Probing Mining Industry Questions using Synchrotron Radiation

L.L. VAN LOON[1,2], N.R. BANERJEE[2], J.M STROMBERG[2], K. FEICK[2], L. STAMMERS[2], E. KOPE[2]

[1]Canadian Light Source, Saskatoon, SK, Canada, lisa.vanloon@lightsource.ca

[2]Department of Earth Sciences, Western University, London, ON, Canada, neil.banerjee@uwo.ca

Synchrotron science for life of mine (mineral exploration, production, and remediation) questions is an innovation with the potential to change the way in which high resolution techniques are used to address industry relevant questions. But the barrier to adoption of these techniques by the broader geoscience community is significant. Through a unique collaboration between academia, industry, and synchrotrons we are tackling this problem head on to develop techniques for the geoscience community and mining industry.

Synchrotron micro X-ray fluorescence (uXRF) provides rapid and cost-effective micron-scale trace element analysis and mapping of ore minerals at ppm levels. Speciation of trace elements important for understanding element mobility can be probed using X-ray absorption near-edge structure (XANES) spectroscopy. uXRF mapping and XANES analysis of pyrite grains associated with gold deposits in the prolific Timmins and Kirkland Lake gold camps in Canada has revealed key indicators of mineralization history and novel exploration vectors. Gold in these deposits is present both as free and/or “invisible” gold, bound in the pyrite crystal lattice. The high flux and energy of a synchrotron allows for *in situ* and non-destructive detection of invisible gold by uXRF, and probes its nature using XANES spectroscopy.

Furthermore, new fast-scan boron K-edge XANES spectroscopy is being evaluated to provide a direct, rapid boron analysis for novel uranium exploration vectors. XANES directly identifies the speciation and the proportions of trigonally-coordinated (BO_3 moieties) and tetrahedrally-coordinated (BO_4 moieties) boron in complex mineralogical mixtures in whole rock samples and suggests a link between trigonally-coordinated boron with uranium mineralization.

For regulatory compliance it is important to determine which minerals are present in any tailings management facility and how they evolve over time. XANES spectroscopy is an excellent tool for determining element speciation. Mineral phases can be accurately identified as well as relative amounts determined. With this information the oxidation-reduction of deleterious-element bearing compounds (e.g., As, Se, Mo, Cr, etc.) can be monitored and effective management practices implemented to ensure long-term capture of deleterious phases.