Quality Assurance and Control Procedures to Improve Soil-Gas Sampling Methods in Stray Gas Investigations

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PSE Healthy Energy

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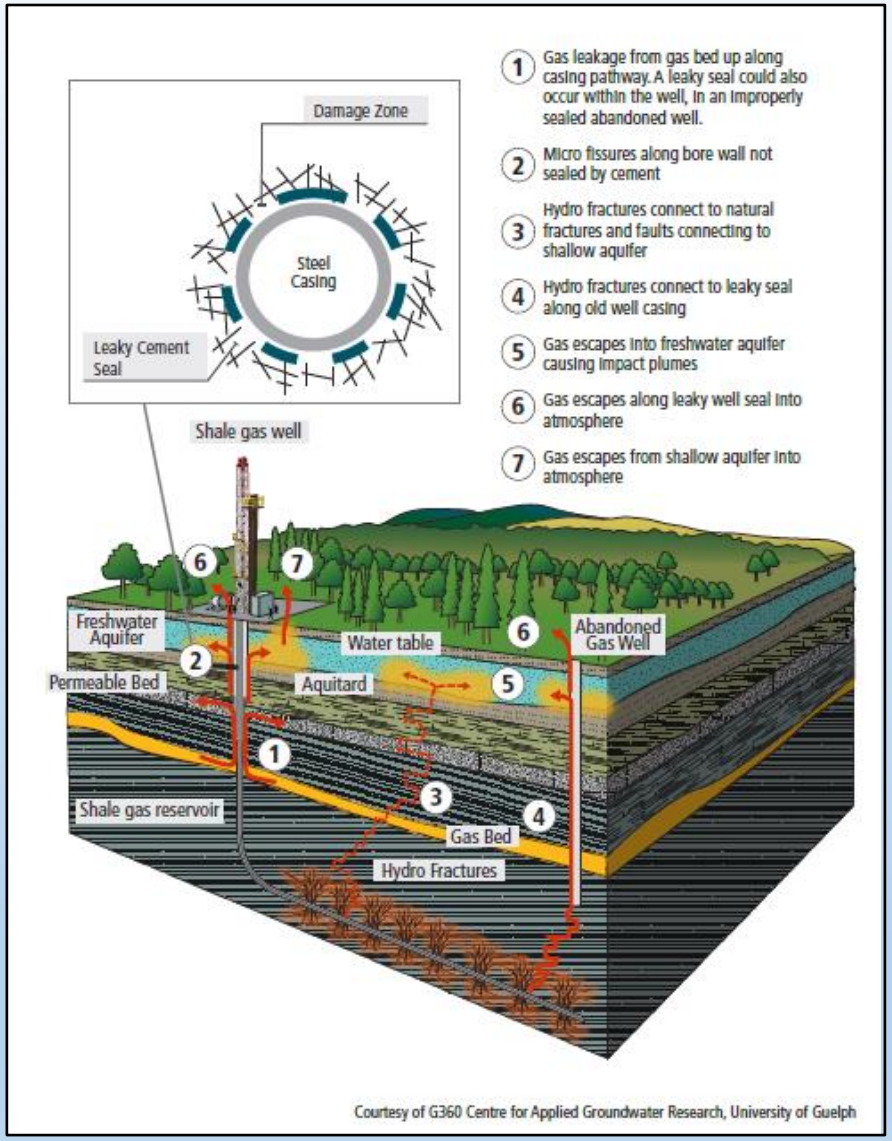
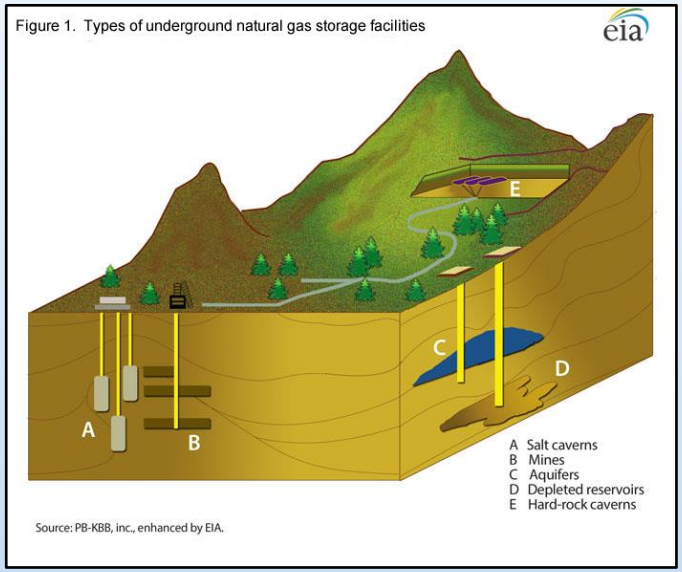
Why Conduct this Research?

Monitoring leakage during gas development



Monitoring leakage from natural gas storage reservoirs

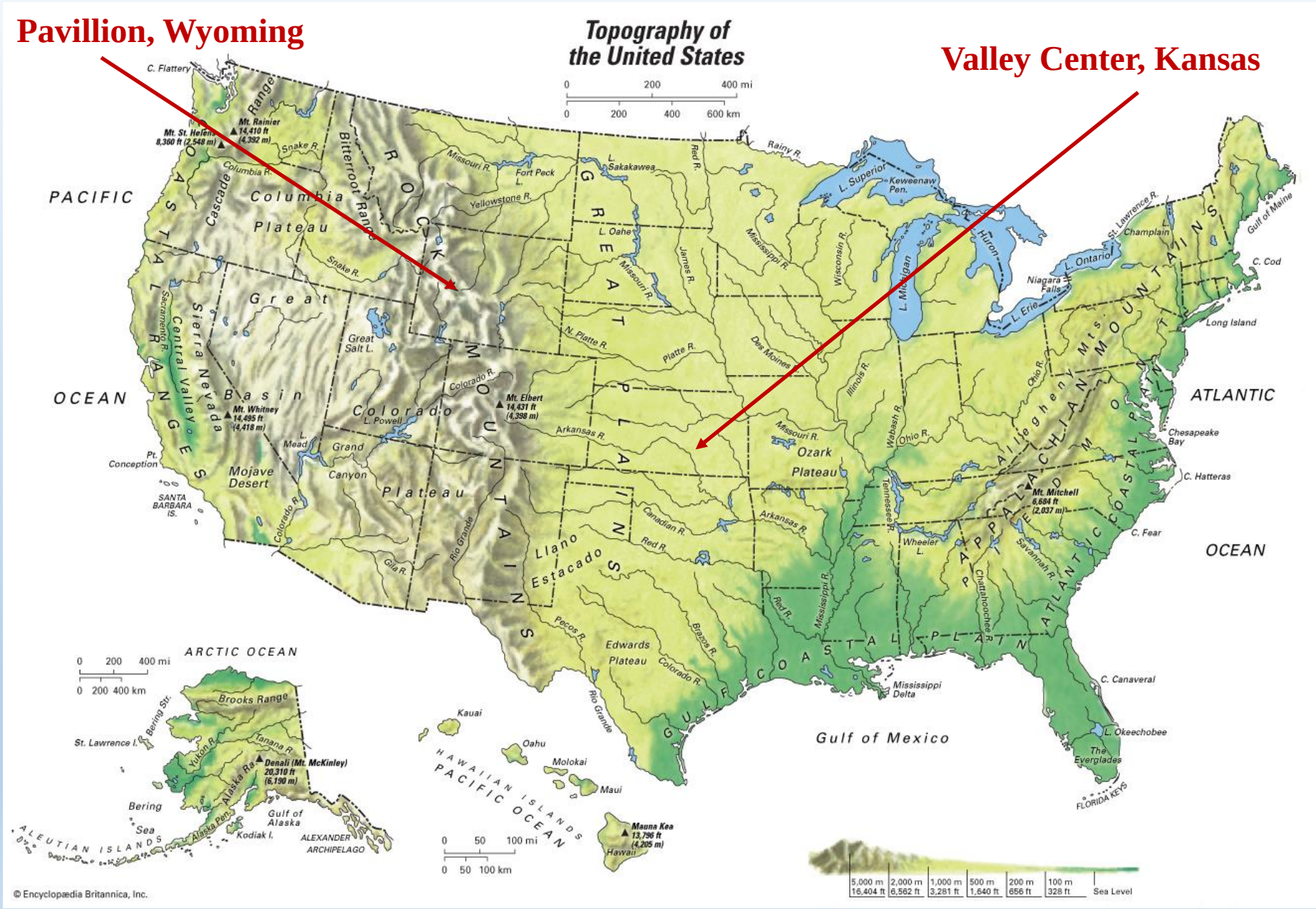


Monitoring leakage from pipelines

Crews continue to investigate a fatal house explosion on April 27, 2017 in Firestone, Colo. RJ Sangosti—Denver Post/Getty Images

QA/QC protocols are lacking for soil-gas sampling to support stray gas investigations.

Study Locations



Study Locations

Valley Center, Kansas (CO_2)

During heavy precipitation, low O_2 (10%) and high CO_2 (7%) in basements caused by rapidly rising water table.

Pavillion, Wyoming (CH_4)

Natural gas charged groundwater

Environmental Science & Technology

Article

pubs.acs.org/est

Impact to Underground Sources of Drinking Water and Domestic Wells from Production Well Stimulation and Completion Practices in the Pavillion, Wyoming, Field

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Elements of Field-Based Research

- Leak Testing (discussed here)
- Calibration and Bump Testing of Portable Gas Analyzers
- Gas Permeability Testing
- Equilibration Testing
- Flow Testing
- Purge Testing

Data from U.S. EPA – public domain

Points of Leakage in Vapor Probe Clusters (7 tested)

Vapor Probe Cluster
at Valley Center, KS

15 cm cast iron
bolted
well cover

(1) Leakage from chamber fittings and sample train

(2) Leakage from surface through quick-connect bodies

Swagelok
stainless-steel
quick connect body

(3) Leakage from surface to upper probe

Washed 20 - 40 sand

~ 30 cm

(4) Leakage between upper and intermediate probe

6.35 mm O.D. stainless-steel
tubing

6.35 mm O.D. 15.24 cm long
Geoprobe® stainless-steel screen

(5) Leakage between intermediate and lower probe

Bentonite grout

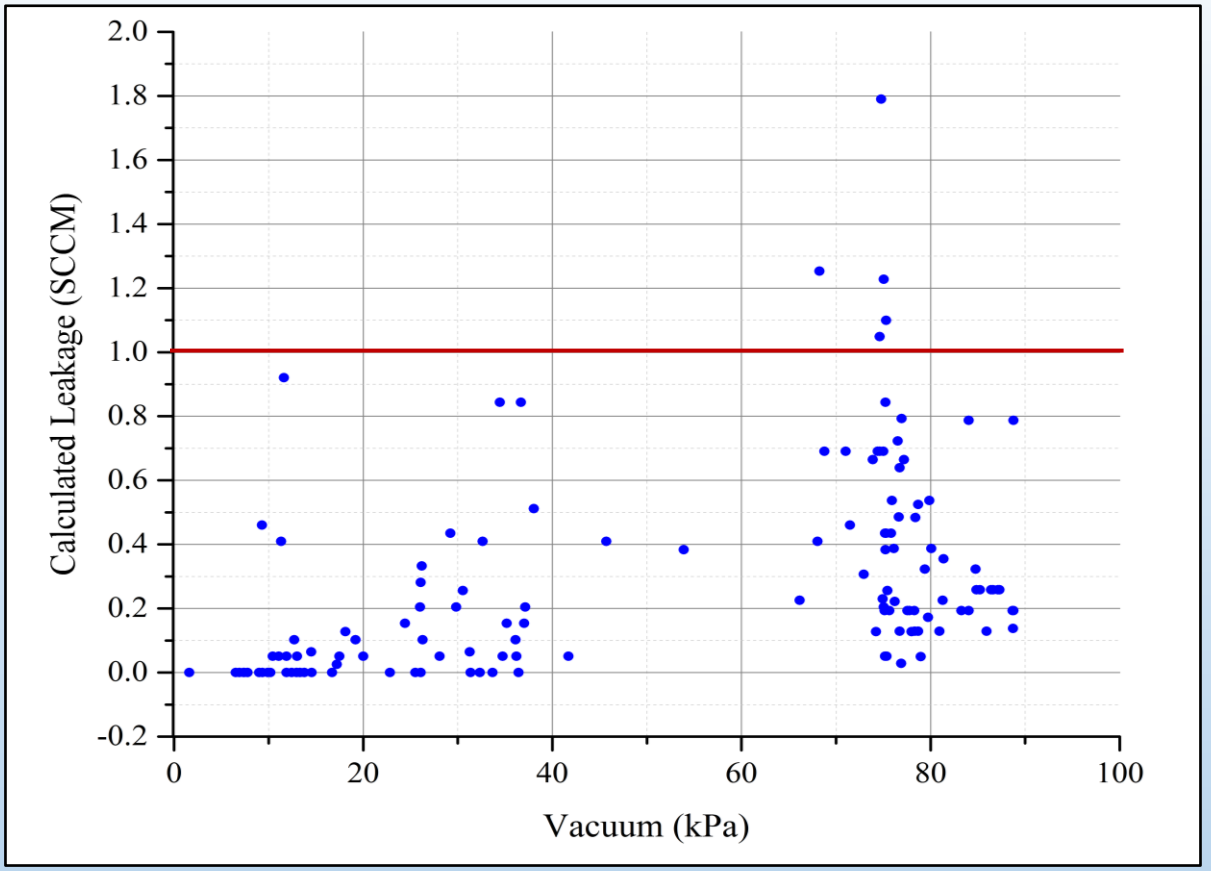
Granular Bentonite

~ 7-8 cm

~ 6 cm

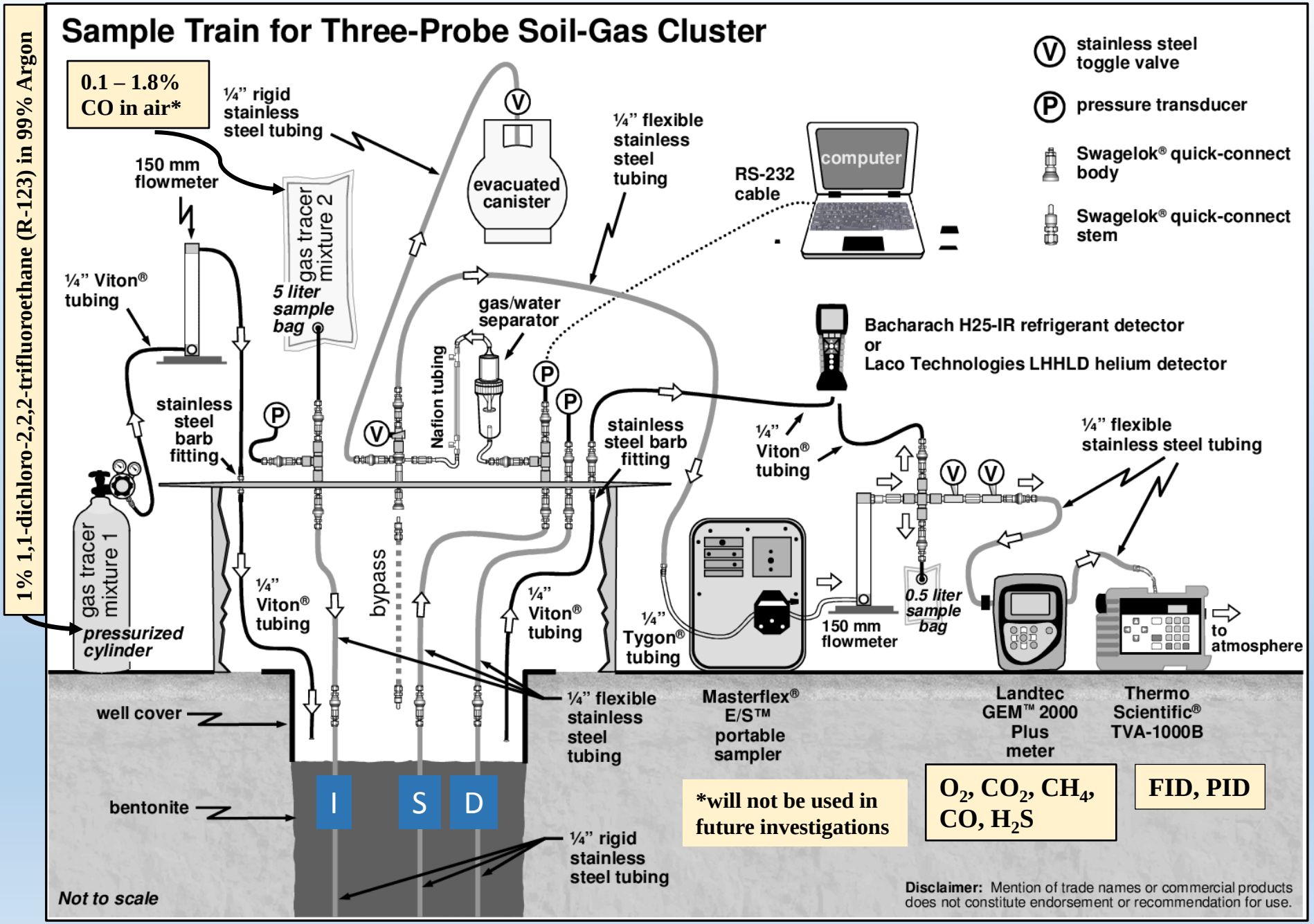
One-Minute Shut-In Tests of Fittings

$$Q_S^{STP} = \frac{V_S}{\Delta t}\frac{\Delta P}{P^S}\frac{T^S}{T}$$

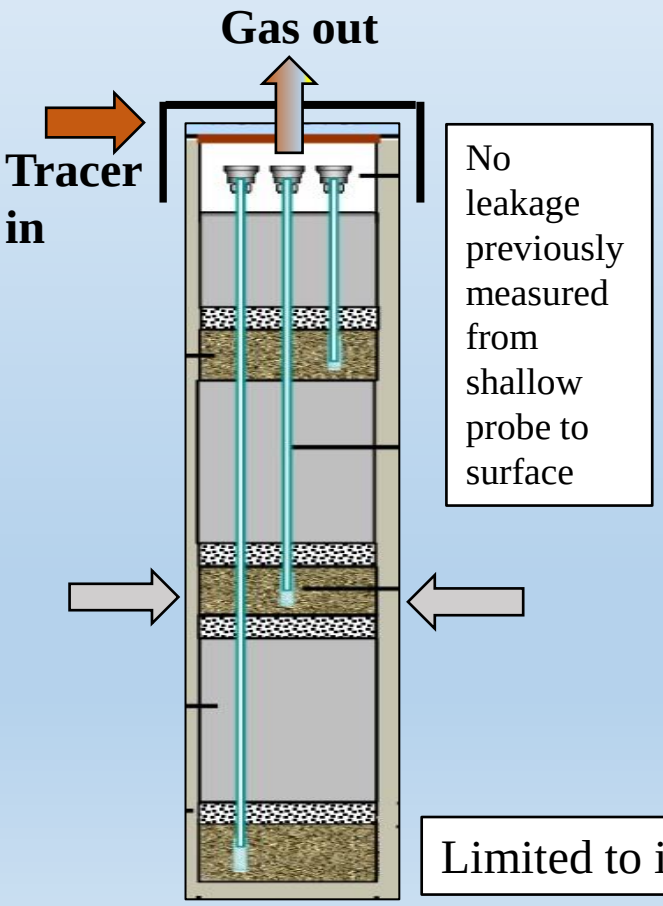


- Shut-in tests were conducted at “high”, “medium”, and “low” vacuum.
- Quality control criterion of 1 SCCM
- Leakage of 1 SCCM at a sample flow rate of 500 to 1000 SCCM is equivalent to 0.1% to 0.2% and hence inconsequential.

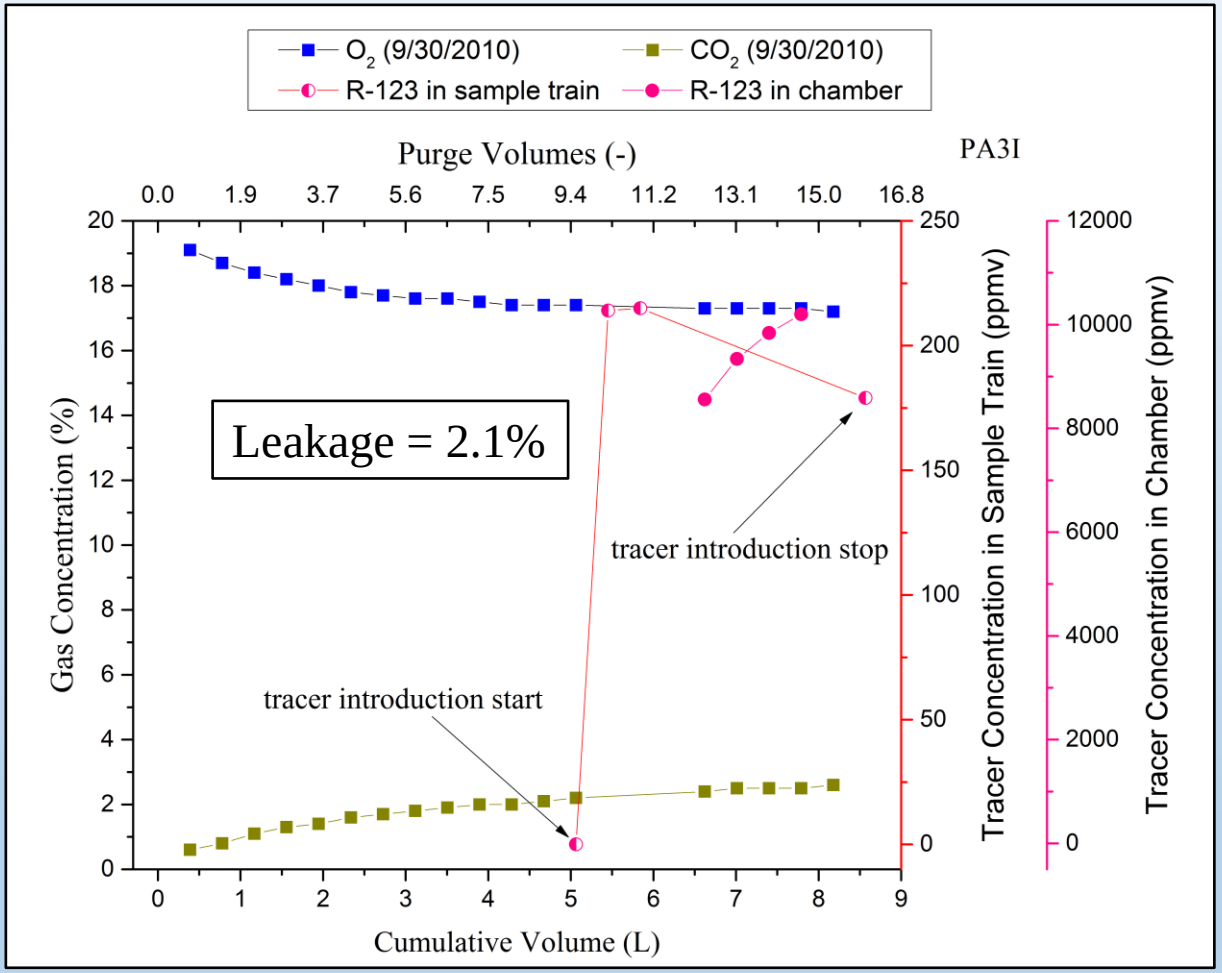
Design for Sample Collection and Purge, Leak, and Gas Permeability Testing



Leakage Through Quick-Connect Compression Fittings

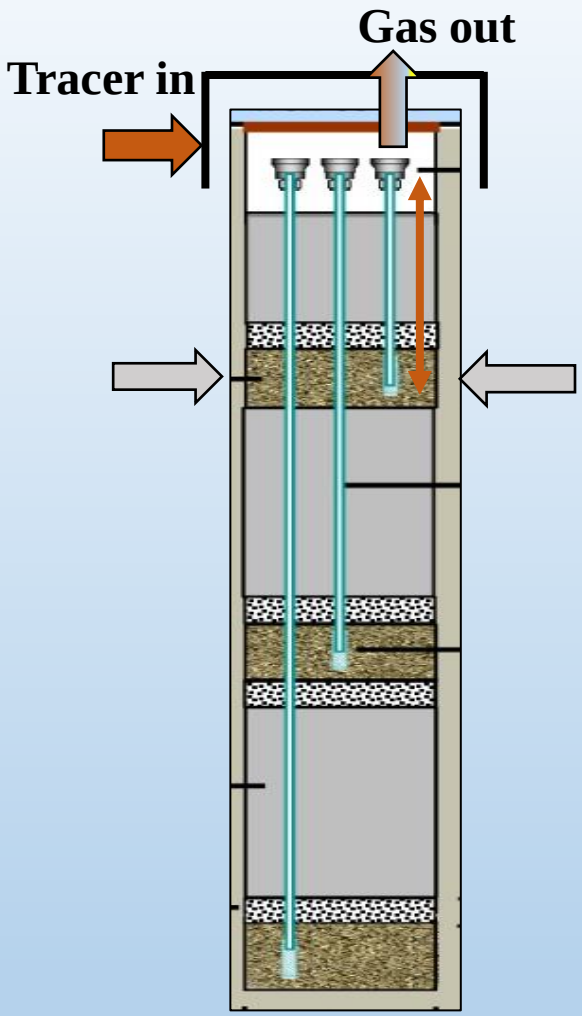


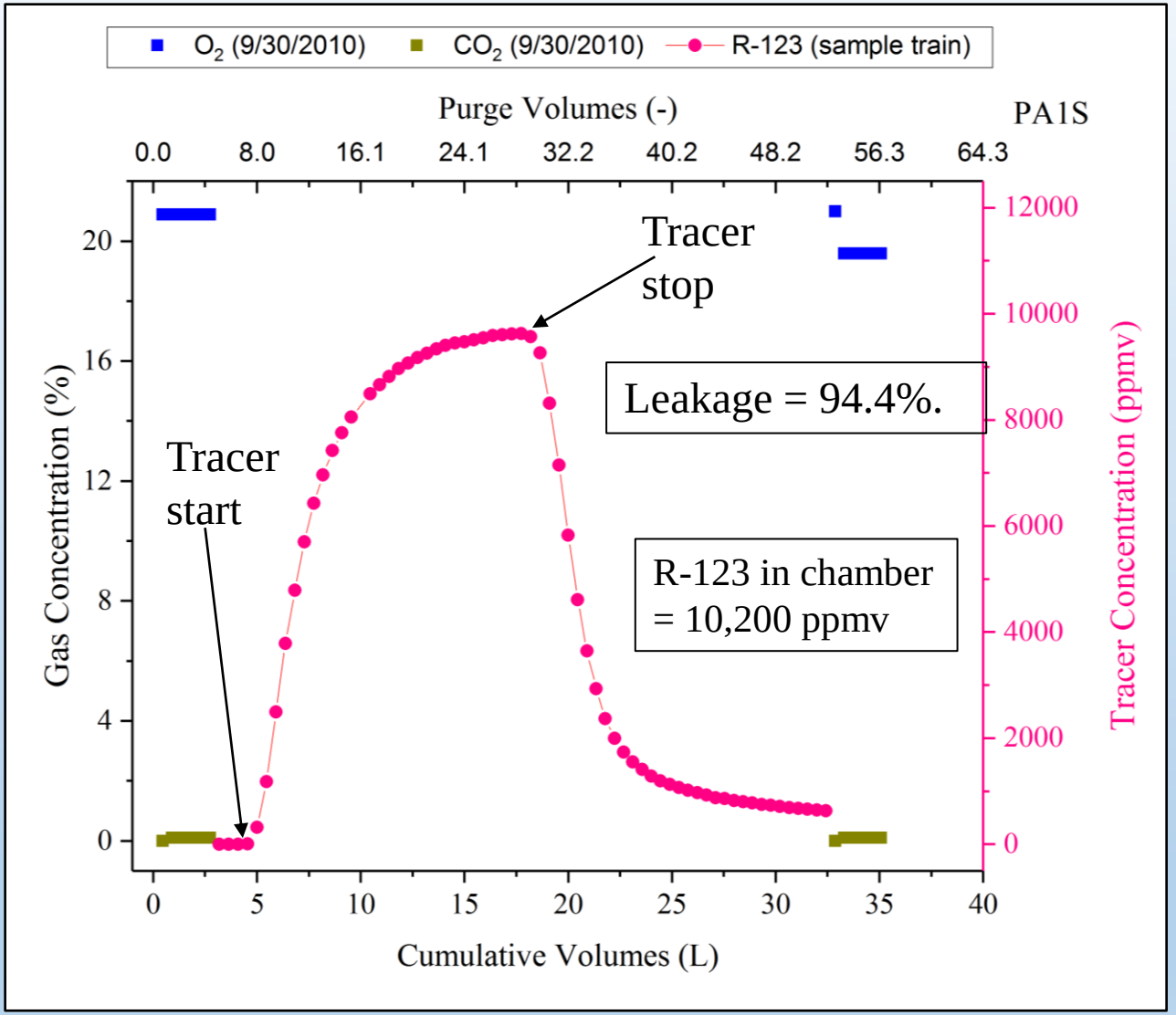
No leakage previously measured from shallow probe to surface



Limited to intermediate and deep probes.

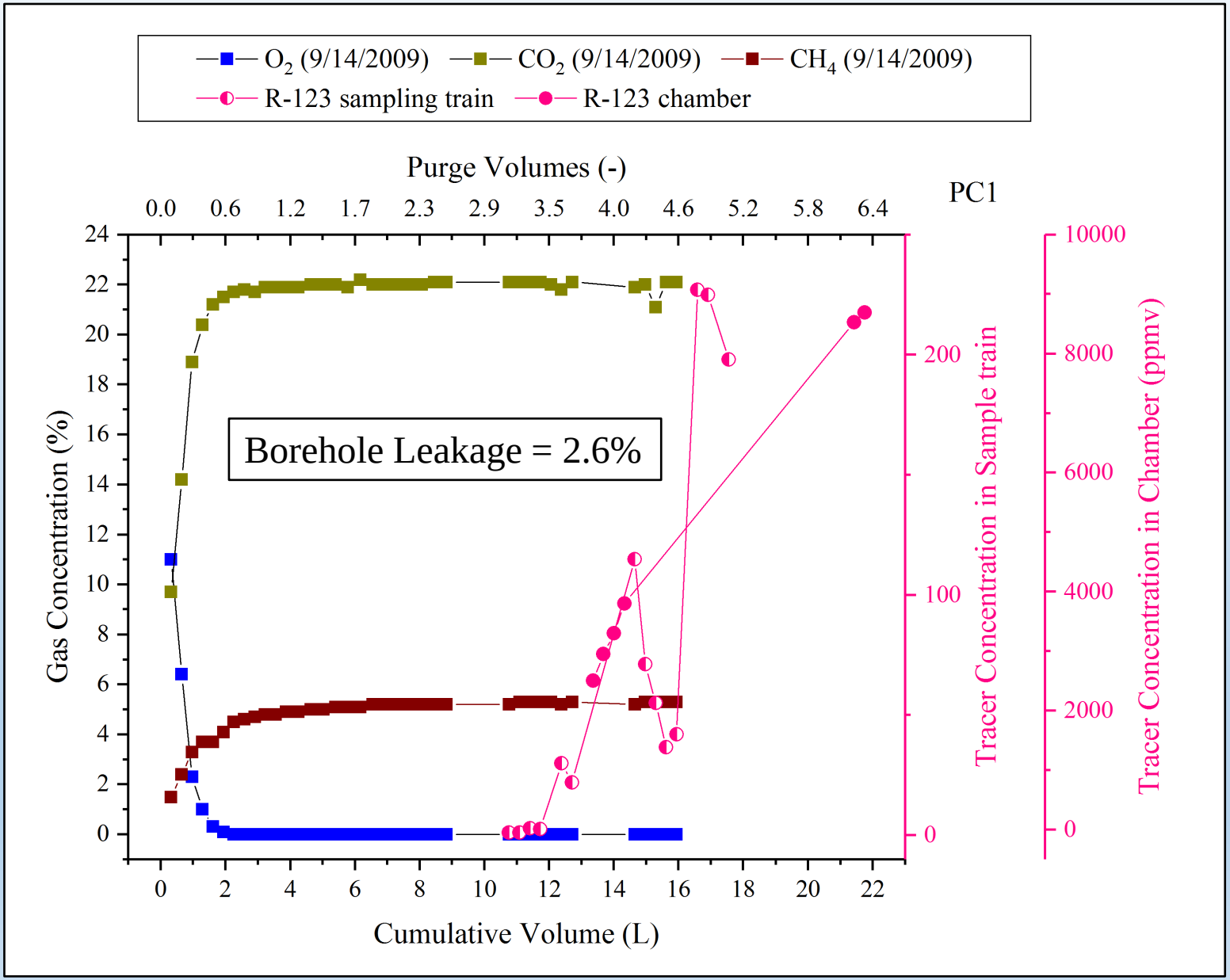
Leakage Through the Borehole to an Upper Probe



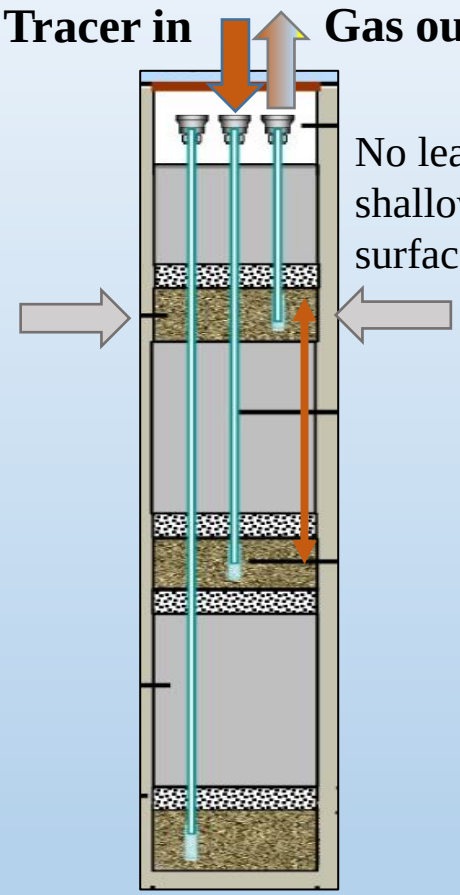


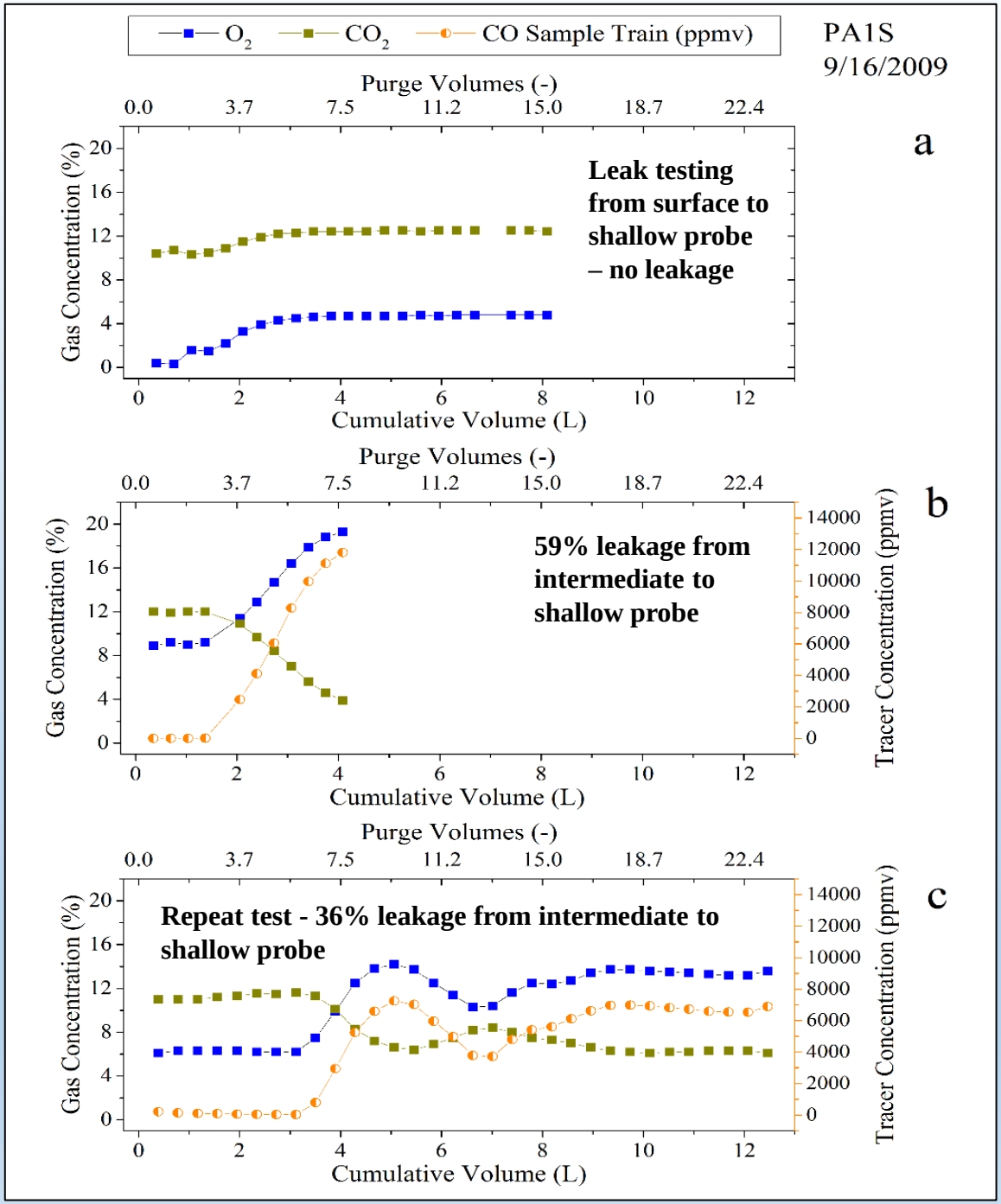
Tracer profile characteristic of two-domain (matrix, preferential pathway) gas transport. Modeling to follow.

Leakage from a Natural Gas Line



Leakage Through the Intermediate and Shallow Probe





Conclusion

- A robust method for leak testing vapor probe clusters has been developed.
- This method will assist in detecting stray gas migration to the near surface environment from conventional and unconventional oil and gas wells, natural gas storage reservoirs, and buried pipelines.

The final QA/QC inspection