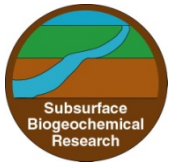
Hanford 300 IFRC: Geophysical monitoring system and scientific opportunities

All hands meeting
Jan. 19-20, 2011
Richland, WA



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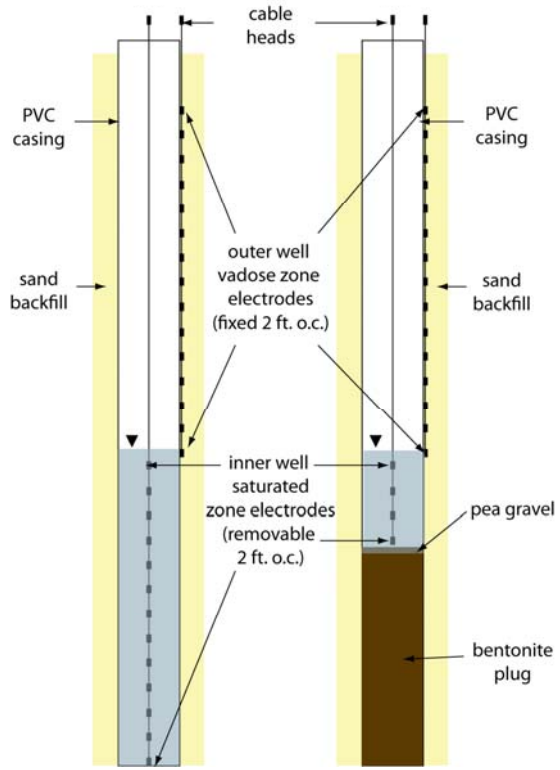
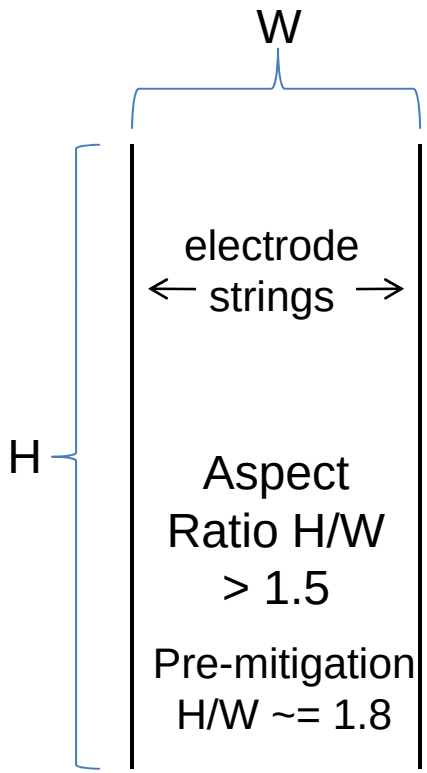
Overview

- Wellfield mitigation:
  - implications for geophysical capabilities
  - Augmentation options and costs
- 3D ERT/IP characterization
  - integration status and path forward
- Integrated research opportunities
  - 3D CR characterization
  - Time-lapse aquifer/river exchange monitoring
  - 4D tracer test monitoring
  - 4D surface infiltration monitoring

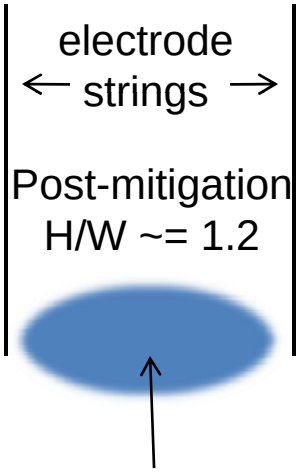
Well-field mitigation: implications for geophysical capabilities (spatial resolution)

pre-mitigation post-mitigation



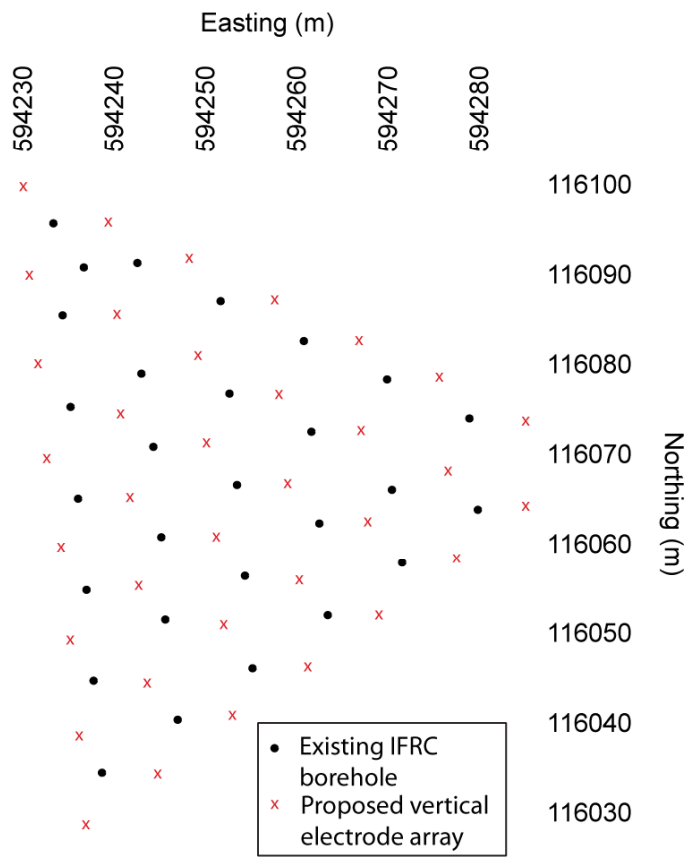


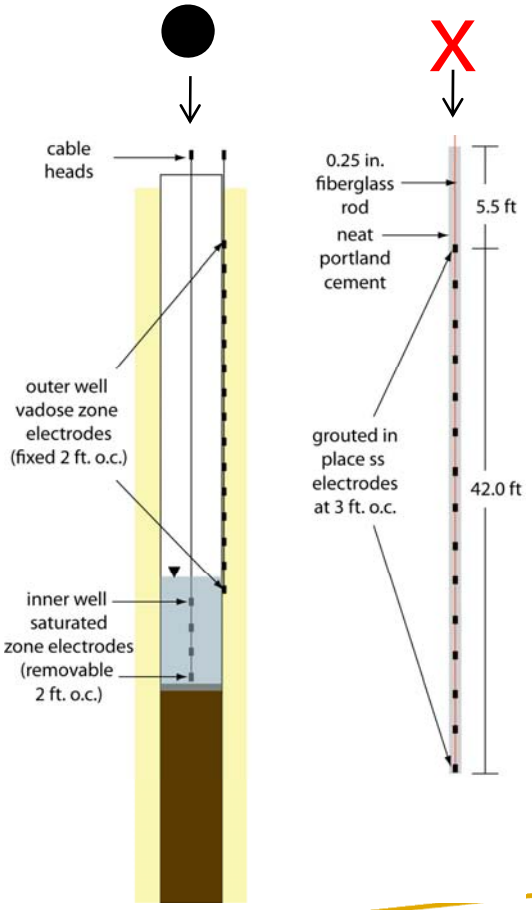
Temporary surface arrays help resolution in upper VZ



Poorly resolved in saturated zone

Array augmentation options





Cost Estimate:

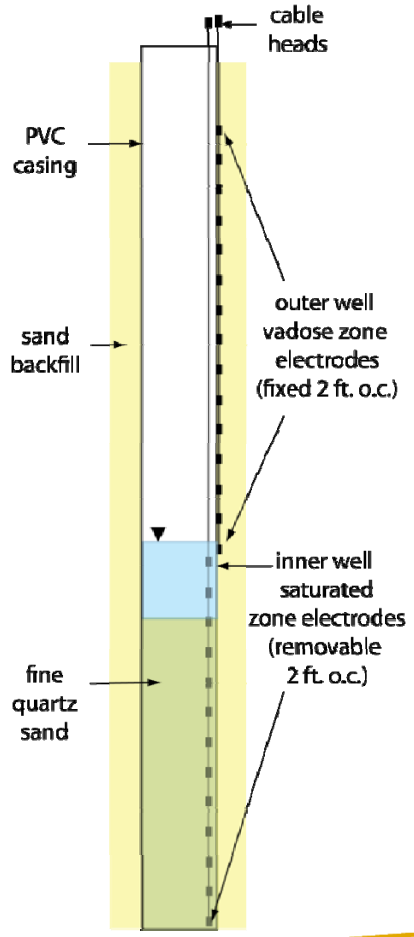
- $300-450K for fully penetrating strings depending on conditions
- $200-250 K for partially penetrating strings
- Costs can be reduced significantly by eliminating perimeter wells

Less expensive options and tradeoffs

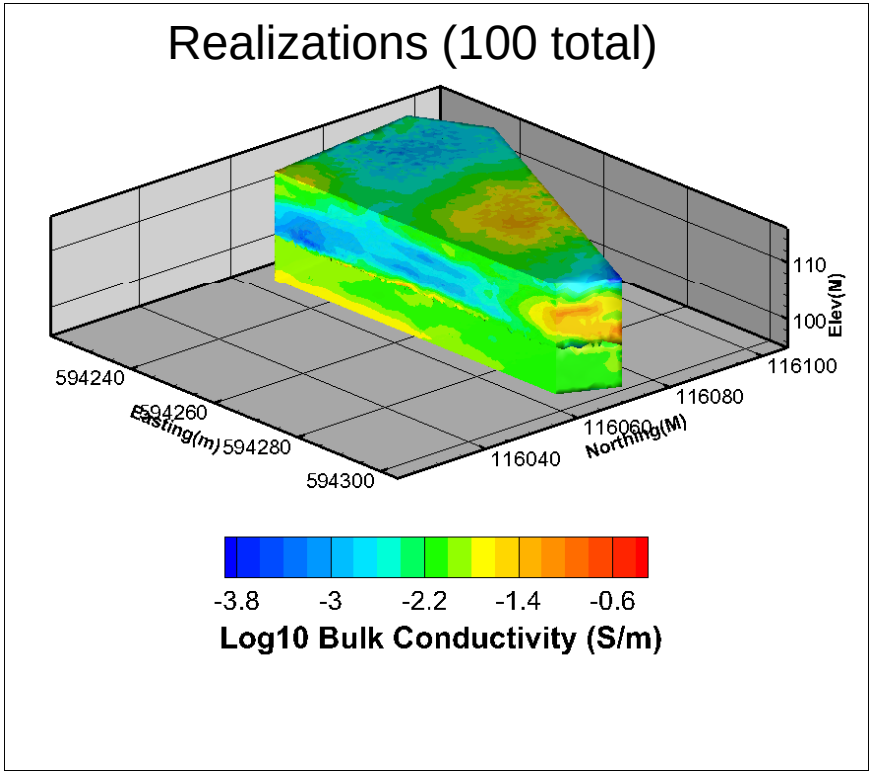
1. Sand Grouting
   - + inexpensive (~$300 /well)
   - + improved imaging capability
   - + sand removal
   - - permanent up-hole cable
   - - more testing

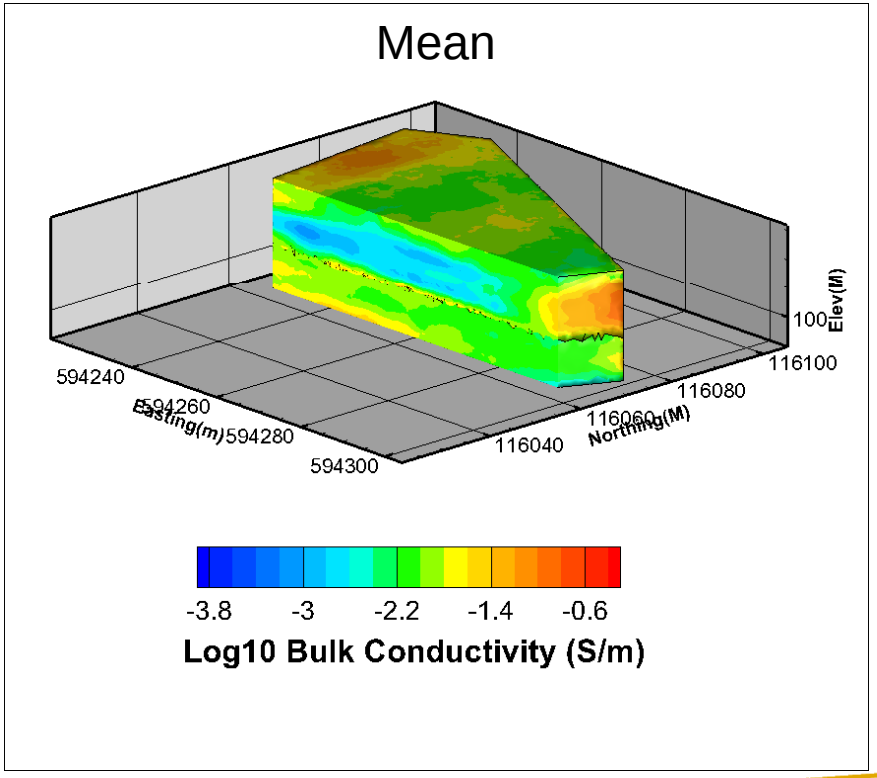
2. Temporary surface arrays
   - + inexpensive & adaptive
   - + improved near surface resolution
   - - will not recover original subsurface resolution
   - Focus on VZ or larger scale imaging (i.e. aquifer river interaction)

3. Custom combinations



3D ERT characterization

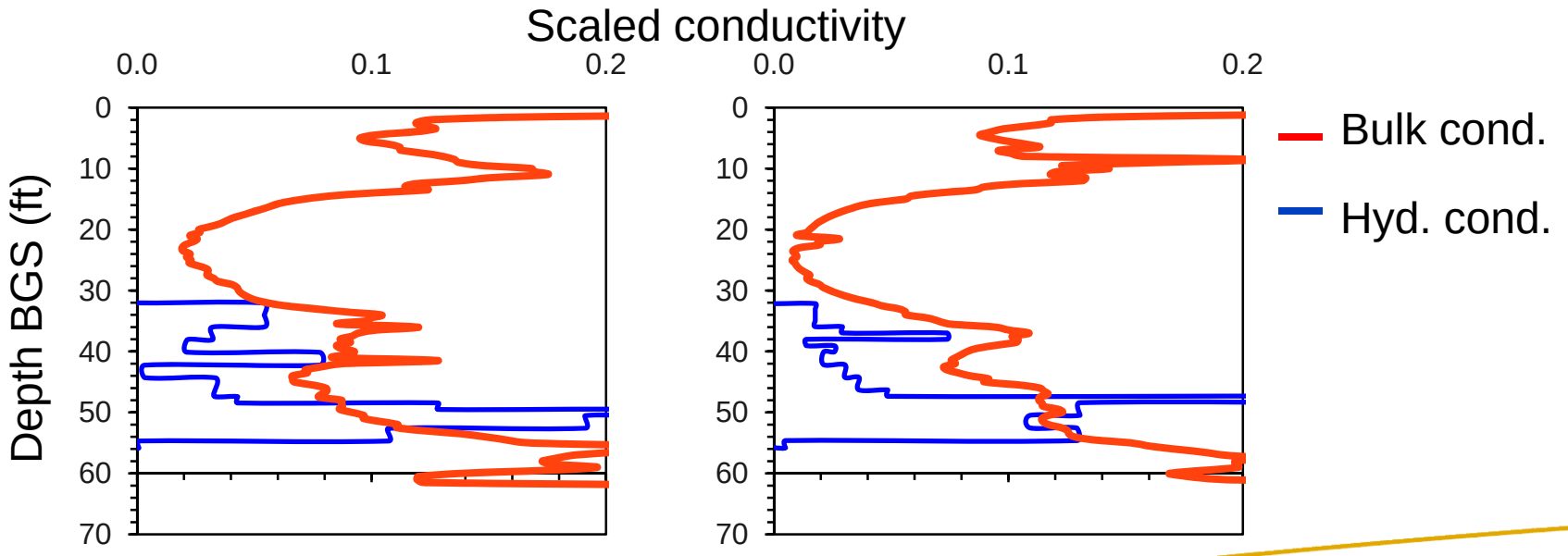




3D ERT integration status

Stepwise approach …

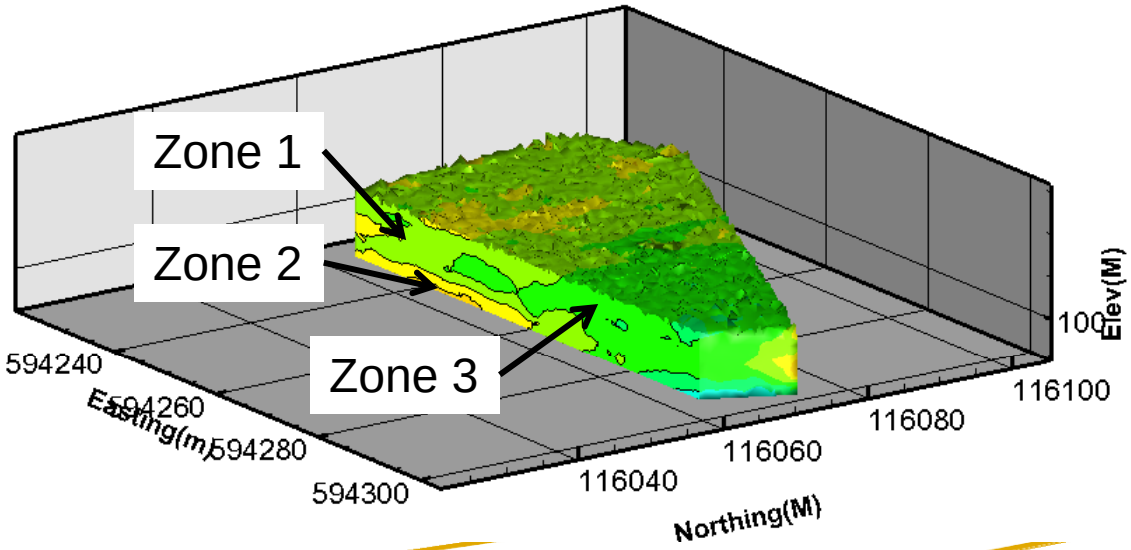
1) Estimated petrophysics for porosity (Rockhold …next talk, Ward)
2) Structural zonation and inversion



3D ERT integration approach

Stepwise approach …

1) Estimated petrophysics for porosity (Rockhold …next talk, Ward)
2) Structural zonation and inversion
3) Electrofacies (electrical and hydro. core measurements necessary)
4) Joint inversion (Koestal et. al, 2009; Kowalsky et. al, 2009; Johnson et al., 2009)



Research opportunities

1) 3D complex resistivity characterization

- Principles based links to hydraulic properties (Binley et al., 2005; Jougnot et al., 2010; Kruschwitz et al., 2010; Revil & Florsch, 2010; Slater & Lesmes, 2002; Tong et al., 2006)
- Tested primarily at core scale, unique field scale application/verification at IFRC (wealth of supporting info)
- Petrophysics from Rutgers core measurements
- Parallel CR inversion code under development
- Recommended before grouting with bentonite

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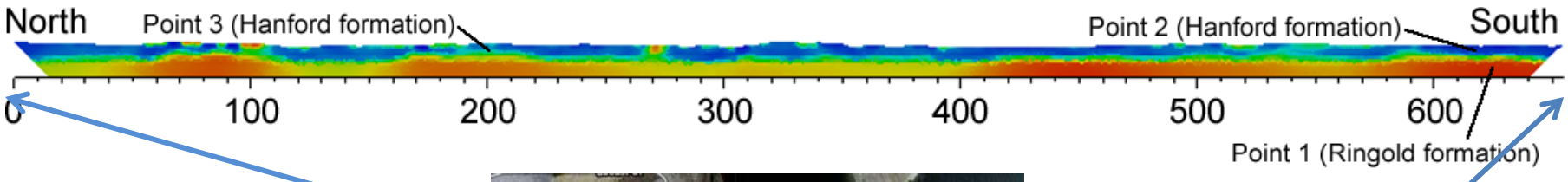
Research opportunities

2) Time lapse aquifer/river exchange monitoring during spring runoff



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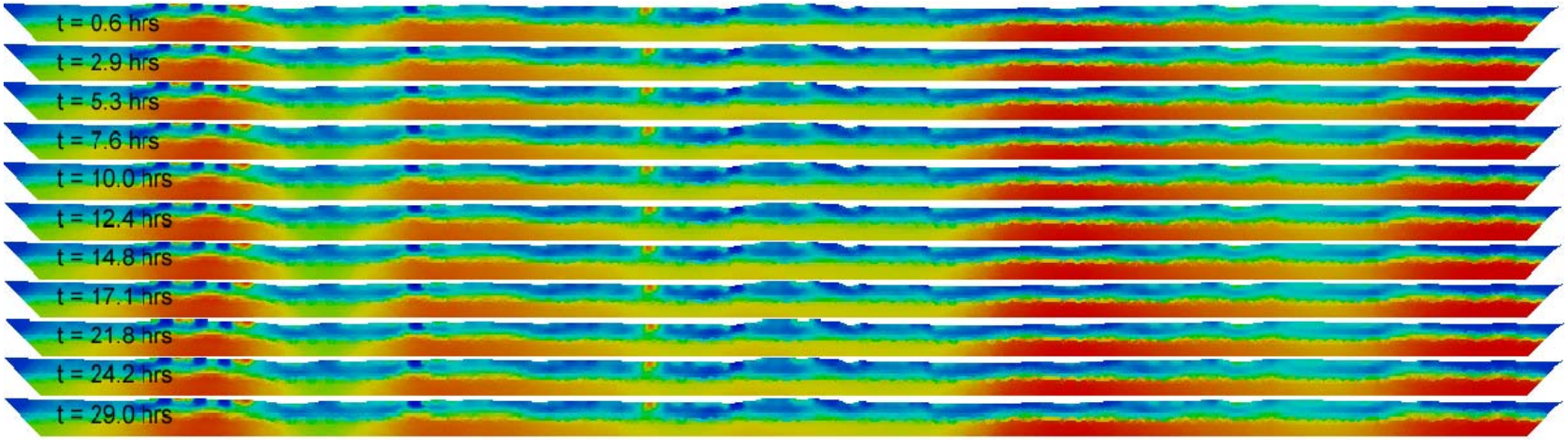
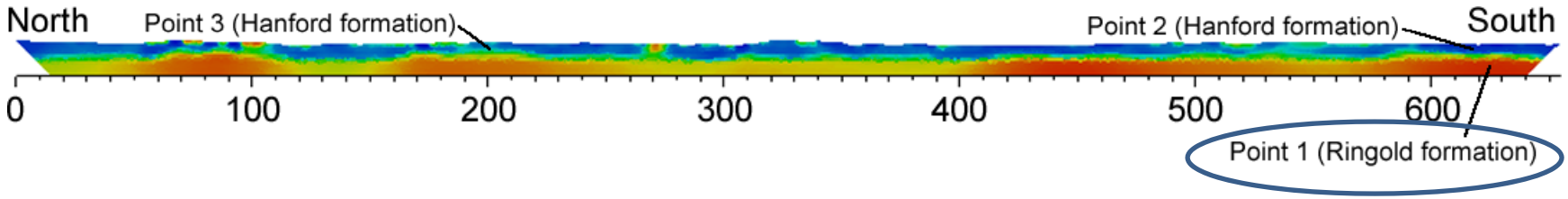
Research opportunities

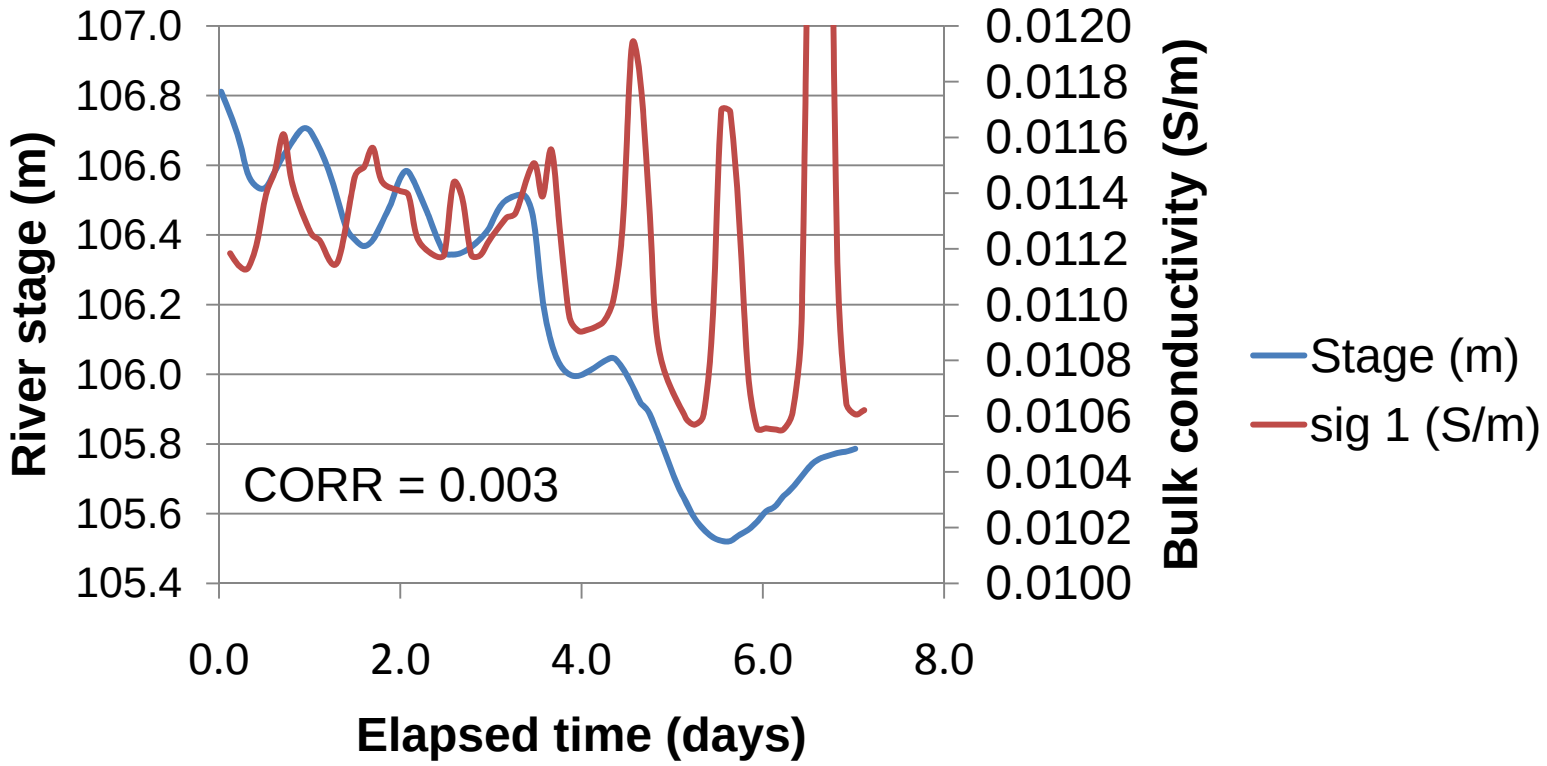
Time lapse images … first 29 hours of monitoring



Research opportunities

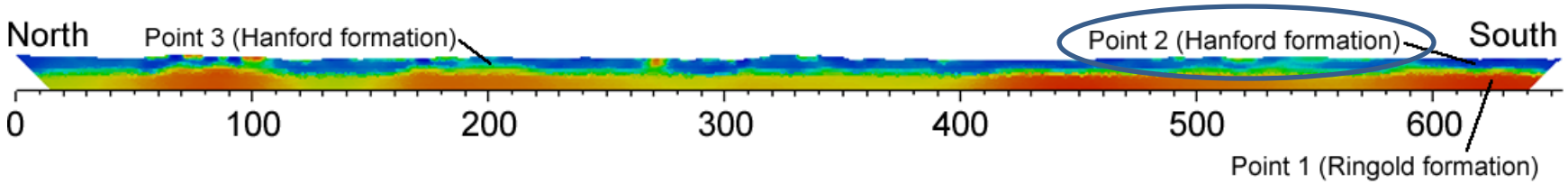
Example of stage vs. bulk conductivity in Ringold Formation

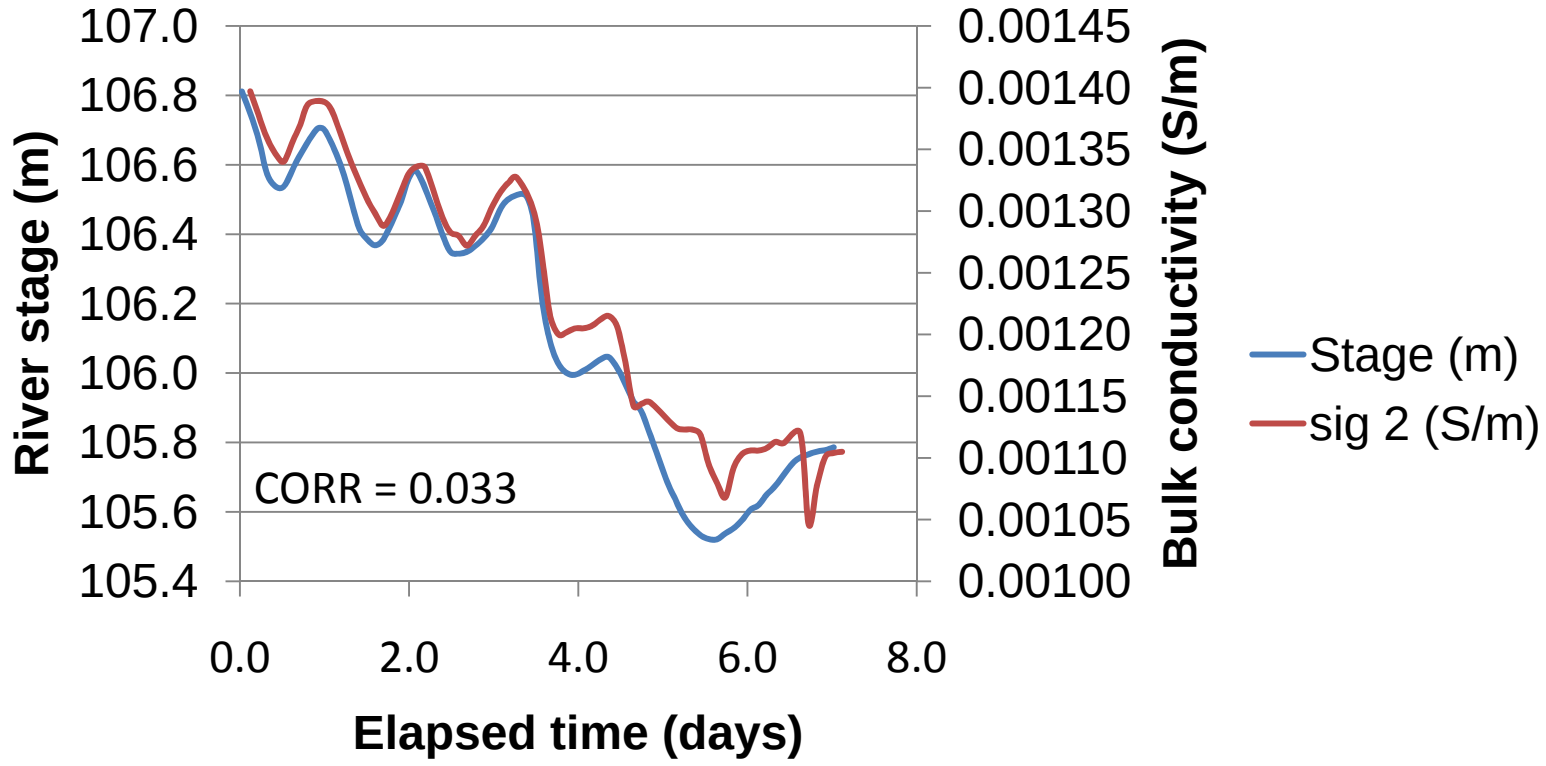




Research opportunities

Example of stage vs. bulk conductivity in Hanford Formation





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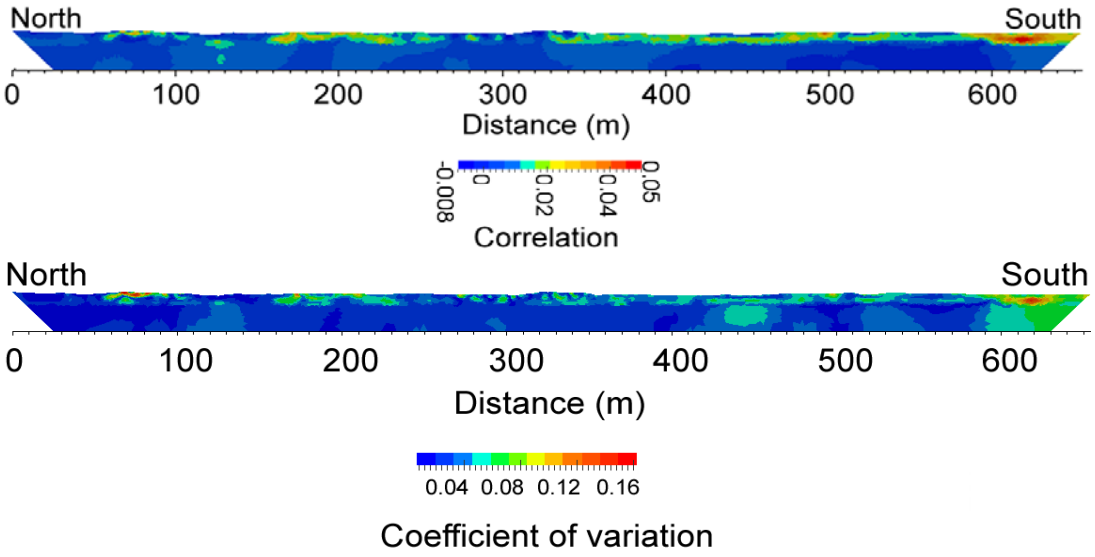
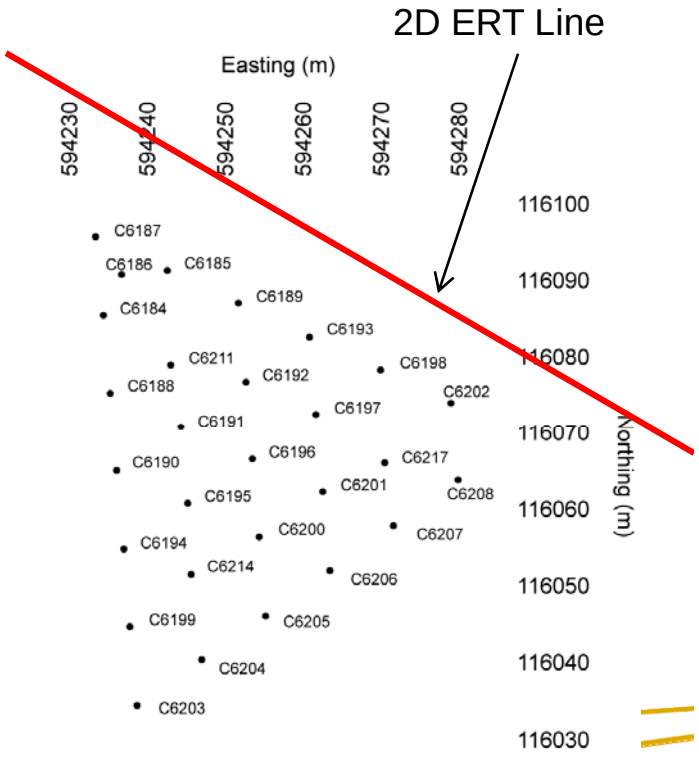
Research opportunities

Time lapse river stage/bulk conductivity correlations and variability reveal active interchange zones



Similar experiment at IFRC (2D or 3D)



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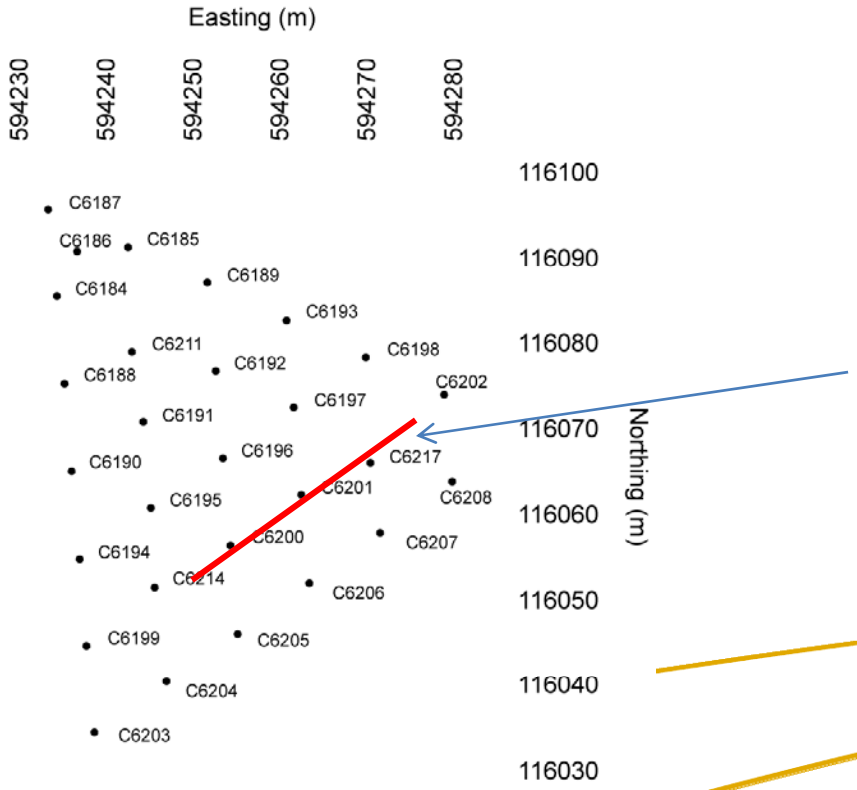
Research opportunities

3. Infiltration monitoring experiment

Current passive monitoring experiment: understanding vadose zone flow



64 surface electrodes at 0.5 m spacing + 3 borehole arrays

Research opportunities

3) Multi-objective induced infiltration experiment
- 3D time-lapse ERT to illuminate flow pathways and low K zones
- Concurrent chem sampling at water table in test wells
- How, where is uranium being mobilized?
- Can we identify possible release zones (low K zones?)

4) Time-lapse multi-objective tracer test
- mitigation issues
- 3D time-lapse ERT to track tracer movement (conductive)
- Concurrent water level, chem sampling in test wells
- Joint inversion for K estimates?

Final comments on integration

- Petrophysics and time-lapse ERT/IP data … unique relationships?

- Integrating geophysics with joint modeling and inversion with soft constraints (i.e. correlations)

- Other ideas ???