

Superfund Geophysics: Case Studies from Region 4

CLU-IN Webinar

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Poll Questions

1. How many sites do you manage? (a) 1-2, (b) 3-5, (c) 5-10, (d) >10
2. How many of your sites have used/are using geophysical surveys? (a) 1-2, (b) 3-5, (c) 5-10, (d) >10
3. In your opinion, over the last 10 years, have you seen geophysics being used (a) more, (b) less, or (c) the same over time, (d) I'm not sure

Now this set is only if you've used geophysics before on a site:

- a. At your sites did the geophysical surveys help? (a) Yes, (b) No, (c) NA
- b. Which of the following objectives were geophysical surveys used for? [Multiple selection] (a) CSM development, (b) plume mapping, (c) remediation monitoring, (d) other _____
- c. If no, what was the main problem or impediment for success? [Multiple selection] (a) Survey did not meet objectives because of data quality, resolution, or ability to see planned targets, (b) The geophysical survey was effective but still did not help, or (c) Could not understand or interpret the results, (d) NA
- d. Would you use a geophysical survey again? (a) Yes, (b) No, (c) Maybe

Big Picture

Superfund Optimization Program

Green Remediation Program

Data and Evidence Program

Need better
characterization!

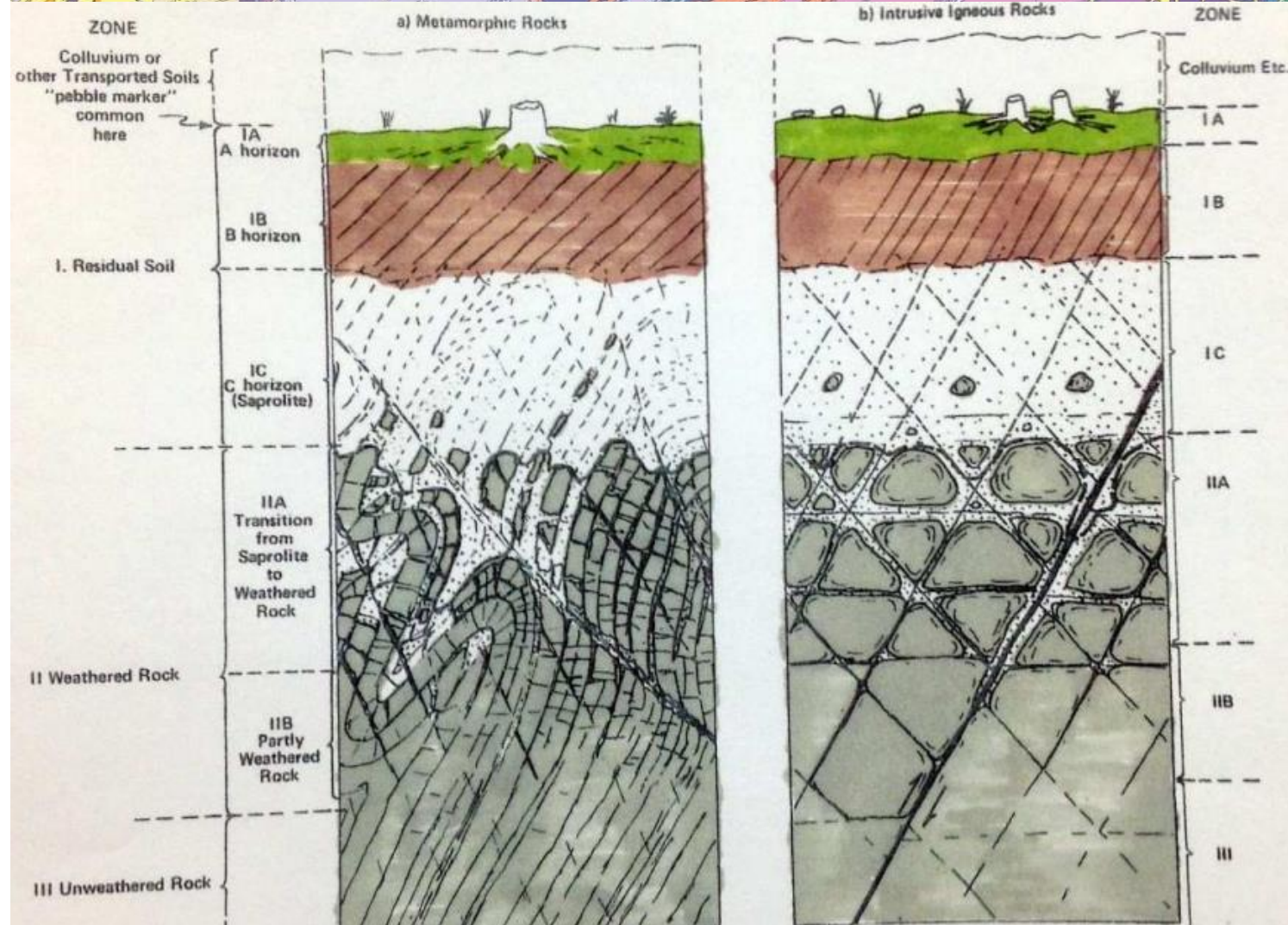
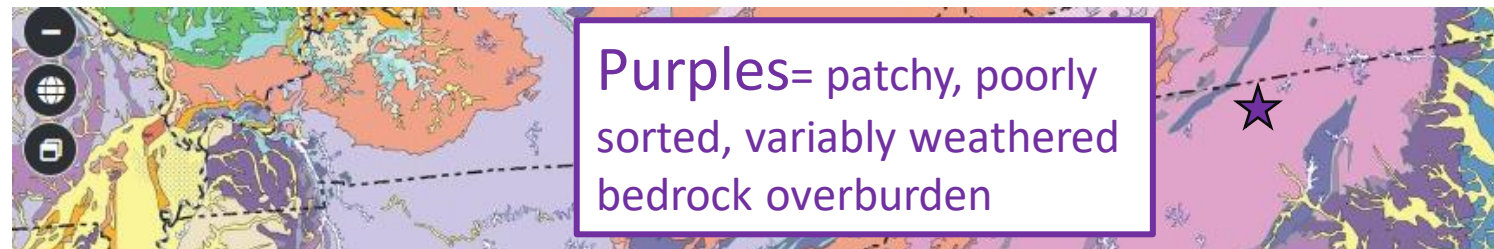


- Spot anomalies/targets
 - CSM features: tanks, pipes, drums, contamination (90/10)
 - Lateral heterogeneity
- Reconcile boring log data
- 100 years old, based on physics
- Now with updated collection, analytical, and visualization methods!

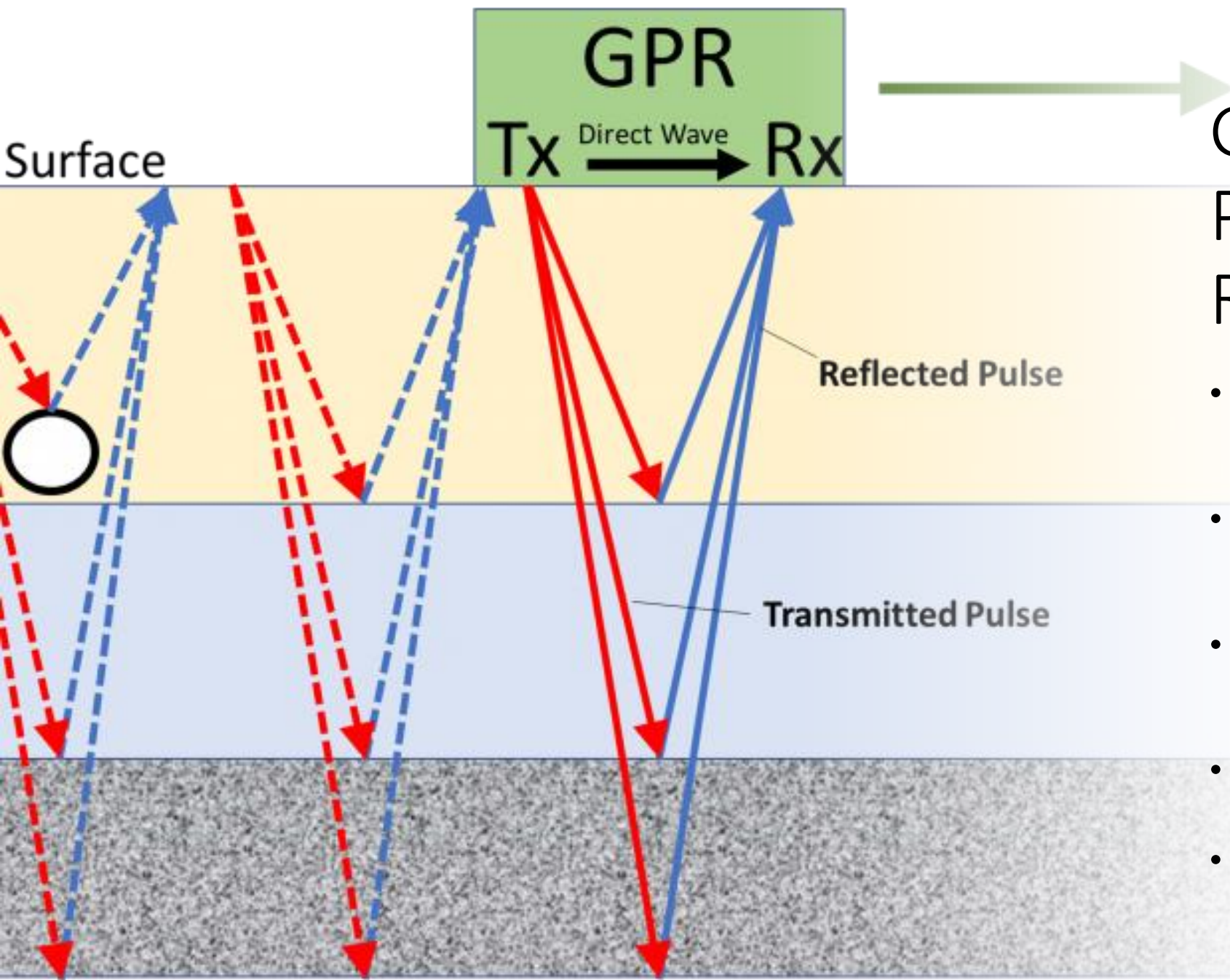
Our Toolkit:

- Boring log (single point, high cost, convert to well, invasive)
- Borehole HRSC tools (single point, high resolution, continuous, Environmental Sequence Stratigraphy)
 - Nuclear Magnetic Resonance (NMR), MIP/HPT, Geoprobe, etc
- Surface geophysics (not as high resolution as borehole, broad brush, continuous)
 - GPR, EM, ERT, Seismic, etc.

Region 4



Deere, D. U., Patton, F.D. Slope Stability in Residual Soils. Proc. 4.. Pan. Am. Conf. Soil Mech. Found. Engng., Puerto Rico. 1971

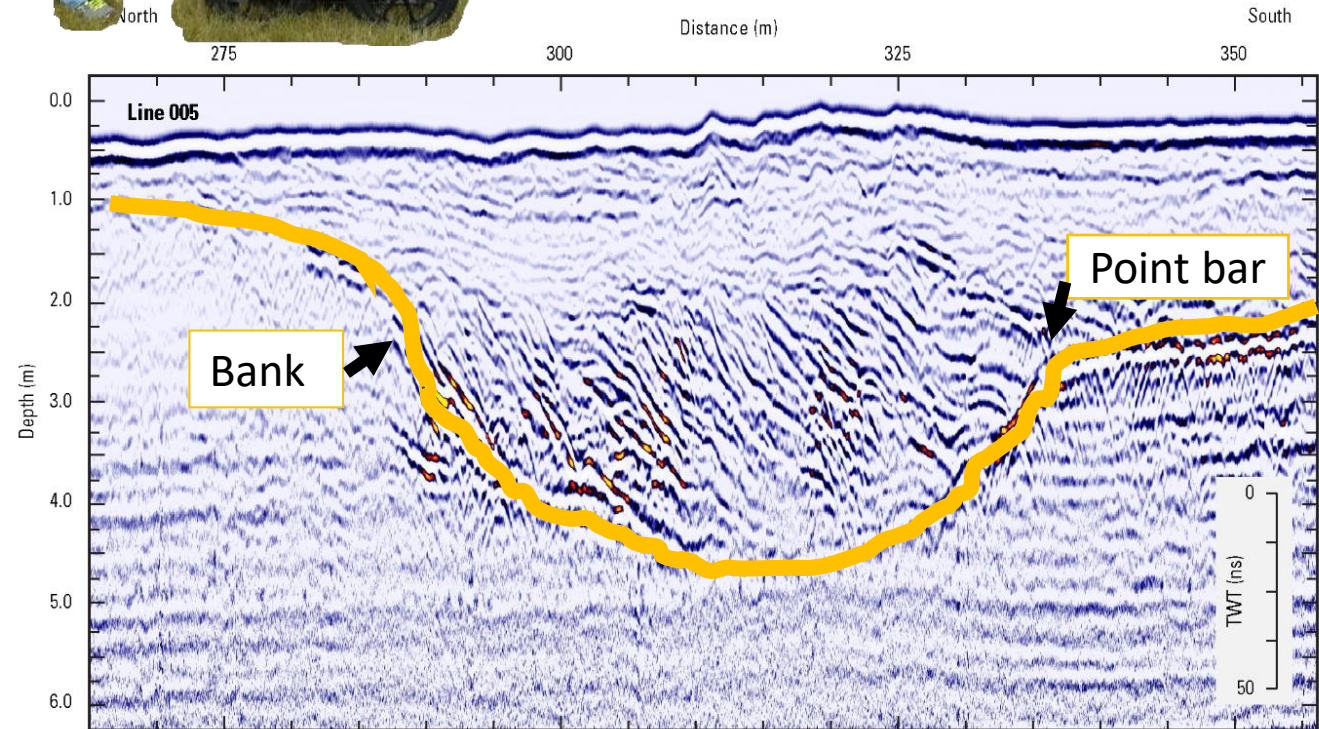


Ground Penetrating Radar (GPR)

- It is electromagnetic waves on the same frequency as landline telephones
- When it encounters another material, it will reflect or travel at a different velocity
- Very good for detecting shallow structures (<10 ft, utilities, USTs, mine tunnels)
- Good at answering “where?” (not “what”)
- Clay or reinforced concrete can limit depth of investigation

GPR (cont.)

- Typically GPR results do not require a lot of processing
- Can see results real time
- New UAS based surveys

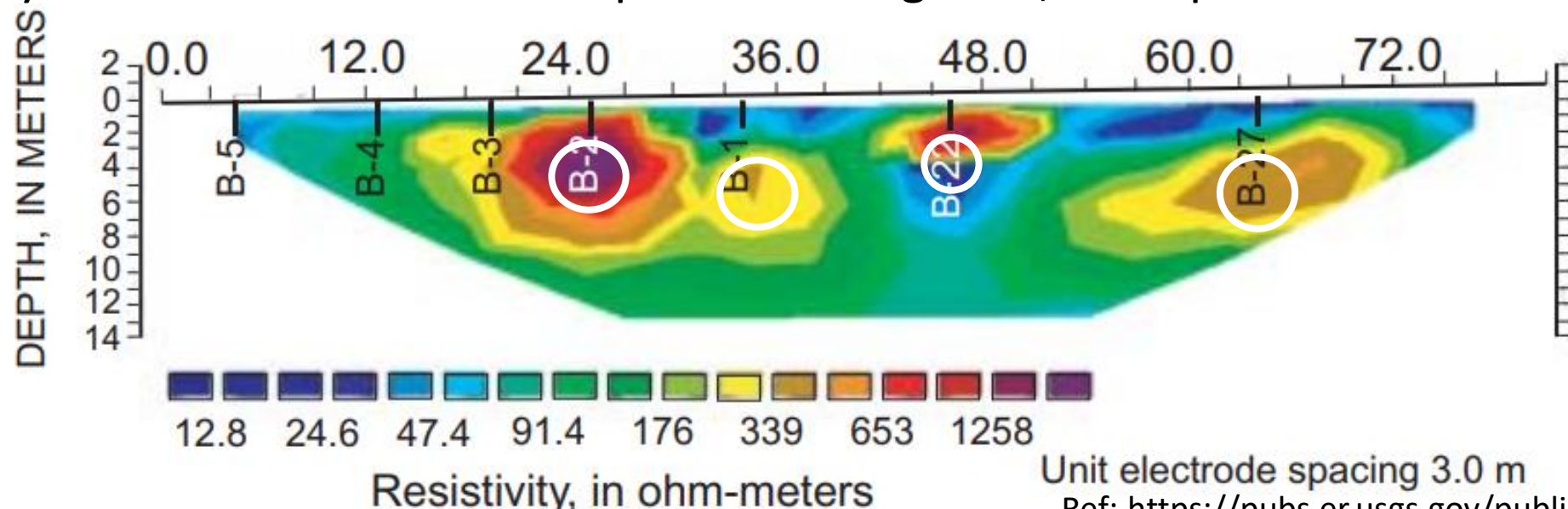


Provisional data. USGS.

Ref: <https://www.usgs.gov/media/images/ground-penetrating-radar-gpr-data-shows-buried-channel>

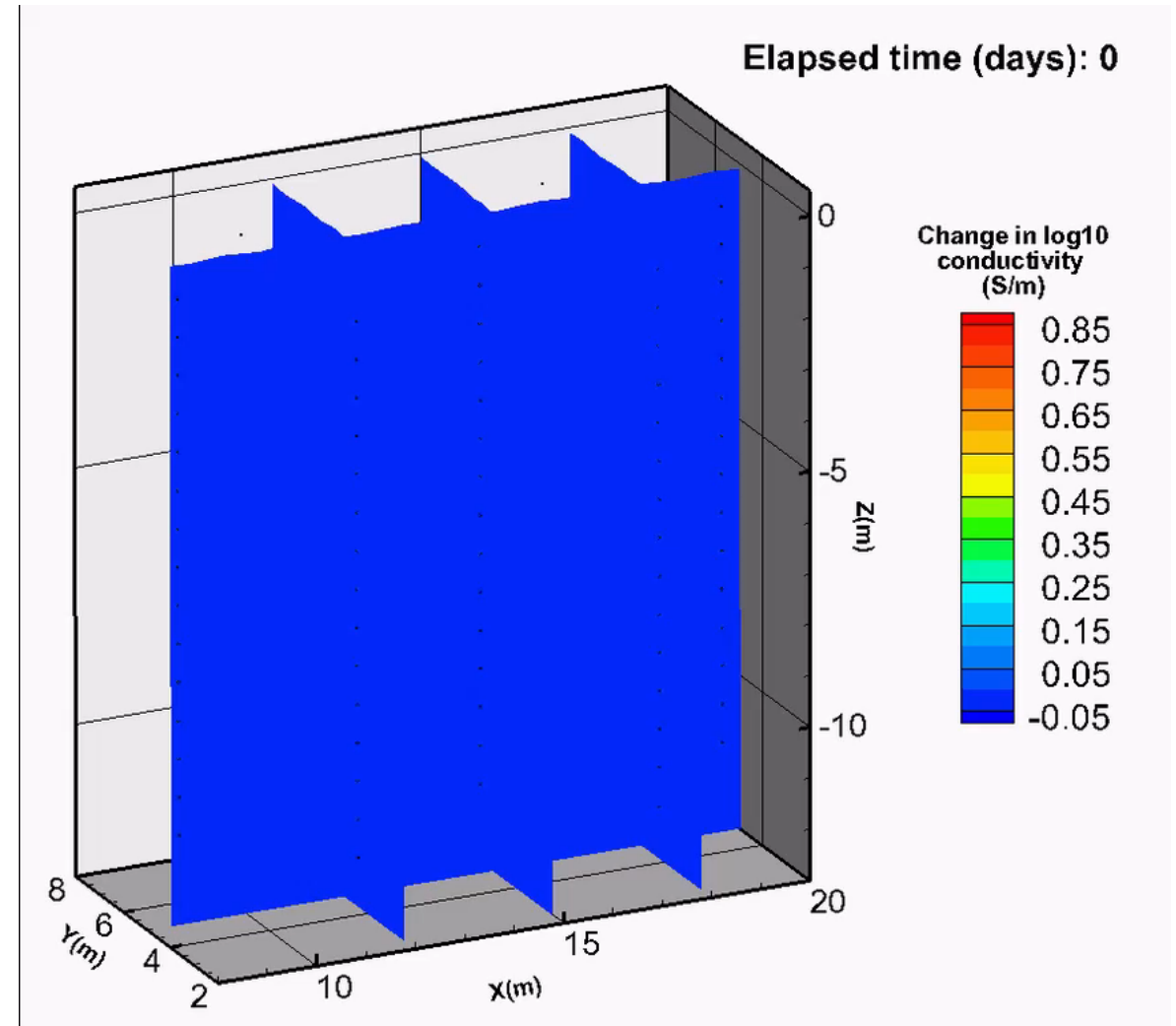
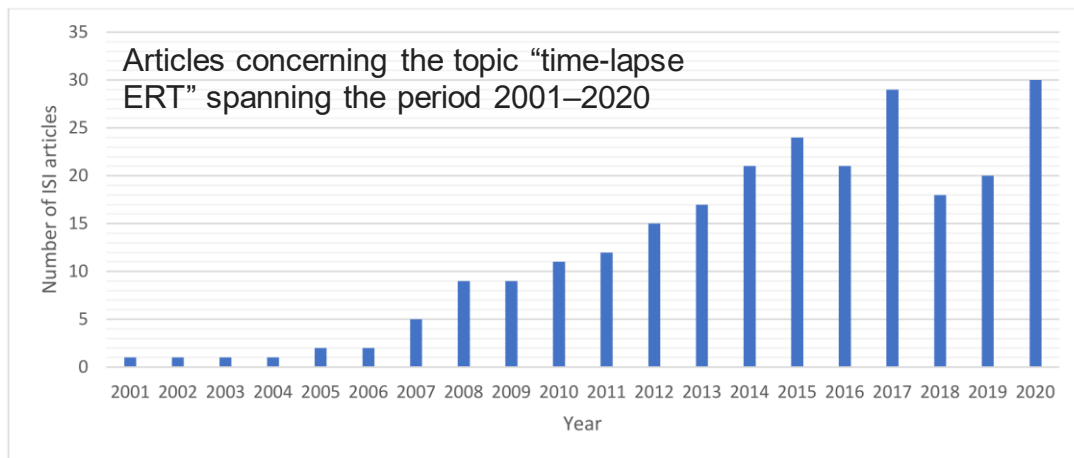
Electrical Resistivity (ERT/ERI)

- Send a current, reads the voltage, derives “resistivity” value ($V=IR$)
- Can power with car battery
- Good for distinguishing between materials (<100 ft, saturated zone vs free product, voids, igneous vs sedimentary, microbial activity!)
- With borehole info, connects the dots
- Highly resistive soils can limit depth of investigation; susceptible to electrical noise



Time-lapse Electrical Resistivity

- Resistivity measurements over time
- Monitoring water infiltration, injected amendments, plume migration, tracer studies, storage



Paper citation: Johnson TC, Versteeg RJ, Day-Lewis FD, Major W, Lane JW Jr. Time-Lapse Electrical Geophysical Monitoring of Amendment-Based Biostimulation. *Ground Water*. 2015 Nov-Dec;53(6):920-32. doi: 10.1111/gwat.12291. Epub 2014 Dec 2. PMID: 25457440.

Previous webinar by Fred Day-Lewis: https://www.clu-in.org/conf/tio/GeophysicalMethods_102918/

ERT + Seismic

Seismic:
geophone



Resistivity: Metal stake



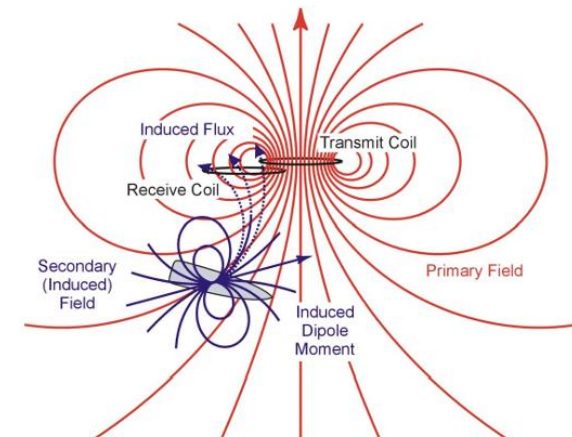
Electromagnetics (EM)

- May see it 2 ways:
- Detect groundwater seeps (gw-sw interaction)
- Locate faults
- Locate spills, buried drums, tanks, metal utilities, and metal objects
- 1-100s meters depth
- Susceptible to electrical noise, metal fences, rebar
- Surface map deliverable (on next slide)



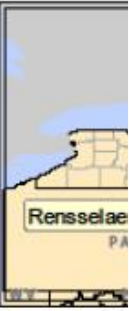
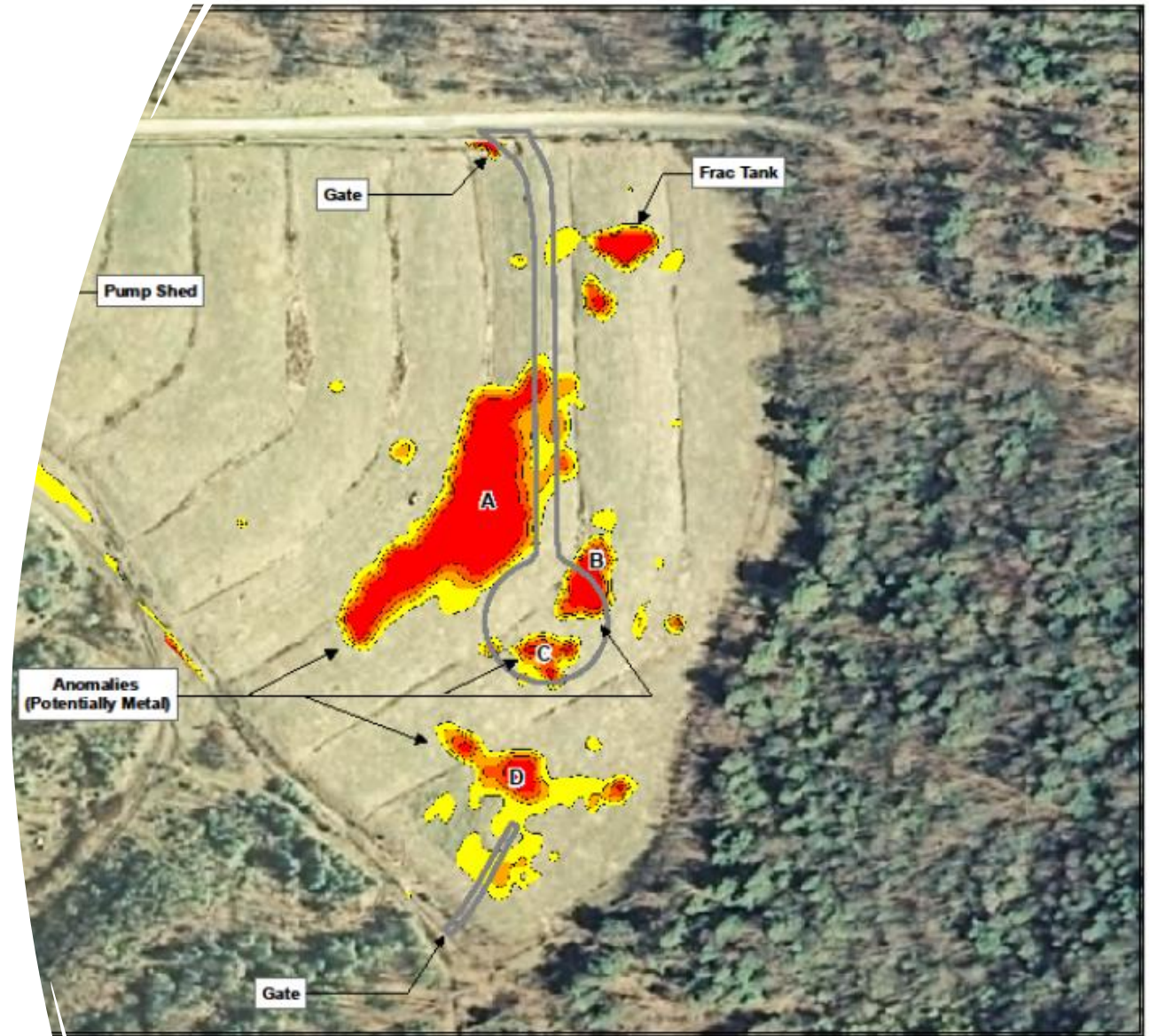
Helicopter towing a geophysical device as part of an electromagnetic and magnetic survey to collect TDEM data
([USGS](https://pubs.usgs.gov/of/2006/1257/pdf/OF06-1257.pdf))

Image of FDEM (Lucius et al., 2006
<https://pubs.usgs.gov/of/2006/1257/pdf/OF06-1257.pdf>)



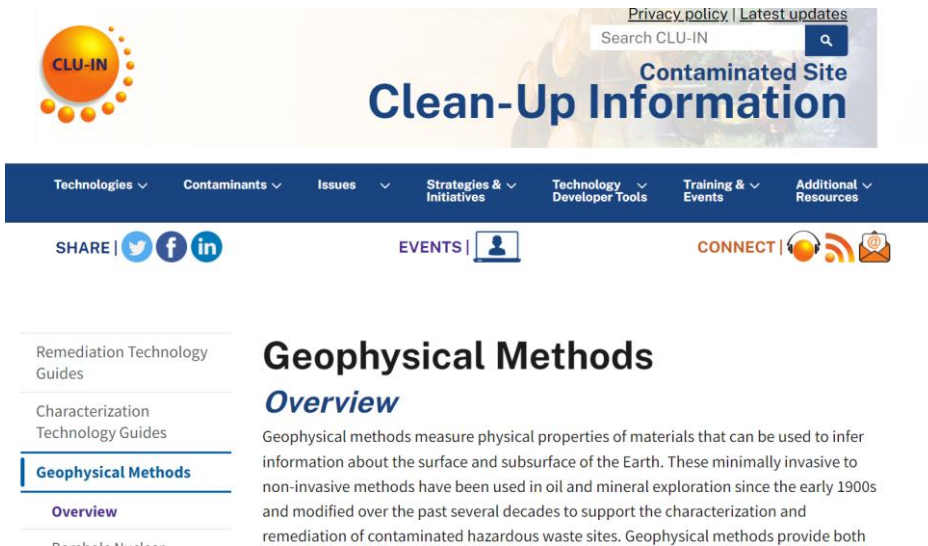
How to deploy Geophysics?

- Contractor/sub
- For EPA RPMs:
- Regional Science Support
 - ORD (via Superfund Technical Liaisons)
 - EPA's Emergency Response Team
 - USGS (via Interagency Agreements)
 - Reach out to me
(Dunnington.lucila@epa.gov)!




D R A F T

Public Resources



The screenshot shows the CLU-IN website header with the logo and navigation menu. The main content area is titled 'Geophysical Methods Overview' and includes a sidebar with 'Remediation Technology Guides' and 'Characterization Technology Guides'. The text describes geophysical methods as minimally invasive techniques used for site characterization and remediation of hazardous waste sites.



The screenshot shows the EPA website header with the logo and navigation menu. The main content area is titled 'Environmental Geophysics' and features a large image of a desert canyon with a blue overlay box containing the text 'Learn more about Environmental Geophysics' and a link to learn more about environmental geophysics and applications.

- **CLU-IN Geophysical Methods**- Case Studies, comparative costs and capabilities: https://clu-in.org/characterization/technologies/default2.focus/sec/Geophysical_Methods/cat/Overview/
- **EPA Environmental Geophysics**- Selection tools, Technology overviews, scientific papers: <https://www.epa.gov/environmental-geophysics>
- **HRSC Selection tool**- Simple to use screening for relevant tools: TBD