

Natural uranium getters in near surface environments at the Nopal I deposit, Peña Blanca, Mexico

M. FAYEK¹, S. UTSUNOMIYA², R.C. EWING²
AND A. SIMMONS³

¹Dept. Earth Planet. Sci., Univ. Tennessee, Knoxville, TN 37996, USA (mfayek@utk.edu)

²Dept. Geol. Sci., Univ. Michigan, Ann Arbor, MI 48109, USA (utu@umich.edu)

³LANL, Los Alamos, NM 87545, USA (asimmons@lanl.gov)

The Nopal I uranium (U) deposit, Peña Blanca District, Mexico, is, in some regards, analogous to the high-level waste (HLW) repository at Yucca Mountain, Nevada. Here we present preliminary data on: (i) the distribution and characteristics of the fractures and faults associated with the deposit, and (ii) the transport and retention of U in the near surface environment at the Nopal I deposit.

Three new vertical diamond drill holes (DDHs) were recently drilled at Nopal I. DDH-PB1 with continuous core was drilled 1 m from the Nopal I deposit and two additional DDHs were drilled ~50 m on either side of the cored hole. These DDHs terminate 20 m below the current water table, thus allowing the detection of possible gradients in radionuclide contents resulting from transport from the overlying uranium deposit.

New field work indicates that there are two faults that bound the western and eastern margins of the Nopal I deposit. These faults are near vertical and strike 305° NM. Slickensides on the fault surface dip 20°. The core recovered from PB1 was systematically sampled. Using radiation counters, the amount of α , β , and γ radiation produced by each sample from DDH-PB1 was measured. The greatest amount of radiation (~1000 cps) was measured in sample PB1024009 collected at a depth of 190.8 meters. This sample is a highly altered conglomerate with large fractures infilled with clay. This sample was examined using back-scattered electrons (BSE) and HRTEM to characterize the uranium-bearing phases. BSE imaging as well as elemental mapping of the sample shows that the sample also consists of disseminated grains of rutile (TiO₂) as well as rutile replacing highly altered sphene. Preliminary energy dispersive spectroscopy (EDS) analyses identified the phases orthobrannerite (U⁴⁺U⁶⁺Ti₄O₁₂(OH)₂ and uraninite (UO₂). These phases are intimately associated with rutile and appear to rim or replace the rutile. These preliminary results suggest that orthobrannerite is actively sequestering the uranium from the fluids that have interacted with the conglomerate.

Probing uranium speciation in contaminated Hanford sediments

JEFFREY G. CATALANO^{1,2}, ZHEMING WANG³,
JAMES P. MCKINLEY³, JOHN M. ZACHARA³,
STEVE M. HEALD⁴ AND GORDON E. BROWN, JR.^{2,5}

¹Environmental Research Division, Argonne National Laboratory, Argonne, IL 60439-4843, USA (catalano@anl.gov)

²Department of Geological & Environmental Sciences, Stanford University, Stanford, CA 94305-2115, USA

³Pacific Northwest National Laboratory, Richland, WA 99352, USA

⁴Advanced Photon Source, Argonne National Laboratory, Argonne, IL 60439, USA

⁵Stanford Synchrotron Radiation Laboratory, SLAC, Menlo Park, CA 94025, USA

Subsurface uranium contamination at many locations across the U.S. Department of Energy's Hanford site is due to leakage of high-level nuclear waste. Of particular concern are (1) the BX tank farm, where the overfilling of tank BX-102 released approximately 7,500 kg of uranium dissolved in caustic aqueous sludge to the vadose zone, and (2) the 300 Area processing ponds, where up to 70,000 kg of uranium in waste effluent was released directly to the ground. The speciation of uranium in the subsurface source areas must be understood to assess the potential hazards posed by these contamination events and to develop and apply accurate contaminant transport models. We used synchrotron-based x-ray spectroscopic and diffraction techniques to characterize the distribution, phase associations, and chemical form of uranium in samples from the two locations. In samples from the BX tank farm, x-ray absorption fine structure (XAFS) spectroscopic studies demonstrated that the primary uranium species is likely a uranium(VI) silicate of the uranophane group of minerals. We used x-ray microdiffraction to identify the specific phase present as sodium boltwoodite. For the 300 Area, the XAFS data are consistent with uranium incorporation into calcium carbonates known to have formed in the processing pond sediments during waste disposal. At both sites the same two-step process was observed for uranium subsurface migration: (1) Reactive uranium-bearing wastes interacted with subsurface sediments, immobilizing much of the uranium in the solid phase. (2) Reaction with local waters induced dissolution of the uranium-bearing solid, slowly releasing uranium to the local groundwater.