Interpreting VSP, streamer, and ocean-bottom seismometer data from the White Rose oilfield, offshore Newfoundland

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Outline

• Introduction and motivations
• Stratigraphy of the White Rose oilfield, offshore Newfoundland
• VSP interpretation
• Converted-wave OBS interpretation
• Conclusions
• Acknowledgements
Motivations for this work

- Create a better image of the White Rose reservoirs (& prospects) using PS waves
- Tie together the VSP, streamer, & OBS information to identify targets
Location of White Rose oilfield, Offshore Newfoundland

Modified from Geography Network, 2002

Modified from Husky Oil Operations Ltd, 2001
Stratigraphy of White Rose field

Diagram showing the stratigraphic columns for the Cretaceous and Jurassic periods, illustrating the distribution of various rock types such as Shale, Sandstone, Siltstone, Carbonates, Shale-Sandstone, and Source rock. The diagram is modified from Deutsch/Meehan-Husky Oil, 2000.
H-20 well Multi-VSP analysis
PP synth & Offset VSP

Synthetic gather (45Hz Ricker wavelet) - stack

VSP-CDP actual data. Increase in acoustic impedance is a peak
PS synth & Offset VSP

Synthetic gather (45Hz Ricker wavelet) - stack

VSP-CCP actual data. Increase in acoustic impedance is a peak
PP synth & Walk-Above VSP

Synthetic gather (45Hz Ricker wavelet) - stack

VSP-CDP actual data. Increase in acoustic impedance is a peak.
Synthetic (45Hz Ricker wavelet) - stack

North South PP Seismic section and Synthetic seismogram
(Black is a peak and red is a trough)
OBS data analysis
White Rose imaging challenges

- Hard Water Bottom
- Strong P-wave impedance contrast at the T-K unconformity
- Poor P-wave impedance contrast between the Avalon and Nautilus Formations
- Distortion of the reservoir image by the presence of gas clouds in the overlying T sediments

Terra Nova boulders
(www.huskywhiterose.com/, 2002)
2000 OBS Survey

Modified from odp.tamu.edu
2000 OBS Survey
PP and PS (vertical & radial components) seismic sections

Vertical component (PP time)
Radial component (PS time)

Modified from Cary and Stewart, 2003
2002 OBS Survey

Modified from Jackson et al., 2002

Modified from Hall and Stewart, 2002
2002 OBS Survey Equipment

Modified from phys.ocean.dal.ca, 2002

Modified from Jackson et al., 2002
Well-log Interpretation (H-20 & L-08)

**Well H-20**
- PP Synth (45Hz Ricker wavelet)
- PS Synthetic

**Well L-08**
- PP Synth (45Hz Ricker wavelet)
- PS Synthetic
Well-log Interpretation (L-08)

PP Synthetic (4/8 25/30 bandpass wavelet) - stack

PS Synthetic (4/8 25/30 bandpass wavelet) - stack
OBS Interpretation
PP synthetic-Vertical component

TWT (ms)

Xline

2000
2100
2200
2300
2400
2500
2600

PP Time (ms)
PP seismic section

L-08

100 92 84 76 68 60

PP Synthetic Stack

TrtE
Smara
Btrt
Naut
Aval
Eshl
OBS Interpretation
PS synthetic-Radial component
Correlation
OBS P data-Streamer P data
OBS Interpretation
Radial component - Vertical component

PP Time (ms)
PS seismic section

PP Time (ms)
PP seismic section
Vp/Vs analysis
Average Vp/Vs maps
Conclusions
Conclusions (VSP interpretation)...

- The P-P synthetics seismograms match well with the Offset VSP (PP) field data, with the Walk-above VSP (PP) and the seismic section (PP)

- The P-S synthetic seismograms match well with the Offset VSP (PS) field data

- Comparing the PS to the PP synthetic seismograms and comparing the field results of the Offset VSP (PS) to the offset VSP (PP), the PS images improve the top of the Avalon Formation.

- PS (synthetic and offset VSP data) shows less amplitude loss at the top of the Tertiary unconformity leaving more energy to image below
Conclusions (OBS interpretation)...

- Detailed correlation information from the wells L-08 and H-20 enabled the interpretation of the low impedance contrast between the Avalon and Nautilus Fms on the synthetics.

- A reasonable data match was found for:
  - PP synthetics & PP vertical component seismic section (OBS)
  - PS synthetics & PS radial component seismic section (OBS)

- Vp/Vs values from the seismic and the well L-08 are related, presence of lateral Vp/Vs anomalies is evident on the seismic.

- Acquiring converted wave with the help of an OBS survey, should help address the different image challenges of White Rose field.
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