U.S. Department of Energy — Office of Science

Integrated Field-Scale Subsurface Research Challenge

Oak Ridge Field Research Center

Hydrogeophysical Quantification of Plume-Scale Flow Architecture and Recharge Processes at the ORNL IFRC

Susan S. Hubbard[*1] (sshubbard@lbl.gov), Gregory S. Baker*[*2], David Watson*[*3]*

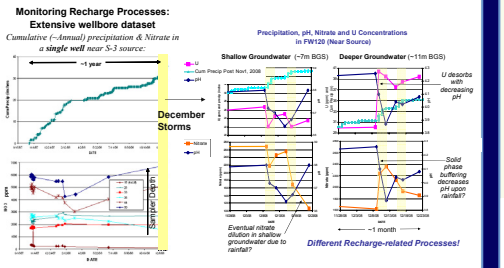
David P Gaines[*2], Jinsong Chen*[*1], Michael Kowalsky*[*1], Erika Gasperikova*[*1], Aubrey Modi*[*3], and Phil Jardine (PI)*[*3]*

*[1]LBNL; [2] Univ. Tennessee; [3] ORNL; [4] Battelle

INTRODUCTION

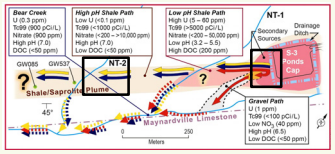
The impact of large episodic, seasonal, and annual recharge on remediation and natural attenuation of subsurface contaminants is not well understood and could represent a significant factor, especially at humid DOE sites.

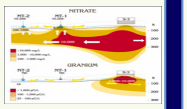
- At the ORNL IFRC, recharge adjacent to the source (S-3 ponds) and along the length of the groundwater plume is the main hydraulic driver for groundwater flow and dilution of contaminants along the pathway.
- Through extensive data acquisition and analysis coupled to predictive models, we explore the potential of geophysical datasets for quantifying flowpaths and recharge-related processes at the watershed scale.



We present field ORNL IFRC hydrogeochemical-geophysical (seismic reflection, seismic refraction, and electrical conductivity) datasets and the analysis of these datasets using joint inversion and coupled modeling approaches. The study is leading to new geophysical monitoring methods and approaches to integrate multi-scale, disparate datasets and insights about recharge processes and aquifer structure that may impact assessment of natural attenuation across plume-scale regions. We review the ORNL datasets and inversion approaches used to:

1. **Quantify subsurface architecture that may influence flow at the plume scale at the NT-2 and the S-3 Areas.**
2. **Remotely monitor subsurface hydrogeochemical processes induced by recharge, initially at the S-3 source area.**





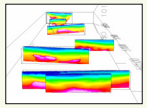
SUBSURFACE ARCHITECTURE

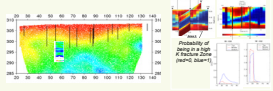
BACKGROUND Surface geophysical datasets are useful for providing information about subsurface geometry that can impact flow. The conventional procedure entails inversion of the geophysical dataset followed by comparison with wellbore data for interpretation. This two-step procedure does not take advantage of the often complimentary information on offered by the wellbore and surface geophysical dataset in the inversion. Additionally, the geophysical inversion result can be significantly altered by inversion choices.

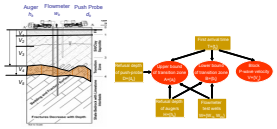
Building on previous research that indicated the use of seismic tomographic datasets to quantify fracture zonation at the local scale (Chen et al., WRR, 2005), we are using surface seismic refraction datasets within an inversion framework to quantify flow architecture at the regional scale. We develop and test a stochastic inversion approach that simultaneously honors wellbore datasets to provide estimates of key interfaces and their uncertainties.

DATASETS Several types of datasets are available for use in this analysis, including:

- Regional seismic refraction tomography profiles located along plume strike
- Depth of penetration information from direct push approaches
- Depths to key interfaces from wellbore information.
- Wellbore flowmeter and crosshole tomographic measurements






Auger
Flowmeter
Push Probe
Field active time
Infrared signal (sensor on-off)
Sensor on-off
Infrared signal (sensor on-off)
Sensor on-off
Sensor on-off
Sensor on-off