Characterization and Data Management at Hanford's 300-Area IFC Site

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BACKGROUND

A major challenge to the accuracy and realism of transport models lies in attempts to characterize subsurface heterogeneity with the usually sparse data sets. At Hanford, the typical hydrogeologic data set consists of driller's logs; core samples from very few depths in sparse wells; dry-sieved grain size distributions; and limited borehole logs (neutron moisture, spectral gamma) measured in steel-cased wells. Data are usually collected and "managed" by different groups who are typically unaware of each others data and efforts.

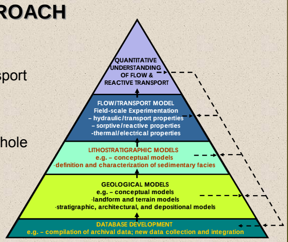
Advanced geological analyses, reservoir-characterization tools, and workflows linked with comprehensive data management protocols have proven quite successful in oil field research but have found little application for the shallow unconsolidated formations typically studied in hydrogeology and DOE waste management efforts.

OBJECTIVES

- ***Science Objective***- to develop quantitative models of subsurface properties and processes which accurately capture the multi-scale spatial and temporal heterogeneities of the 300 Area IFC
- ***Technical Objectives***-
  - integrate all historic and new data from the 300 Area into a central, well organized, relational, and accessible repository
  - provide tools for efficient data access, management, interpretation, and result generation

APPROACH

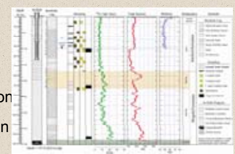
- Progresses from database development to a quantitative understanding of flow and transport
- Combines elements of geology, sedimentology, hydrology, geo-chemistry with surface and borehole geophysics
- Quantitative spatial information
  - structure & heterogeneities
- Quantitative Temporal Information
  - Processes



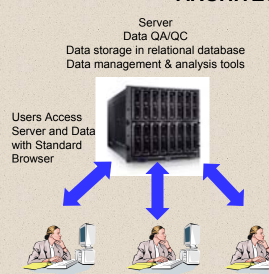
DATA MANAGEMENT

Accomplishments to date

- Inventory of existing and anticipated data
- Data management architecture decision
- Data organization, database population and interface creation



ARCHITECTURE



- Web accessible database with rich client interface
- Central server and application – distributed users
- Allows for access control, data uniformity and ease of maintenance

TECHNICAL DETAILS

- Linux FC8 server
- Standard APACHE/MySQL/PHP stack
- Tomcat for webservices
- Rich Client side using Ajax (Javascript,CSS)
- Extensive use of 3rd party toolbox (Google Maps 2.x API, jfreechart, OpenDX,…) both client and server side
- Database models based on industry/university standards to the extent possible (CUASHI ODM, gINT/LAS, Columbia University GeochemDB)

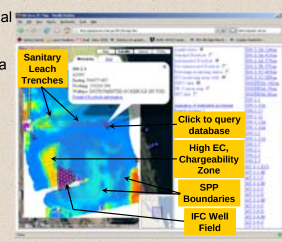
DATABASE DEVELOPMENT

Over 8000 boreholes at Hanford, most with borehole logs and particle size (> 40,000 psds). Approximately 100 in the 300 Area (13 instrumented) with 29 new wells planned for the IFC. A partial list, with both archival and new data includes:

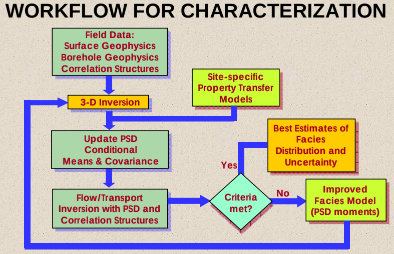
- Sample data (physical, chemical, biological)
- Geophysical surface and borehole data
- Hydrologic monitoring data (hourly)
- River-stage data
- Regulatory contaminant concentration data (quarterly)
- Model data
- Topography data
- Environmental data
- Uranium adsorption results

EXAMPLE INTERFACE

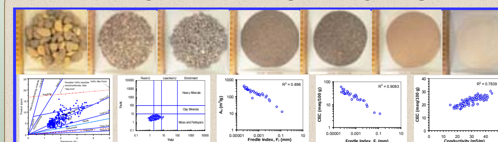
- Uses Google Maps with optional hi-res aerial image underlay
- Ajax Interface to access to data
- Server database queried for details
- On data, Javascript keeps the application responsive
- Example shows EC (EM31) overlay on "remediated" south process pond



WORKFLOW FOR CHARACTERIZATION

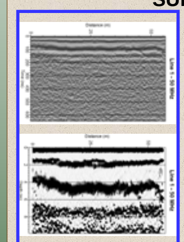


PROPERTY TRANSFER MODELS

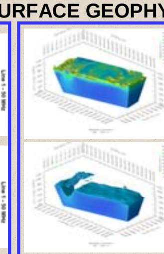


Property transfer models are based on particle size distributions (PSDs). Correlations with CEC, surface area (A_s), surface conductance, chargeability, KUT, and hydraulic properties are being developed for fractions and mixtures. Examples of some correlations for ternary (sand, silt, clay) mixtures of 300 Area fractions are shown above.

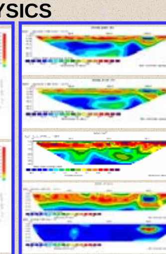
SURFACE GEOPHYSICS



GPR Penetration limited to ~ 5 m even at 50 MHz (~ depth of pond backfill after excavation



3-D ERT Inversion Showing 500 and 100 Ωm Iso-surfaces. Note Low Resistivity Anomaly on Left.



2-D ERT Inversion of Adjacent Lines Showing Contacts and Eroded Surfaces. Note High EC/IP anomaly.

SUMMARY

- Web accessible, relational database implemented using Google Maps to provide lightweight GIS access to data.
- Coupling to back end (HEIS, water level data) and borehole databases in progress
- High-resolution borehole logs (vadose zone neutron; KUT) provides geological setting; property transfer models based on PSD moments being used to determine vertical transition probabilities
- GPR showed limited penetration (≈ 5 m) even at 50 MHz
- Surface Resistivity/IP form main geophysical data source, supplemented with EMI data (EM31, GEM, EM34) and are being used to map large-scale properties and determine horizontal/transverse transition probabilities.

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