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Effect of extraction temperature and time on the chemical and colloidal properties of dissolved organic matter

Erika Andersson[1], Victoriia Meklesh[2,3], Per Persson[3], Anders Tunlid[2], and Ulf Olsson[1]
[1]Division of Physical Chemistry, Lund University, Sweden
[2]Microbial ecology group, Lund University, Sweden
[3]Centre for environmental and climate research, Lund University, Sweden

Dissolved organic matter (DOM) is ubiquitous in terrestrial and aquatic ecosystems where it serves several important functions. It plays a central role in the landscape carbon balance, connects the terrestrial and aquatic environments, and acts as a vector for both nutrients and contaminants. Herein DOM is defined as dissolved molecules and suspended colloidal objects with a size below 0.2 µm. Despite the high interest of DOM, the important connection between the chemical composition of DOM and its colloidal structure are poorly understood. An active discussion in this field of research is how different extraction procedures affect the properties of DOM. Historically, sodium hydroxide extraction has been widely applied but today water extraction, more resembling the natural process, is commonly used. Even when using water as the solvent, the protocol for DOM extraction can differ greatly resulting in the study of different material.

We have systematically investigated the effects of extraction temperature and time on the chemical and colloidal properties of DOM extracted with water from a boreal forest soil. Chemical composition was determined using elemental analysis, pH, z-potential and ^{1}H NMR while the colloidal structure was probed using a combination of dynamic and static light scattering (DLS, SLS) and small angle x-ray scattering (SAXS). Our results show that chemically the DOM is dominated by carbohydrates irrespective of extraction time and temperature. Concentration and colloidal structure on the other hand are affected by these parameters. At high temperatures the concentration of all identified components increases, with the most notable difference in the carbohydrates. Also, with increasing extraction temperature the colloidal structure transforms from dense clusters to something resembling flexible polymer chains.

Contrast match experiments of DOM using small angle neutron scattering (SANS) have also been performed in preparation for studies on DOM-mineral interactions. The results show that the match point of DOM agrees with that of carbohydrates further confirming our results of the chemical composition. We believe our broad combination of complementary techniques is necessary to advance the understanding of DOM, in particular the correlation between chemical composition and colloidal properties. In the long-term it can help to reveal the importance of DOM size distribution and aggregation of DOM components for biogeochemically important processes in soil.