**Analysis of Fractures in Sandstone of the Athabasca Basin as Records of Primary and Secondary Element Dispersion**

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The McArthur River deposit is a known unconformity-related uranium deposit and 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. They were collected to reflect a spectrum of fracture-coating types in core within a vertical depth of ~115 m to 593 m and a horizontal extent of ~3150 m, from near-ore to unmineralized areas to compare fracture-fill mineralogy and chemistry to the background signature of the Athabasca Group. The main objective is to determine if fracture-coatings record the migration of U mineralization components resulting from primary and secondary dispersion. Fracture fillings were placed into seven fracture types that represent various colors, fill mineralogies, and chemistries as revealed by optical petrography, SEM (Scanning Electron Microscope), XRD (X-ray diffraction), and SWIR (Shortwave Infrared Reflectance Spectroscopy). Fracture orientations indicate that most fractures are at shallow angles to core axis. Sample digestion using Weak Acid Leach (WAL) was performed to leach mobile elements, followed by Continuous Leach (CL-ICP-MS) to observe the relationship between trace elements and Pb isotopes released from specific mineral phases using real-time data produced by progressively reactive solutions from water to 30% nitric. Fracture coatings show similarities in clay mineralogy between the fracture filling and adjacent wall-rock, indicating that fluid-rock interaction extended into the host rock 4-7 cm away from the fracture itself. The fractures result from various fluids associated with primary and secondary dispersion, as well as diagenetic background fluids of the Athabasca Group. The $^{207}Pb/^{204}Pb$-$^{206}Pb/^{204}Pb$ age of most fracture fills of 874 ± 84 Ma, represents secondary dispersion from the ore zone. REE patterns in some leachates from fractures, coated with druzy quartz, Fe-Mn oxides/hydroxides, clays and tourmaline, are preferentially enriched in medium REEs showing a bell-shaped pattern, which is characteristic of uraninite from unconformity-type U deposits in the Athabasca Basin, including McArthur River. Although Sr- and LREE-rich APS minerals on fracture-coatings are major hosts for many REEs, minerals such as tourmaline, clays, and Fe-Mn oxides/hydroxides also host REEs, leading to normalized patterns that are enriched in LREE or have equant LREE/HREE ratios. Fractures-coatings can be used to detect primary and secondary dispersion from U mineralization at depth through geochemical and mineralogical analyses. This research may lead to the development of new U exploration techniques in the Athabasca Basin, as it will enlarge the footprint of the deposit.