

PGCE 2009:

**Keys to Success in Unconventional
Shale Gas Resource Plays**

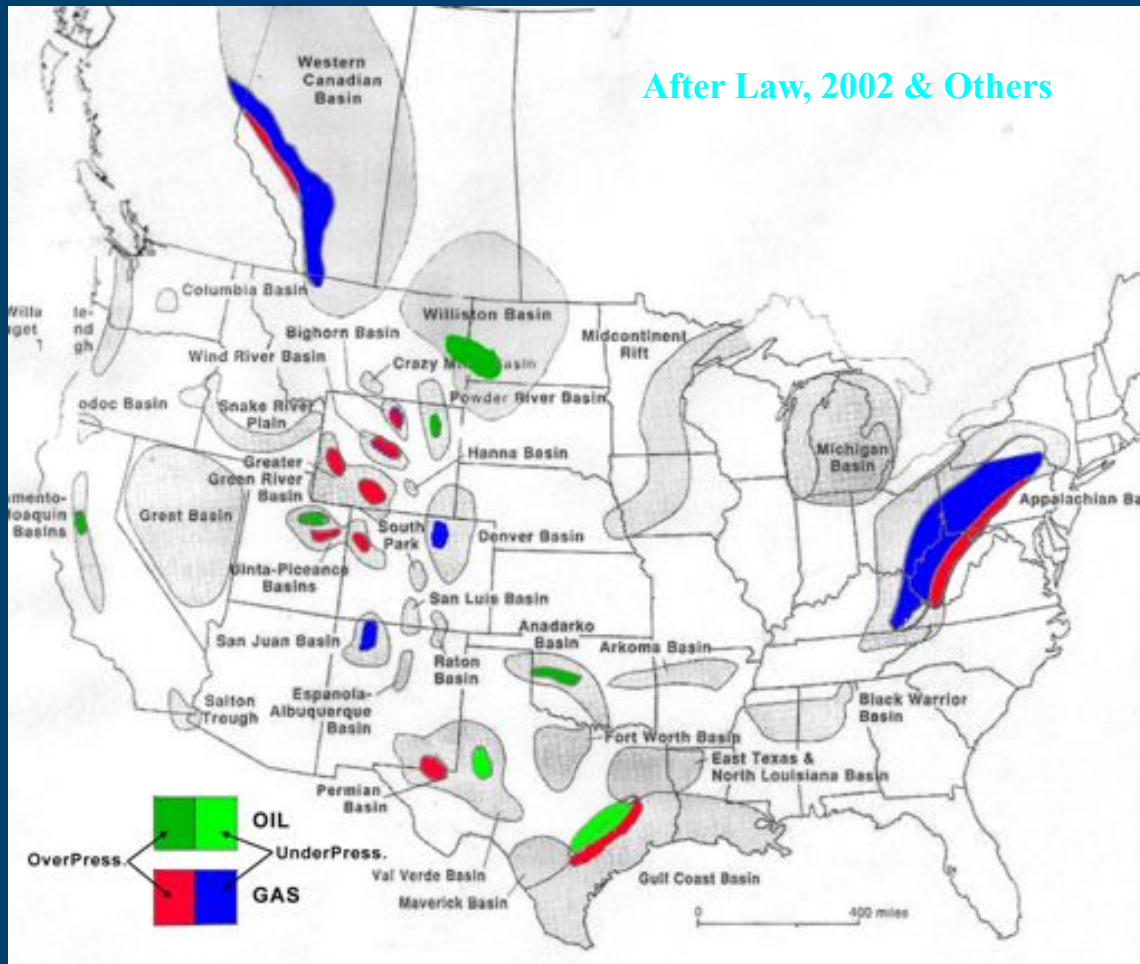
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March 3, 2009

Outline of Presentation

- **Unconventional Resource Plays in North America**
- **Characteristics of Shale Gas Plays**
- **Operations & Economics**
- **Implications for Supply and Prices**

Unconventional Resource Plays



- Tight Gas Sands
- Shale Gas
- Coal Bed Methane
- Heavy Oil Sands

U.S. Gas Production - 2007

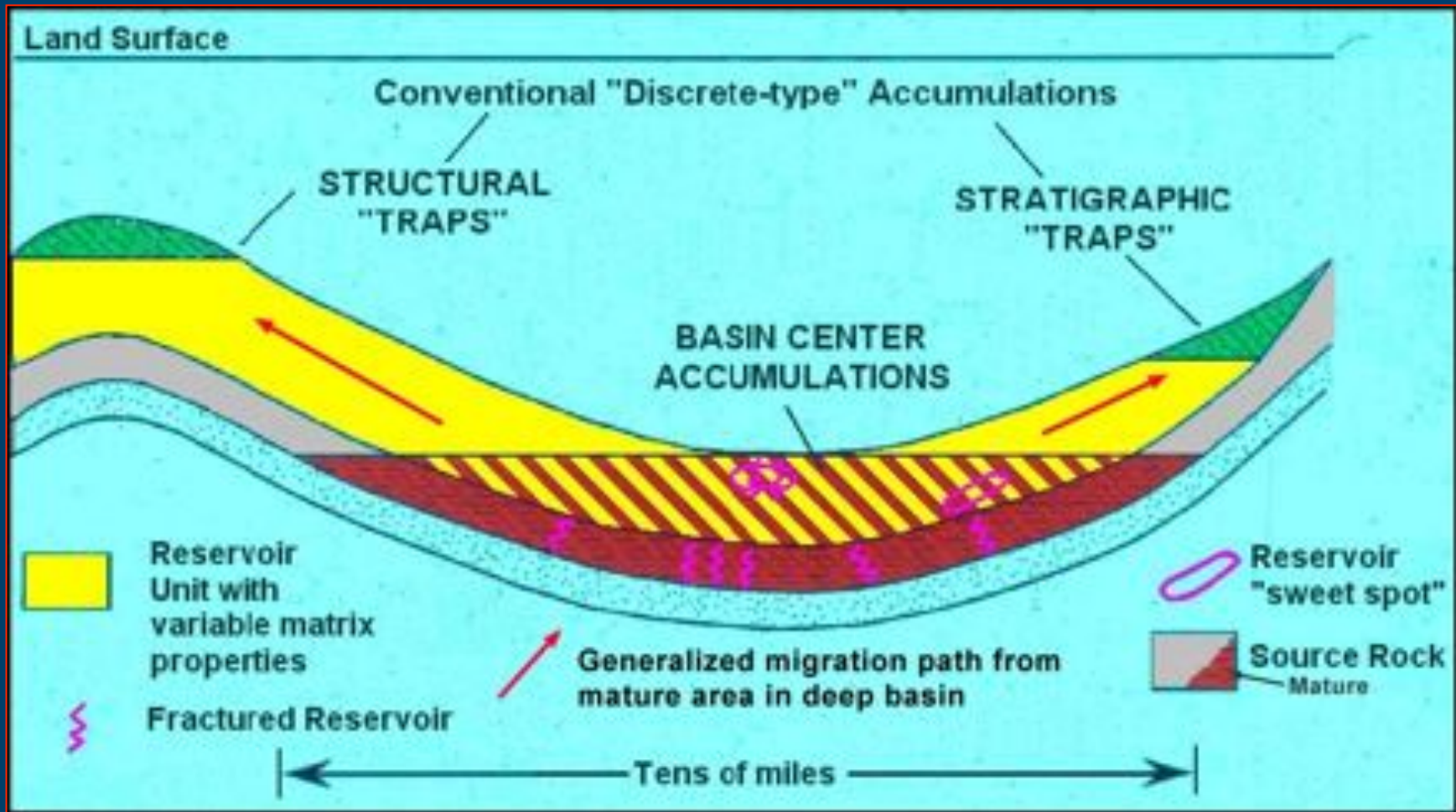
Top 10 U.S. Fields Ranked by Gas Production from Estimated 2007 Field Level Data*

Rank	Field Name	Location	Accumulation Type	Continuous Classification	Discovery Yr	2007 Est. Prod. Vol. Bcf
1	San Juan Basin Gas Area	CO & NM	Continuous	Coalbed gas	1927	1,320.7
2	Newark East	TX	Continuous	Shale Gas	1981	1,110.3
3	PRB Coalbed	MT & WY	Continuous	Coalbed gas	1992	442.0
4	Jonah	WY	Continuous	Tight sandstone and basin centered gas	1977	366.3
5	Hugoton Gas Area	KS, OK & TX	Conventional	NA	1922	357.8
6	Pinedale	WY	Continuous	Tight sandstone and basin centered gas	1955	313.4
7	Carthage	TX	Conventional	NA	1936	231.7
8	Natural Buttes	UT	Continuous	Tight sandstone and basin centered gas	1940	170.4
9	Wattenberg	CO & NM	Continuous	Chalk gas and basin centered	1970	169.0
10	Prudhoe Bay	AK	Conventional	NA	1967	168.7

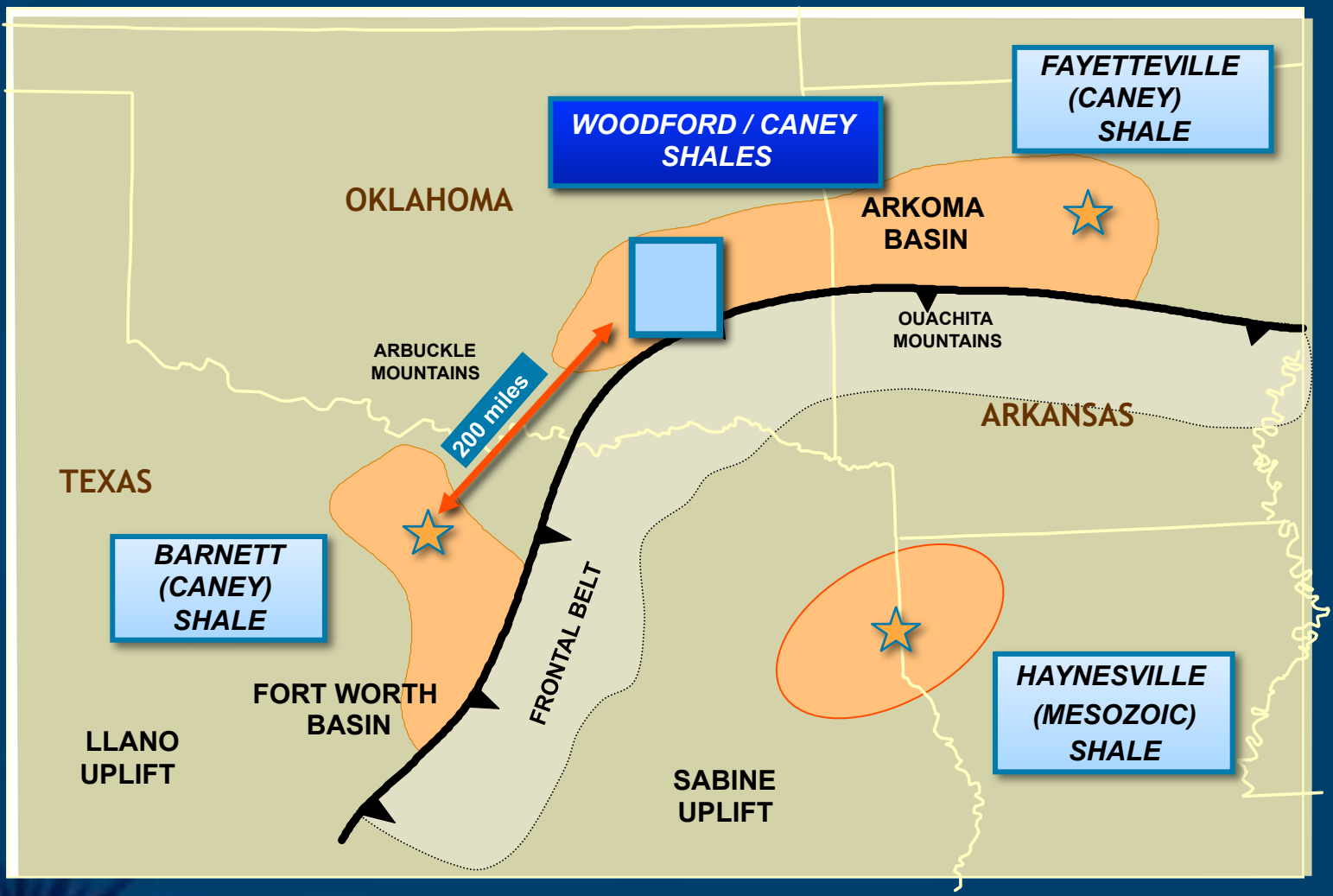
*Energy Information Administration, US Crude Oil, Natural Gas and Natural Liquids Reserves 2007 Annual Report

Shale gas + tight gas + coalbed methane = 42% of US gas production in 2007 and could account for ~48% by 2010
(Warlick Int. NA Unconventional Gas Market Report 2008)

Basin Centered Gas



Paleozoic Shale Gas Plays



Play Characteristics Comparison

PARAMETER	TARGET RANGE	Western Arkoma WOODFORD	Fort Worth CANEY/ BARNETT	Eastern Arkoma CANEY/ FAYETTEVILLE	North Louisiana HAYNESVILLE/ BOSSIER
Total Organic Carbon	2 – 10%	3 – 10%	3 – 8%	3 – 8%	3 – 5%
Thermal Maturity Vitrinite % Ro	1.1 – 3.0%	1.1 – 3.0%	1.2 – 2.0%	1.2 – 4.0%	?
Mineralogy/ Silica Content	30 – 80%	60 – 80%	40 – 60%	40 – 60%	<40%?
Gas Filled Porosity	2 – 8%	3 – 6.5%	3 – 5.5%	3 – 5.5%	6–10%
Depth (feet)	NA	6,000 – 14,000	6,000 – 9,000	1,500 – 6,500	10,500 – 13,500
Thickness (feet)	NA	100 – 220	300 – 500	50 – 325	200– 240

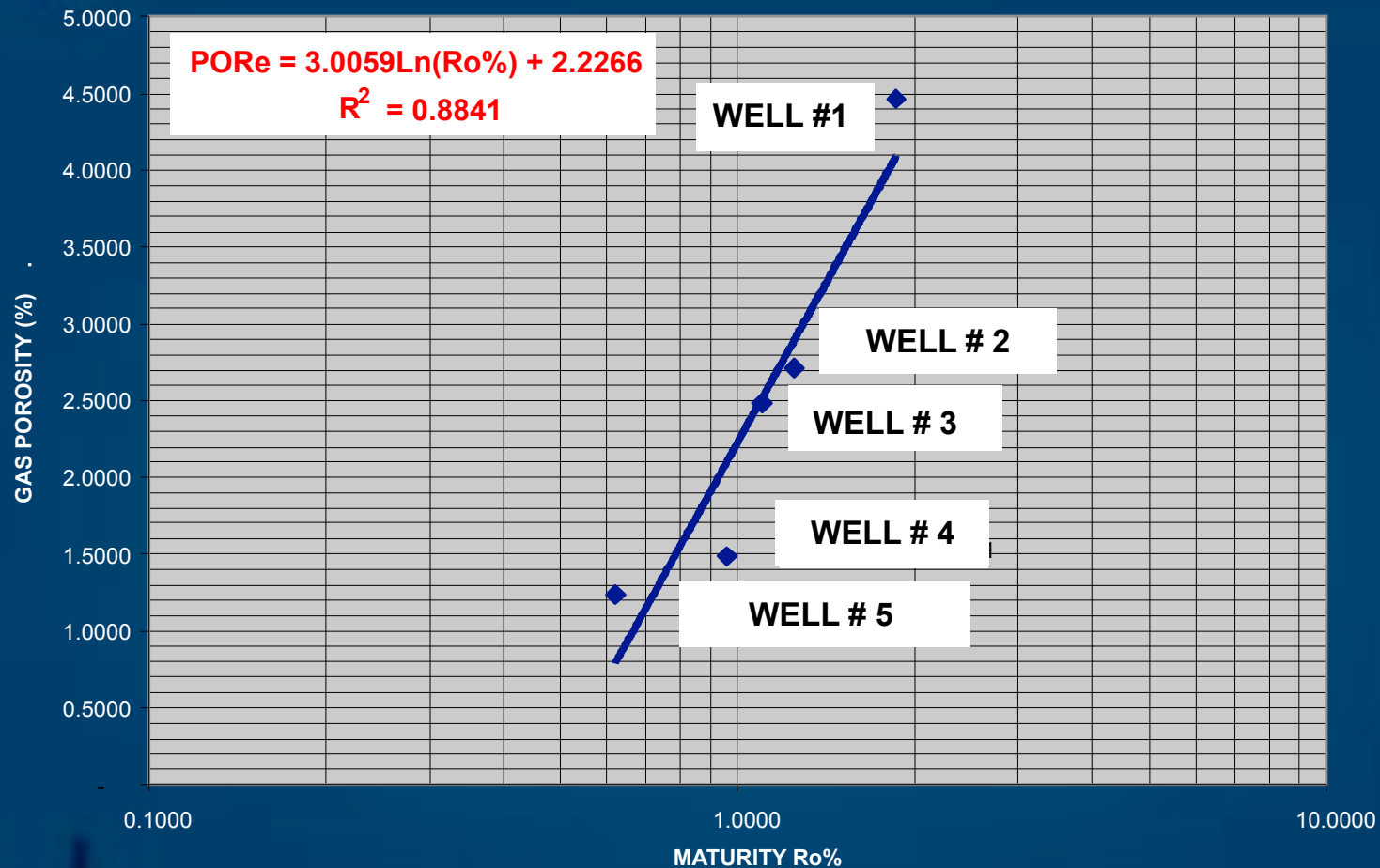
Radiolarian Ooze



SOURCE

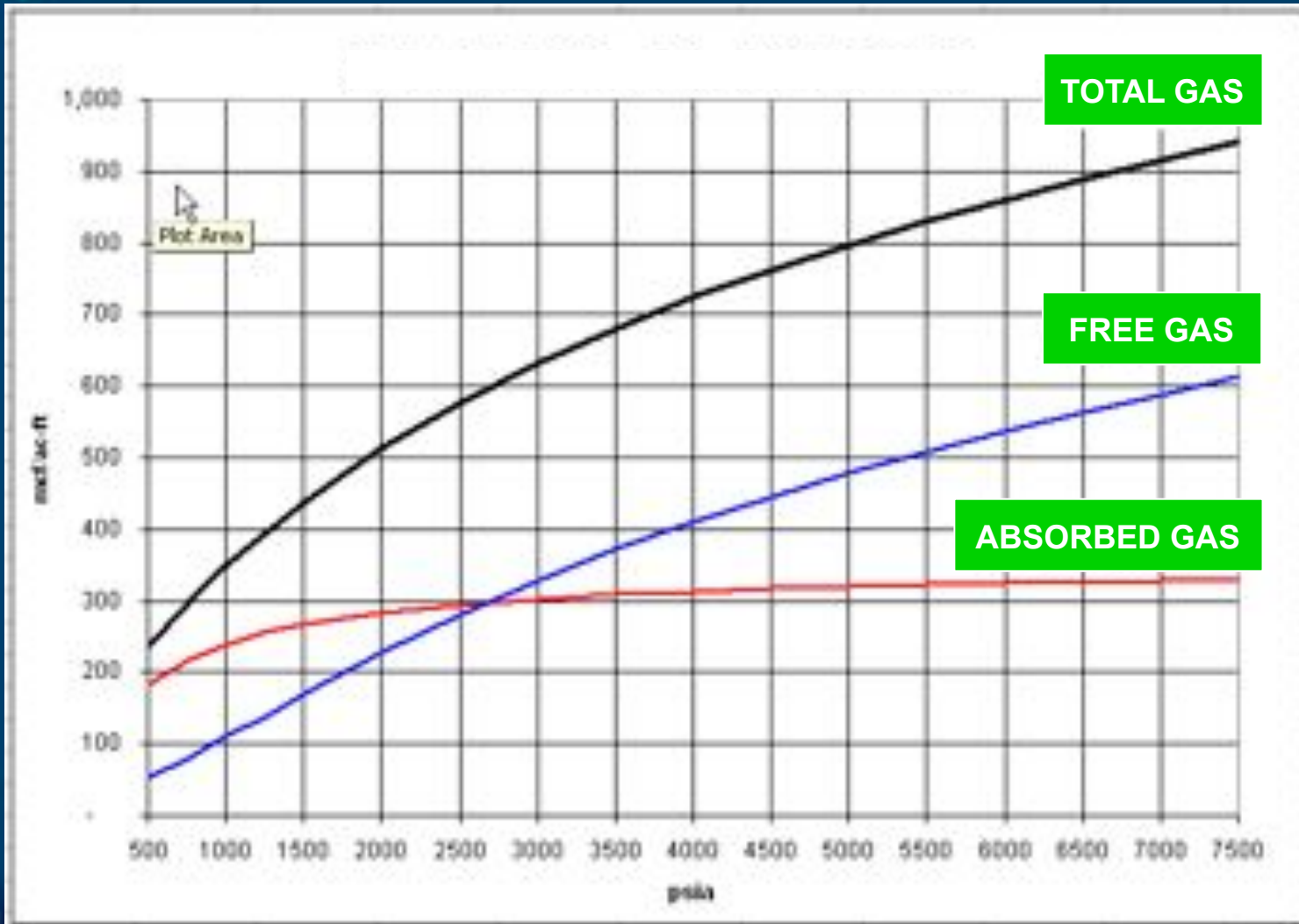
- TOC
- Porosity
- Brittleness

Effective Gas Porosity vs. Maturity for the Barnett Shale



Shale porosity increases with maturity. This is opposite to conventional plays in which porosity and permeability decrease with depth.

Gas In Place Components

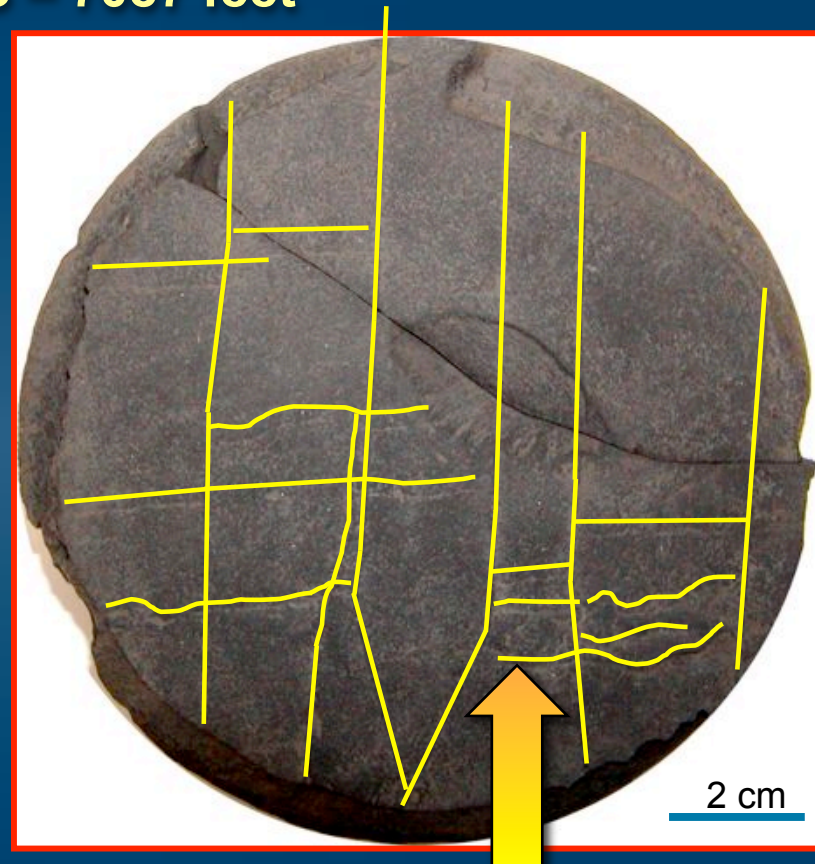


Faults, Fractures & Seals

- **Understanding Faults and Direction of Principle Stress is Critical to:**
 - *Orienting Wells*
 - *Designing Drill Plan*
 - *Avoiding Drilling Out of Zone*
 - *Avoiding Non Sealing Faults*
- **Fracture Swarms (Cracks)**
 - *Intensity in patterns is critical to permeability to wellbore*
- **Vertical Seals are Critical to Containing Fracture Stimulation**

Natural Fractures

**Grant #1-6
END VIEWS – 7087 feet**

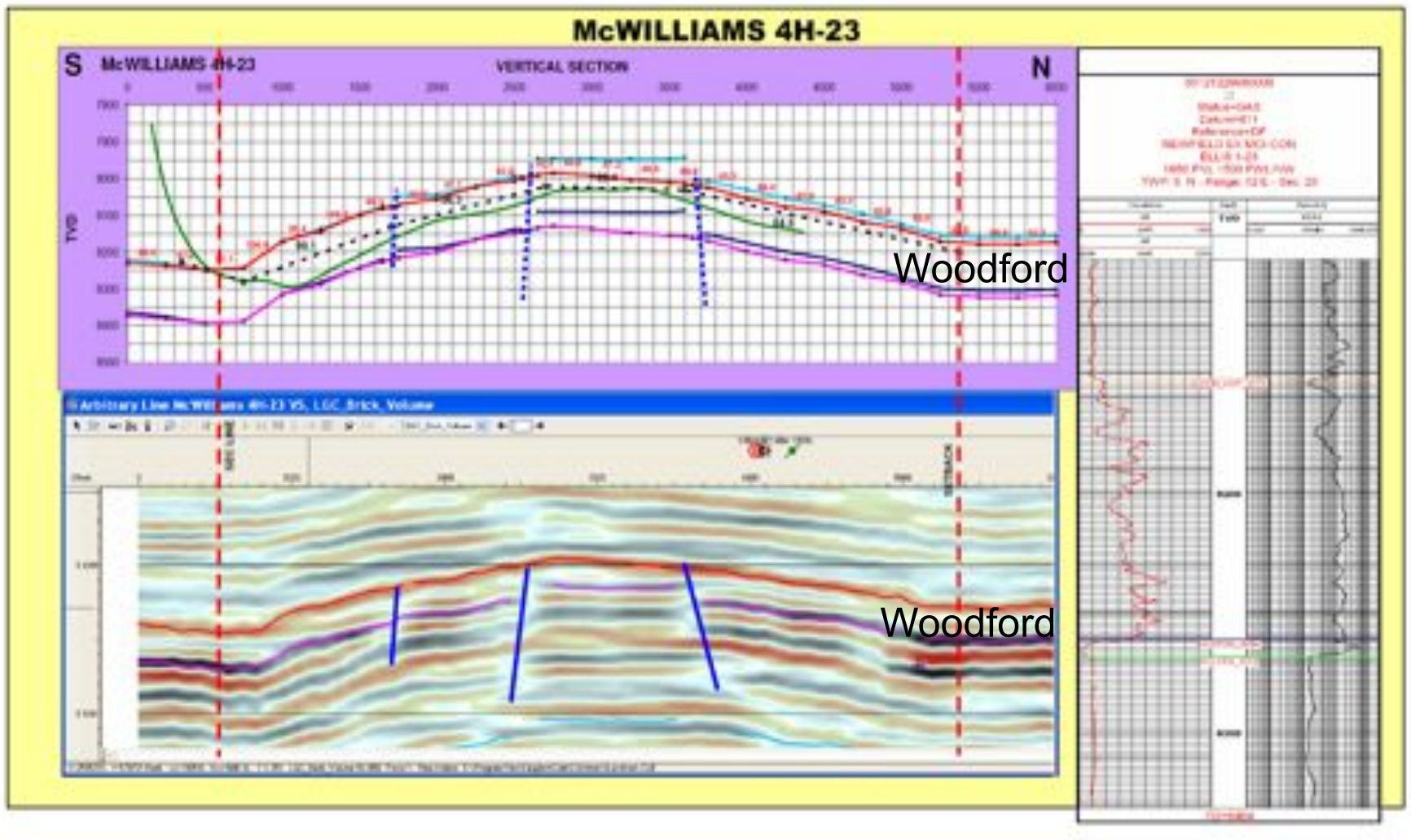


Natural Fractures = Gas Conduits

Recipe for Success

- **Commercial risks outweigh geologic risk**
- **Collect science early**
 - *Regional perspective to define sweet spots*
- **Operational solutions are key to success**
 - *Ability to rapidly build a learning curve and adapt to change*
 - *Integration of G&G and Operations is key to lowering cost*
- **Fracture containment is imperative**
- **Geophysics are important – don't drill WITHOUT 3-D!**
- **Horizontal drilling improves economics**

Geosteering



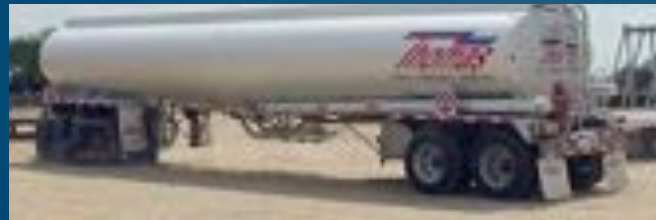
Woodford Horizontals – Fracture Treatment Size

Typical Job Size = 12,000 bbls = 504,000 gallons = 126 Tanker Trucks



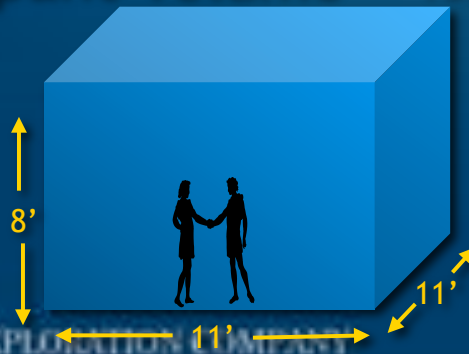
x 126

Typical Job Rate = 100 bbls/min = 4200 gallons/min = 1 Tanker Truck/min



Per Minute

Typical Proppant Volume = 100,000 lbs = 1000 cu. ft



Would fill an
8'x 11'x 11' room

Aerial View of Locations



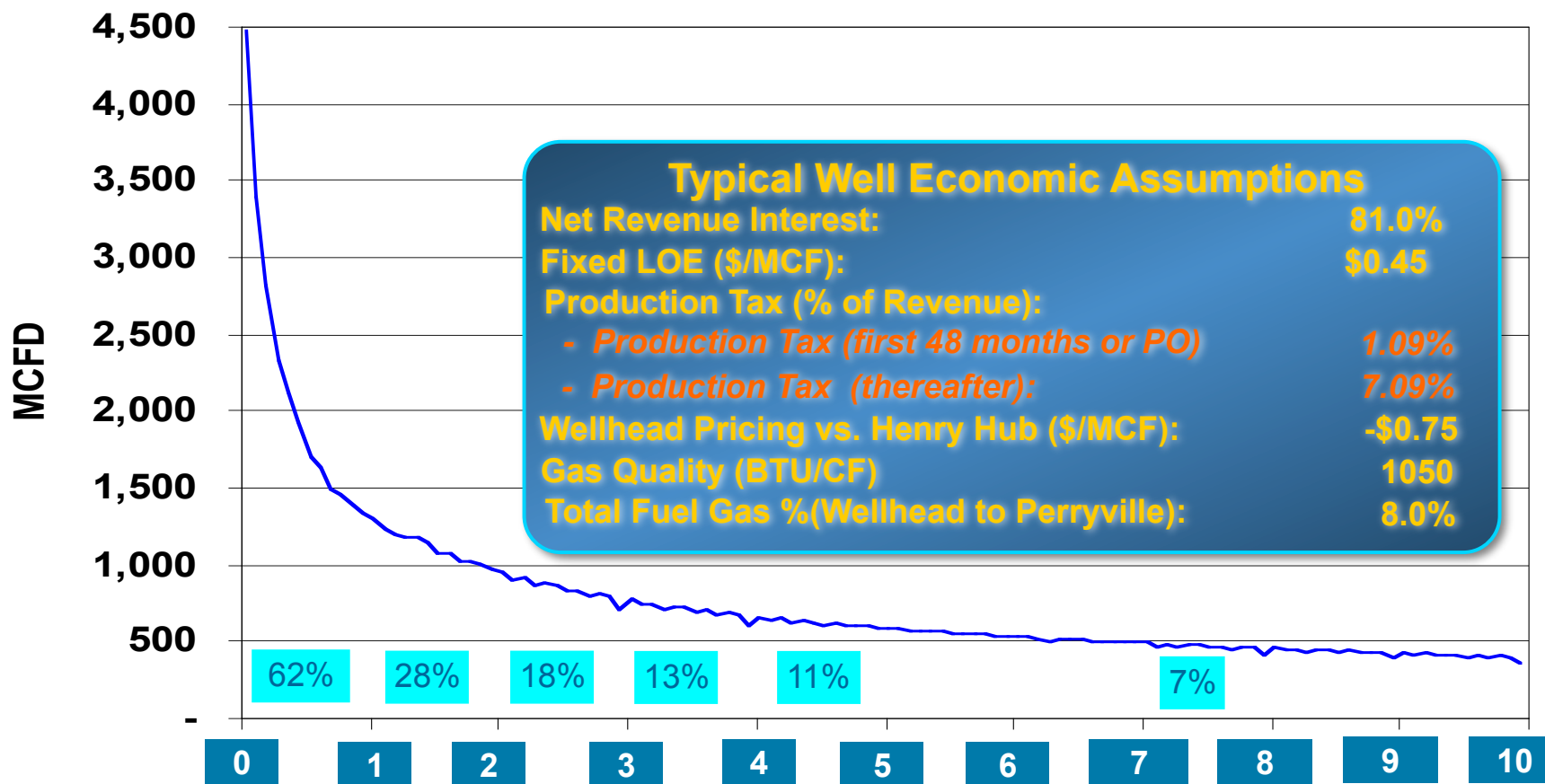
Frac Ponds

Typical Frac Location Set Up

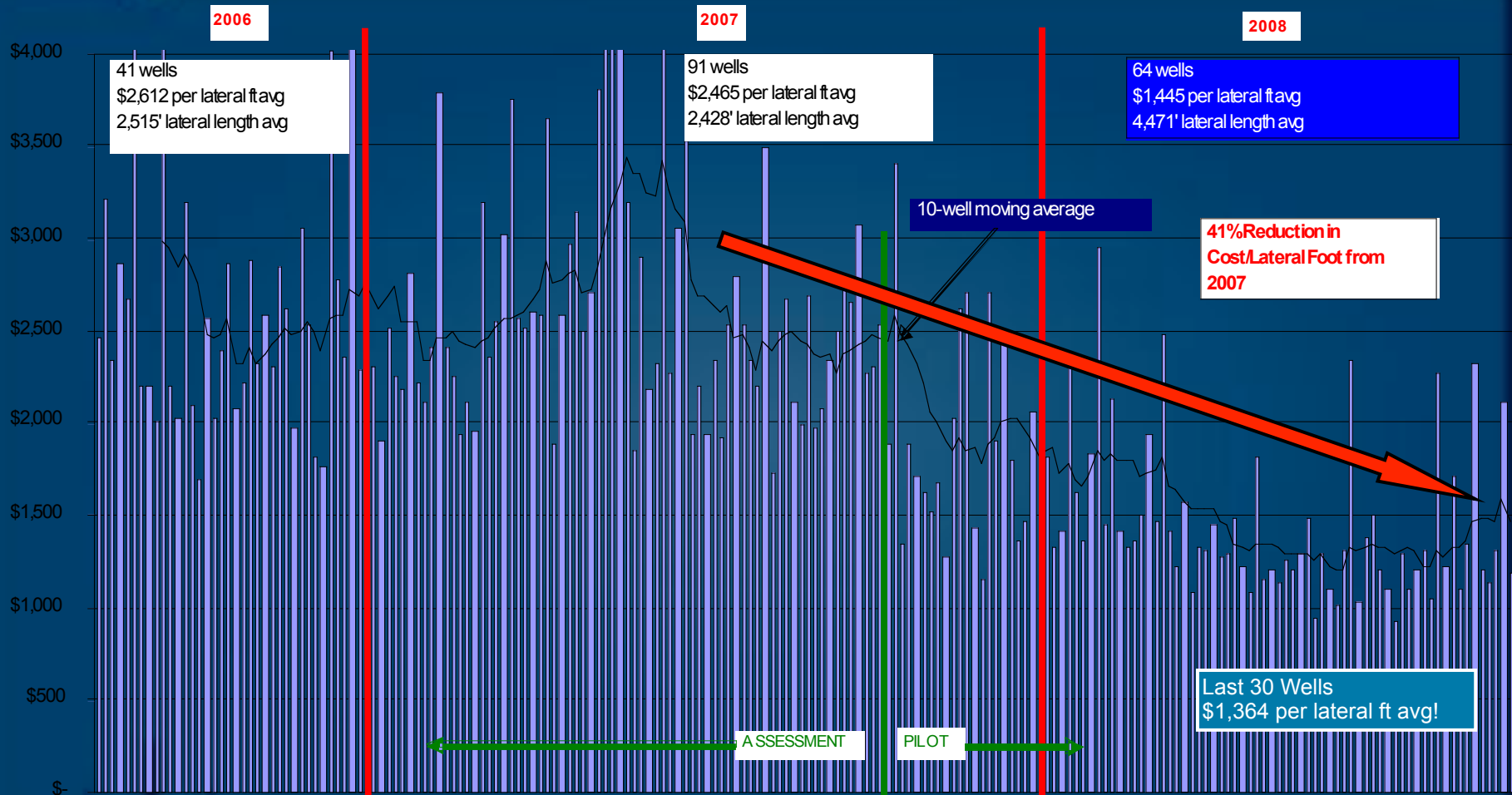


Horizontal Woodford Type Curve

5 Bcfe Typical Well



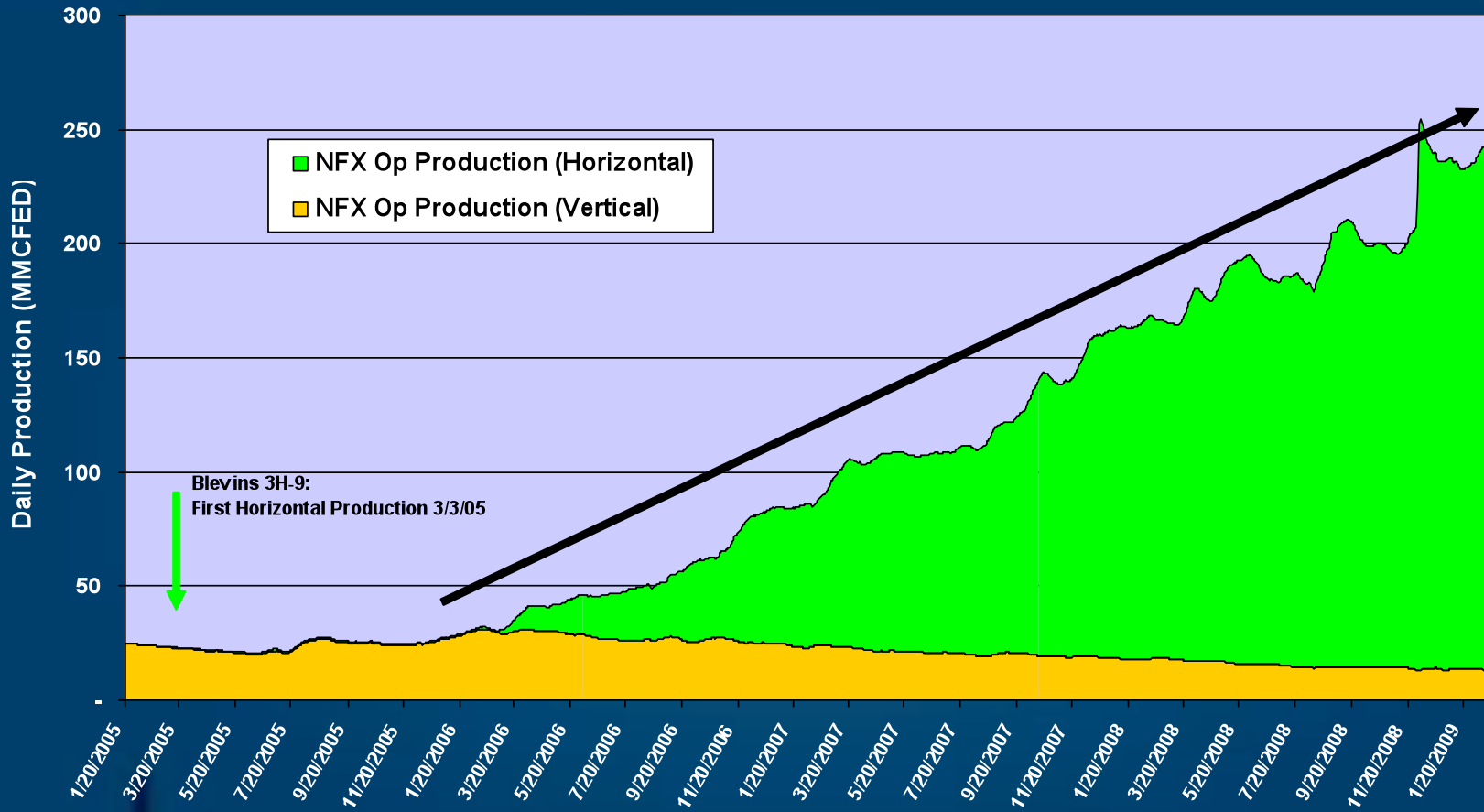
Learning Curve - cost per lateral foot



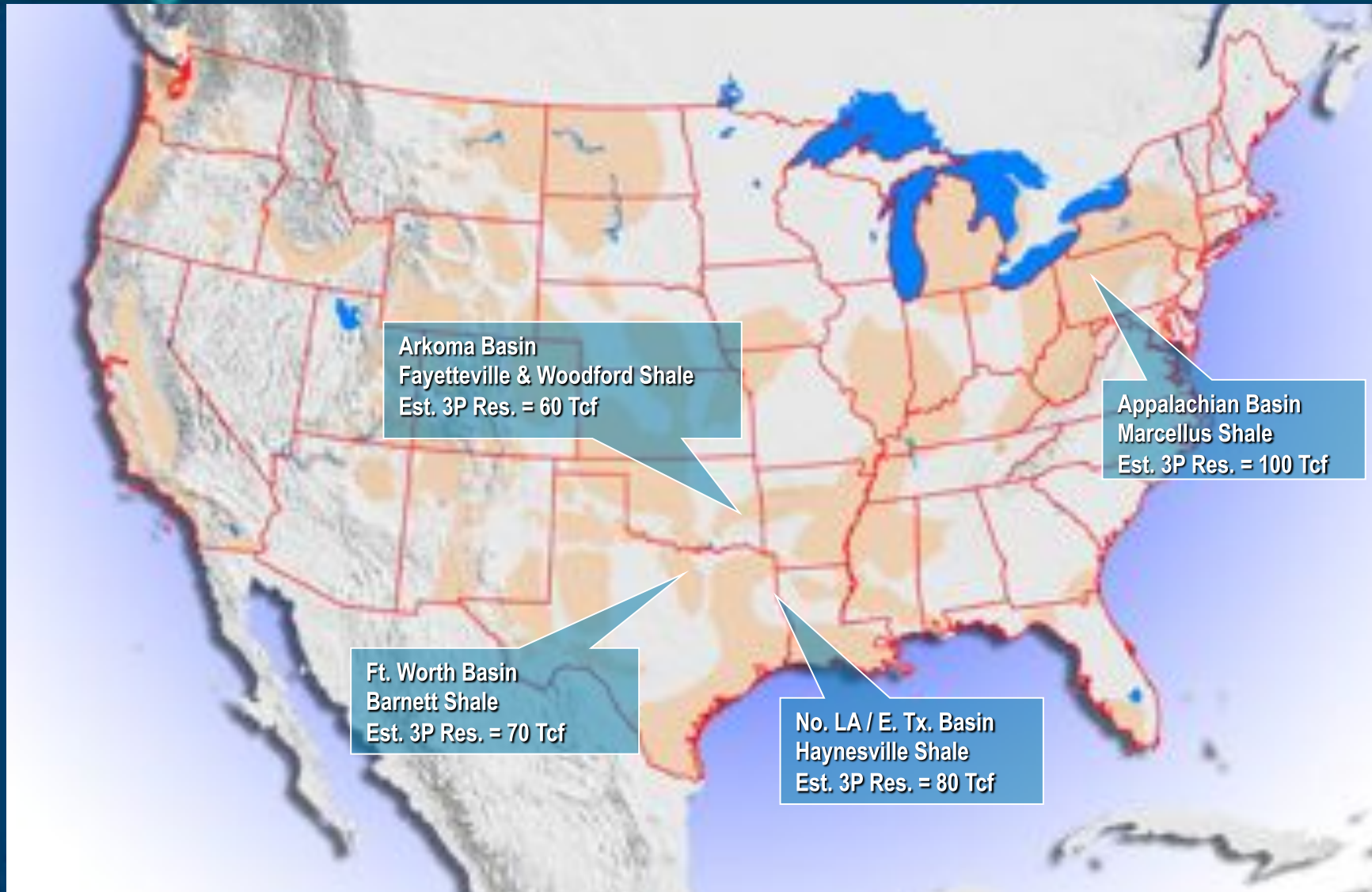
Note: 7 mechanical problem wells removed from 203 total wells drilled (<3.5%)

Woodford History – NFX Gross Production 20-Day Moving Average

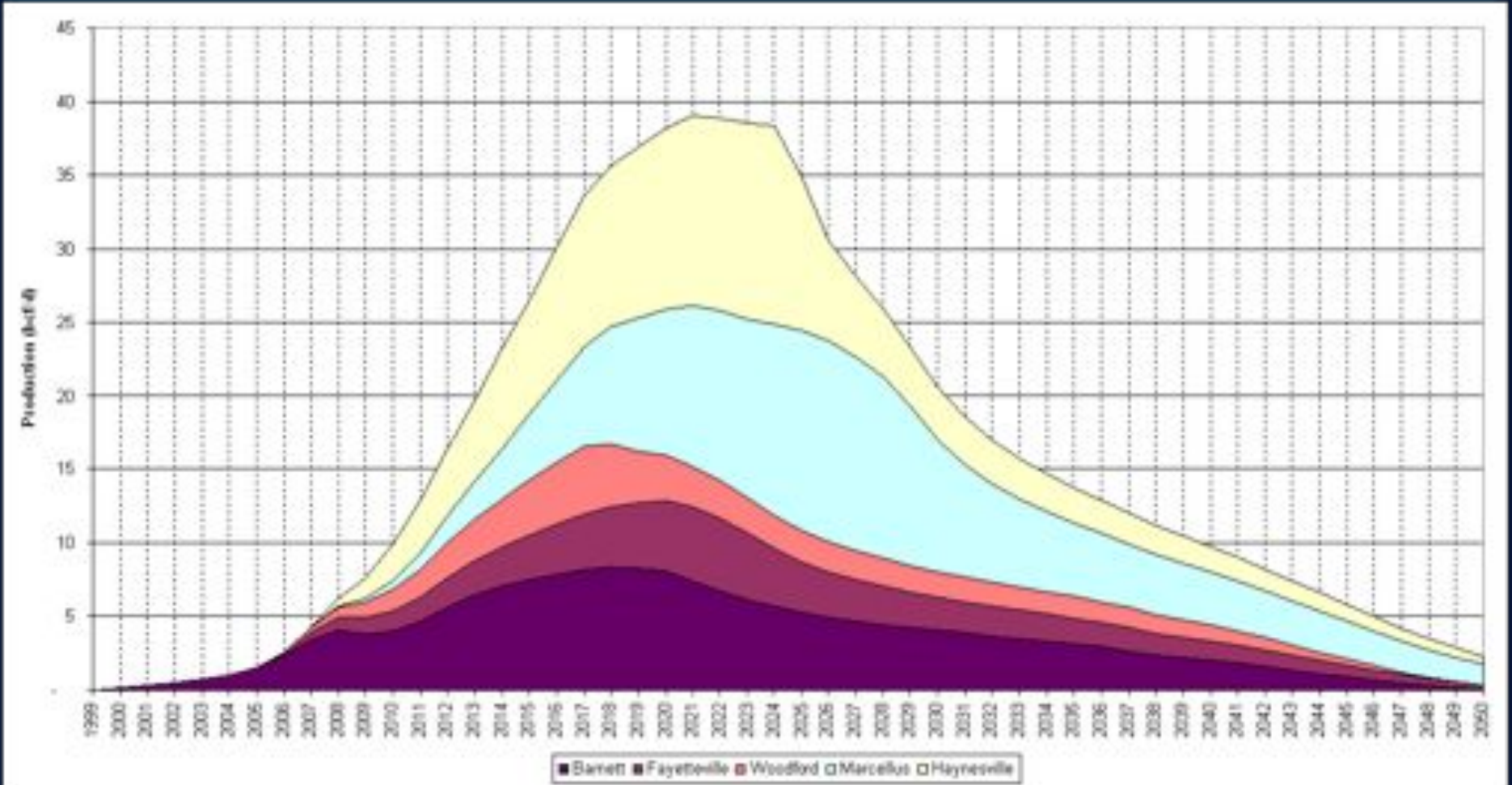
www.newfield.com



Major U.S. Shale Gas Plays



Impact on U.S. Gas Production



Implications for Gas Supply

- **Abundant new source of natural gas in North America**
- **LNG regasification facilities in US are overbuilt and underutilized.**
- **Arctic pipelines to produce Alaska and Mackenzie Delta gas will be delayed.**
- **Natural gas will begin to displace crude oil in some segments in the US.**

Implications for Natural Gas Prices

- Supply in No. America exceeds demand.
- Prices have fallen from >US\$13.00/mmbtu in mid-2008 to <US\$4.00/mmbtu currently.
- Natural gas prices in No. America will continue to be lower than prices in Europe and Asia in coming years.

Conclusions

- **Reserves additions from unconventional resource plays have reversed a 30 year decline in US natural gas reserves.**
- **Production from shale gas represents 10% of US supply and will grow significantly in the future.**
- **Unconventional resource plays on other continents could have similar impact on natural gas markets worldwide.**