A summary of surface seismic reflection data acquired at the Field Research Station near Brooks, Alberta

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ABSTRACT

We have been acquiring surface seismic reflection data at the Field Research Station near Brooks, Alberta, since 2014. The data include 3D3C, 2D3C and 2D1C surveys. All the data had similar processing, designed to attenuate noise and enhance reflectivity, and were post-stack migrated. The 3D3C data acquired in 2014 exhibits the best imaging of the subsurface on both PP and PS sections. Offset gathers show that offsets of 200-400 m are best for imaging the Basal Belly River, which is the CO_2 injection sandstone, with PP surface seismic data.

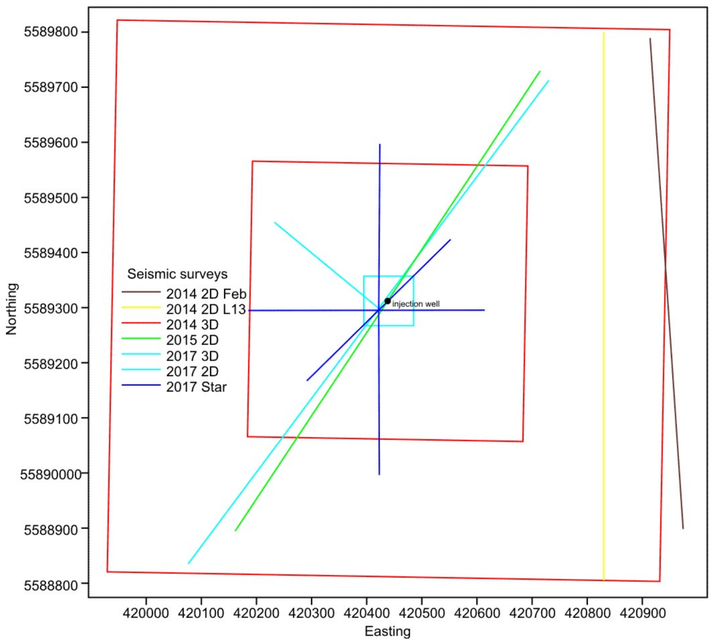

Figure 1. Plot of surface reflection seismic surveys acquired since 2014.

The layouts of the surface seismic surveys acquired at the FRS are plotted in Figure 1. All the data were processed using a fairly standard processing flow which included refraction and residual statics, geometric spreading compensation, trace equalization, spike and noise burst edit, and air blast attenuation. The final datum was 800 m with a replacement velocity of 2600 m/s.

Radial filters or surface wave noise attenuation were applied to the data to help attenuate noise. All the data had Gabor deconvolution applied and we often also applied a spatial filter to help bring out the signal in the shallow section of interest. We post-stack migrated the data using finite difference migration and applied bandpass filters of 10-15-80-100 Hz to the PP data and of 5-10-60-70 Hz to the PS data for these displays.

The 3D3C data acquired in 2014 show the best continuity of reflections and consistency of seismic character (Figure 2), so the other surveys were matched to this one with phase rotations and time shifts, where appropriate.

The primary reflection of interest is the Basal Belly River (BBR), which is the injection horizon at a depth of 295 m KB (+489.5 m ASL). This event is the peak seen just below 0.25 s on the PP migrated seismic section. The sandstone is very thin (6.5 m) and is close to tuning thickness for the wavelength of about 45 m. The reflection amplitude of this event is, therefore, subject to tuning effects. A thin sandstone in the Medicine Hat Formation at about 503 m KB, equivalent to about 0.390 s on the PP seismic data, is a potential secondary deeper injection target.

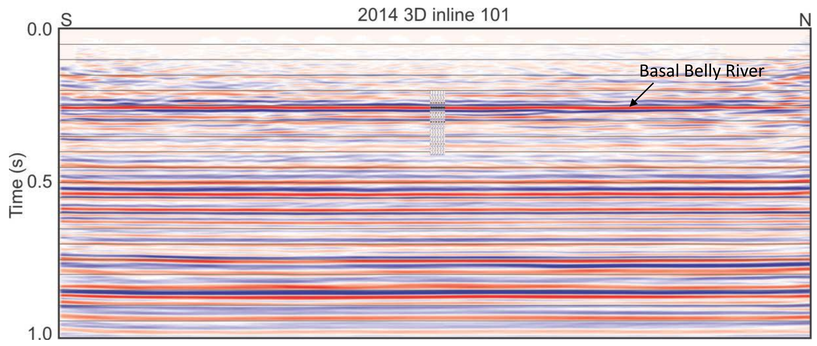

Figure 2. The best imaging of the Basal Belly River is on the 2014 3D PP data.

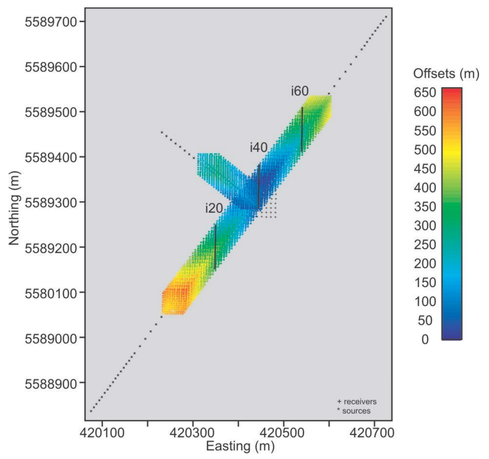

Figure 4. Offset distribution of traces recorded by the geophones in the small 3D array. Offsets of 200-400 m (green) are best for imaging the Basal Belly River target. Migrated inlines i20, i40 and i60 are displayed in Figure 5.

Good quality converted-wave data have been acquired. Figure 6 displays PS inline 101 from the 2014 3D survey, which exhibits the best consistency and continuity of character across the section, and the PS synthetic seismogram from the injection well. The Basal Belly River (BBR) event is the red peak at 0.5 s.

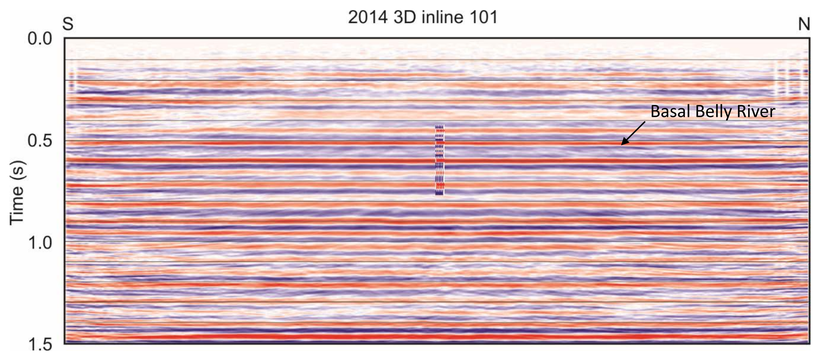

Figure 6. The best PS data, inline 101 from the 3D3C survey acquired in 2014.

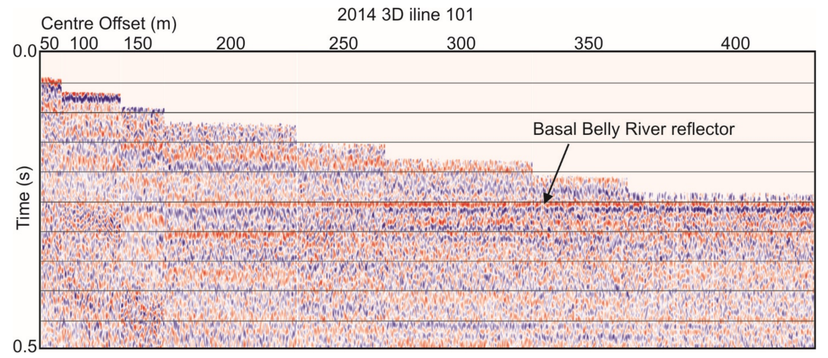

Figure 3. Offset gathers showing that the best range for imaging the Basal Belly River is 200-400 m..

On looking at offset gathers (Figure 3) and NMO-corrected CDP gathers, we notice that the target Basal Belly River reflection is best imaged on offsets of 200-400 m. The offset distribution of traces recorded by geophones in the small 2017 3D is shown in Figure 4. The green colour shows where the offsets are 200-400 m, best for imaging the Basal Belly River reflector, as can be observed in Figure 5. Here we display three migrated inlines: 20, 40 and 60. Inlines 20 and 60 have offsets sufficiently long to image the Basal Belly River (150-500 m and 185-445 m, respectively) but inline 40, which is in the centre of the 3D receiver grid, only has offsets of 10-160 m.

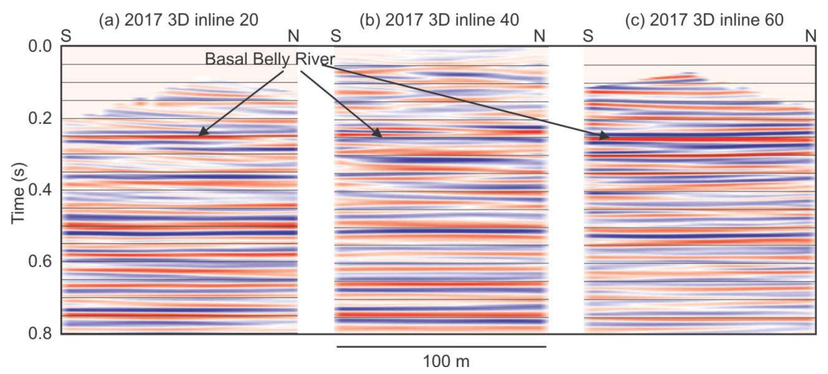

Figure 5. Three images from the small 3D3C 2017 survey. Inlines 20 (a) and 60 (c) contain offsets sufficient for imaging the Basal Belly River, whereas inline 40 (b), which runs through the middle of the 3D receiver grid, does not. The locations of these lines are annotated on Figure 4.

ACKNOWLEDGEMENTS

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