Actionable Science for Communities

Geophysical Decision Support System (GDSS) – SHC 3.61.1

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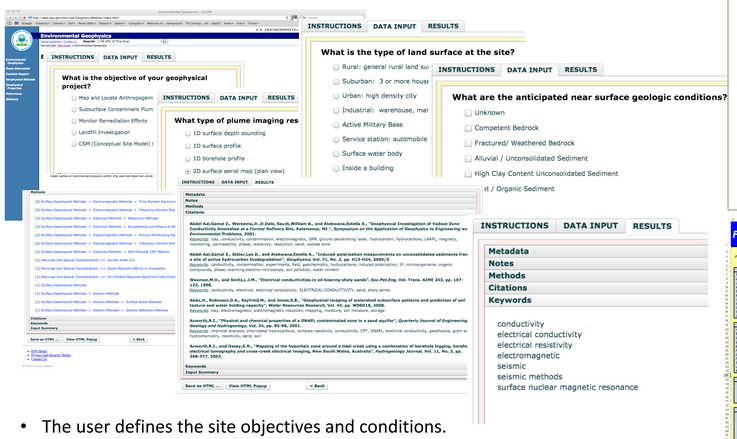
Purpose/Utility of Research

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://clu-in.org/characterization/technologies/geophysics/



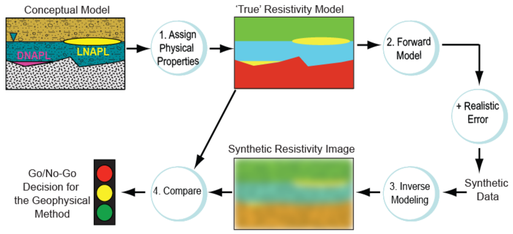
- The user defines the site objectives and conditions.
- The GDSS generates a list of likely successful geophysical techniques, online textbook links, keywords, and a list of recent relevant peer reviewed literature via RSS feeds – which the system logic is based

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.

Example of pre-modeling workflow



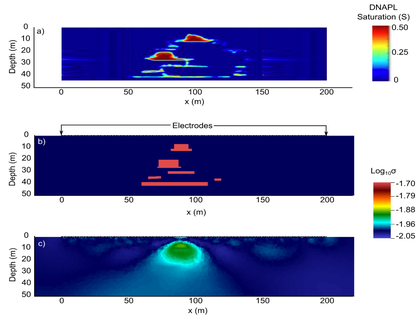
- *Conceptual models* per site conditions and objective
- *Synthetic models* of physical properties are constructed
- Forward modeling produces *synthetic data*
- Realistic, random noise is added
- Inverse modeling codes yield yielding *synthetic field survey images*
- True model and synthetic images are compared
- Repeated with different survey designs to optimize for the site and target

Example: surface resistivity model considered to image DNAPL

a) conceptual model of DNAPL with gw flow

b) values assigned producing resistivity cross section

c) synthetic image produced per acquisition parameters and inversion routine



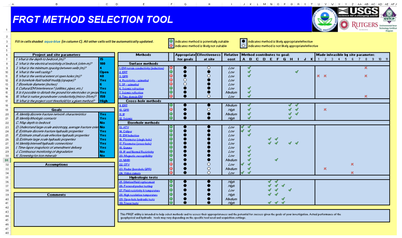
Comparison of c) to a) and b) indicates surface resistivity unlikely to resolve the DNAPL

Application & Translation

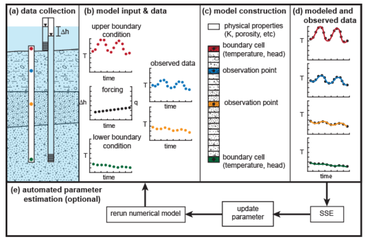
➢Connects *state-of-the-research* geophysical technology with *state-of-the-practice* geophysics

➢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

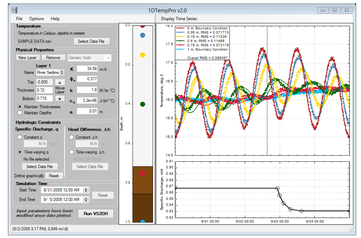
- Latest examples include:
  1. Fractured Rock Geophysical Toolbox Method Selection Tool (FRGT-MST)[1]; The user to input site characteristics and project goals, and identifies which methods are appropriate to the specified goals and likely to be effective at the specified site.
  2. 1DTempPro[2 & 3]: 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



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

Initial techniques used for GTDSS pre-modeling

Surface Geophysics	Borehole/crosshole geophysics
Electrical resistivity	Borehole electromagnetics
Seismic refraction	Borehole gamma
Seismic reflection	Borehole magnetic susceptibility
Electromagnetic induction	Crosshole ground penetrating radar
Ground penetrating radar	Crosshole resistivity
Surface induced polarization	Crosshole 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
- The system moves the science forward by providing users valuable, relevant, and current information on environmental geophysics to inform their decision 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
- GDSS had ~65% of the hits on the Division (former ESD in NERL) server prior to the current migration to the Drupal CMS

References

1. 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, doi:10.1111/gwat.12369.
3. Voytek, E. B., Drenkelfuss, A., Day-Lewis, F. D., Healy, R., Lane, J. W. and Werkema, D., 2014, 1DTempPro: Analyzing Temperature Profiles for Groundwater/Surface-water Exchange. *Groundwater*, 52: 298–302. doi: 10.1111/gwat.12051
4. Werkema Jr., D.D., Jackson, M., and Glaser, D., 2010, The environmental geophysics web site and geophysical decision support system (GDSS), *U.S. Environmental Protection Agency*, Washington, D.C., EPA/600/C-10/004.