

Analysis of multicomponent walkaway vertical seismic profile data, Tucker Lake, Alberta

CREWES Project
Department of Geoscience
University of Calgary

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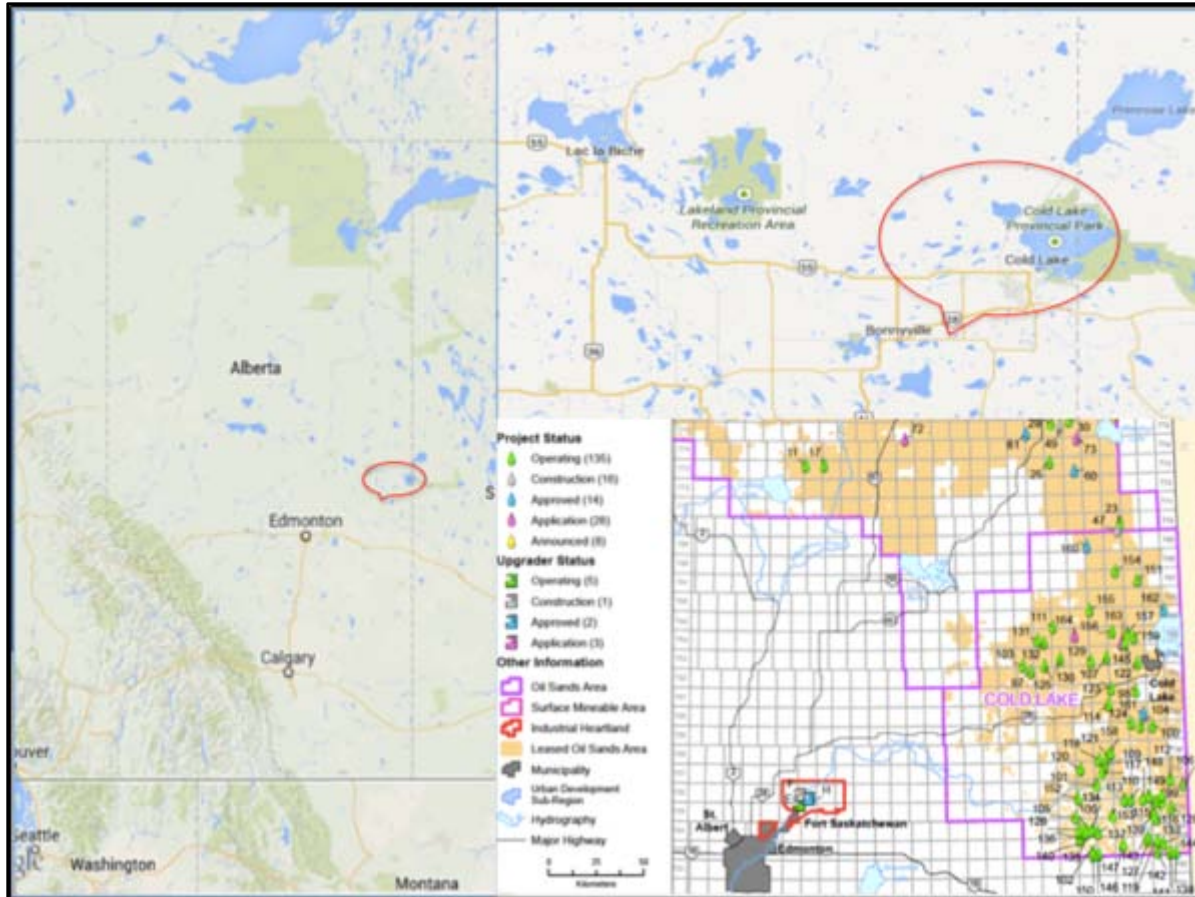
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- Introduction
- VSP processing
- Interpretation
- Summary and future work
- Acknowledgements



Location of Tucker Lake Field



Clearwater Formation

Important resource of
9-10 API bitumen

Steam assistant gravity
drainage (SAGD)

Location of Tucker Lake Field (from <http://www.google.ca/maps> and Alberta Energy Regulator).

- Study the AVO response of the oil sand reservoir by 3C walkaway VSP
- Obtain rock properties by PP-PS joint inversion and better characterize the reservoir



Why 3C walkaway VSP data?

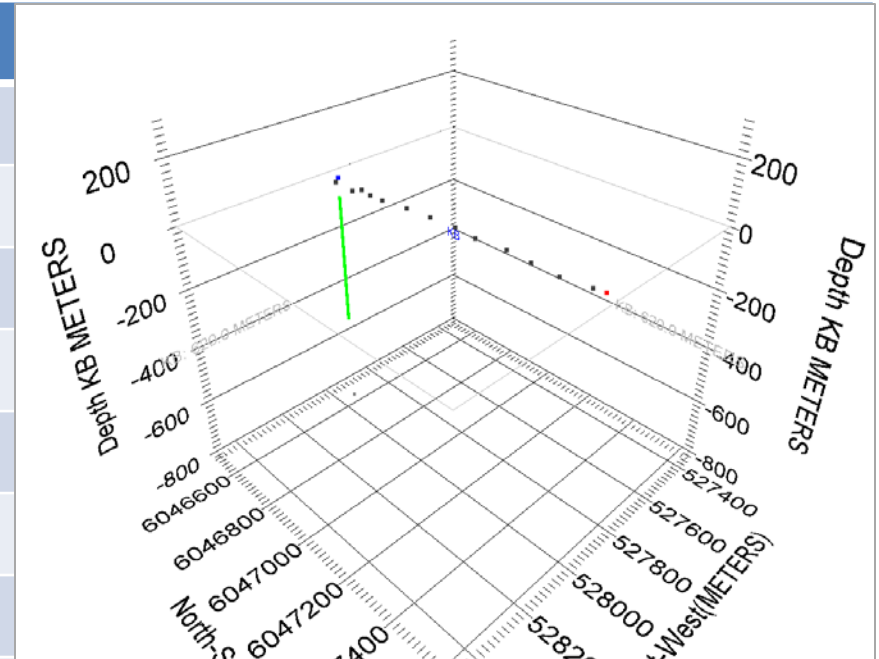
- High S/N, broader frequency
- Deterministic deconvolution
- Easy to obtain reflection coefficient
- Walkaway VSP(offset VSP) geometry designed for AVO analysis
- Converted-wave data enhances the traditional compressional wave exploration

Tucker Lake 3C walkaway VSP



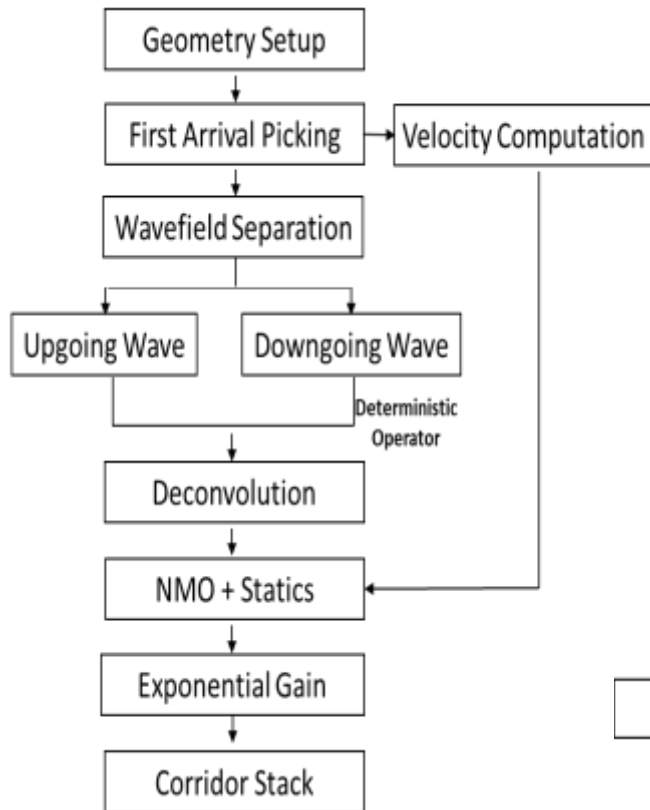
Acquisition parameters & geometry

	Dynamite	Vibroseis
Receiver type	VectorSeis	VectorSeis
Number of receivers/spacing	220/2m	220/2m
Receiver depth (m)	55-507	55-507
Sample rate(ms)	1	1
Record length (s)	3	3
Offset(m)	11.5-1031	11.5-1031
Source depth/elevation(m)	9/612-622	612-622
Charge (kg)/ Sweep	0.125	EnviroVibe, 10-300Hz, over 20s, linear, one sweep per vibe point, 100/1000ms taper
Borehole	562m TD, vertical, no fluids in borehole	

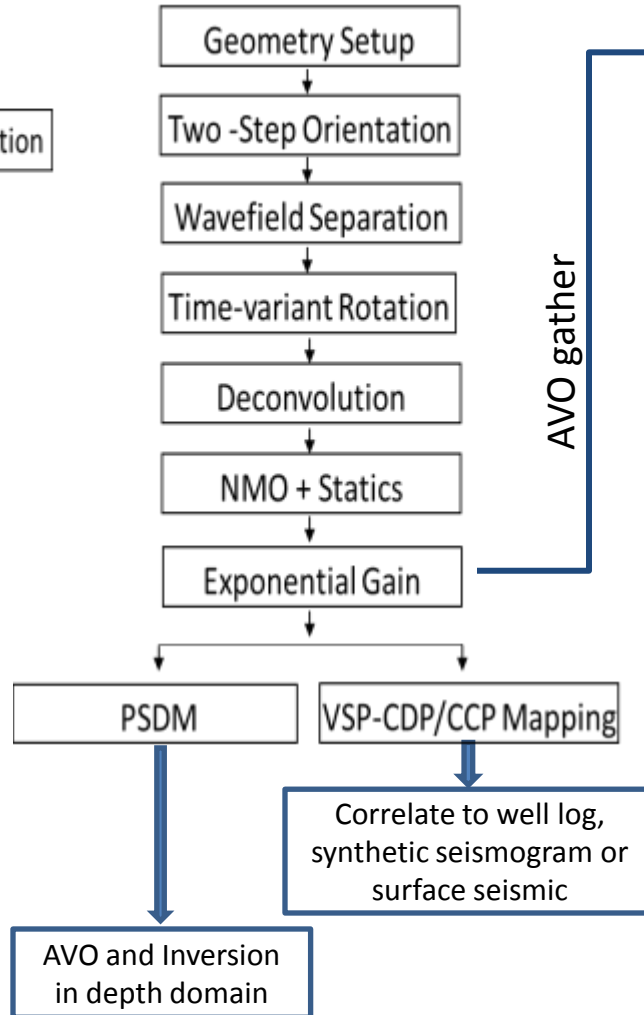


Processing Flows

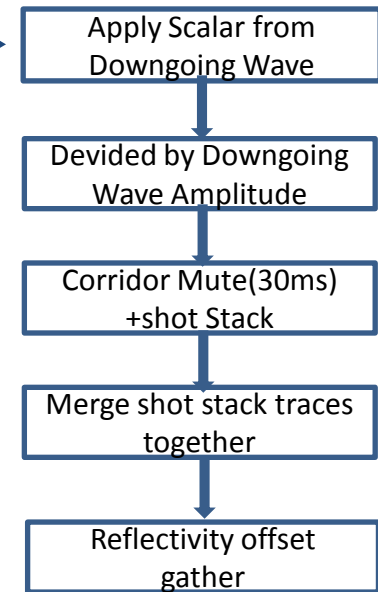
Zero-offset VSP



Walkaway VSP

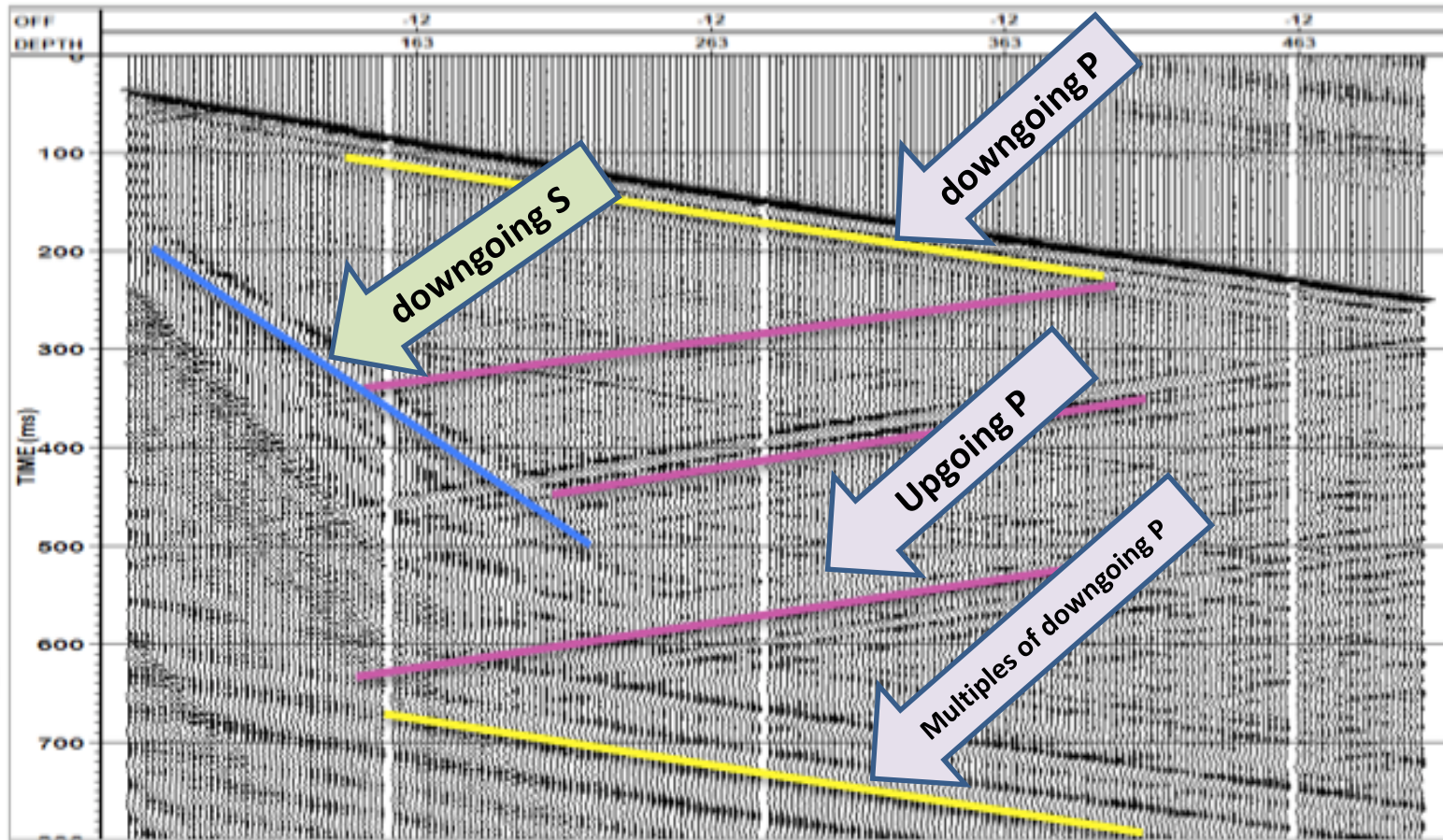


AVO gather



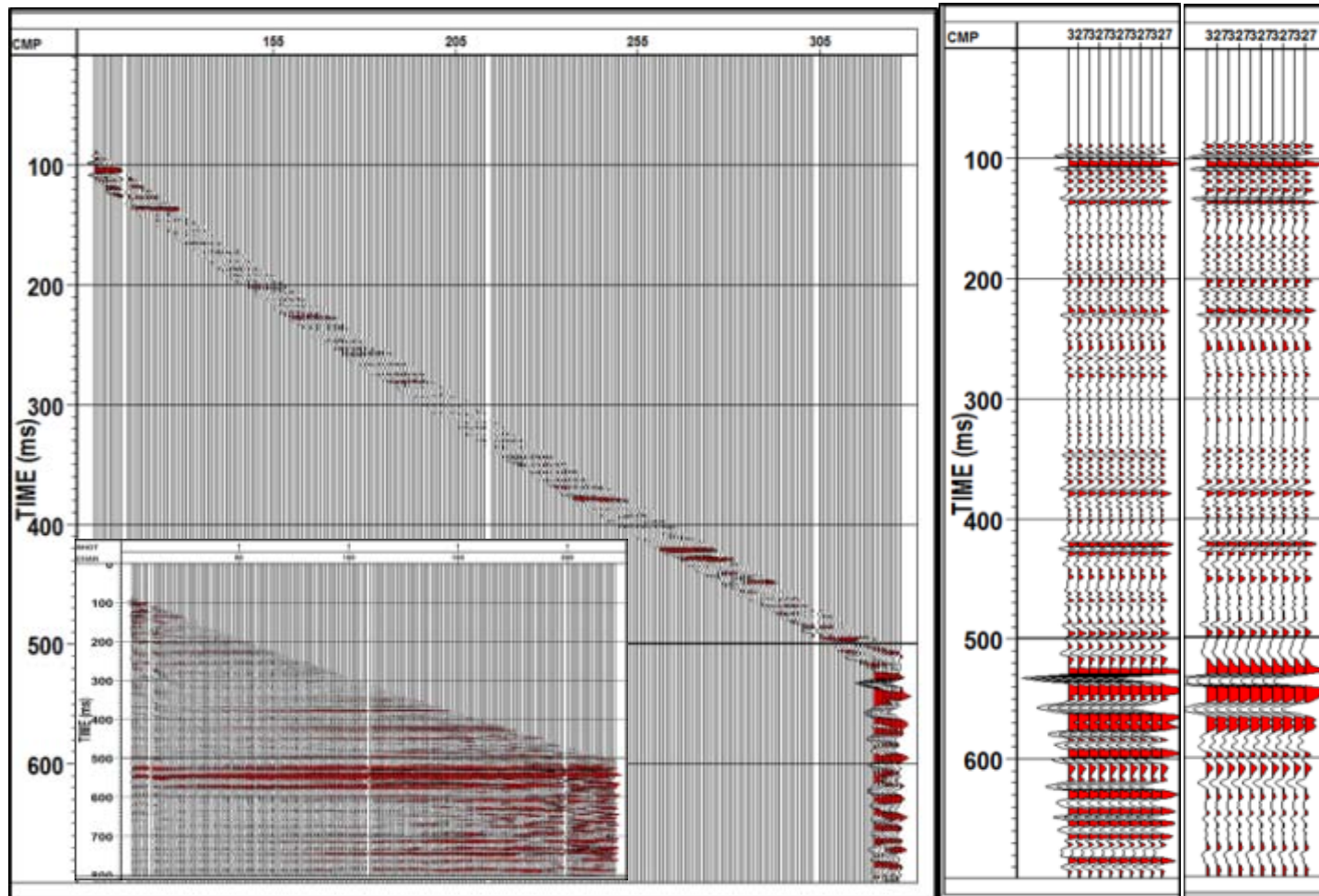
AVO gather

Wavefield Analysis – Zero-offset VSP



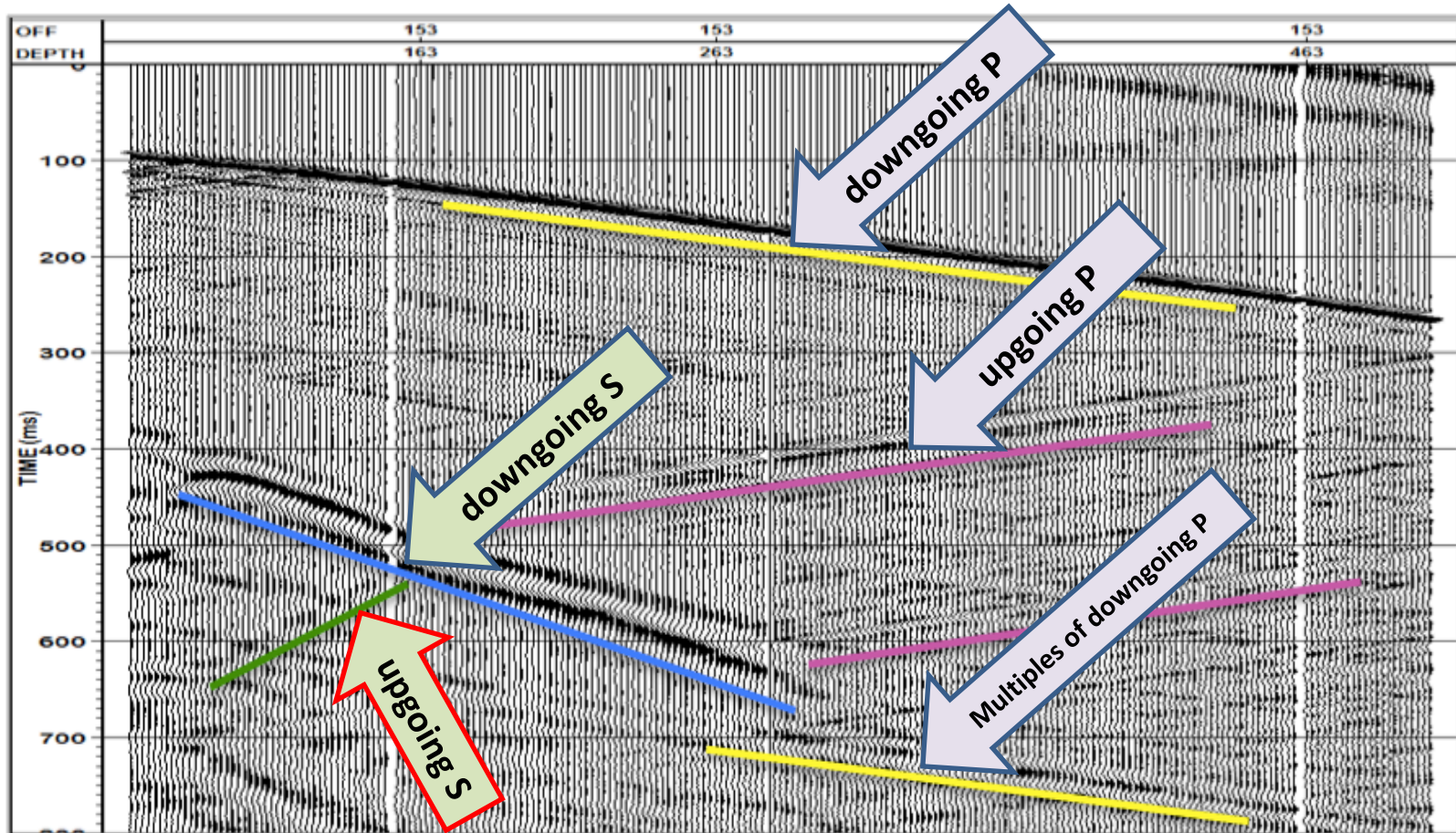
Vibroseis zero-offset vertical component

Zero-offset VSP Corridor Stack



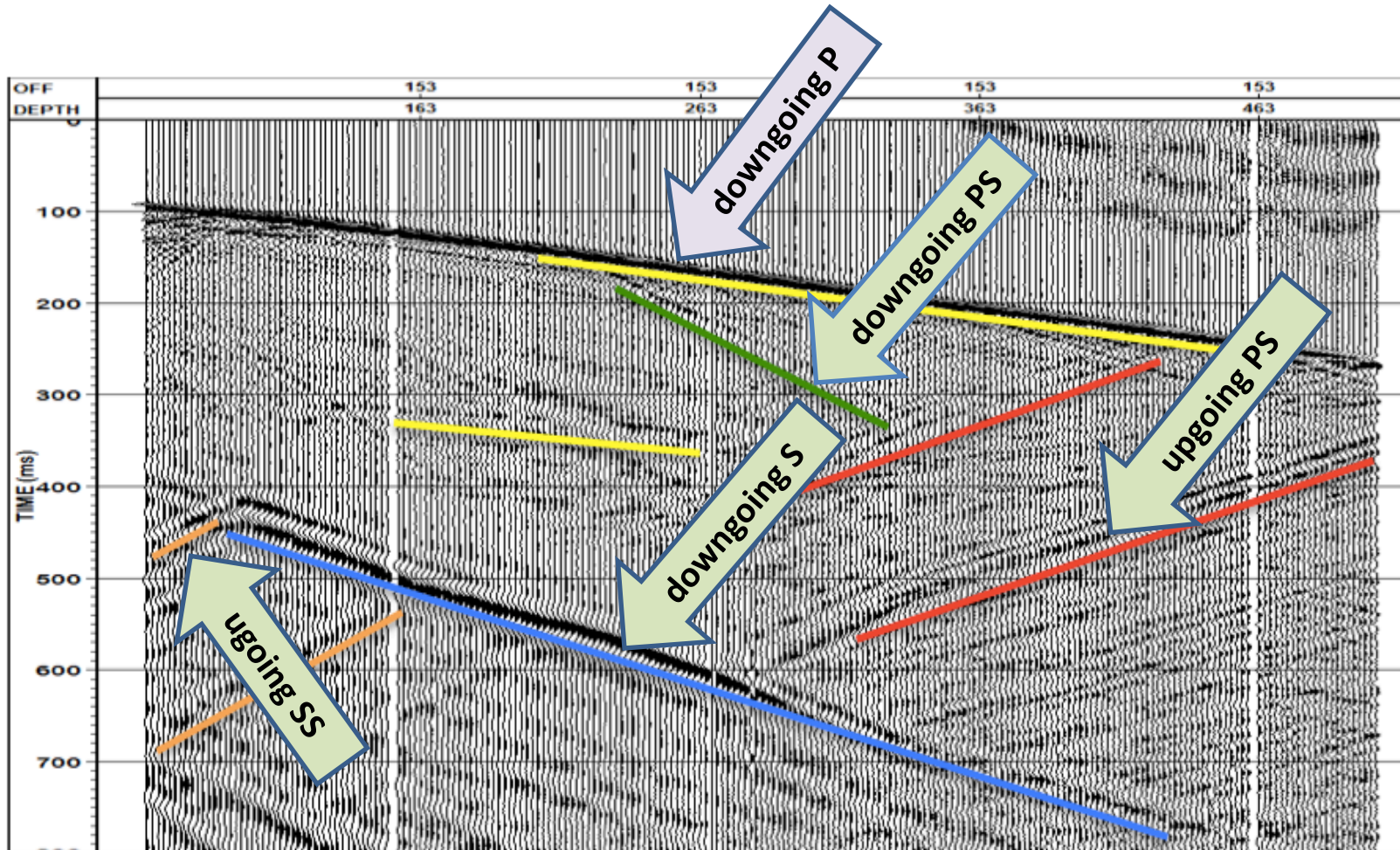
Shot1 - Processed shot gather, after corridor mute, corridor stack and full stack

Wavefield Analysis – Offset VSP



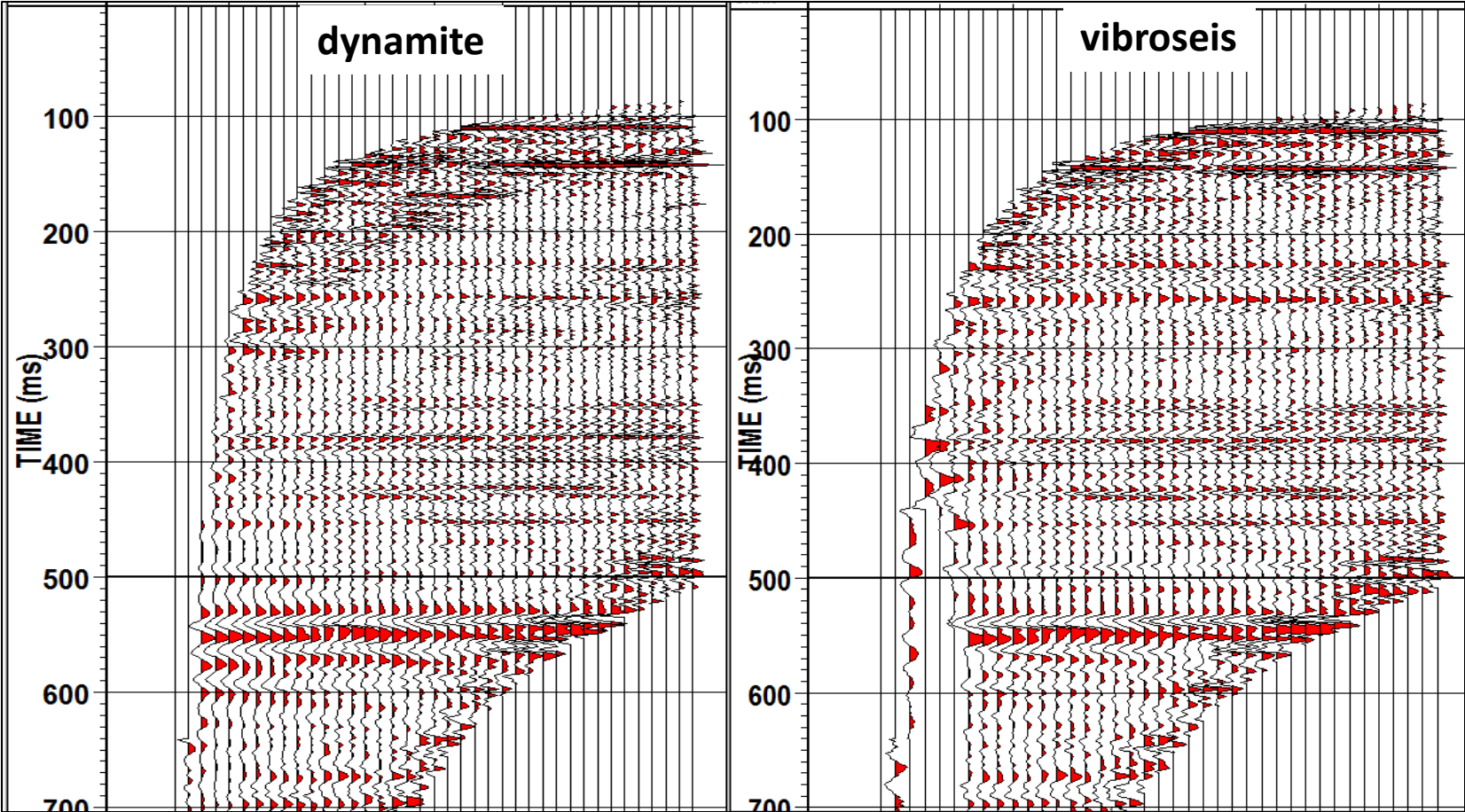
Offset=153m, vertical component

Wavefield Analysis – Offset VSP



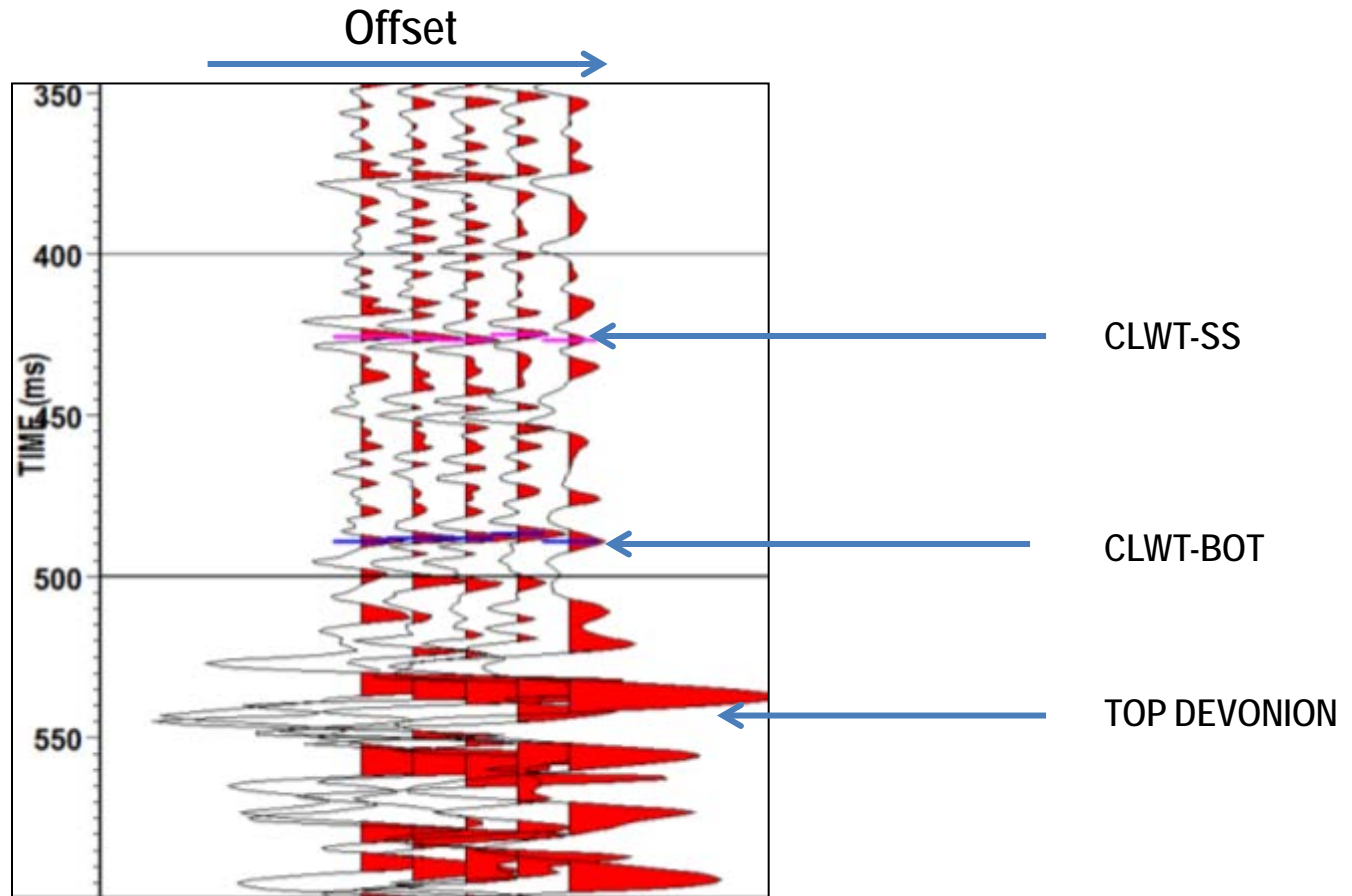
Offset=153m, Hmax component(after horizontal rotation)

VSP-CDP Mapping



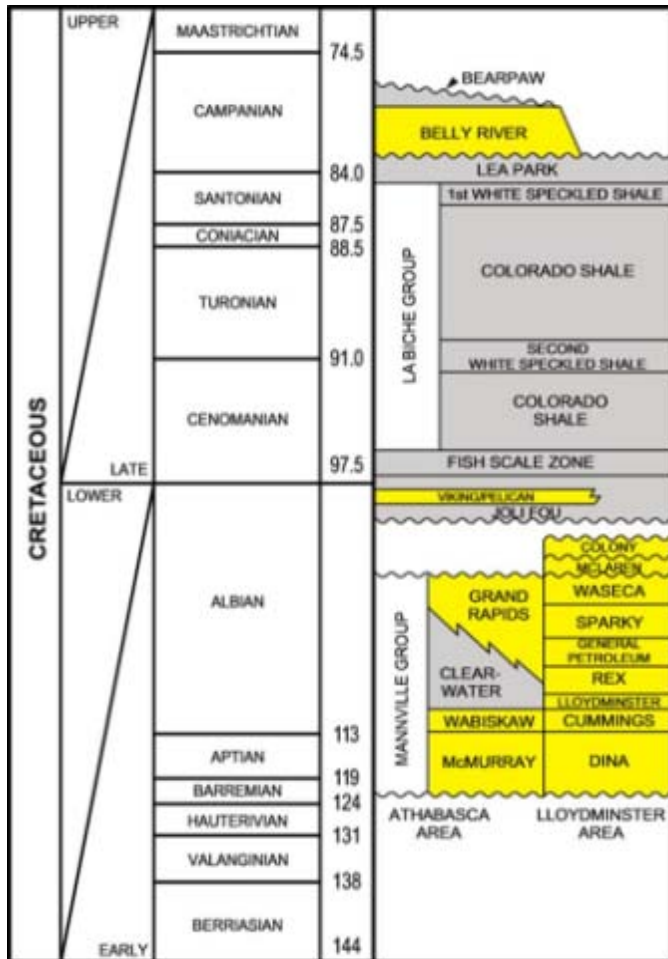
Shot 4(offset=153m), grid size=2m, AGC window=200ms

Common Shot Reflectivity Gather

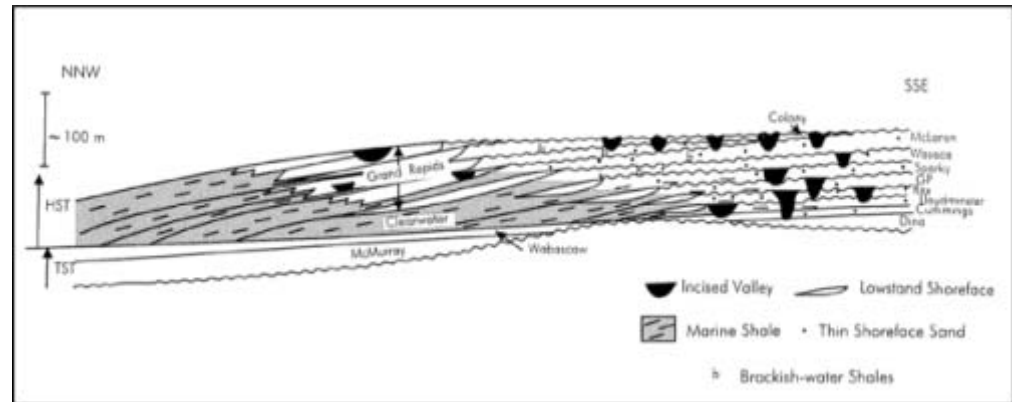


Common shot reflectivity gather (offset=11.5-308m)

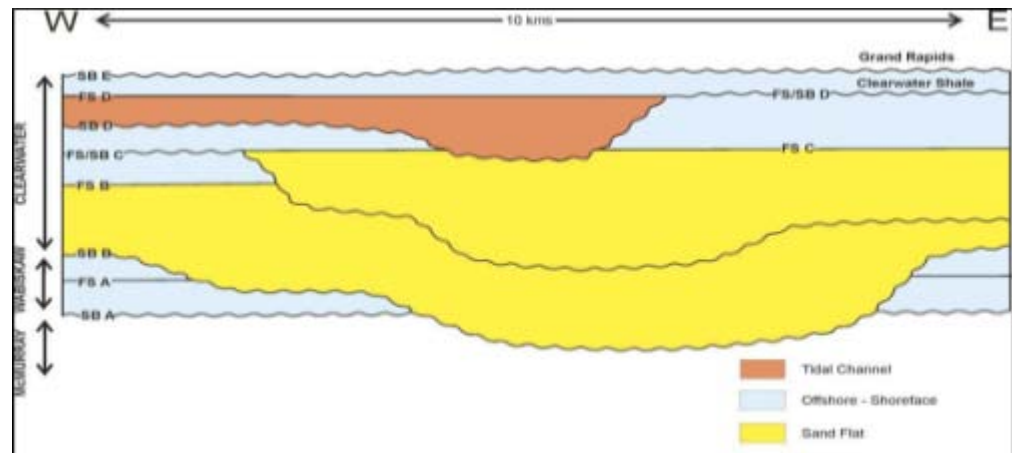
Stratigraphy



Sequence Stratigraphic Correlation Chart (from Core Laboratories Geological Science Department, Canada)

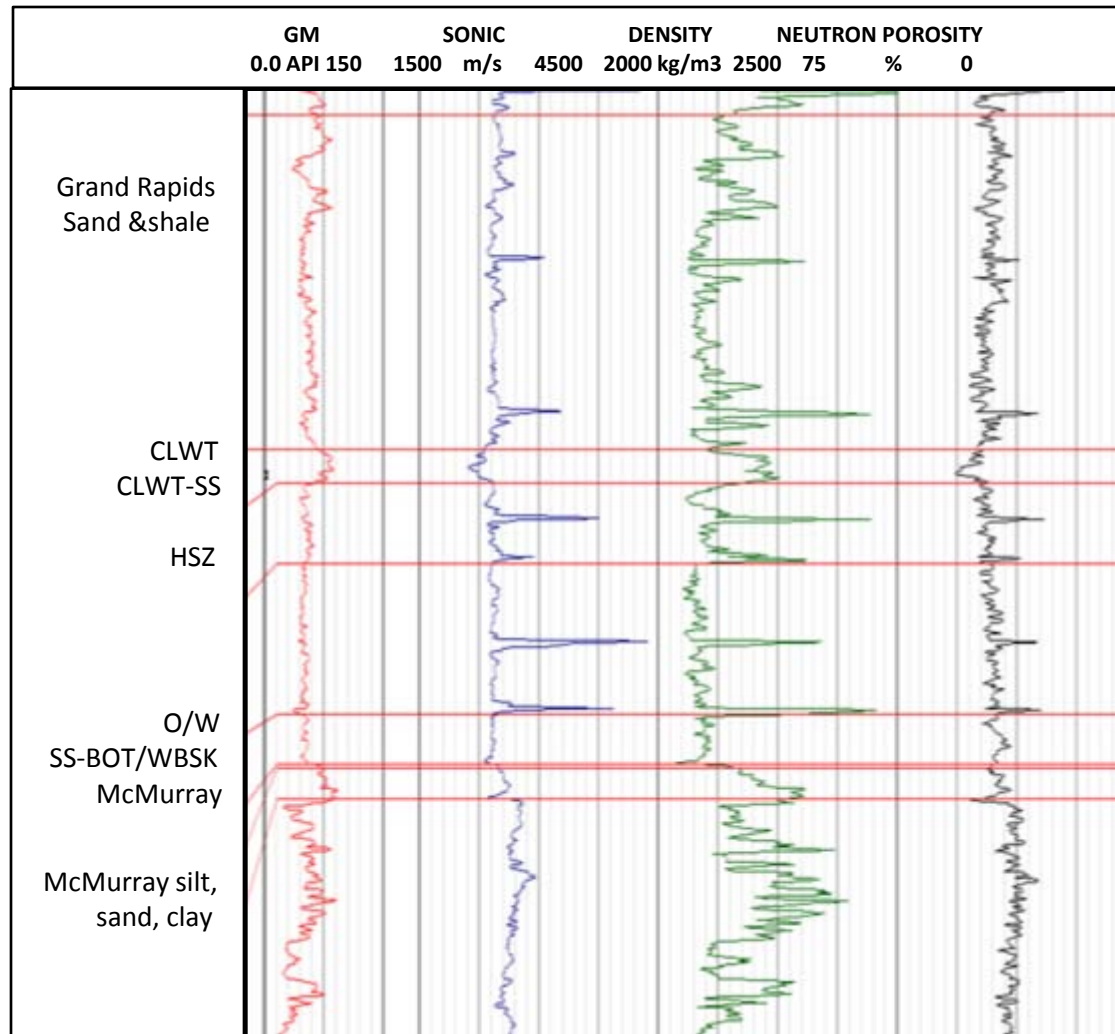


Stratigraphy model of Clearwater Formation in Cold Lake field (Hein et. al, 2007)



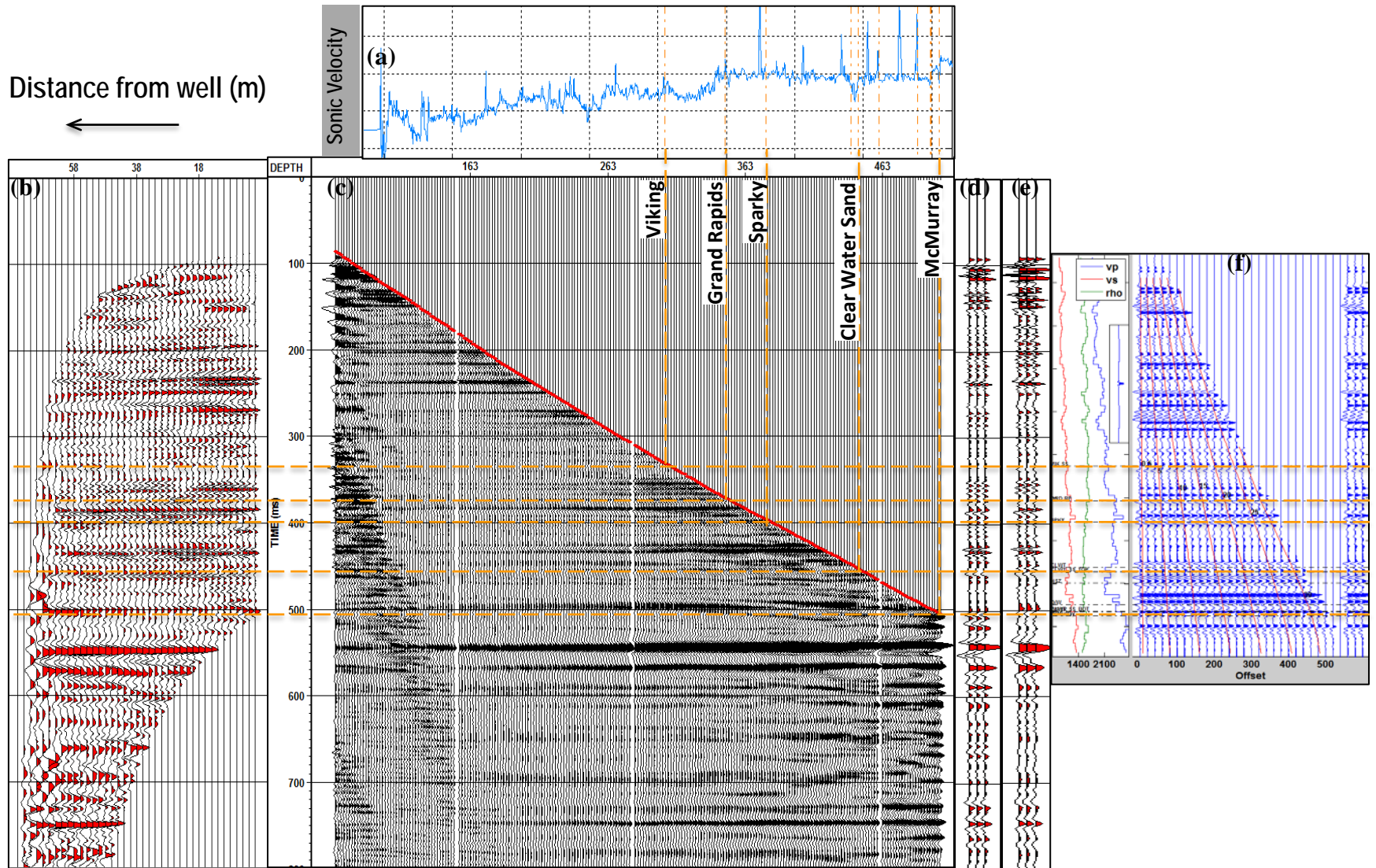
The schematic cross-section of Clearwater formation at Tucker area, AB. (From Alberta Energy Regulator annual performance presentation, 2013)

Well Log Analysis



Logs from Well A

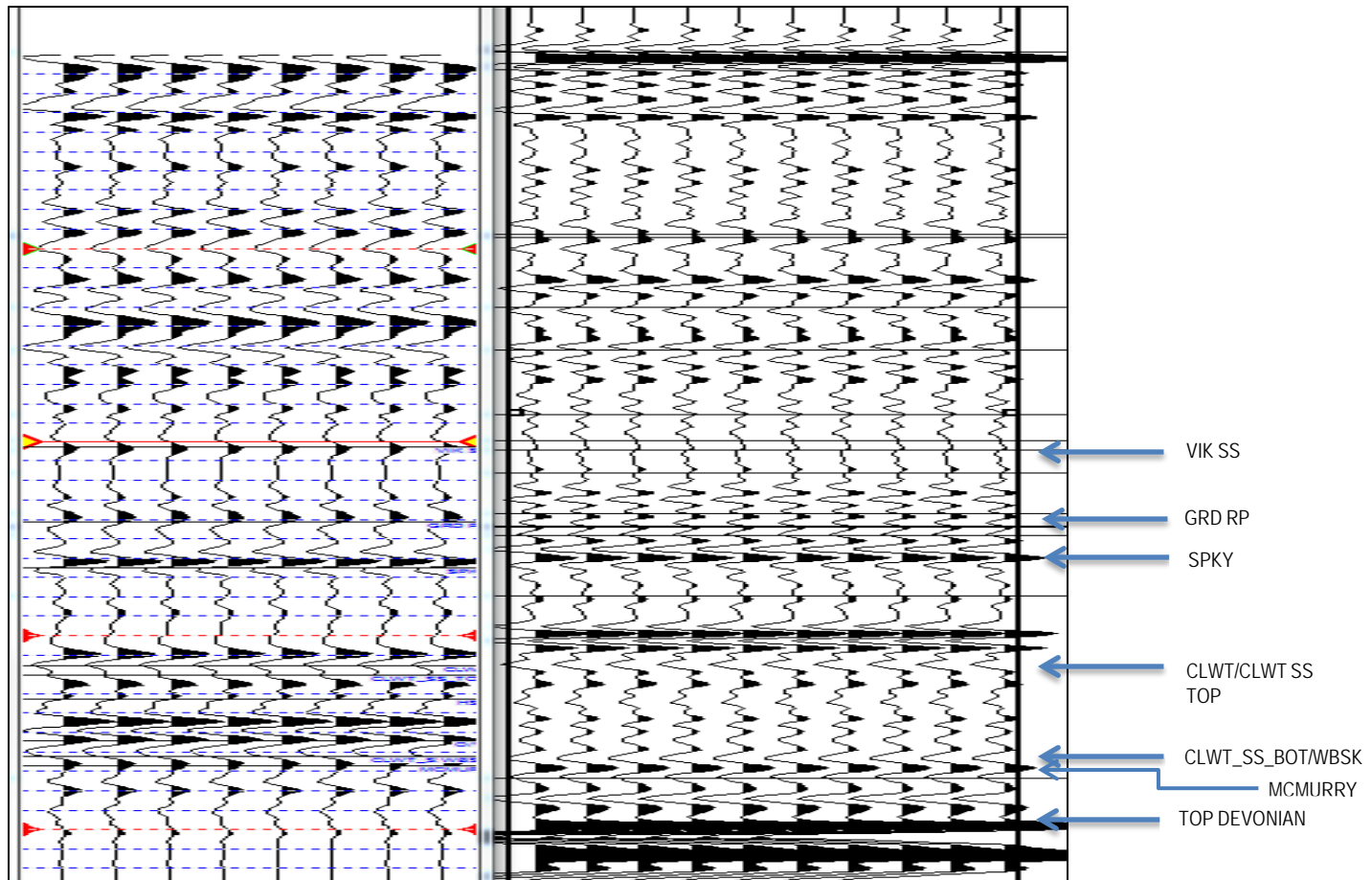
Correlation -1



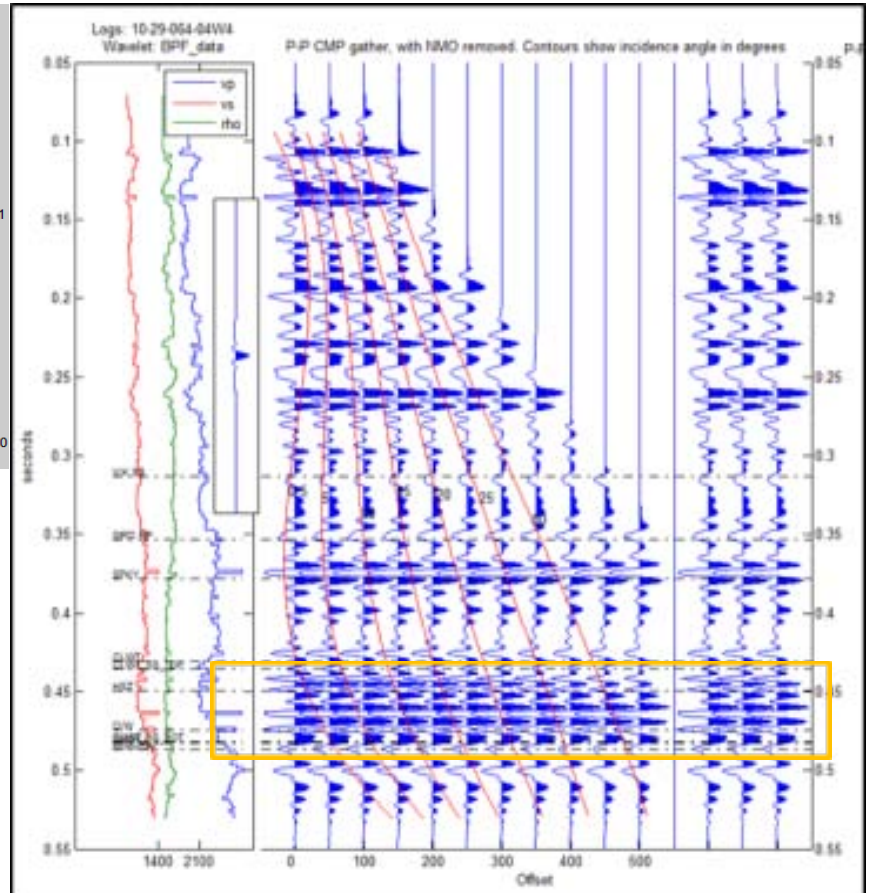
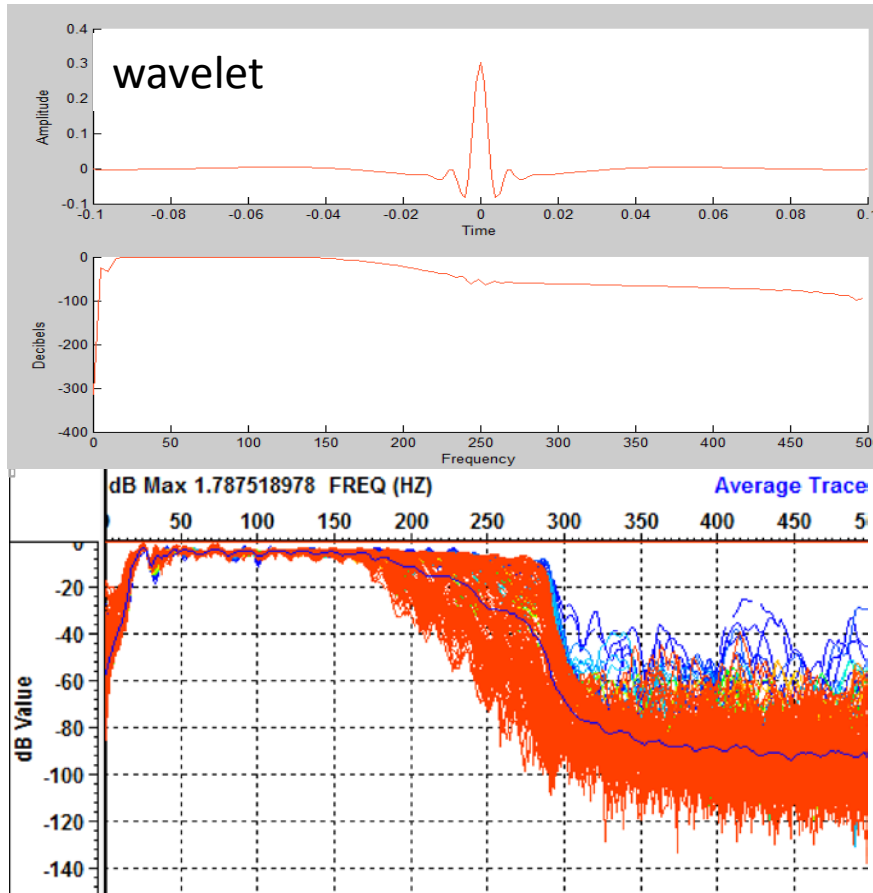
Correlation -2

zero-offset synthetic
seismogram

VSP corridor stack



Synthetic Seismogram - PP

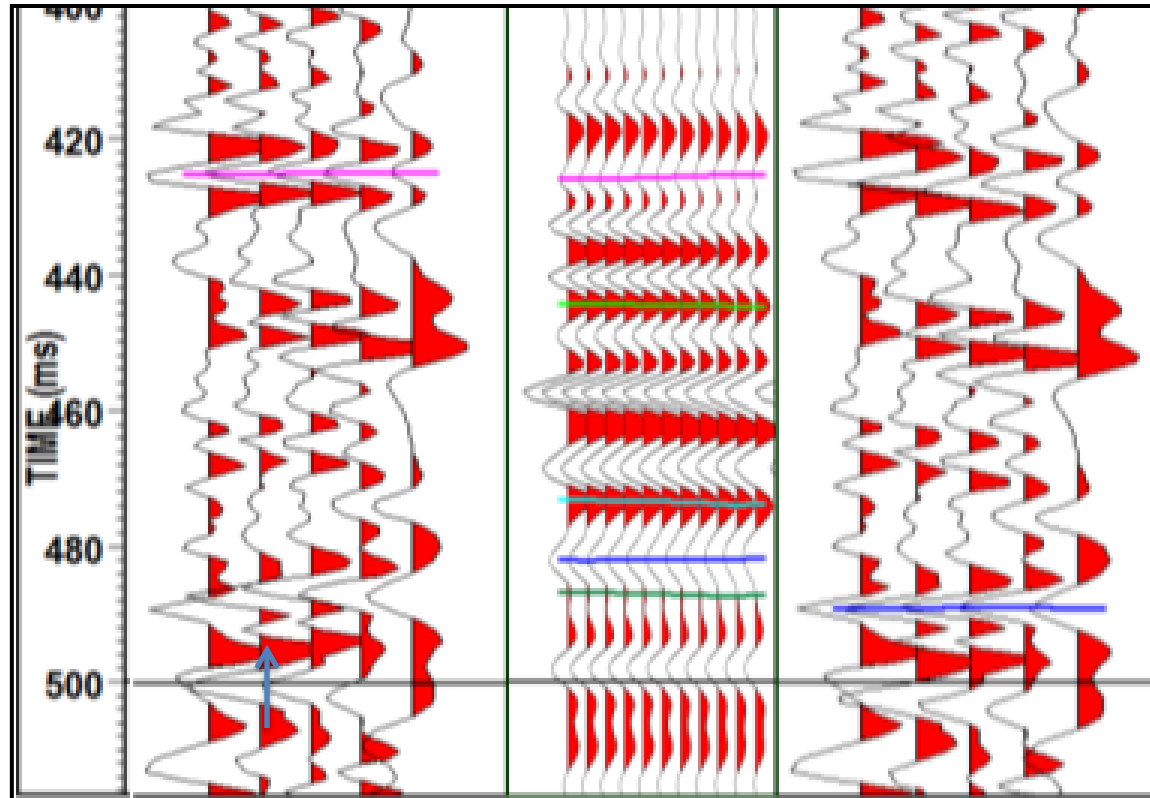


Correlation of Synthetic and VSP gather CREWES

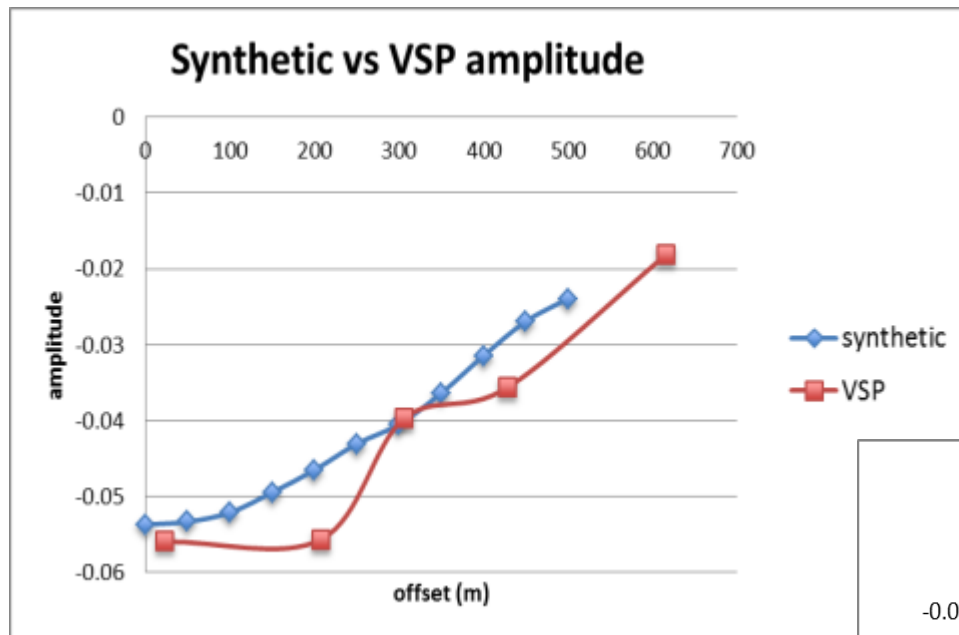
VSP gather flatten
by CLWT-SS

Synthetic gather

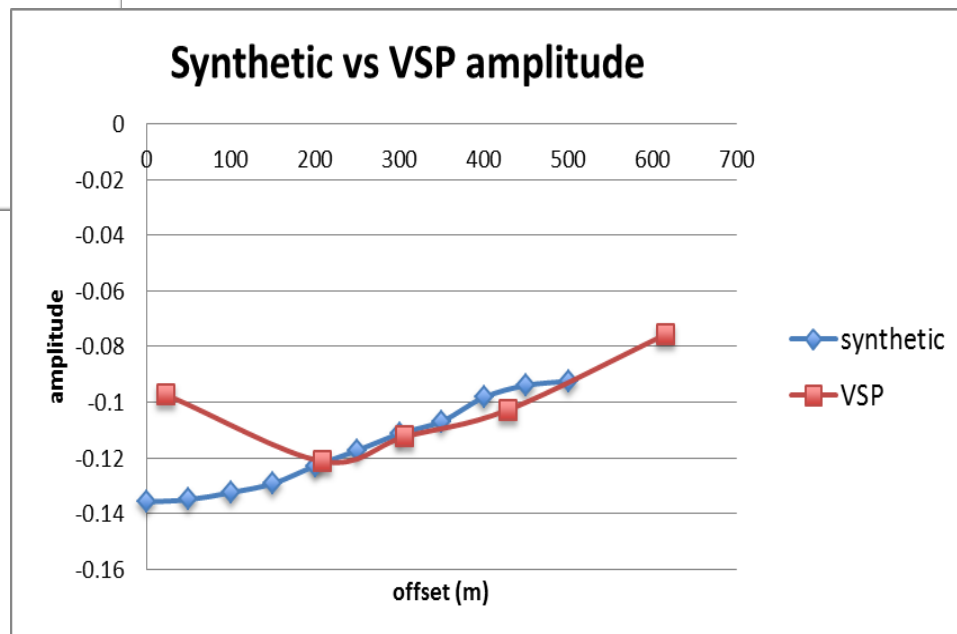
VSP gather flatten by
CLWT-BOT



Comparison of AVO Responses



AVO response of the top of reservoir



AVO response of the bottom of reservoir

Summary and Future Work



- ✓ The PP wave of walkaway VSP data has been processed and applied in AVO study successfully
- ✓ Robust interpretation is achieved
- ✓ On top and bottom of the reservoir, the PP wave AVO responses of VSP and synthetic seismogram show similar trends. The results give us promise of rock properties inversion.

In the future:

- AVO Cross-plot analysis
- Build up an accurate velocity model of shear wave data, process and interpret it
- Obtain and study rock properties through PP – PS joint inversion



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