



Energy & Environmental Research Center (EERC)

RECENT ADVANCES IN ONSHORE SEISMIC AND NONSEISMIC MONITORING STRATEGIES

CO₂ Storage Conference 2026

The Chester Hotel, Aberdeen

October 6–7

Amanda Livers-Douglas

Assistant Director for Geoscience



REGIONAL ACTIVITY

~40 years of CCUS Operations

>2500 kilometers of CO₂ Pipeline

>200 million tonnes of CO₂ Stored**

Project	Net CO ₂ Stored,* tonnes
Bell Creek EOR	≈ 13,000,000*
Blue Flint	507,641**
Cedar Creek Anticline EOR	≈ 4,000,000*
DGC Beulah	3,628,408**
U.S. Regional Pilots and Field Tests	> 4,000*
Aquistore	> 620,000*
Quest	> 11,000,000*
Gevo Richardton CCS	698,846**
Weyburn	> 44,000,000*
Wyoming EOR	≈ 101,000,000*
Shute Creek Class II AGI	> 8,000,000*
Canadian Pilots and EOR	≈ 13,000,000*
Tallgrass E. WY Sequestration Hub	≈ 1,500,000*

* Calculated estimate.

**Tonnes stored as of July 2026.



Reservoir Characterization via 3D Seismic Interpretation

The seismic survey reveals ancient river channels in the reservoir similar to the modern-day Mississippi River valley.

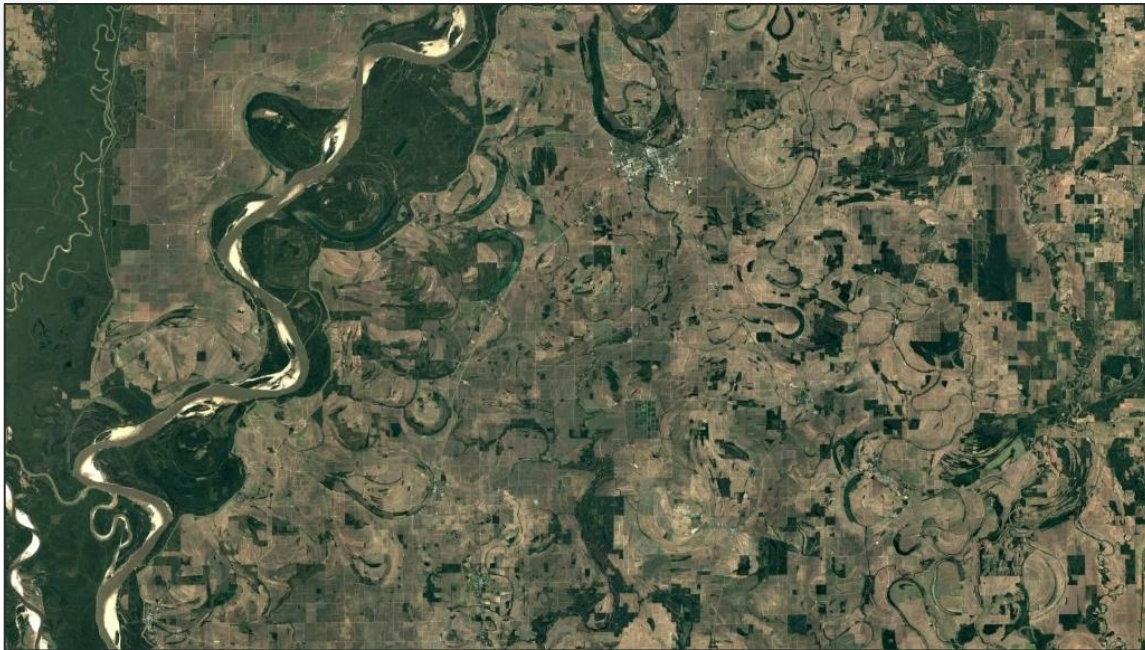
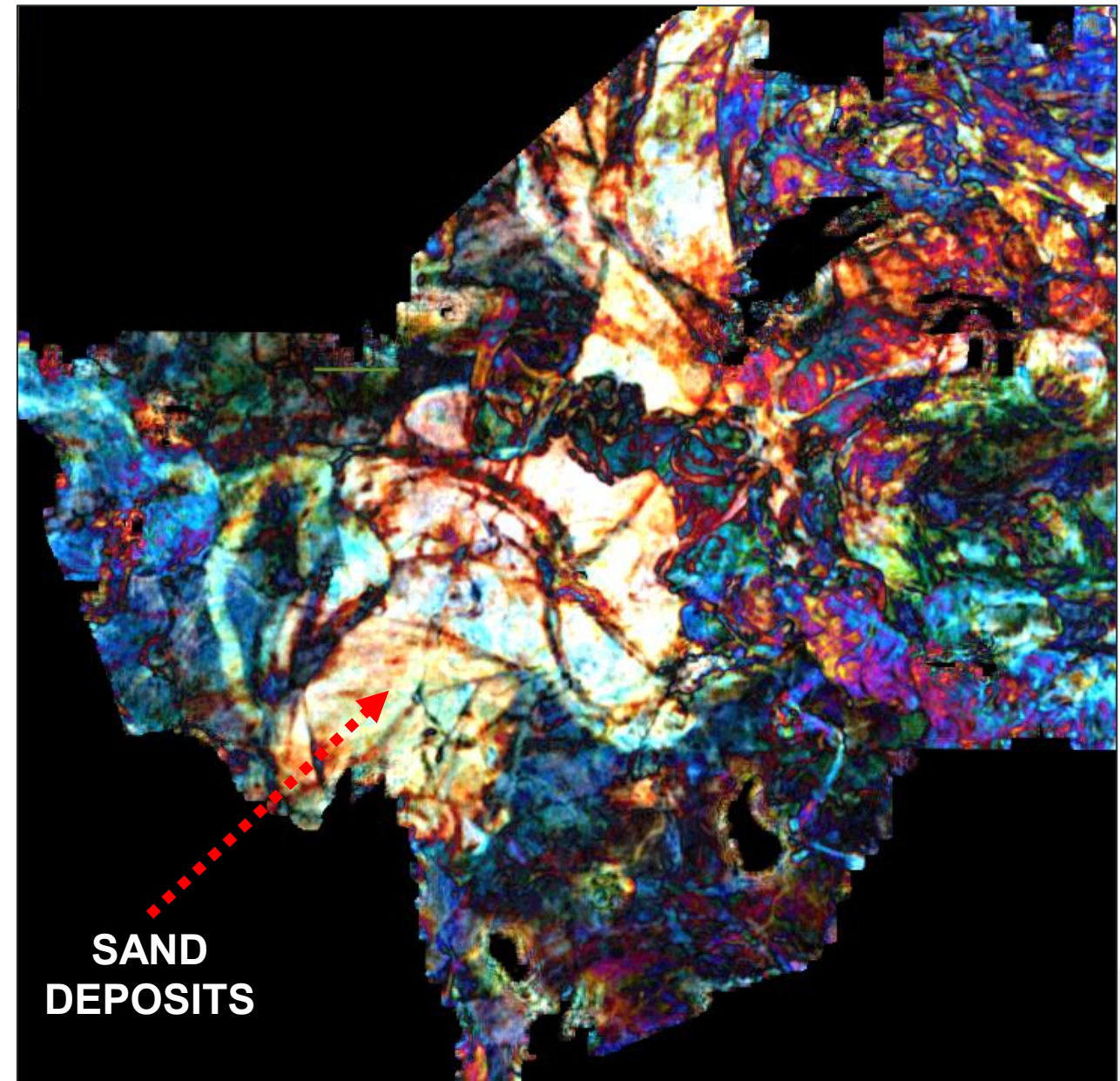


Photo Credit: Image captured from Google Earth showing the Mississippi river valley in northwestern Mississippi.



Underwood 3D Seismic Survey: By the Numbers

120 Days

Working in the Field

40 Days

of Weather Delays

611

Square Kilometer
Survey Area

45,106 Sensor
Locations

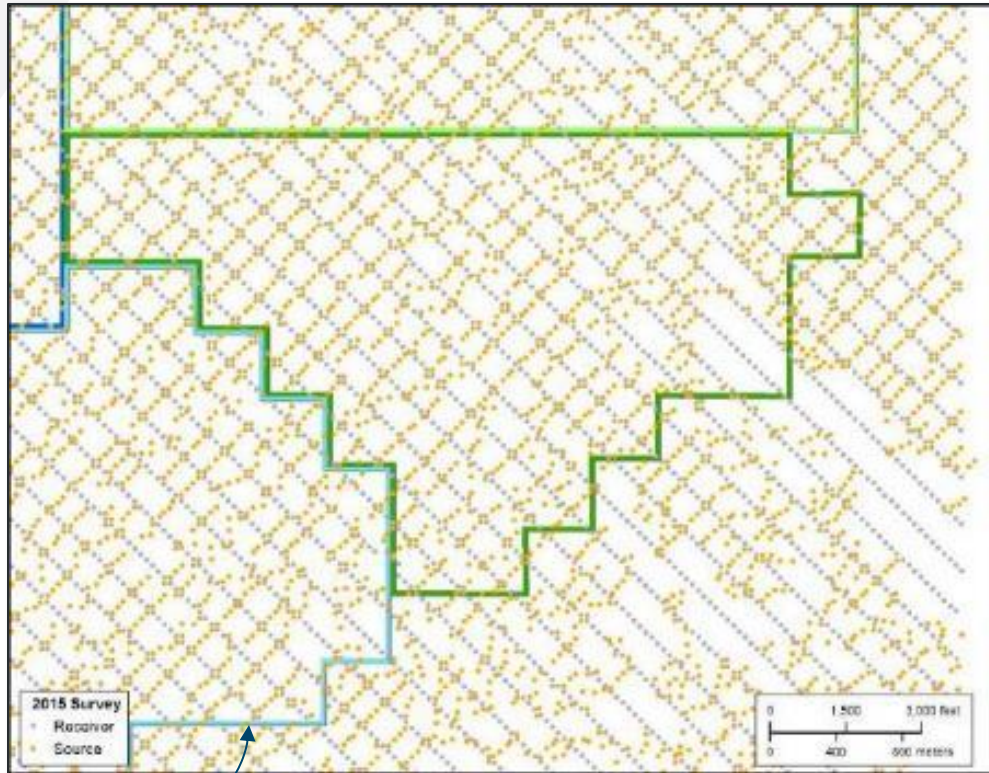
35,290 Source Truck
Points



CONVENTIONAL VERSUS SPARSE ACQUISITION

Conventional Seismic Data Acquisition

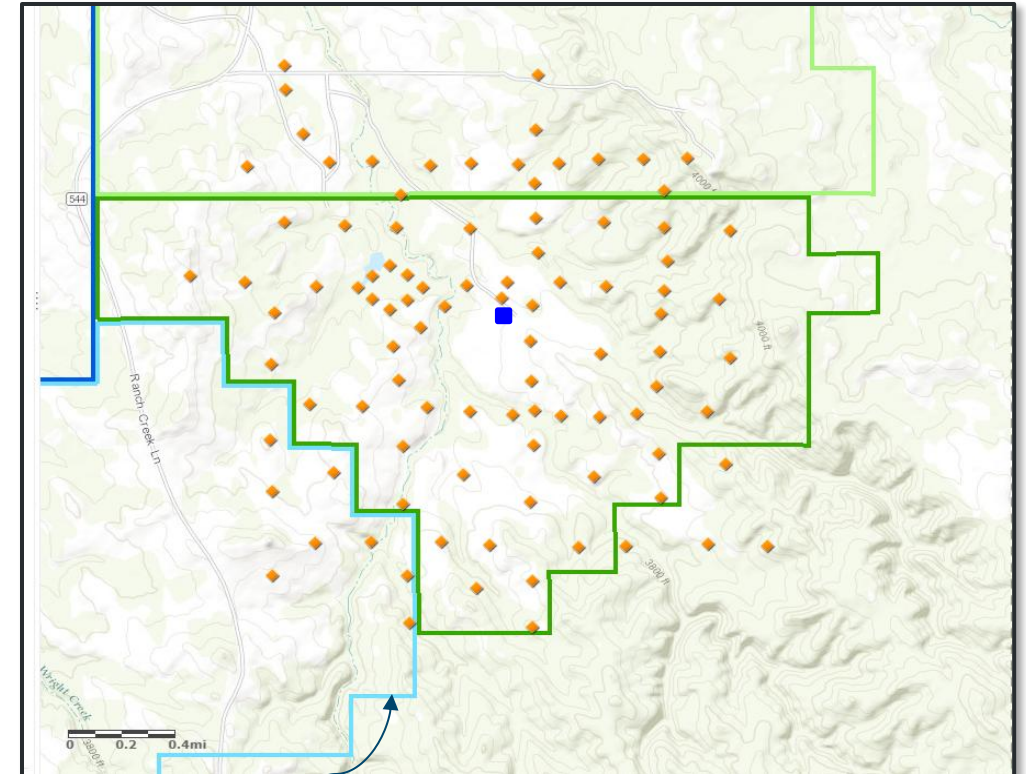
● Receiver
● Source



Development regions

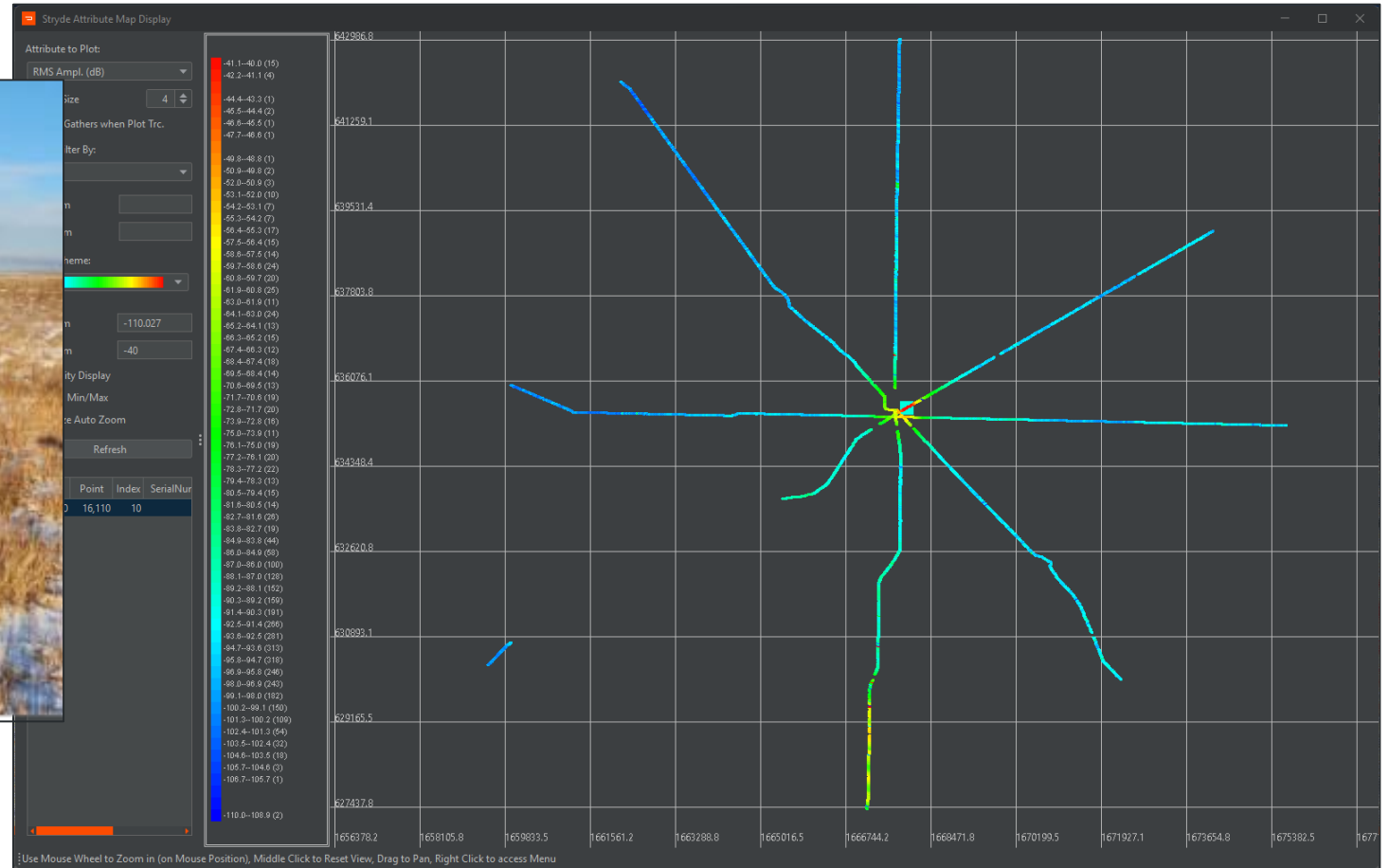
Sparse Data Acquisition

◆ Receiver
■ Source



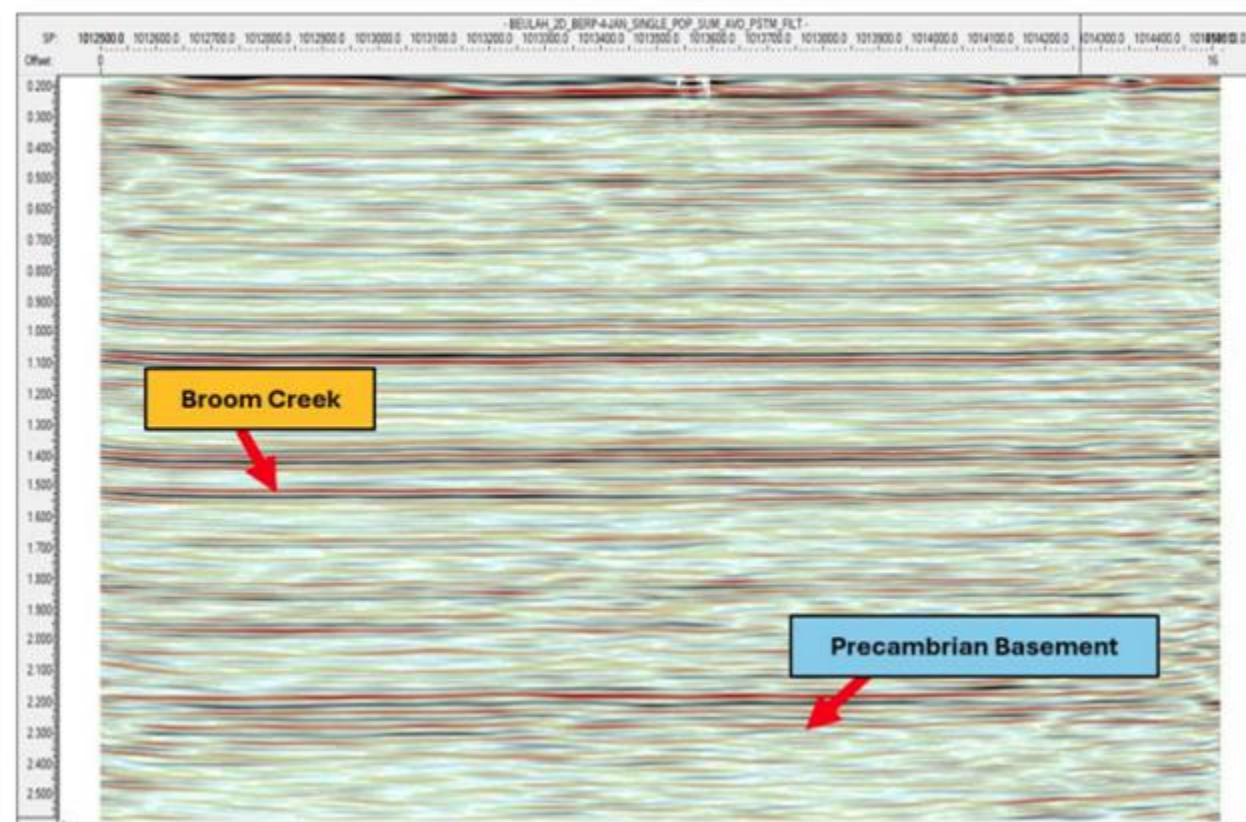
Development regions

LOW-IMPACT SEISMIC DATA ACQUISITION

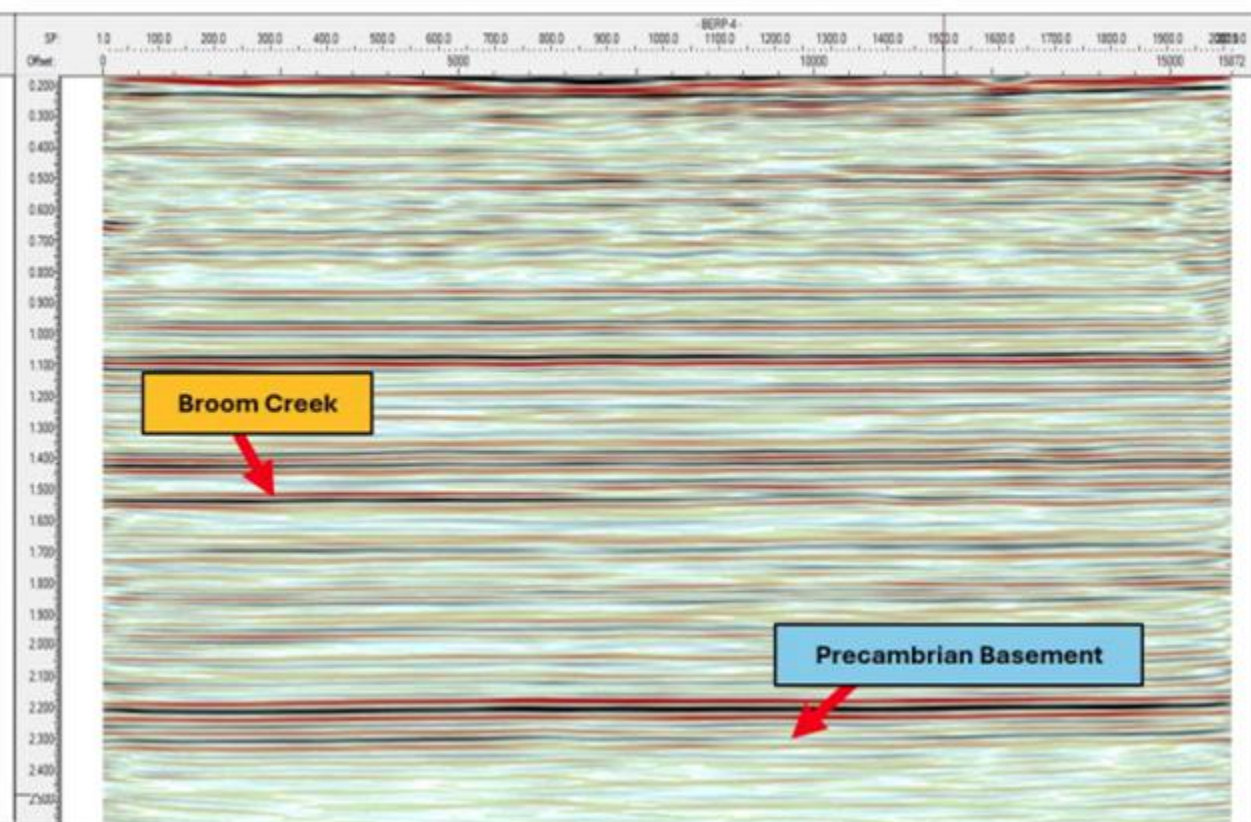




Jan 2024 Single Drop



Sept/Oct 2024 10 Drops



SCALABLE, AUTOMATED, SPARSE SEISMIC ARRAY (SASSA)

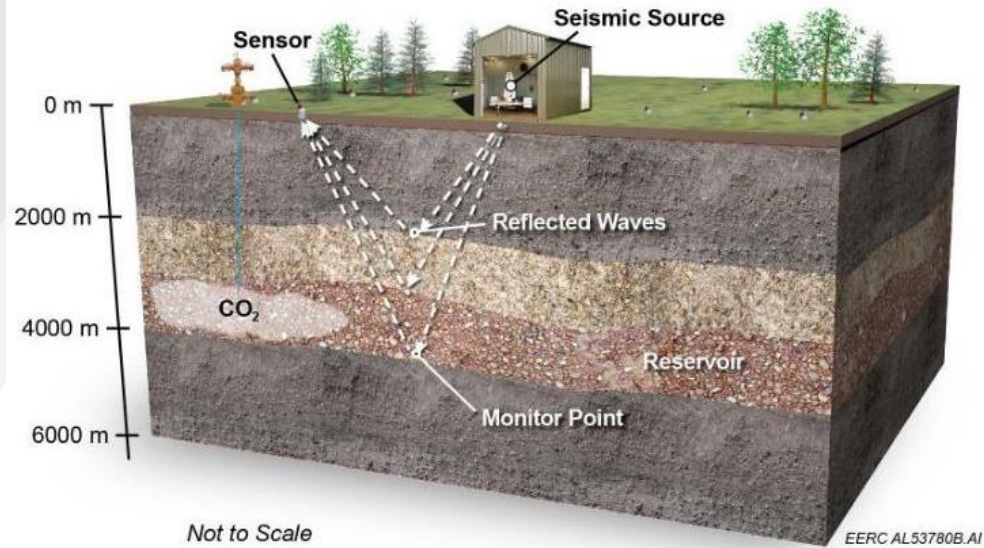
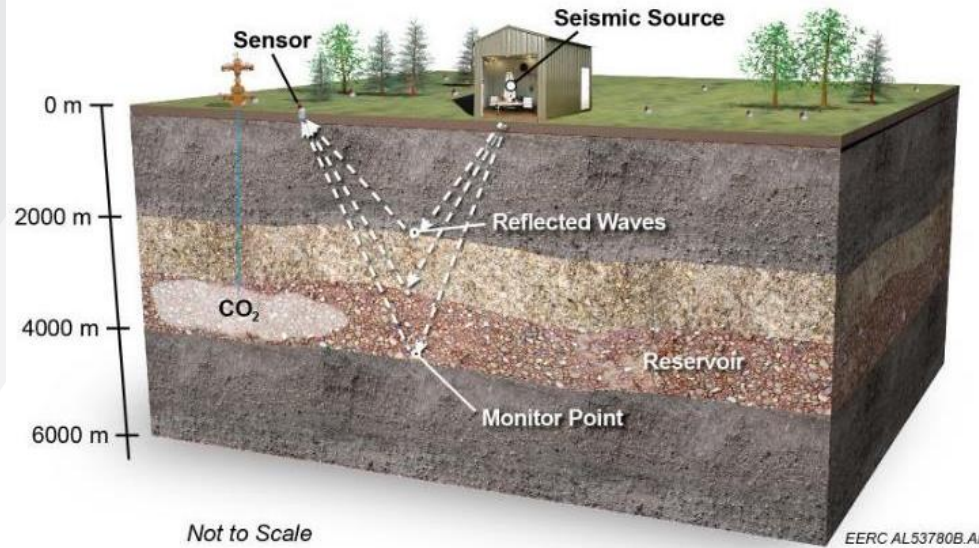


Image from Correa, J., Wood, T., Pevzner, R., Isaenkov, R., Yavuz, S., Yurikov, A., Teryshnikov, K., and Freifeld, B., 2021, 2nd generation SOV-DAS Task 2 – Core carbon storage and monitoring research (CCSMR) Project ESG14095: U.S. Department of Energy National Energy Technology Laboratory Carbon Management and Oil and Gas Research Project Review Meeting, August 2021.

SCALABLE, AUTOMATED, SPARSE SEISMIC ARRAY (SASSA)



Surface Orbital Vibe (SOV)

3D Seismic Vibroseis

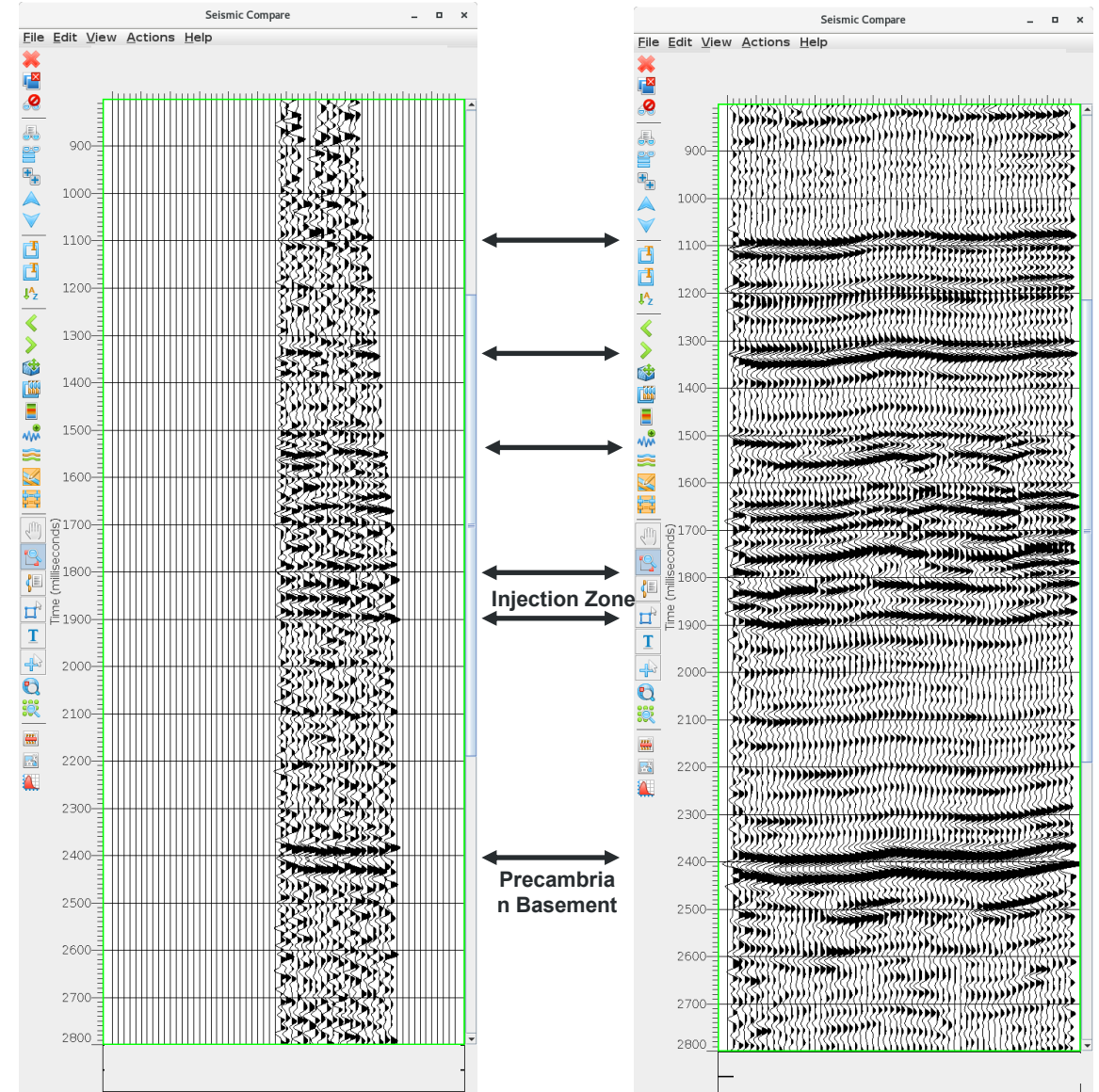
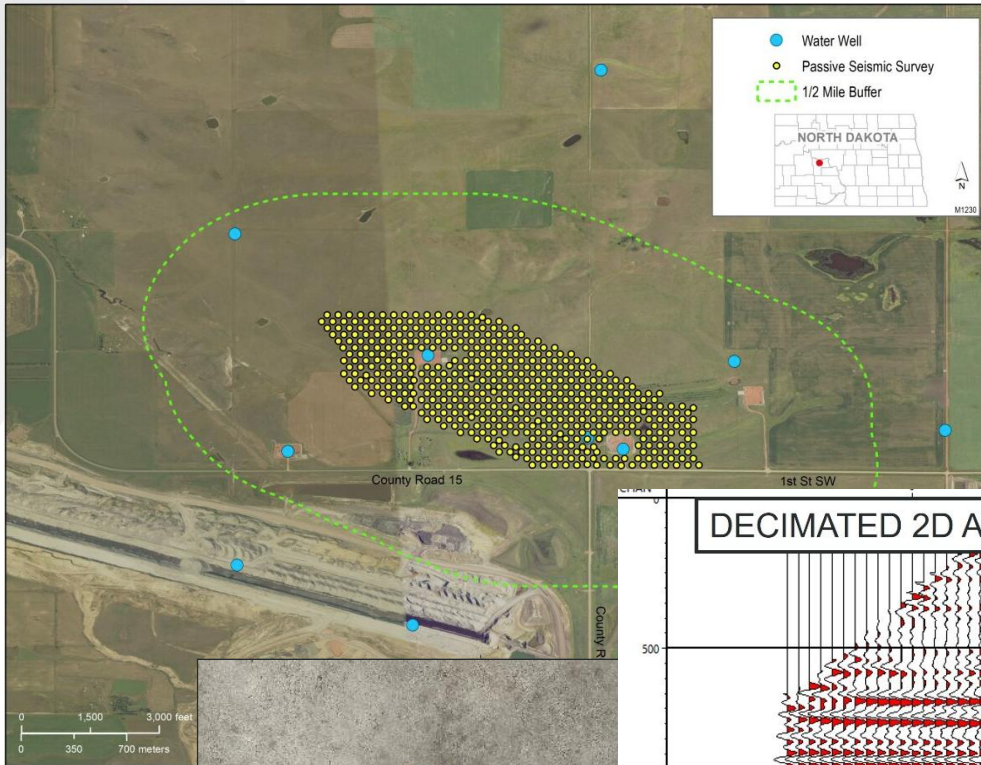
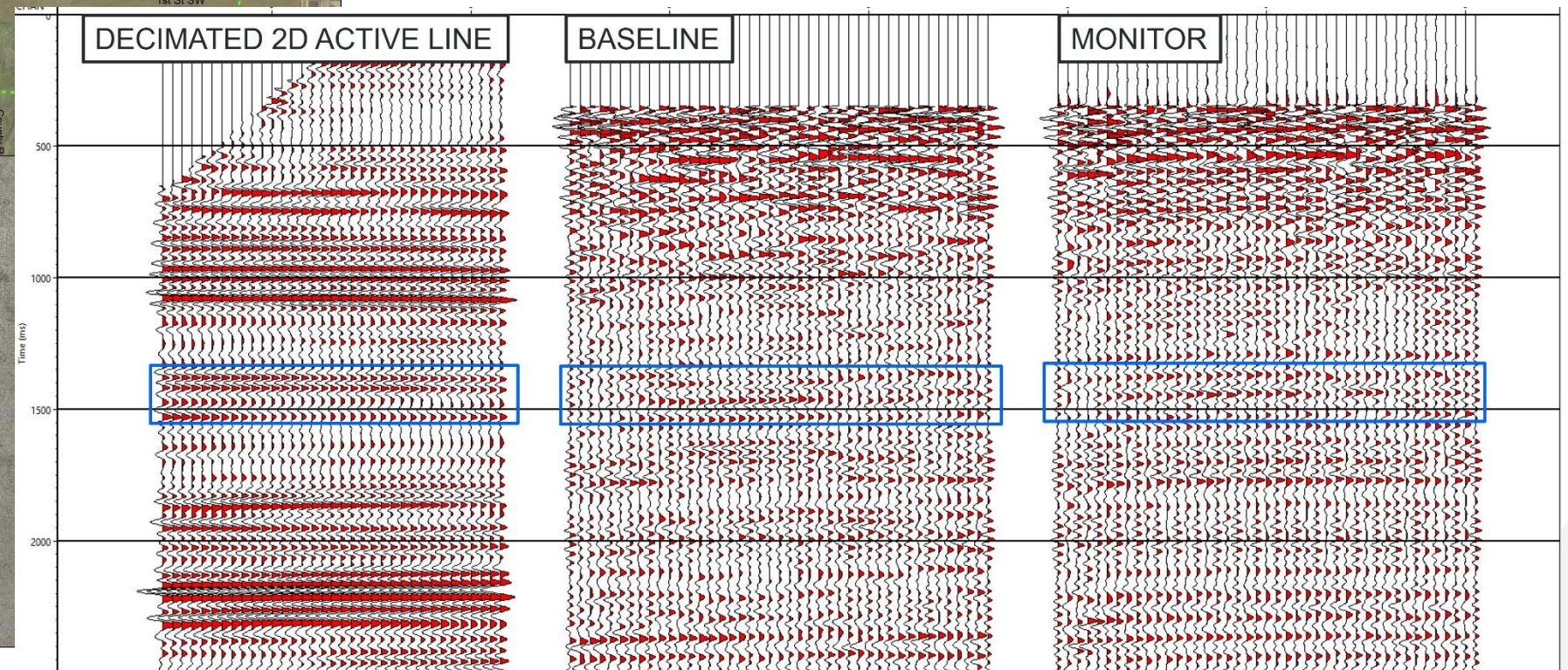


Image from Correa, J., Wood, T., Pevzner, R., Isaenkov, R., Yavuz, S., Yurikov, A., Teryshnikov, K., and Freifeld, B., 2021, 2nd generation SOV-DAS Task 2 – Core carbon storage and monitoring research (CCSMR) Project ESG14095: U.S. Department of Energy National Energy Technology Laboratory Carbon Management and Oil and Gas Research Project Review Meeting, August 2021.

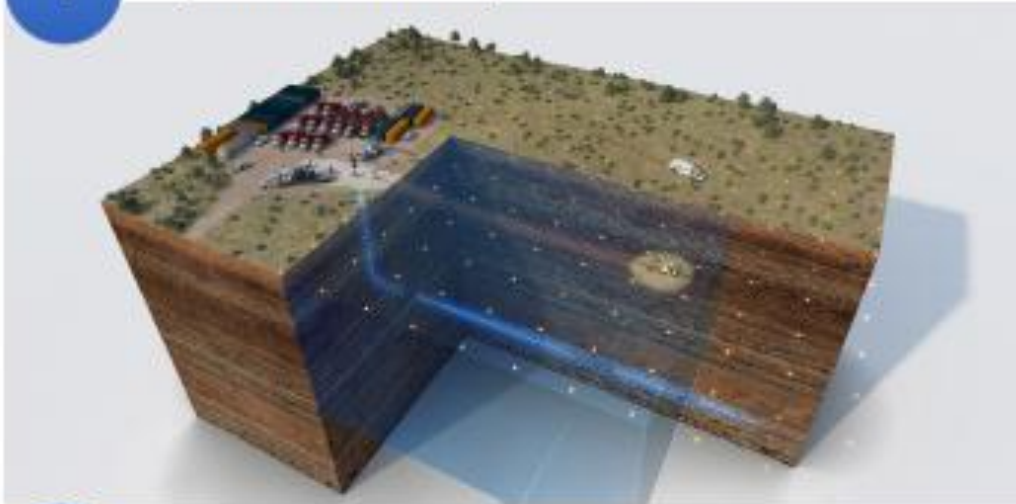


PASSIVE SEISMIC ACQUISITION

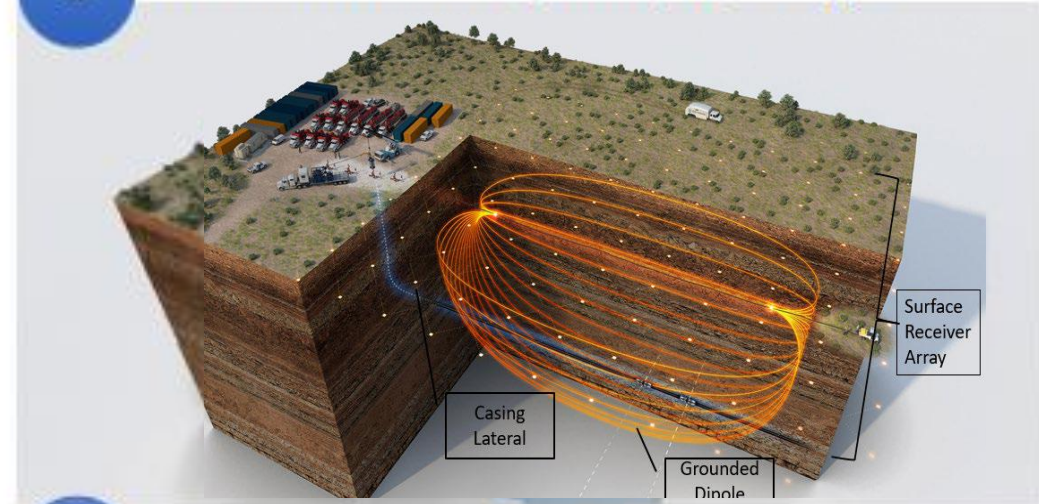


CSEM Basics

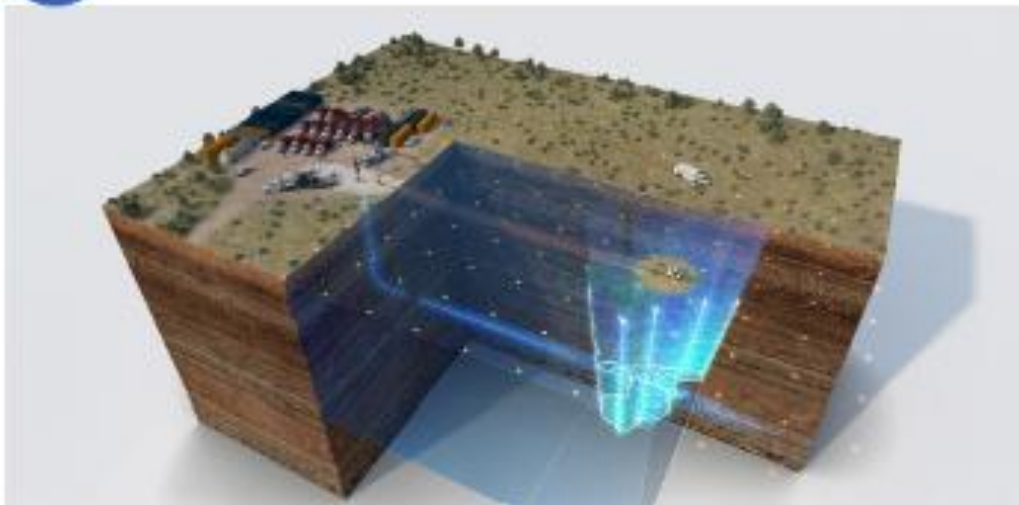
1 Layout surface array



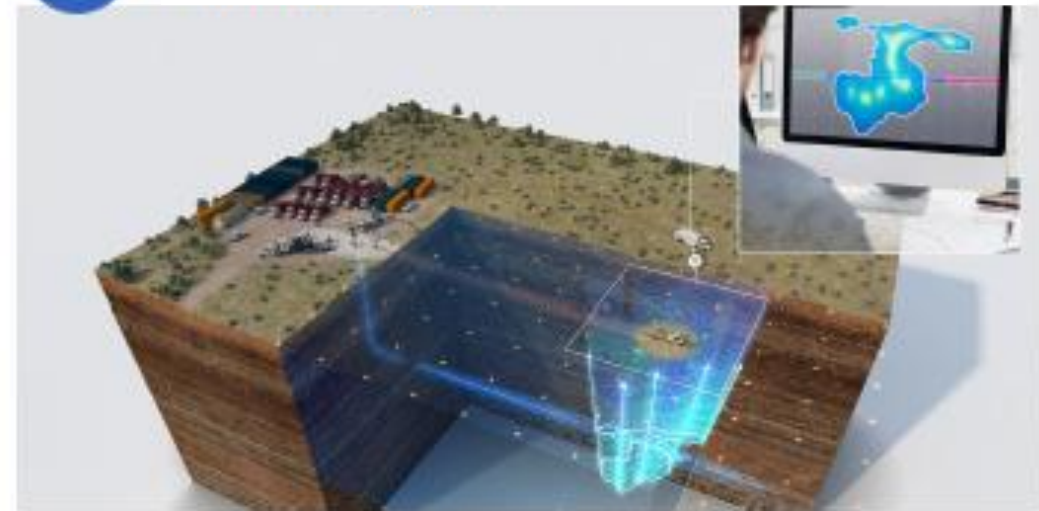
2 Generate electromagnetic (EM) energy



3 EM signatures are recorded



4



EM Survey – Charged Well Casing

Baseline Survey (2024)

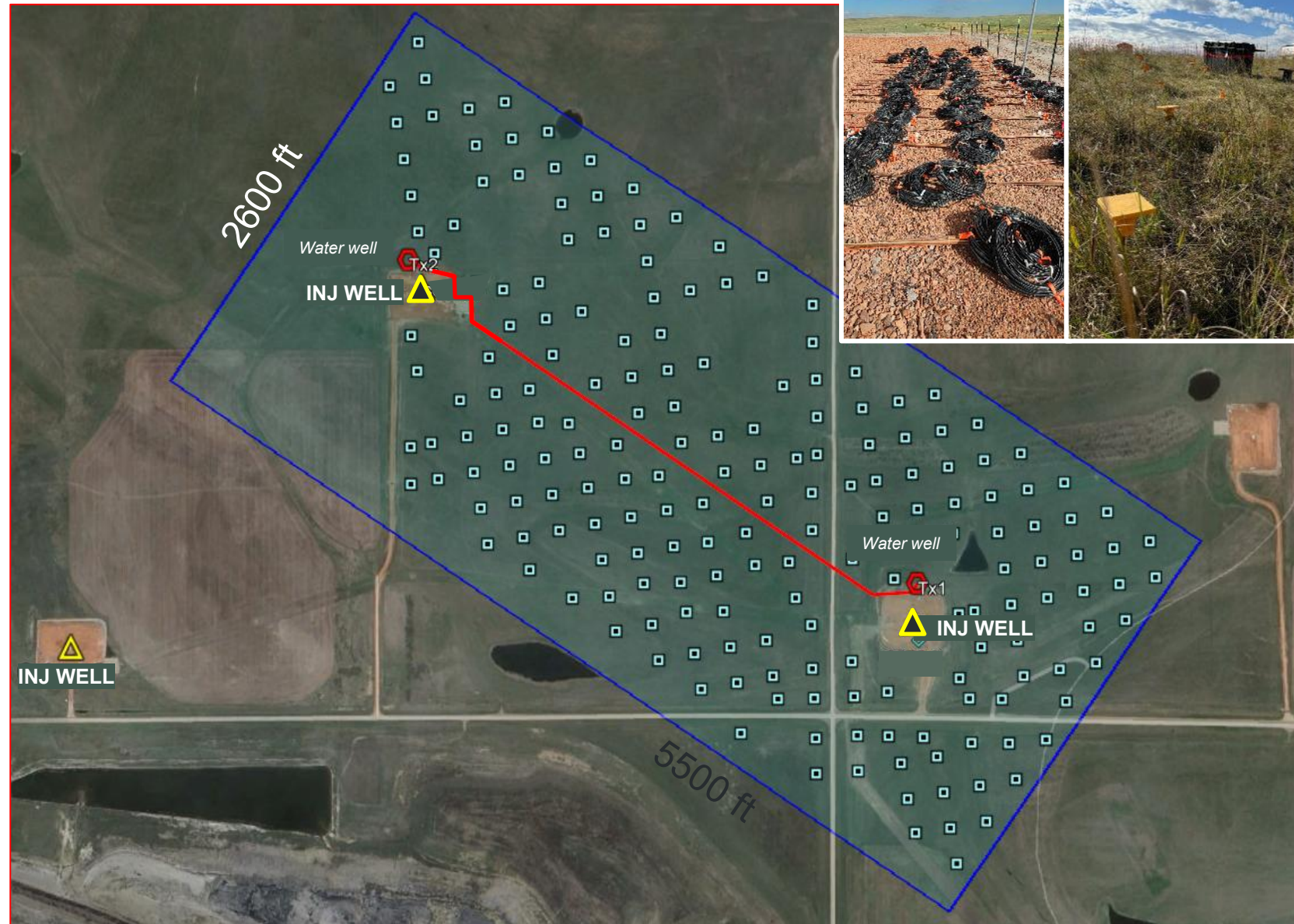
Monitor Survey (2025)

242 receivers (◻)

48-in. steel rod electrodes installed
near existing wells

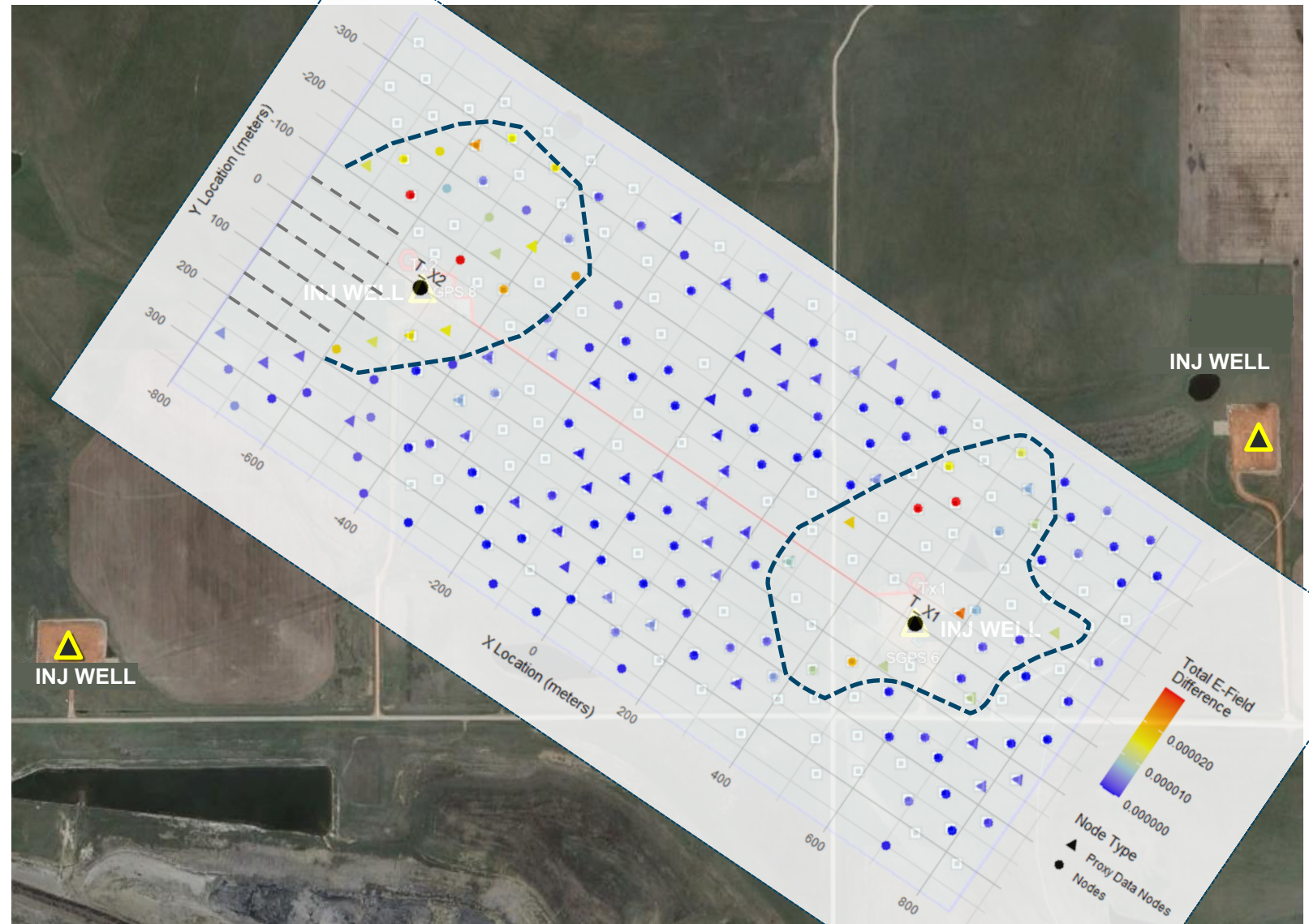
2 water wells (●)

2 injection CO₂ wells (▲)



Total Electric Field Difference (2025 – 2024)

Map shows difference in total electric field in volts/meter measured with the traditional CSEM charged well casing method.



Streaming Potential (SP)

Measured concurrently with traditional CSEM

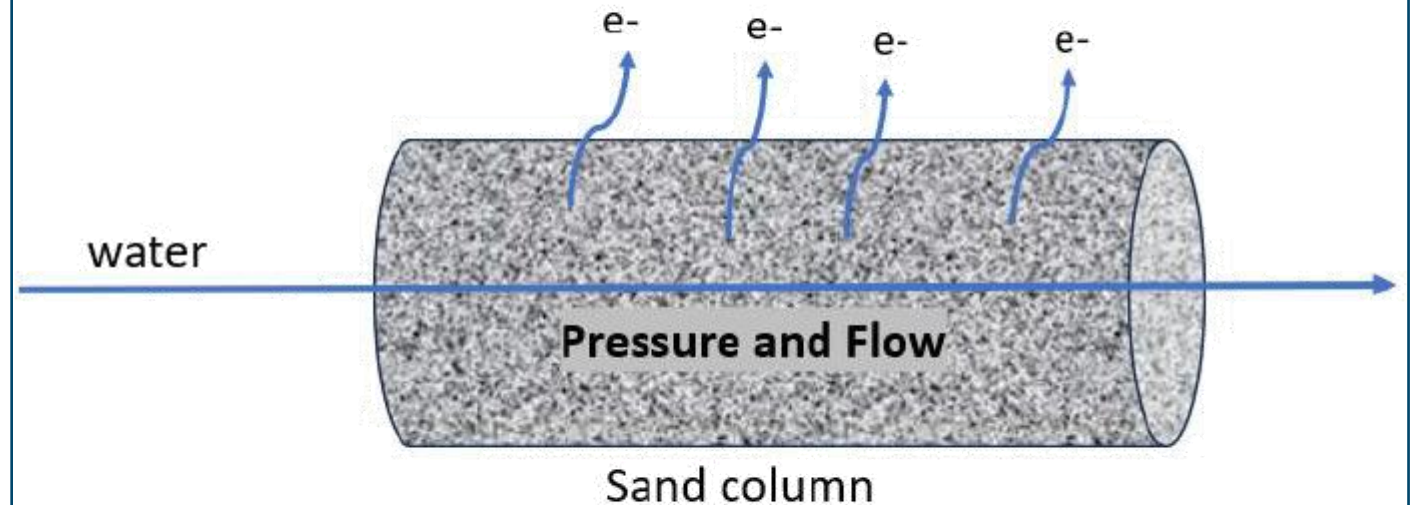
Observed additional transient EM signals when pumping rates change

- Signal directly related to pumping pressure and flow operations
- Potential to aid history matching of reservoir simulation models

Secondary Source Created

Credit ESG

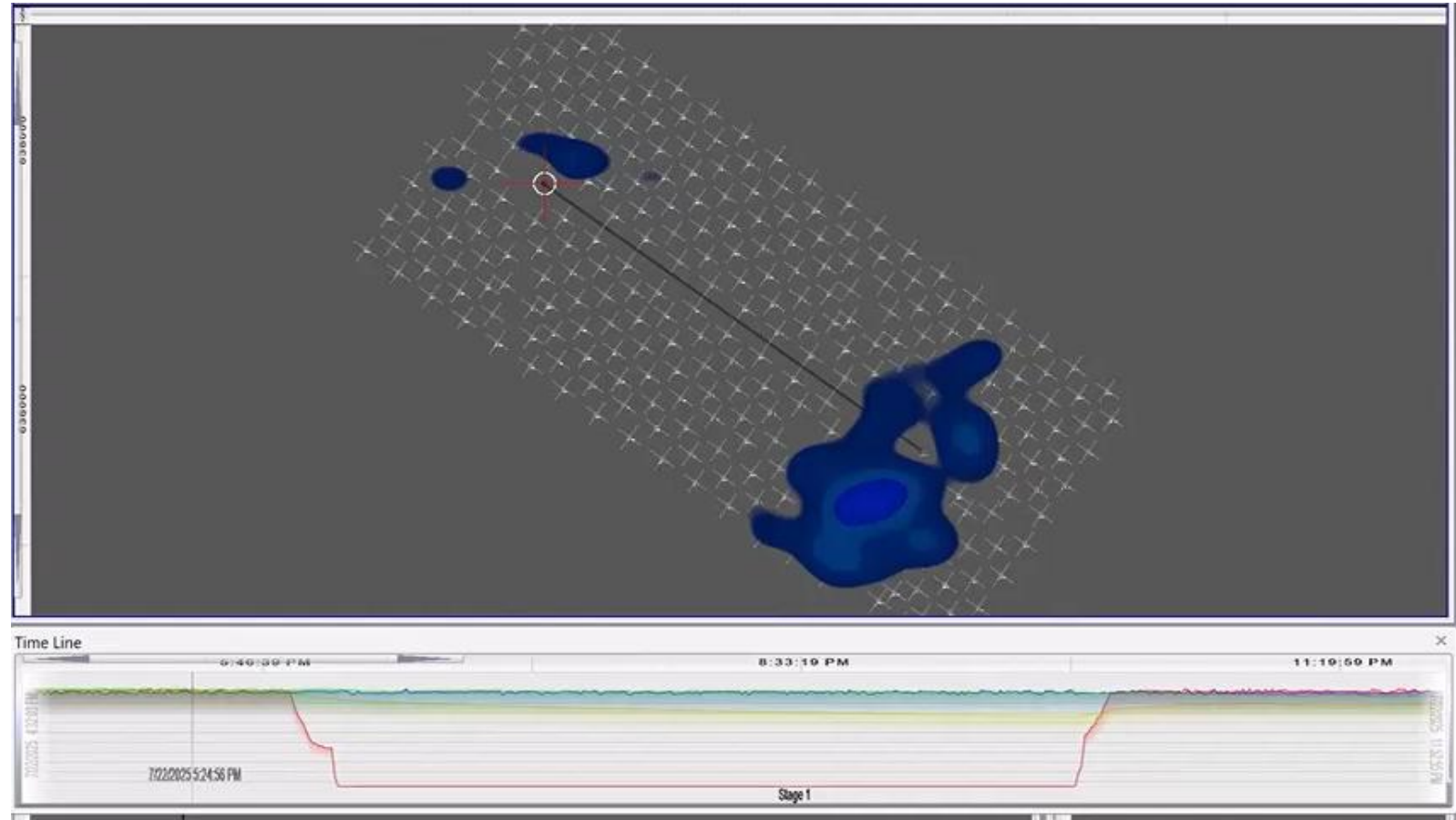
As water moves through sand, ions are stripped, creating a source. This source is a result of pressure and flow, known as streaming potential.



Streaming potential signal is sensitive to surface area of fractures, fluid content and sand particles.

SP: Time-Lapse Response

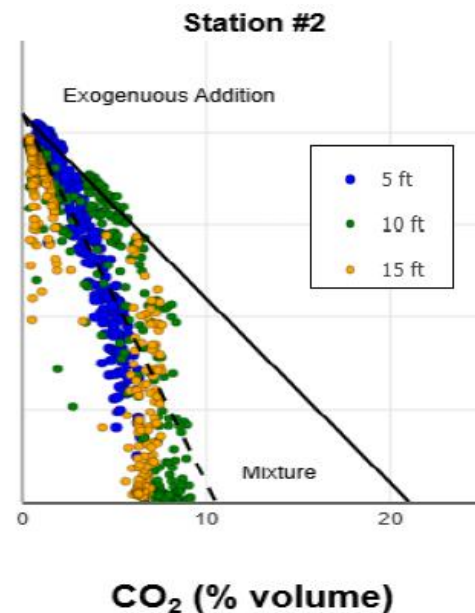
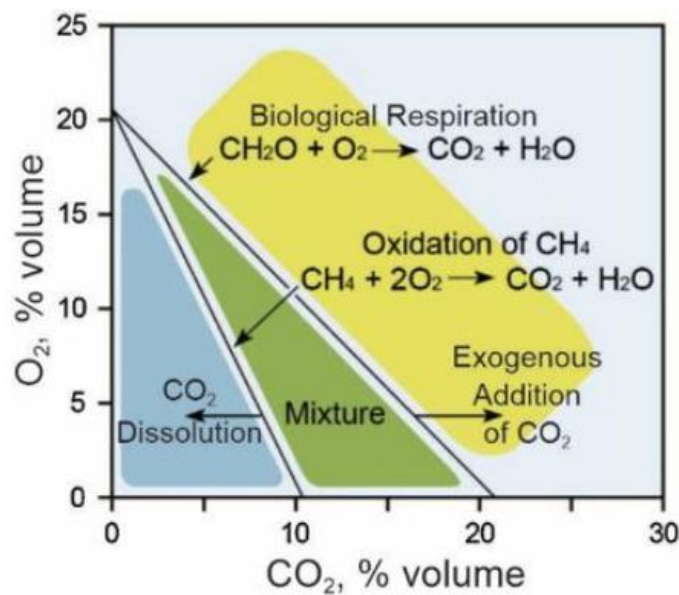
- These measurements over just a few hours as both wells performed the stop and start.
- SP response related to pressure and flow changes both **at source point** and **within reservoir**.



AUTOMATED, INTEGRATED, MODULAR (AIM) MONITORING NETWORK

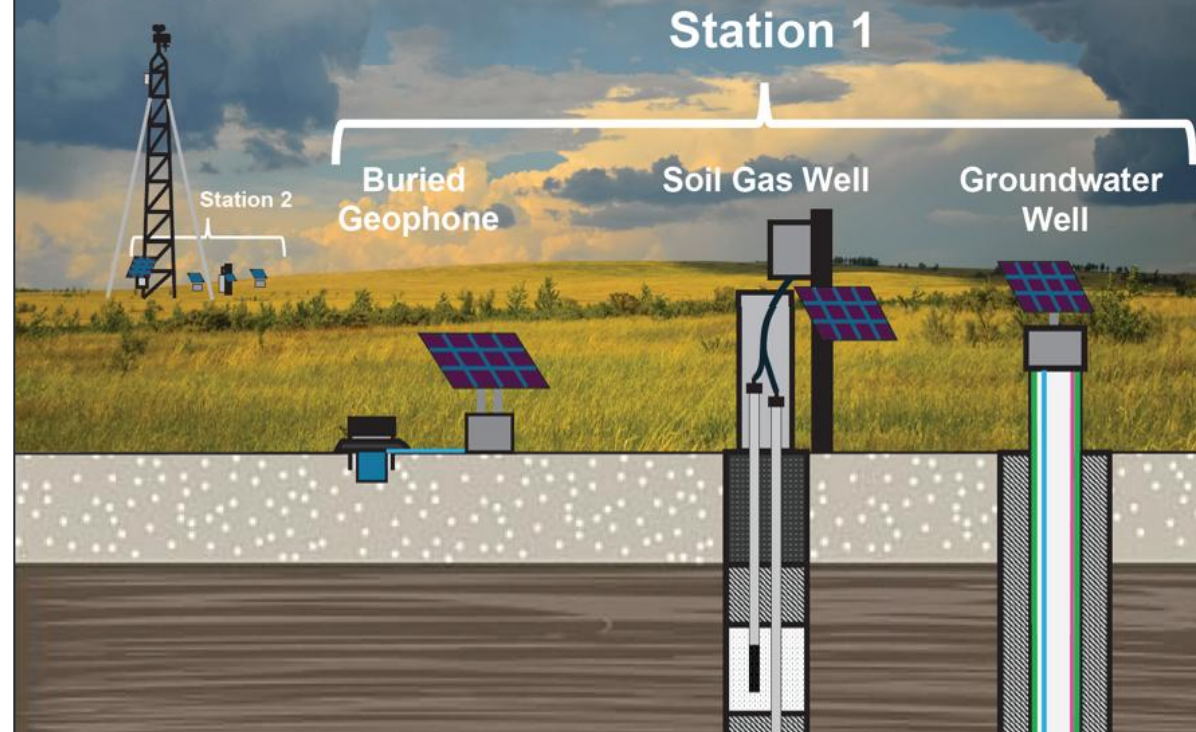
Near-real-time monitoring of multiple environments, including:

- Ambient air, soil gas, groundwater, and deep subsurface attributes.
- Automated data-gathering, processing, and visualization solutions.



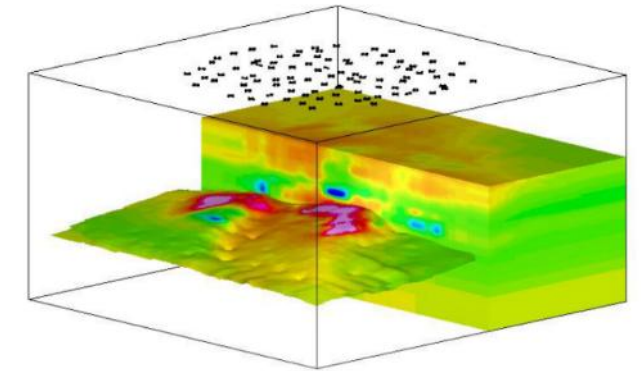
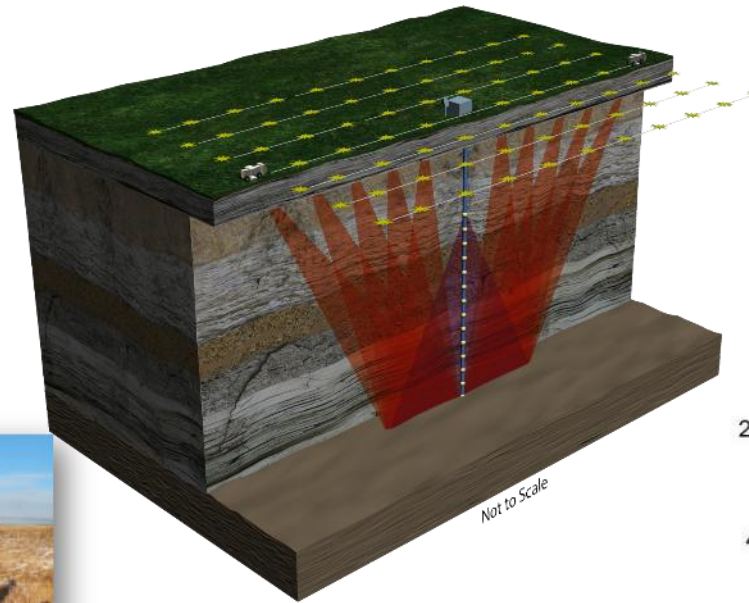
AIM: Autonomous, Integrated, Modular

Weather Tower

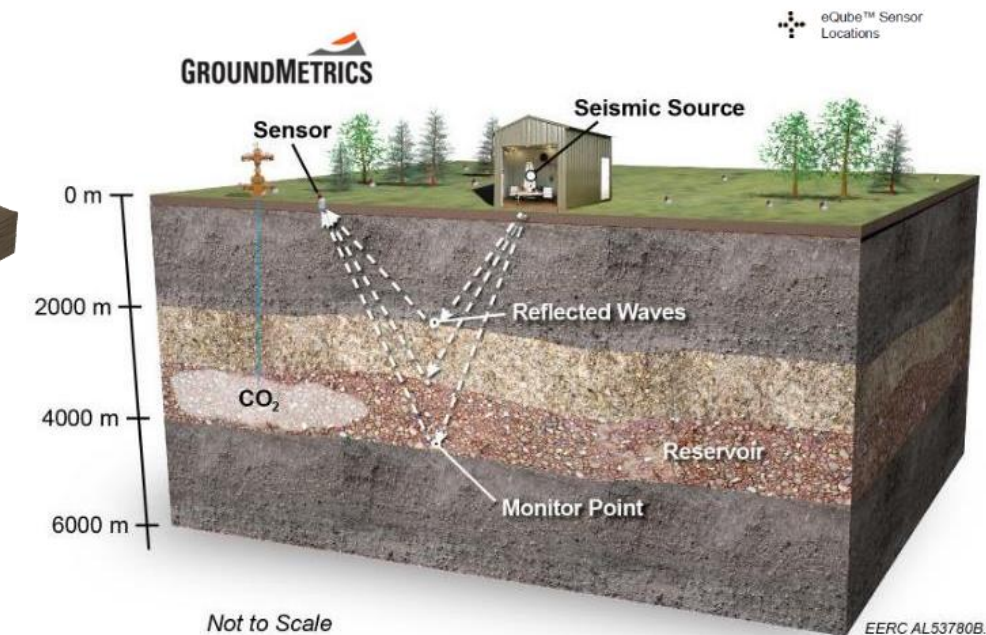


NEXT GENERATION MONITORING

- Lower-impact, lower-cost solutions for monitoring long-term CCUS projects.
- Demonstrating novel methods at active sites.
- Continue to work closely with regulators and rule makers to accelerate acceptance.



SEG Y Format





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A wide-angle photograph of a university campus at sunset. The sun is low on the left, casting a warm glow over the scene. In the foreground, there are large trees with yellowing leaves. In the background, there are several large, multi-story brick buildings, likely university halls or administrative buildings. A parking lot with many cars is visible in front of the buildings. The sky is a mix of orange, yellow, and blue.

THANK YOU

Critical Challenges. Practical Solutions.

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PERMITTED NORTH DAKOTA SALINE STORAGE PROJECTS

