Characterization of U(VI) Sorption-Desorption Processes and Model Upscaling

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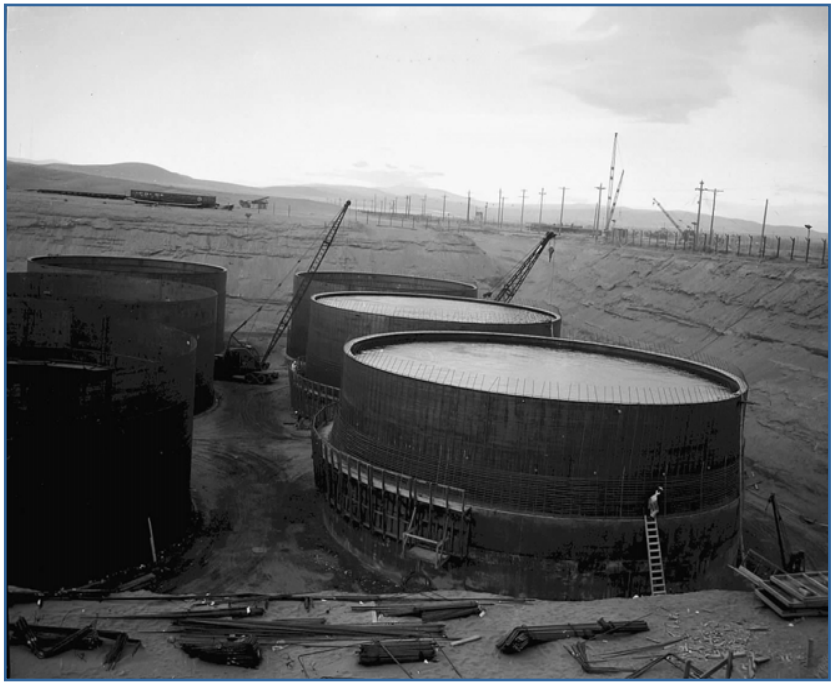
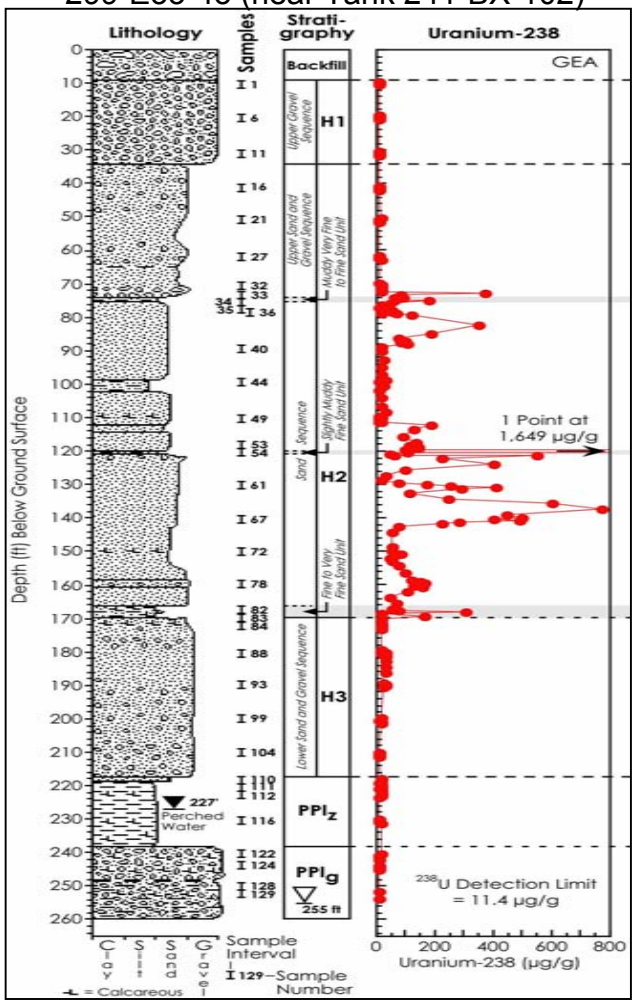
A Big Problem in Hanford's B-BX-BY Tank Farm: 10 Tons of Lost Uranium

- **B-BX-BY tank farm**

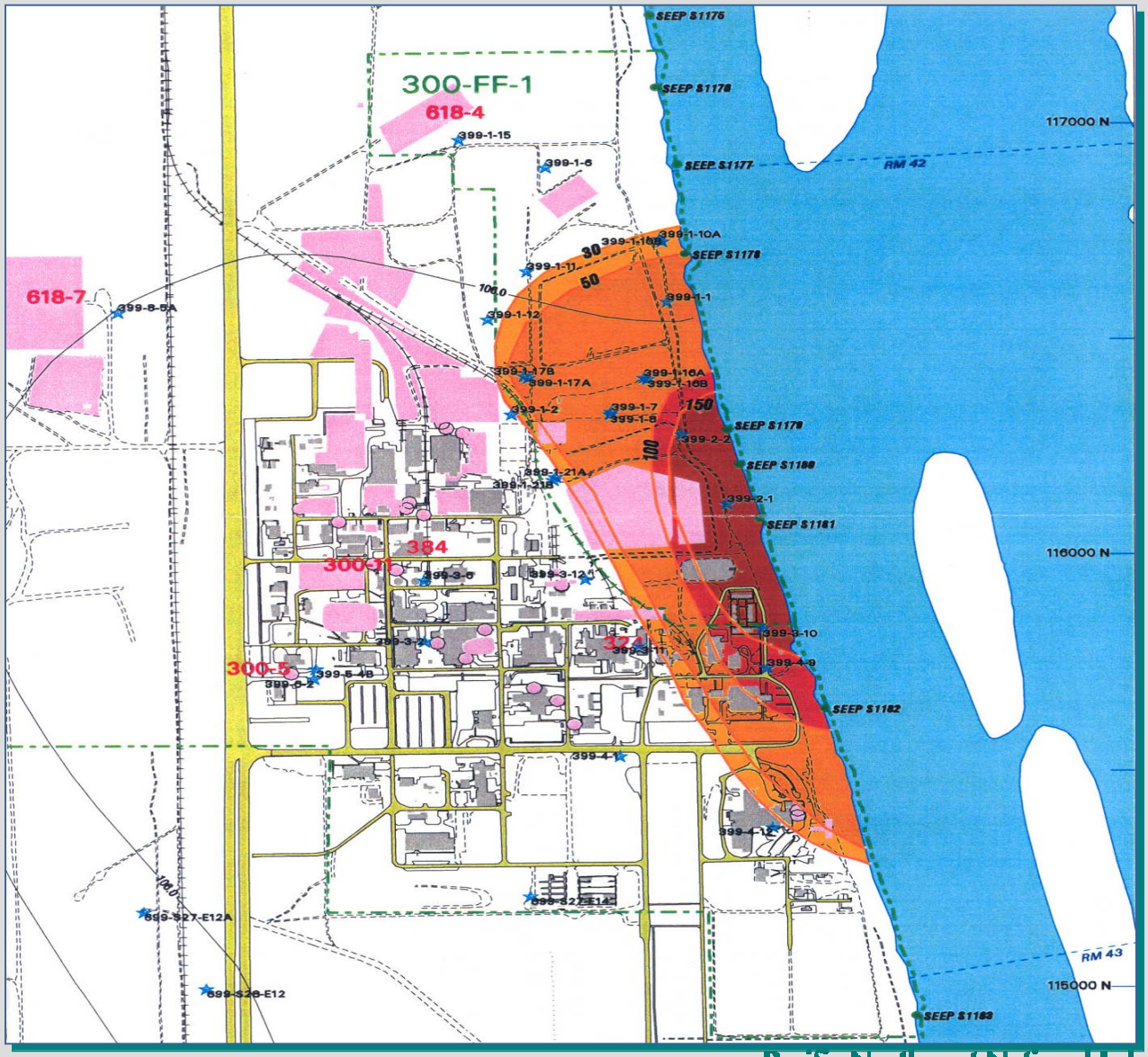


- **U distribution**

299-E33-45 (near Tank 241-BX-102)



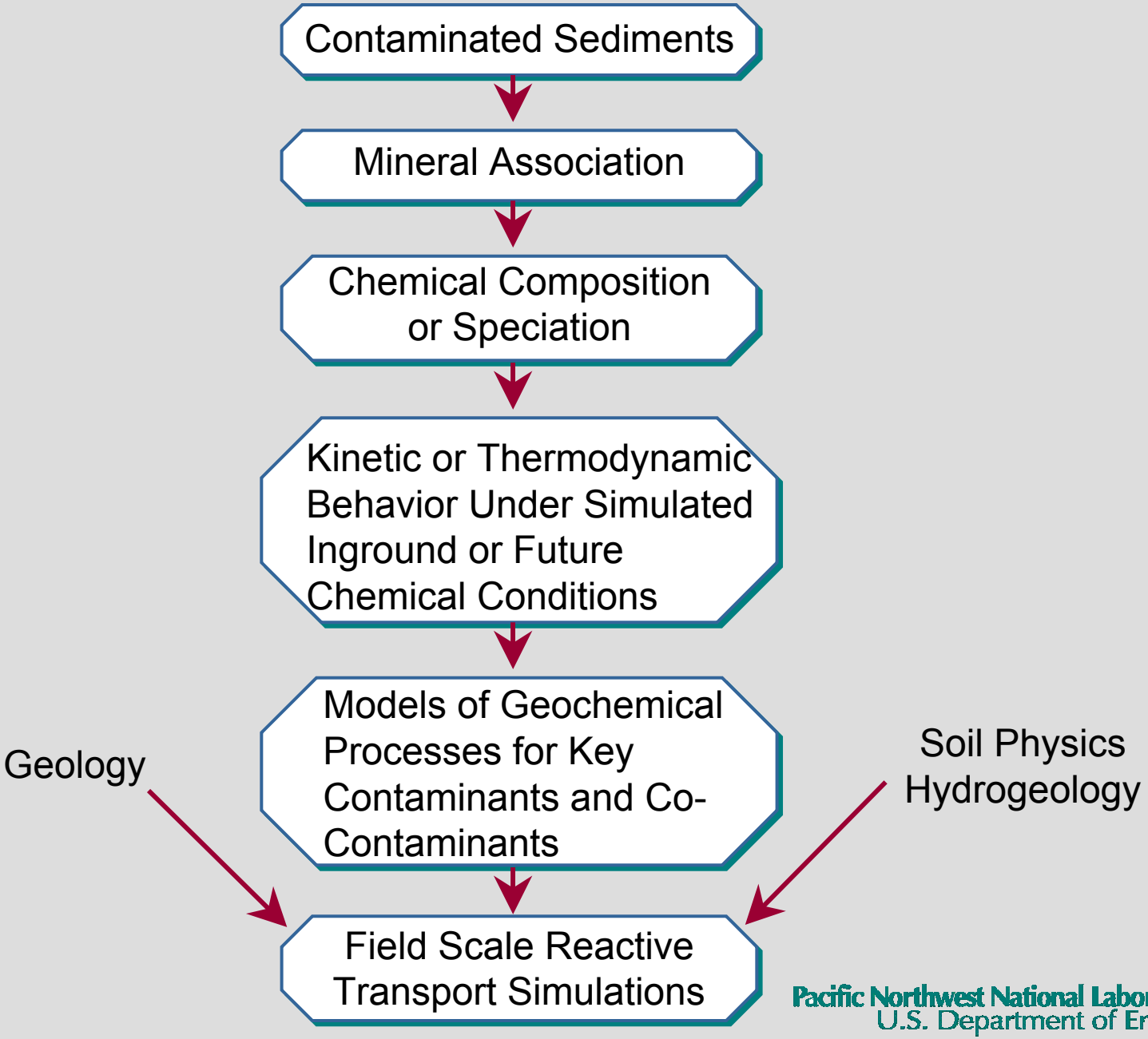
Concentrations in the 300 Area U Plume



Project Objectives

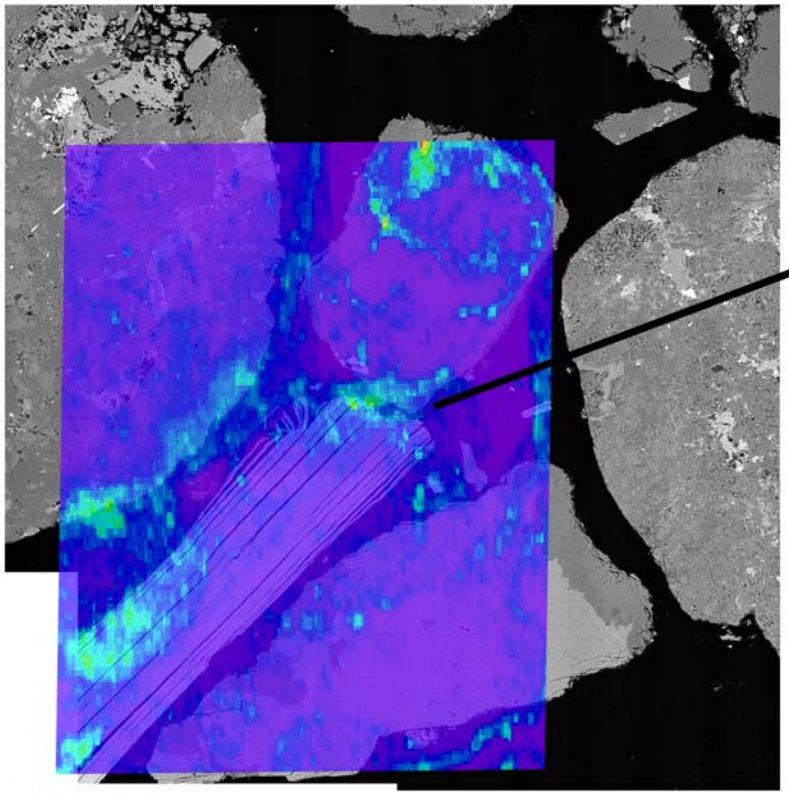
- Characterization predominant retardation mechanism of U(VI) in Hanford sediments
  - Adsorption and/or precipitation
  - Vadose and saturated zones
  - Facies and lithology effects
  - Key waste sources
- Develop a kinetic model for U release from contaminated sediment
  - Consider speciation and physical distribution
  - Solubility/desorption
  - Mass transfer effects
  - Robust over Hanford pH range and electrolyte composition
- Demonstrate an approach to model U transport through vadose zone and aquifer sediments
  - Column experiments
  - Simple scaling approaches
  - Reaction based approach with mass transfer

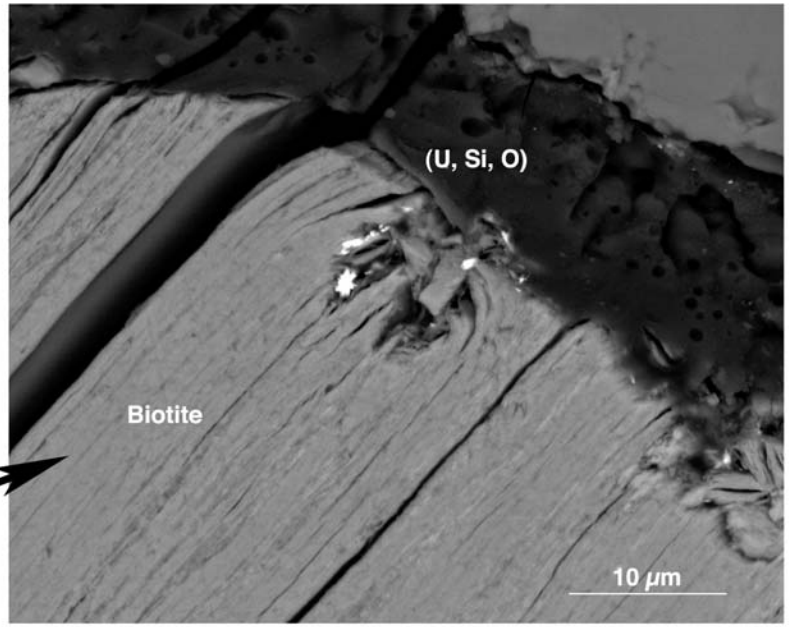
Overall Scientific Strategy



XRM and SEM Analyses of U(VI) Containing Hanford Sediment

Uranium abundance (XMP)
Overlain on backscattered electron image

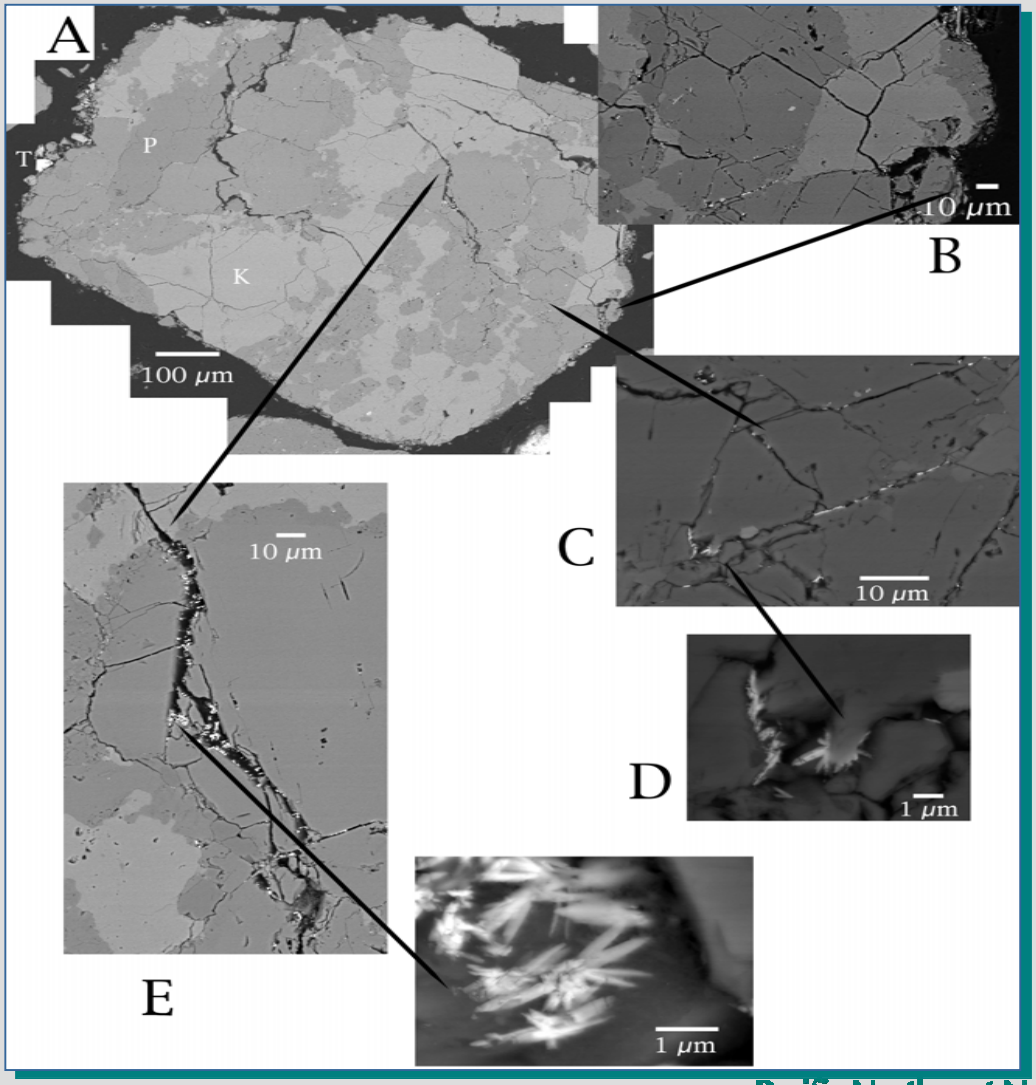




Detail backscattered electron image showing uranium silicate precipitates at biotite edge.

Composition information by EDS

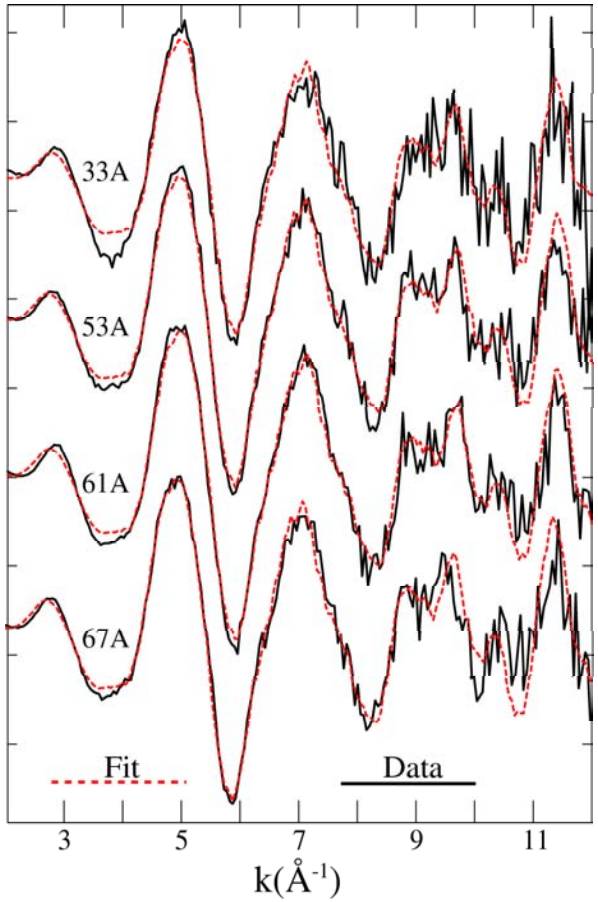
U(VI) Microprecipitates Exist within Grain Fractures of Quartz and Feldspar in BX-102 Sediment



X-ray Absorption Spectroscopy Helps Define U-U Interatomic Distances, Bond Number, and Phase Identity

(Performed with Stanford Univ. Collaborators at SSRL)

Extended X-ray absorption fine structure



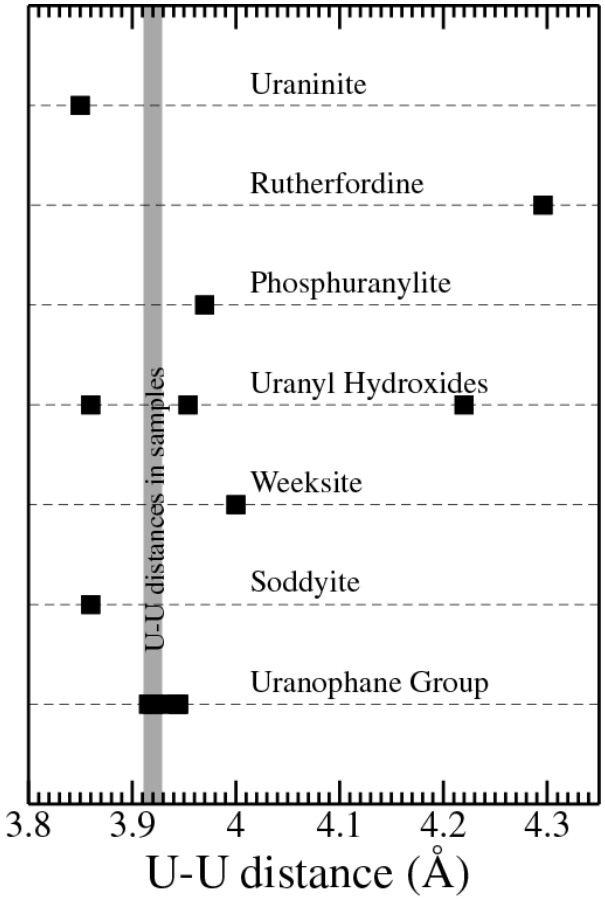
102% Uranophane
residual = 0.674

99% Uranophane
residual = 0.240

98% Uranophane
residual = 0.212

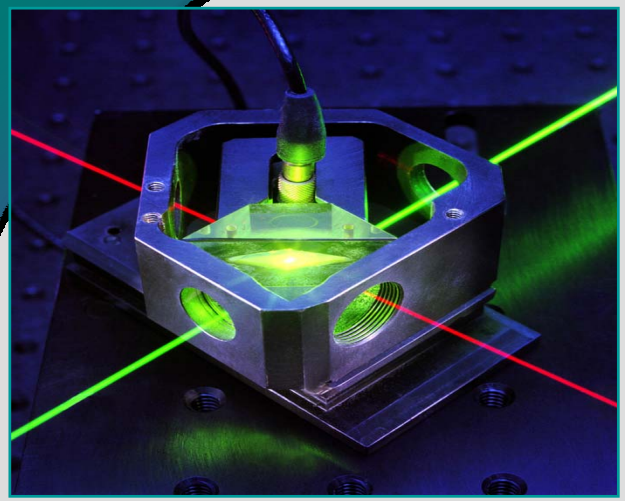
100% Uranophane
residual = 0.348

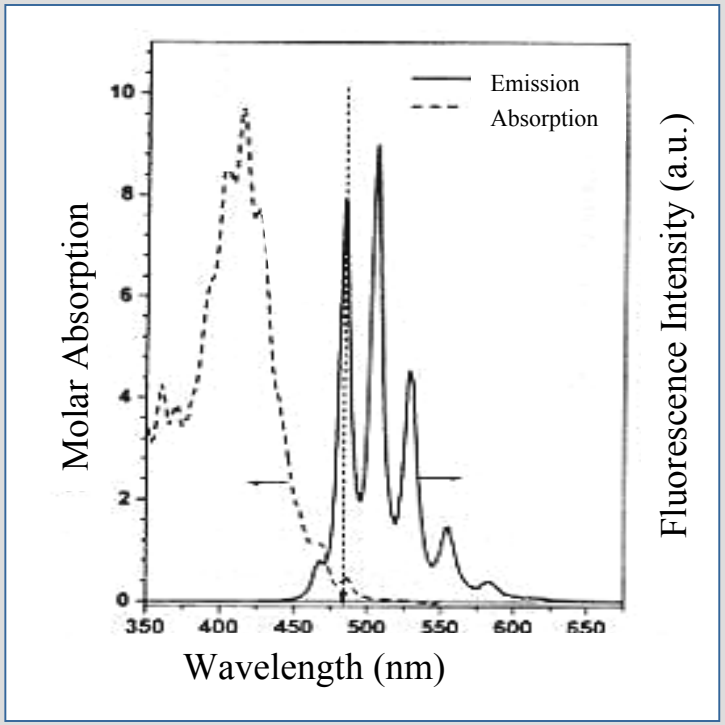
U-U distance

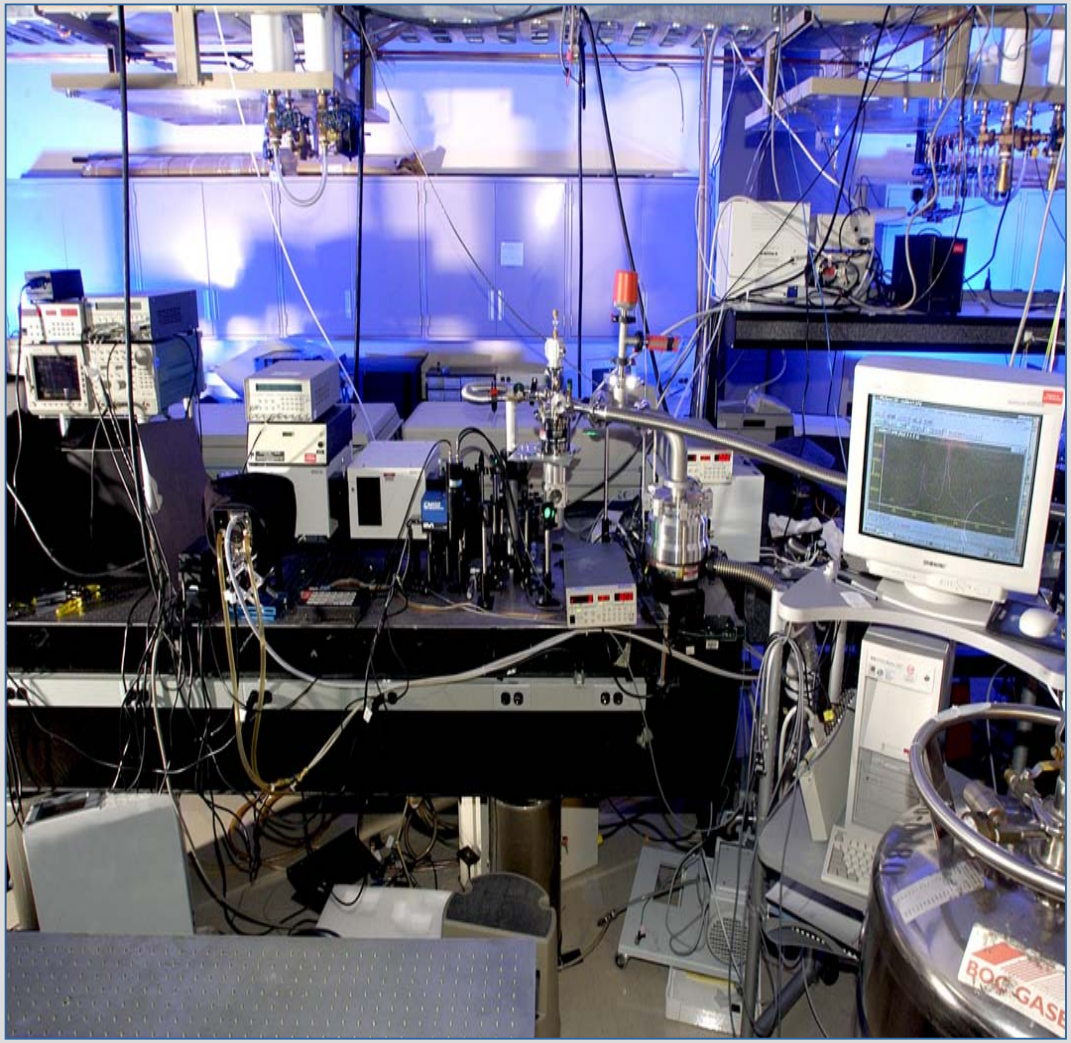


Uranophane = $Ca(H_3O)_2(UO_2)_2(SiO_4)_2(H_2O)_3$

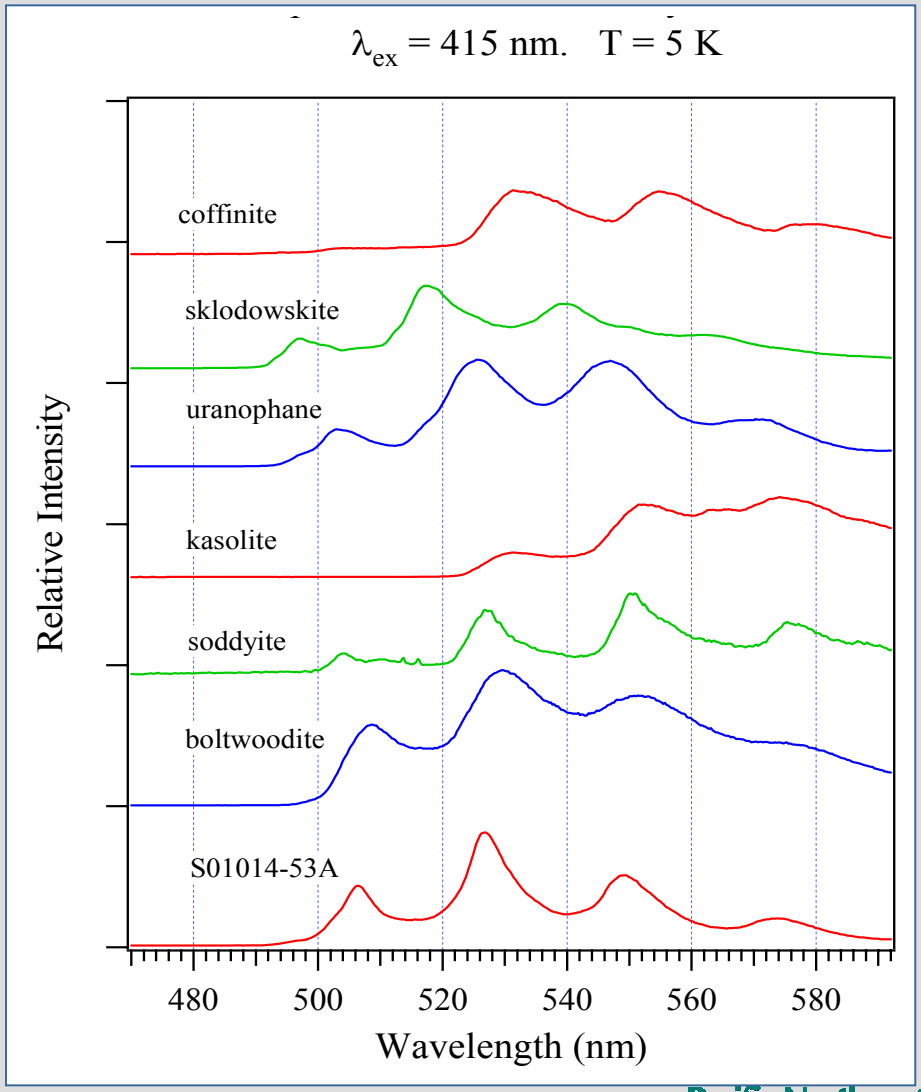
Fluorescence Spectroscopy for U(VI) Speciation Measurements



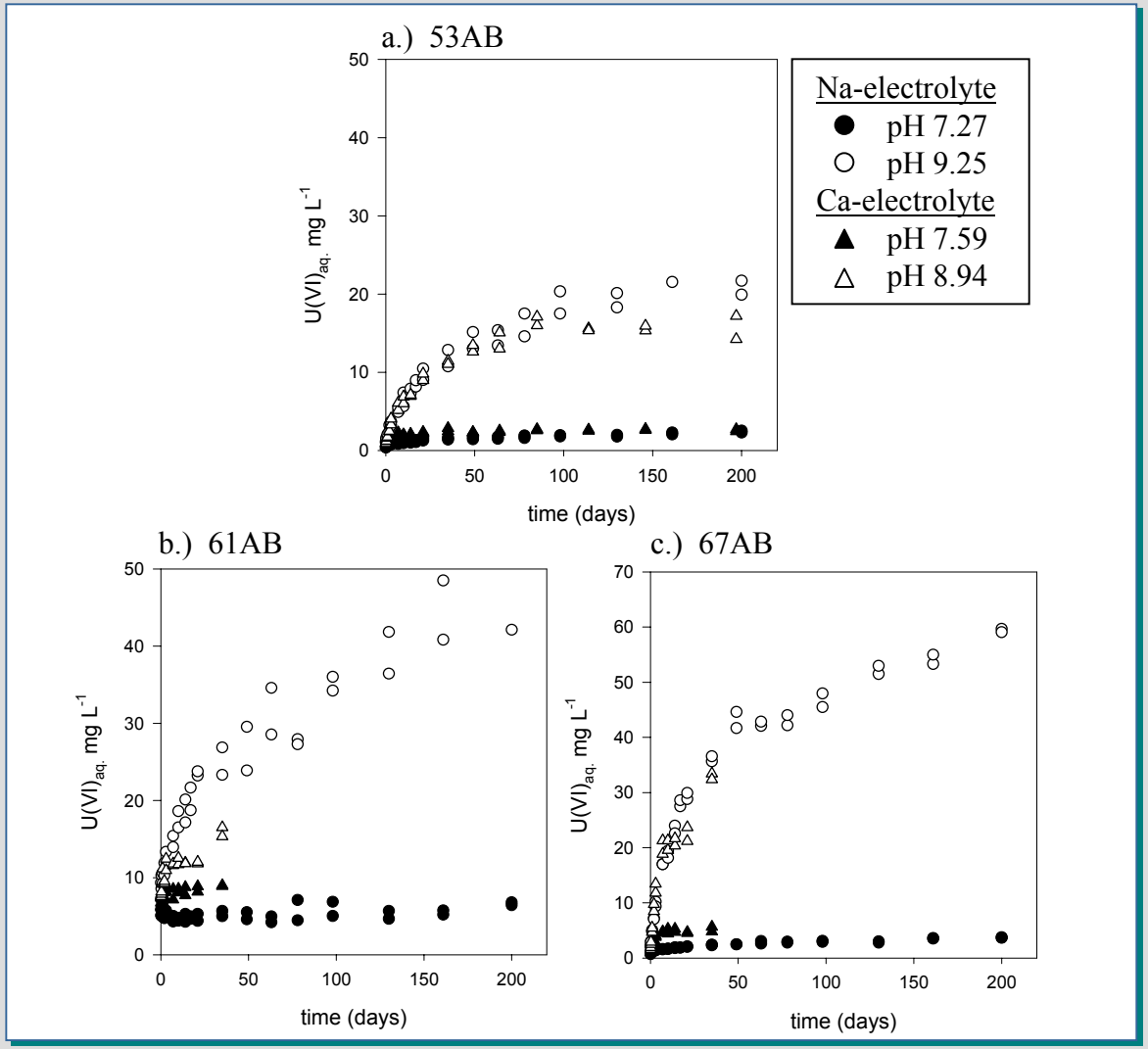




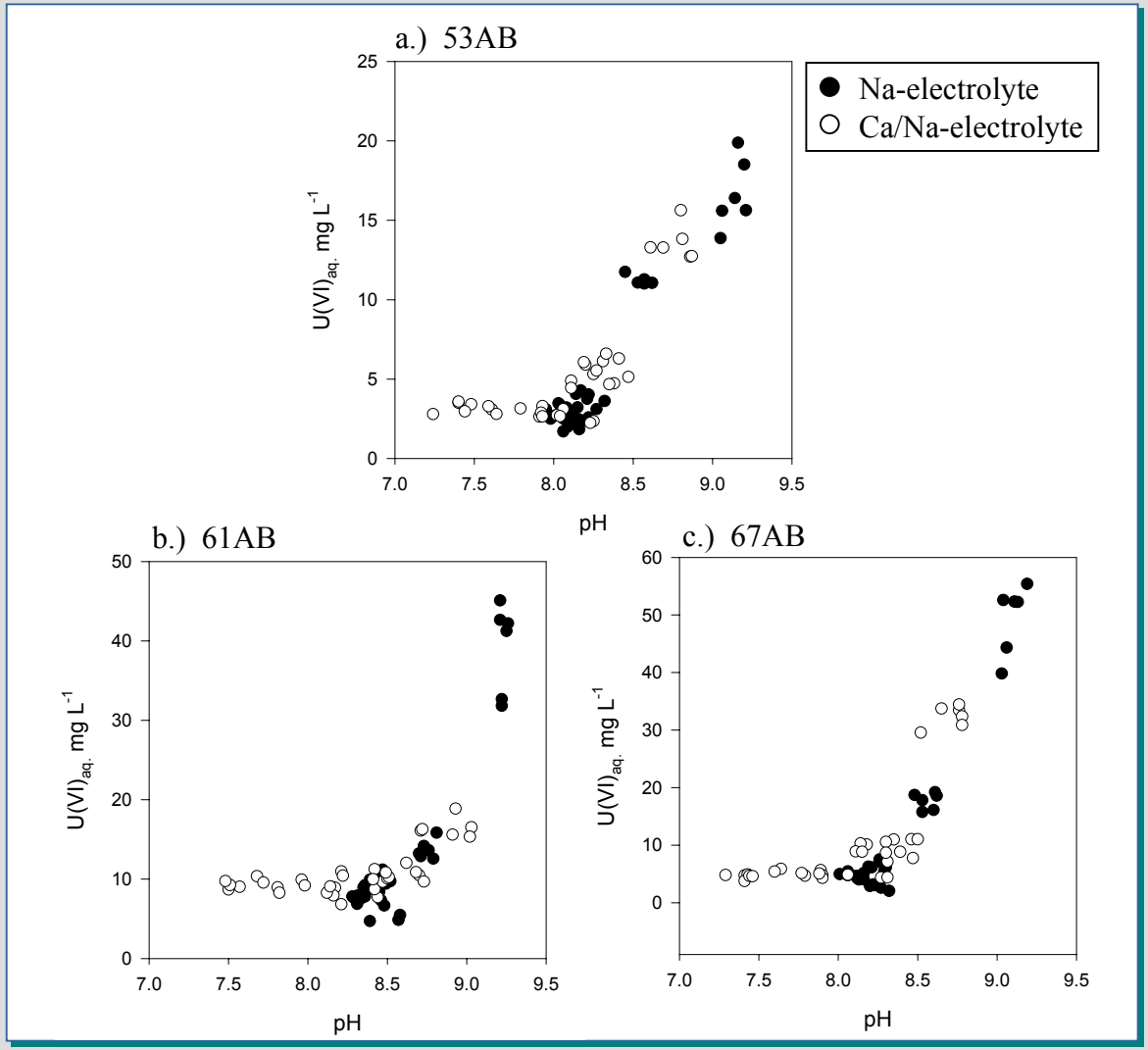
Fluorescence Spectra of Standard Uranyl Silicate Minerals and Hanford BX-102 Sediment 53A



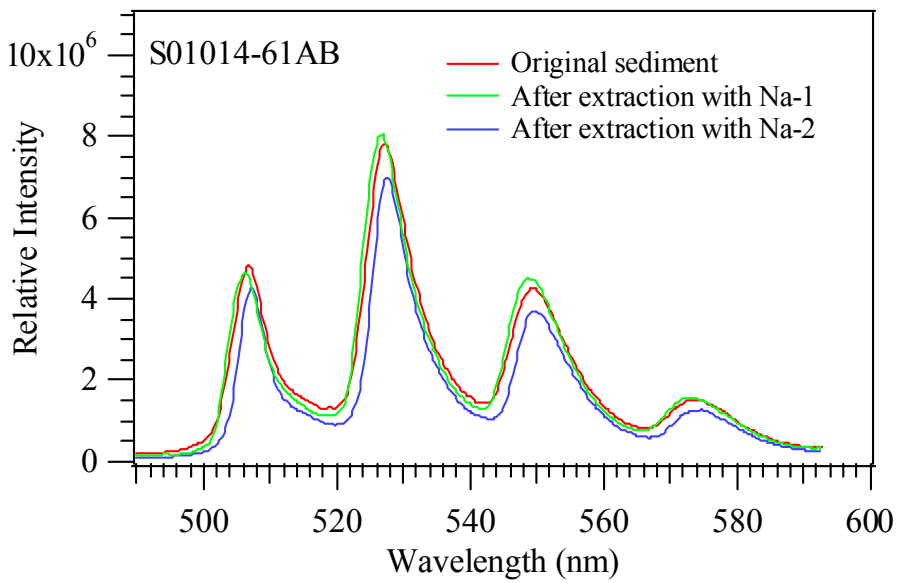
Dissolution of U(VI) from BX-102 Sediment

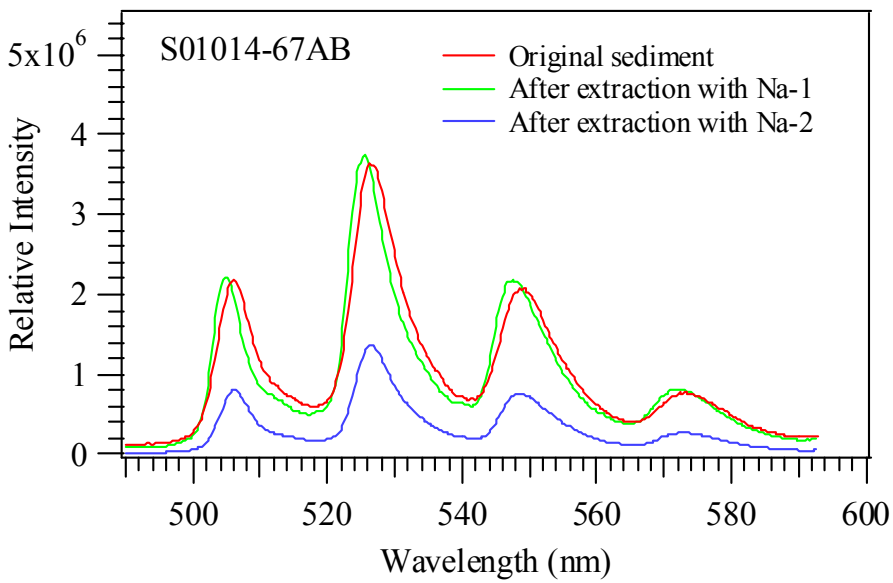


Solubility Behavior of U(VI) in BX-102 Sediments (200 d Equilibration)

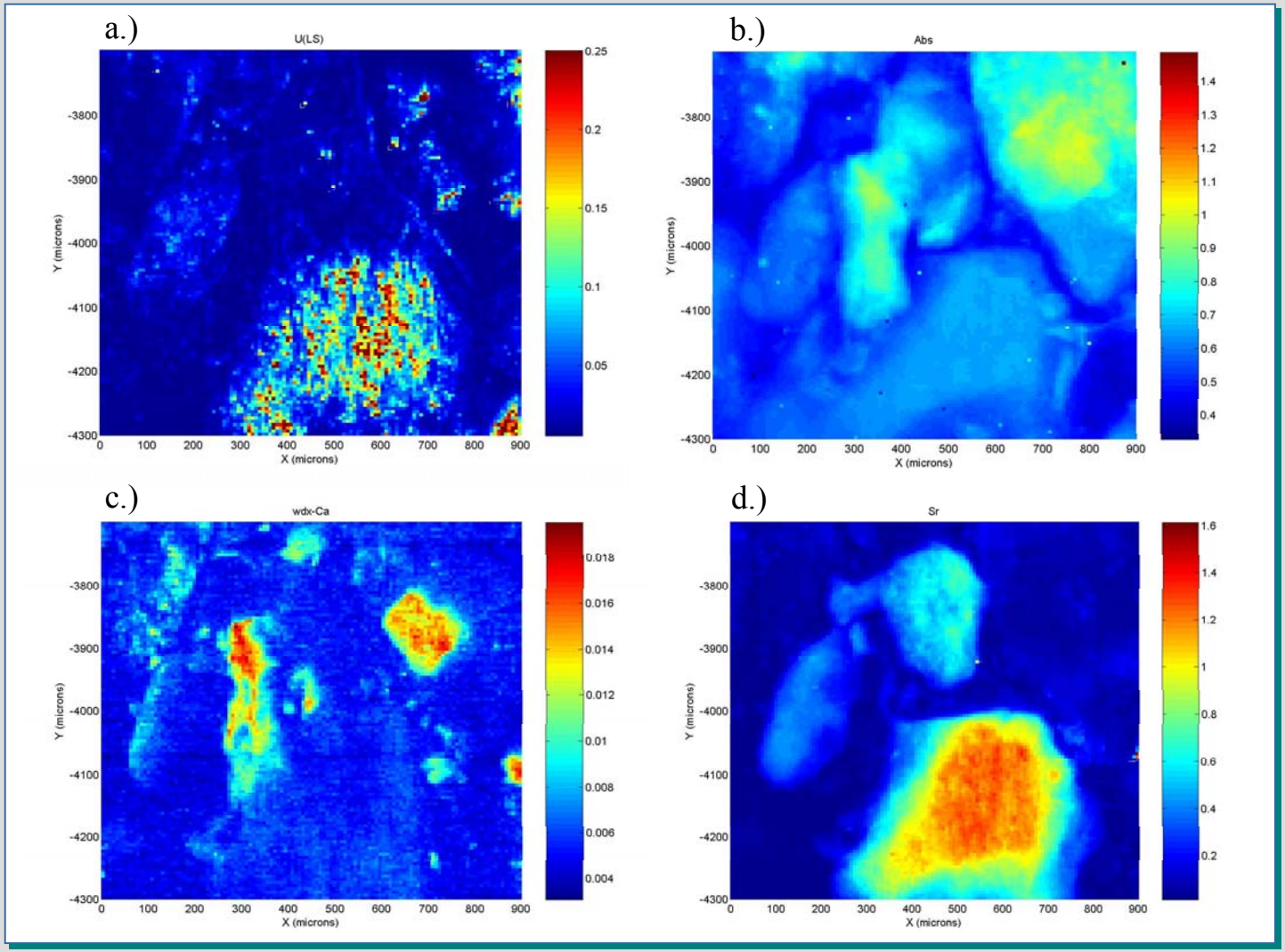


Fluorescence Spectra of Hanford BX-102 Sediment Before and After U(VI) Desorption





XRM Imaging of BX-102 Sample 61AB After 200 d Equilibration at pH ~9



Sampling Locations in the 300 Area U Plume

North Process Pond – Pit #1