Connecting Soil Organic Matter (SOM) Residence Time with SOM Molecular Structure and the Soil Environment

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Soil organic matter (SOM) dynamics are governed by the interaction of SOM with the soil physical-chemical environment, microbial activity, other biogeochemical cycles, and landscape processes such as erosion and forest-pasture conversion. In this talk we will present highlights from four studies that looked at SOM molecular structure in relation to these ecosystem processes and conditions. We used sSolid-state CP MAS 13C nuclear magnetic resonance (NMR) spectroscopy to investigate the chemical structure of vegetation tissues, and of soil fractions (particulate organic carbon (free light fraction), intra-aggregate light fraction, and mineral-associated fraction. This was combined with radiocarbon analysis to estimate SOM pool sizes, chemical quality, and turnover times - on soils collected from long term experiments or environmental gradients. The NMR analysis was done at the DOE Environmental Molecular Sciences Laboratory (EMSL) at PNNL, whose scientists also assisted with the interpretation. The four highlights to be presented concern (1) nitrogen cycling: process-level links between microbial responses to N deposition and shifts in soil organic matter (SOM) quality and quantity. (2) Erosion and Deposition: the influence of the physico-chemical state (i.e., in aggregates, mineral-associated) and molecular structure of OM on its storage and persistence in different types of eroding and depositional landform positions. (3) pasture-forest transitions: changes in SOM cycling with time in tropical secondary forests regrowing on abandoned pastures. (4) influence of chemistry of plant inputs: soil carbon dynamics in adjacent old-growth redwood forest and prairie, with contrasting tissue lifespan and litter chemistry.