Remedy Selection and Implementation for Radionuclides in Soil and Ground Water

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Context
- Attenuation and transport processes are important to consider for remediation decisions in the vadose zone and groundwater.
  - Important for both remedy selection and remedy implementation.
- Remedy technology decisions consider the intersection of:
  - Radionuclide characteristics
  - The target problem
  - Remedy functionality
  - Remediation objective

Outline
- Case study background – Hanford Site
- Attenuation and transport processes
- Remedy selection considerations
- Remedy implementation considerations
- Conclusions

Hanford Background

Key Contaminants
- Tc-99
  - 410 Ci discharged; No breakthrough to groundwater; Most mass between 30 - 50 meters below surface.
- Uranium
  - 36,000 Kgs discharged; Minimal breakthrough to groundwater; Unknown mobility and presence in deep vadose zone.
- I-129
- Chromium

Central Plateau: Deep Vadose Zone Sites
- Uranium
  - 10,000 Kgs discharged; ~20 Kgs in groundwater @ 150 X standard.
- Tc-99
  - ~40 Ci discharged; Groundwater @ ~100 X standard.
- I-129
- Chromium

DOE 2017
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Attenuation and transport processes

What do we need to know?
- Vadose Zone
  - Quantify vadose zone contaminant flux to groundwater
  - Determine where and what type of mitigation is needed
- Groundwater
  - Quantify plume dynamics and secondary source characteristics
  - Exit strategy for P&T
  - Transition to MNA
- Coupled System
  - Assess continuing and long-term sources not related to current plumes

Central Plateau: Deep Vadose Zone Sites

Key Contaminants
- Tc-99 Uranium, I-129, Chromium

Central Plateau: Deep Vadose Zone Sites

Attenuation and transport processes

Processes
- Hydraulic attenuation
- Adsorption
- Transformation
- Sequestration

Ramifications
- Temporal profile of source flux and concentrations
- Inventory of mobile contaminants
- Spatial distribution information
- Plume dynamics
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Attenuation and transport processes

- Vadose zone attenuation/transport SAP
  - Target sampling and analysis for
    - Important hydrologic units
    - Representative contaminant discharges
    - Problematic waste sites
  - Define analyses based on national guidance for attenuation tailored to site needs
    - COC and primary biogeochemistry
    - Sequential extractions and other indicator diagnostics
    - Leaching or batch Kd studies to support estimating transport parameters
    - Hydraulic/physical properties where needed to support model configuration

Reaction and Mobility – Vadose Zone

Distribution and Mobility

Source characteristics (location/flux)

Evaluation of VZ Transport

- Contaminant Distribution
  - Geophysical logging
  - Spectral gamma log
  - Neutron moisture log
  - Geophysics
    - Electrical Resistivity Tomography

Reaction and Mobility - Groundwater
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Technology evaluation
- Treatability tests and assessments
  - Determine technology in relation to radionuclide characteristics
  - the target problem
  - remedy functionality
  - remediation objectives
- Examples
  - Soil flushing
  - Surface barriers/desiccation
  - Uranium sequestration

Source characteristics (location/flux)

Surface Barrier
- Effect of drainage

Geochemical stabilization – vadose zone
- Ammonia gas for uranium sequestration

Remedy Implementation
- Vadose zone remediation target
  - Where
  - What chemical form
  - How much flux reduction
- Diminishing plumes
  - How much is needed
  - Secondary or continuing sources
- Transition to MNA
- Current plumes versus long-term sources

Remedy Implementation
- Adaptive Site Management
  - National Research Council
  - ITRC
    - Remediation Management of Complex Sites
    - http://rmcs-1.itrcweb.org/
- Exit Strategies (P&T)
  - http://bioprocess.pnnl.gov/Pump-and-Treat.htm
- Monitoring
  - Objectives based
  - Performance metrics
  - Transition for long-term
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References

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- Serne R, et al. 2010. Conceptual Models for Migration of Key Groundwater Contaminants Through the Vadose Zone and into the Upper Unconfined Aquifer Below the B-Complex. PNNL-19277, Pacific Northwest National Laboratory, Richland, WA.