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Visualizing chemical phases in 3-D heterogeneous soil environments: combining X-ray microtomography with SEM-EDX

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Our knowledge of the location and incorporation of chemical compounds and soil organic carbon (C) into soil structure has largely evolved from experiments involving disruption of soil to obtain macro- and micro-aggregates. Inevitably, such results may be affected by our ability to produce aggregates from soil artificially; hence the true spatial distribution of chemical compounds within soil is largely obscured. Techniques such as Scanning Electron Microscope-Energy Dispersive X-Ray Analysis (SEM-EDX) are increasingly being used to study the chemistry of organic materials in soils through the analysis of C, O and N ratios. The application to soil thin sections allows mapping of chemical phases, but only in 2-dimensions. Spatial maps with a resolution of 8 μm can be produced for an area of 1 cm2. In this paper we present preliminary findings where we combine sequential 2-dimensional maps of chemical phases produced using SEM-EDX with 3-dimensional visualization of soil structure produced by X-ray microtomography. We discus the challenges we face in order to combine these techniques so that we can quantify changes in soil microstructure and the spatial distribution of C during degradation of organic matter. Further development of such techniques can greatly advance understanding of C in soil and could, for the first time, link the dynamics of soil structure with organic matter decomposition in situ.