

Identifying New Science Opportunities in Biogeochemistry for DOE Sites

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Breakout Session

DOE-ERSP Spring PI Meeting 4 April 2006



OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

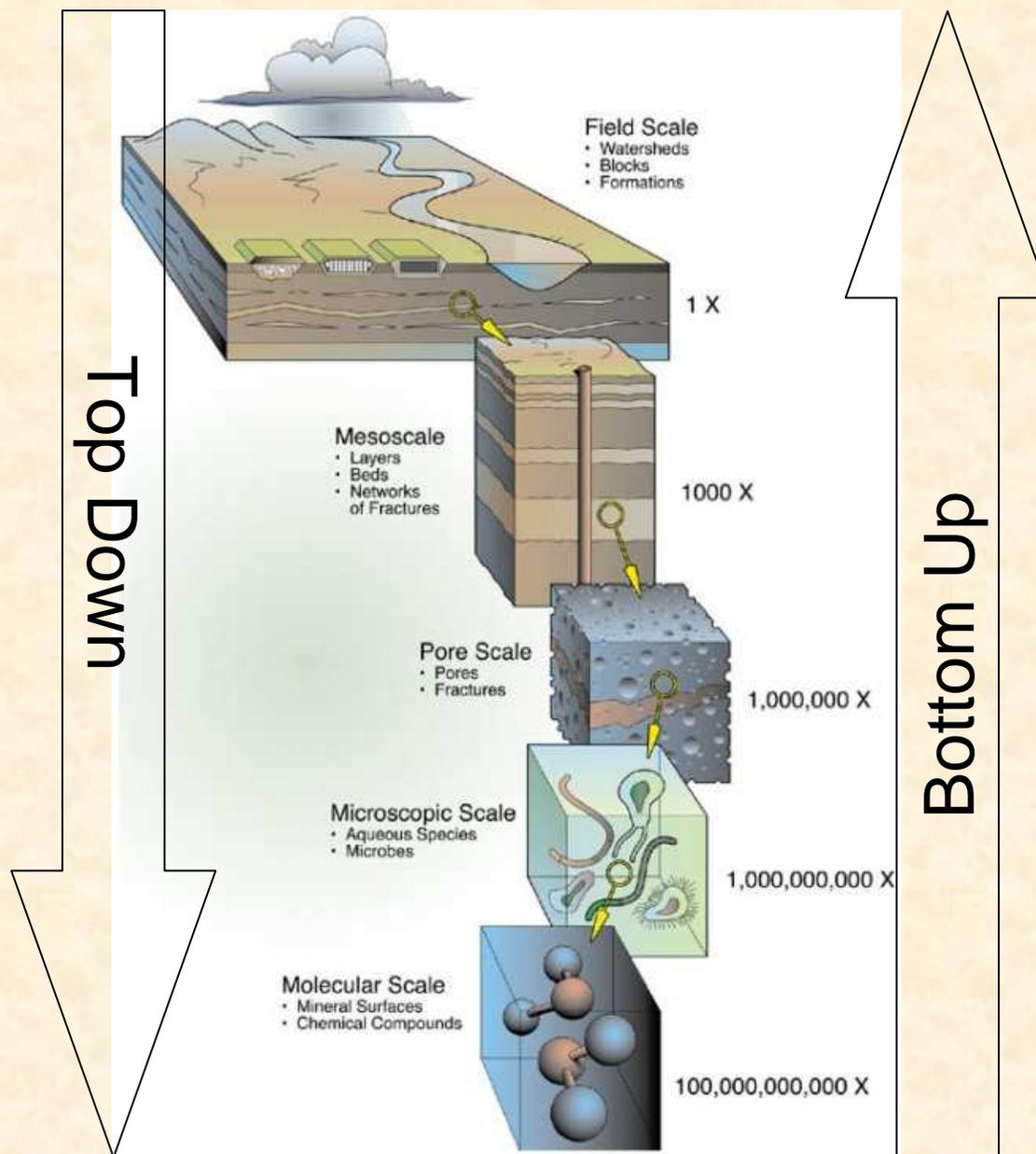


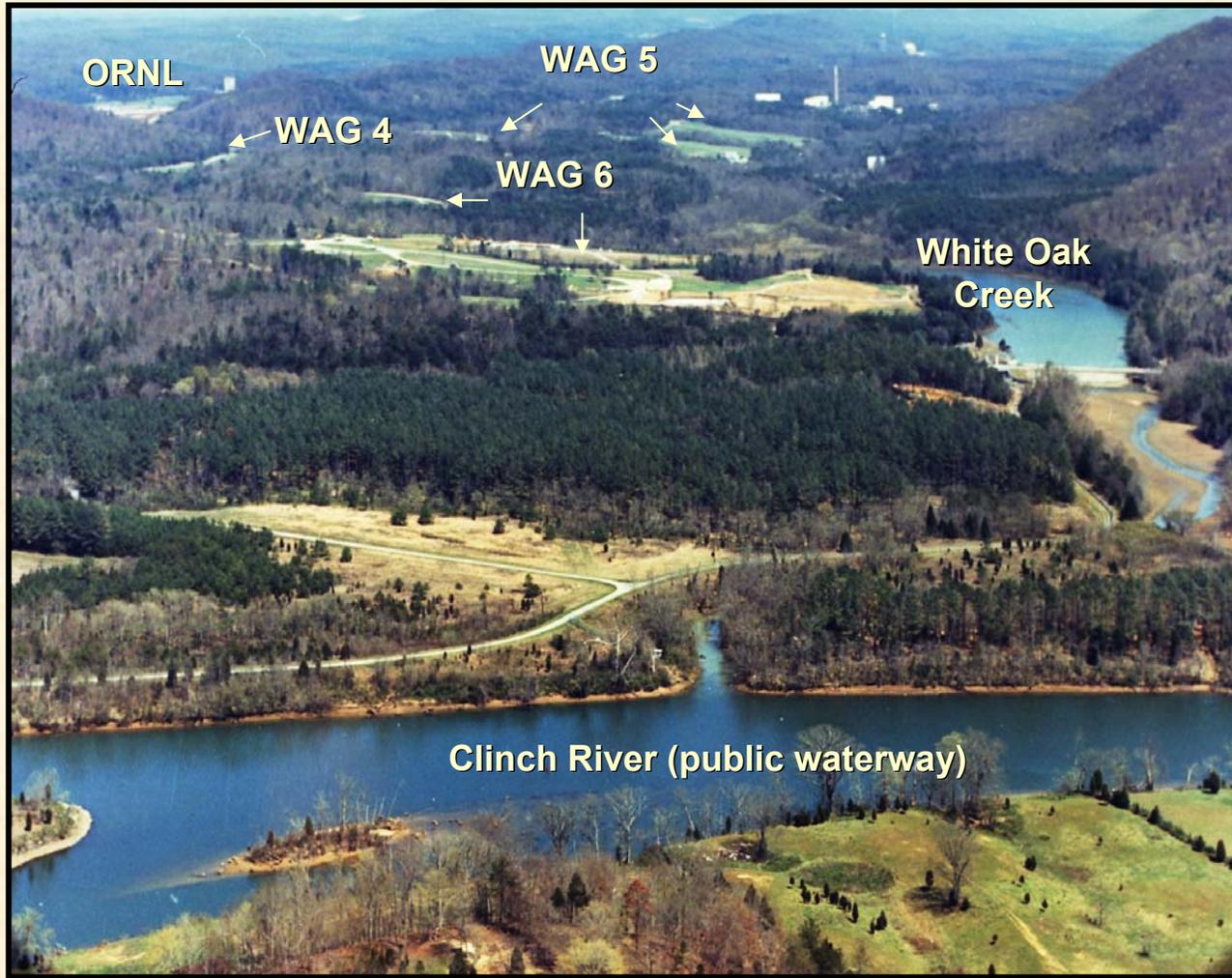
Clinton Labs

- **Created as part of Manhattan Project**
- **Y-12 : electromagnetic separation of fissile isotopes of U**
 - Nation's storehouse of weapons-grade U
 - Weapons design and manufacture
 - World's largest repository of Hg
- **K-25 : gaseous diffusion (closed in mid-80's; D&D)**
 - Surface soil contamination – U, Pu
- **X-10 : radiochemistry lab**
 - Graphite reactor design and operation
 - Separated mg quantities of Pu
 - Radiochemical techniques developed and tested
 - Most promising passed to Hanford for large scale work
- **Waste compositions are some of the most complex in the DOE system.**
 - HLW - Gunnite tanks, reactor fuel elements
 - ILW – unlined seepage trenches
 - Thousands unlined trenches

Clean-up, Restoration, Remediation, and Long-Term Stewardship

- **Understanding Processes at Multiple (and Relevant) Scales**
 - Hydrology
 - Geochemistry
 - Microbiology



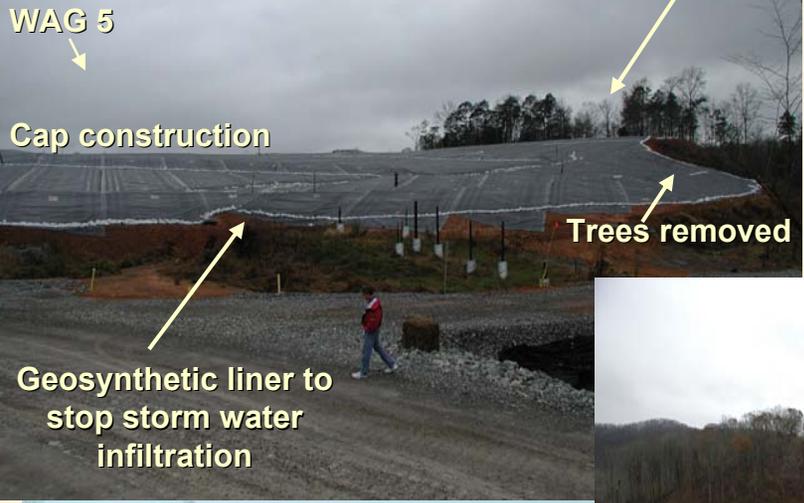




- **The ORNL Waste Area Groups (WAGs) contain thousands of unconfined pits and trenches containing low level radioactive and organic waste.**
- **Remediation strategies : leave contaminants in-place and install RCRA caps**
- **Primary objective : controlling the infiltration of storm water into the waste trenches.**



Historical waste disposal practices at the ORNL WAGs



WAG 5

Cap construction

Trees removed

Geosynthetic liner to stop storm water infiltration

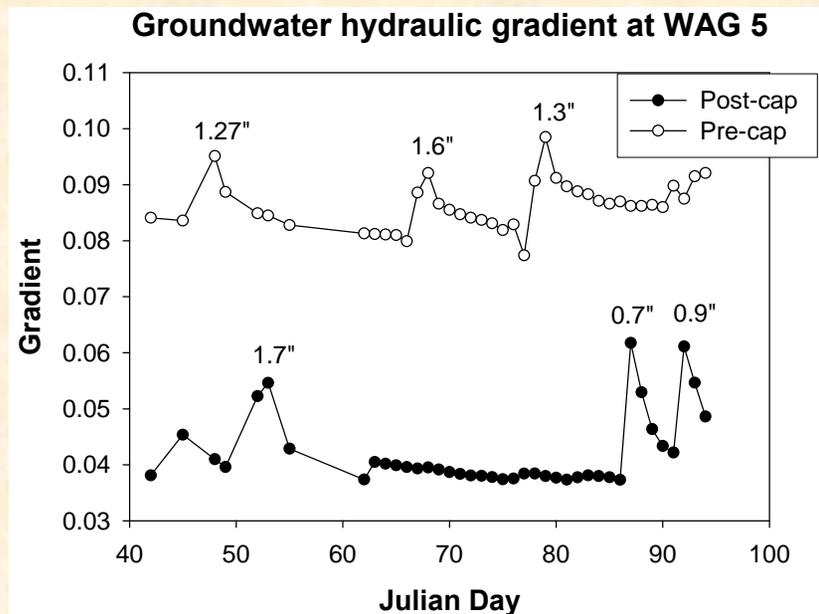
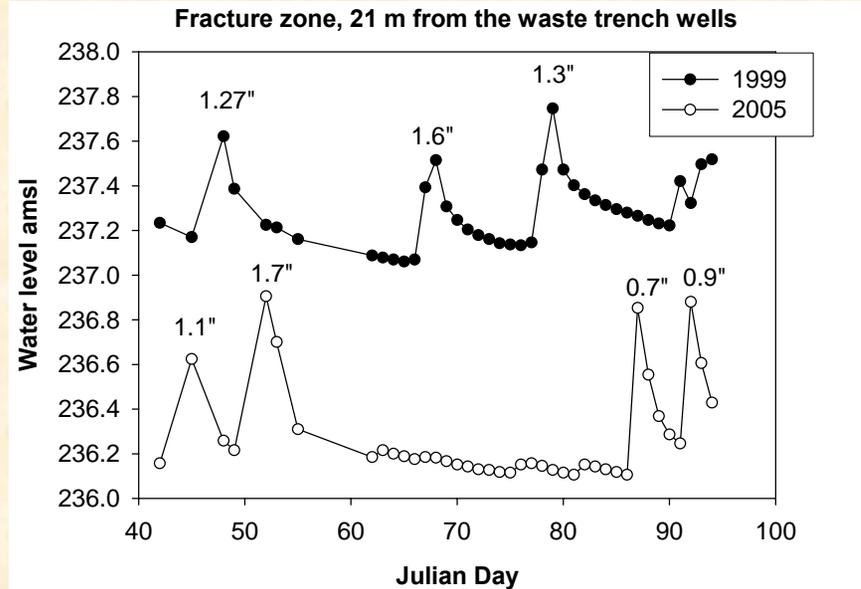


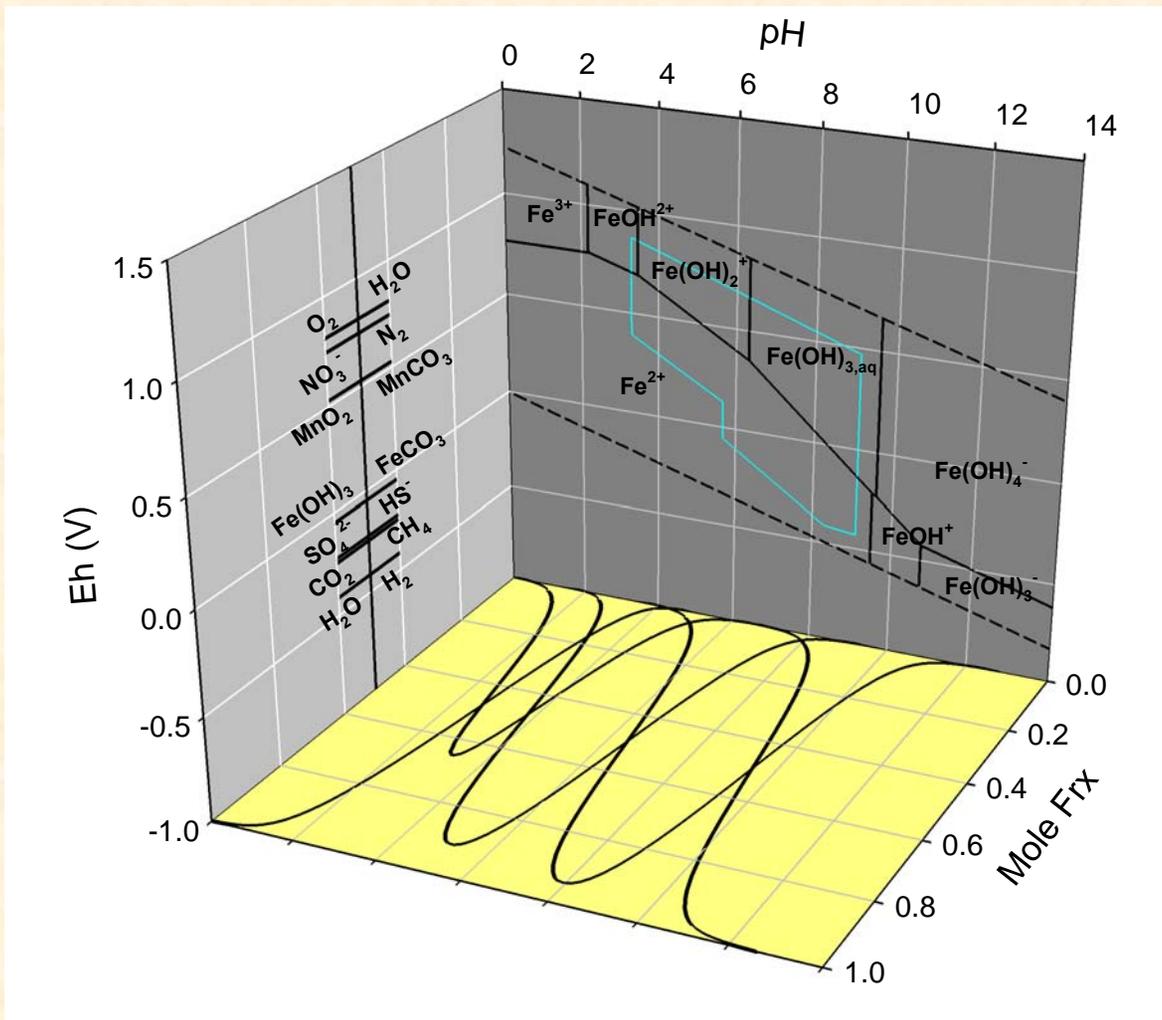
WAG 4

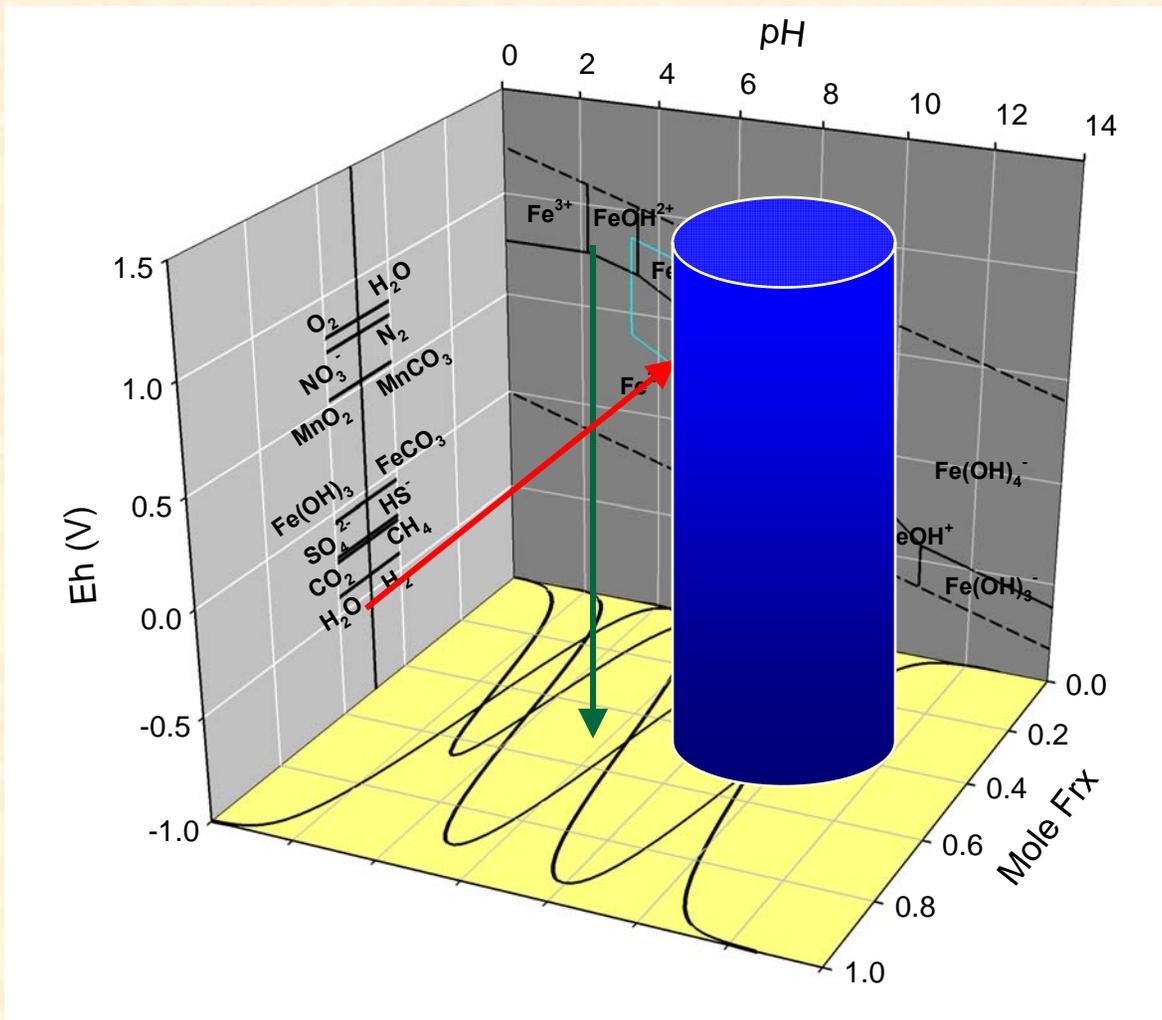
Finished cap with vegetation layer

Stewardship challenges

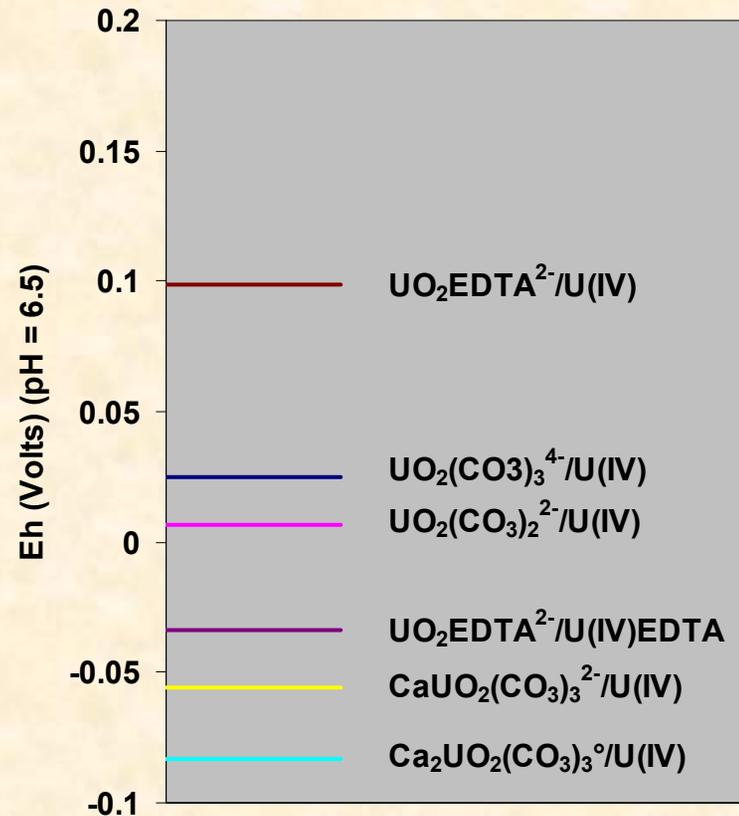
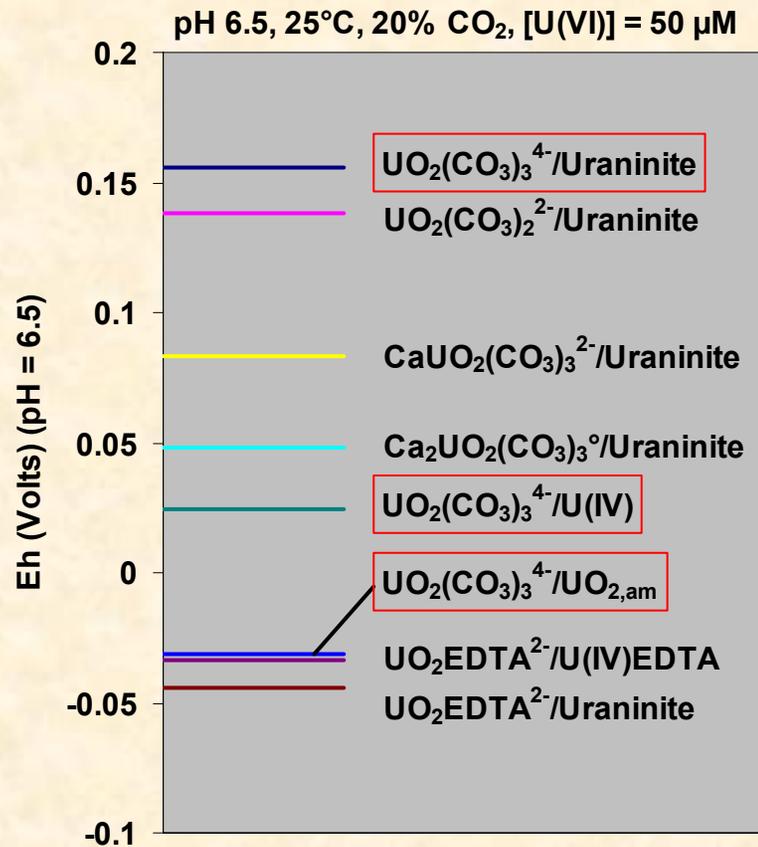
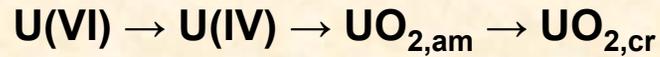
- **Post Capping - Observed**
 - decreased in water-level and site hydraulic gradient
 - shifts in geochemistry
 - suggest a local-scale influence from the cap
 - Thus base-flow contaminant flux has decreased as a result of the cap.
- **However :**
 - hydraulic head responses to storm events appear to be of similar magnitude to pre-cap conditions
 - Suggests regional-scale influence of groundwater flow.
 - Thus, storm water intrusion into waste trenches during rain events remains plausible.







Molecular – Field scale linkage...



How much complexity is necessary and sufficient?

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Equivalence of two models for biodegradation during contaminant transport in groundwater

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[1] We compare two models that have been used frequently for describing biodegradation during contaminant transport in groundwater. One is a “simple” model based upon macroscopic properties only, and the other is a “biofilm” model that accounts for contaminant diffusion and reaction in biofilms... the two models are exactly equivalent at the macroscopic scale when steady state conditions prevail... Under transient (nonsteady state) conditions the two models are not strictly equivalent. However, the error between the two models is negligible in certain cases. In particular, when the rate-limiting step for biodegradation is either mass transfer across the boundary layer or diffusion within the biofilm, there is no distinguishable difference between the predictions of the two models.