Integrated Soil Organic C Analyses at EMSL Enable New Understanding of Soil C Protection Mechanisms

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Our conceptual understanding of the soil C cycle is largely based on chemical or physical separations of operationally defined soil C pools. This representation has provided a rich foundation of gross C transformations and rates. However, new technical advances in spatially-resolved sampling and high-resolution mass spectrometry can now be applied to soil samples to reveal new spatial and chemical detail about the arrangement and molecular nature of native soil organic C. Laser-ablation-aerosol mass spectrometry (LA-AMS) has been used to “map” C:N ratios in sub-millimeter soil aggregates, and to characterize the chemical nature of soil C in unstructured soil samples. Fourier transform ion cyclotron resonance (FTICR) mass spectrometry can identify more than 1500 different peaks in the C profile of pore water samples or associated with soil solids. Molecular formula assigned to these peaks allows differentiation into chemical compound classes such as lipids, proteins, unsaturated hydrocarbons, lignins, carbohydrates, amino sugars, tannins, and condensed hydrocarbons. Integrating these techniques and data will yield exciting new insights into the balance between physical protection and chemical recalcitrance as mechanisms controlling the persistence of SOC in soils. A clear characterization of this balance will also lead to an improved understanding of how ecosystem perturbations lead to increased losses of SOC and net greenhouse gas emissions.