Joyce NJ, Layton-Matthews D, Kyser TK, Ansdell K, 2017, Alteration mineralogy and pathfinder element inventory of the McArthur River unconformity-related uranium deposit, Saskatchewan, Canada, Abstract, GAC-MAC, Kingston, ON

The chemical compositions, modal mineralogy, and textural variability of interstitial minerals in sandstones of the Athabasca Group strata in the vicinity of the McArthur River unconformity-related uranium deposit were characterized using a combination of short wave infrared spectroscopy (SWIR), lithogeochemistry, scanning electron microscopy (SEM), electron probe microanalysis (EPMA) and laser ablation mass spectrometry (LA-ICP-MS) to determine the residence sites of pathfinder trace elements. The importance of integrating in-situ mineral chemistry with whole-rock analyses resides in the possibility to establish the mineralogical and paragenetic context of geochemical signatures in defining the footprint of the deposit. Located in the Athabasca Basin, Saskatchewan, Canada, the deposit is situated below ~550 m of quartz arenitic sandstones that are strongly silicified between depths of approximately 200-400 m. The silicified layer exhibits significant control on the distribution of alteration minerals, and appears to have restricted both the primary and secondary dispersion of pathfinder trace elements, which include U, radiogenic Pb isotopes, V, Ni, Co, Cu, Mo, As, Zn, and REEs. Diagenetic background sandstones contain assemblages of illite, dickite, aluminum-phosphate-sulfate (APS) minerals, apatite, and Fe-Ti oxide minerals. Altered sandstones contain assemblages of Al-Mg chlorite (sudoite), alkali-deficient dravite, APS minerals, kaolinite, illite, and oxide minerals. Throughout the sandstones, APS minerals account for the majority of the Sr and LREE concentrations, whereas late pre-ore chlorite, containing up to 0.1 wt.% Ni, accounts for the majority of Ni concentrations. Cobalt, Cu, Mo, and Zn occur predominantly in cryptic sub-micron sulfide and sulfarsenide inclusions in clay mineral aggregates and in association with paragenetically-late Fe-Ti oxides. Uranium occurs predominantly in cryptic micro-inclusions associated with pyrite in late-stage quartz overgrowths, and with paragenetically late Fe-Ti oxide micro-inclusions in kaolinite. Additionally, up to 0.2 wt.% U is cryptically distributed in post-ore Fe-oxide veins. Early diagenetic apatite, monazite and apatite inclusions in detrital quartz, and detrital zircon also contribute significant U and HREE to samples analyzed with an aggressive leach such as Aqua Regia. Detailed LA-ICP-MS chemical mapping of interstitial assemblages, detrital grains, and cements provides new insights into the distribution and inventory of pathfinder elements in the footprint of the McArthur River uranium deposit.

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