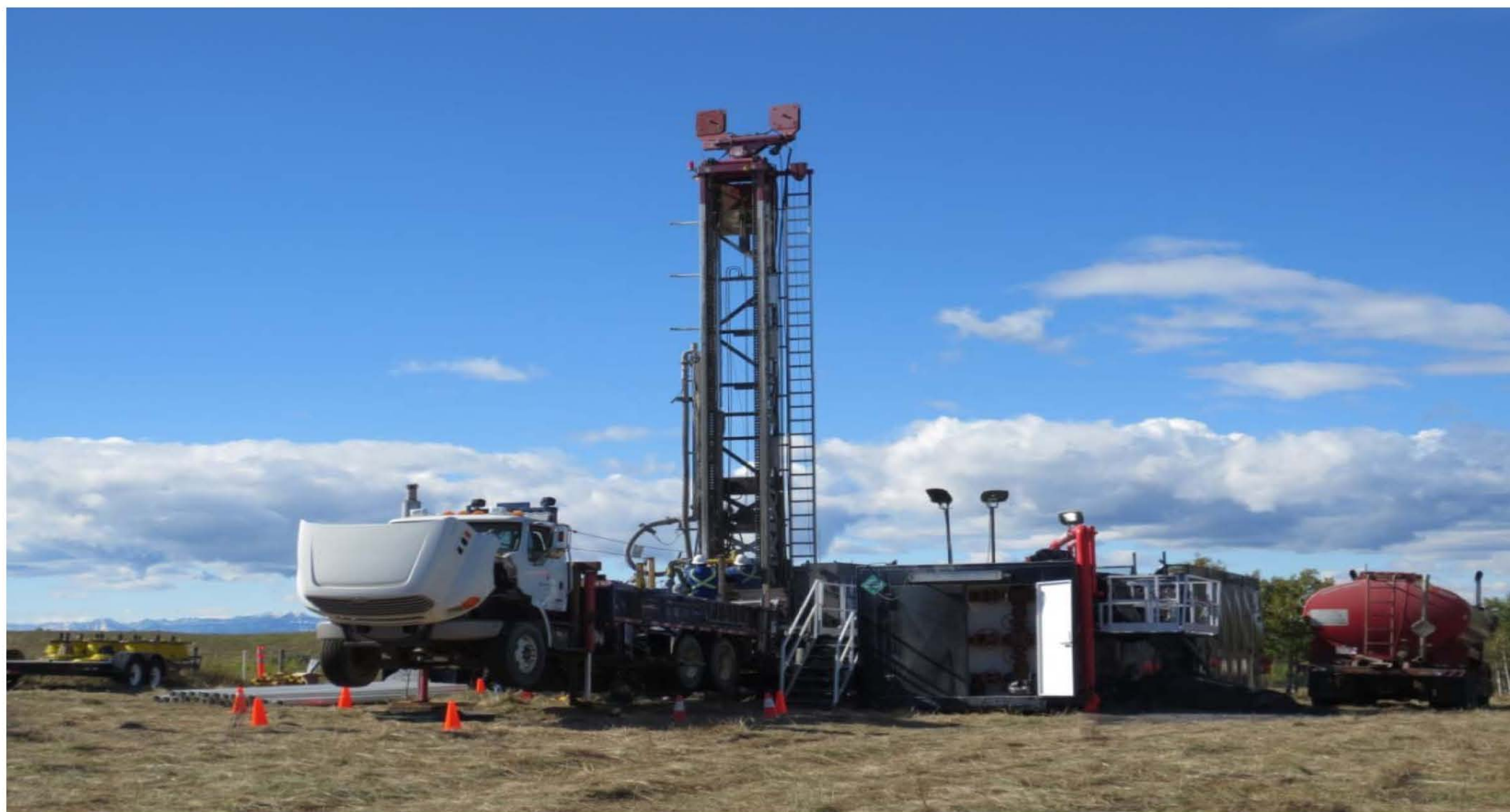


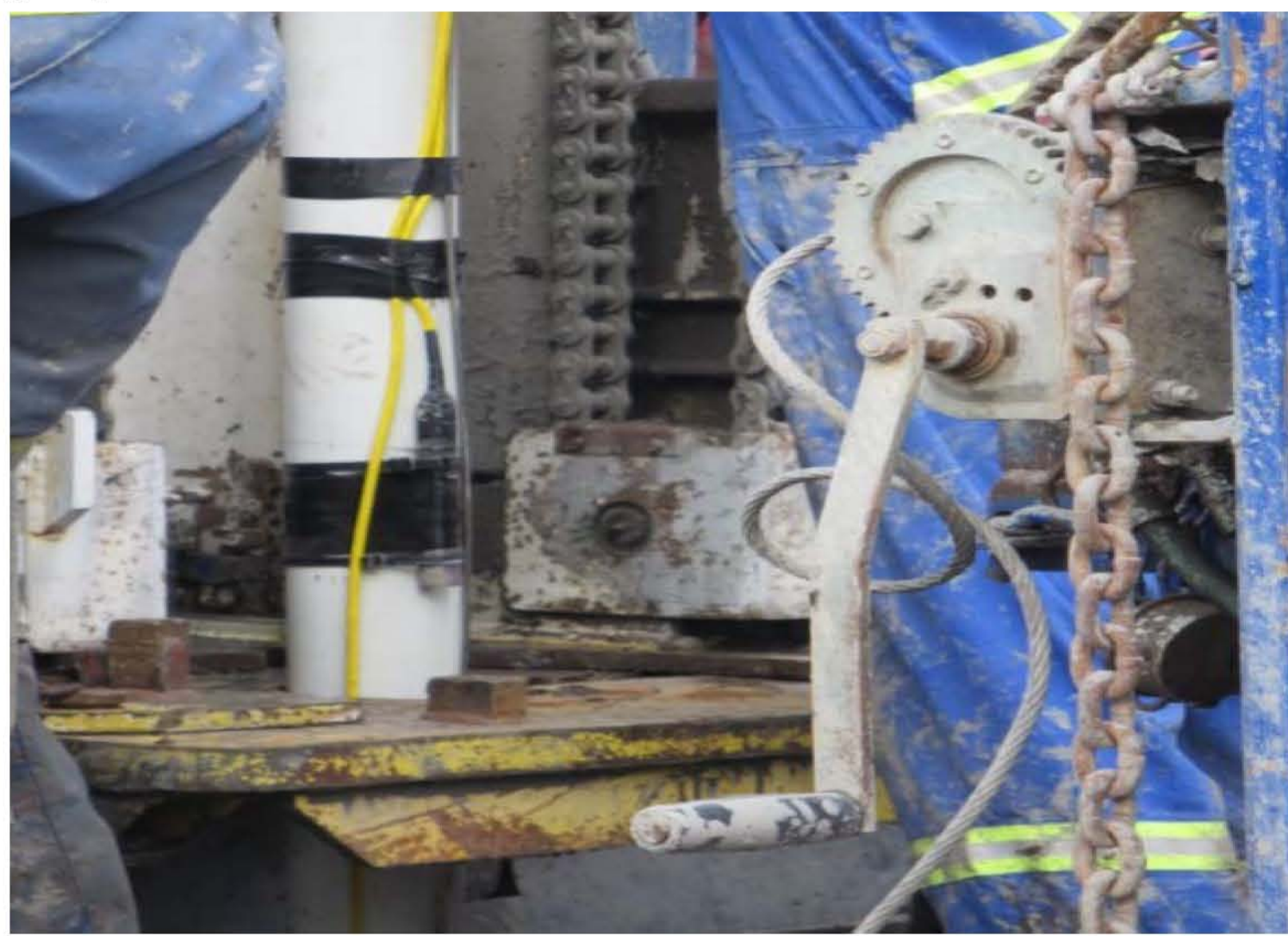
Recent data from the Priddis Geophysical Observatory

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New wells at the Priddis site



The drilling rig on site at Priddis. Two new wells were drilled in early October 2013. Well 1 is 146m deep and has 45 3C GS14 geophones installed on the outside of the casing as well as single- and multi-mode fiber for DAS recording. The reels of yellow down-hole geophone cables are visible on the trailer to the left.



Installation of the geophones on the white PVC casing. The stainless steel tubing with the fibers inside is visible alongside the geophone housing. 11 of the yellow cables each have four 3C geophones connected. Cable 12 has a single 3C geophone giving 45 geophones overall. These are spaced at 3.06m from 11m to 146m. Following the insertion of the casing, the annulus of the well was cemented to surface.

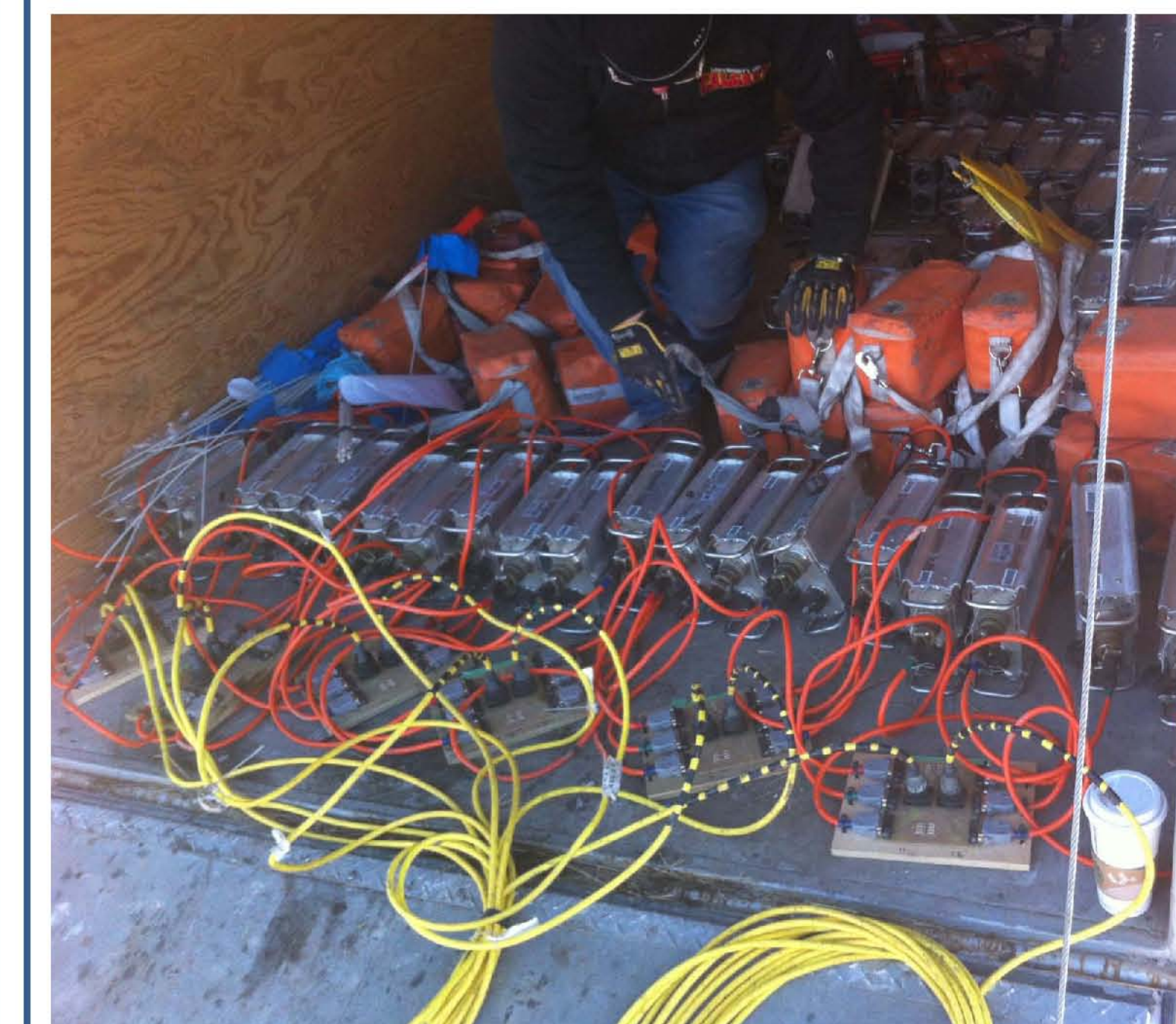
The new shear wave thumper



The new thumper is mounted on a small trailer that can be towed behind any vehicle including, as shown here, the Envirovibe. The mechanism consists of a hammer which is lifted by hydraulics, then released and accelerated down by a nitrogen gas pressured cylinder. The hammer then strikes an aluminum foot which is pressed on to the surface of the ground to provide good coupling. The hammer strike can be at any angle from vertical to 45 degrees in either direction. If the axis of the trailer is along the receiver line, then the resulting energy is produced as a combination of P- and SH-wave modes. The first field test of this new seismic source was during two surveys conducted at the Priddis Geophysical Observatory in October 2013. These surveys were also the first to record data from the down-hole 3C geophones that had just been installed in the new well.

Acquisition

Two field surveys were acquired in October 2013 after completion of the wells. The first recorded the down-hole array and four surface lines of 3C SM24 geophones. Two of these lines ran north-south (52 geophones at 6m spacing) and east-west (44 geophones at 6m). Two shorter lines ran at a slight angle to the east-west direction (16 geophones each at 6m). These two were part of an experiment to measure shear wave generation from small dynamite shots. All lines were centered on the Well 1 location. Sources used were dynamite, the University Envirovibe and the new shear wave thumper. The second survey recorded the down-hole array after the re-ordering of the channels had been accomplished, and two short surface lines running north-south and east west centered on Well 1. Each line had 16 3C SM24 geophones at 10m spacing. Sources for this survey were the Envirovibe and the new thumper.

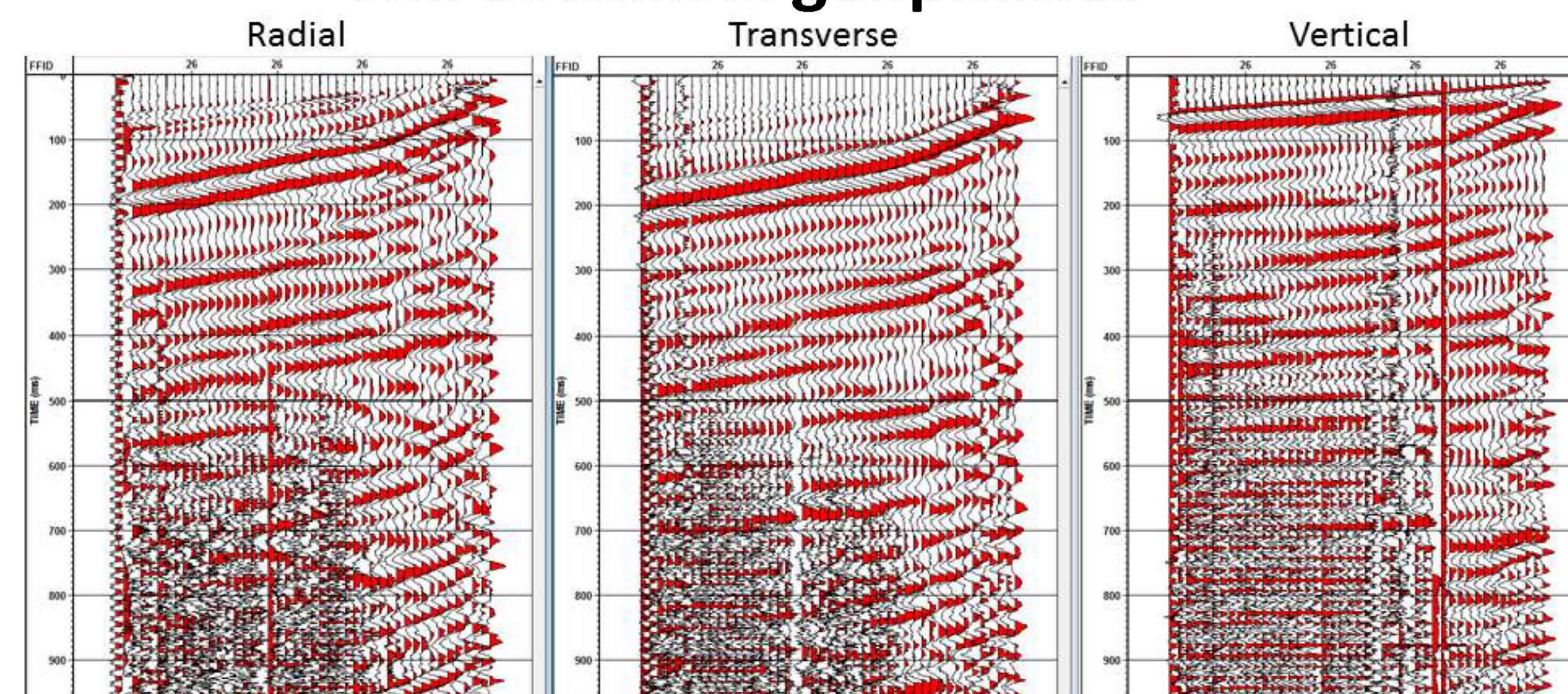


The down-hole geophone array was recorded using a set of custom circuit boards to interface with the Aries recording system. This photo shows the setup in a trailer at the well site with the 12 cables connected to the adapter boards and 19 Aries RAM boxes attached for acquisition. The axes are separated by the interface boards so the array appears to the Aries system as three separate lines, X, Y and Z, and are treated as part of a 3D spread design in the Aries software.

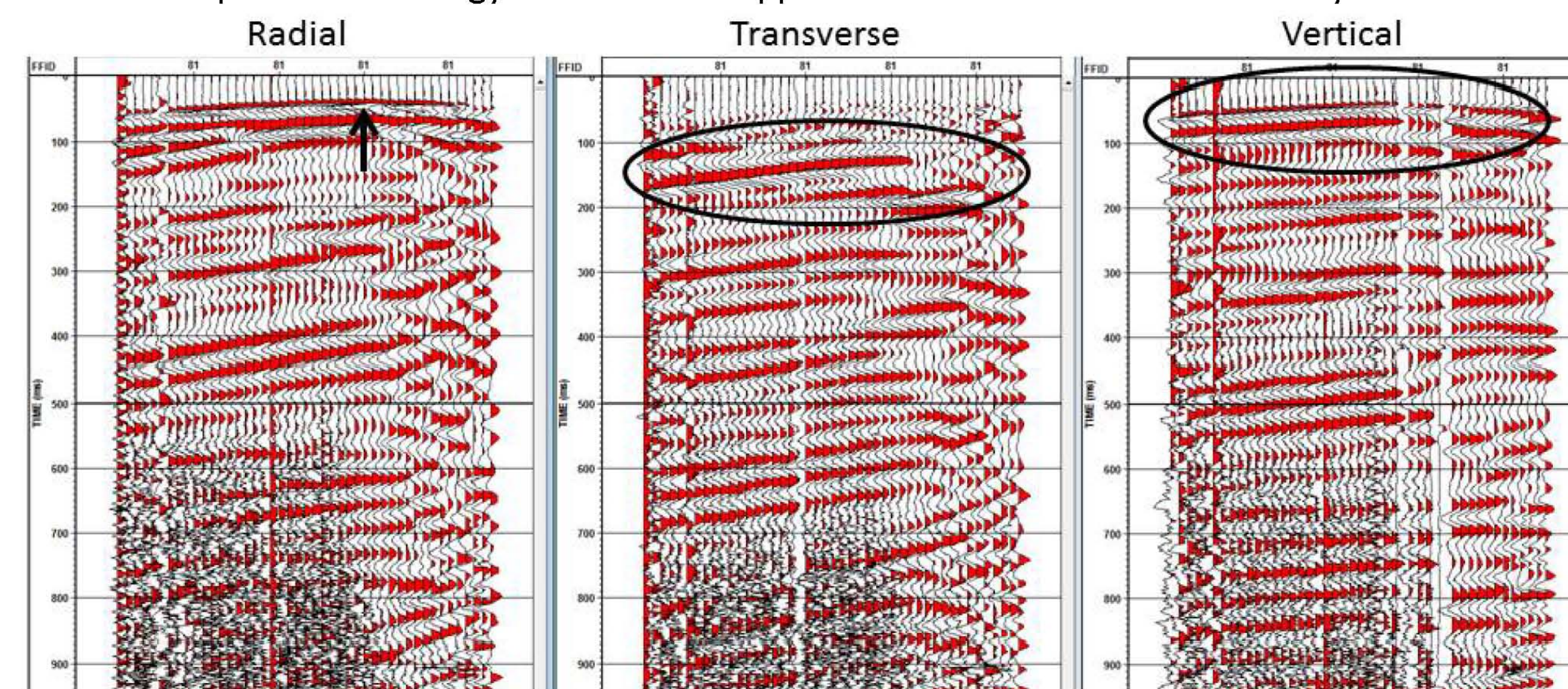


Because the down-hole geophones are installed in an interleaved order in the well, it is necessary to re-order the channels for a more logical output. This photo shows the punch-down panel installed at the well head to perform this modification to the array.

The downhole geophones

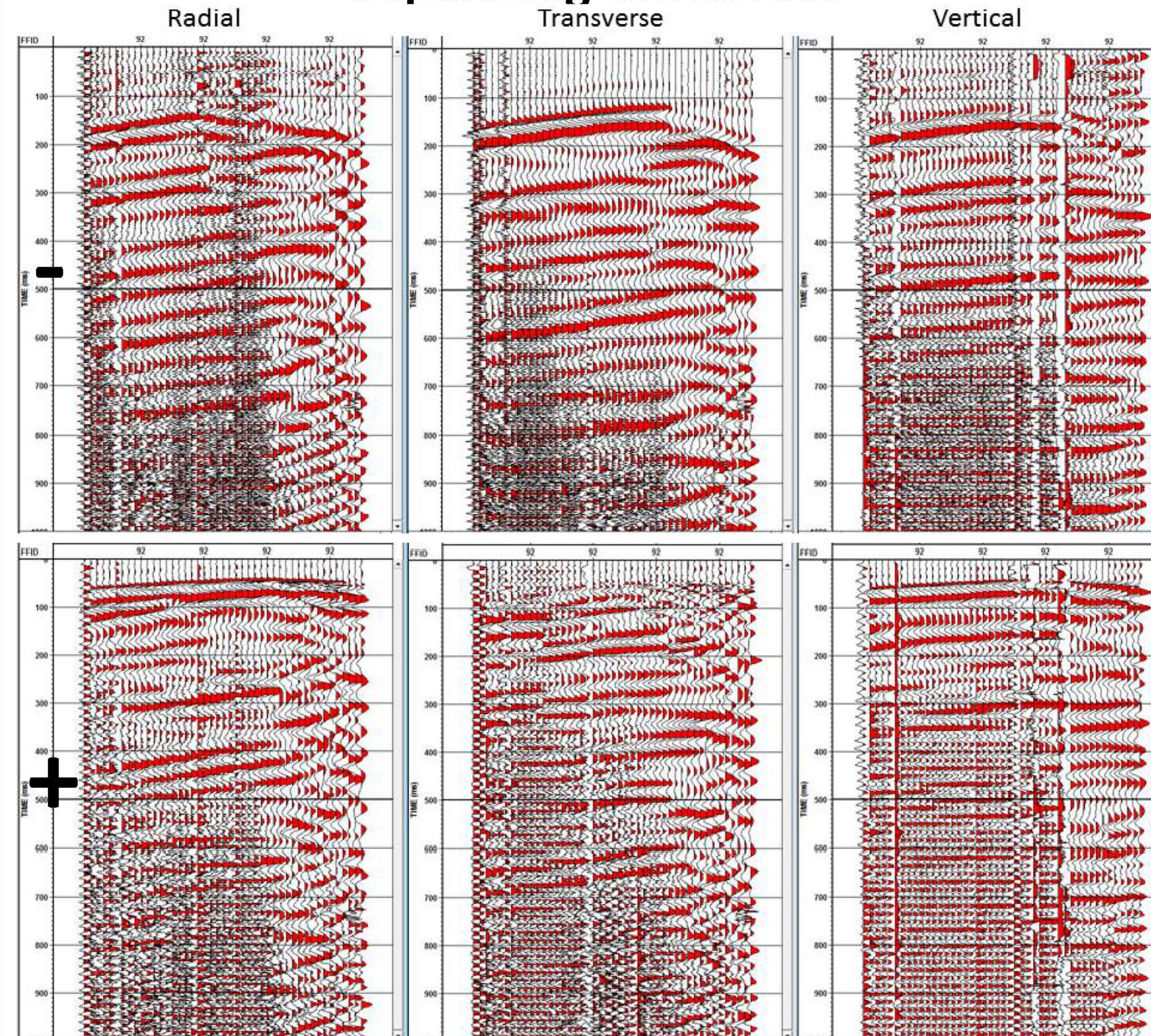


A gather from the down-hole geophones for a thump at 45° towards the north. The shot location is 2.5m south and 3.7m west of Well 1. The axes have been rotated into Radial (E-W), Transverse (N-S) and Vertical. The separation of energy into P and S is apparent. Data from the second survey.



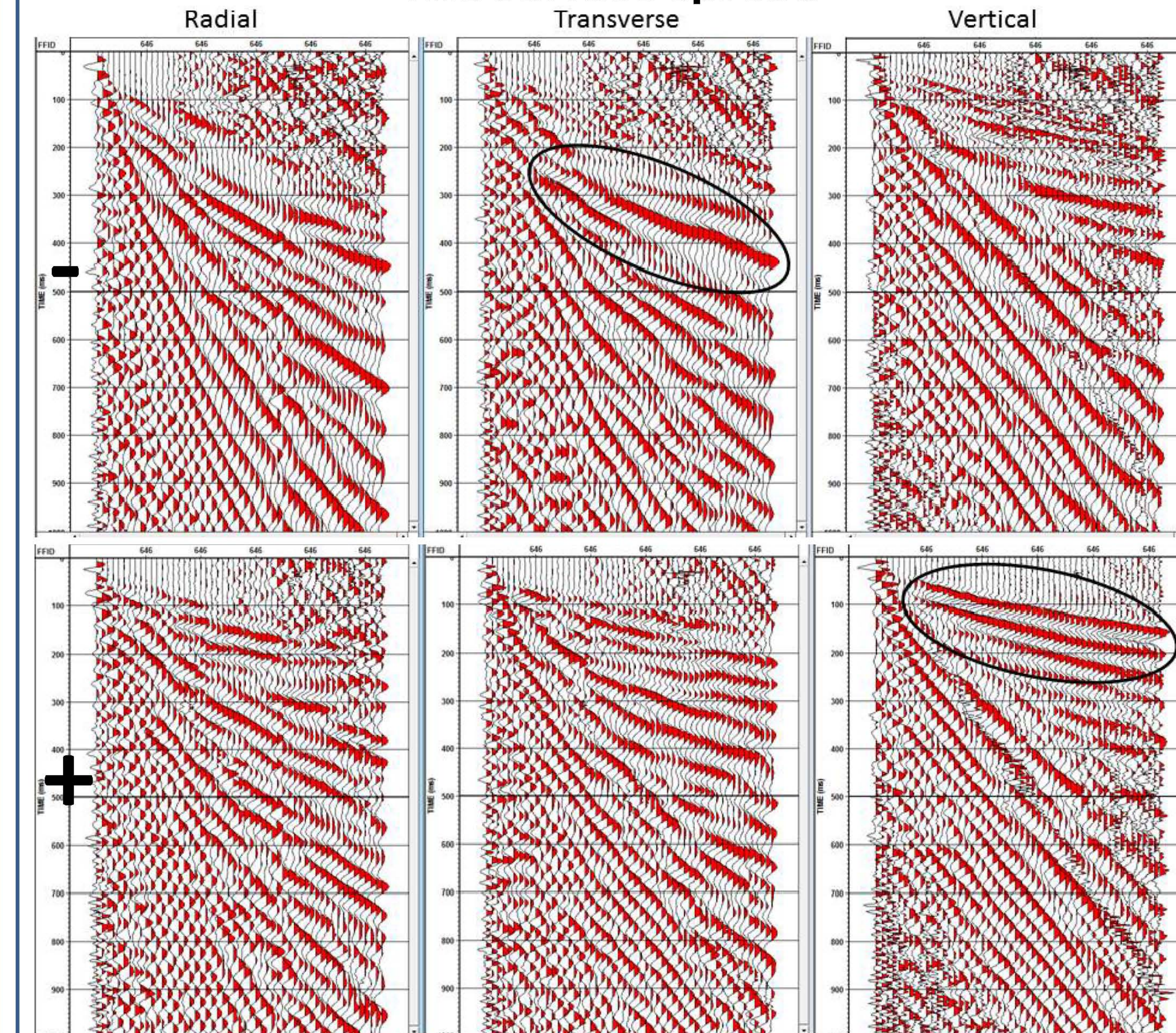
A gather from the down-hole geophones for a vertical thump 80m west of the Well 1. This is the gather that was used for the rotation of the geophone axes. The P-wave energy is outlined on the vertical axis (right panel), the S-wave on the Transverse axis (centre panel) and the arrow on the Radial axis (left panel) indicates the location of a P to S conversion. This is also visible in the figure above.

Separating the modes



The result of subtracting (top) and adding (bottom) two thumps of opposite polarity (north and south thumps at 45°) at a shotpoint 80m west of the well. The gathers were scaled before the process. In the subtracted gathers the P-wave energy is almost entirely lost on the Vertical and Radial components while the S-wave energy is enhanced. The reverse is evident on the added gathers. In the added Radial gather there is apparent P-S conversion. Some upgoing energy is visible on both Radial and Transverse plots.

The surface spread



The surface geophones from Line 1 (North-south) recorded during the first survey after the same procedure as the panel to the left. Subtracted gathers top row and added gathers bottom row. The shot point is at the north end of the line with thumps to the east and west being processed. The separation of the different energy modes is clearly shown with the P-wave enhanced by summing (bottom right) and the SH by subtraction (top middle).