Boron Geochemistry Associated with Uranium Deposits: Development of a new analytical method for uranium exploration

T Flynn[1], LVan Loon[2,3], D Quirt[4], L Zuin[5], N Banerjee[2]

[1]Department of Chemistry, University of Guelph, Guelph, ON, flynnt@uoguelph.ca; [2]Departement of Earth Science, University of Western Ontario, London, ON; [3]LISA CAN Analytical Solutions, Saskatoon, SK; [4]AREVA Resources Canada, Saskatoon, SK; [5]Canadian Light Source, Saskatoon, SK;

The hunt for uranium in northern Canada is a crucial step towards using cleaner energy sources, such as nuclear power, in an effort to reduce our current dependence on fossil fuels. The current method for determining uranium rich areas in Canada's north involves the exploration of remote locations at a significant financial cost. To remain at state-of-the-art levels, mineral exploration requires advanced analytical techniques and new methodologies to be developed. It is currently accepted that clay minerals and tourmaline (boron aluminosilicate) are pathfinders for areas of uranium mineralization, but the B-U relationship is still not well-understood. In some locations, the host mineral for boron cannot be identified using traditional analytical techniques, such as X-Ray Diffraction (XRD) and reflectance spectroscopy, so other methods must be developed. Tourmaline is the most common boron mineral and is the dominant carrier of trigonally-coordinated boron. However, clay minerals such as illite also host boron in tetrahedral sites. X-Ray Near Edge Structure (XANES) spectroscopy is a non-destructive analysis that can be performed directly on whole-rock assay powders, capable of analyzing both amorphous and crystalline materials. It is an element-specific measurement that is sensitive to coordination chemistry, making it uniquely suited for identifying the varying boron chemistry. Highly-specific energy parameters are required for quality spectra, and therefore data collection must be performed at a synchrotron facility. The Canadian Light Source is Canada's national synchrotron research facility and home to the world's premier beamline (Variable Line Spacing Plane Grating Monochromator (VLS-PGM) for measurements of boron geochemistry. XANES spectroscopy was conducted to determine the proportions of trigonally-coordinated BO_3 (i.e., tourmaline) and tetrahedrally-coordinated BO_4 (i.e., clay minerals) in a series of powdered whole-rock samples from boron-bearing drill-core, including both composite and discrete samples. In addition, a suite of museum-quality mineral specimens has been analysed to determine the spectroscopic signatures associated with trigonally and tetrahedrally-coordinated boron. Development of the analysis included a detection limit study and a comparison study between the traditional step-scan method and a newly implemented, faster, fly-scan method. The resolution was evaluated for both scan methods, and a standard procedure was developed for the collection of boron spectra. XANES directly identifies the speciation and relative amount of trigonally- and tetrahedrally-coordinated boron in complex mineralogical mixtures. Several trials of this method suggest a possible link between boron coordination and uranium mineralization in specific locations and research is ongoing to investigate this link.