

Valentino MM, Kyser TK, Leybourne MI, Kotzer TG, Quirt DH, 2016, Mineralogy and geochemistry of fracture coatings in Athabasca Group sandstone as records of primary and secondary elemental dispersion, Abstract, SGS Open House, Saskatoon, SK

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 mineralogy and chemistry to the Athabasca Group background signature. Because the fracture coatings result from precipitation from various fluids associated with primary and secondary dispersion, as well as from diagenetic background fluids of the Athabasca Group, the main objective of the study is to determine if and how the fracture coatings and their immediate wall-rocks record the migration to surface of U mineralization components from depth, as a result of primary and/or secondary dispersion. Seven types of fracture fillings were identified, representing various colors, fracture coating mineralogies, and chemical features, as revealed by optical petrography, scanning electron microscopy, X-ray diffraction, shortwave infrared reflectance spectroscopy, and geochemical analysis. Fracture orientations indicate that most of the fractures are at shallow angles to core axis, allowing permeable pathways for fluid movement. Sample digestion using weak acid leach (2% HNO₃) was performed 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 the Pb isotopes, and their release from specific mineral phases in real-time through leaching by progressively reactive solutions from water to 30% nitric. The ²⁰⁷Pb/²⁰⁶Pb ratios of fracture coating materials and of wall-rock reflect the effect of secondary dispersion fluids imprinted on near-fractures (low ²⁰⁷Pb/²⁰⁶Pb values), followed by a less radiogenic fluid related to the fracture coatings (higher ²⁰⁷Pb/²⁰⁶Pb values). Hyperspectral imaging of fracture coatings shows the presence various layers of alteration minerals that reflect precipitation from multiple fluid events. The characteristics of the primary fracture fluid are recorded in the near-fracture sandstone volume, as shown by gradational mineral zoning from adjacent to the fracture surface to background away from the fracture surface. The CL-ICP-MS data suggest an organic control on common Pb as major elements are adsorbed onto organics, and secondary dispersion of U during 10% hydrogen peroxide. CL-ICP-MS also suggests a kaolinite and Fe oxide control on radiogenic Pb as Fe and Al are especially released, and primary or secondary dispersion of both Pb and U during 30% nitric, extending the deposit footprint. Fracture coatings can be used to detect primary and secondary dispersion from U mineralization at depth through geochemical and mineralogical analyses. This research indicates that the footprint of the deposit extends upwards through some fracture networks.

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