Characterization of Field Experimental Sites at Hanford’s 300-Area IFC Site

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Primary Goal

- Develop quantitative model of heterogeneity that incorporates dominant features at the significant scales, and
  - reflects geologic variability
  - reflects multi-scale nature of stratigraphy
  - honors core and well log data
  - forms basis of conceptual hydrostratigraphic models
Approach

**QUANTITATIVE UNDERSTANDING OF SUBSURFACE FLOW AND REACTIVE TRANSPORT**

- **FLOW AND TRANSPORT MODEL**
  - Characterize:
    - hydraulic/transport properties
    - sorptive/reactive properties
  - Quantitative Analysis (e.g. water balance)
    - Numerical Modeling

**HYDROSTRATIGRAPHIC MODELS**
- e.g. - conceptual models
- definition and characterization of aquifer properties

**GEOLOGICAL MODELS**
- e.g. - conceptual models
- landform and terrain models
- stratigraphic, architectural, and depositional models

**DATABASE DEVELOPMENT**
- e.g. - compilation of archival data; new data collection and integration
Sedimentary Facies Concept

- Classifies formation using primary sedimentary features at scale of facies structure
  - No need to identify texture
  - Size statistics, surface area, mineralogy, fabric

- Sediment properties primarily controlled by granulometry

- Sedimentary facies
  - Electrofacies
  - Lithofacies
  - Hydrofacies
  - Chemofacies
  - Biofacies

\[ R^2 = 0.896 \]

\[ R^2 = 0.9083 \]

\[ R^2 = 0.7839 \]
Subsurface Characterization Workflow

Data input
Information management
GIS database

Calibration
History Matching
Sensitivity Analysis
Management Decisions
Design, Implement Remedy

Borehole Logging
Log Interpretation
Transition Probabilities
Well Correlation
Surface Identification and Mapping

Transition Probabilities
Data Spatial Analysis
Facies Modelling
Transition Probabilities
Borehole Testing

STOMP
3D Flow and Transport simulation
Multi-phase, Density-dependent Flow
Fully-coupled Energy Equations
Modeling of Geochemical Reactions

3D Geological Model
Geological Conceptual Model
3D Flow/Transport Property Model
Upscaling to Simulation Grid

Uncertainty Analysis
Upscaling of Processes
Flow/Transport Property Population

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Hydrogeophysical Workflow 300 Area IFC

Low-resolution Reconnaissance:
- Electromagnetic Induction
- Shallow Magnetics
- Magnetic Gradiometry
- Ground Penetrating Radar
- Reflection Seismic

High-resolution Imaging:
- Seismic Reflection
- Broadband EMI
- Resistivity
- Ground Penetrating Radar
- Nuclear Magnetic Resonance

Identify Cultural Features
Map Local Stratigraphy
Map Basement

Best Locations for IFC Characterization and Monitoring wells

Drill Boreholes
Sediment Samples

High-resolution Borehole Logs:
- Accelerator Porosity Sonde
- Triple Detector Litho-density
- Array Induction
- Cased-hole Resistivity Tool
- Magnetic Resonance Scanner
- Electromagnetic Propagation
- Elemental Capture Spectroscopy
- Spectral Gamma

Vertical and Lateral Transition Probabilities
Spatial Correlation Structure
Workflow for Quantitative Hydrostratigraphy

1. Initial 3-D Stratigraphic Model
2. Update Conditional means, Covariances, Transition Probabilities of Sedimentary Properties
3. Field Experimental Data: Hydrofacies, Chemofacies, Correlation Structures
4. Criteria met?
   - Yes: Accurate Petrophysical Functions
   - No: Improved Estimate of 3-D Stratigraphic Model
5. Site-specific Pedotransfer Functions
6. Quantitative Heterogeneity Model Reflecting Geologic Variability Multi-scale Stratigraphy