Alteration mineralogy of the McArthur River uranium deposit

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Characterization of the chemical, modal, and textural variability of interstitial minerals using a combination of SWIR, SEM, EPMA and LA-ICP-MS techniques was used to determine the residence sites of pathfinder trace elements showing elevated concentrations in the sandstone around the McArthur River unconformity-related uranium deposit, Athabasca Basin, Saskatchewan, Canada. The deposit is located below ~ 550 m of quartz arenitic sandstones, of which the basal ~ 200 m are strongly silicified. Altered sandstones contain complex assemblages of Mg-chlorite, alkali-deficient dravite, APS minerals, kaolinite, 1Mt illite, and oxide minerals that overprint diagenetic background assemblages of 1Mc illite, dickite, earlier svanbergite-goyazite APS minerals, and oxide minerals. Beneath the silicified layer – defined also by the presence of diagenetic dickite – and in fracture zones, fine-grained florencitic APS minerals and Mg-sudoite chlorite characterize the sandstones that have been affected by diagenetic-hydrothermal host-rock alteration. Overall, in the altered sandstones, APS minerals account for the majority of the Sr and LREE concentrations, whereas chlorite, containing up to 0.1 wt.% Ni, accounts for the majority of Ni concentrations. Co, Cu, Mo, and Zn occur predominantly in cryptic sub-micron inclusions in clay mineral aggregates. U 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. Heavy mineral bands consisting of detrital monazite, apatite, and zircon also contribute significant U and HREE. The innovative approach to the study, based on detailed LA-ICP-MS chemical mapping of entire interstitial assemblages, detrital grains, and overgrowth quartz, provides critical insight as to the distribution of pathfinder trace elements in the mineralogy of the deposit footprint. This forms part of a larger study designed to characterize the 3D footprint of the McArthur River deposit through the integration and analysis of geological, geochemical, mineralogical, petrophysical, and geophysical datasets.