

Microseismic monitoring of CO₂ injection at CaMI – Newell County: comparison and integration of technologies

Joanna Cooper¹, Marie Macquet¹, and Don Lawton^{1,2}

¹Carbon Management Canada, ²University of Calgary

Summary

Carbon Management Canada operates the CaMI – Newell County CO₂ storage research site in southern Alberta, with the goal of developing and evaluating monitoring, measurement, and verification (MMV) technologies for Geologic Carbon Storage. One aspect of MMV is microseismic monitoring, in order to detect potential injection-induced seismicity, to assess geomechanical deformation including fracturing, and to track fluid migration in the storage complex. At the CaMI – Newell County facility, we have a variety of continuous microseismic monitoring tools deployed, from conventional technologies such as broadband seismometers, permanent surface geophones, and permanent borehole geophones, to newer and developing technologies including trenched and downhole DAS fibre, and a SADAR[®] array network. Microseismic bulletin processing and results for past years using the SADAR[®] network were previously reported in Hutchenson et al. (2023). In this study we compare event detections, locations, and characterizations determined from our microseismic MMV technologies over a 10-day period in January, 2023. Using the SADAR[®] bulletin provided by Quantum Technology Science Inc., we find that of the 59 locatable events automatically detected using the SADAR[®] array network, 95% were detected on the surface geophones, 92% were detected on the surface DAS, 81% were detected on the broadband seismometers, 45% were detected on the borehole geophones, and 0% were detected on the downhole fibre at depths equivalent to the geophones. Based on these comparisons, we discuss the advantages and disadvantages of the different technologies, and show how integration of datasets is beneficial.

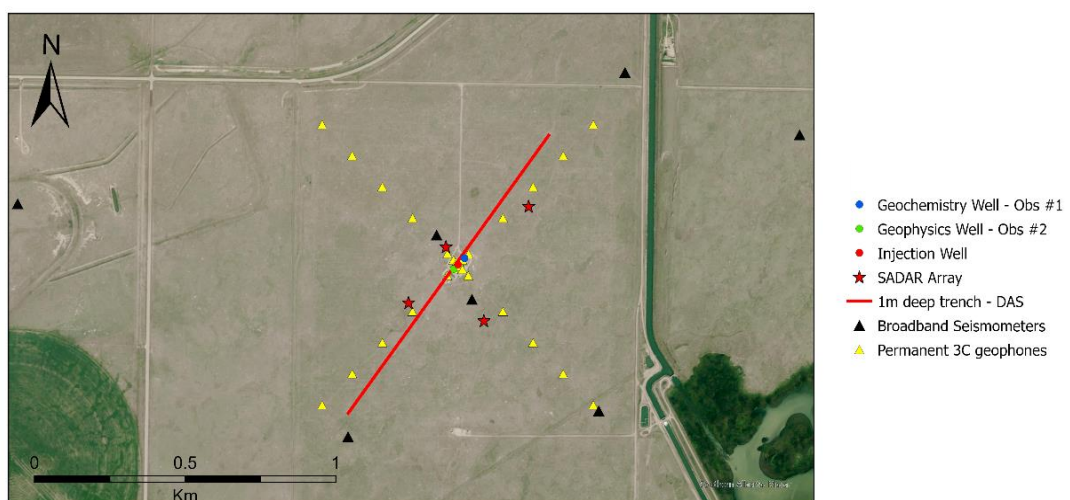


FIG.1: Distribution of microseismic monitoring technologies installed at CMC's CaMI – Newell County Facility. Observation wells #1 and #2 contain straight DAS fibre. Observation well #2 also contains helically-wound DAS fibre and a permanent downhole 3C geophone array.

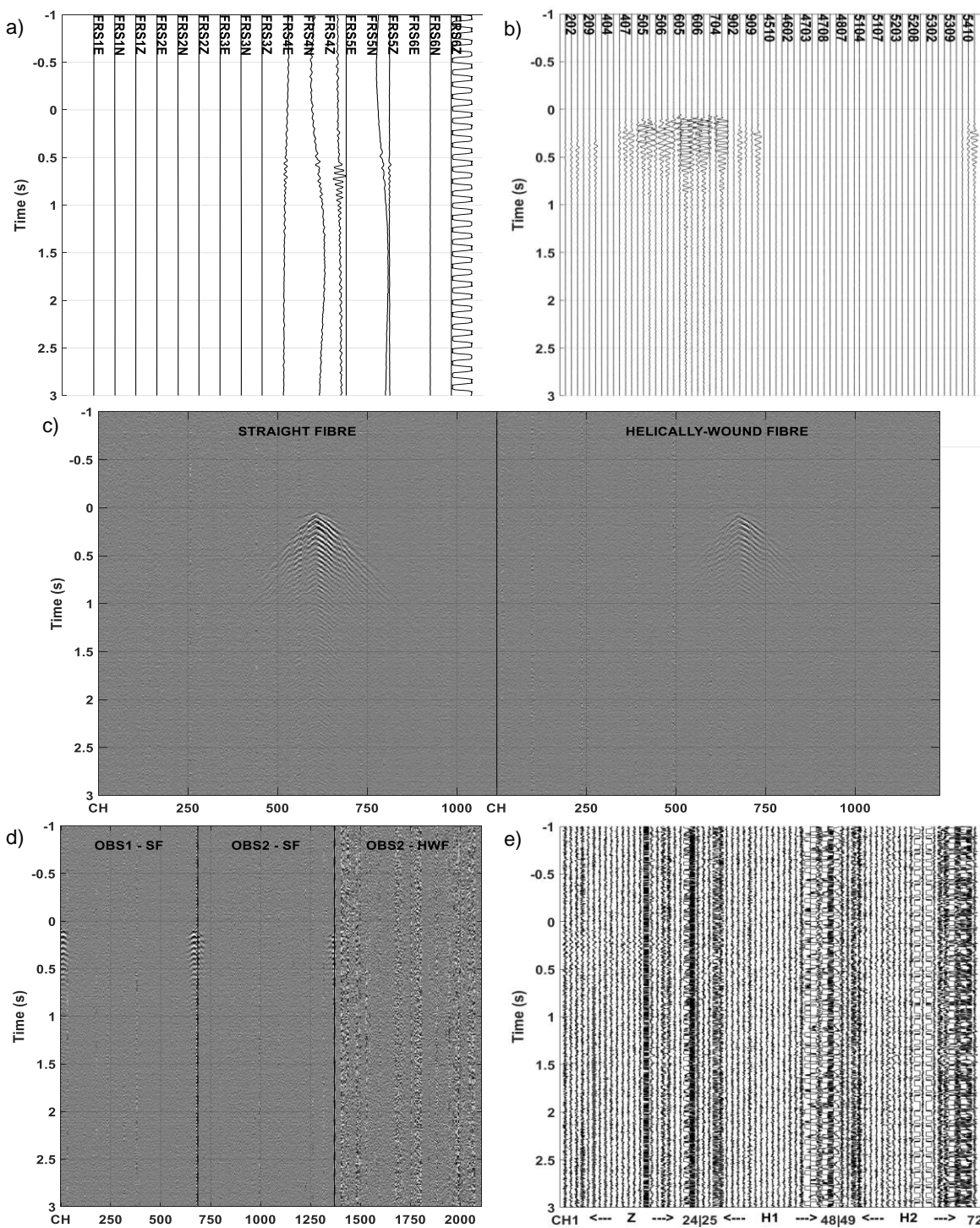


FIG.2: Example of an event detected on different microseismic monitoring technologies: SADAR[®] (not shown – T_0 : 01/16/2023 03:55:37.378250 UTC, Depth: 190.803 m, M_w : -2.13), broadband seismometers (a), surface 3C geophones (b), trenched DAS – straight fibre and helically-wound fibre (c), downhole DAS – SF in both wells and HWF in Observation well #2 (d), and downhole 3C geophones in Obs well #2 (e).

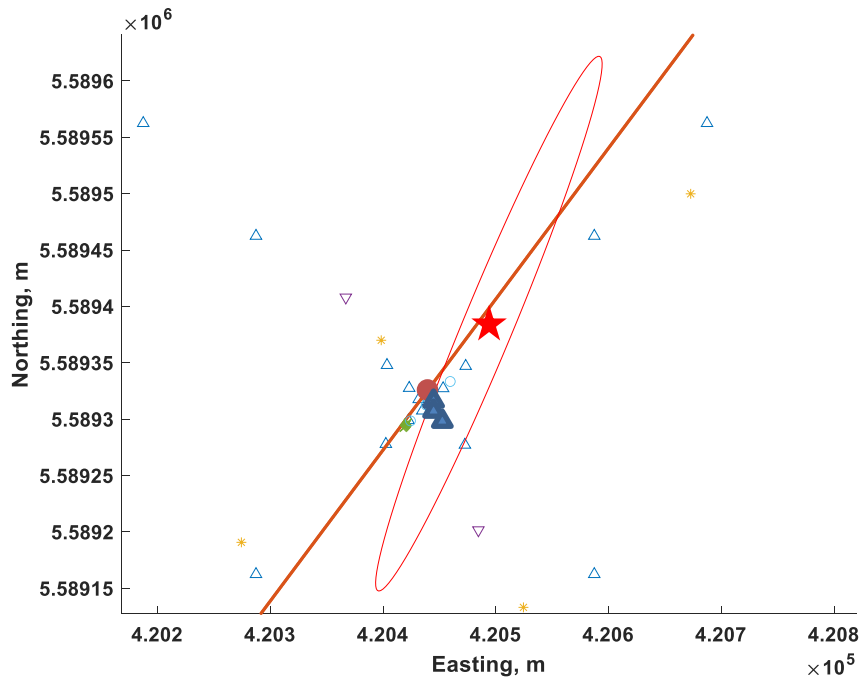


FIG. 3: Example of integration of monitoring technologies. The red star and red ellipse are the event location and error ellipse reported in the SADAR[®] bulletin (T_0 : 01/16/2023 03:55:37.378250 UTC, Depth: 190.803 m, M_w : -2.13). The DAS trench channel with first arriving energy (filled orange circle), and the surface geophones with first arriving energy (filled blue triangles) help further constrain the event location.

Acknowledgements

The authors thank the CMC-CaMI Joint Industry Project members for their continuous support. We also acknowledge financial support from the Canada First Research Excellence Fund through the University of Calgary's Global Research Initiative in Sustainable Low-Carbon Unconventional Resources. We thank Quantum Technology Science Inc., a subsidiary of Geospace Technologies Corporation, for access to their microseismic bulletin.

References

Hutchenson, K.D., D. Quigley, J. Longbow, E.B. Grant, P.A. Nyffenegger, J. Jennings, M.A. Tinker, M. Dahl, D. Grindell, M. Macquet, and D.C. Lawton, 2023, Microseismic monitoring using SADAR arrays at the Newell County carbon storage facility: what have we learned in a year?: Presented at GeoConvention 2023.