VSP using distributed acoustic sensing at the CaMI Field Research Station in Newell County, AB - August 2018

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ABSTRACT

We examine the seismic data acquired by Fotech at the Containment and Monitoring Institute Field Research Station (CaMI FRS) in Newell County, AB in August 2018 using distributed acoustic sensing. We describe the schematic of the fibre at CaMI FRS and explain the experiment conducted in August 2018. We then show the results of various aspects of the experiment focusing on the vertical seismic profiling of the straight fibre in the two wells at the site.

INTRODUCTION

In August 2018, an experiment was conducted at the CaMI Field Research Station in Newell County, AB. Fotech Solutions acquired seismic data during the experiment using their interrogator and the installed fibre-optic cable system at the site. In this paper, we provide the results of the straight fibre in the two wells. We begin by focusing on the schematic for the fibre at the CaMI FRS. Then we explain the experiment conducted in August 2018. We show the results of the full fibre at one source location. We then look at the results of the straight fibre in wells 1 and 2 for 11 source locations. Finally, we process the zero-offset VSP for well 1 and well 2. For an overview of distributed acoustic sensing and fibre optics, see (Hardeman et al., 2017) and (Grattan and Meggitt, 2000).

CONTAINMENT AND MONITORING INSTITUTE FIELD RESEARCH STATION IN NEWELL COUNTY, AB

The Containment and Monitoring Institute focuses on subsurface monitoring and specifically develops methods for containing carbon as well as other subsurface fluids (CMC Research Institutes, 2015). Figure 1 shows a full-sweep of the fibre at the site at Source Location 155 on line 13. The source is located at the center of the trench which allows us to see the full trench as well as both wells. In comparison to the data in (Hardeman et al., 2017), the data was collected along the opposite direction of the fibre loop. From left to right in Figure 1, we see the results from the trench to well 1 to the straight fibre in well 2 to the helical fibre in well 2.

We provide a schematic of the Field Research Station's fibre loop in Figure 2. In the schematic, the straight fibre is designated by the green lines and the helical fibre is represented by the blue lines. The orange lines depict the connecting fibre. The full schematic begins with the fibre leaving the shed and connecting to the straight fibre for half the length of the trench. The fibre then goes along the trench helically for 1.1 km and then returns halfway along the trench straight. Afterwards, the fibre connects to well 1 where it de-

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scends into the earth straight for approximately 300 m before returning the the surface. It then proceeds to well 2 where it goes down into the well and returns to the surface straight. Then it descends again into well 2 helically before returning to the surface at which point it returns to the shed.

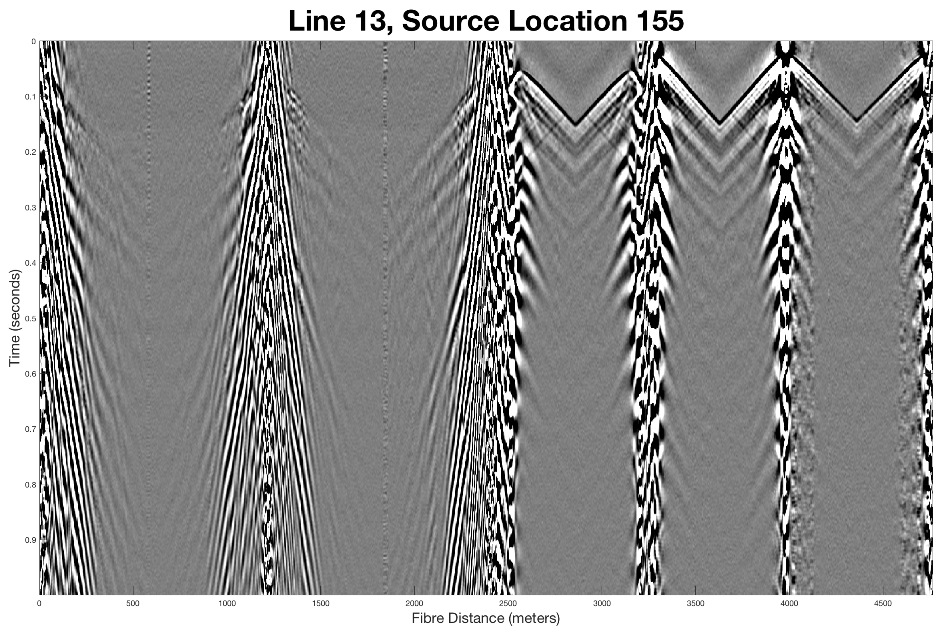

FIG. 1. Full fibre data for line 13 flag 155

Figure 3 shows an aerial view of the site with each of the source locations along the trench marked as well as the two wells. The red dots signify the source locations we will consider in the following section to show what occurs in the wells as the source location is moved along the trench. The blue dots represent well 1 and well 2; and, the blue balloons show the source locations used to process the vertical seismic profiles for each well.

EXAMPLES

For the experiment, a Vibroseis truck generated 110 source locations, numbered 101 to 210, along the 1.1 kilometers of the trench. The source locations were approximately 10 meters apart. A total of 448 shots were acquired on one full line, Line 13. The raw backscattered data was processed to obtain the optical phase. Each shot was cross-correlated with the pilot sweep and then stacked. Each stack consisted of 4 shots.

Figures 4 to 9 show the straight fibre in wells 1 and 2 at 11 different source locations along the trench. In particularly, we consider the results for source locations 101, 112, 123, 134, 145, 156, 167, 178, 189, 200, and 210. The eleven source locations were chosen so that consecutive flags were approximately 110 meters apart.

The top image of Figure 4 depicts the results from the wells when the source location is the farthest southwest on the trench. No conclusive information is acquired by the straight fibre in wells 1 and 2 at source location 101. When the vibroseis truck is moved closer

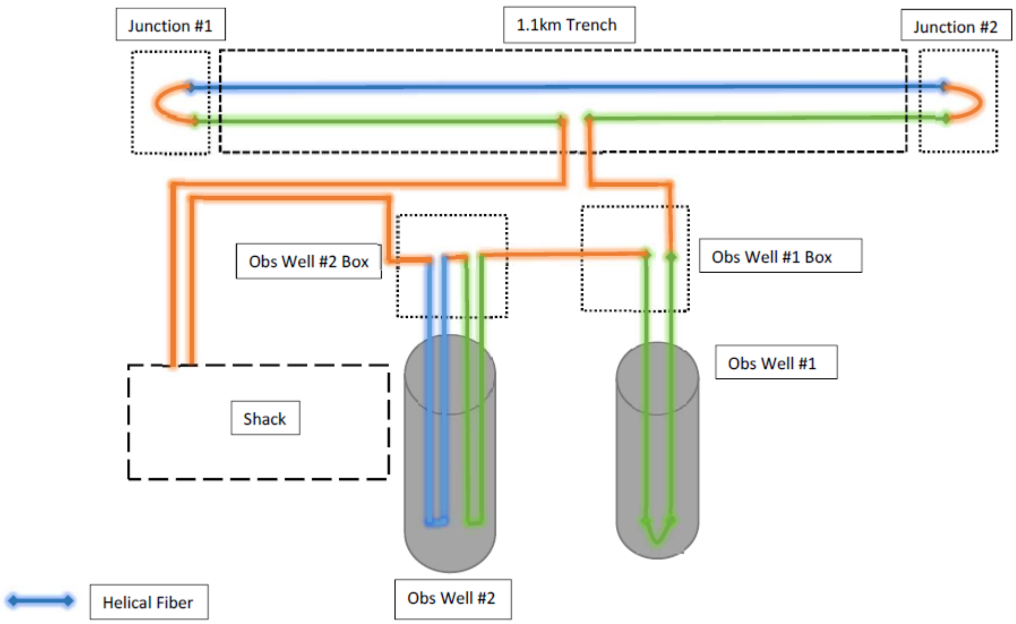

FIG. 2. A schematic of the fibre at the site in Newell County, AB.

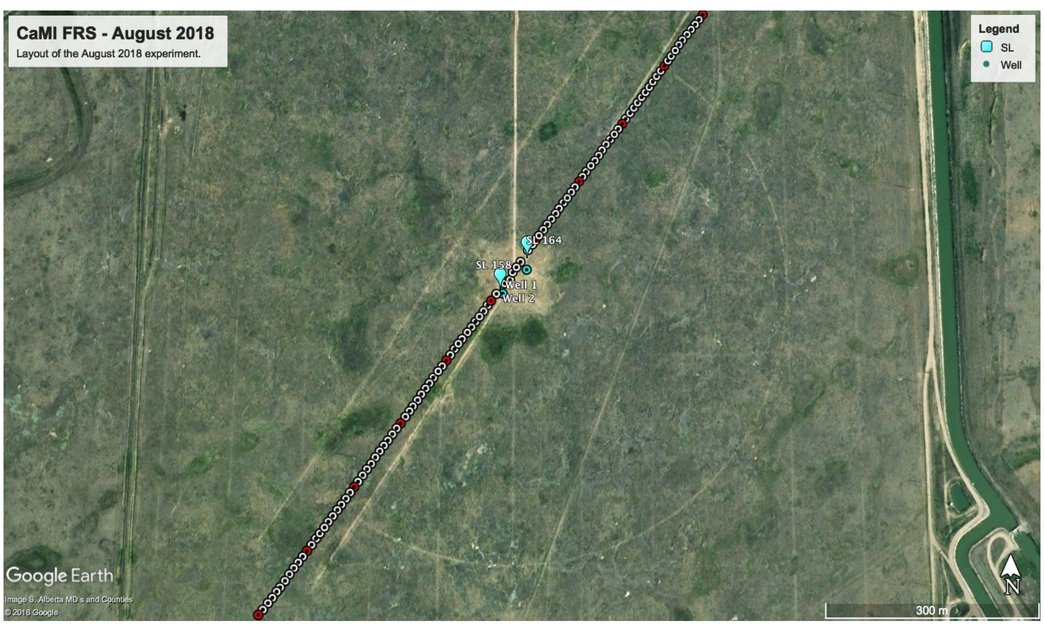

FIG. 3. A aerial view of the experiment at the site in Newell County, AB.

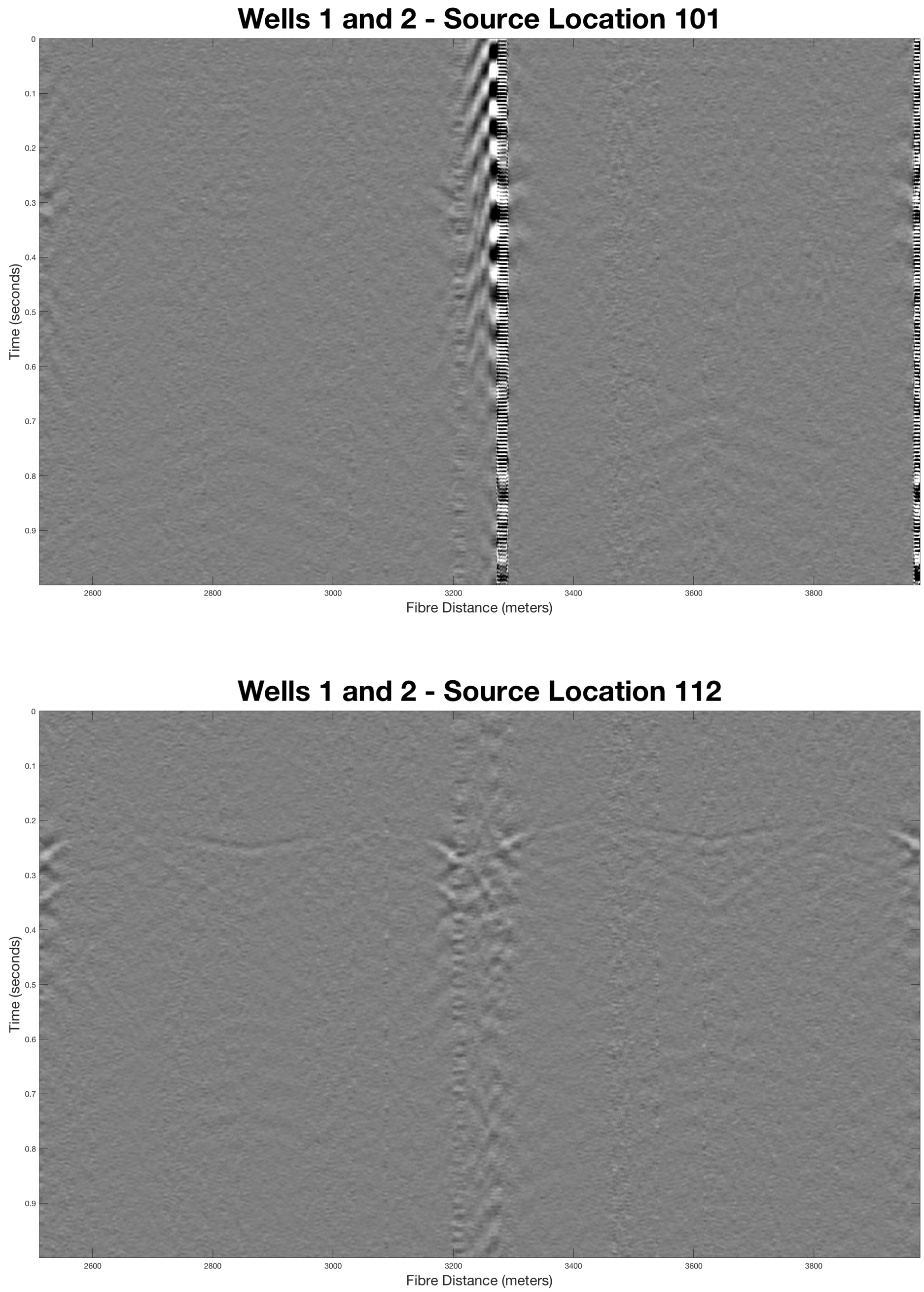

FIG. 4. The straight-fibre from well 1 to the straight fibre in well 2 acquired when the vibroseis truck was at source locations 101 (top) and 112 (bottom)

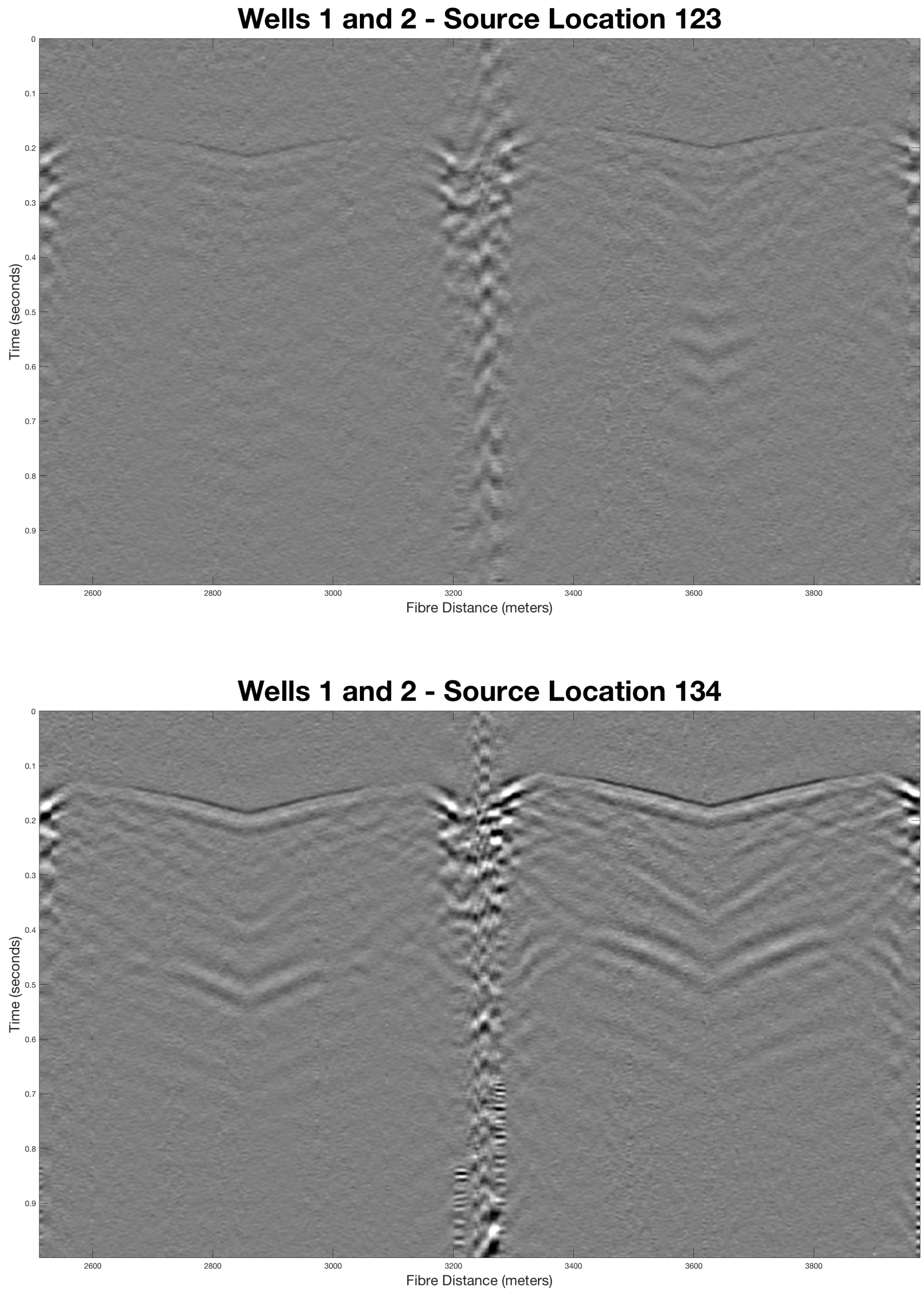

FIG. 5. The straight-fibre from well 1 to the straight fibre in well 2 acquired when the vibroseis truck was at source locations 123 (top) and 134 (bottom)

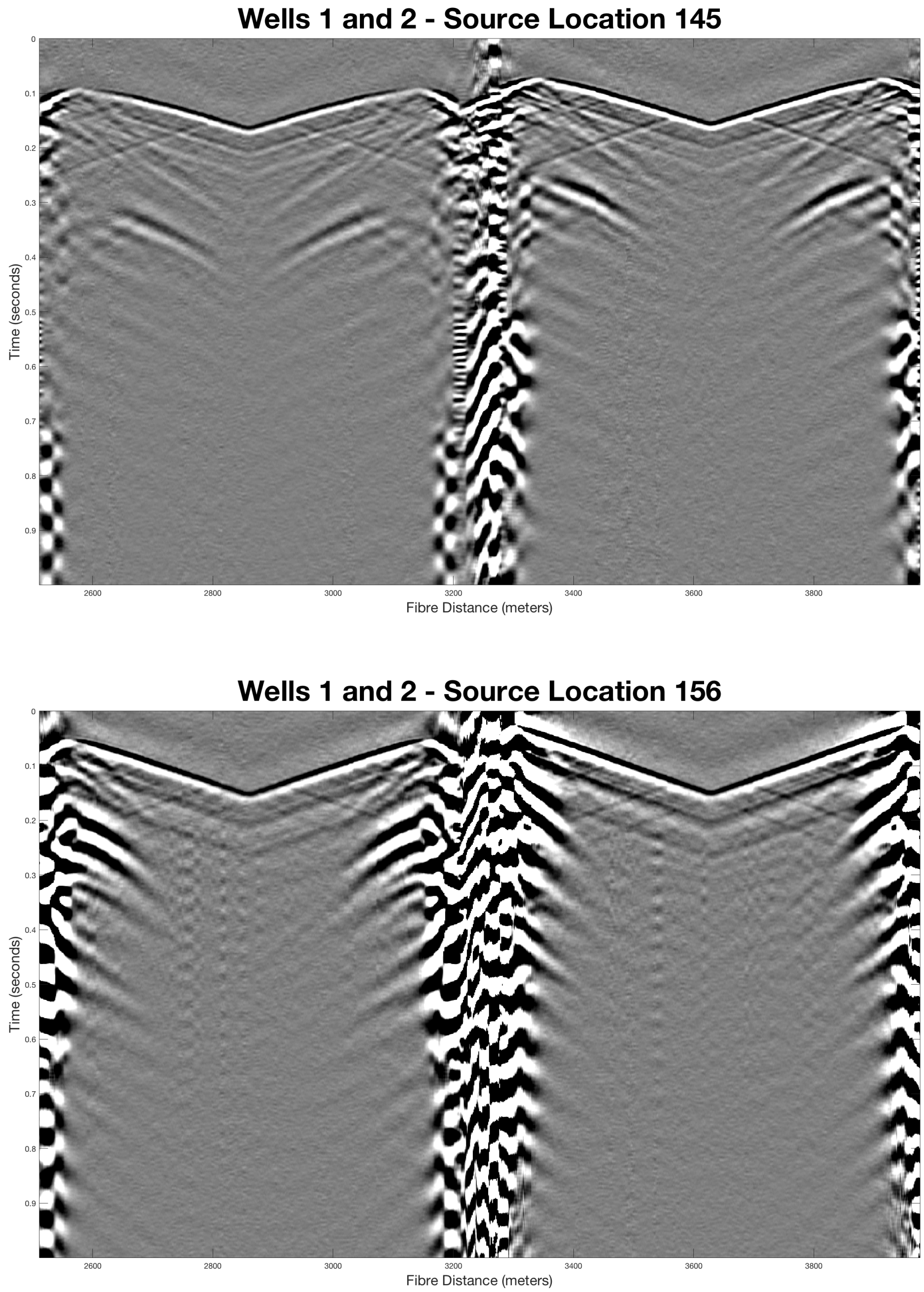

FIG. 6. The straight-fibre from well 1 to the straight fibre in well 2 acquired when the vibroseis truck was at source locations 145 (top) and 156 (bottom)

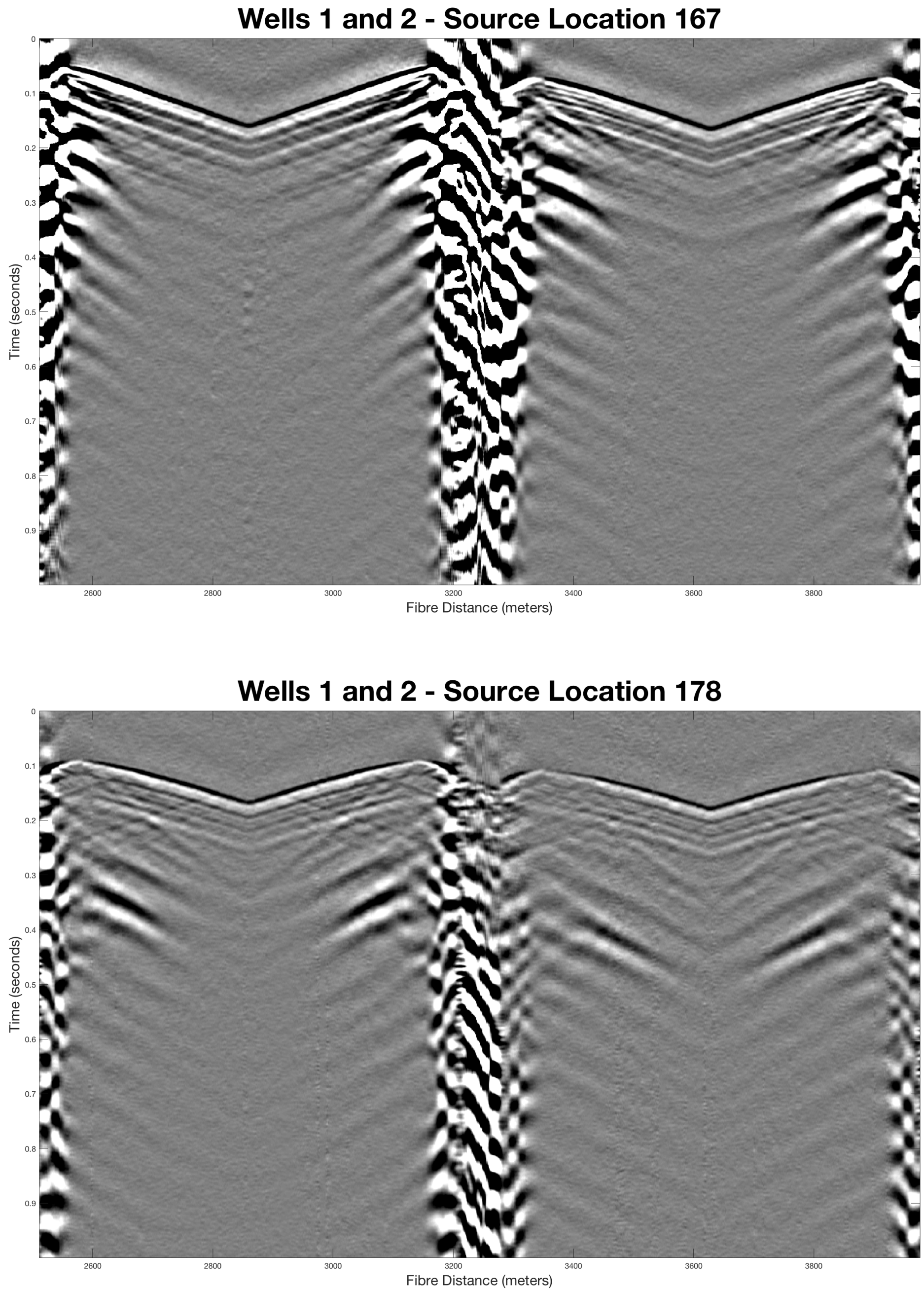

FIG. 7. The straight-fibre from well 1 to the straight fibre in well 2 acquired when the vibroseis truck was at source locations 167 (top) and 178 (bottom)

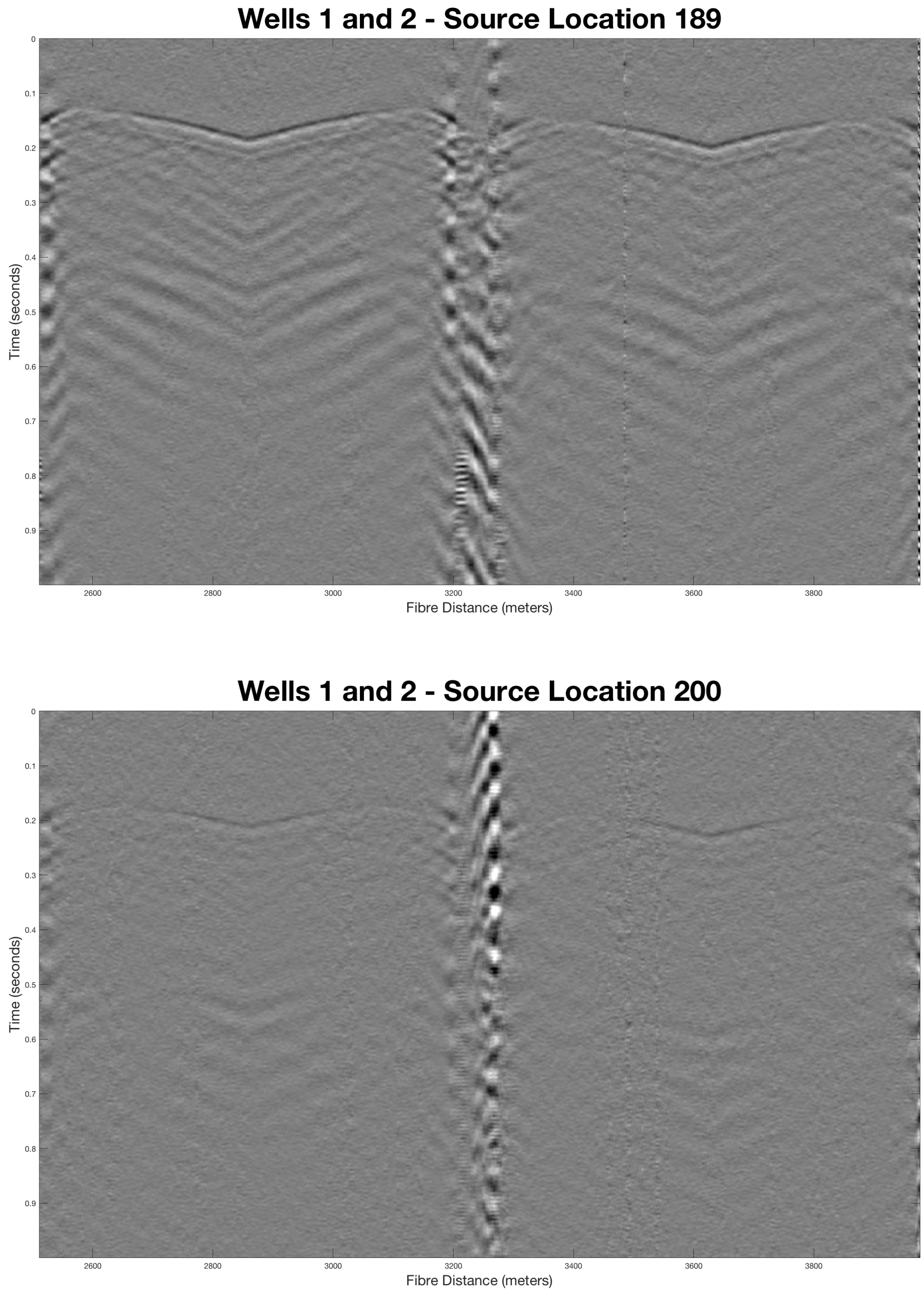

FIG. 8. The straight-fibre from well 1 to the straight fibre in well 2 acquired when the vibroseis truck was at source locations 189 (top) and 200 (bottom)

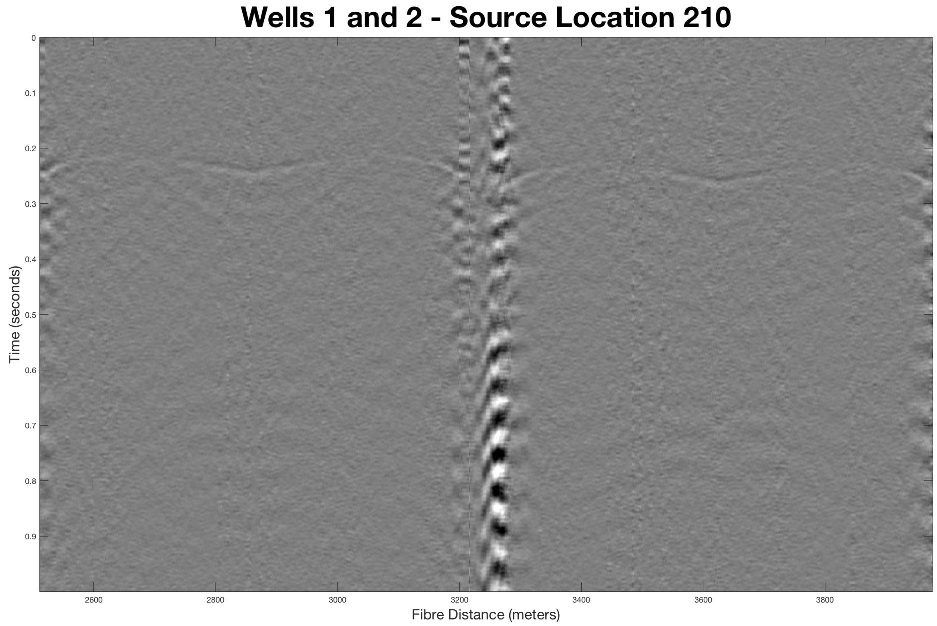

FIG. 9. The straight-fibre from well 1 to the straight fibre in well 2 acquired when the vibroseis truck was at source location 210.

to the wells at source location 112, the fibre picks up details about the wells. This pattern continues as the source locations move closer to the center of the trench. Figures 6 and 7 provide the best resolution for the wells. Some P-wave and S-wave responses are evident in all four source locations. The clarity of the data results from these source locations being the closest to the center of the trench which means they are closest source locations to the wells out of the eleven source locations shown. After source location 178, the fibre picks up less detail about the wells from the straight fibre as the vibrosesis moves to source locations further from the center of the trench. Note that the straight fibre acquires more information when the truck is at source location 210 (the farthest northeast on the trench) than it does at source location 101.

VSP for Well 1

Now, we consider the vertical seismic profiles for well 1. Source location 164 was used. Figure 10 (left) shows well 1 when the vibroseis truck was at source location 164. Since the fibre goes down and back up the well, we fold the well data in half which can be seen on the right in Figure 10.

Figure 11 shows the upgoing and downgoing wavefields.

We employed the CREWES public toolbox to find the first break pick and flatten the upgoing wavefield for well 1 at source location 164 (Margrave, 2018). Figure 12 shows the first break pick on the right and the flattened upgoing wavefield on the left.

Finally, we deconvolved the upgoing wavefield. Figure 13 provides the results of the upgoing wavefield (left) next to the results of the deconvolved upgoing wavefield (right).

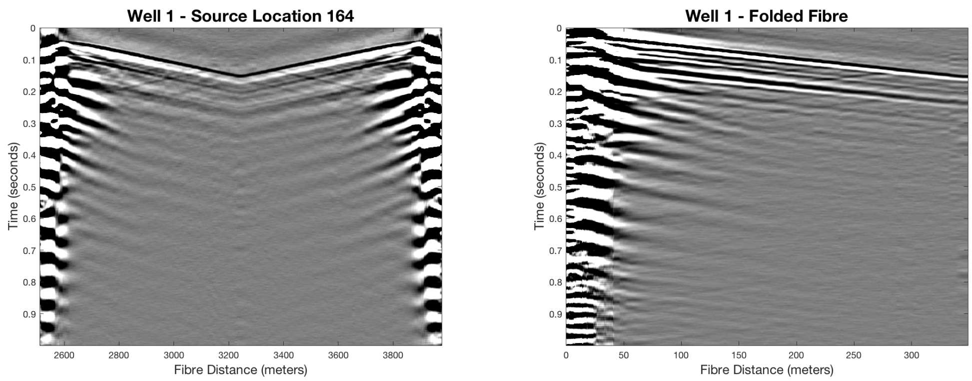

FIG. 10. (Left) Well 1 when the vibroseis truck is at Source Location 164. (Right) The straight fibre in Well 1 folded.

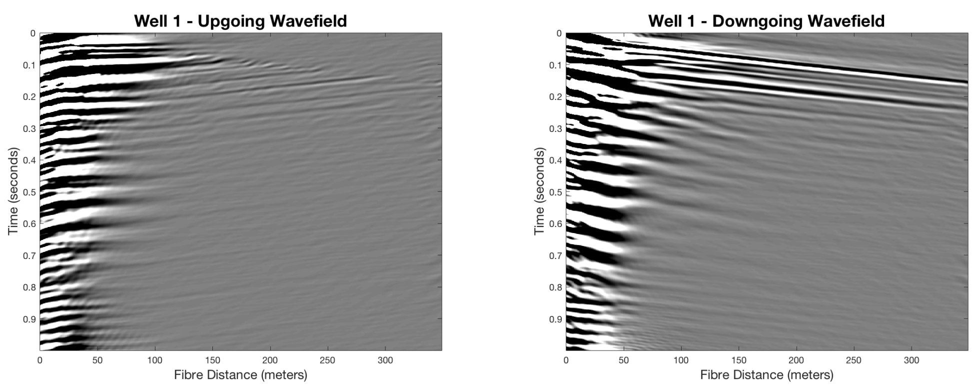

FIG. 11. (Left) The upgoing wavefield for Well 1. (Right) The downgoing wavefield for Well 1.

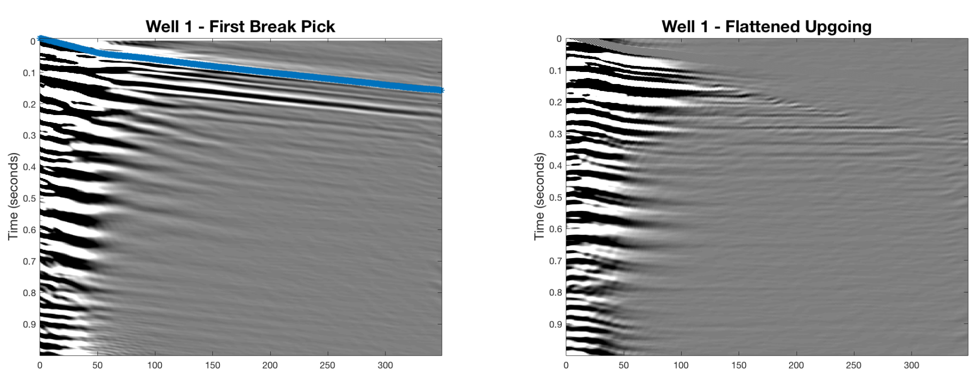

FIG. 12. (Left) The first-break picks for Well 1 at source location 164. (Right) The flattened upgoing wavefield for Well 1.

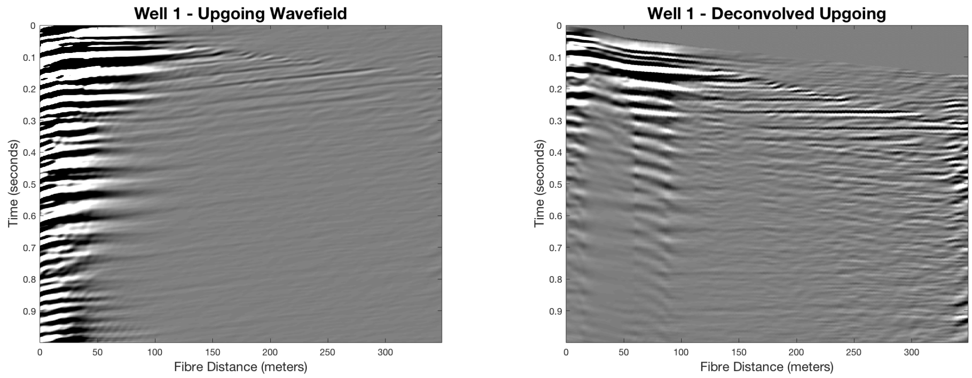

FIG. 13. (Left) The upgoing wavefield for Well 1. (Right) The deconvolved upgoing wavefield for Well 1.

VSP for Well 2

For well 2, we utilized source location 158 to process the vertical seismic profiles. Figure 14 shows the results of the well 2 at source location 158 on the left. Given that the fibre goes straight down well 2 and returns to the surface, we folded the data in half as seen on the right in Figure 14. We then used the folded fibre to compute the VSP for the well.

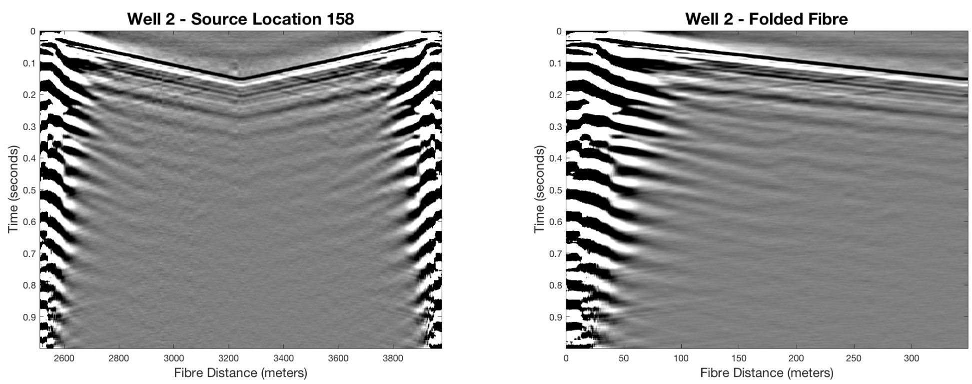

FIG. 14. (Left) Well 2 when the Vibroseis truck is at Source Location 158. (Right) The straight fibre in Well 2 folded.

As with well 1, we started by computing the upgoing and downgoing wavefields for well 2. We shows the results of this computation in Figure 15.

We then picked the first break which can be seen on the left in Figure 16. We used the first break pick to flatten the upgoing wavefield as seen on the right in Figure 16. The CREWES public toolbox was utilized to find both the first break pick and the flattened upgoing wavefield.

We also used the CREWES public toolbox to deconvolve the upgoing wavefield. In Figure 17, the upgoing wavefield is on the left and the deconvolved upgoing wavefield is on the right.

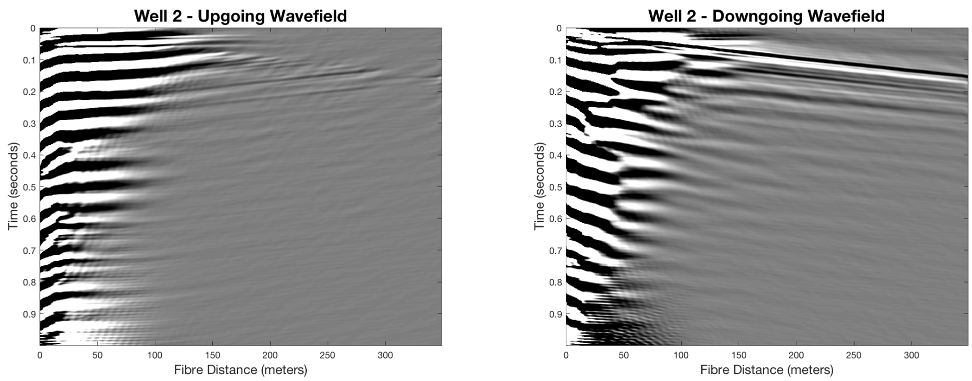

FIG. 15. (Left) The upgoing wavefield for Well 2. (Right) The downgoing wavefield for Well 2.

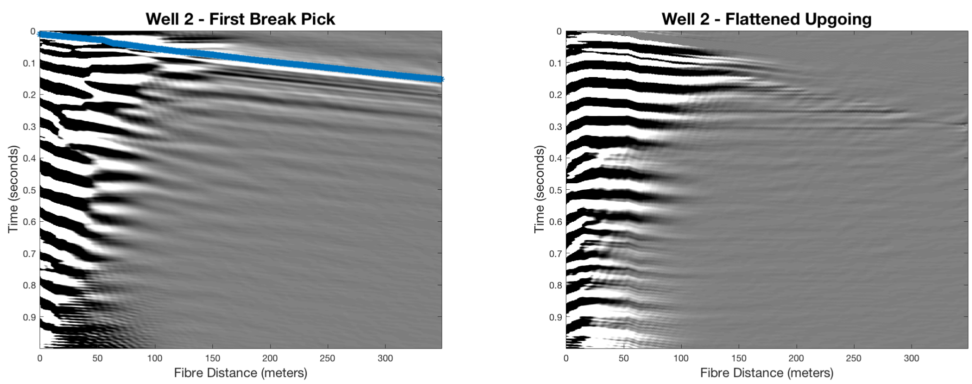

FIG. 16. (Left) The first-break picks for Well 2 at source location 158. (Right) The flattened upgoing wavefield for Well 2.

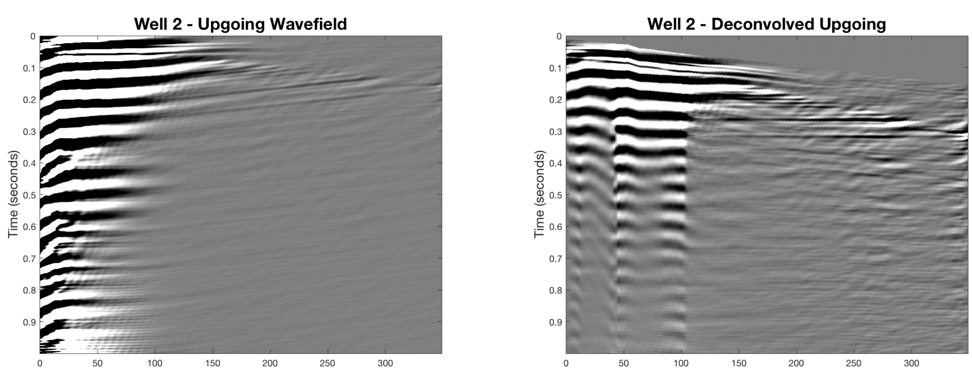

FIG. 17. (Left) The upgoing wavefield for Well 2. (Right) The deconvolved upgoing wavefield for Well 2.

CONCLUSIONS

We began with an discussion of the Containment and Monitoring Institute's Field Research Station. We focused on the schematic of the fibre loop at the site. The experiment conducted in August 2018 was explained. We looked at the straight fibre in wells 1 and 2 at 11 different source locations along the trench. The source locations between 145 and 178 provided the best results for the wells. We also noted that source location 210 provided more information about both the wells than source location 101. Then, we used standard processing techniques to find the vertical seismic profiles of well 1 at source location 164 and well 2 at source location 158.

ACKNOWLEDGEMENTS

We also thank our colleagues at Fotech and CREWES. We express gratitude to CMC Research Institutes Inc and the Lawrence Berkeley National Laboratory for enabling access to the site and the installed optical fibre. We also gratefully acknowledge support from NSERC (Natural Science and Engineering Research Council of Canada) through the grants CRDPJ 461179-13, CRDPJ 522863-17, and through a Discovery Grant for the third author.

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