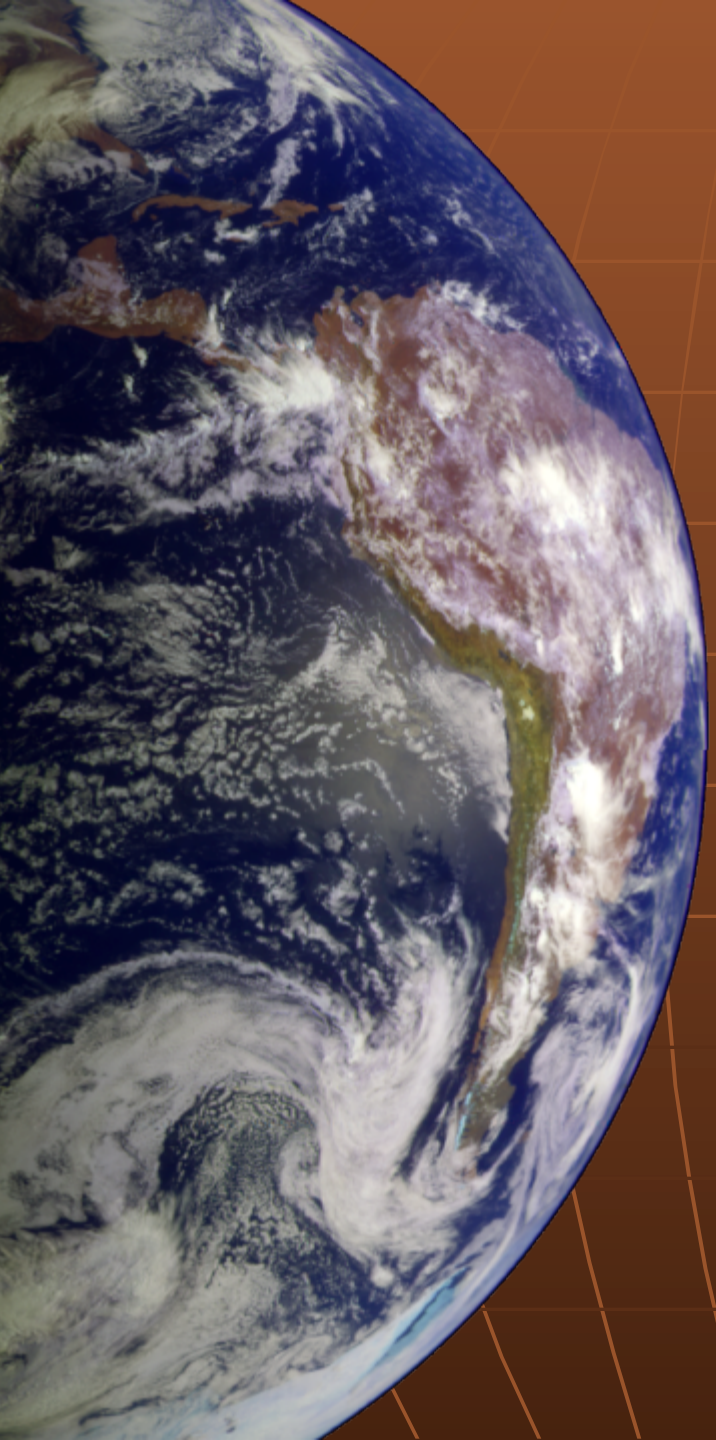

UT-AUSTIN EDGER FORUM

Characterization of Resource Shales from Surface Seismic Data

Summary of Students' Activities

Robert H. Tatham

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Why Seismic?

In resource plays, all wells should (ideally) be productive. In practice, one good well (3 day payout) may be followed by a 3 year payout well in an adjacent offset location.

Can seismic help discriminate between better and poorer wells?

What can seismic do?

- **Structural issues:**
  - **Fault location (Hazards?)**
  - **Define structure for horizontal drilling**
  - **Attributes**
- **Microseismic:**
- **"Shale" Characterization**

Characterization of "Shales"

From Seismic Data (3C data)

- Vp/Vs (Poisson's Ratio)
  - Lithology
  - Gas Saturation
- Anisotropy Parameters (HTI & VTI)
  - Fracturing
  - 'Shaliness,' TOC
- Crack parameters (Aspect ratio, h)
- Density

Characterization of “Shales”

Back-to-basics studies :

How seismic responds to change is reservoir parameters.

Use borehole data to predict how the surface seismic response to changes in relevant reservoir properties.

Characterization of “Shales”

- **Log Parameters (Dipole logs)**
  - **Vp/Vs (Poisson’s Ratio)**
  - **Anisotropy**
    - **HTI Anisotropy (Fracturing)**
    - **VTI Anisotropy (‘Shaliness’)**
  - ***Detailed imaging log***
  - ***Density and Gamma Ray***

Back to Basics Approach

Start with log data (including shear information) and 'reservoir' (or Shale) description

Evaluate seismic response to 'reservoir' properties that can be seismically observed

Predict surface seismic response to variations in reservoir properties (Sensitivity and Resolution Analysis)

Results (Suggestions) to date:

Seismic Property	Shale Property
Poisson's Ratio	'Chertiness' net/gross
HTI	Fracturing
VTI	Clay Content Source/Seal, TOC

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Results (Suggestions) to date:

Seismic Property (Speculative hints?)	Shale Property
Crack Aspect Ratio	Gas/Liquid Effects
Crack Density	Fracking Conditions
Density	Shale Properties

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Projects and Plays

(Including results of cooperative projects in Focused Areas of Application)

Bakken

Bossier

Woodford

Marcellus

Haynesville

Eagle Ford

Projects and Plays

Bakken

Fiona Ye (MS 2010)

- Oil Shale
- Upper and Lower Bakken:
  - VTI Anisotropy
  - Lower Vp/Vs
- Middle Bakken:
  - Minimal Anisotropy
  - Higher Vp/Vs
- Test seismic sensitivity to:
  - VTI in Upper and Lower Bakken
  - HTI in Middle Bakken

Ongoing activity

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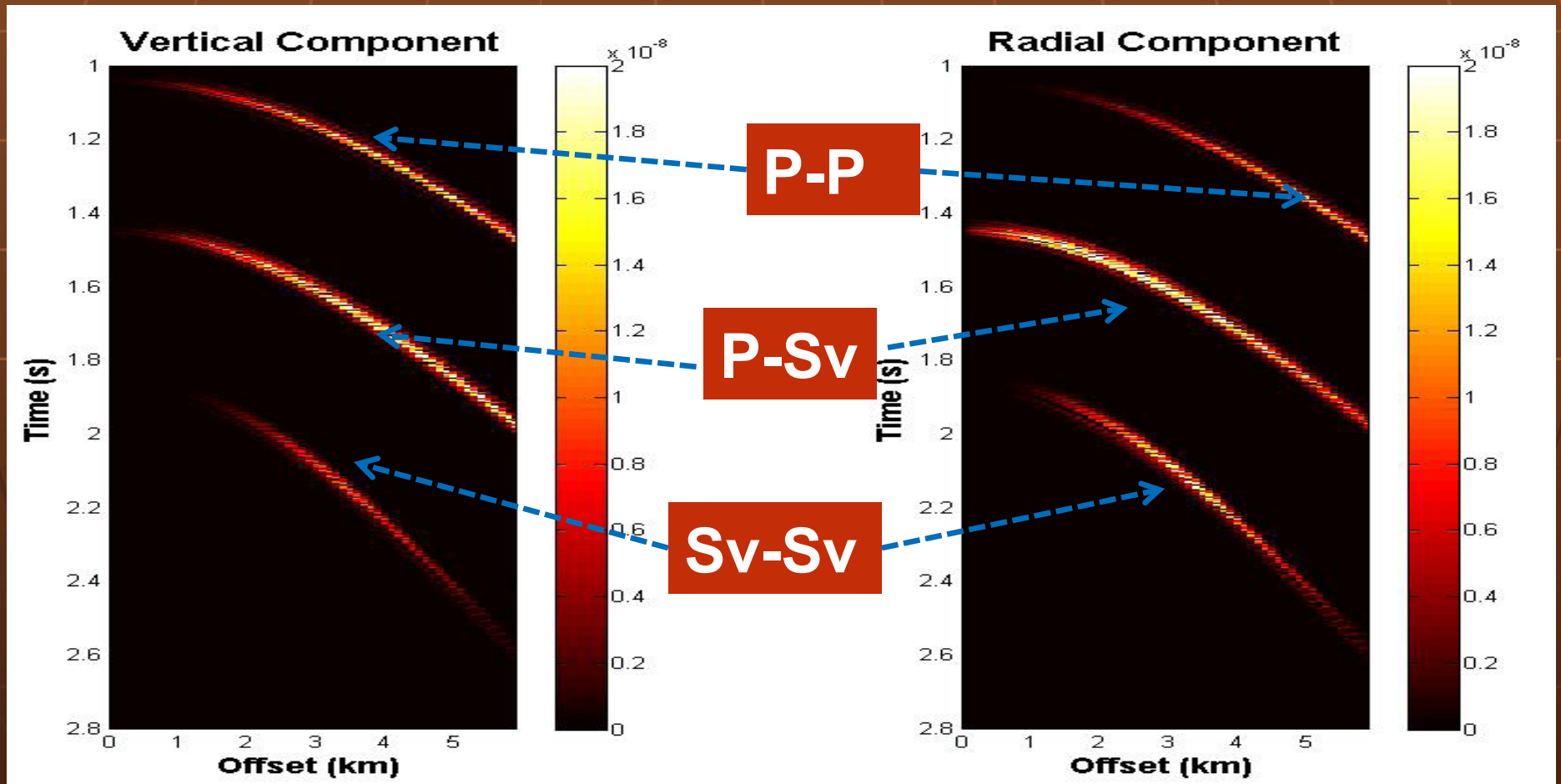
Projects and Plays

Bakken

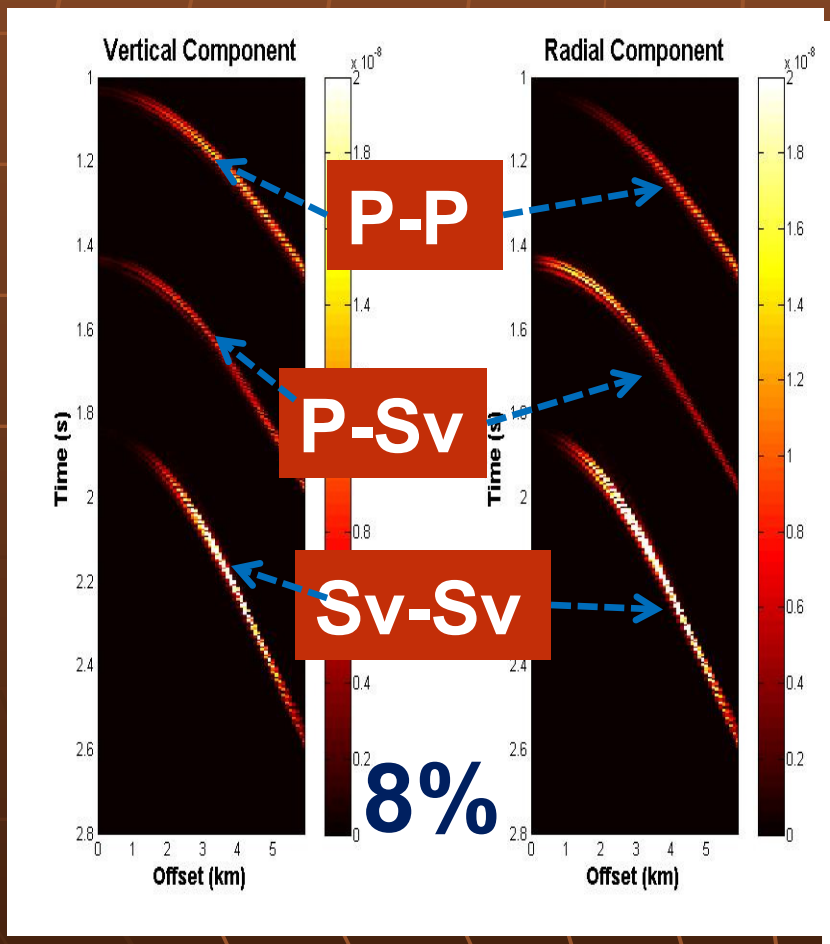
VTI Upper & Lower Bakken: Difference between Isotropic and Anisotropic (Ye et al. 2010)

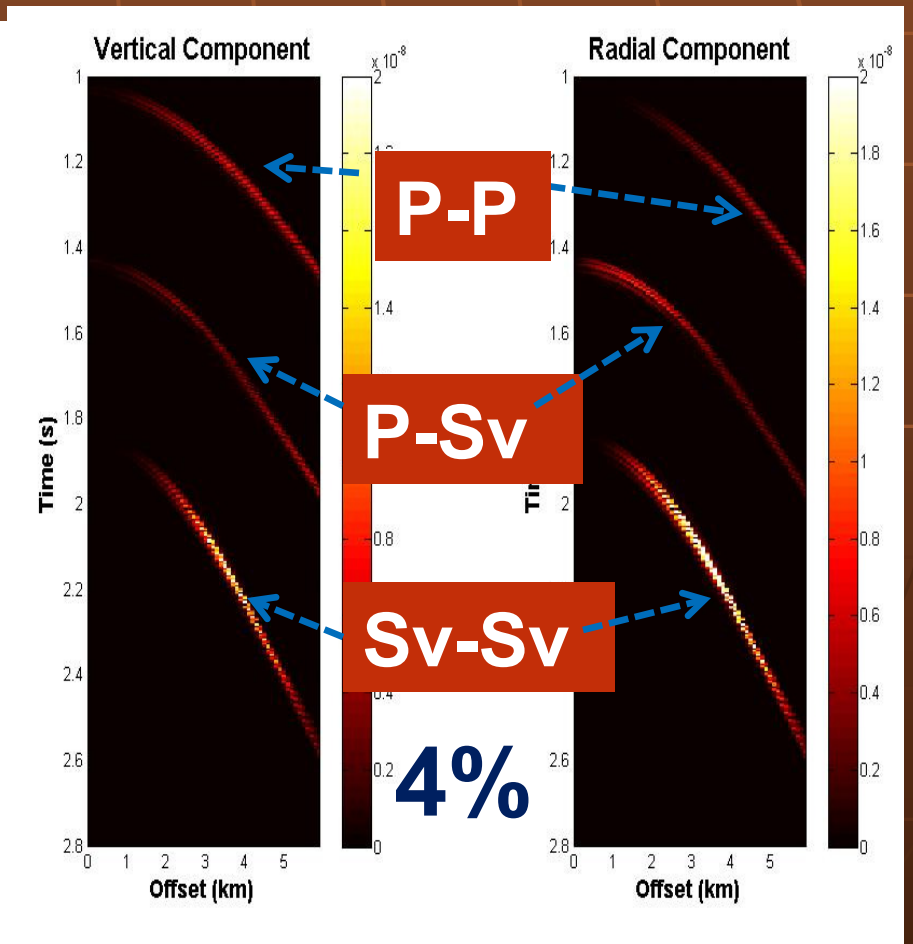


Projects and Plays

Bakken

HTI Middle Bakken:
Crack Density – 4% & 8%
Difference between Isotropic and Anisotropic (Ye et al. 2010)





Projects and Plays

Bossier

Diego Valintin (MS 2010)

Vp/Vs interpetation applied to 3D 3C surface and VSP data to predict tight gas sand distribution

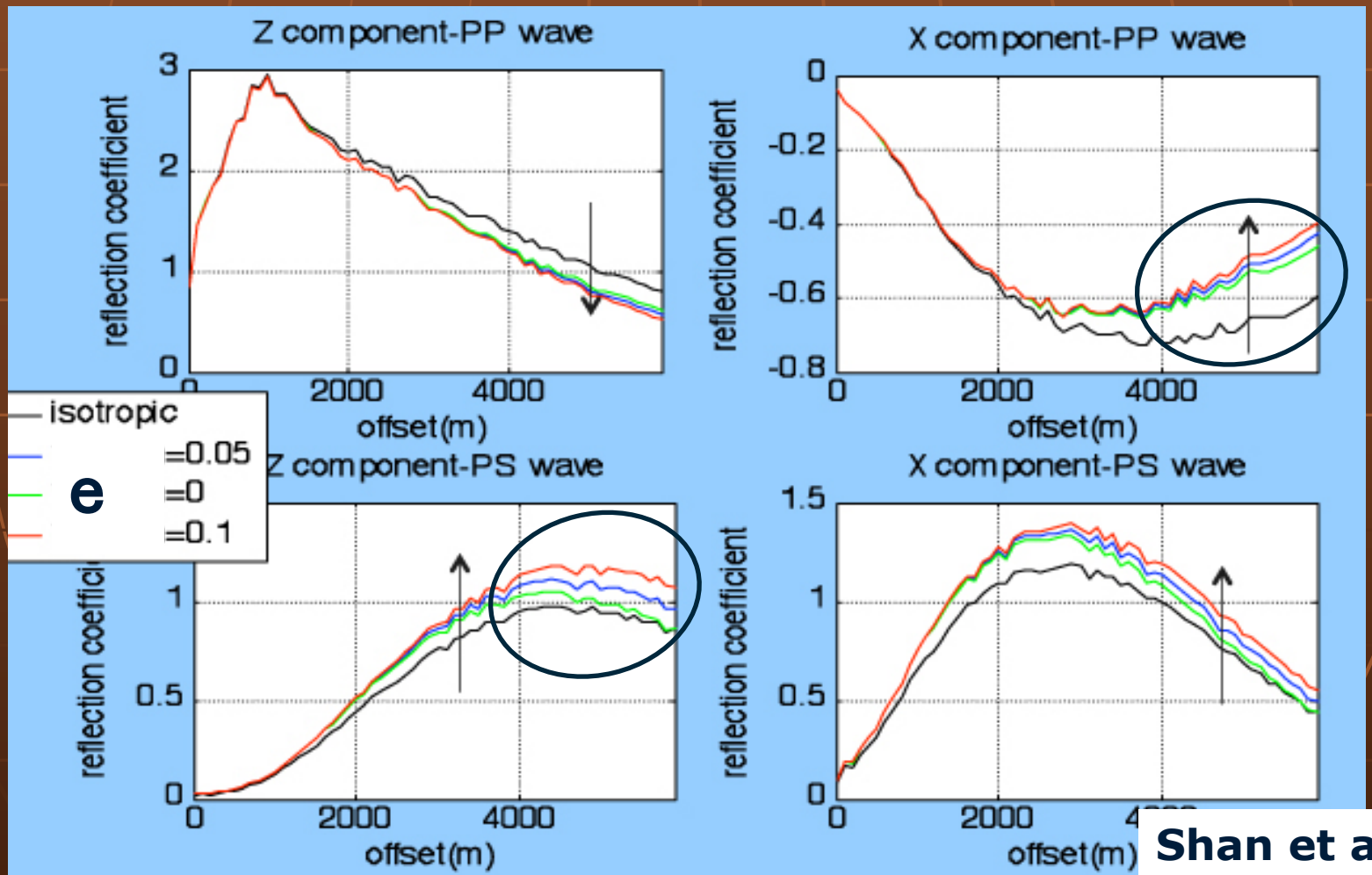
Projects and Plays

Woodford

(Delaware Basin)

Na Shan (MS 2010)

Sensitivity to VTI



Shan et al. 2010

Projects and Plays

Woodford Alex Lamb (Active MS stud.)

(Anadarko Basin)

Sensitivity to HTI

- AVAZ from 3D surface seismic
- Comparison with borehole (dipole) log data.

Progress reported at this meeting.

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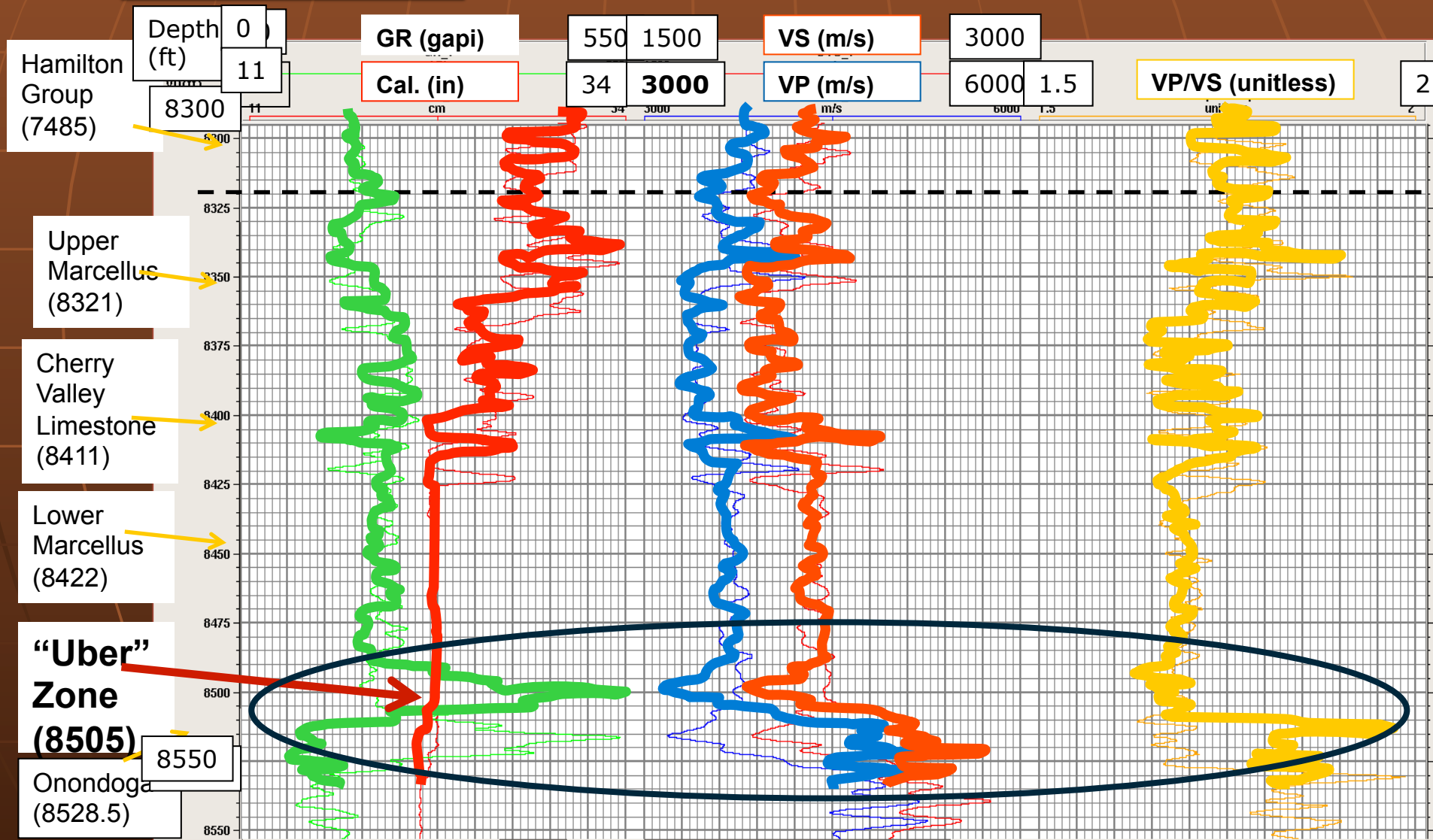
Projects and Plays

Marcellus

Rob Brown (MS student)



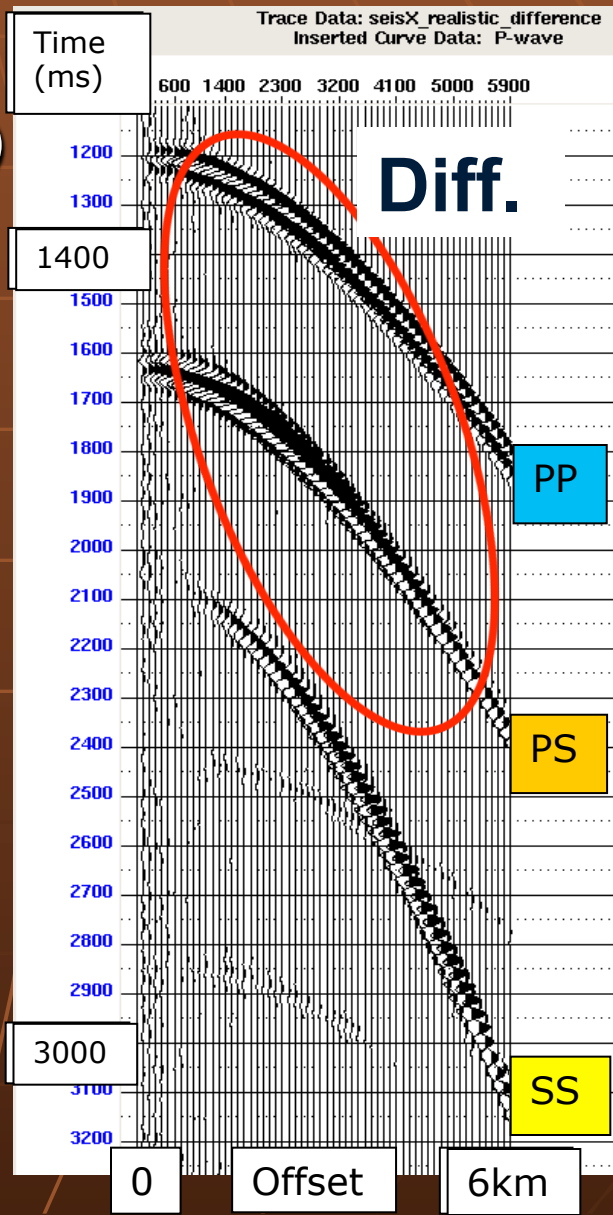
Projects and Plays

Marcellus

Rob Brown

(MS student)

Modeling suggests observable differences in seismic response for the P-P and P-SV components, especially on the horizontal receivers, for differences in VTI anisotropy in the lower Marcellus shale.



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Projects and Plays

Marcellus

Sharif Morshed (Active PhD student)

Active PhD student working on 'Active Characterization of VTI anisotropy in resource shales.'

Will work with Marcellus data and extend to Hayneville and Eagle Ford (and other?) shales.

Progress reported at this meeting.

Projects and Plays

Haynesville

Students have begun examining Haynesville data.

Acquisition of data sets under active discussion with sponers.

Should be a fruitful area for further research.

Projects and Plays

Eagle Ford

Active and competitive oil shale play

Seeking access to data and cooperative projects for student and faculty research.

Future Directions

Collaborate with Rock Physicists and Quantitative Anisotropy and Inversions specialists to relate Rock Properties to Seismic response and invert seismic response to rock characteristic.

Poisson's ratio	⟷	**'Chertiness'**
HTI parameters	⟷	**Fracturing and stress state**
VTI parameters	⟷	**Clay content source richness seal efficacy**

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Other Students

Shear-wave propagation & reflection

Terence Campbell (Active PhD Candidate):

Correcting phase distortion of direct shear-wave reflections: Application to real data. Status: Working with real data.

Suggestion of extending Alford rotation of polarized S-wave data beyond the normal incidence assumption.

Progress reported at this meeting.

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Research in the UT-Austin EDGER Forum focus a broad range of seismic and rock physics directions to problems associated with resource shales.

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