Infiltration and Injection Sites and Example Experiments

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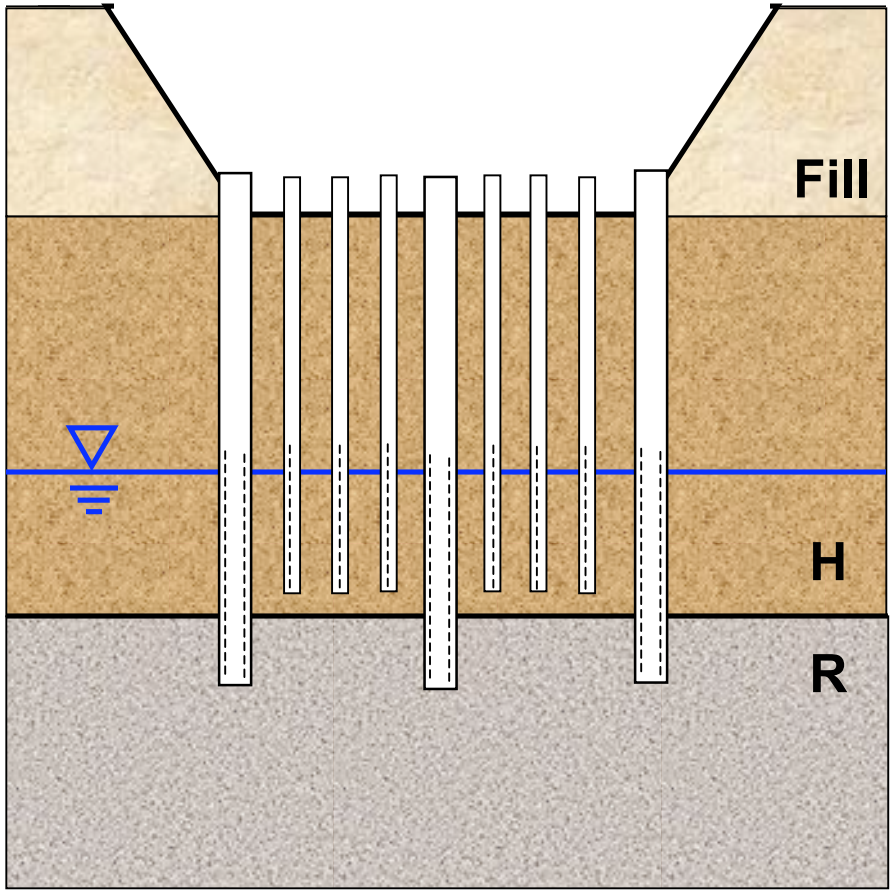
Objectives

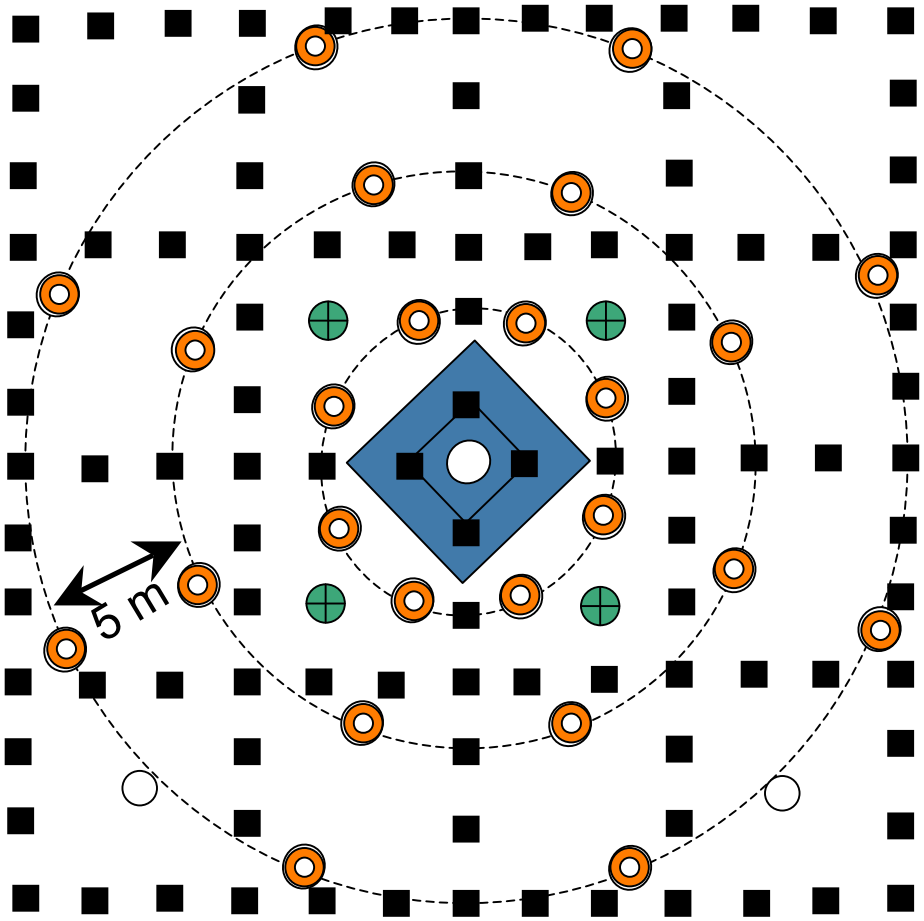
- Design a characterization and monitoring strategy for vadose zone infiltration and aquifer injection sites
  - Water infiltration with reactive chemical species (eg. bicarbonate, phosphate, etc.)
    - controlled source area for underlying aquifer
  - Separate aquifer injection experiments
- Track spatial and temporal evolution of water and reactive chemicals through vadose zone and aquifer
  - Transport and fate of reactive species
  - Influence of multi-scale heterogeneity on mass transfer

Cross-section through infiltration plot



- Excavate fill material to base of former N. process pond
- Install 3 large-diam. (7-8 in) characterization boreholes to top of Ringold fm
- Install 24 small-diam. (3 in) PVC wells to low-stage water table elev. (~104.5 m)

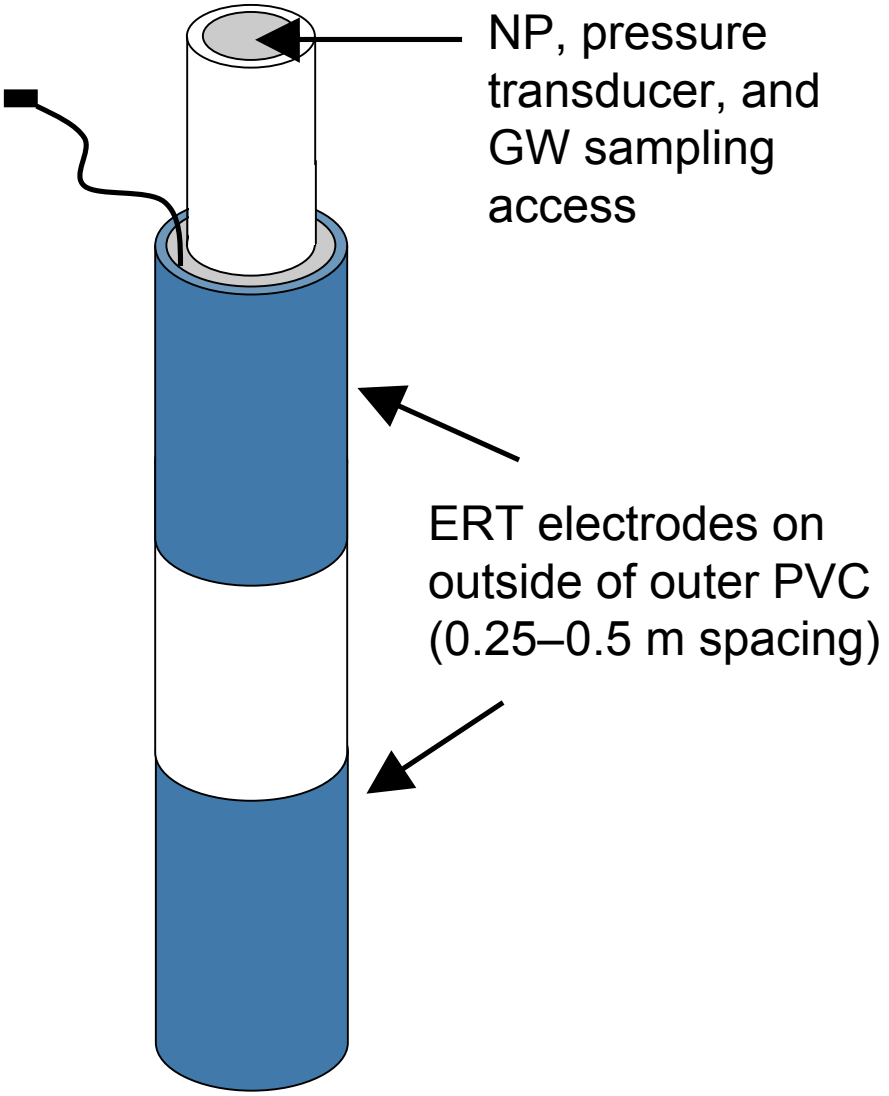
Plan view of infiltration plot



- Characterization wells (continuous core)
- Multi-function PVC access tubes for ERT, NP, etc.
- ERT surface electrodes
- Infiltration area
- Nested tensiometer locations (porous cups at 1, 2, 3, and 4 m bgs)

Note: Alternative plot designs are also being considered.

Multi-function access tubes for VZ plot

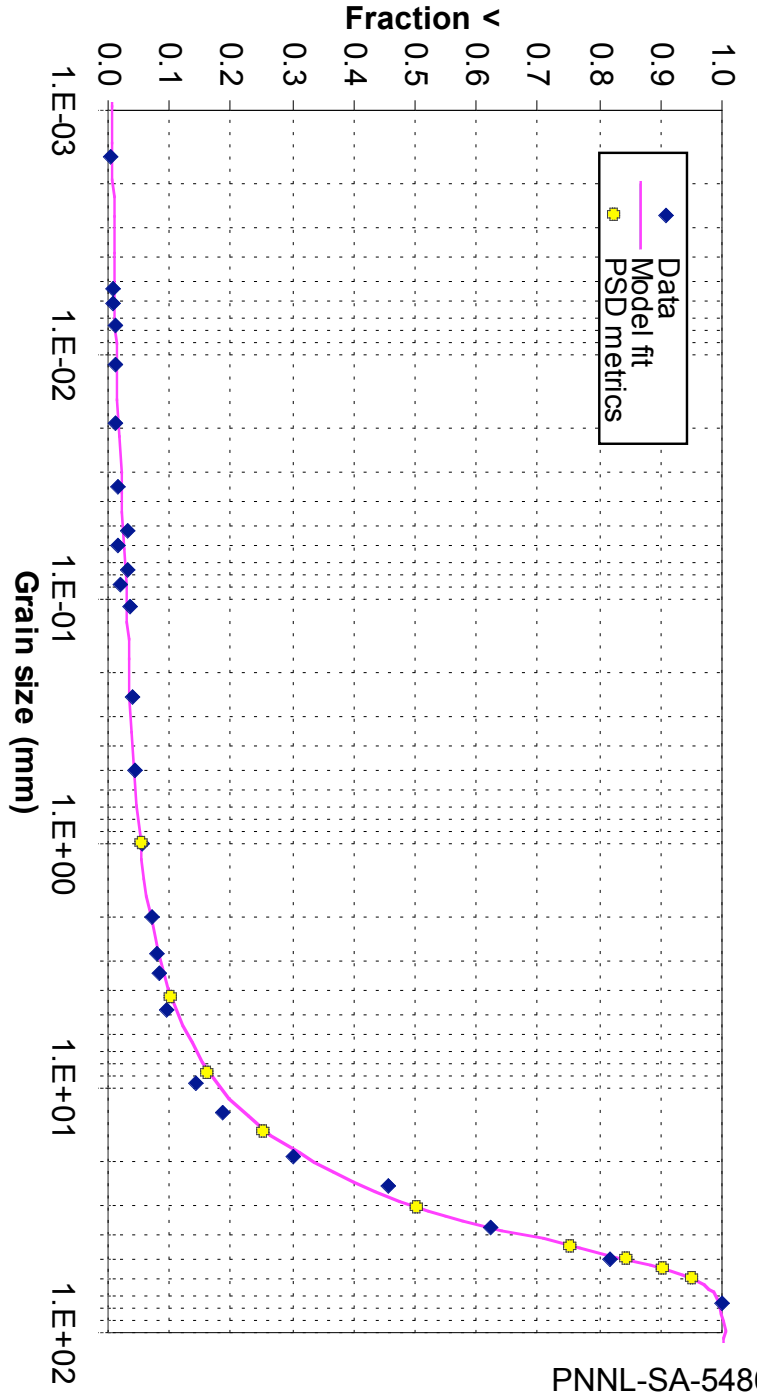


- Tube-within-a-tube design
  - Inner tube remains in place
  - ERT electrode wiring runs between inner and outer tubes
- Inner tube can be used at any time for
  - NP access
  - Pressure transducers
  - GW sampling
- Probably can't be used for cross-hole radar
  - ERT probe wiring interference

Borehole characterization data

- Sonic drilling method
- 7- to 8-in-diameter boreholes, 6-in PVC completions
  - Gross and spectral gamma logging
  - Neutron moisture
  - NMR
- Continuous, 5-in-diameter cores
  - Moisture content
  - Density and porosity
  - Grain-size distribution
  - Hydraulic properties
  - Bulk mineralogy
  - Uranium

399-3-18 (sample elev. 105 m)



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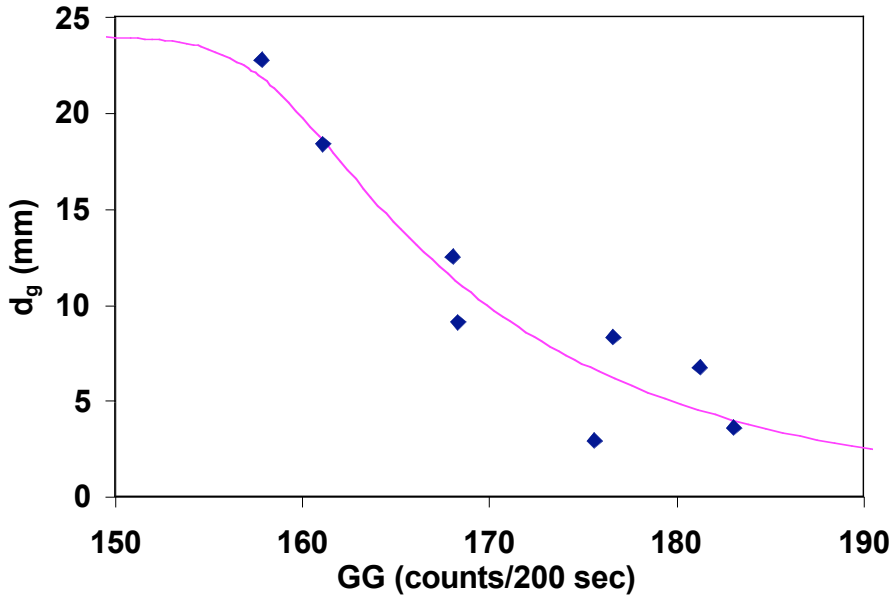
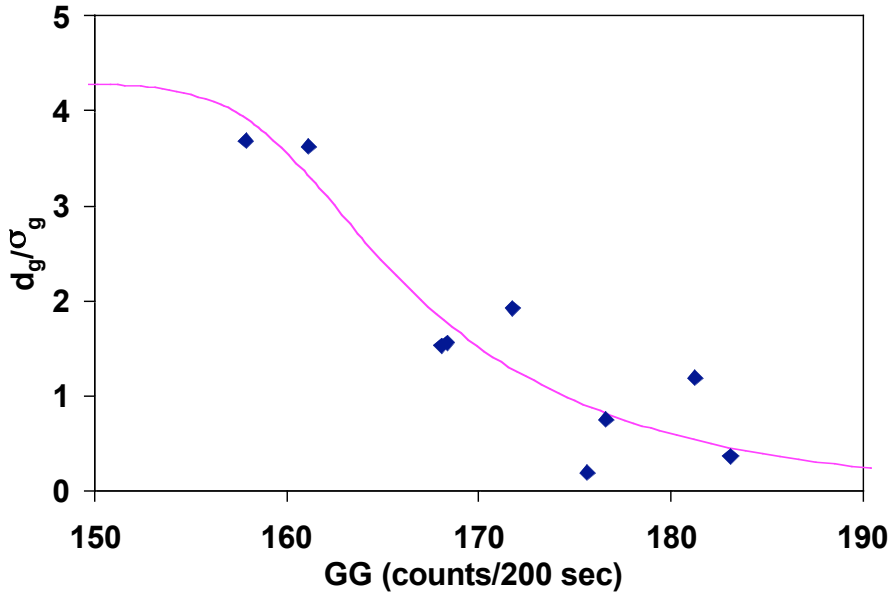
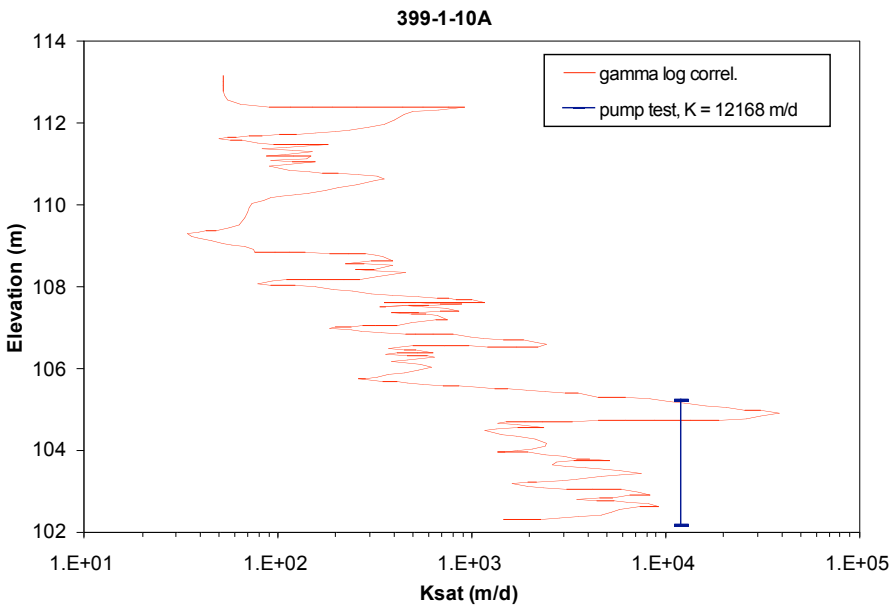
Trend plots for gamma log and grain size data

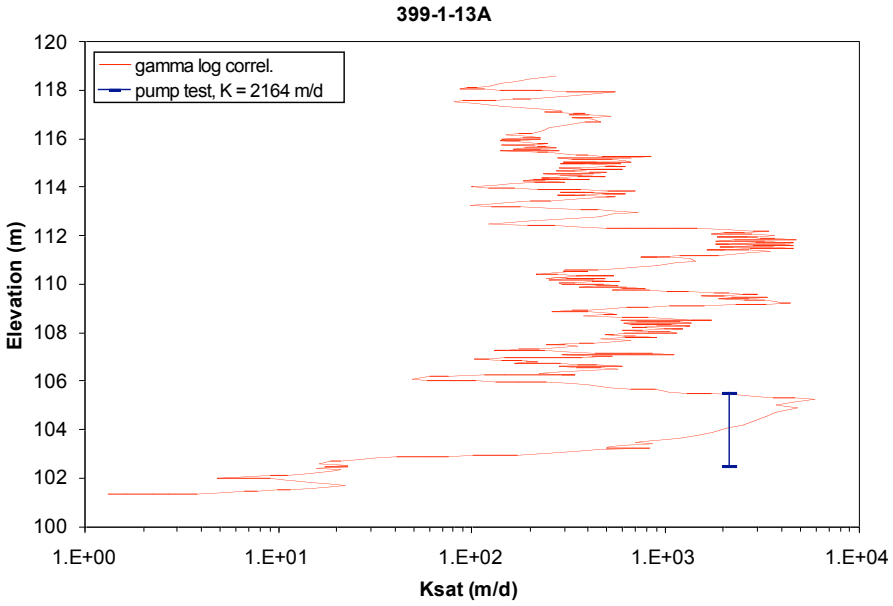


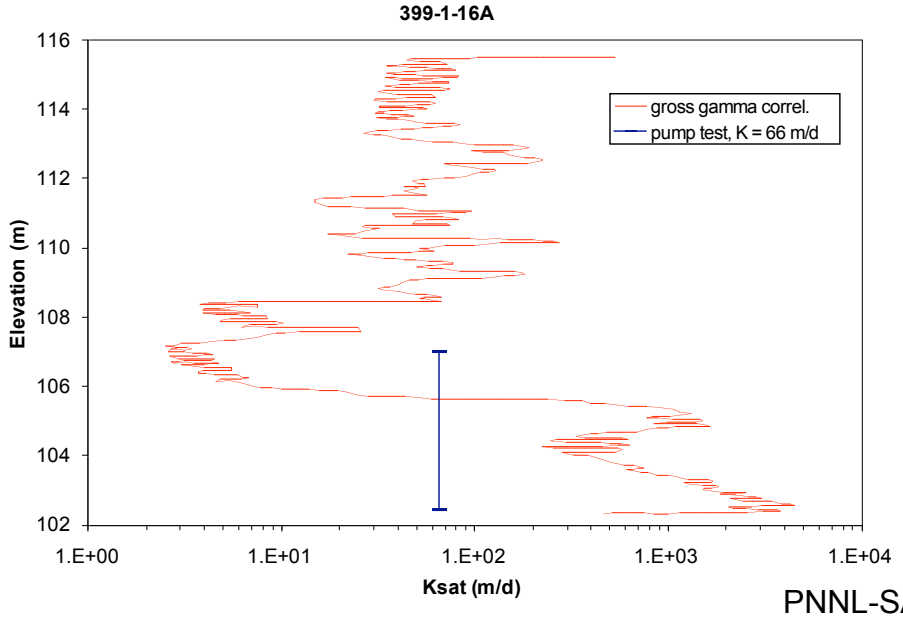


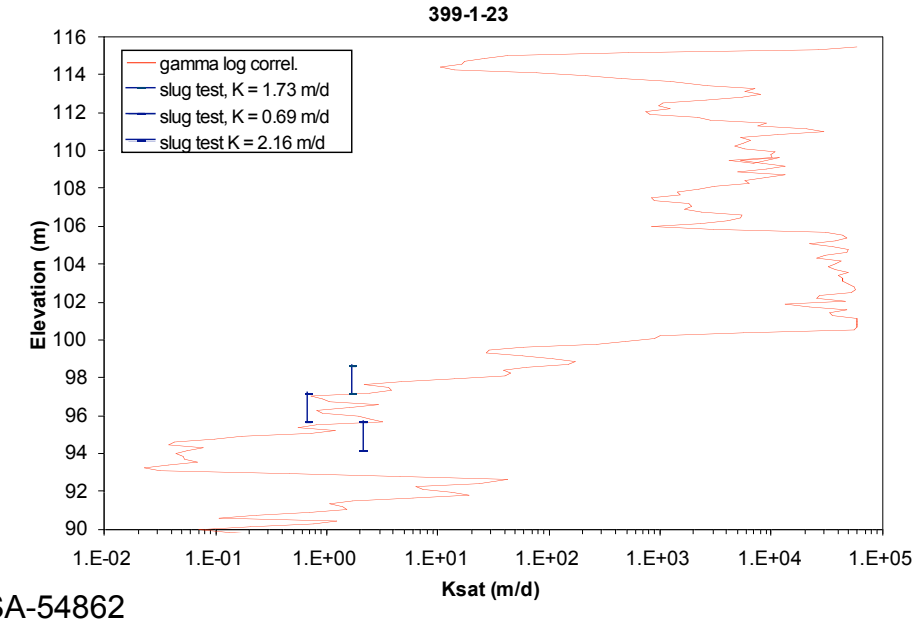
- Grain-size metrics are correlated with borehole geophysical data
  - Neutron moisture
  - Gross and spectral gamma
- Correlations are well-specific and require
  - Cross-calibration
  - Standardization

Ksat from gamma log correlations and pump tests









Monitoring data

- Moisture content
  - Gravimetric sampling (initial conditions)
  - Surface and borehole geophysics
    - Neutron moisture logging (PVC wells)
    - Surface and cross-borehole radar data
    - ERT
- Hydraulic head
  - Tensiometers in vadose zone
  - Piezometers and pressure transducers in aquifer
- Solute concentration
  - Wick samplers in vadose zone
  - Groundwater sampling from PVC wells
  - Surface and cross-borehole geophysics
    - Indirect estimation of ionic solute concentrations is possible using time-lapse electrical methods under steady flow conditions
- Temperature
  - Thermocouples

Types of Experiments

- Infiltration experiments in U(VI)-contaminated vadose zone
  - Scale-dependent mass transfer, geochemical kinetics (e.g., dissolution /desorption), and water pathway effects on U(VI) fluxes to the capillary fringe and aquifer
    - Varying water application rates, volumes, and composition (HCO_3/pH; Na/Ca; PO_4)
- Injection experiments in the U(VI)-contaminated saturated zone
  - Scale-dependent mass transfer involved in forward (adsorption); backward (desorption), and steady-state (isotopic exchange) reaction processes in flow paths with different trajectories and residence times
    - Varying HCO_3 and U(VI) concentrations, and U(VI) isotopic ratios
- Injection and infiltration experiments associated with remediation strategies
  - Evaluate role of mass transfer and microbiological processes on different forms of phosphate added to precipitate and immobilize contaminant U(VI)
    - Polyphosphate, Ca-citrate/PO_4, organic P in presence and absence of desorption agents (HCO_3)

Status

- Analyses of existing surface and borehole geophysics and core data are underway
  - Geostatistical analyses and pre-experiment modeling
  - Basis for selection of dimensions and location of infiltration plot, and placement of characterization boreholes, and wells
- Characterization plan for experimental domain will be started in May 07
  - Details on characterization data, infiltration plot layout, monitoring well network configuration, instrumentation
  - Review by external collaborators and IFC advisors