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Using computed microtomographic images to determine spatial heterogeneity in the soil matrix of differing long term managements

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With the advent of computed microtomography (μCT), *in situ* 3D visualization of soil at micron scale became easily achievable. However, most μCT-based research has focused on visualization and quantification of soil pores, roots, and particulate organic matter (POM), while little effort was put in exploring the soil matrix itself. This study aims to characterize spatial heterogeneity of soil matrix in macro-aggregates from two differing long term managements, conventionally-managed (Conv) and biologically-based (Bio) row-crop agricultural systems. First, we completed a geostatistical analysis of the aggregate matrix. It demonstrated that, while the treatments had the same range of spatial correlation, there was much greater overall variability in soil of the Bio system. Since soil from both managements has the same mineralogy and texture, we hypothesized that greater variability is due to differences in soil organic matter (SOM) distributions, driven by spatial distribution patterns of soil pores. To test this hypothesis, image grayscale values (GVs) at different distances from visualized pores were quantified. The analysis showed a gradient with lower GVs in voxels directly adjacent to pores increasing as distance from pore increased up to 208 μm. The GVs of the two managements only differed at 143-208 μm, the largest distance observed, where Bio management had higher GVs than Conv management. Since SOM has lower gray scale values than mineral soil, lower GVs may indicate increased amounts of SOM. This may indicates that very little SOM travels far from pores. Then, to directly map SOM, we applied osmium (Os) staining to intact micro-cores from the Bio management, and examined Os staining gradients every 4 μm from 12 to 204 μm distance from pores with or without POM. Pores with POM had the highest SOM levels adjacent to the pore, which receded to background levels at distances of 100-150 μm. Pores without POM had lower SOM levels adjacent to the pores and returned to background levels at distances of 30-50 μm. This indicates that some of the spatial heterogeneity within the soil matrix can be ascribed to SOM distribution patterns as controlled by pore and POM distributions.