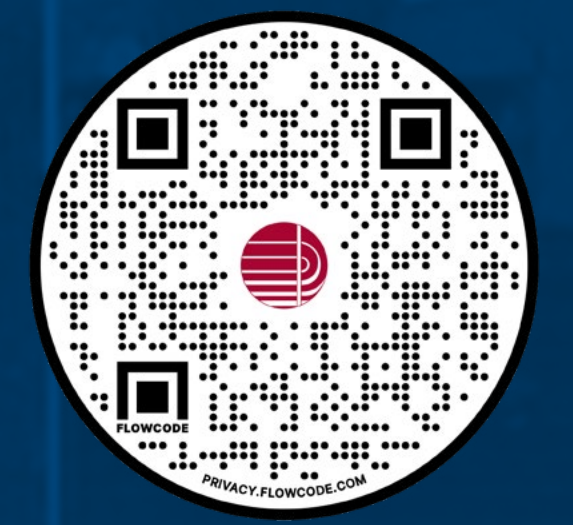




LOW-ENVIRONMENTAL-IMPACT MONITORING OF CO₂ USING SEISMIC METHODS IN NORTH DAKOTA

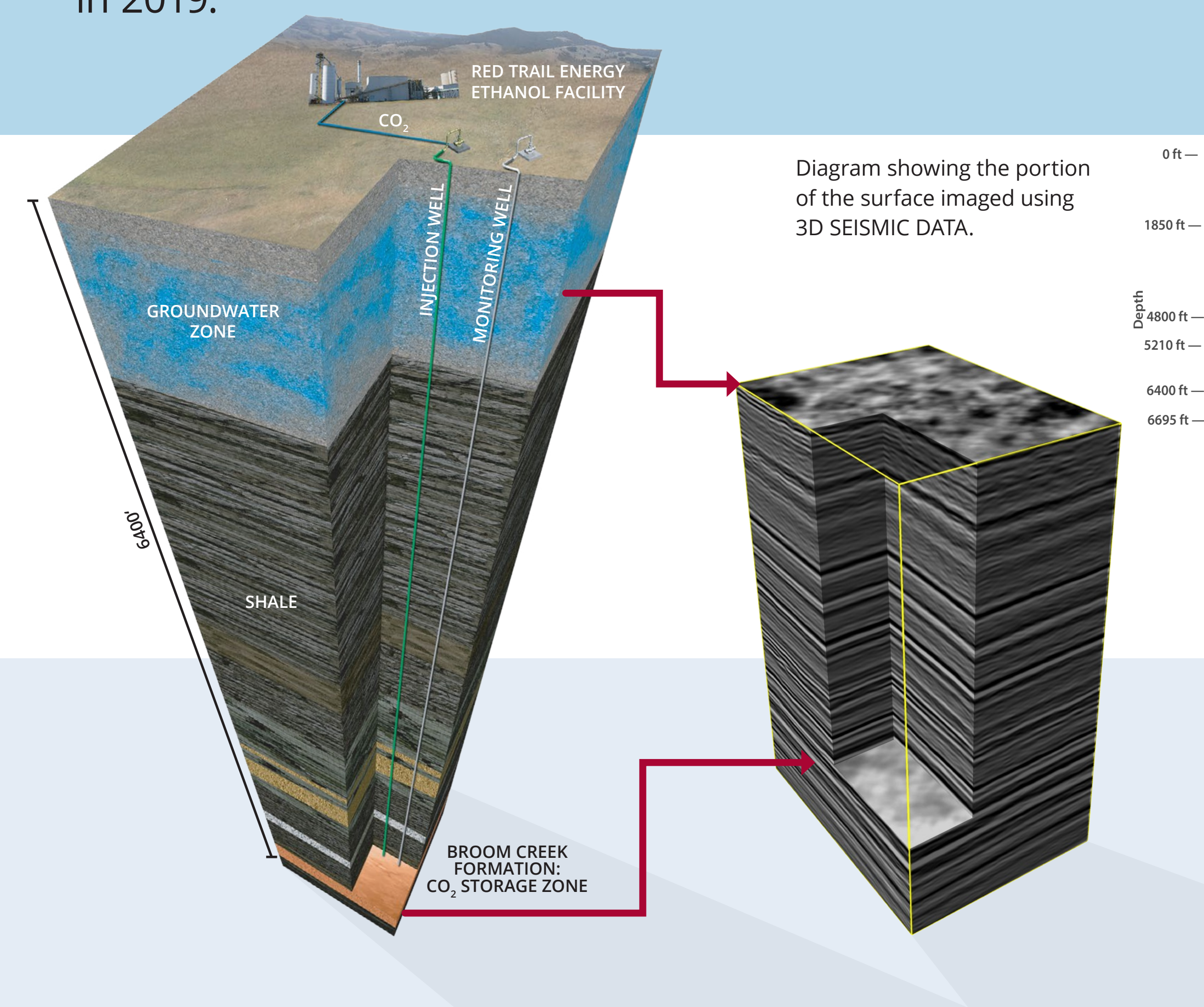
KEY ELEMENTS

In 2021, the Energy & Environmental Research Center initiated a multiyear research project associated with Red Trail Energy's Carbon Capture and Storage Project.

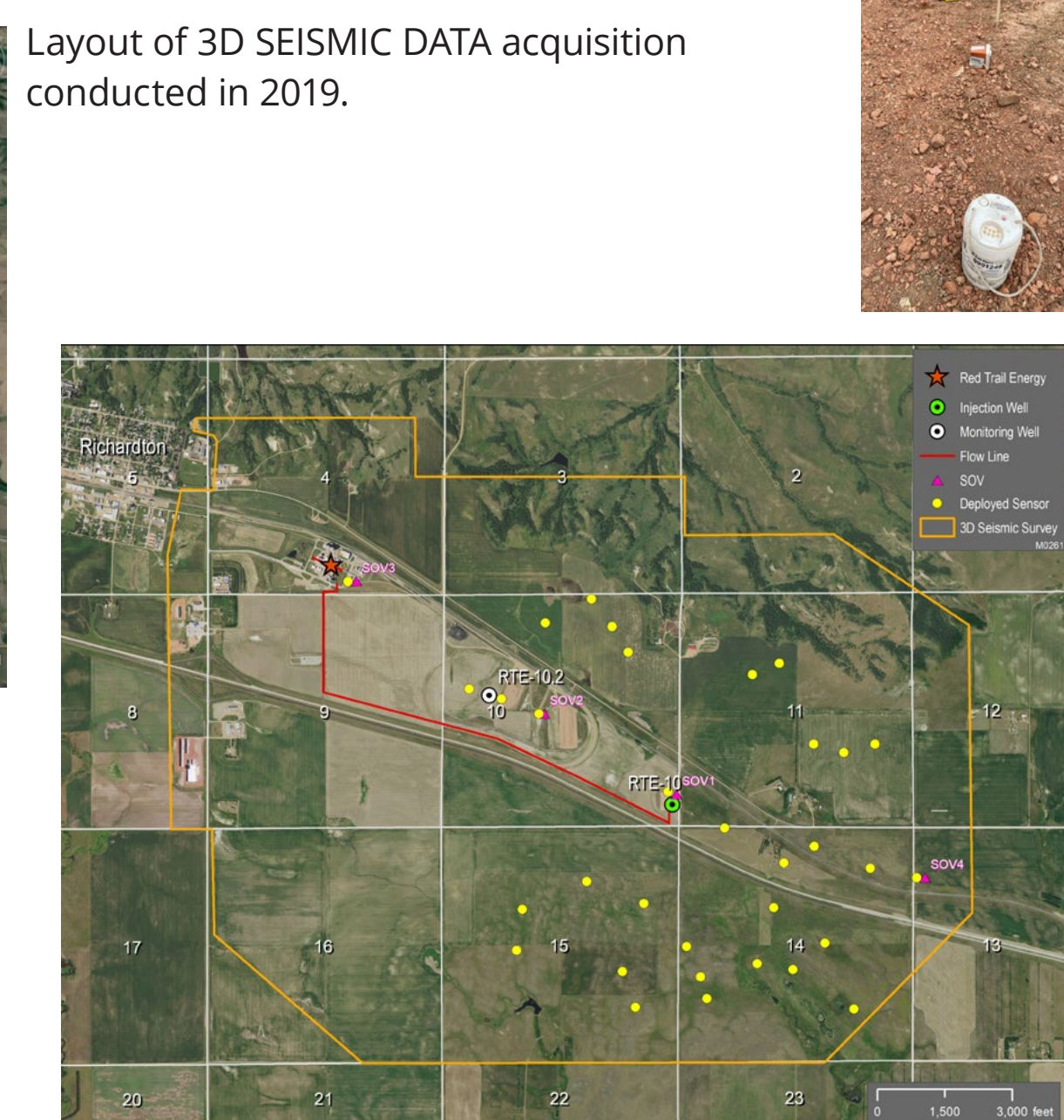
- The research is based on the scalable automated sparse seismic array (SASSA), a lower-cost, less invasive seismic method that could replace the large-scale 3D seismic surveys by using four stationary seismic sources called surface orbital vibrators (SOVs) and a small number of seismic sensors deployed sparsely within the same 8-square-mile area investigated with a 3D seismic survey conducted in 2019.

GOAL | Demonstrate and qualify the use of the SASSA method combined with semiautonomous SOVs as a lower-impact method of monitoring the location of injected CO₂ for compliance with permit and incentive program requirements. The test is being conducted at RTE's commercial CO₂ storage site.

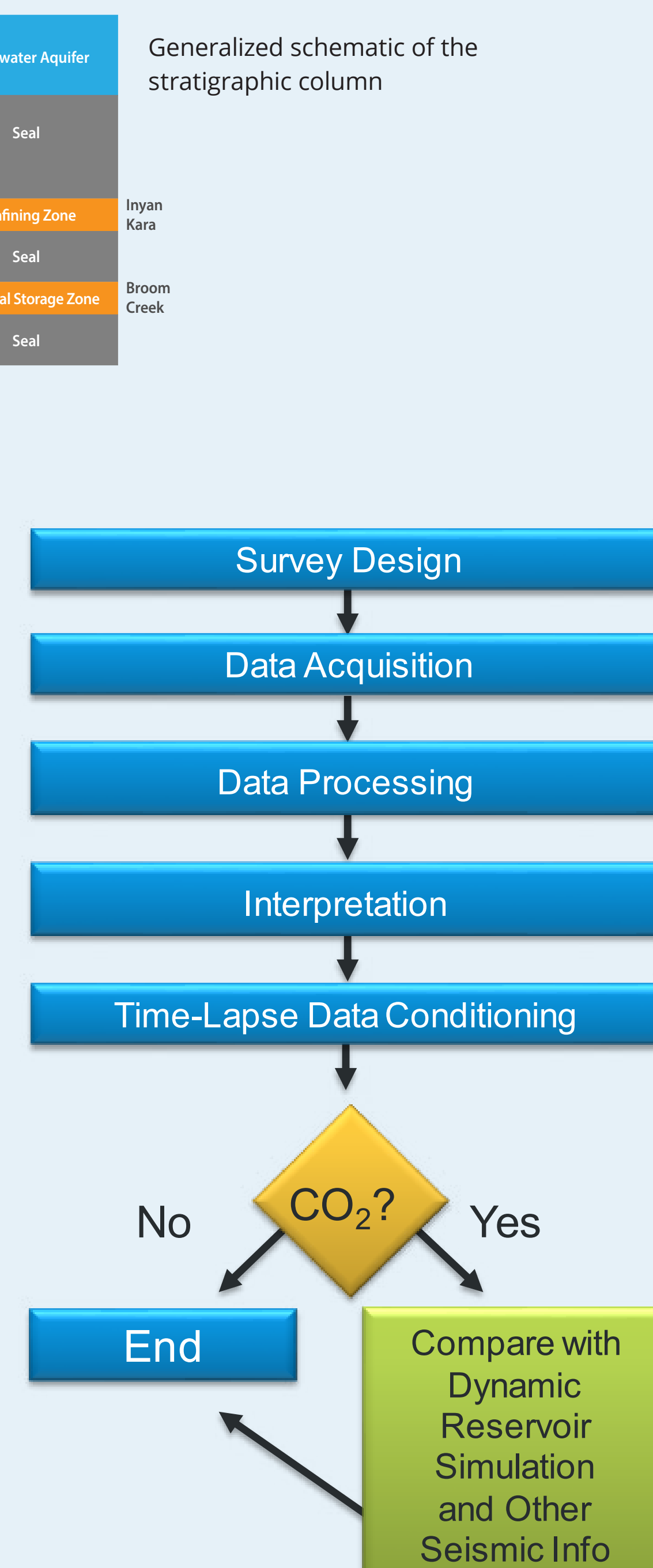
TECHNICAL PARTNERS | Plains CO₂ Reduction (PCOR) Partnership, with technical support from Research Institute of Innovative Technology for the Earth, Class VI Solutions, and Red Trail Energy



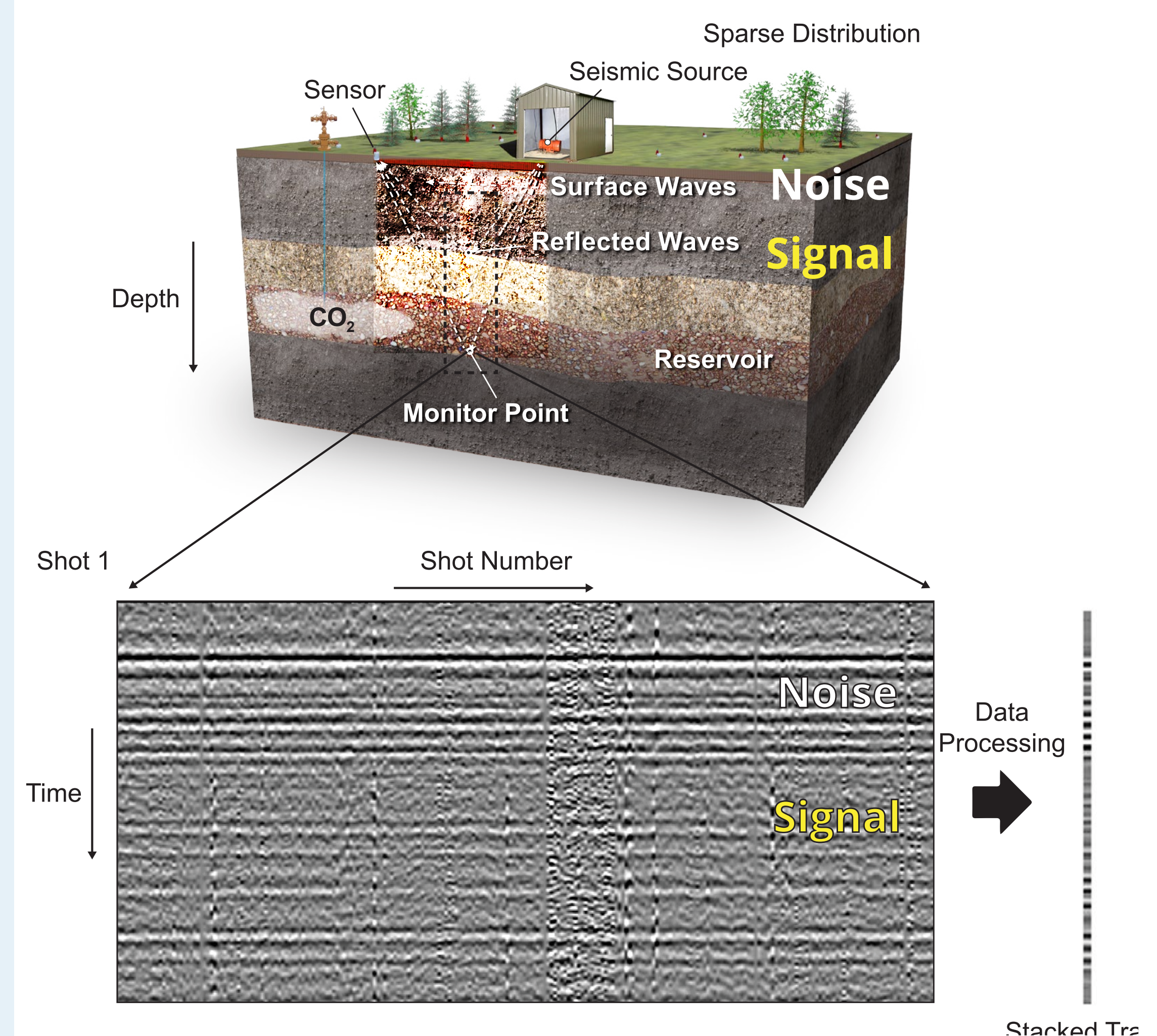
Location of seismic sensors deployed for a SASSA noise test within the same 8-square-mile area investigated with the 3D seismic survey conducted in 2019.



Deployed Sensors



SASSA Workflow



Schematic description of the basic SASSA concept. Bottom: a common receiver gather with AGC and a band pass filter applied and the stacked trace after the complete application of the data processing workflow.

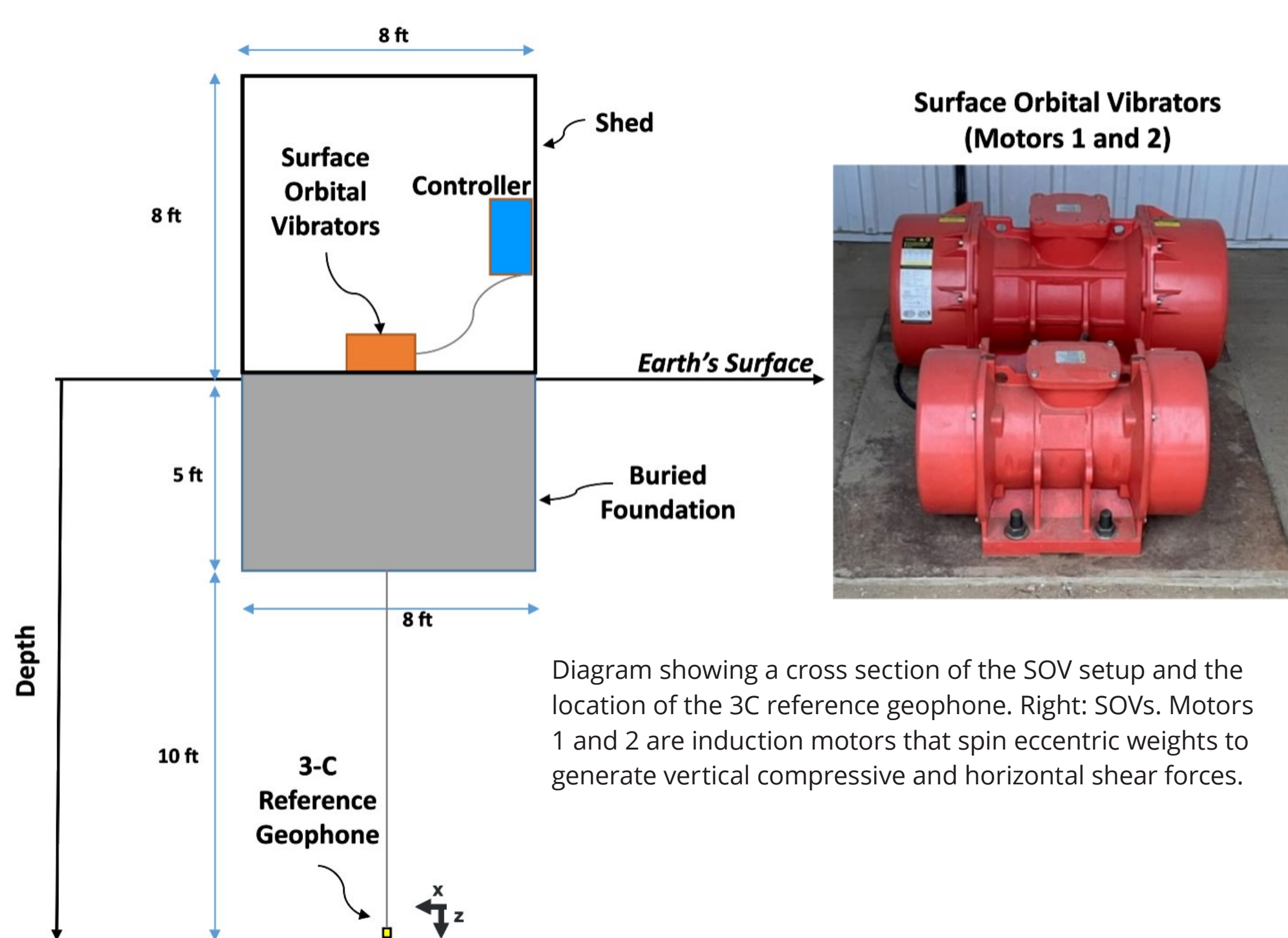
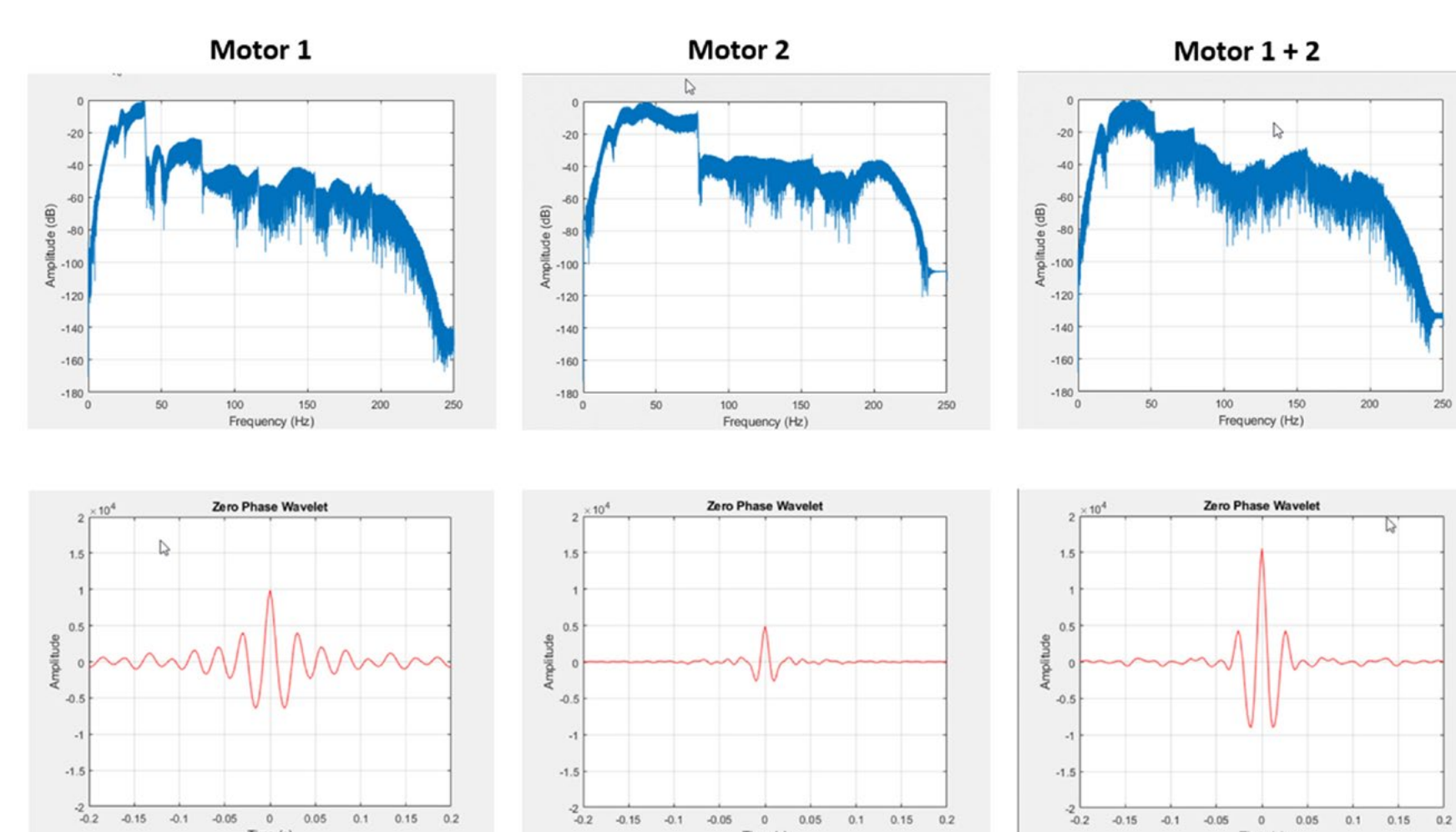
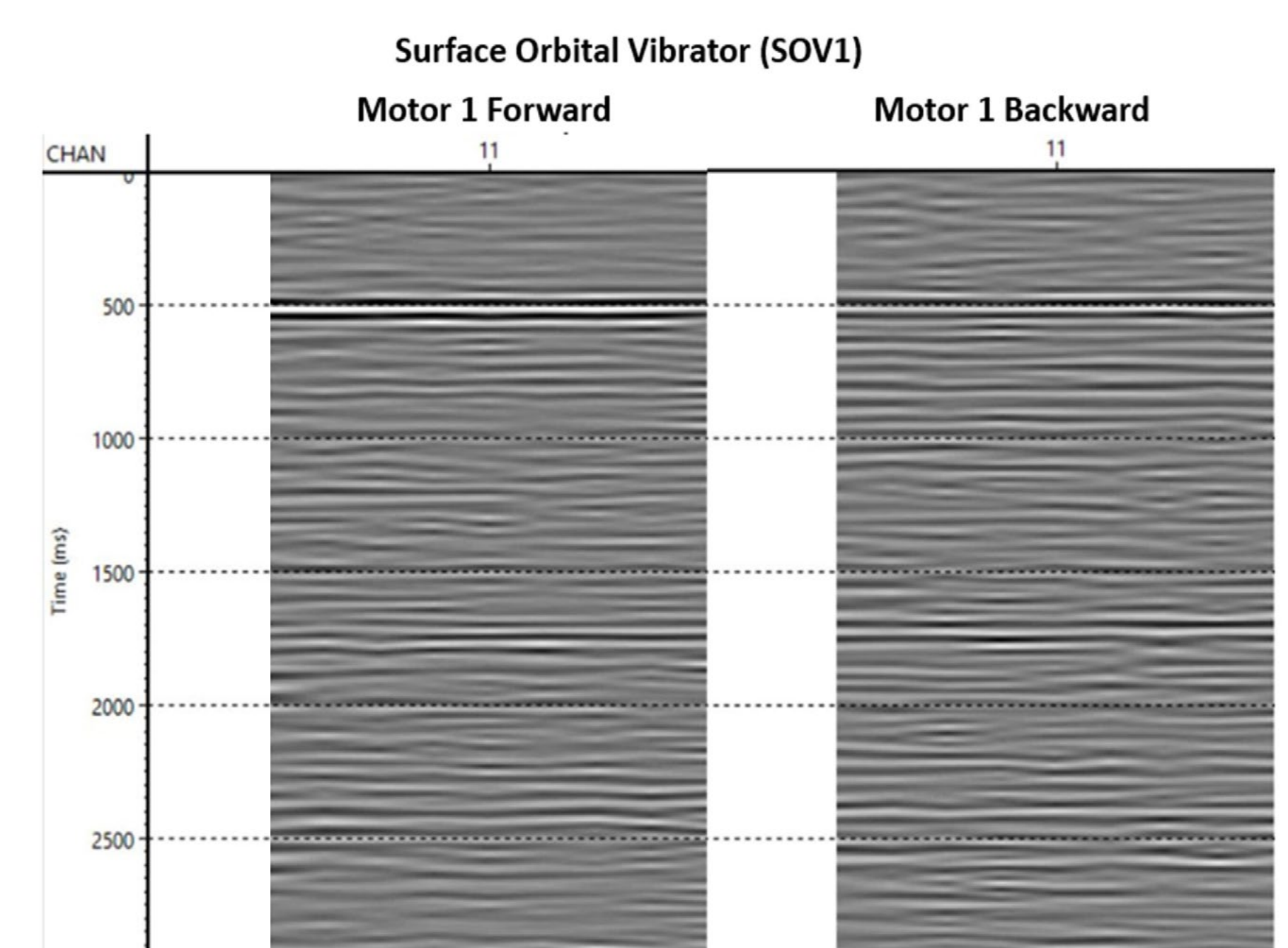


Diagram showing a cross section of the SOV setup and the location of the 3C reference geophone. Right: SOVs. Motors 1 and 2 are induction motors that spin eccentric weights to generate vertical compressive and horizontal shear forces.



Power spectra (top) and zero-phase wavelets of SOVs, Motor 1, 2, and combined 1 and 2 from a 3C sensor at SOV1. The sweep record length is 140 s.



Example of common receiver gathers using SOV1 from the noise test. Left: forward, right: backward. AGC and a band pass filter were applied.