Molecular Composition and Dynamics of Dissolved Organic Matter from the Podzolic Soils of a Temperate Wetland

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In podzols, the production and mobilization of dissolved organic matter (DOM) account for a considerable loss of carbon from the forest floor. The dynamics of DOM in the podzol soils of a pine forest result from complex interactions between water infiltrations, weathering, biological transformation, and retention-mobilization mechanisms. However, little is known about how the molecular composition of DOM changes spatially in the podzol soil as it moves from the upper horizons (organic (O) and eluvial (E)), the illuvial horizon (B(h/s)) to the groundwater (Gw). In this study, DOM samples were collected in the upper (A1) and accumulation (Bh) horizons of a sandy permeable podzol with a hydrology occurring exclusively through drainage of shallow water (no surface runoff), as well as from the groundwater. Samples were concentrated on a Strata-X-AW solid-phase extraction cartridge and directly infused using electrospray ionization in the negative mode coupled with an LTQ-Orbitrap mass spectrometer. Over 2300 monoisotopic molecular formulas of CHO and CHON with molecular weights up to 600 Da, assigned mainly to lignin-like compounds (53%), tannins (22%), condensed aromatics (14%), proteins-like, lipids (3%), aminosugars/carbohydrates (1%) and unsaturated hydrocarbons were identified in DOM from the upper podzol horizon (A1), indicating that leaching of plant debris dominates the DOM pool released in the soil seepage waters. Among all molecular formulas detected, 31% were unique to A1, while only 6.9% were only detected in Bh and 12.9% in Gw. VK diagrams of these unique formulas clearly highlighted an evolution of the OM molecular composition along the podzol soil profile, from the upper horizon, through the accumulation horizon, to the groundwater with a shift from the high-oxygen, plant-derived compounds (tannins-like and lignin-like) to the low oxygen classes (unsaturated and condensed hydrocarbons), suggesting a reduction process either microbially mediated or via preferential adsorption of oxygen-functionalized DOM compounds to mineral surfaces.