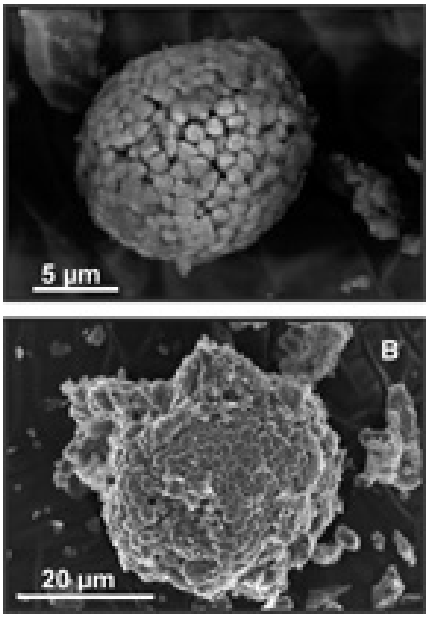
Being Smart About Fool's Gold

For the first time, uranium is linked to framboidal pyrite at former ore processing site

Using microscopic and spectroscopic resources at the Department of Energy's EMSL, scientists determined that pyrites or fool's gold in bio-reduced alluvial sediments may initially sequester subsurface uranium and then serve as a long-term source under conditions of slow oxidation. Thus, microbially altered, unconsolidated sediment may contribute to the persistence of uranium in the groundwater at former uranium milling sites. These results may help in developing remediation measures for uranium-contaminated aquifers.

Small particles of framboidal pyrites (FeS_2), from ~10−20 µm in diameter, were abundant in the <53-µm fraction of the sediment from the saturated zone at the Integrated Field Challenge Site near the Colorado River near Rifle, Colorado. These particles were of varying microcrystal morphologies, degrees of surface weathering, and internal porosity. However, these pyrites were absent where microbial activity had not reduced the surrounding minerals. An array of spectroscopic techniques showed elevated uranium in both the oxidized and reduced states was present in framboidal pyrite.

These characterizations were made possible by integrating spectroscopic and microscopic resources at EMSL. These resources included scanning electron microscopy combined with focused ion beam, high-resolution transmission electron microscopy combined with selected area electron diffraction and ^{57}Fe-Mössbauer spectroscopy. Resources in laboratories at Pacific Northwest National Laboratory and Argonne National Laboratory (x-ray absorption spectroscopy) were also used.



By integrating resources, the team was to obtain extremely detailed views of the framboidal (French for raspberry) pyrites found in the sediment of interest. The top image is of a sphere-like structure and the bottom image is an irregular framboidal structure.

Scientific impact: The study presents data showing that framboidal pyrite has an affinity for uranium, decreasing its transport via groundwater. This work is part of EMSL's ongoing efforts to characterize surfaces with unprecedented spatial resolution.

Societal impact: At a number of sites around the country including former nuclear weapons sites, uranium has contaminated sediments and groundwater. For example, the subsurface at the Hanford Site in Washington State is estimated to hold 202,703 kilograms of uranium. Understanding how and when uranium migrates may aid in creating remediation approaches to extract or halt the radionuclide's progress.

For more information, contact EMSL Communications Manager Mary Ann Showalter (509-371-6017).

Reference: Qafoku N, RK Kukkadapu, JP McKinley, BW Arey, SD Kelly, CM Wang, CT Resch, and PE Long. 2009. "Uranium in framboidal pyrite from a naturally bioreduced alluvial sediment." *Environmental Science & Technology* 43(22):8528-8534.

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