Using plant biopolymer isotopic composition to track litter and soil organic matter dynamics

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Compound-specific stable carbon isotope analysis (CSIA) of the analytical decomposition products of plant biopolymers has opened new windows into the study of organic matter cycling in soils, sediments, and aquatic fractions. These investigations span spatiotemporally from micron to continental basin scale and from annual cropping cycles to the paleoclimate records. Recent work exploiting the natural isotope shifts in plant communities or applying enrichment labeling techniques has demonstrated how organic matter derived from biopolymers such as lignin, cutin, and suberin are decomposed, partitioned, stabilized or destabilized in nature. By far, most CSIA in terrestrial biopolymer studies have focused upon lignin as it provides a relatively higher level of discrimination among botanical sources and is well suited to track input from natural and agroecosytems to soil, rivers, and continental shelves as well as track botanical changes induced by global environmental change through geologic time. Indeed, the CSIA of lignin phenols in litter and soil particle fractions has helped to change the perception of lignin as a "refractory" biomolecule in mineral soil and focus attention on aliphatic and microbial macromolecules for long term soil organic matter stabilization. Building from this, greater research attention is being paid to aliphatic polyesters like suberin and cutin which, because of differences in chemical structure, have the capacity to help discriminate among foliar/shoot and root inputs to soils and their relative importance in soil organic matter accrual. This talk will highlight some of these important applications and developments. New research on the stabilization/destabilization of soil organic matter, as a result of land cover change in grassland to woodland transitions and changes to below ground productivity from an enhanced atmospheric CO2 forest experiment, will also be discussed. Additionally, CSIA of lignin, cutin and suberin from invertebrate fecal pellets in forest soils will illustrate the potential role that these organisms play in the selective packaging and delivery of root and foliar tissue to soil particles and how they can contribute to accumulation patterns of plant organic matter observed in soil.