In Situ Immobilization of Uranium in Structured Porous Media via Biomineralization at the Fracture/Matrix Interface

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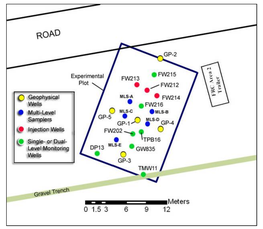
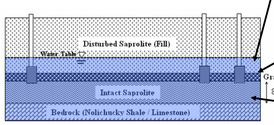
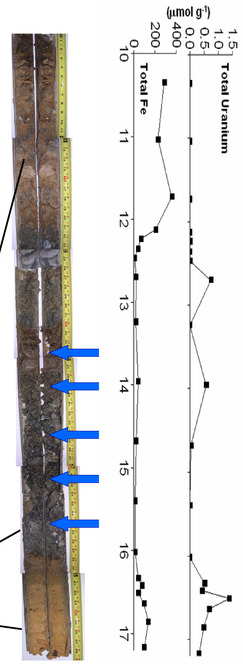
1 FRC Area 2







Coring FWB202, May 2003 (David Watson, Kirk Hyder, and George Houser)

Groundwater sampling during the August 2004 tracer test (Wiwat Kamolpornwijit and Scott Brooks)

Groundwater sampling during the August 2004 tracer test (Tim Scheibe and Melanie Mayes)

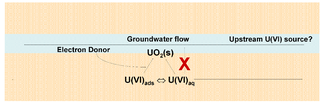
Preparing core for shipment to University of Alabama, May 2003 (Ken Overstreet, David Watson, and George Houser)

2 Hypothesis

Saprolitic Fill Material

Gravel Zone

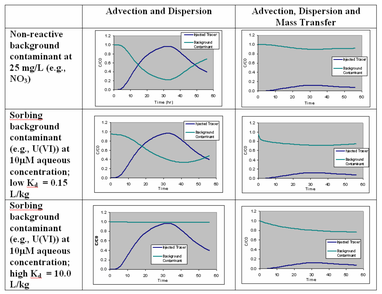
Intact Saprolite Material



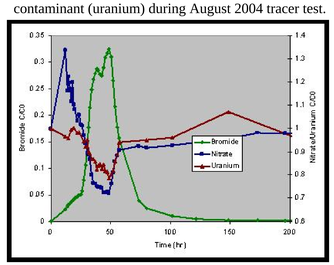
HYPOTHESIS: "In heterogeneous porous media, microbial activity can be stimulated at interfaces between zones of high and low groundwater flow rates in such a manner as to create a local, distributed redox barrier. Such a barrier will inhibit the transfer of contaminants from the low-flow zones that serve as long-term contaminant sources into the high-flow zones that transport contaminants to receptors."

3 Tracer Test / Flush Experiment

CRITICAL ISSUE: How to test hypothesis at the field scale?

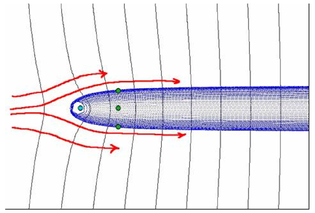


Below: Observed response of injected tracer (bromide), non-sorbing background contaminant (nitrate) and sorbing background contaminant (uranium) during August 2004 tracer test.



EXPERIMENTAL CONCEPT: Flush Experiment for Mass Transfer Rate Determination

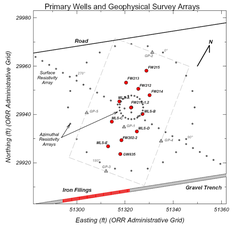
Left: Simulated response to flush injection for three different scenarios, considering advection and dispersion with or without mass transfer

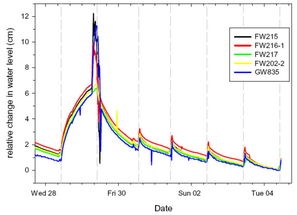


Above: Schematic diagram showing streamlines of injected water (with tracer) in dark blue and diverted streamlines under injection conditions of contaminated water flowing into the study zone from upgradient (red lines with arrows). The light blue circle represents the injection well (i.e., FW215) and dark green circles represent nearby monitoring points (FW212, FW213, FW214). Contours of hydraulic head are indicated by the grey lines. Accessible porosity within the zone of the aquifer encompassed by the blue streamlines is "flushed" of ambient contamination during the injection event. Any remaining solutes must then be provided from a local source (e.g., desorption and/or mass transfer from secondary porosity or an non-advective zone)

4 Biostimulation Experiment

APPROACH: Inject ethanol as an electron donor to stimulate microbial activity, focused at interfaces between regions of rapid and slow groundwater movement. During and after long-term stimulation (2 months), conduct flush experiments to quantify changes in mass transfer rates of uranium.





- Injection rate 3 liters per minute in each of FW212, FW213, FW214.
- Bromide 500 mg/L
- Ethanol 10 mM
- Initial 24-hr injection pulse followed by daily 1-hr pulses. Natural gradient flow except during injection episodes.
- Groundwater and microbial community sampling, frequent in first week diminishing to 3x per week, in both multi-level and single-port wells.
- Geophysical monitoring by surface (azimuthal and line) and cross-borehole electrical resistivity
- Pre- and post-stimulation coring and microscopic analysis to determine mineral phases and distributions.

Setting up groundwater sampling station, September 2005 (Tim Scheibe and Santosh Mohanty)

Injection system mastermind (Wiwat Kamolpornwijit)

A peek inside the mixing tank

Geophysical survey in progress (Jacob Sheehan and Les Beard – hiding under the tent)

Inspecting the injection solution mixing operation, September 2005 (Scott Brooks and Tim Scheibe)