

Mineral chemistry of fracture coatings in Athabasca Group sandstone as records of element dispersion

M Valentino¹, K Kyser¹, M Leybourne², T Kotzer³, D Quirt⁴, P Lypaczewski⁵, K Ansdell⁶, K Wasyliuk⁶

¹Department of Geological Sciences and Geological Engineering, Queen's University, Kingston, Ontario; ²Department of Earth Sciences, Laurentian University, Sudbury, Ontario; ³Cameco Corporation, Saskatoon, Saskatchewan; ⁴AREVA Resources Canada Inc., Saskatoon, Saskatchewan; ⁵Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta; ⁶Department of Geological Sciences, University of Saskatchewan, Saskatoon, Saskatchewan

The McArthur River deposit is a well-documented unconformity-related uranium deposit that is located in the southeastern portion of the Athabasca basin in Saskatchewan, Canada. Samples of Athabasca Group sandstone containing fractures were selected from drill core of the Manitou Falls Formation. The core samples were collected to reflect a spectrum of fracture coating types within a vertical depth range from ~11 m to 593 m, over a horizontal extent of ~3150 m, and from near-ore to unmineralized areas, to compare McArthur River area fracture coating mineral chemistry to the Athabasca Group background signature. Fracture coatings record precipitation from various fluids associated with both syn-mineralization and post-mineralization dispersion, as well as from diagenetic background fluids of the Athabasca Group. The main objective of the study is to determine whether the fracture coatings and their immediate wall rocks provide evidence for the migration of elemental components associated with U mineralization at depth, to the surface near the McArthur River deposit. Seven types of fracture coatings were identified, representing various colors, mineralogies, and chemical features revealed by optical petrography, scanning electron microscopy, X-ray diffraction, shortwave infrared reflectance spectroscopy, and geochemical analysis. Weak acid leach (2% HNO₃) and aqua regia were used to leach mobile elements, followed by high-resolution inductively-coupled plasma mass spectrometry to obtain the bulk fracture coating geochemistry. Continuous leach inductively-coupled plasma mass spectrometry (CL-ICP-MS) was used to determine the relationship between trace elements, including Pb isotopes, and their release from specific mineral phases in real-time through leaching by progressively reactive solutions from water to 30% nitric acid. The ²⁰⁷Pb/²⁰⁶Pb ratios of fracture coatings and of wall rock reflect the post-mineralization dispersion of components from the deposit into the near-fracture sandstone (low ²⁰⁷Pb/²⁰⁶Pb values), as shown by gradational changes in Pb isotopic ratio values from anomalous adjacent to the fracture surface to background values away from the fracture surface. This dispersion was followed by a less radiogenic fluid from which the fracture coatings, containing higher ²⁰⁷Pb/²⁰⁶Pb values, were deposited. Hyperspectral imaging of fracture coatings shows the presence of numerous layers of alteration minerals that reflect precipitation from multiple fluid events on many fractures. This research indicates that the footprint of the deposit extends upwards through fracture networks and may be detectable in analyses of overlying surficial media, and that fracture coatings can be used to detect fluid dispersion from U mineralization at depth through geochemical and mineralogical analyses. NSERC-CMIC-Footprints Exploration Project Contribution #122