A new S-wave seismic source

Don Lawton, Eric Gallant, Malcolm Bertram, Kevin Hall, Kevin Bertram, Rafael Asuaje

Bertram et al., Recent data from the Priddis Geophysical Observatory

Asuaje et al., Analysis of multicomponent seismic data recorded with the new thumper source

Motivation

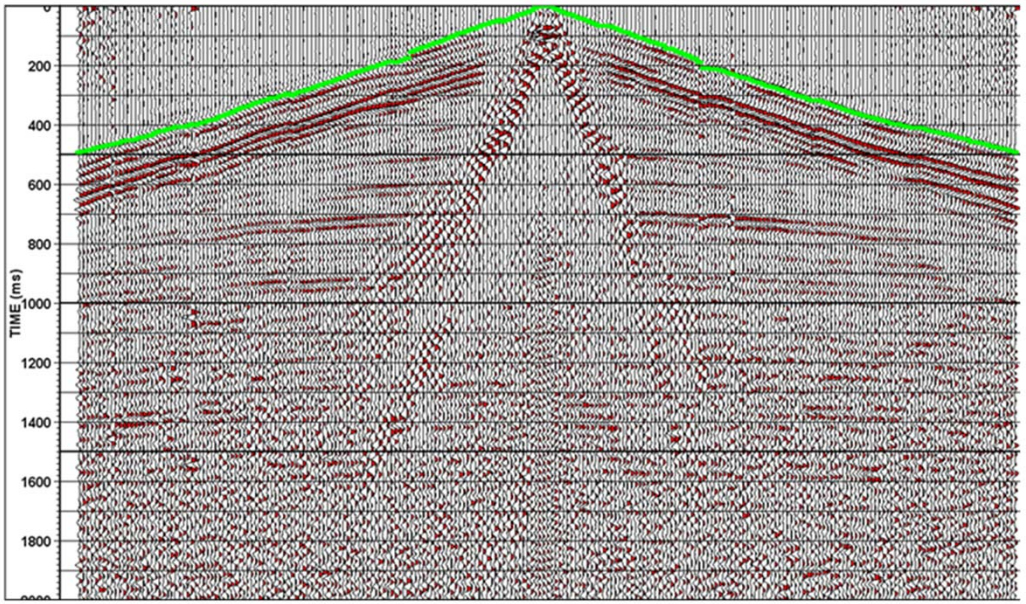
- Near-surface P-wave and S-wave velocity structure
- Vp/Vs as a function of depth
- S-wave attenuation in near-surface layers
- S-wave statics in converted-wave surveys
- PP and PS section registration
- Shallow anisotropy
- Anisotropic S-wave statics

“Flintstone” S-wave hammer

Lawton, D.C., 1990, A nine-component refraction statics experiment: *Canadian Journal of Exploration Geophysics*, 26, 1-9.

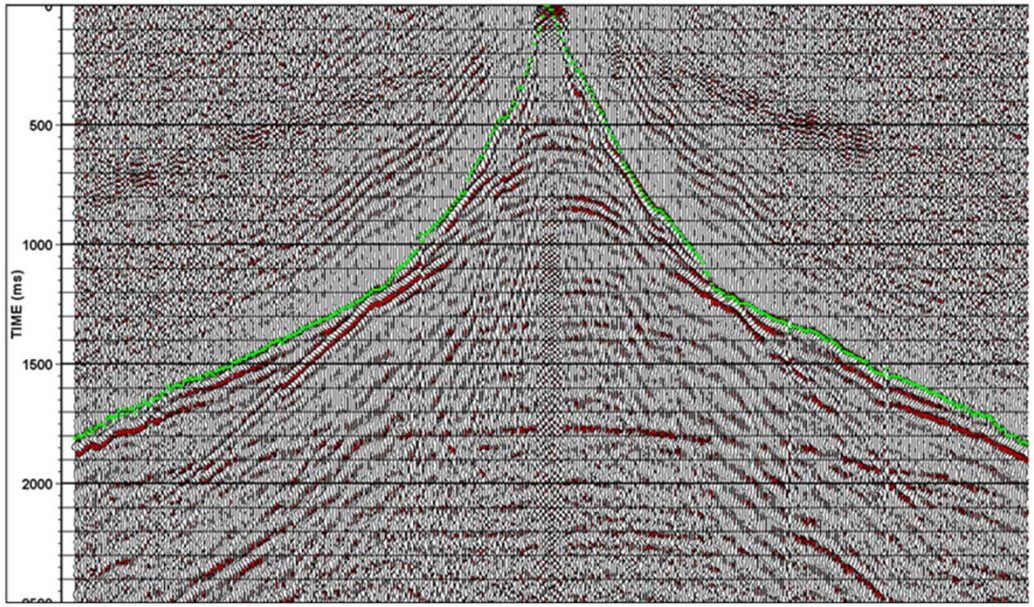
The near-surface

Vertical vibe



Vertical

SH vibe

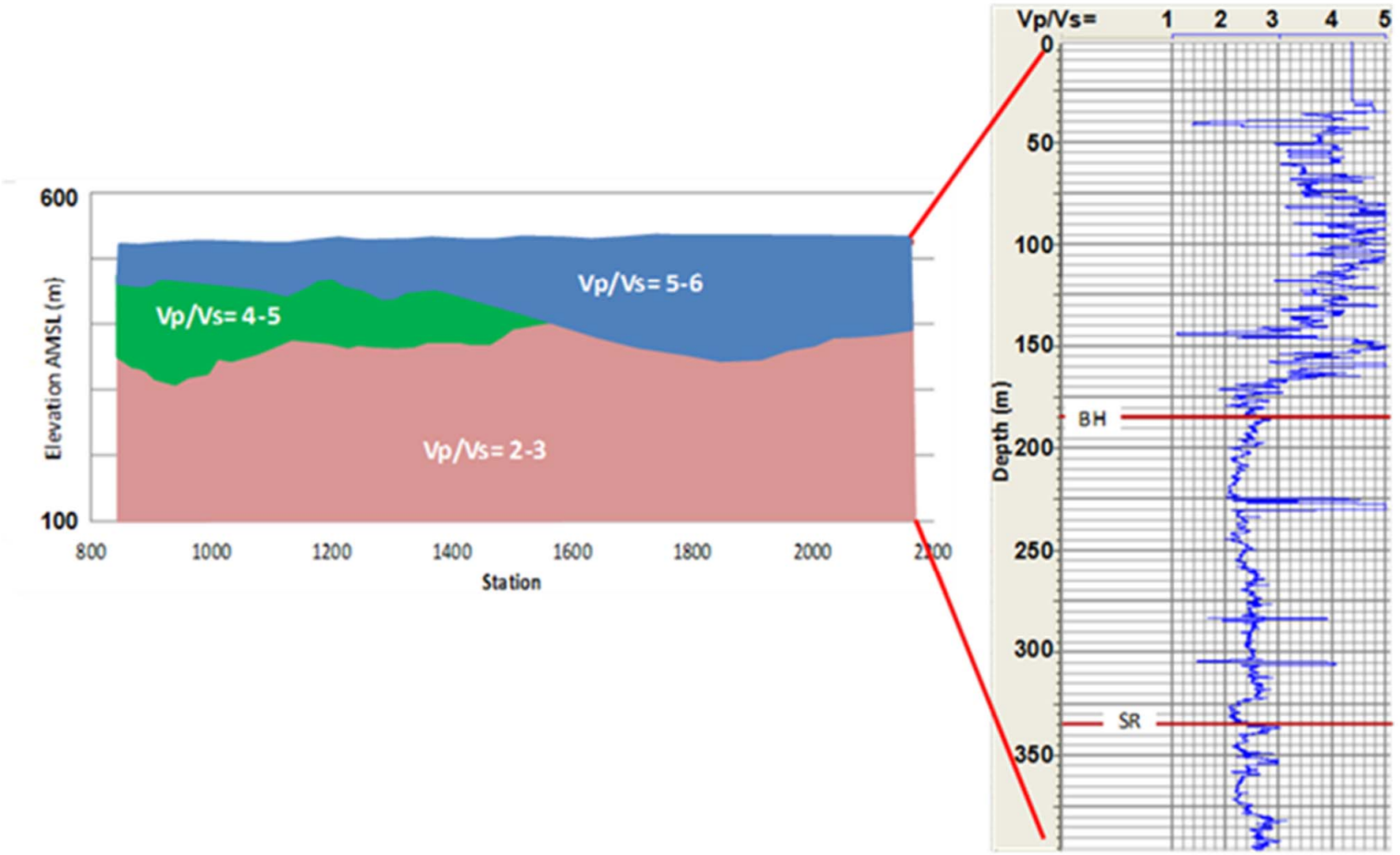


Transverse

Zuleta, 2012

Data courtesy of Nexen

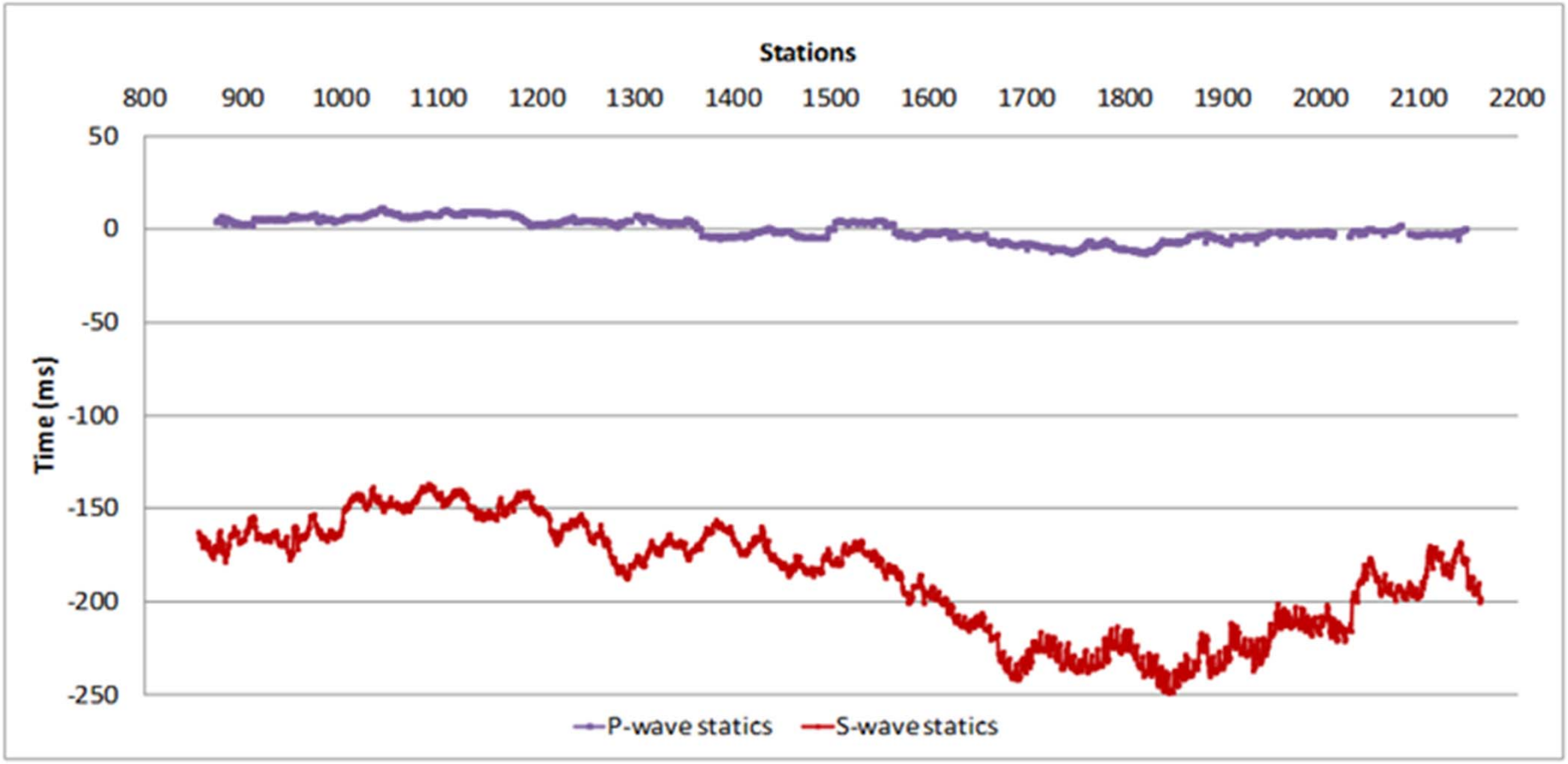
Near-surface structure and Vp/Vs



Zuleta and Lawton, 2012

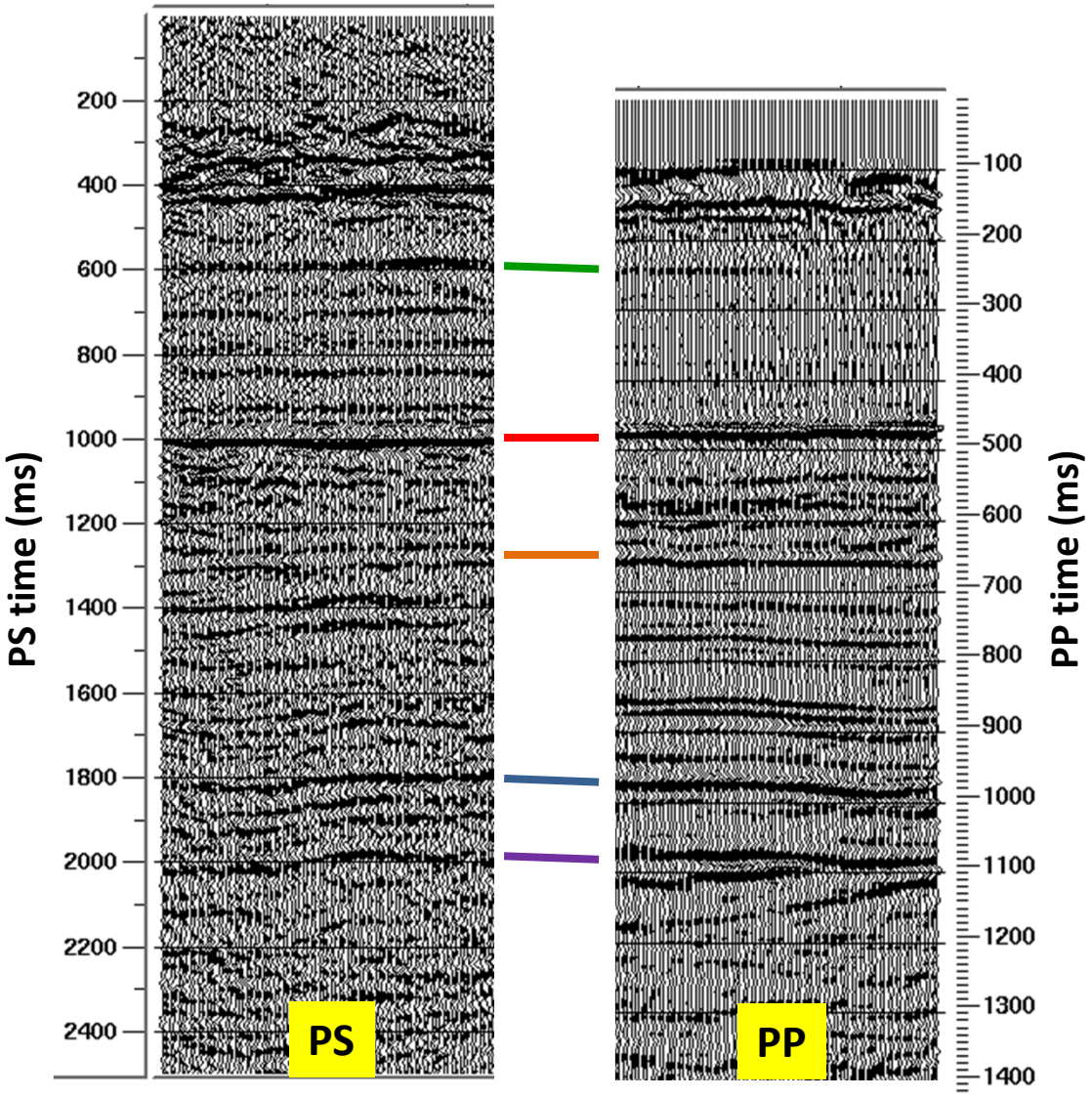
Well data courtesy of Nexen

P & S-wave statics



Zuleta and Lawton, 2012

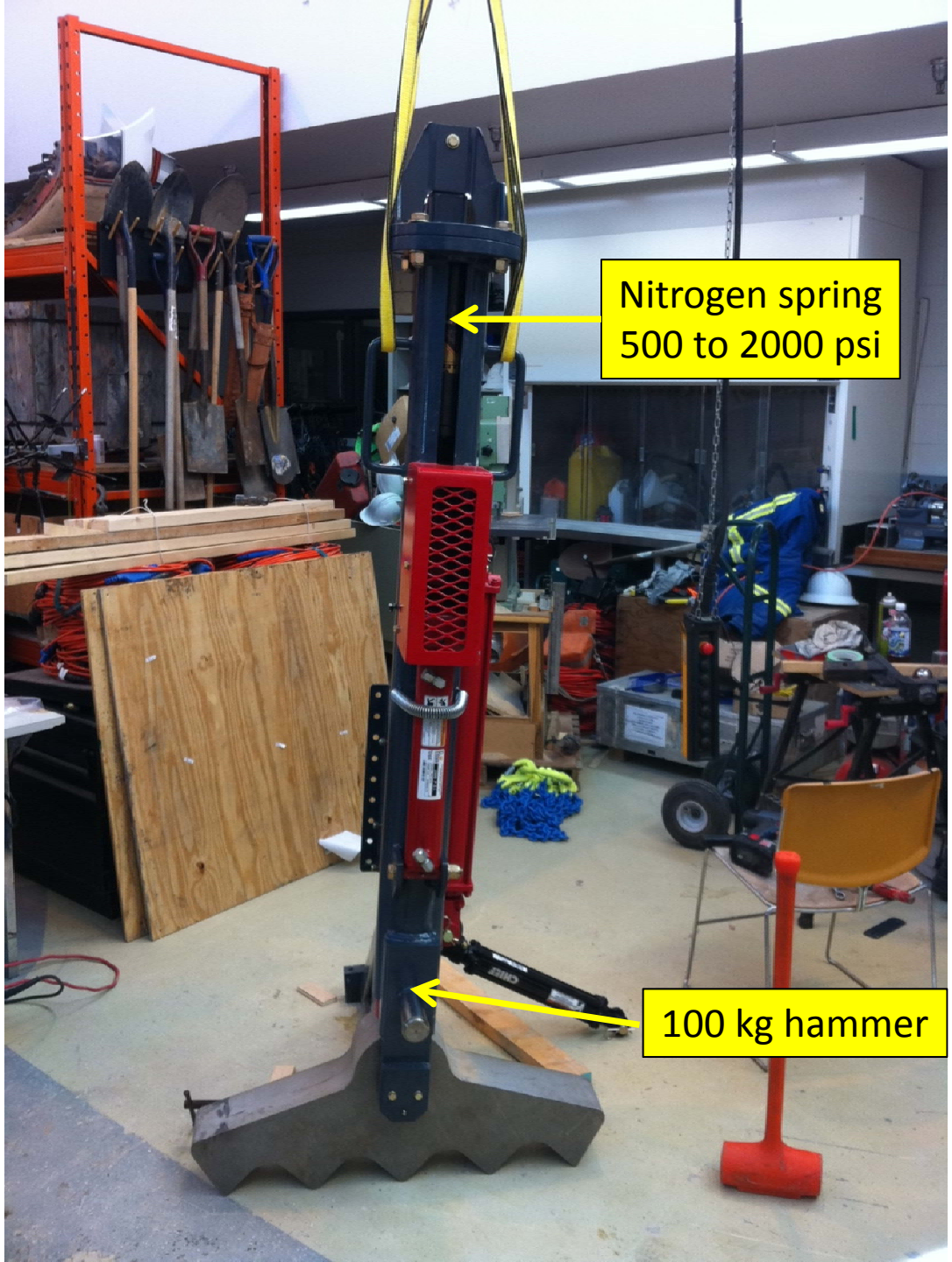
The PP – PS registration conundrum



Stewart and Mazur, 2001, Steen River Impact Structure

United Service Alliance Model A200

- Anvil style compressed nitrogen accelerated weight drop
- 18 cm piston travel
- 3 kJ @ 1800 psi
- 2000 kg trailer mount

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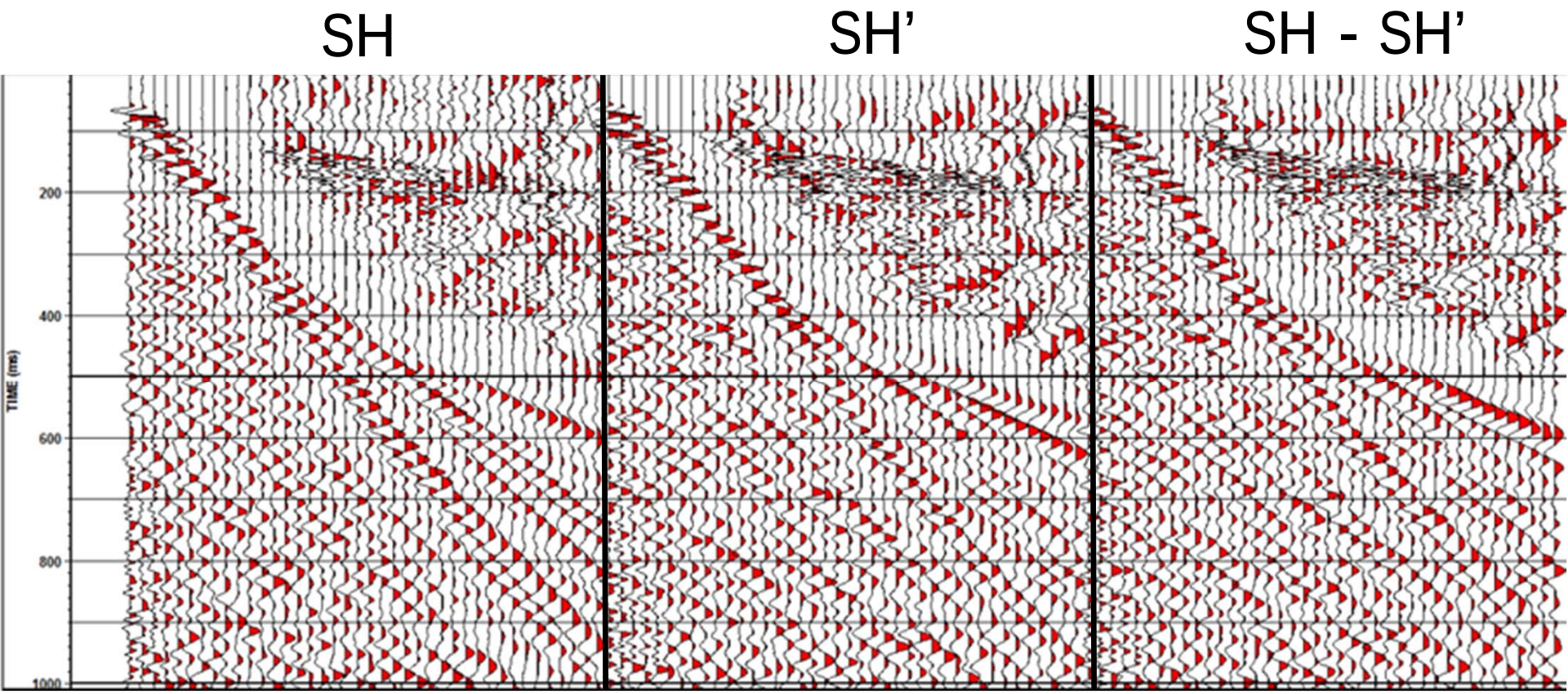
Thumper source operation

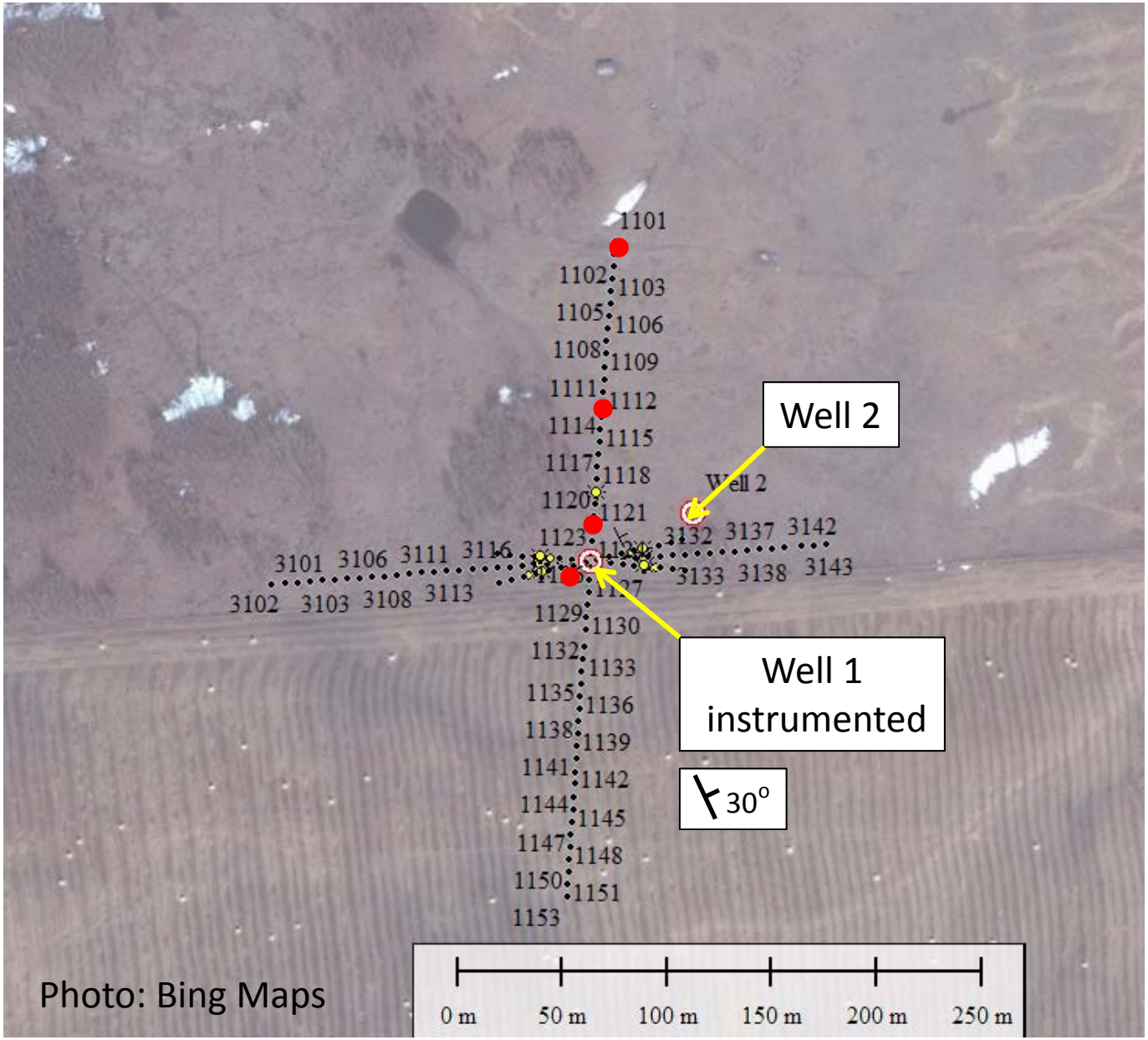
SH source into transverse component



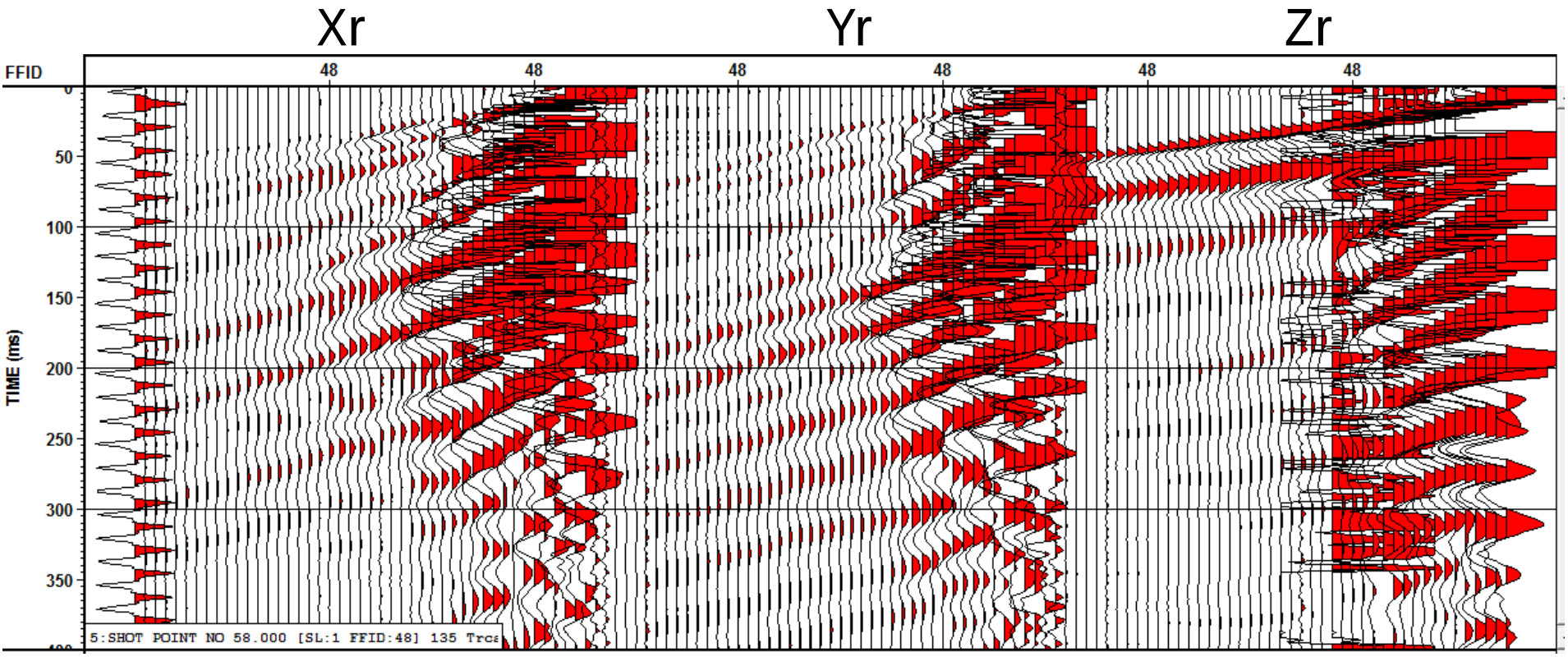
Uof C campus

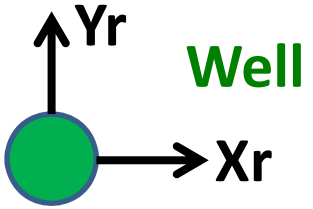
Shallow Vp/Vs = 3.9

Experimental layout - Priddis



Zero offset VSP at Priddis well





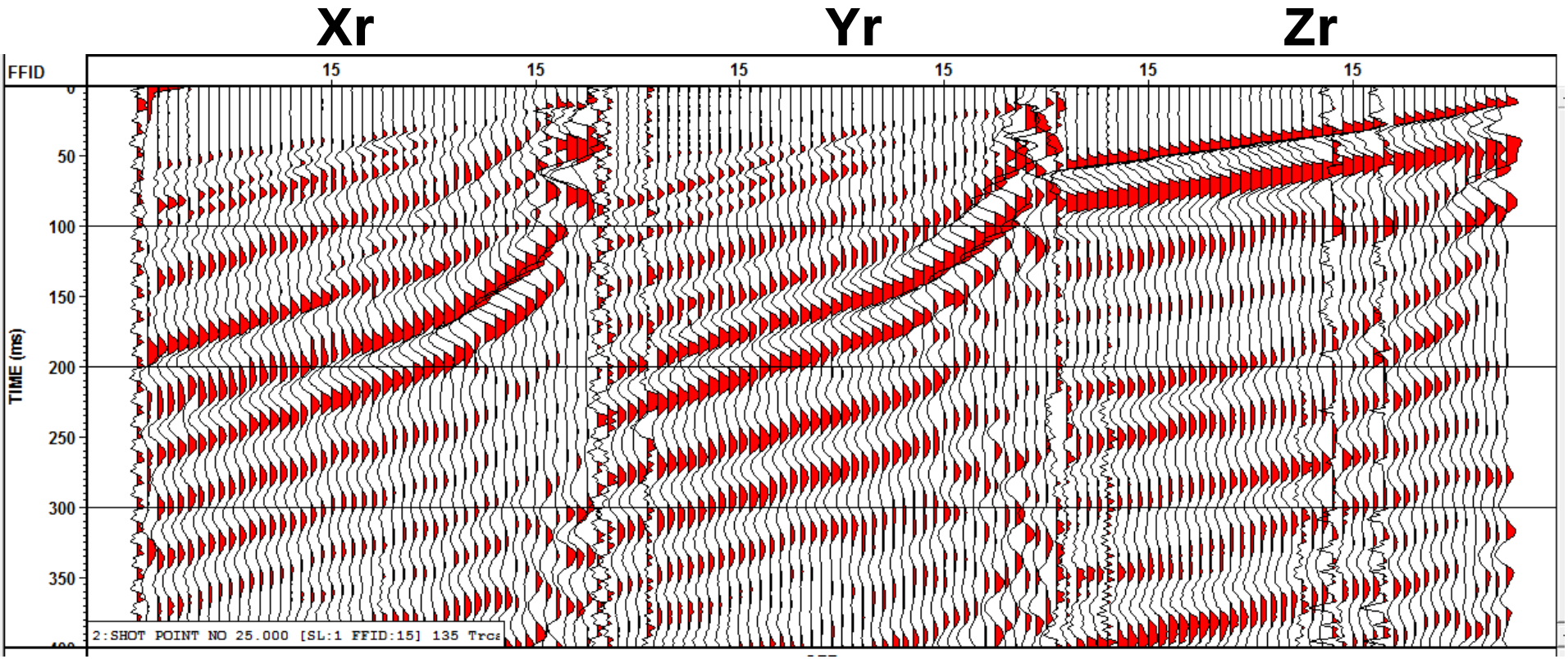
Well

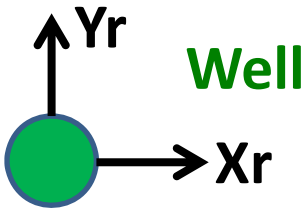
Offset dx = 2.5 m W

Offset dy = 3.7 m S

Source

Zero offset VSP at Priddis well: source V





Well

Offset dx = 2.5 m W

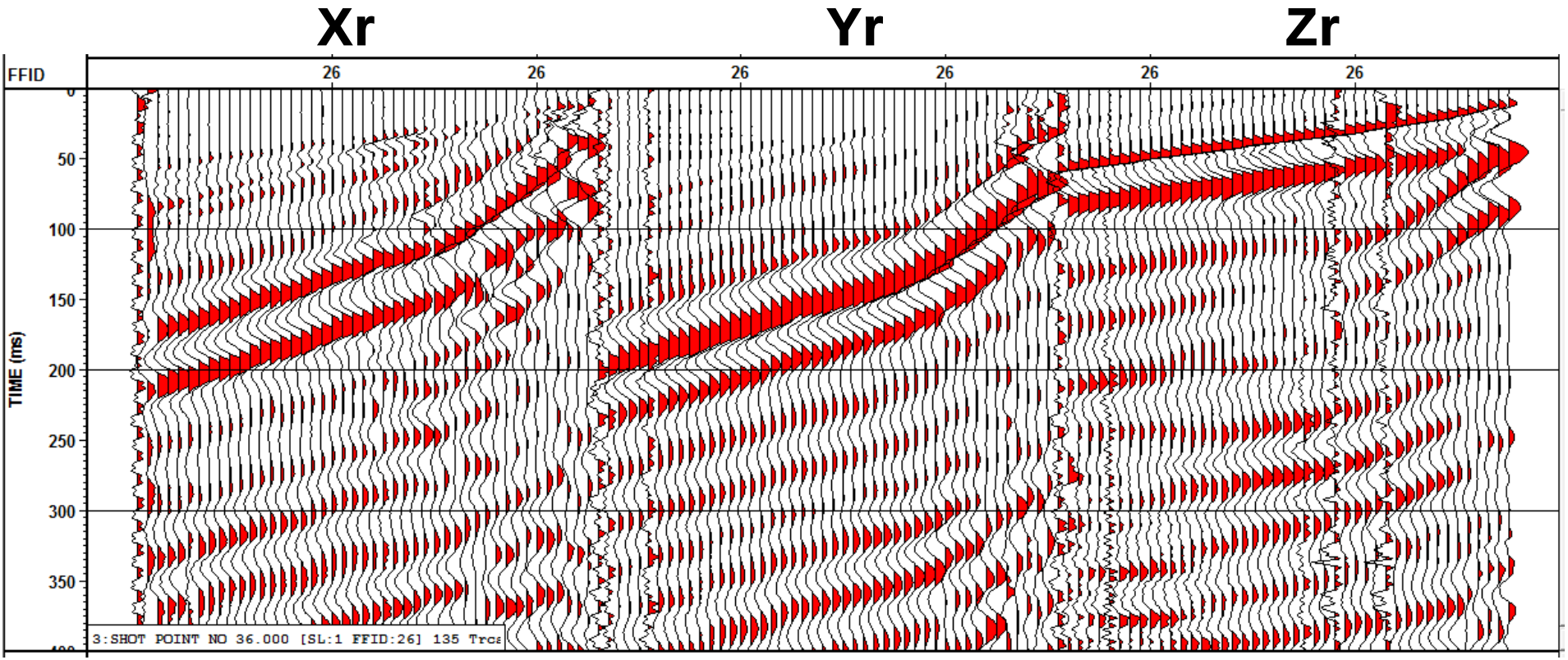
Offset dy = 3.7 m S

Vp1 = 2160 m/s

Vp2 = 3210 m/s

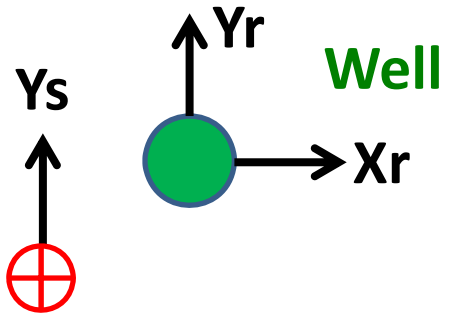
Source

Zero offset VSP at Priddis well: source Ys



Offset dx = 2.5 m W

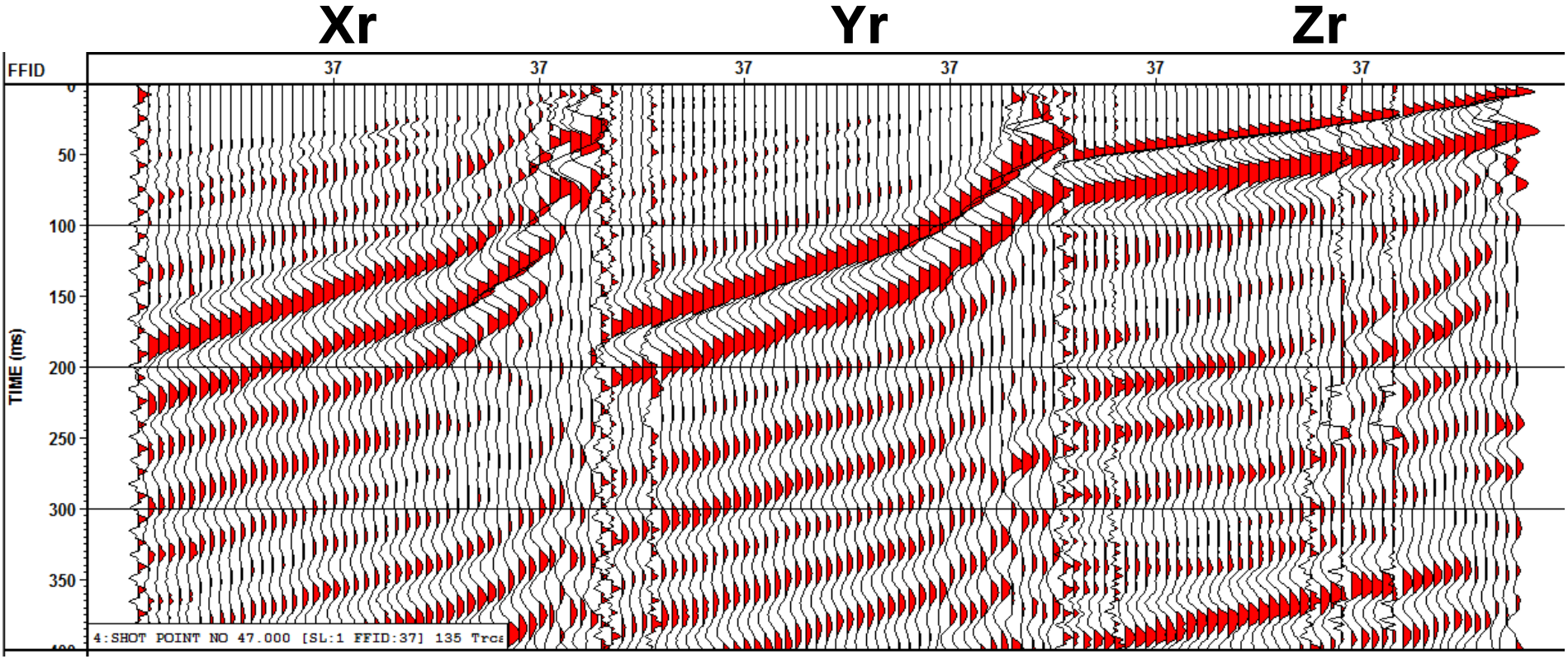
Offset dy = 3.7 m S

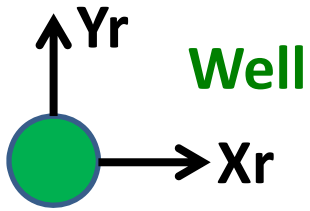


Vs1 = 520 m/s

Vs2 = 1400 m/s

Zero offset VSP at Priddis well: source Y's

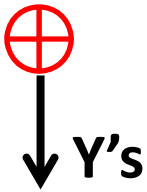




Well

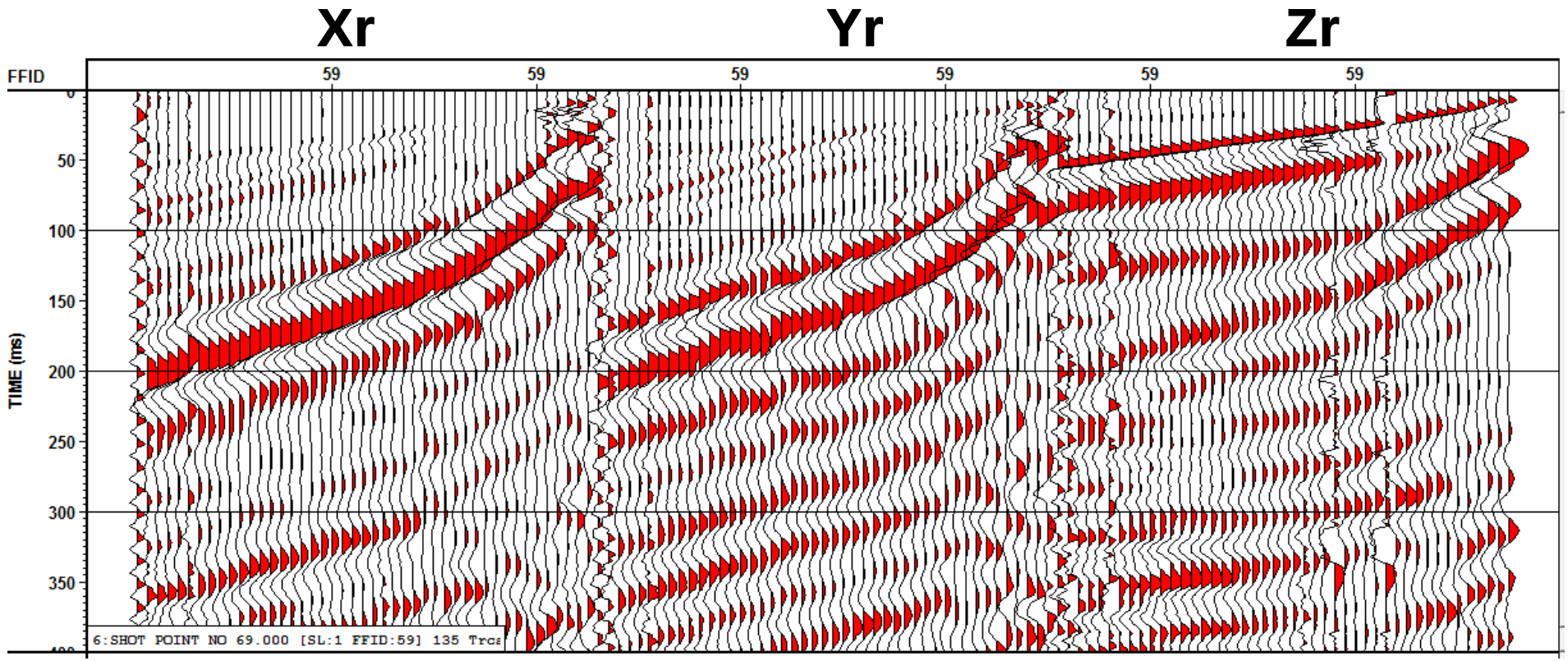
Offset dx = 2.5 m W

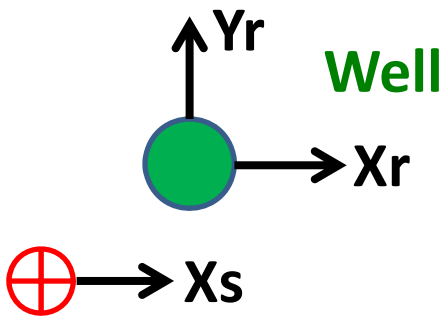
Offset dy = 3.7 m S



Source

Zero offset VSP at Priddis well: source Xs



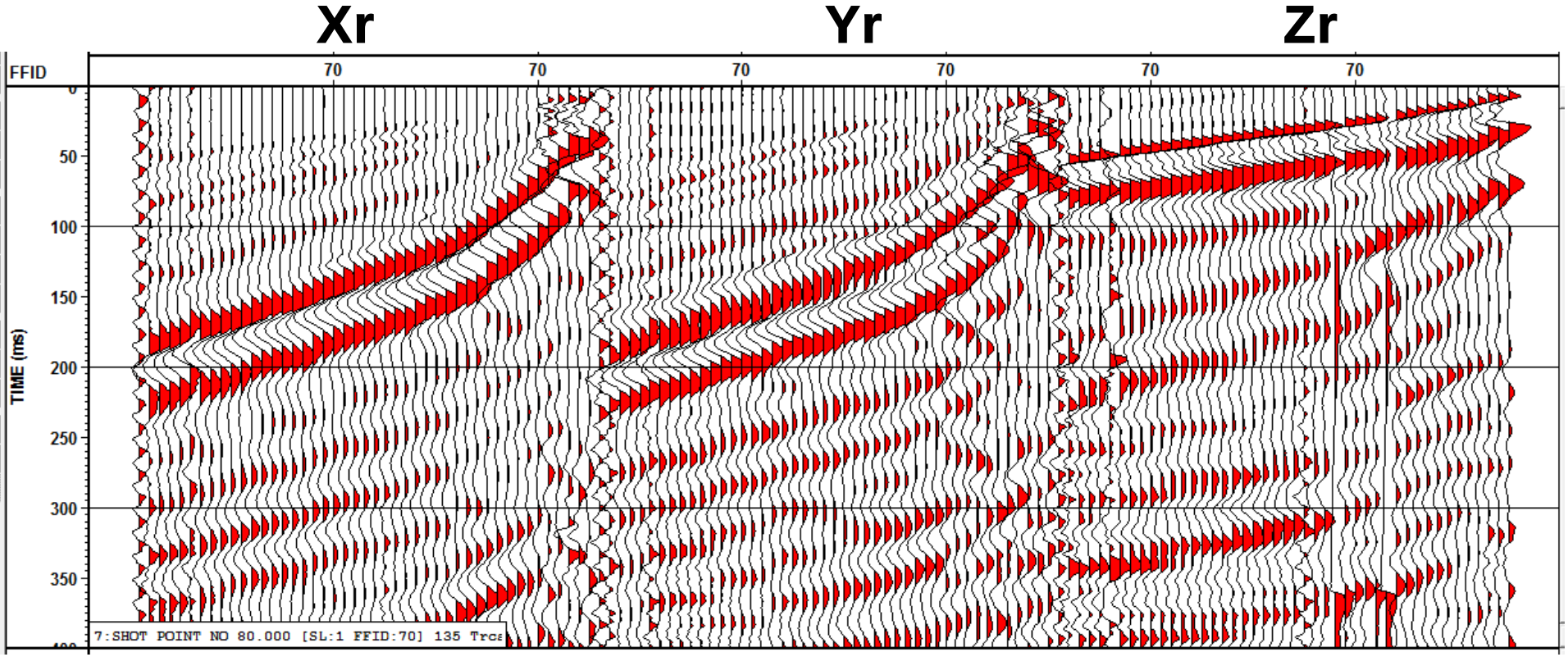


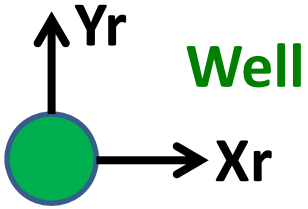
Offset dx = 2.5 m W

Offset dy = 3.7 m S

Source

Zero offset VSP at Priddis well: source X's





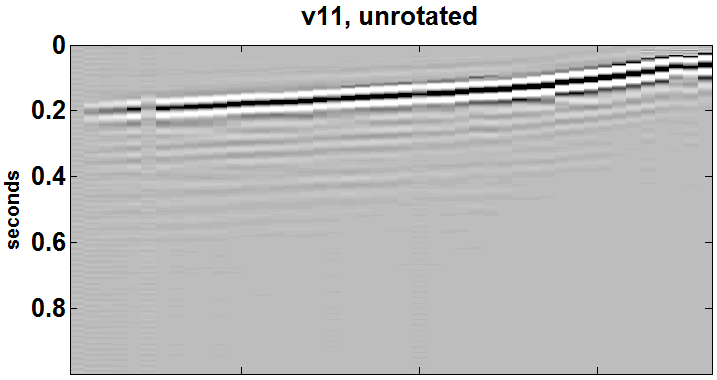
Well

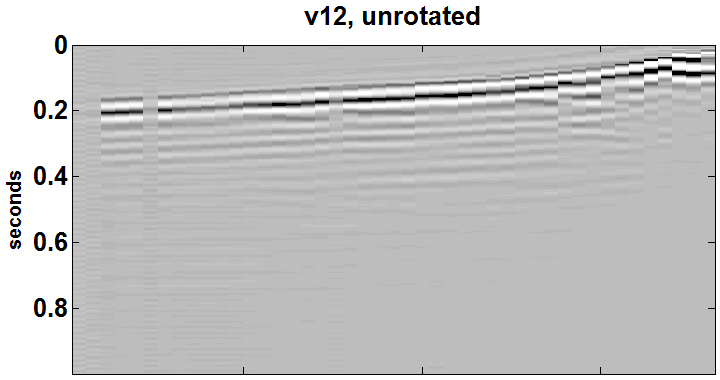
Offset dx = 2.5 m W

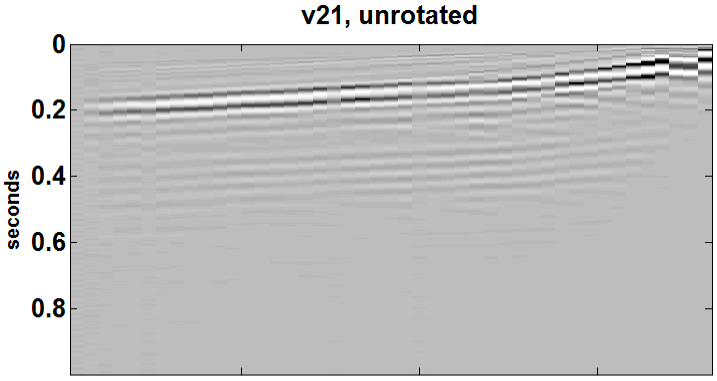
Offset dy = 3.7 m S

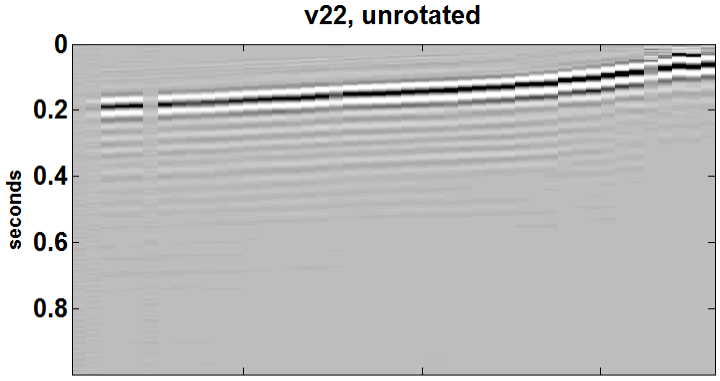
Source

Input components, unrotated

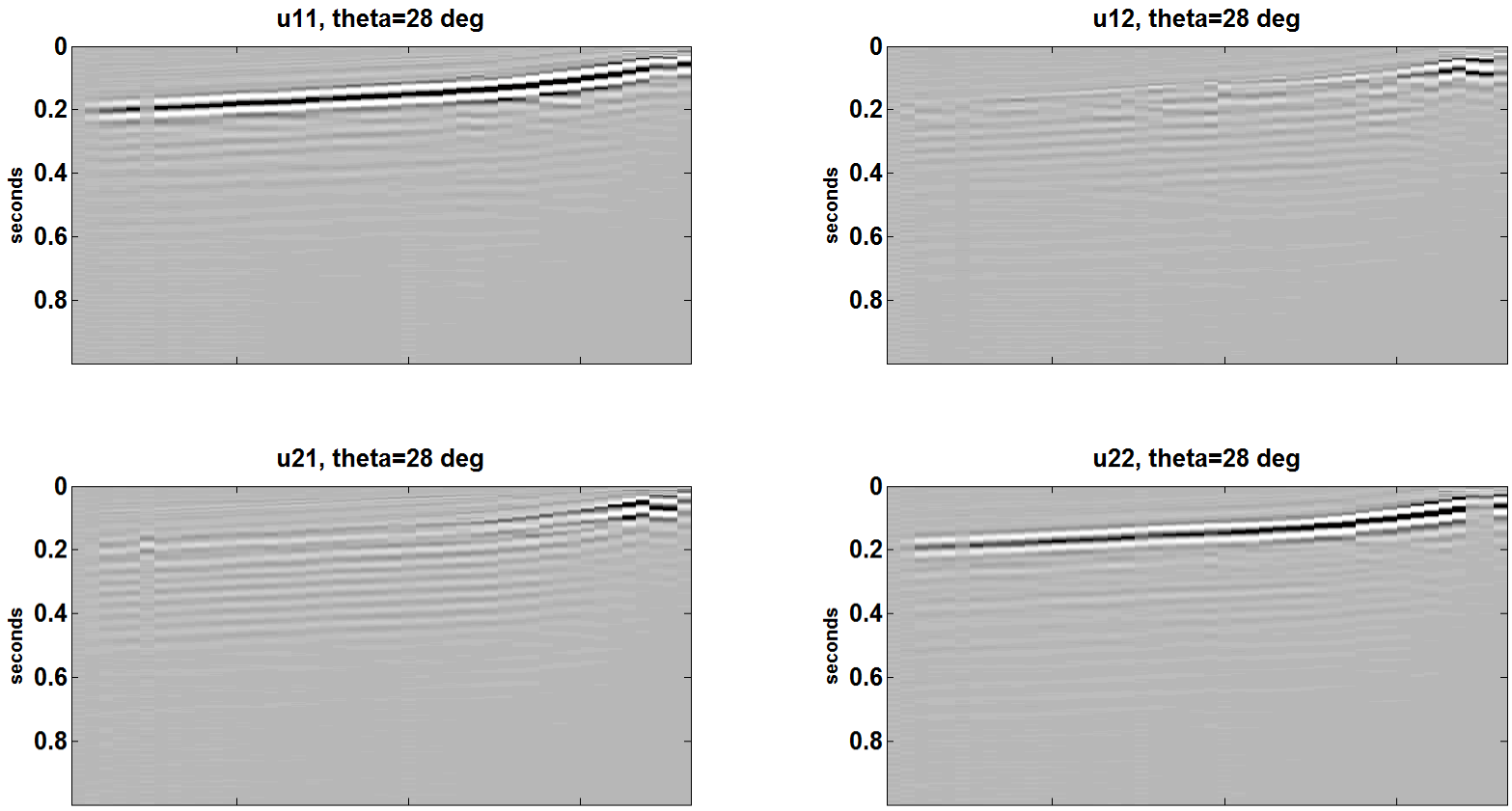






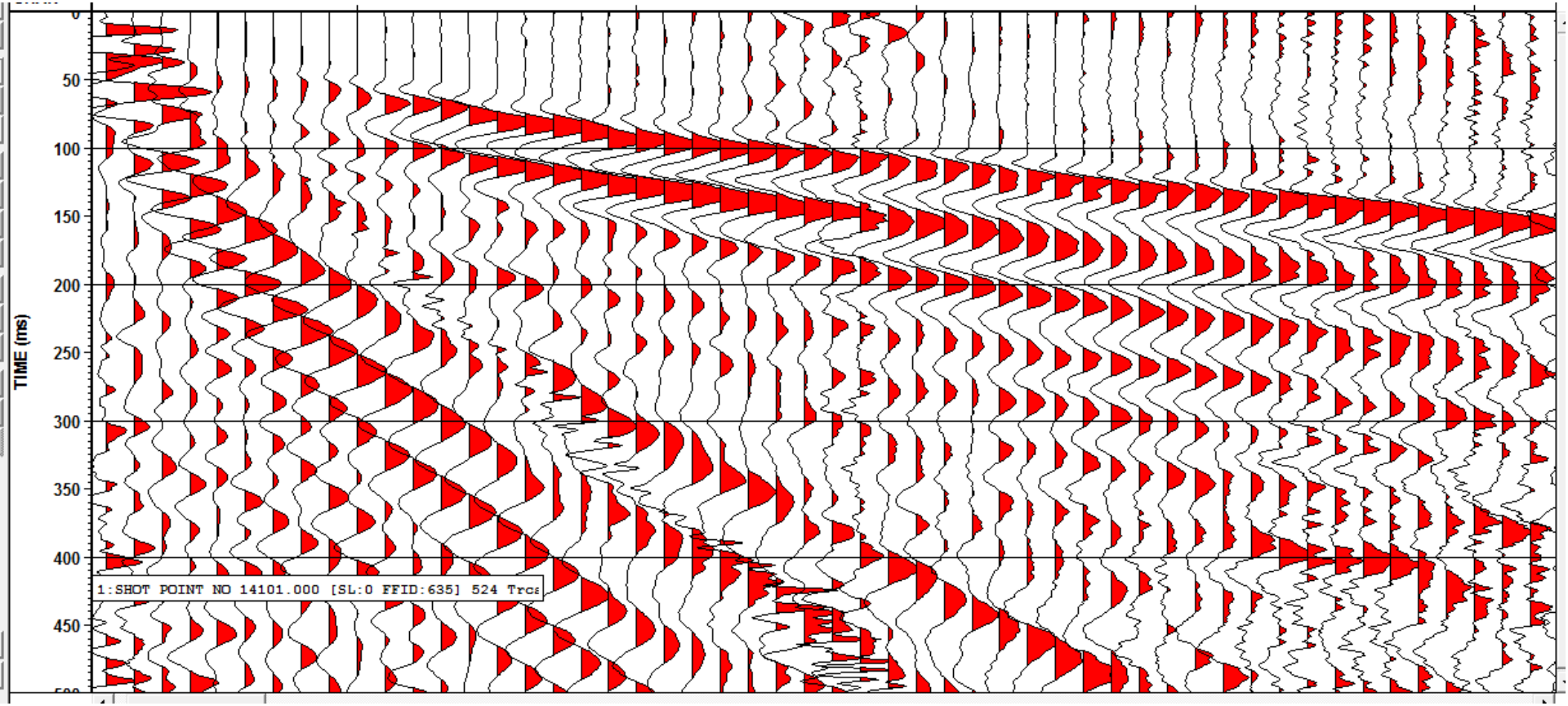


Alford rotation



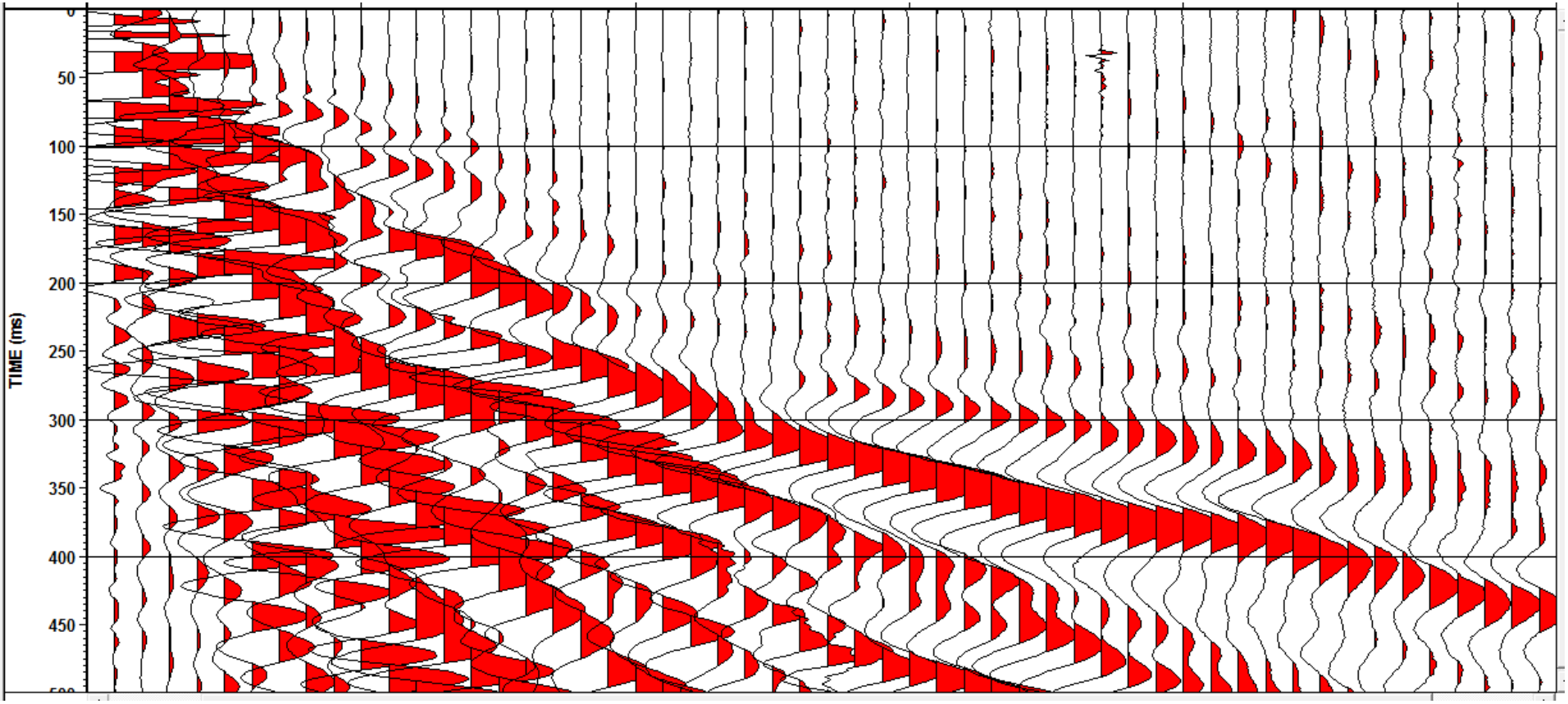
Courtesy Gary Margrave

Surface spread
V source and V component receiver



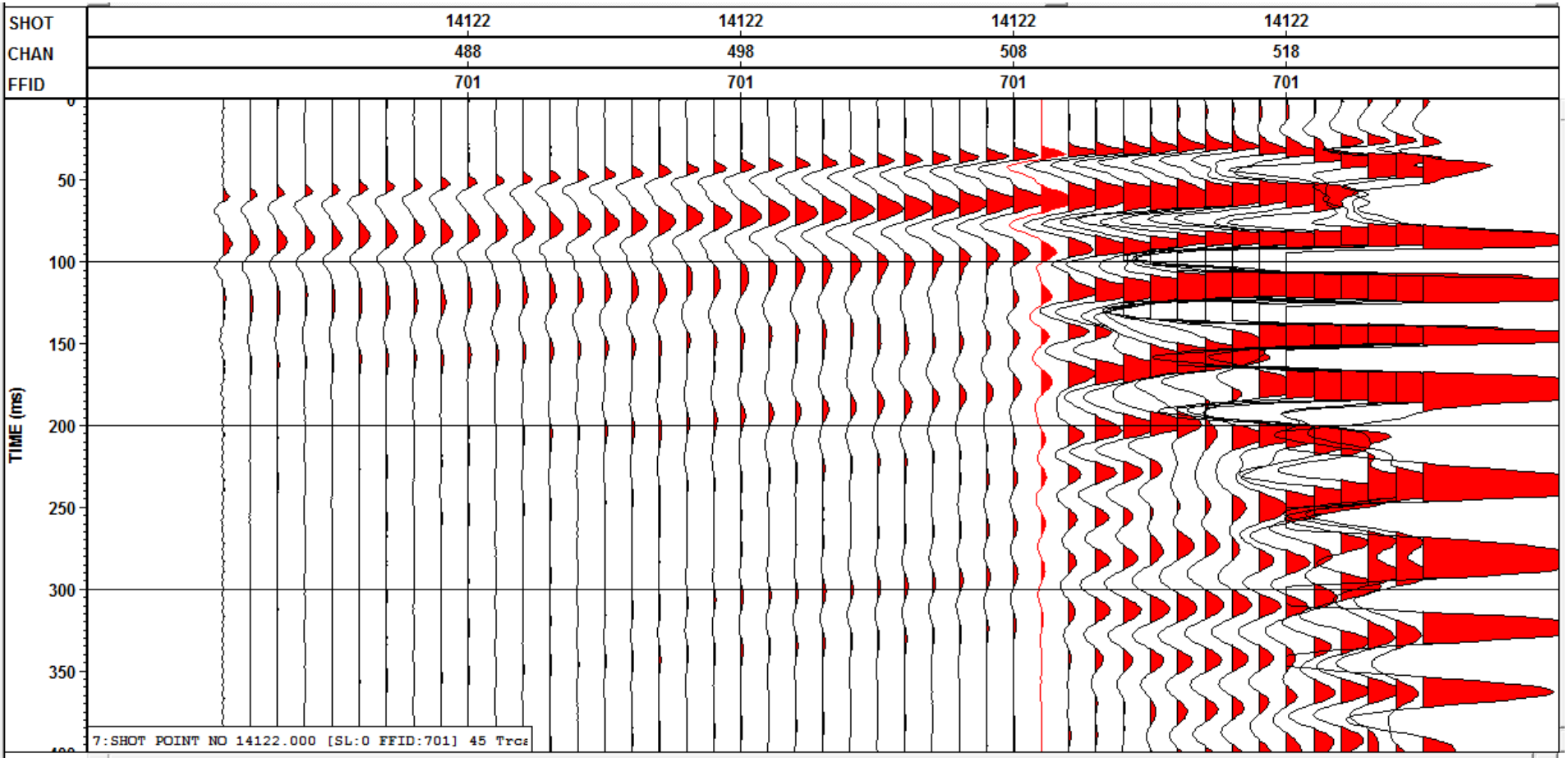
Vp1 = 2000 m/s
Vp2 = 2900 m/s

Surface spread
SH source and T component receiver



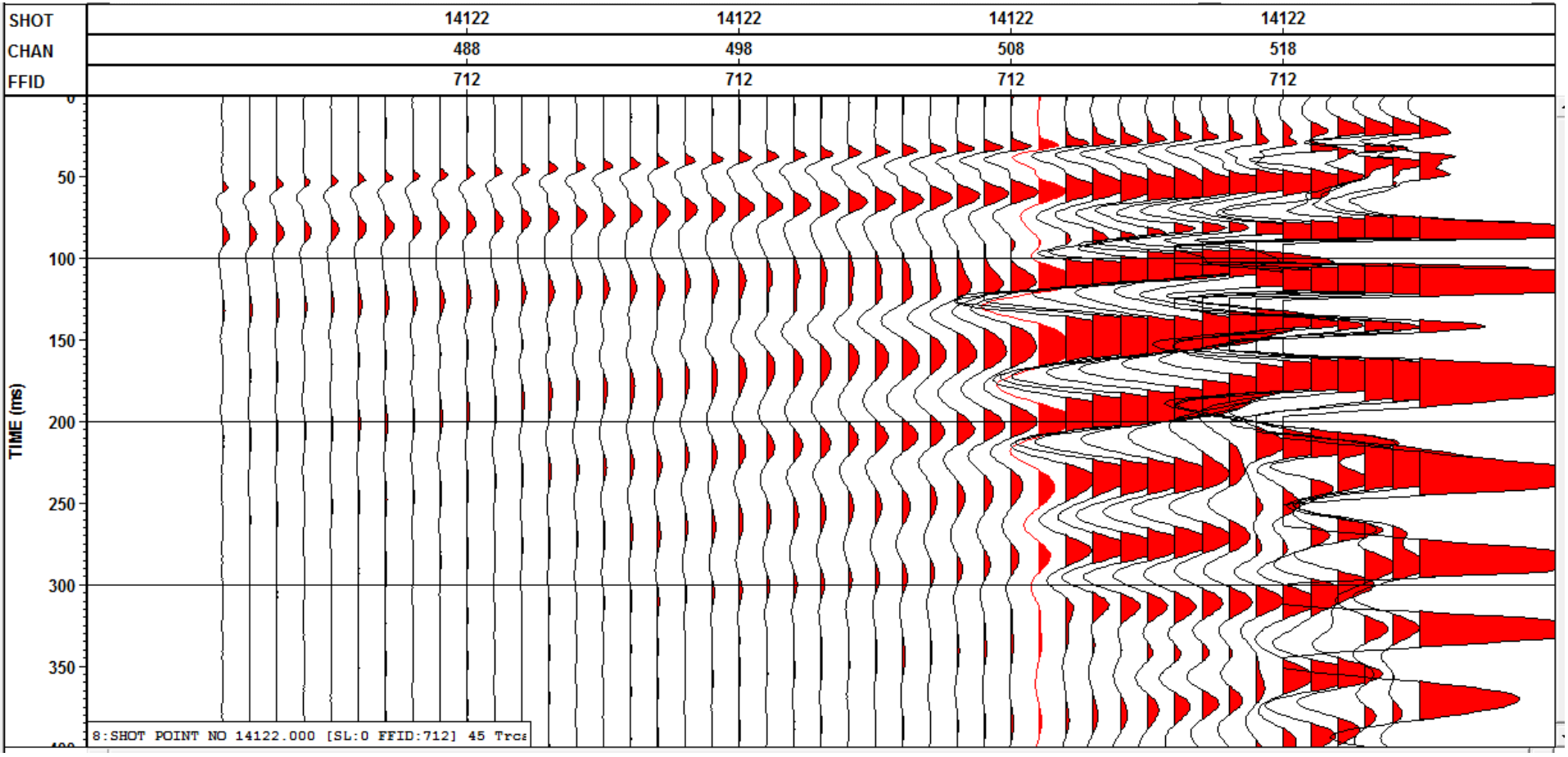
Vs2 = 1360 m/s

V source, 20 m offset from well



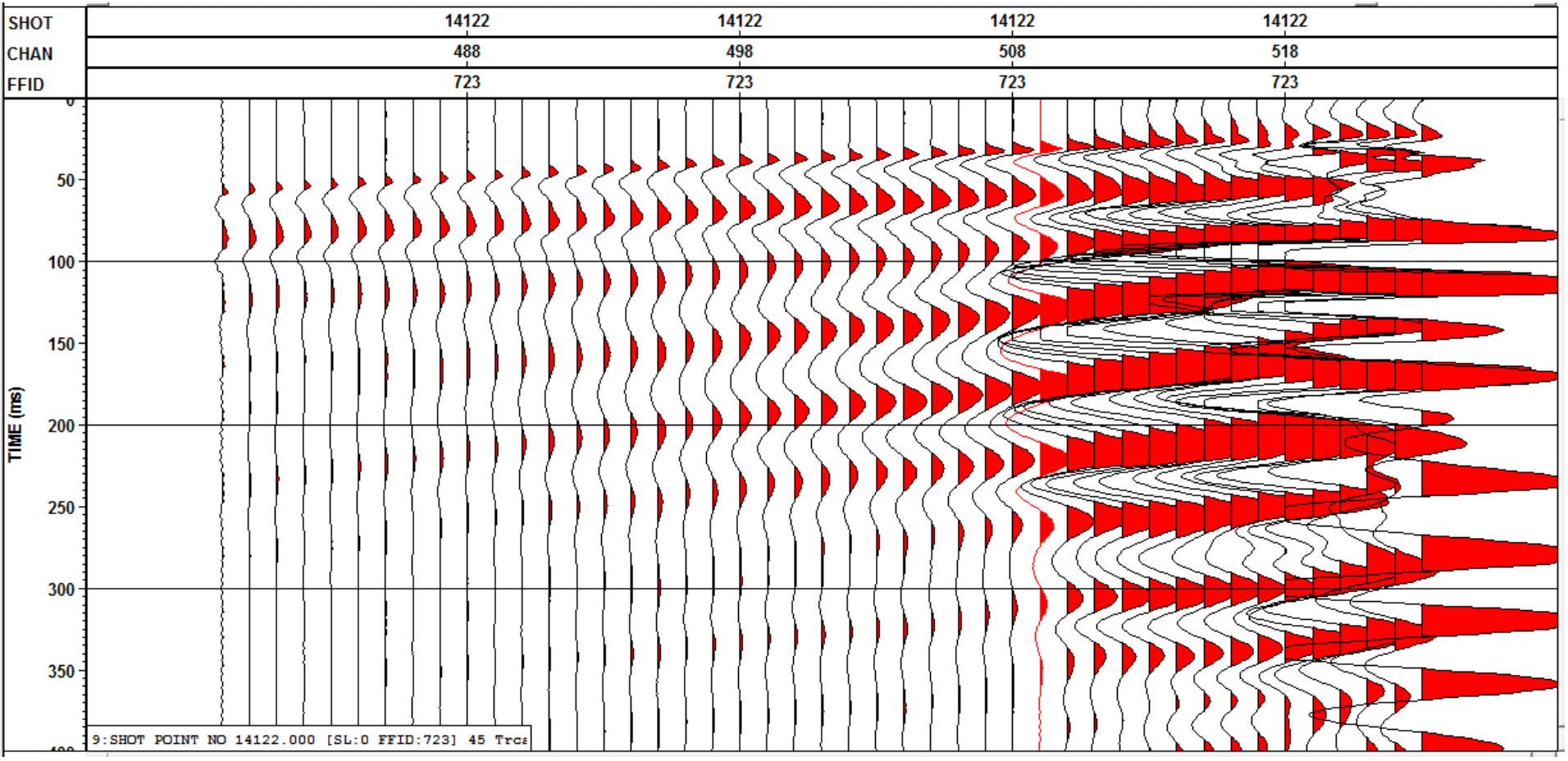
Vertical component receiver

Y source, 20 m offset from well



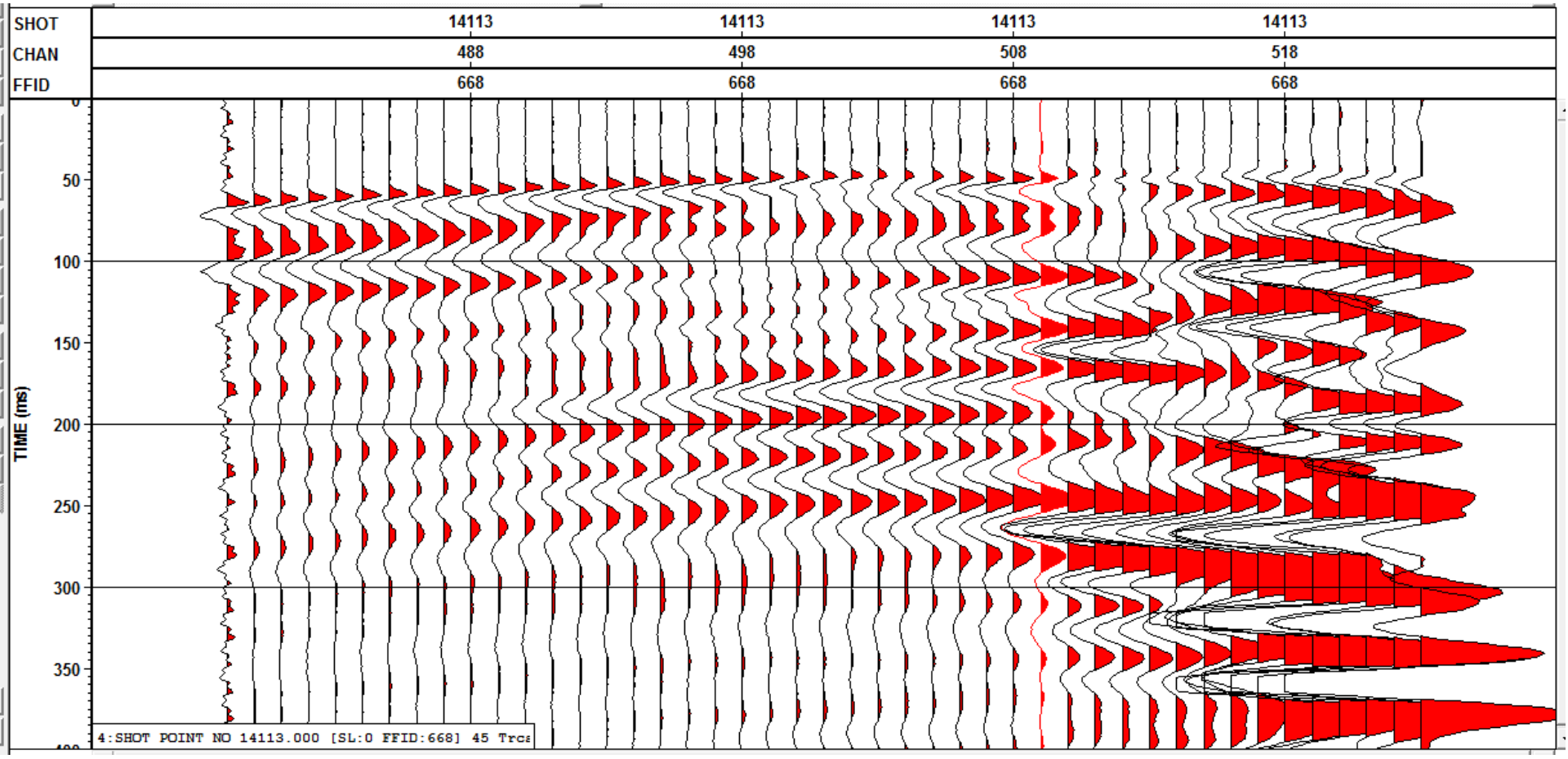
Vertical component receiver

Y’ source, 20 m offset from well



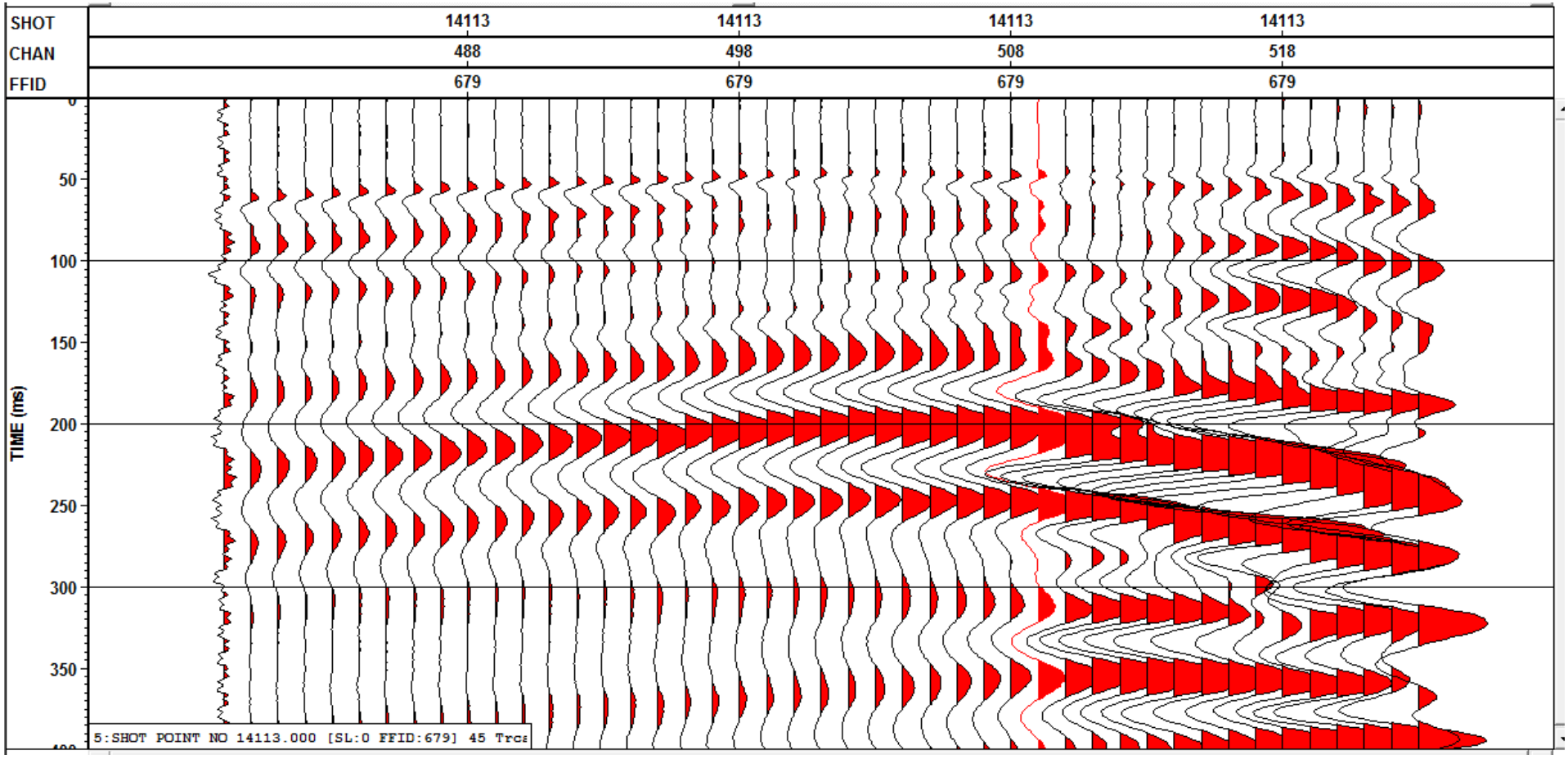
Vertical component receiver

V source, 80 m offset from well



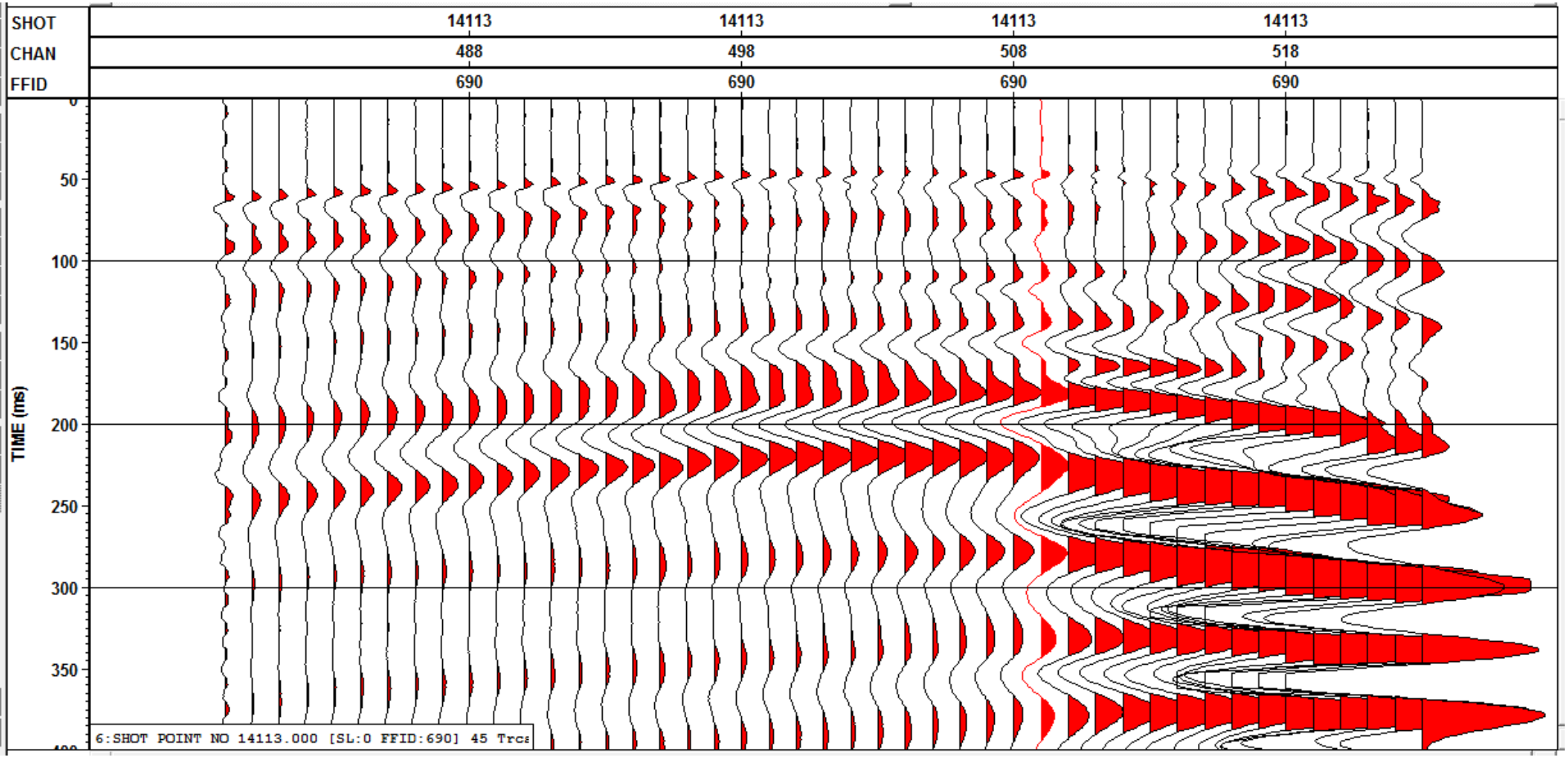
Vertical component receiver

Y source, 80 m offset from well



Vertical component receiver

Y’ source, 80 m offset from well



Vertical component receiver

Summary

- Source built and tested successfully
- Good P and S energy to 250 m offsets
- Good P and S energy to 150 m depth
- Vp/Vs = 3.9 on campus
- Vp/Vs = 4.2 to depth of 40 m at Priddis
- Vp/Vs = 2.3 below 40 m depth at Priddis
- Turning rays evident from offset shots
- Shallow azimuthal anisotropy evident

Acknowledgments

- CREWES sponsors
- NSERC
- Carbon Management Canada