



Fracture Model Calibration

Liberty Engineering Solution



Frac Modeling Challenge

Too Many Unknowns

Critical Model Input Parameters

- Fluid rheology
- Wallbuilding coefficient
- Pressure-dependent leakoff
- Closure stress in pay

 Young's modulus

 Permeability and pore pressure

 Closure stress in neighboring layers

 Fracture complexity

 Tip effects

 Composite layering and width decoupling

 Cluster efficiency

 Stress interaction between fracs

 Heterogeneity and faulting

Color Key:

“Known knowns”: Relatively easy & reliable measurement

“Known unknowns”: Harder to measure directly and less reliable

“Unknown knowns”: Impossible to measure directly and physics not well understood

“Unknown unknowns”: Impossible to measure on all required scales

Frac Modeling Challenge

Conducting More Measurements Can Help

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- ▾ Tip effects
- Composite layering and width decoupling
- ▬ Cluster efficiency
- ◀▶ Stress interaction between fracs
- ◀▶ Heterogeneity and faulting

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Improved
Measurements

Frac Modeling Challenge

Locking In Unknowns through Model Calibration

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Measurements

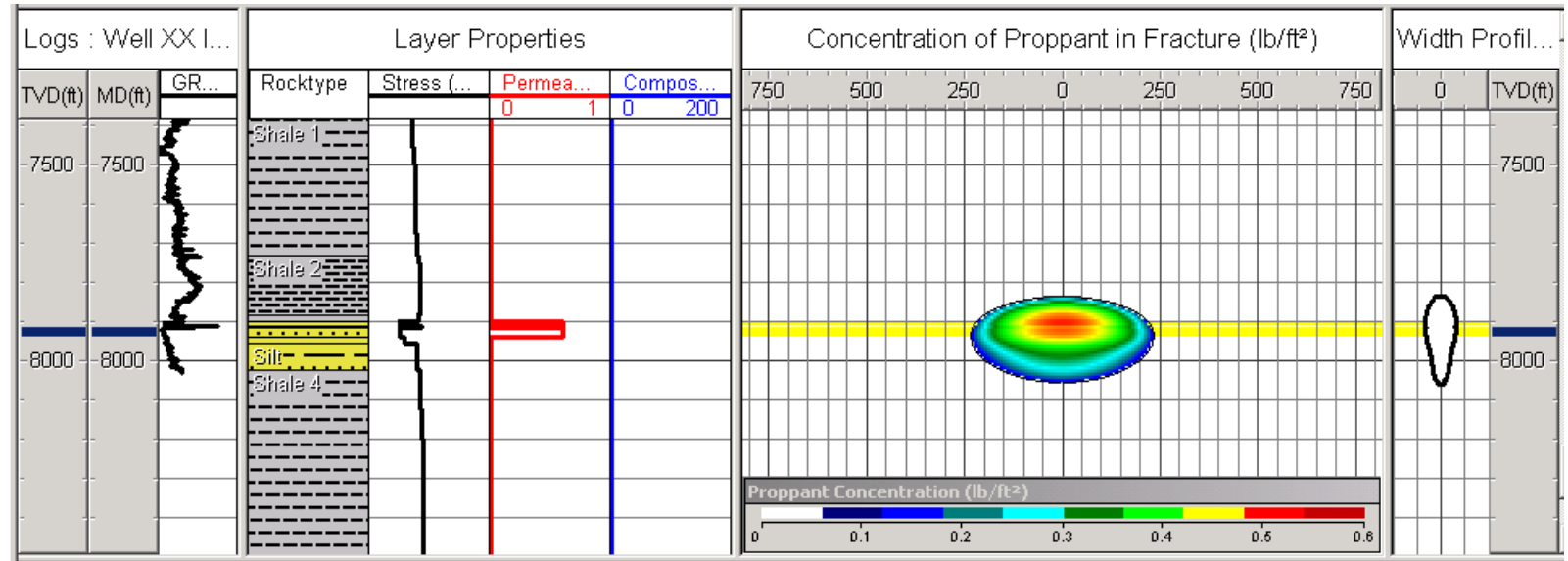
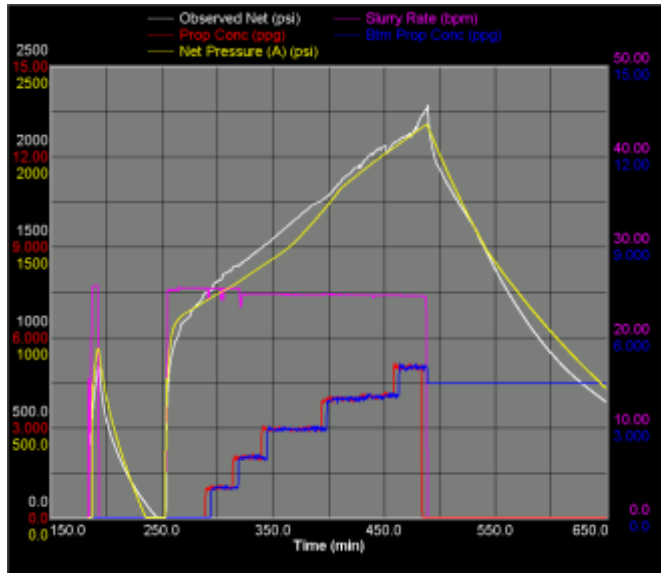
Model
Calibration

- Net pressure
- Fracture length
- Fracture height
- Fracture width and conductivity
- Number of efficient clusters

◀ ▶ Heterogeneity and faulting

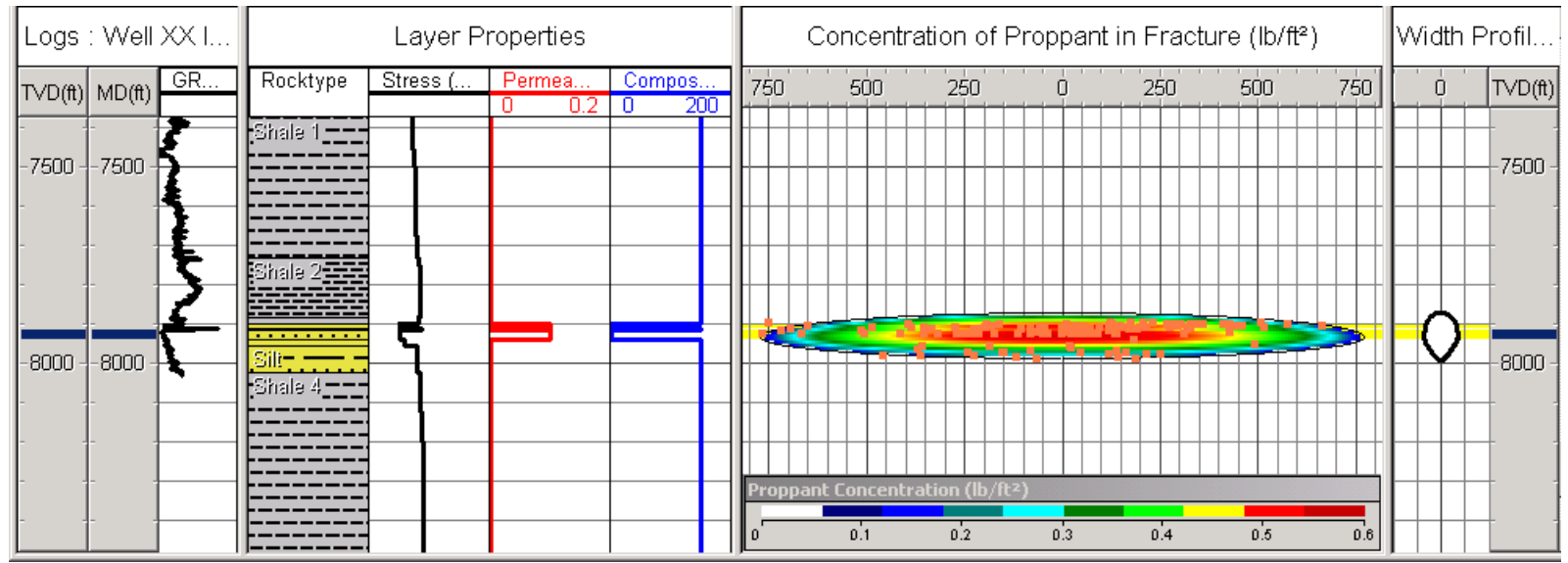
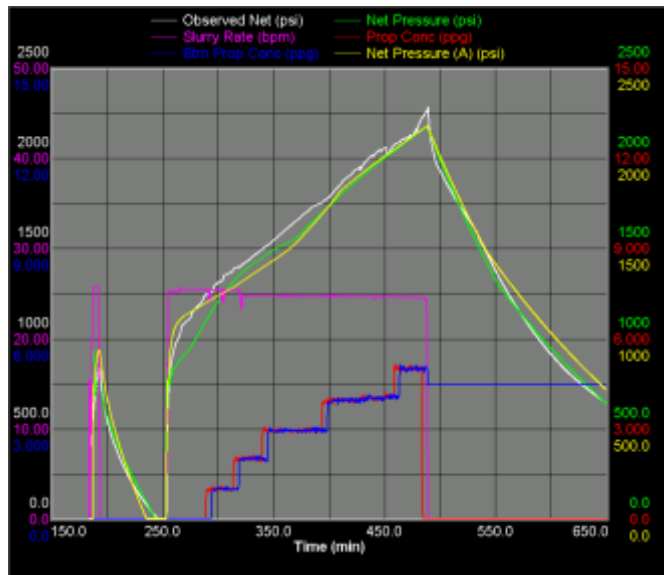
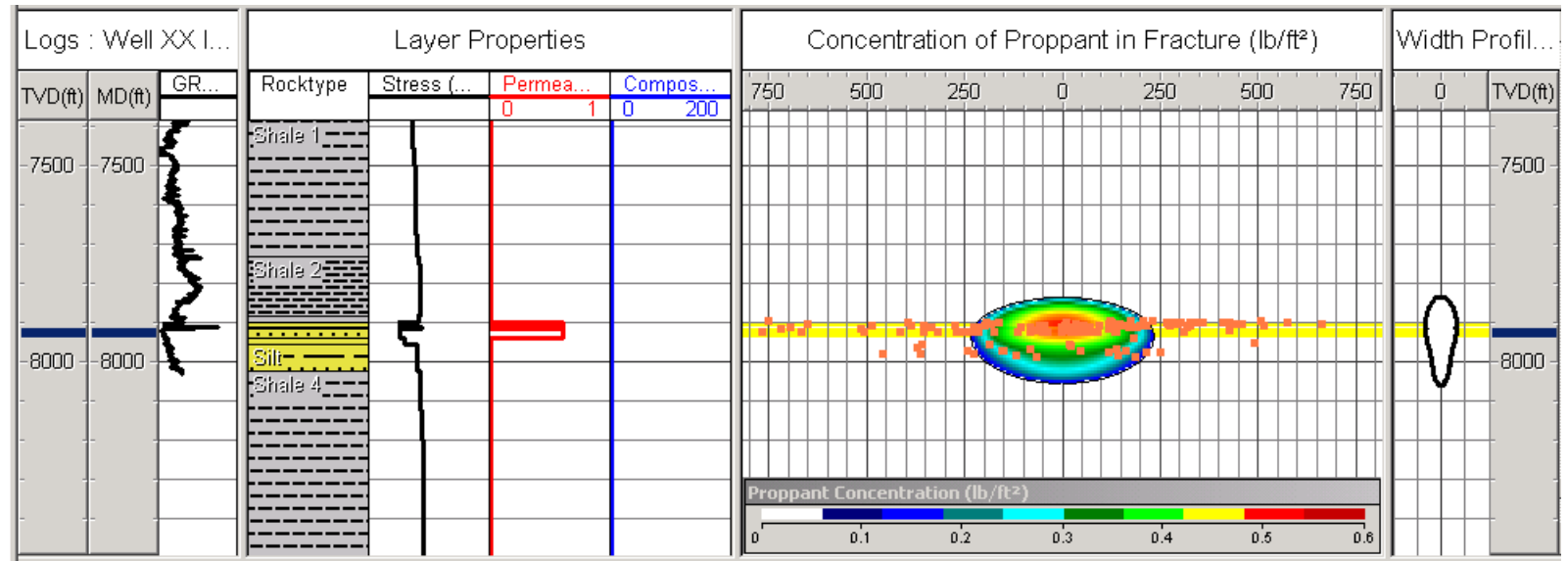
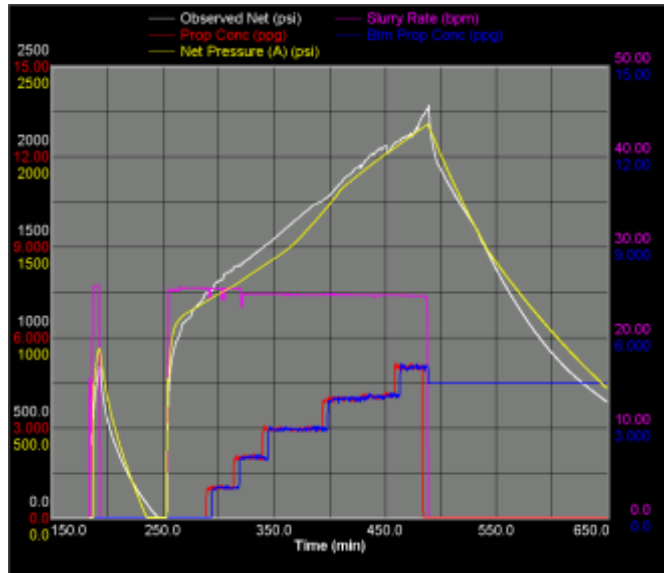
Frac Model Calibration Example

Net Pressure Match



Frac Model Calibration Example

Net Pressure Match and Micro-Seismic Events Match



Calibrated Modeling Approach

Modeling AND Measuring

Fracture Growth Models
Incomplete Physical Understanding

Direct Diagnostics
Not Predictive

**Calibrated models more realistically
predict how fractures will grow for
alternative designs**



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