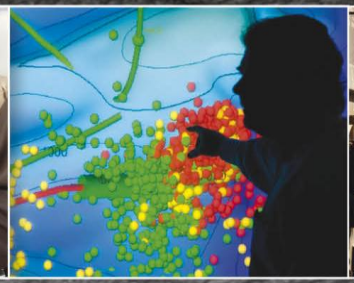
Unconventional Resources



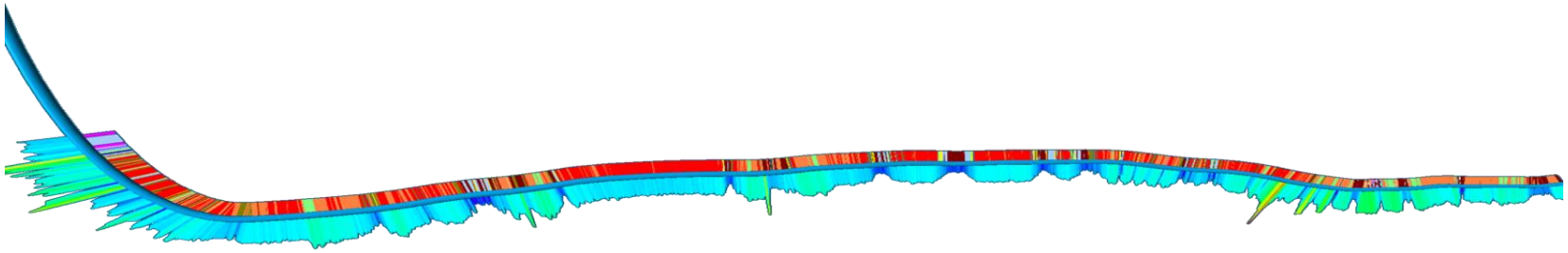
Role of Reservoir Characterization in Unconventional Resource Developments

Andrew Acock
Business Manager
Unconventional Resources

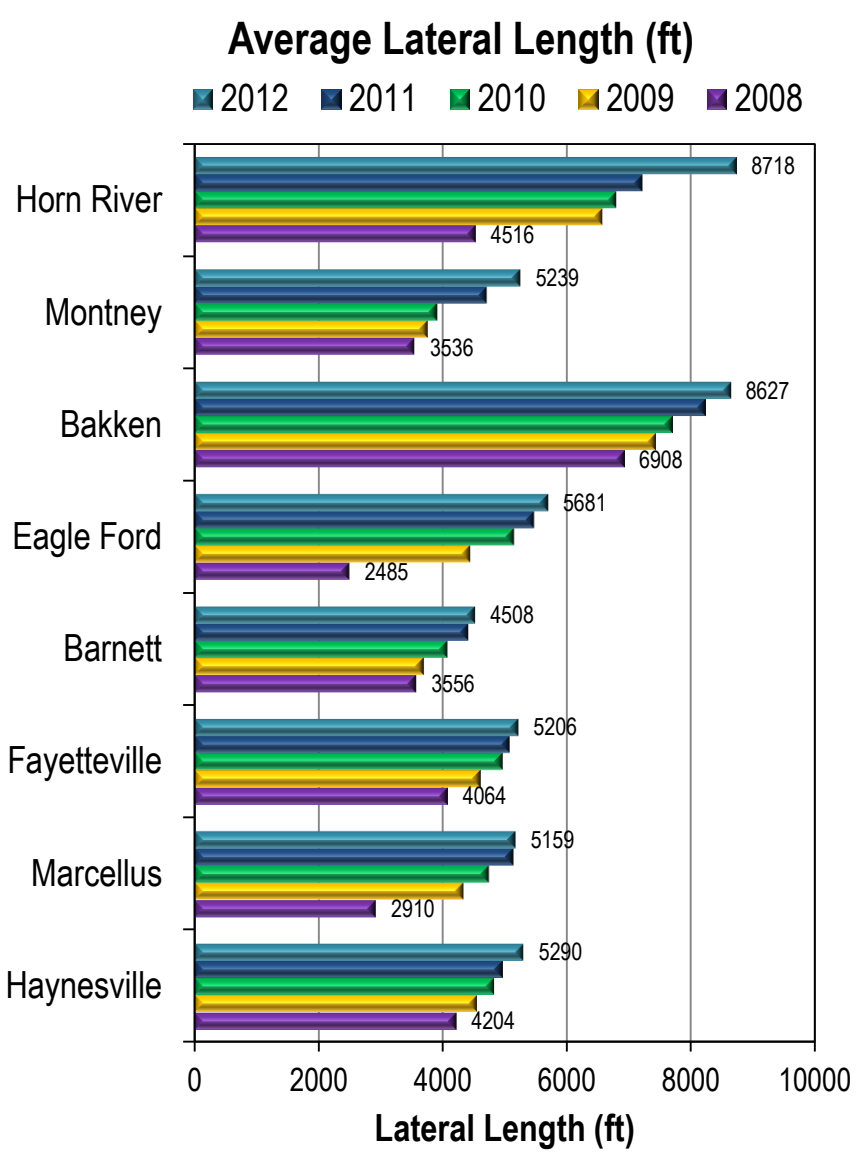
Schlumberger

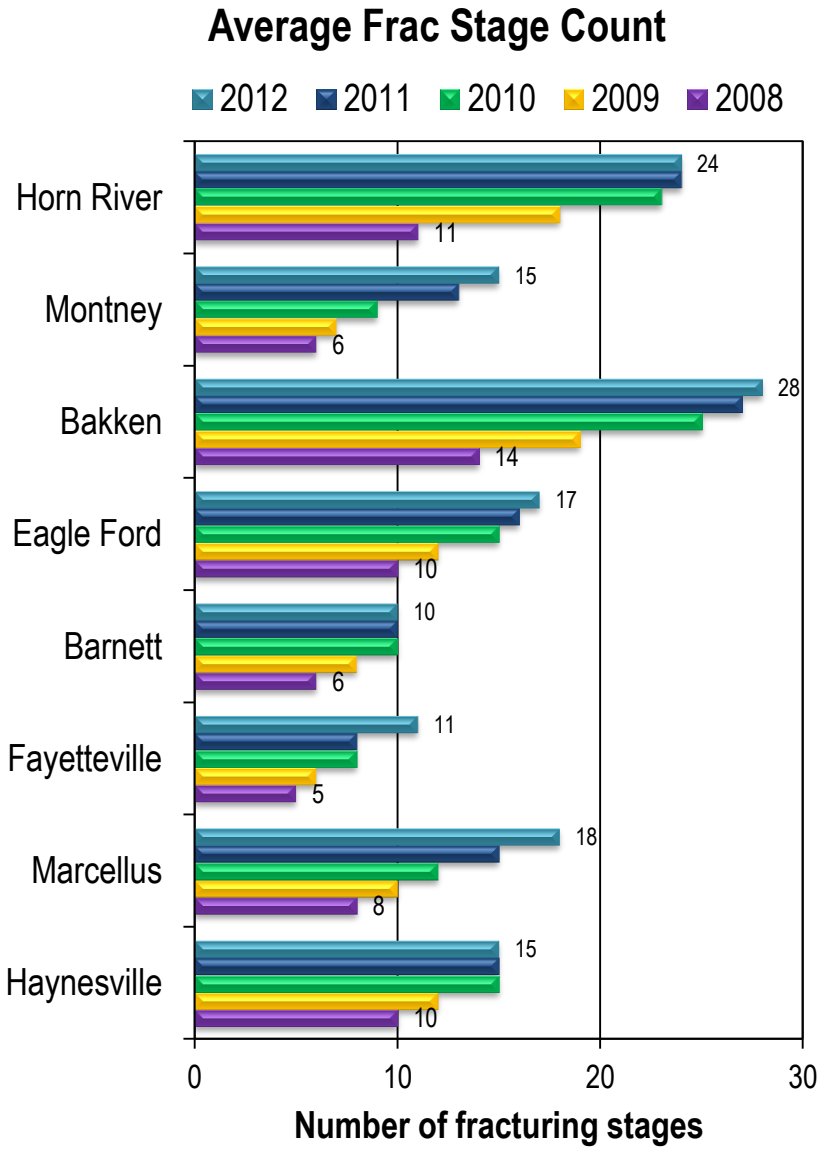
Agenda

- Introduction Unconventional ROC & Eagle Ford Consortium Overview
- Reservoir Quality - Grouping “Like Rock”
- Completions Quality – Evaluating the Near Wellbore Stress
- Completions Advisor - Putting it all Together & Completion Review
- Consortium Examples - PL, Well Path, Production
- Conclusions

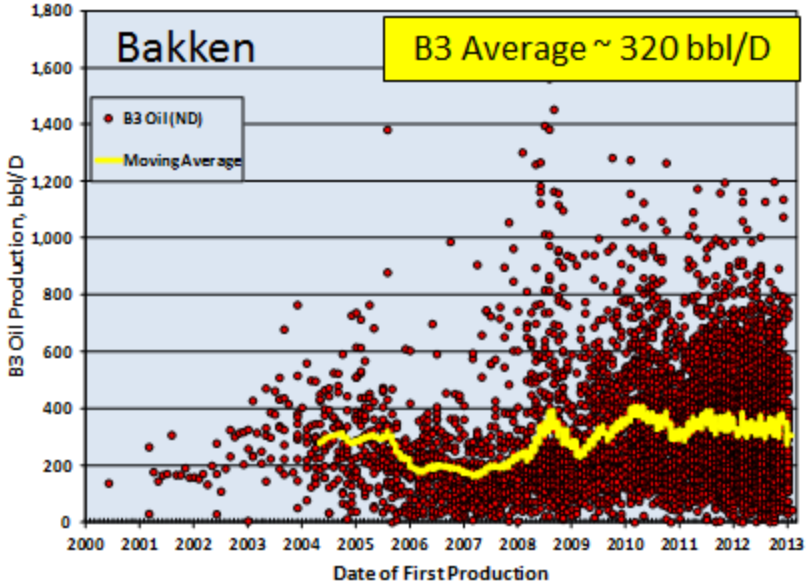


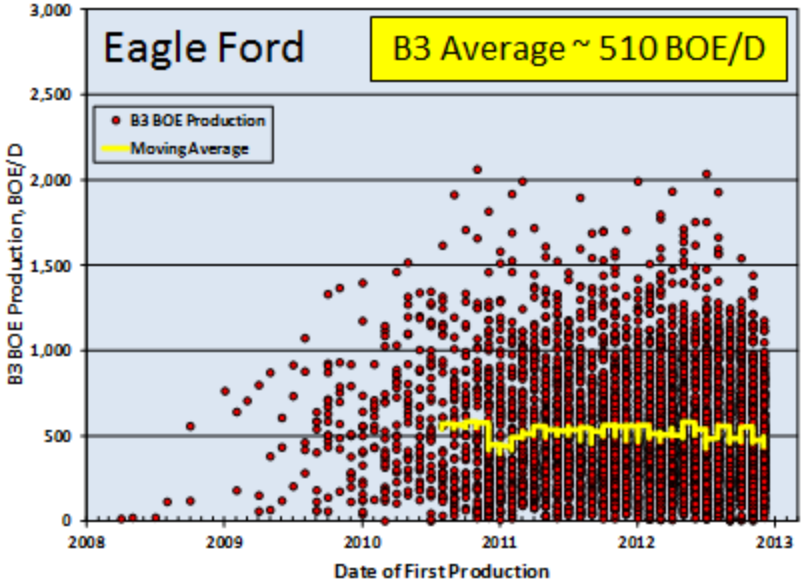
Technology Has Played a Role, but More Science is Required

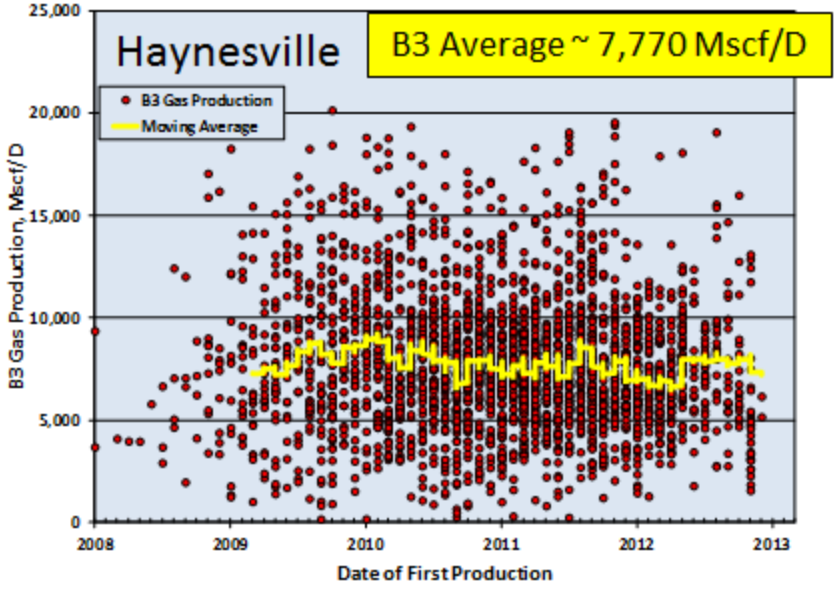


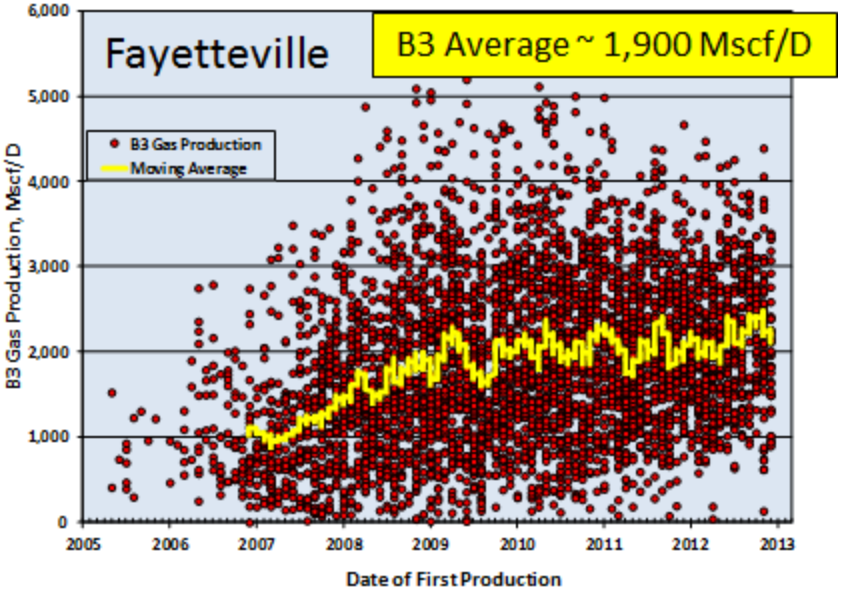


Best 3 Month Production

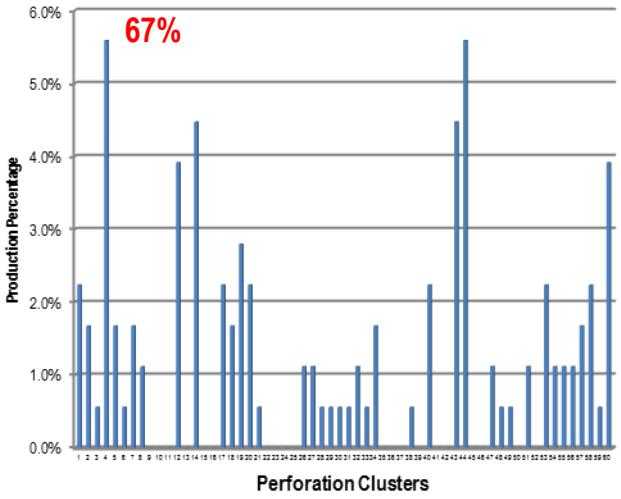


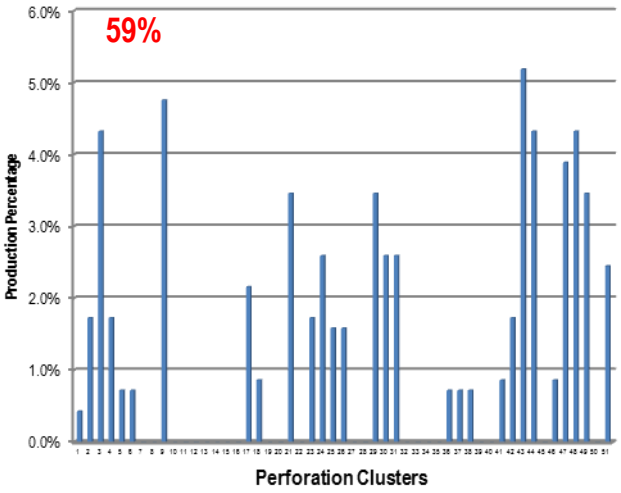


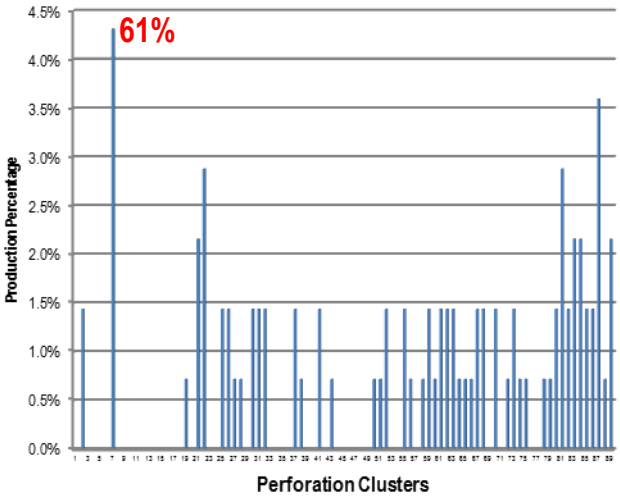


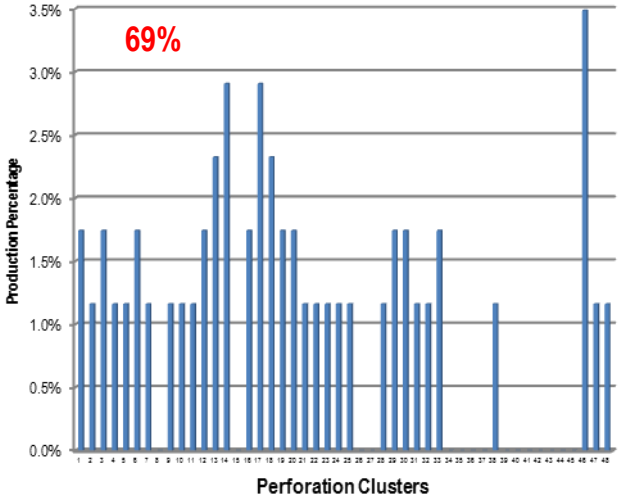


Production is Not Uniform



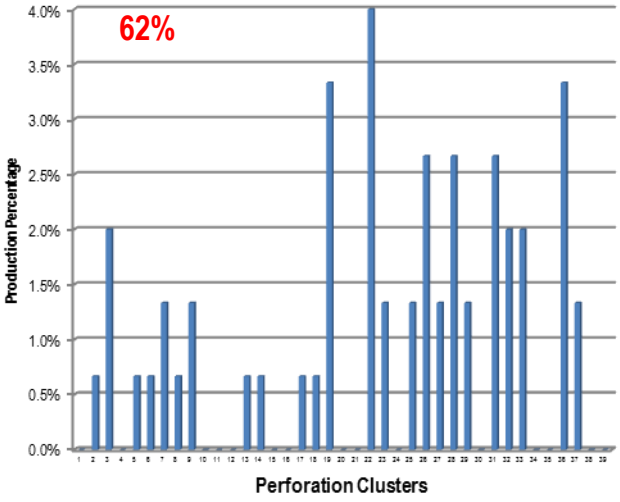






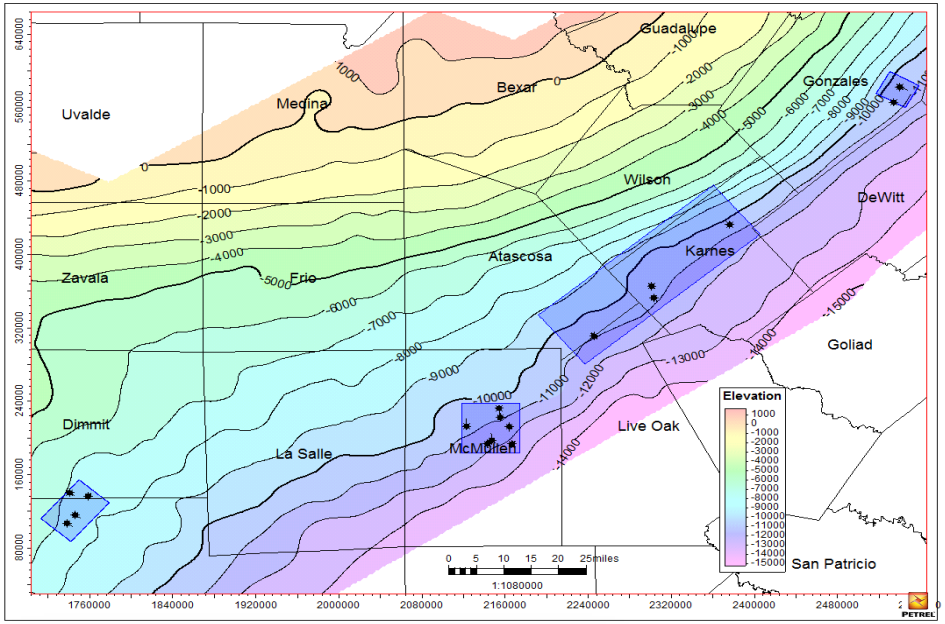
Eagle Ford PL Examples

- Only 64% of the Perforation Clusters contributing
- All well were completed Geometrically

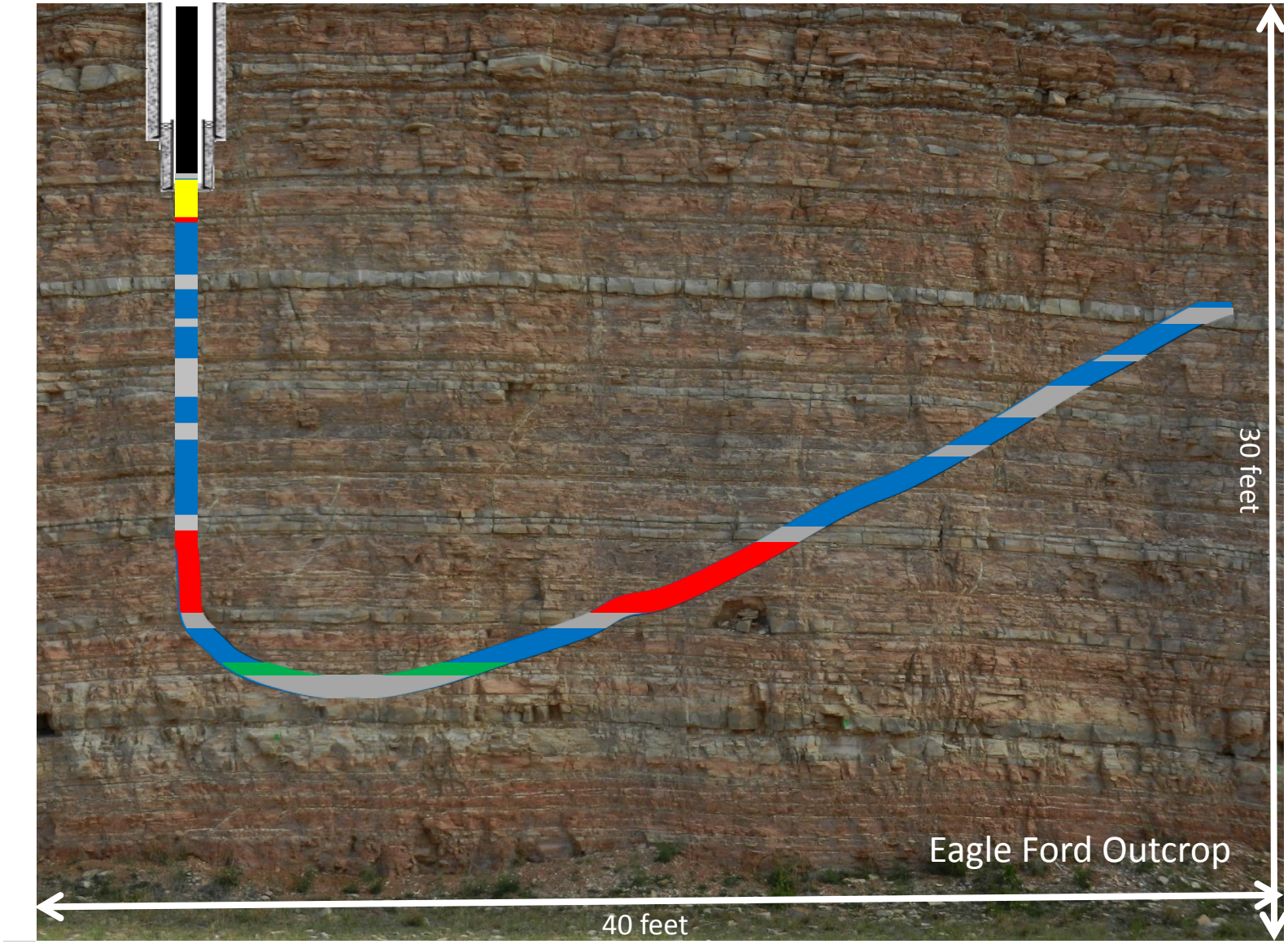


The Consortium

- Challenge
  - Efficiency vs. effectiveness
  - Only 64% of clusters contributing
  - Solution that fits existing workflows
- Approach
  - Evaluate laterals using new technologies
  - Compute Reservoir Quality & Completion Quality
  - Optimize completion to maximize production
  - Share data among the consortium
- Evaluation
  - Compare production results of Engineered vs. Geometric Completions



Pilot to Lateral “like rock” types



Data Inventory

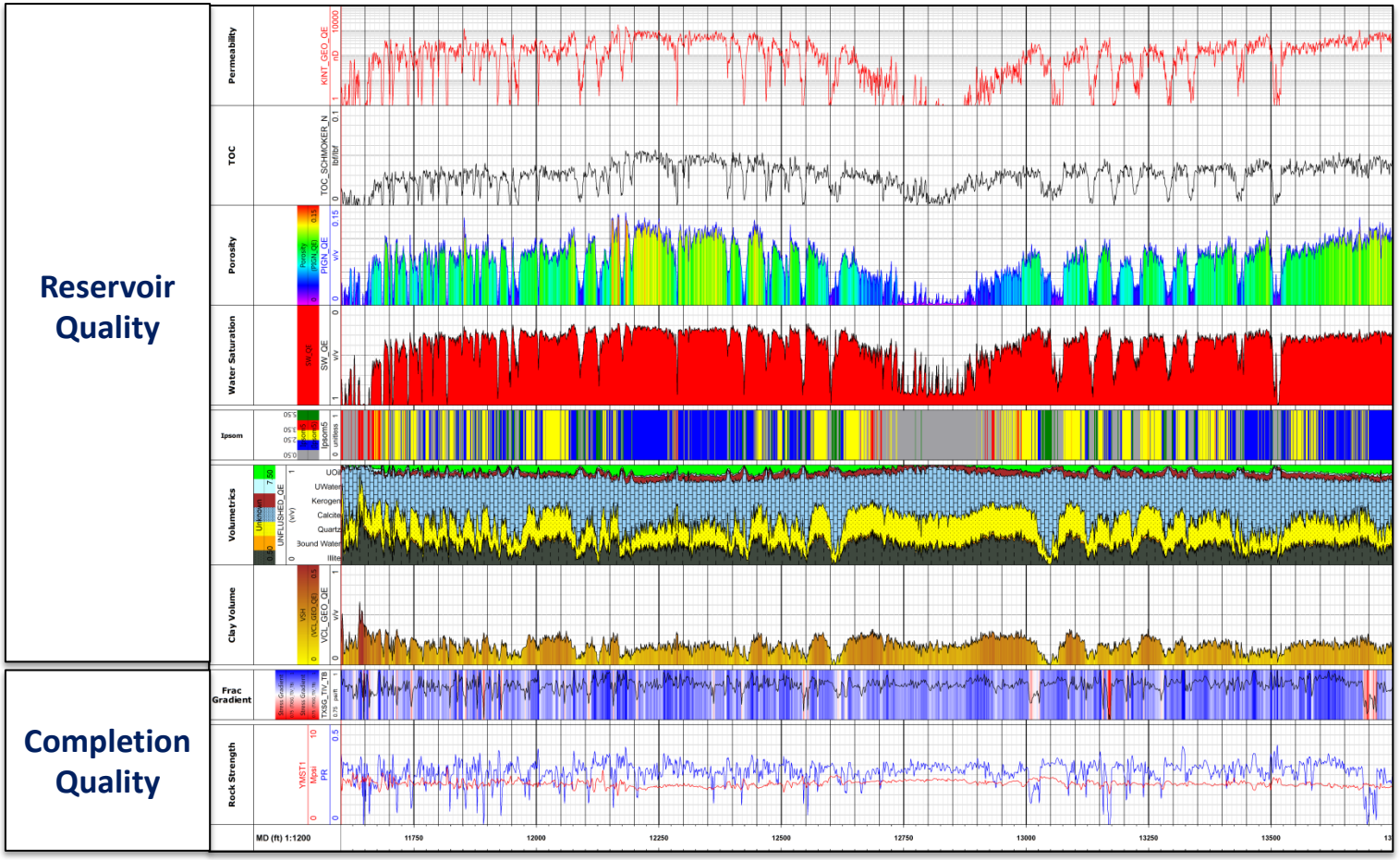
12 Lateral Logs with ThruBit, 3 with sonic scanner, 2 LWD and 1 OBMI

6 offset vertical wells

7 FSI Production logs

Well	Pilot	Offset	ThruBit	Wireline	LWD	FSI
OFFSET		X				
WELL A			X	QUAD (SS)		X
OFFSET		X				
WELL B			X			X
WELL C			X	OBMI		X
WELL D			X			
WELL E	X		X			X
WELL F			X	SS		
WELL G			X			X
WELL H			X			
OFFSET		X				
OFFSET		X				
WELL I			X	SS	X	X
OFFSET		X				
WELL J			X			
WELL K			X			
WELL L			X		Quad	X

Reservoir & Completion Quality



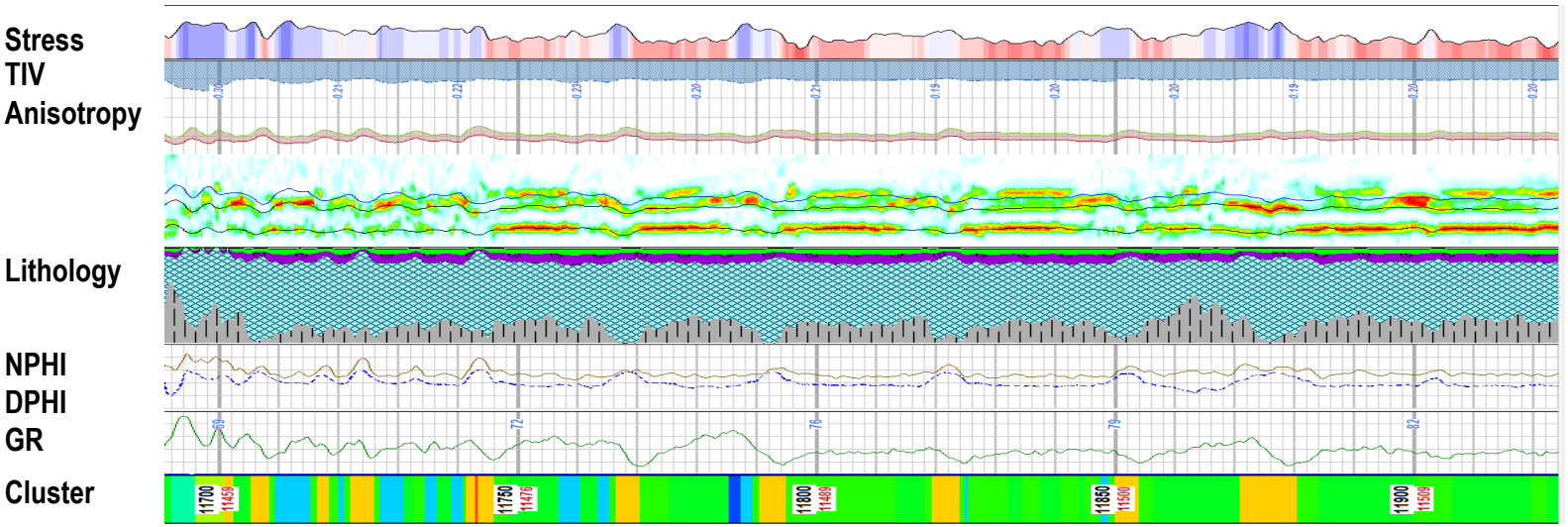
Reservoir Quality

Grouping “like rock” using HRA

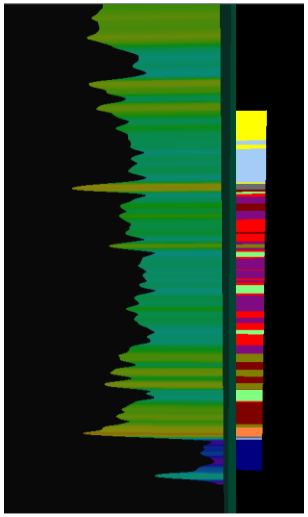
Color/Rock Type	Best	Good	Fair	Tight	Poor
Clay Volume Fraction (v/v)	0.134	0.294	0.434	0.055	0.210
Effective Porosity (v/v)	0.074	0.068	0.034	0.039	0.016
Permeability (nD)	245	133	23	24	10
Total Organic Carbon (weight %)	4.9%	4.3%	2.2%	3.0%	1.9%
Thermal Neutron Porosity (v/v)	0.162	0.208	0.212	0.086	0.102
Bulk Density (g/cc)	2.422	2.449	2.565	2.519	2.579
Gamma Ray (gAPI)	67.9	87.0	99.4	49.9	69.6

HRA – Heterogeneity Rock Analysis

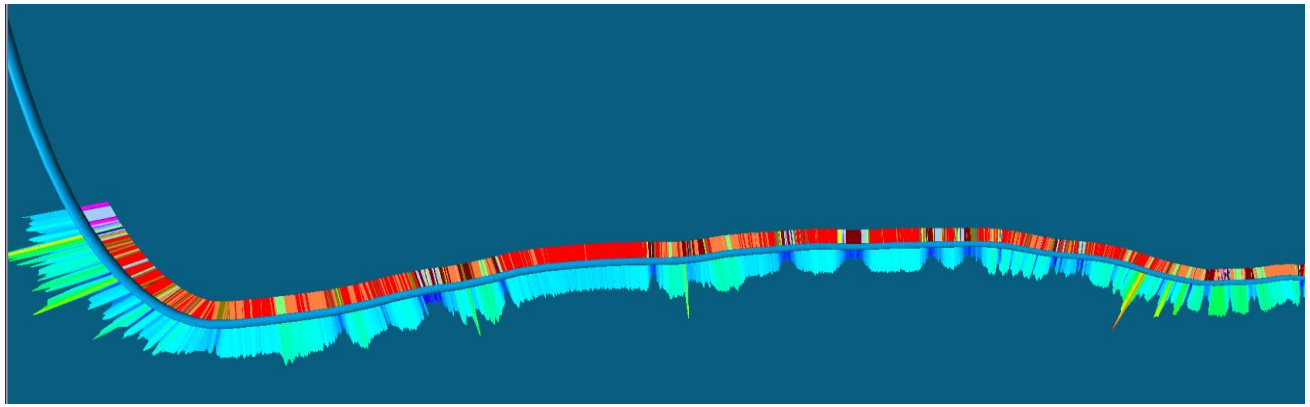
Completion Quality - CQ



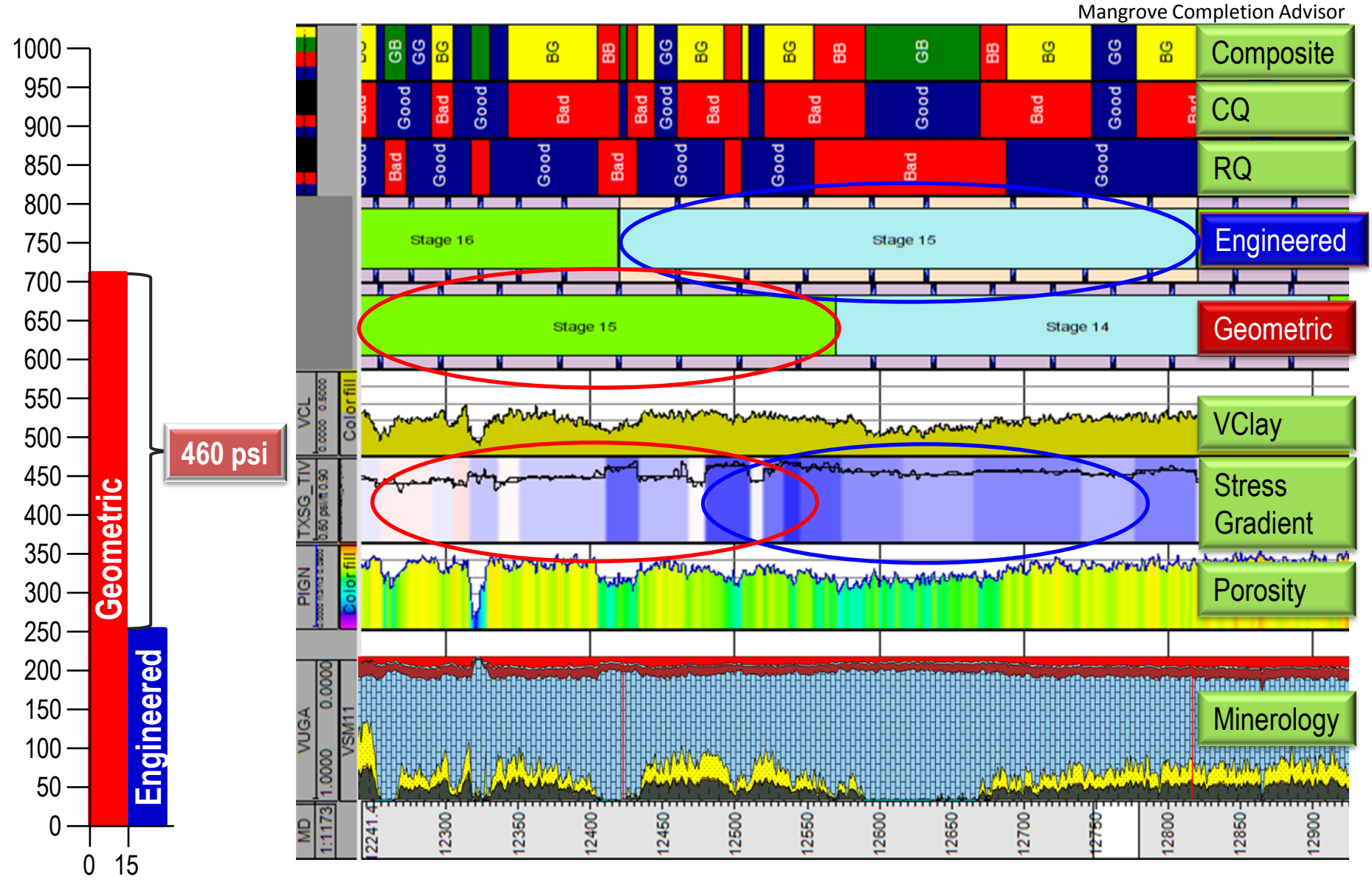
Pilot Well Measurements



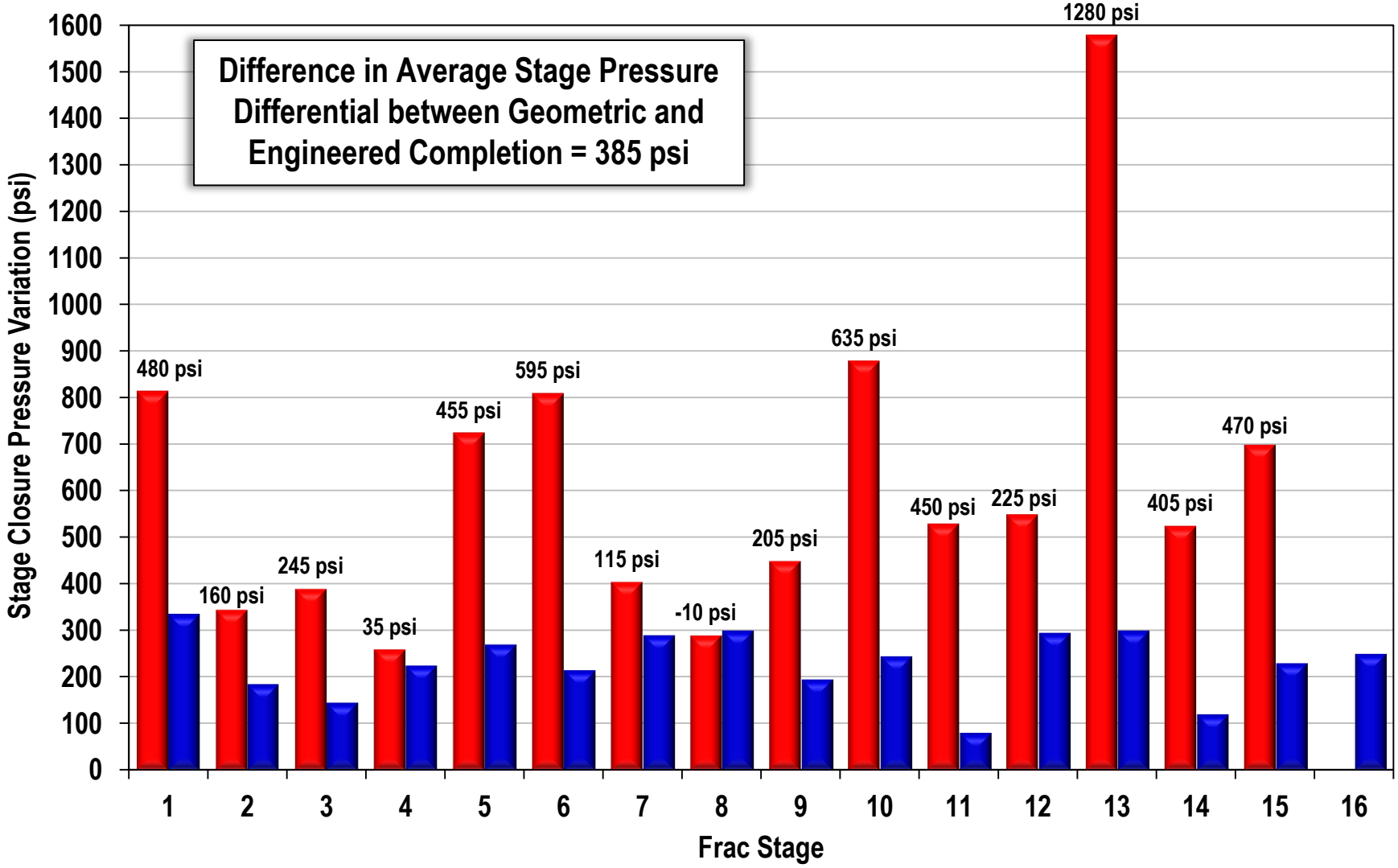
Lateral Well Measurements



Optimizing Completion using RQ and CQ



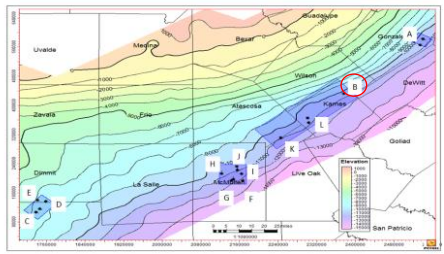
Eagle Ford Shale Frac Stage Pressure Differential

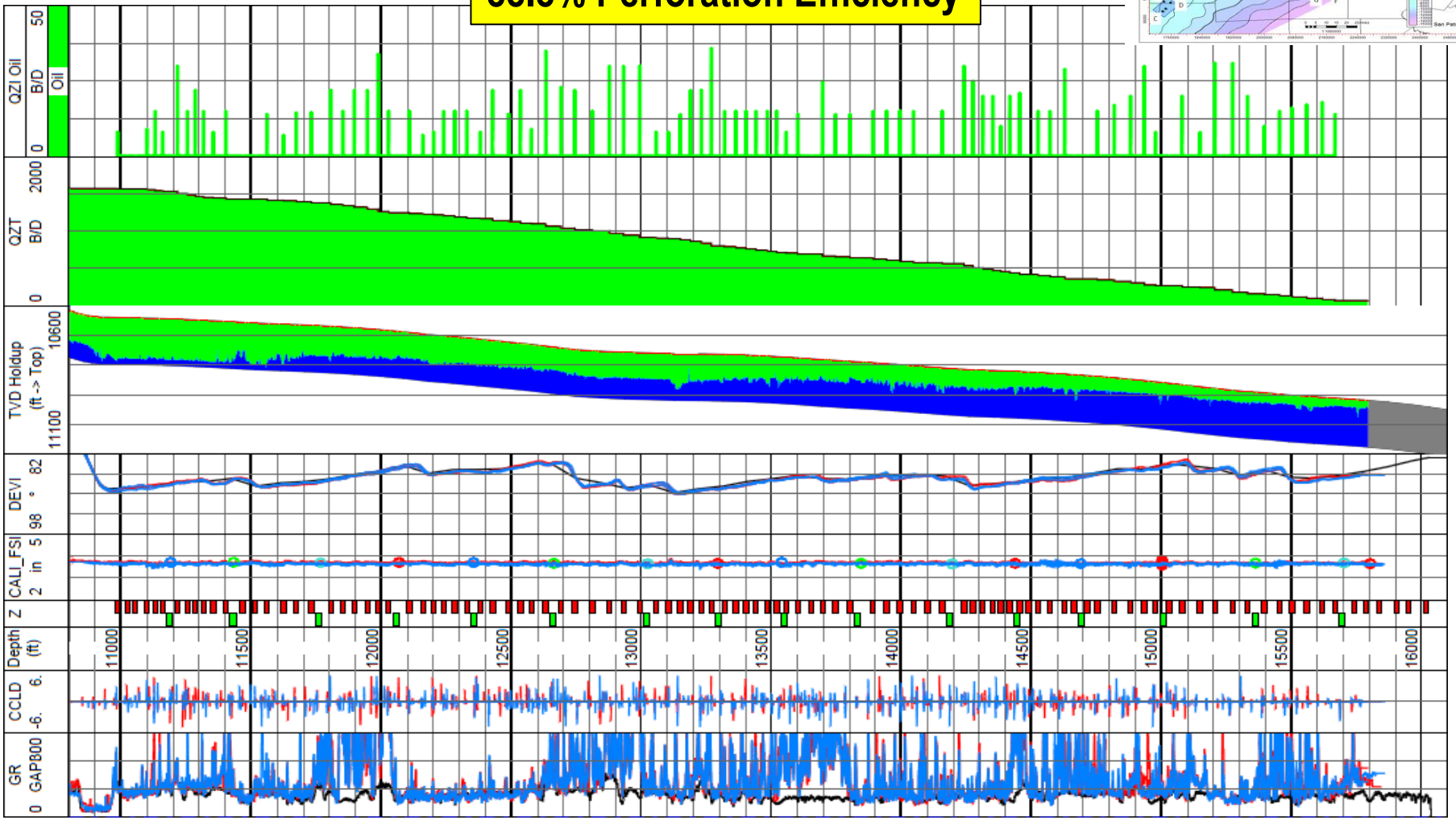


EXAMPLE Well B Engineered Completion

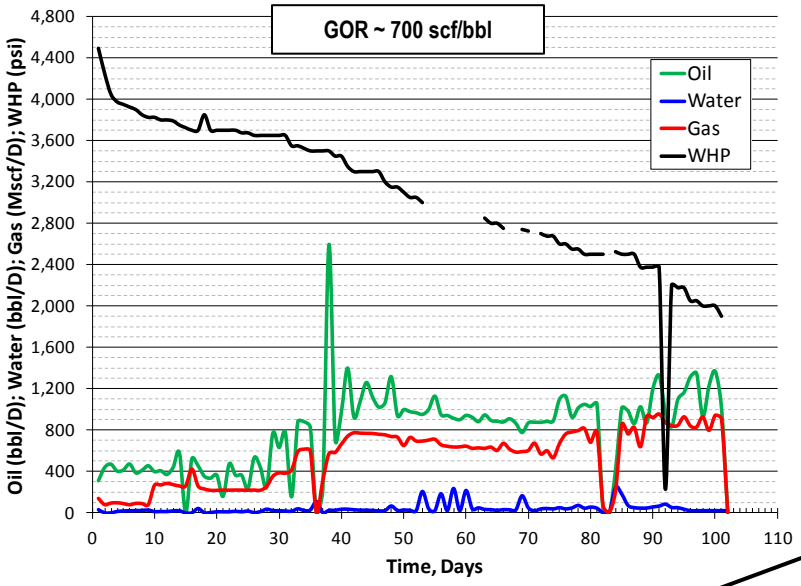
5-1/2 x 4-1/2 Csg / 17 Stg / 102 Perf / 1065 bopd

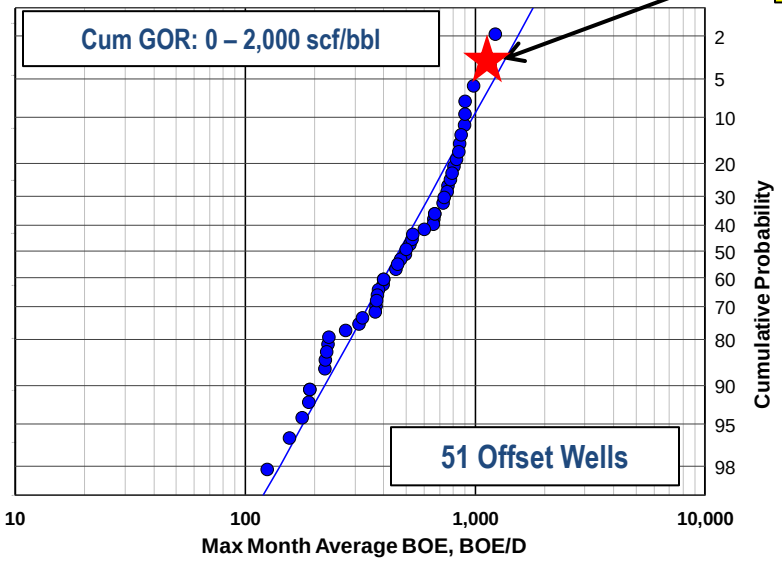
88.8% Perforation Efficiency



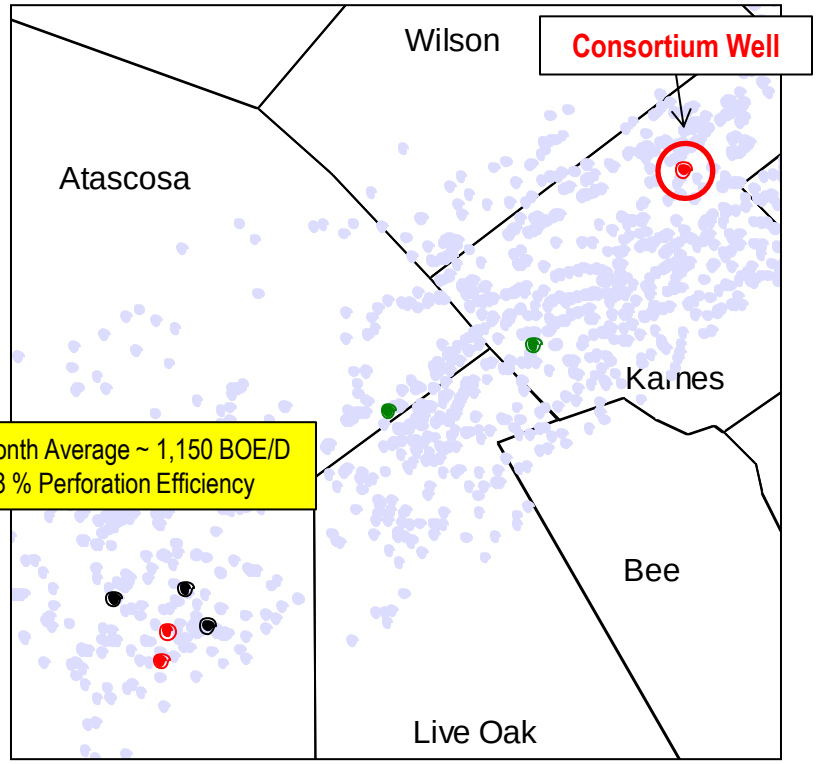


Well B – Production Engineered Completion



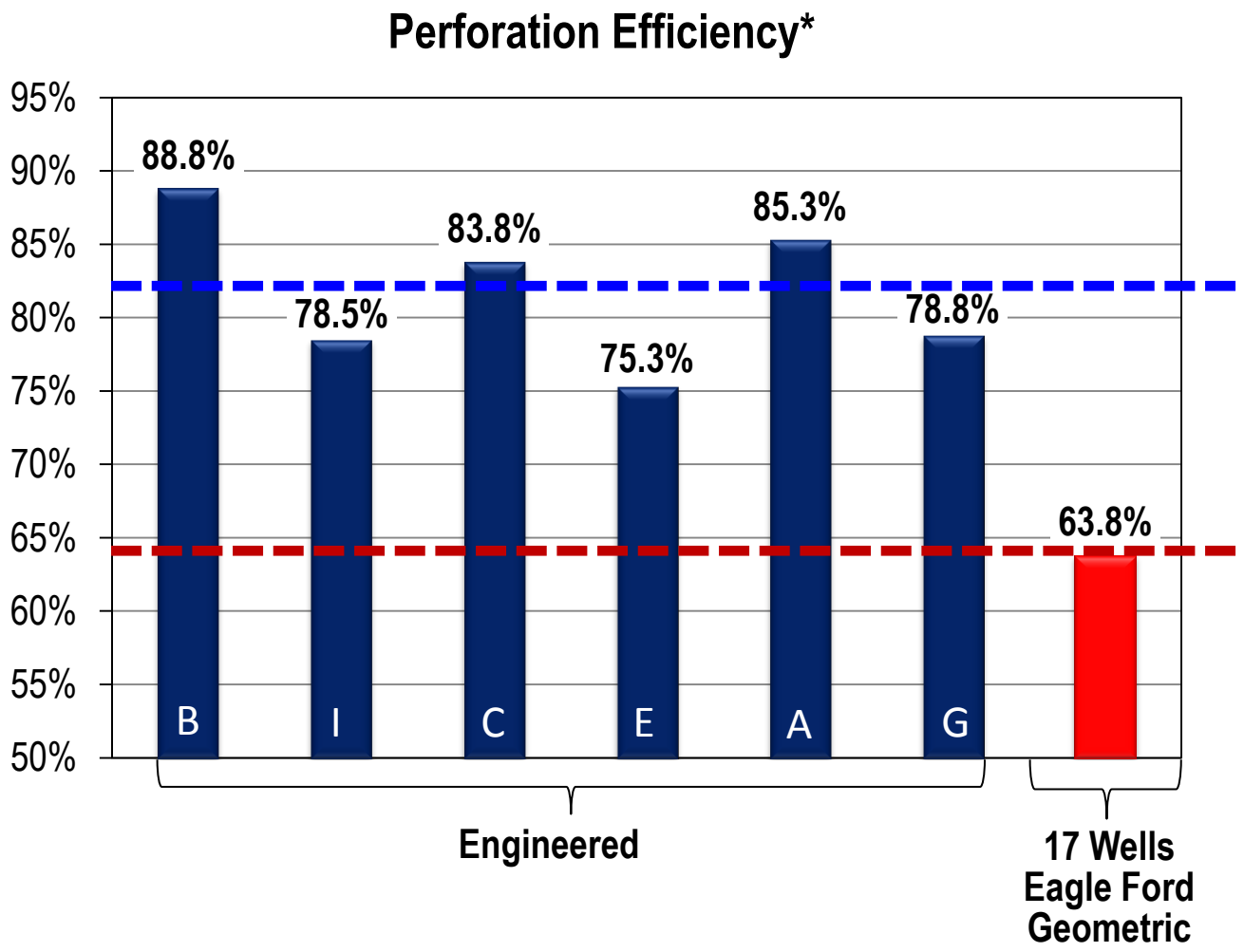


Max Month Average ~ 1,150 BOE/D
88.8 % Perforation Efficiency



1 BOE = 1 bbl oil or 6 Mscf gas

Summary Perf Efficiency: Engineered vs. Geometric

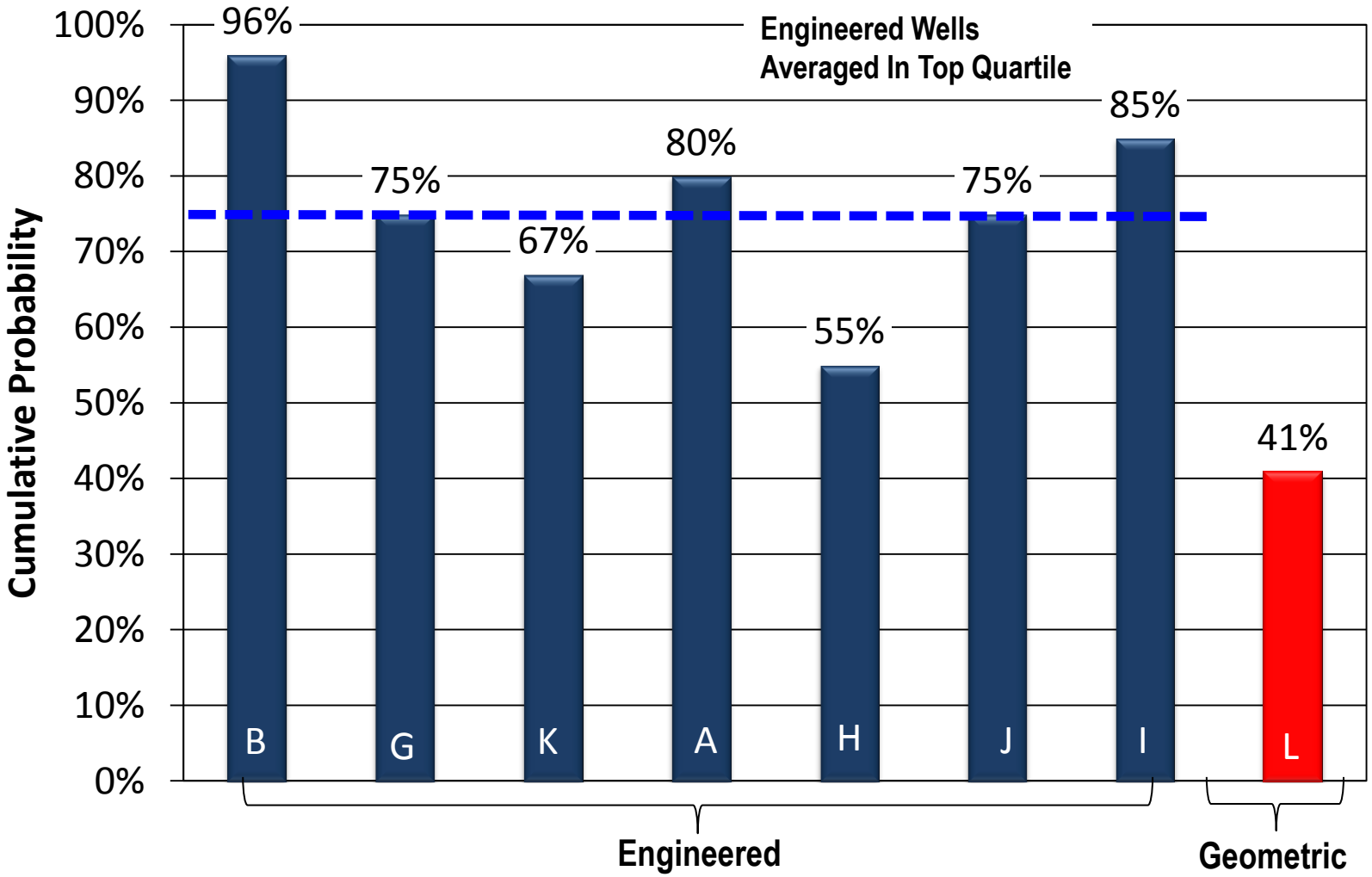


82 %
Engineered
Completion
Eagle Ford
Consortium
6 Well Avg

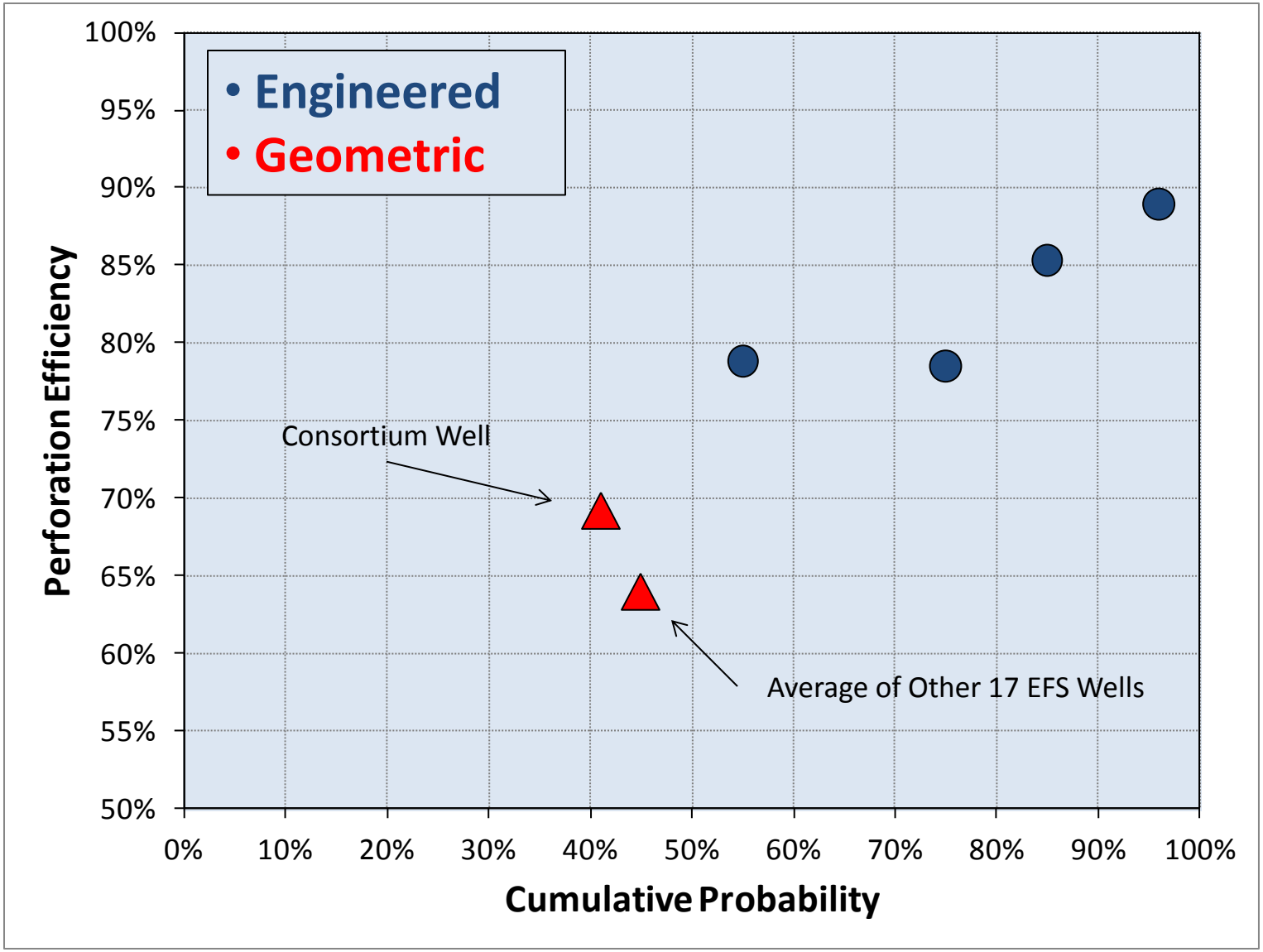
64 %
Geometric
Completion
Eagle Ford
17 Well Avg

* Perforation Efficiency is defined as the number of perforation clusters contributing to production divided by the total number of perforation clusters.

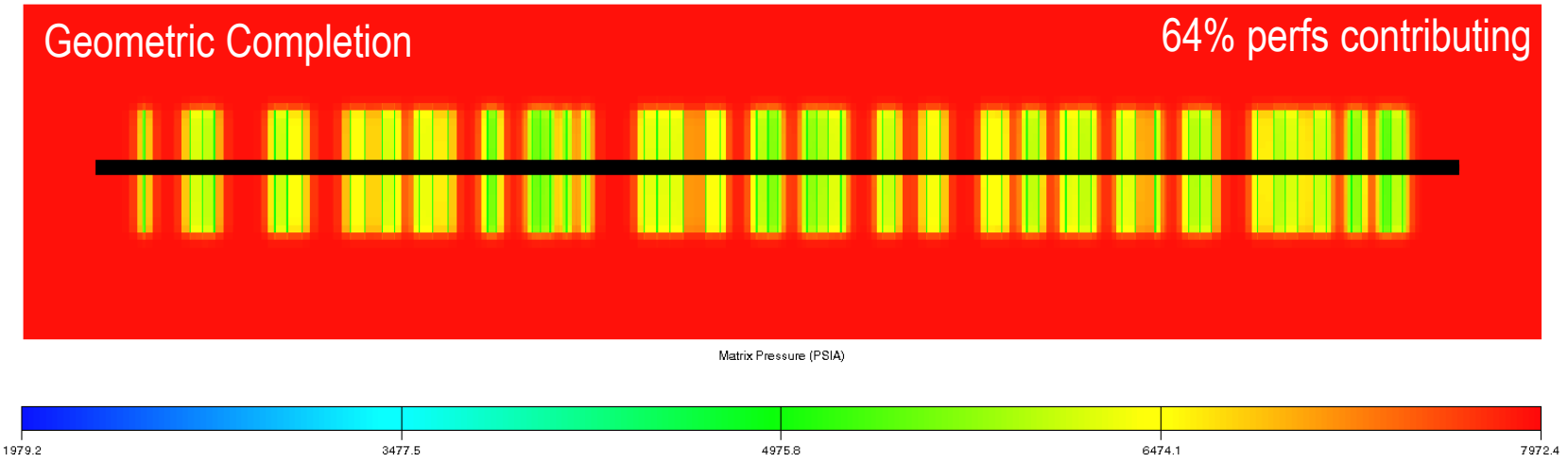
Summary Production Comparison – Engineered vs. Geometric

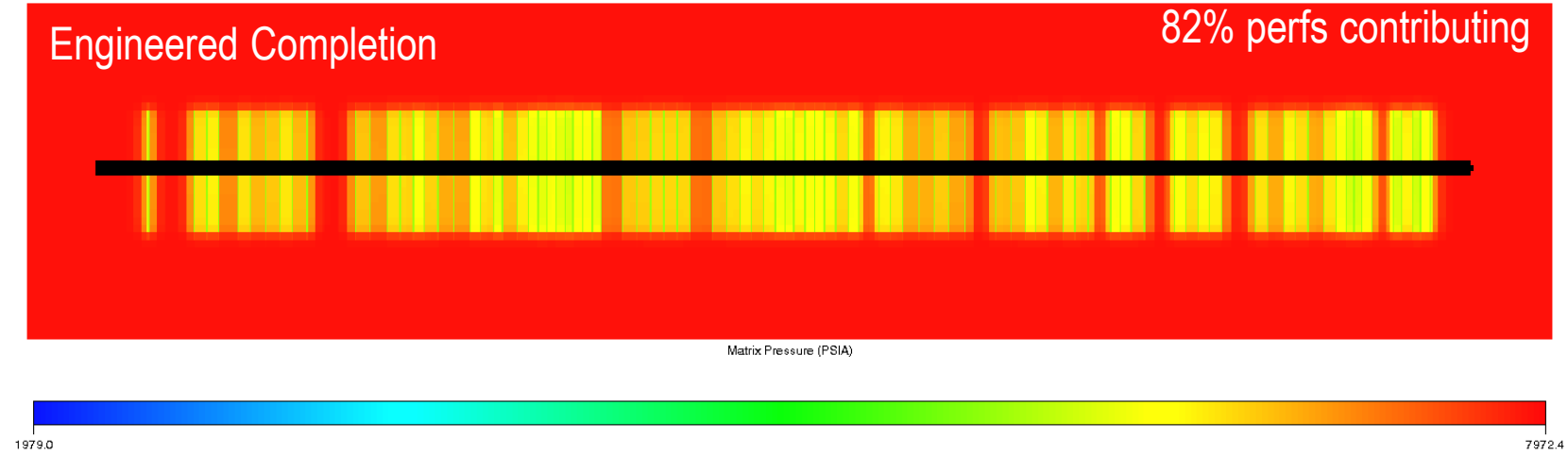


Perforation Efficiency vs. Production

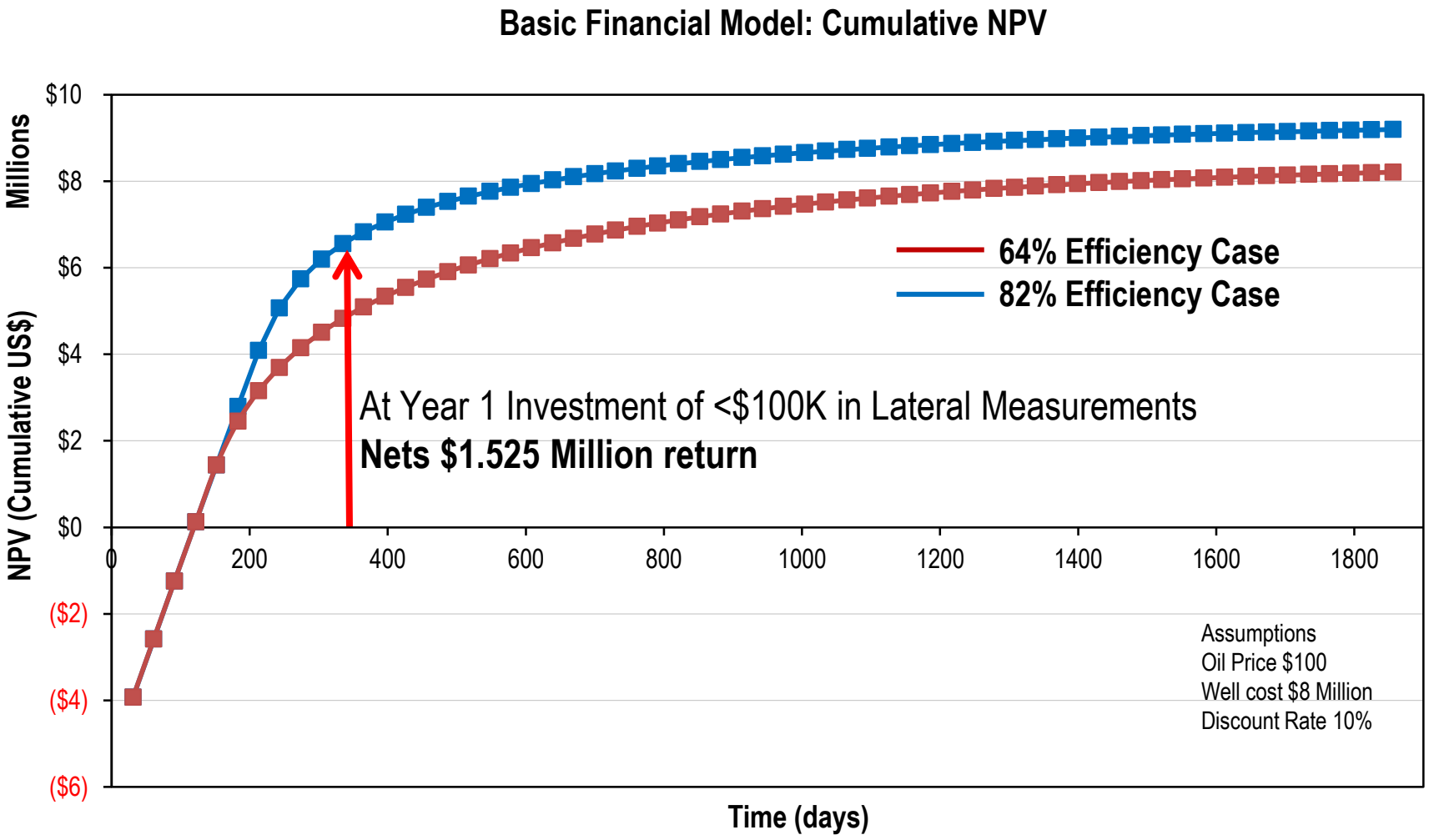


Pressure Drainage Comparison in 1 Year





Engineered and Geometric – NPV impact



Summary

- Reservoir Characterization in the lateral is essential for more effective completions
- Low risk, cost effective lateral measurements
  - ThruBit Quad Combo and SonicScanner used to derive RQ and CQ
- Perforation Cluster Efficiency improved by 28%
- Wells with Engineered Completions were top quartile wells compared to offsets
- Average value per well $1.525M