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Baseline DAS VSP acquisition at the Meadowbrook Carbon Storage Hub

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Summary

The Meadowbrook Carbon Storage Hub (MCSH) is in the process of being commissioned by Bison Low Carbon Ventures. To date (October 2025), 32 tonnes of CO_2 have been injected, and the plan is to sequester 3 Mt per year into a deep saline aquifer over 25 years. The target reservoir is the Cooking Lake Formation (Bison Low Carbon Ventures, 2025). CREWES was invited to participate in the baseline survey by Bison, to record the surface seismic program on optical fibre in the injection well. Near-offset Vertical Seismic Profile (VSP) stacked and corridor stacked traces compare well to a synthetic seismic trace generated from velocity and density well logs, showing that the Leduc and Cooking Lake Formations can be imaged below the end of the fibre.

Seismic acquisition

Two north-south and two east-west source lines were acquired by SAExploration in October 2025 with Vibe Point (VP) offsets from the injection well ranging from 37 to 1670 m. A total of 458 Vibe Points (VP) were acquired using one sweep per VP. The source was a Sercel Nomad-65 running a 4-120 Hz linear sweep. Surface receivers were Geospace GCL 5 Hz 1C and 10 Hz 3C nodes. The injection well has single and multi-mode optical fibres on the outside of casing from surface to top of cap rock. VP were recorded by two DAS interrogators, one operated by CREWES and one by ESG Solutions.

Processing and initial interpretation

CREWES DAS field data were decimated from 16 kHz sampling frequency to 1 kHz and debiased. Uncorrelated source gathers were extracted from the continuous data stream using GPS timestamps. Depth registration was conducted using the known fibre installation depth and tap tests on the collar flange. Uncorrelated and correlated source gathers were stored as SEG-Y files after adding source-receiver geometry information to the trace headers. The closest VP to the injection well was processed as a near offset VSP (Figure 1) following Hinds et al. (1996). The down-going P-wavefield was modelled by flattening to a datum using first-break picks, median filtering, reversing the flattening step, and subtracting the filtered results from the input. The data were then NMO corrected and the up-going P-wavefield was flattened, top-muted, and (1) stacked to obtain a VSP stack trace, and (2) bottom muted and stacked to obtain a VSP corridor stack trace.

Figure 1a shows injection well logs converted to P and S velocities (blue and red), and densities (green). Figure 1b shows a synthetic seismic trace created using P-velocity and density, and a wavelet extracted from the NMO corrected up-going P-wavefield VSP data. Figure 1c shows the extent of fibre in the injection well. Figures 1d and 1e show the VSP stack and VSP corridor stack. Synthetic, VSP stack, and VSP corridor stack traces have been duplicated ten times for visibility.

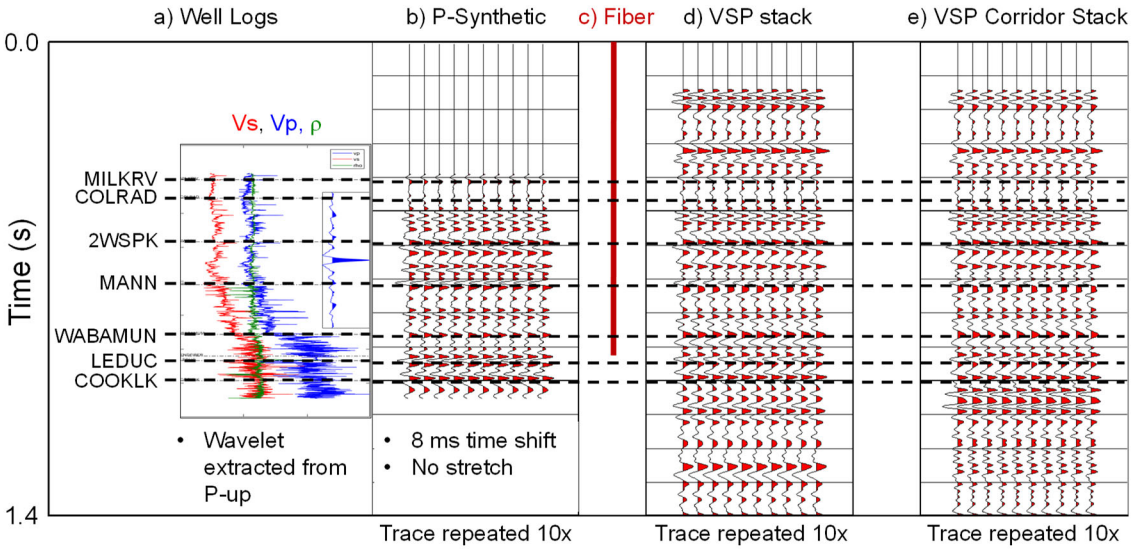


FIG. 1. Well logs and wavelet (a); P-synthetic seismogram (b); Fibre extent in well (c); VSP stack (d), and VSP corridor stack (e).

Conclusions and Future Work

Uncorrelated and correlated files were created from the continuous DAS data using GPS timestamps. Depth registration was conducted using tap tests and end of fibre. The VP closest to the injection well was processed to NMO corrected VSP stack and corridor stack traces. A synthetic seismic trace was created using well logs and a wavelet extracted from the NMO corrected up-going P-wavefield. The VSP stacks compare well to the synthetic seismic and show that the Leduc and Cooking Lake Formations below the end of the fibre can be imaged. Future work includes processing the remaining VP to pseudo 2D seismic sections that can be compared to the surface seismic full waveform inversion. Full Waveform Inversion (FWI) will also be considered. Ultimately, the goal is to track subsurface development of the CO_2 plume over time by comparing future seismic surveys to this baseline survey.

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References

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