NATIONAL ENERGY TECHNOLOGY LABORATORY

# NETL's Near-Surface $CO_2$ Monitoring Program

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**Workshop on UK-US Collaboration on Energy RTD**

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# NETL's Near-Surface $CO_2$ Monitoring Program

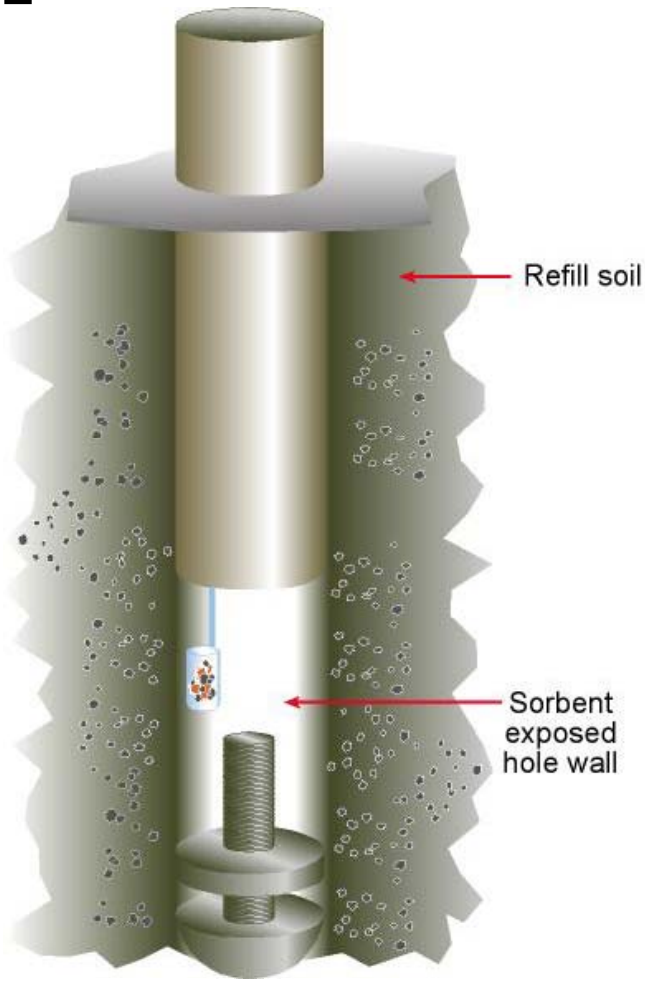
- **Monitoring to near surface for leakage of sequestered $CO_2$**

- **Programmatic Goal: "99 percent storage permanence: After 100 years, less than one percent of the injected $CO_2$ has leaked or is otherwise unaccounted for." –CCS Roadmap**

- **Need to quantitatively establish permanence of carbon sequestration based on measurable parameters**

# NETL Tracer Detection

- Perfluorocarbon tracers co-injected with $CO_2$ (mL to ton levels)
- Detachable Head Penetrometer equipped with CATS (Capillary Adsorbent Tracer Samplers)
- Collection by soil gas probes, tethered balloons and unmanned helicopters.
- Also can detect from produced fluids.
- Tracers detected by gas chromatography/mass spectroscopy



# Complementary Direct Soil Gas Monitoring

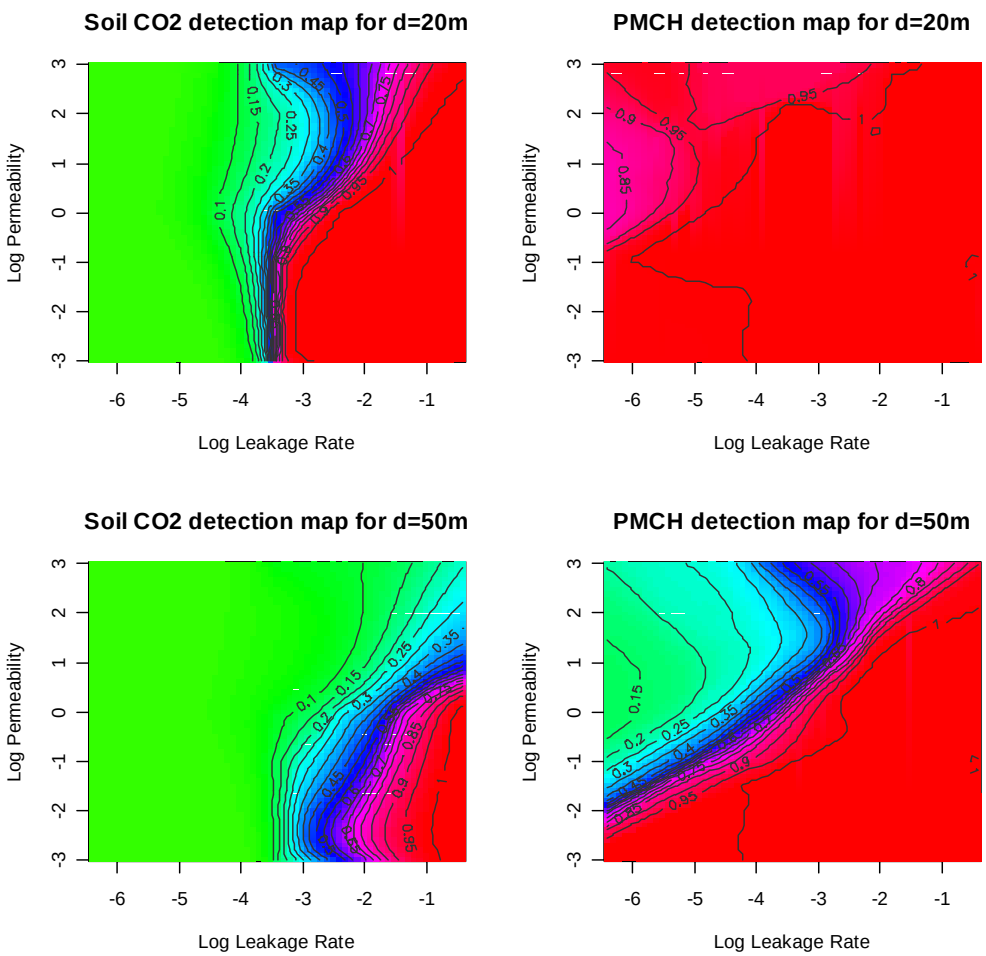
- **$CO_2$ Soil flux measurements**
- **Soil gas depth profiles**
  - GC determination of $CO_2$
  - $\delta^{13}C$ of $CO_2$ (stable isotope ratios)
  - Hydrocarbons as natural tracers

# Strata Interactions Laboratory (PFTs and Carbon Dioxide)

- Flow experiments through relevant mineral and soil media.
- Provide Fundamental Parameters for Reservoir and Migration Pathway Simulations
- Evaluate the Retention of Tracers and $CO_2$ on Reservoir and Overlying Strata

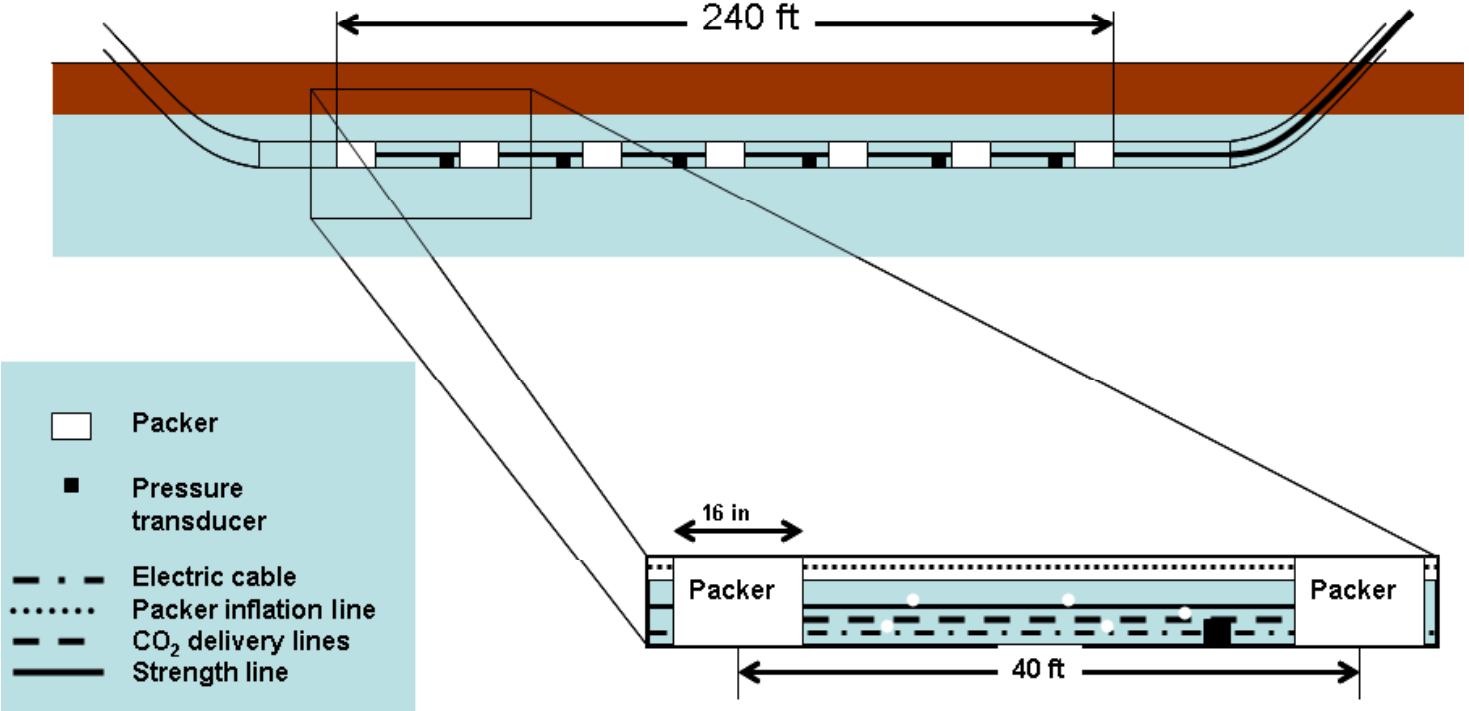
# Bayesian Belief Network Study

- **Bayesian Belief Network used to determine monitoring confidence levels (probability of false positives and false negatives) and to design monitoring grids.**
- **The probability of detection of Soil $CO_2$ flux and PMCH tracer methods for different site conditions (permeability and leakage rate) and two monitoring densities (distance between monitors (d), d= 20m and d= 50m) are shown here.**
- **The red color indicates detecting the probability of detecting a leak is ~1.0, while in the green region, the probability of detecting a leak is ~0.0.**



# Example Results ZERT experiment

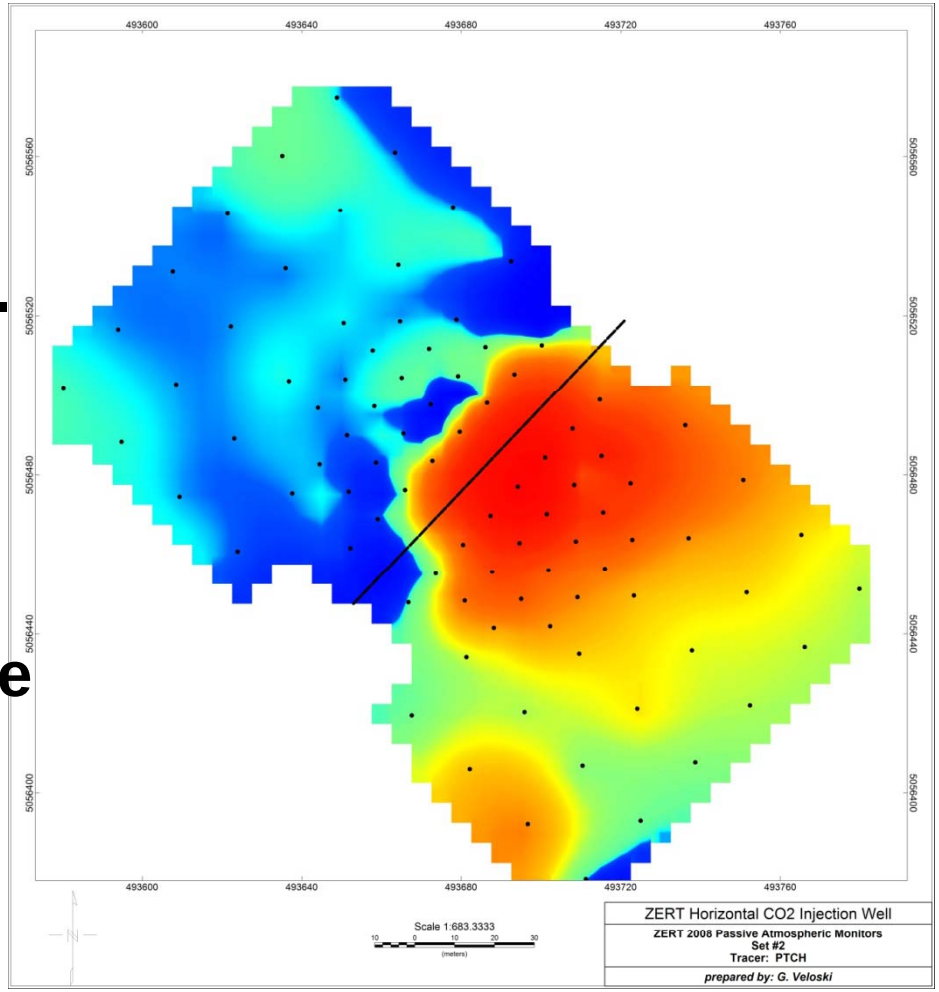
- **Small Injection into the shallow subsurface to simulate leakage from sequestration**
  - 240 foot horizontal well at depth of 5-10 feet
  - Injection to 6 isolated sections.
  - 0.3 ton/day release in July 2008
  - Tracer injected at 9mL tracer/ton $CO_2$

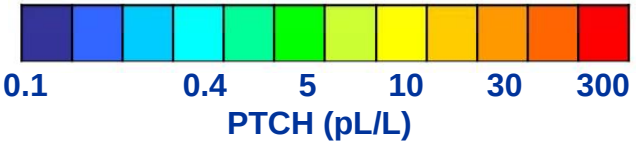


# Example Results: ZERT experiment

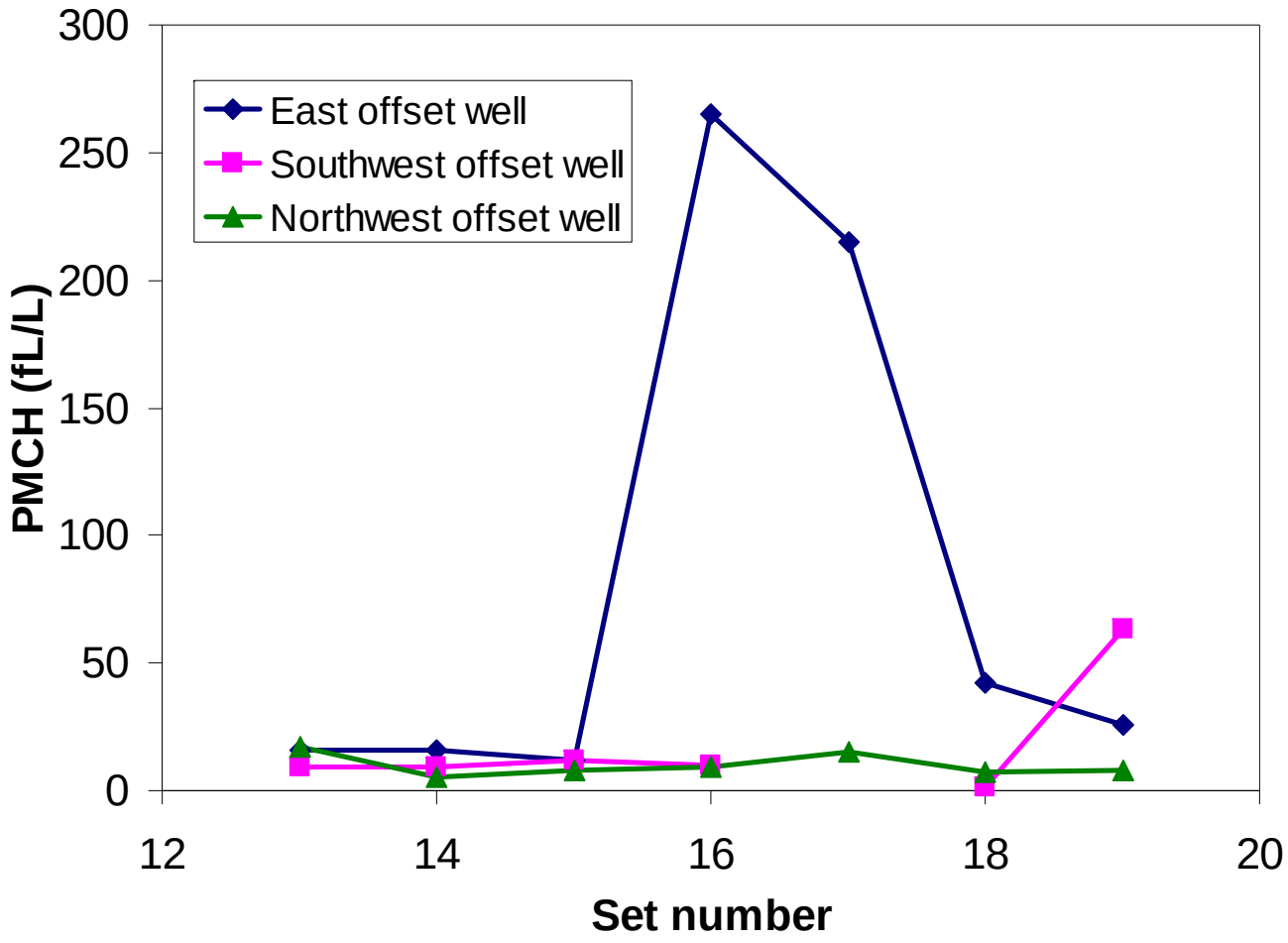
- Atmospheric plume of tracers detected at five orders of magnitude beyond background levels.

- Proven to be highest sensitivity technique deployed at this multi-organizational collaborative site,



# Detection of Tracers in produced gas (Pump Canyon Project)




- 13 – Oct 14- Oct 24
- 14 – Oct 25- Nov 12
- 15 – Nov 13- Dec 12
- 16 – Dec 13- Feb 20
- 17 – Feb 21- Apr 13
- 18 – Apr 14- May 29
- 19 – May 29- Jul 4

# Conclusions

- **Perfluorocarbon tracers provide an inert and highly sensitive means of detecting very low levels of leakage.**

- **Field verification, laboratory experimentation and statistical modeling are currently underway to further develop the technology.**