Hydrologic Characterization and Results from the First Tracer Experiment at the Hanford 300 Area IFRC Site

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Outline

► Hydraulic property characterization
► Tracer test (Nov. 2008 field experiment)
► Preliminary flow and transport modeling
Hydraulic Property Characterization

- Constant rate injection tests (field)
- Electromagnetic borehole flow meter (EBF) testing (field)
- Multi-step outflow experiments (lab)
Constant Rate Injection Tests

- Number wells tested: 14
- Injection rate: 316 gpm
- Test duration: 20 min
- Typical displacement:
  - $< 0.1$ ft (2-3 cm)
- Methods of analysis:
  - Neuman (1975)
  - Theis (1935)
- Average $K = 6945$ m/d
EBF Testing

- Number of wells tested: 26
- Extraction rate: 1.04 - 1.55 gpm
- Measurement interval: 1 - 2 ft (~0.3 - 0.6 m)
- Method of analysis:
  - Molz et al. (1994)
- Absolute K estimated from

\[
\bar{K} = \frac{\sum_i K_i dZ_i}{b}
\]

\[
b = \sum_i dZ_i
\]
Normalized EBF - K Profiles

Locations where test conditions resulted in non-representative EBF profiles
Locations where test conditions resulted in non-representative EBF profiles.
Multi-Step Outflow Experiments (40 cores)

Intact cores

Automated measurement system
Additional lab characterization

- Ksat
- Bulk and particle densities
- Whole sediment grain-size distributions
- Geochemical properties (Zachara)
- GEA (Ward)
- Electrical properties (Ward and Versteeg)
Tracer test (Nov. 2008 experiment)

- Injection well: 399-2-9
- Injection volume: ~160,000 gal
- Injection rate: 180 gpm
- Injection duration: ~900 min (15 hr)
- Avg. Br- concentration: 56 mg/L
- Experimental duration: Nov. 11 – Dec. 8, 2008
Tracer test (Nov. 2008 experiment)
Tracer test (Nov. 2008 experiment)
Flow and Transport Modeling (STOMP)

Grid specifications

- Coarse grid†
  - 91 x 91 x 20 grid blocks (165,620 total)
  - Uniform 1-m spacing in x-y, uniform 0.5-m spacing in z

- Fine grid
  - 121 x 121 x 110 grid blocks (1,610,510 total)
  - Uniform 1-m spacing in x-y, uniform 0.1-m spacing in z

†A coarse grid STOMP model has been provided to INL and to two SFA projects.
Interpreted Elevation of Hanford-Ringold Fm Contact
Variography

- Hydraulic conductivity
  - Single-structure spherical model
  - Nugget = 0
  - Sill = 1 (standardized)
  - Horizontal range = 27 m
  - Vertical range = 2 m
Variography

- Gamma log data
  - Nested spherical model (2 structures)
  - Nugget = 0
  - Sill 1 = 0.57
  - Sill 2 = 0.43
  - Horizontal range 1 = 11 m
  - Horizontal range 2 = 47 m
  - Vertical range 1 = 1.5 m
  - Vertical range 2 = 6 m
Flow and Transport Modeling

- Property field generation
  - Simple kriging
  - Co-kriging
  - Simulated annealing
Flow and Transport Modeling
Observed versus simulated water levels

IFRC well field
Observed and simulated tracer BTCs
Observed versus simulated tracer BTCs

IFRC well field
Observed versus simulated tracer BTCs

IFRC well field
Observed versus simulated tracer BTCs

IFRC well field

399-3-30 (shallow)

399-3-31 (deep)

399-3-25

399-3-32 (intermediate)
Observed versus simulated tracer BTCs
Spatial moments of simulated tracer plume
Summary

- Field hydraulic characterization appears to have been relatively effective
  - Constant rate injection tests and EBF results could be reinterpreted using alternative methods (e.g. inverse modeling)
  - Measurements in additional wells could be made
  - Additional constraints on elevation of Hanford-Ringold Fm contact beyond the footprint of the IFRC well field would be useful (incorporate recent interpretation based on surface geophysics)

- First tracer experiment was successful, but some refinements could lead to improved results
  - Smaller injection volume
  - Slower injection rate
  - More stable river conditions

- Very good matches between simulated and observed water levels can be obtained

- Fair matches between simulated and observed Br- tracer concentrations – no formal calibration yet
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