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[AV]The Evolution of the American Shale Plays: Where We Are and How We Got There*

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Abstract

Since around 2006 the exploration, appraisal, and development of shale reservoirs in the Lower 48 has seen a dramatic escalation, first starting with the gas productive shale reservoirs then followed by those that are liquid productive. The result has been a total renaissance for the domestic E & P industry. Each of the plays, which total approximately 14 that have seen substantial development, underwent an evolutionary cycle that was driven by the roles of the various functions that contribute to the success of any given play: land, geologic, drilling, completion, and production. As each play progresses through the evolutionary cycle, the role of each function changes accordingly. Even though all of the plays have certain common characteristics, Richard will attempt to point out something uniquely different about each of the 14 plays that might aid in a better understanding of plays yet to be discovered.

Selected References

Bowker, K.A., 2003, Recent Developments of the Barnett Shale Play, Fort Worth Basin: West Texas Geological Society Bulletin, v. 42/6, p. 4-11.

EIA, U.S. Energy Information Administration. https://www.eia.gov/. Website accessed September 2017.

ITG, Investment Technology Group. https://www.itg.com/. Website accessed September 21017.

Jefferies. http://www.jefferies.com/. Website accessed September 2017.

RSEG, RS Energy Group. https://www.rseg.com/. Website accessed September 2017.

The Evolution of the American Shale Plays: Where We Are and How We Got Here

AAPG DPA Mid-Con Playmakers Forum
May 11, 2017

Richard Stoneburner
Managing Director
Pine Brook

PINE BROOK

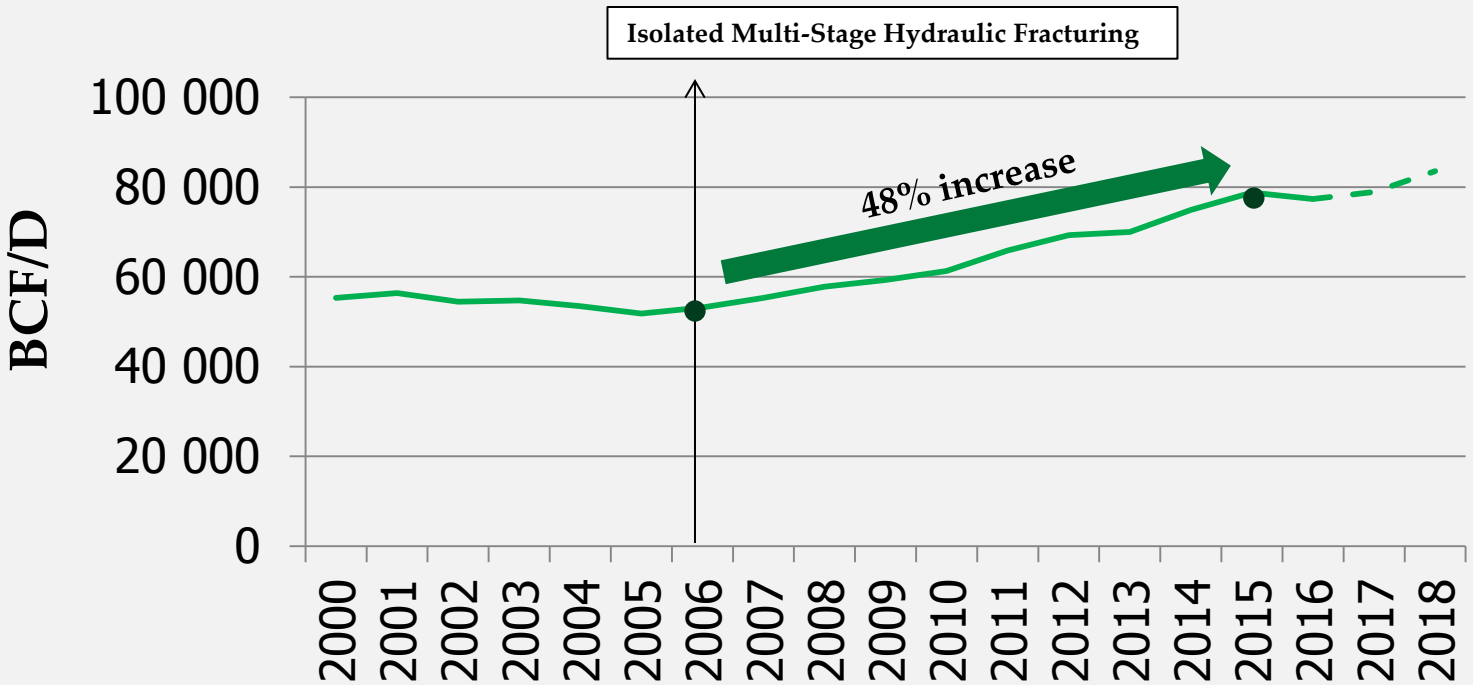
Overview

- I first generated this presentation in August 2014 to present at a conference in Australia
- It was meant to be a “primer” on shale oil and gas development in America at the time
- The approach was to create a categorization of the of American shale plays based on level of maturity
- However, MUCH HAS CHANGED in the almost 3 years since this was presentation was created

The Shale Gas Revolution: A Graphical Depiction

The advent of isolated, multi-stage hydraulic fracturing in ~2006 was the game changer

U.S. Natural Gas Production

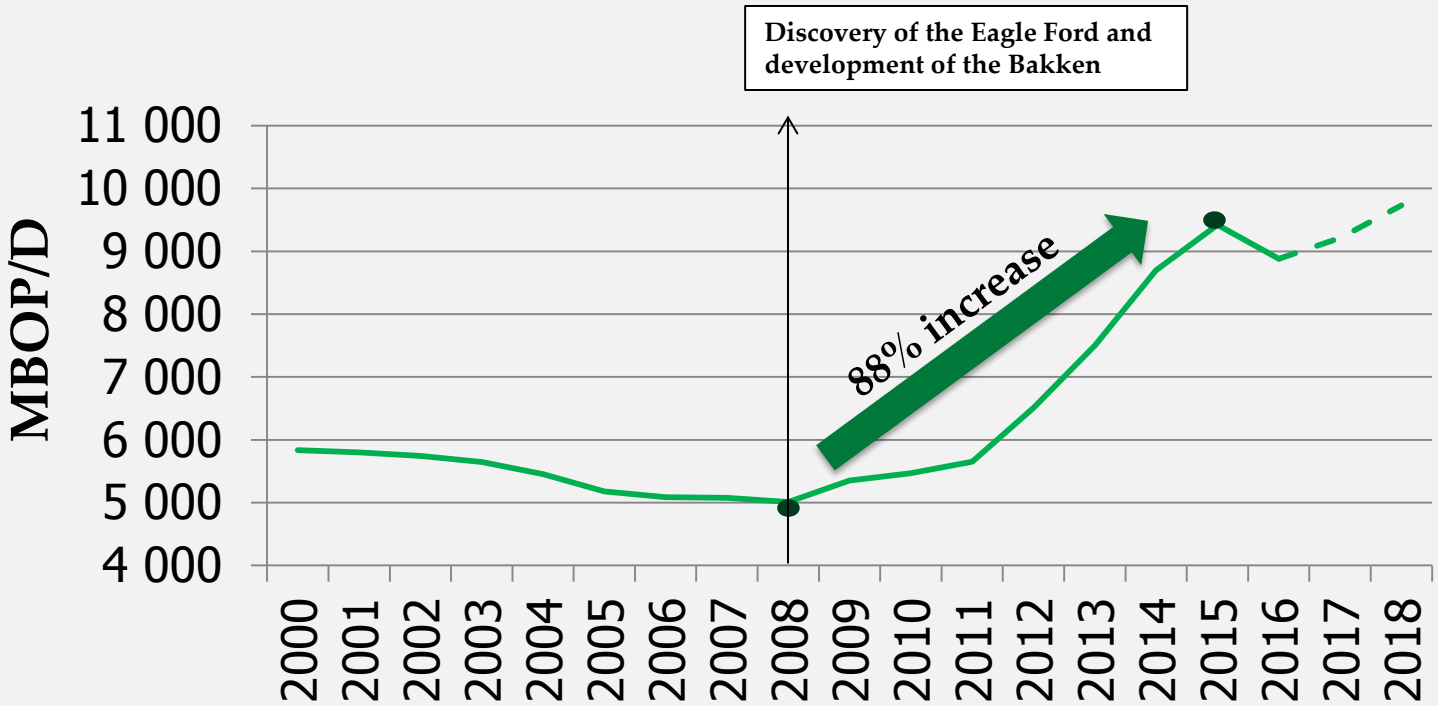


Source: EIA

The Shale Oil Revolution: A Graphical Depiction

The discovery of the Eagle Ford Shale, development in the Bakken Shale and onset of the Permian shale exploration have driven this growth

U.S. Crude Oil Production



Source: EIA

The Maturity Index for American Shales (Circa August 2014)

Emerging	Evolving	Mature
Utica	Niobrara DJ Basin	Barnett
Tuscaloosa Marine Shale	Wolfcamp Delaware Basin	Fayetteville
Eagle Ford East Texas Basin	Wolfcamp Midland Basin	Haynesville
STACK	Woodford Anadarko Basin	Marcellus
		Bakken
		Eagle Ford Gulf Coast Basin

The Maturity Index for American Shales (Circa April 2017)

Emerging	Evolving	Mature
Mancos Shale	Utica	Barnett
Utica	Niobrara DJ Basin	Fayetteville
Tuscaloosa Marine Shale	Wolfcamp Delaware Basin	Haynesville
Eagle Ford East Texas Basin	Wolfcamp Midland Basin	Marcellus
STACK	SCOOP	Bakken
	STACK	Eagle Ford Gulf Coast Basin

The Maturity Index for American Shales (Circa April 2017)

Emerging	Evolving	Mature
Mancos Shale	Utica	Barnett
	Niobrara DJ Basin	Fayetteville
	Wolfcamp Delaware Basin	Haynesville
	Wolfcamp Midland Basin	Marcellus
	SCOOP/STACK / MERGE	Bakken
		Eagle Ford Gulf Coast Basin

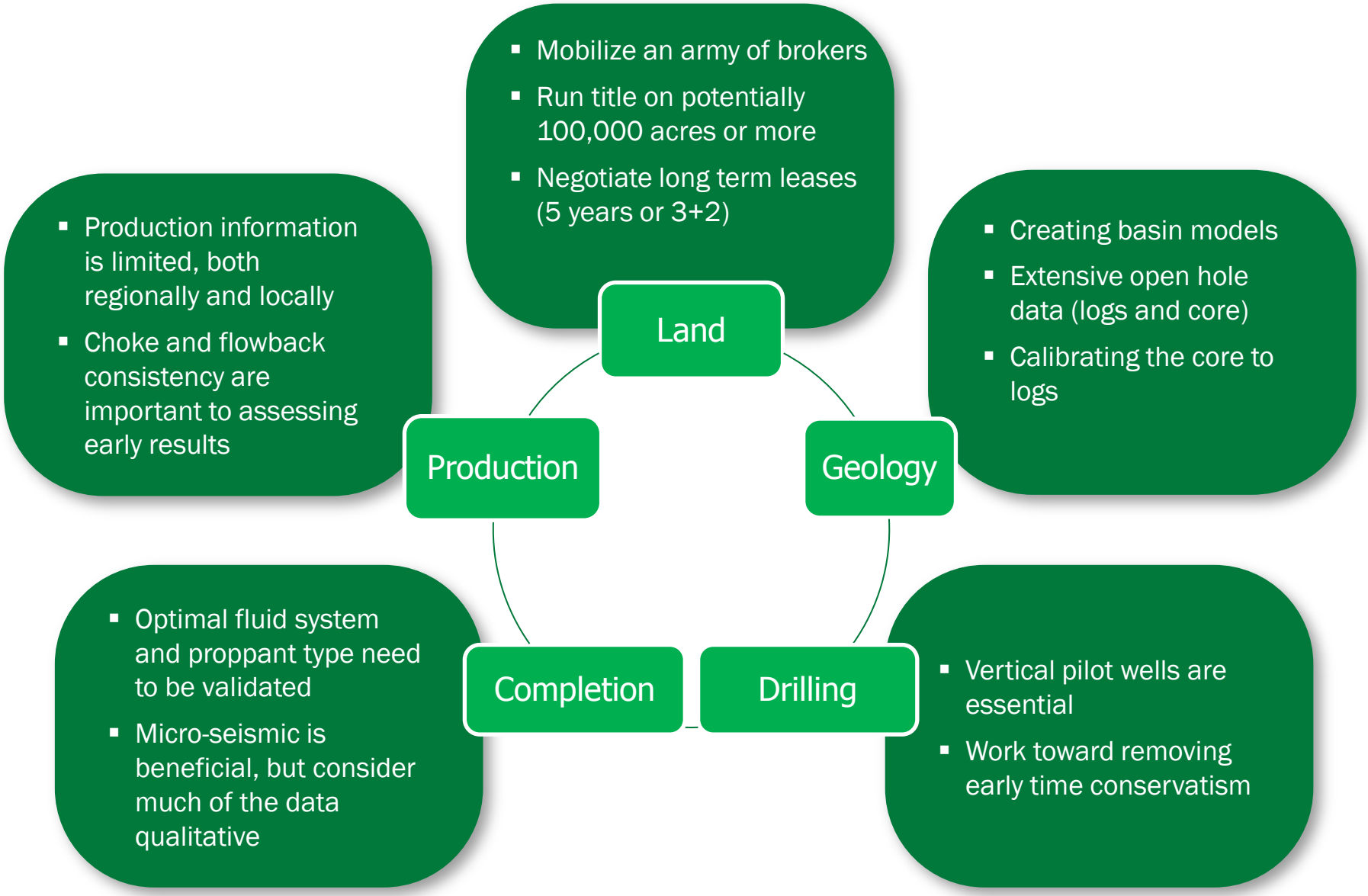
Emerging

The Maturity Index for American Shales

Emerging	Evolving	Mature
Mancos Shale	Utica Niobrara **Wolfcamp Delaware Basin** **Wolfcamp Midland Basin** SCOOP/STACK/Merge	Barnett Fayetteville Haynesville Marcellus Bakken **Eagle Ford** **Gulf Coast Basin**

Emerging

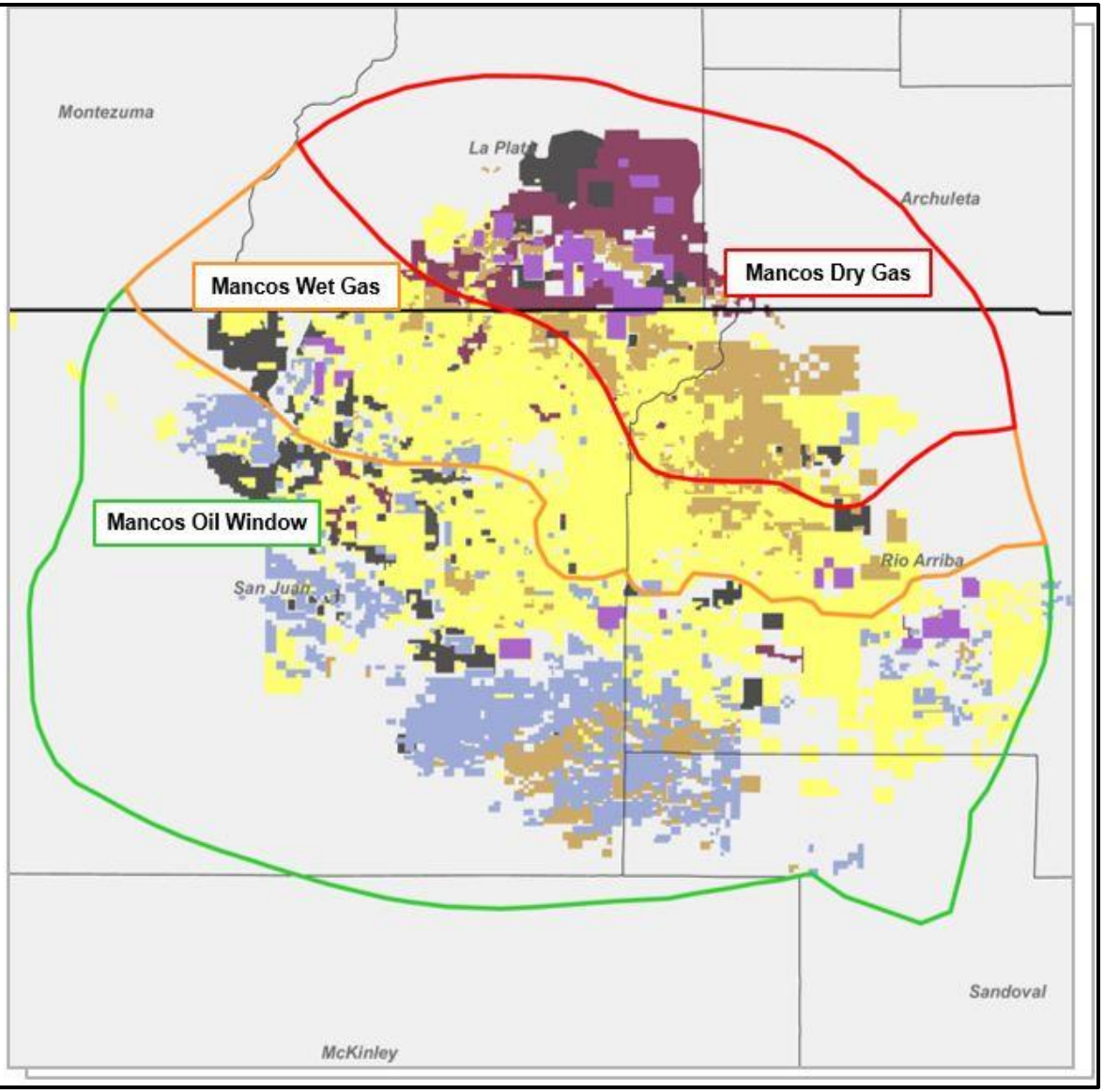
The Functional Processes Associated with Emerging Plays



Emerging

Mancos Shale San Juan Basin: Early Results are Encouraging

- WPX Public Comments on oil window (12-7-16 Capital One Conference):
  - 650 MBOE EUR
  - 65% increase since 2015
  - 7250' lateral length
  - >70% ROR @ strip
  - $4.1 MM D & C
- Gas Window
  - ??????



Source: Jefferies

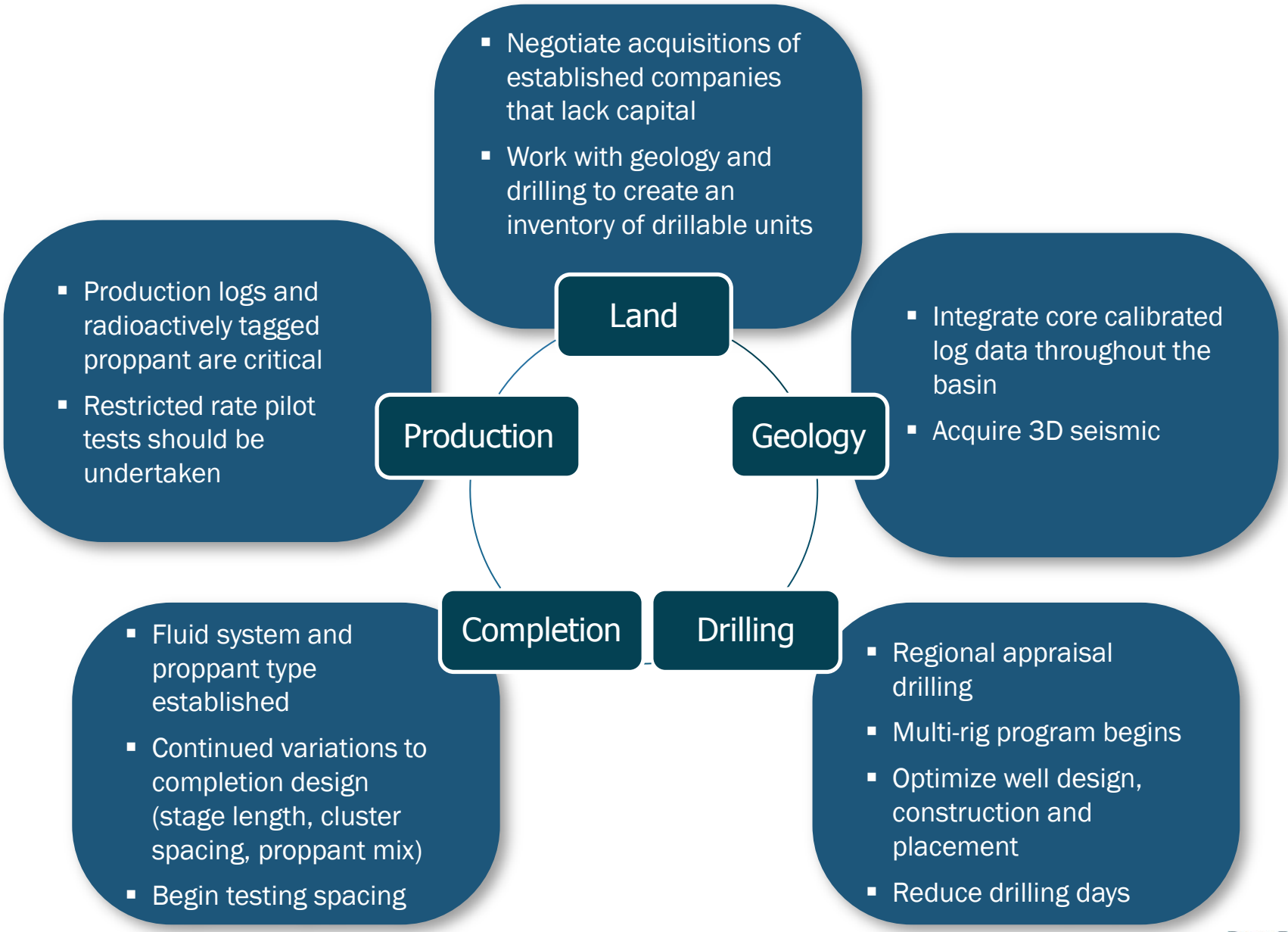
Evolving

The Maturity Index for American Shales

Emerging	Evolving	Mature
Mancos Shale	Utica Niobrara DJ Basin Wolfcamp Delaware Basin Wolfcamp Midland Basin SCOOP/STACK/Merge	Barnett Fayetteville Haynesville Marcellus Bakken Eagle Ford Gulf Coast Basin

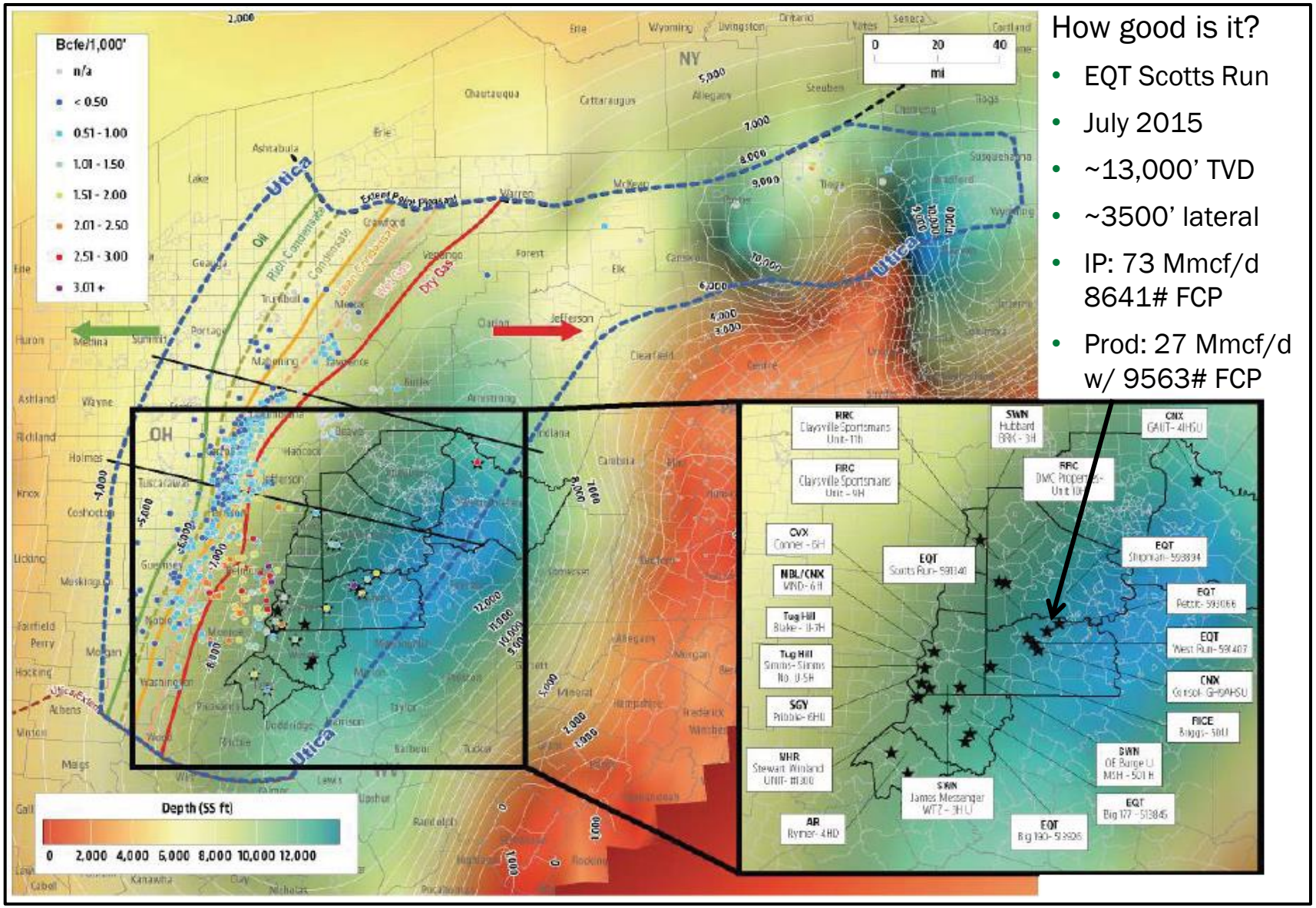
Evolving

The Functional Processes Associated with Evolving Plays



Utica: A Small, but Outstanding, Core of Gas that Could/Should Get a lot Bigger

Evolving



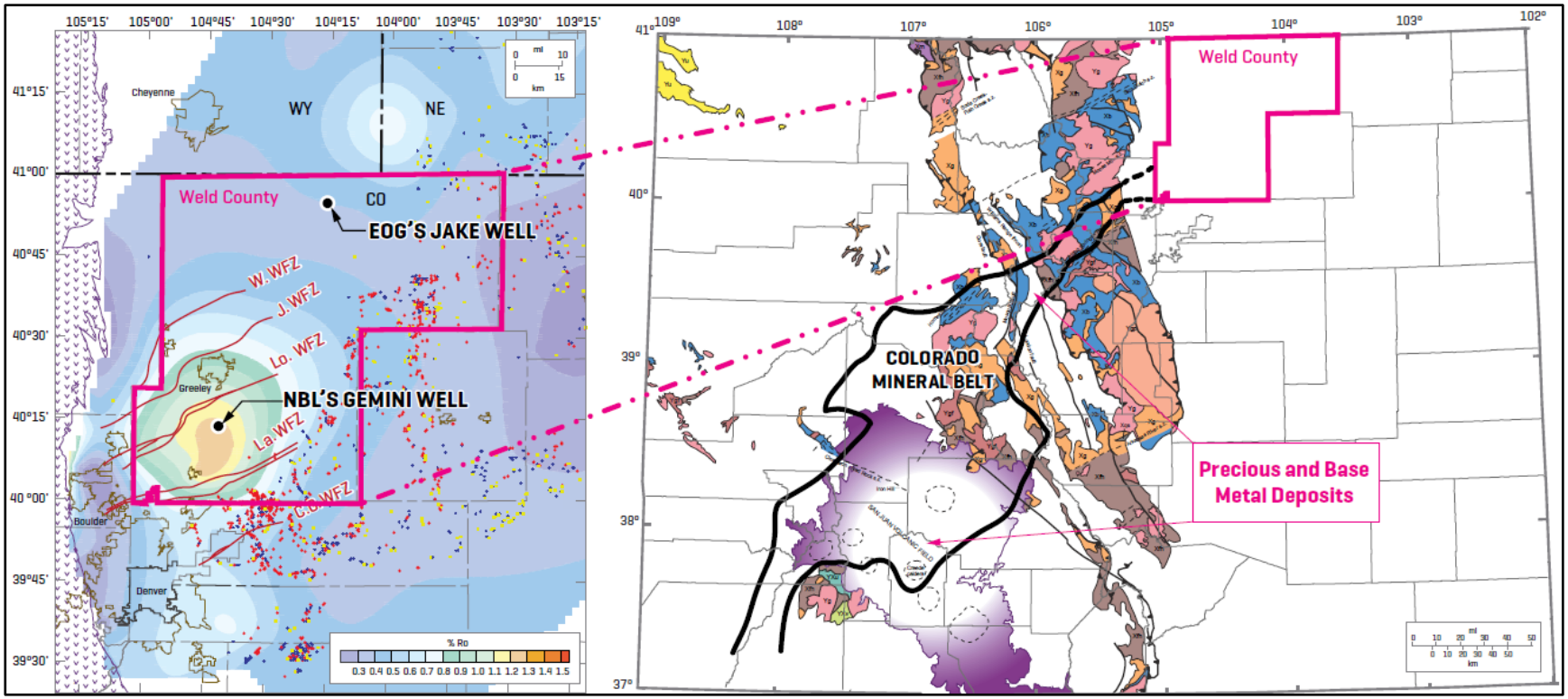
How good is it?

- EQT Scotts Run
- July 2015
- ~13,000' TVD
- ~3500' lateral
- IP: 73 Mmcf/d 8641# FCP
- Prod: 27 Mmcf/d w/ 9563# FCP

Source: RSEG.

Evolving

Niobrara: Anomalous Heat Flow is the Driver, Not Depth

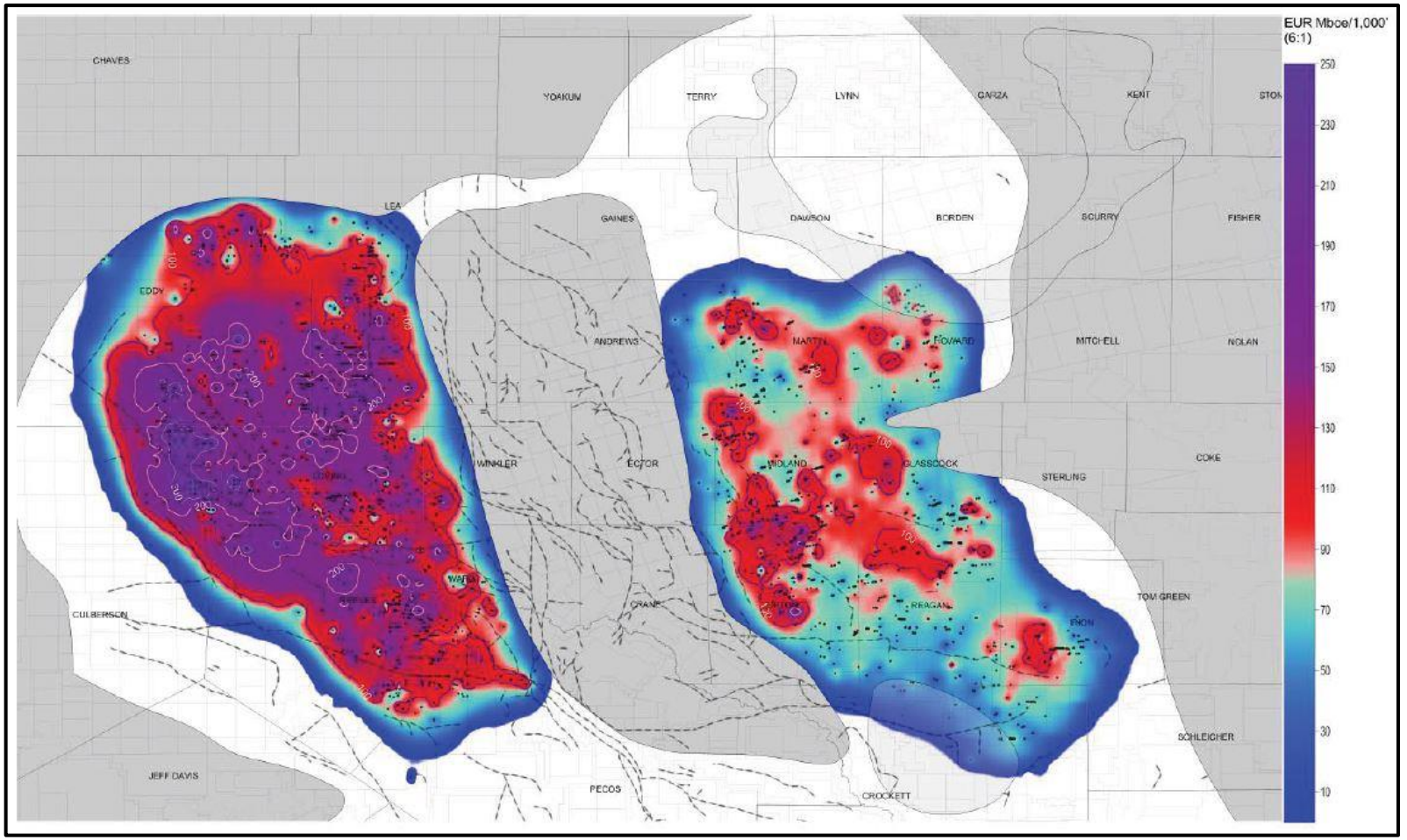


- EOG opened the play with the Jake well in 2009
- It set off a huge land play that focused on not only the entire DJ Basin, but the other Rocky Mountains basins with Niobrara potential
- However, the play failed to prove commercial anywhere other than in the Colorado Mineral Belt as shown above

Source: ITG/RSEG.

Midland vs. Delaware Basin: EUR Comparison (Mboe/1000' Lateral)

Evolving

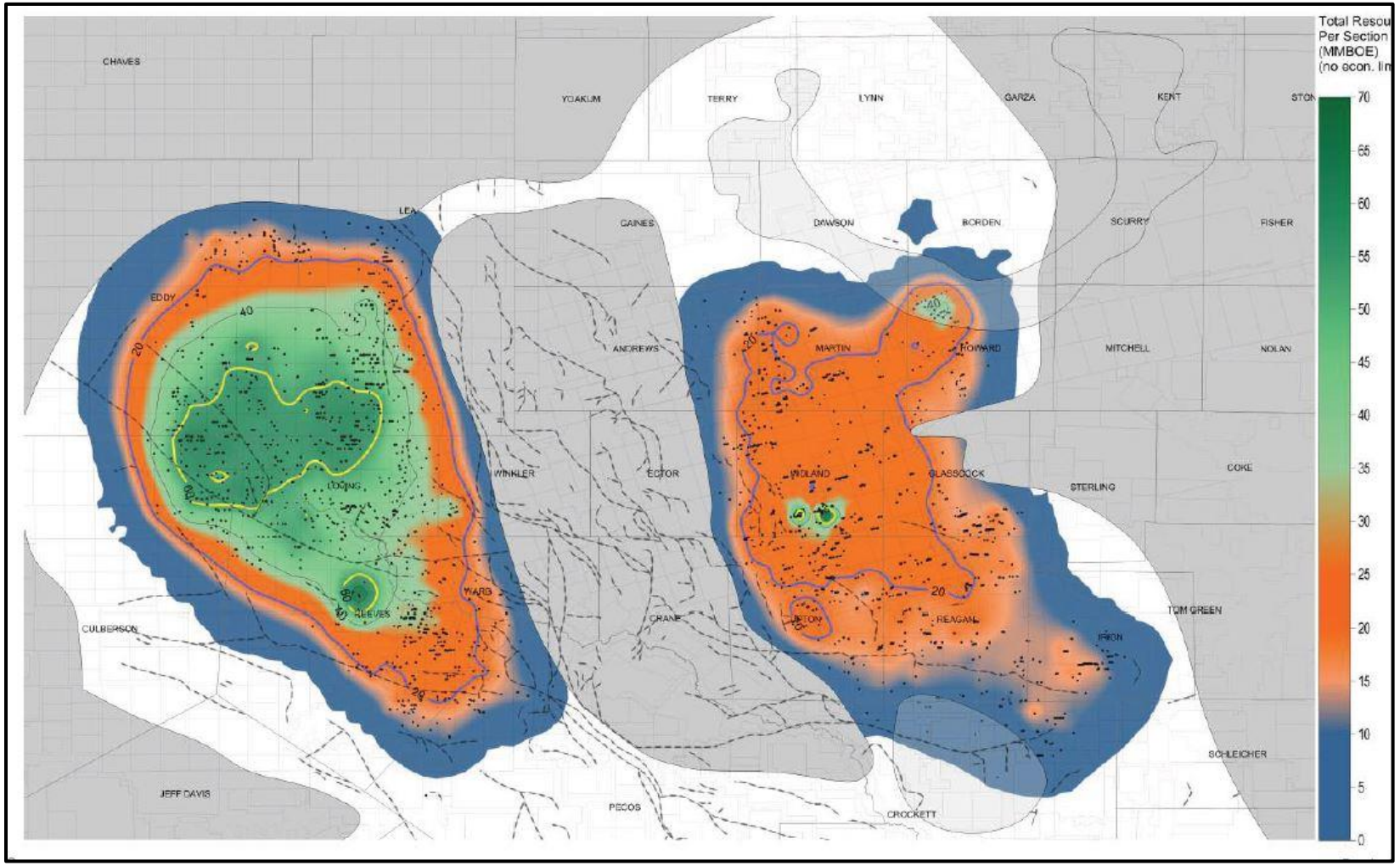


- Midland Basin core ranges from ~70-130 MBOE/1000' (525-975 MBOE normalized to 7500')
- Delaware Basin core ranges from ~100-200 MBOE/1000' (750 MBOE-1500MBOE normalized to 7500')

Source: RSEG

Midland vs. Delaware Basin: Recoverable Stacked Reserves (MMBoe/Section)

Evolving

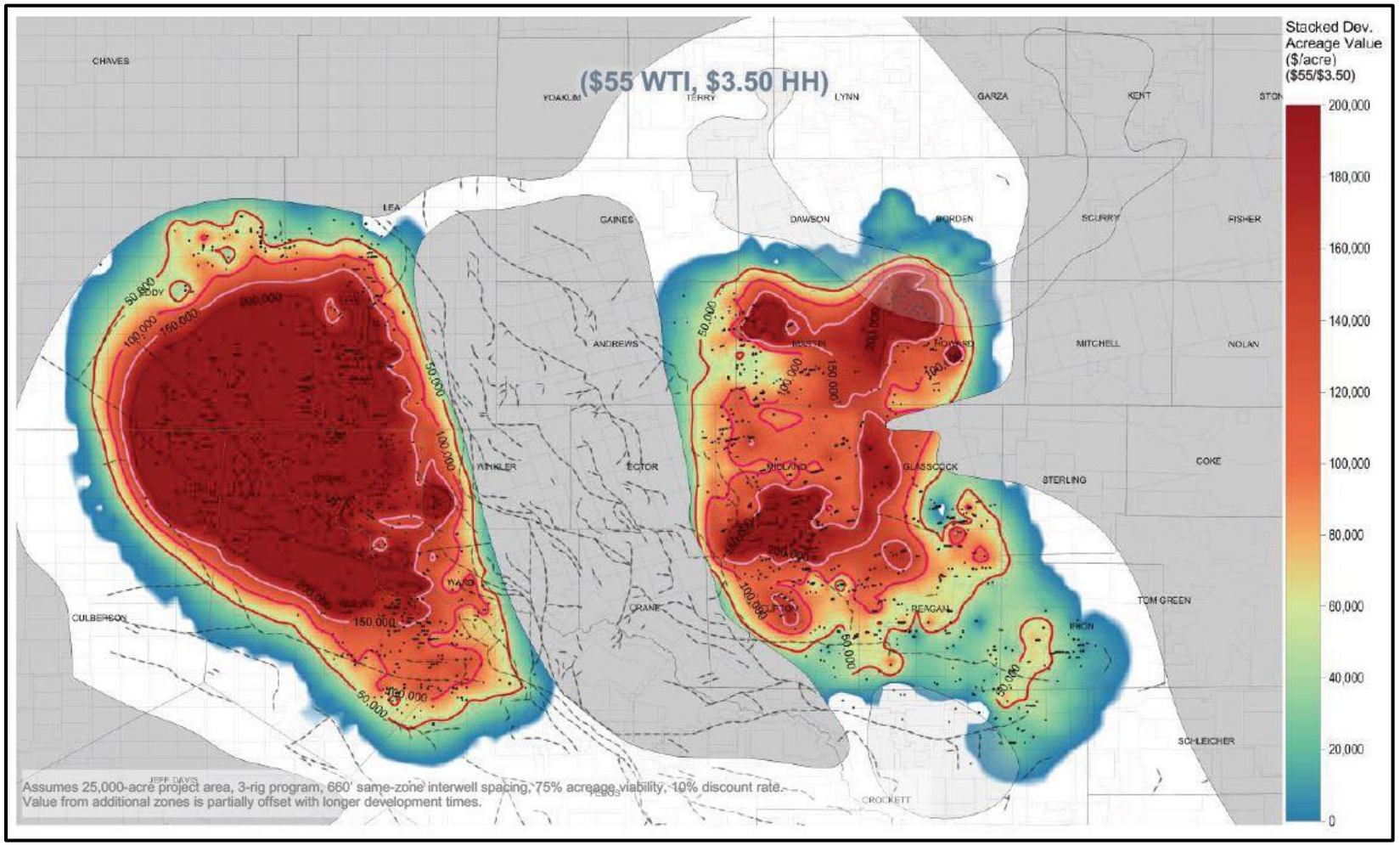


- Midland Basin ranges from ~20-40 MMBOE recoverable per section
- Delaware Basin ranges from 40-60 MMBOE recoverable per section

Source: RSEG

Midland vs. Delaware Basin: Stacked Developed Acreage Value ($/acre)

Evolving

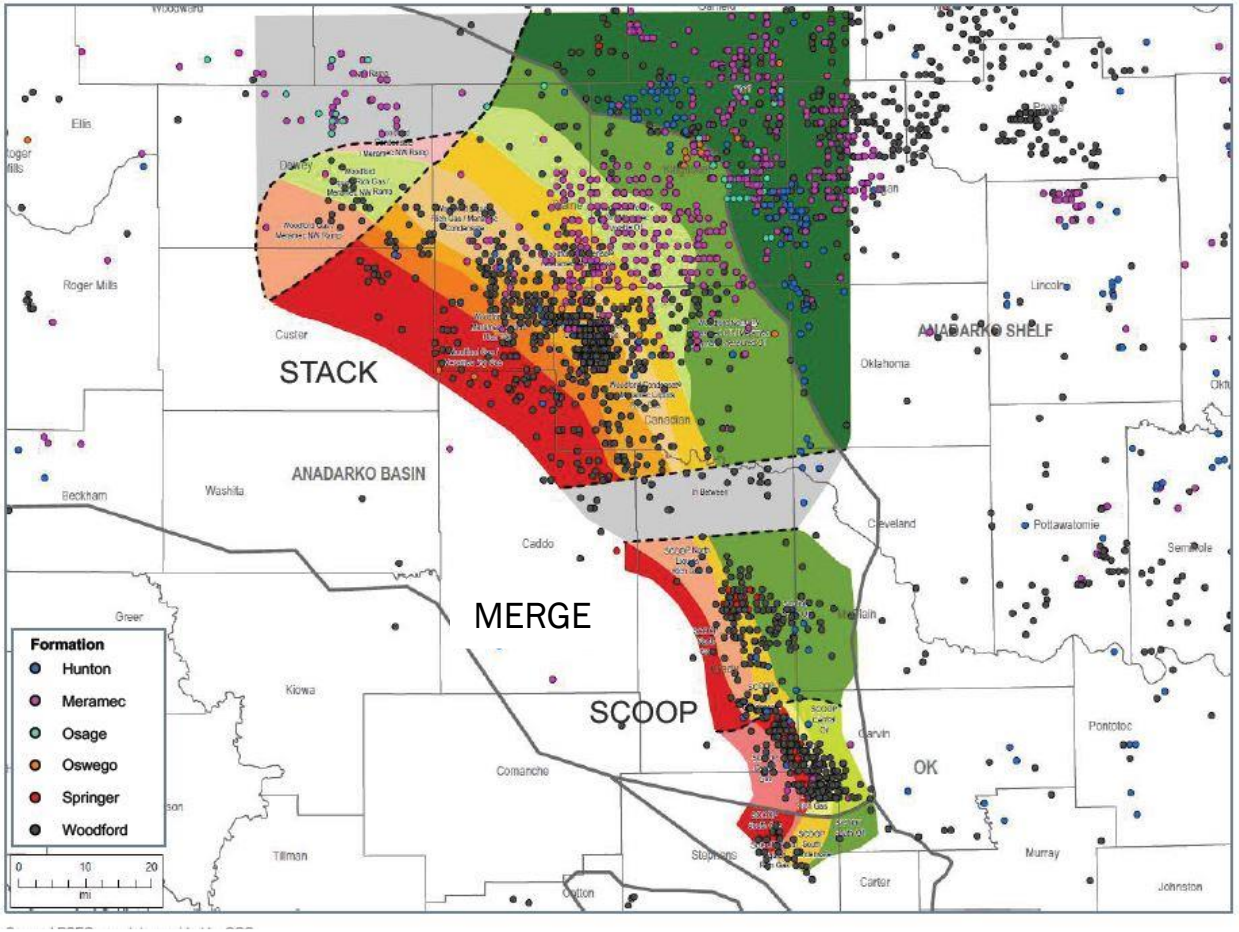


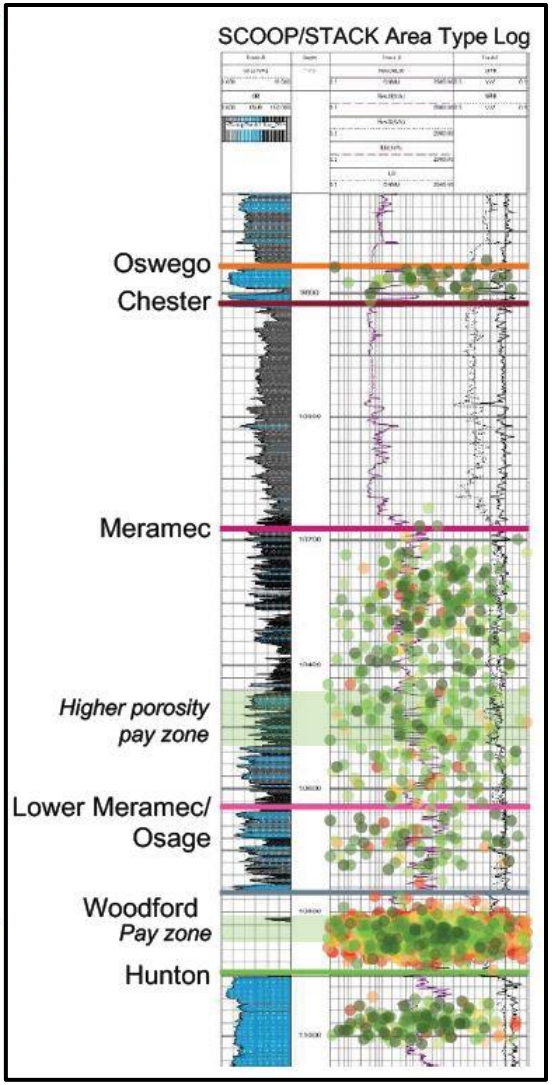
- Midland Basin core ranges from $60,000-$150,000/acre NAV at $55 barrel/$3.50 gas
- Delaware Basin core ranges from $150,000+/acre NAV at $55/barrel/$3.50 gas

Source: RSEG.

Evolving

SCOOP, then STACK, then MERGE, then…..?

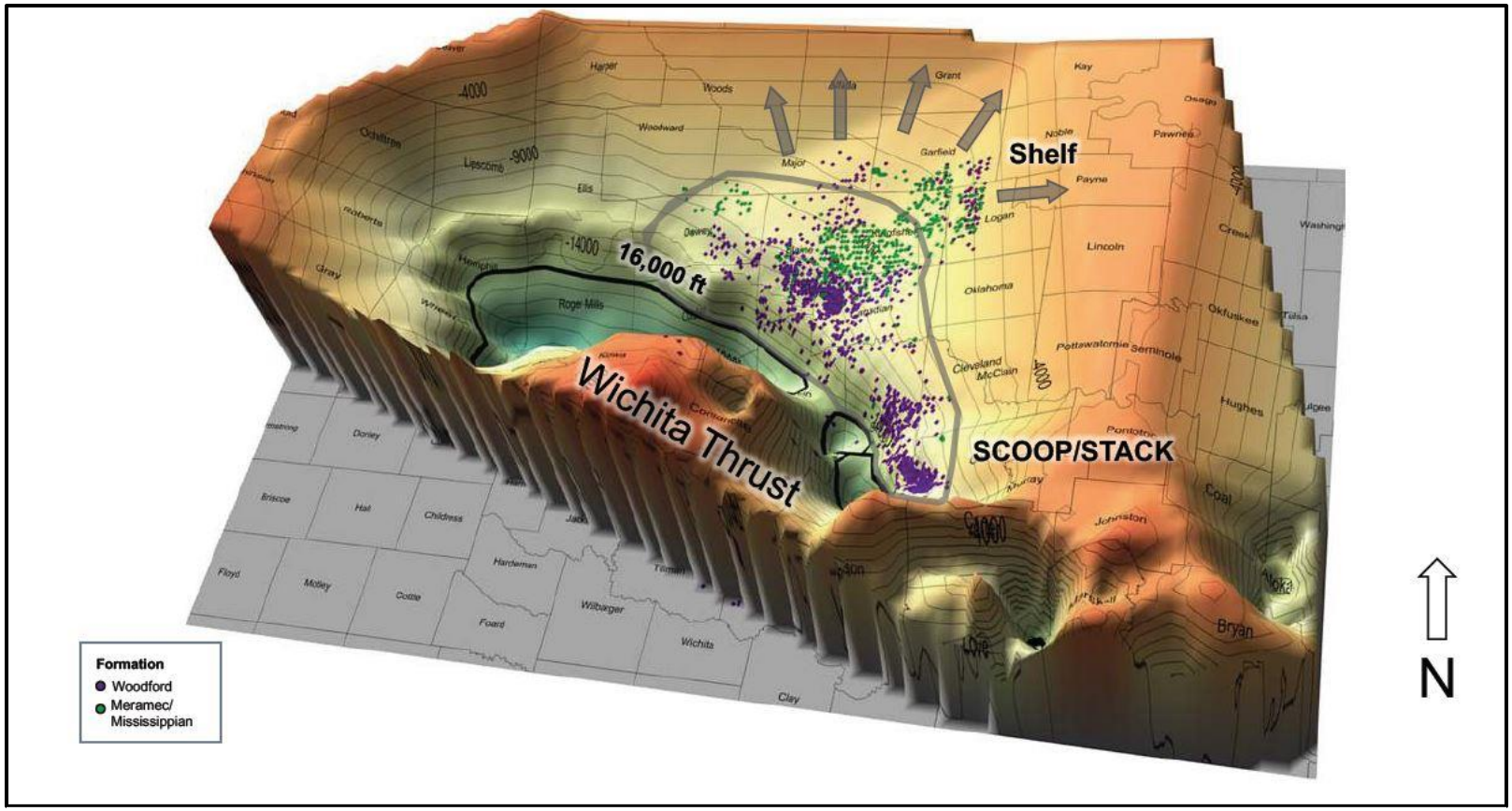




- SCOOP (2012) led to the STACK (2013) which led to the MERGE (2016)
- Where does it go from here? Way too early to say

Source: RSEG

A World Class Petroleum System Drives the Opportunity



- The Devonian/Mississippian aged rocks on the shelf of the Anadarko Basin comprise a classic petroleum system
- As the plays have progressed from the SCOOP to the STACK to the MERGE, new plays continue to evolve as a result of the number of facies that are contained in these formations

Source: ITG/RSEG

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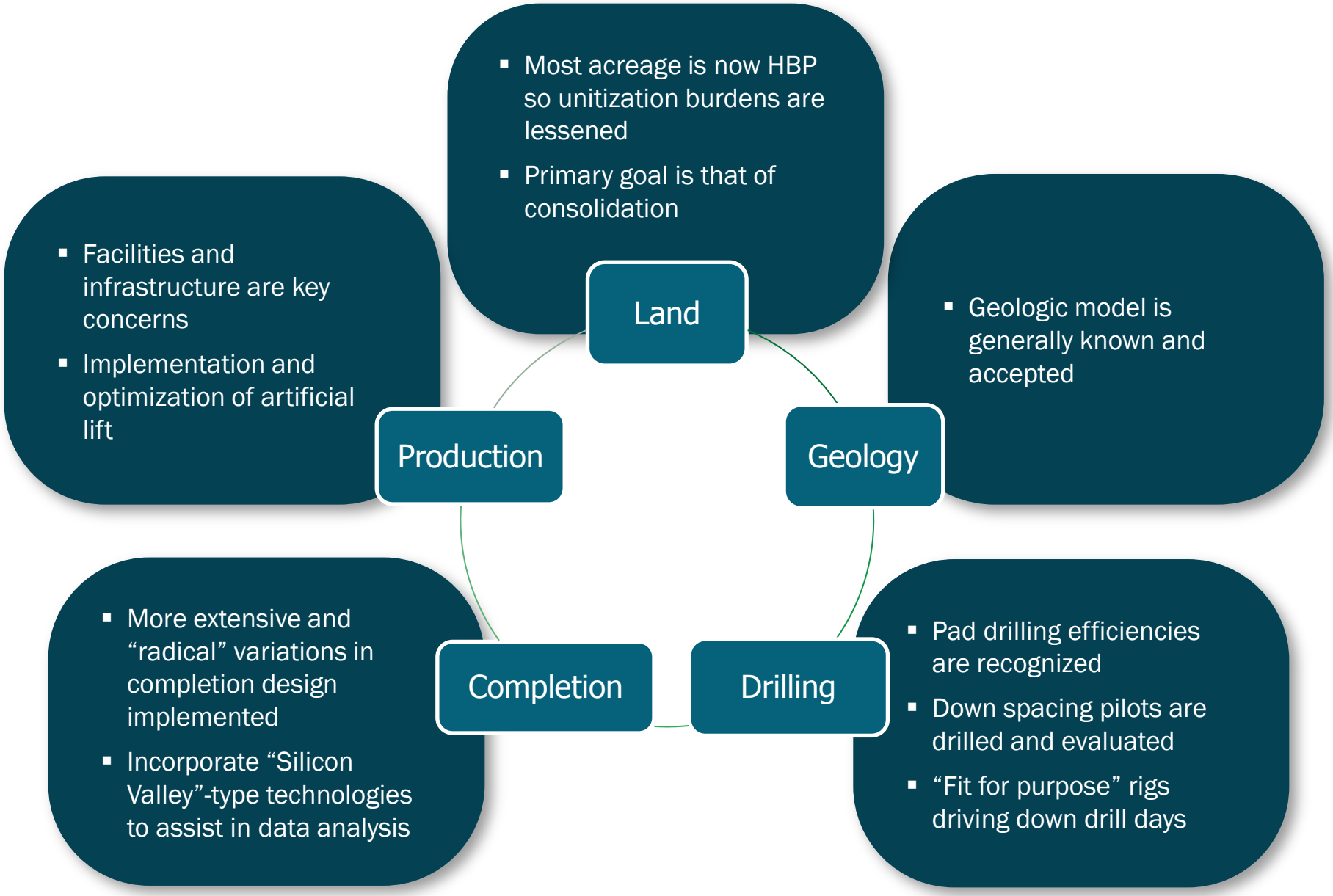
Mancos Shale	Utica Niobrara Wolfcamp Delaware Basin Wolfcamp Midland Basin SCOOP/STACK/Merge	Barnett Fayetteville Haynesville Marcellus Bakken Eagle Ford Gulf Coast Basin

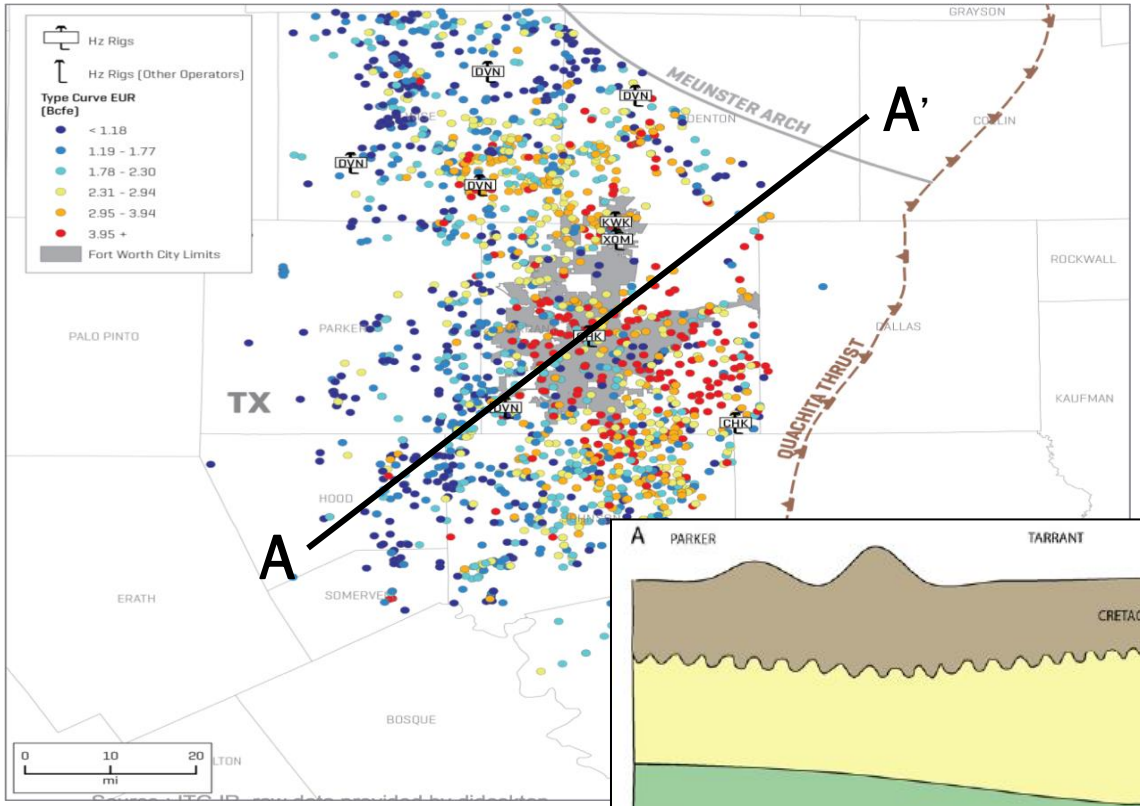
Mature

The Functional Processes Associated with Mature Plays

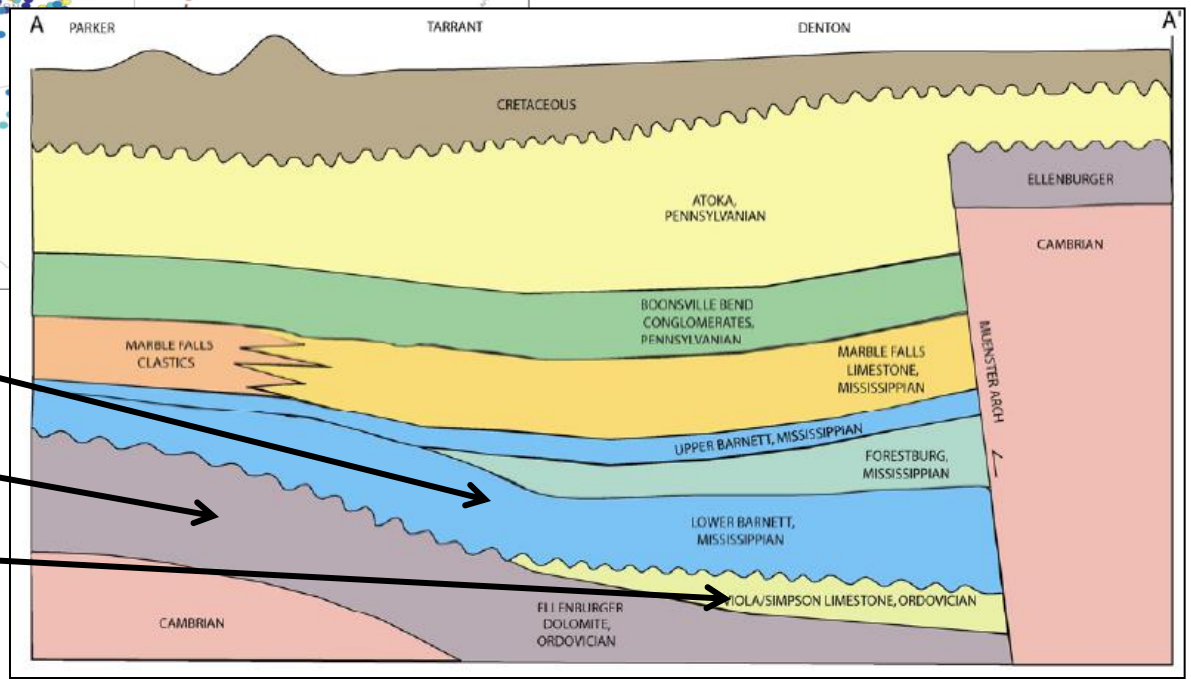


Mature

Barnett: Fracture Containment Matters



- Current: ~4 BCF/d
- Cum.: ~18 TCF
- EUR: ~44 TCF



Barnett: Gas Reservoir

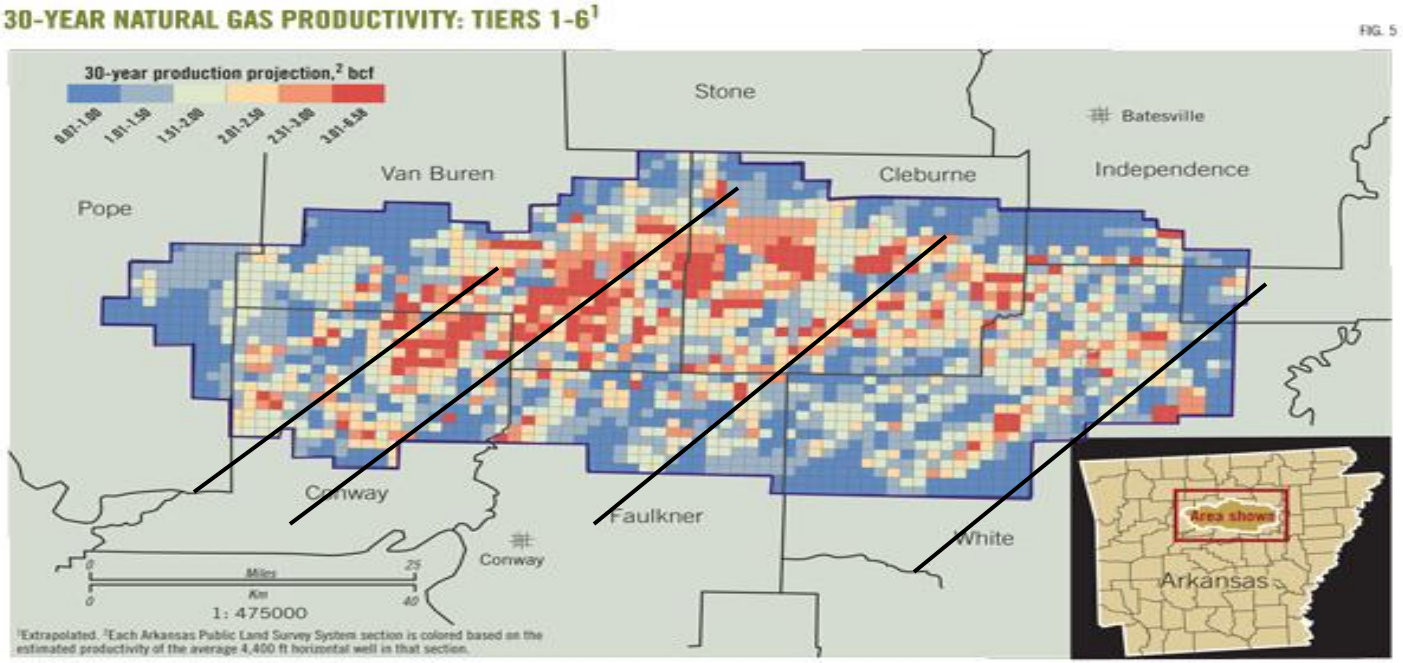
Ellenberger: Water Reservoir

Viola: Frac Barrier

Source: ITG/RSEG and University of Texas, Bowker, 2003.

Fayetteville: It Appears to be Structurally Simple, Yet it is Actually Quite Complex

Mature

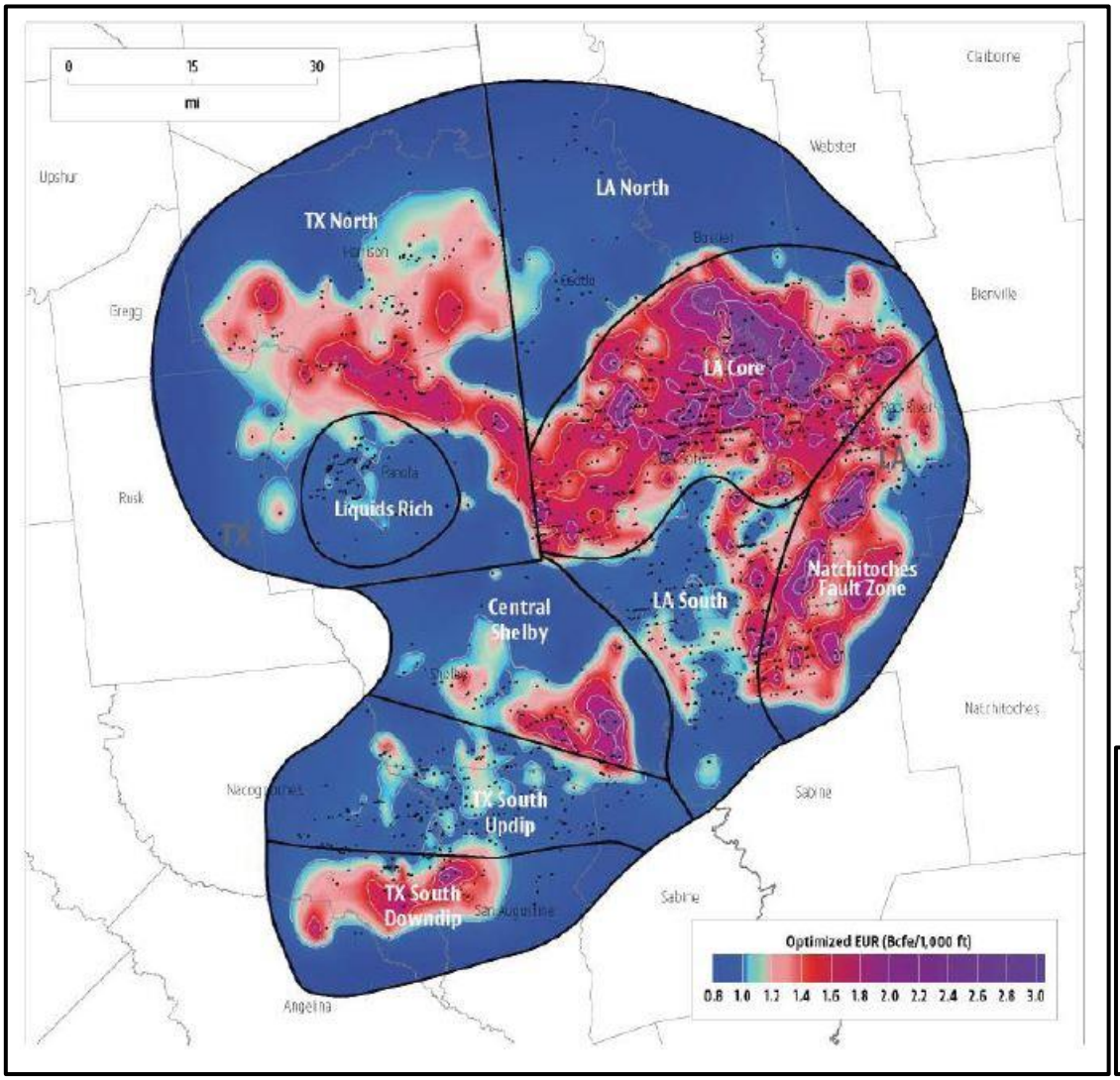


- Current: ~2.5 BCF/d Cum: ~5 TCF EUR: ~18 TCF
- Geologic Overview:
  - The area is dominated by monoclinal dip from north to south with production ranging from as shallow as 1500' to as deep as 8000'+
  - However, there are large regional faults that bisect the play from southwest to northeast
  - In addition to the large regional faults there are a multitude of smaller localized faults that made development highly sensitive to these structural elements

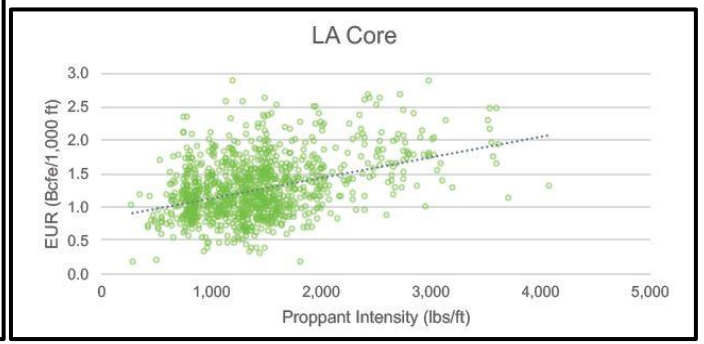
Source: ITG/RSEG and University of Texas Bowker 2003.

Mature

Haynesville: Which Core is Really "The Core"?



- Current: 6.2 BCF/D
- Three fairly discreet geographical areas of the play
- Each has certain positive attributes
- But only one is the winner and that is the Louisiana Core
- Why? Higher TOC, lower clay content and high pressure gradient (~.9 psi/ft)

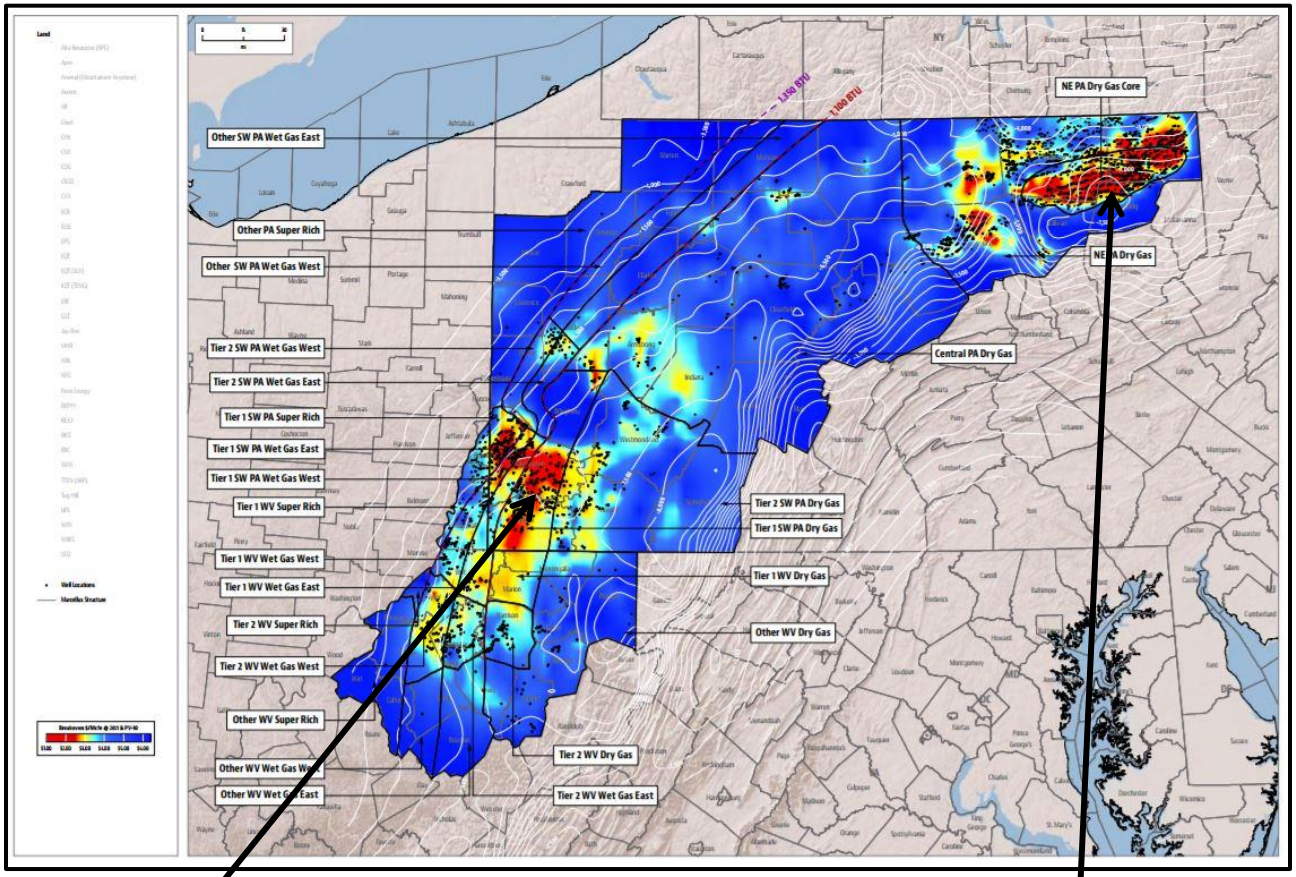


Source: RSEG

Mature

Marcellus: Heads or Tails, but Nowhere Else

- Current: 19.2 BCF/D



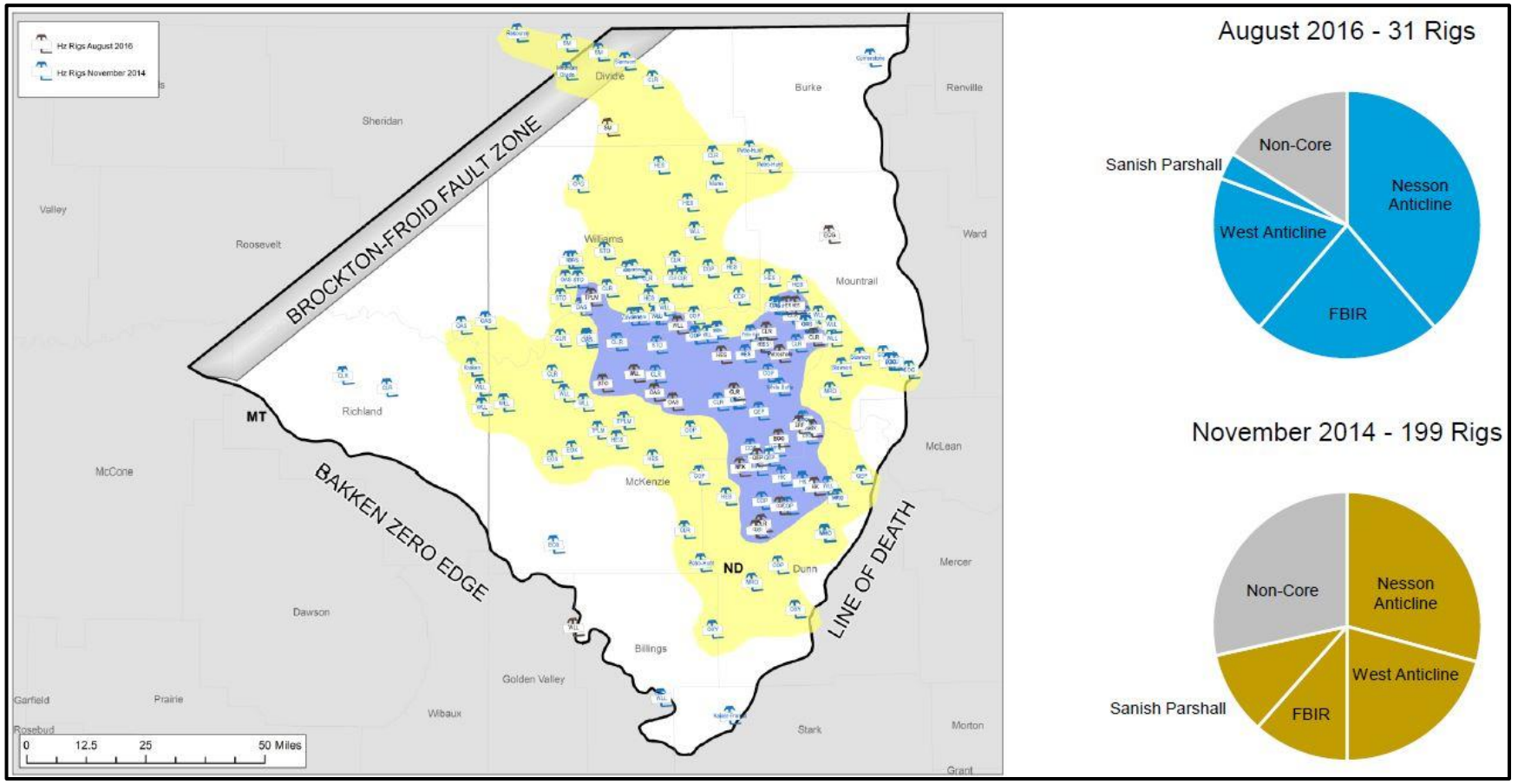
- Ranges Resources (Enercom 3-1-2107):
  - EUR/1000': 2.4-3.0 Bcfe
  - D & C Cost: $6.1-$7.3MM for 8500' lateral
  - Presumed EUR: ~20-25 Bcfe

- Cabot Oil and Gas (Simmons & Co. 3-2-2017)
  - EUR/1000': 4.4 Bcf
  - D & C Cost: $7.2MM for 8000' lateral
  - Presumed EUR: ~35 Bcf

Source: RSEG

Mature

Bakken: A Big Drop from 2014 to 2016

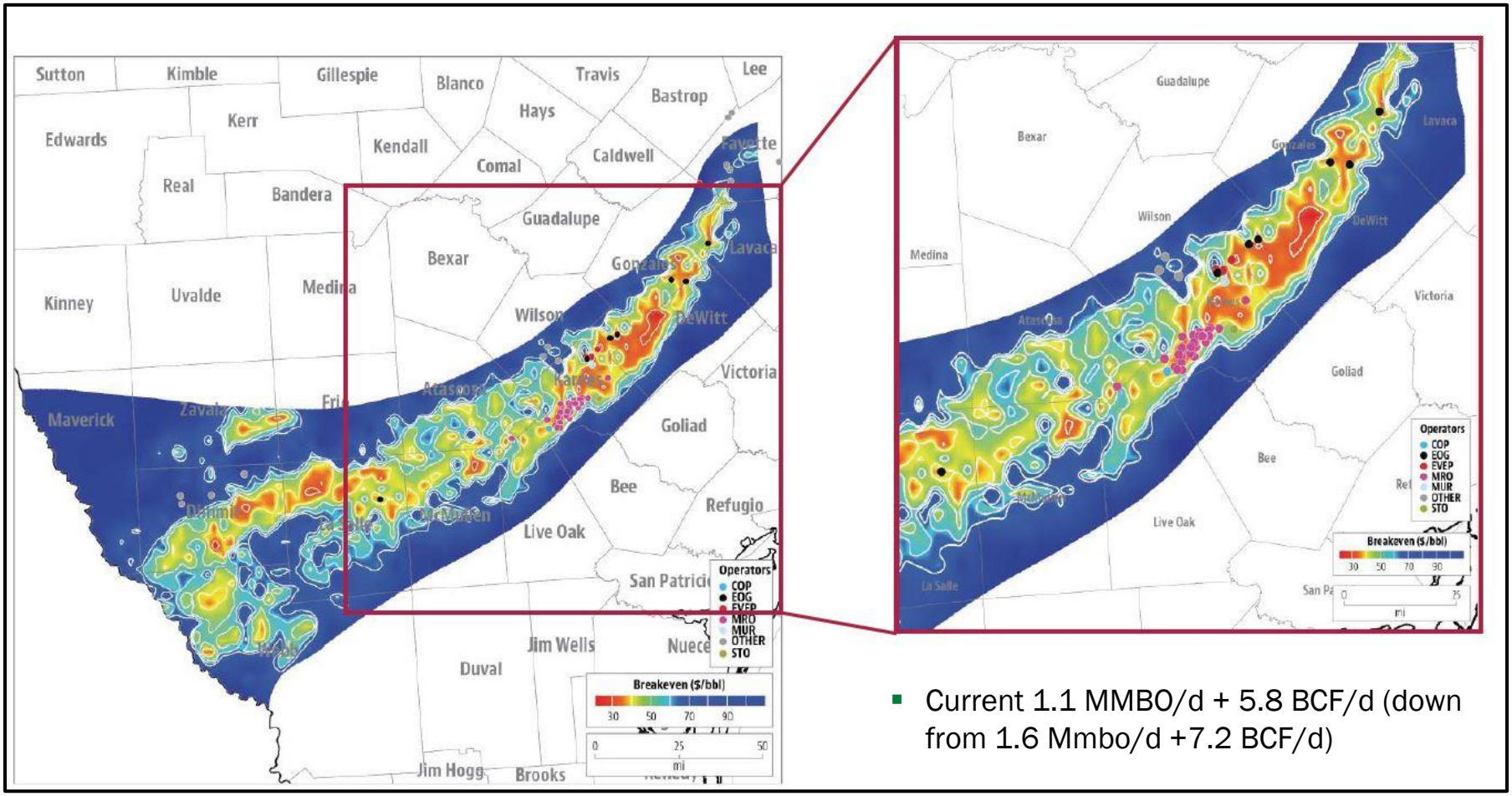


- Current.: 960 MBO/d + 1.6 BCF/d (down from 1.2 MMBO/d + 1.8 BCF/d)
- The blue and yellow shaded areas, and to a lesser extent the white area, all saw rig activity in 2014 (199 total rigs)
- Only the blue shaded area saw the vast majority of the rig activity in 2016 (31 total rigs)

Source: RSEG.

Eagle Ford Gulf Coast Basin: It's All Good (or at Least Most of it)!

Mature

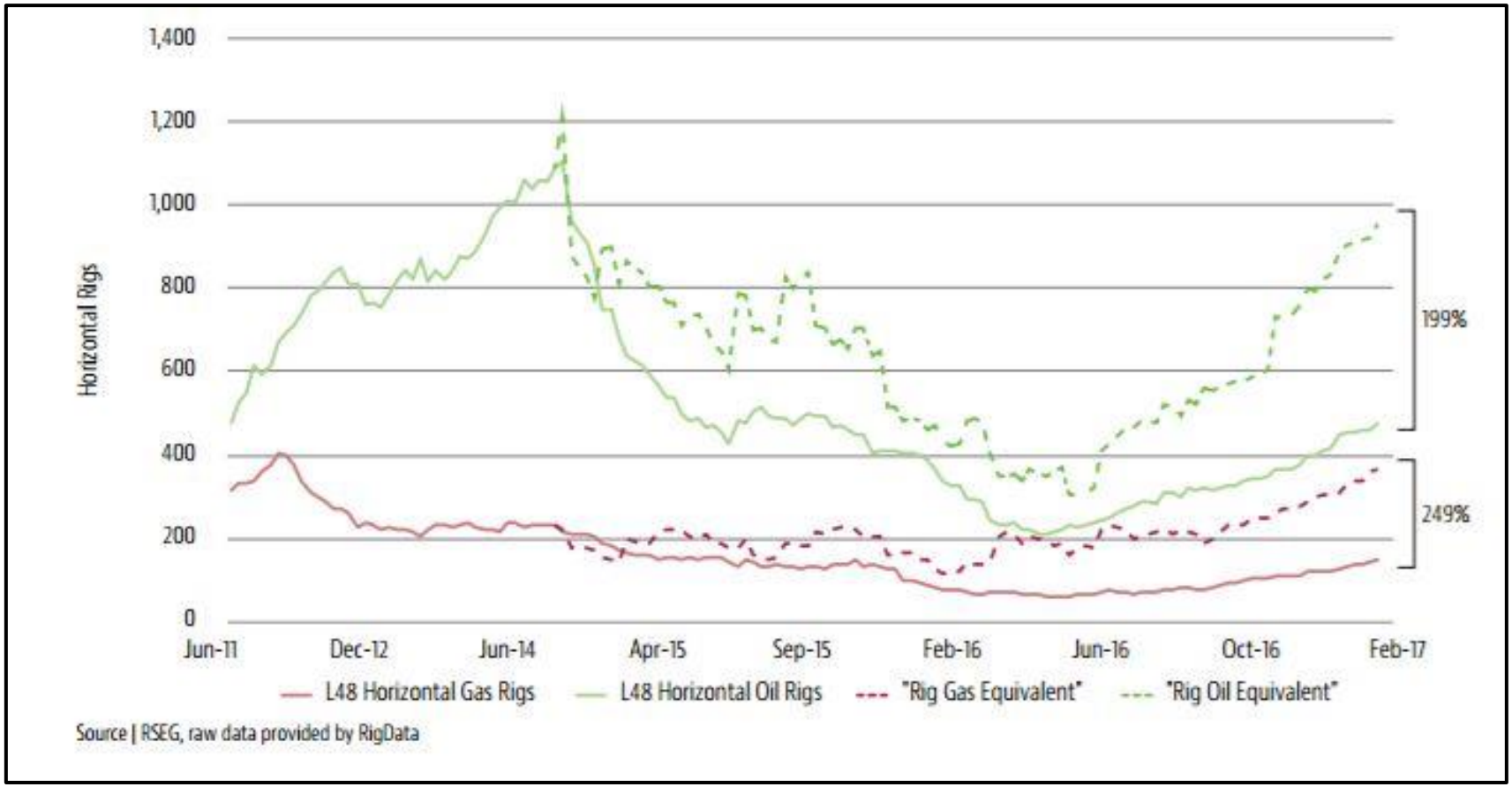


- Current 1.1 MMBO/d + 5.8 BCF/d (down from 1.6 Mmbo/d +7.2 BCF/d)

- The area represented on the map above is approximately 7 million acres
- The areas other than dark blue represent breakeven PV10 <$60/barrel and green/yellow/orange/red represent breakeven PV10 between $60-20 barrel
- This represents an area of over 200 continuous miles that breakeven less than $50 barrel

Source: RSEG.

We Just Keep Getting Better at This!



- Since the onset of the decline in the price of oil in late 2014, the industry is 2X more efficient/oil rig and 2.5X more efficient/gas rig
- How? Primarily by faster drill times and more effective completions (geometry and intensity)

Conclusions

- I bet everyone in this room will agree that what has transpired over the past decade is nothing short of amazing
- Our industry in general, and our profession specifically, should be incredibly proud of what we have accomplished
- We have changed the balance of power in one of the most powerful worldwide industries that exists by virtue of our discovery of shale source rocks as commercially productive reservoirs
- In just the last two years, we have proven to the world and to OPEC that they are no longer in control of the commodity
- For the foreseeable future, the United States will play the lead role in the supply of crude oil and natural gas and will need to be cognizant of the importance of that role