

# **Size matters: Soil porewater nanoparticles and their associated trace-elements characterized by Electrical Field and Flow FFF**

MARCUS BÖHM, STEFFEN HELLMANN AND  
THORSTEN SCHÄFER

Friedrich Schiller University Jena

The migration behavior of nutrients and contaminants like radionuclides as nanometer-sized matter through the vadose zone differs substantially compared to their dissolved states. Especially, the turnover of redox-sensitive long-lived radionuclides such as  $^{79}\text{Se}$  and its mobility limiting phases are of great importance. We found that thermodynamic equilibrium considerations may not apply for Se due to nanoparticle formation in soil environments, especially under the presence of organic matter. Thus, the accurate characterization of concentration, size, charge, and composition of natural nanometer-sized compounds in soil porewaters is essential to understand the migration behavior and predict their impact in reactive transport models. However, analytical challenges and limitations persist in the characterization of polydisperse samples by using bulk analytical methods, such as DLS or ICP-MS.

This study aimed to investigate the properties and associated elements of natural nanosized matter in soil porewaters with an emphasis on Se-transport. To address previous analytical challenges, we focus on the application of the asymmetrical flow field-flow fractionation (AF4) for soil porewater samples. AF4 has emerged as versatile tool for analyzing polydisperse and multi-compound natural nanomaterials in environmental matrices. To provide a comprehensive analysis of soil porewaters, samples were measured after fractionation with an online coupled multi-detector system using UV-absorption, multi-angle light scattering (MALS), fluorescence detector, dynamic light scattering (DLS) and ICP-MS. Additionally, the application of an electrical separation force allowed the determination of zeta potentials of size populations.

Soil porewaters were sampled via suction cups from four mesoscale laboratory lysimeters packed with different natural agricultural top-soil materials in a long-term experiment spanning over 2200 days. Lysimeter soils were characterized by an upward transport driven by a constant evaporation in a climate chamber as well as strong redox gradients from -220 to 650 mV with precipitation fronts at the capillary fringes. Preliminary AF4 measurements indicated a continuous size distribution of porewater nanoparticles from 8–500 nm with a single peak at 8–20 nm in different extension depending on the soil system. Measurement procedures, comparisons to bulk analytical methods and detailed results of soil porewater samples will be discussed in the presentation with an emphasis on nanoparticulate Se-organic associations.