

WolfBone Play Evolution, Southern Delaware Basin: Geologic Concept Modifications That Have Enhanced Economic Success*

Bill Fairhurst¹, Mary Lisbeth Hanson¹, Frank Reid¹, and Nick Pieracacos¹

Search and Discovery Article #10412 (2012)**

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Please refer to a closely companion article, entitled “Evolution and Development of the WolfBone Play, Southern Delaware Basin, West Texas: An emerging frontier: An oil-rich unconventional resource,” [Search and Discovery Article #10411 \(2012\)](#).

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Abstract

The WolfBone play is an emerging unconventional oil resource. Exploration and development have been a systematic evolution from geologic concept to drilling, evaluation, and revision of targets. Originally, Wolfcamp sandstone reservoirs below and Third Bone Spring sandstone reservoirs above the Wolfcampian shale source section were targeted. Current drilling and production are focused on the 1000-ft-thick, oil-rich, unconventional Wolfcamp shale.

The Wolfcamp is an ideal heterogenetic resource consisting of quartz, carbonate, and kerogen. Exploration and field development will be successful over a large area. However, the geologic and economic sweet spot is limited to the basin floor. In this setting quartz and kerogen accumulated in the quiet deep basin interrupted by episodic deposition of shelf to basin-floor carbonate debris flows that settled basinward of the deceleration boundary. These depositional processes resulted in compositional and grain-size heterogeneities and accumulation of the thick organic-rich targets.

During maturation large volumes of oil were sealed in place (108 MMBOIP per section). Expansion from kerogen to oil in a sealed system resulted in overpressure and abundant fracturing that has resulted in enhanced productivity. Individual wells have flowed 45 MBO from 11,000 ft prior to initiating artificial lift, which is atypical of Permian Basin reservoirs. Farther into the basin and upslope these conditions do not exist and are outside the economic sweet spot. Basinward, the unit is consistently thick; however, there is more shale, and the section is starved of siltstones and carbonates. Upslope, the unit thins and is more gas-prone. In these slope environments the mixture of coarser-grained shelf carbonates and sandstones breached the system, providing migration pathways which have limited productivity and lower ultimate economic recoveries.

Since 2009, this play has been developed with vertical wells comingling the oil resource with conventional reservoirs. Interpretation of imaging logs has identified the primary fracture orientation and zones with conjugate fractures systems. Integration with production logs has optimized horizontal target identification, and horizontal drilling has begun. The Leonardian Avalon sweet spots occur at similar depositional setting as the Wolfcampian resource and the same geographic position in this portion of the basin. The Avalon is estimated to have 103 MMBOIP per section.

References

- Fitchen, W.M., 1997, Carbonate sequence stratigraphy and its application to hydrocarbon exploration and reservoir development, *in* I. Palaz, and K.J. Marfurt (eds.), Carbonate Seismology: SEG Geophysical Development Series, no. 6, p. 121-178.
- Wright, W.F., 1962, Abo reef: prime West Texas target, Parts 1 and 2: Oil and Gas Journal, Part 1, v. 60/31, p. 226-235, Part 2, v. 60/32, p. 188-194.

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**WolfBone Play
Evolution, Southern
Delaware Basin:
Geologic Concept
Modifications That Have
Enhanced Economic
Success**

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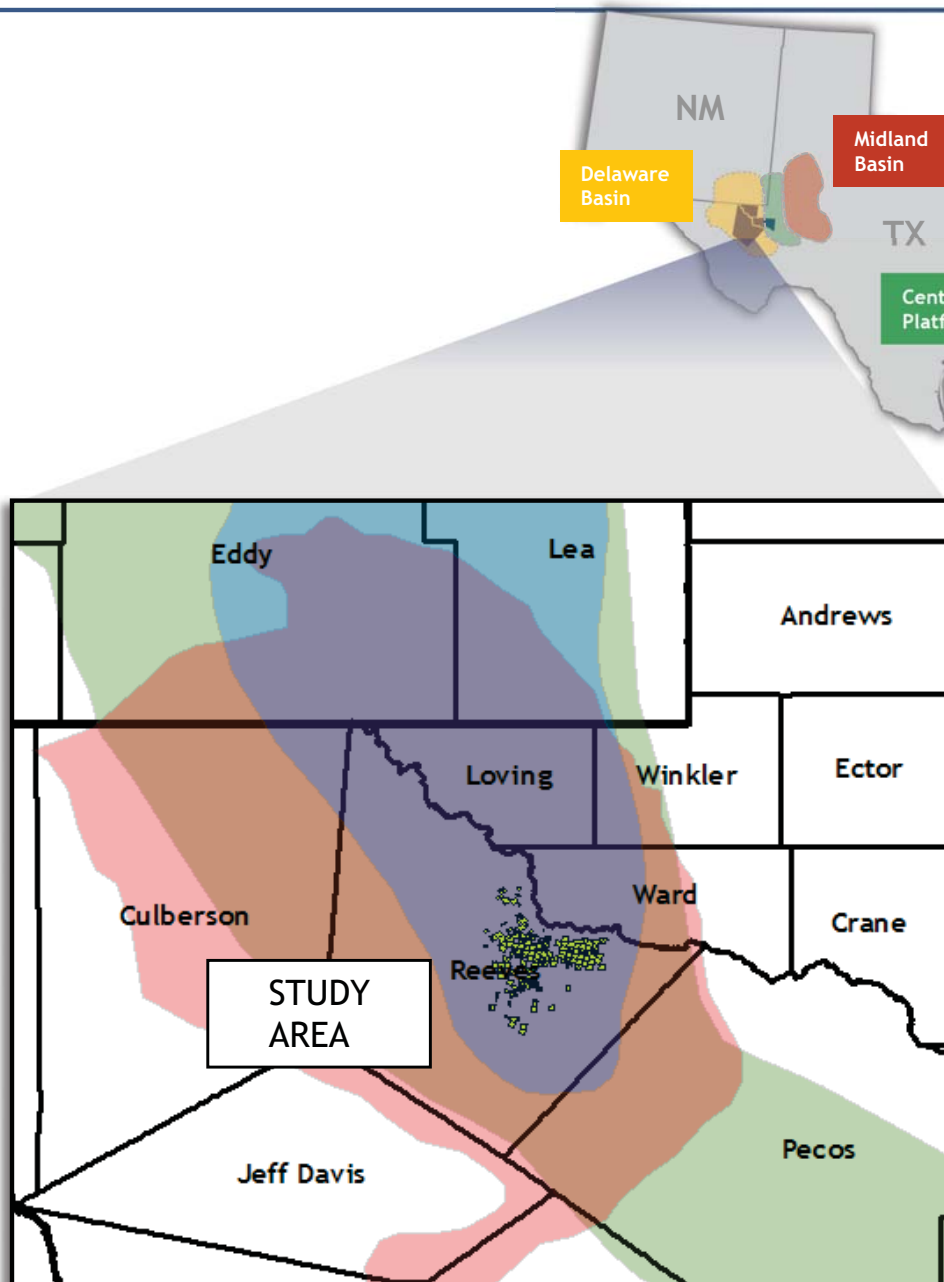
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Overview - Location



- Most active US basin with 433 rigs (Delaware Basin: 214), Hz Rigs: ~35%⁽¹⁾
- Total Resource in place per section: 108 Mmboe
 - Horizontal Development:
 - Alternative Wolfcamp development strategy modeled
 - 3rd Bone Spring development
- **Upside Potential**
 - Horizontal resource in Avalon Shale
 - Avalon Shale - 105 MMboe in place per section
 - Delaware Sands - ongoing vertical & horizontal exploitation
 - Vertical drilling targeting deeper gas zones

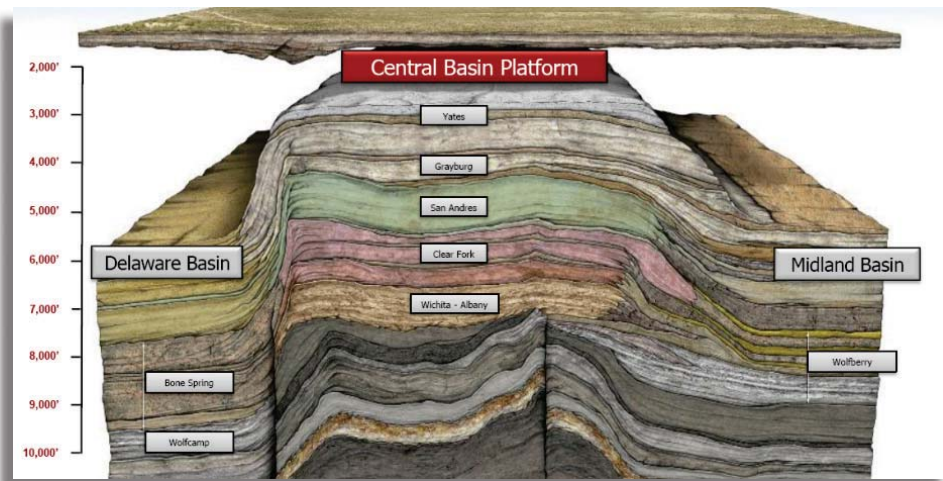
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Production from the Permian System

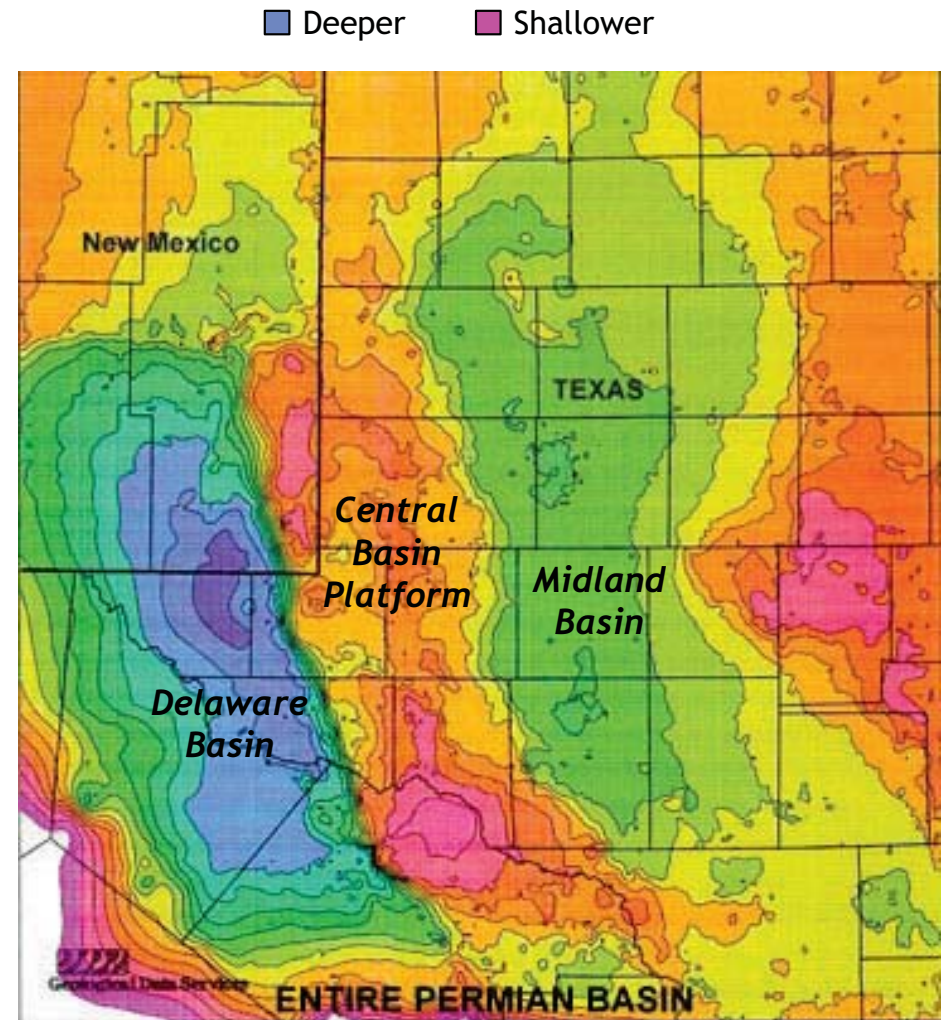
Summary

- Permian system comprised of multiple basins:
 - Delaware Basin
 - Central Basin Platform
 - Midland Basin
- Development progression:
 - Early production from shallow formations on the basin edges
 - Transition to deeper deposits in the central Delaware (Avalon, Bone Spring, & Wolfcamp)
- Recent basin revitalization:
 - Comingled vertical completions
 - Modern horizontal drilling and completion technologies

Permian Basin Cross Section



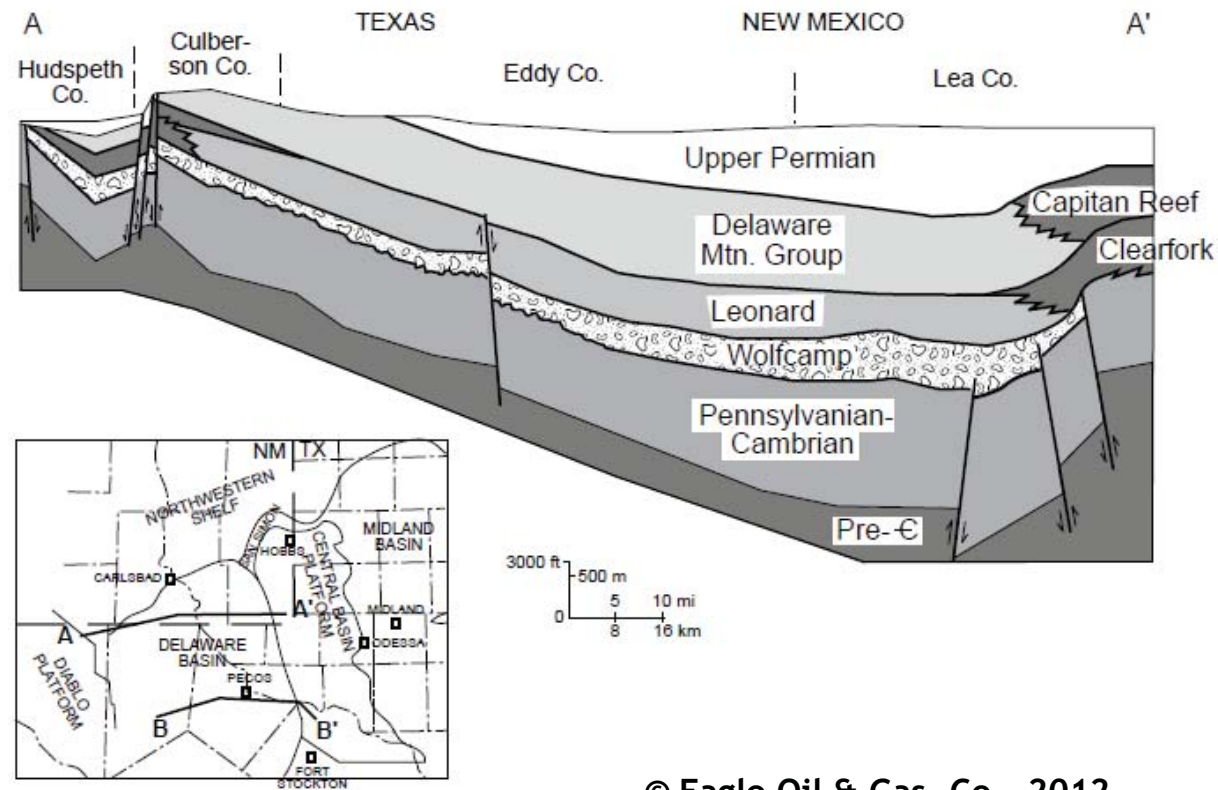
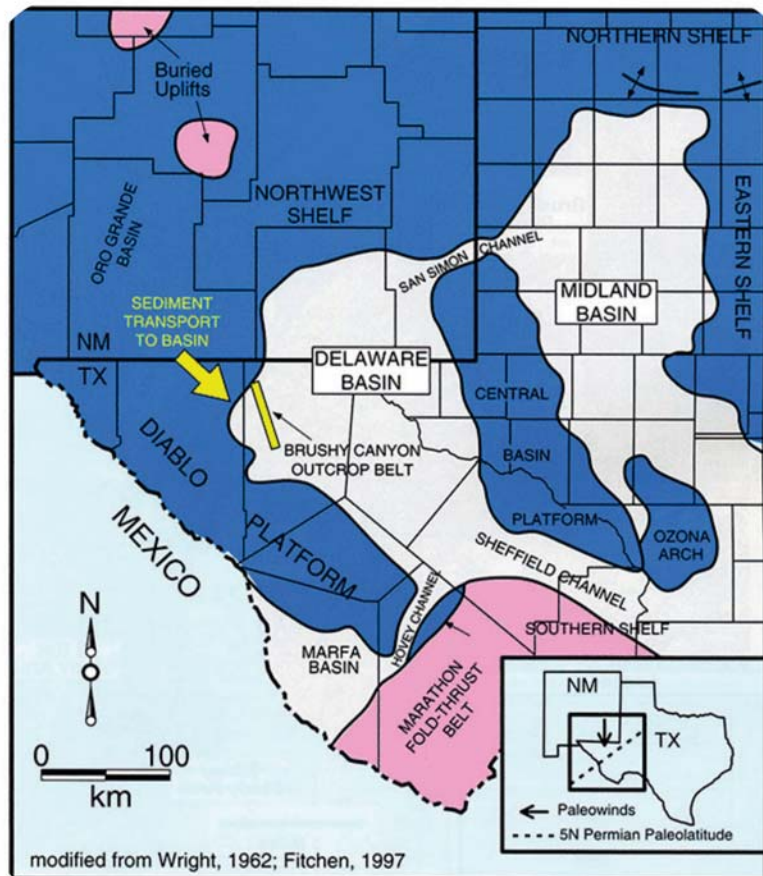
Permian Basin Structure



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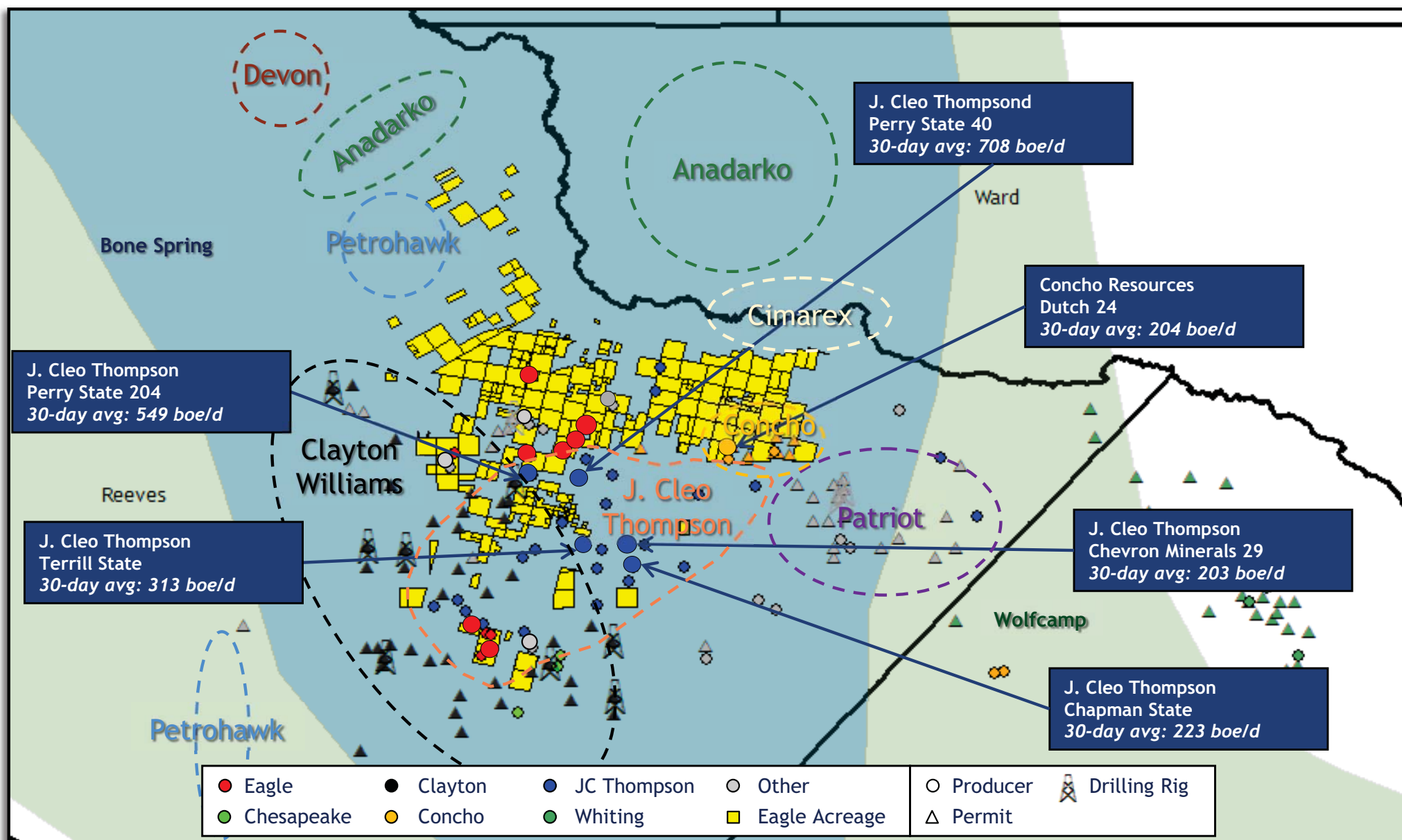
Delaware Basin Deposition

- 2 depositional systems in place
 - Deep submarine channels running off the NW Shelf and Central Basin Platform
 - Periods of influx of carbonate debris
- 3rd process in generation of organics in the photic zone across the entire basin as debris settled
 - Mostly organics settling in the deep basin; carbonates mainly deposited on the Shelf and on the Slope

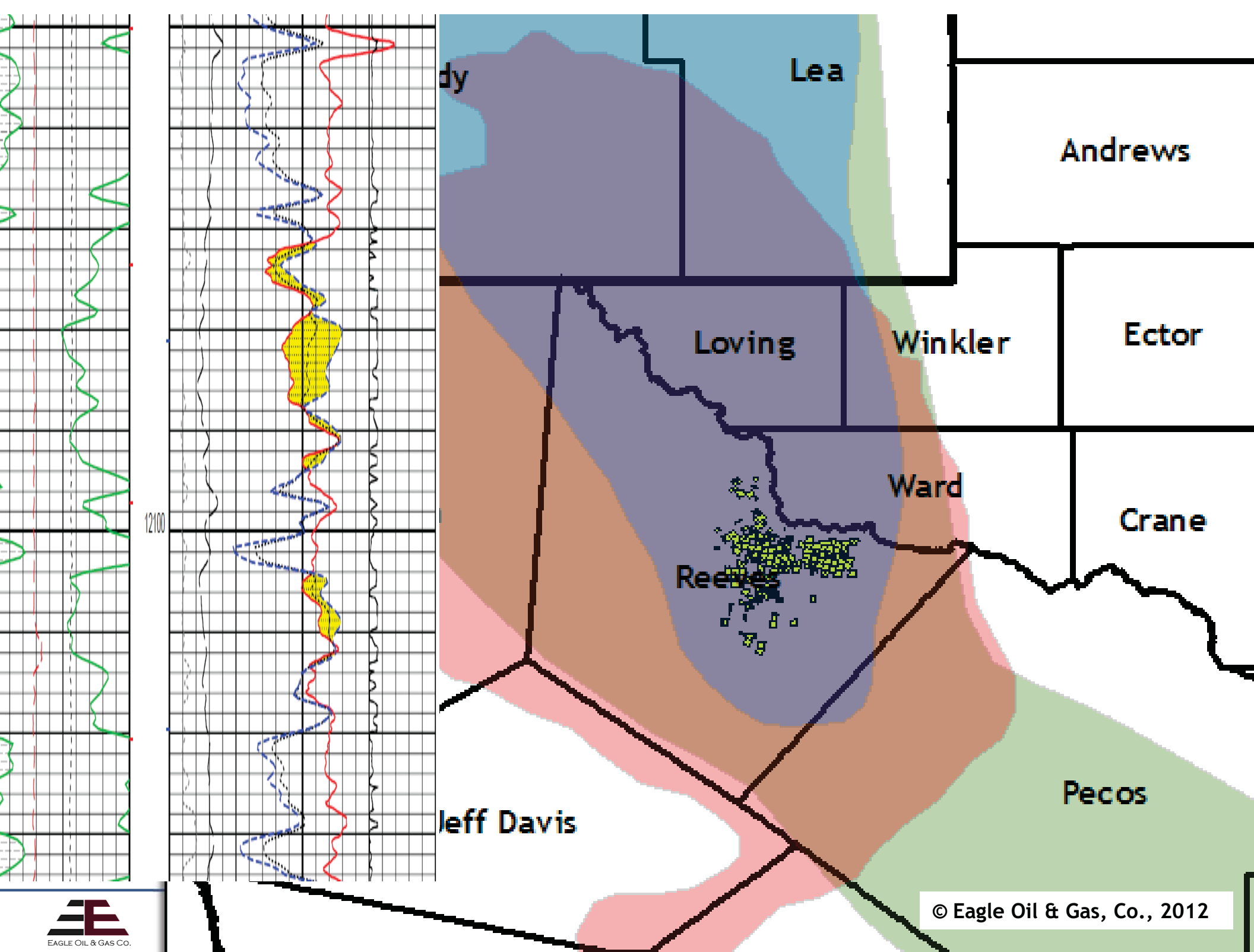


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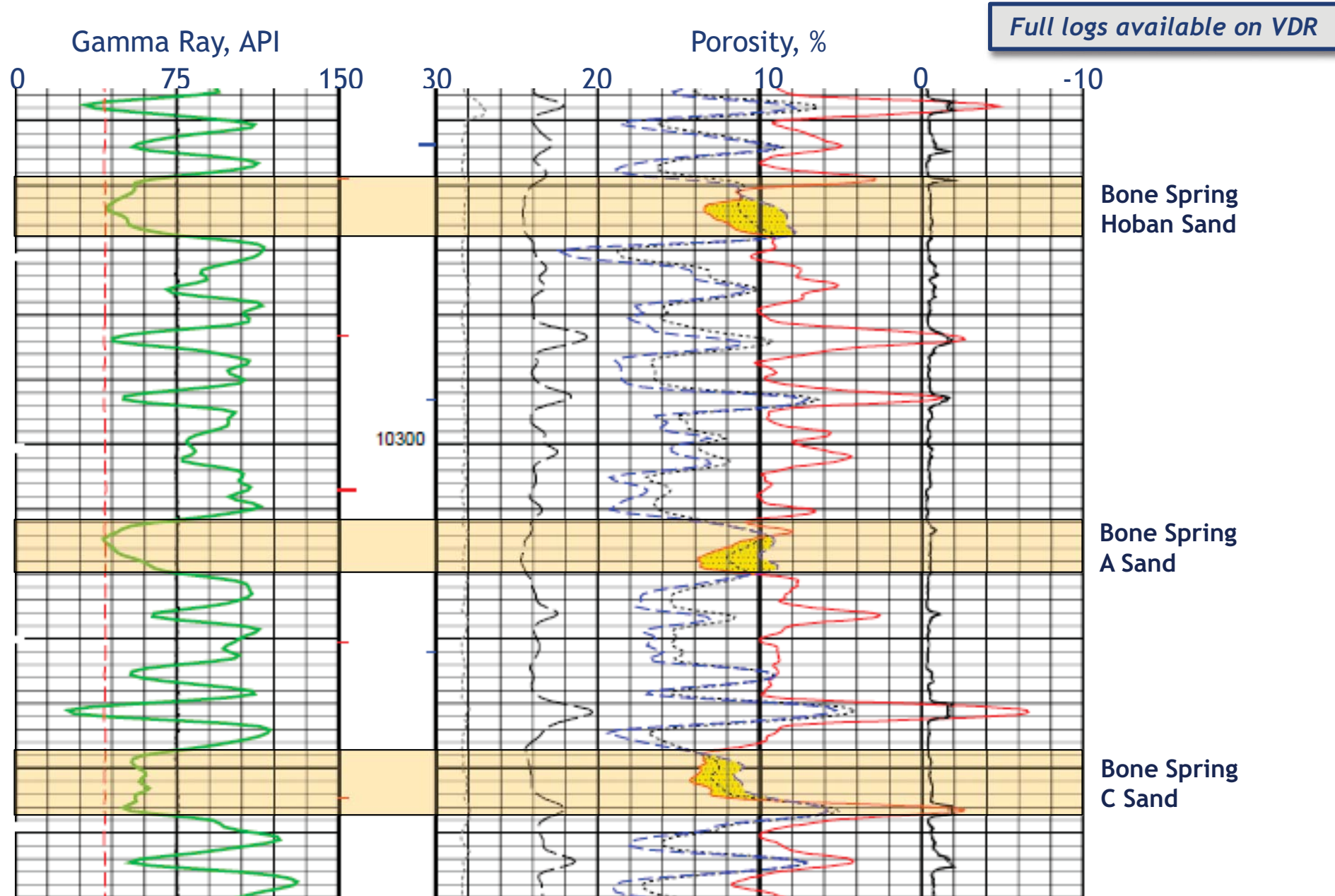
Wolfbone Industry Activity



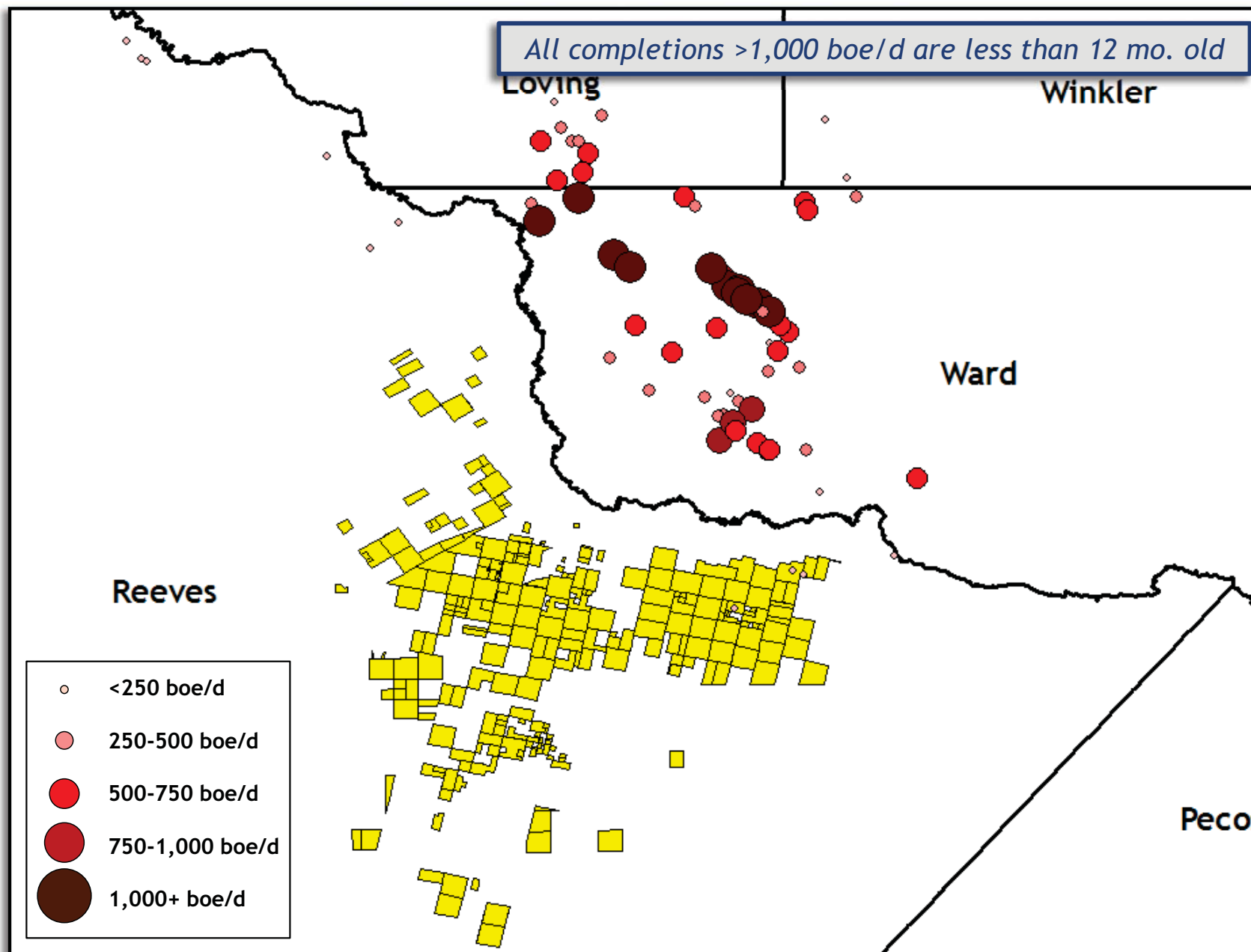
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PERIOD	SERIES	BASIN		PERIOD	SERIES	BASIN	
		FORMATION				FORMATION	
GUADALUPE	DELAWARE GROUP	LAMAR BELL CANYON		GUADALUPE	WHITE-HORSE	TANSILL	
		CHERRY CANYON				YATES	
		BRUSHY CANYON				7 RIVERS	
						QUEEN	
					GRAYBURG		
LEONARD	1ST BONE SPRING	UPPER AVALON SH.		LEONARD	WARD	SAN ANDRES	
		LOWER AVALON SH.				SAN ANGELO	
		1ST BONE SPRING SD					
		2ND BONE SPRING					
		3RD BONE SPRING					
WOLF-CAMP	WOLFCAMP		WOLF-CAMP	WOLFCAMP			
						© Eagle Oil & Gas, Co., 2012	



Bone Spring Type Log Section



H2 Bone Spring IP Bubble Map





5/84



12/05



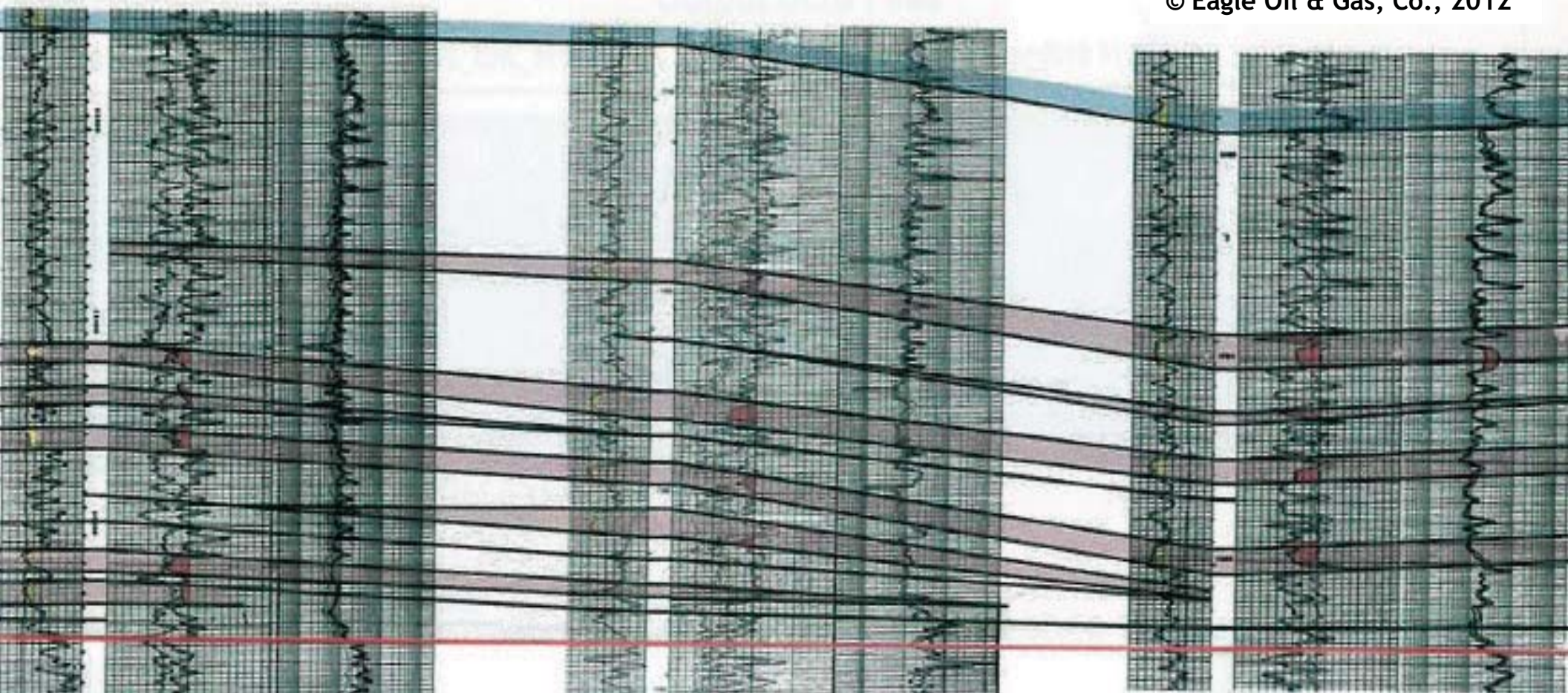
8/78

GETTY OIL CO.
UNIVERSITY "44-20" #1
1320' FNL & 1320' FWL
SEC 44, BLK 20, UNIVERSITY LANDS SURVEY
WARD COUNTY, TEXAS
ELEV 2801'
TD 20,155'

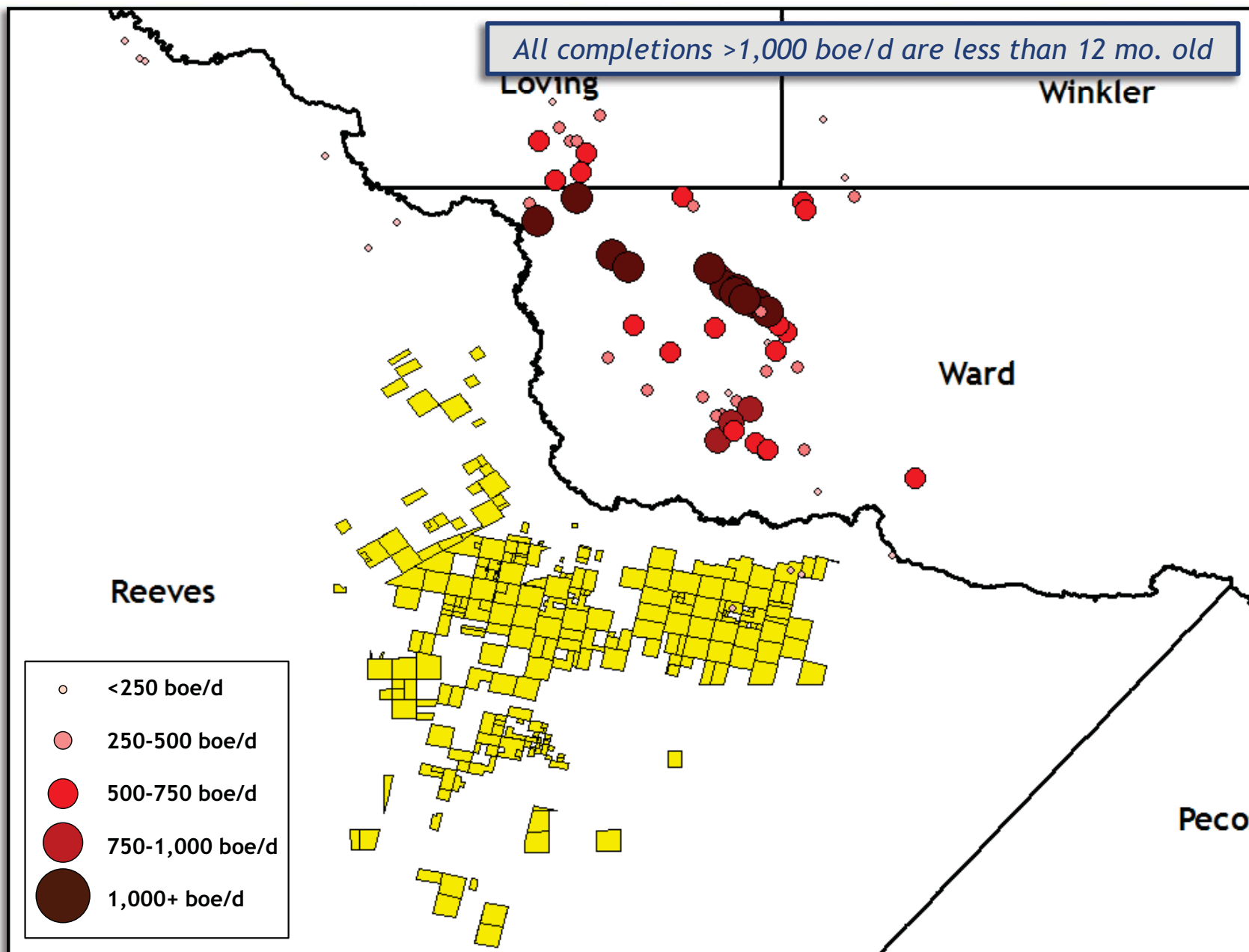
BROWNING OIL COMPANY INC.
UNIVERSITY "18-42" #1
1320' FNL & 1320' FWL
SEC 42, BLK 18, UNIVERSITY LANDS SURVEY
WARD COUNTY, TEXAS
ELEV 2814'
TD 11,860'

C & K PETROLEUM INC.
MEEKER "45" #1
1320' FNL & 1320' FWL
SEC 45, BLK 6, H&GN SURVEY
REEVES COUNTY, TEXAS
ELEV 2562'
TD 20,246'

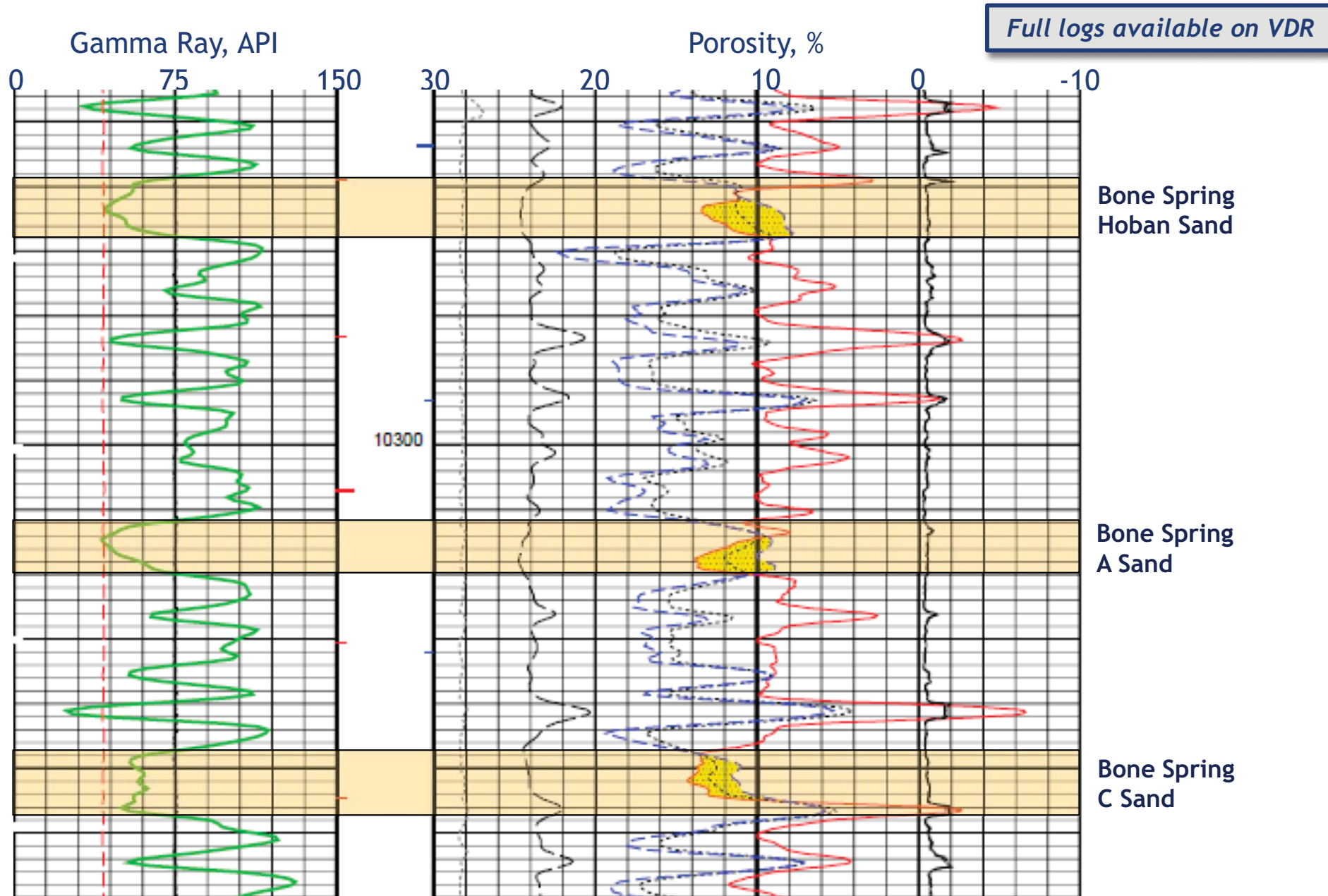
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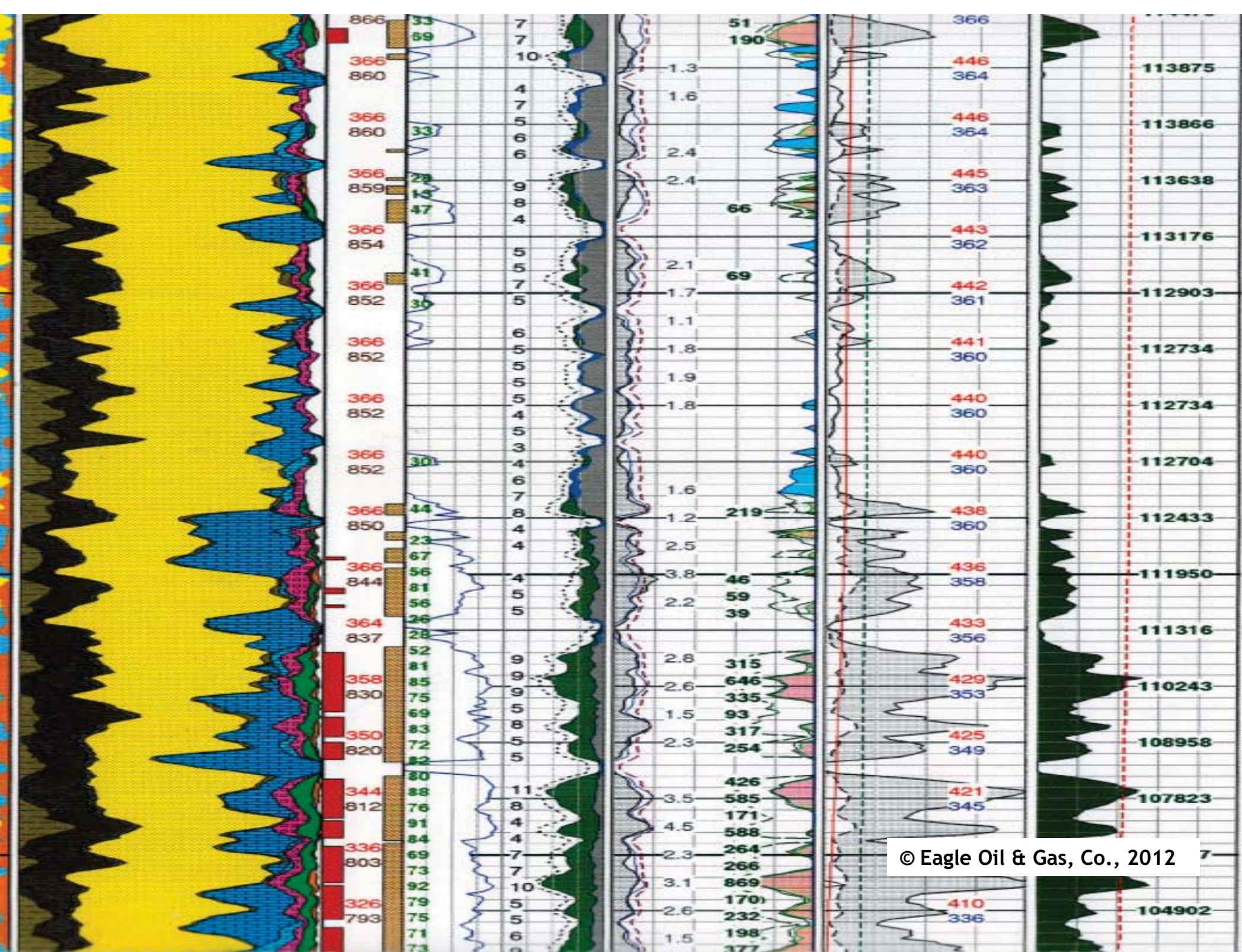


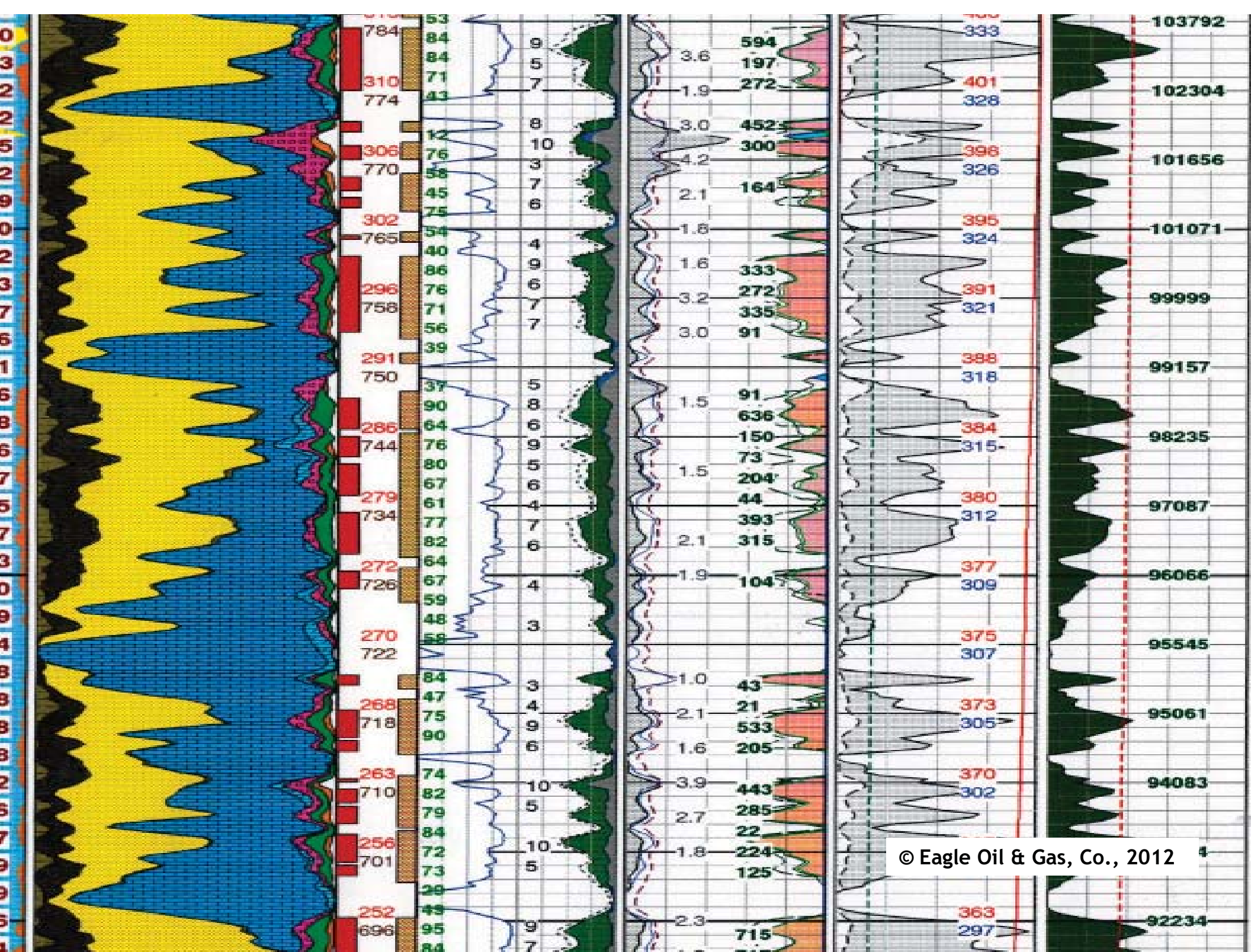
H2 Bone Spring IP Bubble Map

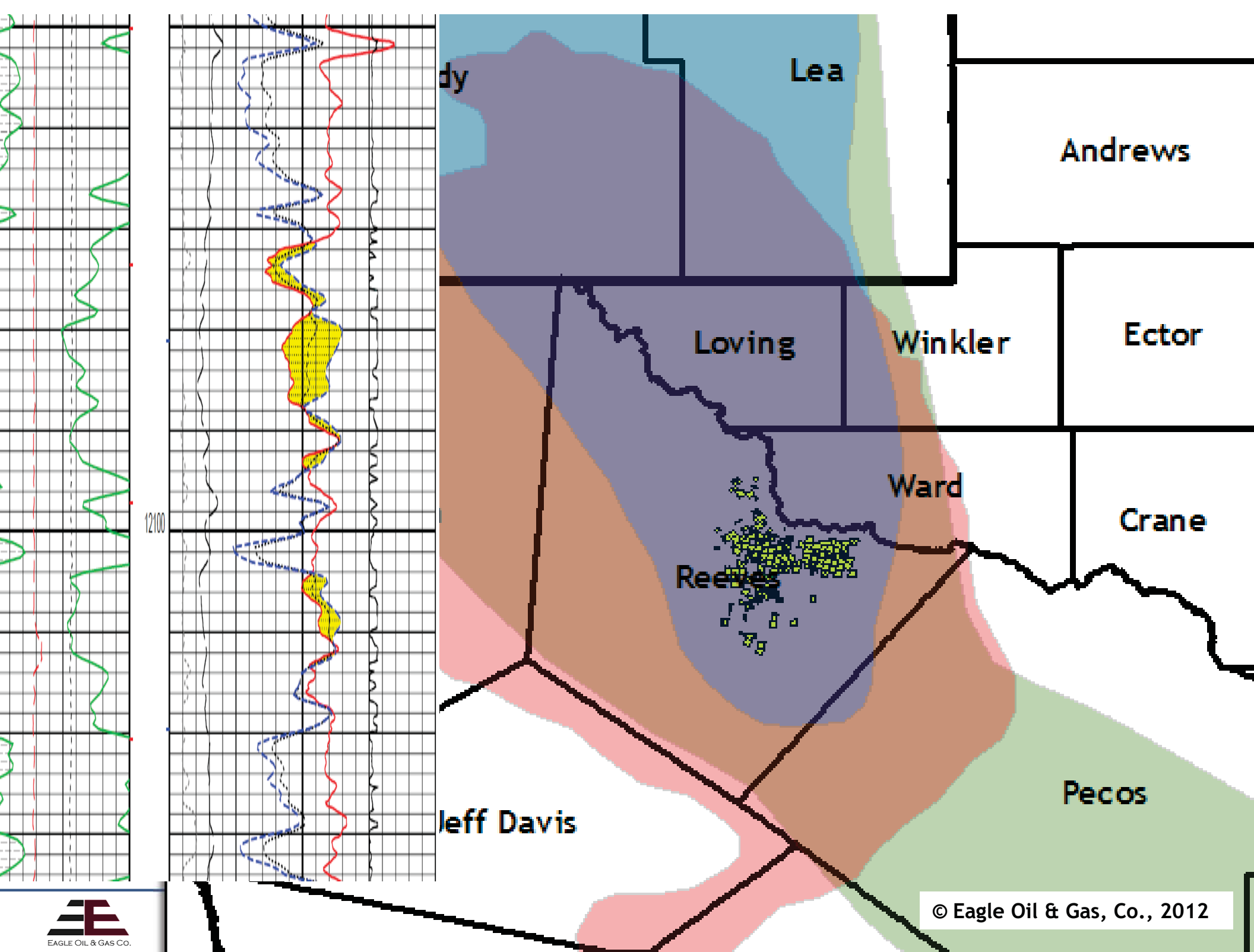


Bone Spring Type Log Section







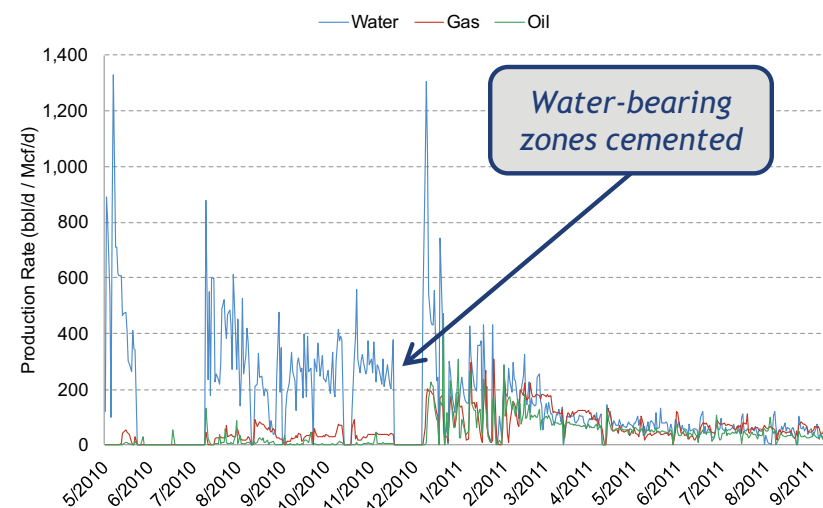


Plugging Water-Bearing Zones Improves Profits

Pistola #1 Case History

- Eagle's 2nd Wolfbone completion
- Well initially flowed >1,000 bblw/d
- Leveled out ~150 bblw/d
- Re-entered wellbore and cement squeezed Middle Wolfcamp Sands C&D
- Re-completed Middle and Upper Wolfcamp shales and 3rd Bone Spring Sands
- **Well IP'd > 450 bopd following intervention**

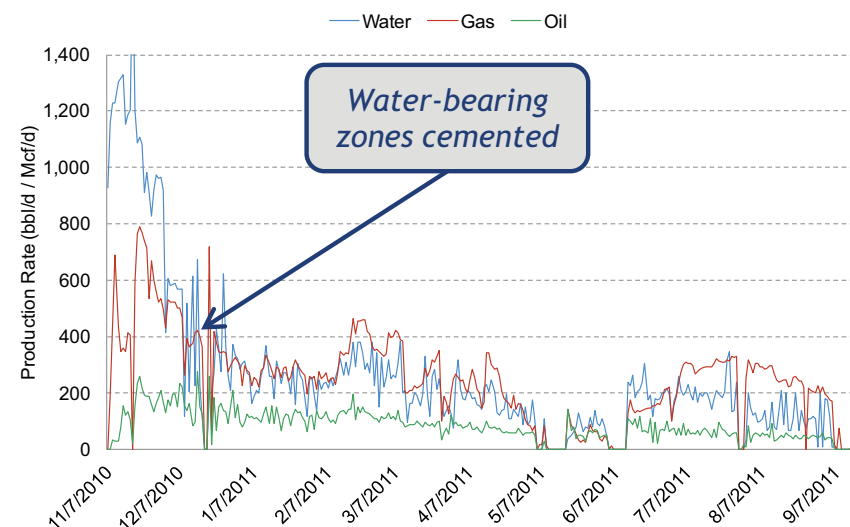
Pistola #1 Production History



City of Pecos 15 #1 Case History

- Eagle's 6th Wolfbone completion
- Well initially flowed >1,200 bblw/d
- Decreased to ~600 bblw/d over 30 days
- Re-entered wellbore and cement squeezed Middle Wolfcamp Sands C
- Re-completed Middle and Upper Wolfcamp shales and 3rd Bone Spring Sands
- **WOR cut in half to ~1.5 from 3+ vastly improving economics**

City of Pecos 15 #1 Production History

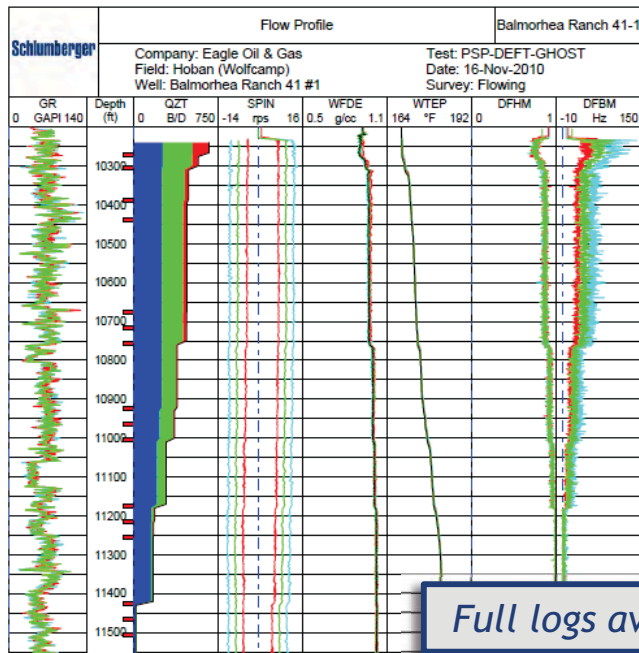


Production Logs = Precision Completions

Production Logs Used to Identify Target Intervals

- Eagle has run production logs in 9 Wolfbone wells
- Tool has multiple sensors to identify contributing intervals:
 - Spinner with dual-axis caliper
 - Pressure and temperature sensors
 - Digital Entry Flowview Imaging Tool (DEFT)
 - Water measurement
 - Gas Holdup Optical Sensing Tool (GHOST)
 - Gas measurement

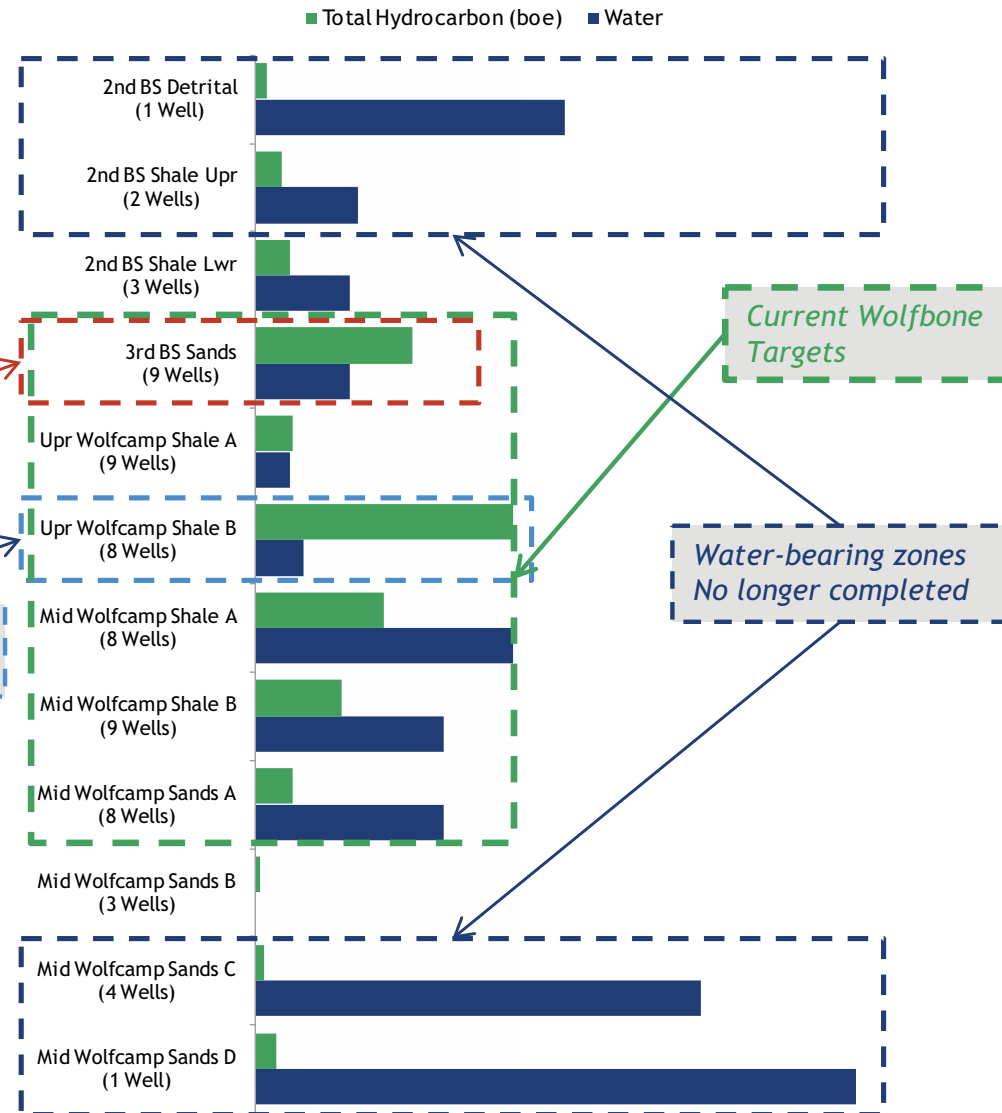
Previously Drilled Hz Target

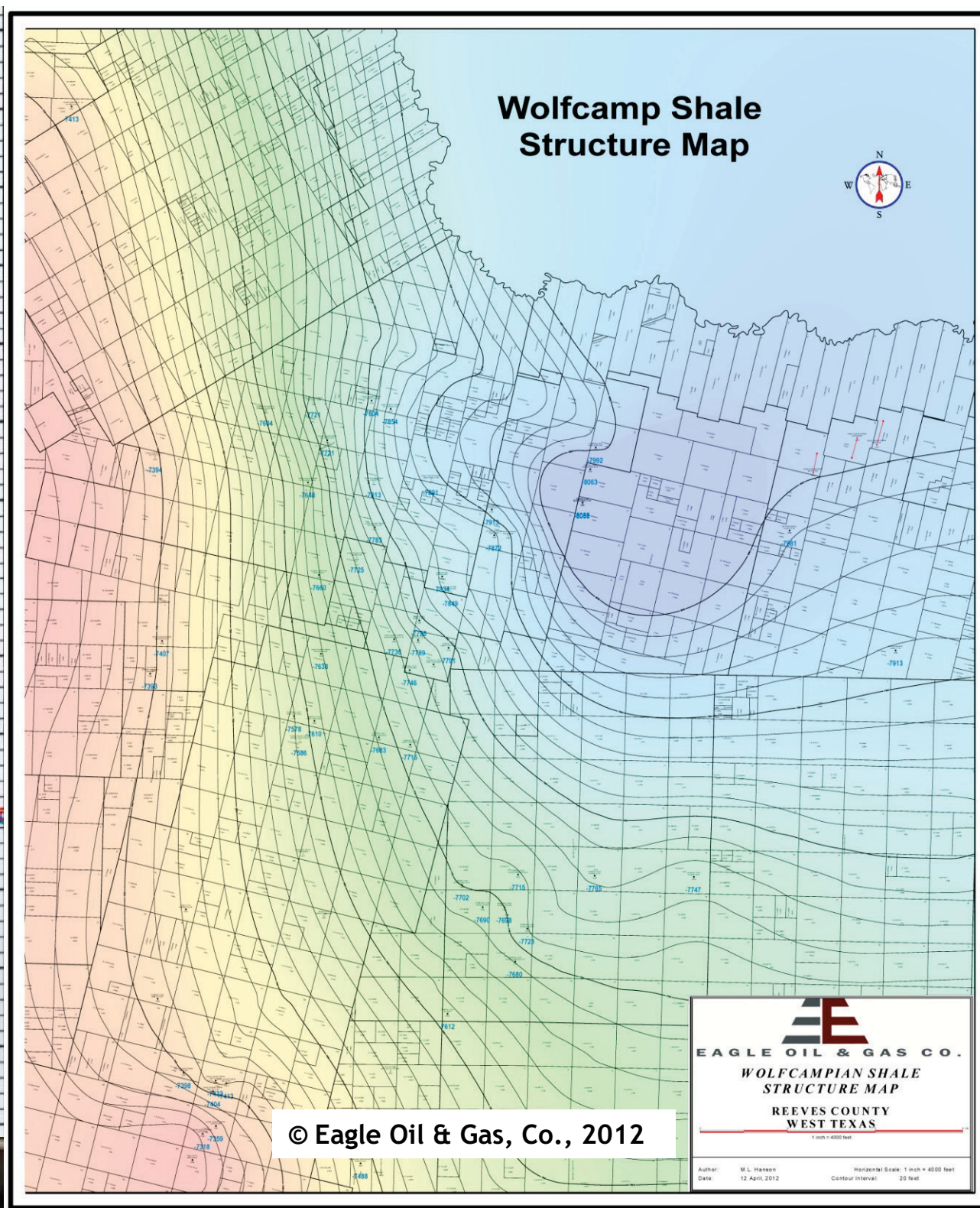
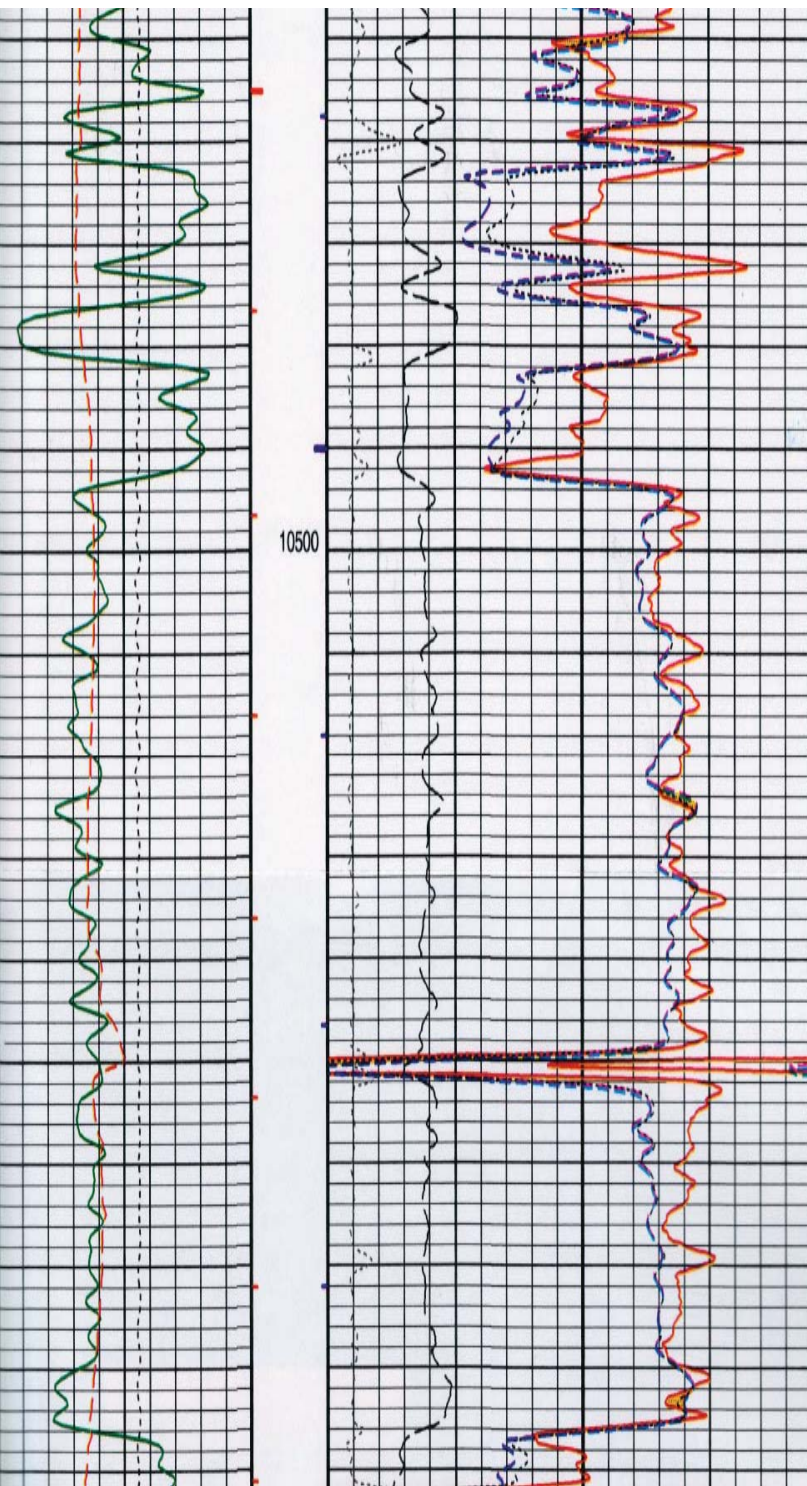


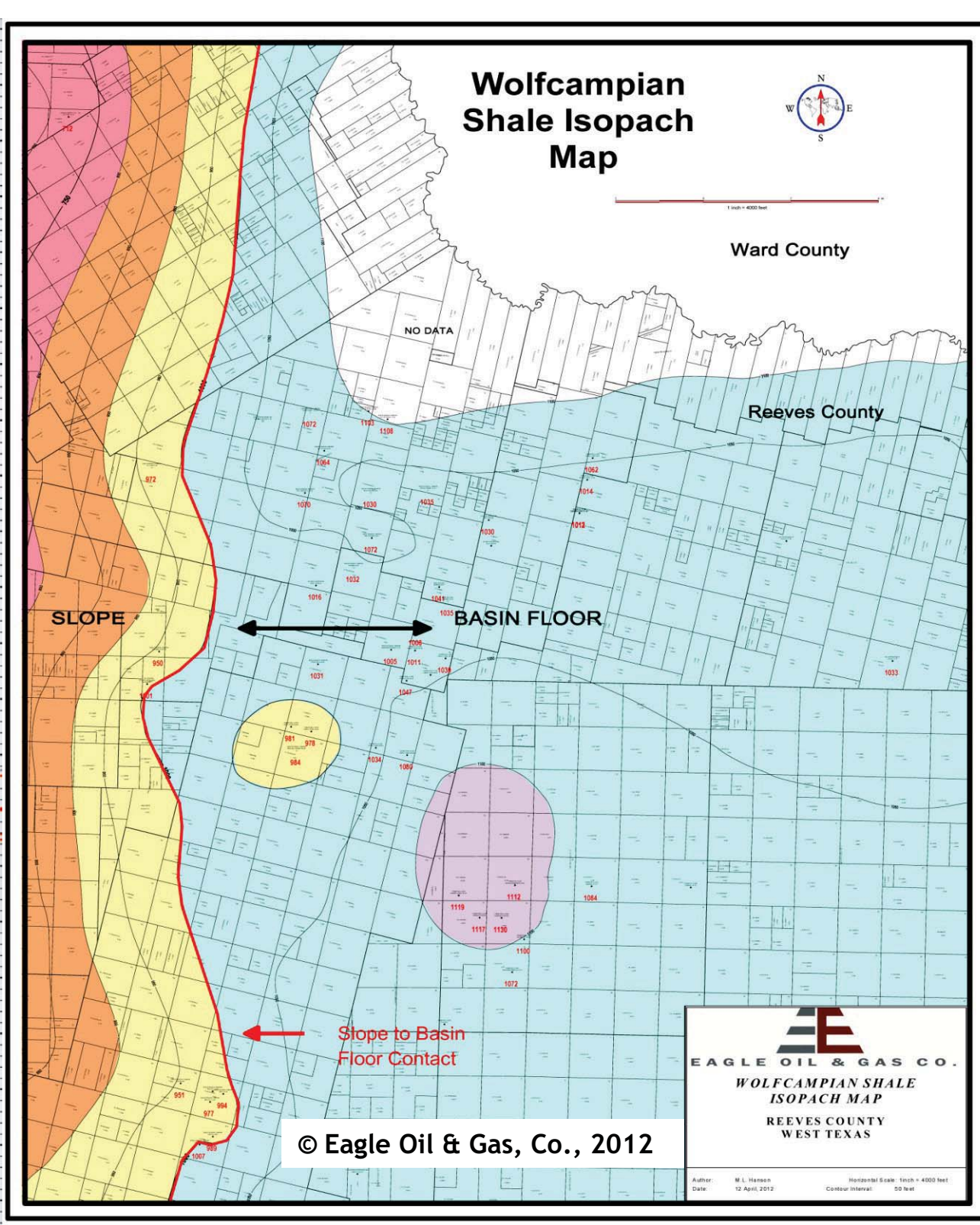
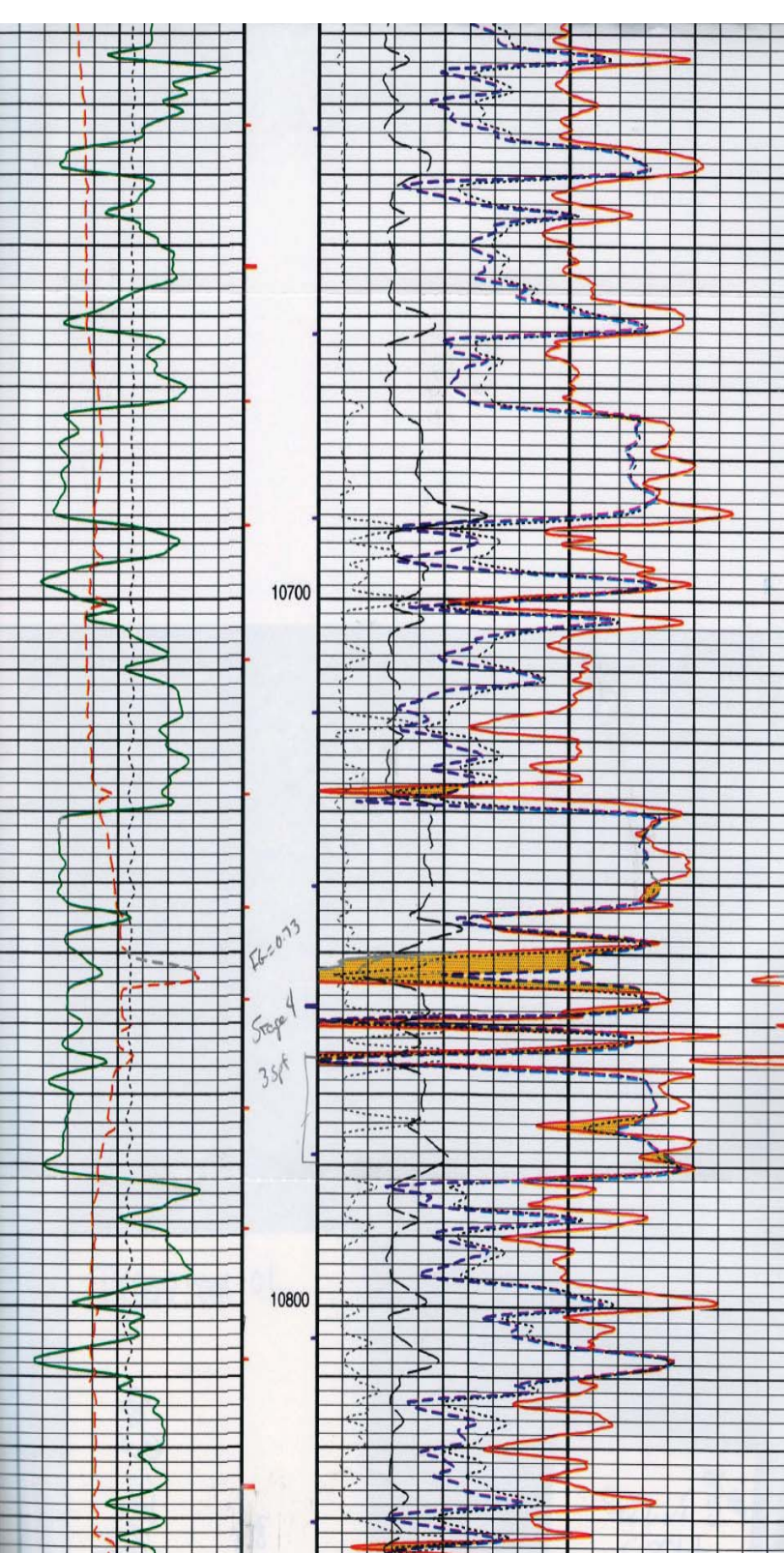
*Current Hz Target
Monroe 39 #2H*

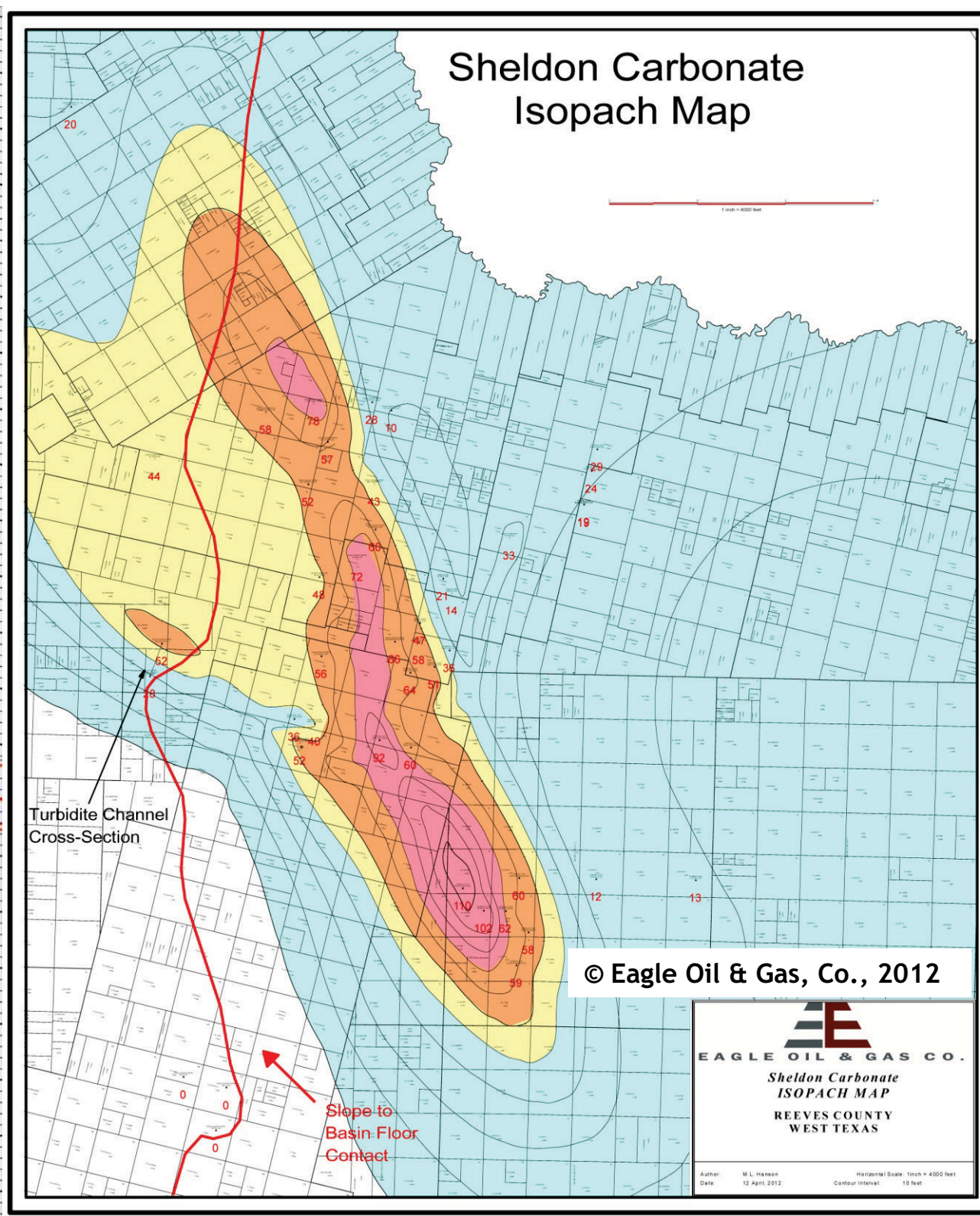
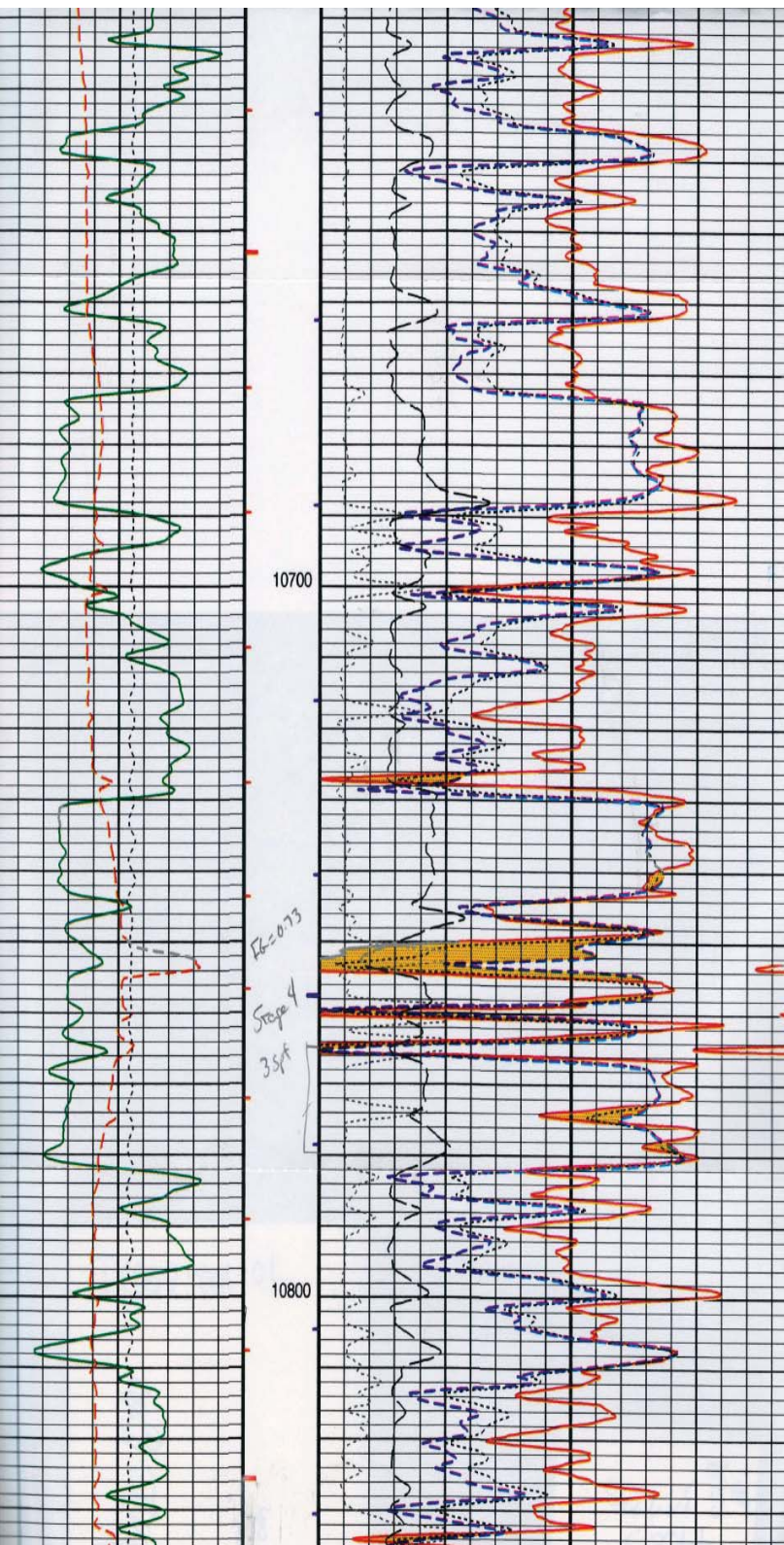
Full logs available in VDR

Relative Flow Contribution by Member⁽¹⁾



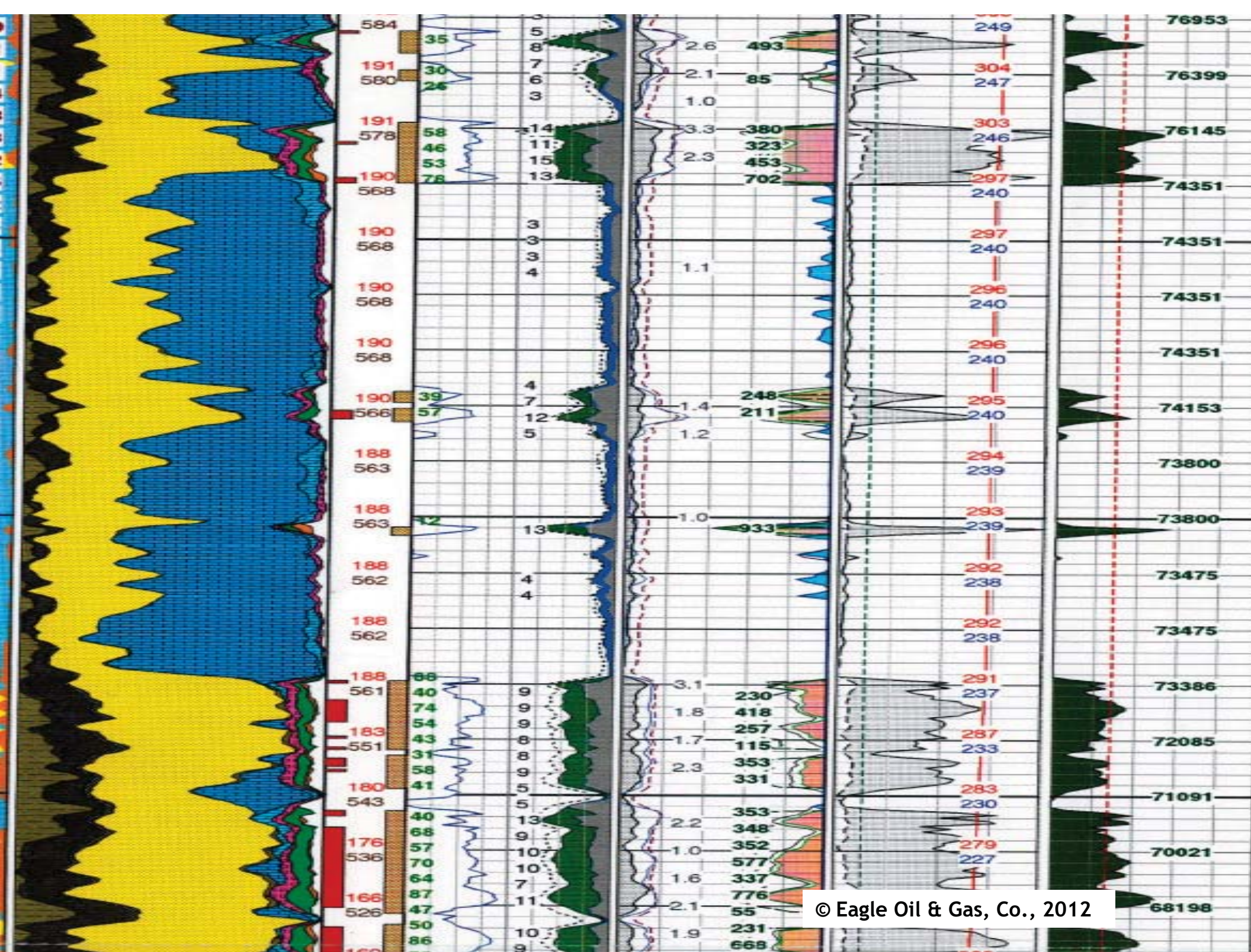


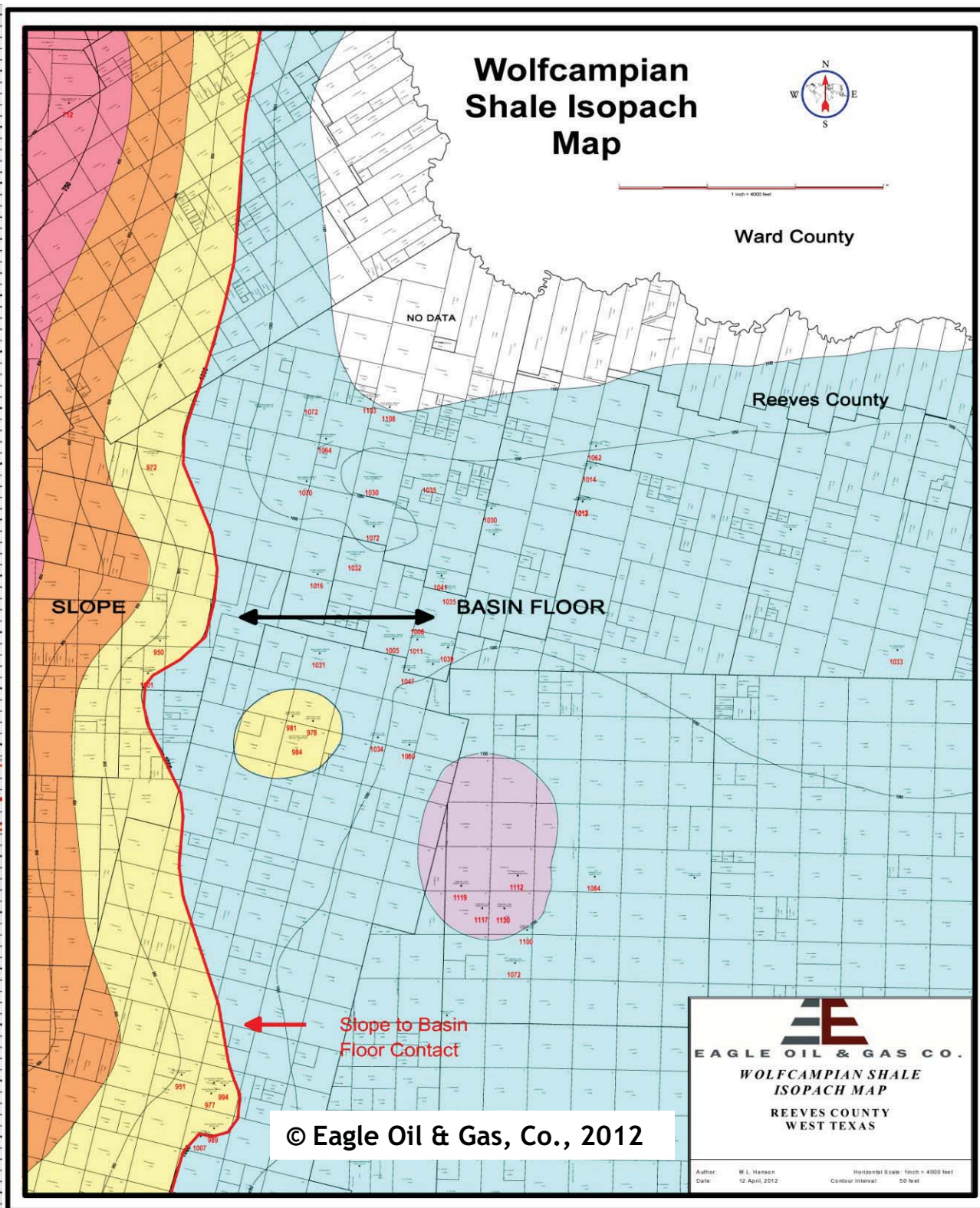
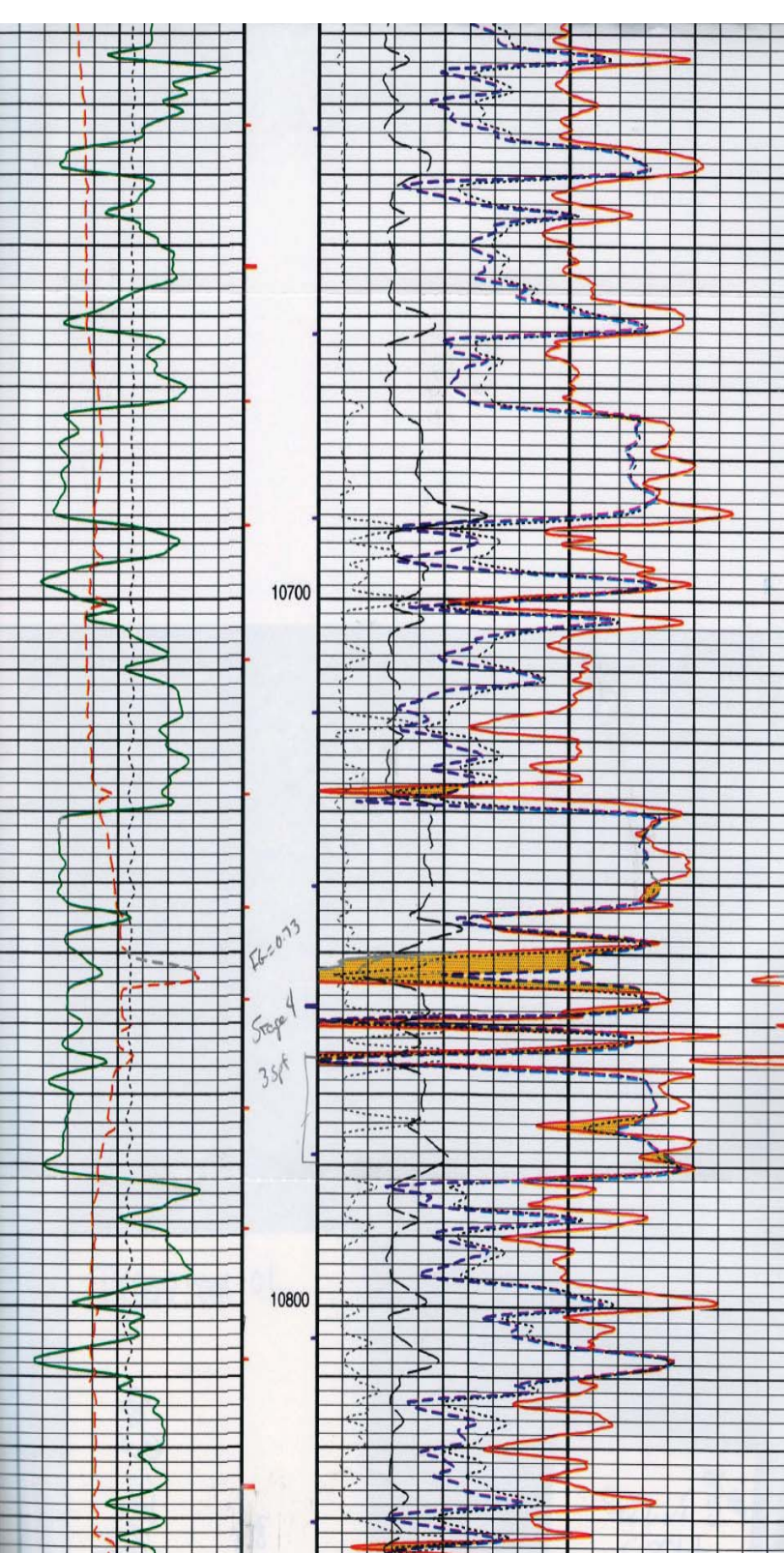


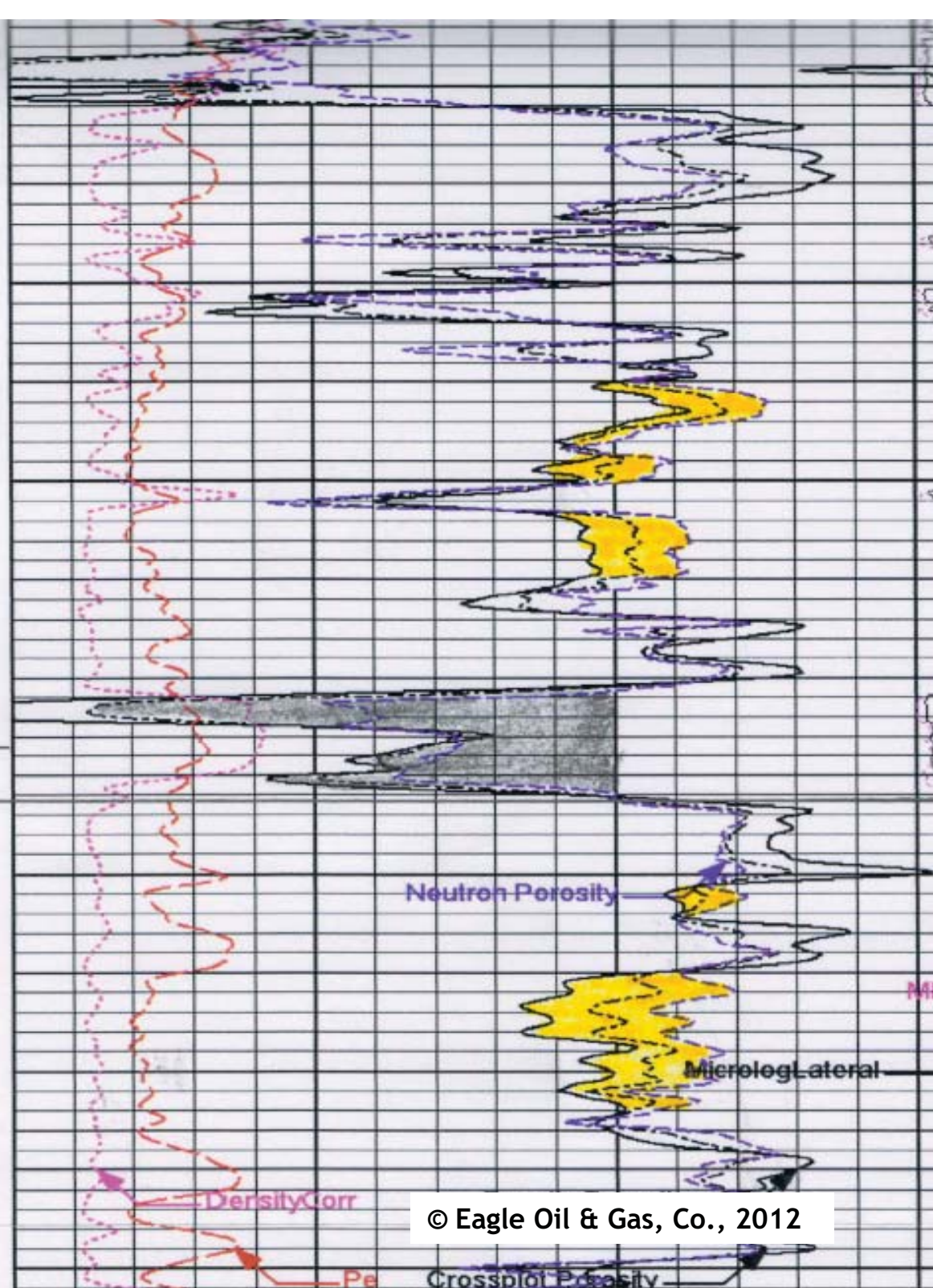
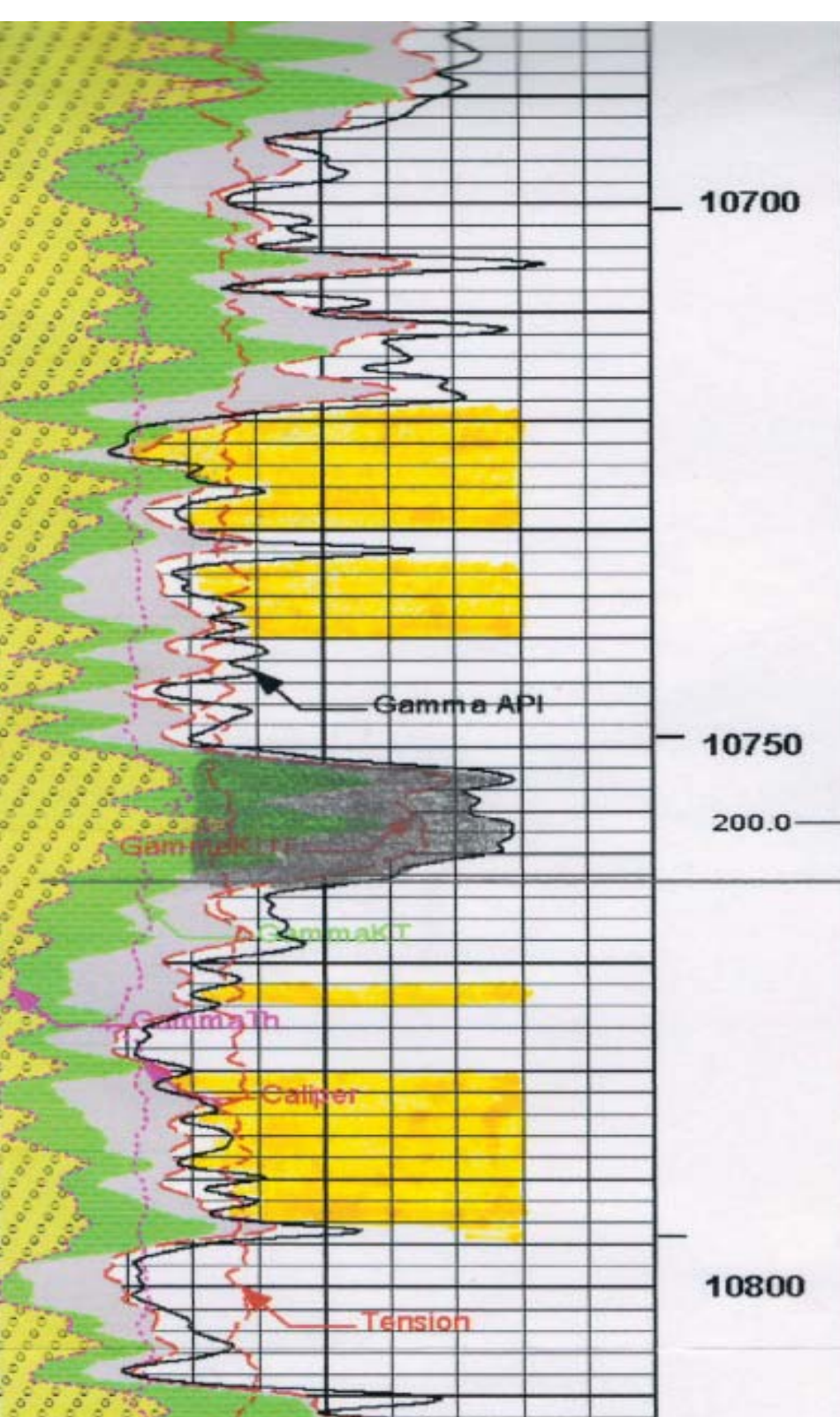


Top of Sheldon

11140





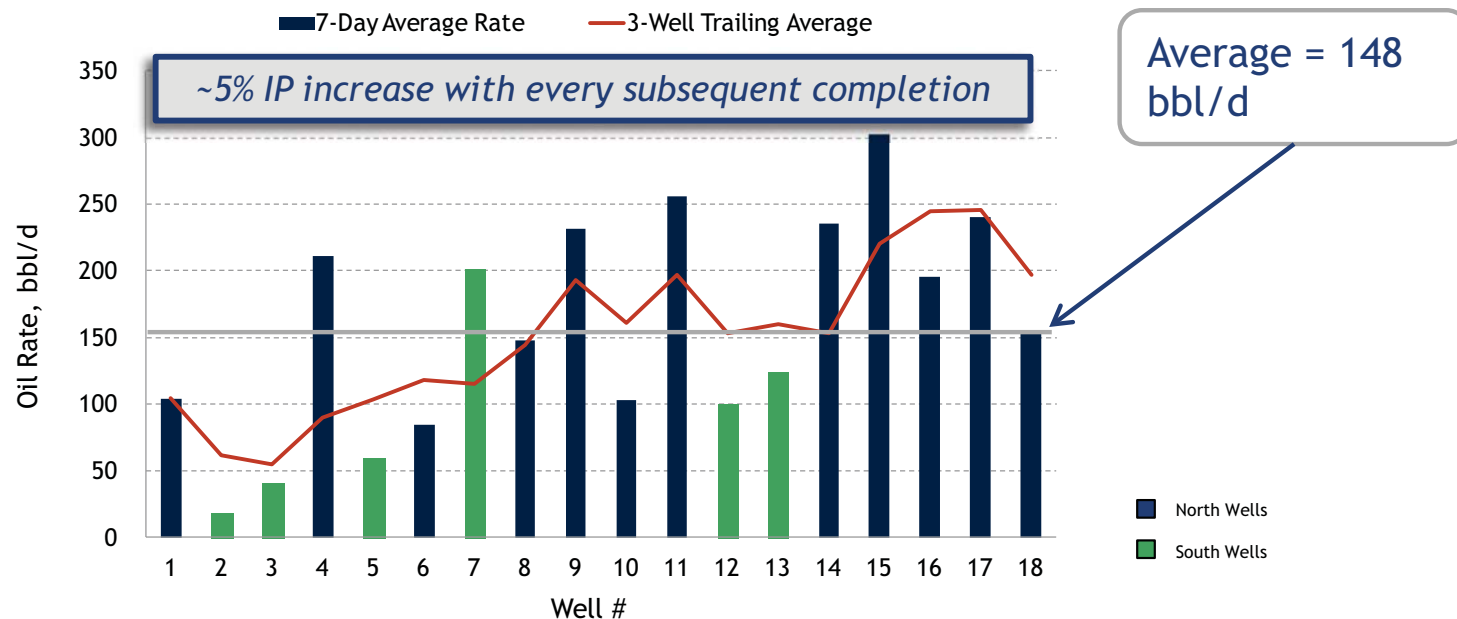


Focusing the Effort

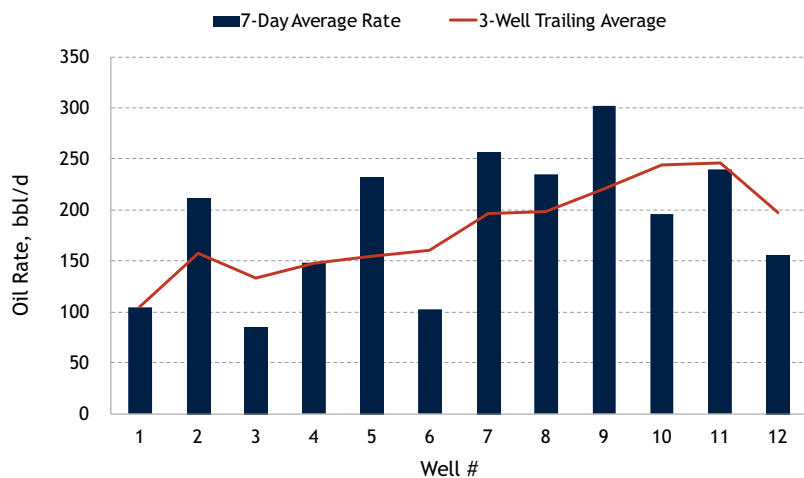


Most recent wells completed consistently with excellent results

IP's Trending Upward as Completions Improve



North Wells

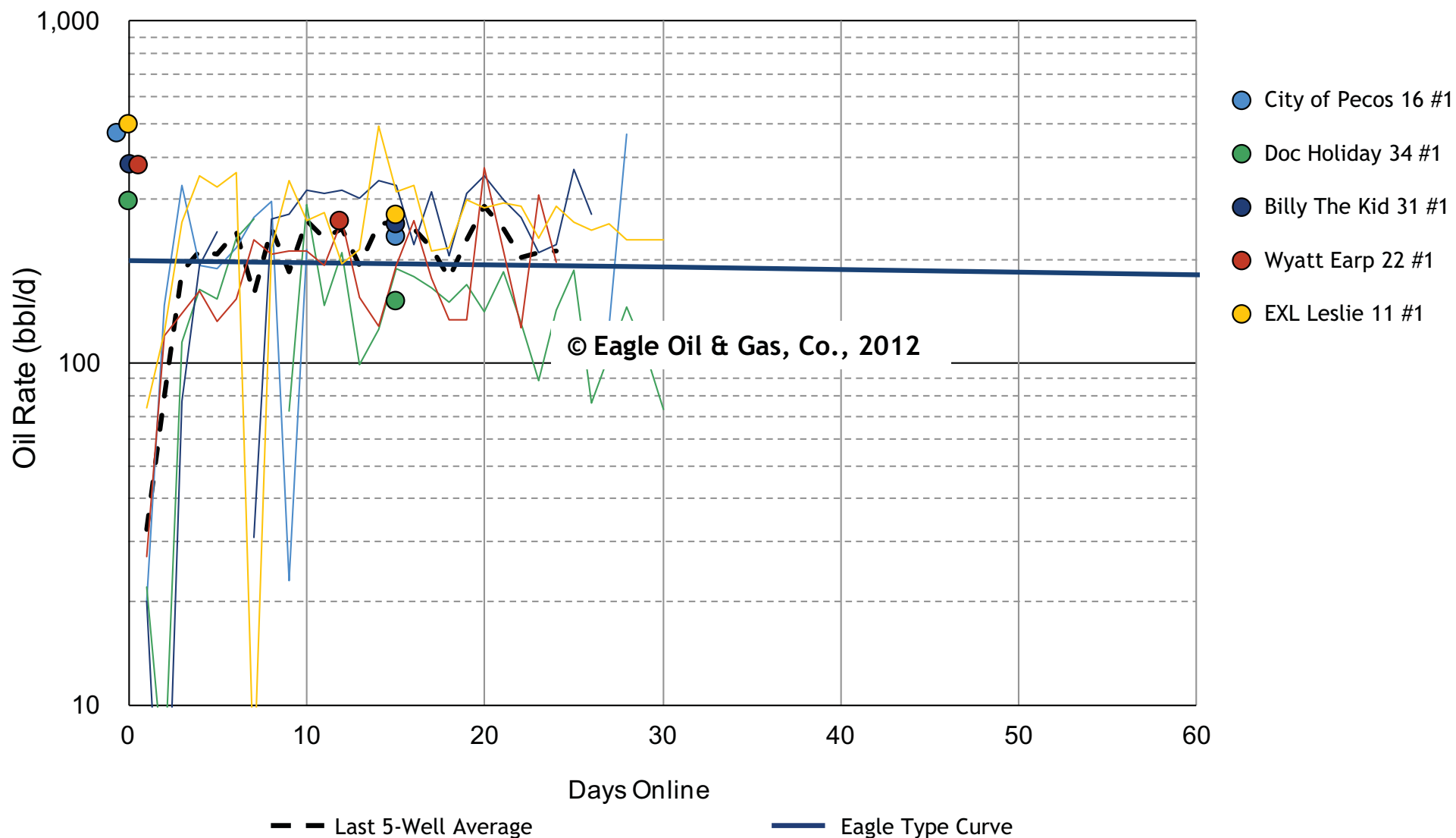


South Wells

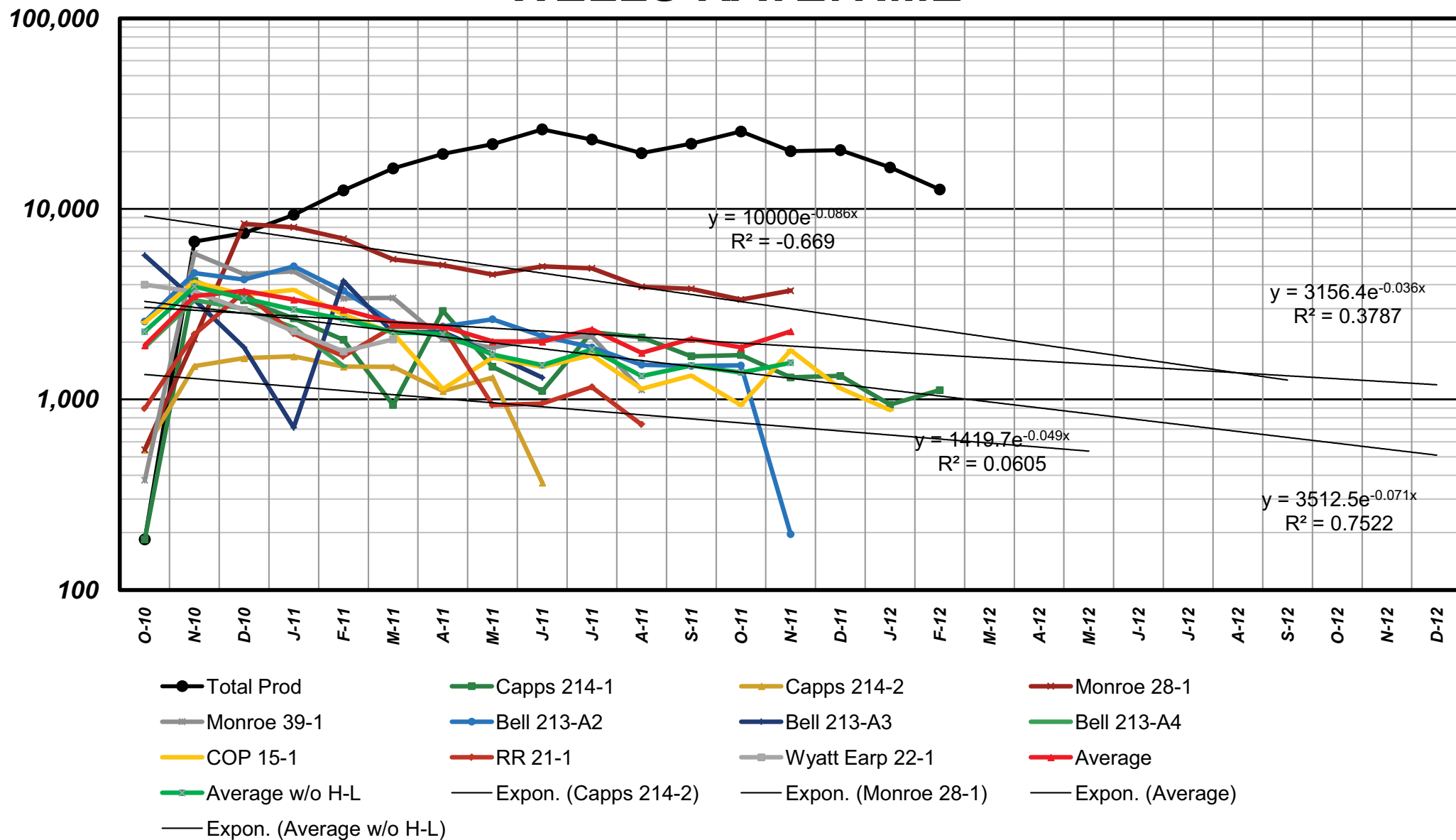


Honoring Recent Data

Recent well data; supports type curve IP

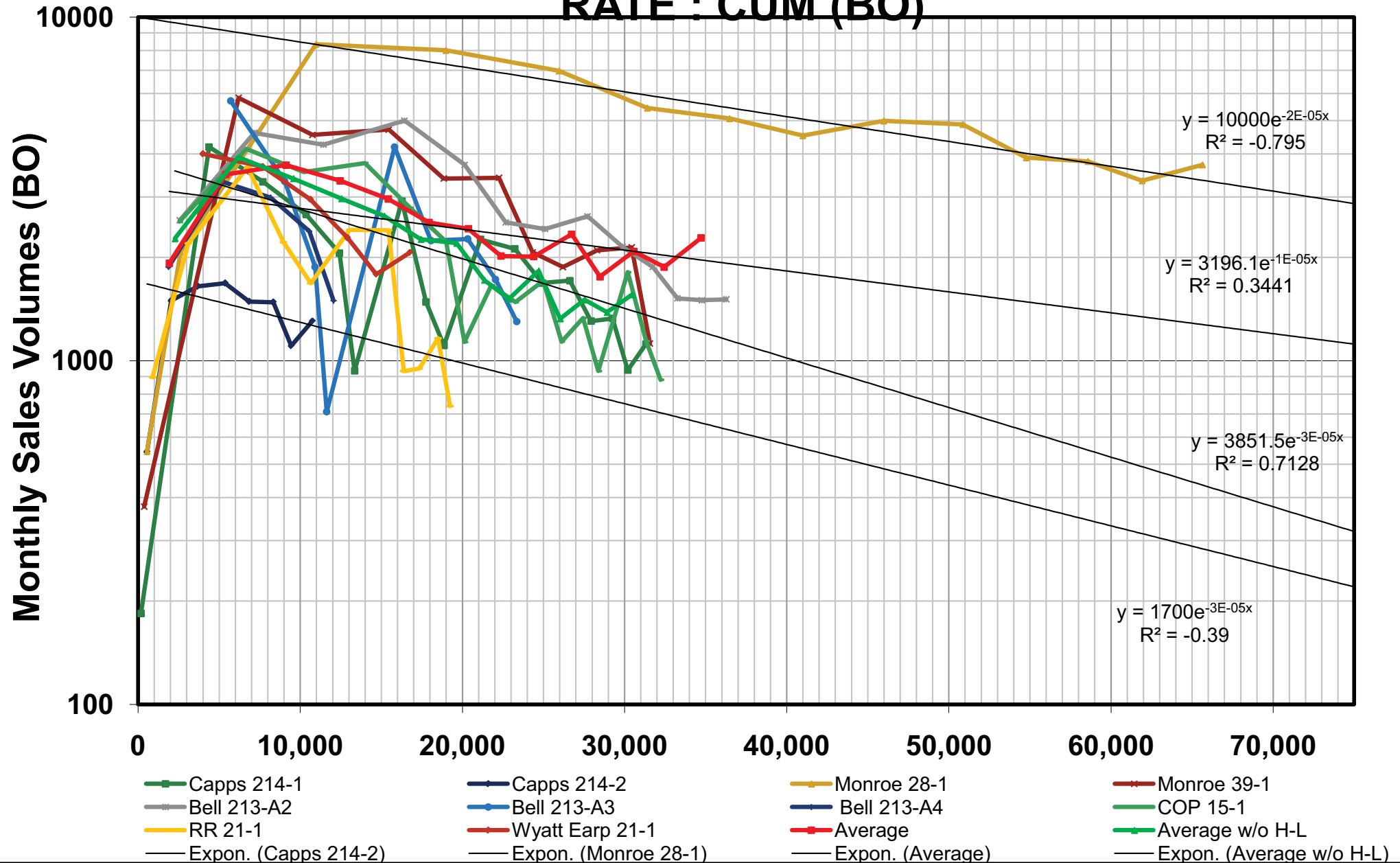


RIVERFORD EXPLORATION, LLC WOLFBONE WELLS RATE:TIME

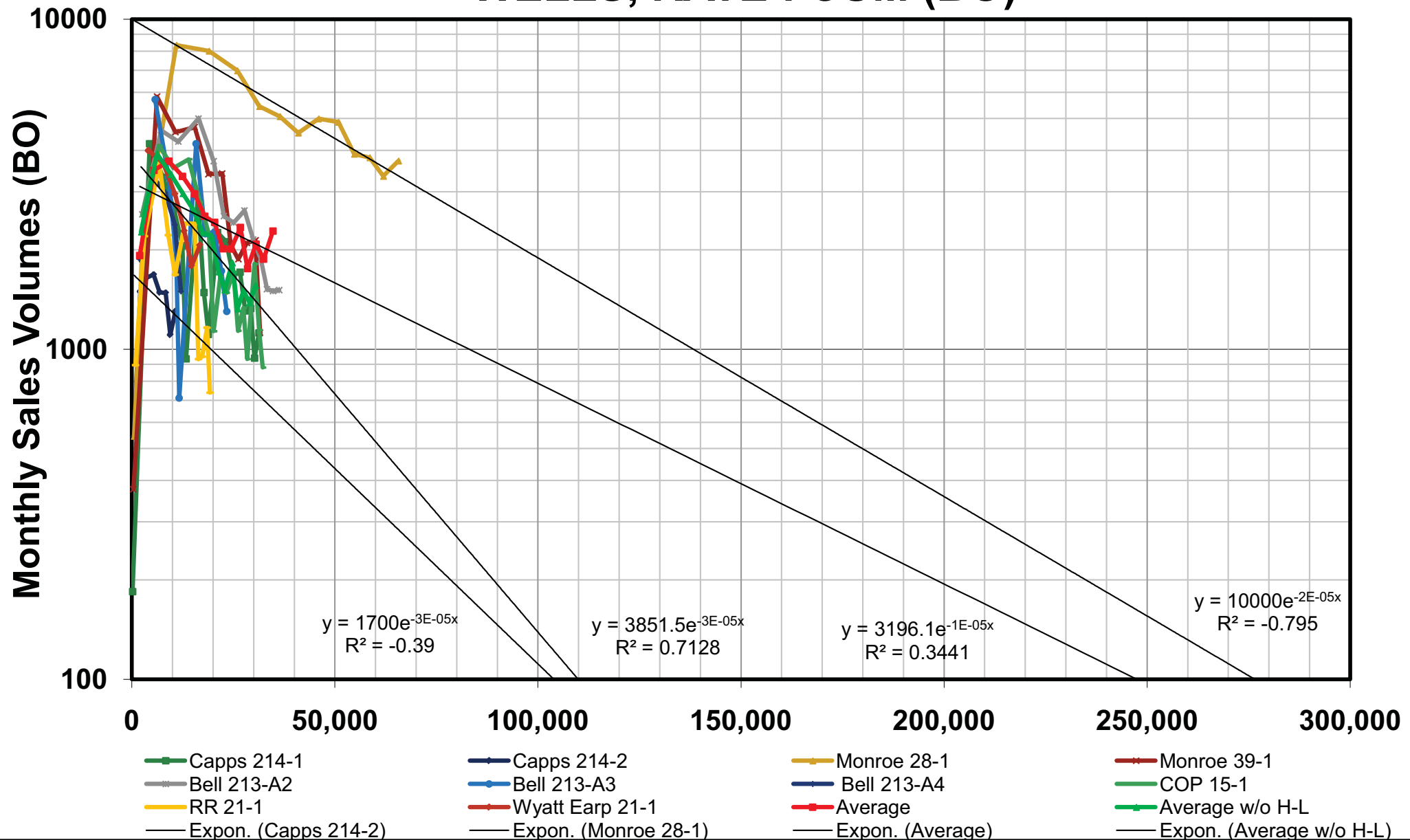


RIVERFORD EXPLORATION, LLC WOLFBONE WELLS

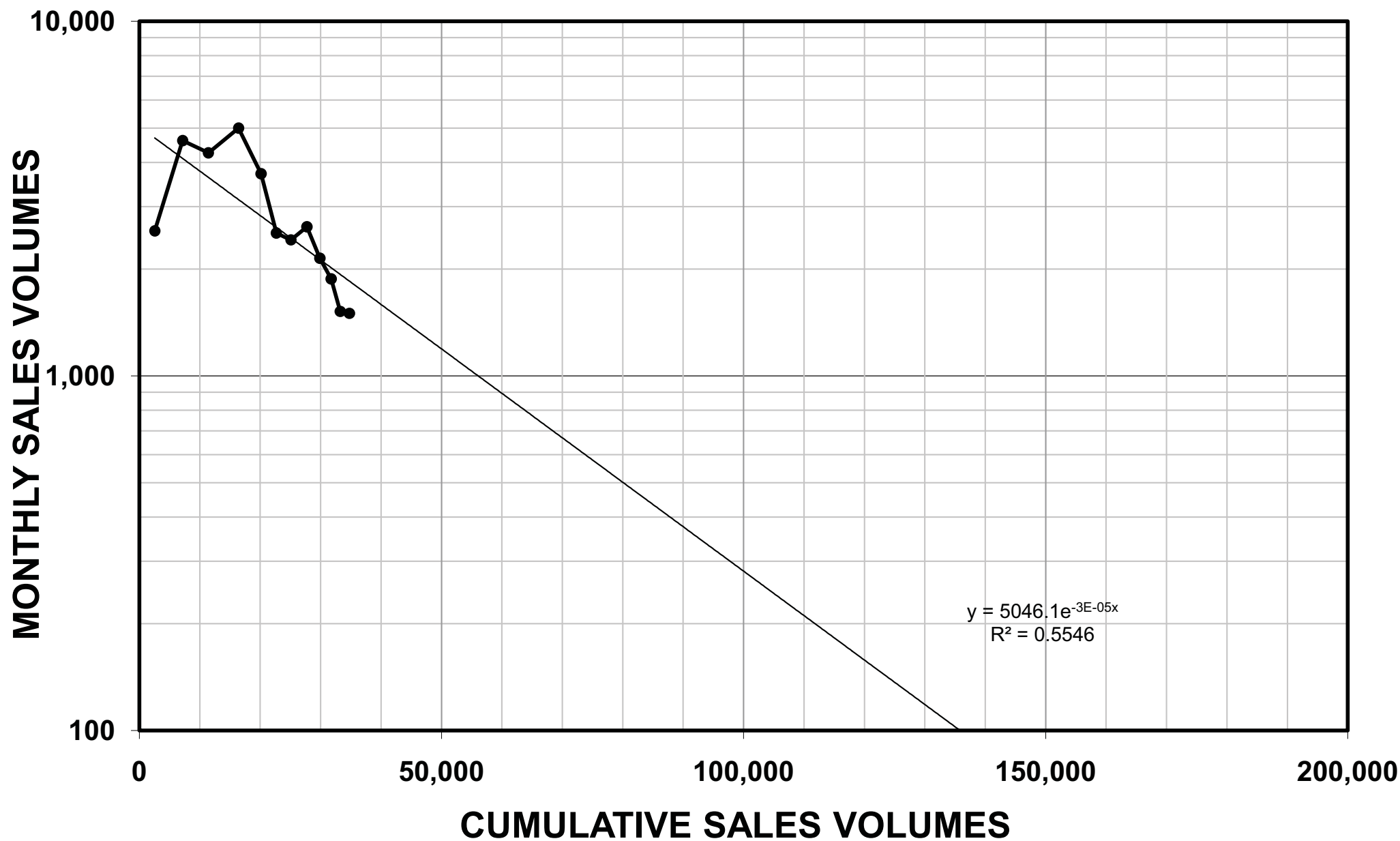
RATE : CUM (BO)



RIVERFORD EXPLORATION, LLC WOLFBONE WELLS, RATE : CUM (BO)

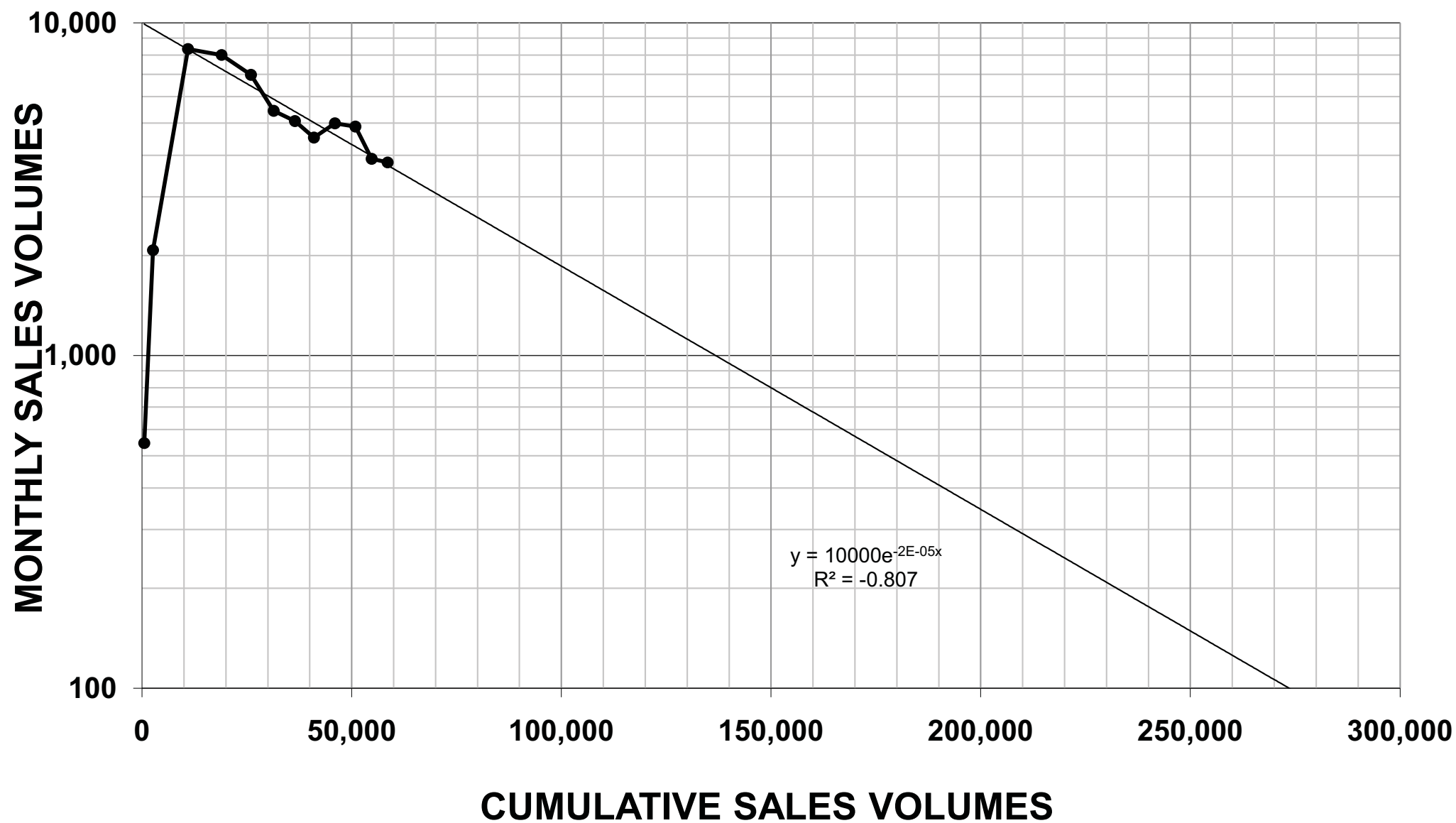


BELL 213-A2 ("TYPE WELL"), RATE : CUM (BO)



MONROE 28 #1 ("HIGH-SIDE WELL")

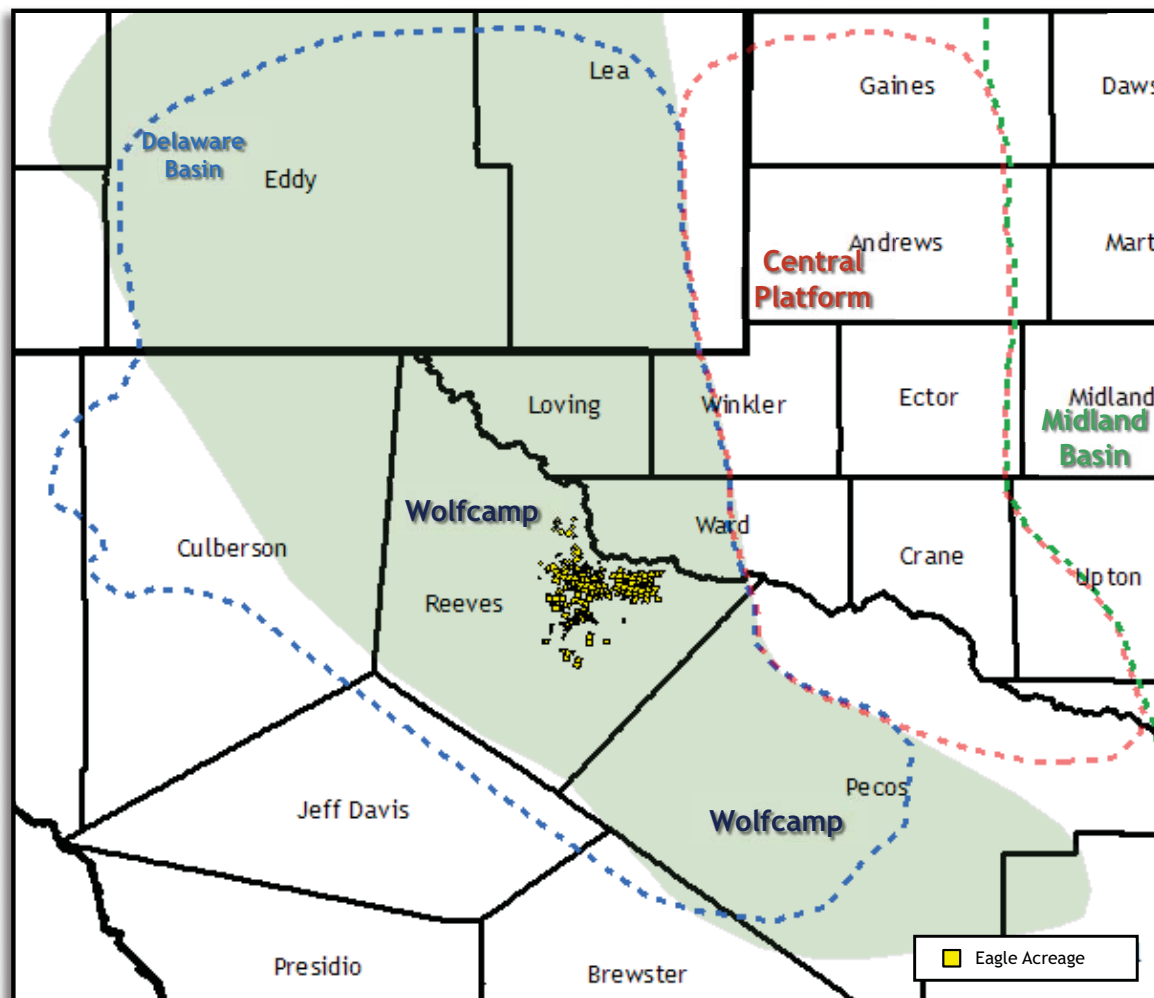
RATE : CUM (BO)



Wolfcamp - The Source of the Delaware's Success

Wolfcamp Geologic Characterization

- Ideal mineralogy and grain-size distribution to behave as both a source rock and a reservoir
- 108 MMboe in-place per square mile
- Approximately 1,000' thick
 - 2-5% TOC
 - 50-90% quartz & carbonate, 10% clay
- 0.7 psi/ft pressure gradient
 - From in-situ hydrocarbon generation & storage
 - Higher production rates
 - Shallower declines
- Carbonate debris flows were the primary target
 - Conventional Wolfcamp production
- Industry now targeting the source rock
 - Modern D&C techniques



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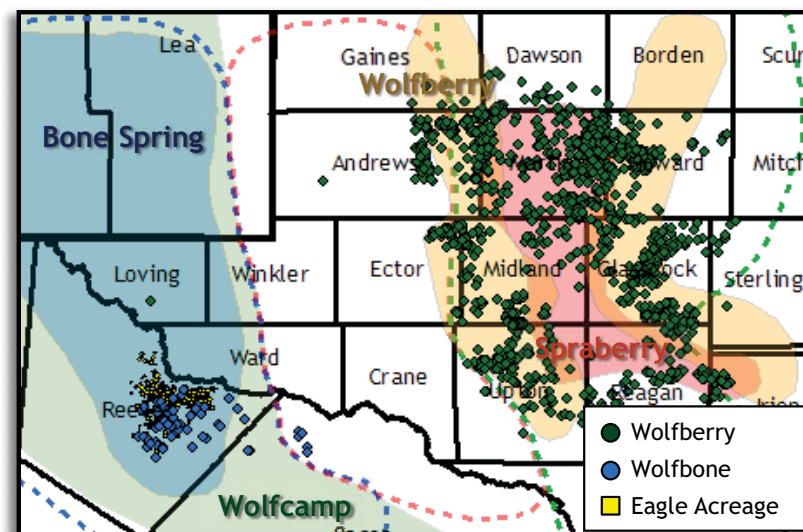
Wolfberry vs. Wolfbone

Wolfbone has Superior Reservoir Properties

- Depth and Pressure → Greater Reservoir Energy
 - Wolfbone is highly overpressured (~ 0.7 psi/ft)
 - Wolfbone is ~ 2,000' deeper
 - **Wolfbone up to 2x Wolfberry pressure**
- Thicker vertical section leads to additional upside
 - Both completed over 1,250' interval
 - Wolfbone has 2,000' additional potential
- Substantial upside in the Delaware Basin
 - Uphole potential in Delaware Sands
 - Hz development

STUDY
AREA

Wolfbone Well Count is Quickly Growing



DELAWARE BASIN				MIDLAND BASIN				
PERIOD	SERIES	FORMATION		PERIOD	SERIES	FORMATION		
GUADALUPE	DELAWARE GROUP	LAMAR BELL CANYON		GUADALUPE	WHITE-HORSE	TANSILL		
		CHERRY CANYON				YATES		
		BRUSHY CANYON				7 RIVERS		
						QUEEN		
		GRAYBURG						
LEONARD	1ST BONE SPRING	UPPER AVALON SH.			LEONARD	WARD	SAN ANDRES	
		LOWER AVALON SH.					SAN ANGELO	
		1ST BONE SPRING SD		CLEAR FORK		UPPER LEONARD		
	2ND BONE SPRING		UPPER SPRABERRY					
	3RD BONE SPRING		LOWER SPRABERRY					
WOLF-CAMP	WOLFCAMP		WOLF-CAMP	WOLFCAMP				

Equivalent Geologic Age

Wolfcamp Unit in Common

Equivalent
Geologic Age

Wolfcamp Unit
in Common

Wolfbone... the Delaware's Wolfberry... only Better

Industry Bringing Midland Basin Technology to the Delaware

- Industry has increased Wolfberry EUR over time by comingling more zones
 - Activity significantly increased with improved results (now > 700 wells/year)
- Deeper, overpressured Delaware yielding superior Wolfbone EUR vs. Wolfberry
- Wolfbone wells flow 3-6 months before pump (20+ Mbo)

	Wolfbone (Delaware)	Wolfberry (Midland)
Primary Zones	3rd Bone Spring to Wolfcamp	Upr Spraberry to Wolfcamp
Additional Zones	Delaware Sands, Avalon Shale, Deeper zones	Non-traditional shale/silt zones and Deeper Zones (Strawn, Atoka, Mississippian)
EUR (Mboe)	240	165
% Liquids □	> 80%	~ 65%
Depth (feet)	11,000 - 12,500	7,500 - 11,000
Spacing (acres)	40 acres 1 well will HBP 160 acres	40 acres (current), testing on 20

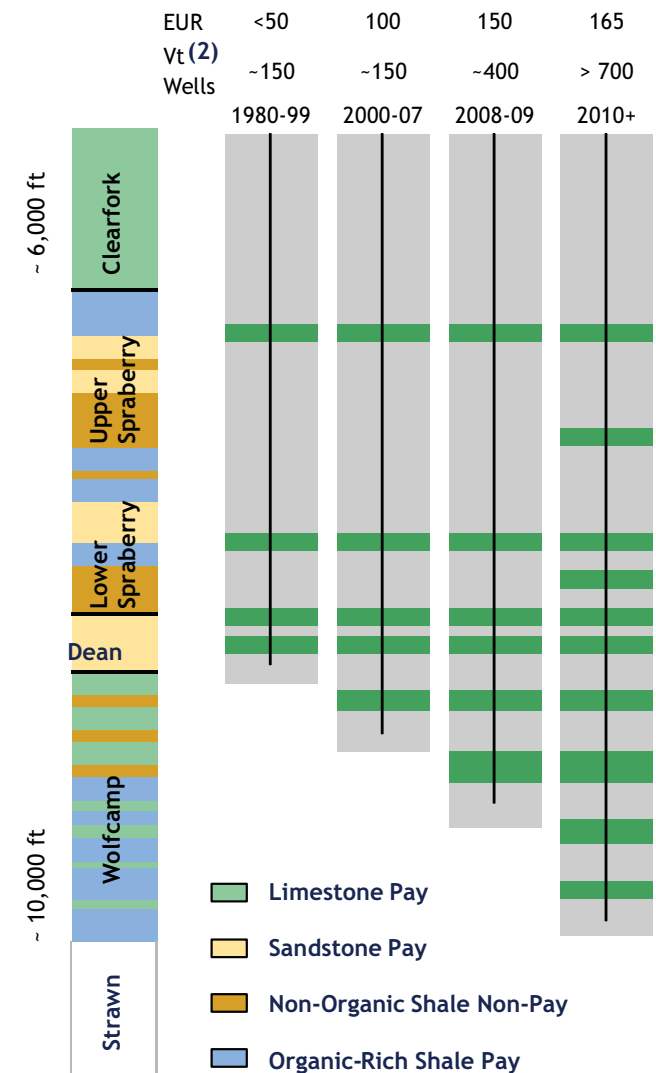
Strat Column

PERIOD	SERIES	DELAWARE BASIN		PERIOD	SERIES	MIDLAND BASIN	
		FORMATION				FORMATION	
GUADALUPE	DELAWARE GROUP	LAMAR BELL CANYON		GUADALUPE	WHITE-HORSE	TANSILL	
		CHERRY CANYON				YATES	
		BRUSHY CANYON				7 RIVERS	
LEONARD	1ST BONE SPRING	UPPER AVALON SH.		LEONARD	WARD	QUEEN	
		UPPER AVALON SH.				GRAYBURG	
		1ST BONE SPRING SD.				SAN ANDRES	
						SAN ANGELO	
WOLF-CAMP	2ND BONE SPRING SAND			WOLF-CAMP	CLEAR FORK	UPPER LEONARD	
						UPPER SPRABERRY	
		3RD BONE SPRING SAND				LOWER SPRABERRY	
WOLF-CAMP	3RD BONE SPRING SAND			WOLF-CAMP	WOLF-CAMP	DEAN	
						WOLF-CAMP	

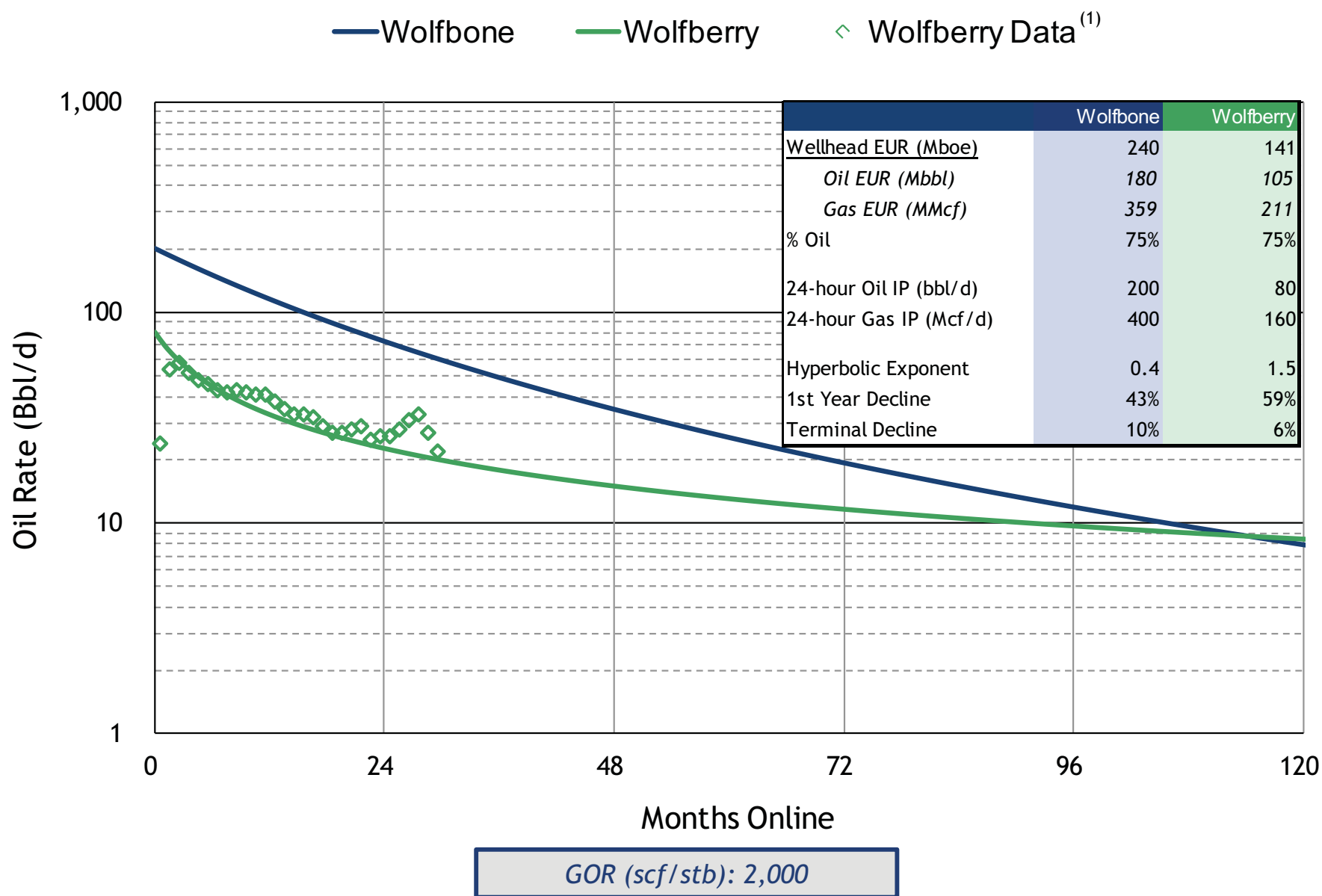
Equivalent Geologic Age

Wolfcamp Unit in Common

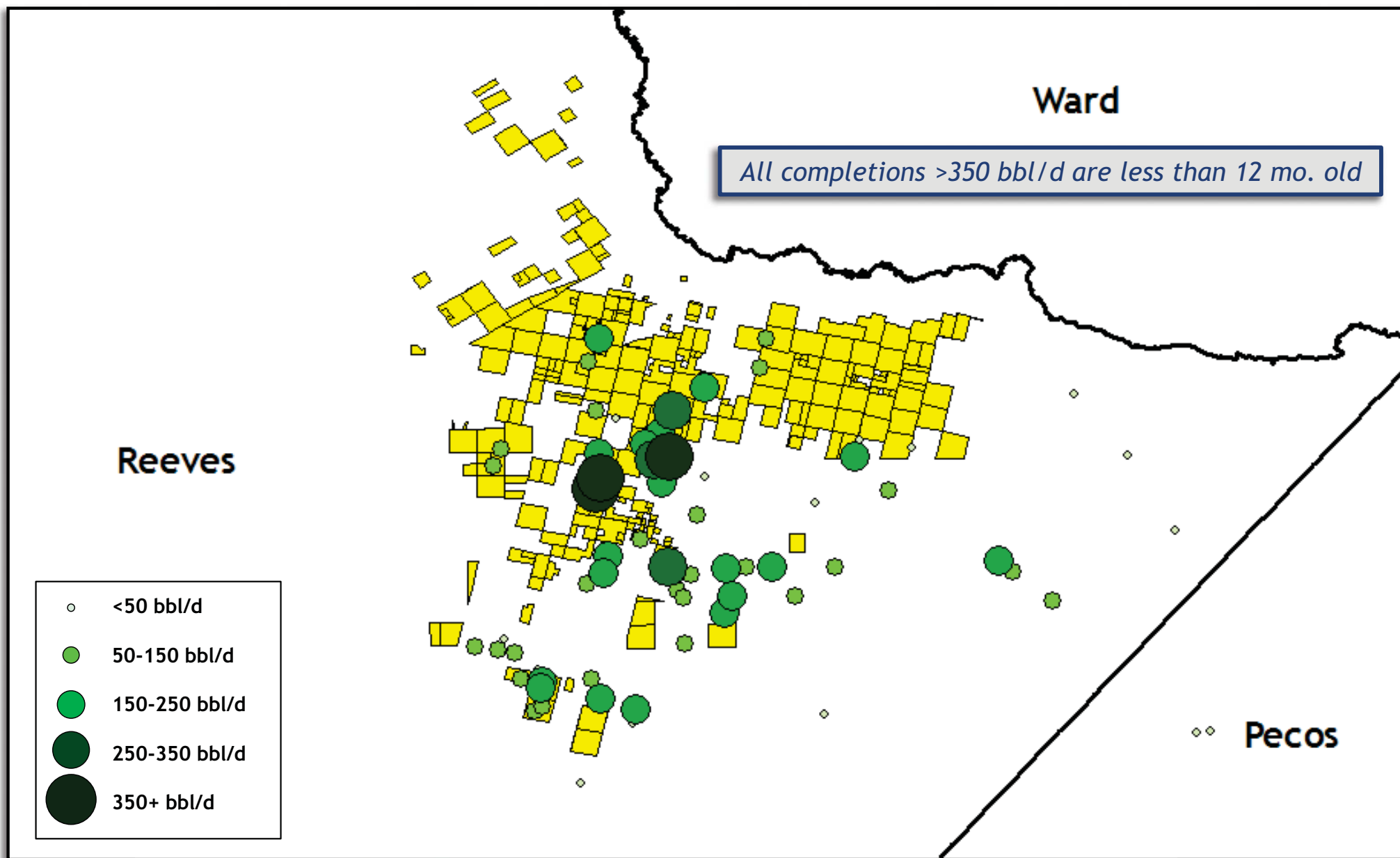
Wolfberry Evolution Through Technology⁽¹⁾



Wolfbone Type Curve (vs. Wolfberry)



Wolfbone 30-Day IP Bubble Map



Eagle Oil & Gas

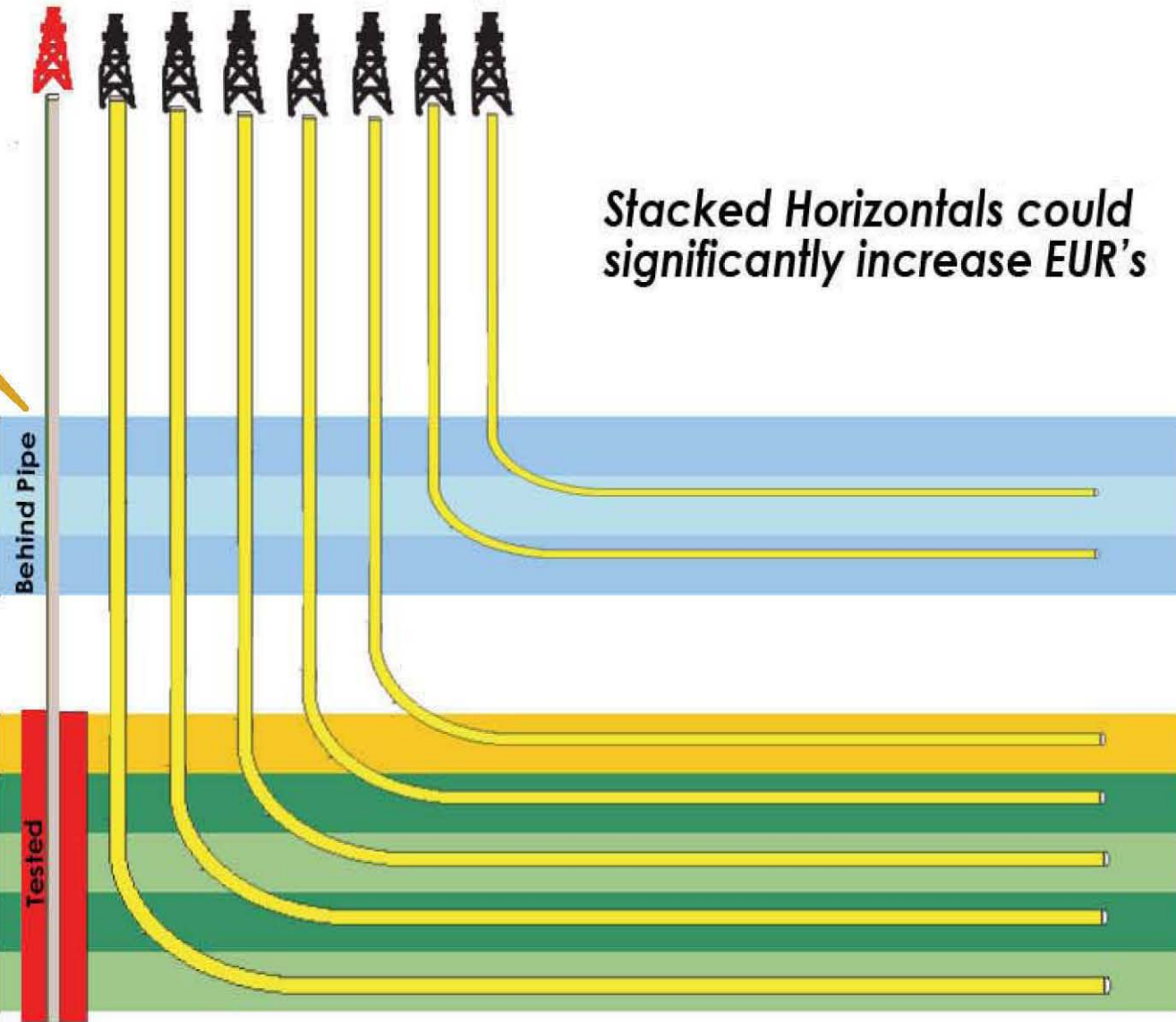
**WolfBone Play
Evolution, Southern
Delaware Basin:
Geologic Concept
Modifications That Have
Enhanced Economic
Success**

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* Courtesy of Carrollton Minerals Partners

Avalon –
 • ~800' thick.
 • 105 MMboe
 in-place per sq. mile

Period	Unit	~ Depth
Permian	Guadalupian	Bell Canyon
		Cherry Canyon
		Brushy Canyon
	Leonardian	Upper Avalon Shale
		Lower Avalon Shale
		1st Bone Spring Sand
		2nd Bone Spring Shale Upr
		2nd Bone Spring Shale Lwr
		3rd Bone Spring
	Wolfcampian	Upr Wolfcamp Shale A
		Upr Wolfcamp Shale B
		Mid Wolfcamp Shale A
		Mid Wolfcamp Shale B
		Md Wolfcamp Sand A
		Md Wolfcamp Sand B
		Md Wolfcamp Sand C



Stacked pay Verticals producing in 3rd Bone - Wolfcamp series

Wolfbone
 Vertical –
 • ~1200' thick.
 • 108 MMboe in-
 place per sq. mile

© Carrollton Minerals Partners, 2012

Going Sideways to Get Ahead

Horizontals in the Delaware

- Operators have been developing the 3rd Bone Spring with horizontal wells
 - Capture more acreage than vertical wells
 - More stimulated rock volume leads to higher rates
 - Larger drainage area leads to greater ultimate recovery
- Thick sections perfect for horizontal development
 - 2+ laterals per unit (Bone Spring, Wolfcamp, Avalon)
 - More laterals increase recovery factor per section

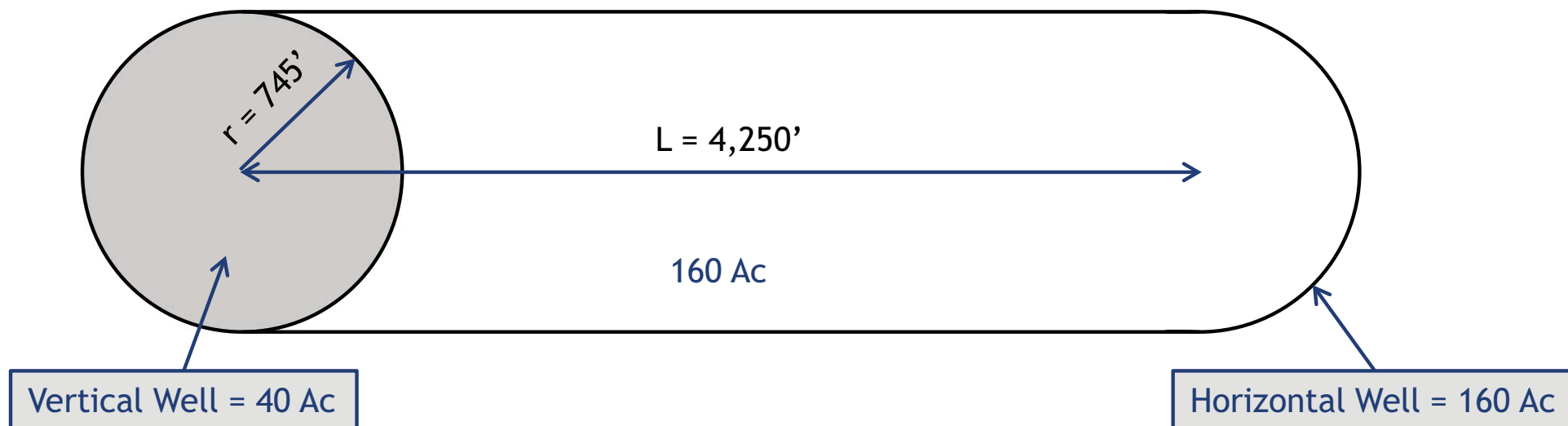
Horizontal Wells consistently Outperform Vertical

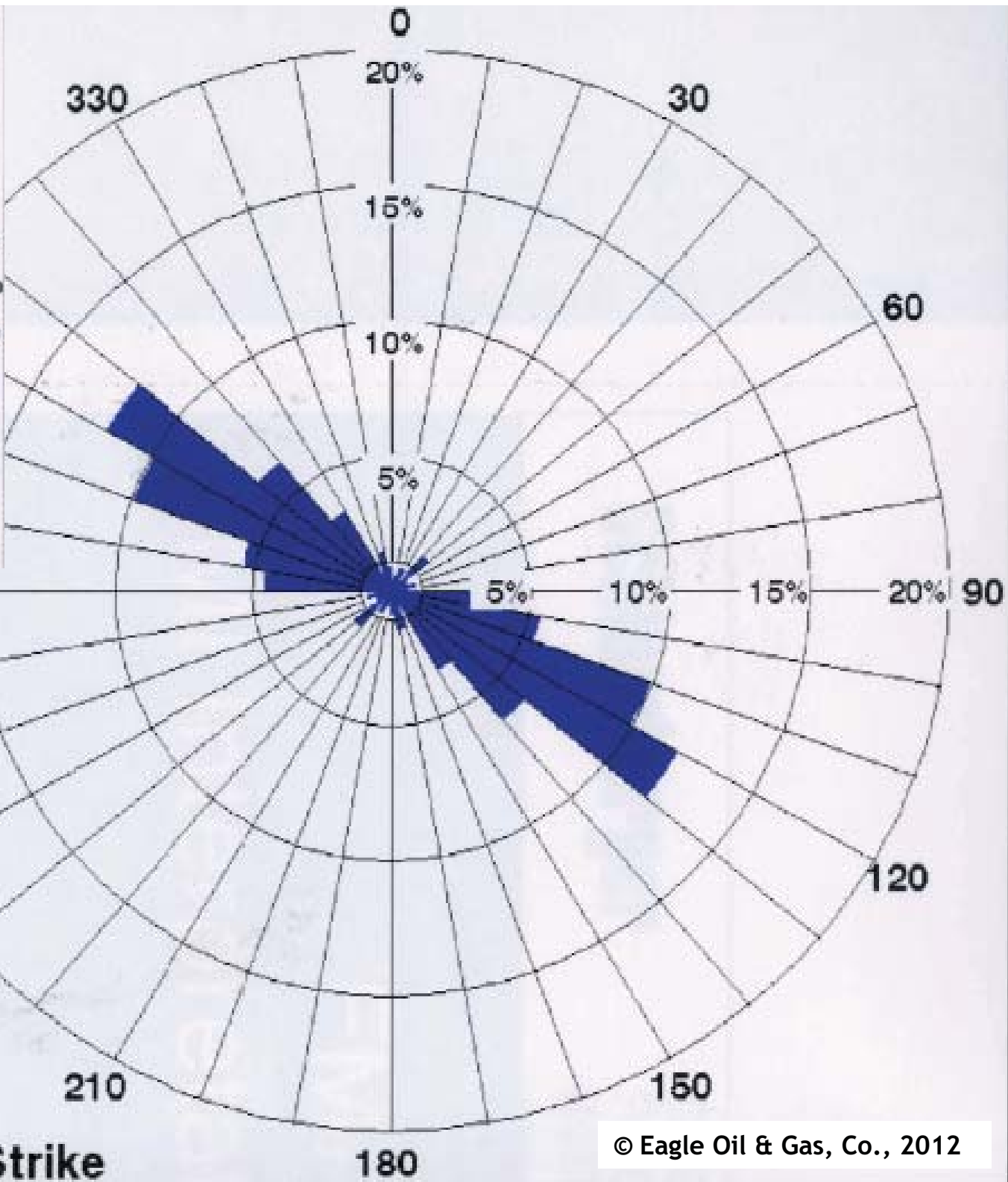
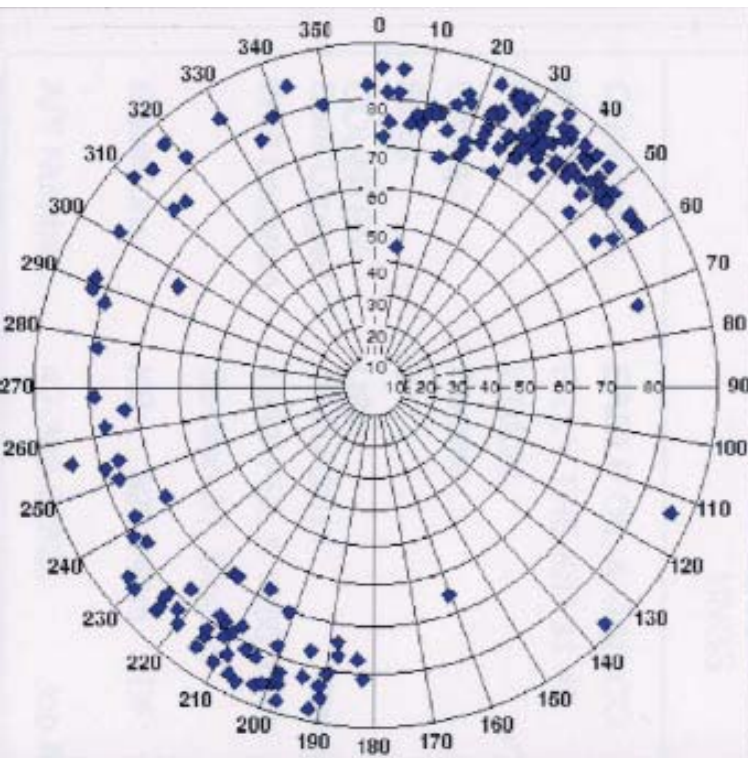
- Vertical to Horizontal EUR factor:

Play	EUR Multiplier
Bakken	3 - 5x
Eagle Ford	5 - 7x
Granite Wash	4 - 5x
Miss Lime	3 - 4x
Niobrara	6 - 8x
Wolfcamp (Midland)	5 - 6x
Wolfcamp (Delaware)	3x

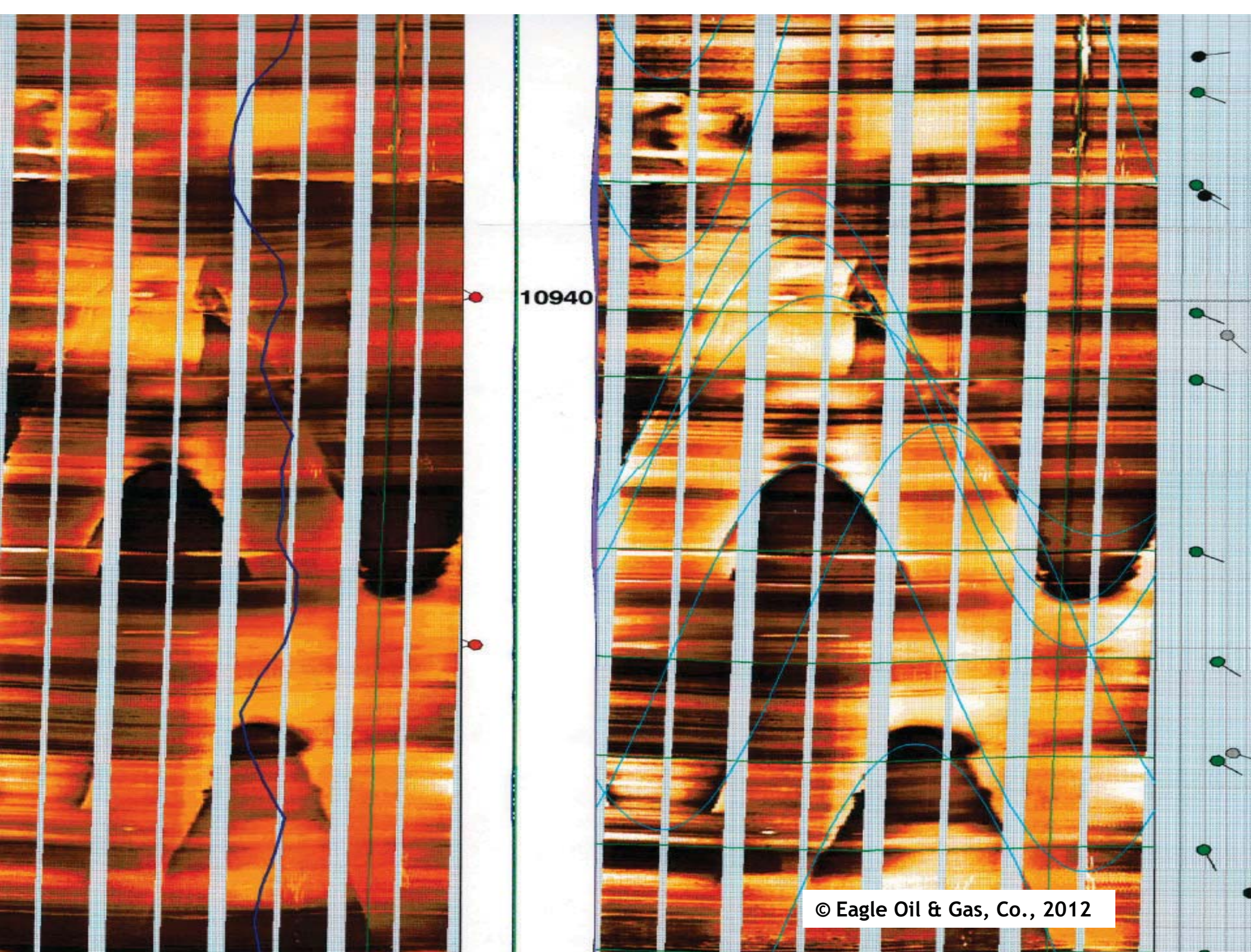
Average ~ 5x

Vertical vs. Horizontal Drainage Area









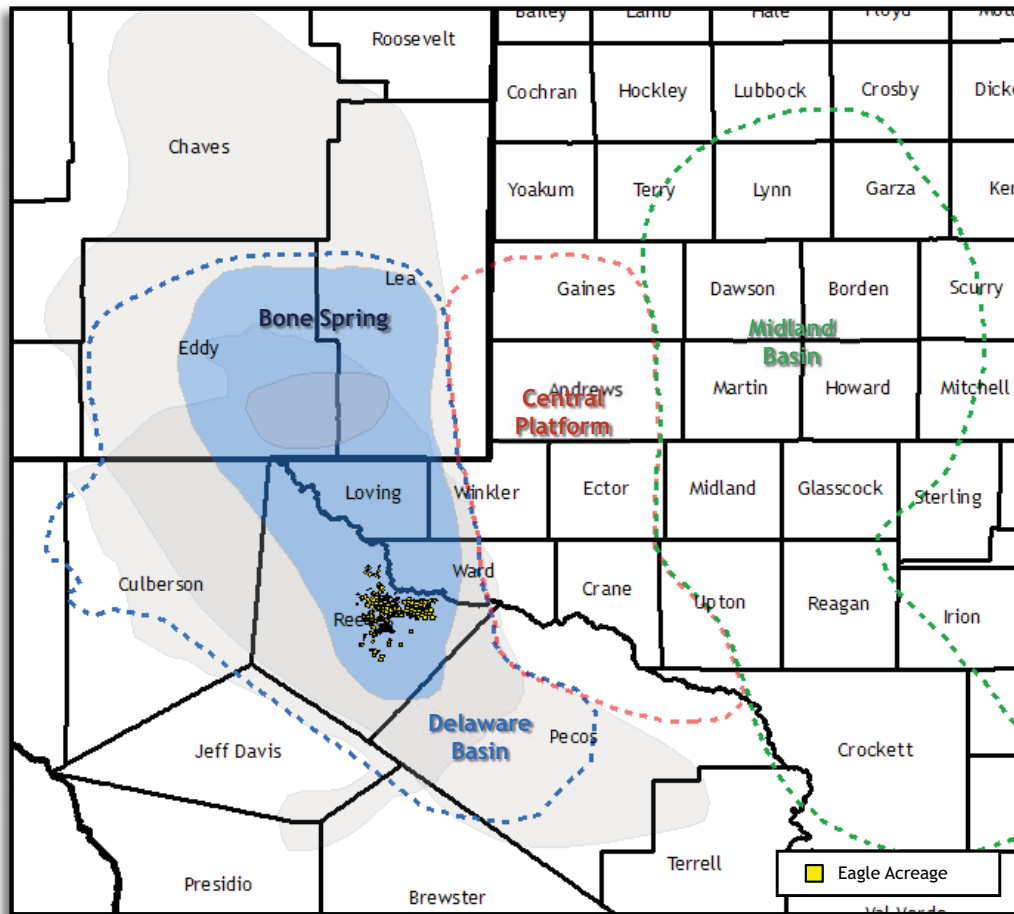
Eagle Oil & Gas

**WolfBone Play
Evolution, Southern
Delaware Basin:
Geologic Concept
Modifications That Have
Enhanced Economic
Success**

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Bone Spring

Bone Spring Depositional Area

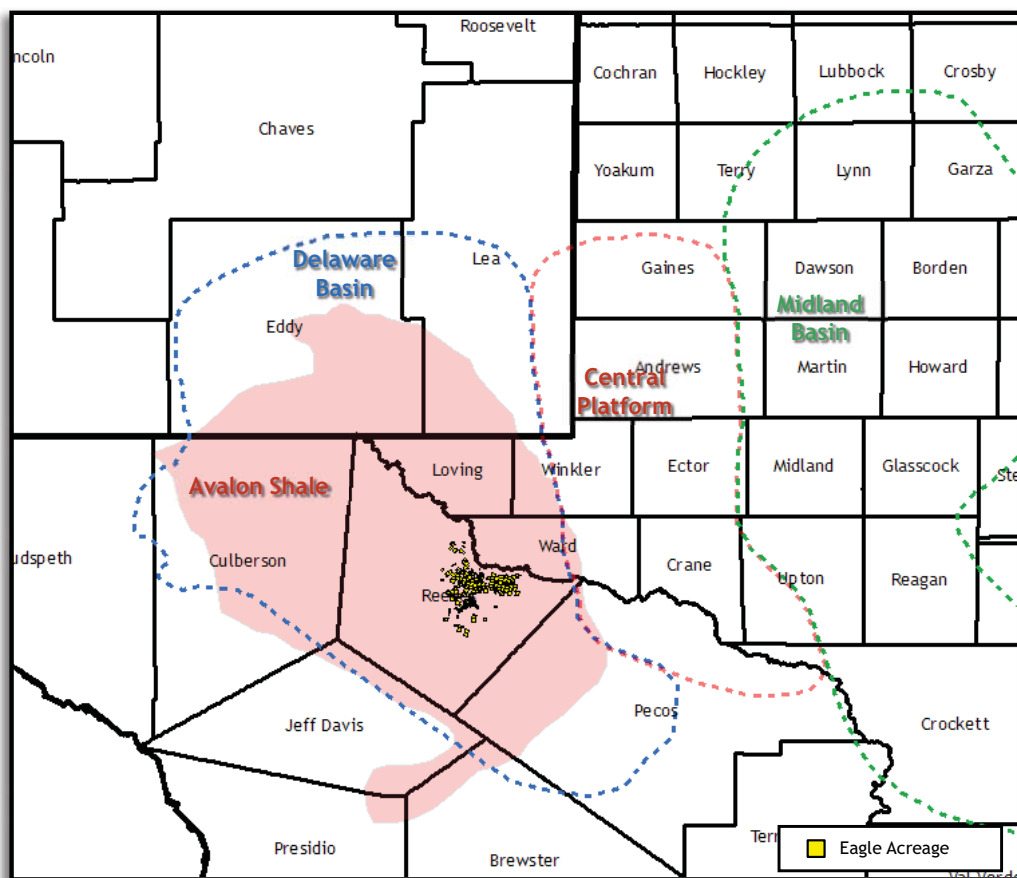


PERIOD	SERIES	DELAWARE BASIN	
		FORMATION	
QUATERNARY		ALLUVIUM	
TERTIARY			
CRETACEOUS	GULFIAN		
	COMAN- CHEAN	FREDERICKSBURG	
		TRINITY SD.	
	UPPER		SANTA ROSA
PERMIAN	OCHOAN		DEWEY LAKE
			RUSTLER
			SALDO
			CASTILLE
	GUADALU- PIAN	DE SANDS	BELL CANYON
			CHERRY CANYON
			BRUSHY CANYON
	LEONARDIAN	1 ST BONE SPRING	
			UPPER AVALON SH.
			LOWER AVALON SH.
			1 ST BONE SPRING SD.
Pennsylvanian		2 ND BONE SPRING	
		3 RD BONE SPRING	
	WOLFCAMPIAN	WOLFCAMP	
	VIRGIL	CISCO	
	MISSOURI	CANYON	
	DES MOINES	STRAWN	
	ATOKA	ATOKA	
	MORROW	MORROW	

The Bone Spring package exists across much of the Delaware Basin though different members are more prevalent in specific areas

Avalon Shale

Avalon Shale Depositional Area



PERIOD	SERIES	DELAWARE BASIN	
		FORMATION	
QUATERNARY		ALLUVIUM	
TERTIARY			
CRETACEOUS	GULFIAN		
	COMANCHEAN	FREDERICKSBURG	
		TRINITY SD.	
	UPPER	SANTA ROSA	
PERMIAN	OCHOAN	DEWEY LAKE	
		RUSTLER	
		SALDO	
		CASTILLE	
	GUADALUPIAN	DE SANDS	BELL CANYON
			CHERRY CANYON
			BRUSHY CANYON
	LEONARDIAN	1 ST BONE SPRING	
		UPPER AVALON SH.	
		LOWER AVALON SH.	
		1 ST BONE SPRING SD.	
PENNSYLVANIAN	WOLFCAMPIAN	2 ND BONE SPRING	
		3 RD BONE SPRING	
		WOLFCAMP	
		CISCO	
	VIRGIL	CANYON	
	MISSOURI	STRAWN	
	DES MOINES	ATOKA	
	ATOKA	MORROW	
	MORROW		

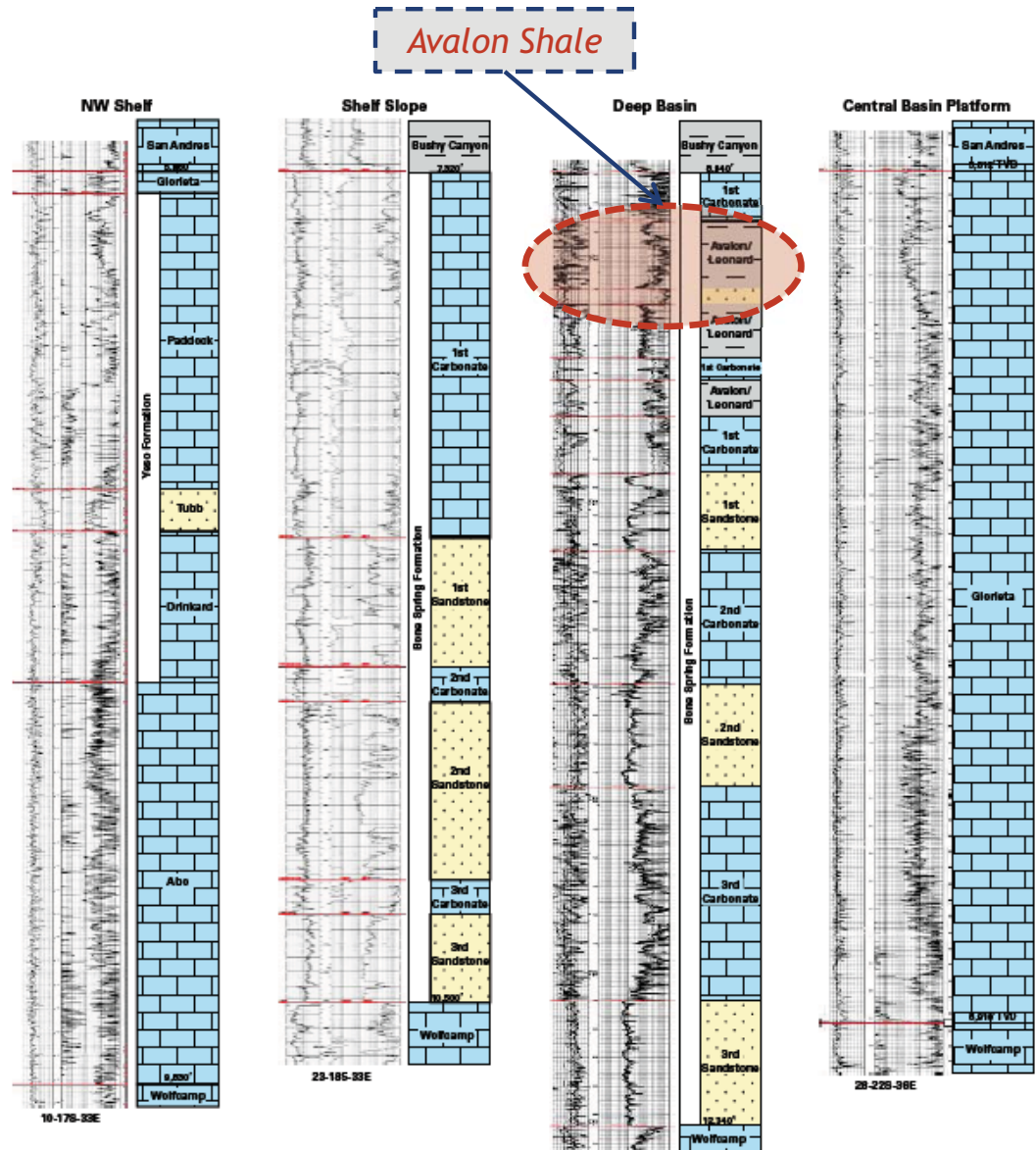
The Avalon Shale is present throughout the Delaware basin and is currently being pursued as an unconventional play in the Northern half

What is the Avalon Shale?

The Avalon Shale is the stratigraphic interval between the top of the Bone Spring Formation & the 1st Bone Spring Sand

Basin Geology

- Bounded by carbonate shelves & platforms
 - North: Northwest Shelf
 - East: Central Basin Platform
 - South: Marathon Fold Belt
 - West: Diablo Platform
- Bone Spring stratigraphy varies across the Delaware Basin
 - NW Shelf: predominantly carbonate
 - Slope: 1st/2nd/3rd sandstones developing in the lower part of the interval
- Deep Basin → Avalon Shale
 - “Shale” development within the upper 1st Carbonate section
 - Organic-rich siltstone and carbonate debris flow
 - Unconventional, continuous accumulation
 - 900 - 1,000’ gross thickness



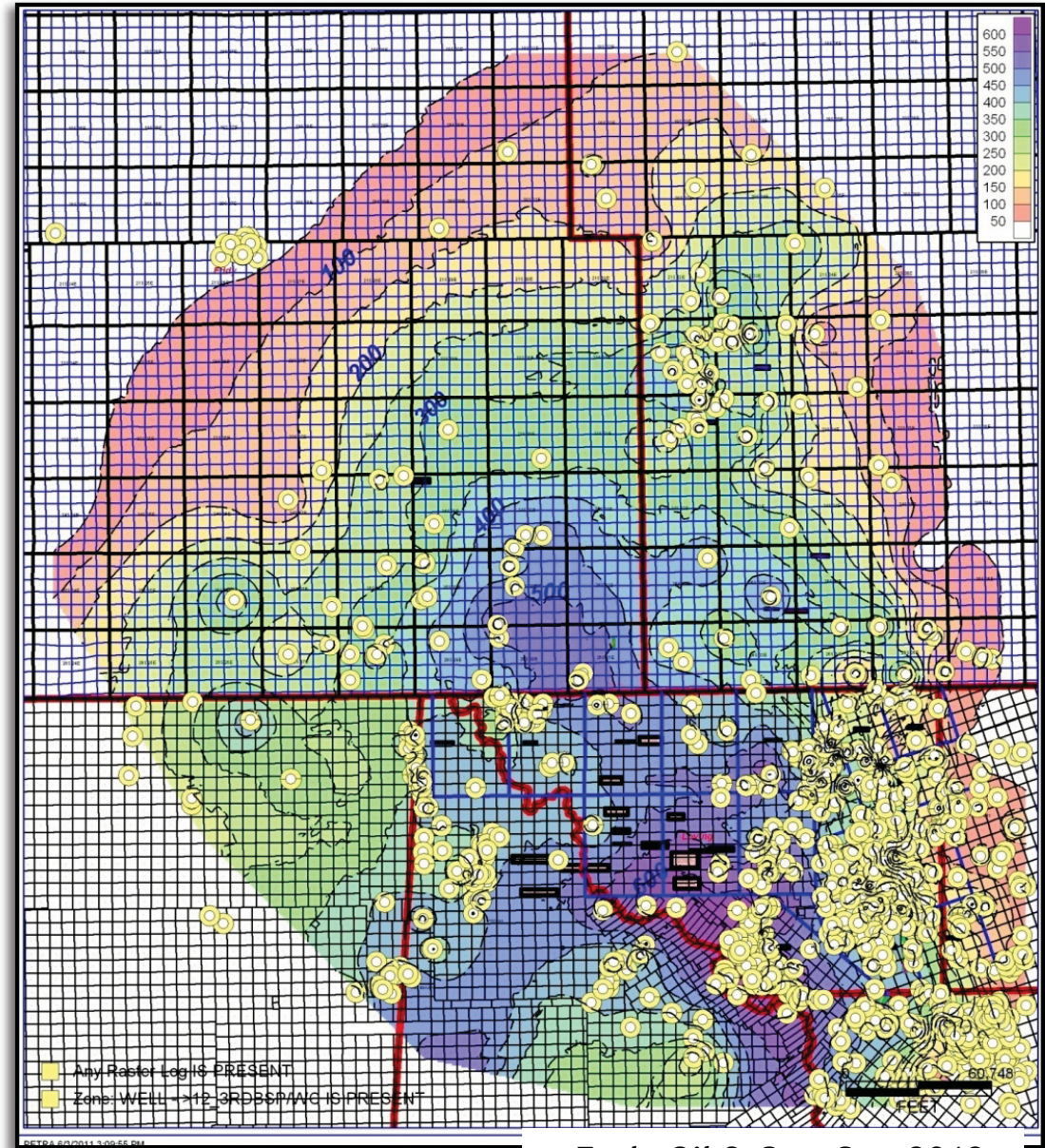
Avalon Shale Net Isopach

Summary

- Map Parameters
 - Ft > 12% Density Porosity
 - GR > 75 Units
 - Resistivity > 20 ohm-m
 - From 600 data points
- Isopach is concentric from basin edges
- Porosity thick coincides with Bone Spring thick above basin low
- Primarily Pelagic deposition

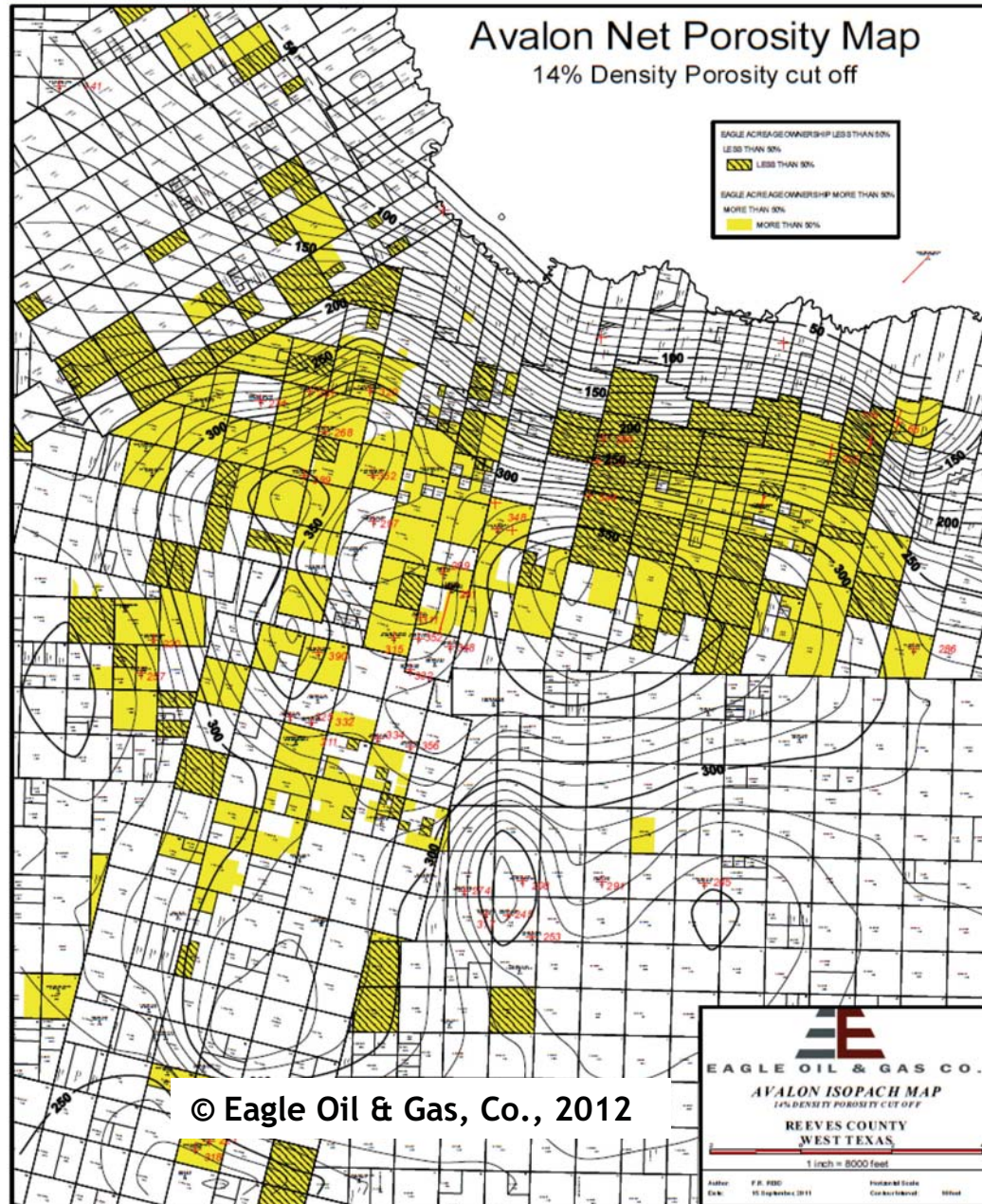
Structure

- Regional Structure dips east at 100' per mile
- 6,000' deep in W. Eddy to 10,000' deep in Lea County
- Lea County has more structural nosing and dip reversals than Eddy
- Axial low of basin trends N-S through Lea and Loving Counties
- GOR varies with depth with oily production in deeper basin



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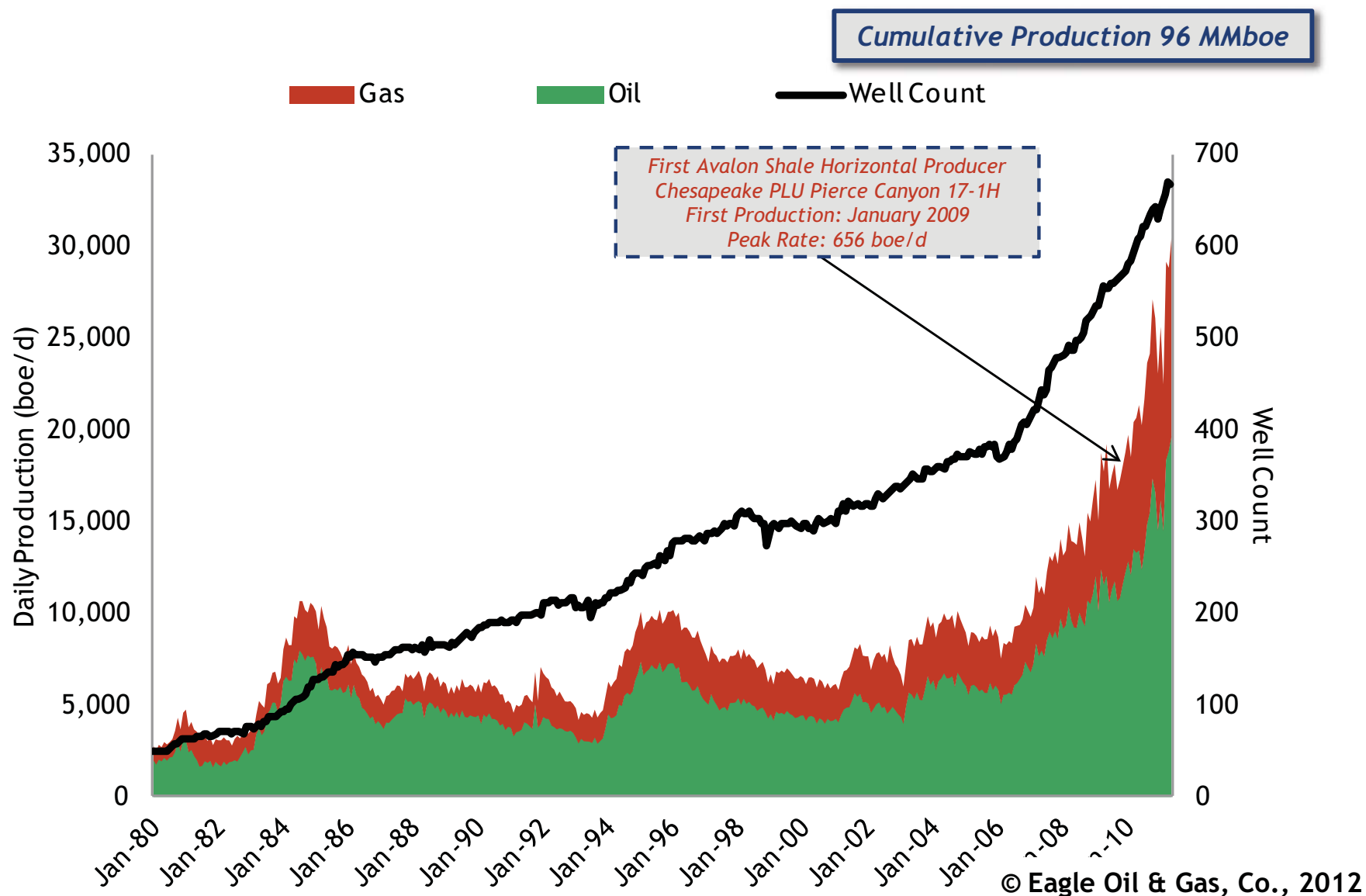
Eagle Avalon Shale Isopach



*105 MMboe in-place per square
mile across Eagle position*

Texas Avalon / Bone Spring Production Increasing

Production growth expected to continue recent momentum given industry focus on liquids and public statements from operators

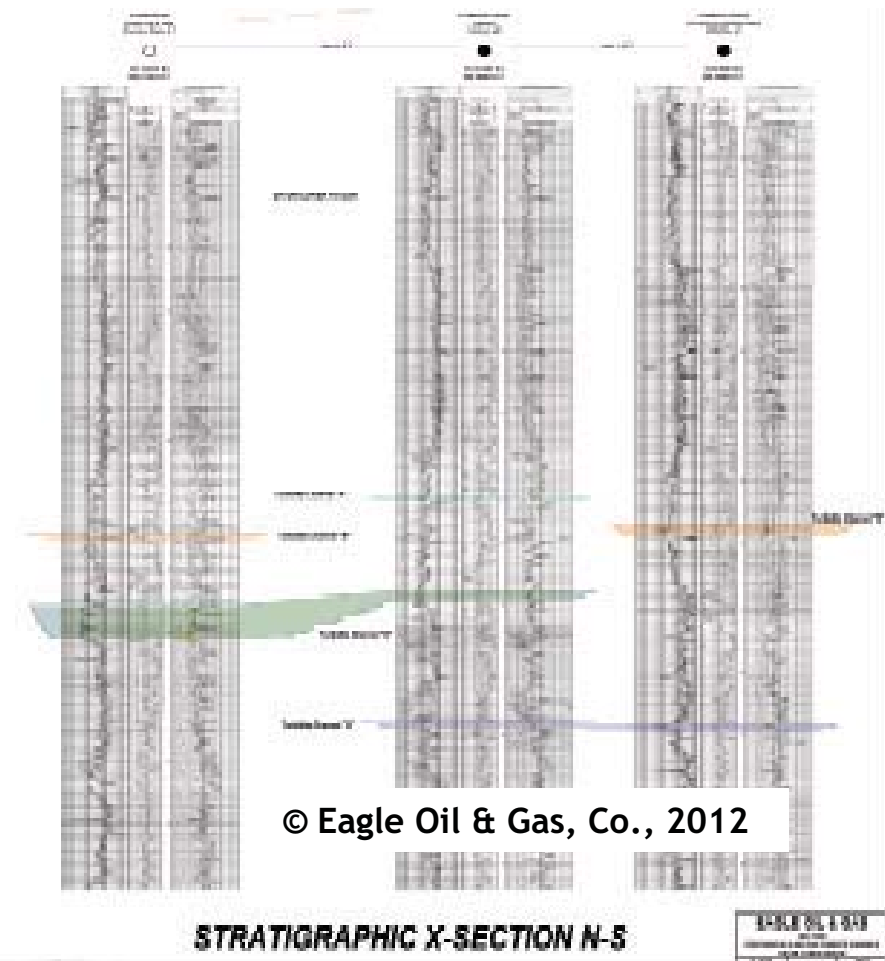
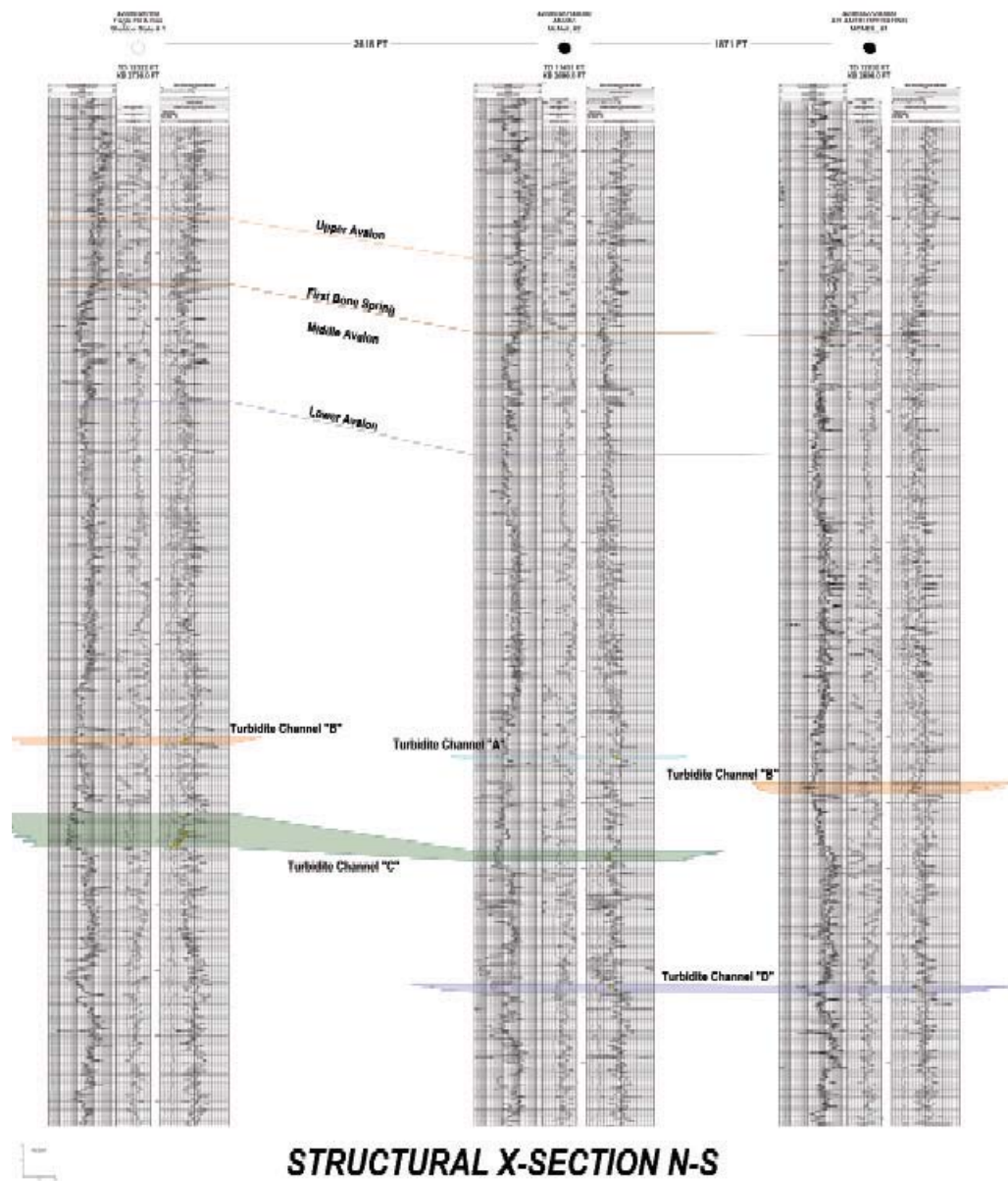


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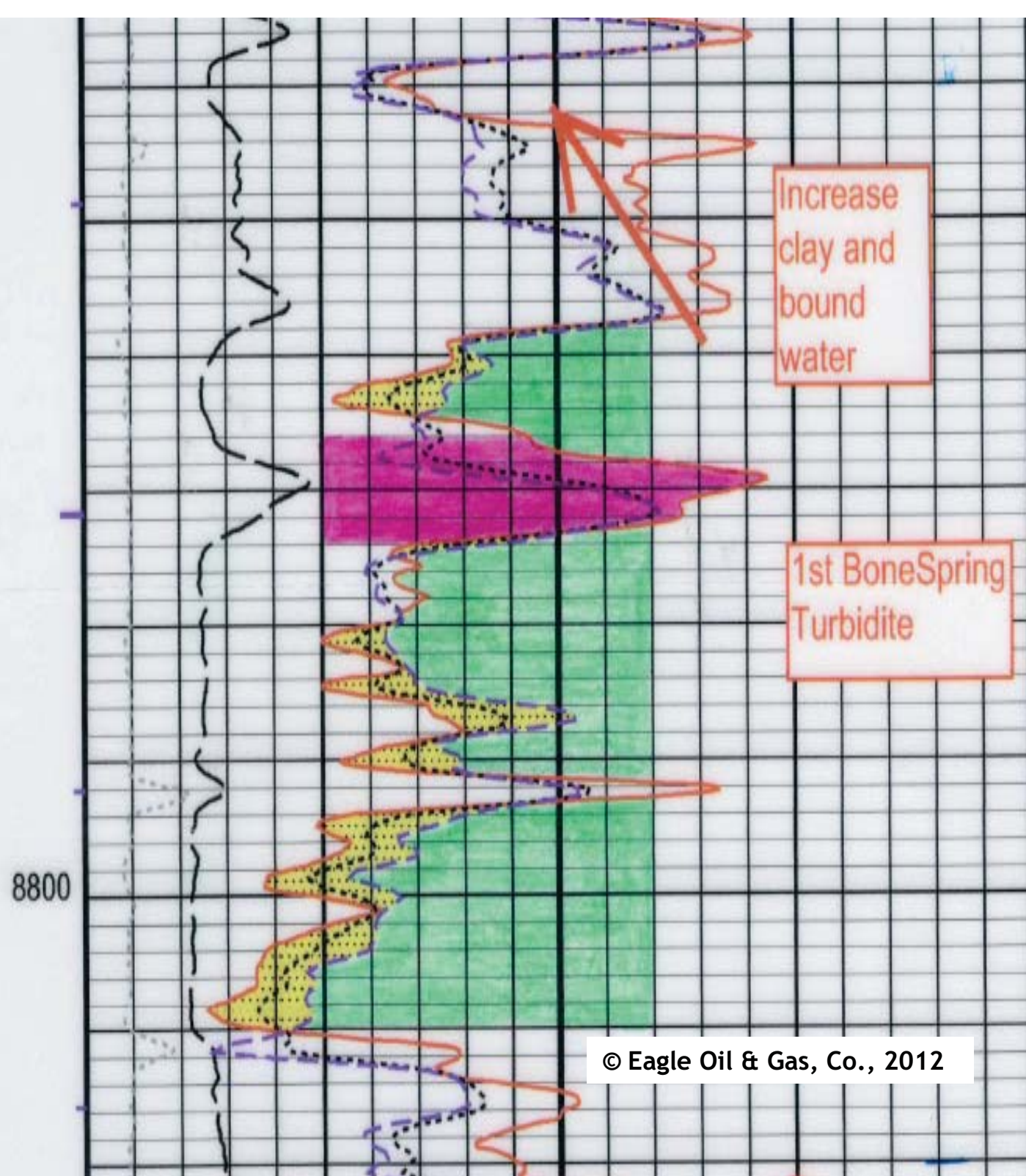
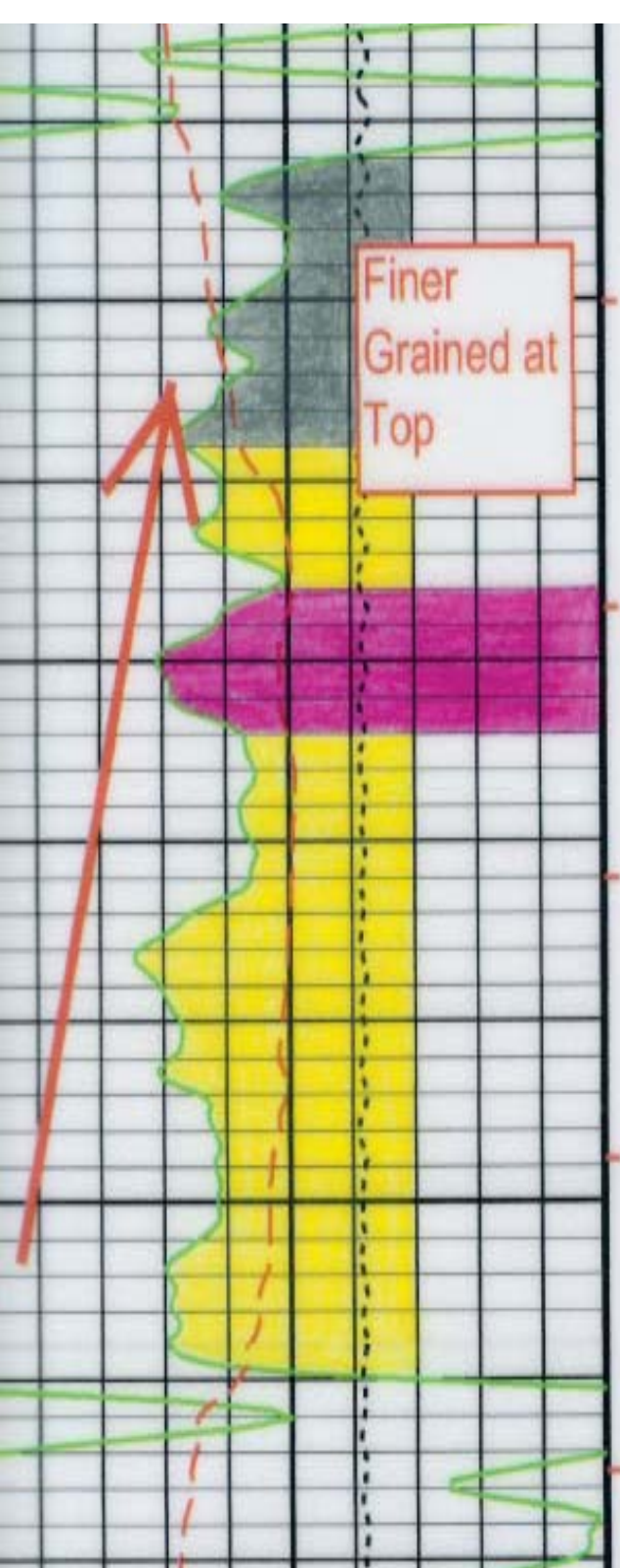
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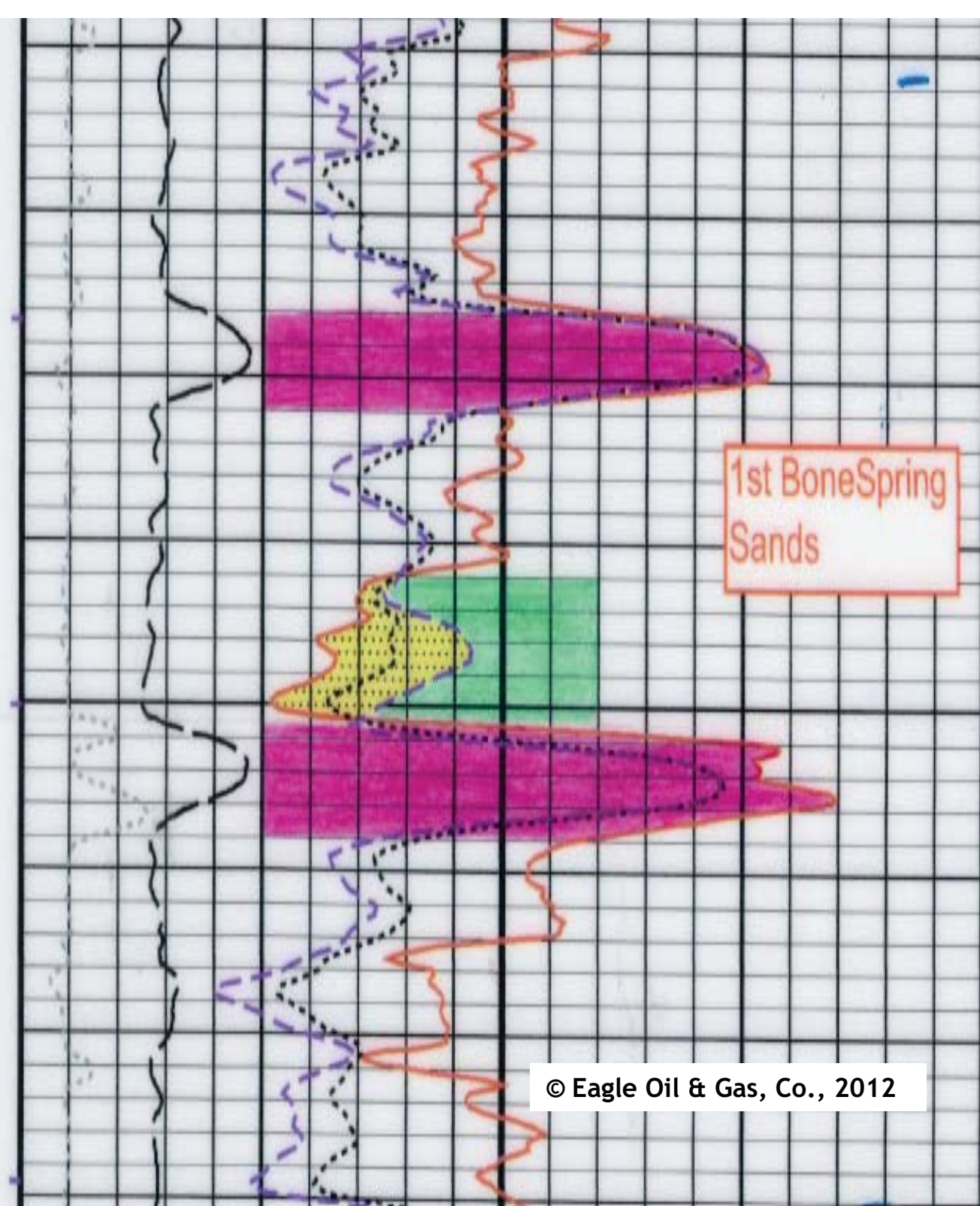
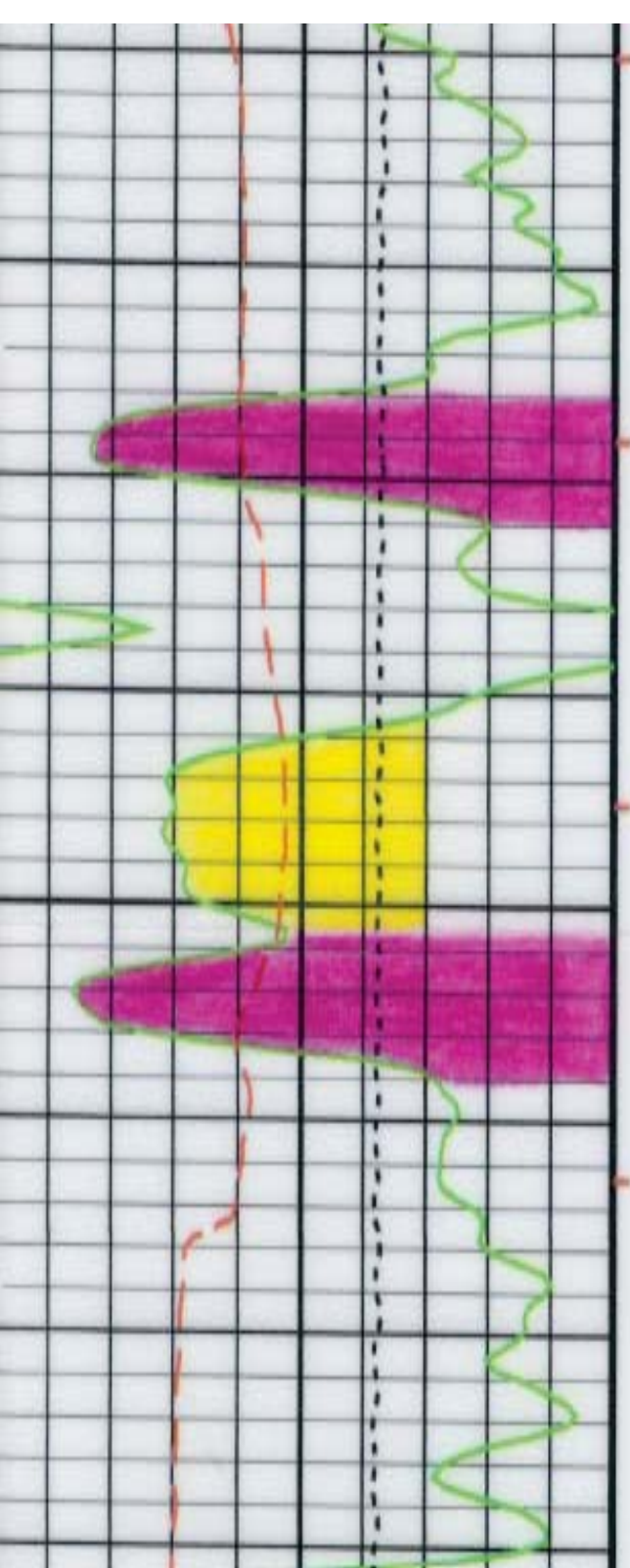
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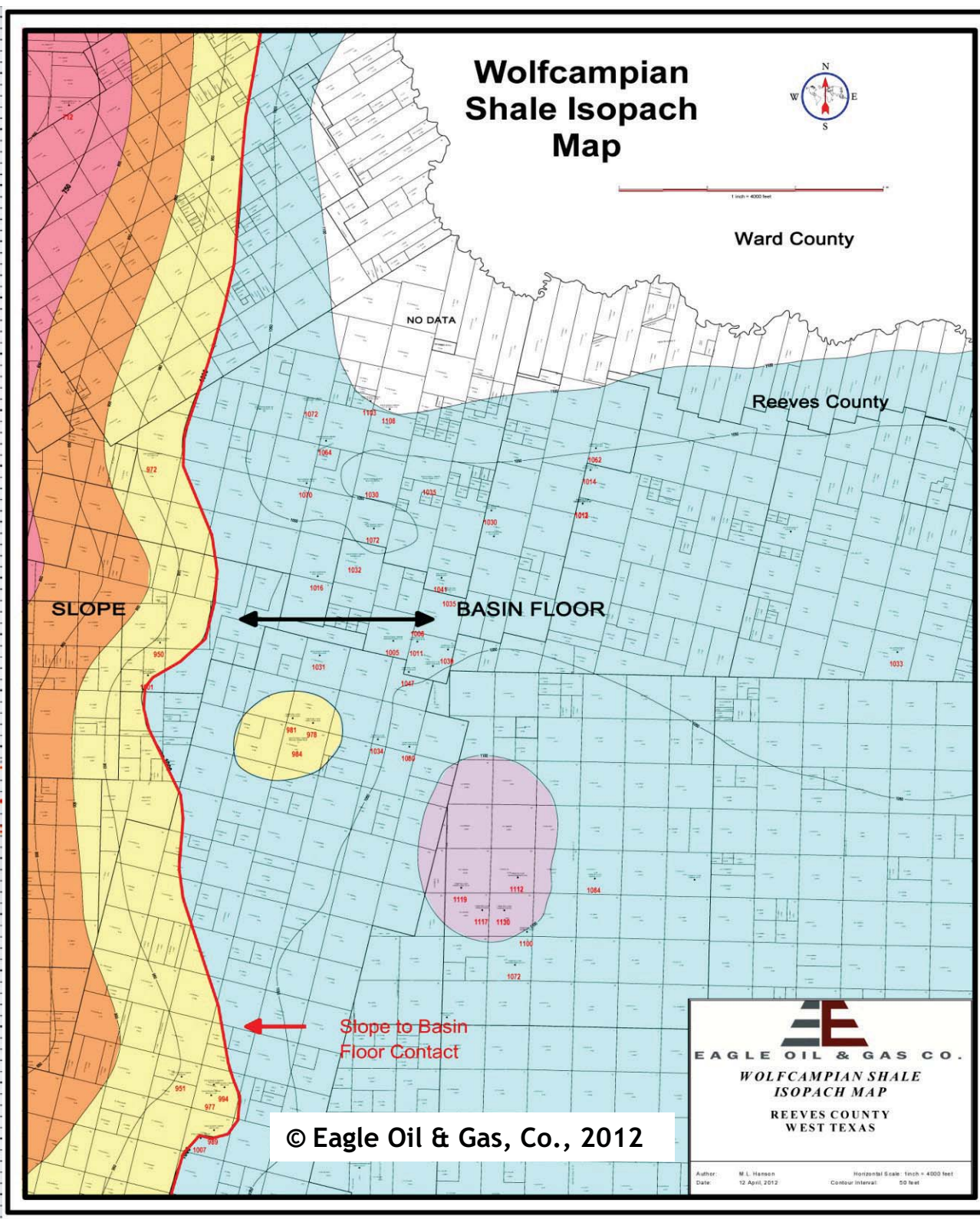
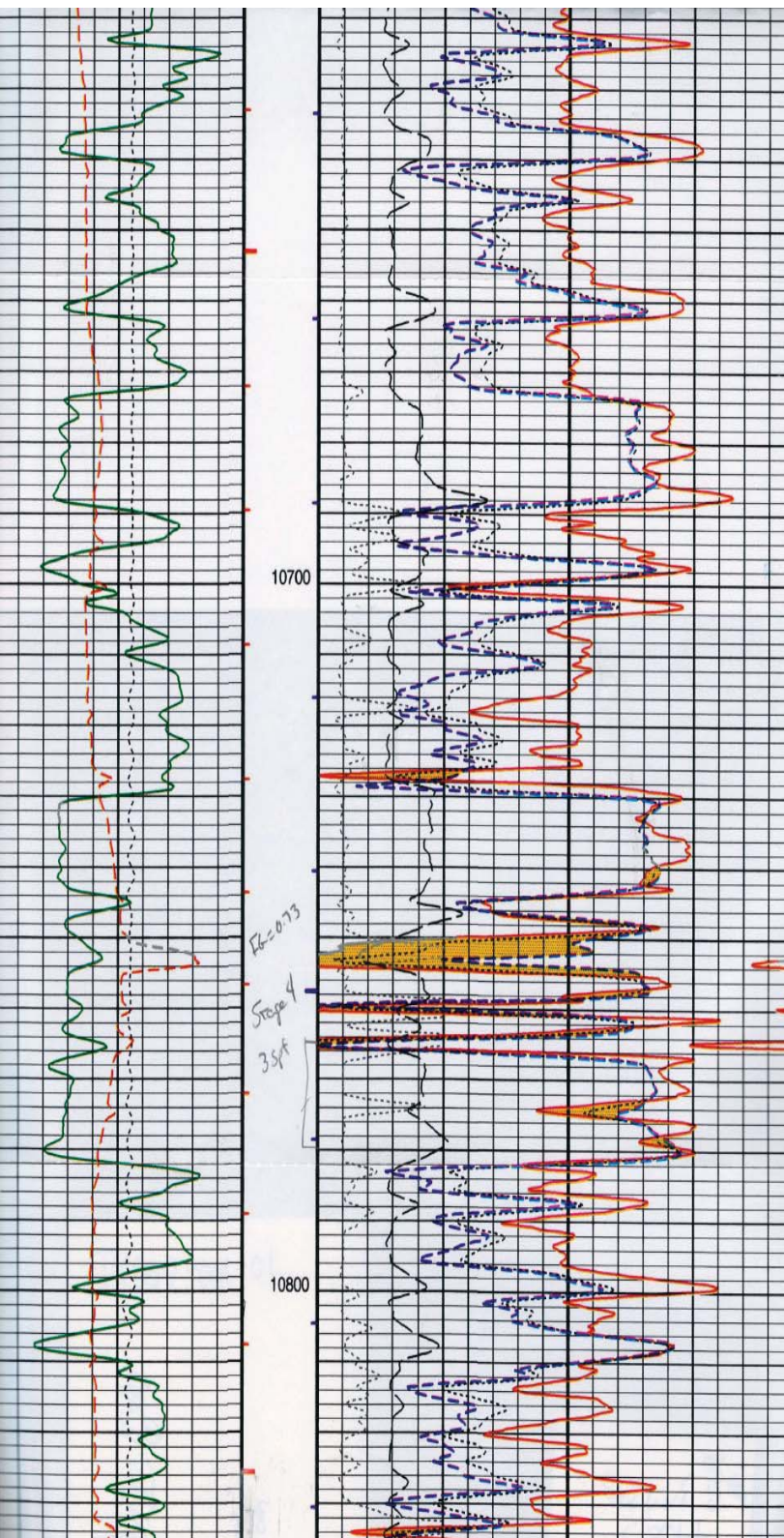
Turbidite Channel Cross-Section

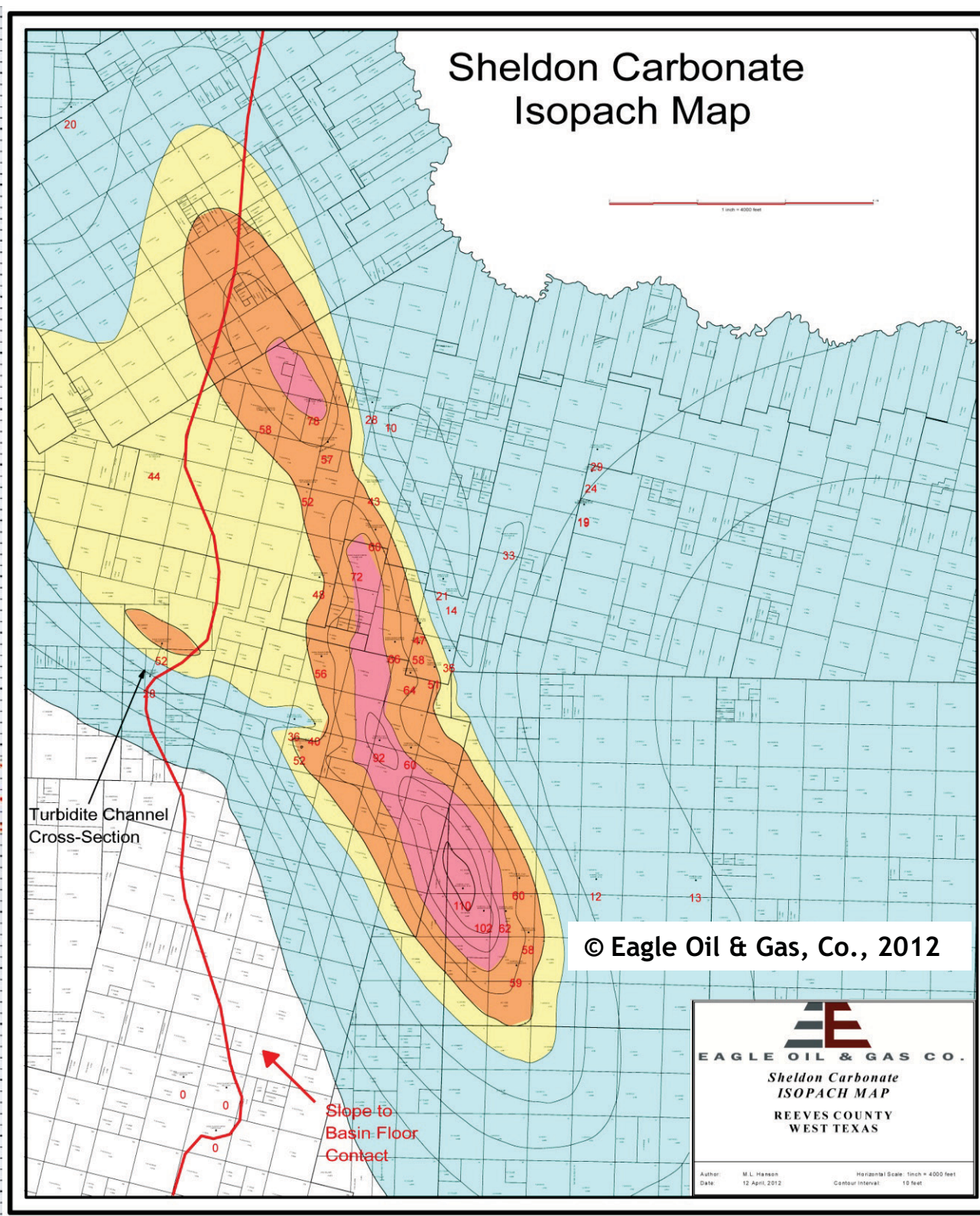
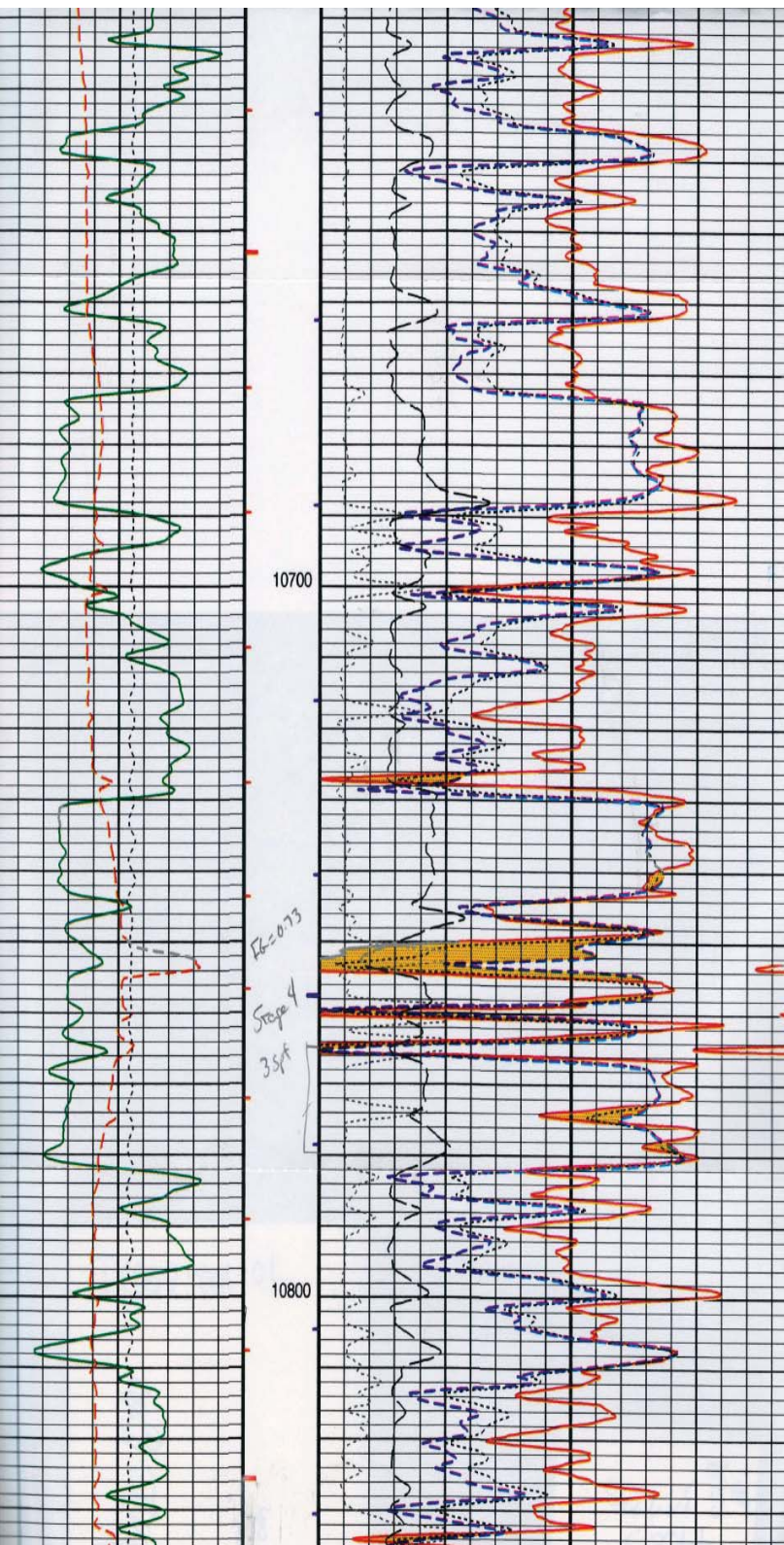


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The Permian is the Premier US Oil Basin

Multi-Zone Vertical and Hz Development Potential

■ Wolfbone

- Commingled vertical wells that capture oil-rich 3rd Bone Spring and Wolfcamp over a 1,250' interval
- Overpressured analog to Wolfberry in the Midland Basin
- High-liquid content provides superior economics
- 108 MMboe in-place per square mile

■ Wolfcamp

- Horizontal drilling has begun in TX and Eddy, NM
- Thick interval provides multi-lateral potential

■ 3rd Bone Spring

- Substantial nearby horizontal drilling

■ Avalon Shale

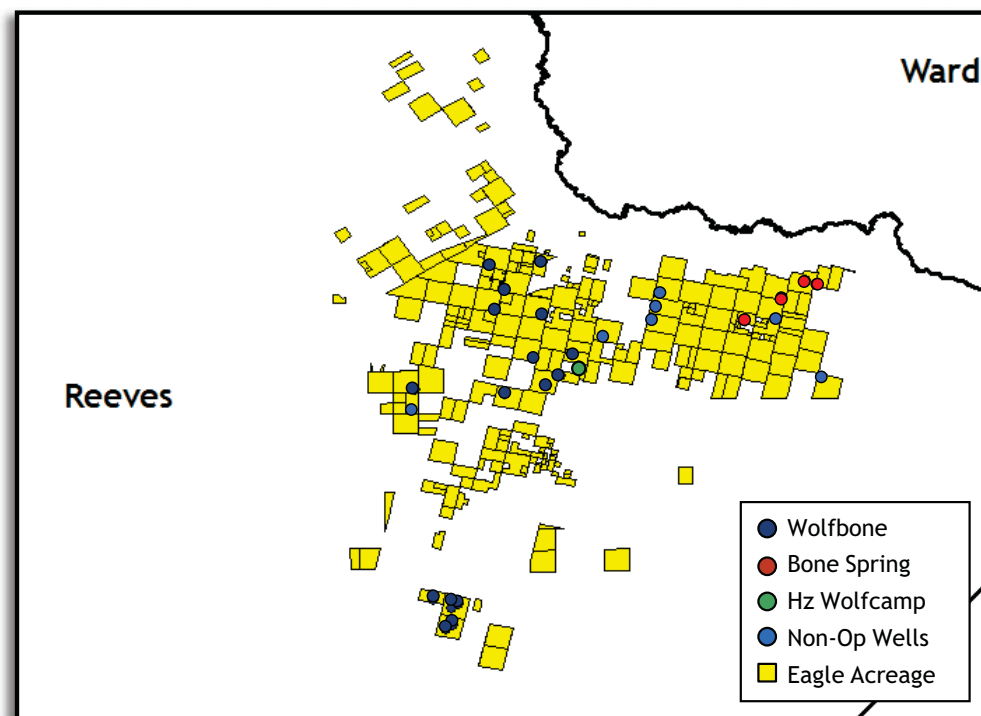
- Up to 1,000' gross thickness across the basin
- Laterally extensive & continuous across Reeves, Co.
- 105 MMboe in-place per square mile

■ Delaware Sands (Brushy, Cherry, and Bell Canyon)

- Vertical & horizontal exploitation of the 3,000 - 3,500' thick interval with dozens of potential pays

Eagle Development is Proving Many Zones

- Eagle currently produces 1,888 boe/d from 28 wells
 - 24 vertical wells commingling production across 3rd Bone Spring members and Upper Wolfcamp members
 - 4 horizontal wells drilled into the 3rd Bone Spring Sands
- Eagle is currently drilling their first horizontal Wolfcamp well in the Upper Wolfcamp Shale B member
 - Excellent results to date with >100' flares during drilling with 12.6 ppg mud
 - Over 100 bbl oil returned to pit while drilling lateral

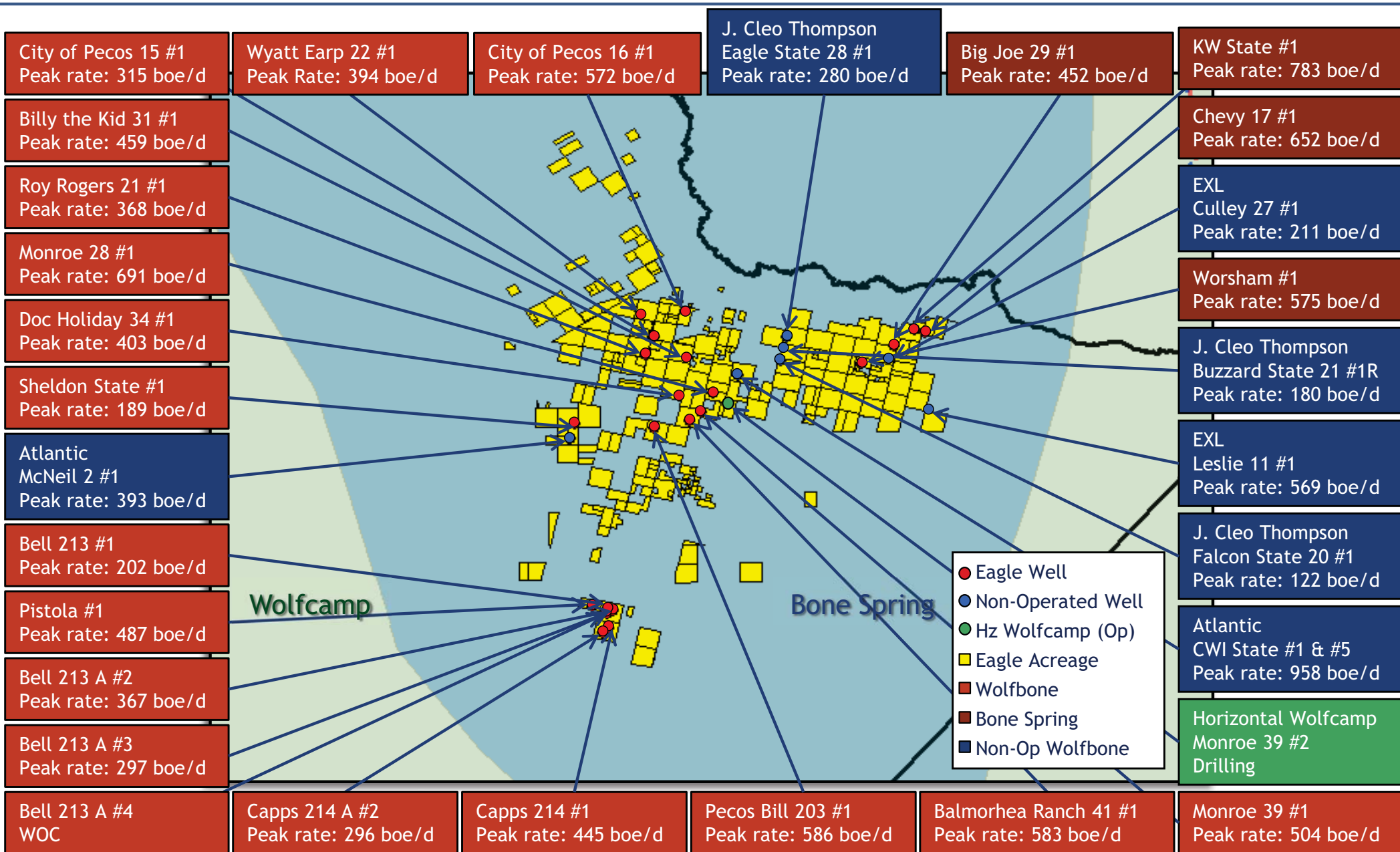


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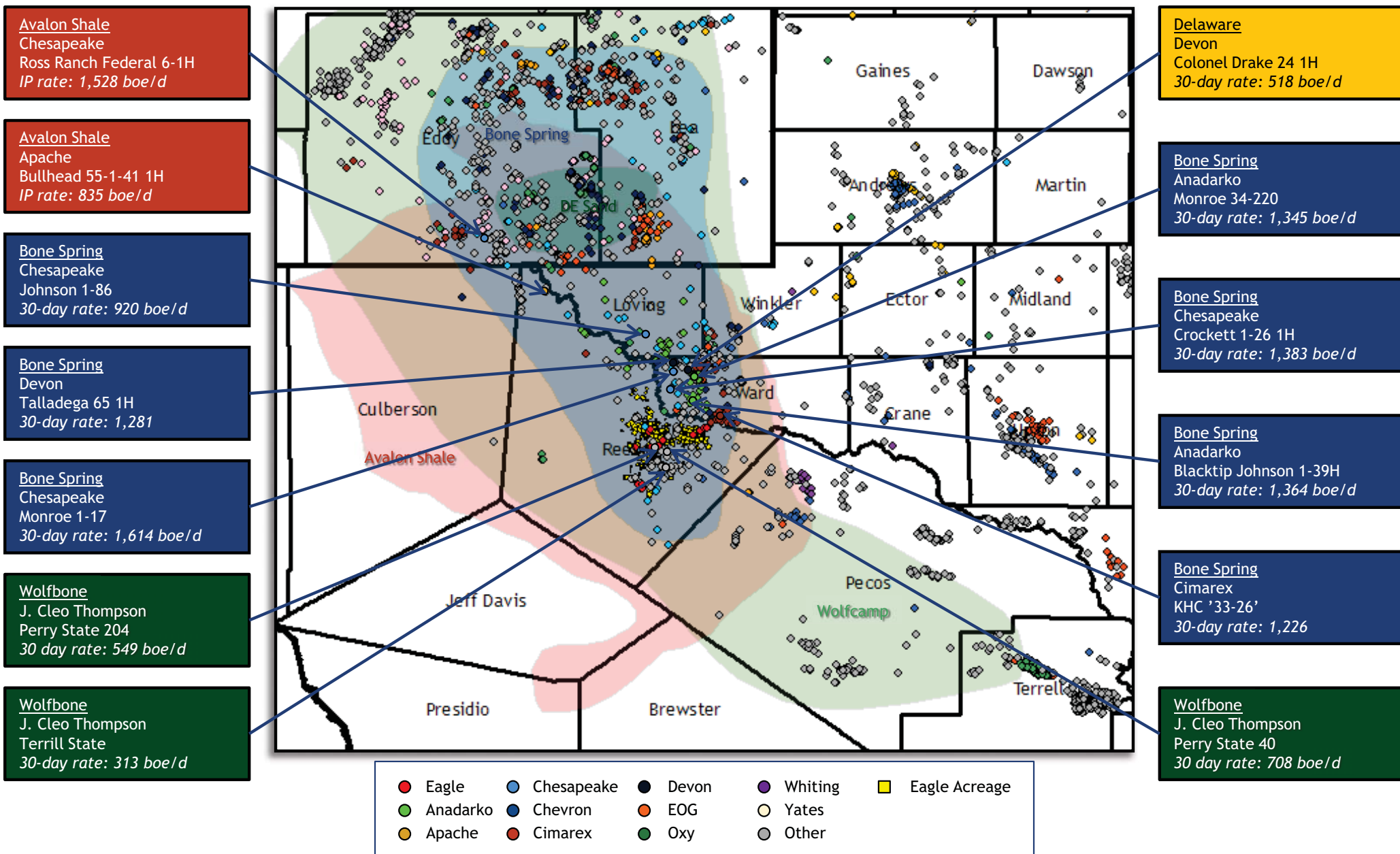
WolfBone Play Evolution, Southern Delaware Basin: Geologic Concept Modifications That Have Enhanced Economic Success

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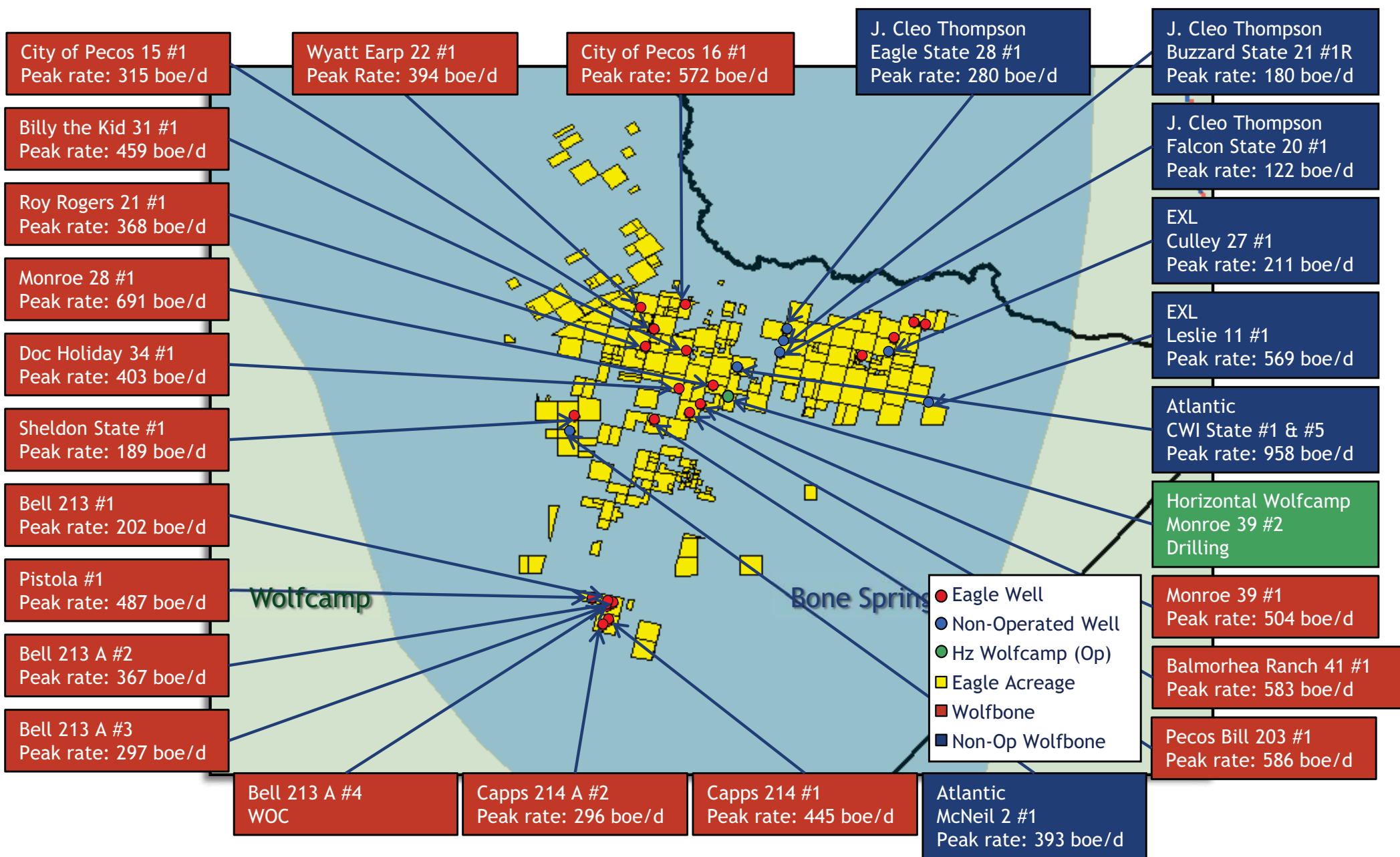
Eagle Well Locations



Recent Nearby Industry Results



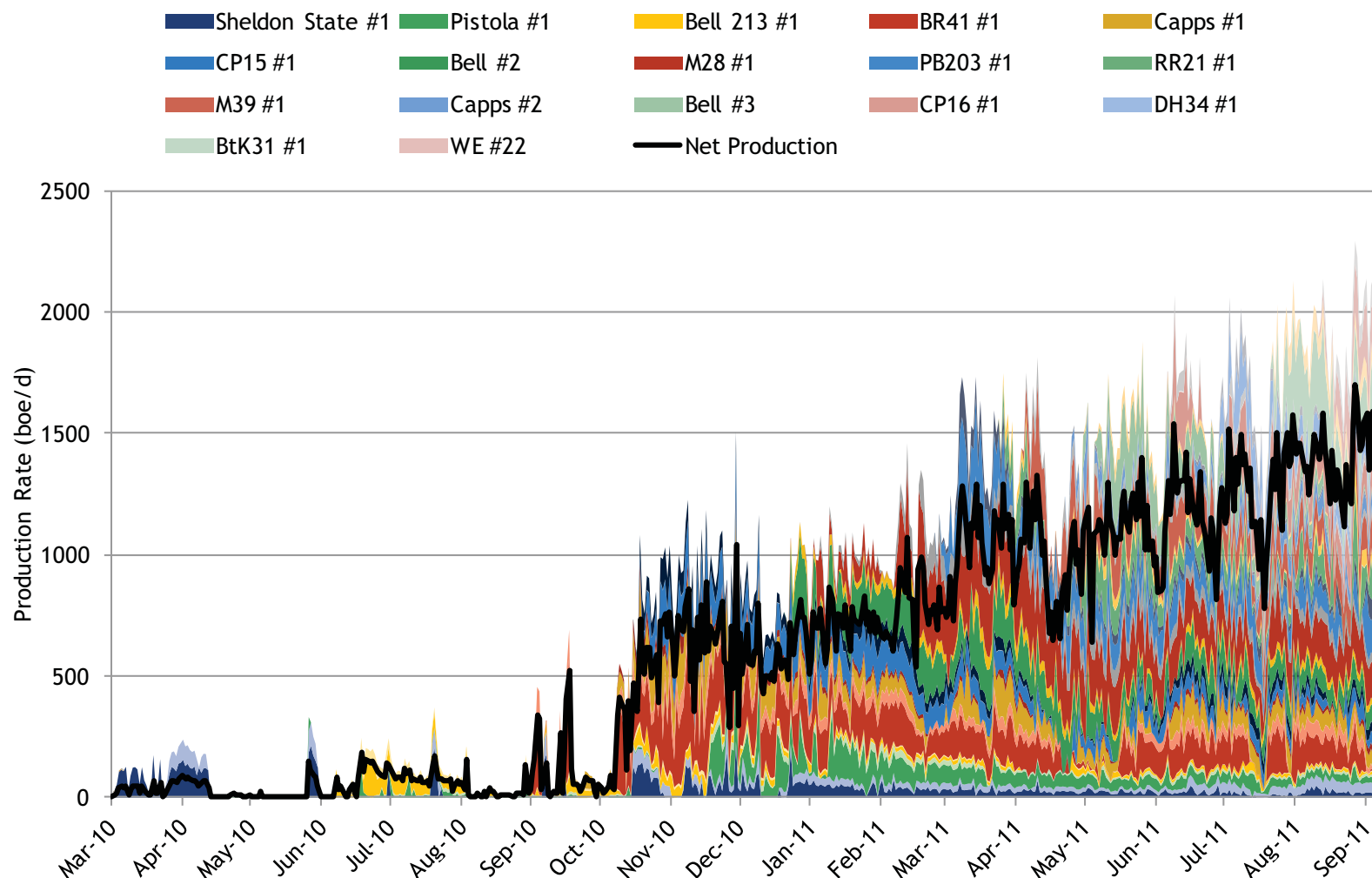
Eagle Wolfbone Activity



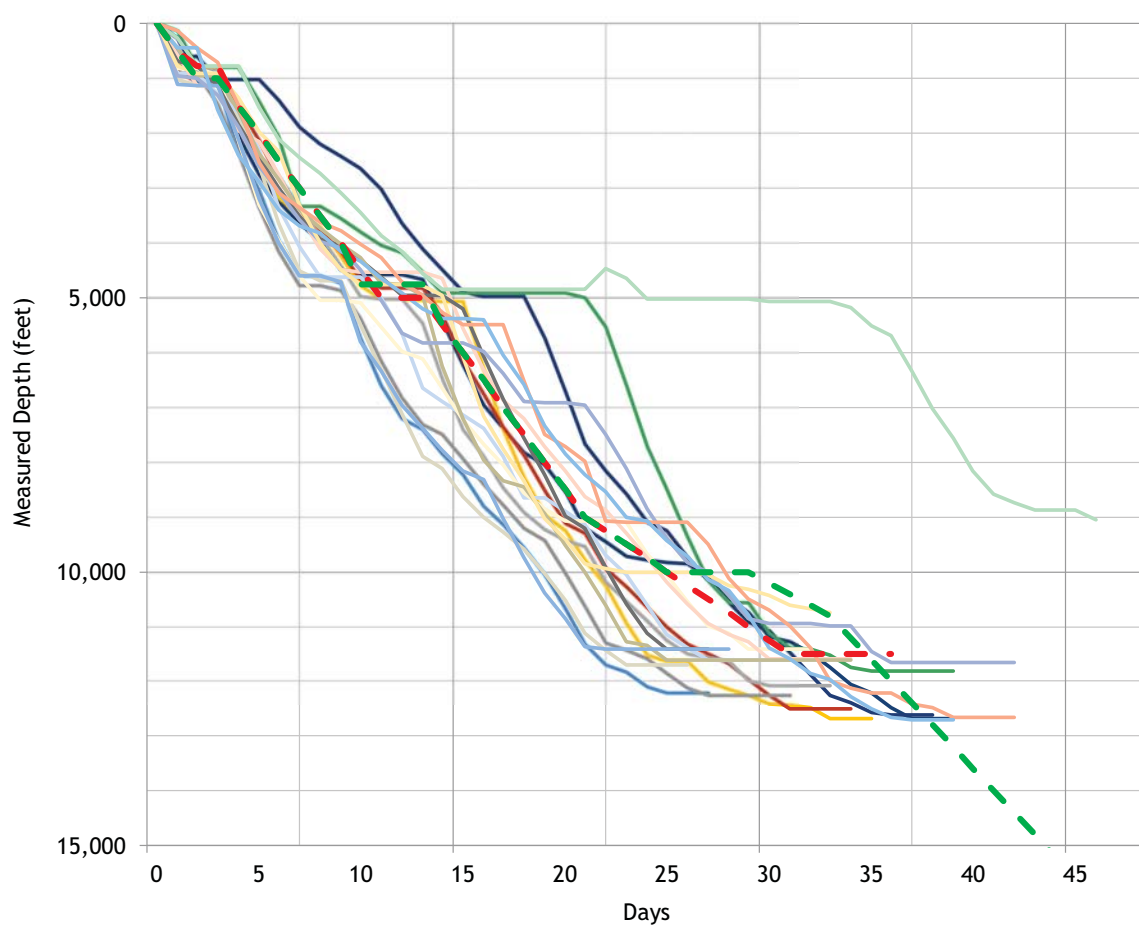
Eagle Operated Wolfbone Production

Total Current Net Production: 1,780 boe/d (2,404 boe/d gross) ⁽¹⁾

Includes 17 operated wells



Wolfbone Drilling Curves



	Well	Spud	TVD (ft)	Spud-to-TD	Spud-to-RR
■	Sheldon #1	12/28/2009	12,685	37	39
■	Pistola #1	2/15/2010	12,602	36	38
■	Bell #2	4/10/2010	11,800	35	39
■	Bell #1	4/12/2010	12,674	33	35
■	Balamorhea Ranch	6/18/2010	12,500	31	34
■	Capps #1	8/4/2010	12,084	30	33
■	City of Pecos 15 #1	9/17/2010	12,206	25	27
■	Monroe 28 #1	10/21/2010	12,250	27	31
■	Pecos Bill 203 #1	12/30/2010	11,690	23	26
■	Monroe 39 #1	1/30/2011	11,601	27	31
■	Capps #2	3/7/2011	11,405	29	32

	Well	Spud	TVD (ft)	Spud-to-TD	Spud-to-RR
■	Wyatt Earp #1	3/7/2011	11,582	30	34
■	Culley 27 #1	3/18/2011	12,655	39	42
■	Bell #3	3/19/2011	11,407	25	27
■	Doc Holliday 34 #1	4/3/2011	11,600	25	34
■	Leslie 11 #1	4/30/2011	12,700	37	39
■	City of Pecos 16 #1	5/4/2011	11,419	22	28
■	Billy the Kid 31 #1	6/10/2011	11,650	36	42
■	Bell #4	7/17/2011	9,055	46	46
■	Monroe 39 #2H	7/30/2011	10,753	33	33
■	Planned Vt		11,500	31	36
■	Planned Hz		15,500	45	48

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Vertical Development Plan Rapidly Proves Acreage

- Drilling a single vertical well allows an operator to book the following:

- 1 PDP
- 8 PUD
- 16 Probable
- 56 Possible

80 total 3P locations

- Using a “fence post” development technique allows an operator to quickly prove an entire field

	27	28	29	30	31	32	33	34	35	
	26	1	2	3	4	5	6	7	36	
	25	24	1	2	3	4	5	8	37	
	56	23	16	1	2	3	6	9	38	
	55	22	15	8	Well	4	7	10	39	
	54	21	14	7	6	5	8	11	40	
	53	20	13	12	11	10	9	12	41	
	52	19	18	17	16	15	14	13	42	
	51	50	49	48	47	46	45	44	43	

1
8
16
56

Proved Developed Producing

Proved Undeveloped

Probable

Possible

40 Ac

*Eagle has already proven a large portion of their acreage →
Only 11 wells required to convert 100% of locations to 3P*

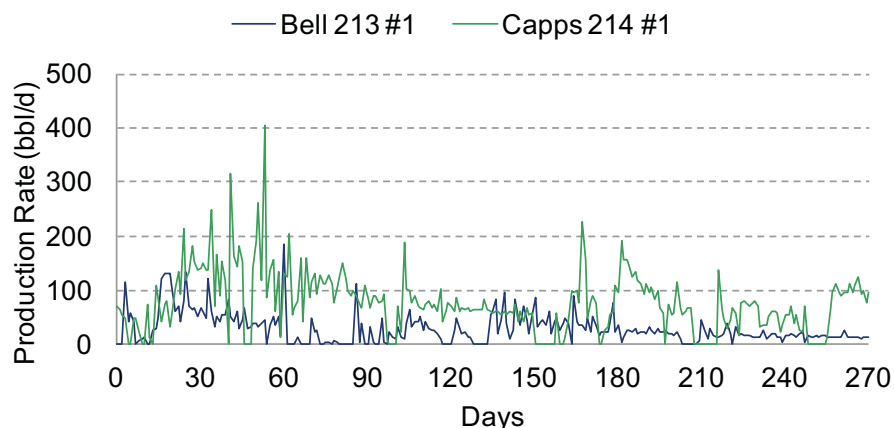
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40-Acre Spacing Works in the Wolfbone

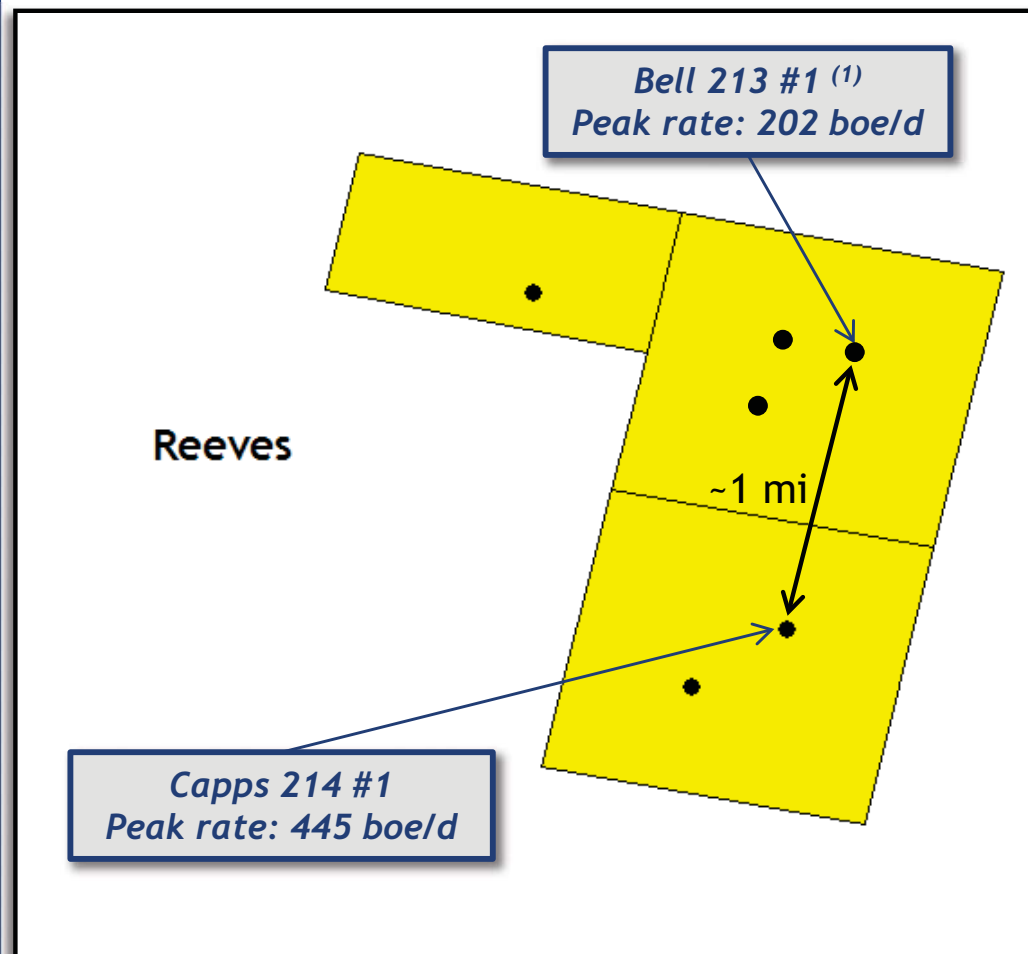
Focused Fracture - Capps 214 #1 Case Study

- Bell 213 #1 completed as a “typical” sandstone
 - Unconcentrated frac targeted sand intervals
 - Wolfcamp Upper and Middle A Shales
 - 3rd Bone Spring Sand
 - *Not completed in Wolfcamp Upper B Shale*
 - Wolfcamp C & D Sands produced excessive water and were plugged
- Capps 214 #1 was completed with a more focused “shale frac”
 - Upper and Middle Wolfcamp Shale
 - Wolfcamp A & B Sand
 - 3rd Bone Spring Sand
 - >2x Bell 213 #1 peak production rate

Same Area - Completely Different Results



Bell/Capps Lease (Southern Area of Eagle Position)



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40-Acre Spacing Works in the Wolfbone

Wolfbone 40-acre Case Study (Bell Lease)

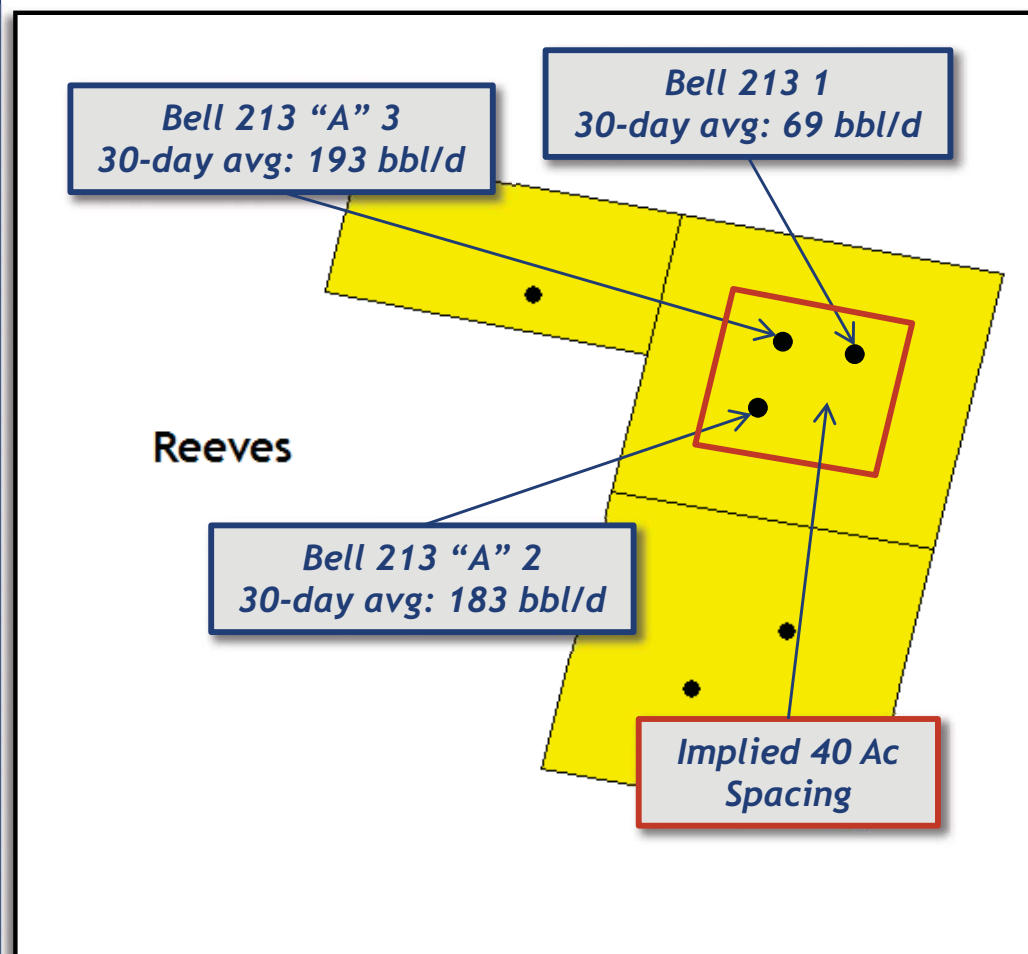
- Bell 213 1, “A” 2, and “A” 3 drilled ~6 months apart
 - 213 1: June 29, 2010
 - 213 “A” 2: Jan 13, 2011
 - 213 “A” 3: May 21, 2011
- No observed interference during completion or production
- Decline rate unaffected by offsetting production
- 40-acre spacing is norm in the Wolfberry (analog)
 - 20-acre development underway in many areas

Wolfbone Down-Spacing Potential (Recovery Factor)

- Oil-in-Place per sq mile = 108 MMboe

		Well Spacing (acres)		
		40	20	10
EUR/Well (Mboe)	200	3.0%	5.9%	11.9%
	225	3.3%	6.7%	13.3%
	250	3.7%	7.4%	14.8%

Bell Lease (Southern Area of Eagle Position)



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SEC Rules Favor Horizontal Well Development

- Drilling a single horizontal well allows an operator to book the following:

- 1 PDP (4 x 40 Ac)
- 4 PUD (16 x 40 Ac)
- 8 Probable (32 x 40 Ac)
- 28 Possible (112 x 40 Ac)

40 total Hz 3P locations

- Horizontal wells are being used to prove fields quickly in North Dakota using the “fence post” development plan
- 2009 SEC booking guideline changes made proving reserves with horizontal wells more favorable to operators
- Old method: Only direct lateral offsets
- New method: Includes toe+ heel offsets

		1-4	5-12	12-16		
	21	17	1	109	105	
	22	18	2	110	106	
	23	19	3	111	107	
	24	20	4	112	108	
29	25	5	1	21	101	97
30	26	6	2	22	102	98
31	27	7	3	23	103	99
32	28	8	4	24	104	100
37	33	9	1	2	25	89
38	34	10	3	2	4	26
39	35	11	5	3	6	27
40	36	12	7	4	8	28
41	45	13	1	29	81	85
42	46	14	2	30	82	86
43	47	15	3	31	83	87
44	48	16	4	32	84	88
49	53	17	73	77		
50	54	18	74	78		
51	55	19	75	79		
52	56	20	76	80		
		57-60	61-68	69-72		

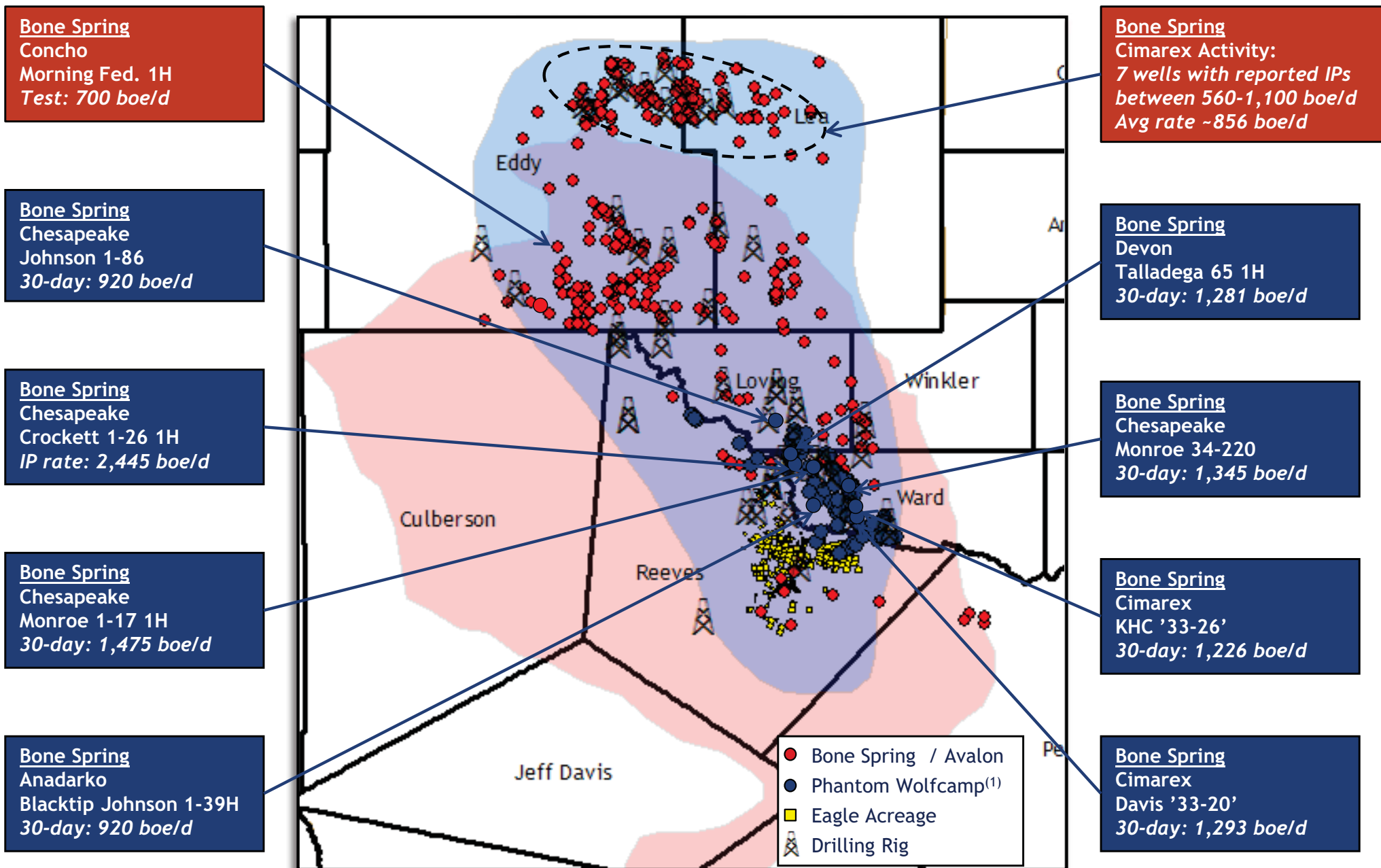
4	Proved Developed Producing
16	Proved Undeveloped
32	Probable
112	Possible

40 Ac

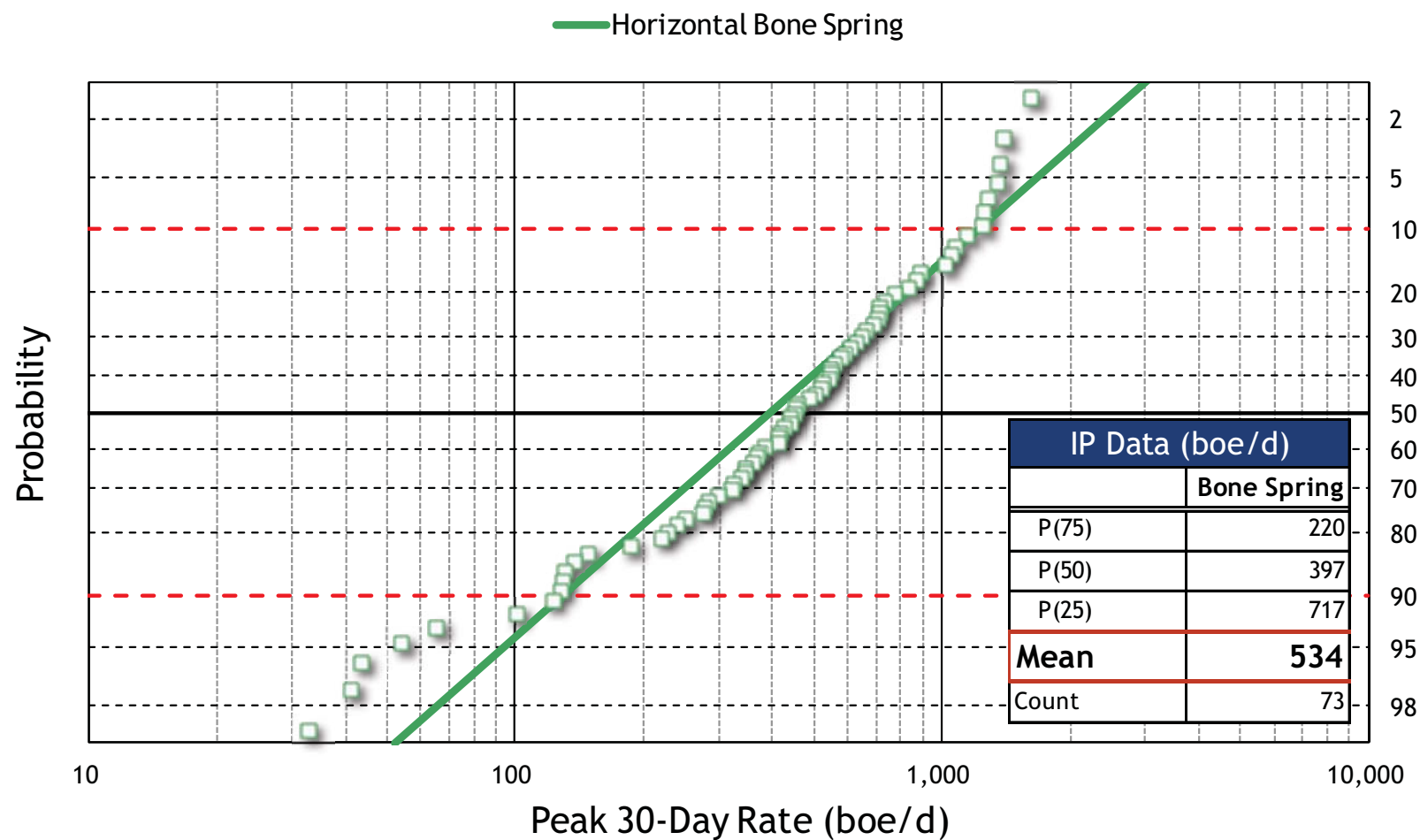
Eagle is currently completing their first Wolfcamp Shale horizontal well

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Bone Spring Industry Activity



Hz Bone Spring IP Rate



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