

DAS and geophone field data comparison from VSP monitoring at the CaMI Field Research Station

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Abstract

At the Containment and Monitoring Institute Field Research Station (CaMI.FRS) in Newell County, Alberta, Canada, injection of CO₂ into a saline aquifer allows for subsurface monitoring technologies to be tested in a simulated shallow-leak scenario. The 300 m deep sandstone reservoir has 6 m thickness and 10% porosity. VSPs monitor the CO₂ plume at an observation well offset 20 m south-west of the injection well. This well has permanent 3-C geophones and both straight and helical DAS fibers cemented outside of casing. A borehole accelerometer survey was also acquired in 2018. A second well 30 m north-east of the injector hosts an additional straight DAS fiber. Simultaneous acquisition of high-SNR geophone and DAS VSP data allows for direct comparisons between data types and between different DAS interrogators. While the geophone array confidently detected a 33 t CO₂ plume, this was not detected with DAS which faced additional time-lapse repeatability challenges. Baseline data was acquired with a single-pulse interrogator using 10 m gauge length and 0.25 m output trace spacing. The 2021 monitor data was acquired with a dual-pulse interrogator using 7 m gauge length and 1 m trace spacing. Trace spacing precision within 0.1% was necessary to avoid introducing coherent, high-frequency time-lapse residuals during depth registration. Differences in checkerboard noise and in high-amplitude traces (Figure 1) caused dissimilarity between baseline and monitor data. Following de-noising and processing, remaining effects of the raw DAS noise and sampling differences interfered with the detection of the CO₂ plume. Compared to geophones, DAS is expected to require greater CO₂ saturation and pore pressure to detect the CO₂. A difference in detection thresholds between geophone and DAS VSP field data informs MMV expectations for geological CO₂ sequestration.

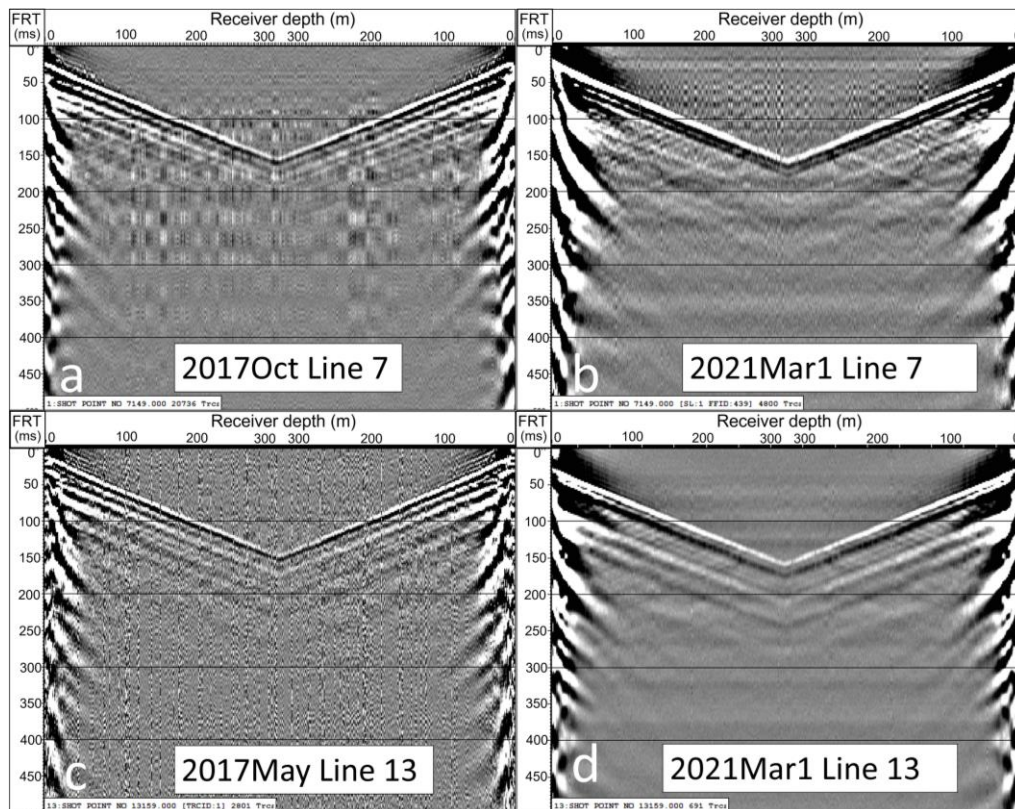


Figure 1 – Examples of different noise levels between baseline (a,c) and monitor (b,d) raw DAS data.