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Molecular-level analysis of organic matter structure and composition from different soil mineral fractions

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The formation and turnover of soil organic matter (SOM) depends on the inherent chemical characteristics of biomolecular inputs (lignin, proteins, carbohydrates, macromolecular lipids, etc.) as well as the interactions between biomolecules and soil mineral fractions. The objective of this study is to characterize organic matter associated with the light, sand, silt and clay fractions of a Canadian agricultural soil. And, because lignin is believed to be a major contributor in SOM formation and preservation, the oxidation state of lignin in the different mineral fractions was measured using mild alkaline copper oxidation and gas chromatography – mass spectrometery which releases lignin phenols that are indicative of lignin sources and stage of degradation. For example, an increase in the acid/aldehyde (Ad/Al) ratio of lignin phenols has been observed with increased lignin degradation (and oxidation). In this study, lignin phenols from organic matter associated with the clay fraction had higher Ad/Al ratios for both syringyl and vanillyl lignin monomers when compared to that associated with silt, sand and the whole soil. These results suggest that either lignin degradation is enhanced by SOM association with clay surfaces or that oxidized lignin is preserved on clay mineral surfaces via sorption after partial degradation has occurred. The structural characteristics of organic matter from the soil fractions will also be examined by solid-state 13C nuclear magnetic resonance (NMR) spectroscopy. Organic matter associated with each mineral fraction will be extracted with NaOH for high resolution solution-state NMR spectroscopy. Results from NMR analysis will determine the relative abundance of functional groups (alkane, aromatic, carbonyl, alkoxy) in each of the soil fractions. Relative intensities of the functional groups are indicative of relative contributions of biomolecular classes such as lipids, lignin, fatty acids, and sugars to the organic matter associated with each fraction. The study comprises our initial steps in characterizing protection mechanisms responsible for the long-term retention and stability of biomolecules and their degradation intermediates in soil.