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

![Graph showing relationship between Conductivity (mS/m) and CEC (meq/100 g) with 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

**Mapping**
- Surface Geophysics
- Interpret Geophysical Images

**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 Flow/Transport Property Model**
- Upscaling to Simulation Grid

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

**Uncertainty Analysis**
- Upscaling of Processes
- Flow/Transport Property Population
Hydrogeophysical Workflow 300 Area IFC

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

Identify Cultural Features
Map Local Stratigraphy
Map Basement

Best Locations for
IFC Characterization and Monitoring wells

Drill Boreholes
Sediment Samples

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

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

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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: Quantitative Heterogeneity Model Reflecting Geologic Variability Multi-scale Stratigraphy
   - No: Improved Estimate of 3-D Stratigraphic Model
5. Accurate Petrophysical Functions
6. Site-specific Pedotransfer Functions