

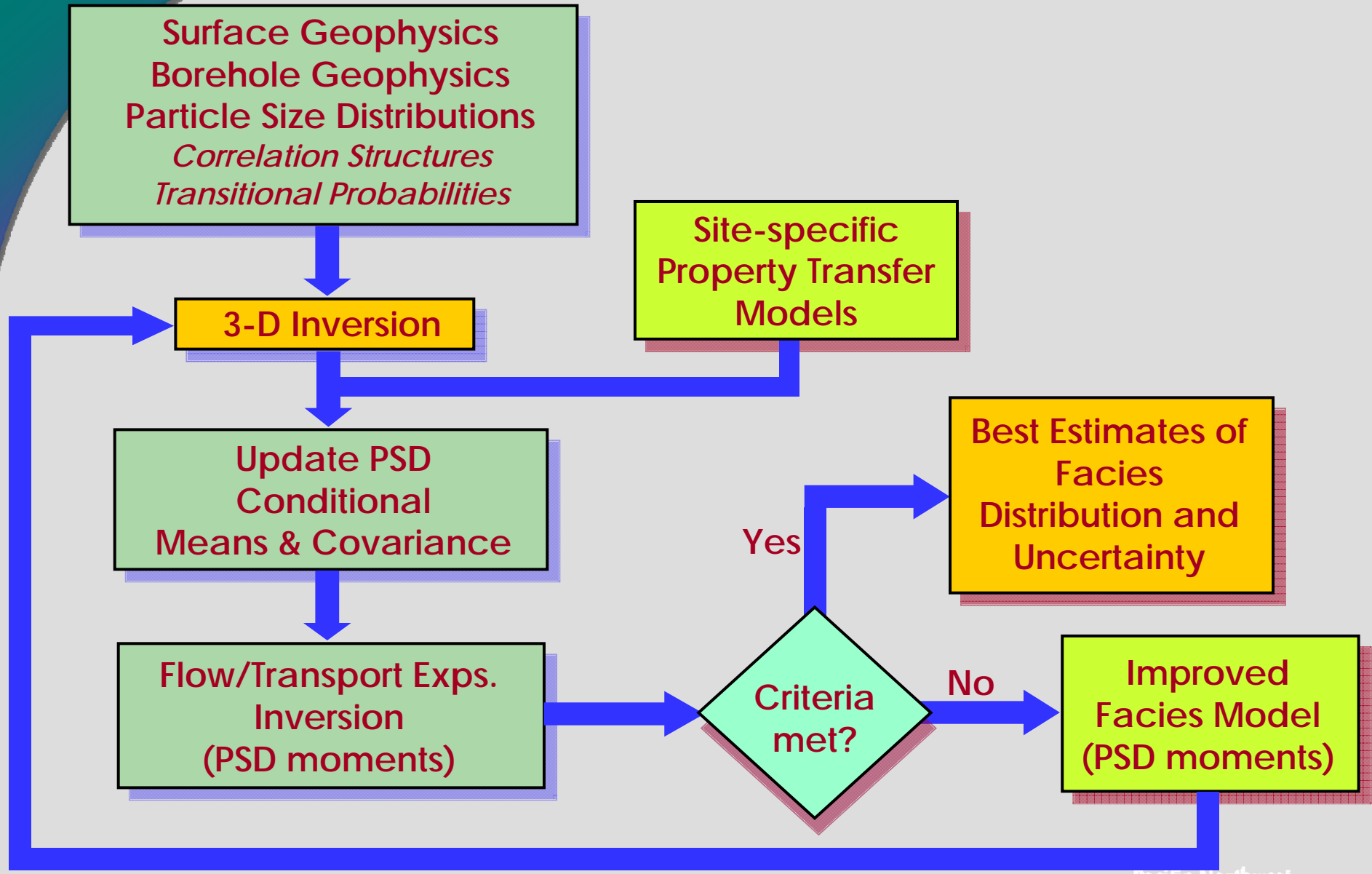


Hanford 300 Area IFC

# Geophysical Characterization: Discussion Points

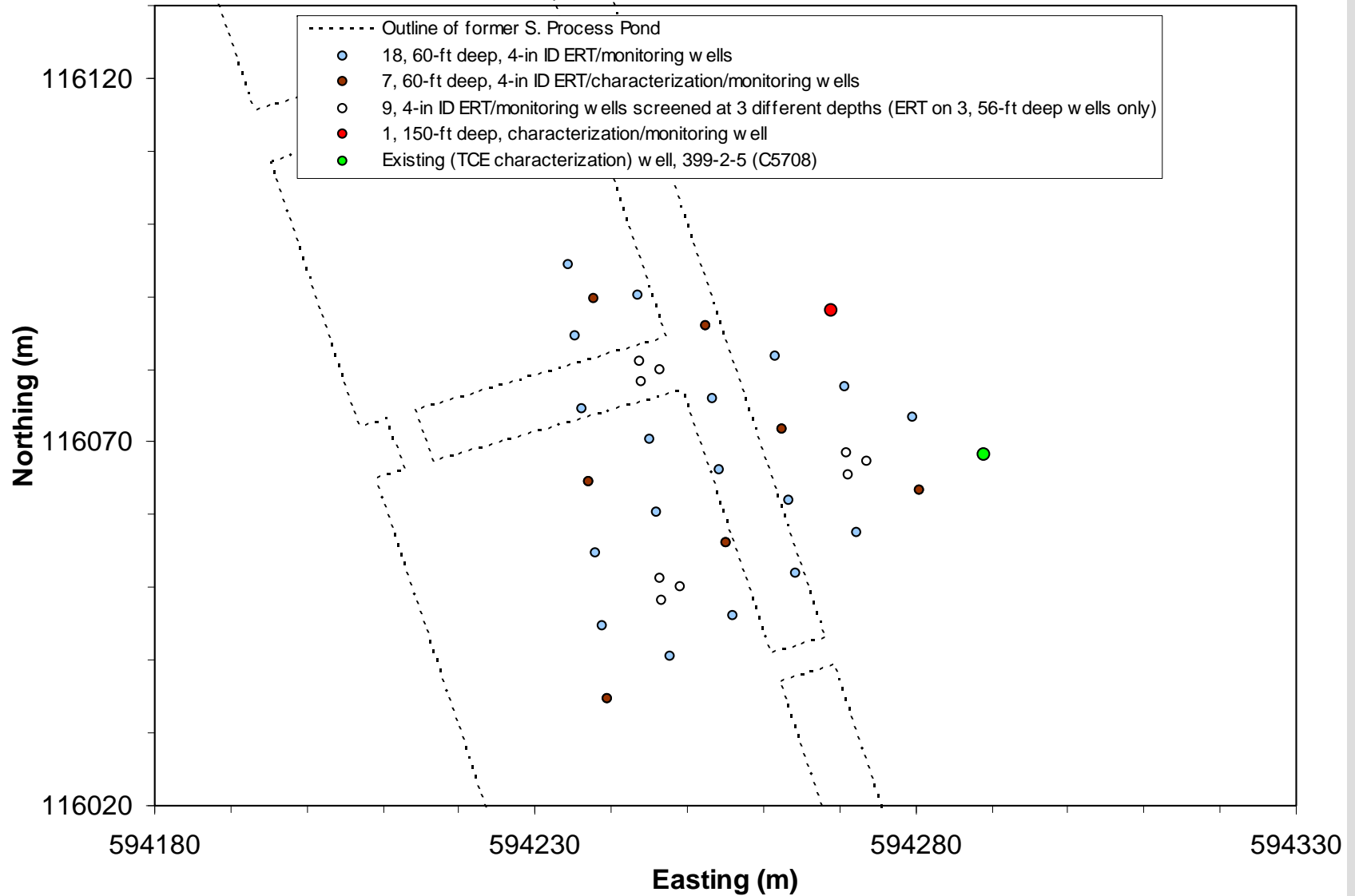
<sup>1</sup>Andy Ward and <sup>2</sup>Roelof Versteeg  
<sup>1</sup>Pacific Northwest National Laboratory, Richland, WA  
<sup>2</sup>Idaho National Laboratory, Idaho Falls, ID

# Characterization Workflow



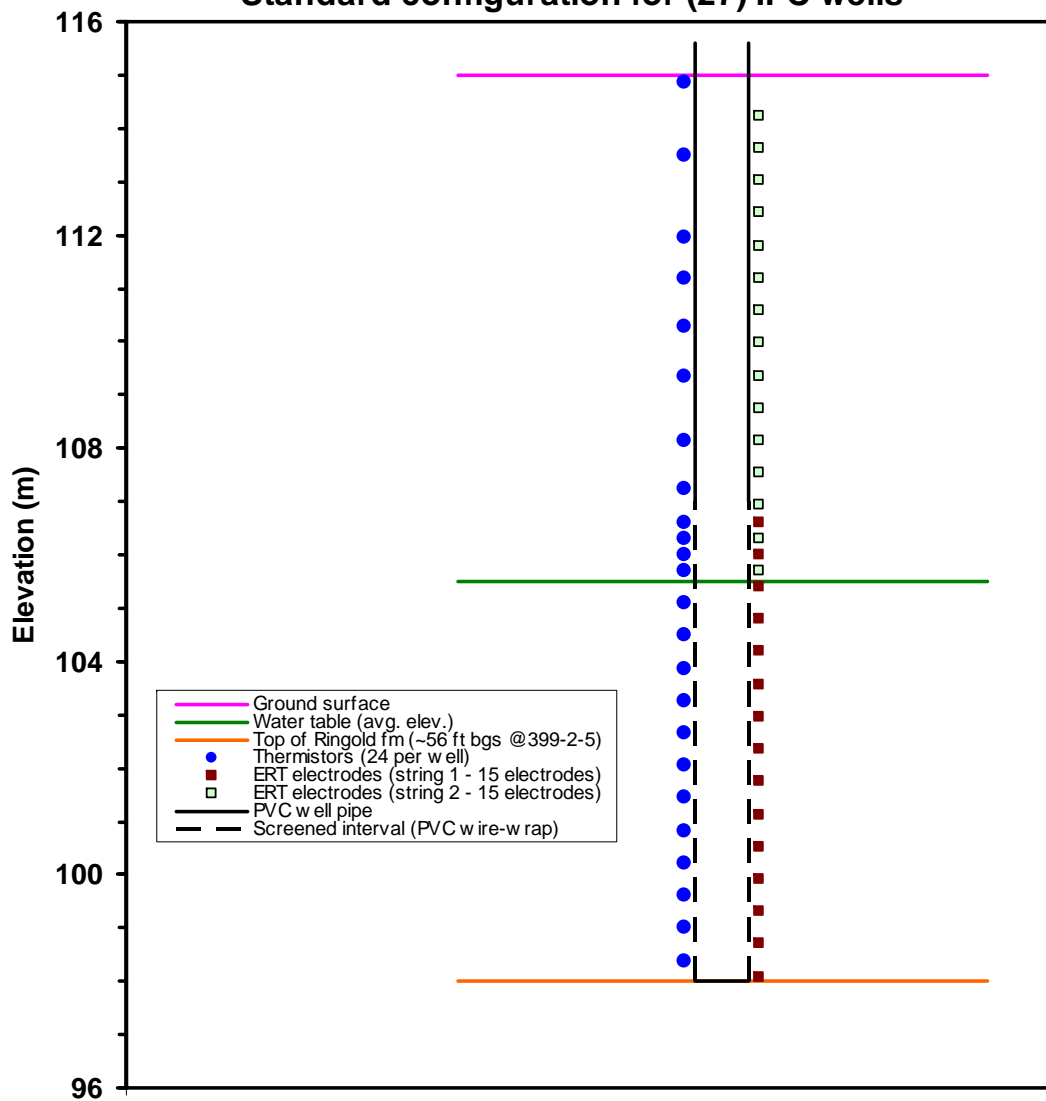
# IFC Well Field

## Revised (01.21.08) Layout of Hanford 300 Area IFC Well Array



# Borehole Measurements

Standard configuration for (27) IFC wells



35 PVC cased wells

- 8-in borehole
- 4-in completion

24 Thermistors

- Variable spacing
- 0.1 °C resolution

30 ERT Electrodes

- Vertical electrode array
- Two 15-conductor cables
- Stainless steel electrodes

Neutron "moisture"

Spectral Gamma

Crosshole GPR

Worth Consideration

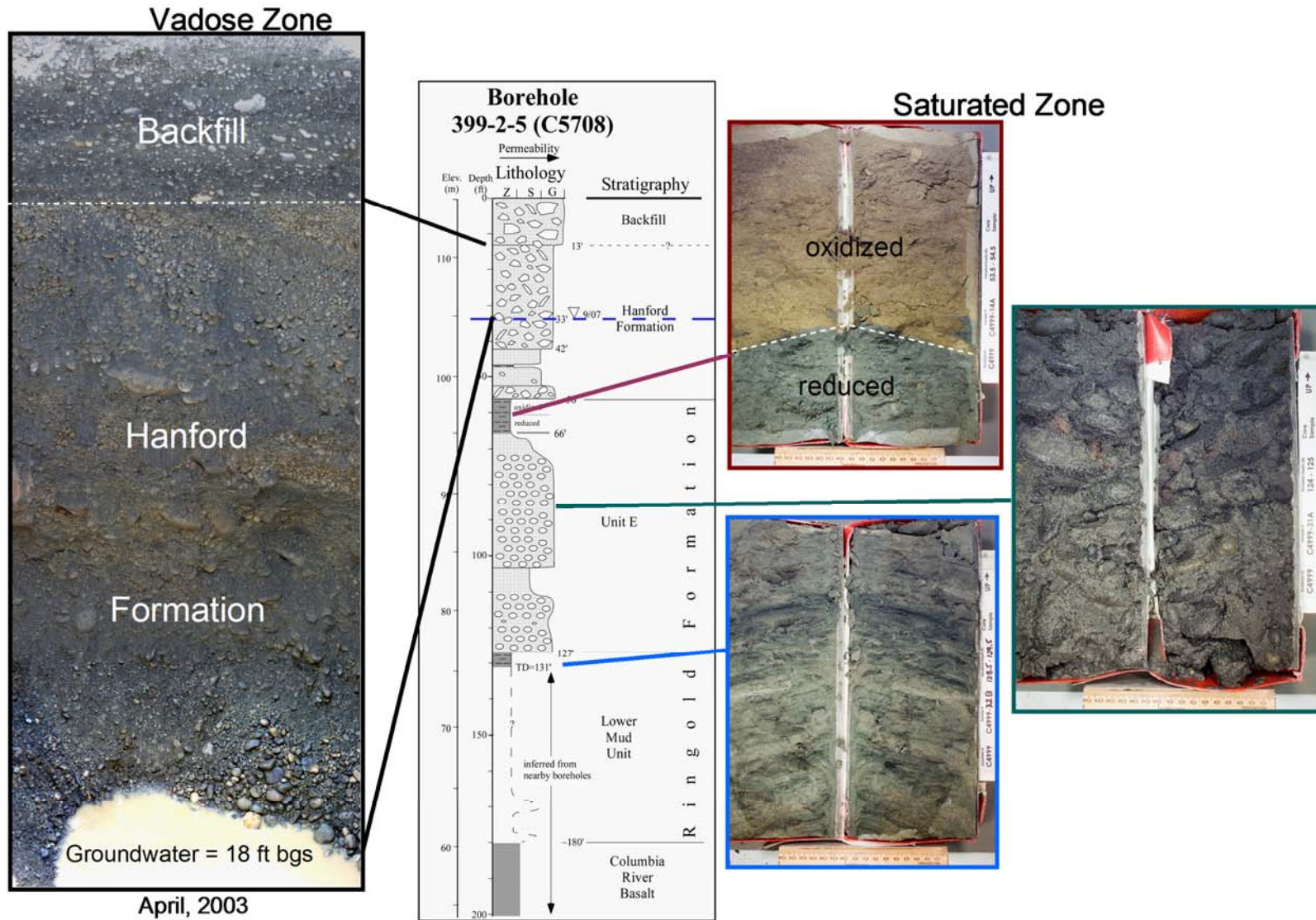
- EMI
- Acoustic Televiwer
- Electron Capture Spectroscopy
- Dual Neutron/Density Gamma
- Line source temperature logging
- High resolution slug testing
- NMR ??

# Instrumentation

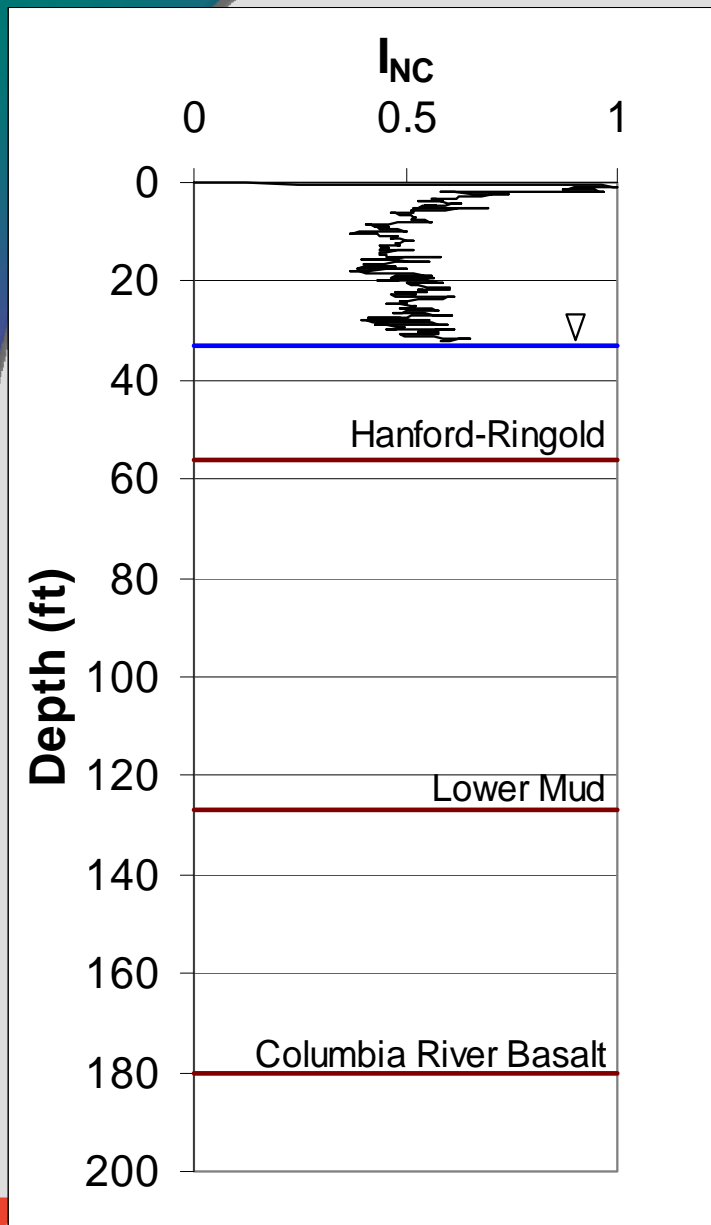


# Borehole C5708

## Strata Beneath South Process Pond

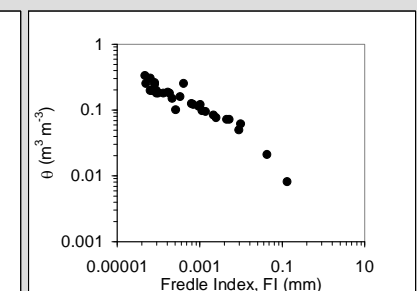
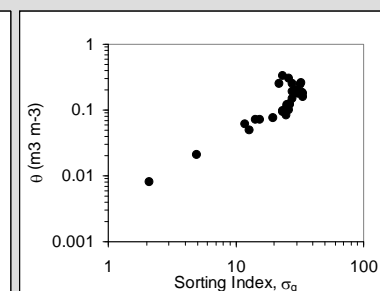
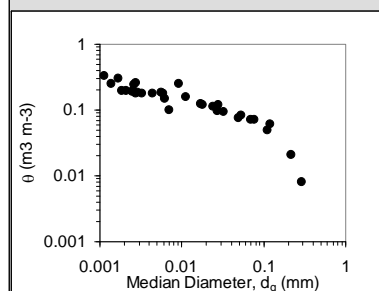
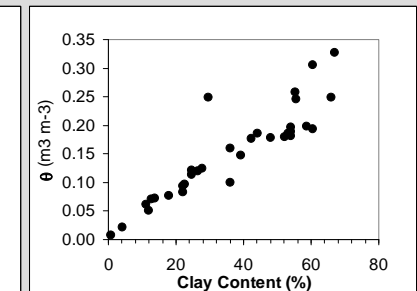
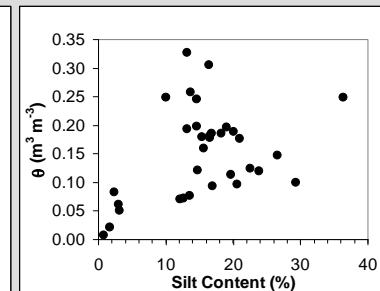
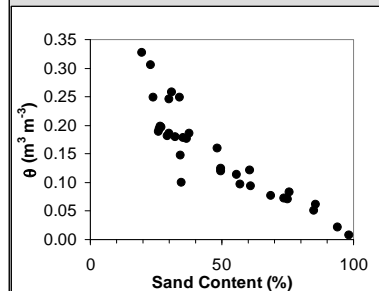


# What we will get- Example from C5708

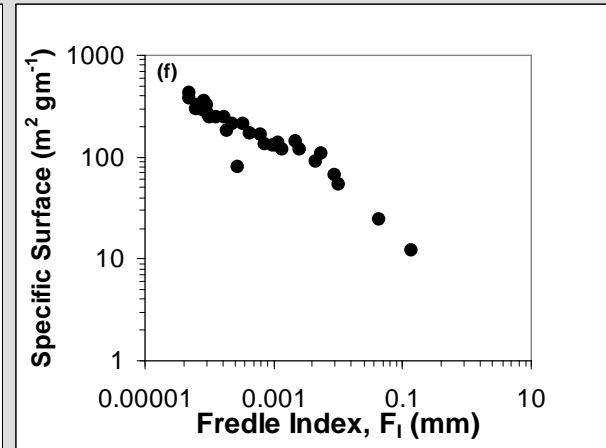
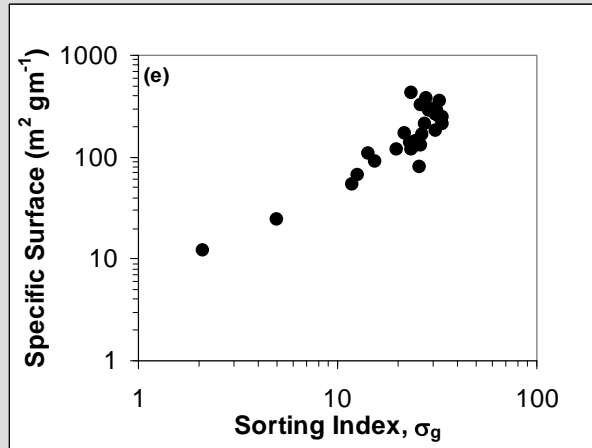
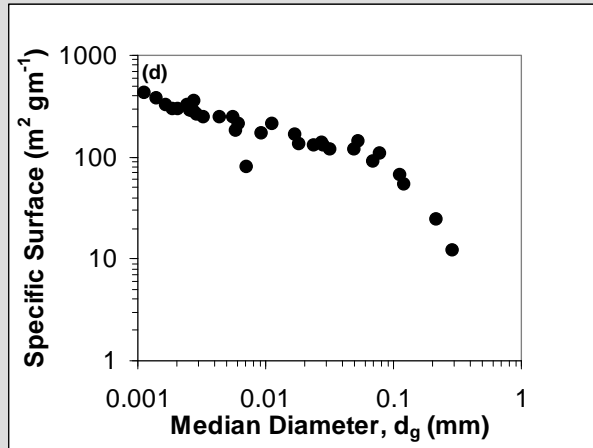
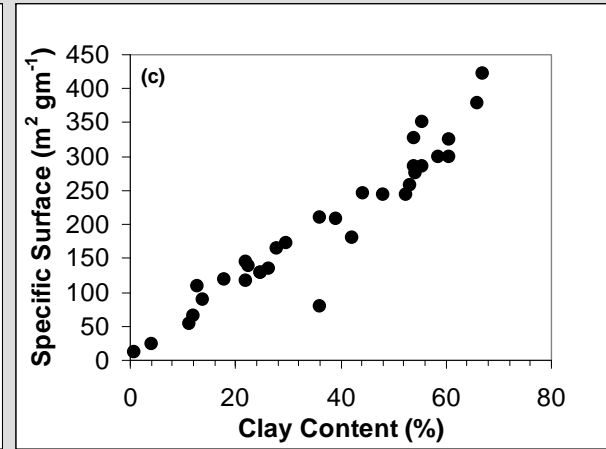
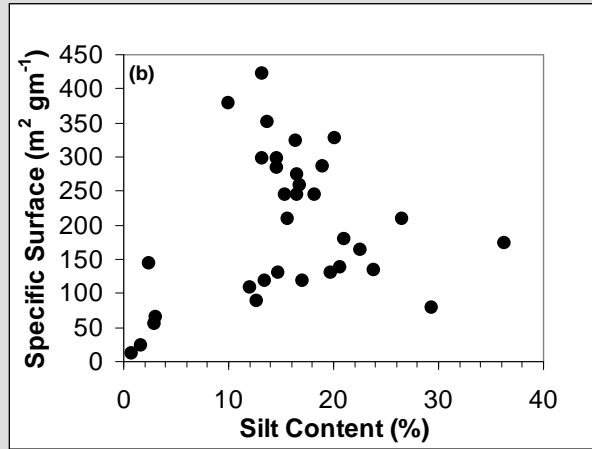
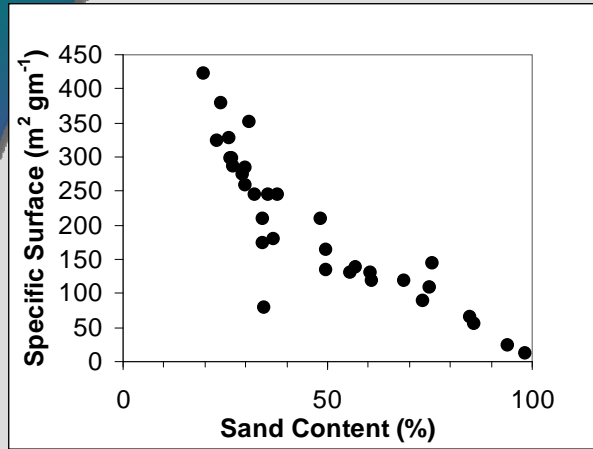


## ► Neutron “moisture”

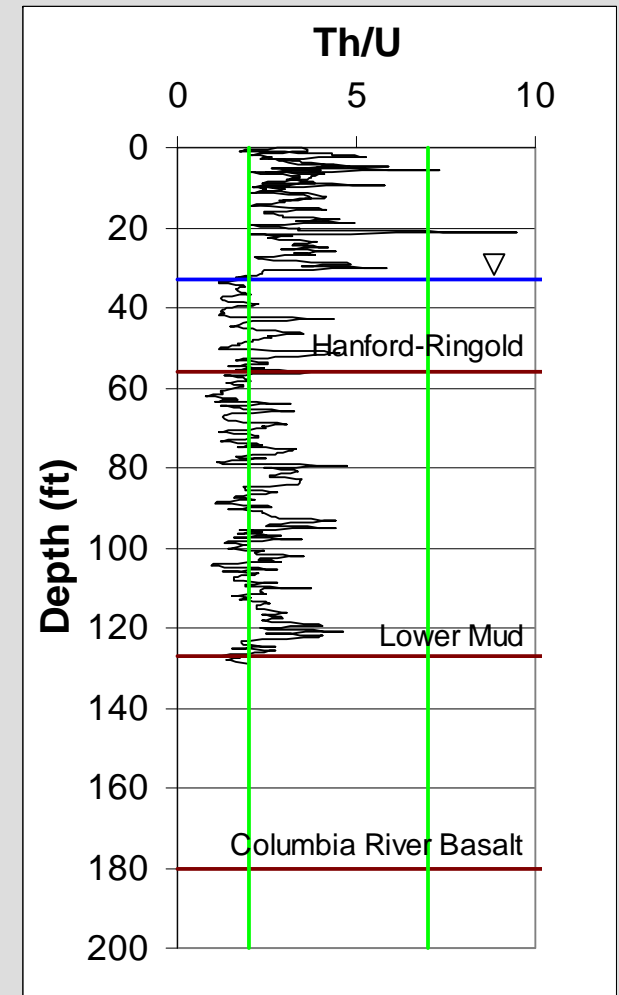
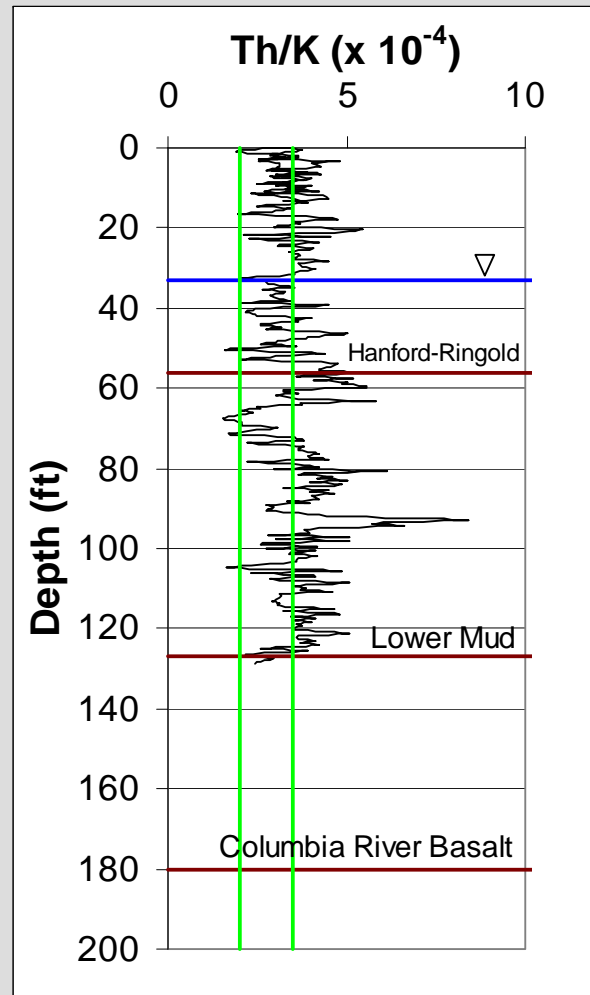
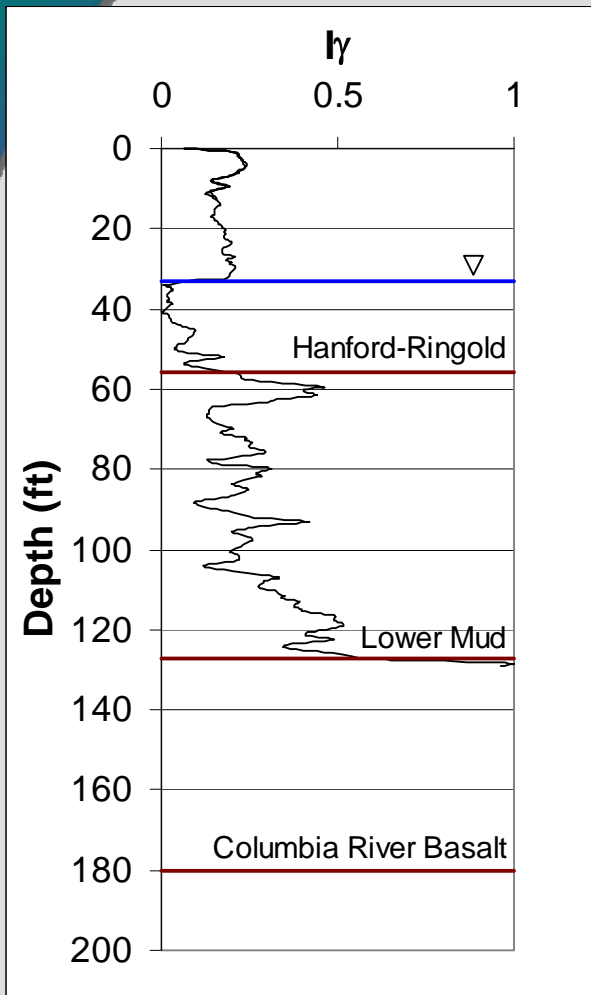
- 50 mCi Am-Be source
- Zone 15 cm (wet), 70 cm (dry)
- Vadose zone only
- Typical  $\Delta z \sim 3$  inches
- Calibrated for 6 and 8-in steel casing- Neutron counts



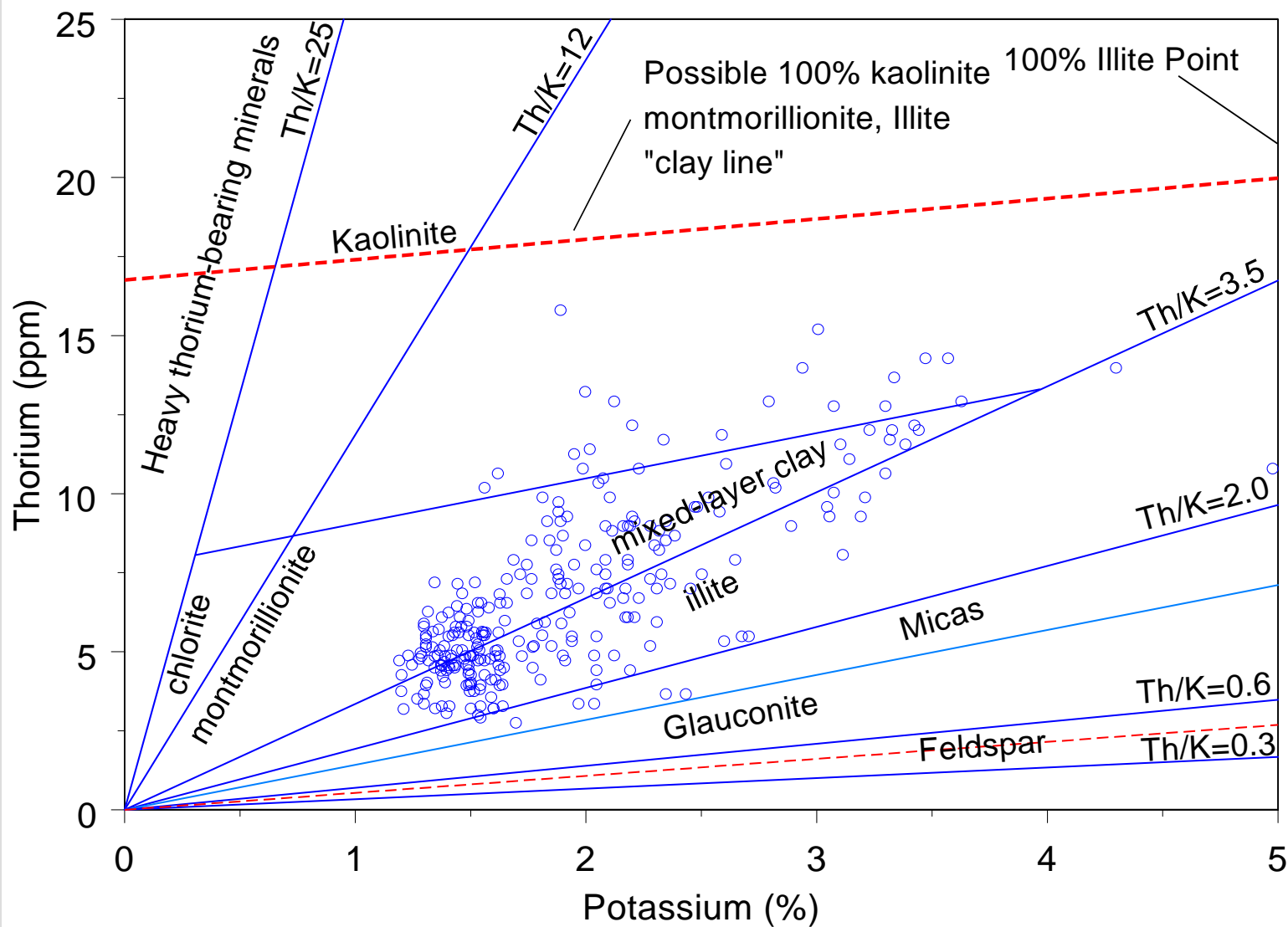
# Physically-based PTM- Specific Surface Area



# What we will get- Example from C5708



# Mineralogy/Chemistry- C5708



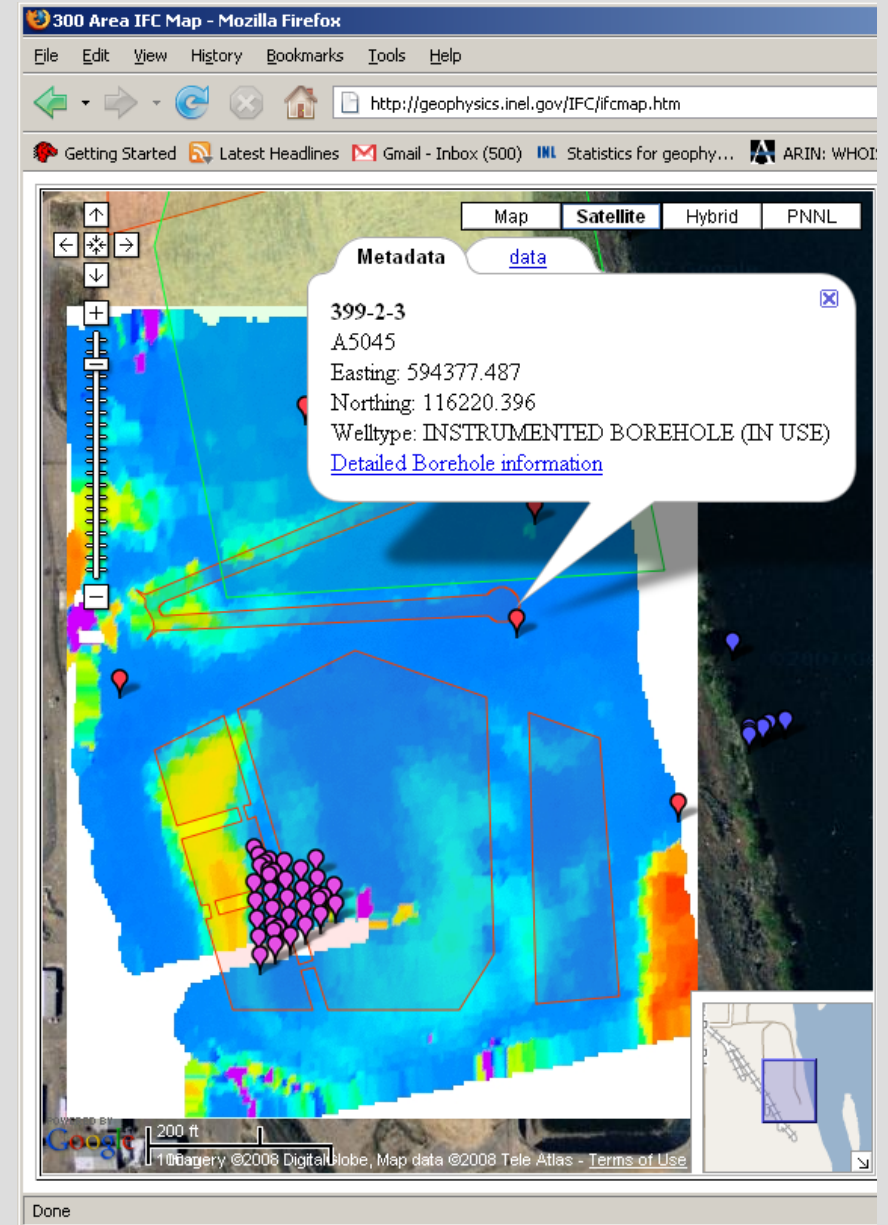
# Radioactivity of Soils and Rocks

Rock Type	K (%)	U ( $10^{-4}$ %)	Th ( $10^{-4}$ %)	Th/U
Shale and Clay	3.2	4.0	11.0	2.8
Sandstone	1.2	3.0	10.0	3.3
Limestone	0.3	1.4	1.8	1.3
Evaporites	0.1	0.1	0.4	4.0

Soil Type	K (%)	Th ( $10^{-4}$ %)
Light and Medium sod-podzolic	1.2	3.3
Light-grey and grey forest Podzolized	1.6	4.8
Medium-humus chernozem	1.7	6.0
Dark chestnut soil	1.8	7.0

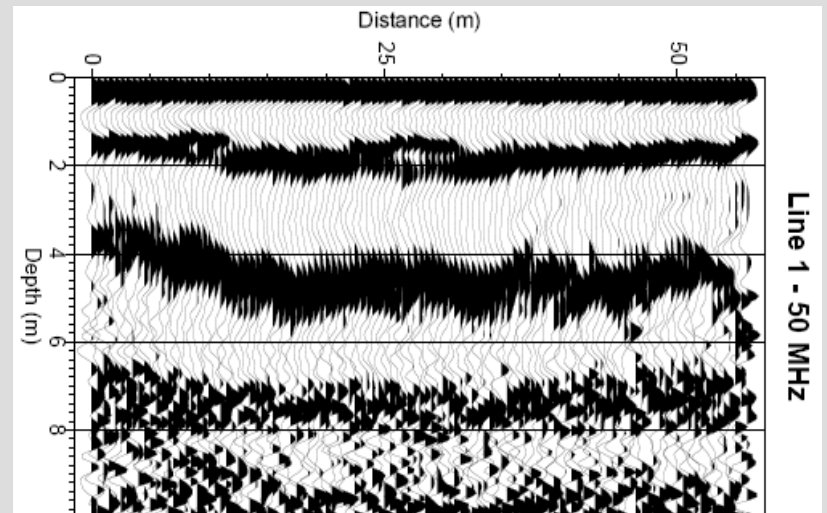
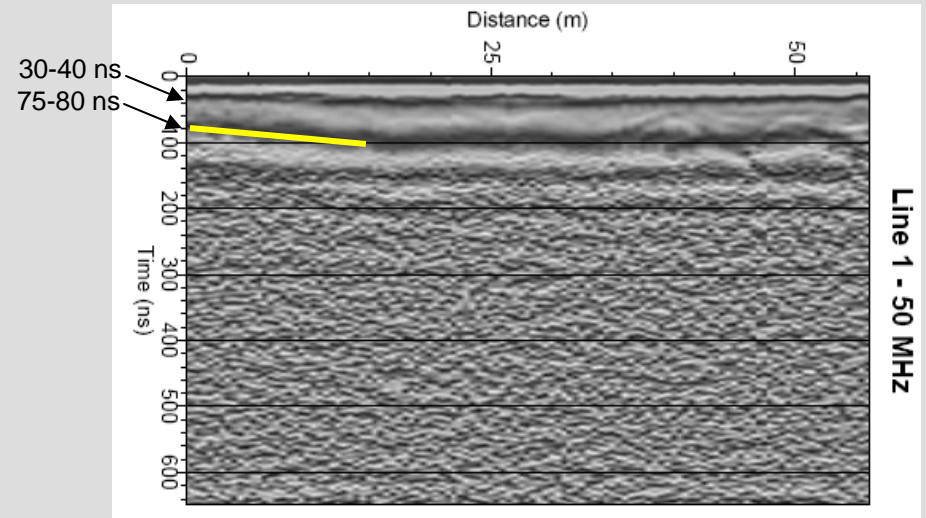
# Surface Geophysics

- ▶ Spatial changes
  - Lateral/horizontal correlation lengths and transition probabilities of different facies
- ▶ Temporal changes
  - Time lapse for monitoring processes
- ▶ Geophysical modalities to date
  - Ground penetrating radar
  - Resistivity
  - induced polarization
  - Magnetometer
  - EMI (EM31, EM34)
- ▶ Planned
  - Feasibility of Reflection Seismic (KGS)



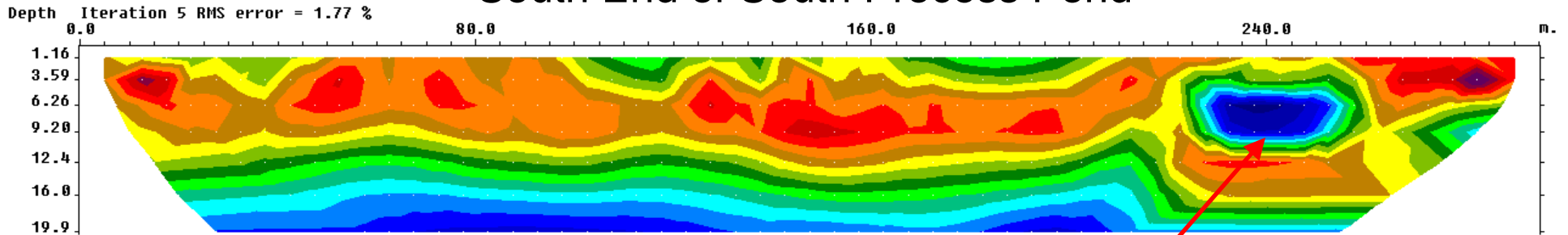
# Ground Penetrating Radar

- ▶ GPR reflection surveys
  - 50, 100, 300 MHz
- ▶ Spatial correlation structure
  - radar reflections, radar stack velocity
- ▶ Transects parallel and perpendicular to river
  - Horizontal spacing of 5 m
  - 30 cm acquisition intervals
- ▶ GPR Penetration limited to ~ 5 m even at 50 MHz (~ depth of pond backfill after excavation)
- ▶ Crosshole radar
  - Monitoring infiltration tests

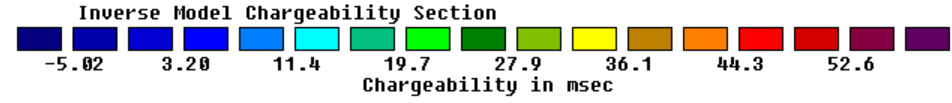
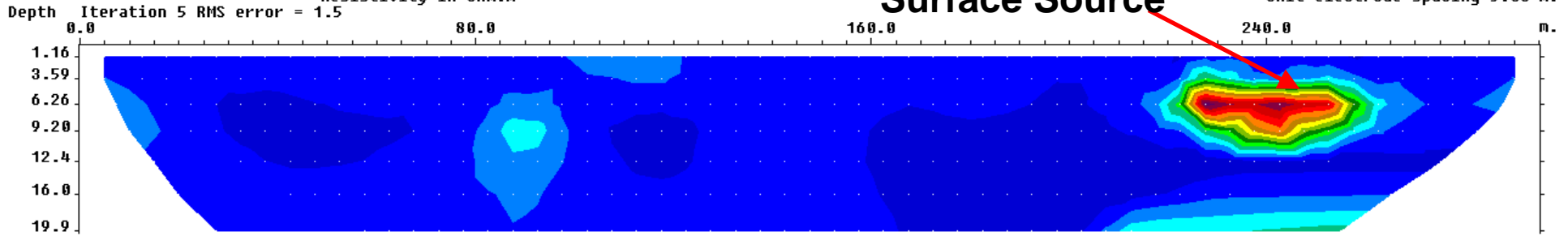
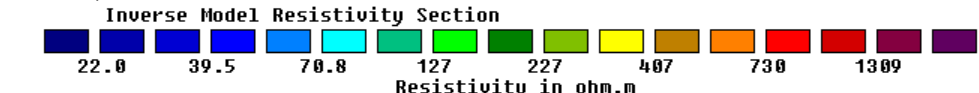


# Resistivity and Induced Polarization

## South End of South Process Pond



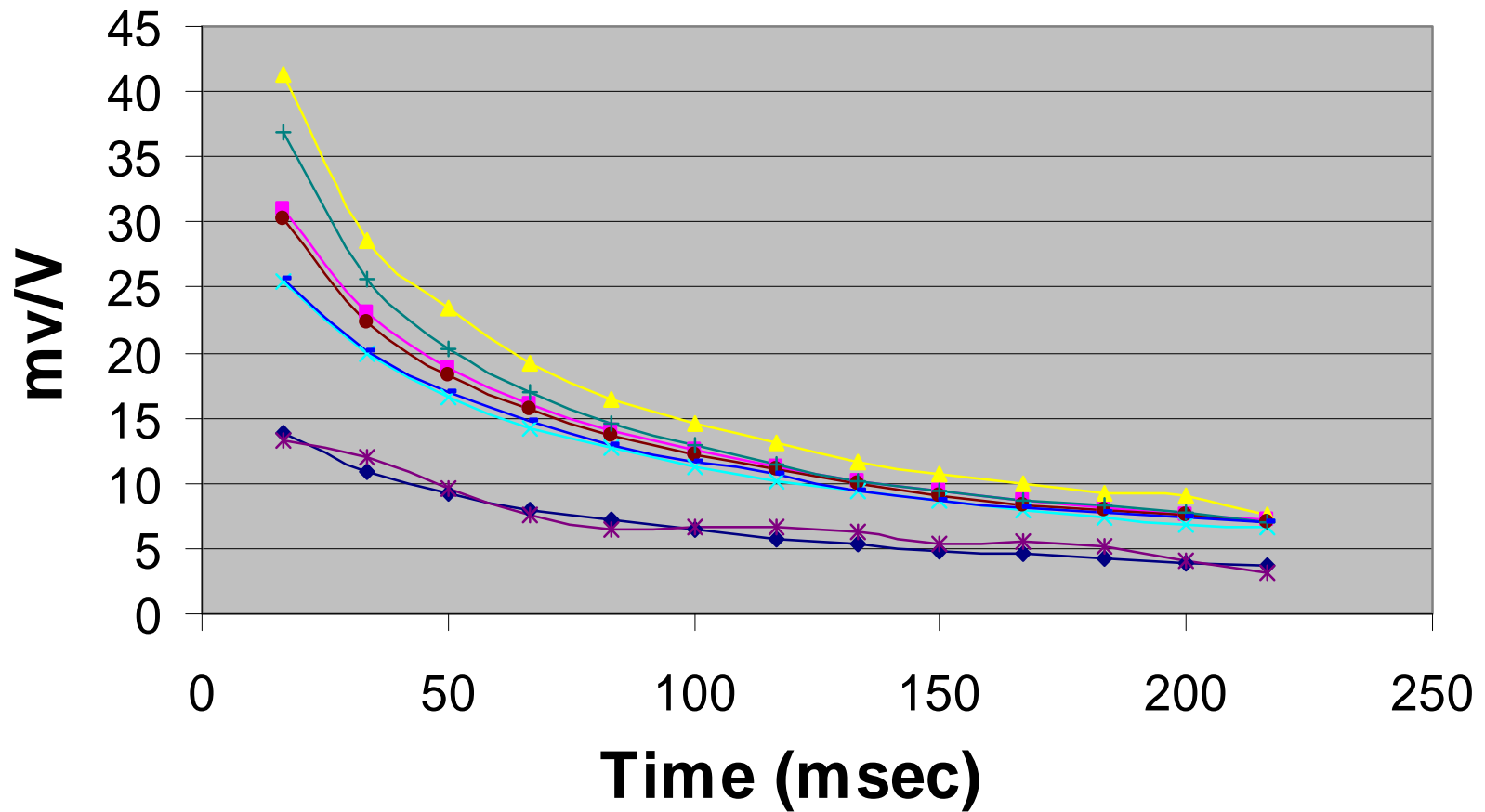
**Possible Near-Surface Source**



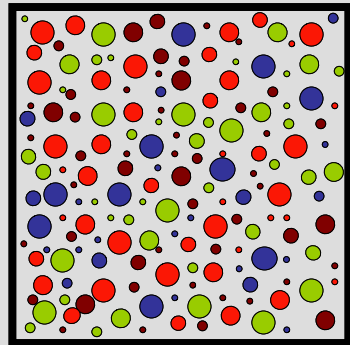
Unit electrode spacing 5.00 m.

Unit electrode spacing 5.00 m.

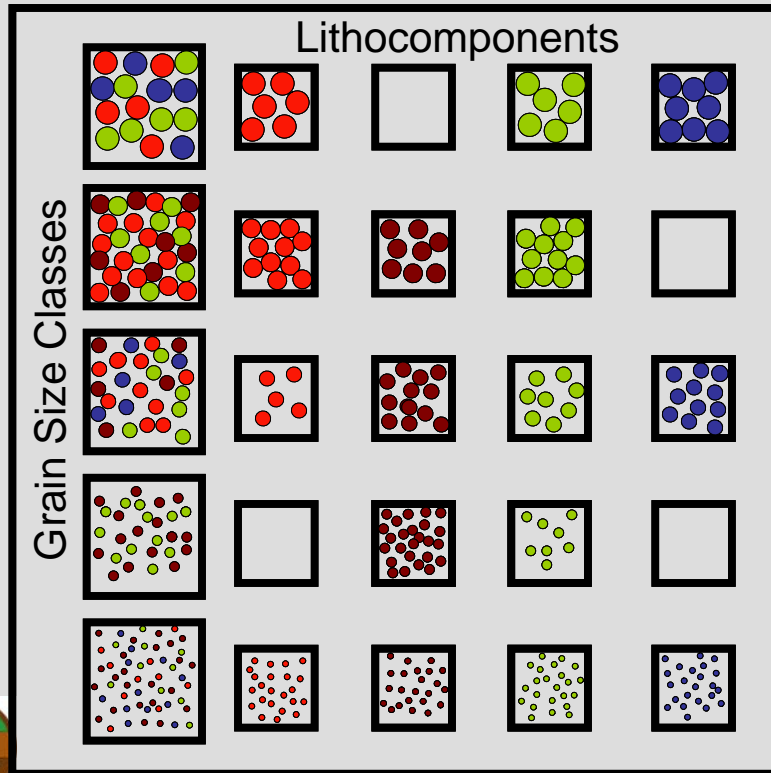
# Field IP Response



## Heterogeneous Sediment



Sieving



## Mass Fraction, $x_{ij}$ , of Size Class and Lithocomponents

Grain Sub-classes	Mass Fraction of Lithocomponents			
○	$x_{1,1}$	$x_{1,2}$	$x_{1,3}$	$x_{1,4}$
○	$x_{2,1}$	$x_{2,2}$	$x_{2,3}$	$x_{2,4}$
○	$x_{3,1}$	$x_{3,2}$	$x_{3,3}$	$x_{3,4}$
○	$x_{4,1}$	$x_{4,2}$	$x_{4,3}$	$x_{4,4}$
○	$x_{5,1}$	$x_{5,2}$	$x_{5,3}$	$x_{5,4}$

### Physico-chemical properties

- Particle shapes
- Porosity
- Density (bulk, particle)
- Specific Surface Area
- Cation Exchange Capacity
- Water Retention ( $\psi[S]$ )
- Hydraulic conductivity ( $K_s, K[S]$ )
- Thermal properties (specific heat, thermal conductivity-saturation)

### Electrical Properties

- Resistivity
- Induced polarization
- NMR ( $T_1, T_2$ ) ??

### Natural Isotopes (GEA)

- $^{40}\text{K}$ ,  $^{238}\text{U}$ , and  $^{232}\text{Th}$

# Discussion

## ▶ Spatial Changes

- Surface
- Borehole
- Crosshole

## ▶ Temporal Changes

- Surface
- Borehole
- Crosshole

## ▶ Laboratory- Property Transfer Models

- What can we measure to help improve conceptualization and model parameterization