A new S-wave seismic source

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*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

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
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

Offset $dx = 2.5 \text{ m W}$
Offset $dy = 3.7 \text{ m S}$
Zero offset VSP at Priddis well: source V

Offset $dx = 2.5$ m W
Offset $dy = 3.7$ m S

$V_{p1} = 2160$ m/s
$V_{p2} = 3210$ m/s
Zero offset VSP at Priddis well: source Ys

Offset $dx = 2.5$ m W  
Offset $dy = 3.7$ m S

$Vs_1 = 520$ m/s  
$Vs_2 = 1400$ m/s
Zero offset VSP at Priddis well: source Y’s

Offset \( dx = 2.5 \text{ m W} \)
Offset \( dy = 3.7 \text{ m S} \)
Zero offset VSP at Priddis well: source Xs

Offset $dx = 2.5$ m W
Offset $dy = 3.7$ m S
Zero offset VSP at Priddis well: source X’s

Offset $dx = 2.5$ m W
Offset $dy = 3.7$ m S
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

$V_{s2} = 1360 \text{ m/s}$
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
• $V_p/V_s = 3.9$ on campus
• $V_p/V_s = 4.2$ to depth of 40 m at Priddis
• $V_p/V_s = 2.3$ below 40 m depth at Priddis
• Turning rays evident from offset shots
• Shallow azimuthal anisotropy evident
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