Paper Number: 2409

Integrated freeze core – ITRAX micro-XRF scanning: a non-destructive and cost effective method of baseline geochemical determination in the low-sedimentation environment of a legacy mining camp in Subarctic Canada

Patterson, R.T.[1], Gregory, B.R.B.[1], Nasser, N.A.[1], Macumber, A.L. [1], Setterfield, T. [2], Sexton, A.[2], Galloway, J.M. [3], Falck, H.[4]

[1] Dept. of Earth Sciences, Carleton University, Ottawa, Ontario, Canada. tim.patterson@carleton.ca
[2] TerraX Minerals Inc., Ottawa, Ontario, Canada
[3]Geological Survey of Canada – Natural Resources Canada, Calgary, Alberta.
[4]Northwest Territories Geological Survey, Yellowknife, Northwest Territories, Canada

---

The Northwest Territories, Canada, "Mine Site Reclamation Policy" stipulates that companies must return environmental systems impacted by mining operations to pre-disturbance conditions. As part of this policy, "Mine Closure and Reclamation Plans" are required before the initiation of mining operations. In the case of legacy mining camps, quantifying baseline contaminant concentrations and distinguishing natural from anthropogenic contaminant sources are prerequisites to the development of remediation plans. The sedimentary record of local lacustrine basins is one setting where the dynamics of prior-contamination vs. natural elemental concentrations can be examined. Given the low-sedimentation rates common in Subarctic lakes, the high-resolution analysis required to decouple anthropogenic and natural variations in metals of interest (e.g. As) can be technically difficult. Developing analytical protocols that can be used to rapidly and cost-effectively determine environmental baseline conditions will greatly aid policy makers and mine developers in determining discharge concentrations and developing "Mine Closure and Reclamation Plans". Of concern to the operators of any potential new mine in the Yellowknife area is the environmental legacy left behind by previous mines in the area, particularly the former world-class Giant Mine (1945-2004; 8.1 million oz.). During the early days of operation, prior to the implementation of rigorous environmental standards, the Giant Mine contributed considerable quantities of As and other contaminants to the Yellowknife landscape, including area lake catchments.

TerraX Minerals Inc. is in the development phase of a potential new gold mine just north of the former Giant Mine site, the Yellowknife City Gold Project, which lies adjacent to several lakes that may have been impacted by the Giant Mine operation and/or may contain naturally high concentrations of metals of concern. Many of the conventional coring methodologies used in lake studies tend to homogenize the water saturated upper sedimentary record, and in low sedimentation rate environments this can potentially obscure any anthropogenically produced contaminant signals. Freeze coring solves this issue by freezing sediment in situ to preserve the soupy sediment-water interface, as well as the sediment stratigraphy. Unfortunately, freeze cores typically do not provide enough sedimentary material to obtain traditional ICP-MS geochemical analyses at a resolution adequate to identify possible anthropogenic influences. Analyzing sediment cores using ICP-MS at high-resolution (mm-scale) is also prohibitively expensive. The ITRAX high-resolution x-ray-fluorescence core scanner (micro-XRF) can be used to rapidly analyze sediment cores at sub-mm resolution for a fraction of the cost of ICP-MS. As ITRAX scanners were initially designed to analyse cores at room temperature a specialized insulated vessel was developed by us to keep freeze cores frozen during the relatively slow scanning process (~1.5 hours/10

cm). To assess the utility of the integrated freeze core – ITRAX micro-XRF scanning methodology, freeze cores were obtained from lakes within the TerraX property to determine if data useful for the development of their "Mine Closure and Remediation" plan could be obtained. The results of ITRAX micro-XRF are only semi-quantitative so in order for this data to be of sufficient quality to inform policy makers and mine developers, a robust method of calibration is required. To minimize the influence of high water content in the sediment cores ratios of As/Ti and As/Ca were used in preference to individual elemental concentrations. Comparison of ITRAX results with ICP-MS data from selected core intervals reveal a high level of correlation, indicating potential of the methodology as a valuable tool in the environmental regulatory process.