Assessment of uranium in post-*in situ*-leach mining of mineralized arkosic sandstone units

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Recent studies of core samples from a post-in situ-leach mining (ISL) of sandstone-type uranium (U) roll-front ore zones at the Smith Ranch-Highland deposits in the southern part of the Powder River Basin of Wyoming, revealed considerable amounts of residual U on surfaces and along fractures of charcoal-like carbonaceous matter, pyrite, clays, detrital minerals, and rock fragments [1]. In contrast, ISL was effective in mobilizing U and oxidizing pyrite in arkosic sandstone units that contain insignificant amounts of carbonaceous matter.

Petrographic, mineralogical, and chemical studies of core samples indicate that the early Tertiary arkosic sandstone units are primarily detrital in origin, consisting of quartz, K-feldspar, albite, and mica derived from granitic rocks exposed along the southern part of the Powder River Basin. Less abundant secondary minerals of smectite, kaolinite, pyrite, calcite, and traces of coffinite occur within the poorly consolidated and well-sorted light to medium gray arkosic sandstone. The carbonaceous matter is detrital in origin and was contemporaneously deposited with the clastic sediments.

U was derived from weathered granitic rocks exposed along the southern margin of the Powder River Basin and from the alteration and leaching of volcanic ashes that accumulated within the basin in late Tertiary [2]. The results suggest that the U minerals formed in two stages during shallow burial diagensis in early Tertiary and during roll-front mobilization and accumulation along a redox front in the Pleistocene [1, 2, 3].

Carbonaceous matter and pyrite played a significant role in accumulating U and continue to act as a strong reservoir for U and other trace metals. μ-XAFS analyses performed on thin sections with the highest U and Fe concentrations reveal that Fe is present in a reduced form as pyrite and U occurs mostly as U(IV) complexed by organic matter or as solid U(IV)-carboxylate complexes. However, partial oxidation of the U associated with the organic matter is also noted. The presence of pyrite suggests that the mined arkosic sandstone retained part of its reducing capacity even though it may not contribute to the restoration process. Ongoing studies are looking at enhancing the sweeping efficiency of ISL fluids.

[1] WoldeGabriel *et al* (2014) ES&T (submitted). [2] Freeman & Stover (1999) Uranium Institute 24th Annual Symposium,1-20. [3] Santos & Ludwig (1983) *Economic Geology* **78**, 498-501.