UNIVERSITY OF CALGARY

CREWES

AZIMUTHAL VELOCITY ANALYSIS FOR FRACTURES: ALTOMENT-BLUEBELL FIELD

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NSERC CRSNG

Objective

- To identify density and direction of fractures for new drilling opportunities and for effective development of reservoirs.

URTeC(Adams et. al., 2014)

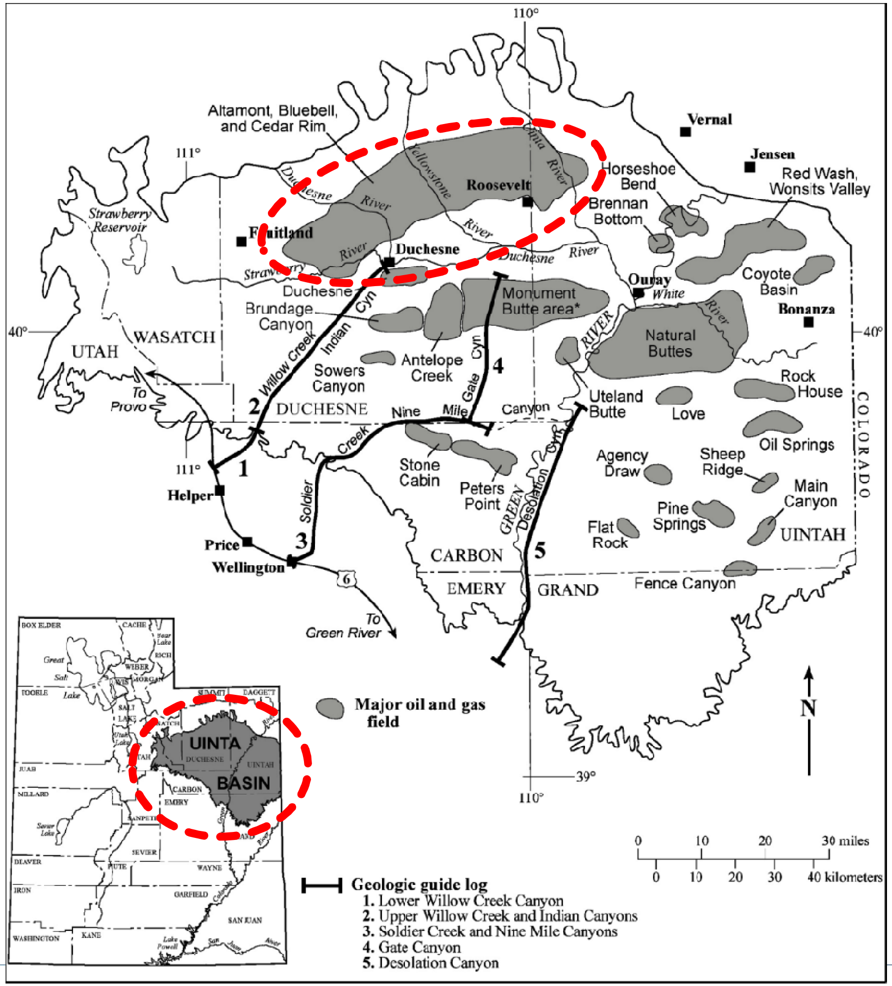
Outline

- Introduction
  - Uinta Basin
  - Data acquisition & processing
- Method
  - Physical Modeling Test
- Altamont-Bluebell 3D data analysis
- Conclusions

Uinta Basin & Altamont-Bluebell Field

- **Northeastern Utah**
- **Northern-central part of the basin.**
- **Lake bounded by:**
  - **North: Uinta mountains making steep north flank.**
  - **South: gentle slope**
- **Accumulative production (2014):**

336 MMBO, 588 BCFG, and 701 MMBW



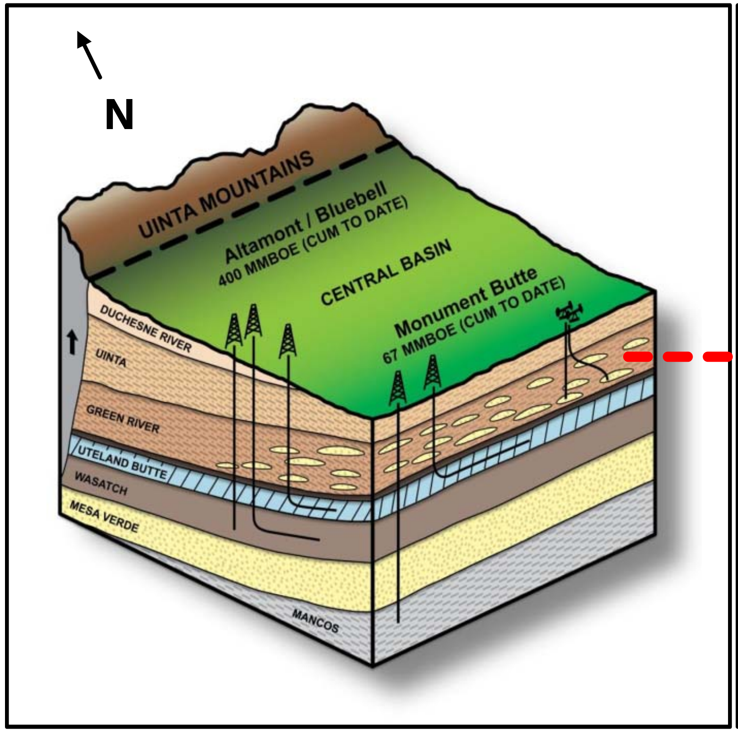
Stratigraphy and targets

- **3 main targets are:**

1. Upper Green River

2. Lower Green River (Uteland Butte and Castle Peak)

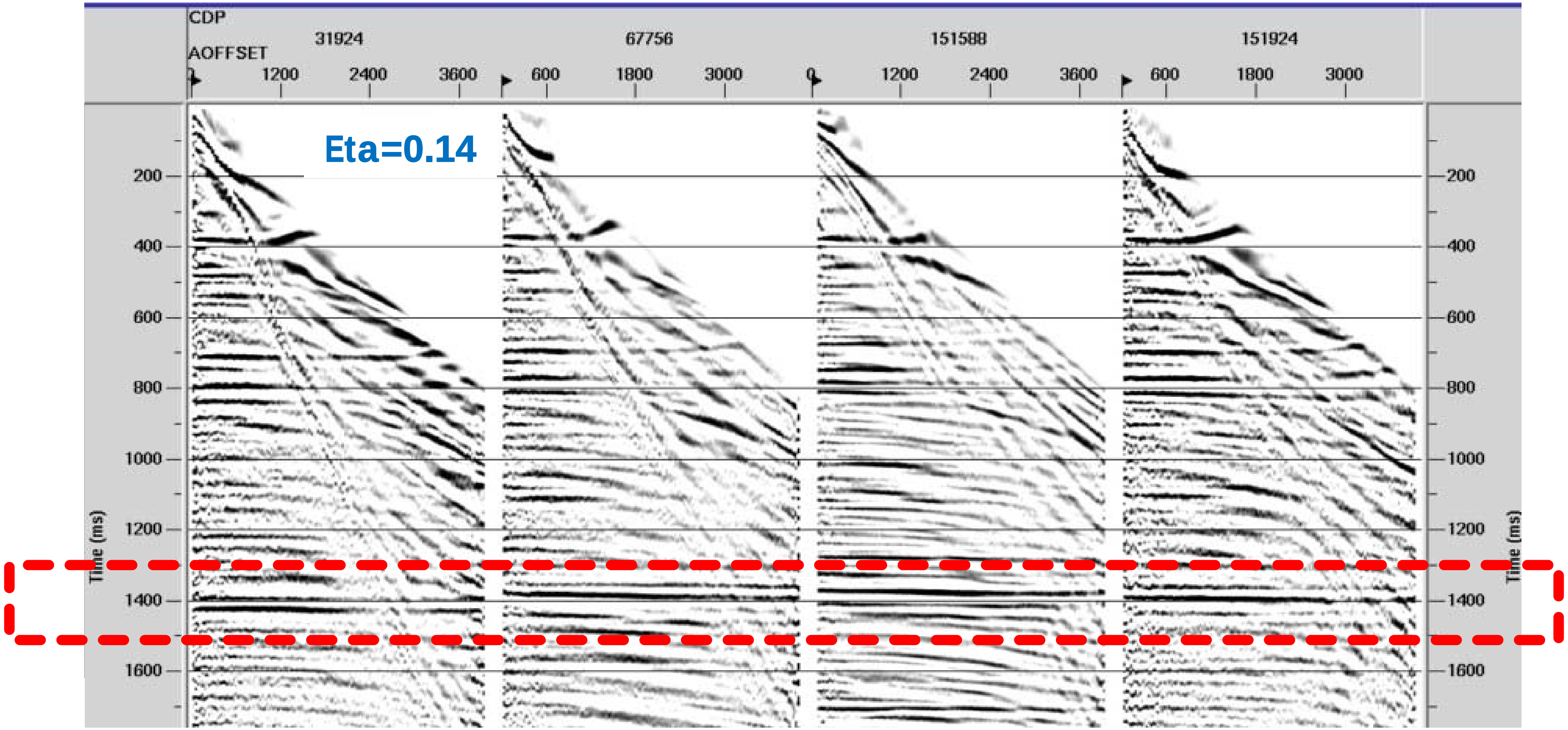
3. Wasatch



Source: Newfield Report

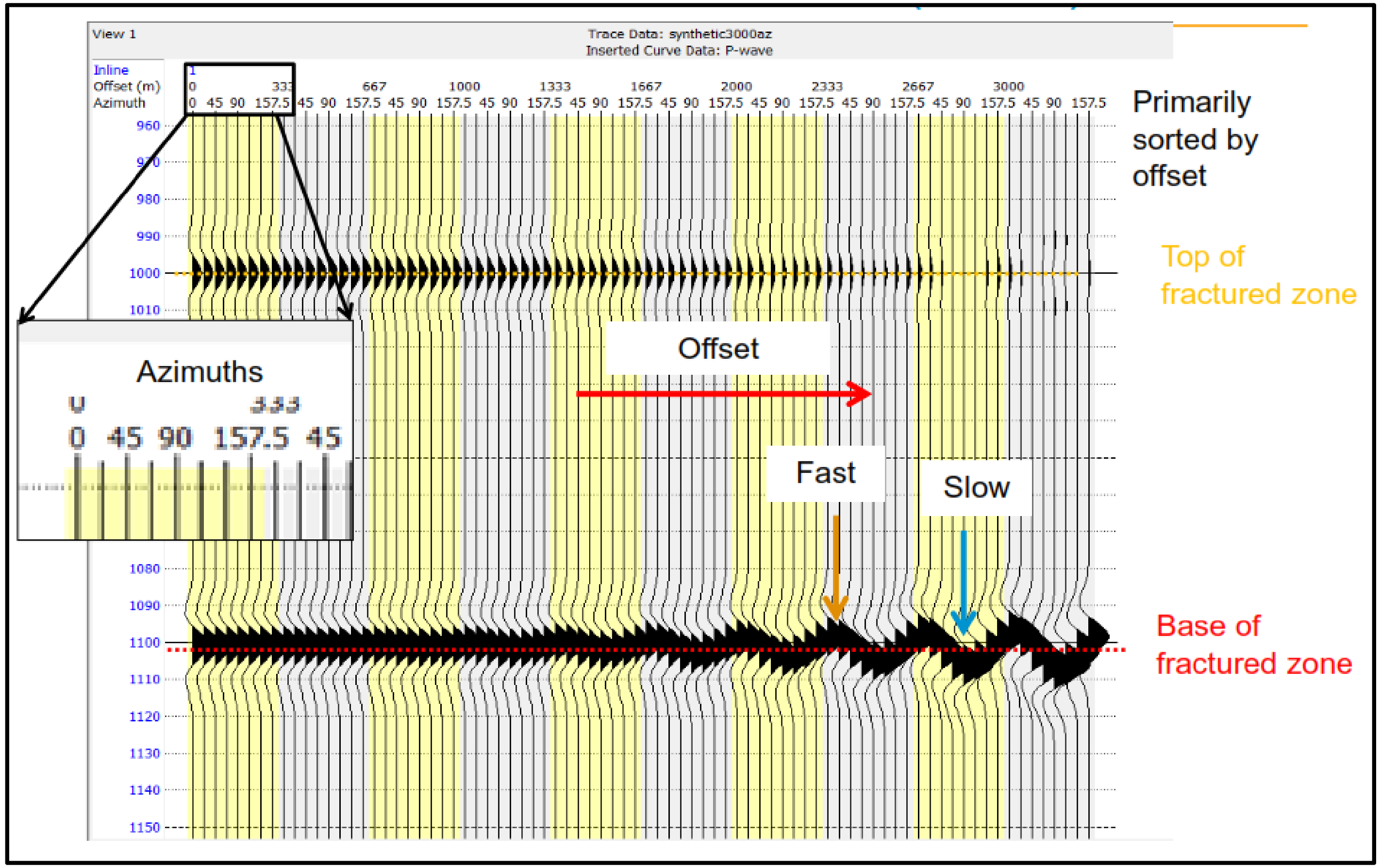
Source: Wooster Geologist Blog

Horizontal Fractures (VTI)



Source: Geophysical Sensor

Vertical Fractures (HTI)

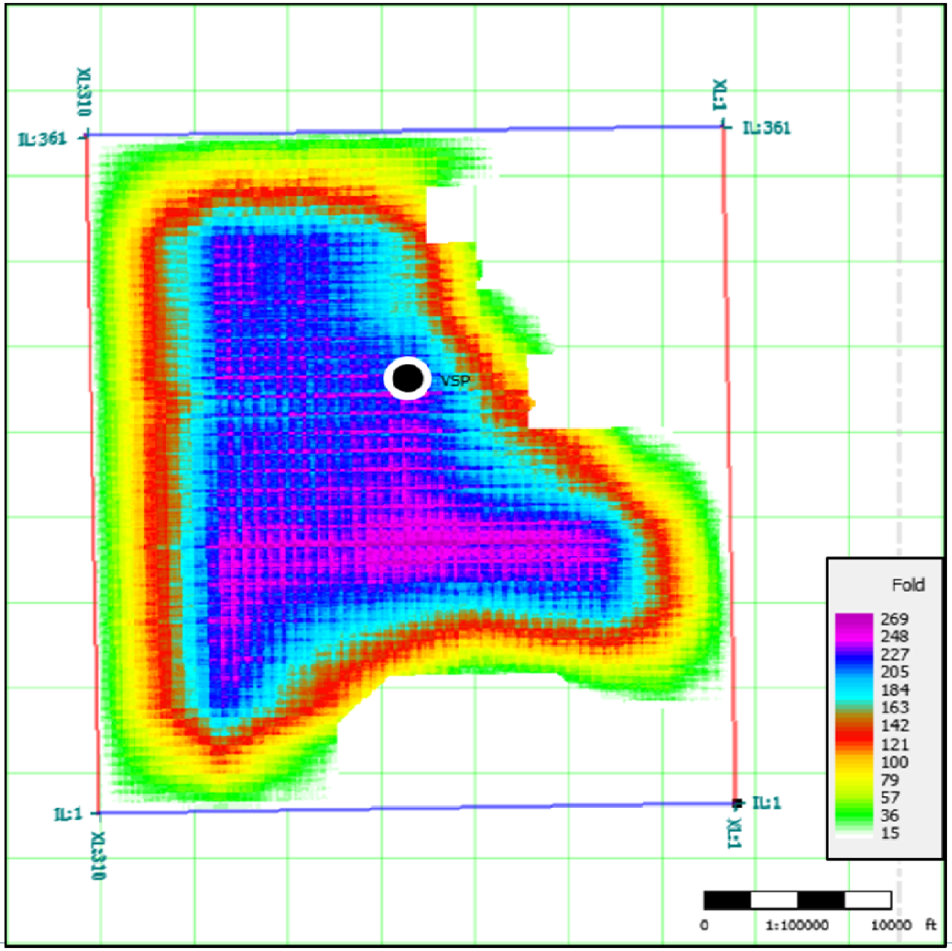


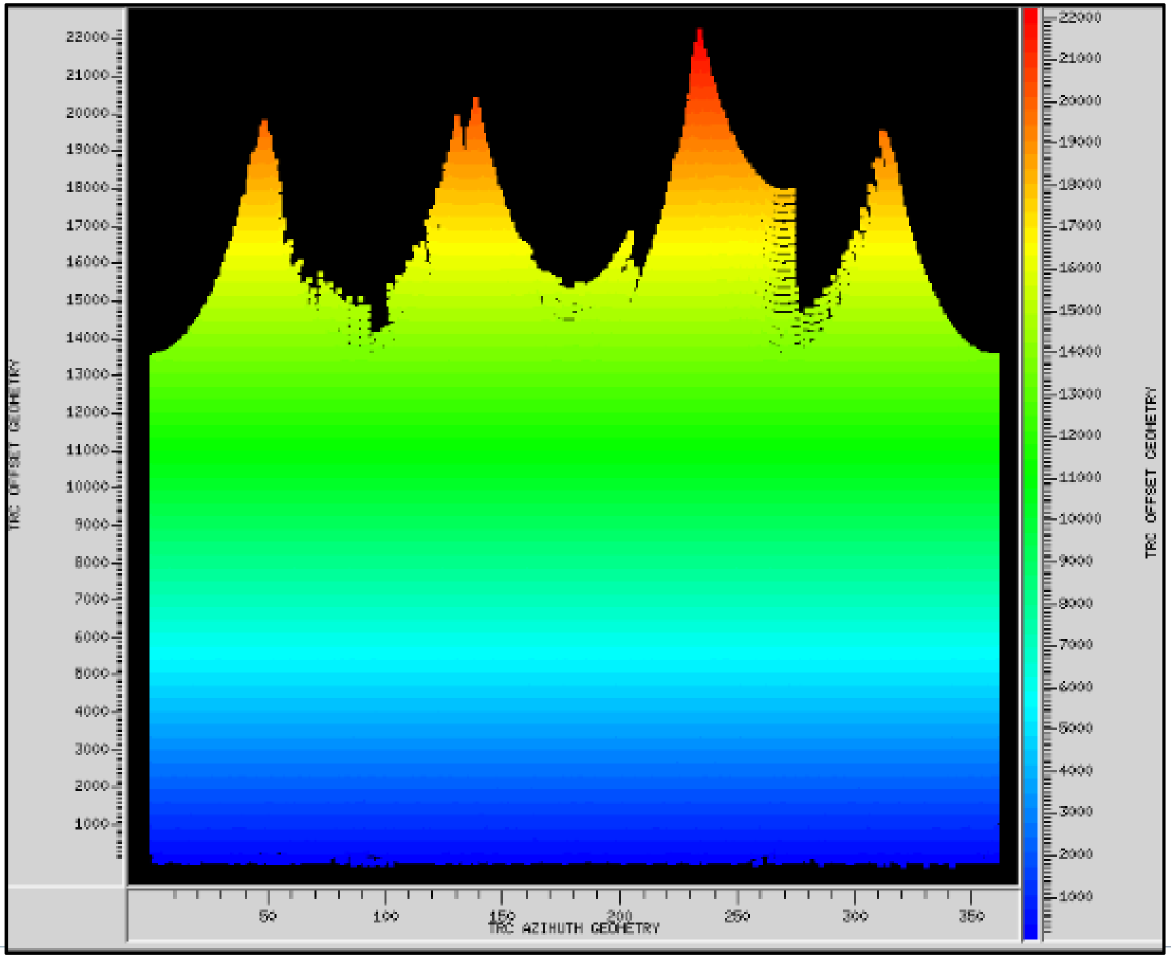
Source: Hampson-Russell RroAZ notes

Data Acquisition

- Acquisition data & area: 2010 & 35 mi^2
- Source: 2 vibes/shot
- Receiver: 6-geophone array/channel
- Source interval: 220’ Receiver interval: 220’
- Source line orientation: N-S
- Source line spacing: 660’
- Receiver line orientation: E-W
- Receiver line spacing: 1100’
- Bin size: 110’x110’
- Nominal fold: 240

Fold & Azimuth distubiution





Data processing

- Geometry
- Refraction Statics Correction
- Amplitude Recovery
- Noise attenuation
- Surface-cons amp & decon
- NMO &Velocity @ 1x1 mi
- Residual statics
- NMO &Velocity @ .5x.5 mi
- 3D COV Binning
- Migration Velocity Analysis
- 3D PSTM

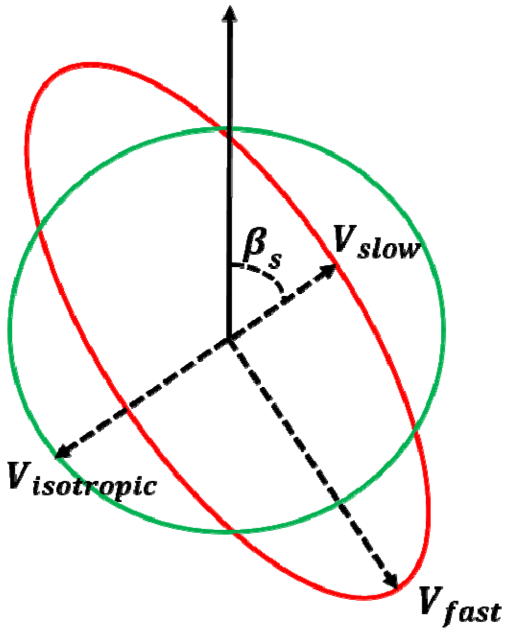
Elliptical NMO (Grechka and Tsvankin, 1998)

$$T^2 = T_0^2 + \frac{x^2}{V_{NMO}^2(\phi)}$$

$$\frac{1}{V_{NMO}^2(\phi)} = \frac{1}{V_{slow}^2} cos^2(\phi - \beta_s) + \frac{1}{V_{fast}^2} sin^2(\alpha - \beta_s)$$

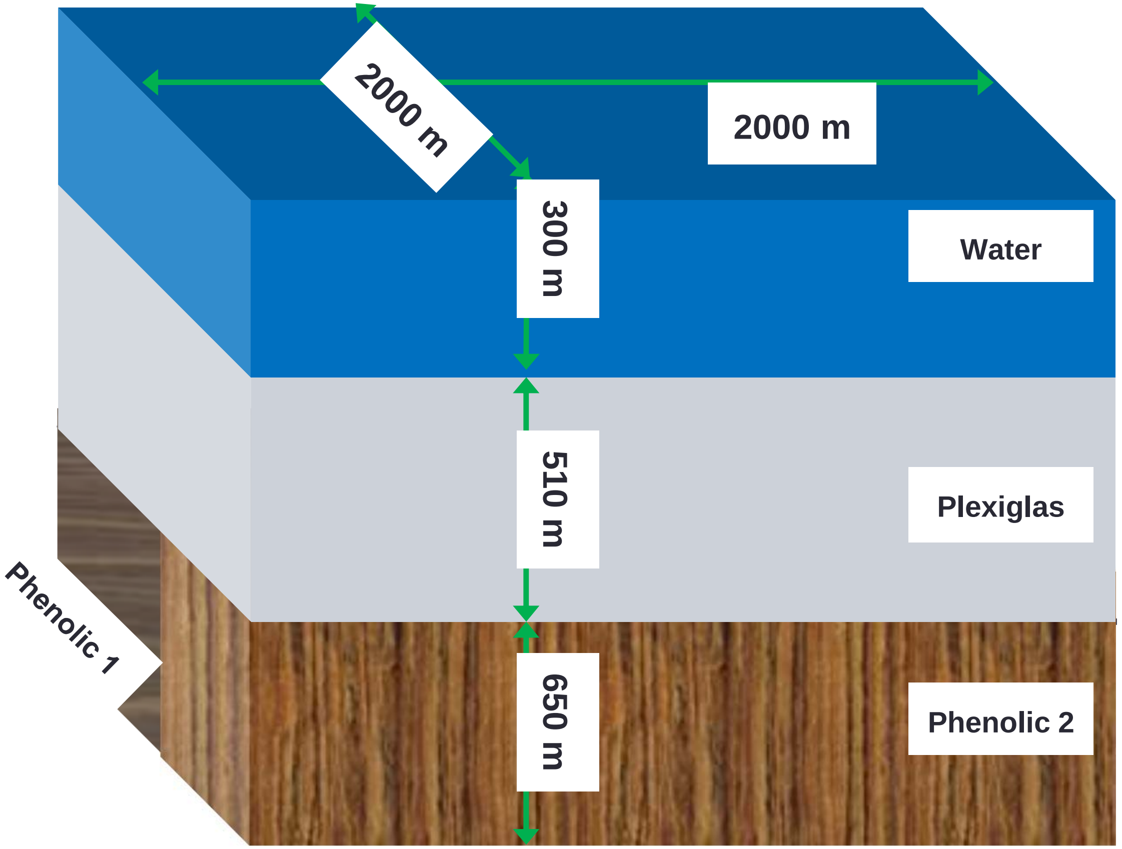
$$T^2 = T_0^2 + x^2 cos^2(\phi) W_{11} + 2x\, cos(\phi) \sin(\phi) W_{12} + x^2 sin^2(\phi) W_{22}$$

$solve\ for\ T_0 and\ W_{ij}\ which\ yeilds\ \ V_{fast}, V_{slow}, and\ B_s$

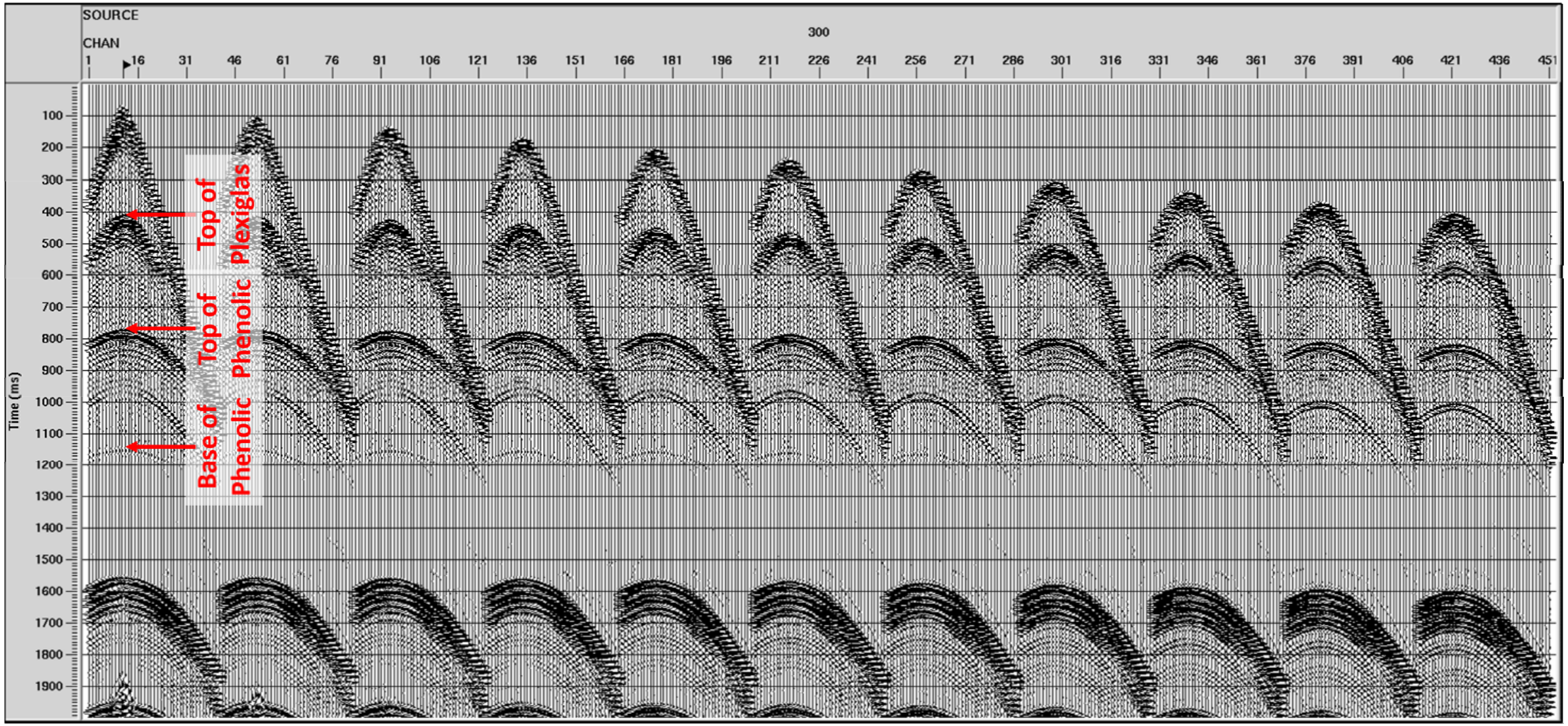


Physical Model

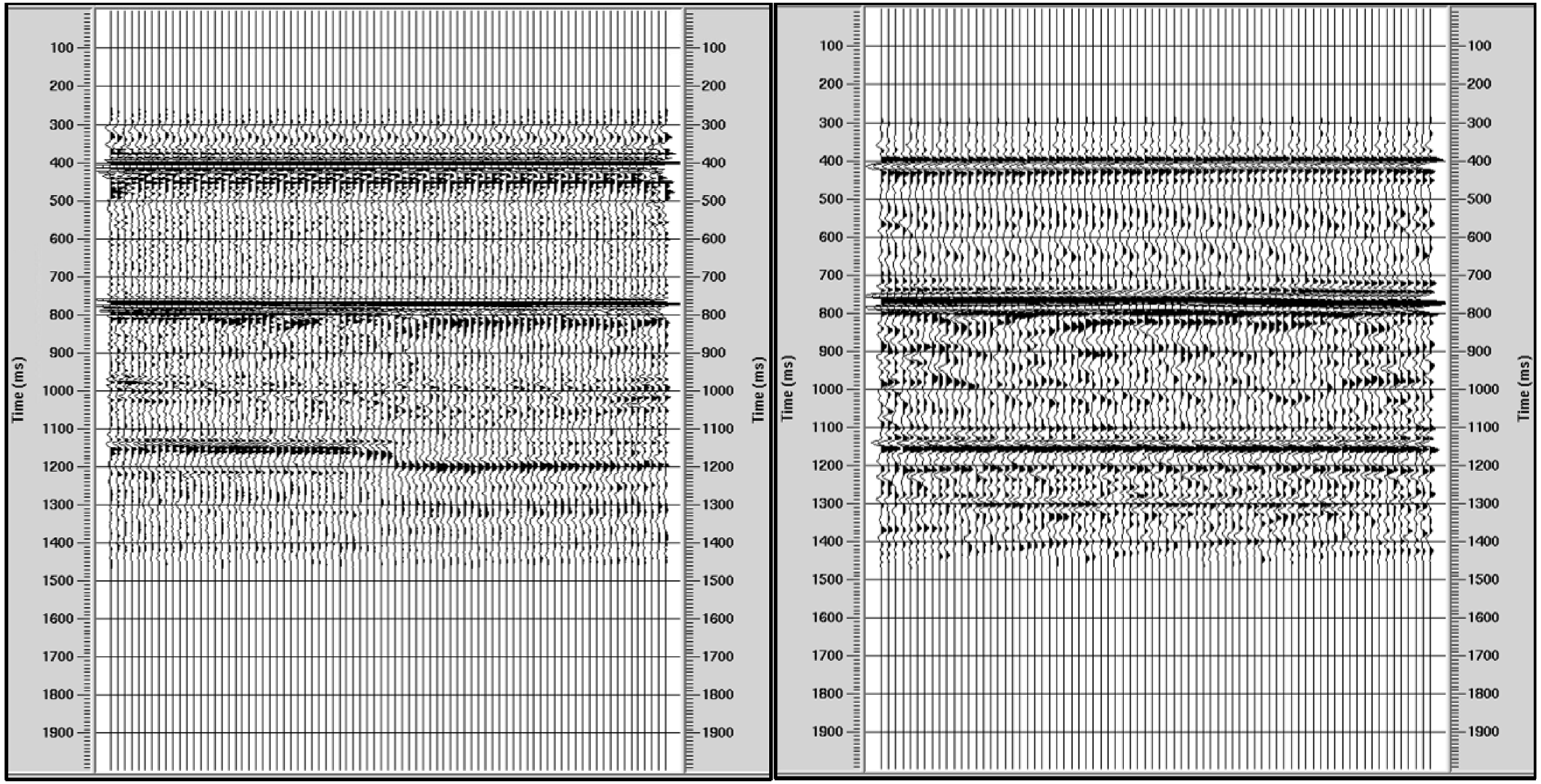
- A 3-layer physical model:
  - 2 laminated Phenolics
  - Plexiglas
  - Water
  - Lab to field scale is 1:10,000 in both length and time.
  - Scaled thicknesses of the 3 layers are: 300 m, 510 m, and 650 m.



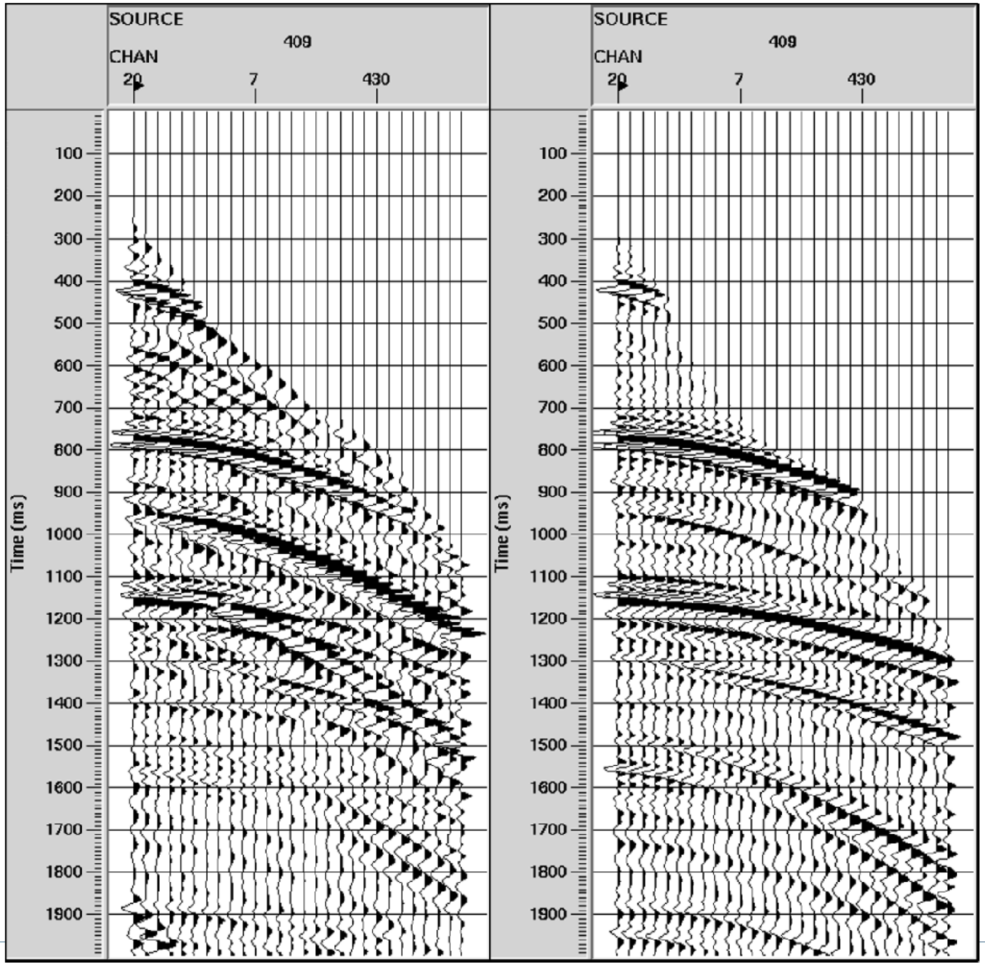
Raw Gathers: 3 Reflections



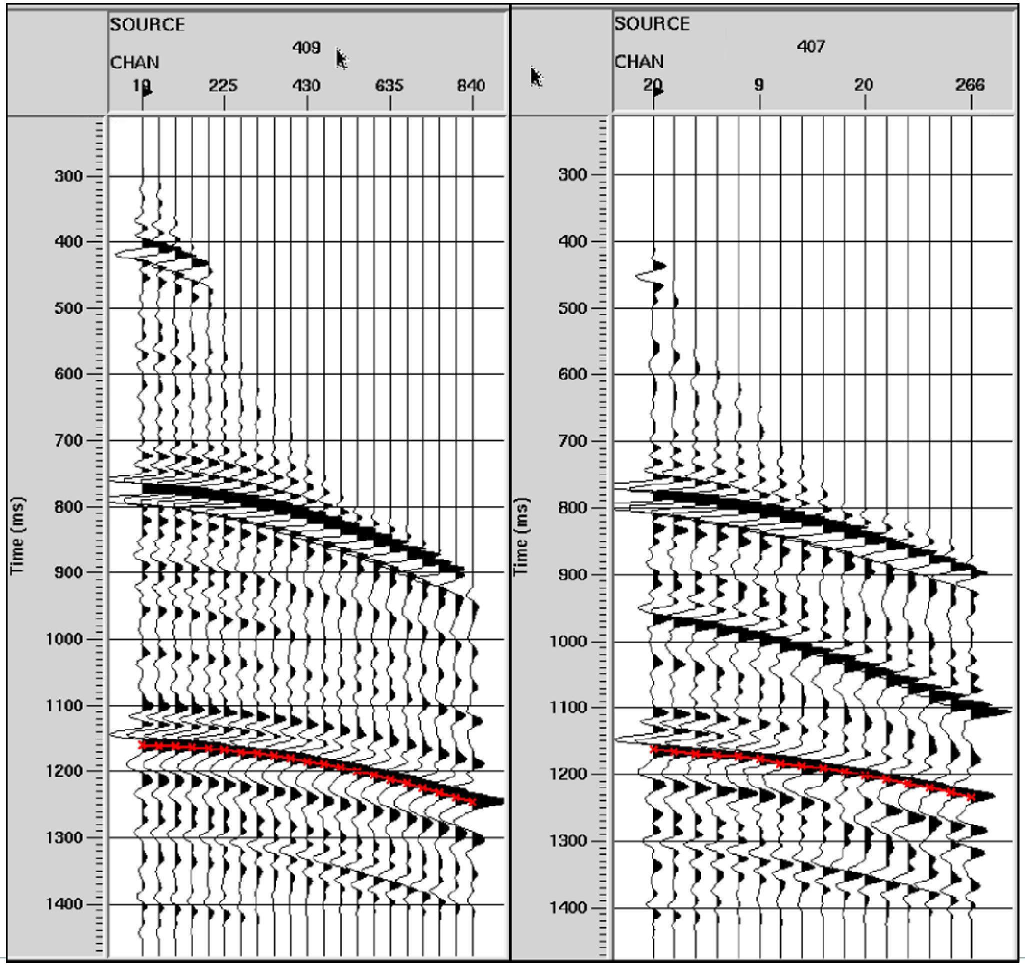
Inline (N-S) & xline (E-W)



Common-offset stack: PS attenuation



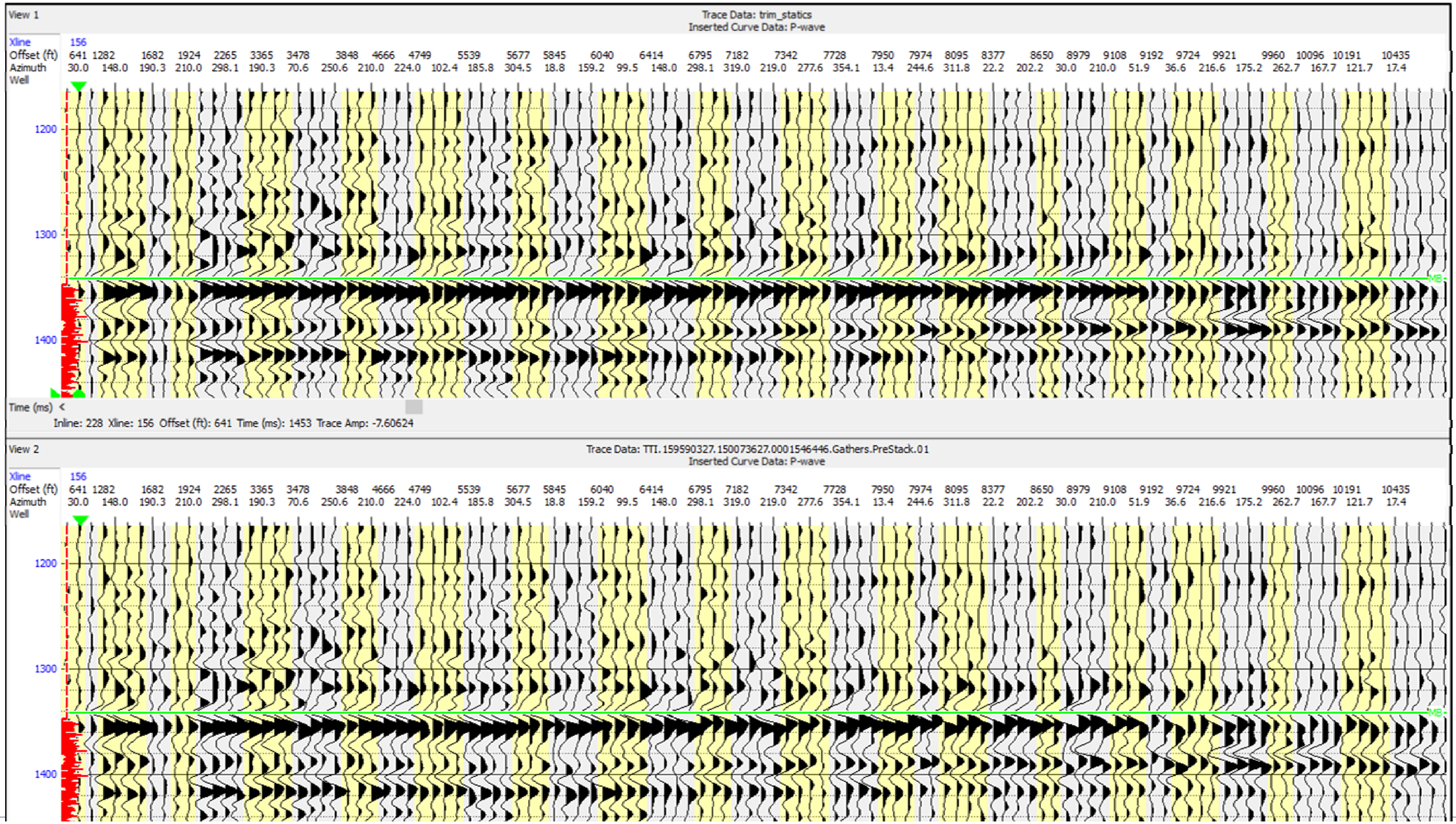
0º sector & ± 90º sector



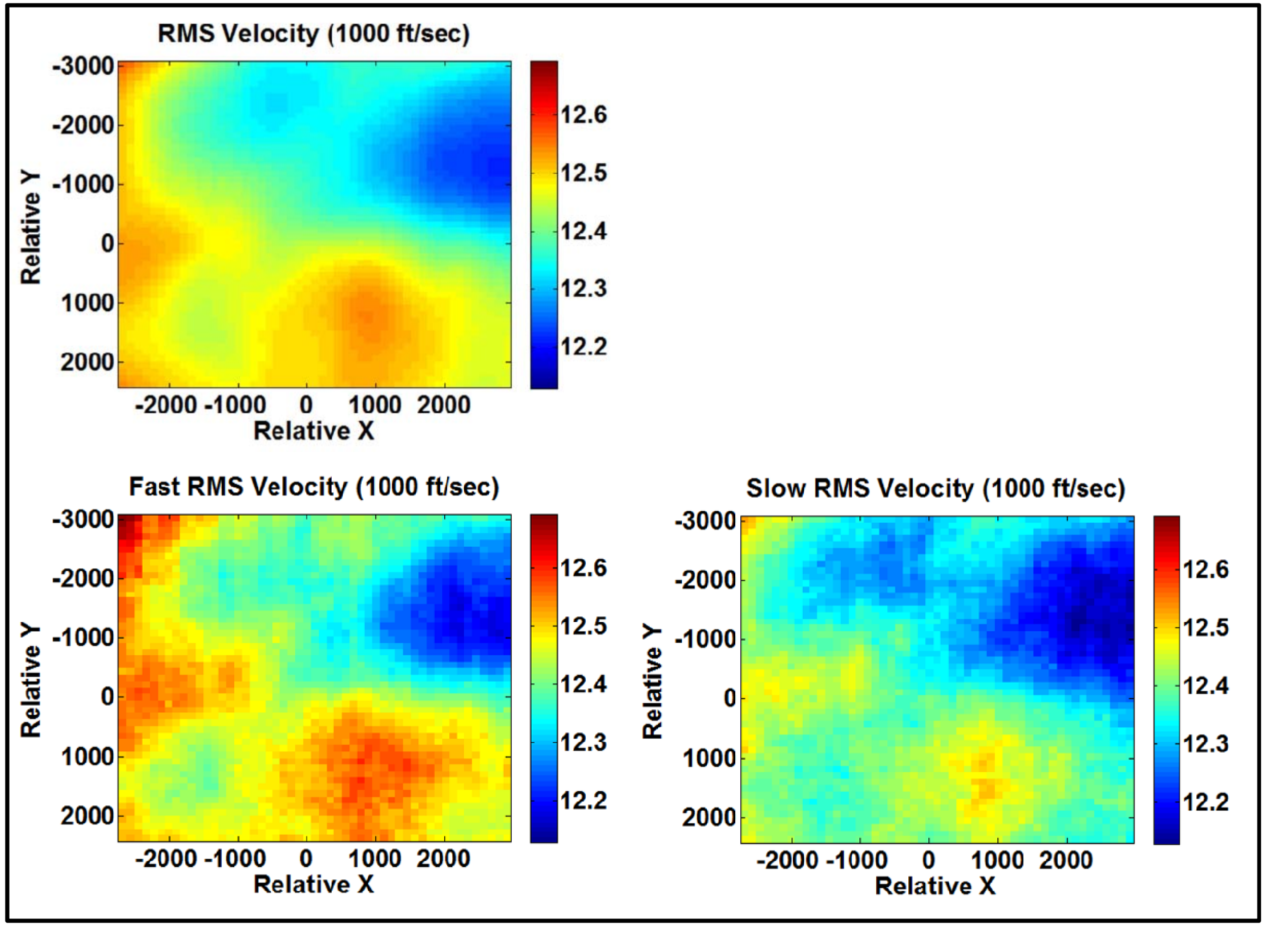
Results

	T_0 from VVAz	β_s from VVAz	V_{slow} from VVAz	V_{fast} from VVAz	Aniso %	Actual β_s	Calc. T_0	Calc. V_{slow}	Calc. V_{fast}
North Half	1.1617	89.809	2454	2641.1	7.3	90	1.1616	2473.3	2764.7
South Half	1.1759	0.6368	2133.1	2623.2	20.6	0	1.1616	2473.3	2764.7

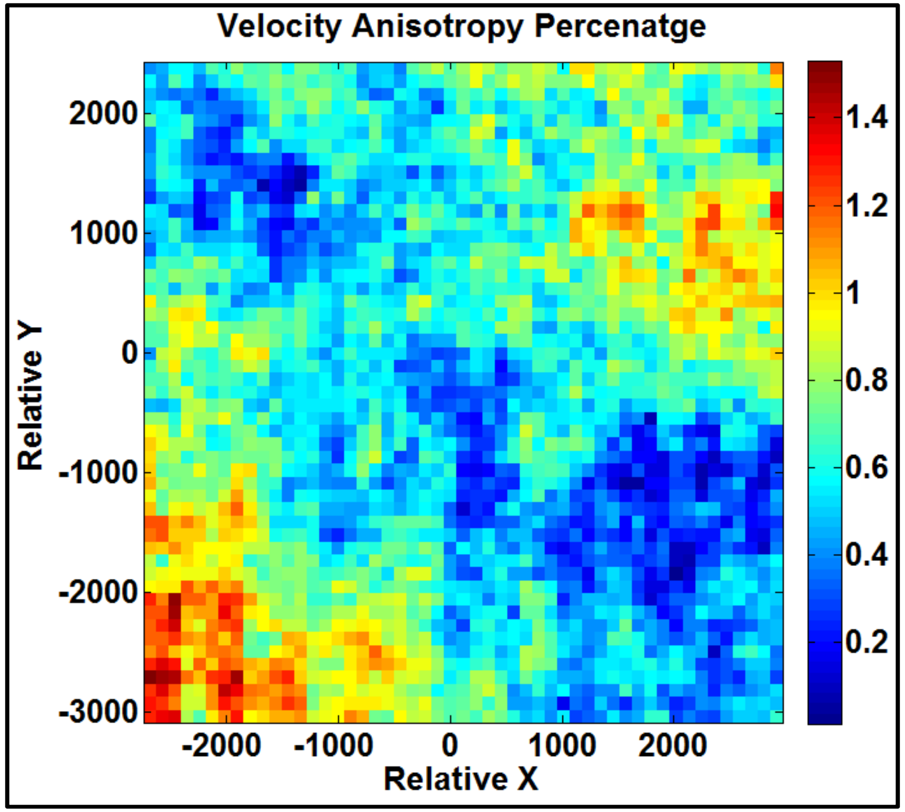
After & Before application of azimuthal residuals

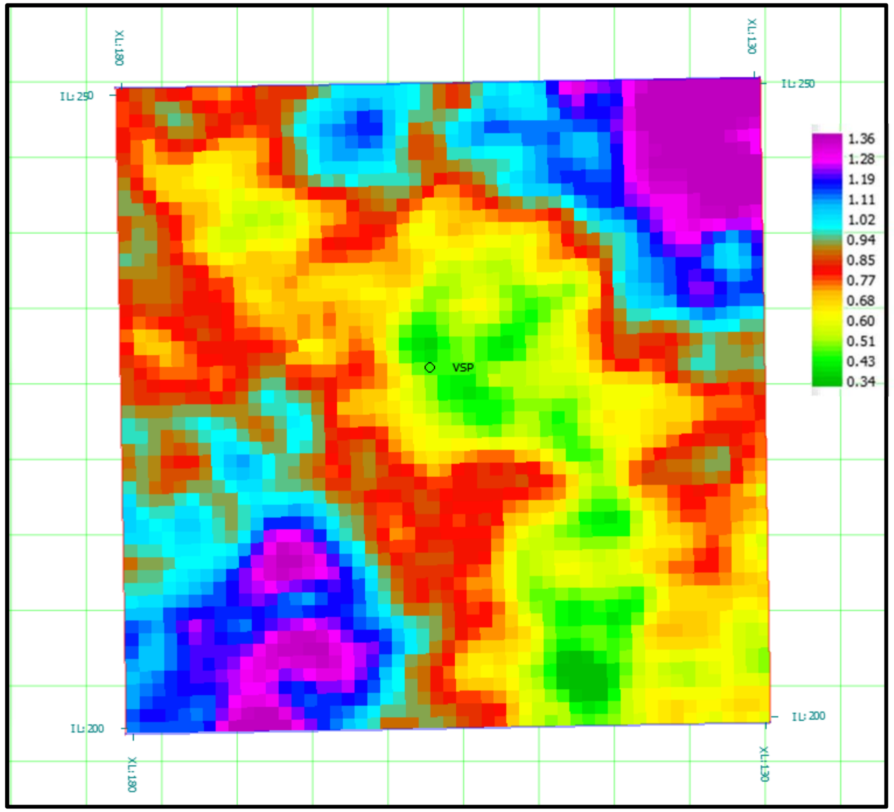


Results: Fast & Slow Velocity

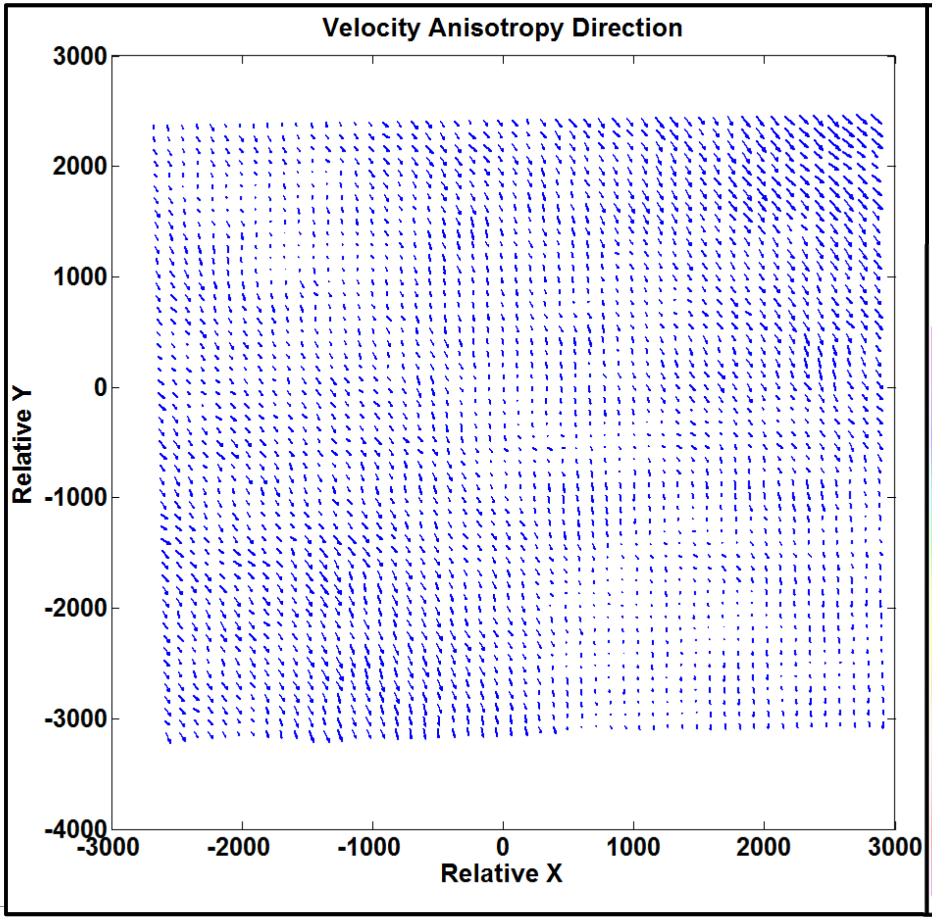


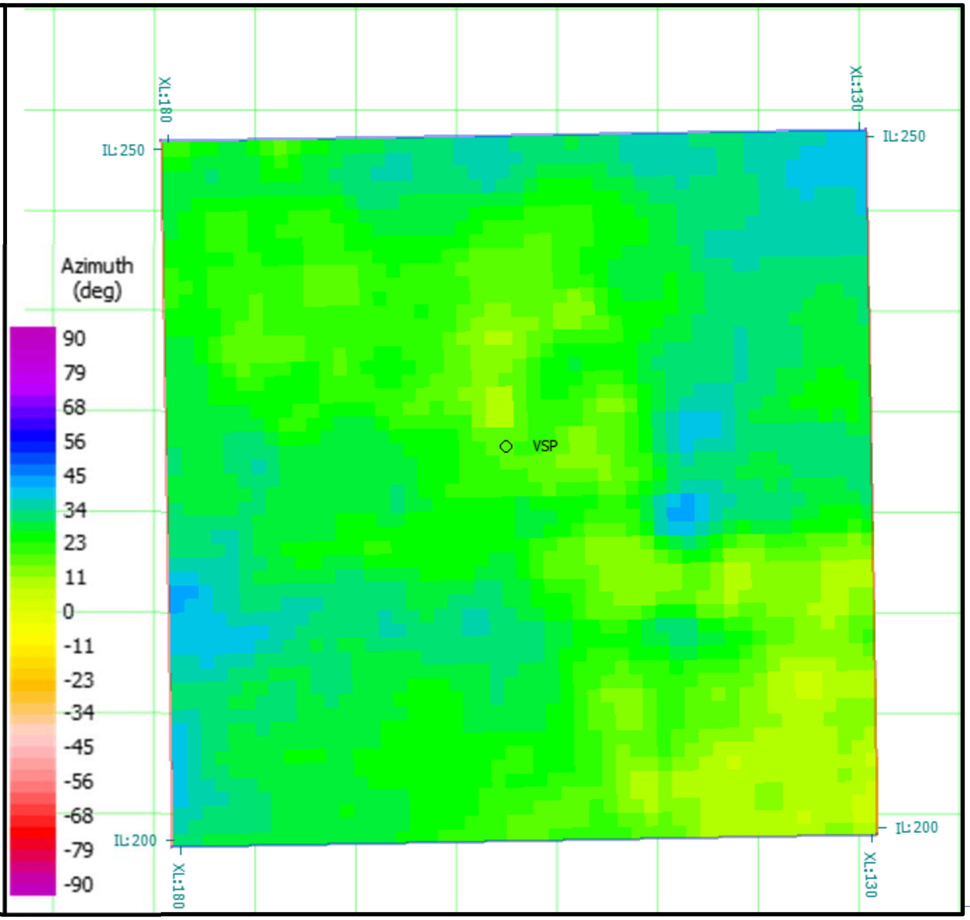
Results: Anisotropy Percentage



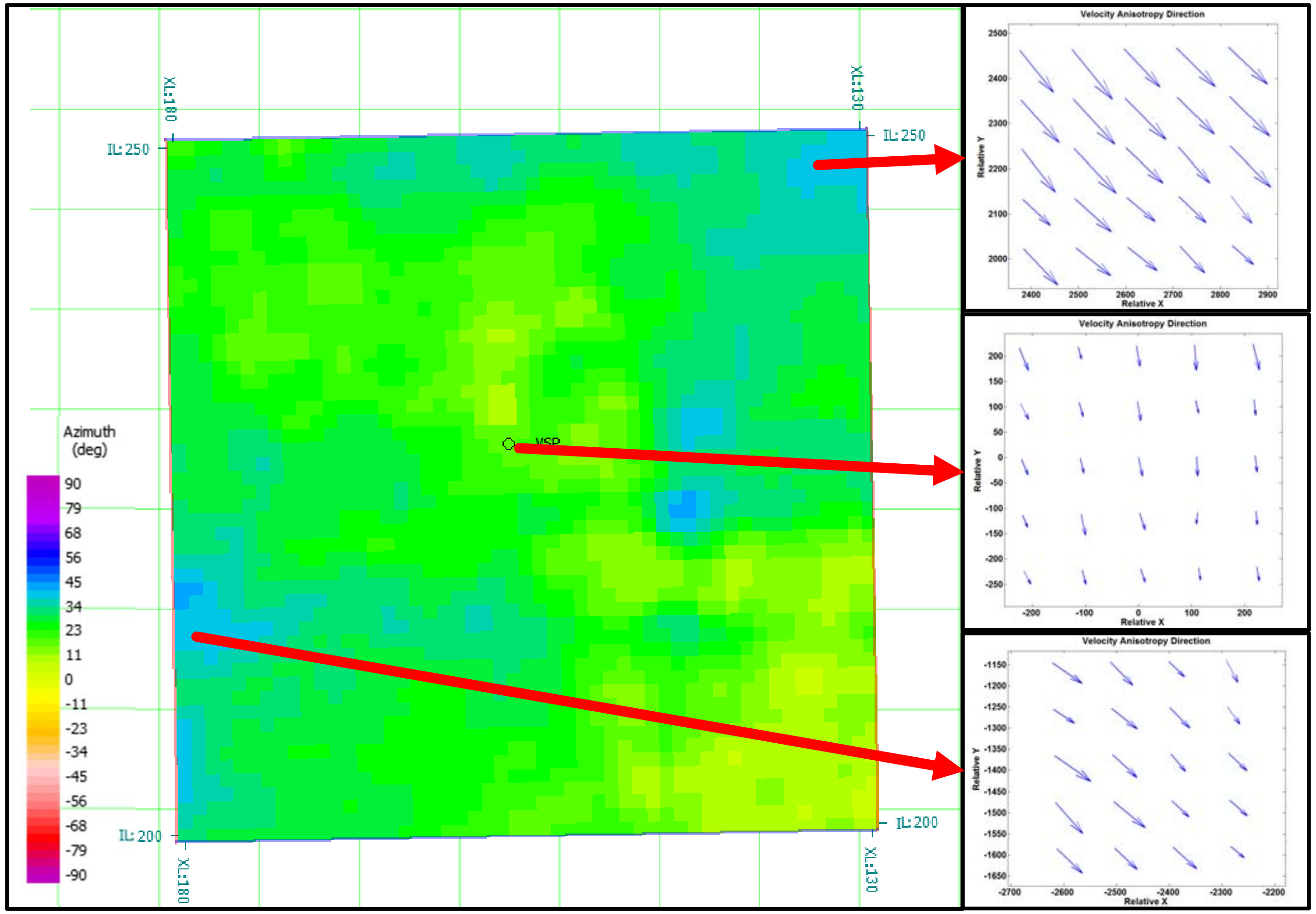


Anisotropy Orientation





Anisotropy Orientation (40º, 19º & 43º)



CONCLUSIONS

Conclusions

- Anisotropic media create strong mode-converted PS waves
- Vertical fractures induce azimuthal seismic anisotropy
- A VVAZ method was used to measure anisotropy percentage and orientation in Altamont-Bluebell field
- 3D physical modeling data was used to validate the VVAZ method and results are found to be adequate
- A commercial software was used for benchmarking our results

Thank you

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