Gulf Coast Carbon Center: Near-Surface Update

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Content

- Groundwater
  - Sampling Updates
  - CO_2 Impacts on Groundwater
- Soil Gas
  - Process-Based Approach
  - Case Study – Cranfield P-Site
- Innovative New Methods

Field campaign for groundwater sampling

- Two field campaigns
  - June, 2013
  - December, 2013

  - ~10 water wells
  - Groundwater pH, alkalinity, DIC, concentrations of major and trace elements
  - Dissolved gases in groundwater, especially CH_4

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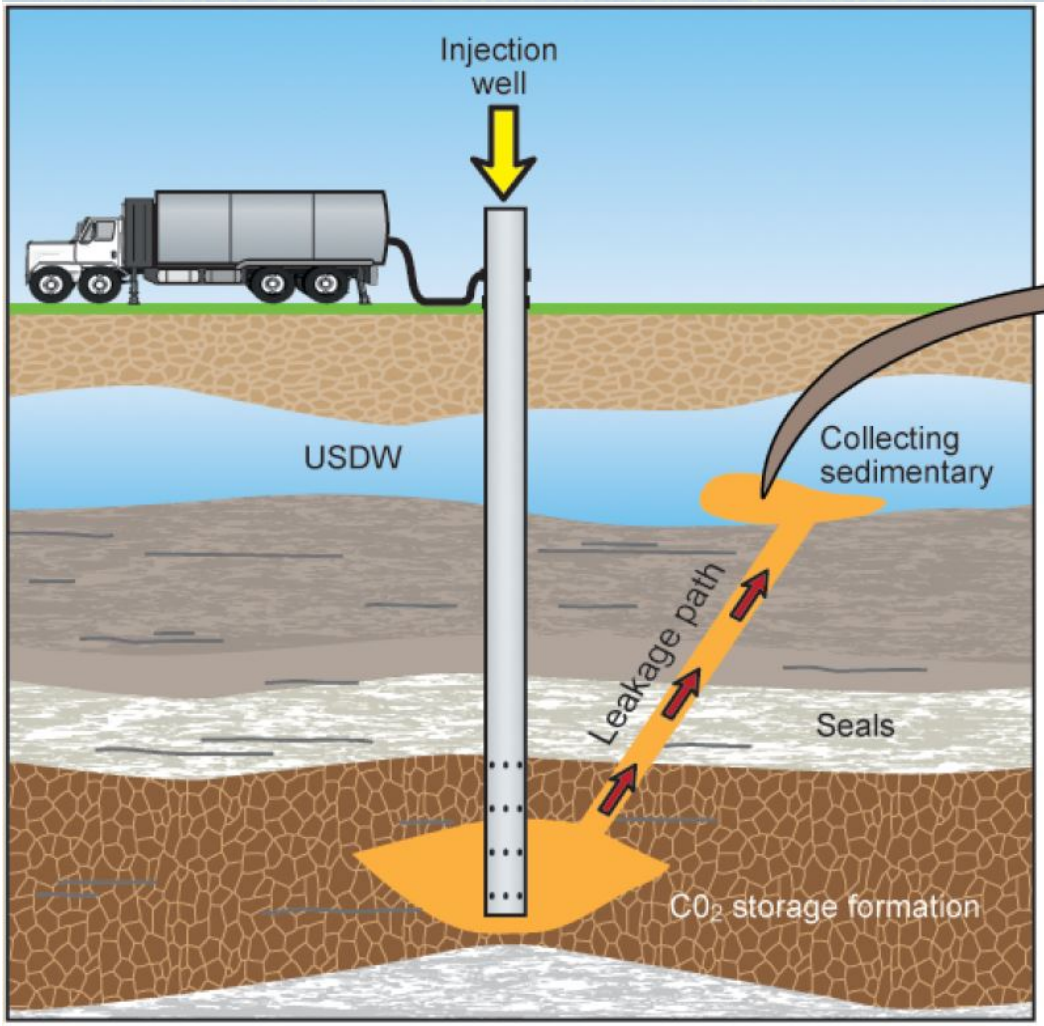
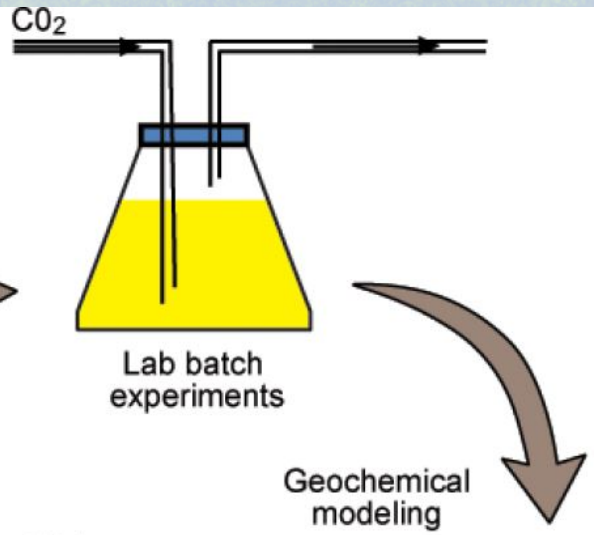
Field campaign for groundwater sampling

- No obvious change in groundwater chemistry in the shallow aquifer

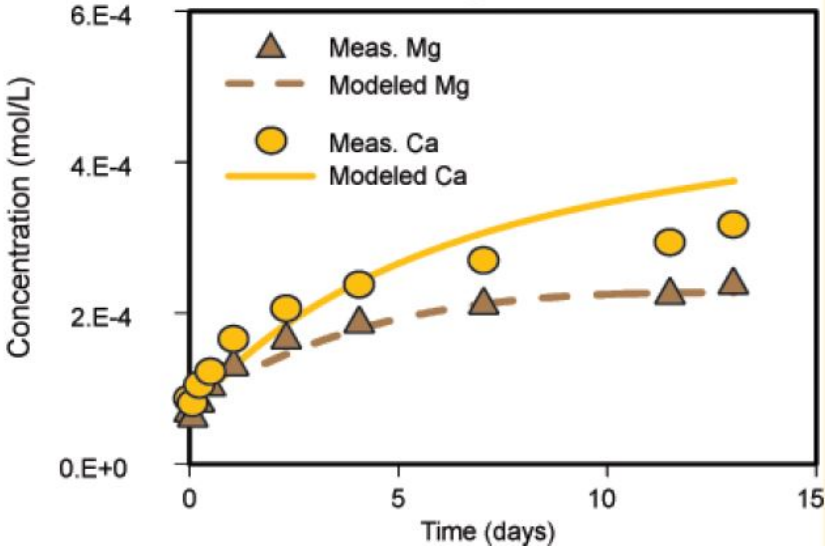
- Dissolved CH4 in groundwater are very low, some are under detection

Inverse Modeling of Water-Rock-CO_2 Batch Experiments: Potential Impacts on Groundwater Resources at Carbon Sequestration Sites





Geochemical modeling



Inverse Modeling of Water-Rock-CO_2 Batch Experiments: Potential Impacts on Groundwater Resources at Carbon Sequestration Sites

- Groundwater pH reductions were more significant in the carbonate-poor aquifers than in the carbonate-rich aquifers.

- The geochemical model confirmed that mobilization of trace metals was caused likely by mineral dissolution and desorption from clay mineral surfaces.

- A selection of geochemical parameters are needed for site-specific CO2 leakage detection.

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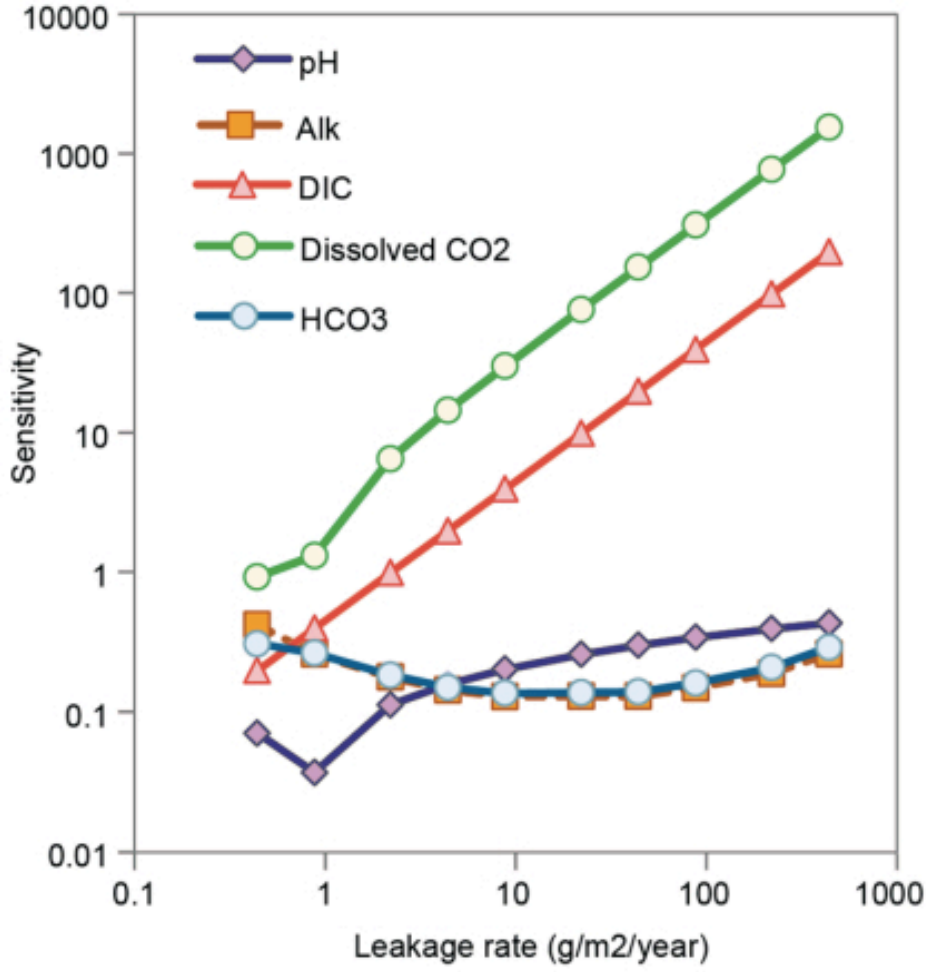
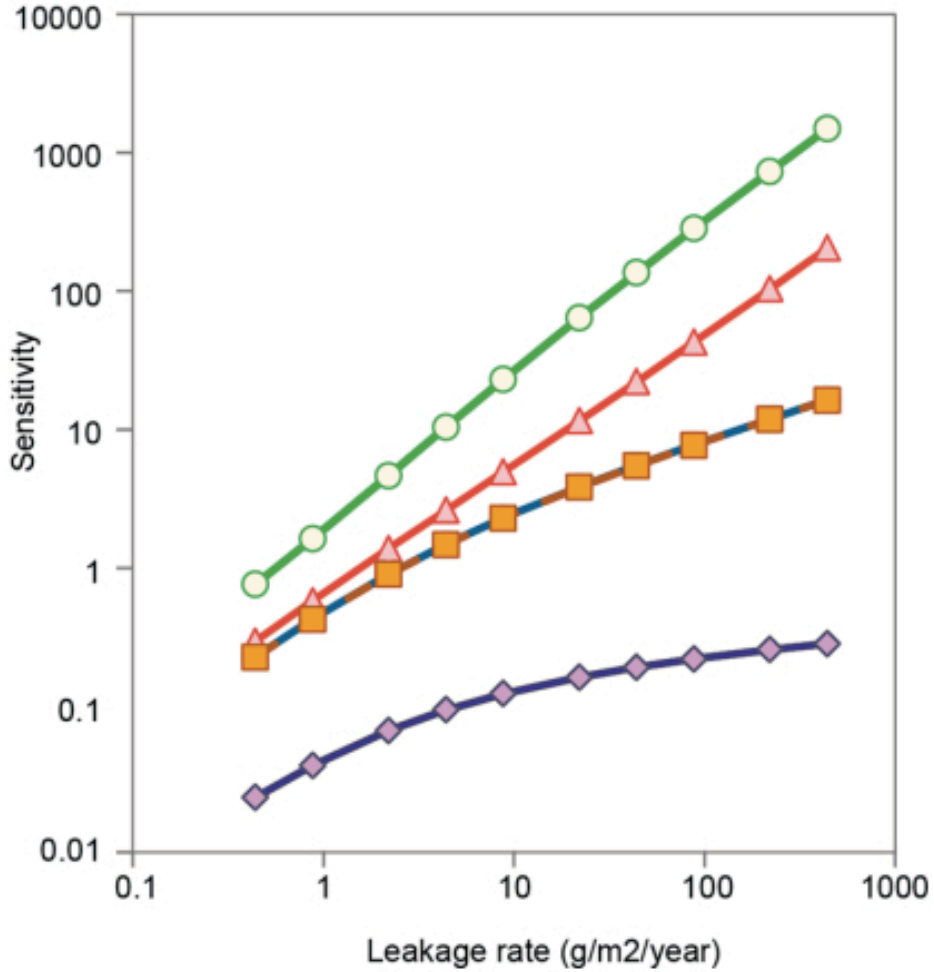
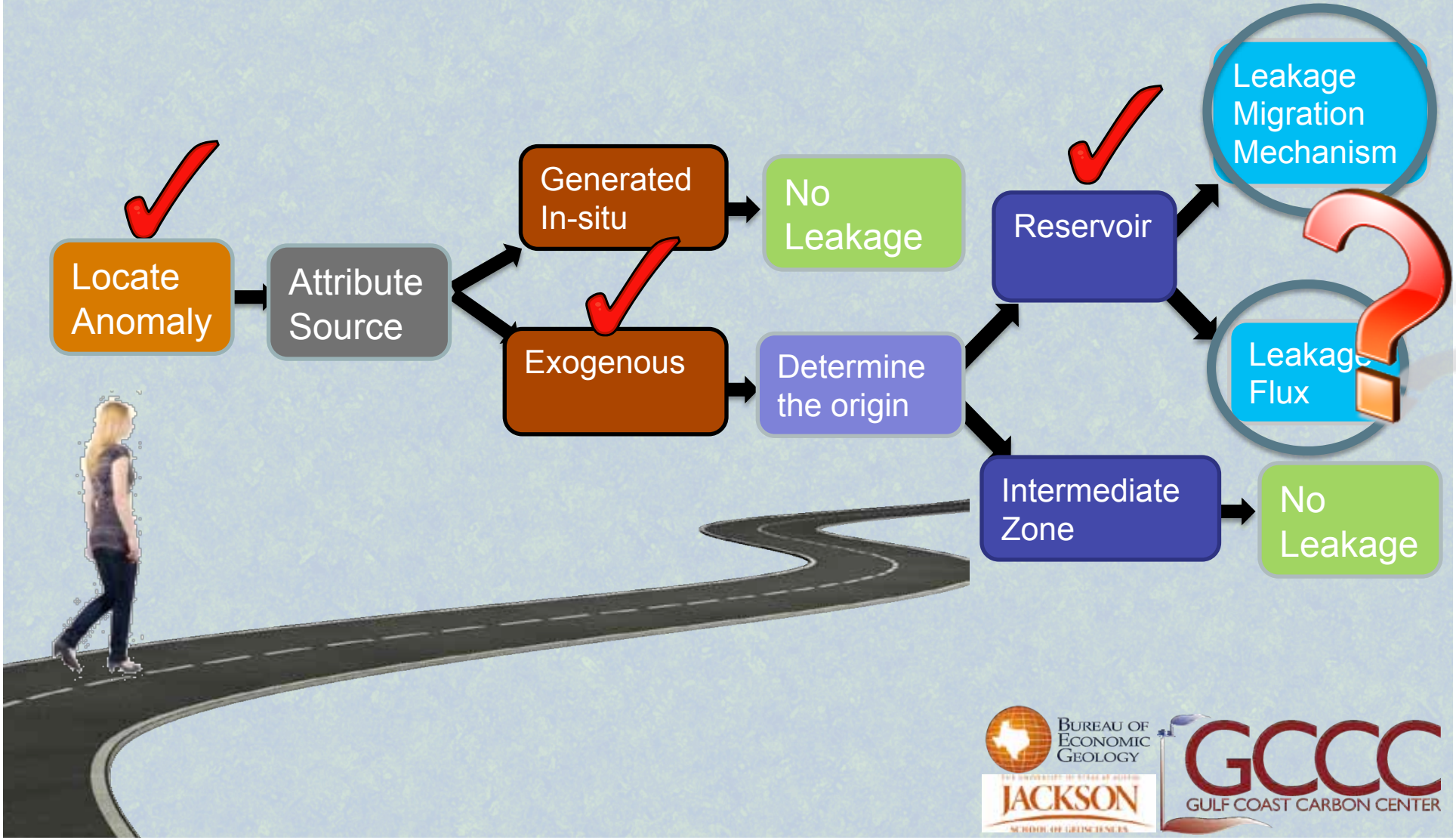
Geochemical sensitivity to CO_2 leakage: detection in potable aquifers at carbon sequestration sites





Near-Surface Leakage Assessment



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Process-Based Soil-Gas Approach

- Developed at a natural CO_2-rich perched playa wetland in West Texas (Romanak et al., 2012)
- Tested at ZERT Controlled Release Field Laboratory (Romanak et al., 2013a)
- Applied at the Kerr Farm, Weyburn-Midale Oilfield where landowners claimed leakage (Romanak et al., 2013b)

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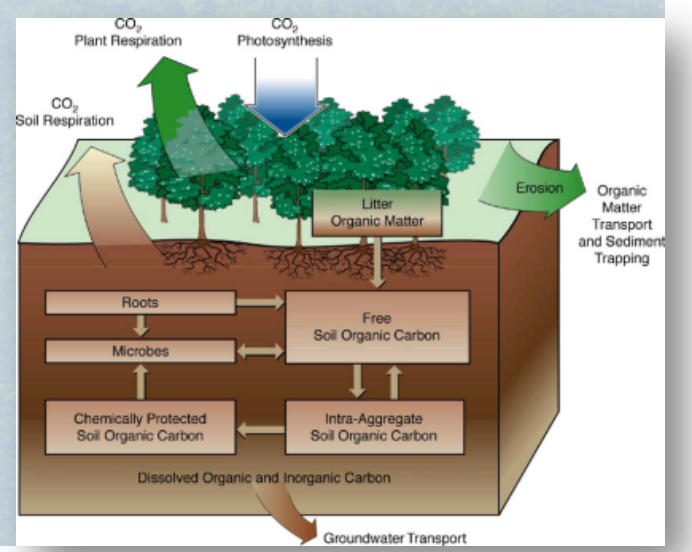
Process-Based Approach

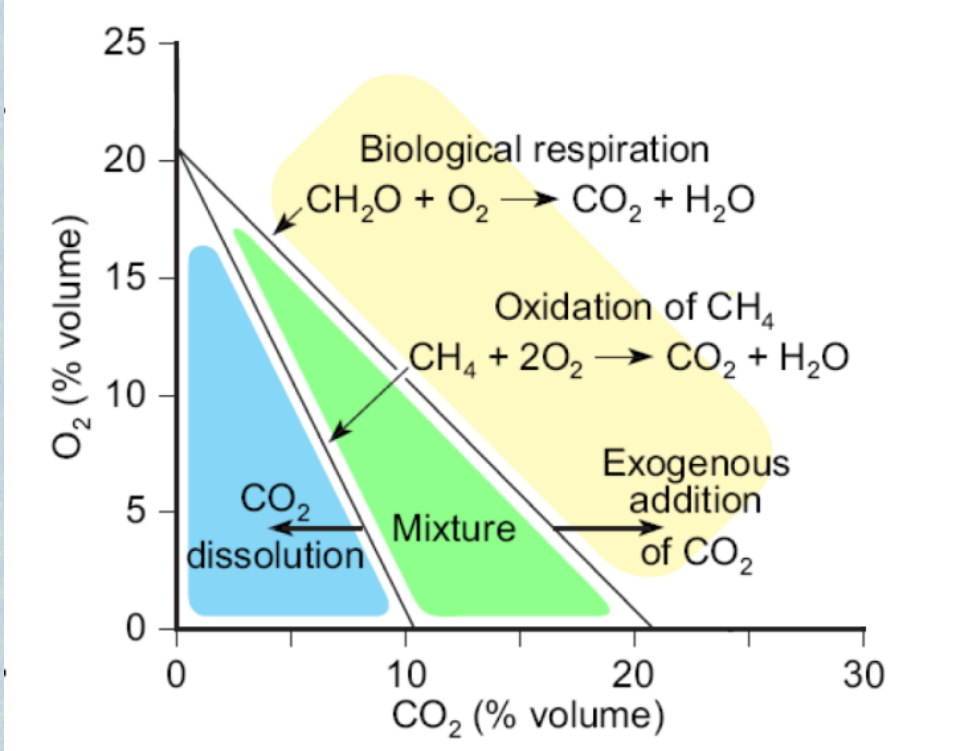
- Approach for near-surface leakage detection above CCS sites
- Different than concentration-based methods that rely on 1-3 years of background measurements and large complex data sets
- Promptly identifies a leakage signal using 3 important ratios of simple coexisting gases (CO_2, CH_4, N_2, O_2)
- Discerns among:
  - Methane oxidation
  - Biologic respiration
  - CO_2 dissolution and reaction with carbonate
  - Atmospheric mixing/dilution
  - Leakage Signal



Process-Based Gas Ratio - 1

O_2 vs. CO_2

- Indicates natural processes that affect CO_2 concentrations
- Distinguishes among respiration, CH_4 oxidation and dissolution
- Gives an initial assessment of leakage



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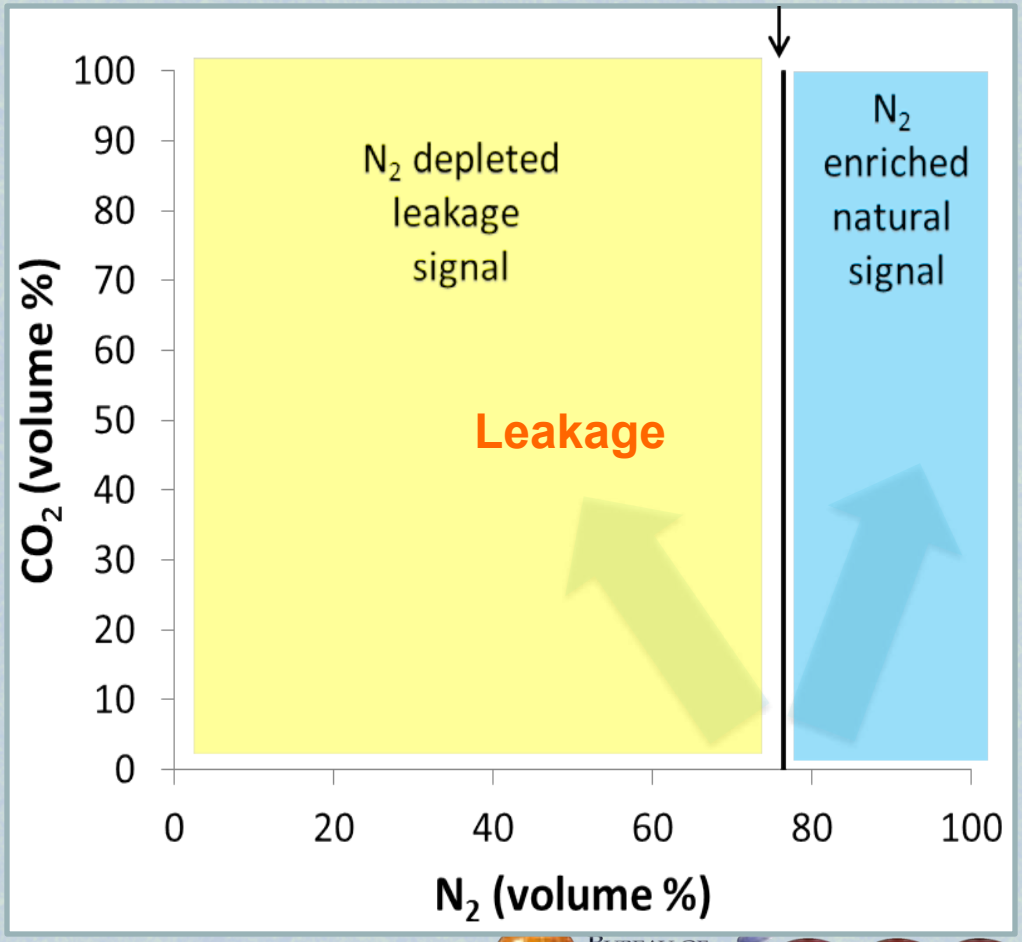
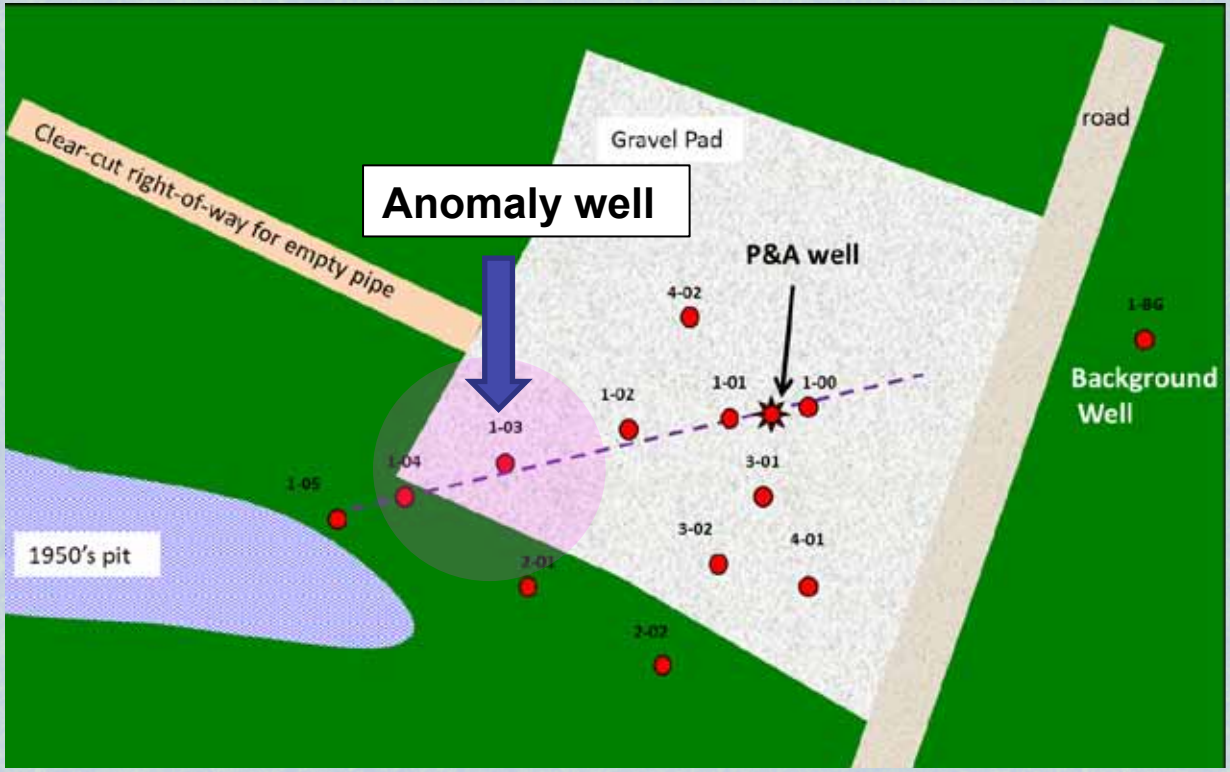
Process-Based Gas Ratio - 2

CO_2 vs. N_2

- Identifies whether gas has migrated from depth.
- Indicates whether CO_2 is being added through leakage or lost through dissolution.



Cranfield, MS P-Site



- Pad, Pit, Plants, P&A well
- Localized monitoring beginning Sept 2009
- 13 multi-depth soil gas sampling stations - 5 m depth
- Localized soil gas anomaly at 1-03
  - **$CH_4 \leq 50$ vol. %**
  - **$CO_2 \leq 45$ vol. %**

Locate Anomaly

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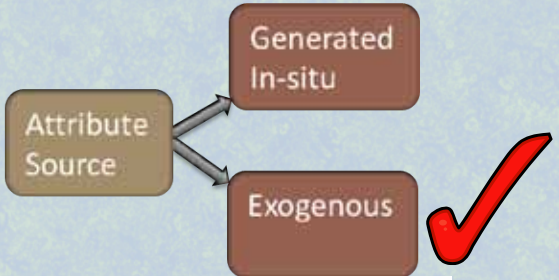
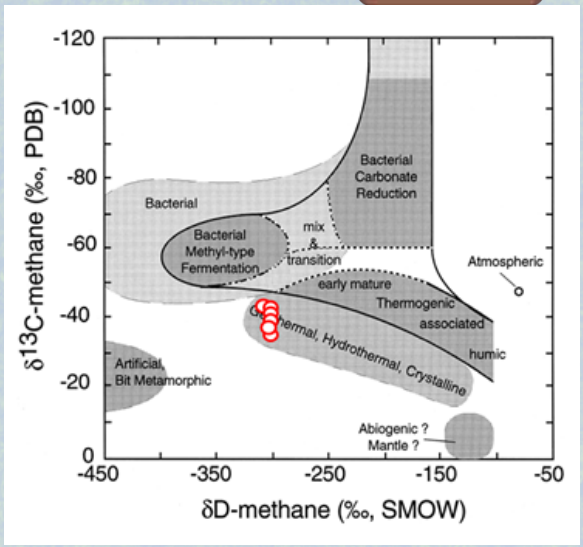
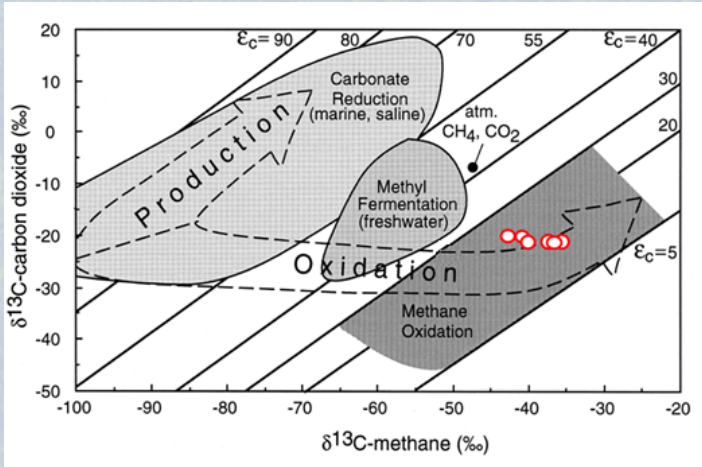
Attribute Source



Exogenous Source Confirmed by Isotopic Signature

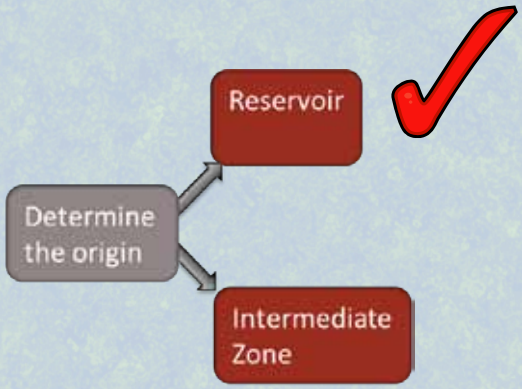
- Anomalous CH_4 from a deep thermogenic oil and gas reservoir
- CO_2 derived from oxidation of the methane

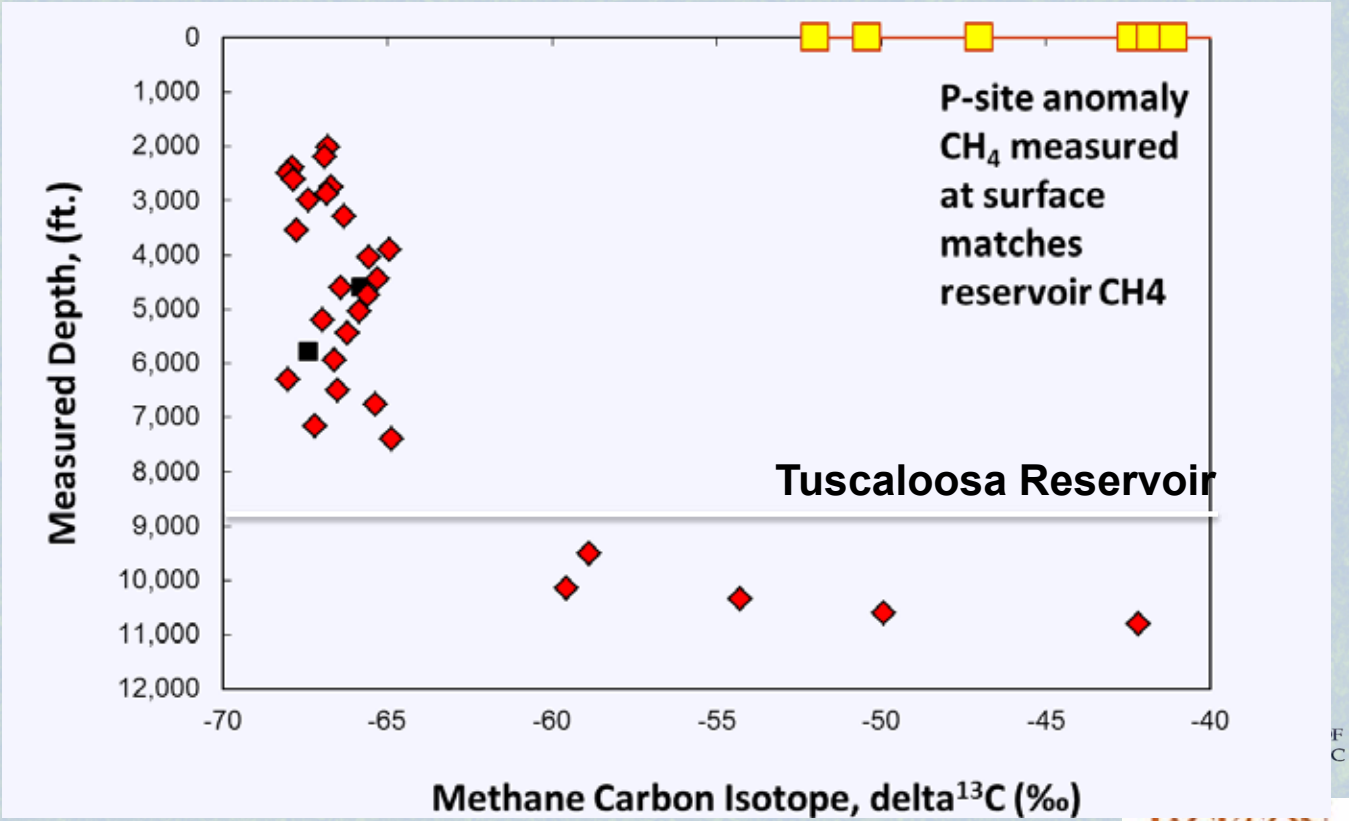




Determining Origin

Tuscaloosa reservoir (10,000 ft, 3200 m)
or intermediate Wilcox (6,000 ft, 2000 m)





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Environmental

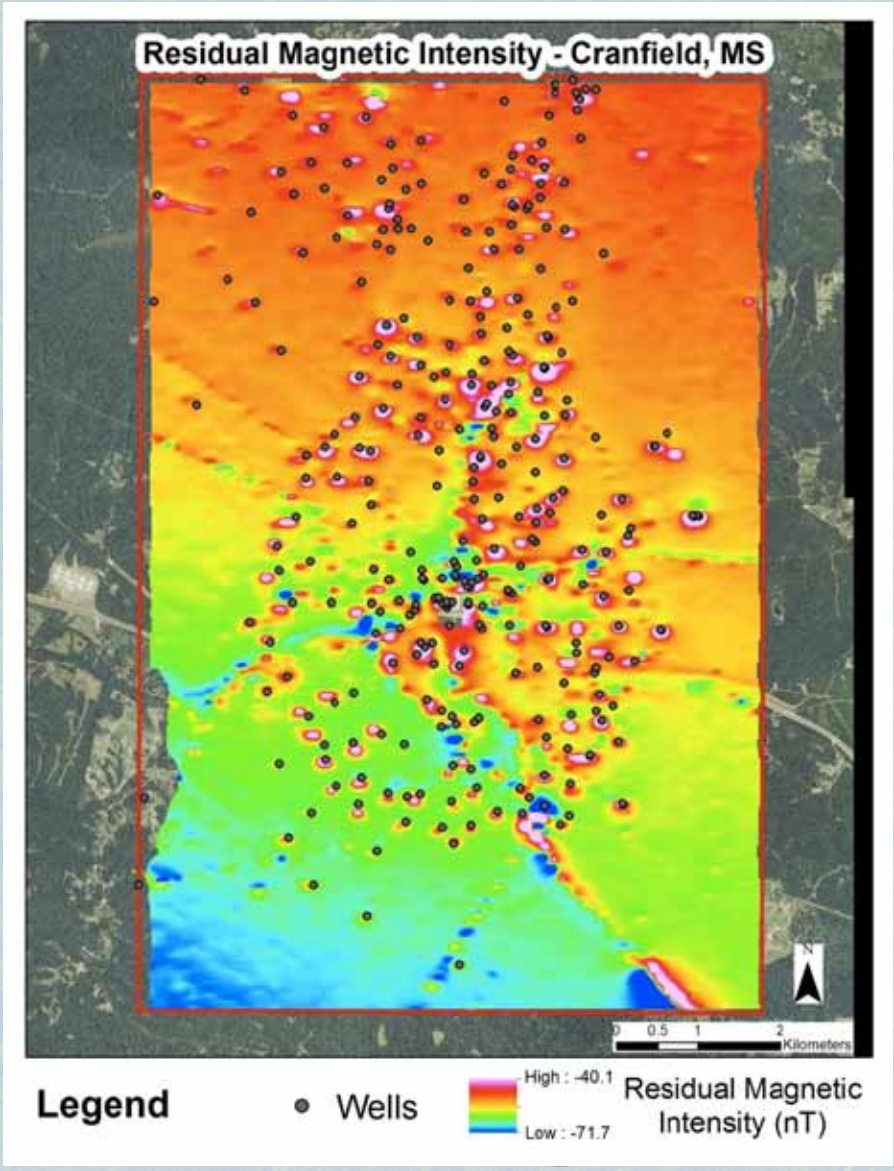
Innovative Use of Magnetics

Goal:

- Improve CCS site characterization by identifying past hydrocarbon migration.
- Hydrocarbon migration can cause deposition of magnetic minerals.

Next Steps:

- Remove cultural signals.
- Remove regional geological trend.
- Identify near-surface geological anomalies.



Conclusions

- Almost no observed changes in groundwater chemistry from injection.
- Numerical simulations show that DIC is most sensitive to leakage.
- Process-based soil gas monitoring can effectively identify leakage.
- Future work includes migration pathway identification and innovative monitoring methods.