

Use of Non-Invasive Near-Surface Geophysics for Managing Brine Releases

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Brine or Produced Water

- Includes water from subsurface formations and water injected into formations that is brought to the surface during oil and gas production.
- Can have a salt content up to 4 times higher than seawater.





Why the concern about produced water?

• Produced water accounts for the largest waste stream volume associated with oil and gas production.



- Salt water is toxic to plant life.
- Salt water spills affect the ability of the impacted soil to resist erosion.
- Impacted fresh water aquifers are difficult to restore and damages awarded for groundwater impacts can be substantial.

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Total Dissolved Solid (TDS) content of produced water from US oil and gas wells.





Oklahoma Site: Near-Surface Geophysical Survey

 Water transfer line failure resulted in surface spill of >1,000 barrels (>42,000 gallons) of produced water.

Chloride concentration approx. 160,000 ppm.



Oklahoma Site: Extent of Visual Impacts and Resistivity Line Locations





Oklahoma Site: Near-Surface Geophysical Survey Objectives

- Non-invasively locate the vertical and lateral extent of brine impacts.
- Assess whether the brine release extended into a deep, bedrock aquifer beneath the shallow groundwater zone.
- Determine optimal location for recovery well installations.



Release Delineation Surface Geophysical Method –Electromagnetics (EM)

- Limited depth of penetration to approximately 5 feet below ground surface.
- Evaluates soil electrical conductivity.
- High-TDS plume delineation in the shallow subsurface.





Release Delineation Surface Geophysical Method – Electrical Resistivity Imaging (ERI)

- Greater depth of penetration than an electromagnetic (EM) Survey.
- Evaluates resistivity/conductivity of soil & groundwater.
- Geologic mapping (lithologic contacts, bedrock features)
- High-TDS plume delineation









Technology – Electrical Resistivity

DC current is introduced into the earth via two current electrodes and the produced voltage is measured with other electrodes. Using the geometry of the electrodes, resistivity is calculated.







































Resistivity Vs. Electromagnetics

Electrical Resistivity

Electromagnetics





EM and ERI Results Comparison



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EM and ERI Results Comparison





Oklahoma Site: 3D EVS Model (Environmental Visualization Systems)





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Findings/Conclusions

- Successful non-invasive imaging of produced water extent.
- Vertical as well as lateral delineation.
- Based on the results of the ER survey, vertical impacts in the vicinity of the release area did not extend beneath the shallow, alluvial groundwater zone.



Findings/Conclusions

- The use of surface geophysical methods eliminated the need for the installation of deep monitoring wells.
- To remediate impacted soils, approximately 48,500 tons of impacted soil were removed from the site.





Other Applications: ERI and Induced Polarization (IP) Surveys

NAPL Mapping – Aquifer/Lithology Mapping – 3D Injectate/Air Sparge Imaging – Brine Mapping



Using Non-Invasive Imaging BEFORE You Drill Saves Time and Money.

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