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

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ABSTRACT

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. 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. 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 in the injection well. We applied some basic processing to both surveys, stacked and migrated them. The streamer array line images the bedrock very well and 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.

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.

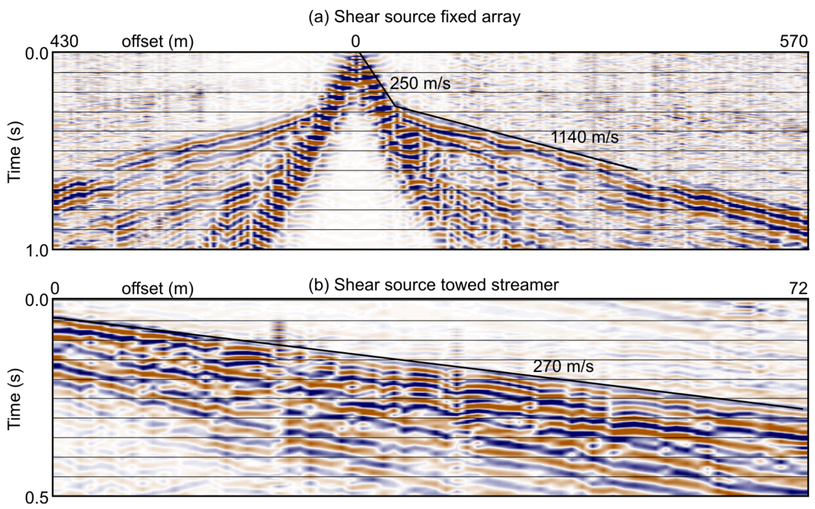

FIG. 1. Shot gathers from the (a) fixed receiver and (b) towed streamer S-wave surveys. First breaks on these particular gathers indicate near-surface S-wave velocities of 250-270 m/s and a bedrock velocity of 1140 m/s.

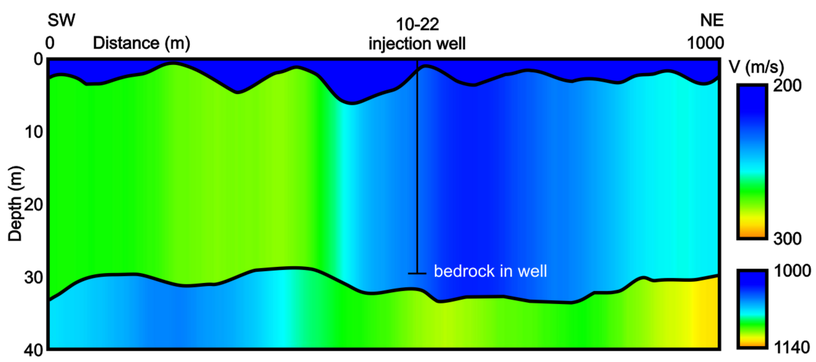

FIG. 2. The depth/velocity model derived from refraction analysis. The actual depth of bedrock in the injection well is 29.5 m.

The recorded reflected S-wave data are of good quality with clear first breaks. The fixed array data (Figure 1a) indicate a near-surface S-wave velocity around 250 m/s and a refractor with a velocity of 1140 m/s intercepting at an offset of 60 m. We picked the first breaks and did refraction statics analysis.

The results of this analysis gave a near-surface S-wave velocity/depth model and a set of shear shot and receiver statics. Figure 2 shows the smoothed S-wave velocity model. 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 results of this analysis compare well with the actual bedrock depth of 29.5 m in the injection well.

We applied some basic processing to both surveys, stacked and migrated them. The fixed array line (Figure 3a) does not reveal any significant reflectors but the streamer array line (Figure 3b) images the bedrock very well. This line was converted to depth (Figure 4) using the refraction velocities. The depth of imaged bedrock compares very well with the true bedrock depth of 29.5 m in the injection well.

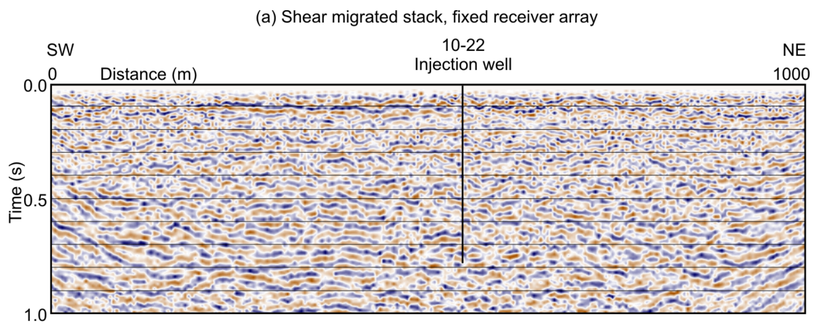

FIG. 3. Migrated (a) fixed array and (b) streamer array data.

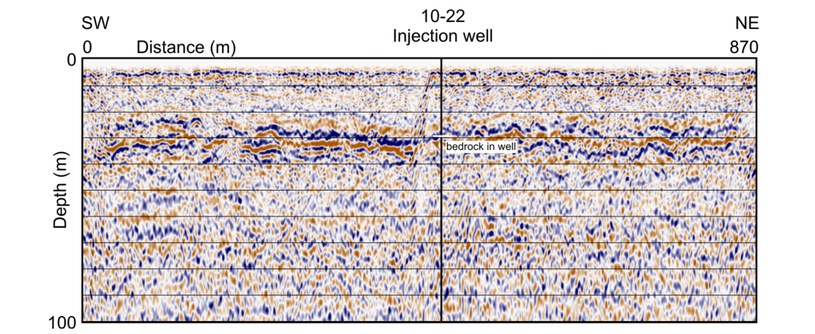

FIG. 4. Migrated streamer array section converted to depth using the averaged velocities of Figure 2. The imaged depth of bedrock compares well to the bedrock depth in the injection well.

A common method for estimating receiver statics is to use the time shifts needed to flatten a reflector on stacked receiver gathers. We applied (a) flattening receiver statics only and (b) smoothed statics from 2018 together with flattening statics to migrated common conversion point (CCP) stacks of the 2017 PS data (Figure 5). Figure 5b shows greater continuity of the target Basal Belly River reflector near 0.5 s and other reflectors.

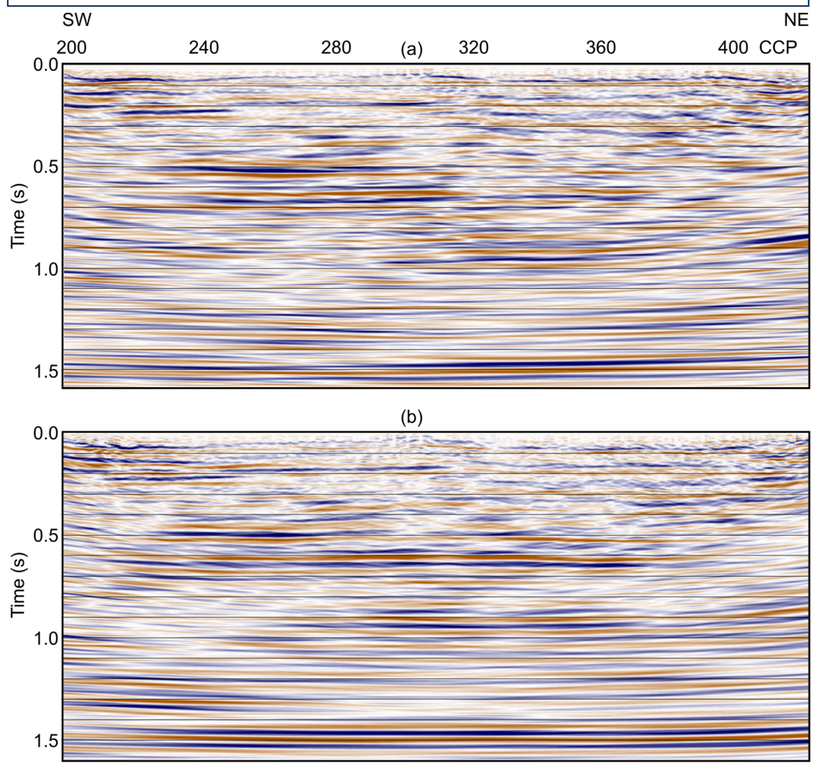

FIG. 5. Migrated CCP stacks of the 2017 PS data with (a) flattening receiver statics, and (b) receiver statics from the 2018 fixed array S-wave data and flattening receiver statics.

CONCLUSIONS

Two S-wave seismic surveys acquired at the CaMI.FRS yielded useful and interesting data. The smoothed S-wave model derived from refraction statics analysis shows a 28.5-34.5 m thick near-surface S-wave layer with velocities of 220-280 m/s. S-wave bedrock velocities are 1045-1110 m/s. Depths to bedrock on the model and on the depth-converted migrated towed streamer array line compare well with the actual bedrock depth of 29.5 in the injection well.

Application of the 2018 receiver statics to the 2017 PS data improved the imaging on CCP migrated data.

ACKNOWLEDGEMENTS

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