☐ **Talk** ☒ **Poster**

Advancing Soil Research Through the eBERlight–EMSL–MONet Collaboration

Debora M Meira[1], Jason G. Toyoda[2], Andrew T. Townsend[2], Kenneth M. Kemner[3], Maxim I. Boyanov[3,4], Lucie Stetten[3,5],Alex A. Lavens[1], Gyorgy Babnigg[3], Yuri E. Corilo[2], Xiaoyang Liu[1], Tamas Varga[2], John Bargar[2], Karolina Michalska[1]

[1]Advanced Photon Source, Argonne National Laboratory, Lemont, Illinois 60439, United States
[2]Pacific Northwest National Laboratory, Richland, WA 99352, USA
[3]Biosciences Division, Argonne National Laboratory, Argonne, IL 60439
[4]Institute of Chemical Engineering, Bulgarian Academy of Sciences, Sofia 1113
[5]Radioactive Waste Disposal and Environmental Remediation National Nuclear User Facility and Williamson Research Centre, The University of Manchester, Manchester M13 9PL, UK.

Author Email: dmeira@anl.gov

The eBERlight program at Argonne National Laboratory's Advanced Photon Source (APS) supports researchers in the biological and environmental sciences by providing access to advanced synchrotron techniques. By leveraging the unique capabilities of synchrotron radiation, the program aids in studying complex Earth systems and offers guidance in project planning, proposal development, experimental workflows, and data interpretation.

As part of this effort, the APS is collaborating with the Environmental Molecular Sciences Laboratory (EMSL) at Pacific Northwest National Laboratory to deliver Fe K-edge X-ray Absorption Fine Structure (XAFS) spectroscopy and X-ray computed tomography (CT) data. These analyses are performed on samples generated through the Molecular Observation Network (MONet) soil function user call, supporting research on soil structure and chemistry at multiple scales.

This contribution presents preliminary Fe XAFS results from the SOILARIUM (SOILs @ APS RIng for Users of MONet) project, a pilot initiative aimed at developing inter-laboratory capabilities and establishing experimental and data management protocols. The project is also laying the groundwork for high-throughput X-ray measurement techniques in soil science.

Fe XAFS spectroscopy provides detailed information on the oxidation state, coordination environment, and mineral associations of iron in soils. This method complements high-resolution molecular analyses of soil organic matter (SOM), which reveal the complexity and composition of organic compounds. While SOM data characterize the organic matrix, Fe K-edge XAFS sheds light on how iron interacts with these molecules as well as inorganic constituents. Together, these approaches offer a more integrated view of soil biogeochemistry, particularly in understanding organic matter stabilization, nutrient cycling, and contaminant mobility. Early findings from SOILARIUM illustrate how the integration of synchrotron-based and molecular-scale techniques enhances our capacity to characterize and model soil function across spatial and chemical gradients.