

Unraveling Soil Nanogeochemistry: Integrating spICP-ToF-MS and AF4- ICPMS for Advanced Characterization of Natural Nanoparticles and Colloids

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Colloids and natural nanoparticles (NNPs) are key vectors for the transport of contaminants and nutrients in soils, influencing their mobility, bioavailability, and potential toxicity. Recent advancements in nanometrology have significantly enhanced our ability to characterize these particles, driving the development of environmental nanogeochemistry as an emerging field.

This study examines the distributions of elements amongst inorganic and organic phases in three different soil solutions (filtered to <0.45 µm) from Newfoundland and Alberta, Canada, using single-particle inductively coupled plasma time-of-flight mass spectrometry (spICP-ToF-MS) and asymmetric flow field-flow fractionation coupled with ICP-MS (AF4-ICPMS). While spICP-ToF-MS enables detailed multi-elemental analysis of individual particles, its detection limits in natural samples with high background signals prevent the observation of inorganic NNPs smaller than 20–50 nm, with certain elements having size detection limits exceeding 100 nm. Conversely, AF4-ICPMS offers a broader size range for quantifying elements associated with inorganic and organic phases but lacks the capability to analyze individual particles.

This presentation will discuss the advantages and challenges of integrating these two techniques as a complementary approach to investigate the nanogeochemical processes in soil solutions. Their potential applications in predicting nutrient and contaminant dynamics will be highlighted, offering potential insights for improving environmental monitoring and soil management strategies.