and pore throat area by 26%, and increased tortuosity by 2% when porosity was reduced from 44 to 33%. Results of this study can be used to explain effects of density changes on model parameters for transport of gas and fluids through porous media.