Laboratory core analysis of potentially in-situ recovery amenable sandstone-hosted uranium deposits in the Morrison Formation/New Mexico/USA

Micha Janosch Zauner*, Matthias* Halisch*, Andreas* Weller

Abstract. Several core plugs from a roughly 1,000 m deep borehole penetrating the Westwater Canyon Member of the Morrison Formation in New Mexico (USA) have been investigated by various petrophysical methods in order to evaluate the potential of mining deep buried sandstone-hosted uranium deposits by in-situ recovery (ISR). Essentially, ISR is the operation of wellfields up to 1,000 m depth by continuously recycling the leaching solution after metal capture (usually by ion exchange) and subsequent refortification (chemical conditioning) before re-injection. Porosity, permeability and mineralization pattern of the host sandstone in the target aquifer are the determining parameters for ISR amenability. Mineralogy and geochemistry of the core plugs were investigated by ICP-MS (Inductively Coupled Plasma – Mass Spectrometry), XRF (X-Ray Fluorescence), XRD (X-Ray Diffraction), MLA (Mineral Liberation Analysis) and optical microscopy. Petrophysical parameters were determined by using He pycnometry, kappa bridge measurements, SIP (Spectral Induced Polarization), N2-adsorption (nitrogen gas adsorption), NMR (Nuclear Magnetic Resonance), µCT (Micro-Computed Tomography), steady state permeametry, and digital rock physics (Mercury Injection Capillary Pressure simulations). Mineralogical investigations revealed a secondary uranium mineralization mainly coating the silica grains of the arkosic sandstone and some interstitial pore fillings. The mineralized coating or seams are well visualized by optical microscopy and MLA. The differences between mineralized and non-mineralized sandstone plugs are highlighted by NMR, µCT and SIP. The NMR results show a doubling of the clay- and capillary-bound water and decrease of free-fluid porosity of mineralized samples. A correlation of mineralization grade and polarization was found through the SIP tests. Non-mineralized samples show a Gaussian pore size distribution, increased porosity and permeability, decreased magnetic susceptibility, smaller specific surface area, lower electric resistivity, and lower total chargeability. Especially the anisotropy of horizontal and vertical permeability of 3:1 shows a significant difference of mineralized samples with increased tortuosity indicating a horizontal stratification of the sandstone formation compared to isotropic and well-sorted non-mineralized core plugs from barren strata. µCT flow simulations confirm preferential horizontal flow around the mineralized grain coatings. Ore – lixiviant interaction by the leaching solution with the uranium coating is favored in horizontal flow direction generally prioritized by standard ISR operations and confirmed by column leach tests of mineralized core samples.