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Production and stabilization of dissolved organic matter throughout the entire soil profile

Karsten Kalbitz (1) and Klaus Kaiser (2)

(1) University of Amsterdam, Institute of Biodiversity and Ecosystem Dynamics, Earth Surface Science, Amsterdam, Netherlands (k.kalbitz@uva.nl), (2) Martin Luther University Halle-Wittenberg, Soil Science, Halle (Saale) (klaus.kaiser@landw.uni-halle.de)

Dissolved organic matter (DOM) is the most mobile and rapidly cycling organic fraction in soil, affecting biogeochemical processes and linking terrestrial and aquatic ecosystems. Although representing just a small portion of total organic, it seems to be a key player in processes ultimately resulting in stabilization of organic matter against microbial decay. Recent studies have pointed out that up to 90% of the organic C in the mineral soil could derive from DOM. Most studies assume DOM to derive from surface horizons having large contents of organic matter such as peats, forest floor layers and mineral topsoils. Once biologically produced or physico-chemically released, DOM is transported into the subsoils characterized by smaller contents of organic matter. Here, DOM is retained by adsorption and/or (co)precipitation, resulting in stabilization against microbial decay. This concept assumes, DOM exported to the hydrosphere is that portion of DOM either not respired or not stabilized within the mineral soil.

We think that this conceptual model is oversimplified and not made up to explain all aspects of organic matter transport and stabilization in soils. All organic matter in soil derives from primary production, entering the soil as leaves, roots and root exudates. The biological decomposition of the primary sources will provide a large variety of compounds of differing reactivity, solubility and stability, with microbial metabolites representing a prominent part of the stable fraction. Microbial decomposition will not ultimately convert all organic material into CO2 but render a certain portion soluble. Also, DOM seems capable to replace sorbed organic matter, thus allowing also for retention in parts of the mineral soil with large contents of organic matter.

Therefore, we think that throughout the entire soil profile, production and release of DOM is possible, as well as retention and stabilization. In organic-rich horizons, especially those close or at the surface, microbial production of DOM predominates, while in the deeper mineral horizons retention and subsequent stabilization by sorption and precipitation is of greater importance. Production of DOM appears to be closely linked to organic matter decomposition, with DOM being a major by-product. That means all factors controlling mineralization will also impact the DOM production. That also implies organic matter in subsoils is not necessarily DOM captured therein and stabilized for once and forever but may be or become source of DOM at appropriate conditions.

Consequently, it seems reasonable to carefully re-consider the concept that a certain portion of organic C in soils derives from DOM stabilization. Instead, DOM can be seen as a model fraction representing greatly the properties and functions of the entire soil organic matter. The distinct sensitivity of DOM production and release to environmental conditions offers the opportunity of using it as an indicator of biogeochemical processes in a changing environment. That will allow for better understanding the possible effects of changes in environmental conditions and land use on soils as the large but vulnerable C sinks they are.