SPE WORKSHOP

13-14 June 2017
The Woodlands, Texas, USA
The Woodlands Resort

From Micro to Macro: Application of a Geomechanically Calibrated, Seismically Constrained Reservoir Model to Unconventional Resource Development

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Jason Gumble, Fracture ID
Paul Heuermann, Sigma Cubed

Work Flow

1) Include core and pilot well data in seismic inversion to interpolate over area of interest to create volumes of:
   a) Compressional Velocity
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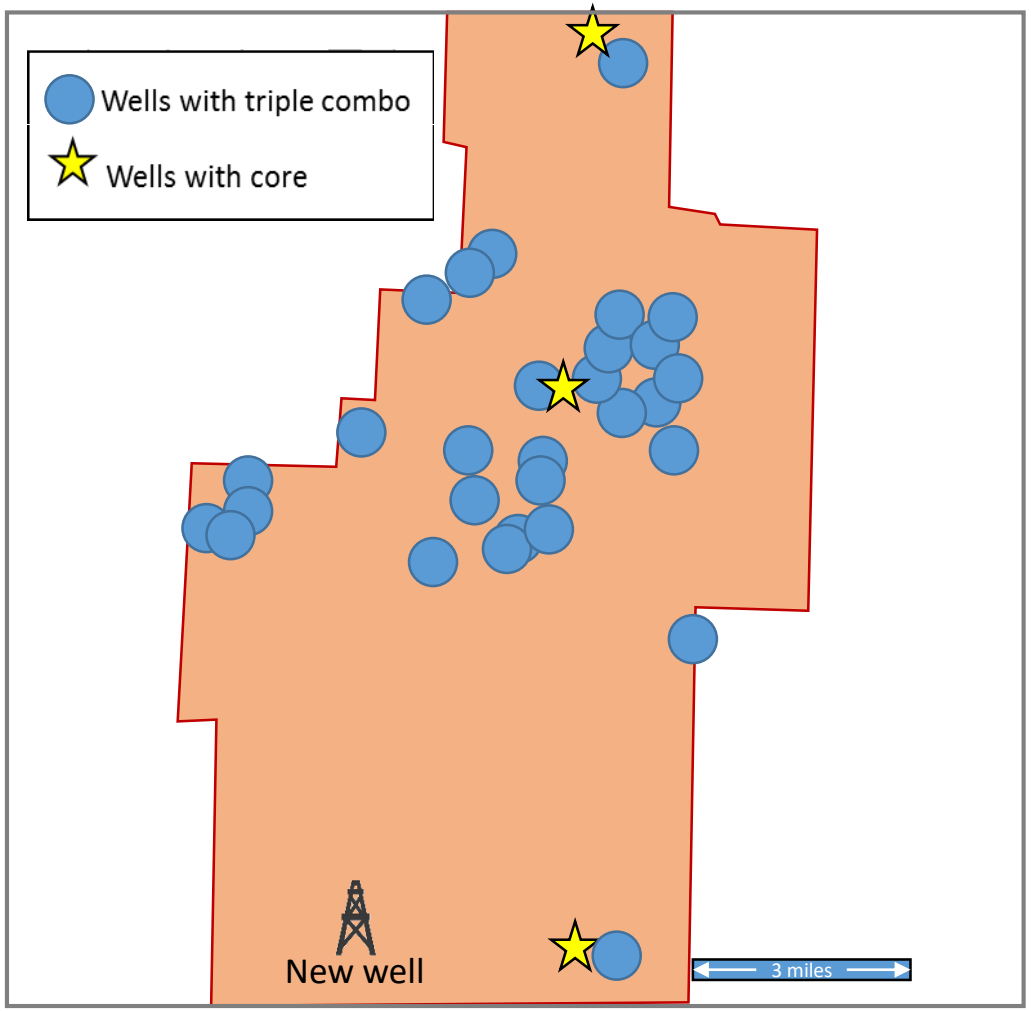
4) Drill 4 horizontal wells in highest shale capacity / porosity rock while collecting rock mechanical data (30’ target windows)
5) Design completions to reduce stress variance over each stage
6) Re-calibrate seismic volumes using lateral rock mechanical data
7) Drill next pilot well

Areal view of new pilot well location. Map highlights distance between new drillwell and offset wells

Earth Model Calibration Data



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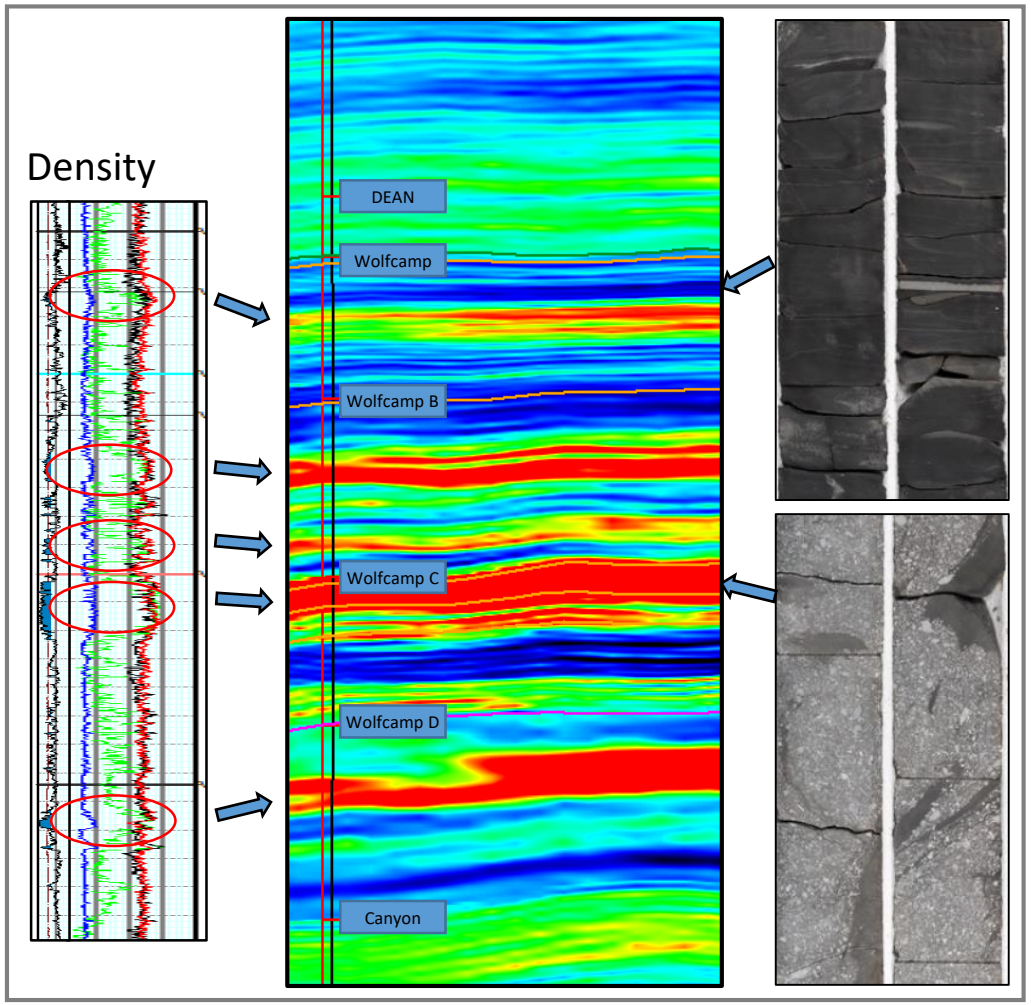
2D seismic image with tie to older wellbore; carbonate and shale lithologies from core data were used to further constrain model

Impedance Volume



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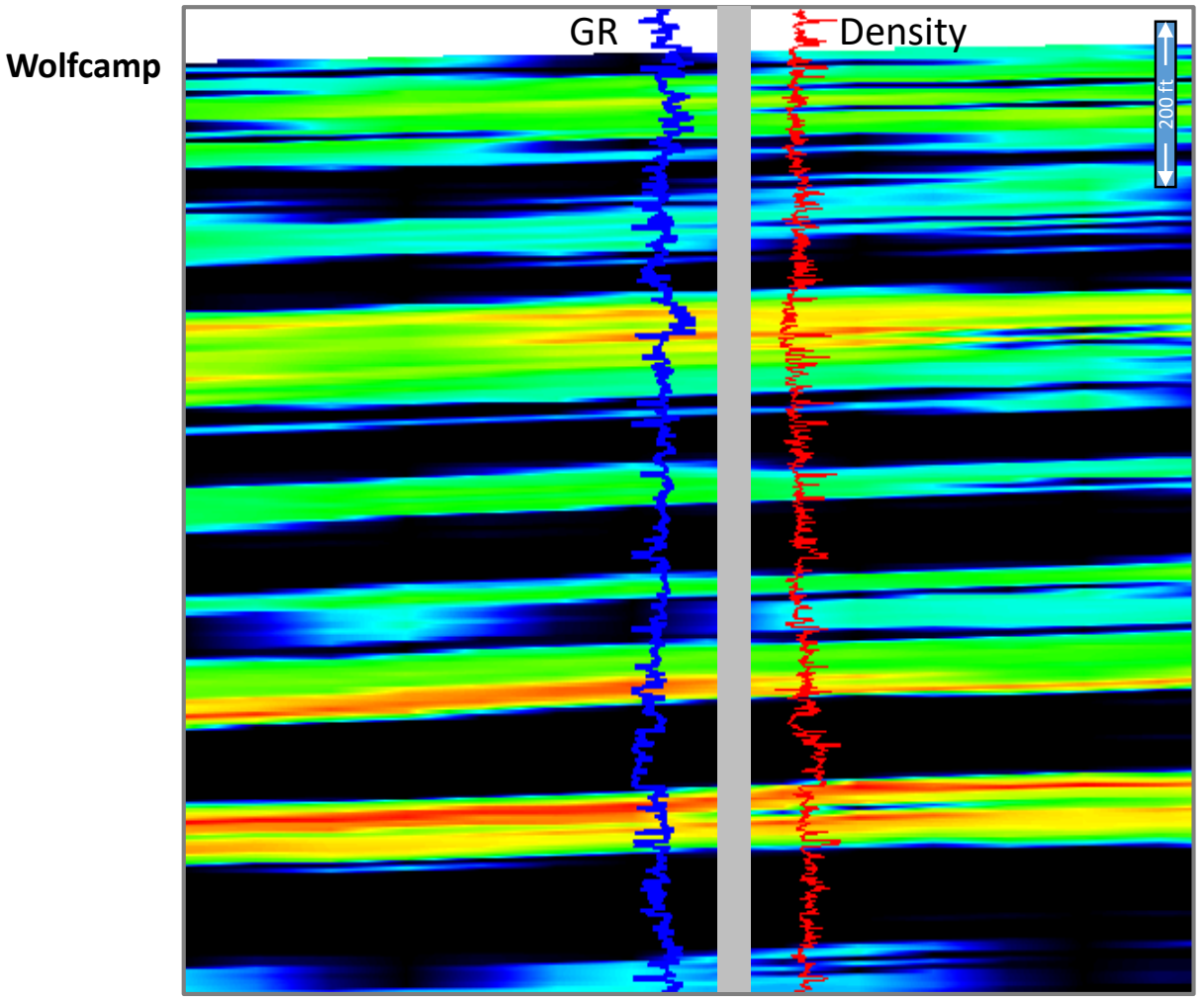
2D seismic image with structural and stratigraphic pre-drill estimates

2016 Shale Capacity Seismically Inverted Volume



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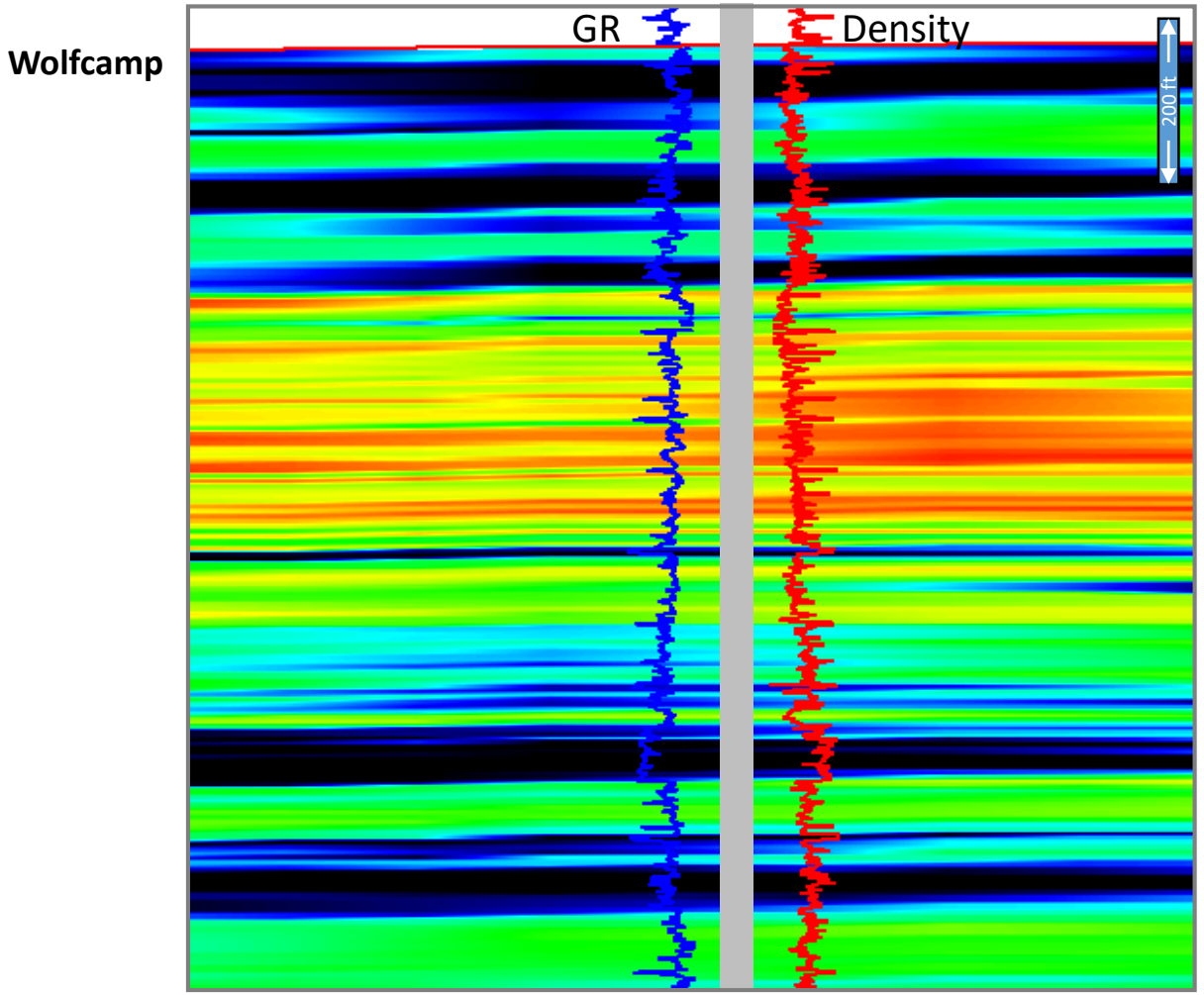
2D seismic image post-drill results. The pre- and post-drill seismic interpretation show a significant change in stratigraphic heterogeneity

2017 Shale Capacity Seismically Inverted Volume



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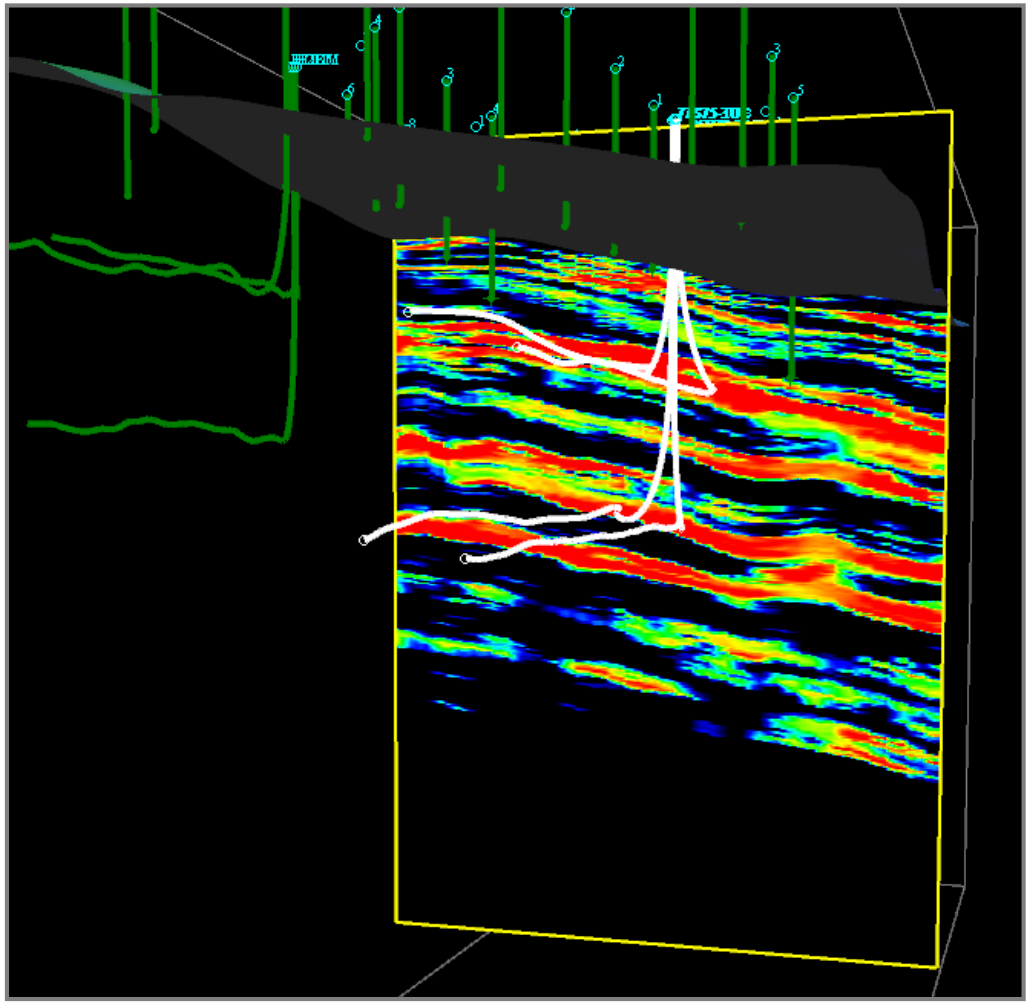
Reinterpreted 3D image of seismic volume highlighting well path relative to the target Wolfcamp zones

Shale Capacity Volume (red = high -> black = low)



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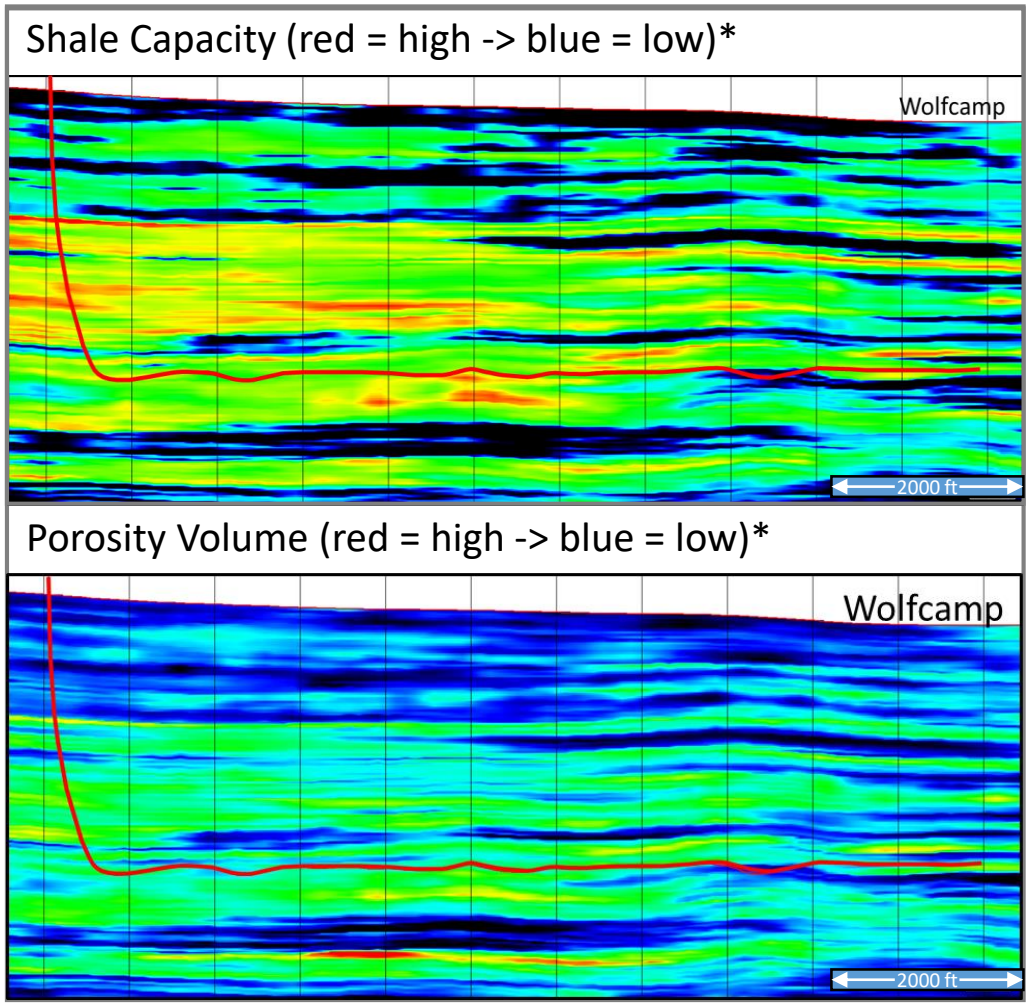
Cross-sectional view of wellbore relative to seismic horizon.

Wellbore Path



*Black indicates reservoir quality criteria not met

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Mechanical rock properties are determined via accelerations measured directly behind the bit on NOVs 12" bit sub by Fracture ID

Fracture ID Rock Mechanics from Drilling Accelerations

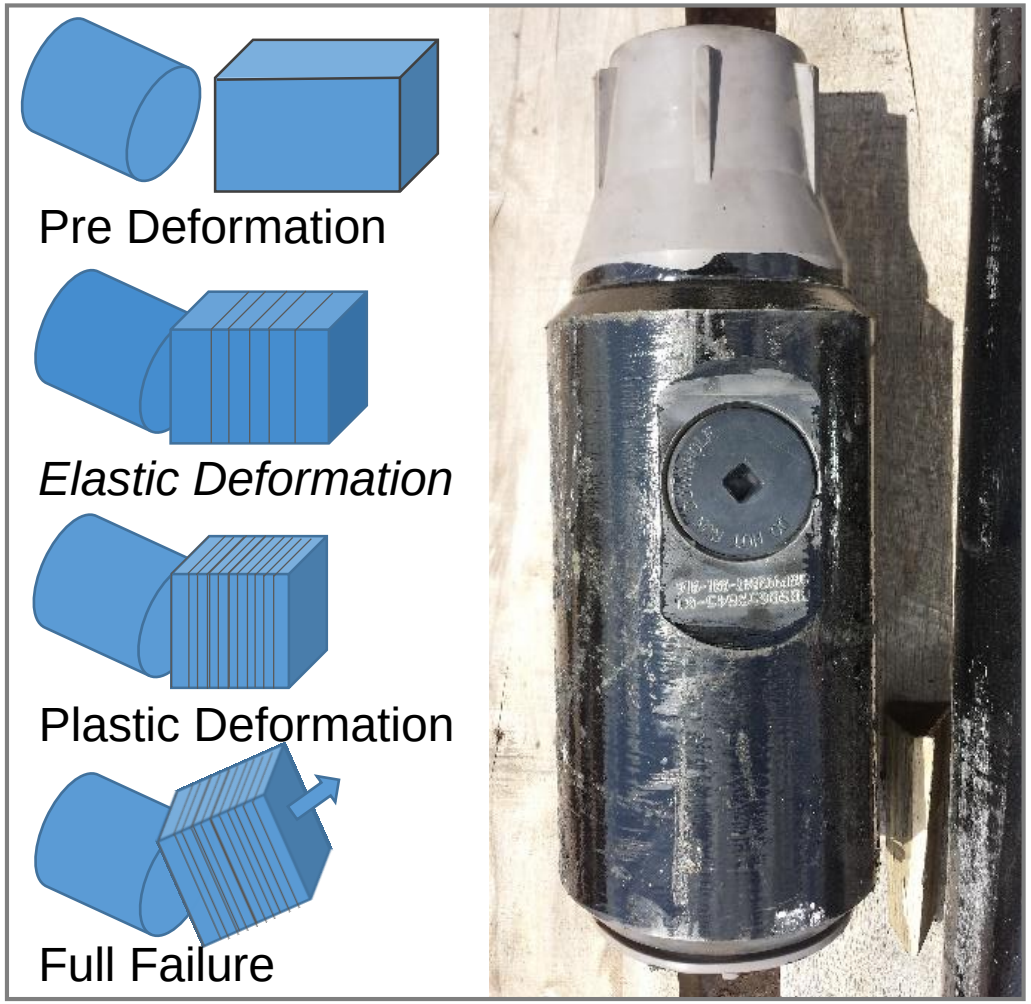

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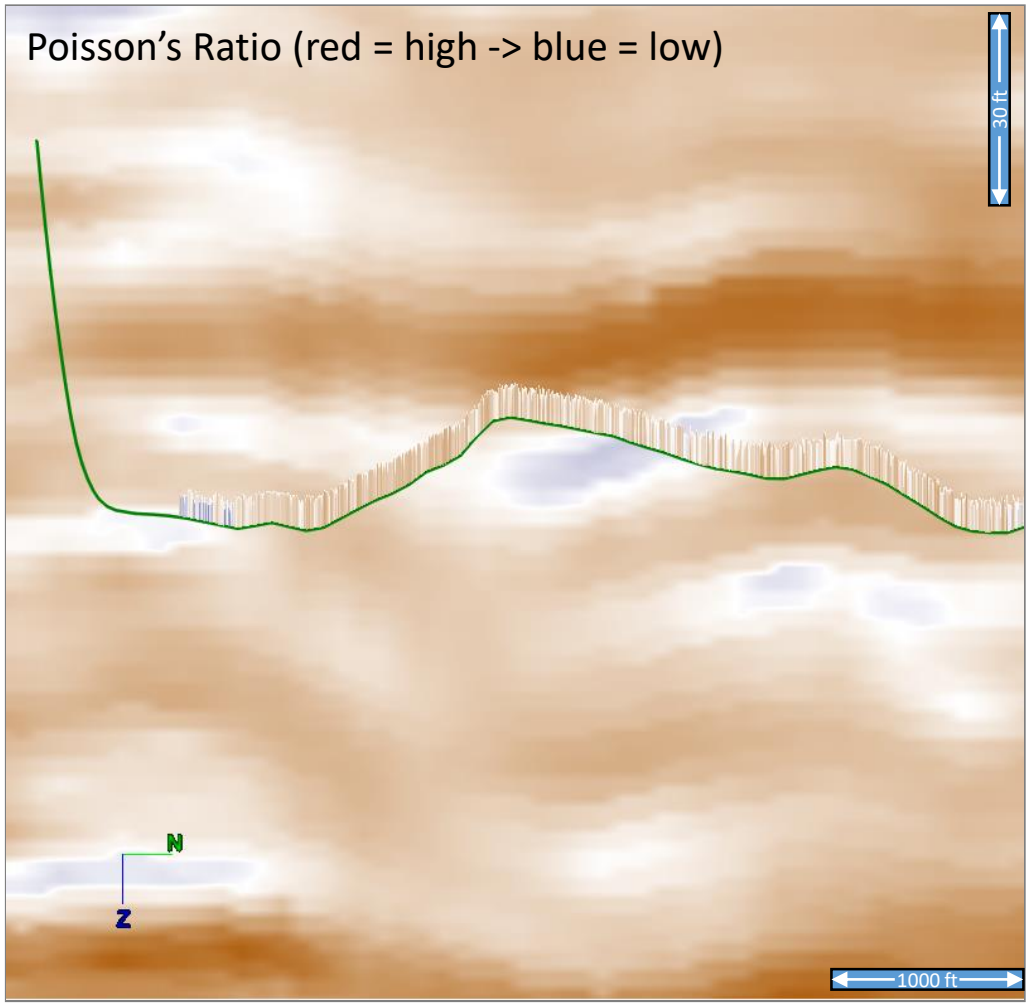
Image of wellbore along seismic. Log data indicates that most sections match the seismic while some do not

Lower Wolfcamp Target



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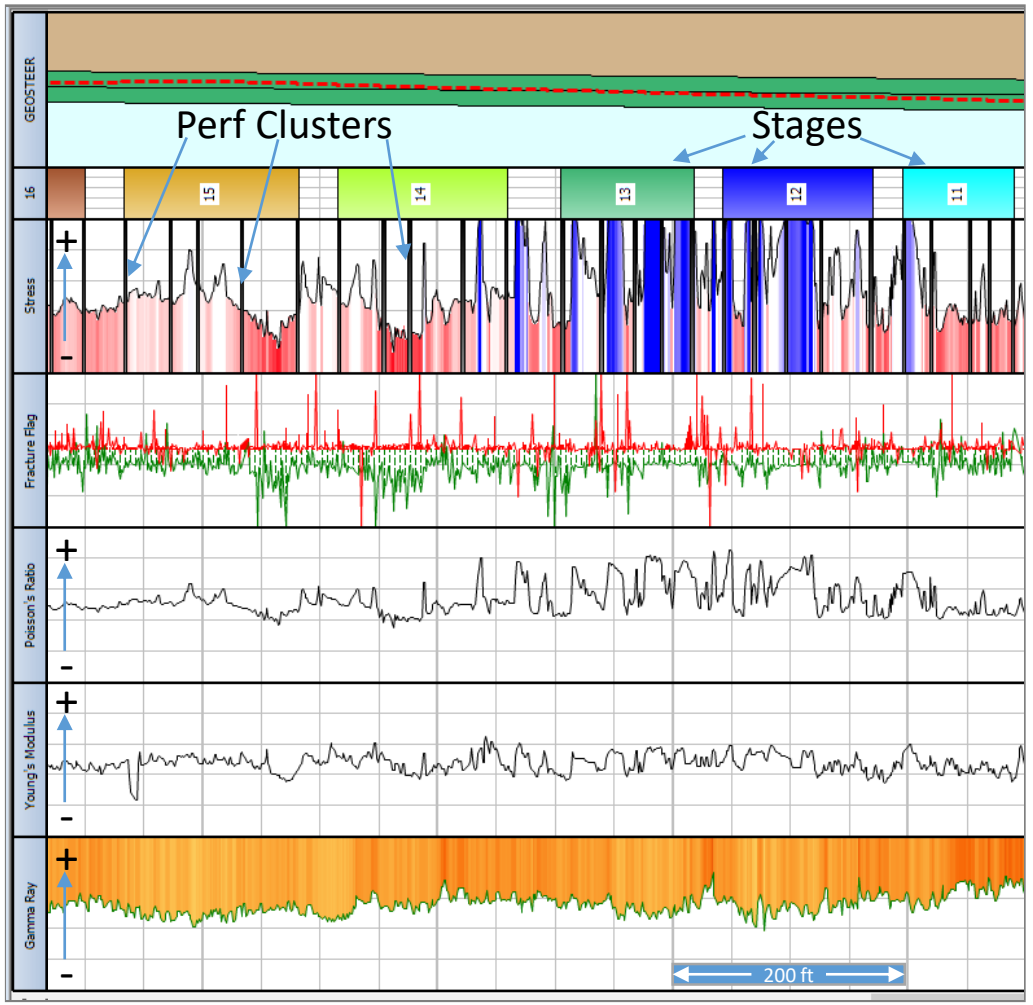
Fracture ID result highlighting mechanical properties and bedding / fracturing along the well. Shmin is calculated from PR and used to drive stage and perf cluster placement (black bars)

Rock Mechanical Data



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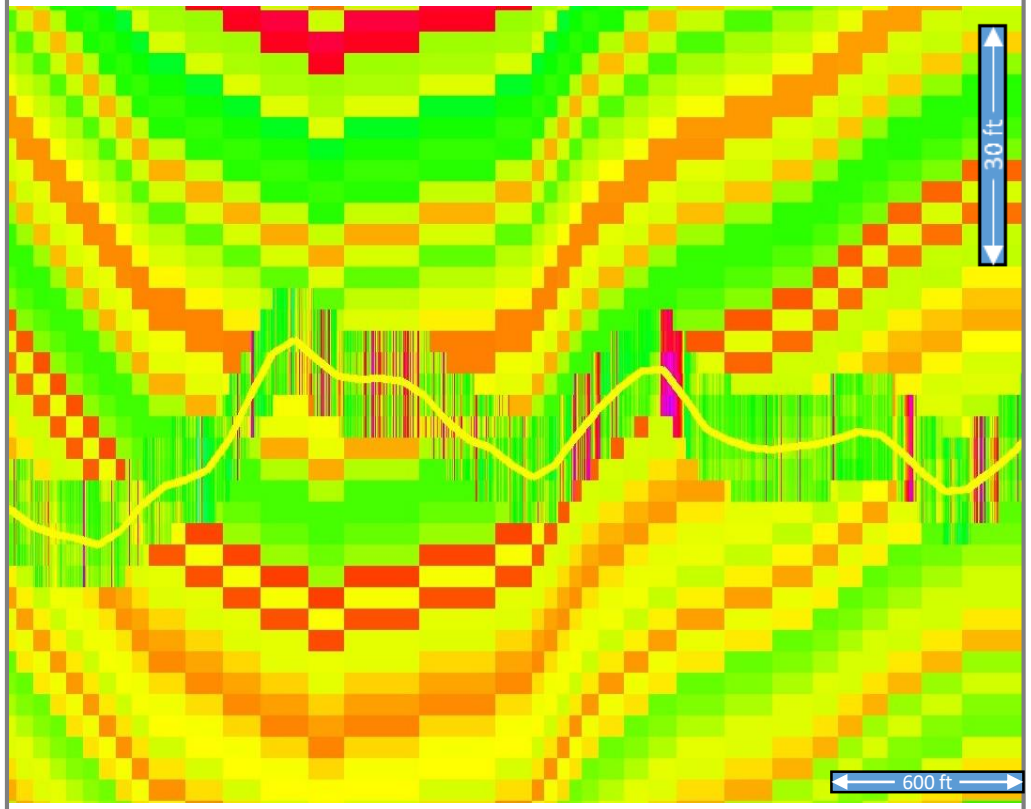
High-resolution stress grid in GOHFER model. This utilizes variable stress along the wellbore to optimize completion design

Stress Balanced Completions Design

Total Stress (red = high -> green = low)



Geometric Completion 48.5% (165/340 clusters)

Stress Equalized Completion 62.0% (204/329 clusters)

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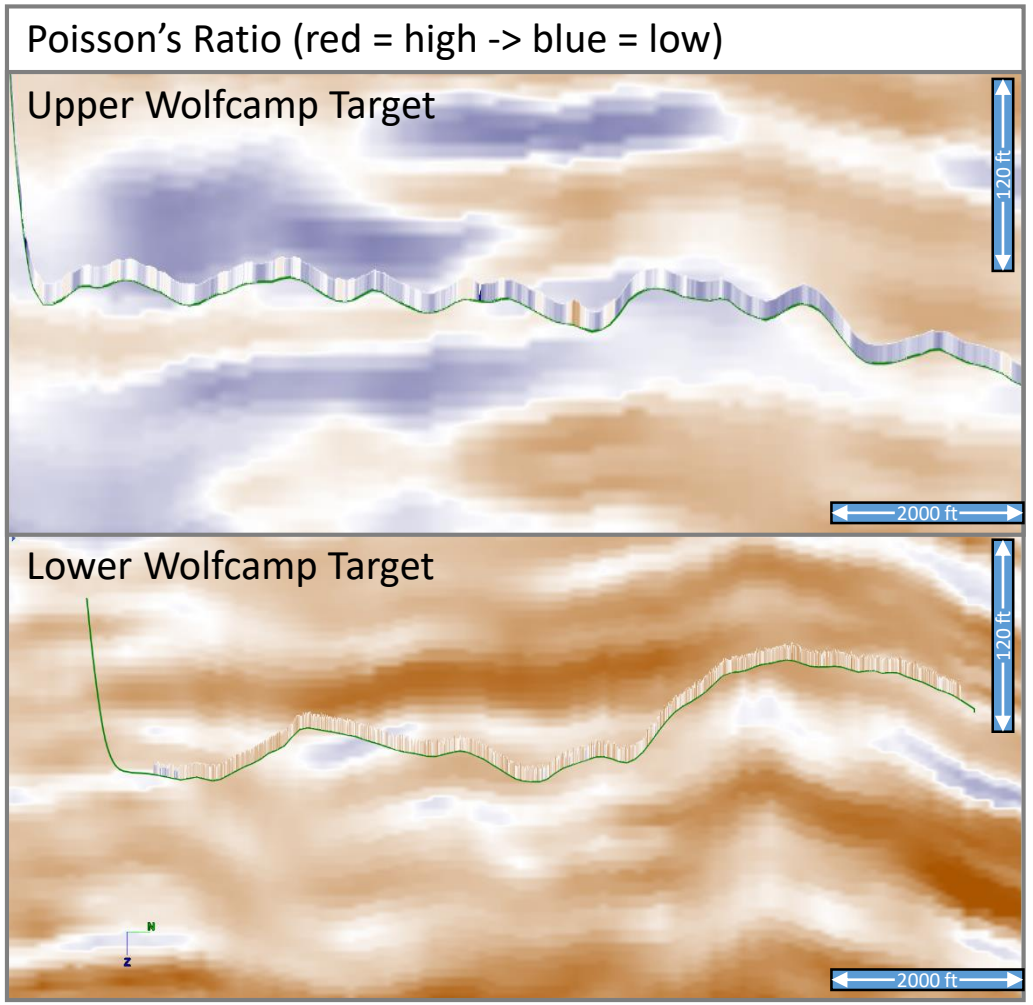
Integration of mechanical rock data and seismic will provide an improved interpreted model

Well Log Overlain on Seismic



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Optimizing well placement and completion design helps increase Return on Investment for development programs

Thank You and Discussion

Thank you to:

Questions to Audience:

- Previous experiences using surface seismic 3D data to improve development
- Previous experiences collecting lateral log rock mechanical data
- Previous experiences applying lateral log data to improve development