Horizontal San Andres Play

Russell K. Hall

Presented at the CO_2 & ROZ Conference

Dec 5, 2018

Midland, Texas

Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers

CO_2 ROZ 2018 Conference Week

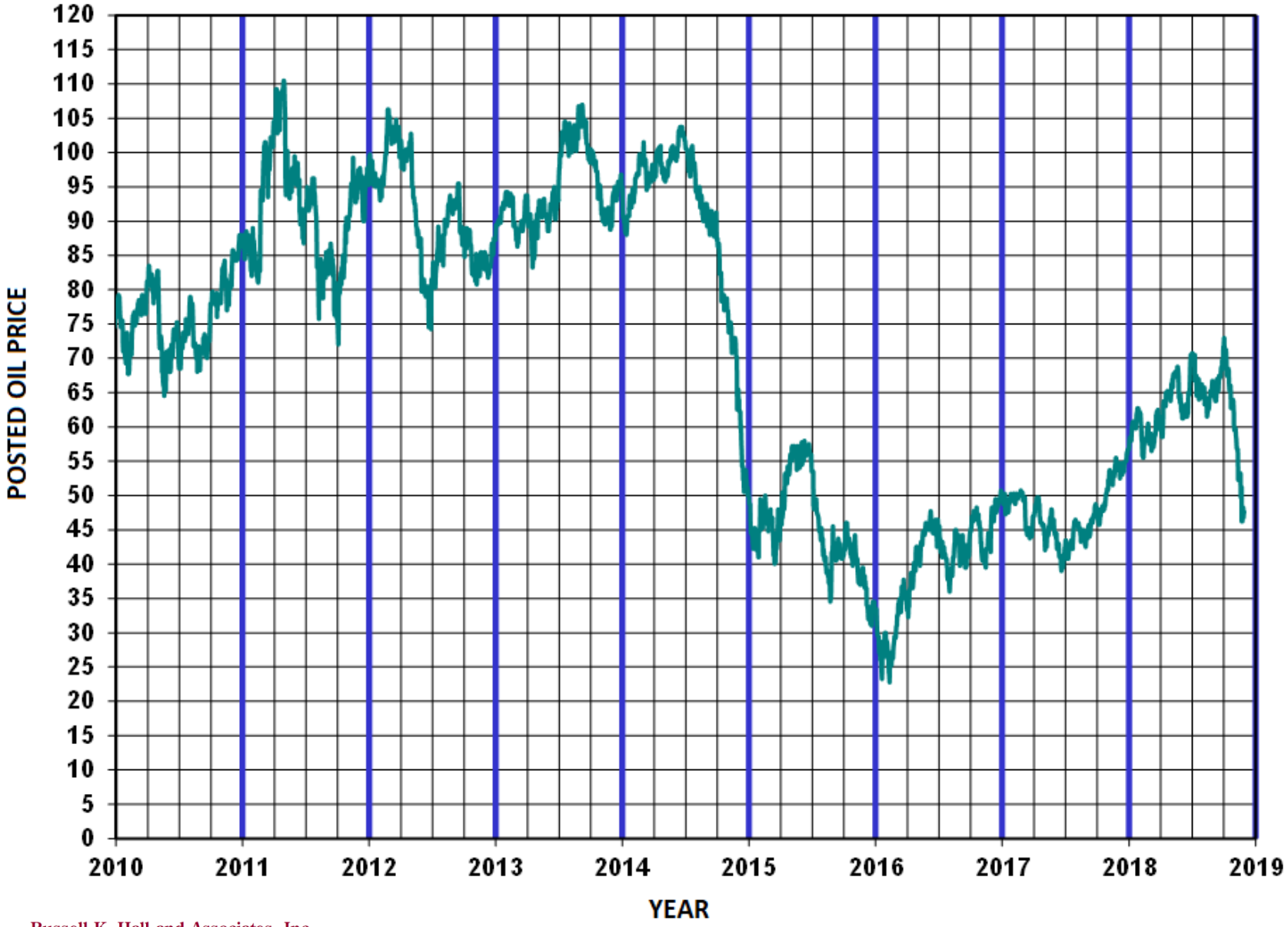
CO_2 Recovery Conference

- Permian Basin Trends
- Horizontal San Andres Play

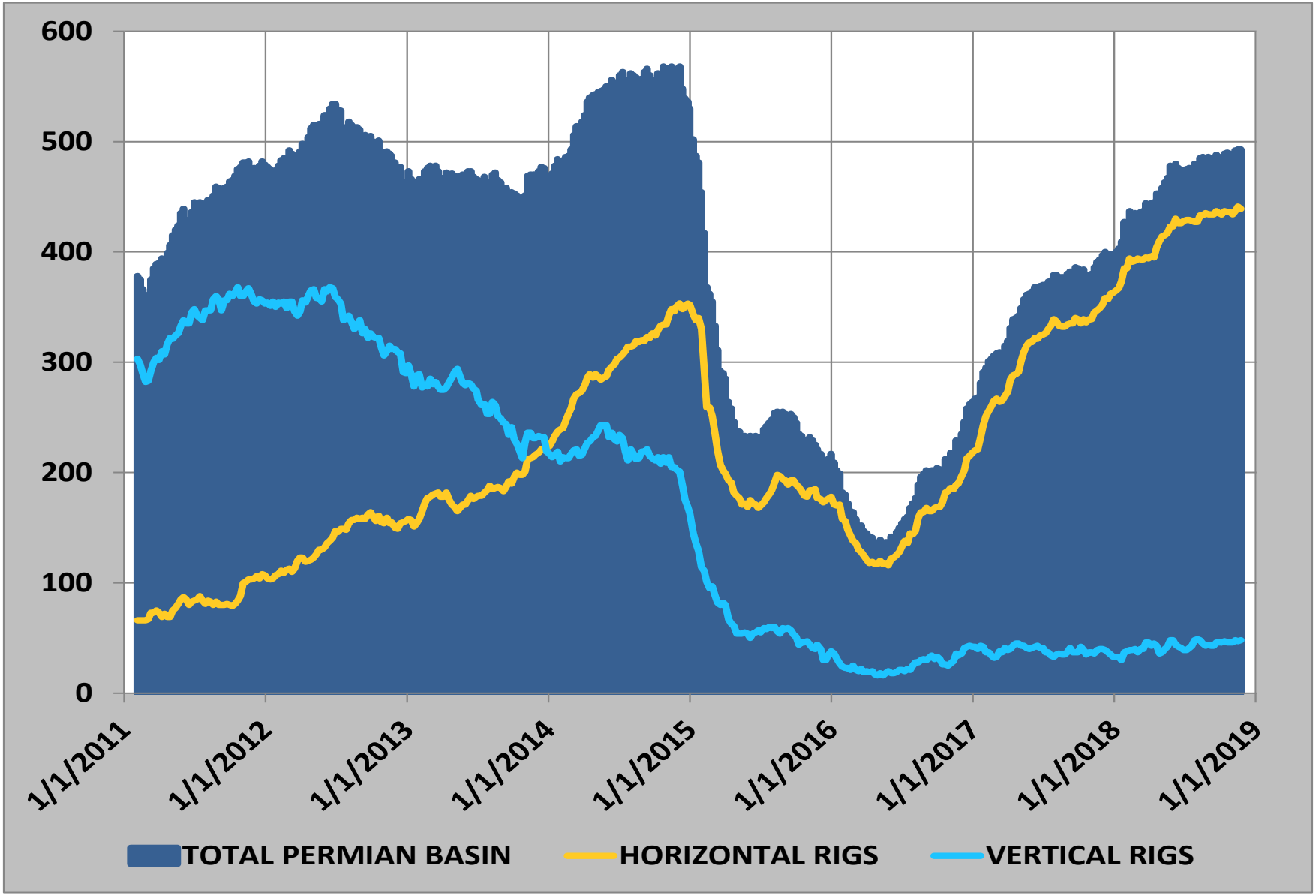
PERMIAN BASIN TRENDS

- Economic Return is Key Driver of Drilling

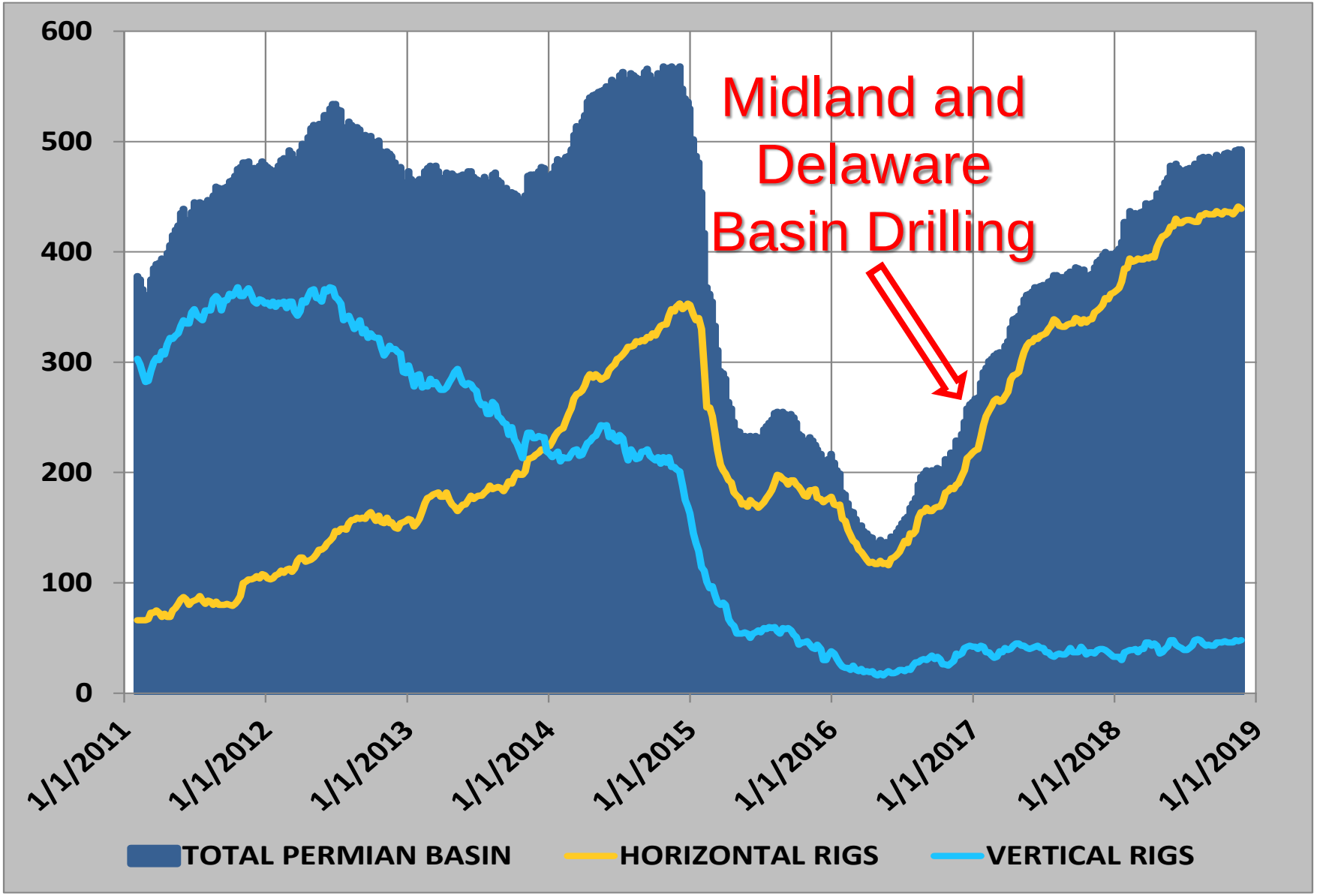
POSTED OIL PRICE



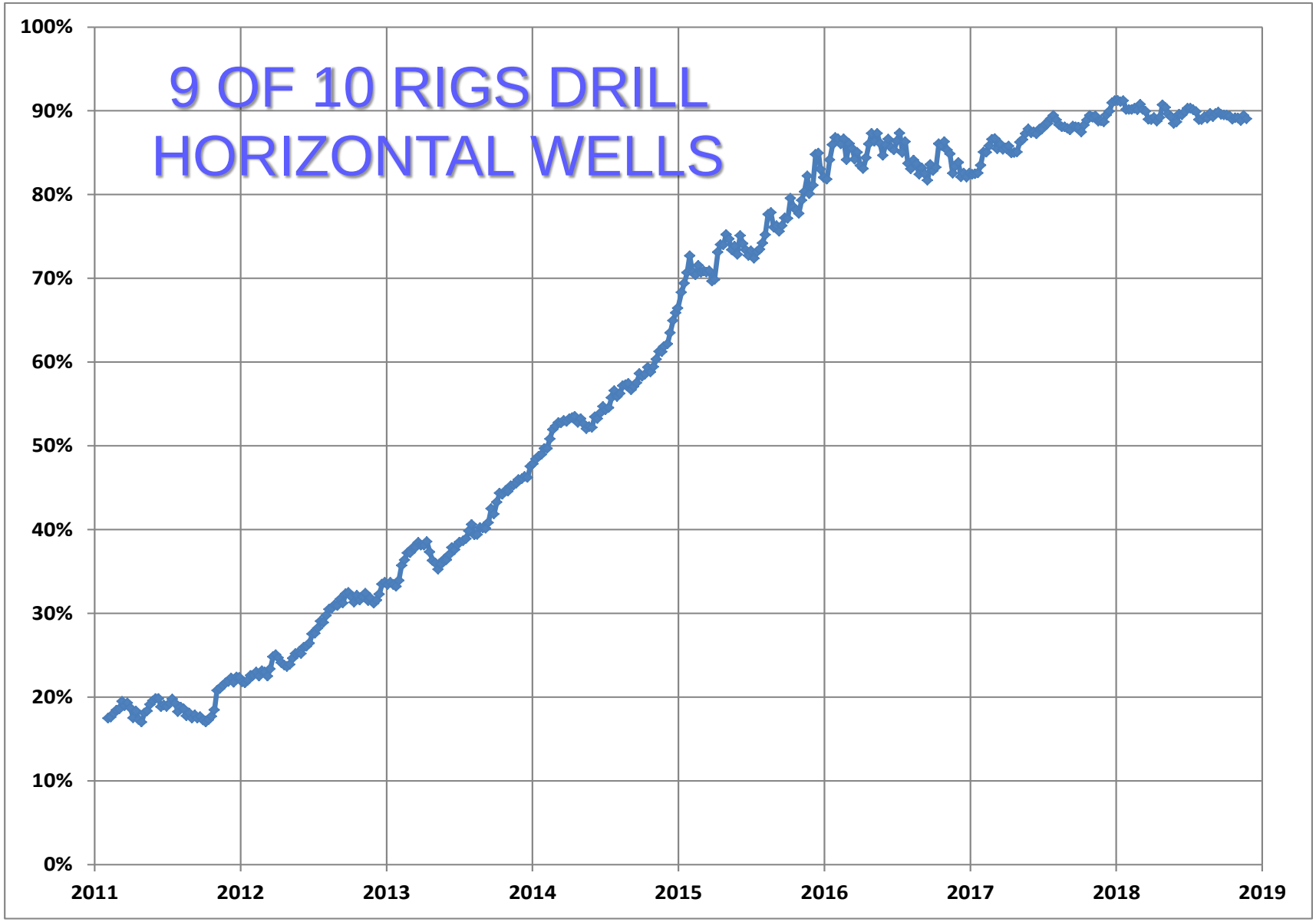
PERMIAN BASIN RIG COUNT



PERMIAN BASIN RIG COUNT



PERMIAN BASIN HZ RIGS



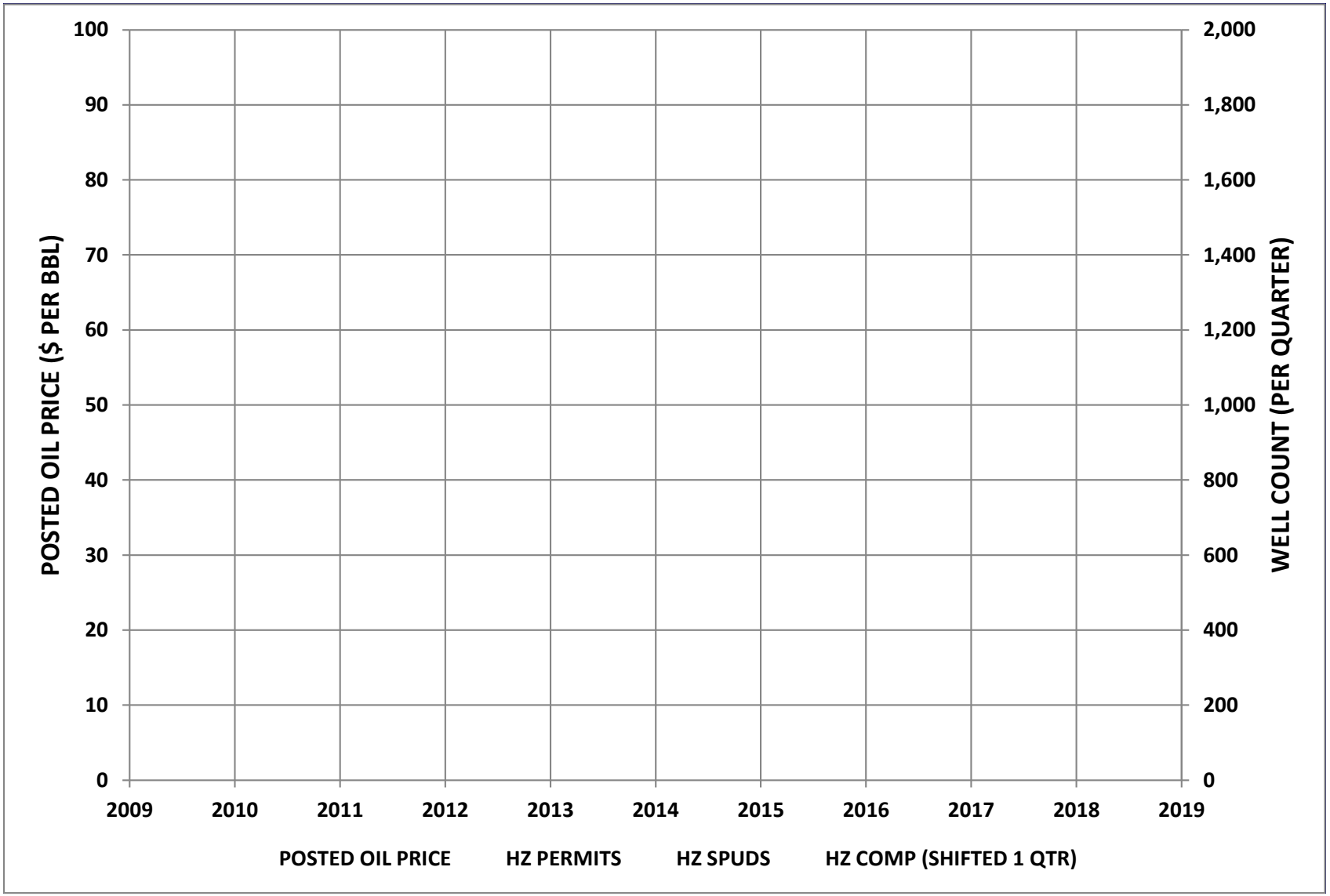
PERMIAN BASIN TRENDS

- Economic Return is Key Driver of Drilling
- Stimulation Costs Have Risen Substantially

PERMIAN BASIN TRENDS

- Economic Return is Key Driver of Drilling
- Stimulation Costs Have Risen Substantially
- Drilled Uncompleted Wells Not As High As Typically Reported

PERMIAN BASIN TRENDS (1)



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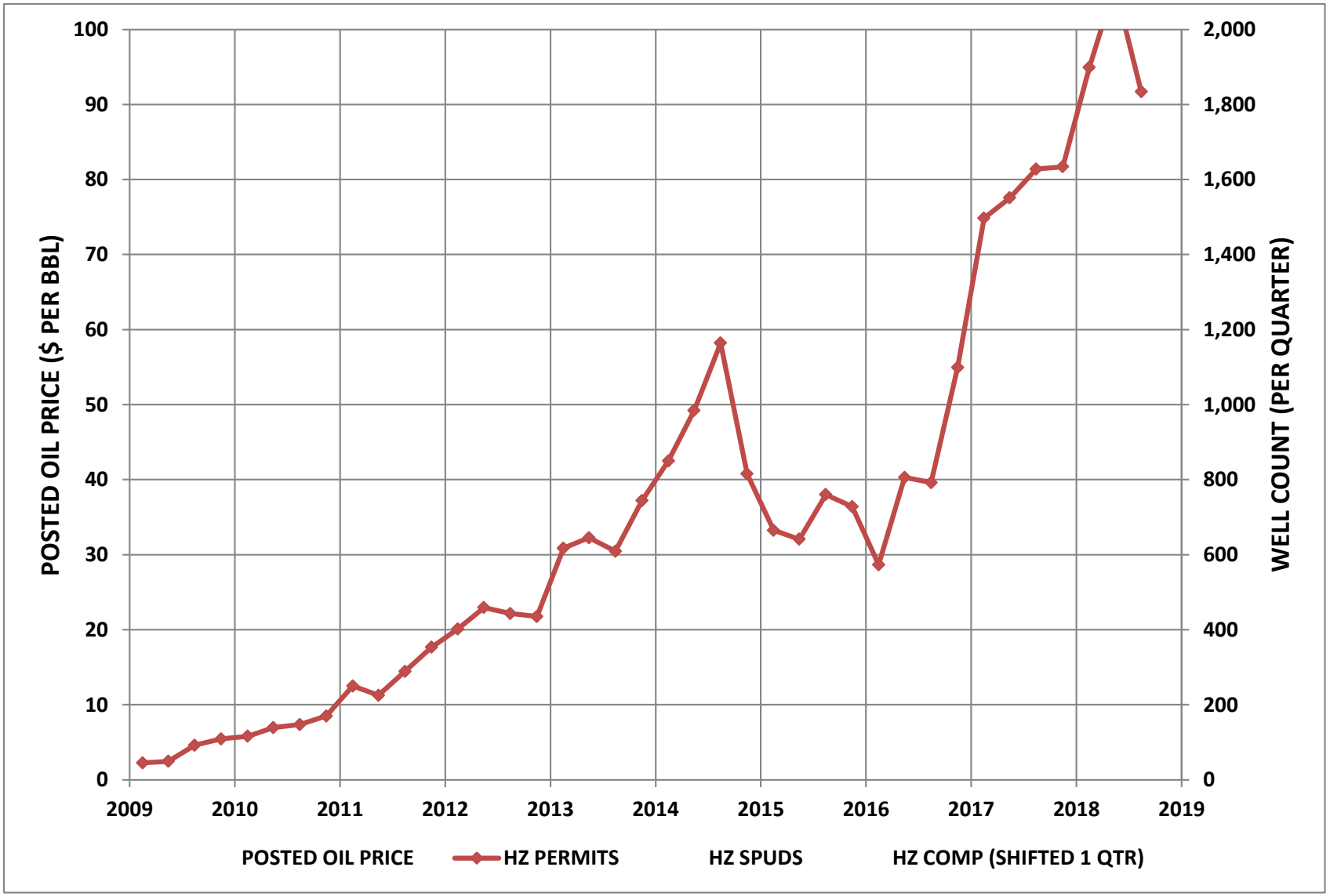

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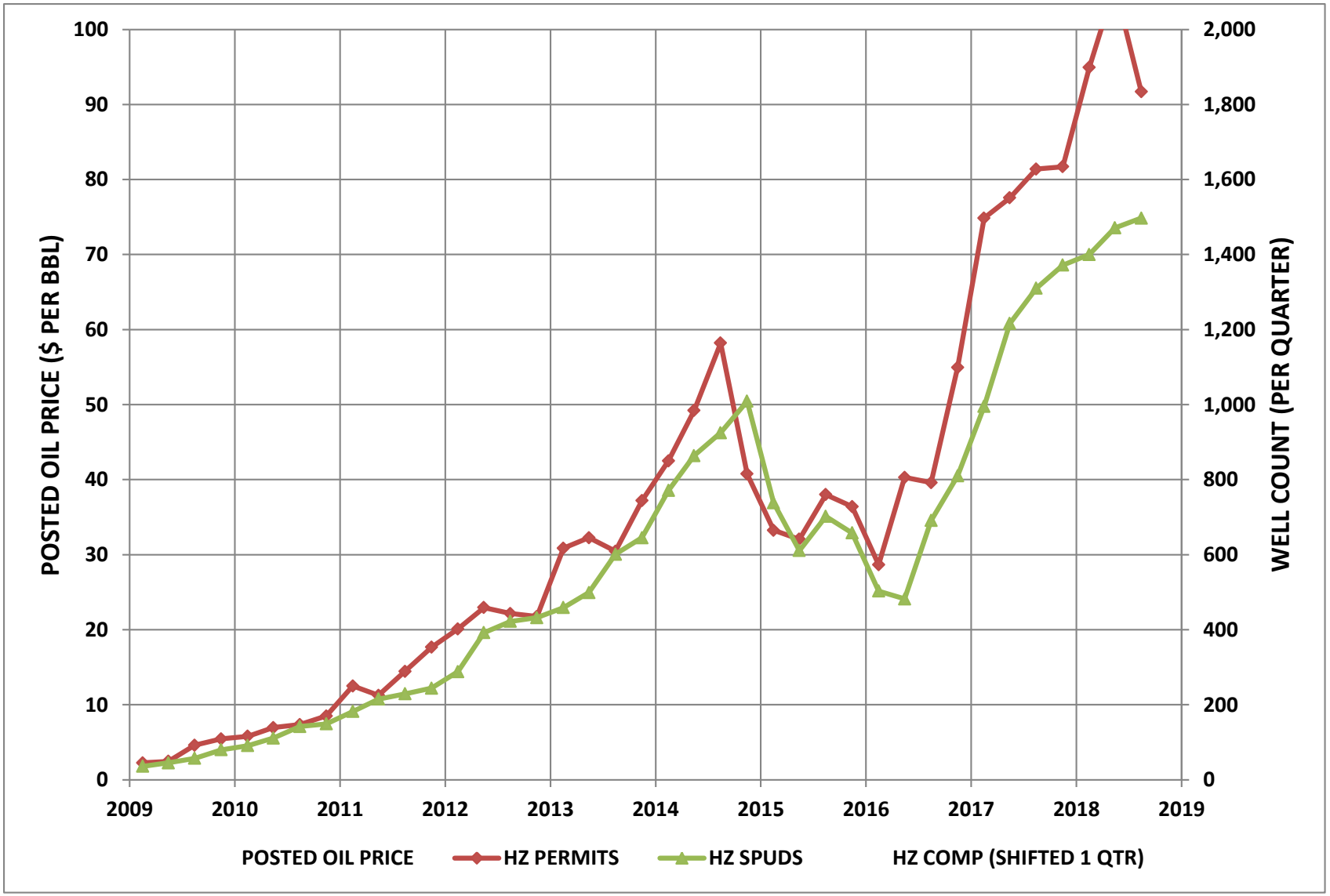
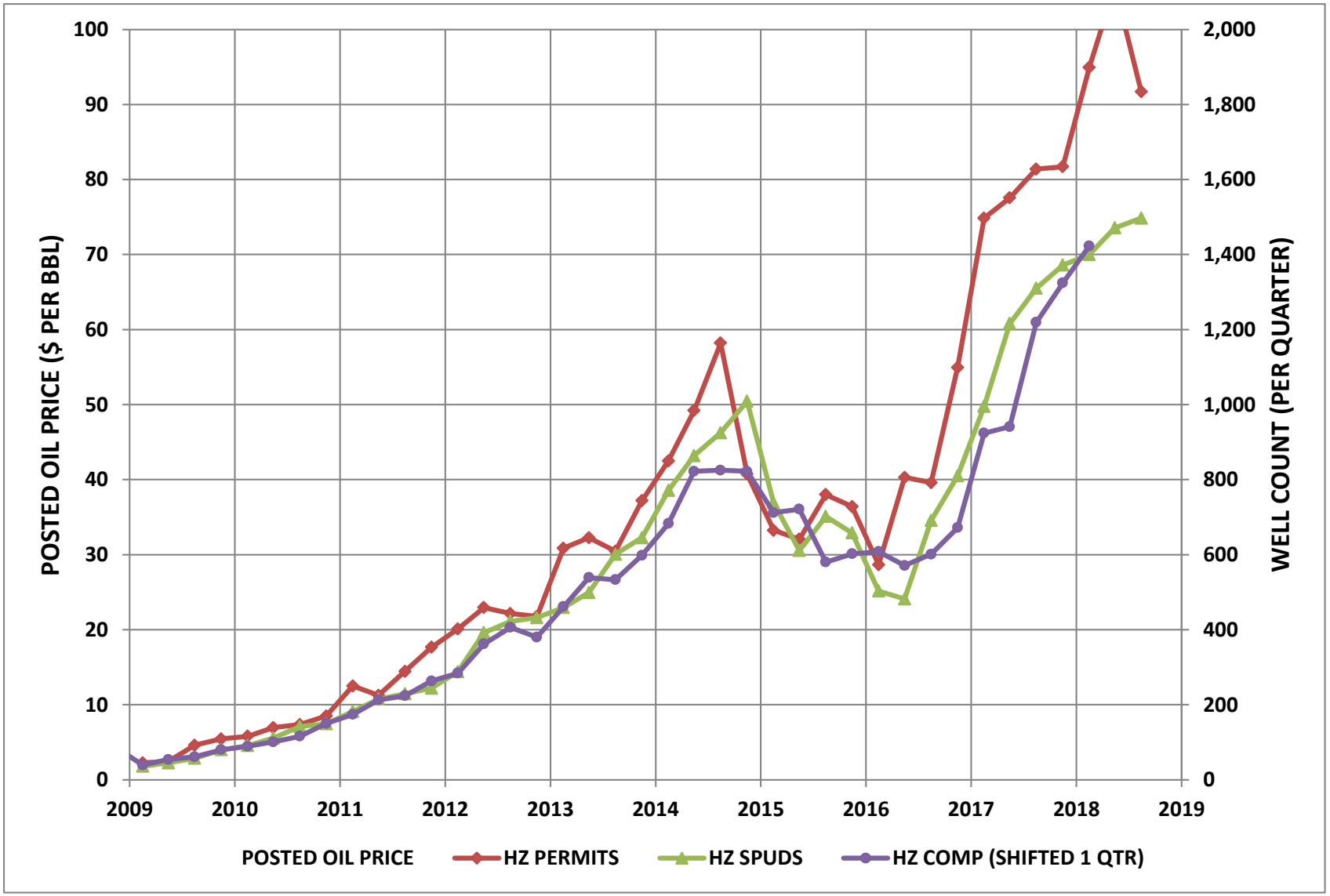


PERMIAN BASIN TRENDS (4)



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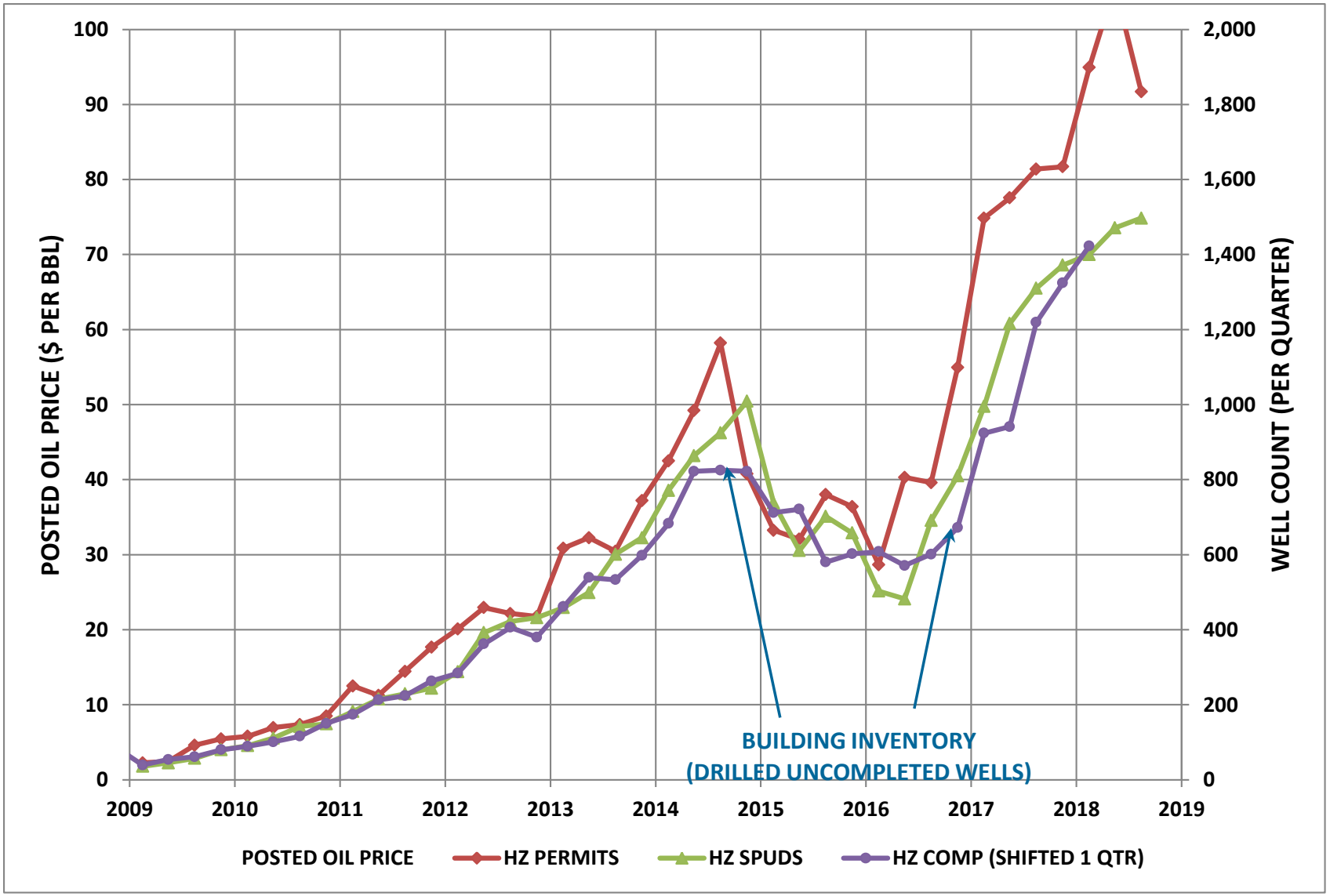
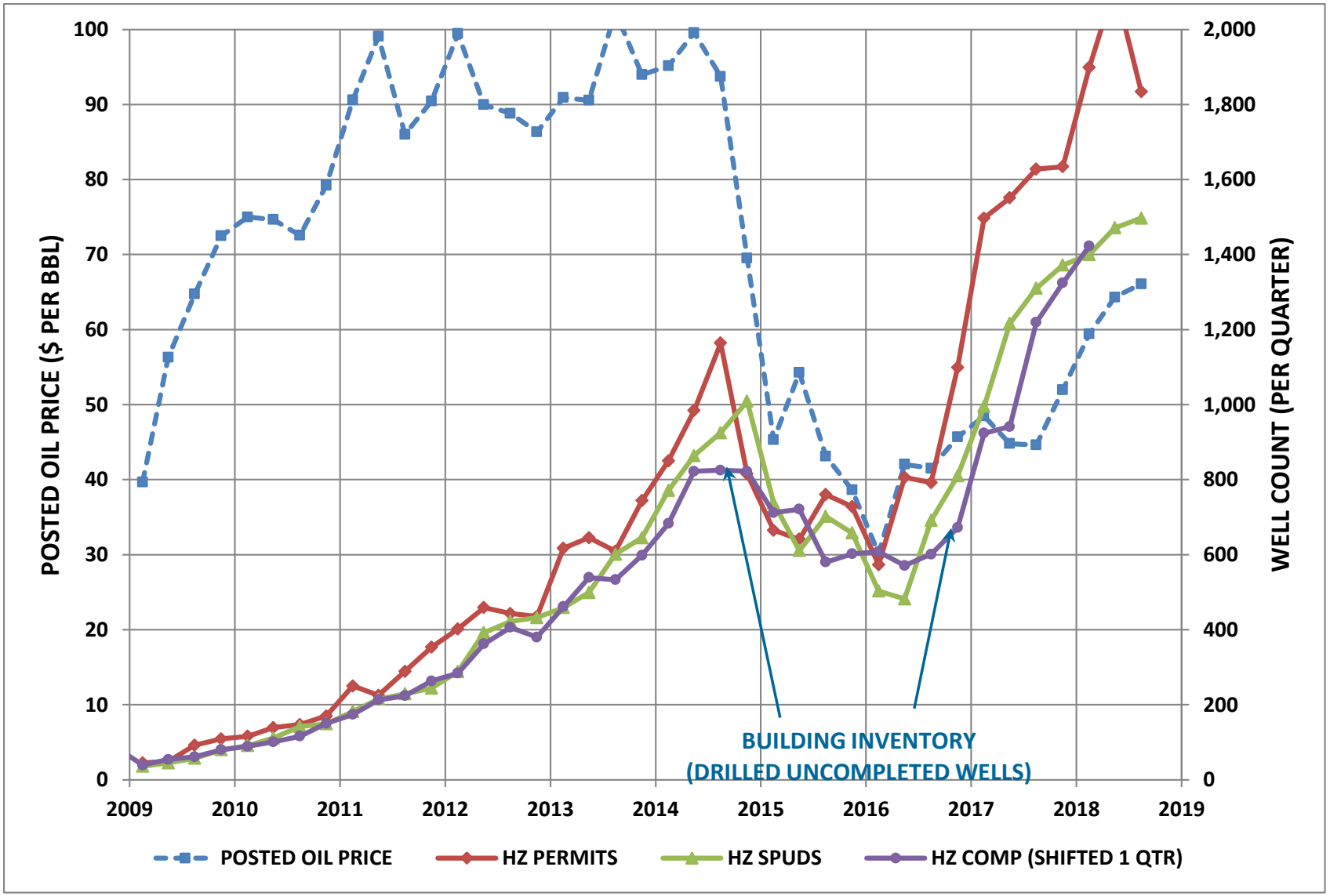


PERMIAN BASIN TRENDS (6)



PERMIAN BASIN TRENDS (7)

"The number of drilled, but uncompleted (DUC) wells in the Lower 48 U.S. states seven most productive basins/plays rose by 3.3% from September to October. The increase occurred despite three of the seven areas reporting a drop in DUCs, according to the November issue of the Energy Information Administration's Drilling Productivity Report (DPR). The DPR reveals 269 DUCs were added to the September total of 8,276. The new total is 8,545, as of Oct. 31, Kallanish Energy reports.

The biggest increase by far from September to October was in the Permian Basin, up 249 drilled, but uncompleted wells, 6.9%, to 3,866, from 3,617. The Anadarko was the closest basin/play to the Permian, up 41 DUCs, or 3.9%, from September to October, to 1,084, the DPR reveals.

The three drilling areas which recorded a month-to-month drop in DUCs were Appalachia (the Marcellus and Utica Shale plays), Bakken and Niobrara, down 19, 20 and 14 DUCs, respectively, to 623, 797 and 401, respectively. The Eagle Ford play saw a 25-DUC increase, to 1,571, while the Haynesville Shale recorded a seven-DUC increase, to 203."

PERMIAN BASIN TRENDS (8)

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PERMIAN BASIN TRENDS (9)

The b[illegible] far from Sep[illegible] October as in the Per[illegible] Ba[illegible] up 249 [illegible]led, but uncom[illegible]ed wel[illegible]% 3,866, from 3,6[illegible]

PERMIAN BASIN TRENDS (10)

PERMIAN BASIN HORIZONTAL DRILLING FROM 1/1/2009 THROUGH 9/30/2018

SPUD WELLS	23,344
COMPLETED OR PRODUCING WELLS	20,763
TREATED WELLS (PER IHS)	485
DRILLING WELLS (RIG COUNT)	493
CORRECT DRILLED UNCOMPLETED WELLS	1,603

DATA EXCLUDES PILOT WELLS

Why Is Industry Reporting DUC Wells Incorrectly?

PENDING WELLS

Production Reports

PR Queries Home | New Lease ID's Built Query | PR Queries Help

Production Report Queries

Production by Lease

*Lease Type: ○ Oil Lease ○ Gas Well ○ Pending

*District: None Selected

*RRC Identifier

*Prod Month Range: from Nov 2018 to Nov 2018

Lease Query

Production by Filing Operator

*Lease Type: ○ Oil Lease ○ Gas Well ○ Oil & Gas ○ Pending

*Operator No:

Operator Directory

District: Statewide

*Prod Month: Nov 2018

Filing Operator

Production by Operator of Record (as shown on RRC Form P4)

*Lease Type: ○ Oil Lease ○ Gas Well ○ Oil & Gas

*Operator No:

Operator Directory

District: Statewide

*Prod Month: Nov 2018

P4 Operator

NOTE: This query will return results *only* for reports filed after Feb 11, 2005.

Production Reports

PR Queries Home | New Lease ID's Built Query | PR Queries Help

Production Report Queries

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Operator Directory

District: Statewide

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P4 Operator

NOTE: This query will return results *only* for reports filed after Feb 11, 2005.

RRC ONLINE SYSTEM

Production Reports

PR Queries Home | New Lease ID's Built Query

Pending Query Results

Return

Showing: 1 - 20 of 100 results

View PR Image

Filing Operator: **SURGE OPERATING, LLC (760725)**

Medium: Online **District:** 08
Type: Original **RRC Identifier:** 741151
Received: 11/02/2018 **Gas Well #:** 1AH

Field Name	Lease Name	Gas Well No.
SPRABERRY (TREND AREA)	DYESS UNIT A 17-08	1AH

Oil/Condensate (whole barrels)							Gas/Casinghead Gas - MCF		
Prod Month	Commingle Permit No.	On Hand Beginning of Month	Production	Disposition Volume	Disposition Code	On Hand End of Month	Formation Production	Disposition Volume	Disposition Code
09/2018		N/A	80			80	0		

View PR Image

Filing Operator: **SURGE OPERATING, LLC (760725)**

Medium: Online **District:** 08
Type: Original **RRC Identifier:** 822015
Received: 11/02/2018 **Gas Well #:** 8AH

Field Name	Lease Name	Gas Well No.
SPRABERRY (TREND AREA)	HAMLIN UNIT 20-29	8AH

Oil/Condensate (whole barrels)							Gas/Casinghead Gas - MCF		
Prod Month	Commingle Permit No.	On Hand Beginning of Month	Production	Disposition Volume	Disposition Code	On Hand End of Month	Formation Production	Disposition Volume	Disposition Code

Pending Query Results

Return

Showing: 1 - 20 of 100 results

View PR Image

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RRC ONLINE SYSTEM

Production Reports

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RRC ONLINE SYSTEM

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ONLINE SYSTEM

Production Reports

PR Queries Home | New Lease ID's Built Query

Pending Query Results

Return

Showing: 1 - 20 of 100 results

WELL PRODUCED 80 BARRELS IN 9/2018

View PR Image

Filing Operator: **SURGE OPERATING, LLC (760725)**

Medium: Online
Type: Original
Received: 11/[illegible]/2018

District: 08
RRC Identifier: [illegible]15
Gas Well #: [illegible]AH

Field Name	Lease Name	Gas Well No.
SPRABERRY (TREND AREA)	DYESS UNIT A 17-08	1AH

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Prod Month	Commingle Permit No.	On Hand Beginning of Month	Production	Disposition Volume	Disposition Code	On Hand End of Month	Formation Production	Disposition Volume	Disposition Code
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RRC ONLINE SYSTEM

Oil & Gas Completions

Completions Home | Help

- (Cmpl_1101) No 'Packet' records found.

Completions Query

Select one or more search criteria below, and click Submit to view the results.
If you select more than one search criteria, all of them have to be true for the Completion record to appear in the results list.

Enter Search Criteria

Date From:	MM/DD/YYYY	Date To:	MM/DD/YYYY

☐ Select to search by submitted date only. Select "Current Status" of NONE.

Current Status:	-All-
District:	-All-
Well Type:	-All-
Purpose of Filing:	-All-
Type of Completion Packet:	-All-
Tracking No.:	
API No.:	03332472
Drilling Permit (DP) No.:	
County:	-All-
Field No.:	Search Field
Filing Operator No.:	760725 Search Operator
Lease No.:	Search Lease
Wellbore Profile:	-All-

NO COMPLETION REPORT ON FILE

RRC ONLINE SYSTEM

Oil & Gas Completions

Completions Home | Help

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Purpose of Filing:	-All-
Type of Completion Packet:	-All-
Tracking No.:	
API No.:	03332472
Drilling Permit (DP) No.:	
County:	-All-
Field No.:	Search Field
Filing Operator No.:	760725 Search Operator
Lease No.:	Search Lease
Wellbore Profile:	-All-

AN UNCOMPLETED WELL (DUC) ???

ONLINE SYSTEM

Oil & Gas Completions

Completions Home | Help

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Completions Query

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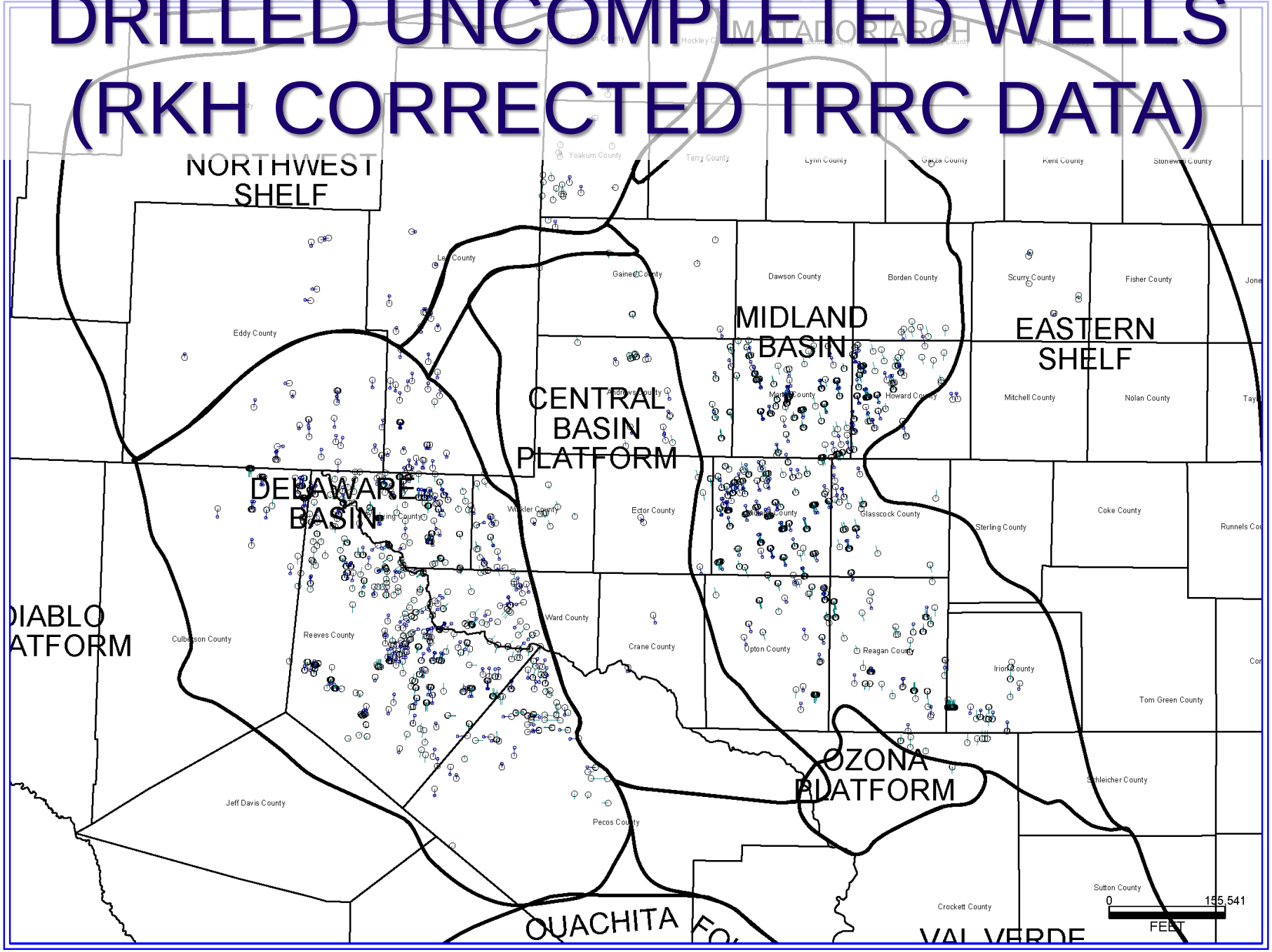
Current Status:	-All-
District:	-All-
Well Type:	-All-
Purpose of Filing:	-All-
Type of Completion Packet:	-All-
Tracking No.:	
API No.:	03332472
Drilling Permit (DP) No.:	
County:	-All-
Field No.:	Search Field
Filing Operator No.:	760725 Search Operator
Lease No.:	Search Lease
Wellbore Profile:	-All-

Operators Sometimes Wait Several Months to File a Completion Report

DRILLED UNCOMPLETED WELLS (RKH CORRECTED TRRC DATA)



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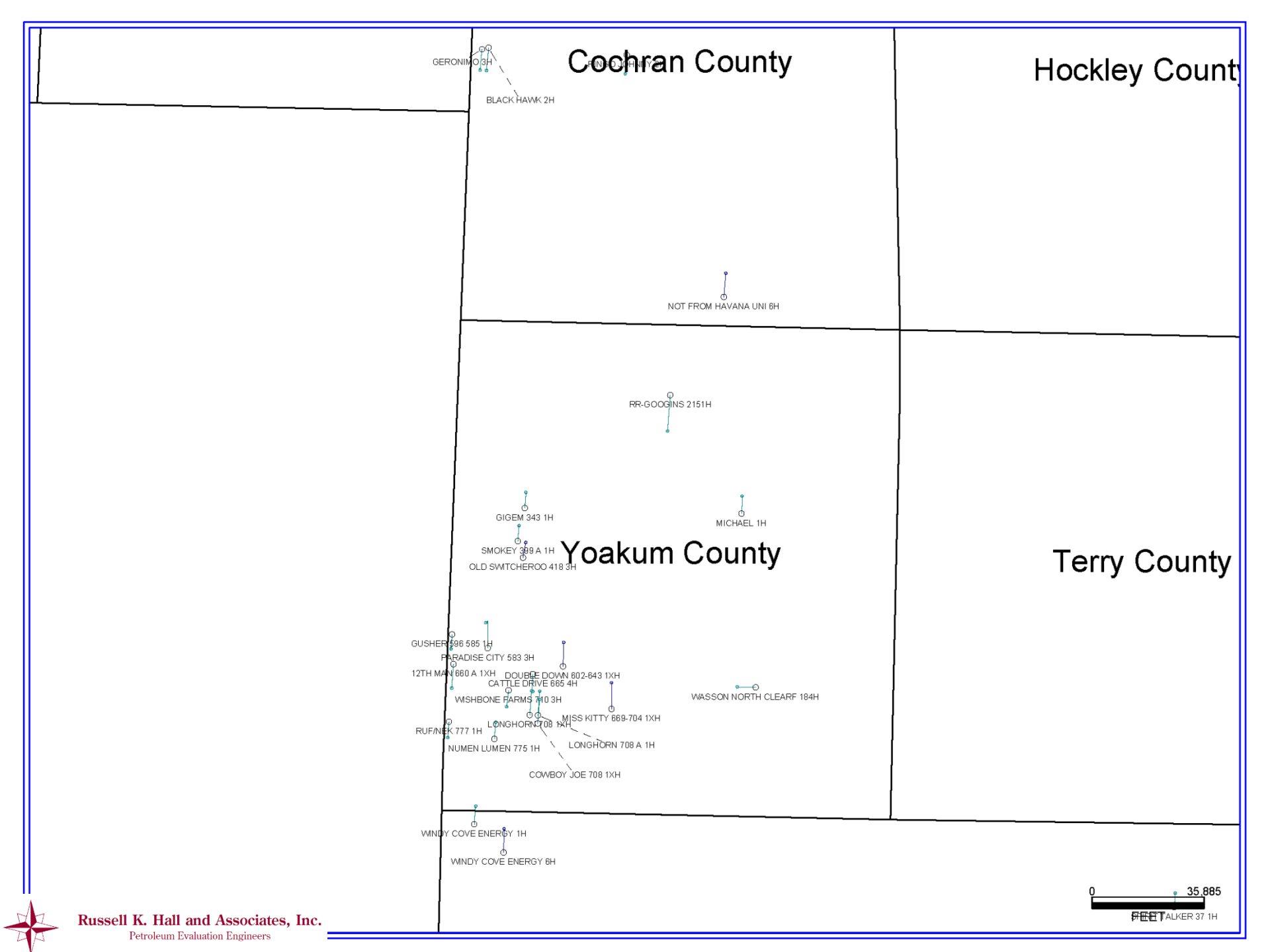
Cochran County
Hockley County
Yoakum County
Terry County
GERONIMO 3H
BLACK HAWK 2H
NOT FROM HAVANA UNI 6H
RR-GOOGINS 2151H
GIGEM 343 1H
MICHAEL 1H
SMOKEY 389 A 1H
OLD SWITCHEROO 418 3H
GUSHER 596 585 1H
PARADISE CITY 583 3H
12TH MAN 660 A 1XH
DOUBLE DOWN 602-643 1XH
CATTLE DRIVE 665 4H
WISHBONE FARMS 710 3H
WASSON NORTH CLEARF 184H
MISS KITTY 669-704 1XH
RUFNEK 777 1H
LONGHORN 708 1XH
NUMEN LUMEN 775 1H
LONGHORN 708 A 1H
COWBOY JOE 708 1XH
WINDY COVE ENERGY 1H
WINDY COVE ENERGY 6H
0
35,885
FEET
PEET TALKER 37 1H

Horizontal San Andres Play

Horizontal San Andres

- Reservoir Is Complex !

Horizontal San Andres

- Reservoir Is Complex !
- Data Strongly Supports ROZ Concept

Horizontal San Andres

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- Diagenetic Changes May Be More Important Than Depositional Environment

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Horizontal San Andres

- Reservoir Is Complex !
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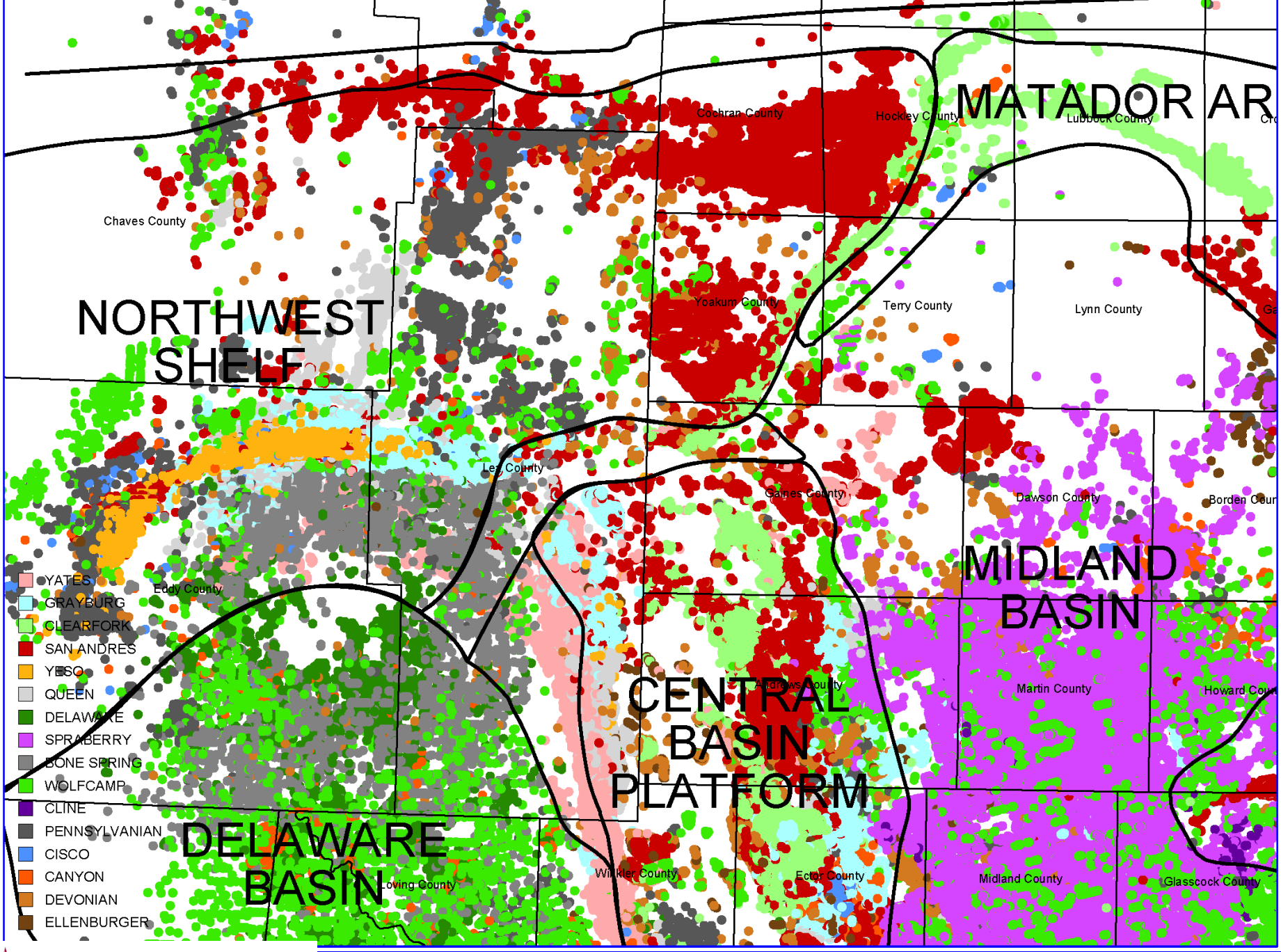
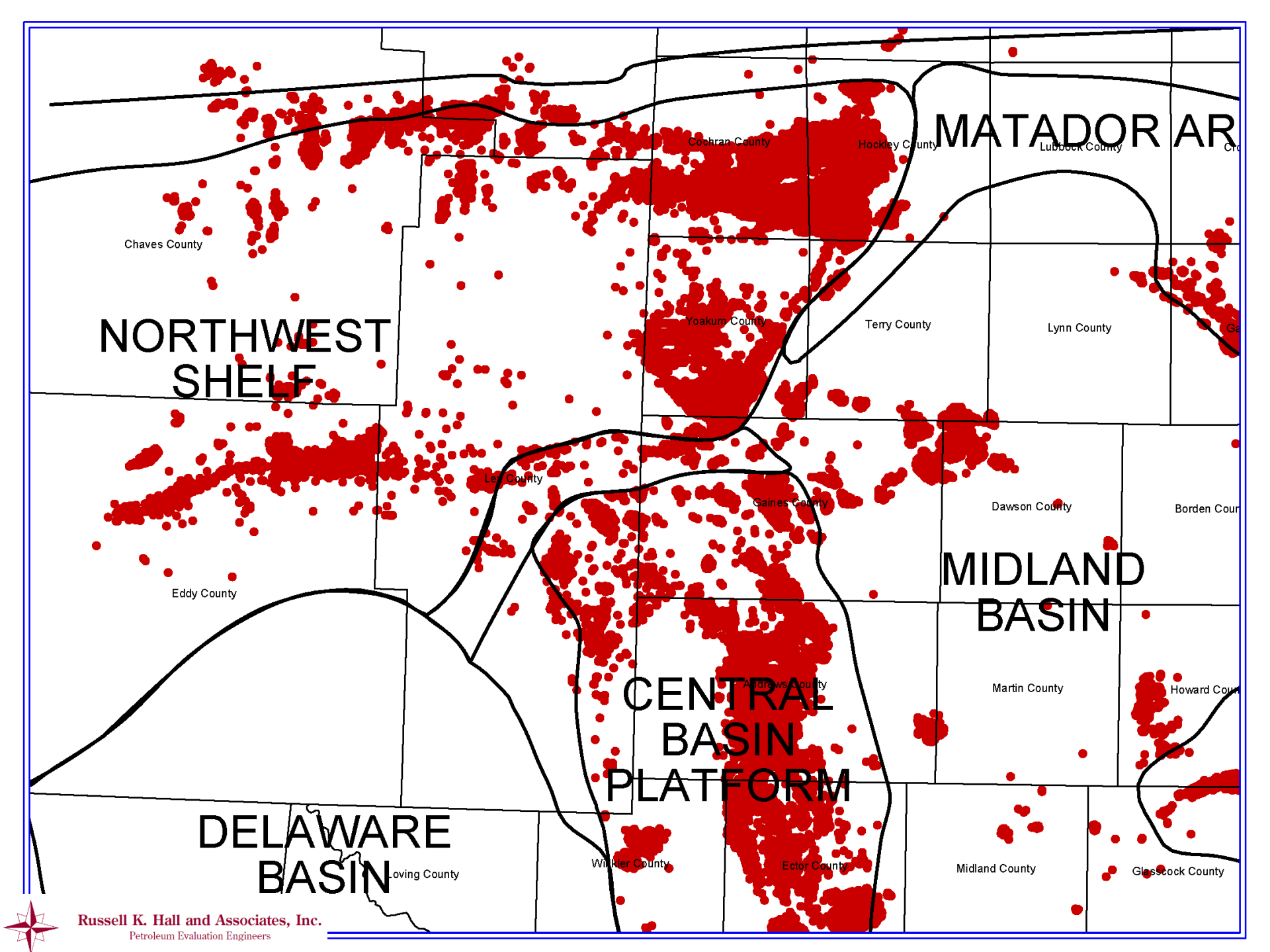
- Diagenetic Changes May Be More Important Than Depositional Environment
- Controlling Frac Growth Is Paramount For Successful Oil Production
- Gas Content Strongly Influences Recovery Efficiency
- Not All Areas Are The Same


MATADOR AR
Cochran County
Hockley County
Lubbock County
Chaves County
NORTHWEST SHELF
Yoakum County
Terry County
Lynn County
Lea County
Gaines County
Dawson County
Borden Coun
MIDLAND BASIN
Eddy County
CENTRAL BASIN PLATFORM
Andrews County
Martin County
Howard Coun
DELAWARE BASIN
Loving County
Winkler County
Ector County
Midland County
Glasscock County
YATES
GRAYBURG
CLEARFORK
SAN ANDRES
YESO
QUEEN
DELAWARE
SPRABERRY
BONE SPRING
WOLFCAMP
CLINE
PENNSYLVANIAN
CISCO
CANYON
DEVONIAN
ELLENBURGER


MATADOR AR
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Eddy County
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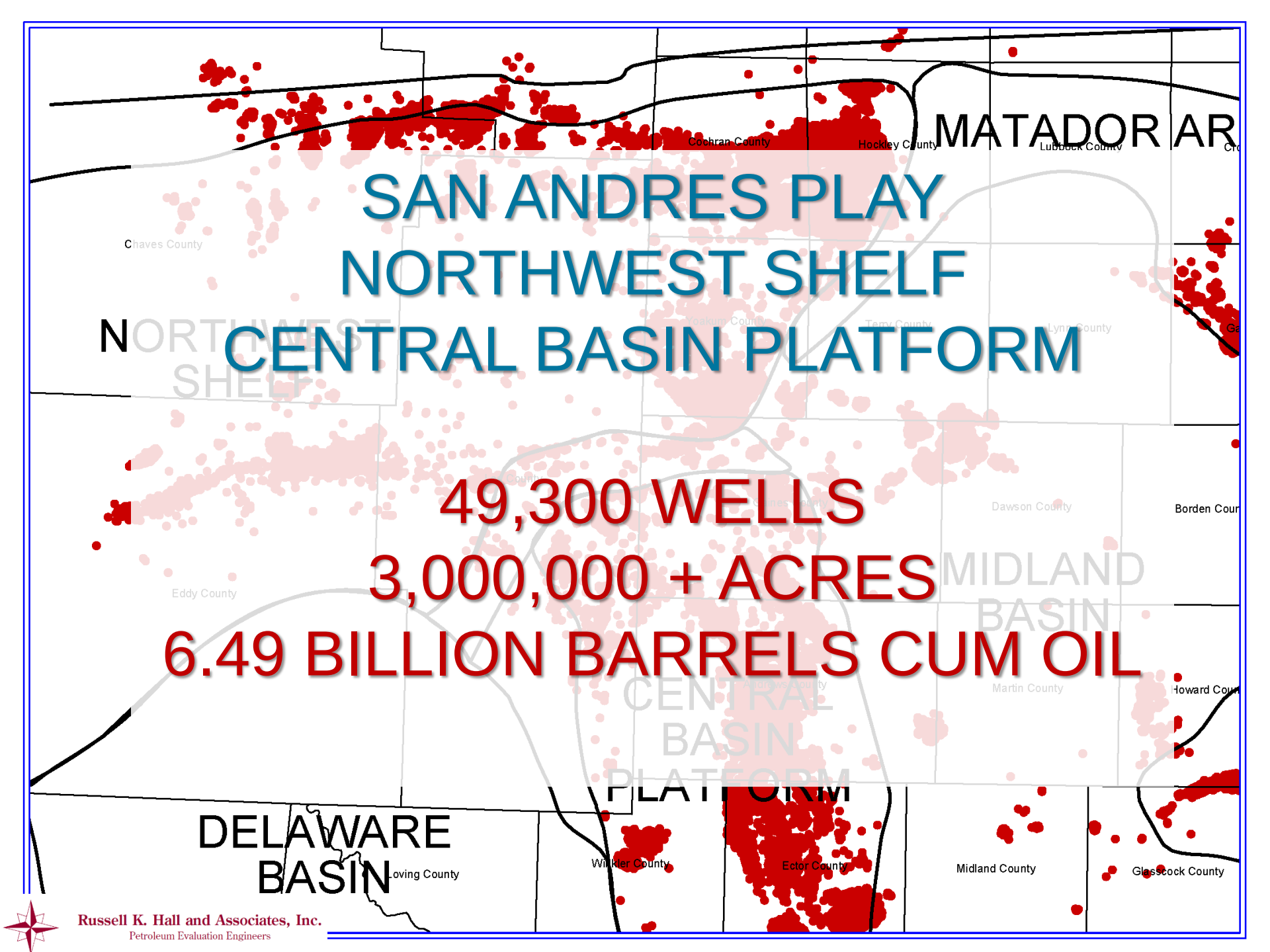
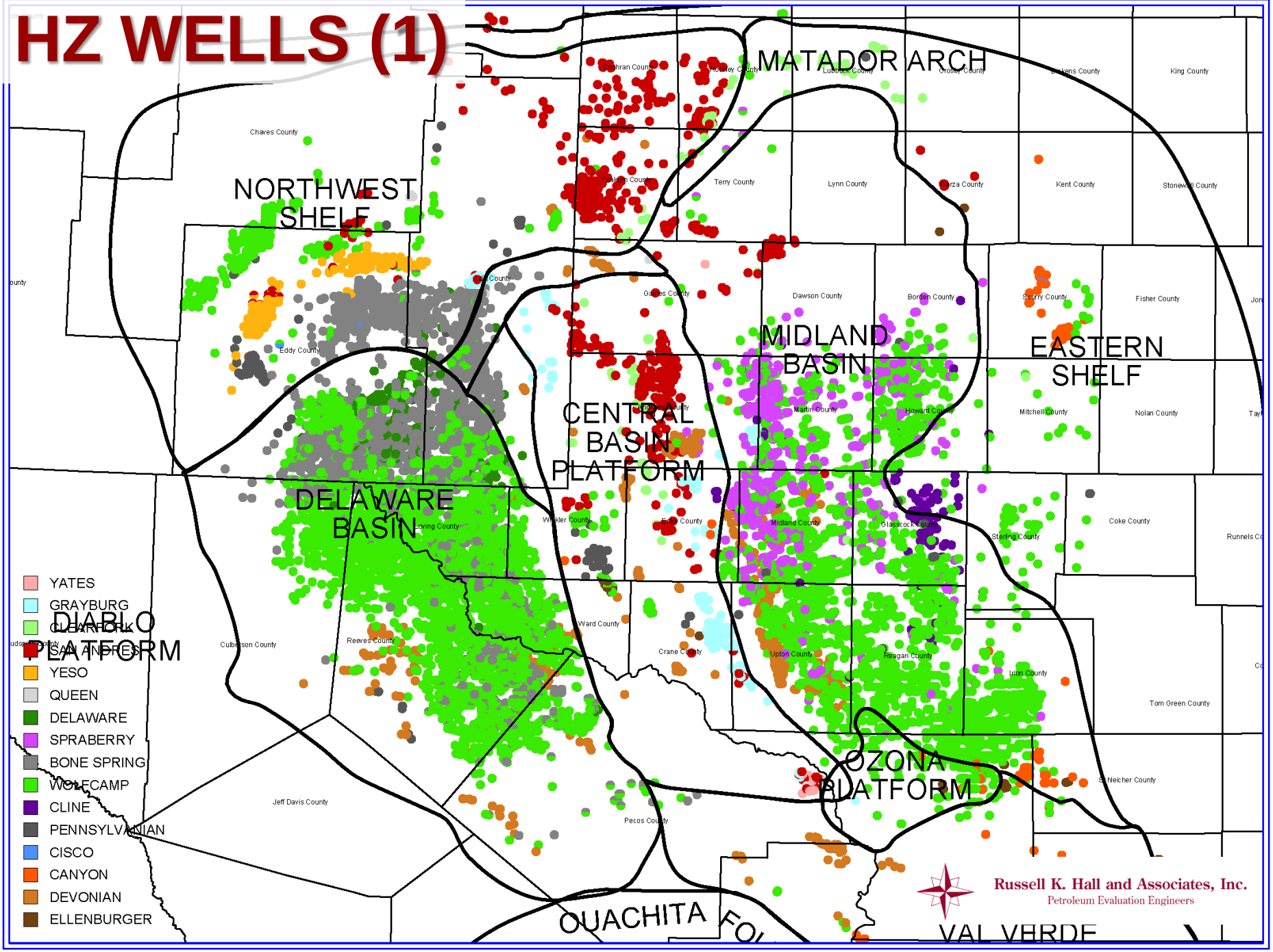
Andrews County
Martin County
Howard Coun
DELAWARE BASIN
Loving County
Winkler County
Ector County
Midland County
Glasscock County



SAN ANDRES PLAY
NORTHWEST SHELF
CENTRAL BASIN PLATFORM

49,300 WELLS
3,000,000 + ACRES
6.49 BILLION BARRELS CUM OIL

HZ WELLS (1)



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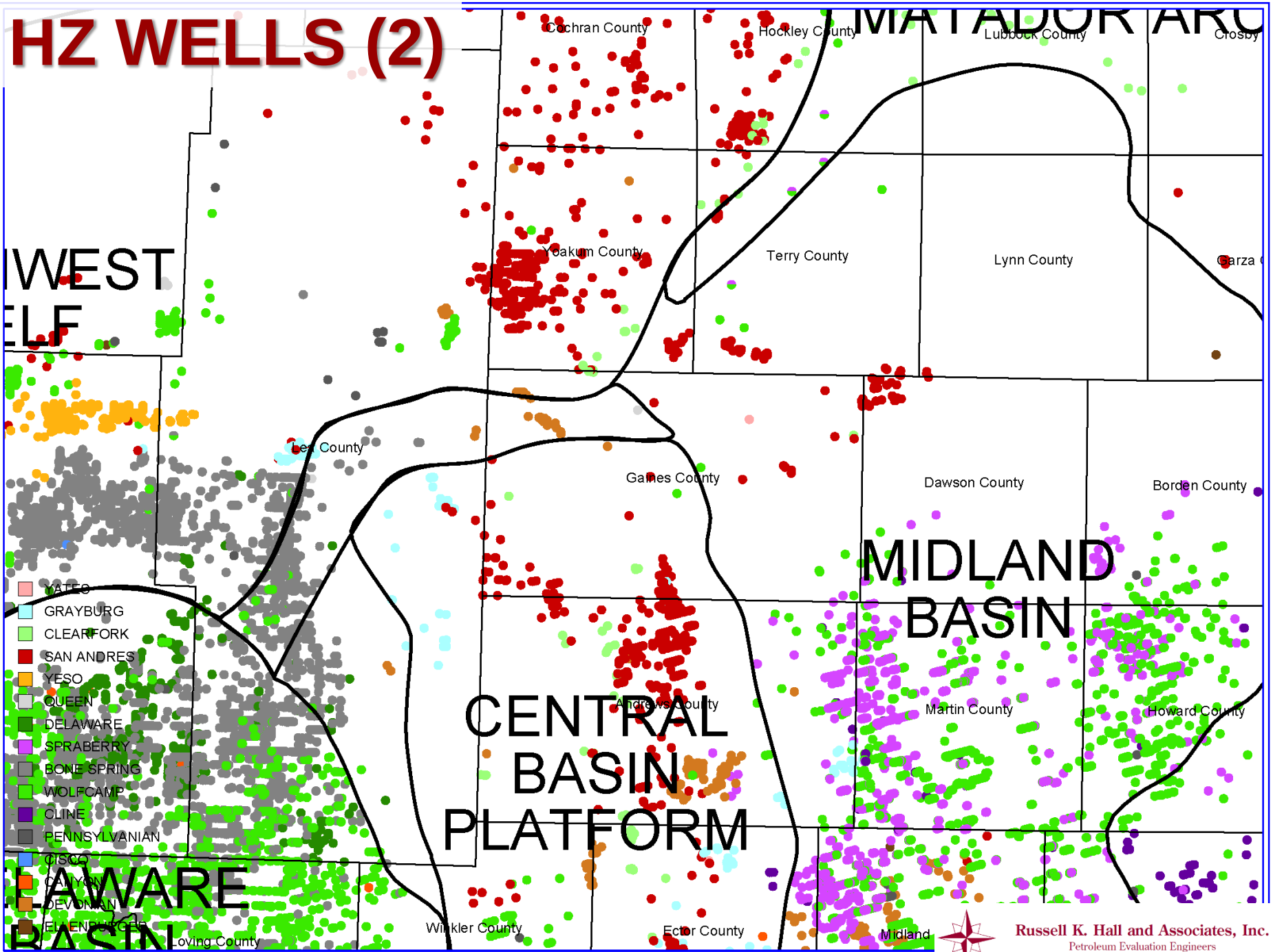
Petroleum Evaluation Engineers

HZ WELLS (2)



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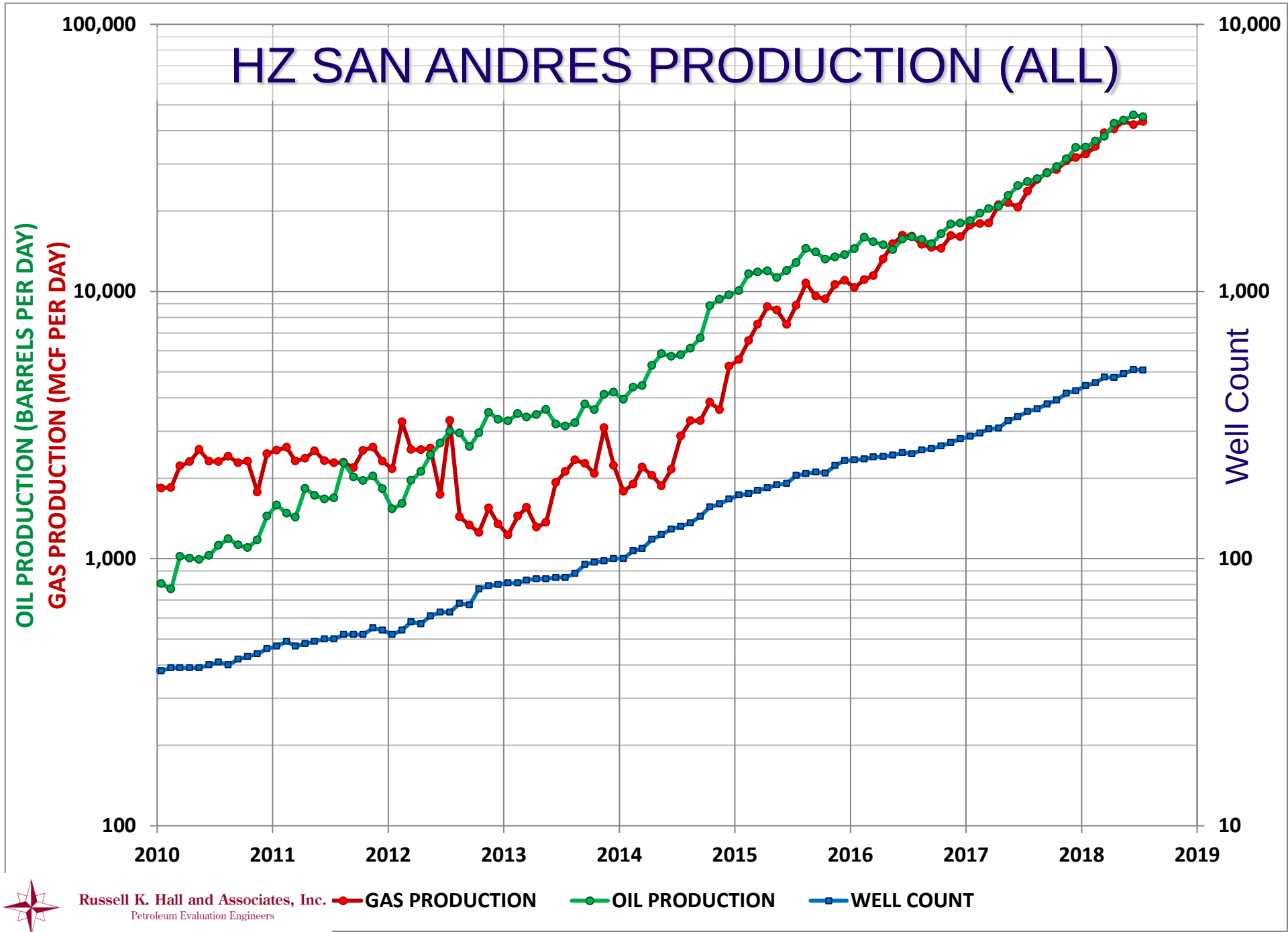
Petroleum Evaluation Engineers

PETRA 11/28/2018 3:18:11 PM



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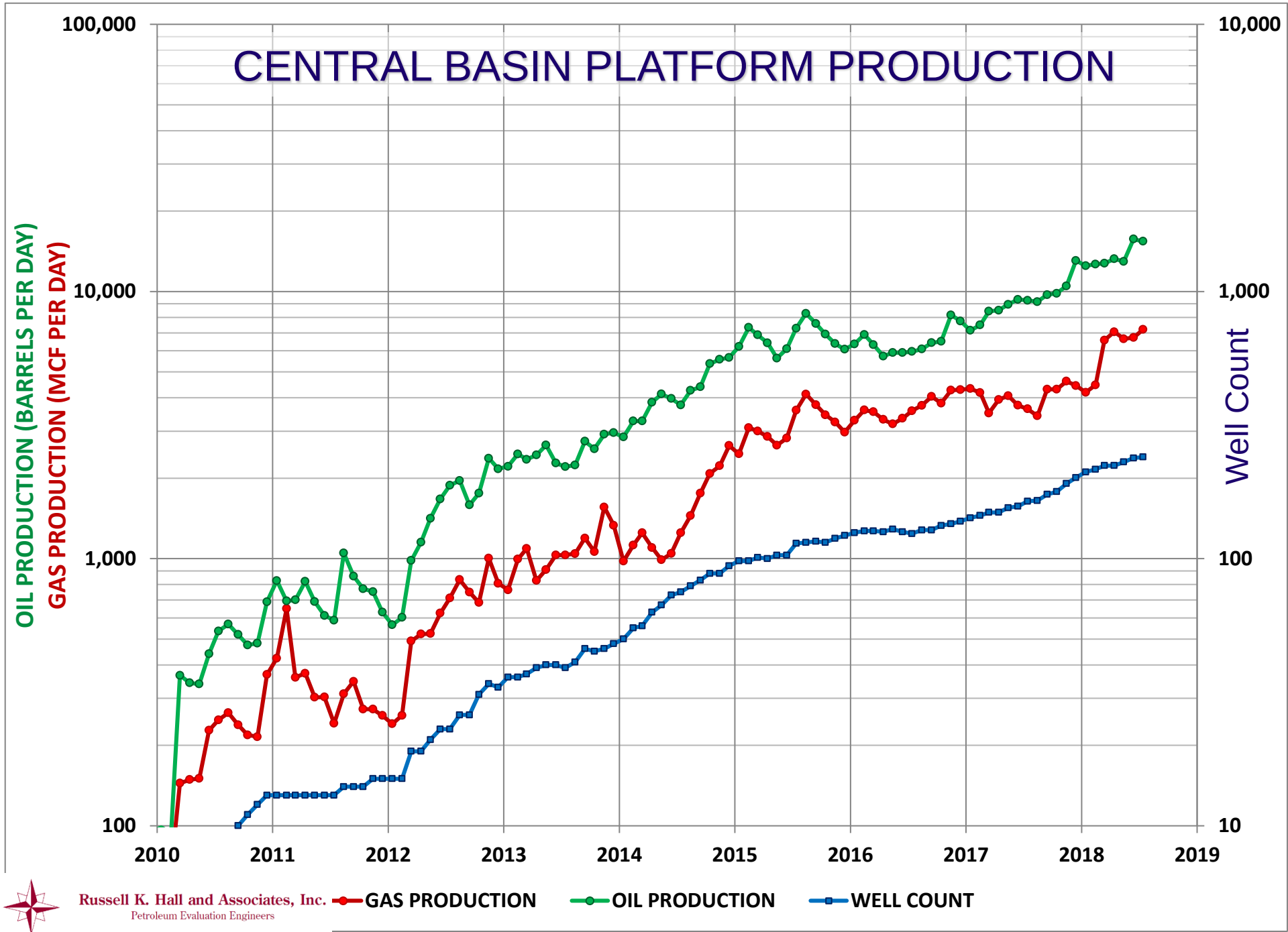

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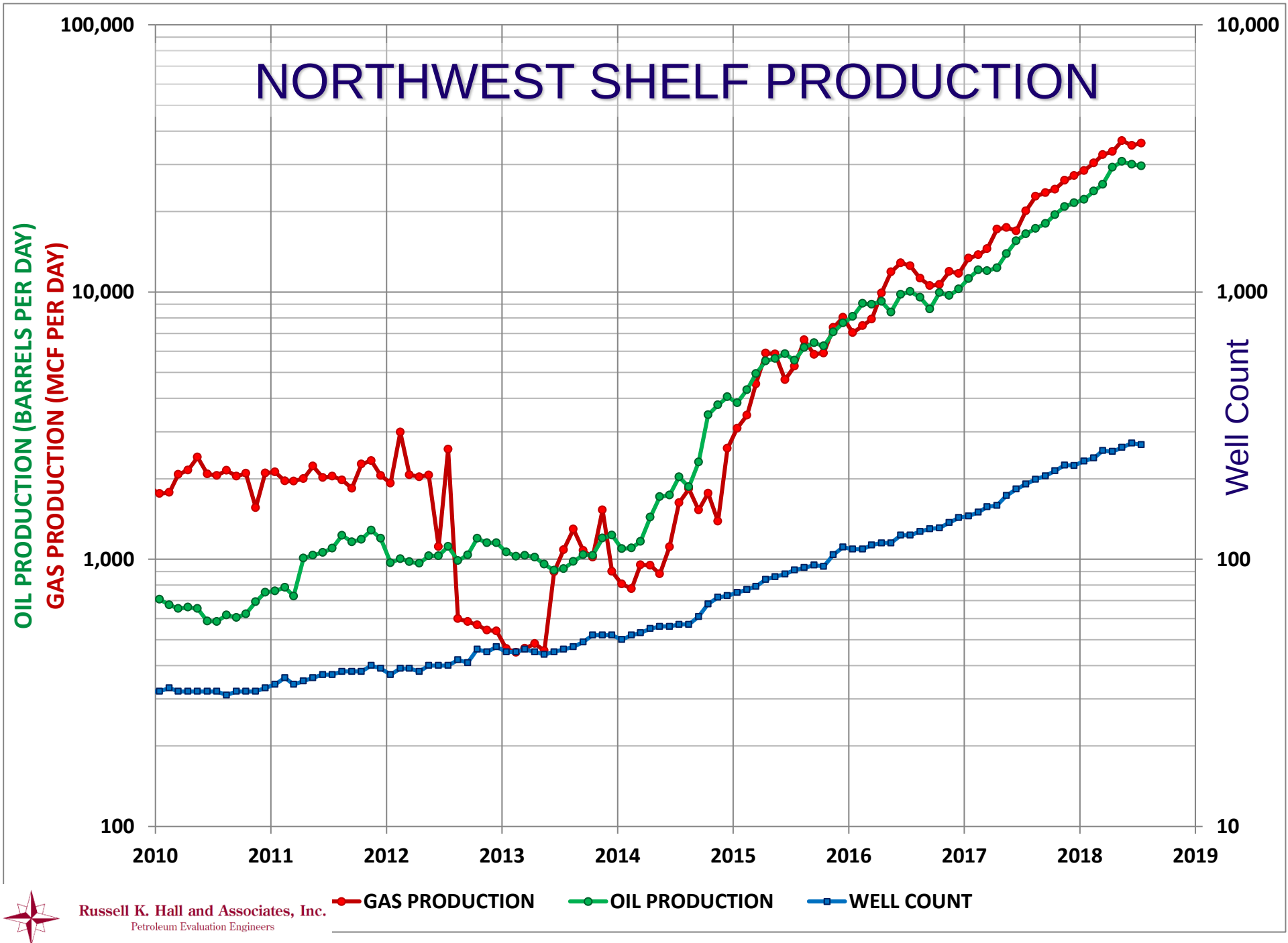
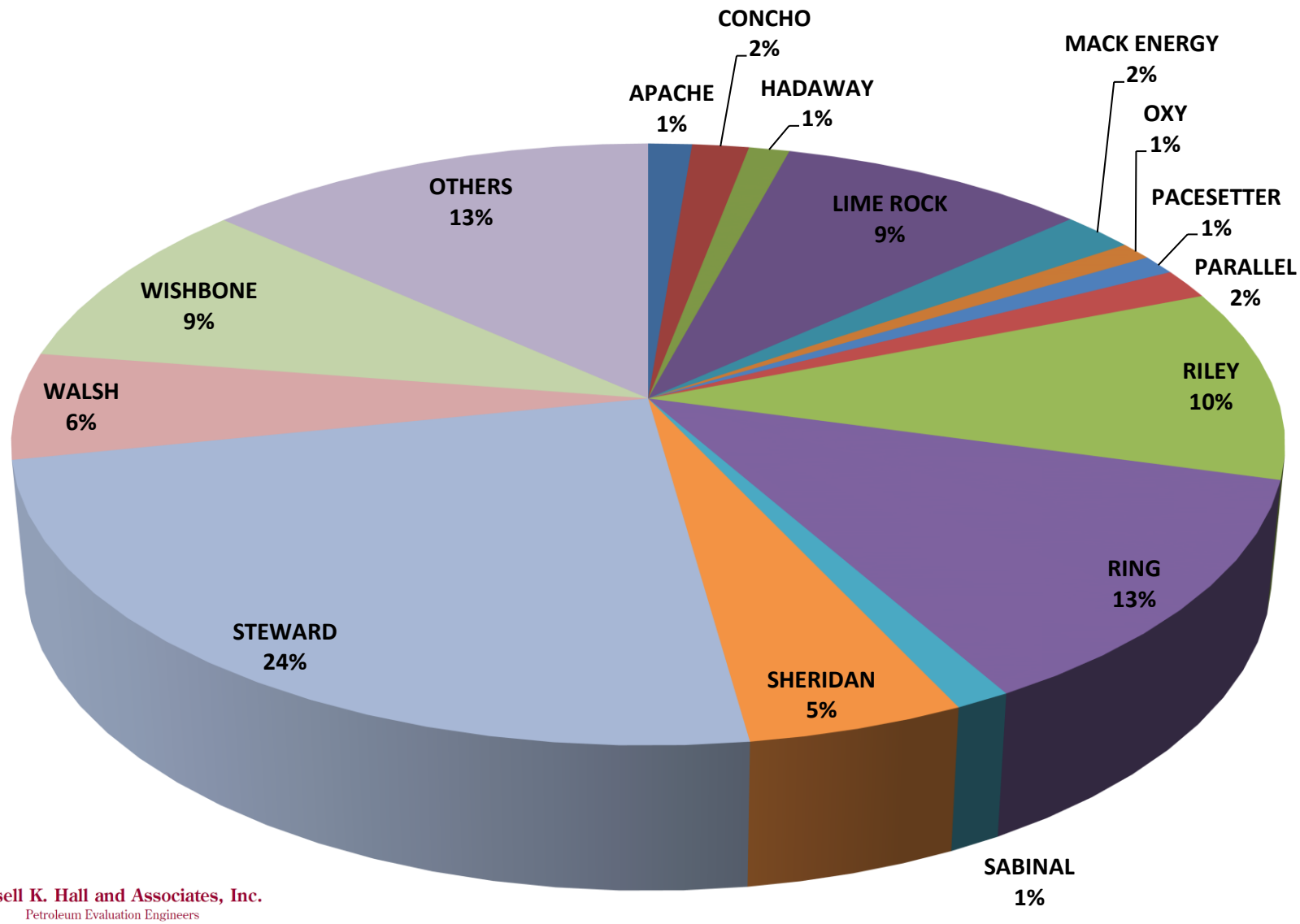
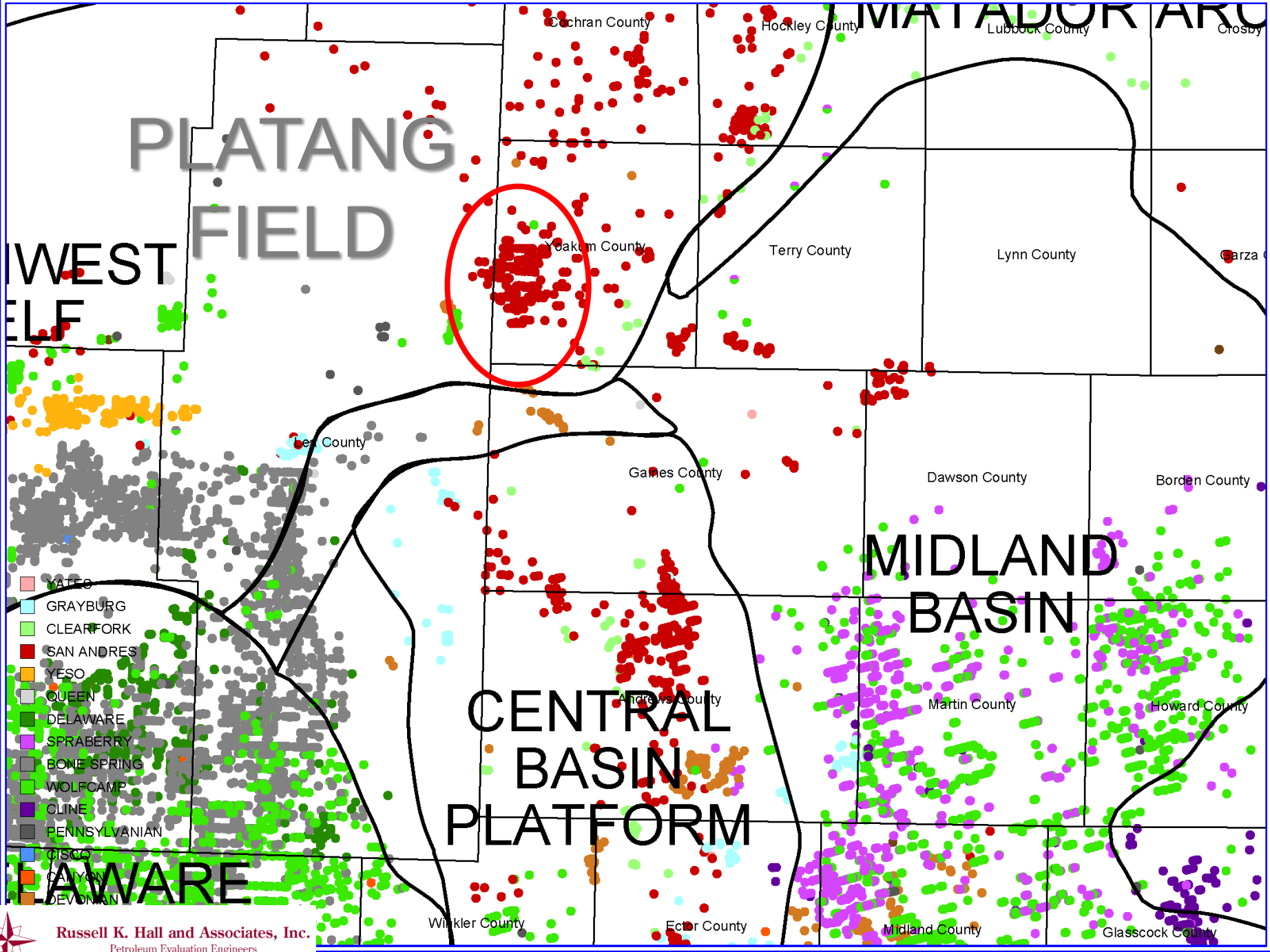
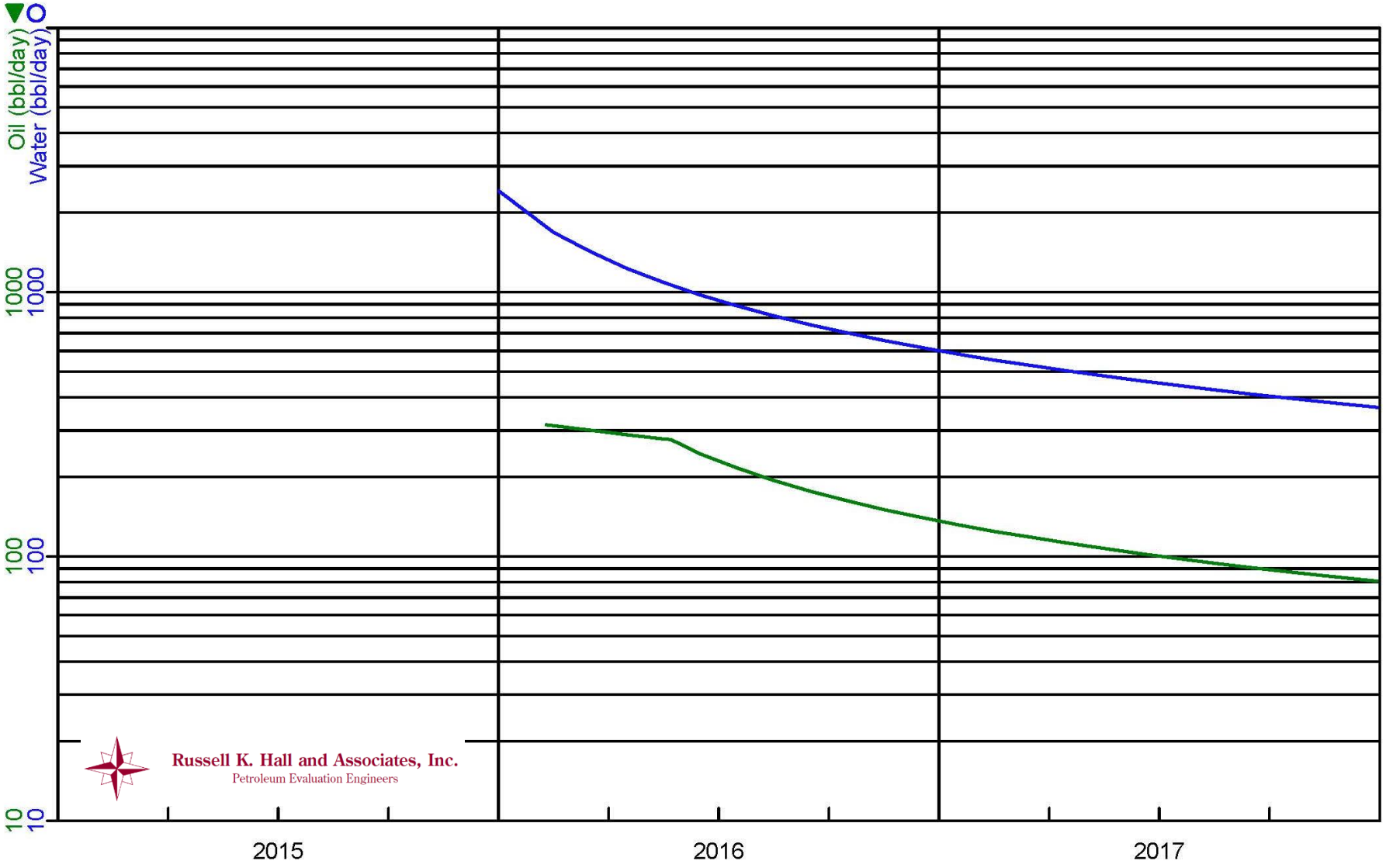

NORTHWEST SHELF PRODUCTION
OIL PRODUCTION (BARRELS PER DAY)
GAS PRODUCTION (MCF PER DAY)
Well Count
100,000
10,000
1,000
100
10,000
1,000
100
10
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
GAS PRODUCTION
OIL PRODUCTION
WELL COUNT
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers

HZ SAN ANDRES OPERATORS JULY '18 OIL PRODUCTION

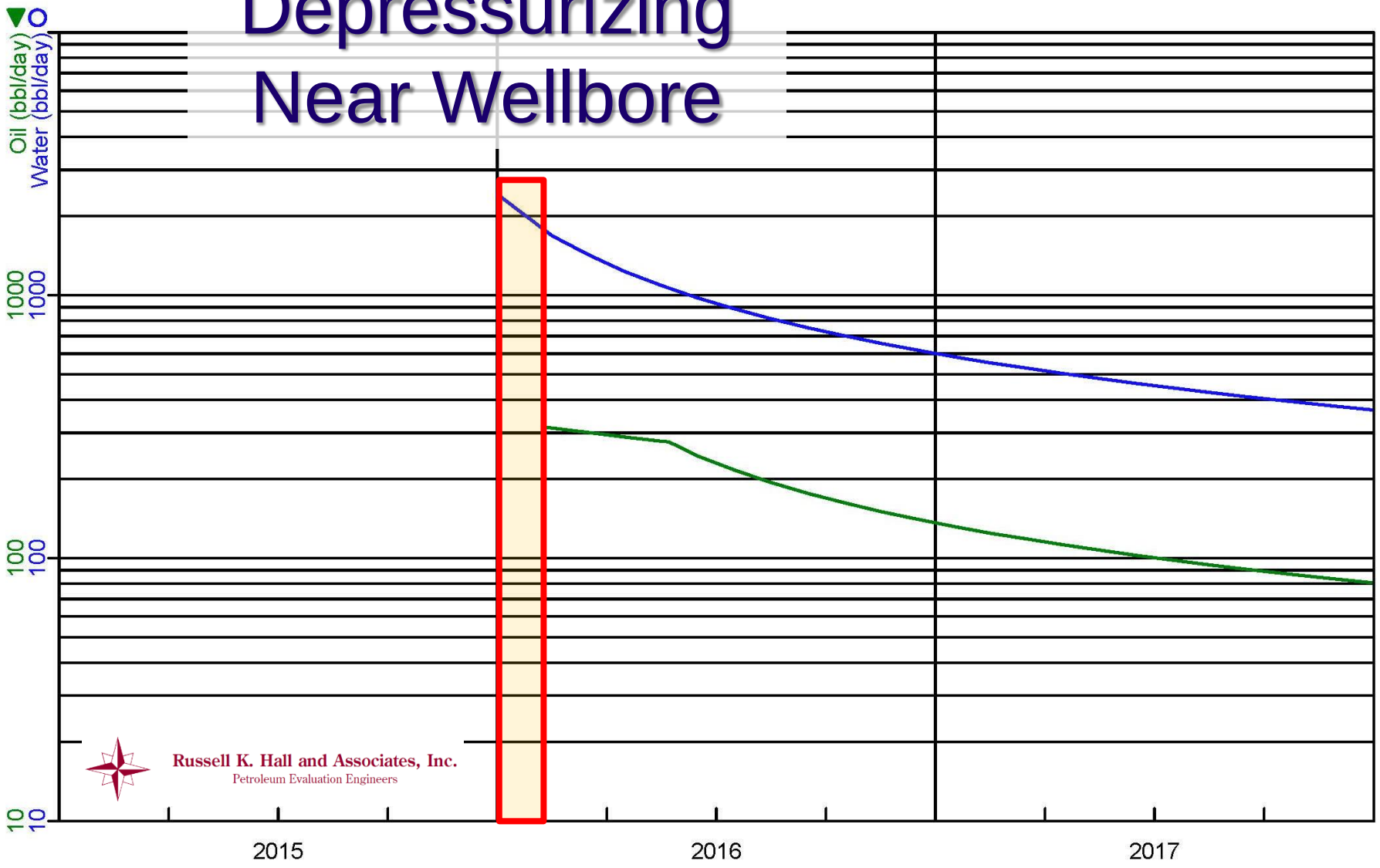



PLATANG FIELD
WEST
ELF
Cochran County
Hockley County
Lubbock County
Crosby
Yoakum County
Terry County
Lynn County
Garza
Lea County
Gaines County
Dawson County
Borden County
MIDLAND BASIN
CENTRAL BASIN PLATFORM
Andrews County
Martin County
Howard County
Winkler County
Ector County
Midland County
Glasscock County
LAWARE
YATES
GRAYBURG
CLEARFORK
SAN ANDRES
YESO
QUEEN
DELAWARE
SPRABERRY
BONE SPRING
WOLFCAMP
CLINE
PENNSYLVANIAN
CISCO
CANYON
DEVONIAN

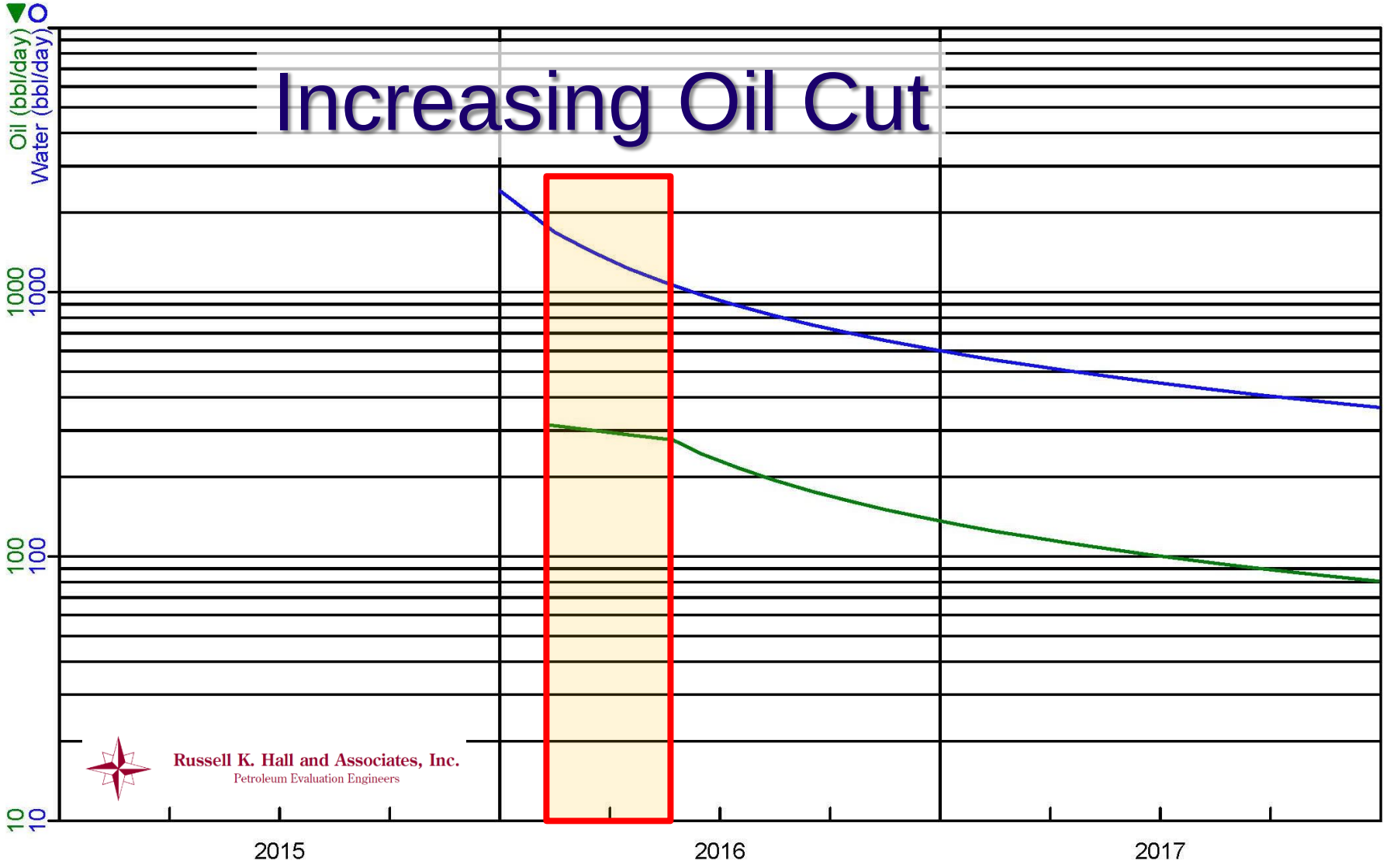
Typical Well Performance (1)



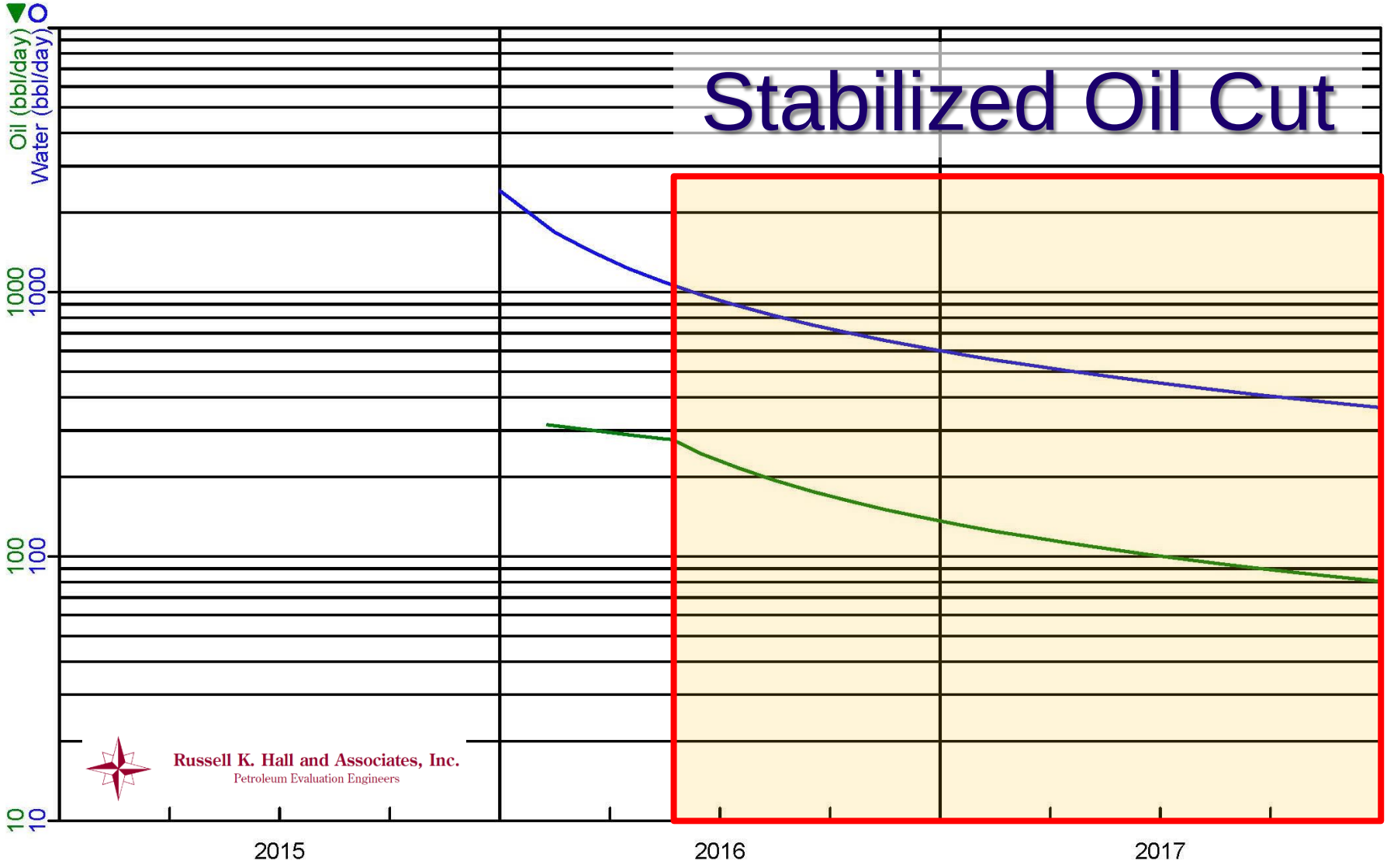
Typical Well Performance (2)

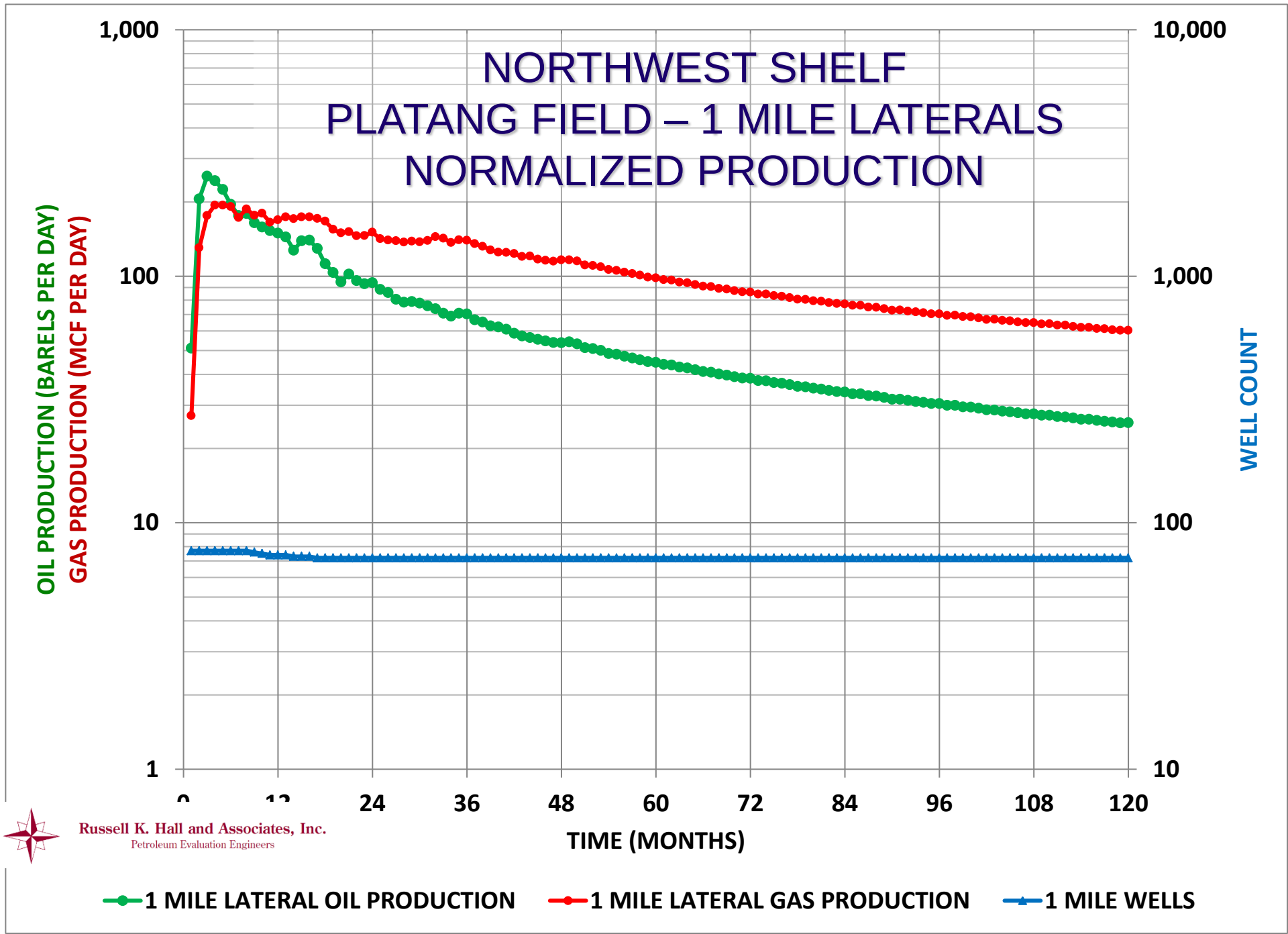


Typical Well Performance (3)

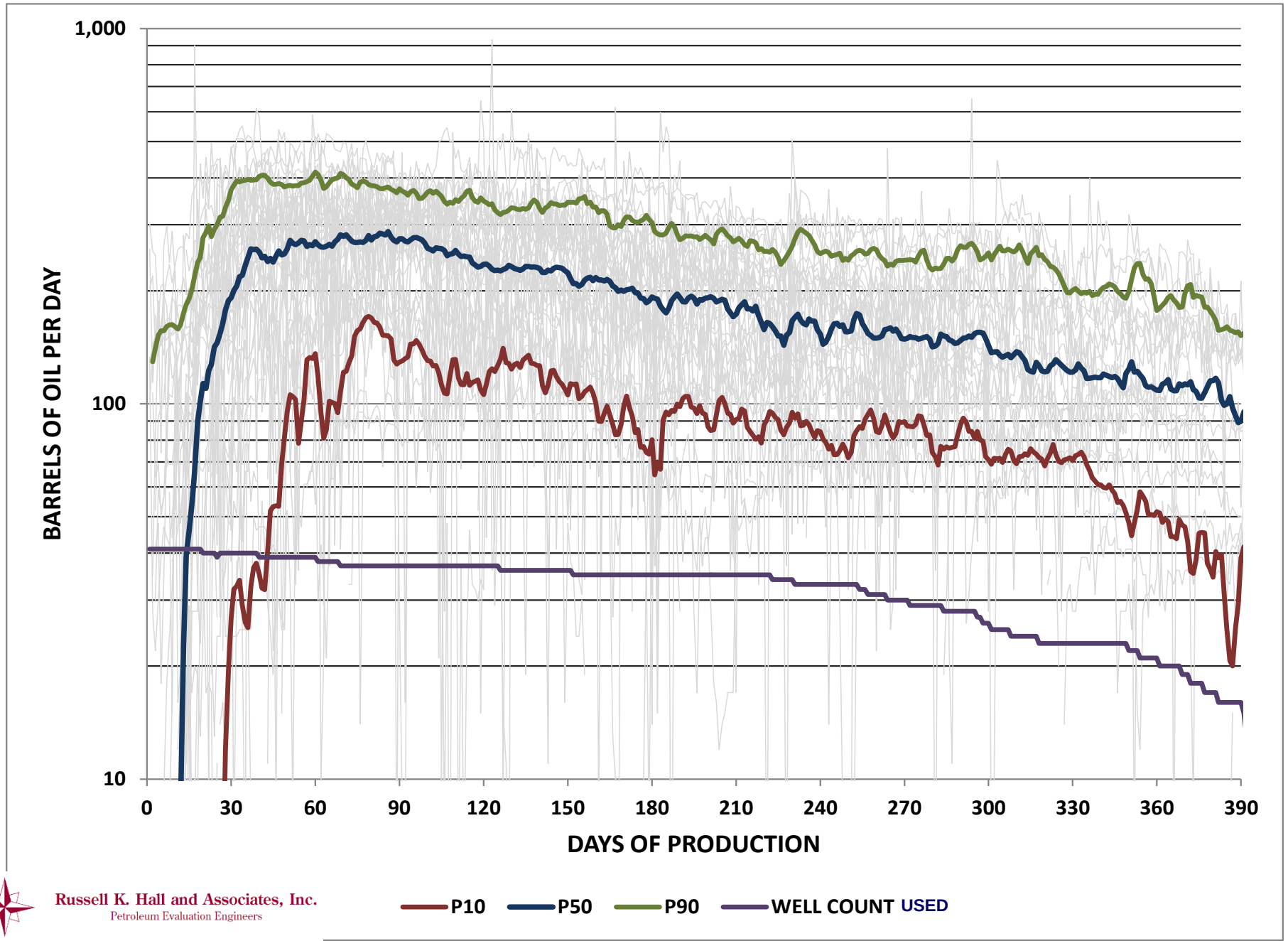


Typical Well Performance (4)

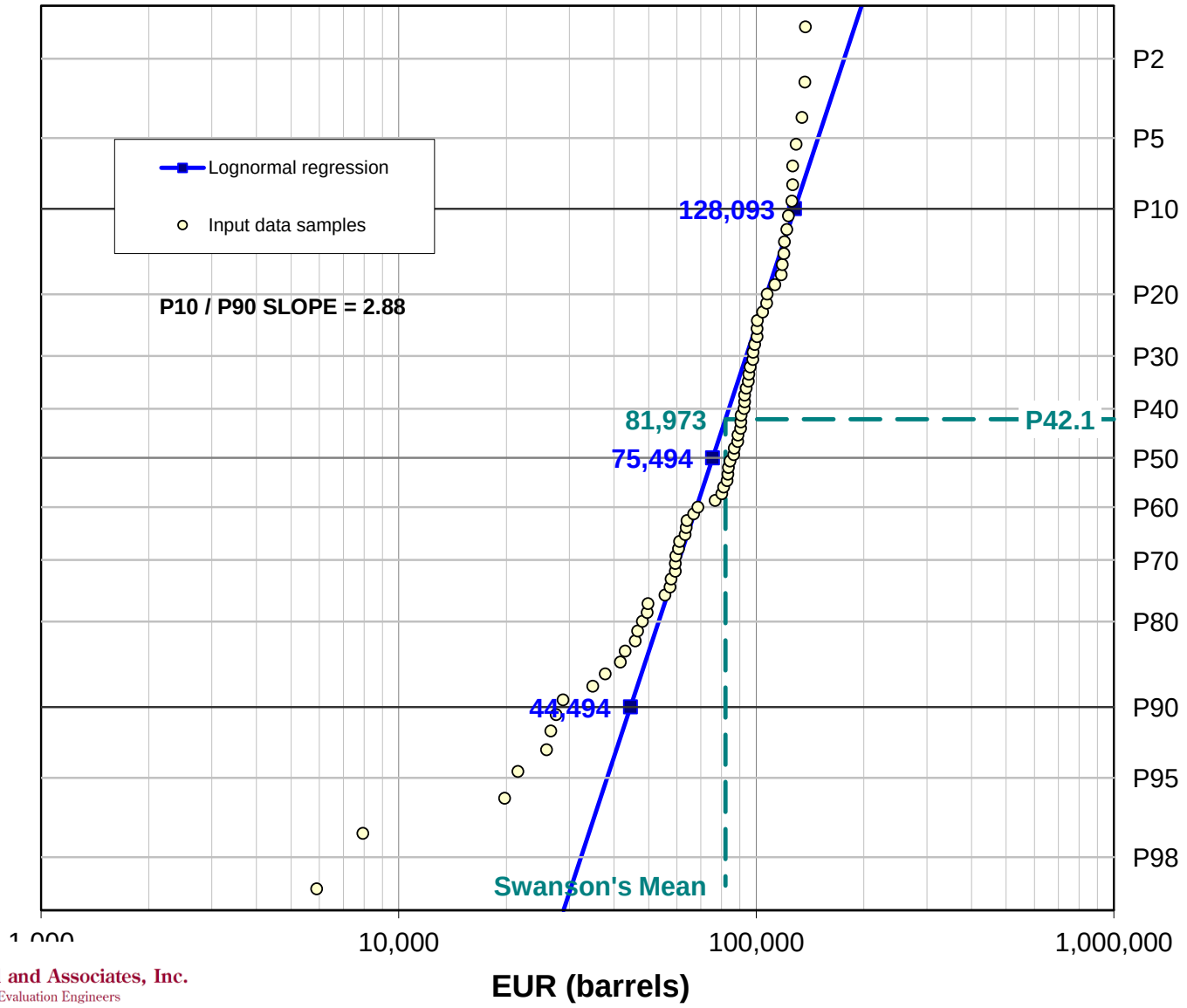



NORTHWEST SHELF
PLATANG FIELD – 1 MILE LATERALS
NORMALIZED PRODUCTION
1,000
100
10
1
10,000
1,000
100
10
OIL PRODUCTION (BARELS PER DAY)
GAS PRODUCTION (MCF PER DAY)
WELL COUNT
0
12
24
36
48
60
72
84
96
108
120
TIME (MONTHS)
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers
1 MILE LATERAL OIL PRODUCTION
1 MILE LATERAL GAS PRODUCTION
1 MILE WELLS

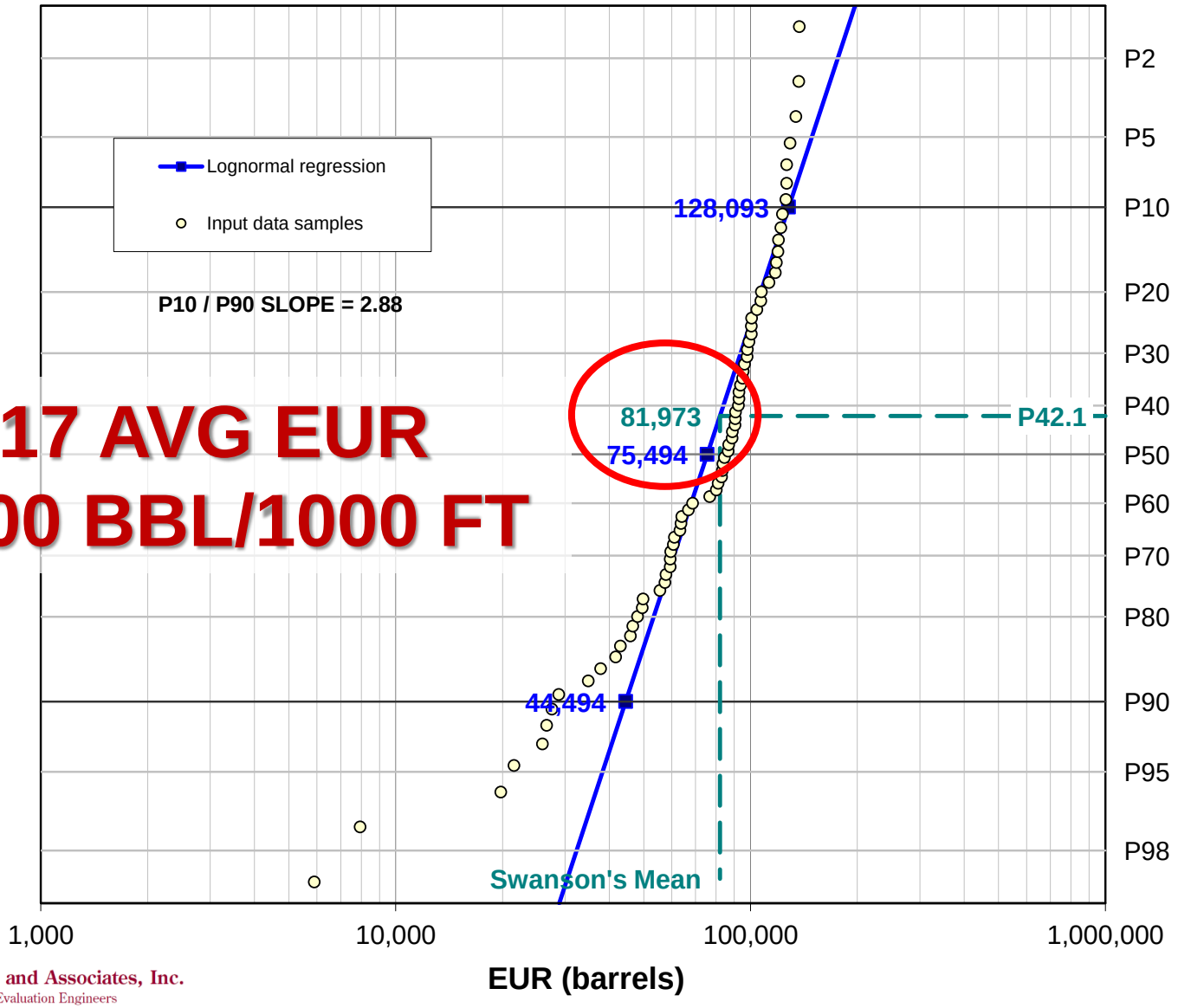
Oil Performance



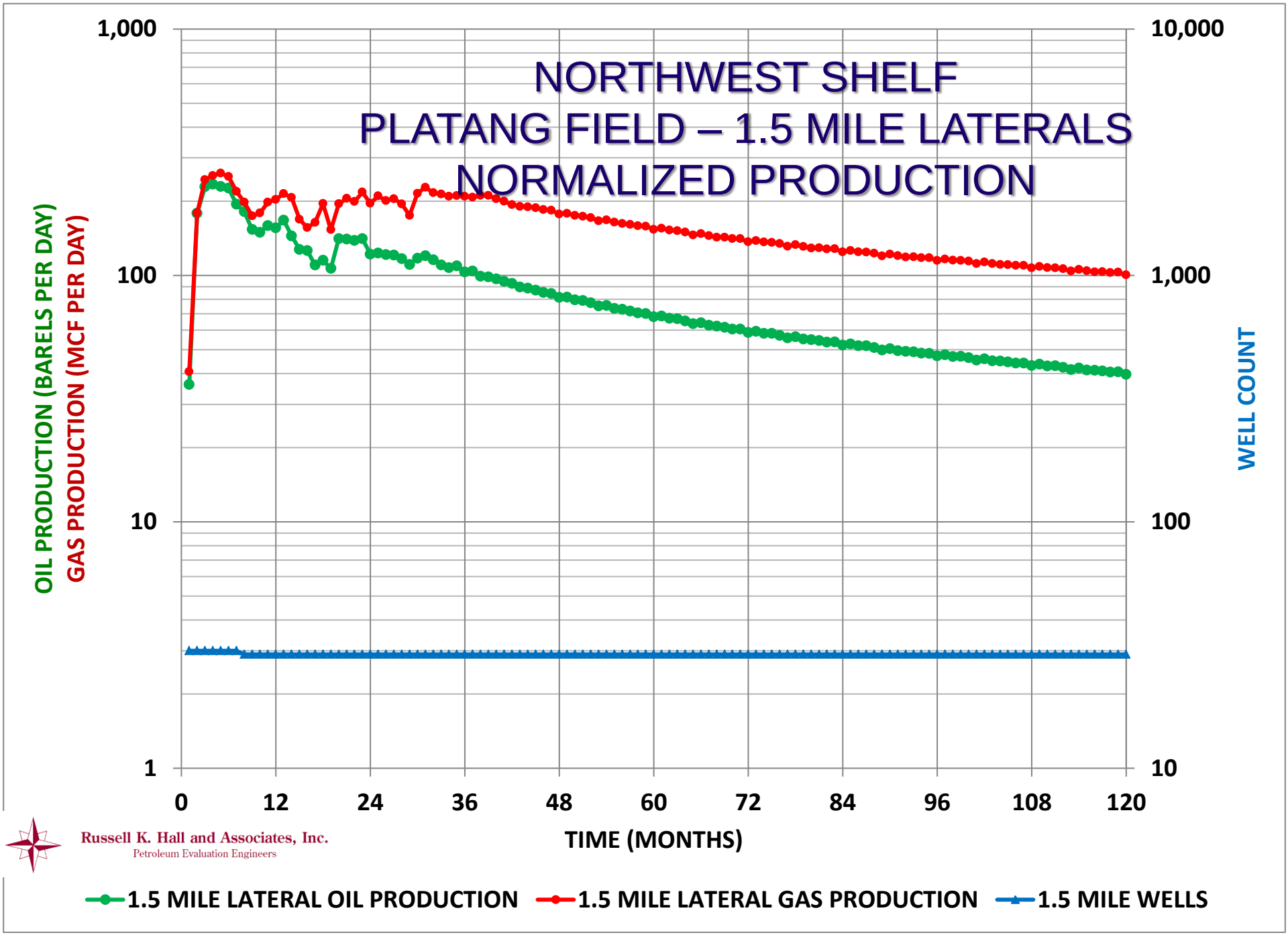
Oil Performance/1000' Lateral Length
Platang Field – Using 1-Mile Laterals

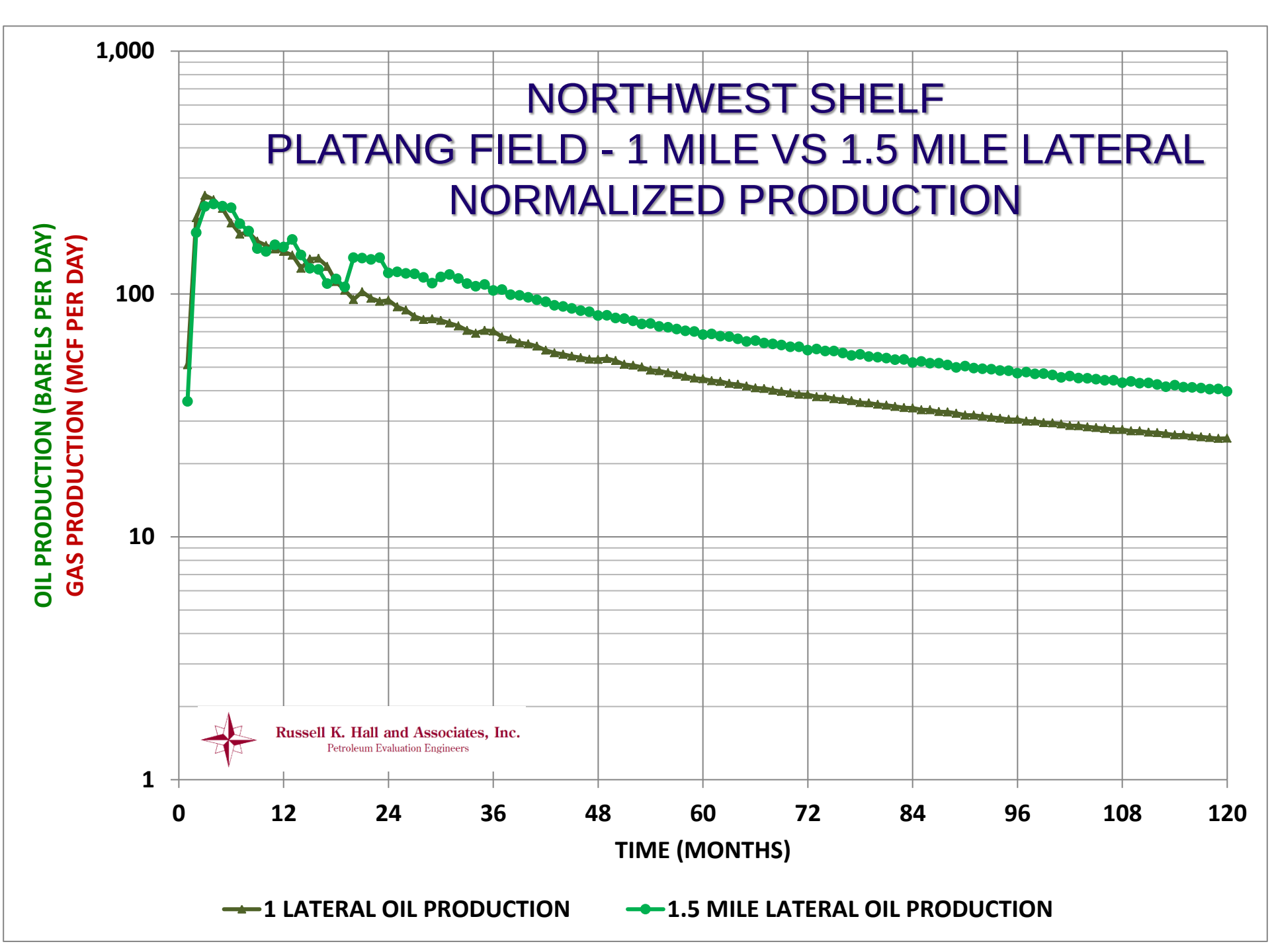


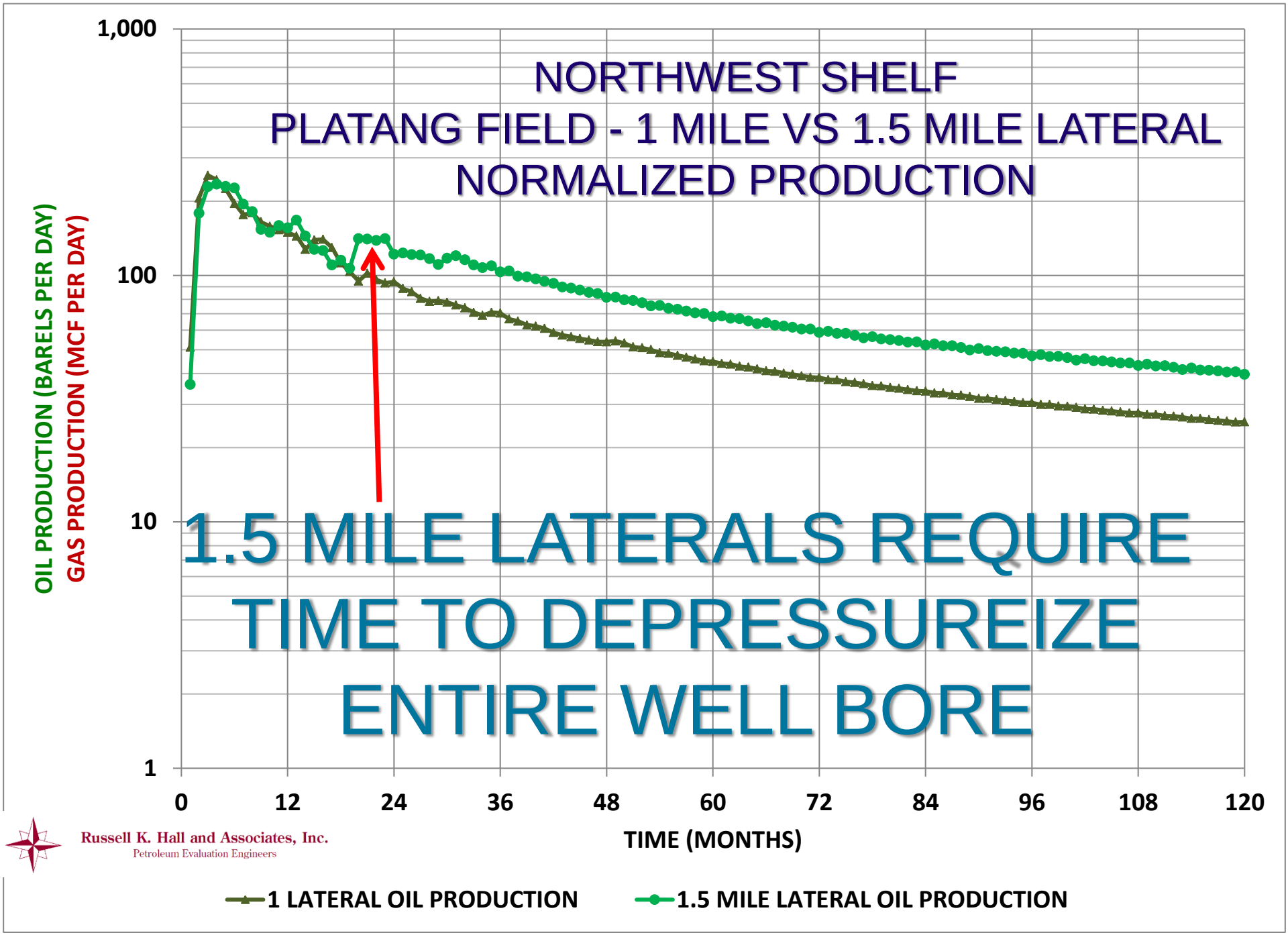
Oil Performance/1000' Lateral Length
Platang Field – Using 1-Mile Laterals

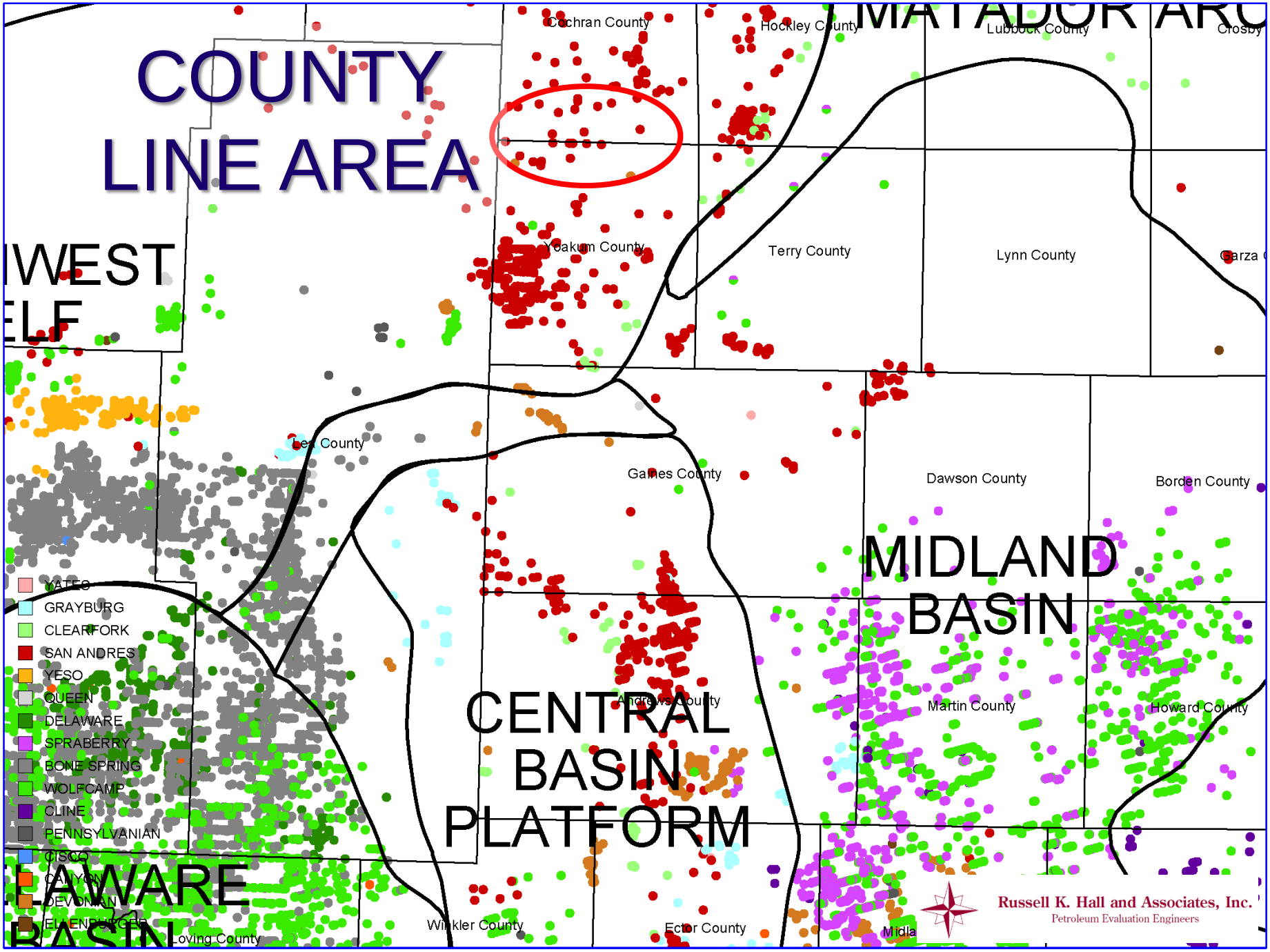


2017 AVG EUR
67,900 BBL/1000 FT


NORTHWEST SHELF
PLATANG FIELD – 1.5 MILE LATERALS
NORMALIZED PRODUCTION
OIL PRODUCTION (BARELS PER DAY)
GAS PRODUCTION (MCF PER DAY)
WELL COUNT
1,000
100
10
1
10,000
1,000
100
10
0
12
24
36
48
60
72
84
96
108
120
TIME (MONTHS)
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers
1.5 MILE LATERAL OIL PRODUCTION
1.5 MILE LATERAL GAS PRODUCTION
1.5 MILE WELLS


NORTHWEST SHELF
PLATANG FIELD - 1 MILE VS 1.5 MILE LATERAL
NORMALIZED PRODUCTION
OIL PRODUCTION (BARELS PER DAY)
GAS PRODUCTION (MCF PER DAY)
1,000
100
10
1
0
12
24
36
48
60
72
84
96
108
120
TIME (MONTHS)
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers
1 LATERAL OIL PRODUCTION
1.5 MILE LATERAL OIL PRODUCTION


NORTHWEST SHELF
PLATANG FIELD - 1 MILE VS 1.5 MILE LATERAL
NORMALIZED PRODUCTION
1.5 MILE LATERALS REQUIRE TIME TO DEPRESSUREIZE ENTIRE WELL BORE
OIL PRODUCTION (BARELS PER DAY)
GAS PRODUCTION (MCF PER DAY)
1,000
100
10
1
0
12
24
36
48
60
72
84
96
108
120
TIME (MONTHS)
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers
1 LATERAL OIL PRODUCTION
1.5 MILE LATERAL OIL PRODUCTION



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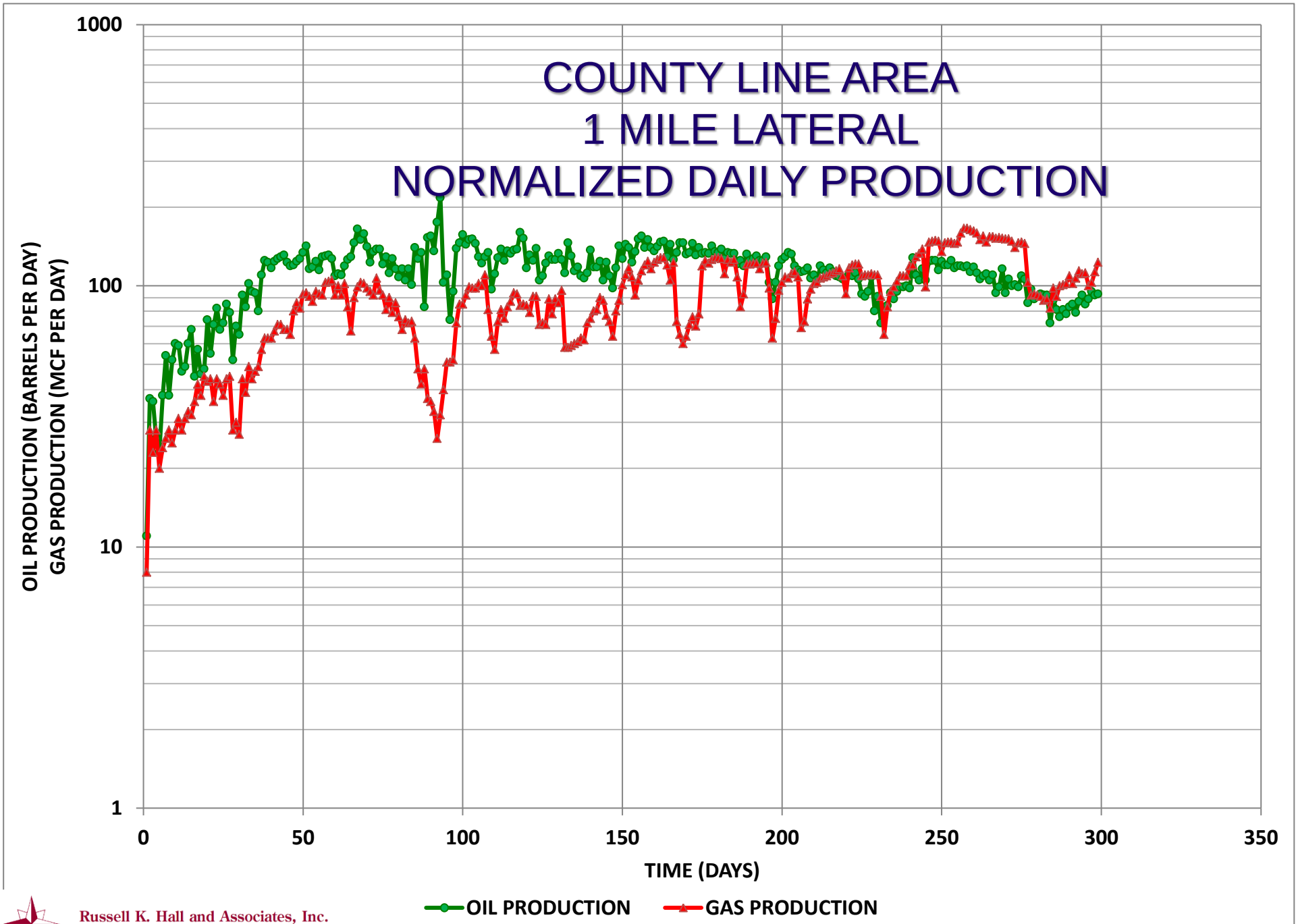
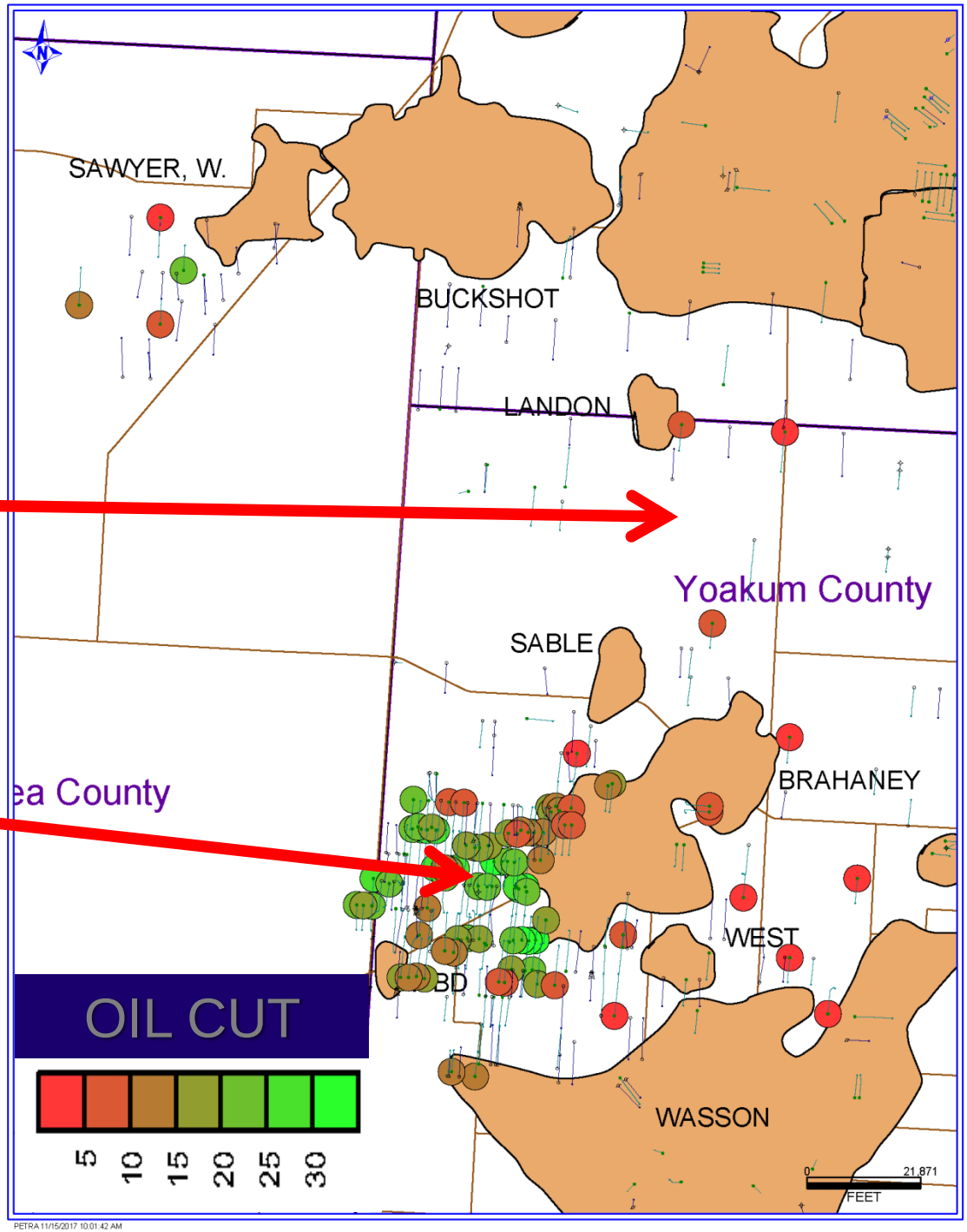

COUNTY LINE AREA
1 MILE LATERAL
NORMALIZED DAILY PRODUCTION
OIL PRODUCTION (BARRELS PER DAY)
GAS PRODUCTION (MCF PER DAY)
1000
100
10
1
0
50
100
150
200
250
300
350
TIME (DAYS)
OIL PRODUCTION
GAS PRODUCTION

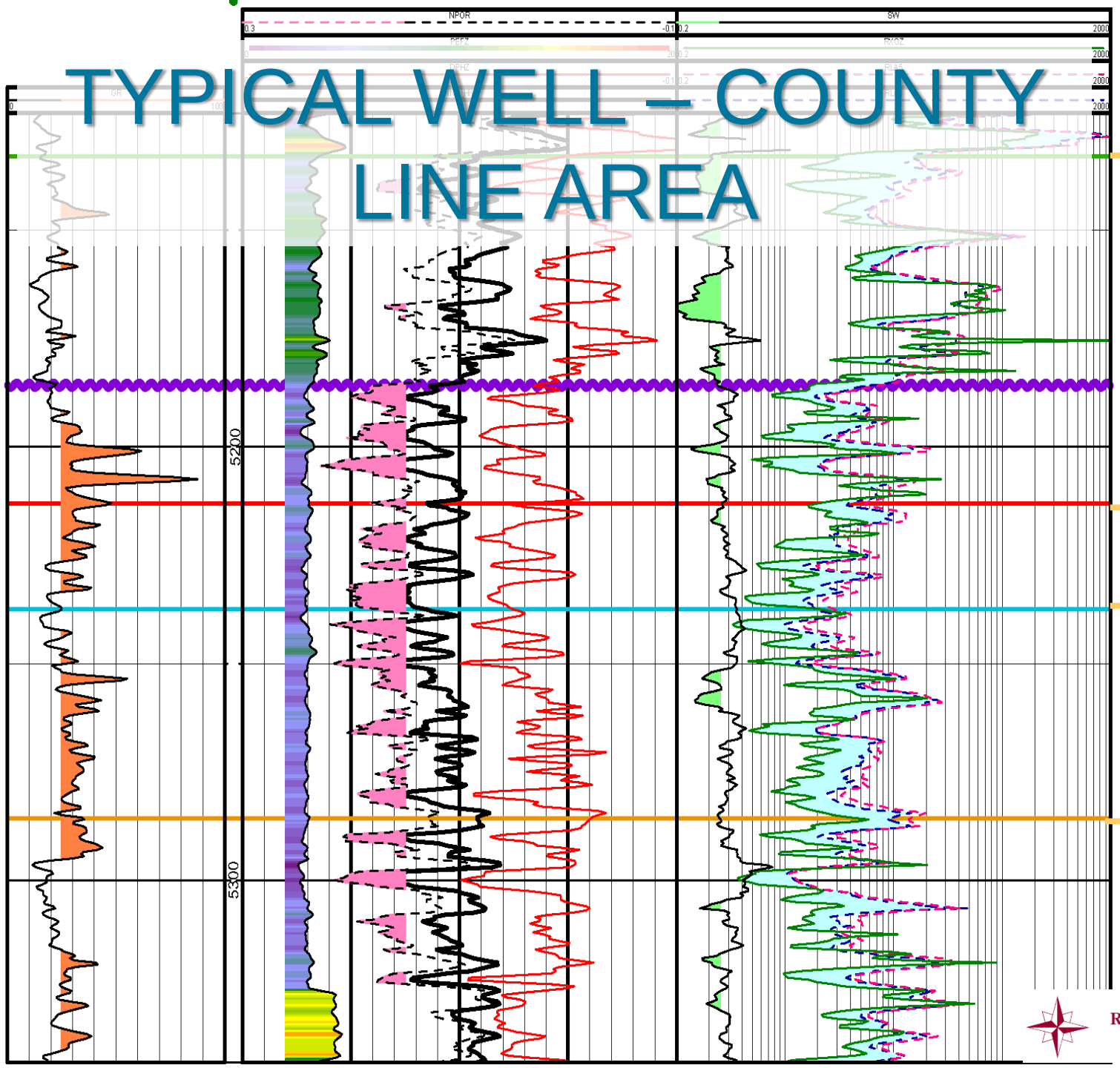
HZ San Andres Performance

5% to 10% Oil Cut

10% to 30% Oil Cut



TYPICAL WELL – COUNTY LINE AREA

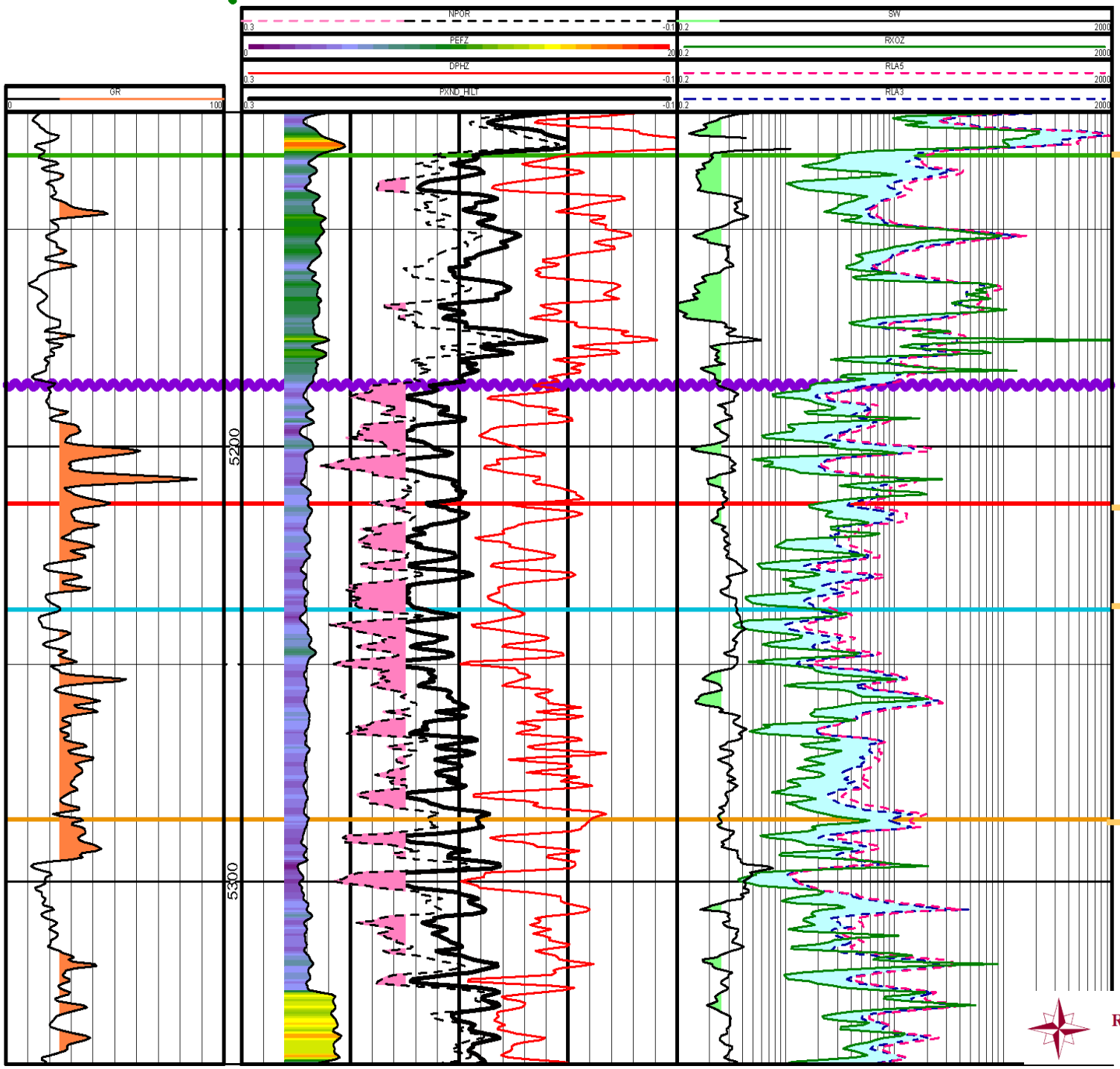


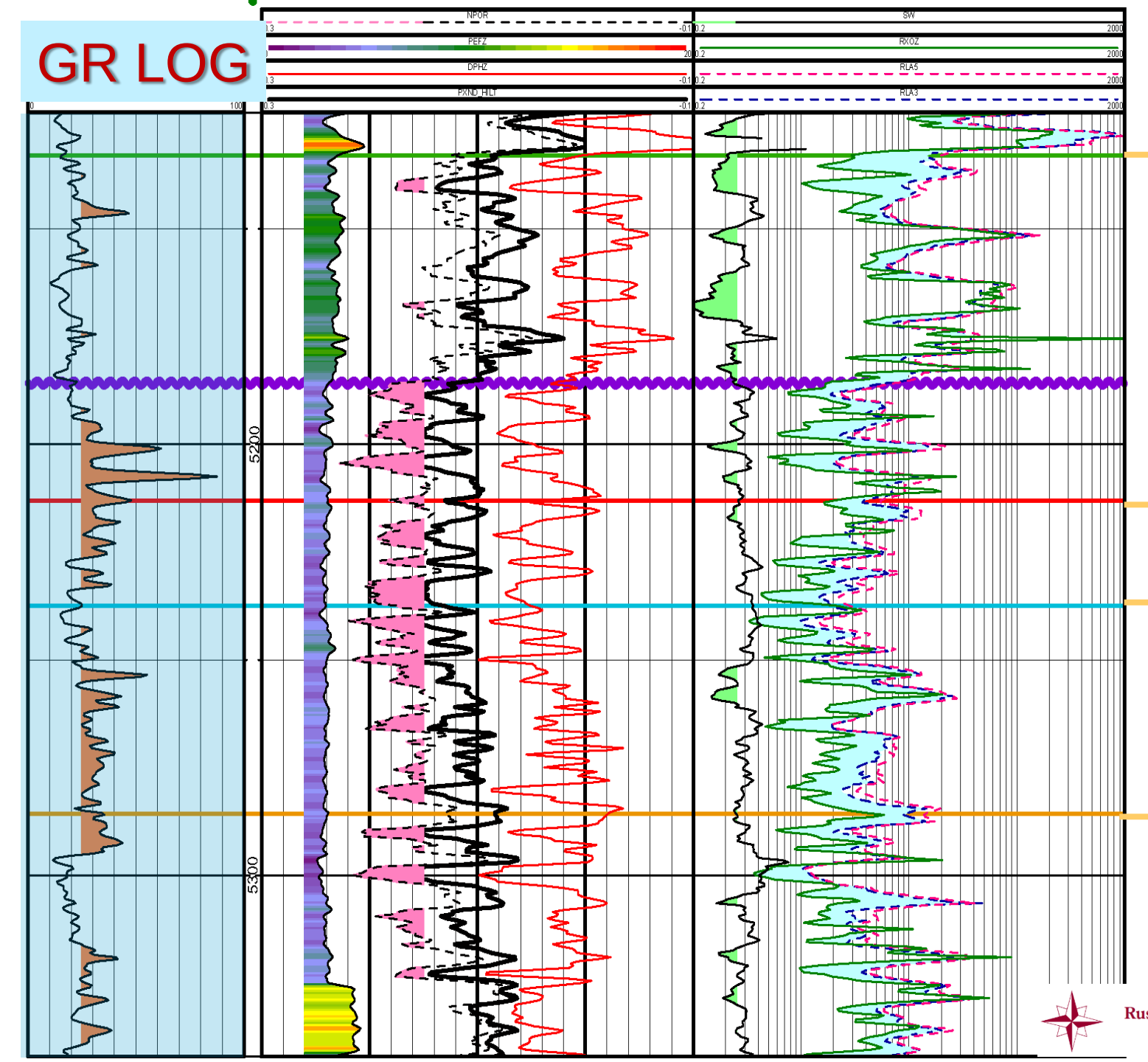
SA P1

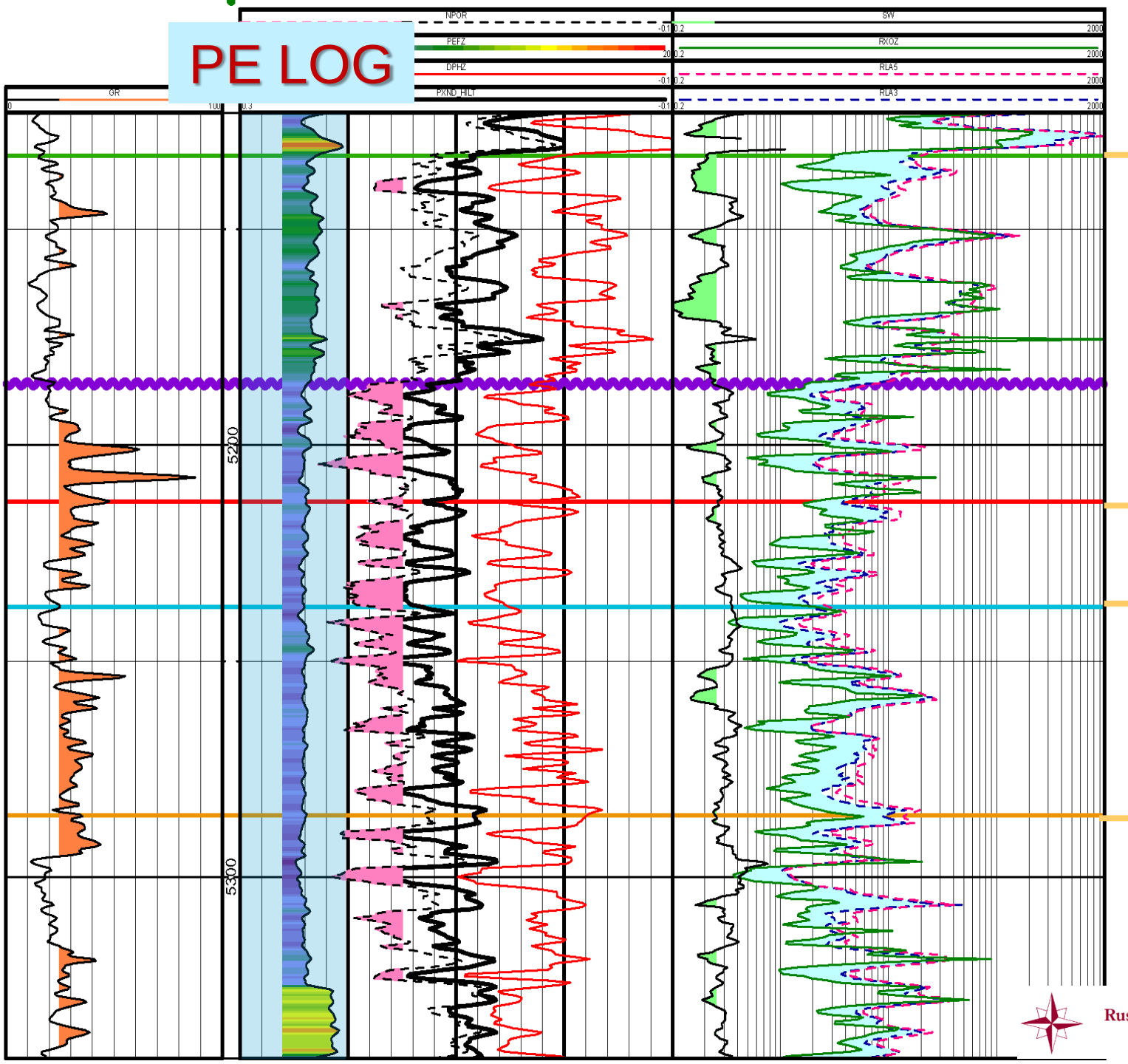
SA P2

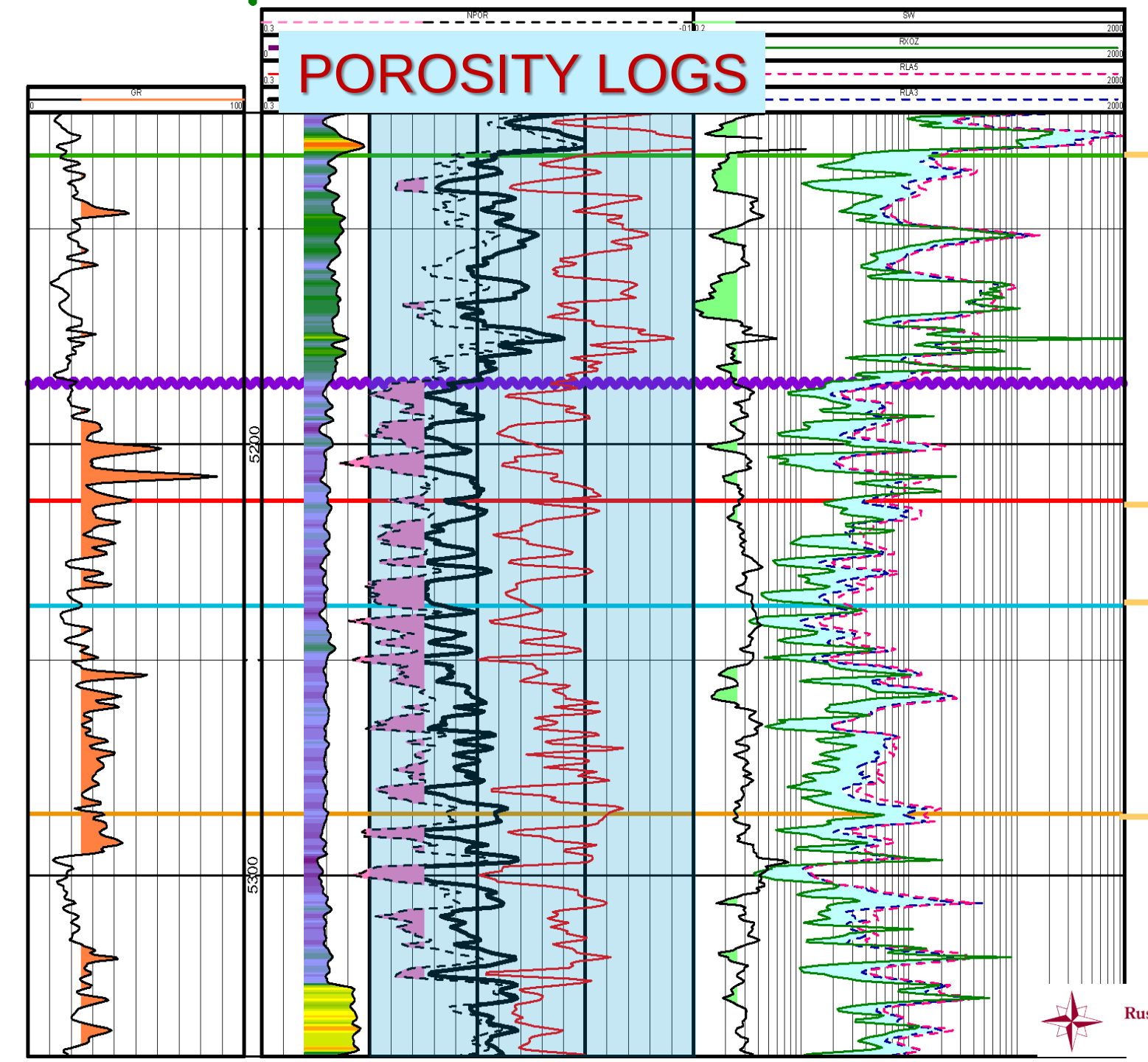
SA P3

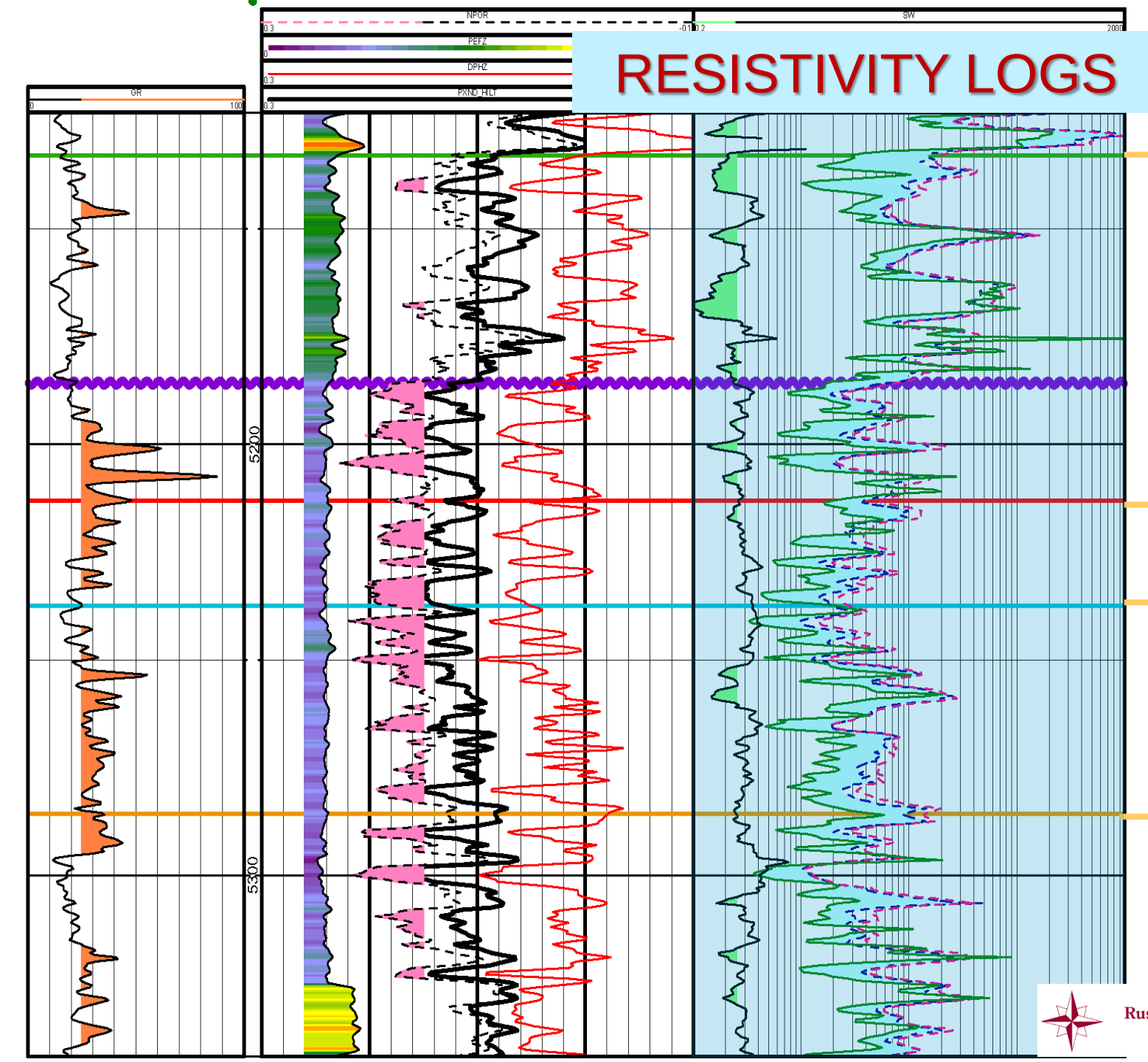
SA P4


NPOR
PEFZ
DPHZ
PXND_HILT
SW
RXOZ
RLA5
RLA3
GR
5200
5300
SA P1
SA P2
SA P3
SA P4


GR LOG
NPOR
PEFZ
DPHZ
PXND_HILT
SW
RXOZ
RLA5
RLA3
5200
5300
SA P1
SA P2
SA P3
SA P4


PE LOG
NPOR
PEFZ
DPHZ
PXND_HILT
SW
RXOZ
RLA5
RLA3
GR
5200
5300
SA P1
SA P2
SA P3
SA P4


POROSITY LOGS
GR
NPOR
SW
RXOZ
RLA5
RLA3
5200
5300
SA P1
SA P2
SA P3
SA P4



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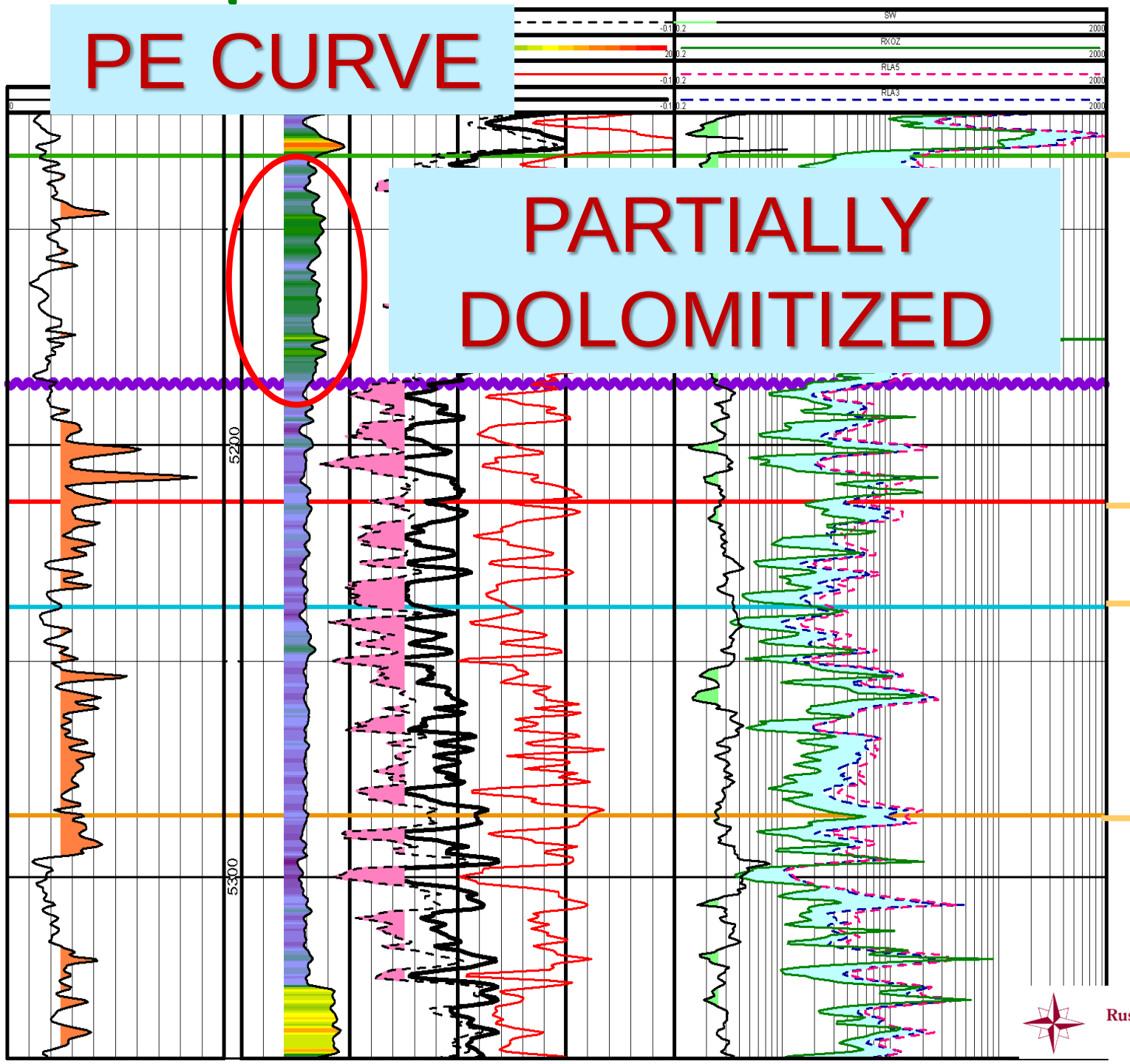
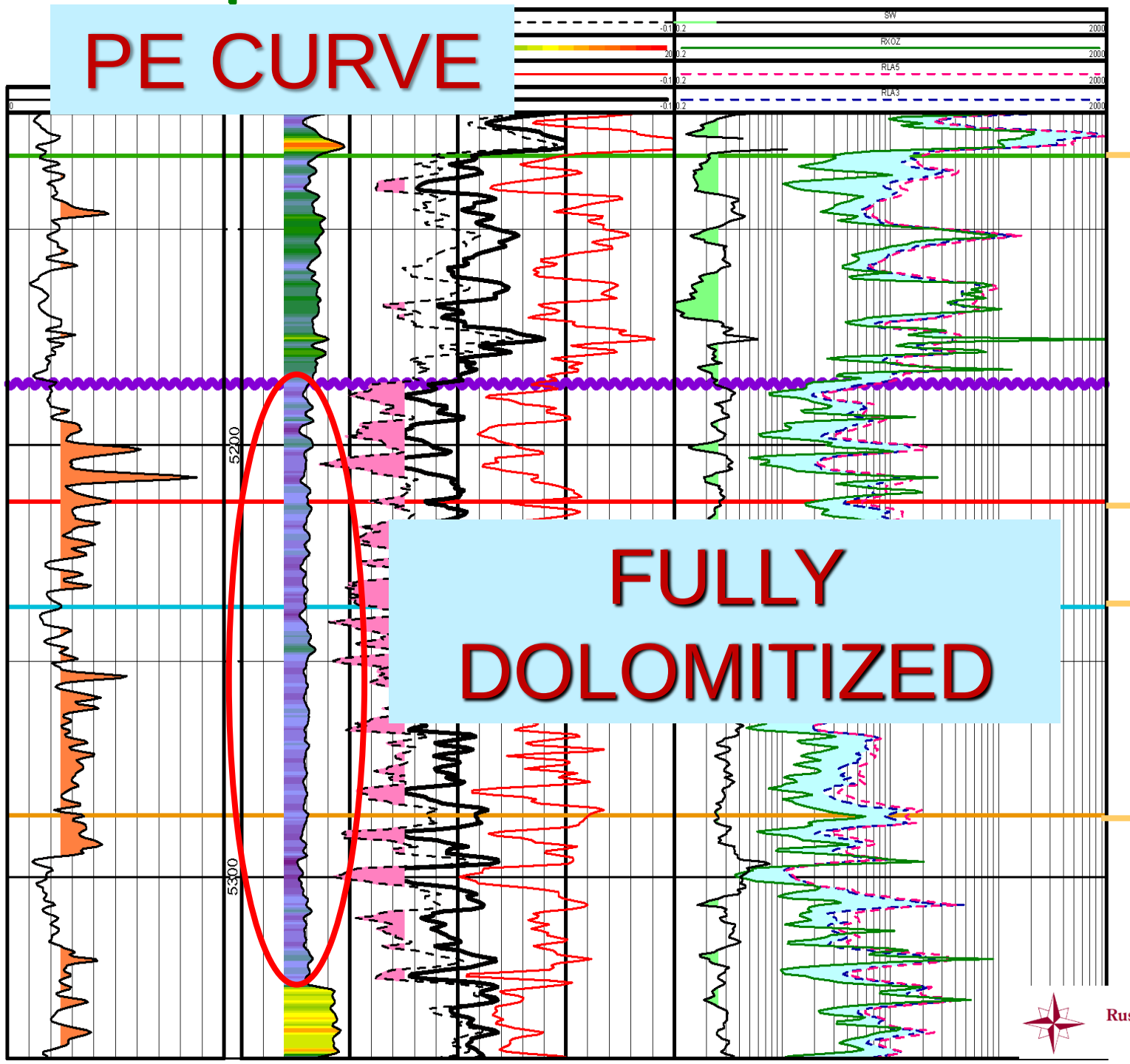
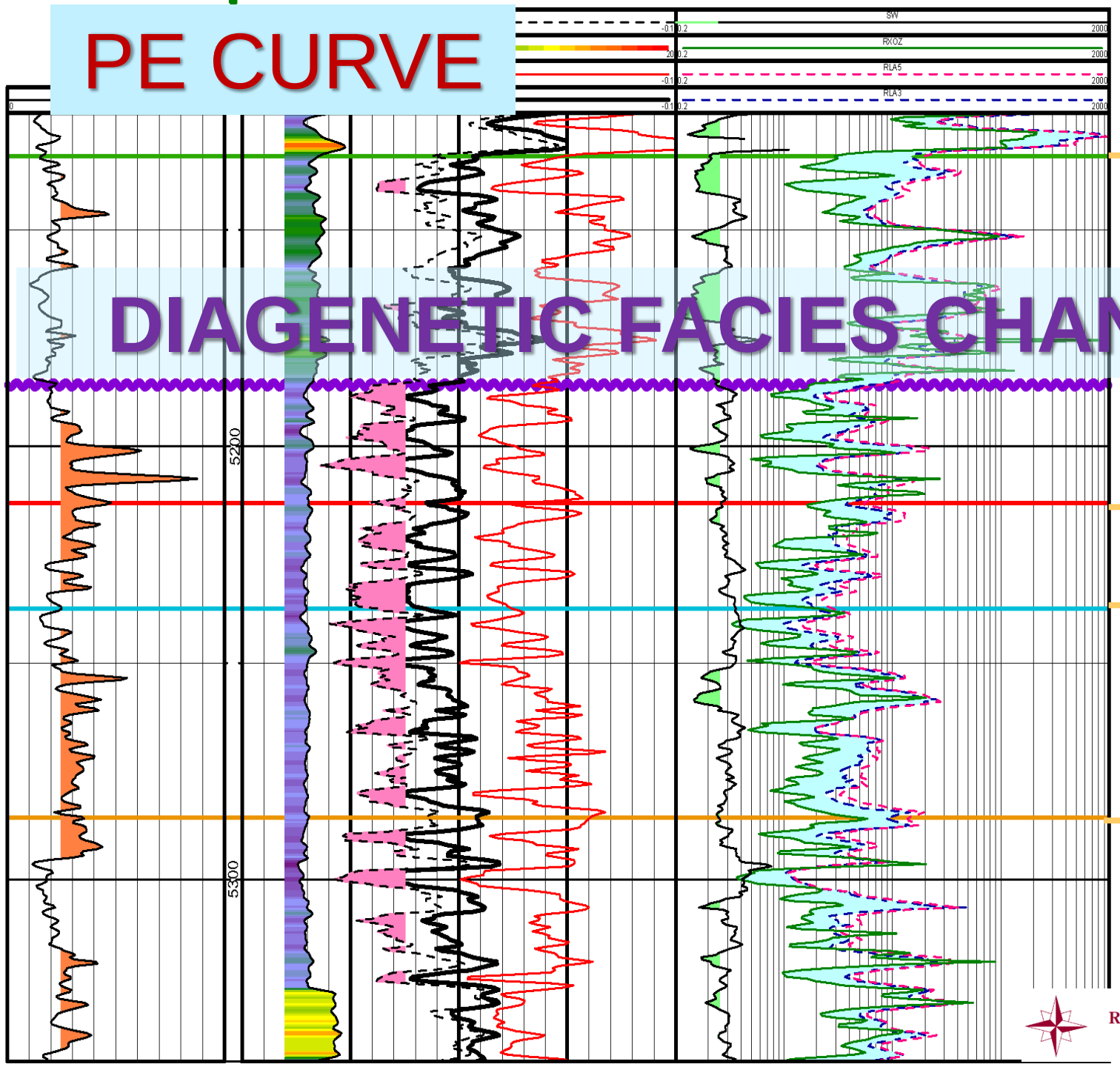
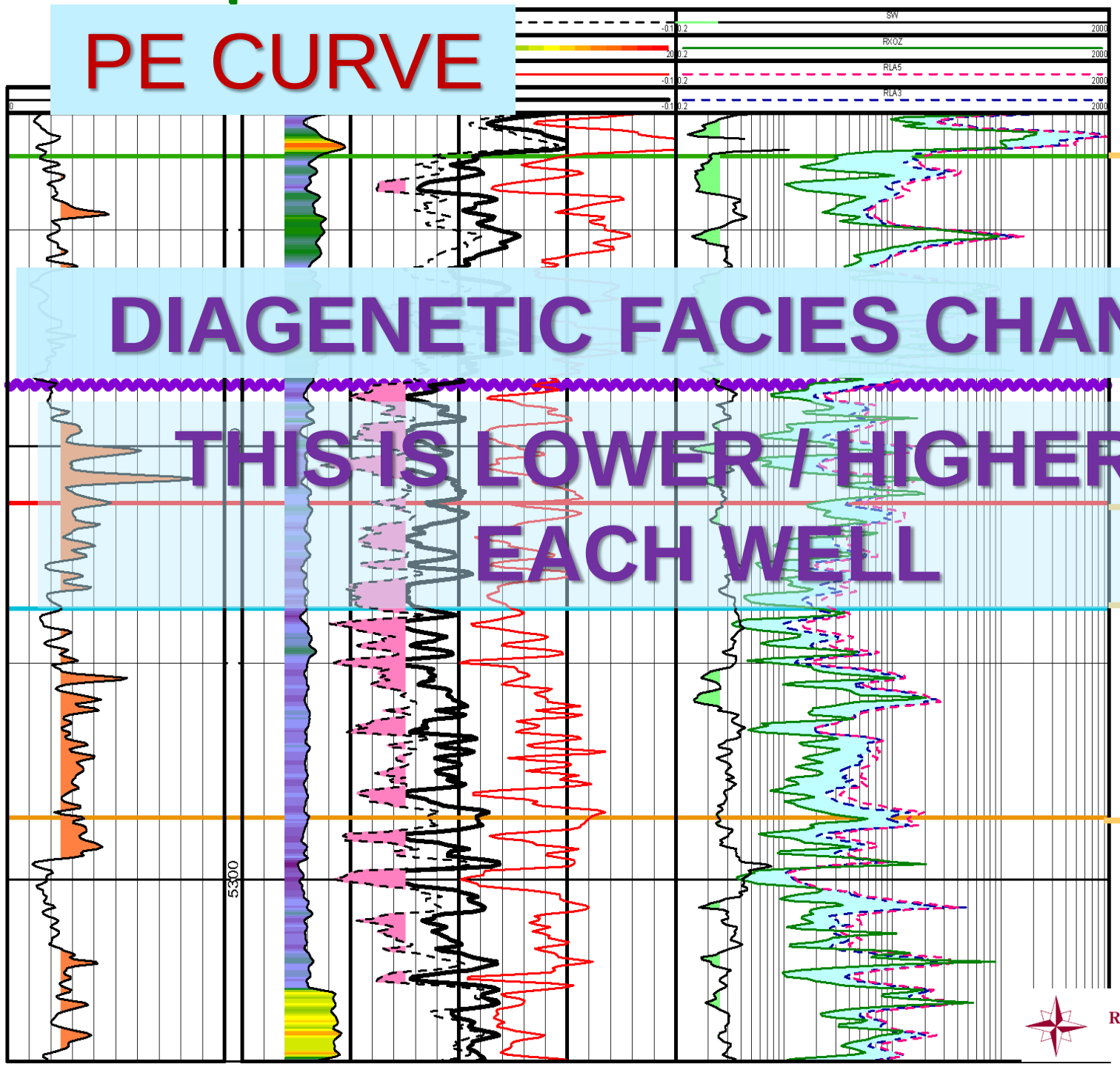
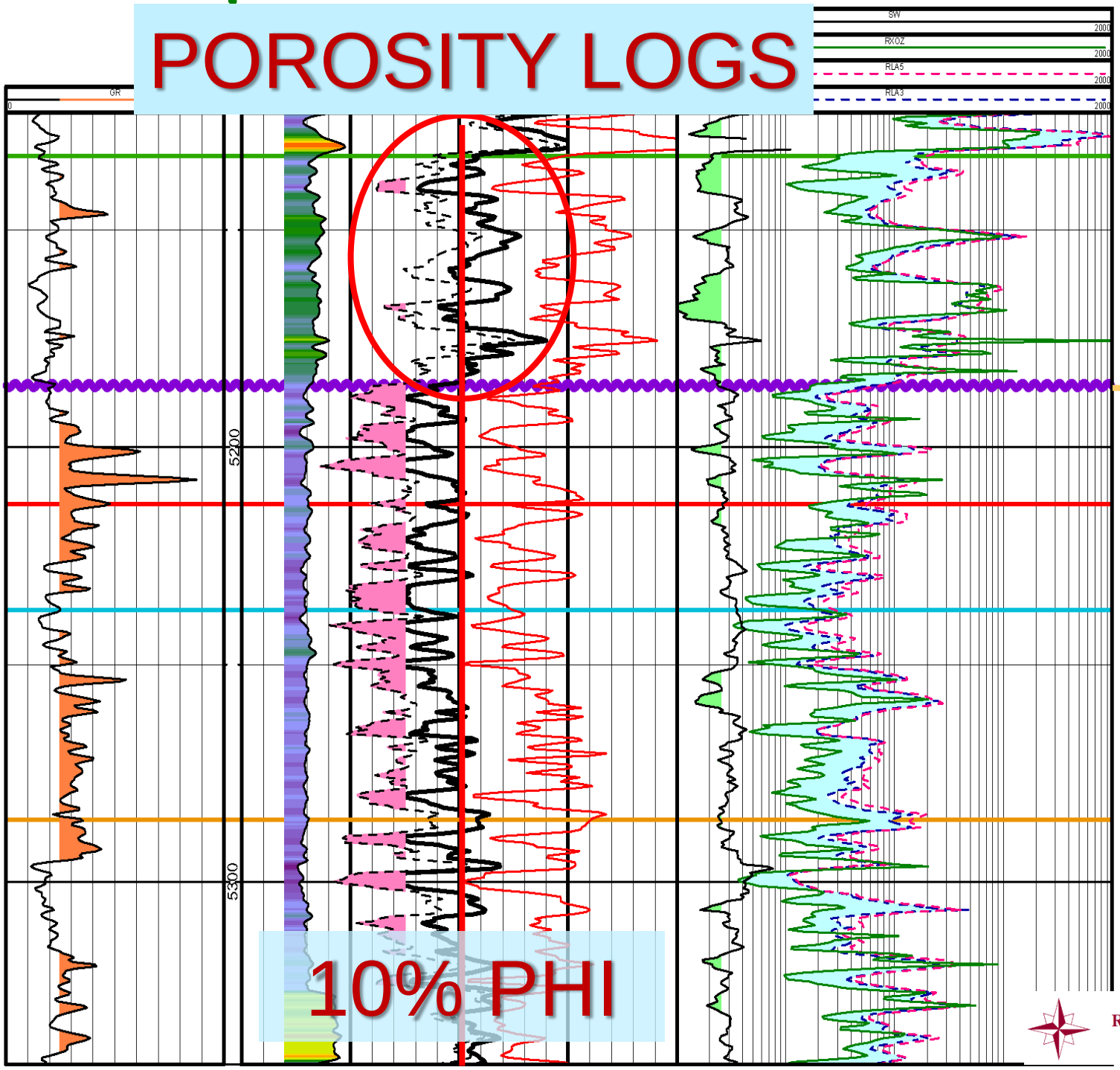

PE CURVE
PARTIALLY DOLOMITIZED
SA P1
SA P2
SA P3
SA P4
SW
RXOZ
RLA5
RLA3
5200
5300


PE CURVE
SW
RXOZ
RLA5
RLA3
5200
5300
SA P1
SA P2
SA P3
SA P4
FULLY
DOLOMITIZED


PE CURVE
DIAGENETIC FACIES CHANGE
SA P1
SA P2
SA P3
SA P4
SW
RXOZ
RLA5
RLA3
5200
5300


PE CURVE
SW
RXOZ
RLA5
RLA3
DIAGENETIC FACIES CHANGE
THIS IS LOWER / HIGHER IN EACH WELL
SA P1
SA P2
SA P3
SA P4
5300

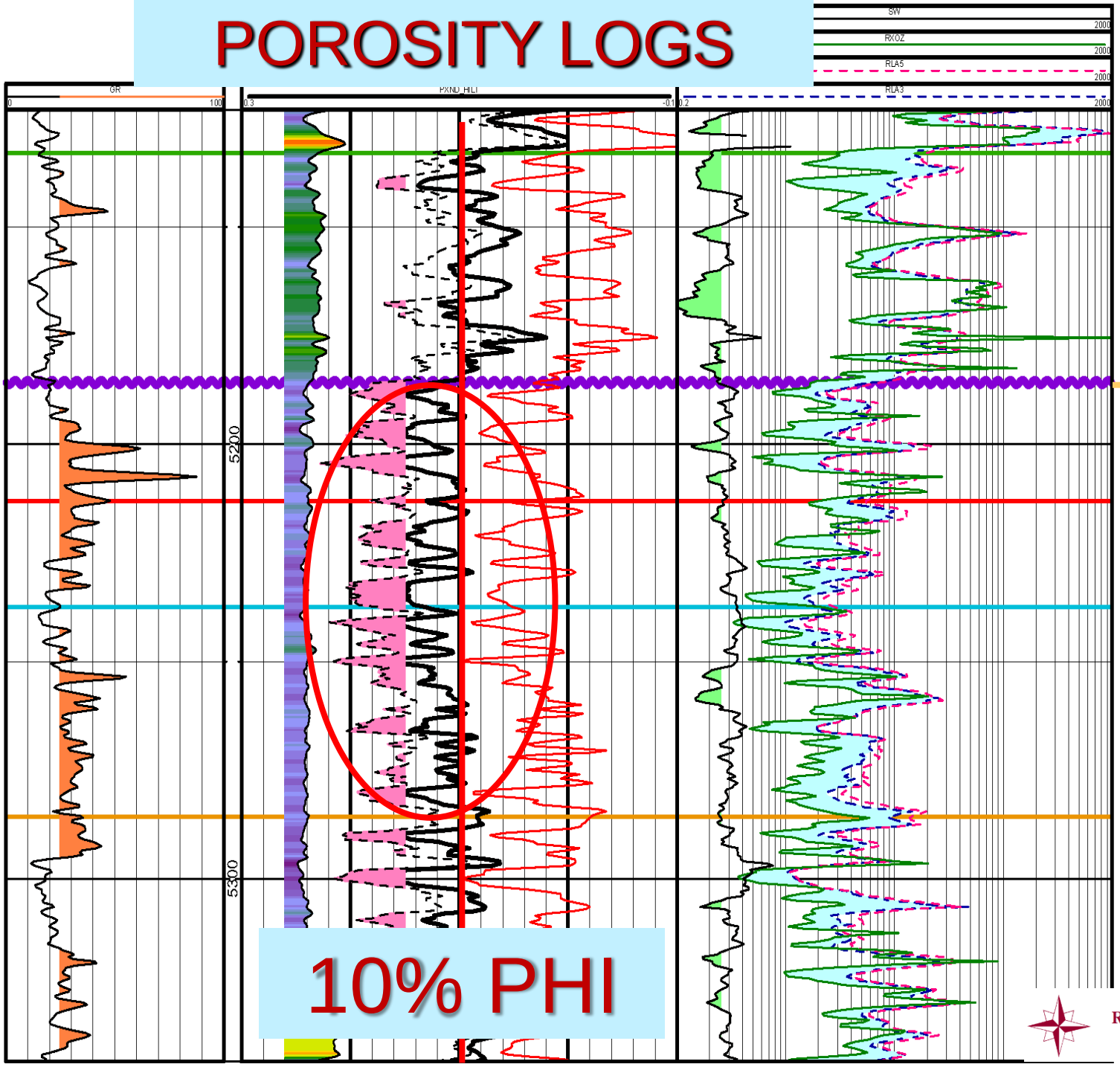
POROSITY LOGS



DIAG

10% PHI

POROSITY LOGS



DIAG

10% PHI

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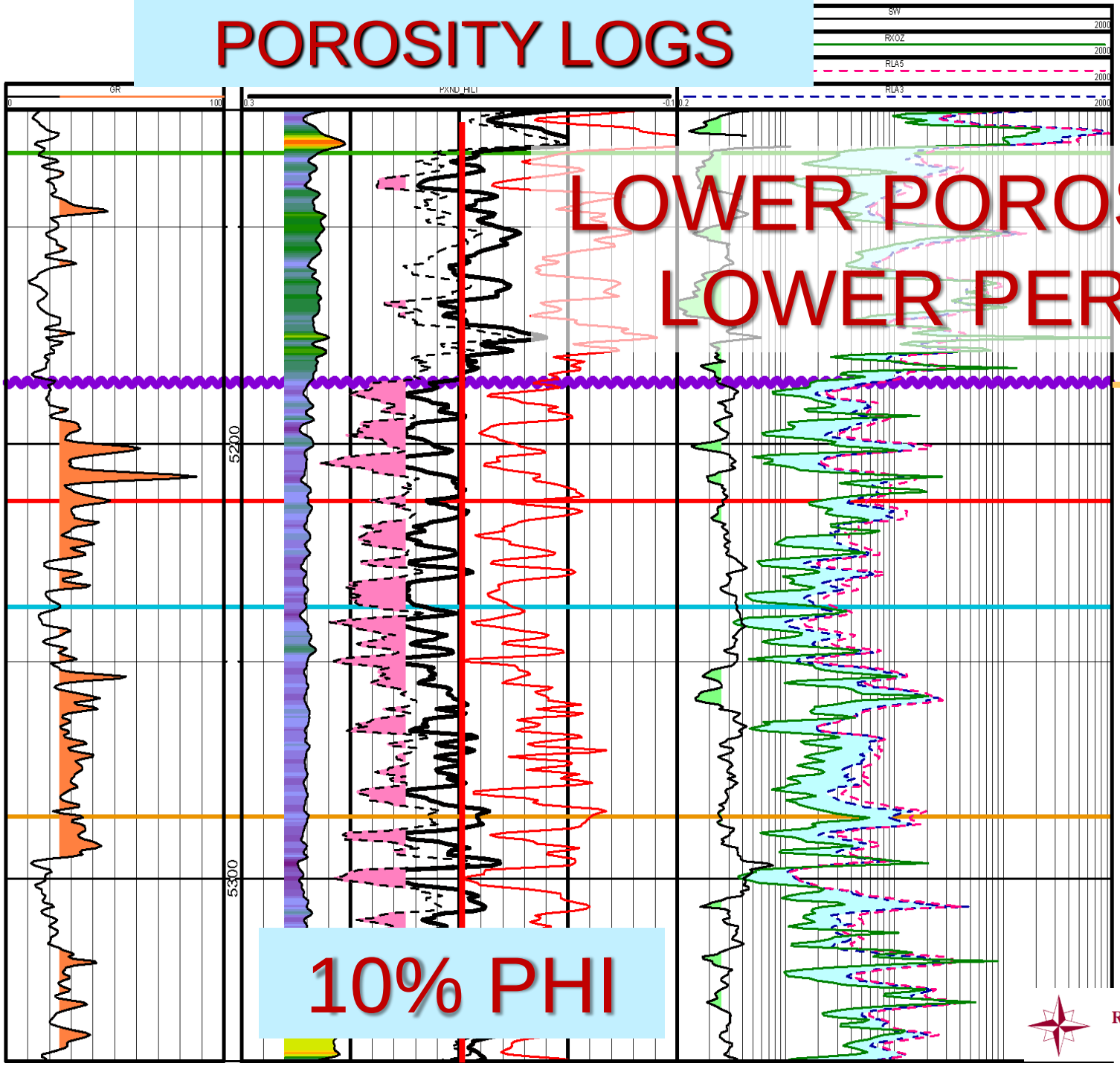
Petroleum Evaluation Engineers

POROSITY LOGS



LOWER POROSITY

LOWER PERM

DIAG

10% PHI

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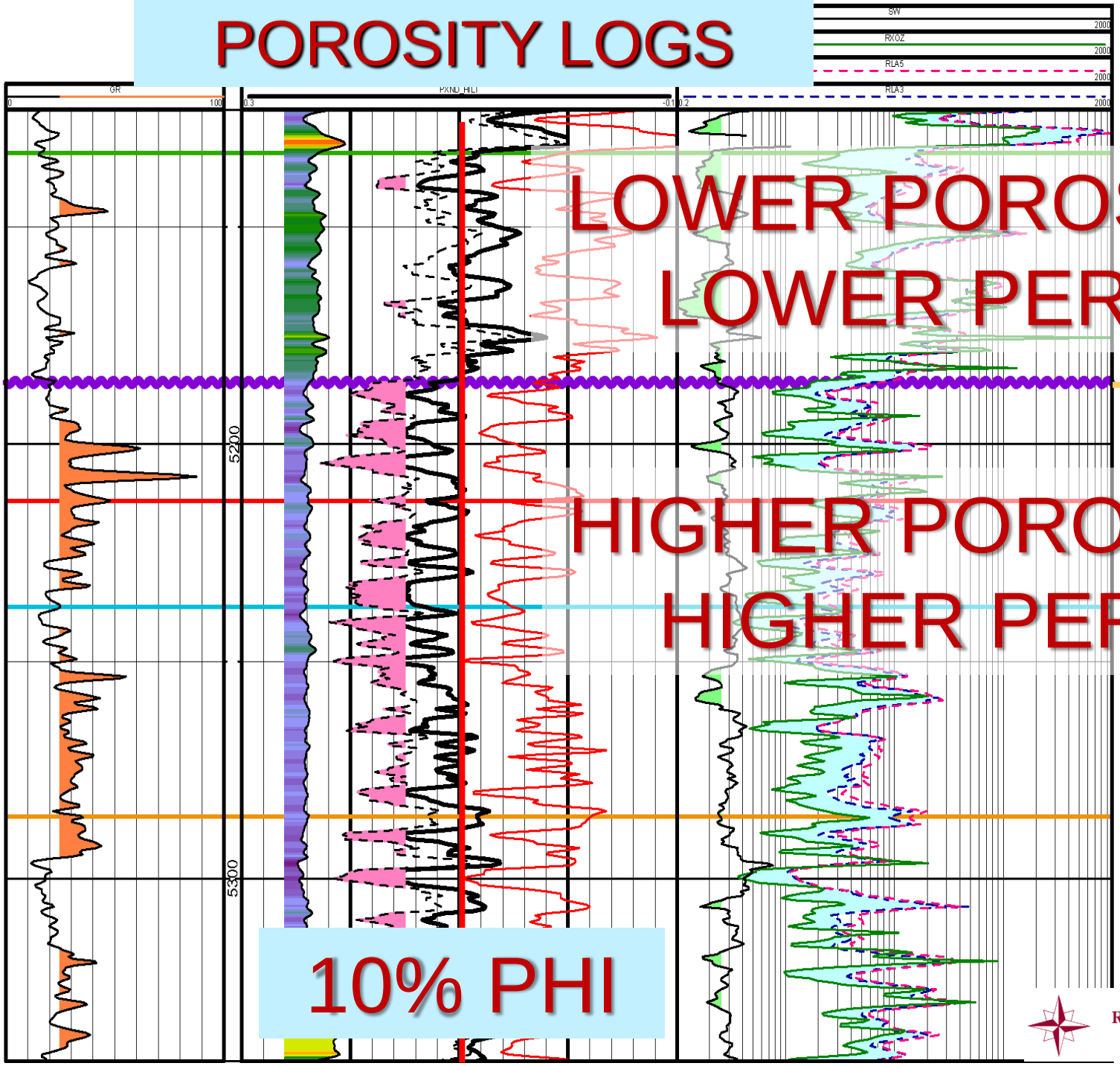
Petroleum Evaluation Engineers

POROSITY LOGS



LOWER POROSITY
LOWER PERM

DIAG

HIGHER POROSITY
HIGHER PERM

10% PHI

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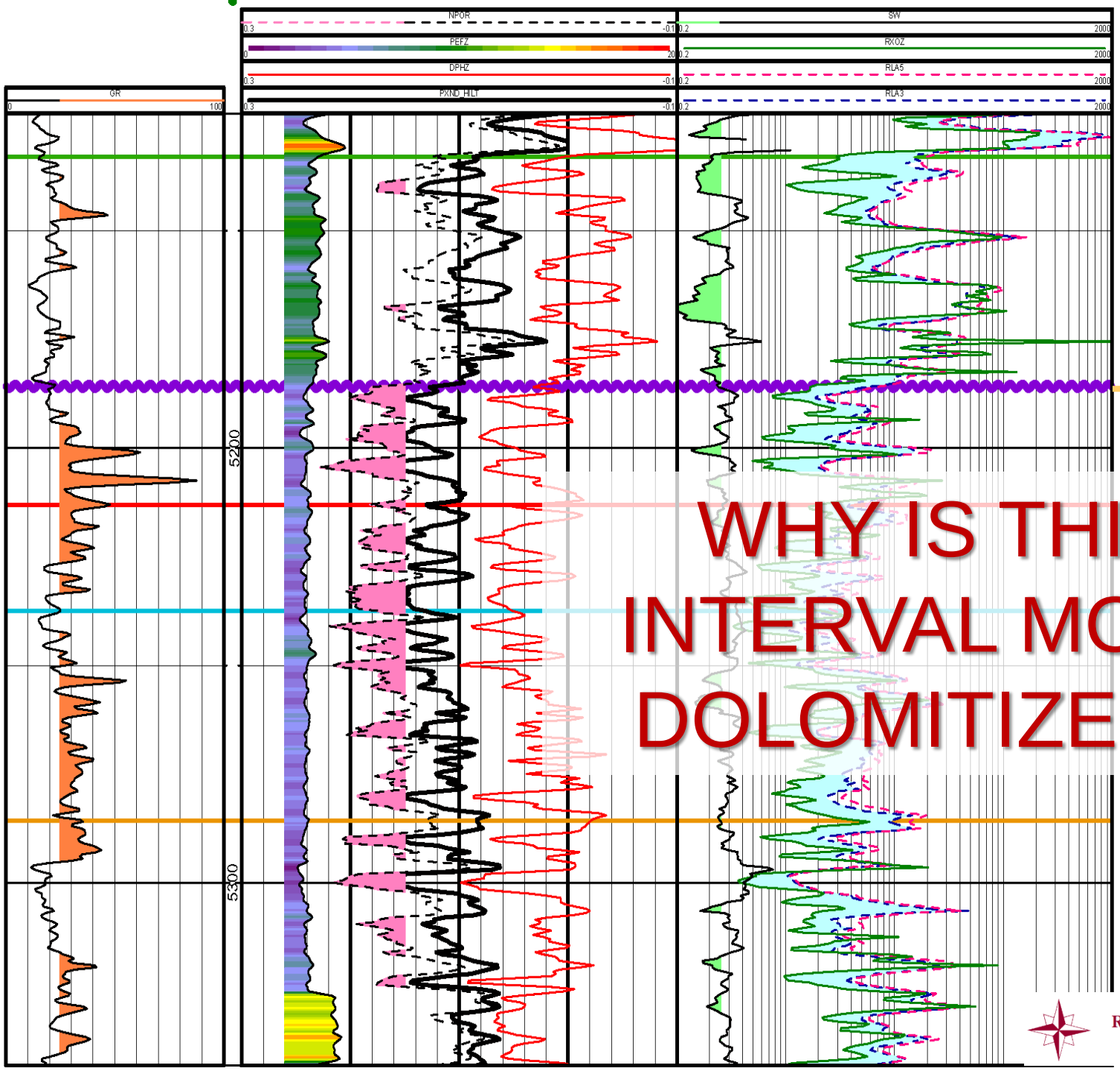
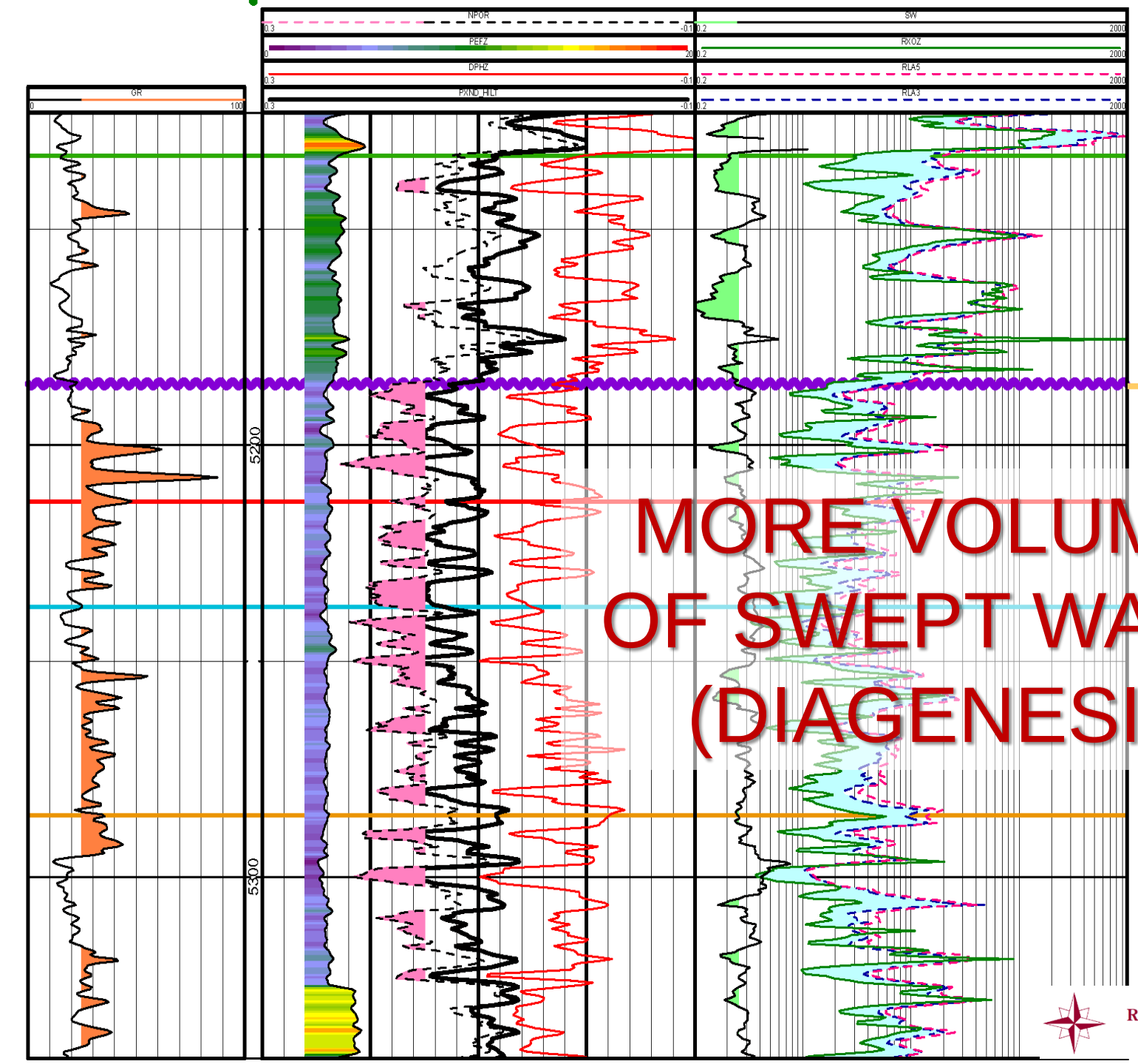
Petroleum Evaluation Engineers



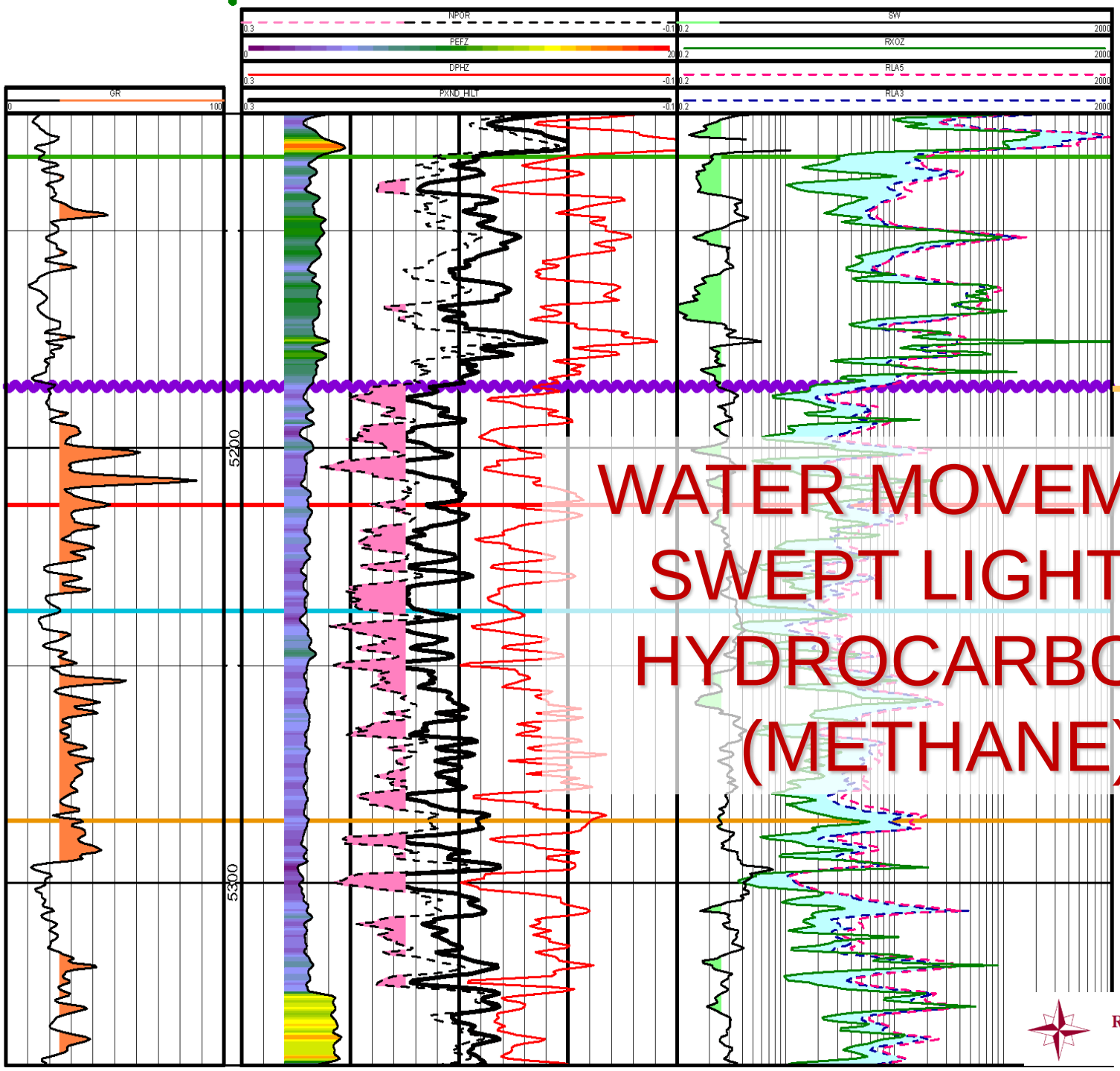
DIAG

WHY IS THIS INTERVAL MORE DOLOMITIZED ?



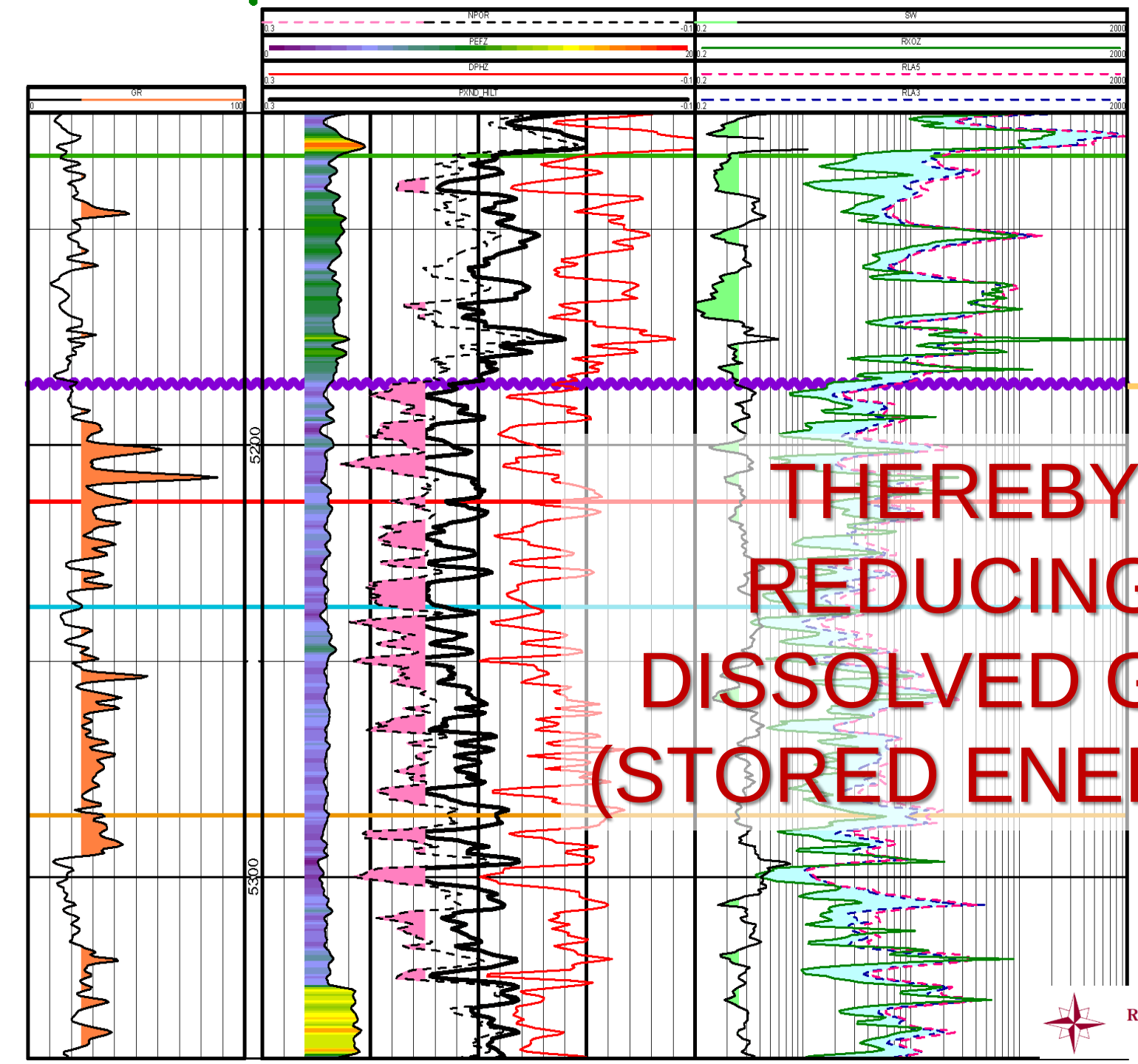
DIAG

MORE VOLUMES OF SWEPT WATER (DIAGENESIS)



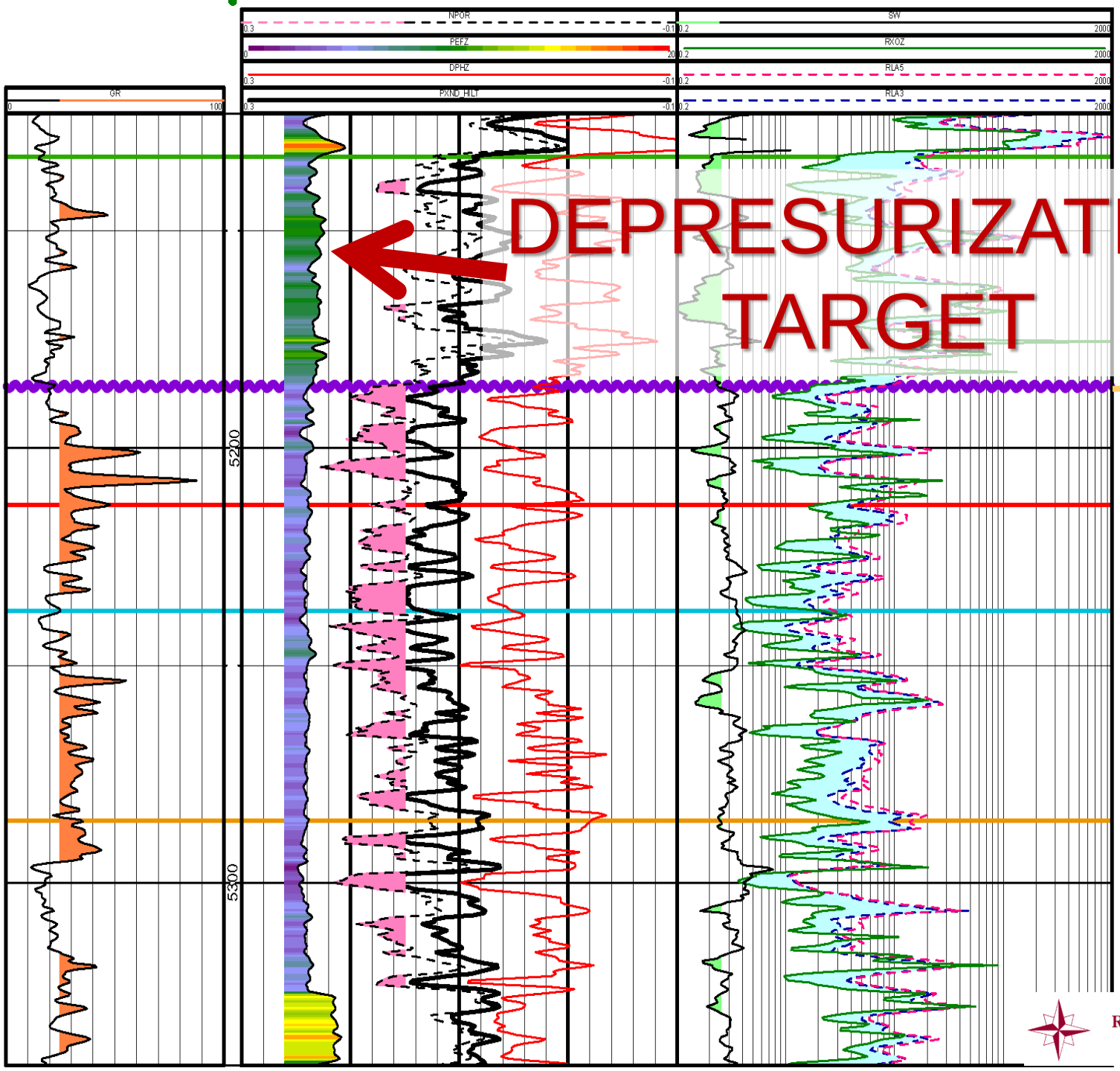
DIAG

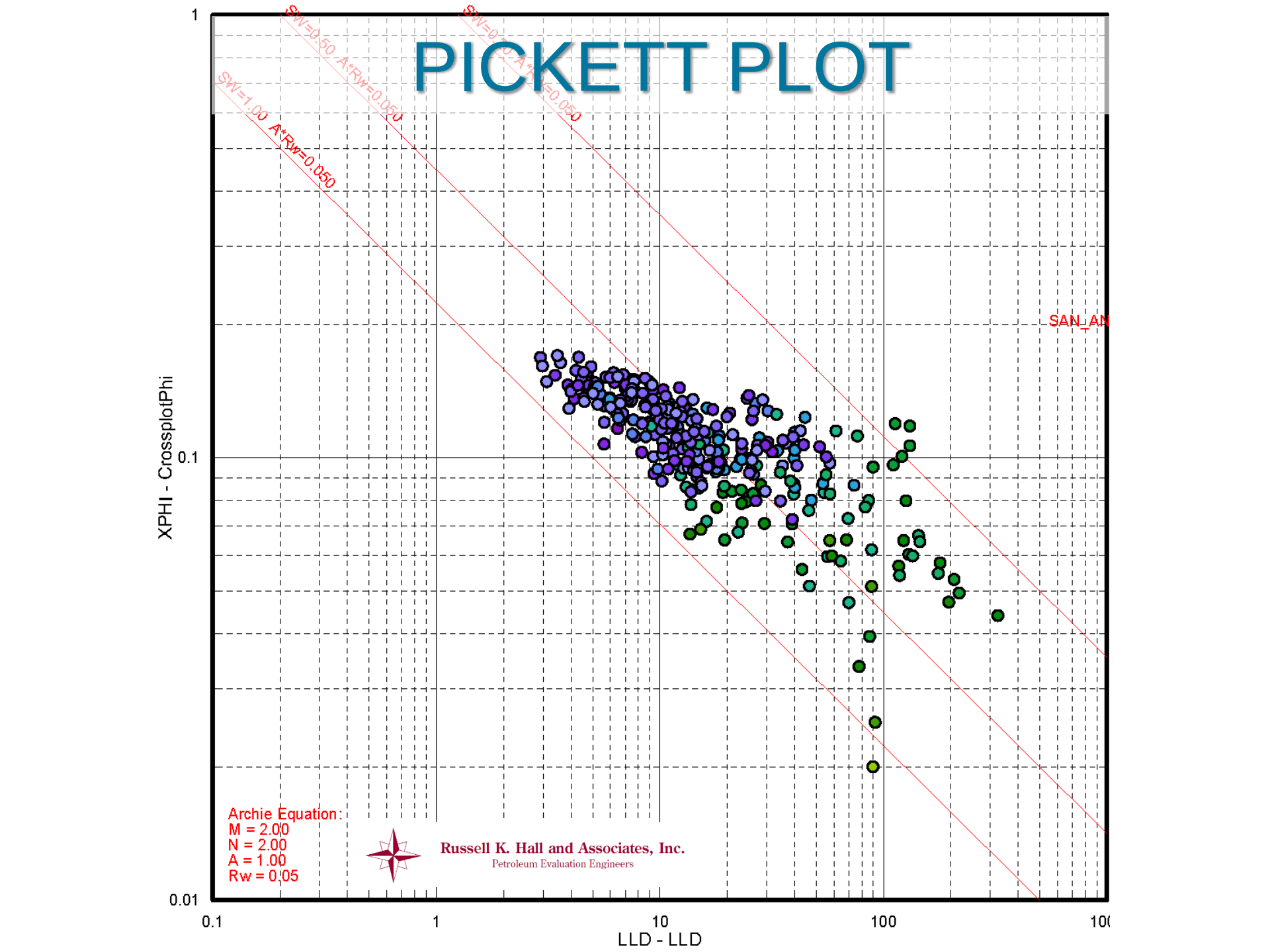
WATER MOVEMENT SWEPT LIGHTER HYDROCARBONS (METHANE)

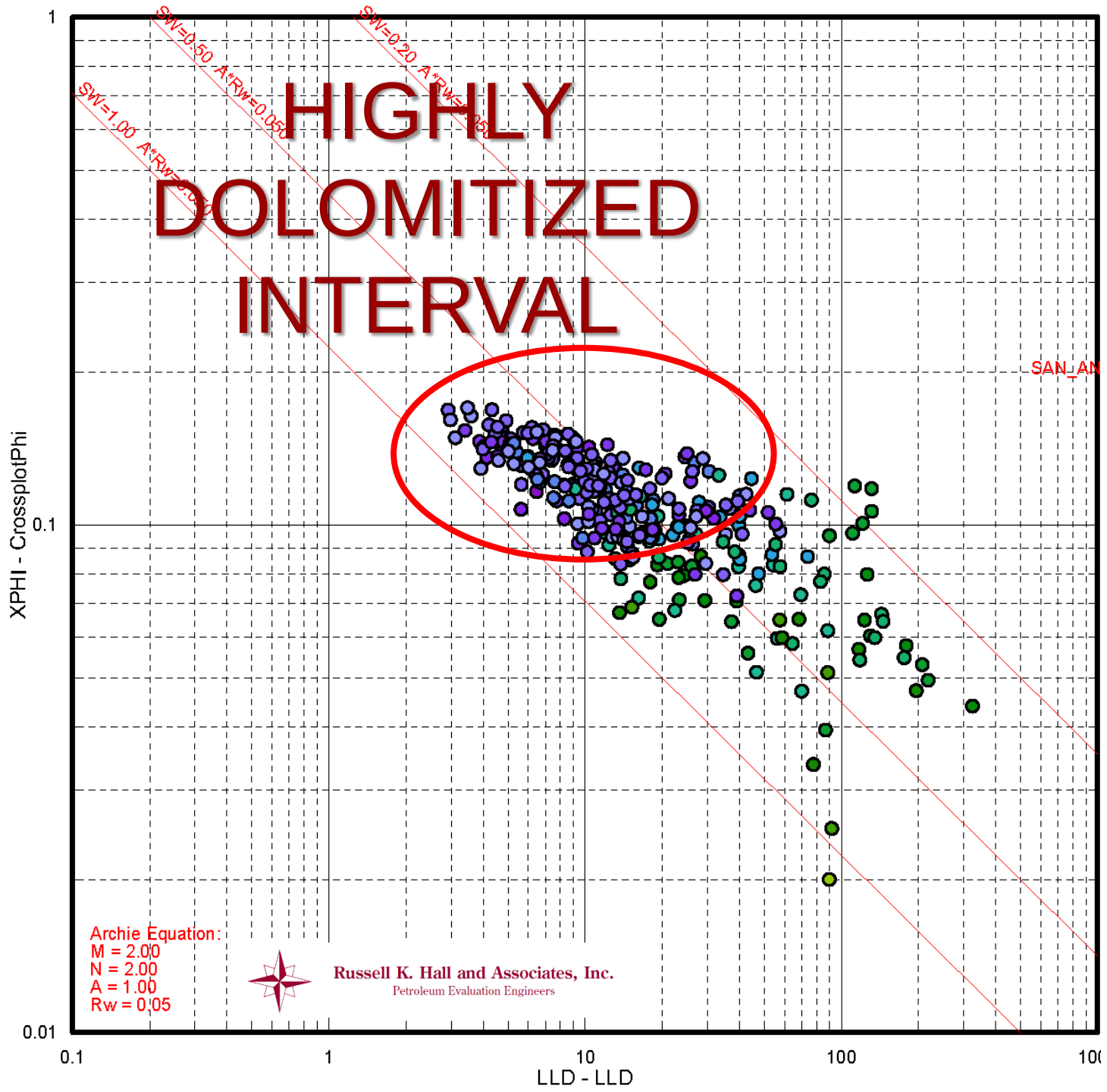


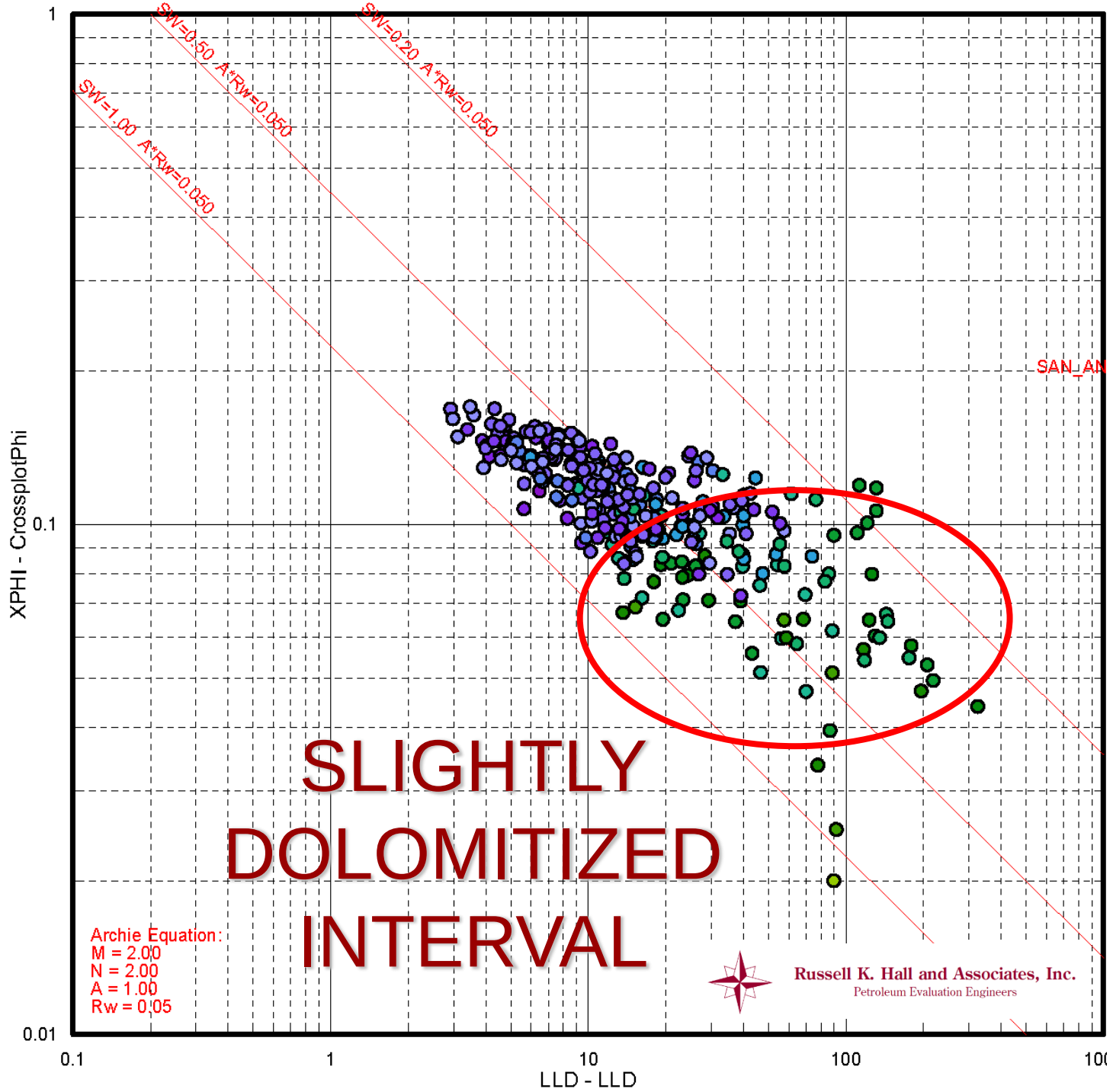
DIAG

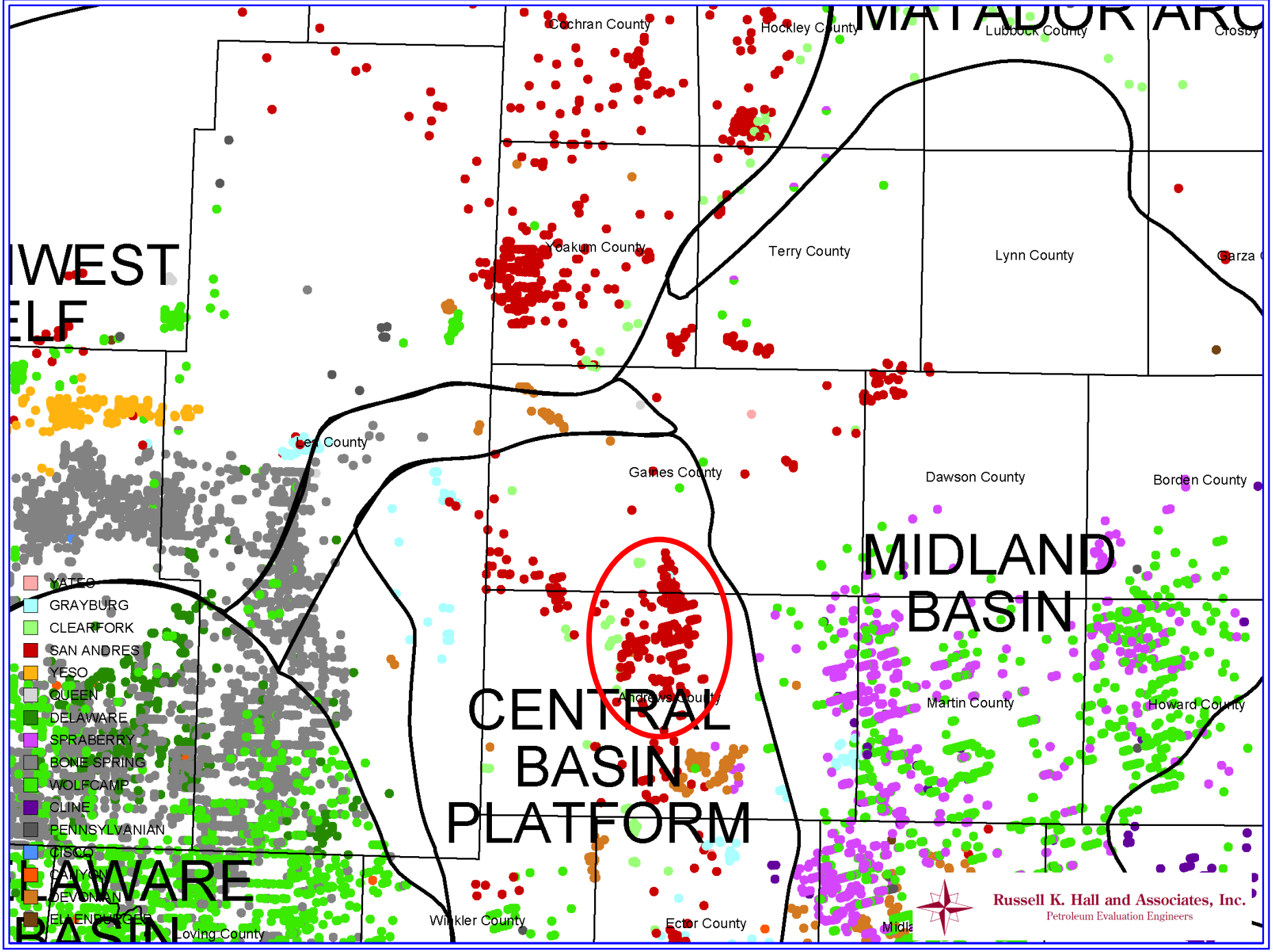
THEREBY REDUCING DISSOLVED GAS (STORED ENERGY)


NPOR
PEFZ
DPHZ
PXND_HILT
SW
RXOZ
RLA5
RLA3
GR
5200
5300
DEPRESURIZATION
TARGET
DIAG


PICKETT PLOT
SW=0.50 A*Rw=0.050
SW=1.00 A*Rw=0.050
SAN_AN
XPHI - CrossplotPhi
LLD - LLD
1
0.1
0.01
0.1
1
10
100
Archie Equation:
M = 2.00
N = 2.00
A = 1.00
Rw = 0.05
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers


HIGHLY DOLOMITIZED INTERVAL
SW=0.50 A*RW=0.050
SW=0.20 A*RW=0.050
SW=1.00 A*RW=0.050
SAN_AN
XPHI - CrossplotPhi
LLD - LLD
1
0.1
0.01
0.1
1
10
100
Archie Equation:
M = 2.00
N = 2.00
A = 1.00
Rw = 0.05
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers


SW=0.50 A*Rw=0.050
SW=0.20 A*Rw=0.050
SW=1.00 A*Rw=0.050
SAN_AN
XPHI - CrossplotPhi
LLD - LLD
1
0.1
0.01
0.1
1
10
100
SLIGHTLY
DOLOMITIZED
INTERVAL
Archie Equation:
M = 2.00
N = 2.00
A = 1.00
Rw = 0.05
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers



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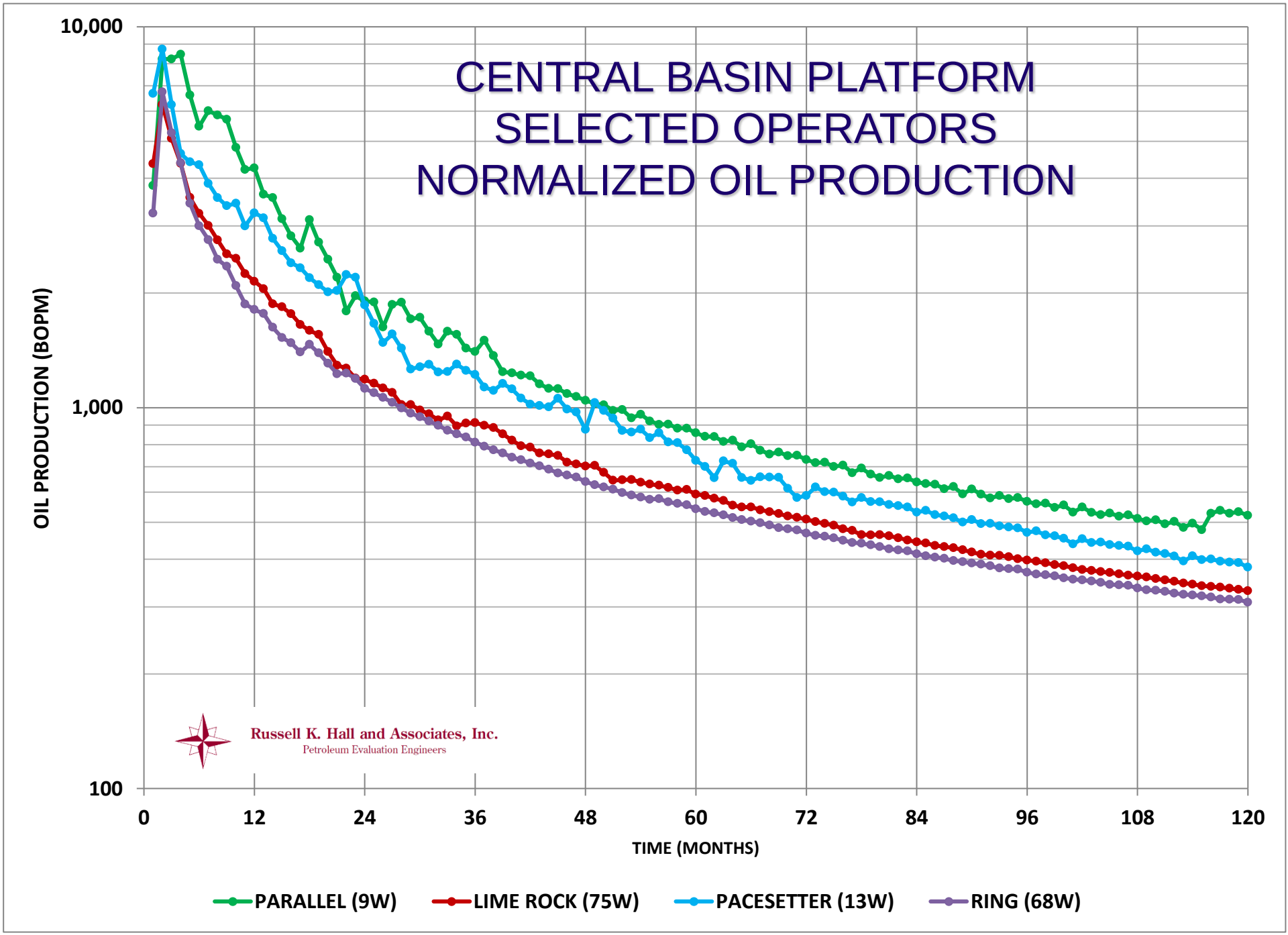
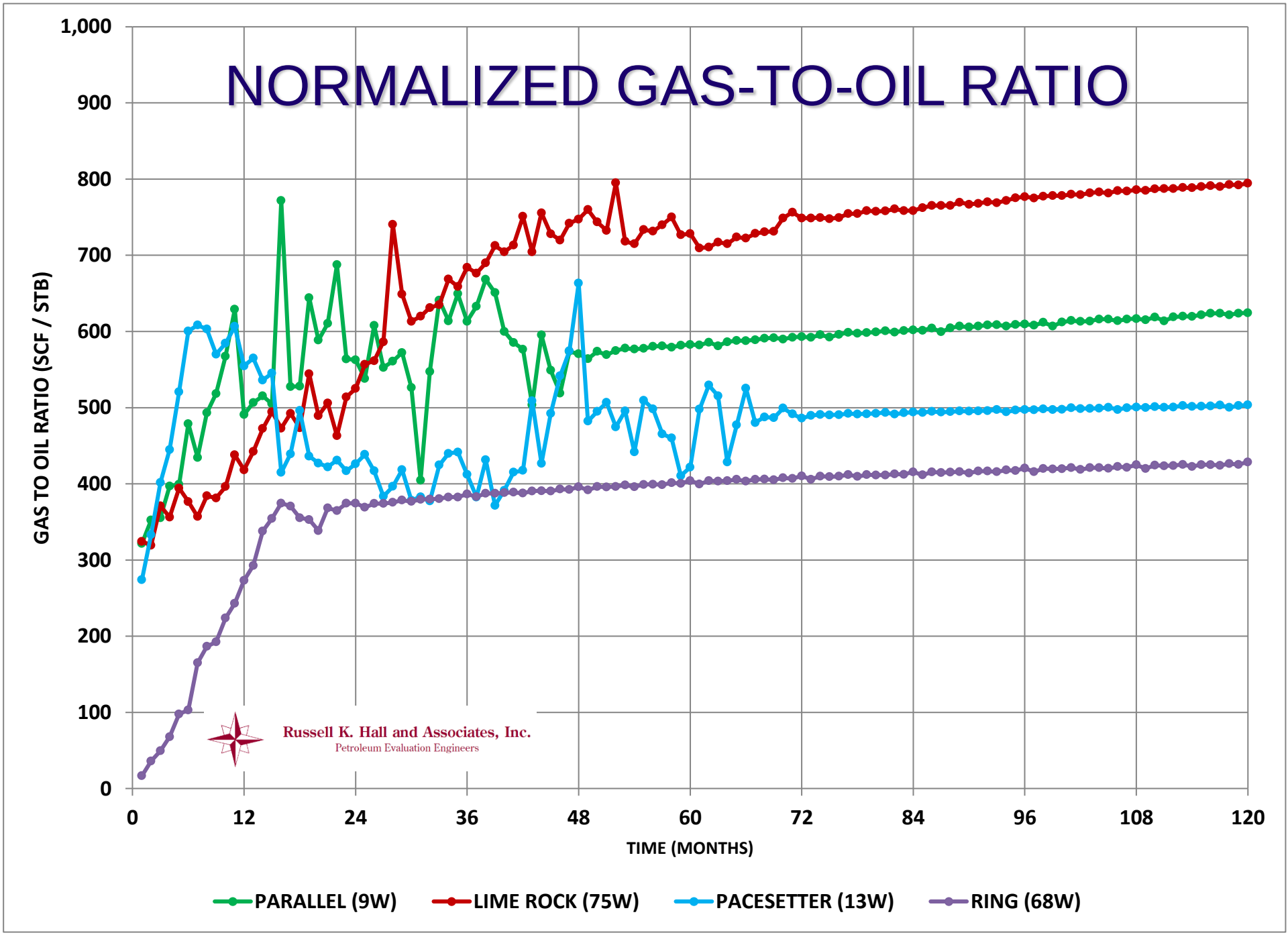
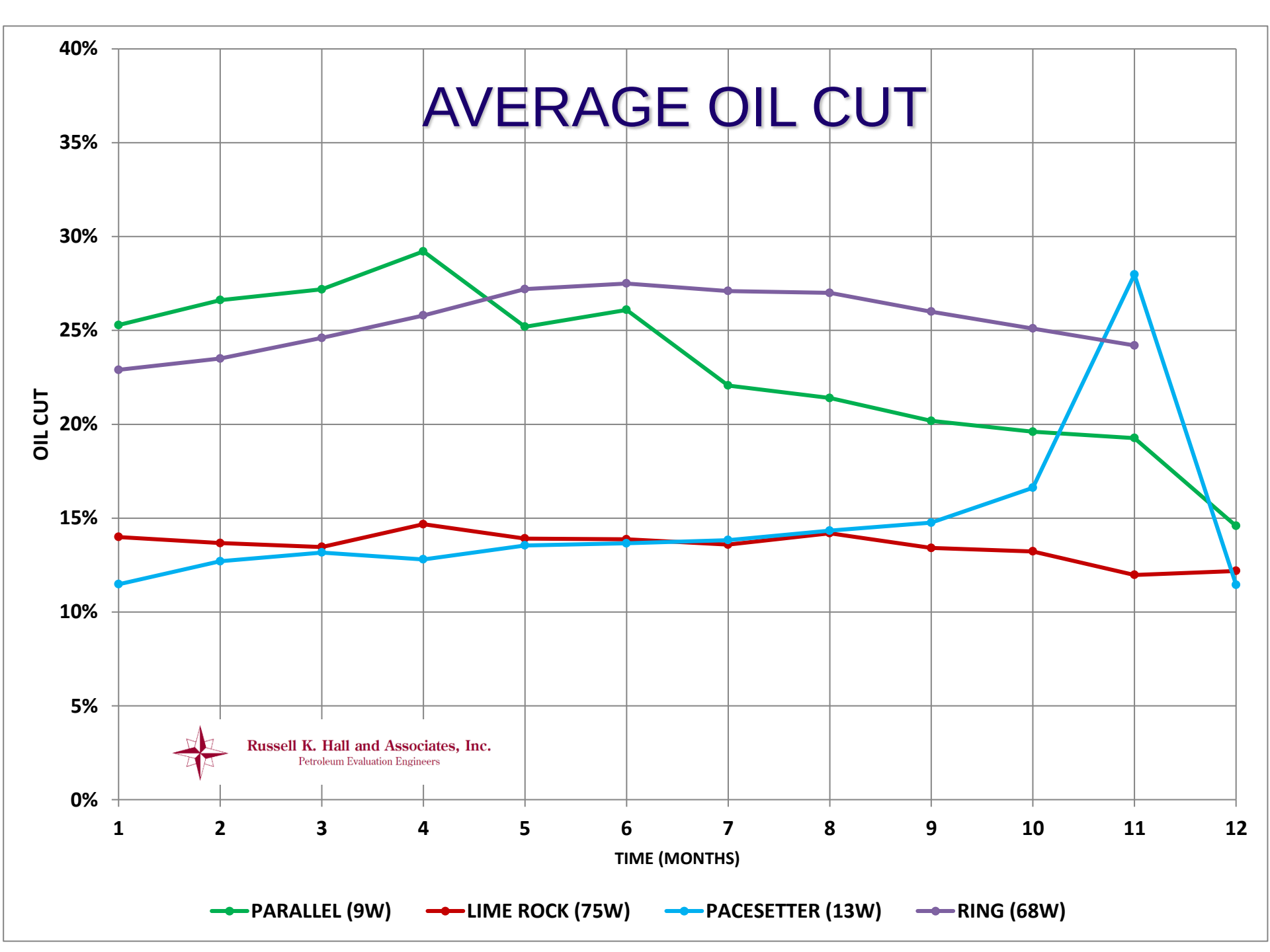
GAINES
COUNTY
ANDREWS
COUNTY
PARALLEL
LIME ROCK
PACESETTER
RING
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers


CENTRAL BASIN PLATFORM
SELECTED OPERATORS
NORMALIZED OIL PRODUCTION
10,000
1,000
100
OIL PRODUCTION (BOPM)
0
12
24
36
48
60
72
84
96
108
120
TIME (MONTHS)
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers
PARALLEL (9W)
LIME ROCK (75W)
PACESETTER (13W)
RING (68W)


NORMALIZED GAS-TO-OIL RATIO
GAS TO OIL RATIO (SCF / STB)
1,000
900
800
700
600
500
400
300
200
100
0
0
12
24
36
48
60
72
84
96
108
120
TIME (MONTHS)
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers
PARALLEL (9W)
LIME ROCK (75W)
PACESETTER (13W)
RING (68W)


AVERAGE OIL CUT
40%
35%
30%
25%
20%
15%
10%
5%
0%
OIL CUT
1
2
3
4
5
6
7
8
9
10
11
12
TIME (MONTHS)
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers
PARALLEL (9W)
LIME ROCK (75W)
PACESETTER (13W)
RING (68W)

ANDREWS COUNTY WELLS (1)

	OIL EUR (BBL)	GAS EUR (MCF)	1ST YR OIL CUT	WELLS
PARALLEL PETROLEUM	286,000	164,000	23.1%	9
LIME ROCK RESOURCES	183,000	123,000	13.5%	75
PACESETTER ENERGY	235,000	113,000	14.7%	13
RING ENERGY	165,000	56,000	25.5%	68

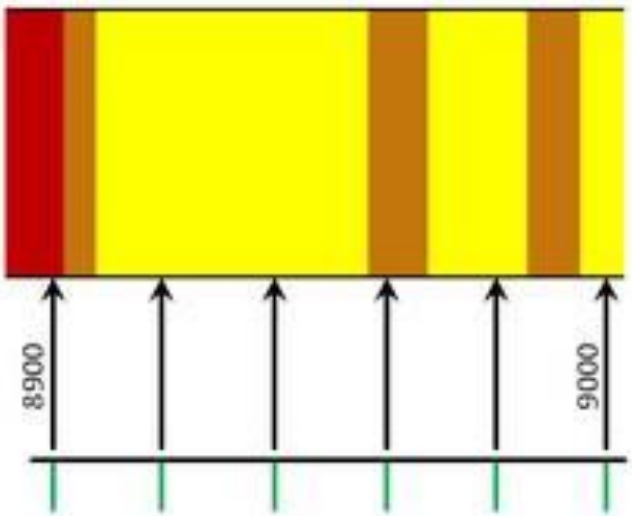
ANDREWS COUNTY WELLS (2)

	OIL EUR (BBL)	GAS EUR (MCF)	1ST YR OIL CUT	WELLS
PARALLEL PETROLEUM	286,000	164,000	23.1%	9
LIME ROCK RESOURCES	183,000	123,000	13.5%	75
PACESETTER ENERGY	235,000	113,000	14.7%	13
RING ENERGY	165,000	56,000	25.5%	68

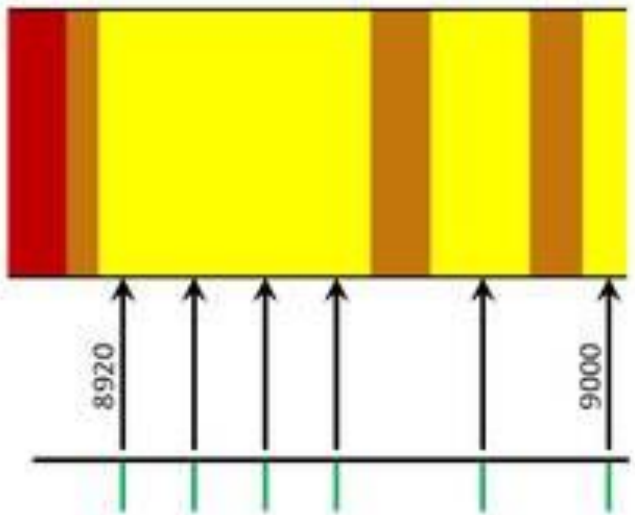
PARALLEL PETROLEUM COMPLETION PROCEDURE (1)

Geometric vs. Geomechanical Completions

Geometric Design



Geomechanical Design



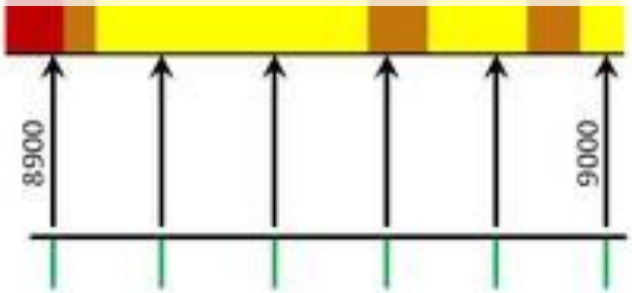
Moving perfs to like rock areas assures better success for each cluster.

PARALLEL PETROLEUM COMPLETION PROCEDURE (2)

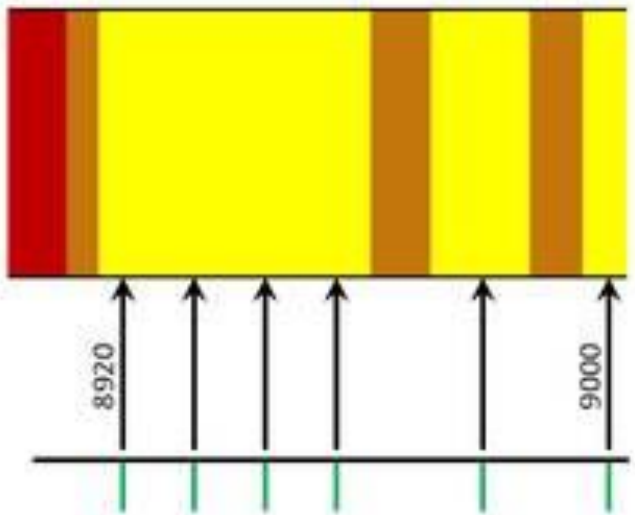
Geometric vs. Geomechanical Completions

Geometric Design

EVENLY SPACED PEFORATIONS



Geomechanical Design

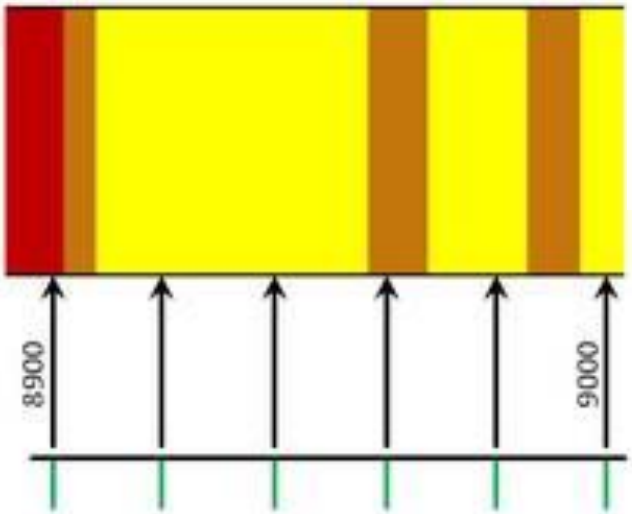


Moving perfs to like rock areas assures better success for each cluster.

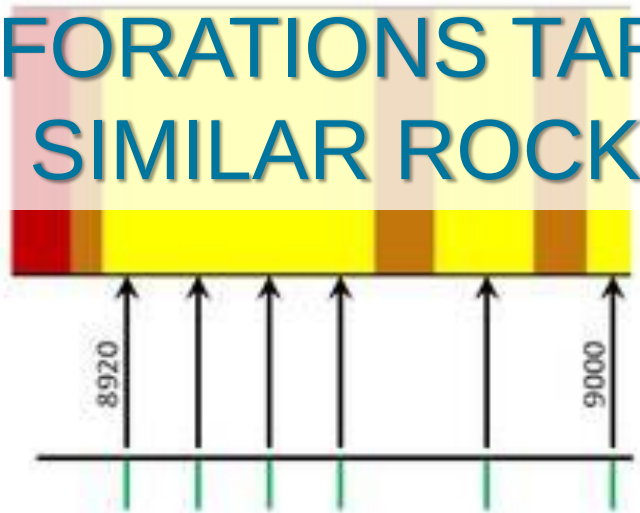
PARALLEL PETROLEUM COMPLETION PROCEDURE (3)

Geometric vs. Geomechanical Completions

Geometric Design



Geomechanical Design



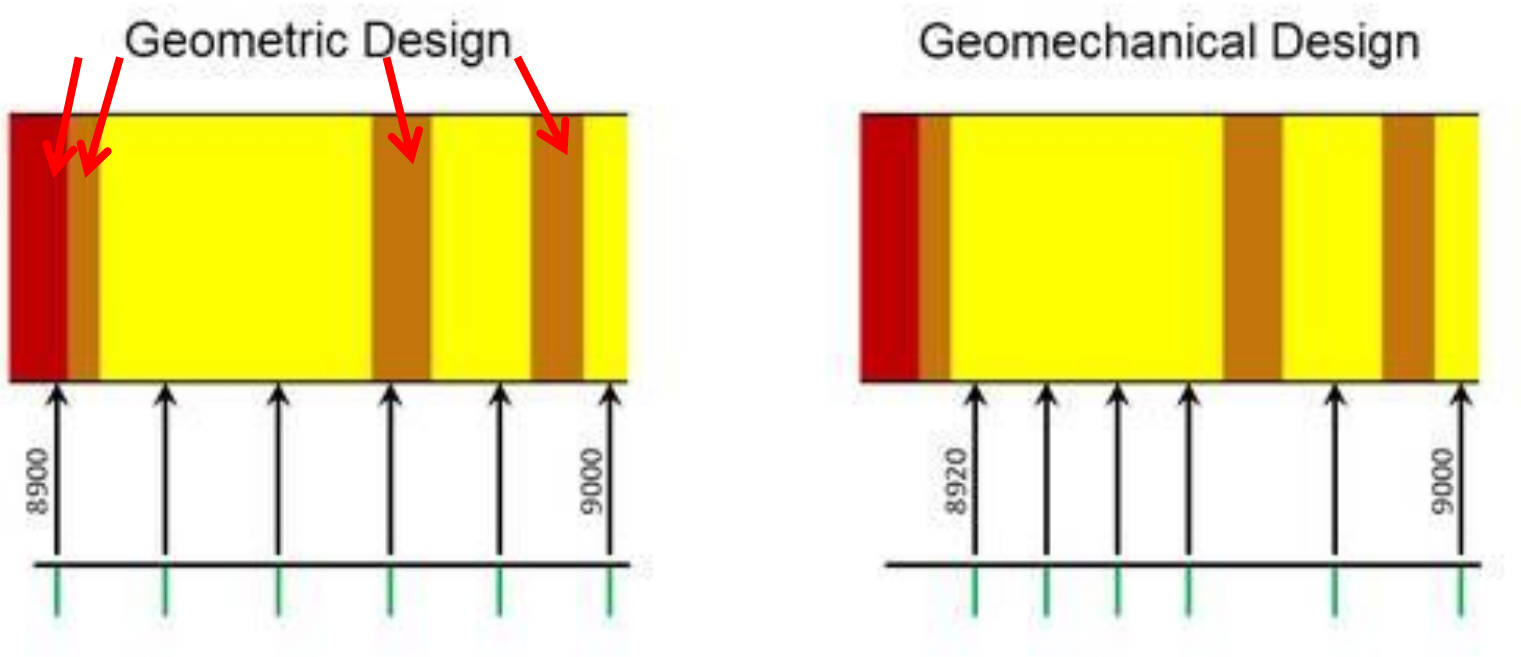
PERFORATIONS TARGET SIMILAR ROCK

Moving perfs to like rock areas assures better success for each cluster.

PARALLEL PETROLEUM COMPLETION PROCEDURE (4)

HIGH FRAC INITIATION PRESSURE

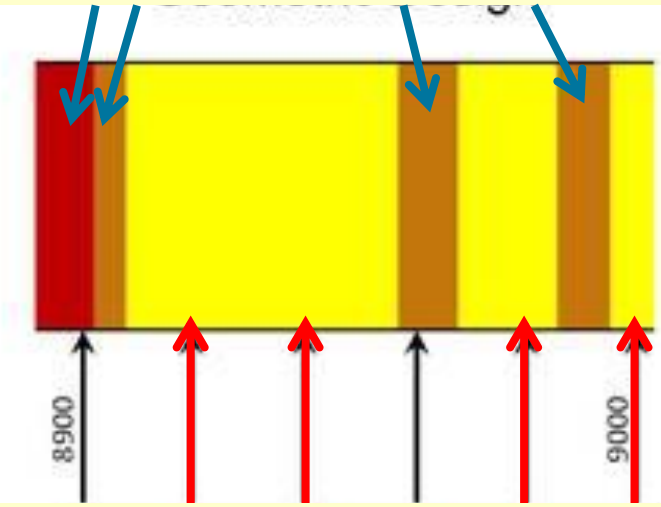
ıechanical Completions



Moving perfs to like rock areas assures better success for each cluster.

PARALLEL PETROLEUM COMPLETION PROCEDURE (5)

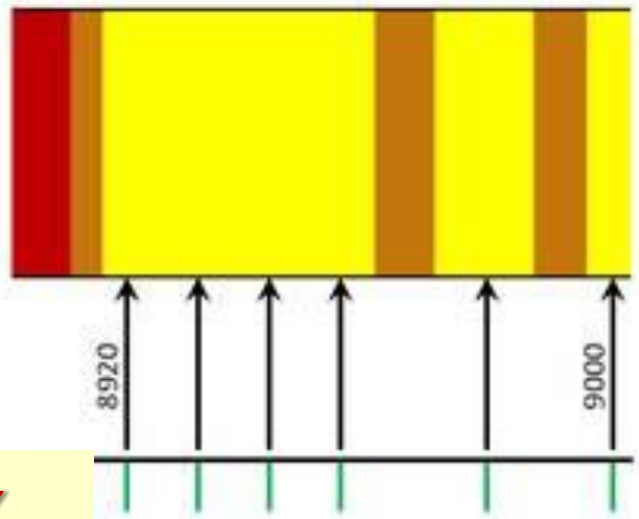
HIGH FRAC INITIATION PRESSURE



FRAC GOES ONLY INTO THESE PERFS

nechanical Completions

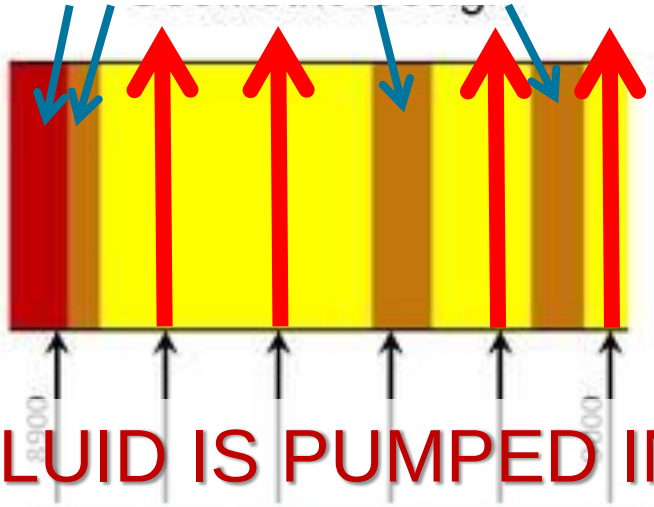
Geomechanical Design



for each cluster.

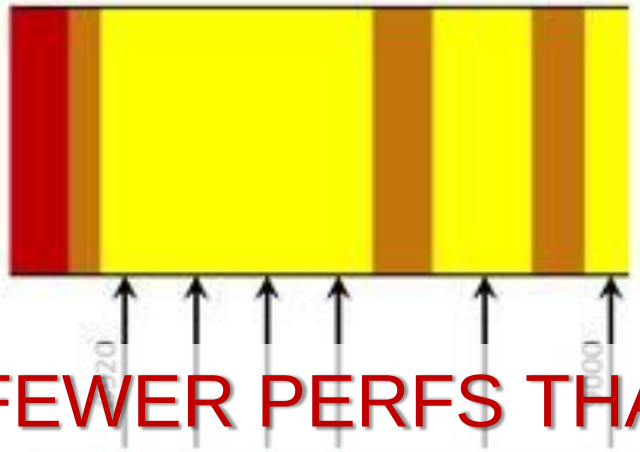
PARALLEL PETROLEUM COMPLETION PROCEDURE (6)

HIGH FRAC INITIATION PRESSURE



nechanical Completions

Geomechanical Design



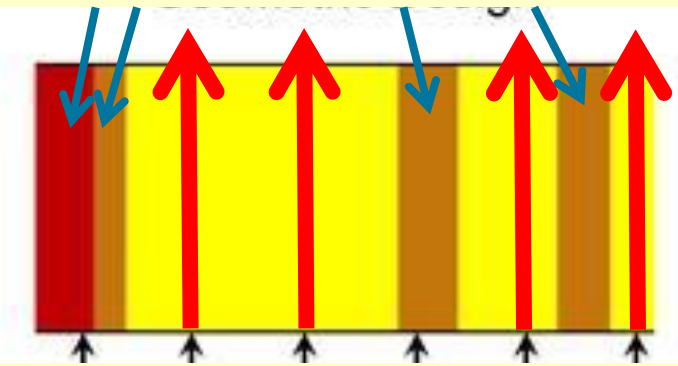
FLUID IS PUMPED INTO FEWER PERFS THAN PLANNED AND FRAC GOES OUT OF ZONE

Moving perfs to like rock areas assures better success for each cluster.

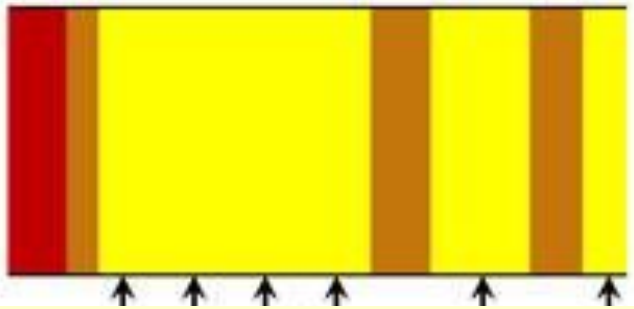
PARALLEL PETROLEUM COMPLETION PROCEDURE (7)

HIGH FRAC INITIATION PRESSURE

nechanical Completions



Geomechanical Design



FRACTURE COMMUNICATES WITH UNDERLYING INTERVAL (LOW GOR, HIGH WATER CUT)

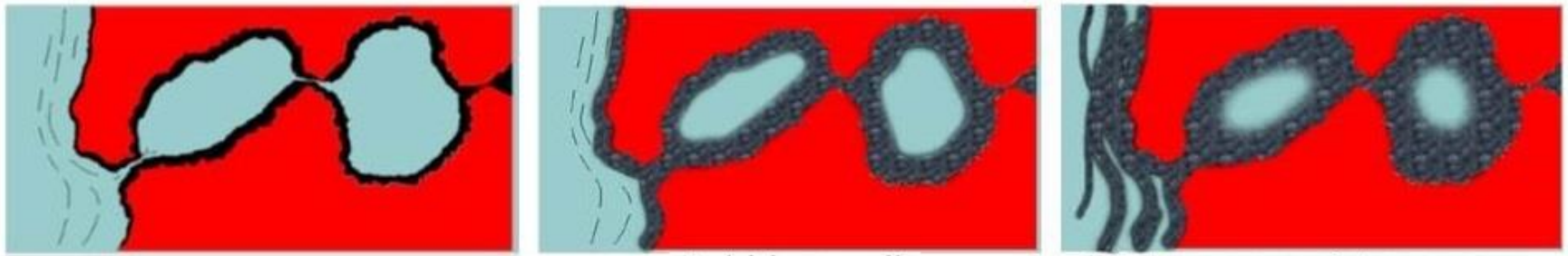
HZ San Andres Completions

- Fracs Tend Towards Downward Growth (Path of Least Resistance)
- Permeability Increases with Depth
- Deeper Formations have Higher Water Saturation ?
- Deeper Formations have Lower GOR ?
- Stimulations Out of Zone Make LOTS of Water

ROZ Depressuring

How Does ROZ Depressuring Work?

The ROZs have Oil Affixed to the Rock Surfaces and, if that Oil Has Gas in it, Depressuring Releases Some of the Oil and Entrained Gas



Bubbles swell

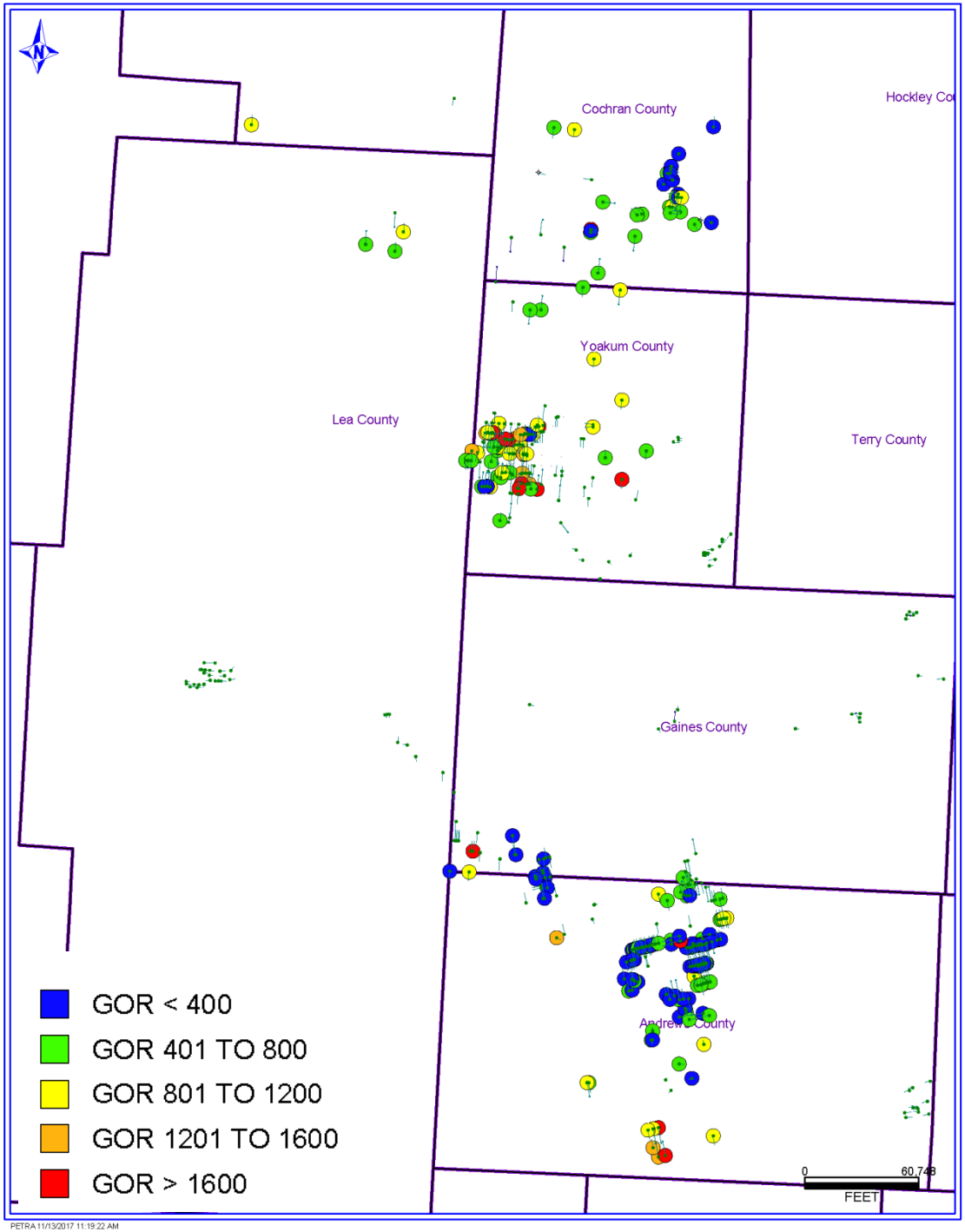
Oil Seeps out of the poors. …

…and into the flowstream to flow to the well. Lots of water is produced to accomplish the depressuring

Melzer Consulting

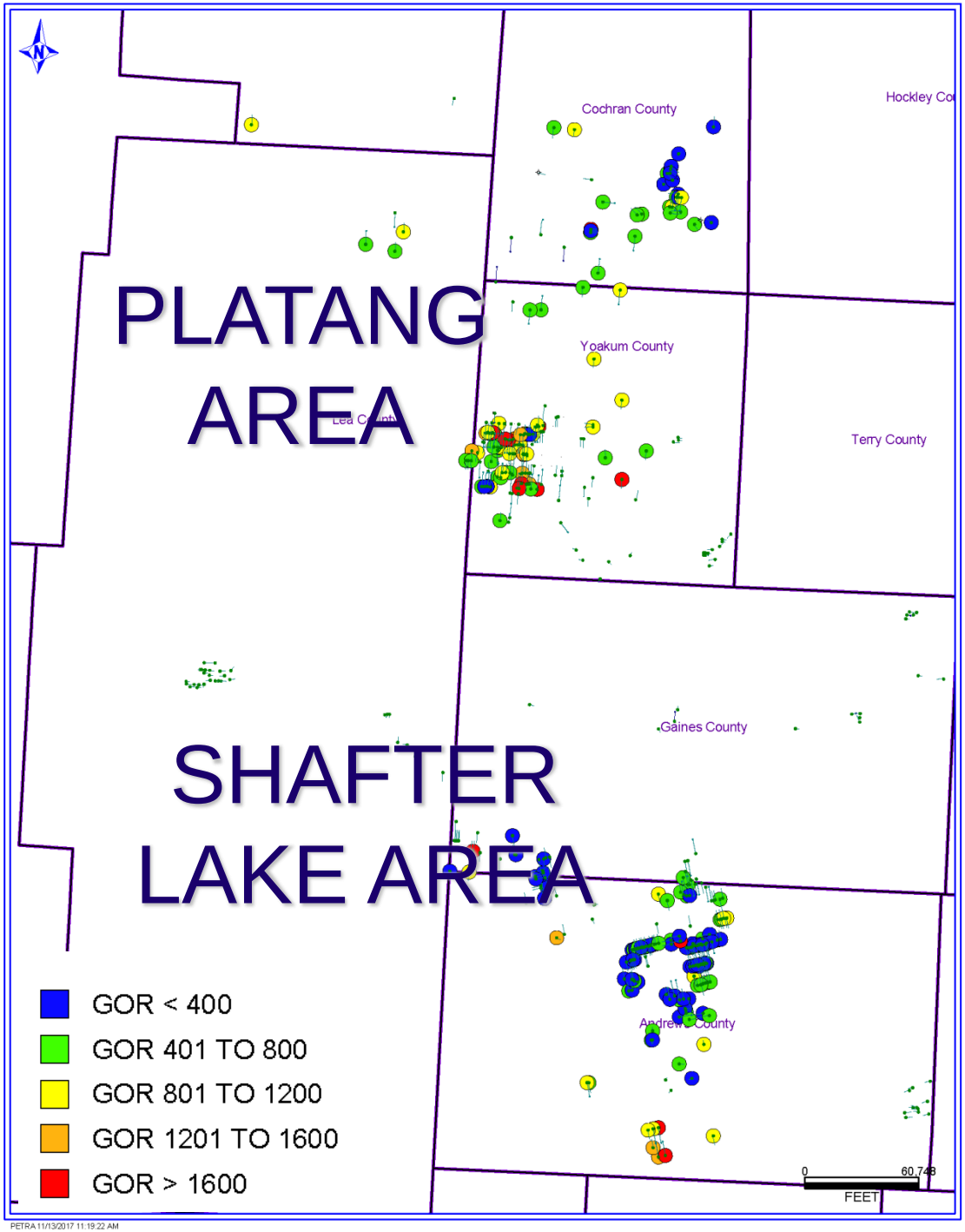
Gas to Oil Ratio (GOR)

After Producing 1 Year



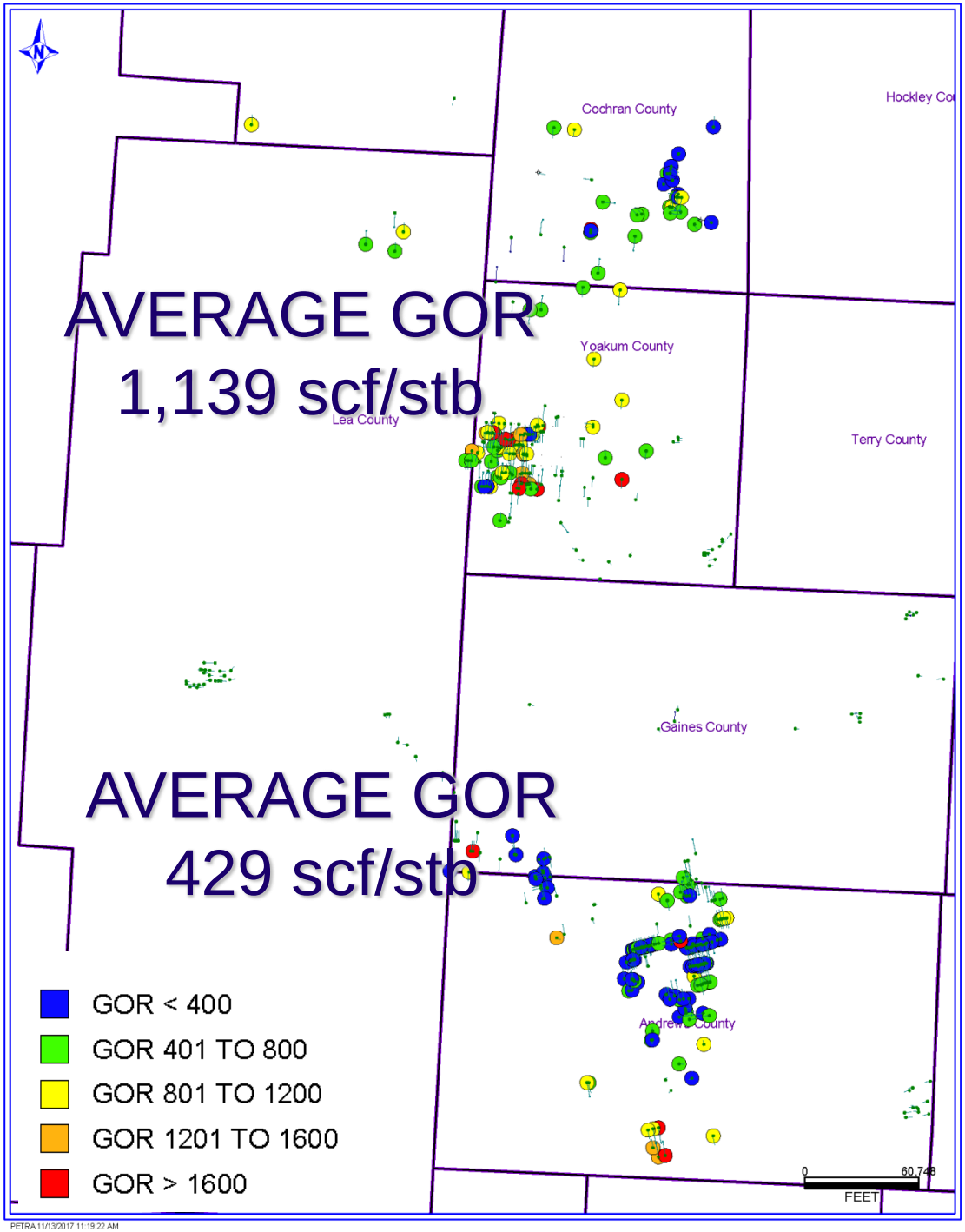
Gas to Oil Ratio (GOR)

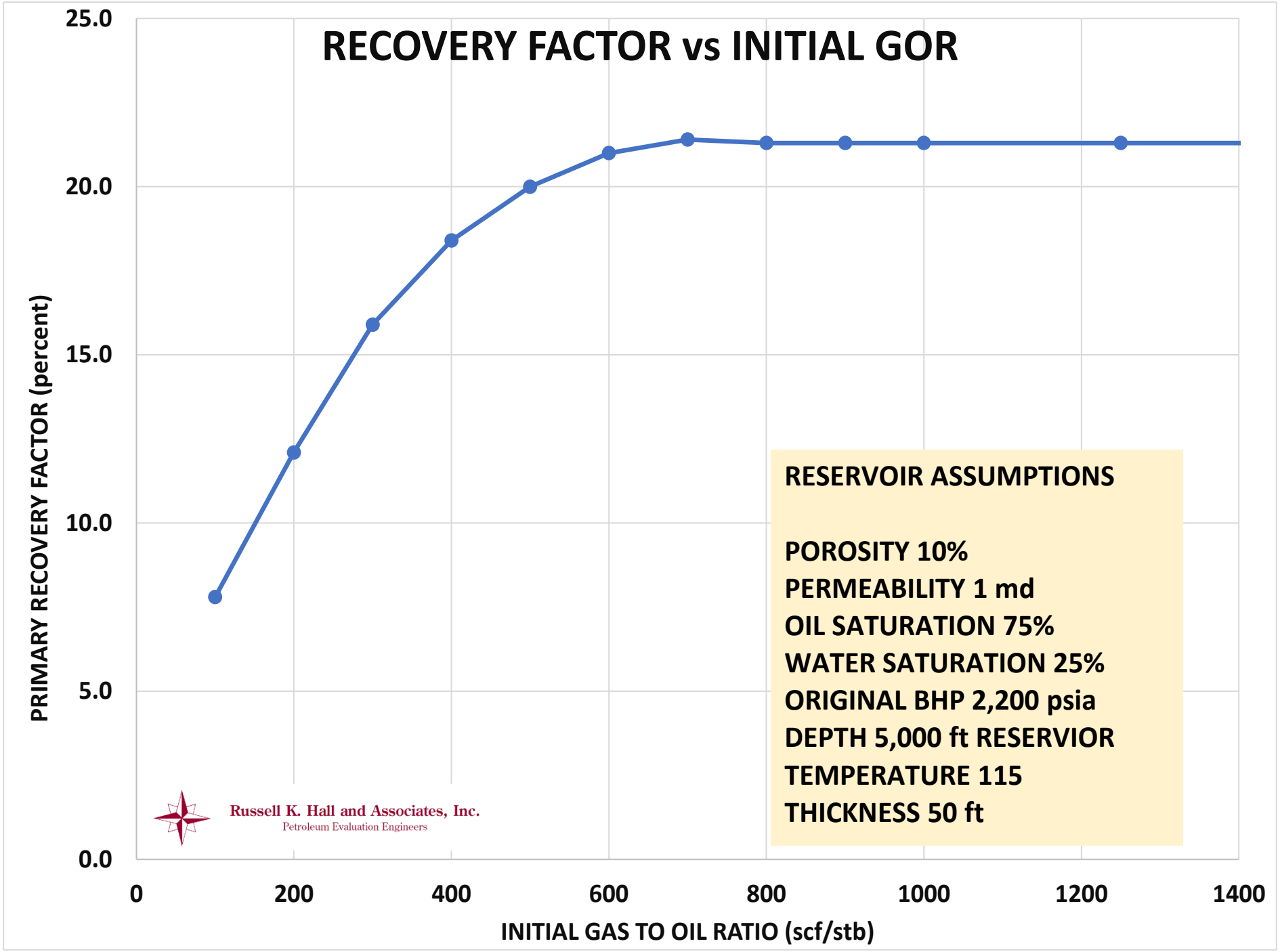
After Producing 1 Year

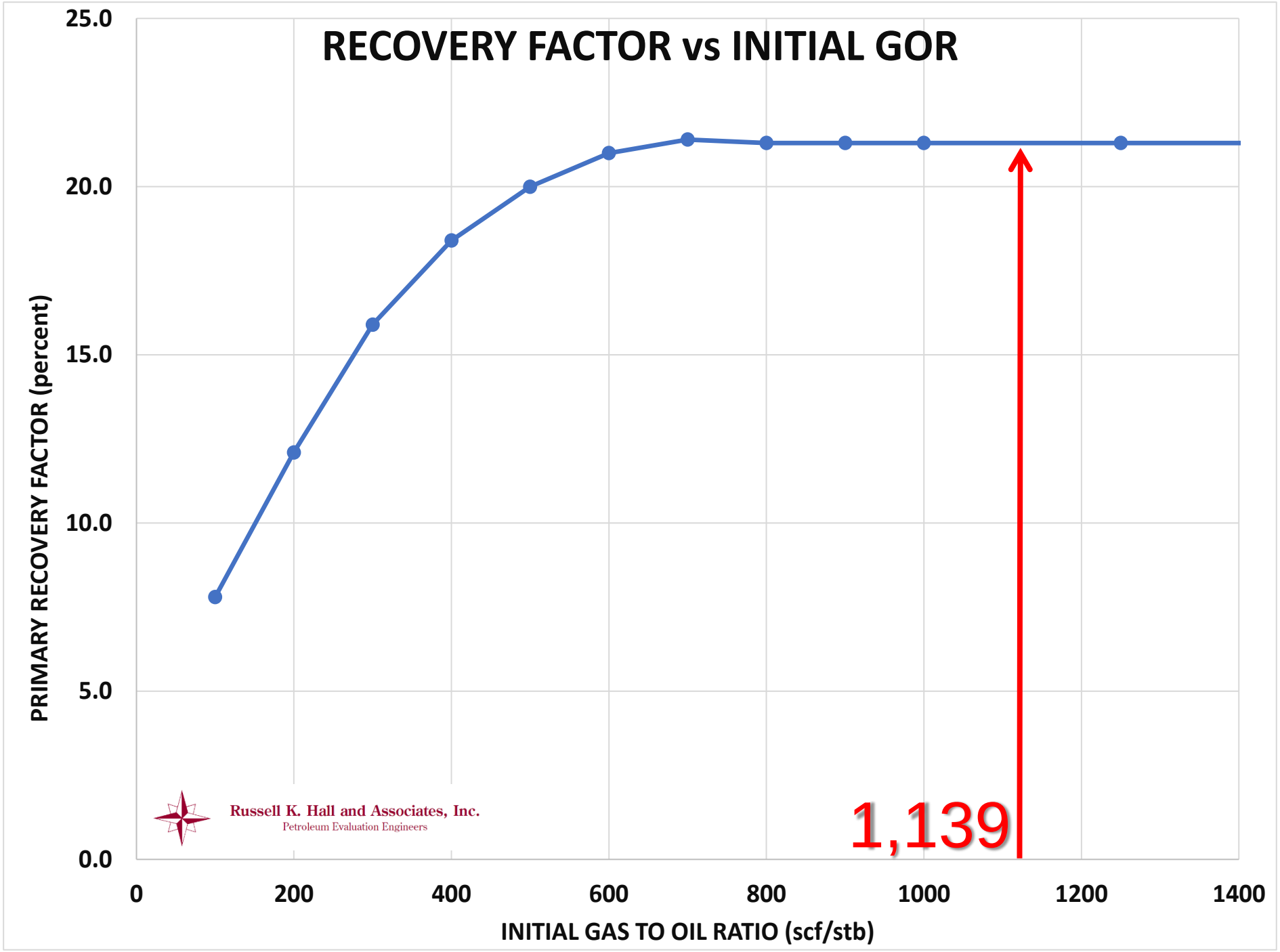


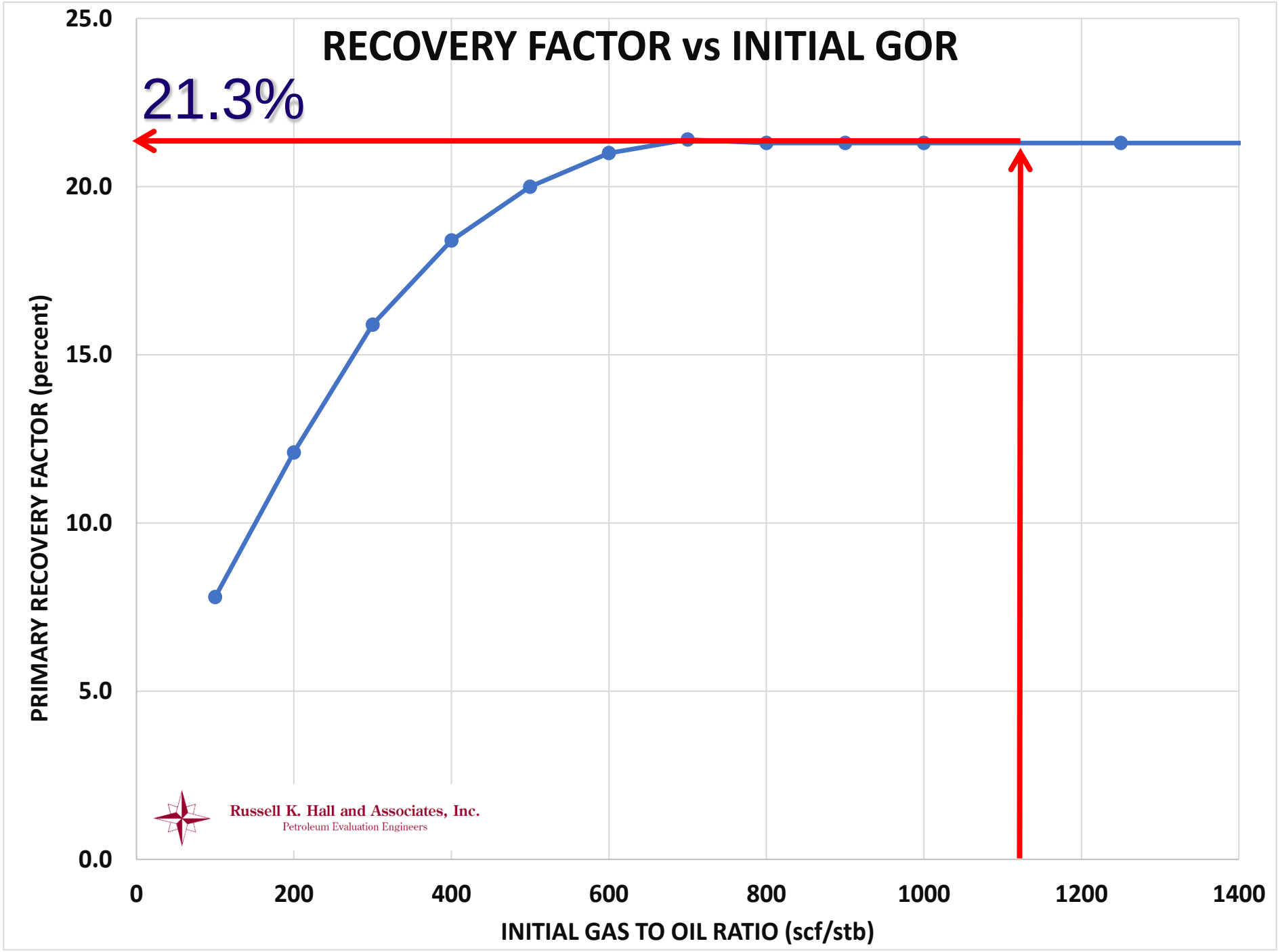
Gas to Oil Ratio (GOR)

After Producing 1 Year




RECOVERY FACTOR vs INITIAL GOR
PRIMARY RECOVERY FACTOR (percent)
25.0
20.0
15.0
10.0
5.0
0.0
0
200
400
600
800
1000
1200
1400
INITIAL GAS TO OIL RATIO (scf/stb)
RESERVOIR ASSUMPTIONS
POROSITY 10%
PERMEABILITY 1 md
OIL SATURATION 75%
WATER SATURATION 25%
ORIGINAL BHP 2,200 psia
DEPTH 5,000 ft RESERVIOR
TEMPERATURE 115
THICKNESS 50 ft
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers


RECOVERY FACTOR vs INITIAL GOR
PRIMARY RECOVERY FACTOR (percent)
25.0
20.0
15.0
10.0
5.0
0.0
0
200
400
600
800
1000
1200
1400
INITIAL GAS TO OIL RATIO (scf/stb)
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers
1,139


RECOVERY FACTOR vs INITIAL GOR
21.3%
25.0
20.0
15.0
10.0
5.0
0.0
PRIMARY RECOVERY FACTOR (percent)
0
200
400
600
800
1000
1200
1400
INITIAL GAS TO OIL RATIO (scf/stb)
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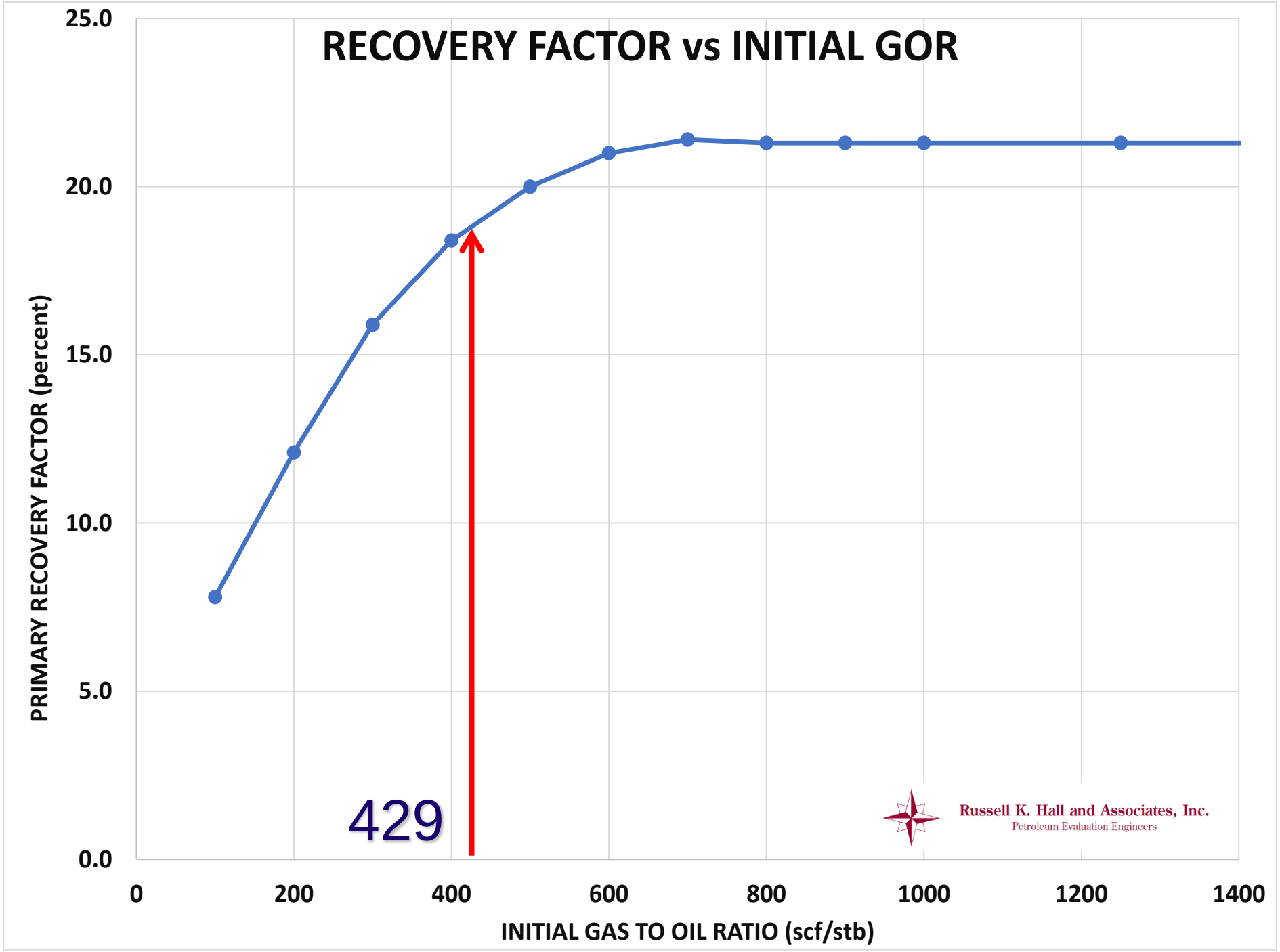
Petroleum Evaluation Engineers


RECOVERY FACTOR vs INITIAL GOR
PRIMARY RECOVERY FACTOR (percent)
25.0
20.0
15.0
10.0
5.0
0.0
0
200
400
600
800
1000
1200
1400
INITIAL GAS TO OIL RATIO (scf/stb)
429
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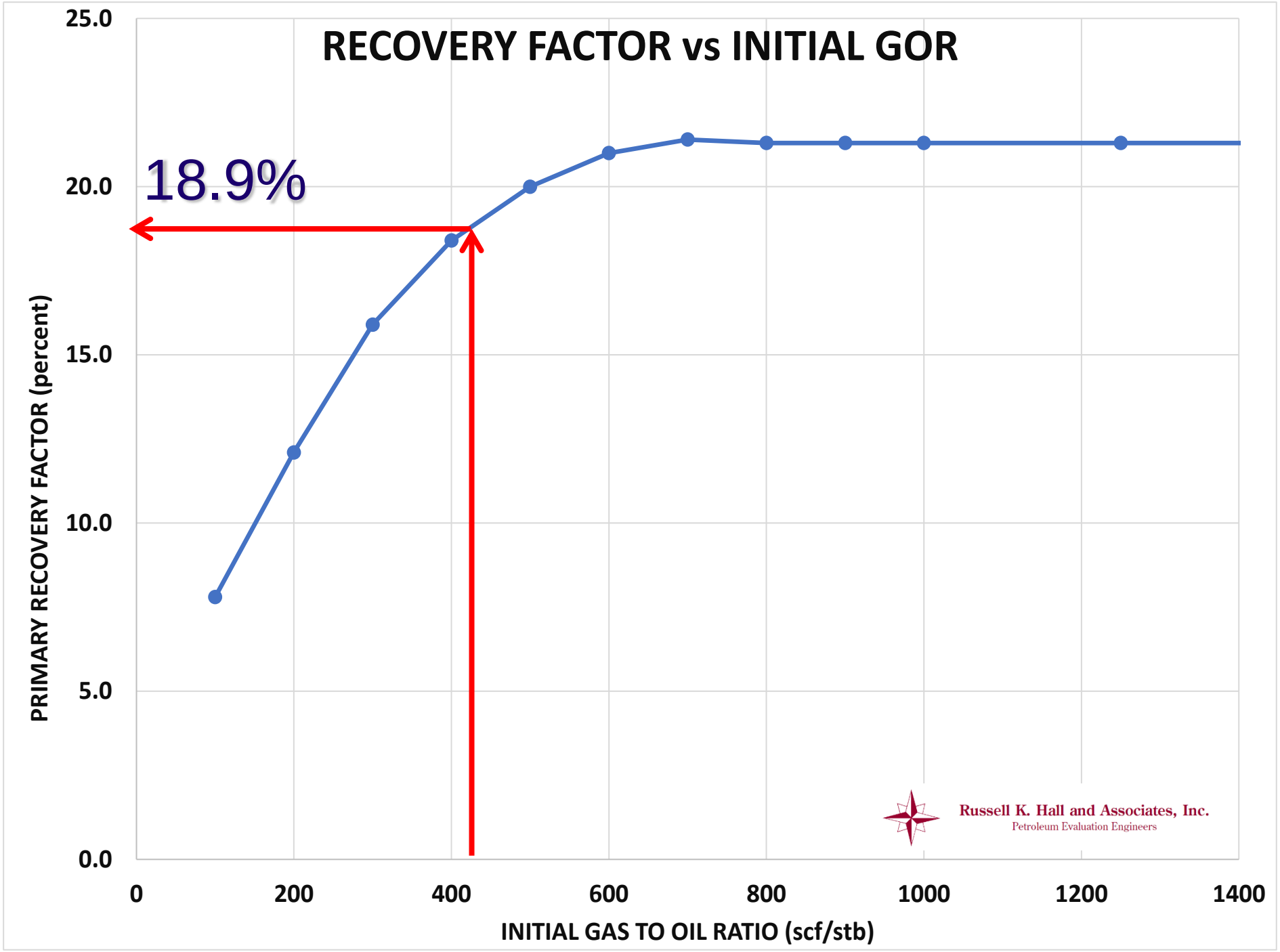
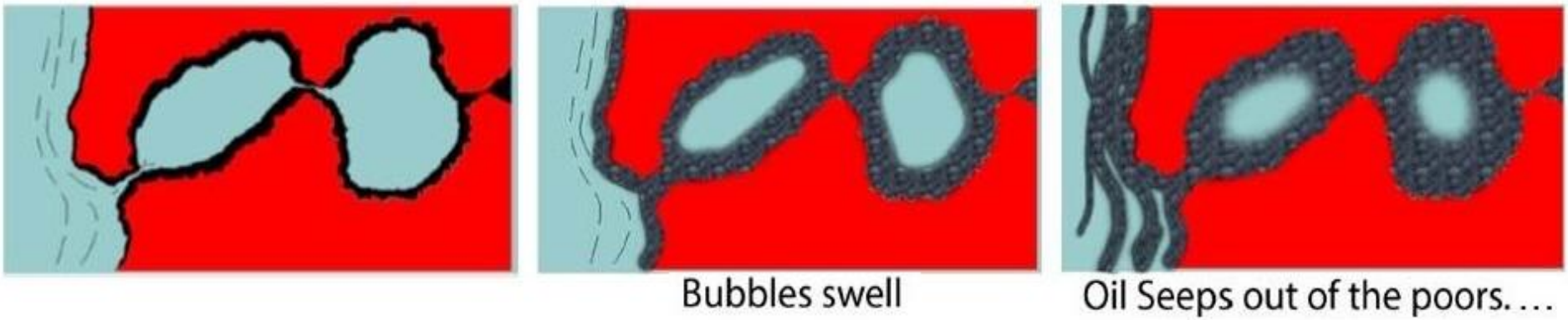
Petroleum Evaluation Engineers


RECOVERY FACTOR vs INITIAL GOR
18.9%
PRIMARY RECOVERY FACTOR (percent)
25.0
20.0
15.0
10.0
5.0
0.0
0
200
400
600
800
1000
1200
1400
INITIAL GAS TO OIL RATIO (scf/stb)
Russell K. Hall and Associates, Inc.
Petroleum Evaluation Engineers

Reservoir Fluid Properties

- Change in GOR (1,139 to 429) Results in 11% Drop in Recovery Factor
- However GOR Change May Have a MORE PRONOUNCED Effect Due to ROZ Depressurization



Source Melzer

Horizontal San Andres

- Reservoir Is Complex !
- Data Strongly Supports ROZ Concept
- Diagenetic Changes May Be More Important Than Depositional Environment
- Controlling Frac Growth Is Paramount For Successful Oil Production
- Gas Content Strongly Influences Recovery Efficiency
- Not All Areas Are The Same

Thank You

Russell K. Hall, P.E.

Russell K. Hall and Associates, Inc.
Midland, Texas

432-683-6622