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The BioXAS sector at the Canadian Light Source: Three Beamlines to Tackle the Challenge Raised by Wildfire, Thawing Permafrost, and Metalloid Remediation

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This presentation discusses the capabilities of the BioXAS sector at the Canadian Light Source (CLS), exemplified with three case studies that illustrate the impacts of climate change and anthropogenic activities on the biogeochemical cycling of hazardous elements such as As, Sb, and U.

The BioXAS sector at CLS comprises three beamlines capable of cutting-edge X-ray spectroscopy and X-ray imaging analyses contributing to improved understanding of metal(loid) mobility in various environments. Two X-ray Absorption Spectroscopy (XAS) beamlines are equipped to support high-sensitivity measurements (2x32px-HPGe detectors) over a wide temperature (15K to 1000K) and energy (5-33 keV) range. X-ray fluorescence imaging, µ-XAS, and XAS-imaging are available at the BioXAS-Imaging beamline spanning energies from 5 to 21 keV and featuring two resolution modes (macro and micro) for energy between 5-21 keV. These three beamlines are ideally suited for the analysis of environmental samples featuring trace levels of metal(loid)s due to their high photon flux (10^{11} to 10^{12} ph/s at 10 keV) and high sensitivity (down to 1-10 µg/g).

The first case study simulates the impact of wildfire on As transformation in soils. By implementing continuous scan (3 min/scan) at the BioXAS-Main spectroscopy beamline, time-resolved monitoring of As speciation was performed during in-situ soil burning experiments. These experiments pinpointed accurately the temperatures at which specific As transformation and redox processes occur. The second case study examines the impact of thawing permafrost on metal(loid) mobility. Analysis of permafrost soils from Yukon (Canada) containing U (4.3-1,040 µg/g) and As (1.9-32 µg/g) at the BioXAS-imaging beamline provided insight into the chemical speciation and oxidation state of these contaminants and their reactivity and mobilization during permafrost thaw. The third case study demonstrates the analysis of mining residues containing 90% As_2O_3 and 0.5 to 4% Sb_2O_3 on both BioXAS-imaging and -spectroscopy beamlines. Despite the low concentrations of Sb compared to As, the beamline produced high-quality results useful in identifying molecular bonds, improving the understanding of mine waste reactivity under changing environmental conditions.

We invite all members of the geochemistry community to communicate with us and explore how the BioXAS sector can be used to contribute to your projects.