Seismic studies of the near-surface at the CaMI Field Research Station, Newell County, Alberta

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ABSTRACT

We reassessed the processing and analysis of the two S-wave seismic surveys that were acquired at the CaMI Field Research Station (FRS) in the summer of 2018. We refined the S-wave depth/velocity model derived from refraction statics analysis of the S-wave fixed array data by restricting the offsets used in the analysis. The new model shows a 19-26 m thick near-surface layer with velocities ranging from 222 to 288 m/s. Below this layer is bedrock having S-wave velocities between 885 and 930 m/s. The depths to bedrock compare well with the actual bedrock depth at the injection well location. The profile of the near-surface S-wave velocity corresponds well with the refractor depth profiles obtained through refraction analysis of 2D P-wave data.

We also improved the imaging of the S-wave streamer data by reprocessing the data. We rebinned the CDPs and applied updated stacking velocities. We also applied pre-stack trace mixing and post-stack f-x deconvolution because of the very short receiver spacing of 1 m and low fold. The resulting reflector is more continuous and better focussed. However, we found that the observed time structure is highly sensitive to the stacking velocities as they are so low.

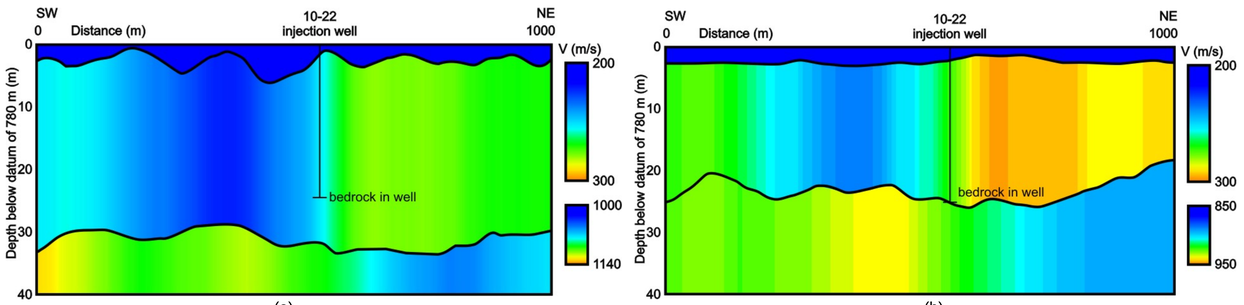

FIG. 1. (a) The first depth/velocity model derived from refraction analysis. Near-surface velocities are 222-280 m/s and bedrock velocities are 1040-1110 m/s. Bedrock depth varies from 28.5-34.5 m. The actual depth of bedrock at the well location is 25 m below the datum of 780 m. (b) The revised depth/velocity model. Near-surface velocities are 222-288 m/s and bedrock velocities are 885-930 m/s. Bedrock depth varies from 19-26.4 m. The new model was derived by restricting the offsets used in the calculation to 70-500 m, reduced from 60-1000 m in the first model.

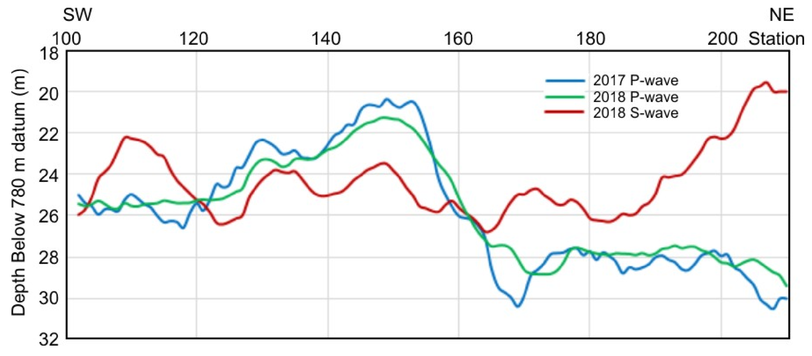

FIG. 2. The refractor depth models derived from analysis of 2017 and 2018 P-wave surveys and the 2018 S-wave survey, which were acquired along almost the same surface profile. The two P-wave models are similar and show a significant increase in refractor depth around the centre of the model. We do not see such a large change on the S-wave model.

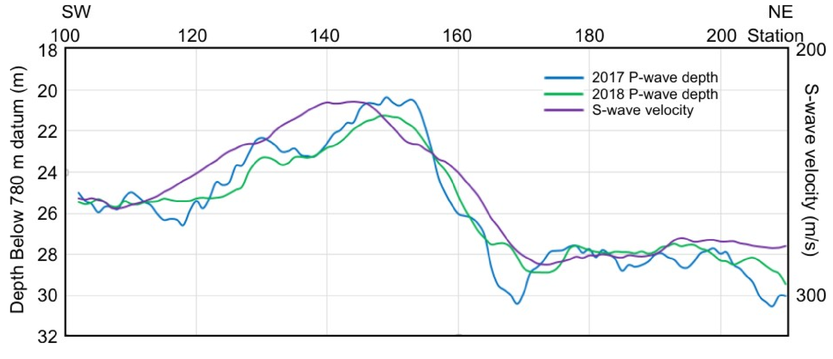

FIG. 3. The refractor depth models derived from analysis of the 2017 and 2018 P-wave data with the S-wave near-surface velocity overlain. We see a similarity between P-wave refractor depth and the S-wave velocity profile.

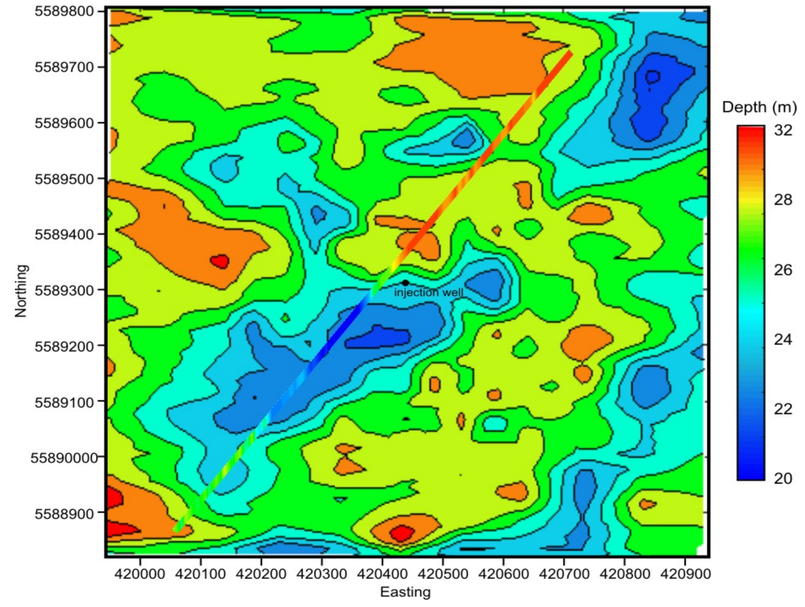

FIG. 4. The refractor depth derived from the 2014 3D data with the average of the 2017 and 2018 2D data overlain. The refractor depth varies from 20-32 m with a SW-NE trending high appearing to run through the middle of the area. It is possible that we are seeing the presence of channels or boulders in the bedrock. We do not see such structure on the S-wave reflection seismic data; however, these data are highly sensitive to changes in stacking velocity.

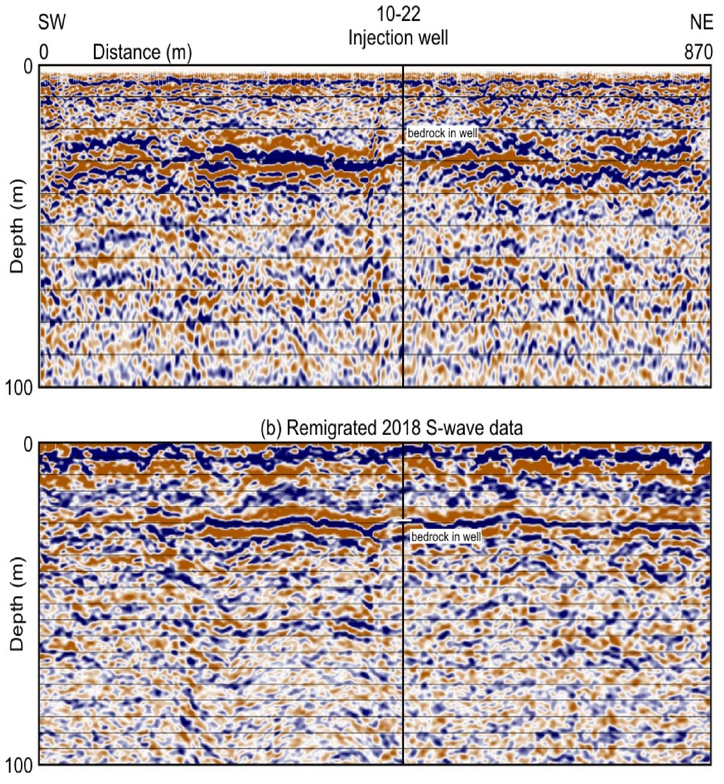

FIG. 5. The original (a) and remigrated (b) S-wave streamer data from 2018. We redatumed the streamer data to 780 m and rebinned the data to achieve a higher CDP fold. The event at 25 m on the new section is more continuous and is better imaged, particularly in the northern part of the line. This reprocessed section does not show the structure predicted by the P-wave refraction analysis. However, since the stack is so sensitive to the stacking velocities, a change in these velocities might introduce structure across the section.

ACKNOWLEDGEMENTS

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