# Shear-wave studies of the near-surface at the CaMI Field Research Station in Newell County, Alberta

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## Summary

The Containment and Monitoring Institute (CaMI), established by CMC Research Institutes Inc., has a Field Research Station (FRS) in Newell County, Alberta, where technologies for the measurement, monitoring and containment of subsurface fluids, including carbon dioxide, are being developed, refined and calibrated. A well for injection of $CO_2$ was drilled in 2015 and small amounts (up to 400 tonnes per year) of $CO_2$ have started to be injected at a depth of 295 m into the Upper Cretaceous Basal Belly River Formation, which is a water-wet sandstone capped by shales, coals, silts and silty sands.

We have acquired 3D and 2D PP and PS data at CaMI.FRS since 2014 (Isaac and Lawton, 2017). In 2018 we acquired S-wave data for the first time, using both a fixed geophone array and a towed land streamer array. These two S-wave seismic surveys yielded useful and complementary information about the near subsurface. From the fixed array survey we obtained an S-wave depth/velocity model derived from refraction statics analysis showing a 28.5 to 34.5 m thick low S-wave velocity layer with velocities ranging from 222 to 280 m/s overlying bedrock with S-wave velocities of 1045 to 1110 m/s. The depth-converted stacked streamer array line images bedrock well and the imaged depth compares very well with the true bedrock depth of 29.5 m in the injection well.

We also used the receiver statics derived from the fixed array survey to assist in the determination of receiver statics for PS data acquired in 2017. These statics improved the imaging of the Basal Belly River reflector on the migrated PS section.

## Method

Two S-wave seismic surveys were acquired at the CaMI.FRS in the summer of 2018 using Echo Seismic Ltd's S-wave Envirovibe. For the first survey receivers were placed every 10 m in a fixed array and the source interval was 20 m. The second survey consisted of a 72-m streamer array towed behind the truck. The source interval was 2 m and the receiver interval was 1 m. The recorded S-wave data are of good quality with clear first breaks. A smoothed S-wave velocity model was derived from refraction statics analysis. The near-surface S-wave low velocity layer is 28.5 to 34.5 m thick, with velocities ranging from 222 to 280 m/s. The S-wave bedrock velocity ranges between 1045 and 1110 m/s. The depths to bedrock compare well with the actual bedrock depth of 29.5 m at the injection well location. We applied some basic processing to both surveys, stacked and migrated them. The streamer array line images the bedrock very well. This line was converted to depth using the refraction velocities. The depth of imaged bedrock compares very well with the true bedrock depth of 29.5 m at the injection well.

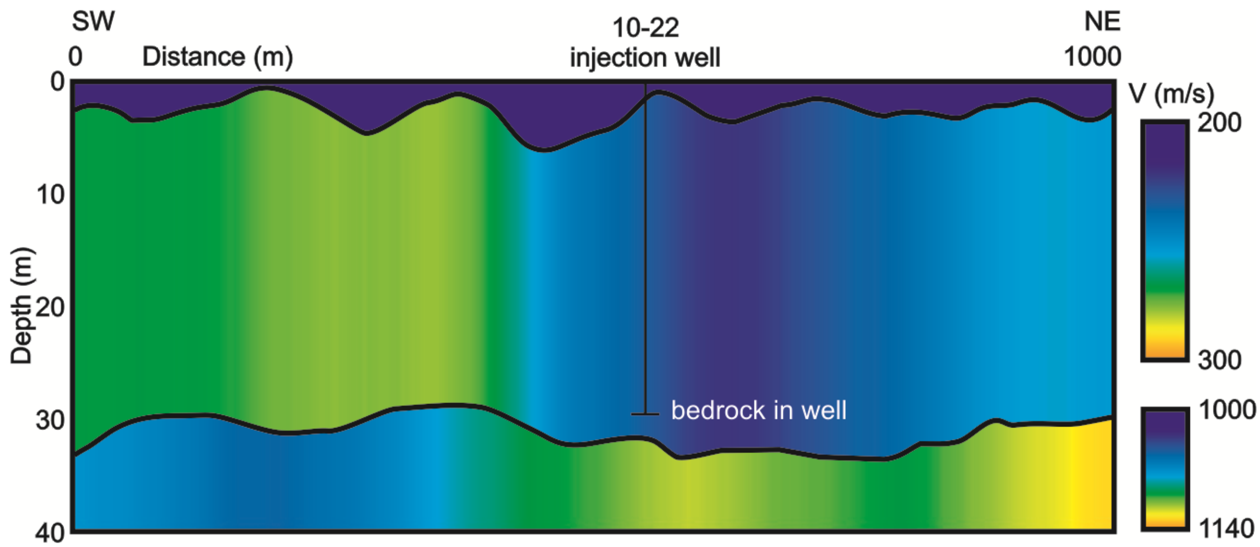


FIG.1. Depth/velocity model derived from refraction analysis of first breaks picked on the fixed geophone array line. Near-surface velocities are 222-280- m/s and bedrock velocities are 1040-1110 m/s. Bedrock depth varies from 28.5-34.5 m. The actual depth of bedrock at the well location is 29.5 m.

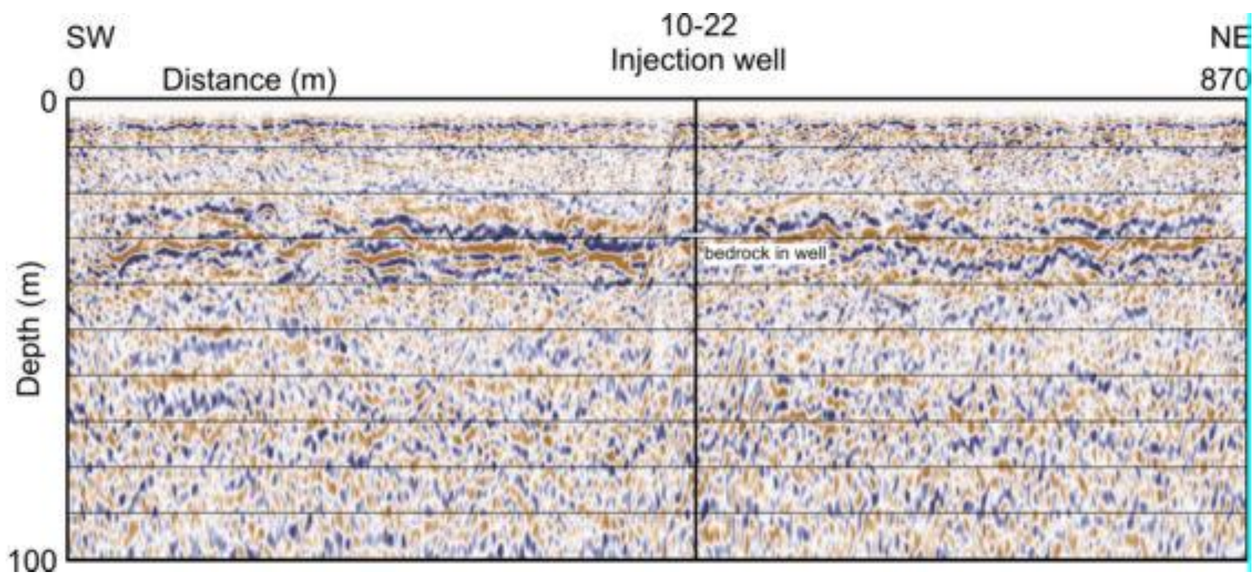


FIG. 2. Migrated towed land streamer array section converted to depth using the velocity model in Figure 1 averaged to a single function. The imaged depth of bedrock compares well to the bedrock depth in the injection well.

We smoothed the receiver statics obtained from the fixed array survey and applied them to the PS survey acquired in 2017. We had estimated receiver statics for that data by flattening a reflector on a stack of receiver gathers and we wanted to compare these results with those obtained using the 2018 S-wave receiver statics as wells as statics derived from a flattened receiver stack. The migrated CCP stacks are shown in Figure 3. Figure 3b, based upon the 2018 S-wave statics, shows greater continuity of reflectors, especially the Basal Belly River reflection near 0.5 s.

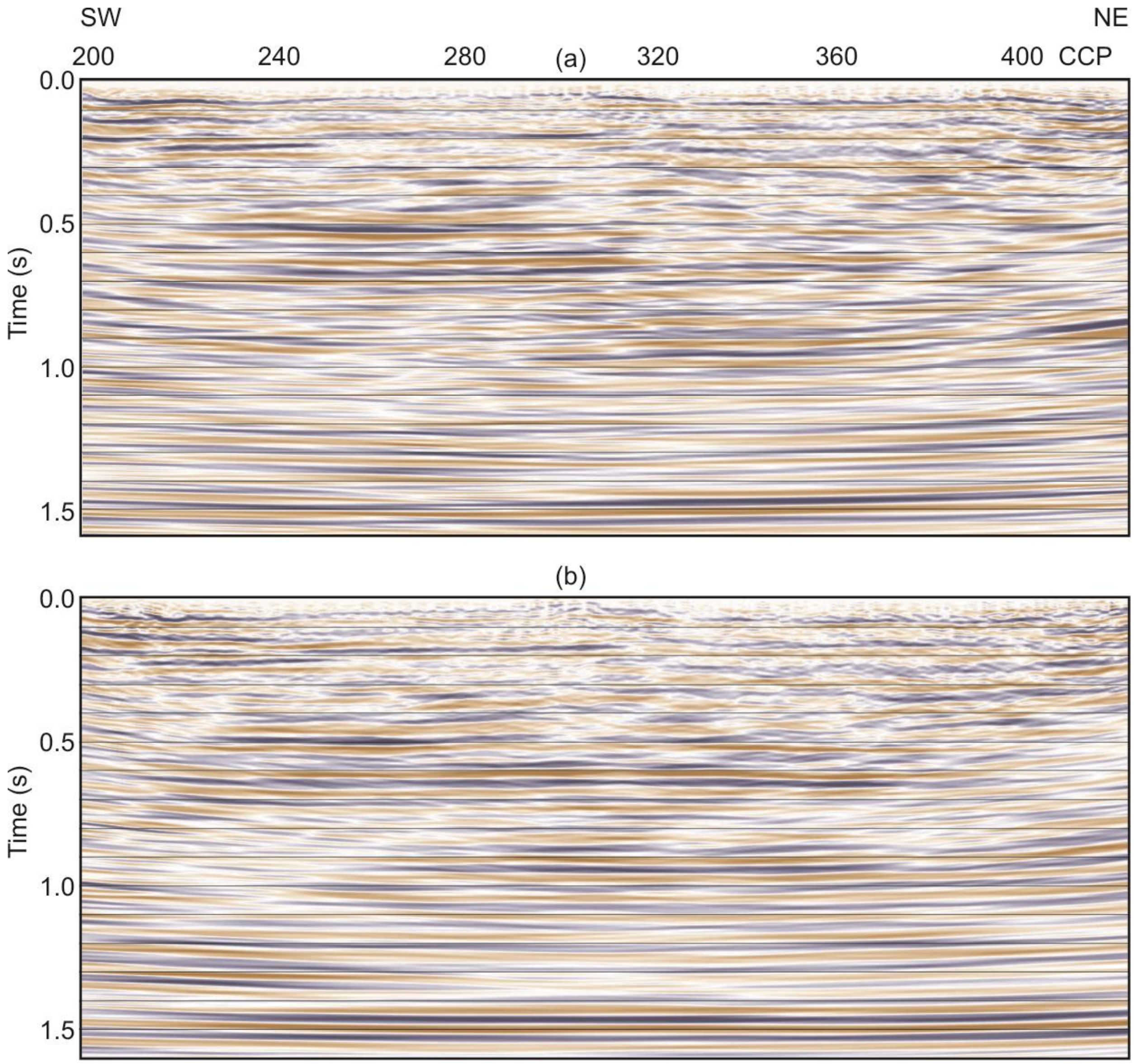


FIG. 3. Migrated CCP stacks of the 2017 PS data with (a) flattening receiver statics, and (b) receiver statics from the 2018 fixed array S-wave survey followed by flattening receiver statics.

## Conclusions

Two complementary S-wave seismic surveys acquired using a fixed array of geophones and a towed land streamer array yielded new information about the S-wave character of the near subsurface. Both the smoothed S-wave depth/velocity model derived from refraction statics from the fixed array line and the depth-converted imaged bedrock on the towed streamer line compare very well with the true bedrock depth of 29.5 m at the injection well. We also found that application of the receiver statics derived from the fixed array survey to the PS data acquired in 2017 improved the imaging of the Basal Belly River reflector on migrated sections.

## Acknowledgements

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### References

**Isaac, J. H. and Lawton, D. C., 2017,** A summary of surface seismic reflection data acquired at the Field Research Station near Brooks, Alberta, CREWES Research Report, 29, 39.1-39.16.