Anthropogenic Uranium Detection with X-Ray Microscopy

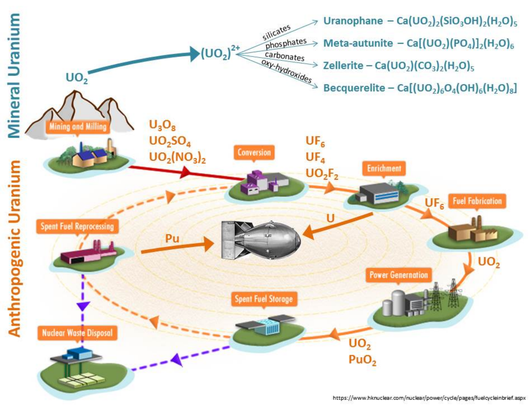
Research Team: Andrew Duffin, Jesse Ward, Gregory Eiden
Key Collaborators: David Shuh (LBNL), David Prendergast (LBNL)

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by **Battelle** *Since 1965*

Project 1.10; October 2012 – September 2015

Purpose

Distinguish anthropogenic and mineral uranium using X-ray absorption microscopy

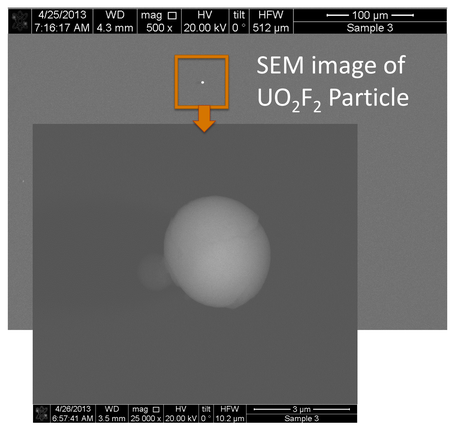


Key Successes

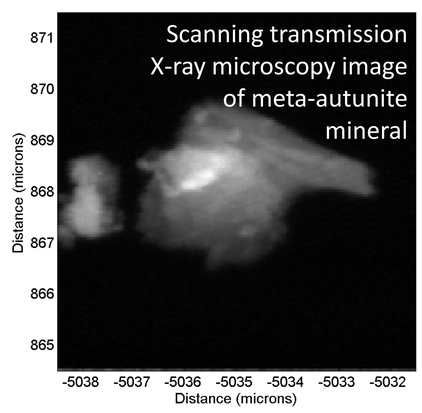
- Uranyl ion peak positions correlate with chemical environment
- Oxygen K-edge X-ray absorption can be used for uranium species identification

Research Accomplishments

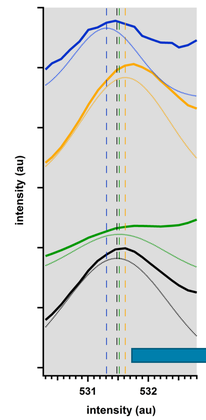
Anthropogenic uranium particles have been prepared at PNNL's Radiochemical Processing Laboratory and at Oak Ridge National Laboratory

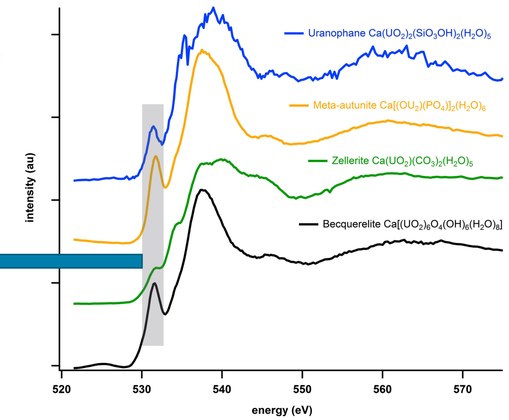


Particle morphology important for sample differentiation



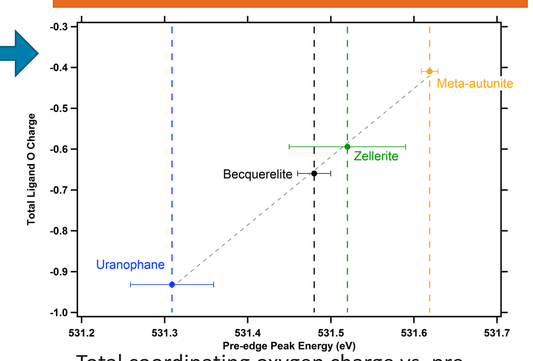
Mineral near edge X-ray absorption fine structure (NEXAFS) spectra collected at Advanced Light Source BL8.0.1 and BL11.0.2



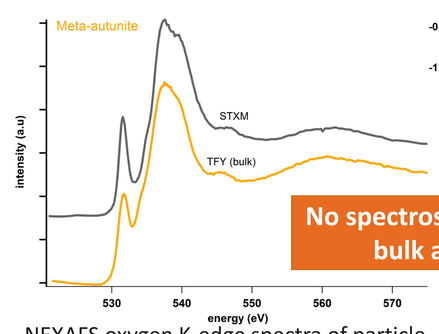


NEXAFS oxygen K-edge spectra of uranium minerals

Uranyl ion peak positions correlate with chemical environment



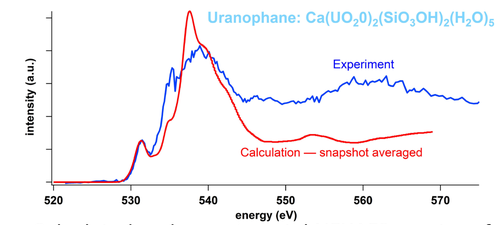
Total coordinating oxygen charge vs. pre-edge peak position



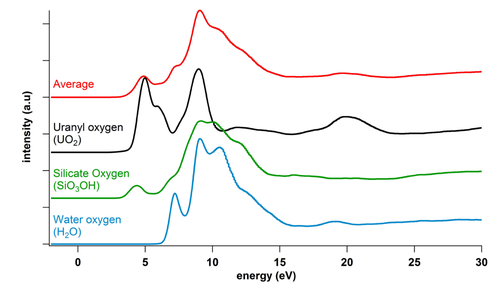
NEXAFS oxygen K-edge spectra of particle and bulk meta-autunite

No spectroscopic difference between bulk and particle samples

Calculations done in collaboration with The Molecular Foundry (LBNL) and EMSL



Calculated and experimental NEXAFS spectra of uranophane



Contribution to calculated uranophane spectra from various oxygens

Calculations aid in spectral analysis

Next Steps

- Spectral data needed for larger mineral library and for anthropogenic uranium samples
- Fluorine/chlorine X-ray data collection
- Improved calculations needed for better spectral analysis
- Incorporation of mass spectrometer for simultaneous collection of chemical and isotopic information

PNNL-SA-96593