

# **Actionable Science for Communities** Geophysical Decision Support System (GDSS) – SHC 3.61.1 Dale Werkema, National Exposure Research Lab (NERL)

## **Purpose/Utility of Research**

### Purpose

- OSWER priority for Contaminated Sites is technical support provided by ORD to Regional and Program Office staff
- Provide intelligent, state-of-the-science geophysical decision support
- Oil and mineral industries use geophysics to image the subsurface for resource extraction and financial gain
- The environmental industry should utilize geophysics to inform decision making for efficient and economical clean-up and protection of our natural resources
- Guidance is needed for the application of geophysics to environmental problems.

## Utility

- The geophysical response is a function of the geology, hydrogeology, biology, and chemistry
- Geophysical imaging is likely applicable and helpful at most sites.
- Provides imaging between borehole and well data
- Lacking is the knowledge, confidence, and understanding of its applicability
- The GDSS and Geophysical Tool Decision Support System (GTDSS) provides a valuable link between the state of the science and its application
- It is an online textbook for the theory, a peer reviewed literature database, and decision guidance for environmental geophysics applications.
- Beta version: https://cluin.org/characterization/technologies/geophysics/

Environmental Geophysics Recent Additions   Search: All EPA O This Area Go	U.S. ENVIRONMENTAL	INSTRUCTIONS DATA INPUT RE	SULTS
You are here: EPA Home > Environmental Geophysics E INSTRUCTIONS DATA INPUT RESULTS		What is the type of land su	urface at the site?
What is the objective of your geo	nhysical	Rural: general rural land sul	INSTRUCTIONS DATA INPUT RESULTS
project?	physical	Suburban: 3 or more house	
Map and Locate Anthropogenic  INST	RUCTIONS DATA INPUT RESULTS	Urban: high density city	What are the anticipated near surface geologic con
Subsurface Contaminant Plum		<ul> <li>Industrial: warehouse, mar</li> </ul>	Unknown
	What type of plume imaging res	<ul> <li>Active Military Base</li> </ul>	Competent Bedrock
CSM (Conceptual Site Model) I	1D surface depth sounding	Service station: automobile	Fractured/ Weathered Bedrock
	1D surface profile	Surface water body	
	<ul> <li>1D borehole profile</li> <li>2D a formation of the second seco</li></ul>	<ul> <li>Inside a building</li> </ul>	Alluvial / Unconsolidated Sediment
trade names or commercial products within this web site does not consti	2D surface aerial map (plan view)     INSTRUCTIONS DATA INPUT RESULTS		High Clay Content Unconsolidated Sediment
ethods	Metadata		It / Organic Sediment
(3) Surface Geophysical Methods > Electromagnetic Methods > Time-Domain Electroma	Notes		
(3) Surface Geophysical Methods > Electromagnetic Methods > Frequency Domain Elec	Methods Citations		
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(1) Warnings and Special Considerations >> Survey When Dry a site of active hydrocarbon biodegradation", Geophys Keywords: conductivity, contamination, experiments, field,			Netes
(1) Warnings and Special Considerations >> Some Methods Difficult or Impossible compounds, phase, scanning electron microscopy, soil pollu (1) Warnings and Special Considerations >> Dry Surface Requires Significant Field Proce			Methods
(1) Surface Geophysical Methods       Waxman,M.H., and Smits,L.J.M., "Electrical conductivit 122, 1968.         Keywords: conductivity, electrical, electrical conductivity, El		es in oil-bearing shaly sands", <i>Soc.Pet.Eng</i> , Vol. Trans. AIME 2	Citations
Inface Geophysical Methods > Seismic Methods > Seismic Methods > Surface Wave Methods and Surface Wave Methods > S			ediction of soil Keywords
(1) Surface Geophysical Methods > Seismic Methods > Seismic Reflection Methods	texture and water holding capacity", Water Resources Keywords: clay, electromagnetic, electromagnetic induction,		
Citations Keywords Input Summary	Geology and Hydrogeology, Vol. 34, pp. 85-98, 2001.	VAPL contaminated zone in a sand aquifer", Quarterly Journal of plex resistivity, conductivity, CPT, DNAPL, electrical conductivity, geop	conductivity
Save as HTML View HTML Popup < Back	hydrochemistry, resistivity, sand, soil		electrical conductivity
	electrical tomography and cross-creek electrical imagin	ic zone around a tidal creek using a combination of borehole long, New South Wales, Australia", <i>Hydrogeology Journal</i> , Vol. 13	1 No 3 np
EPA Home			electromagnetic
Privacy and Security Notice Contact Us	368-377, 2003.		
Privacy and Security Notice	368-377, 2003. Keywords Input Summary		seismic seismic methods

- The user defines the site objectives and conditions.
- The GDSS generates a list of likely successful geophysical techniques, online textbook links, keywords, and a list of recent relevant peer reviewed literature via RSS feeds – which the system logic is based

Conceptual Mode

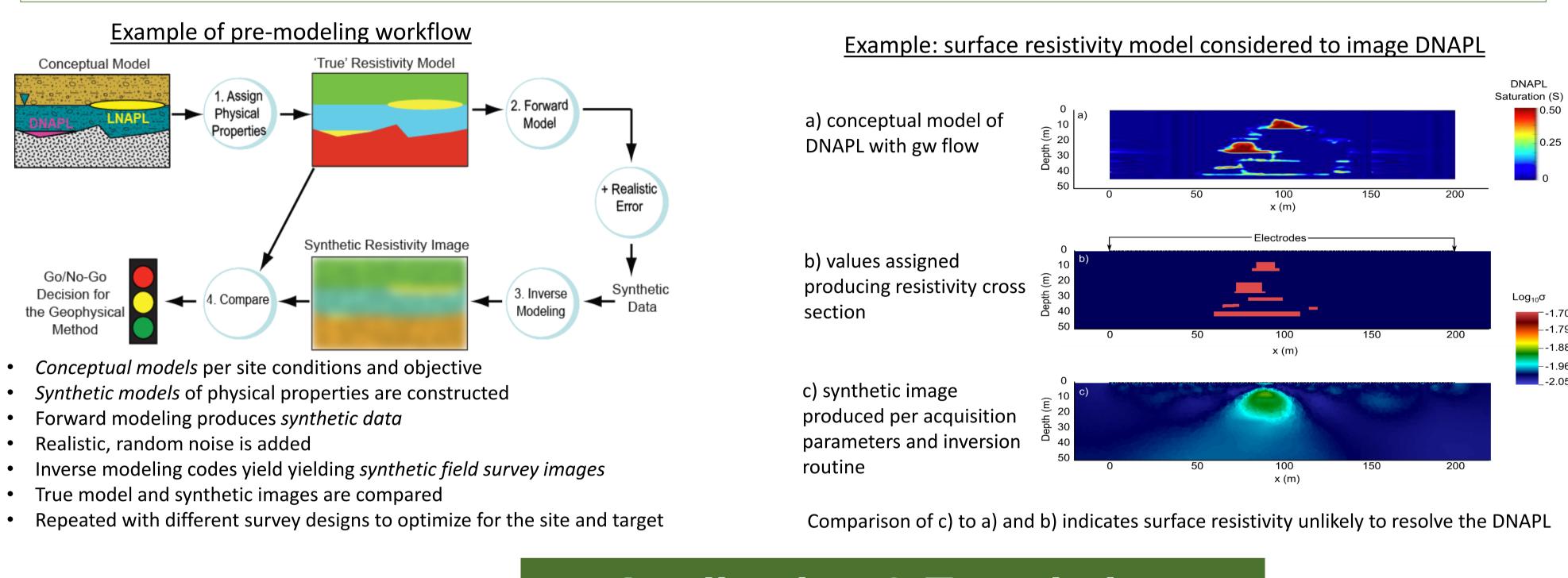
Decision for he Geophysic

Collaborators: John Lane, Fred-Day Lewis, Marty Briggs: USGS; Lee Slater: Rutgers University

## Highlights

The Geophysical Toolbox Decision Support System (GTDSS)

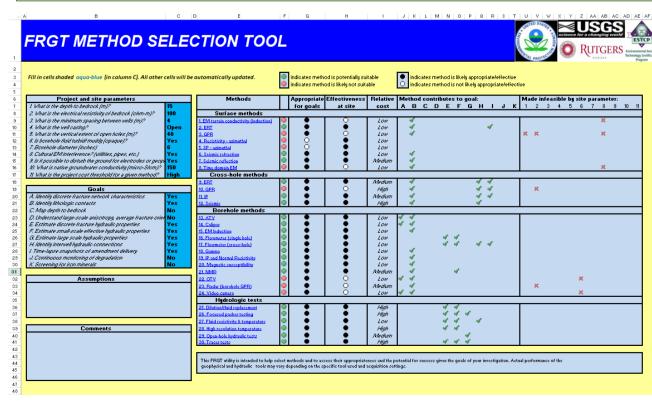
• Quantitative pre-modeling tools predict the geophysical response of a particular technique and if the response will likely achieve objectives such as contaminant detection, fate and transport, remediation monitoring, landfill dynamics, and/or conceptual site model development.



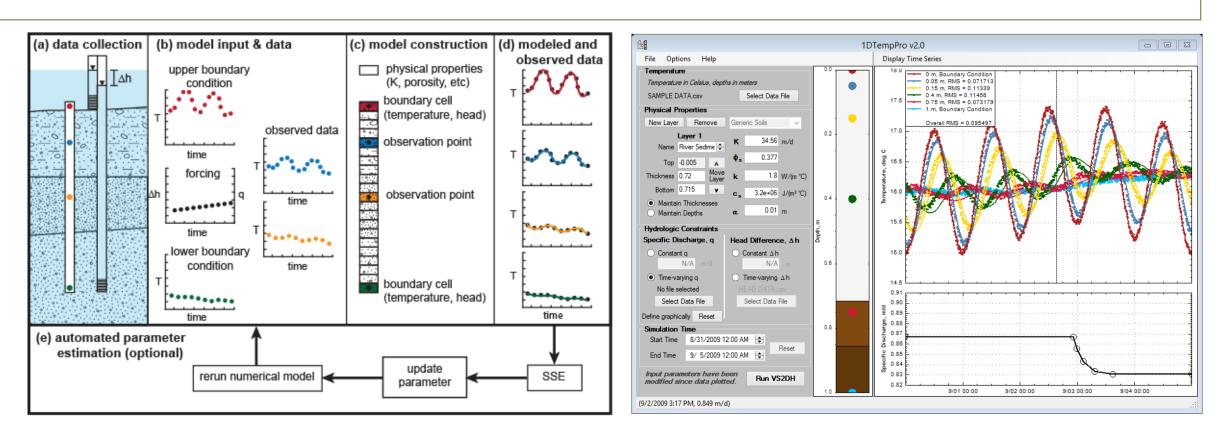
## **Application & Translation**

Connects <u>state-of-the-research</u> geophysical technology with <u>state-of-the-practice</u> geophysics

- >A decision support system (GDSS and GTDSS) with pre-modeling capabilities to enable selection of appropriate and effective geophysical methods to use at a site, given project goals, and site conditions
  - Latest examples include:
    - 1. Fractured Rock Geophysical Toolbox Method Selection Tool (FRGT-MST)<sup>1</sup>; The user to input site characteristics and project goals, and identifies which methods are appropriate to the specified goals and likely to be effective at the specified site.
    - 2. 1DTempPro<sup>2 & 3</sup>: converts field temperature data to physical properties



- user enters site parameters and objectives
- output table indicates feasible methods



- Temperature data collection
- Model construction and generation

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- Main window of 1DTempPro V2
- Parameter input, model estimation

### Initial techniques used for GTDSS pre-modeling

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- **Electrical resistivity**
- Seismic refraction
- Seismic reflection
- **Electromagnetic induction**
- Ground penetrating radar
- Surface induced polarization

## Intended End users

- **OSWER and other Program Offices**
- **Regional Offices**
- State and Local Stakeholders
- **Environmental Geophysics Practitioners**
- Universities
- **General Public**

## Lessons Learned

- Stepwise version development reduces complexity of project scope
- making at contaminated sites.
- Site usage statistics will provide data on the application of geophysical techniques.
- Past usage statistics show a large, global user base
- to the current migration to the Drupal CMS

- doi:10.1111/gwat.12369.
- 10.1111/gwat.12051



**Borehole/crosshole geophysics** 

**Borehole electromagnetics** Borehole gamma Borehole magnetic susceptibility Crosshole ground penetrating radar Crosshole resistivity

Crosshole induced polarization

The system moves the science forward by providing users valuable, relevant, and current information on environmental geophysics to inform their decision

• GDSS had ~65% of the hits on the Division (former ESD in NERL) server prior

### References

Day-Lewis, F.D., Johnson, C.D., Slater, L.D., Robinson, J.D., Williams, J.H., Boyden,C.L., Werkema,D., and Lane Jr.,J.W., 2016, The fractured rock geophysical toolbox method selection tool, Groundwater, In press. 2. Koch, F.W., Voytek, E.B., Day-Lewis, F.D., Healy, R., Briggs, M.A., Werkema, D.D. , Lane Jr., J.W., 2016, 1DTempPro V.2: New features for parameter estimation, heterogeneity, and time-varying exchange, Groundwater, 54, no. 3, 434-439,

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