Application of an OCGS Presentation Results in Economic Production: Examples from Hugoton Embayment and Williston Basin*

John A. Brett, III[1], E.A. (Ted) Beaumont[2], and Dan J. Hartmann[3]

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[1]Brett Exploration LLC, Oklahoma City, OK (john@leemanminerals.com)
[2]Cimarex Energy Co., Tulsa, OK (beaumont@aapg.org)
[3]DJH Energy Consulting, Fredericksburg, TX (djhec@ktc.com)

Abstract

Where is your next exploration or development idea coming from? Why not the next OCGS technical presentation? That is exactly where the technical methods were presented that took a tired, uneconomic prospect to a profitable venture.

An OCGS luncheon meeting unexpectedly unlocked a way to calculate the potential oil column of a low-perm Upper Pennsylvanian (Missourian) Lansing reservoir in the Oklahoma Panhandle of Hugoton Embayment, resulting in the patience to drill "one more well." Ted Beaumont's presentation in 2004 explained how capillary pressures and buoyancy pressure are related, and even measurable. This article shows the field development and the impact of the application on developing additional reserves.

From now on, I, John Brett, always try to take away some nugget from any presentation I attend; you should too. It might just pay dividends!

References Cited

Blakey, R. 2011, Late Pennsylvanian (300 Ma), North American Paleogeographic Maps: Colorado Plateau Geosystems. Website accessed June 7, 2016, https://www2.nau.edu/rcb7/namPP300.jpg.

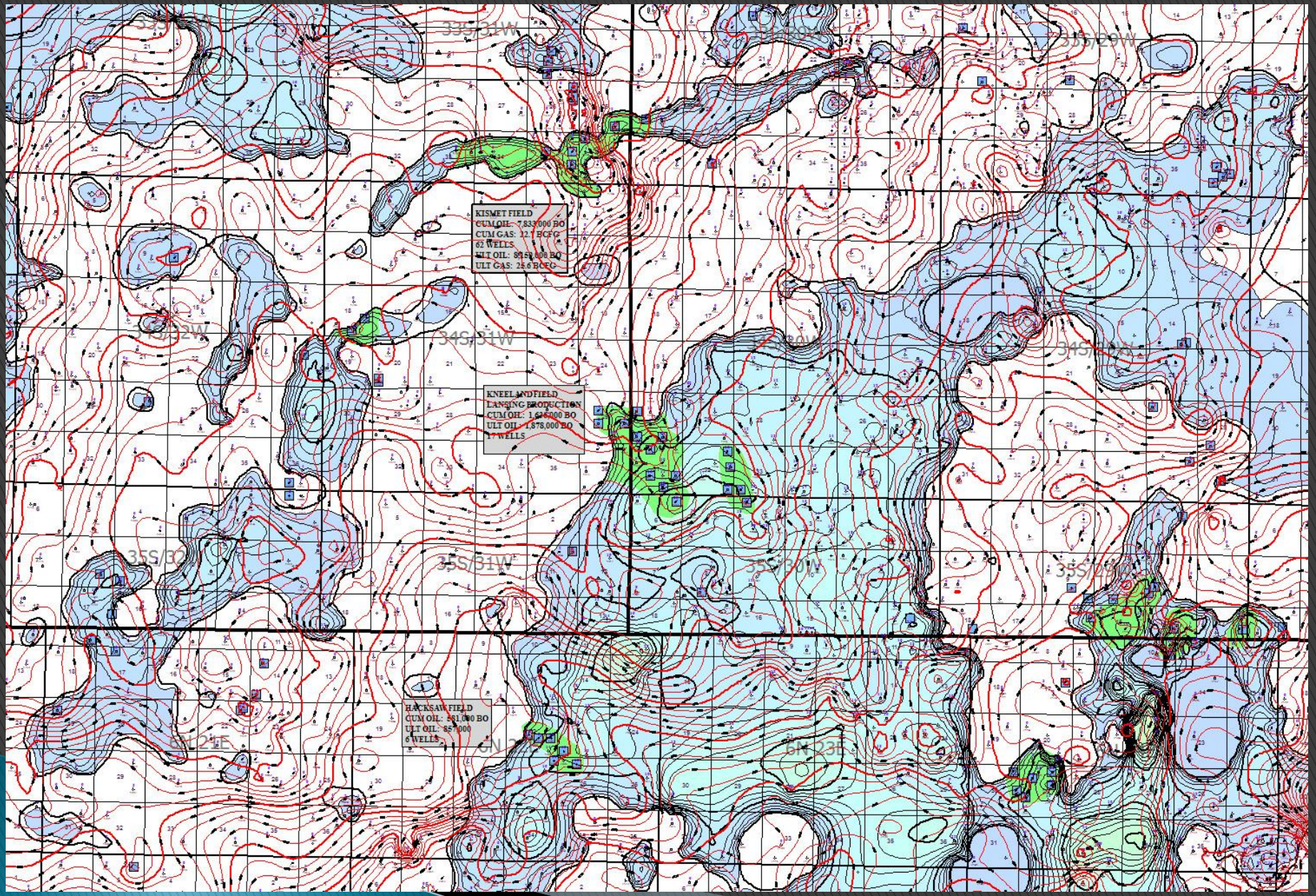
Martin, A.J., S.T. Solomon, and D.J. Hartmann, 1997, Characterization of petrophysical flow units in carbonate reservoirs: AAPG Bulletin, v. 81, 734-759.

"Application of an OCGS Presentation results in economic production"

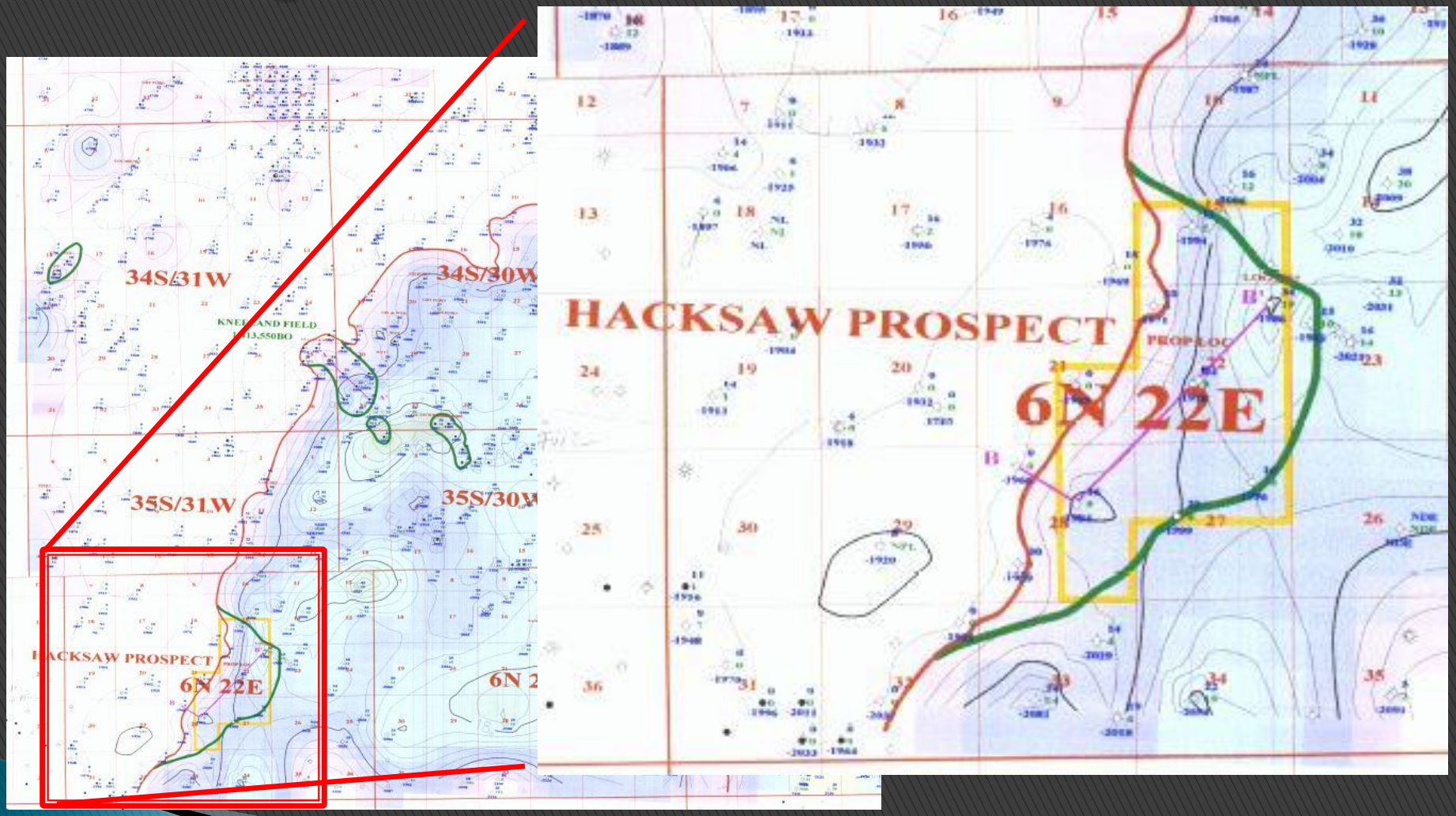
John A. Brett, III

Upper Pennsylvanian Lansing "Satellite" View (Blakey, 2011)

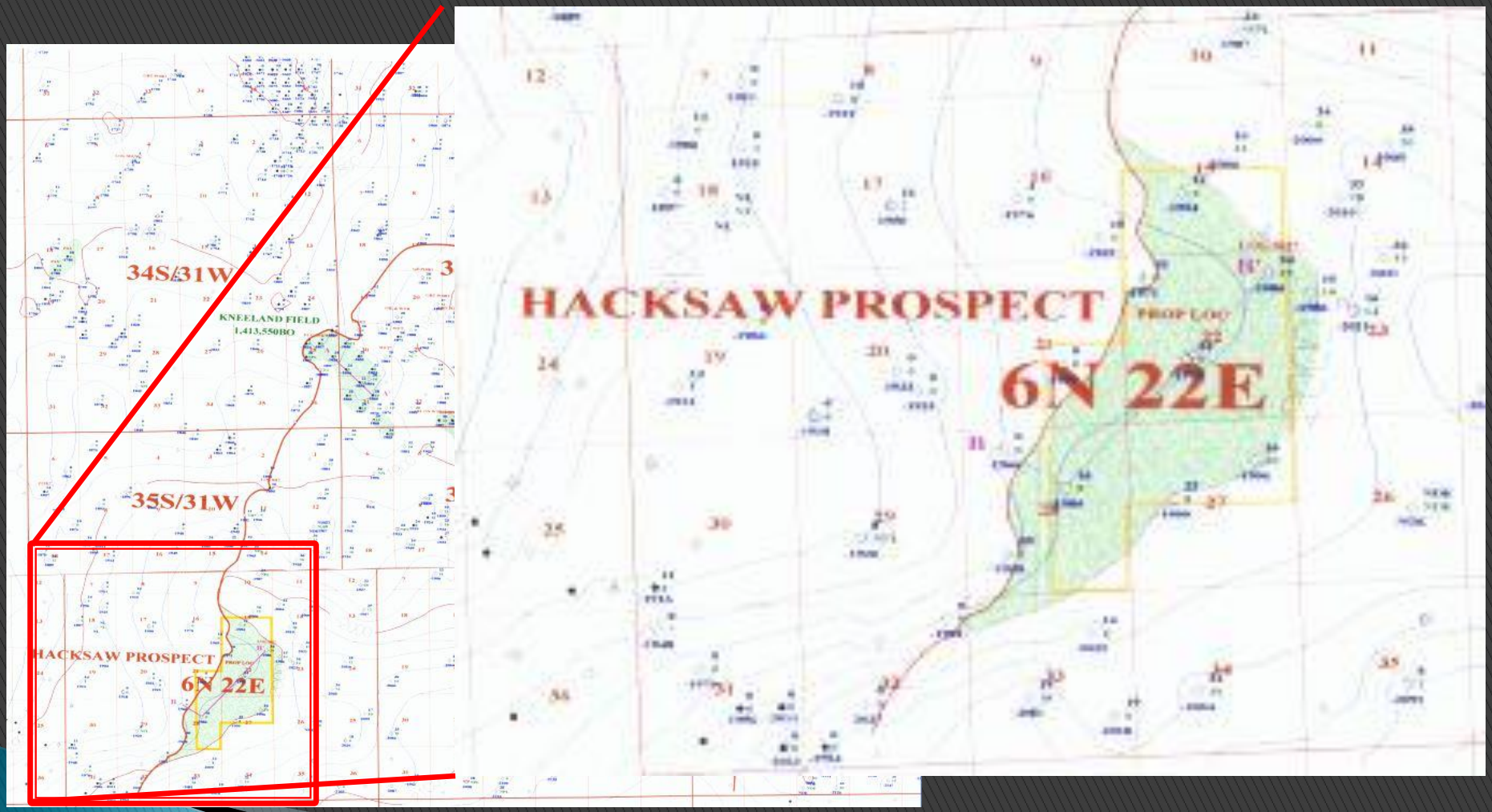
Lansing ‘A’ Isopach/Structure

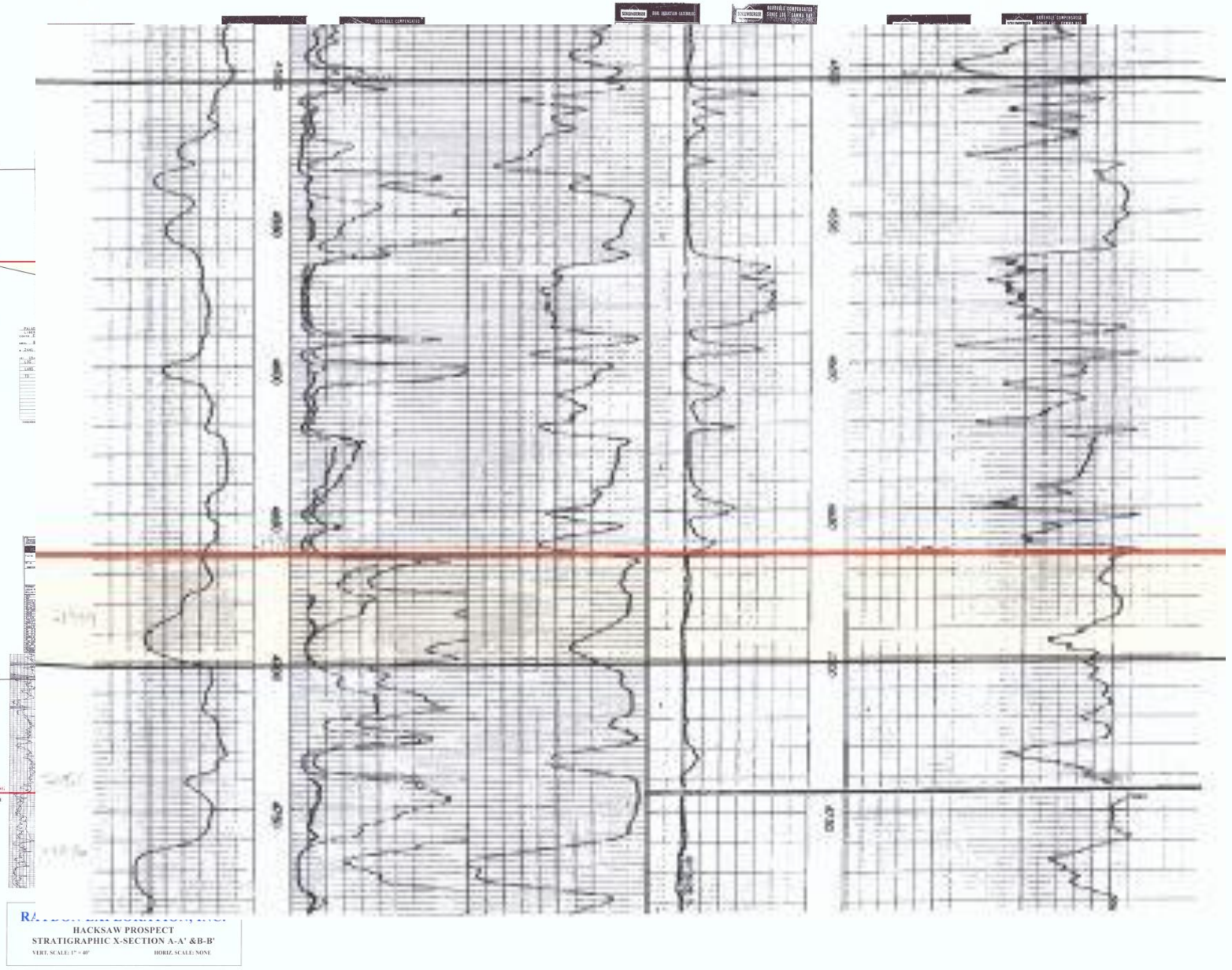


Original Prospect maps
Lansing A net Isopach

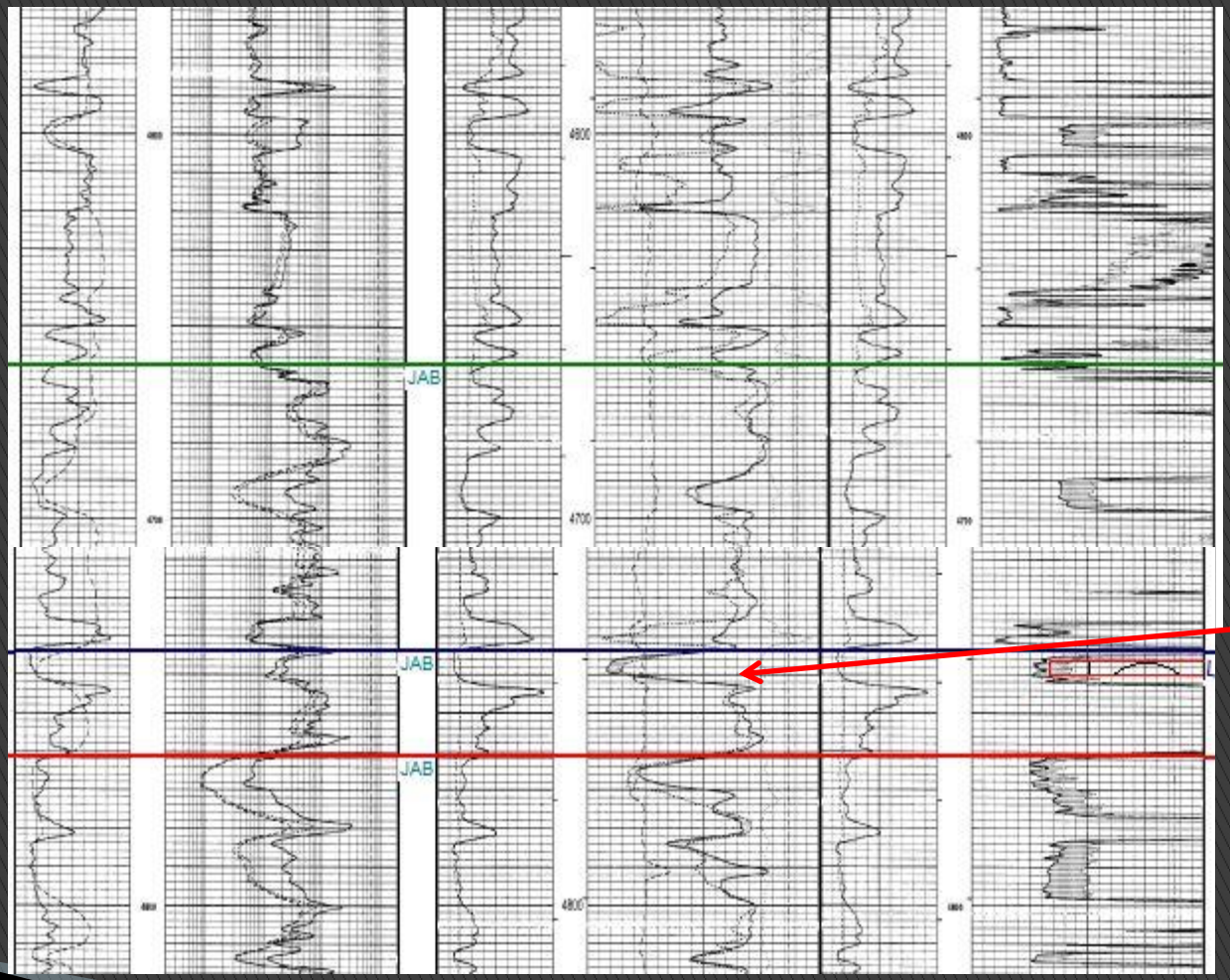


Lansing Structure Map w/ Lansing A updip limit



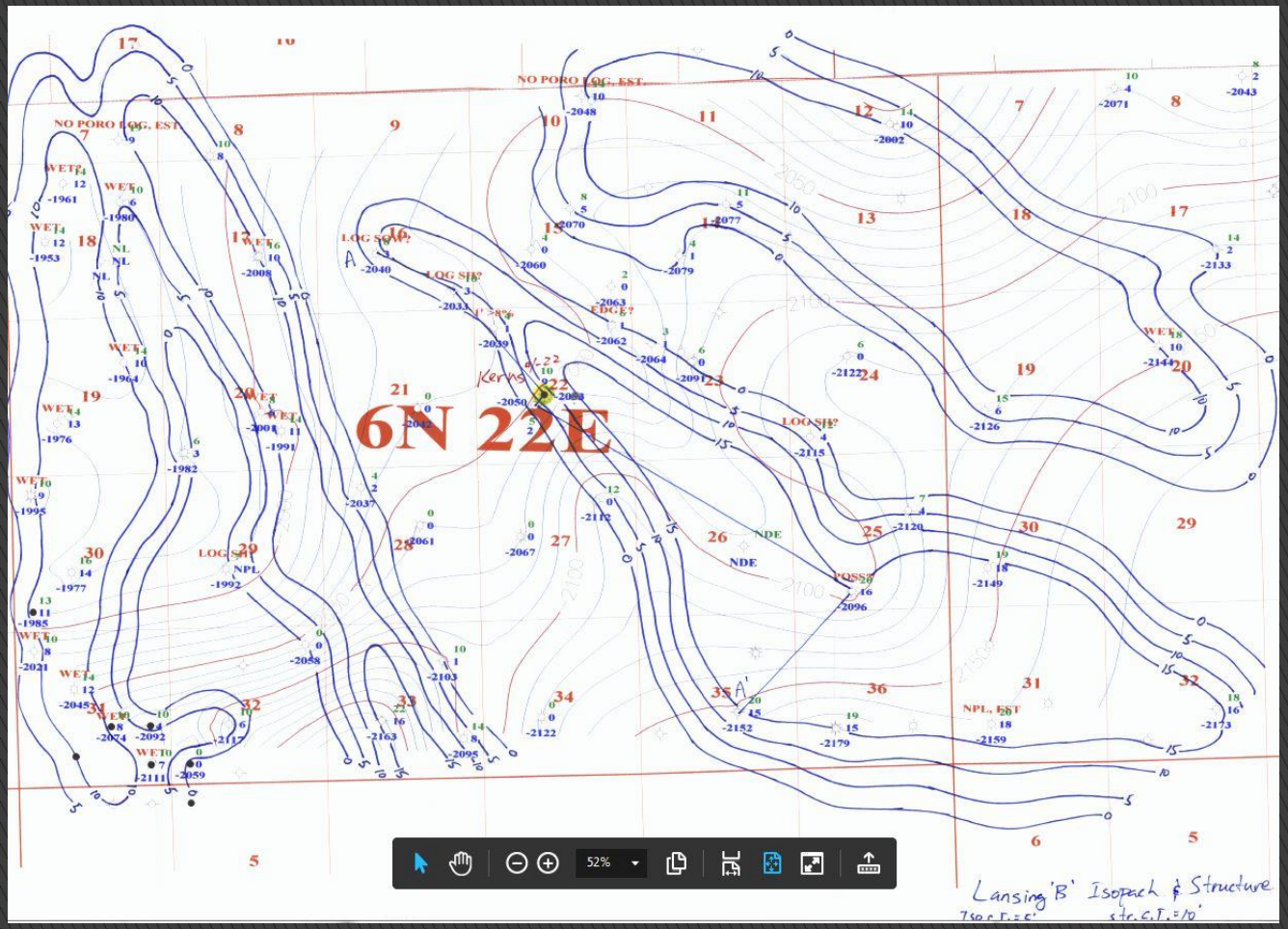

BASE HEEBNER
DATUM: LANSING
LANSING 'A' ZONE
BASE HEEBNER
DATUM: LANSING
LANSING 'A' ZONE
HACKSAW PROSPECT
STRATIGRAPHIC X-SECTION A-A' &B-B'
VERT. SCALE: 1" = 40'
HORIZ. SCALE: NONE

Kerns #1-22



Lansing 'B'
Rec. free oil
on DST,
IPP:
35BOPD

Initial Hand Map (Remember those!)



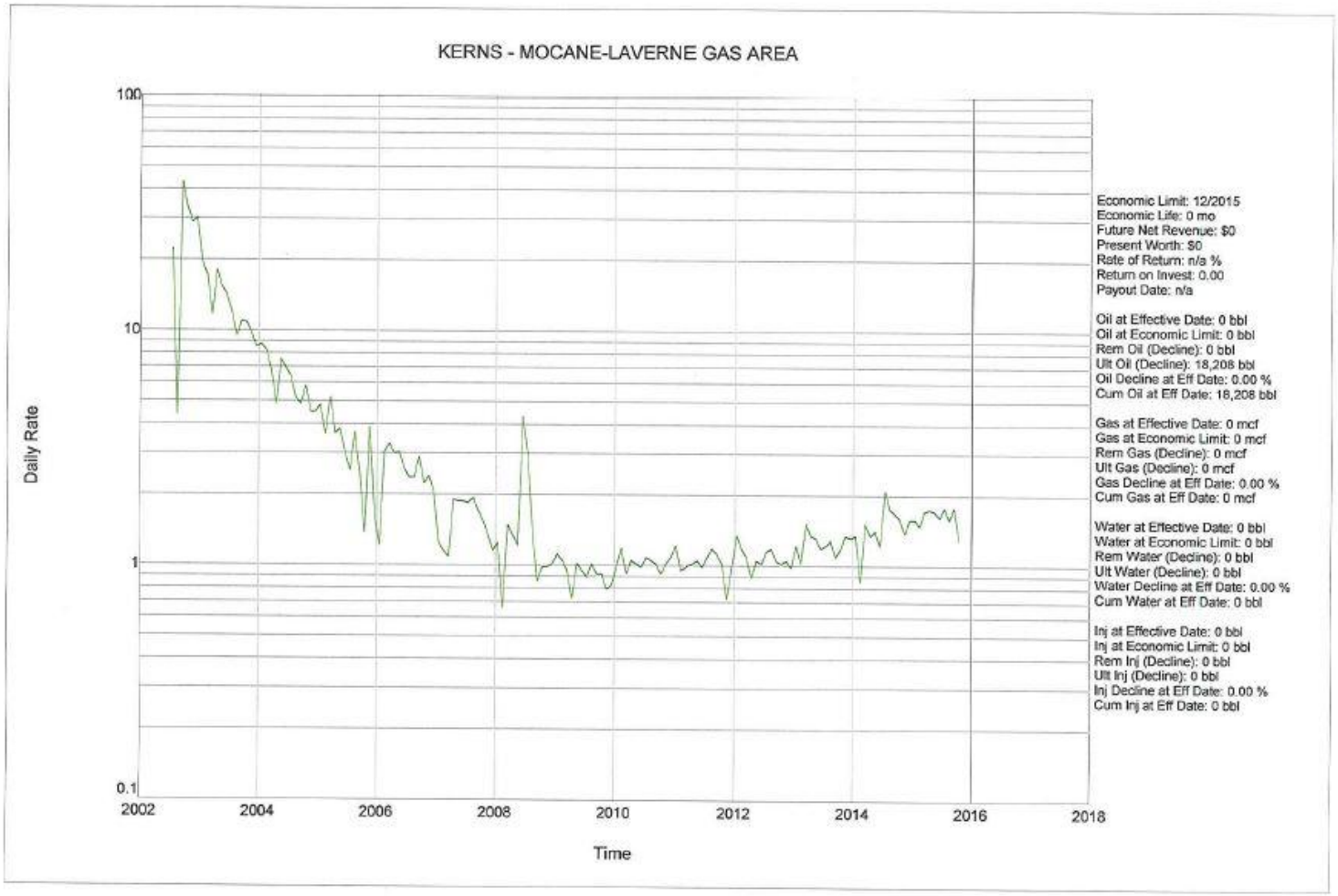
Kerns 1-22 Decline Curve

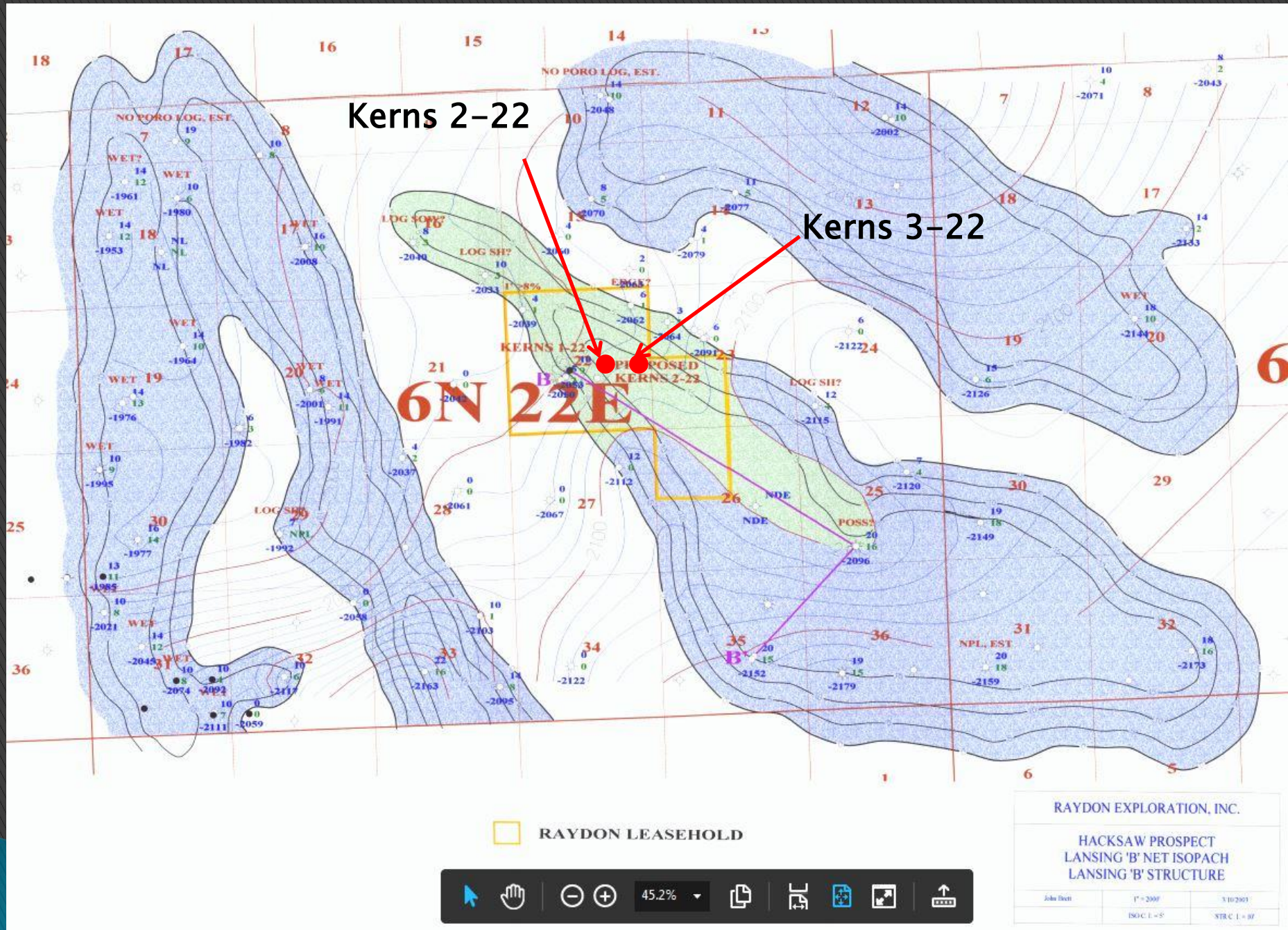
Rate/Time Graph Project: C:\Users\steve.RAYDON\Documents\IHS\PowerTools\Projects v9.2\RAYDON PRODUCTION.mdb

Date: 11/10/2015
Time: 3:30 PM

Lease Name: KERNS (1)
County, ST: BEAVER, OK
Location: 0-0-0

Operator: RAYDON EXPLORATION INCORPORATED
Field Name: MOCANE-LAVERNE GAS AREA

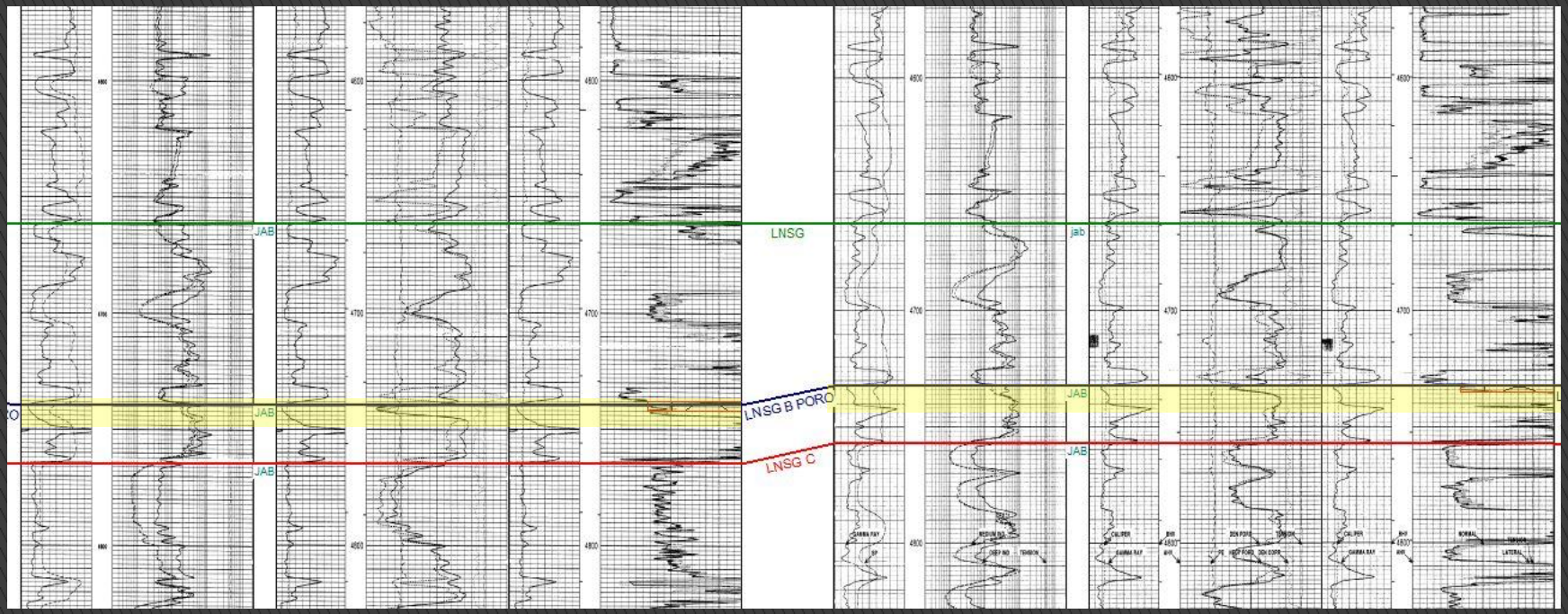



Kerns 2-22
Kerns 3-22
6N 22E
KERNS 1-22
PROPOSED
KERNS 2-22
NO PORO LOG, EST.
LOG SH?
WET?
WET
NL
NDE
POSS?
NPL, EST
RAYDON LEASEHOLD
RAYDON EXPLORATION, INC.
HACKSAW PROSPECT
LANSING 'B' NET ISOPACH
LANSING 'B' STRUCTURE
45.2%

Two More Marginal Wells

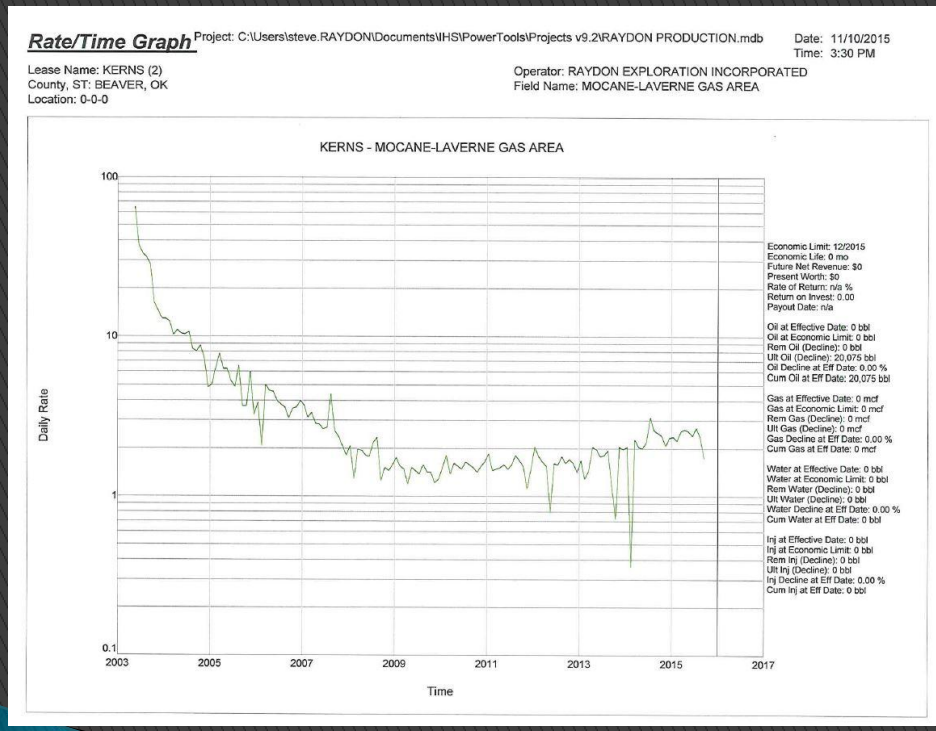
Kerns #2-22

Kerns #3-22



Kerns 2-22 and 3-22 Decline Curves

Kerns 2-22



Kerns 3-22

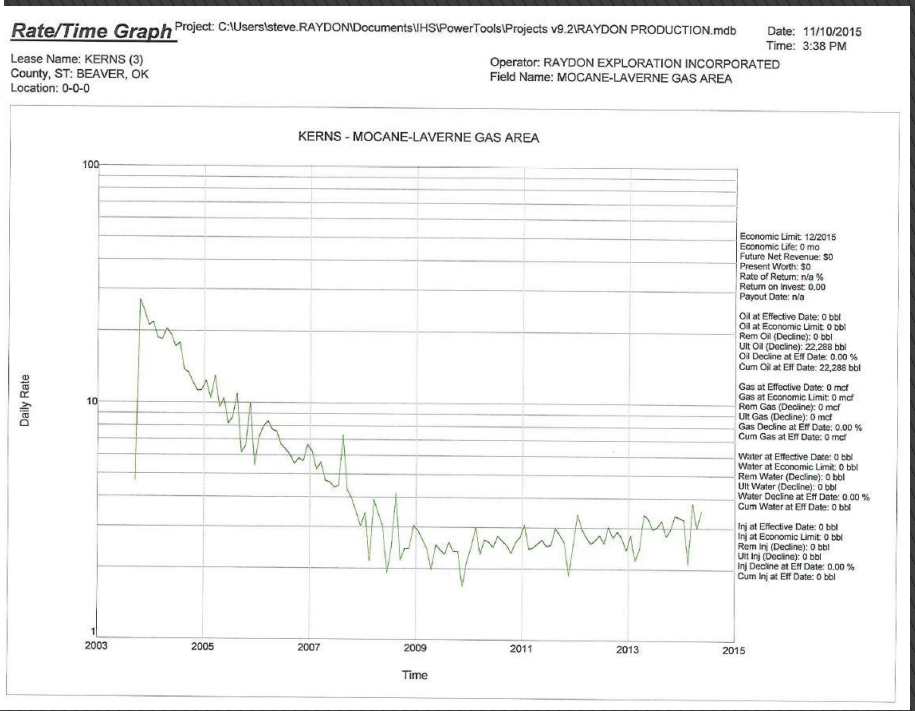
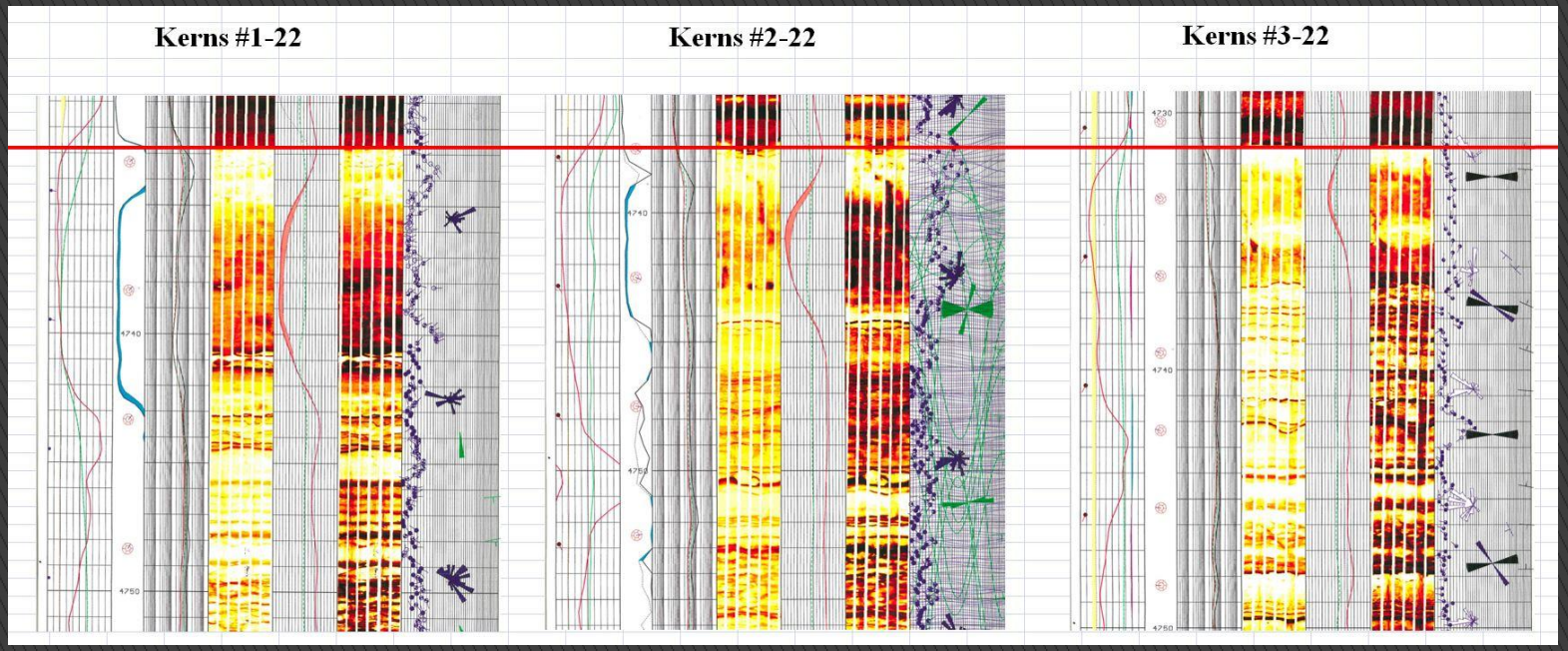
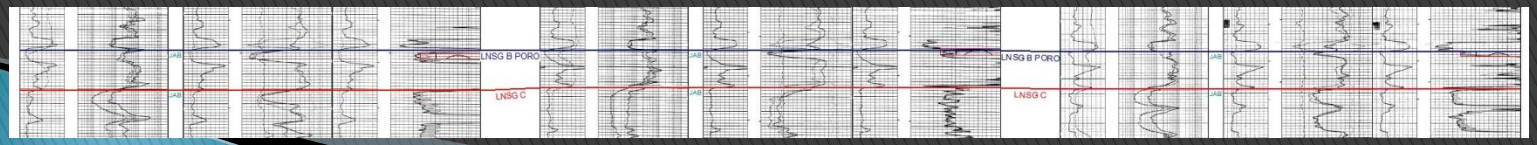


Image Logs show moldic porosity, resulting in lower permeability than would be expected from Rock with 20+% Porosity





“Porosity Wedge Map”

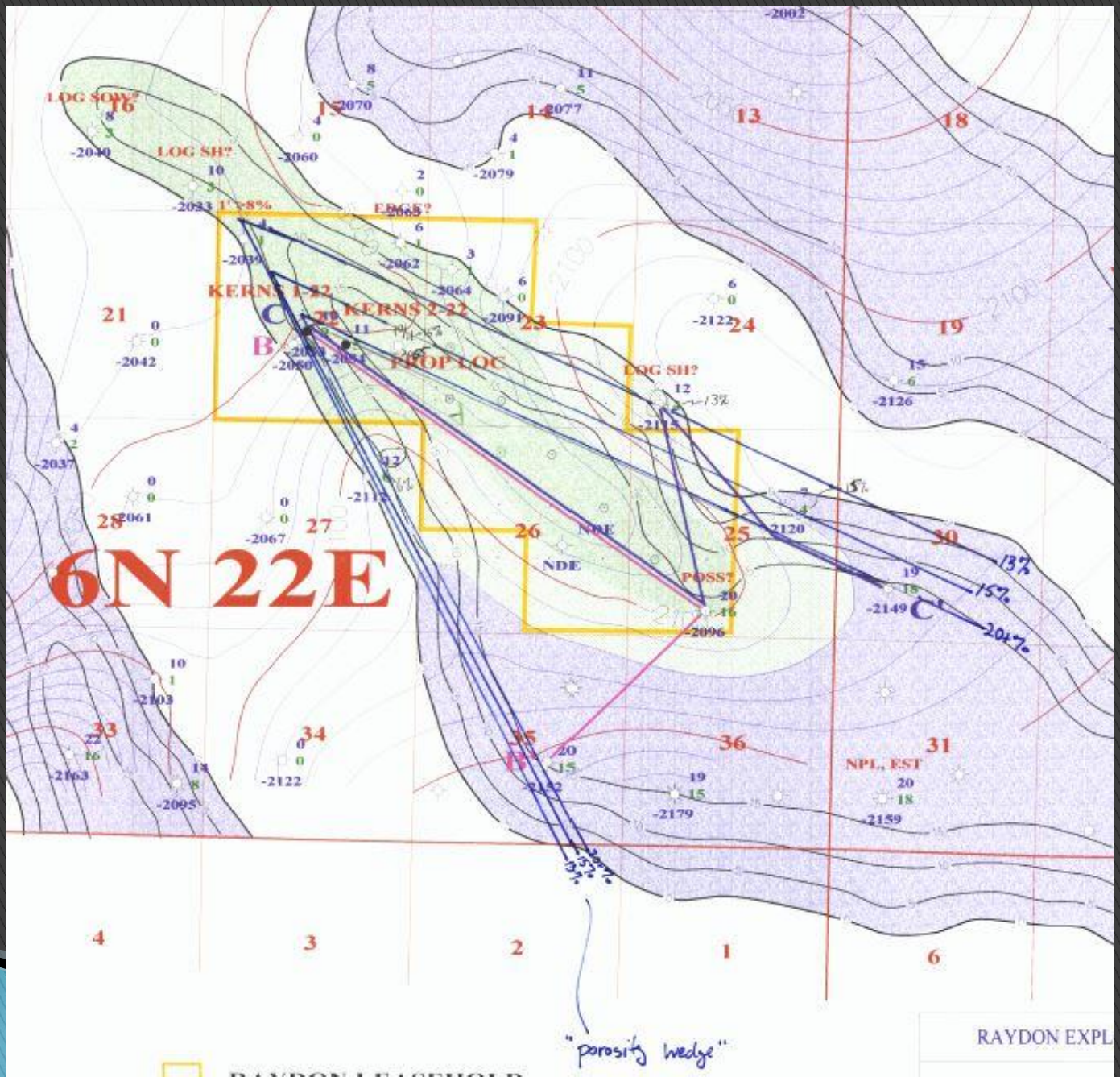
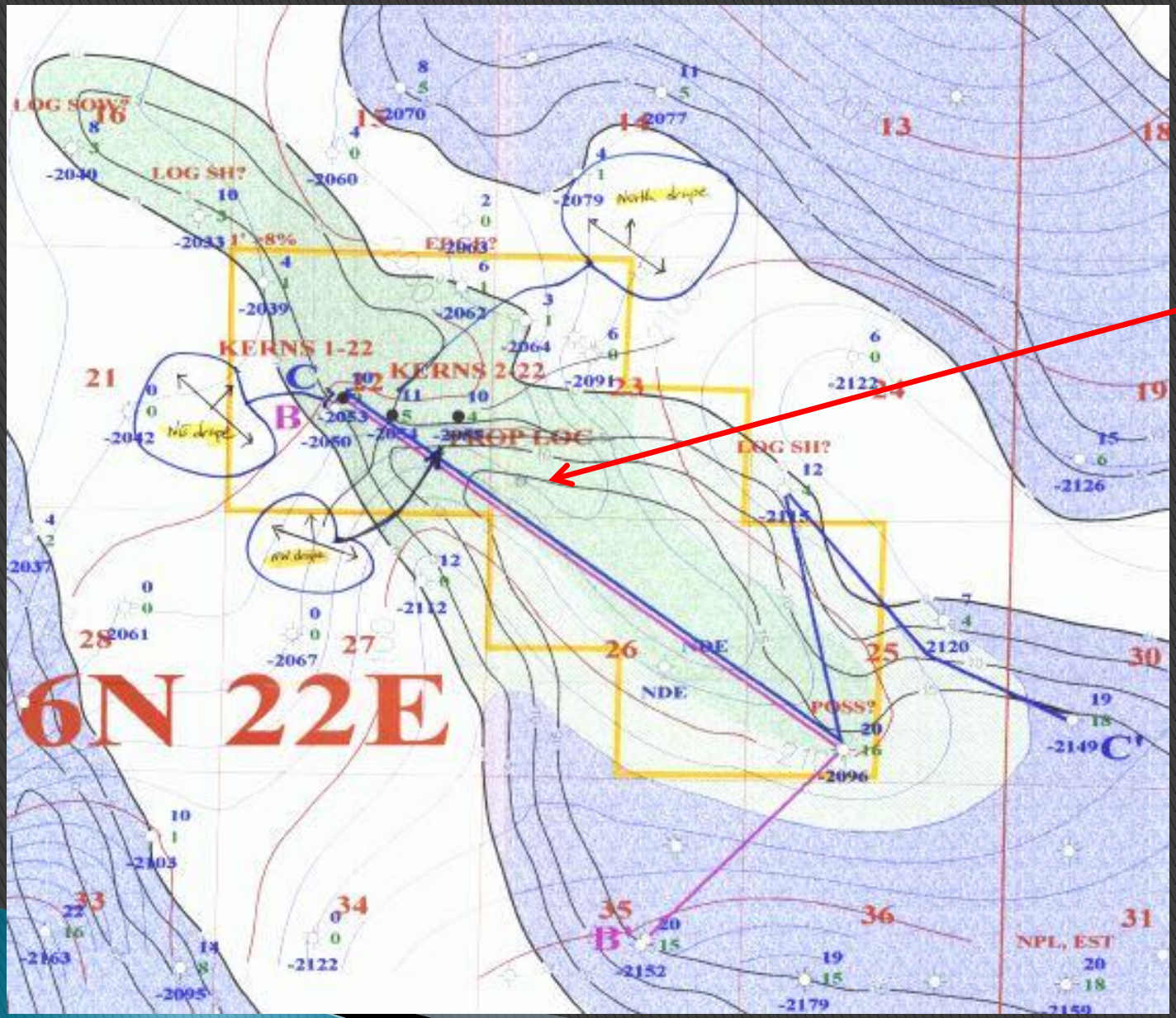


Image Logs to define strike and drape over the mounds



Drill another well?

Application of Petrophysical Principles to the 'Hunt' for Overlooked Carbonate Pay

Edward A. (Ted) Beaumont

(Cimarex Energy Co.)

and

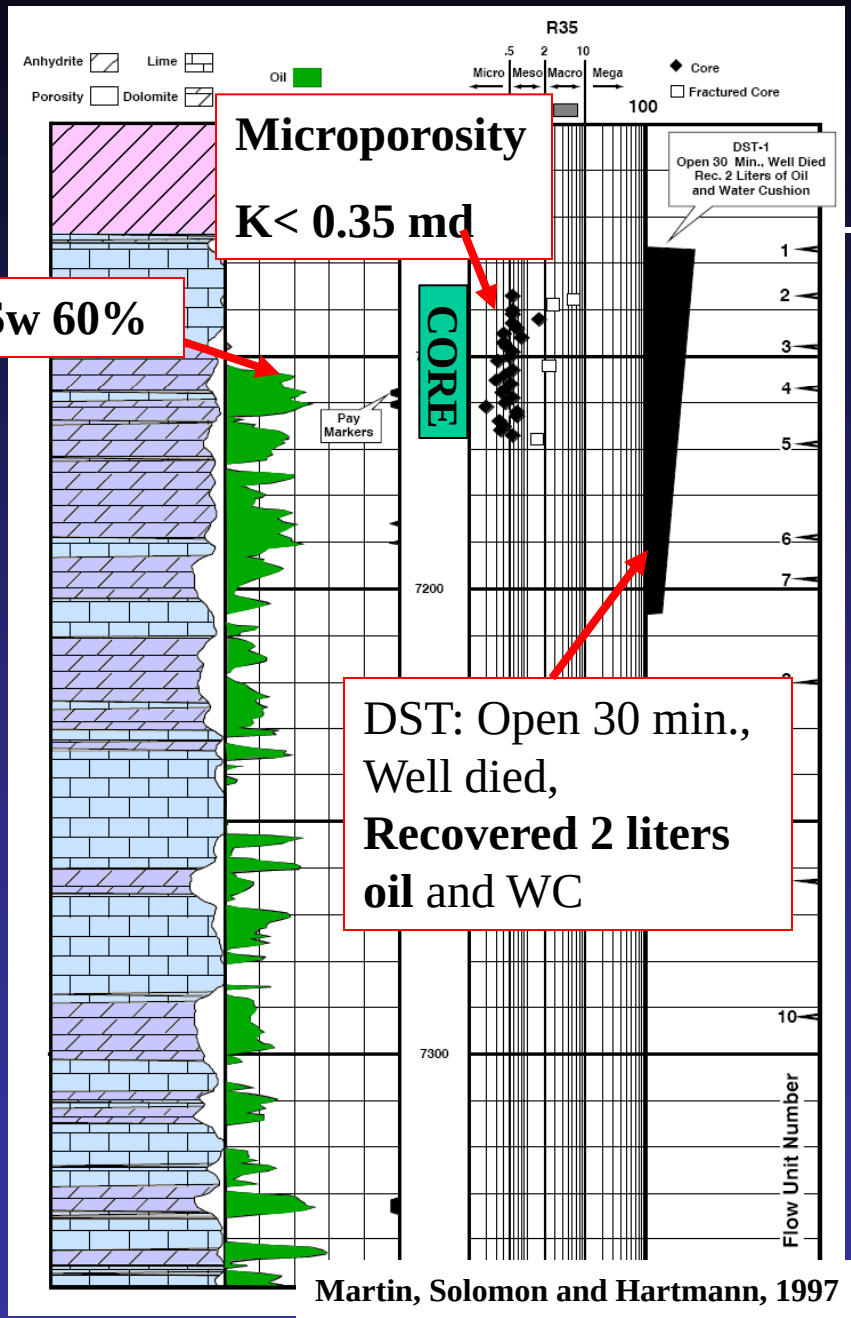
Dan J. Hartmann

Presentation

- Principles
- Approach
- Examples

Example of Application of Pore-Fluid Model to Exploration

Offset? Updip? Downdip?



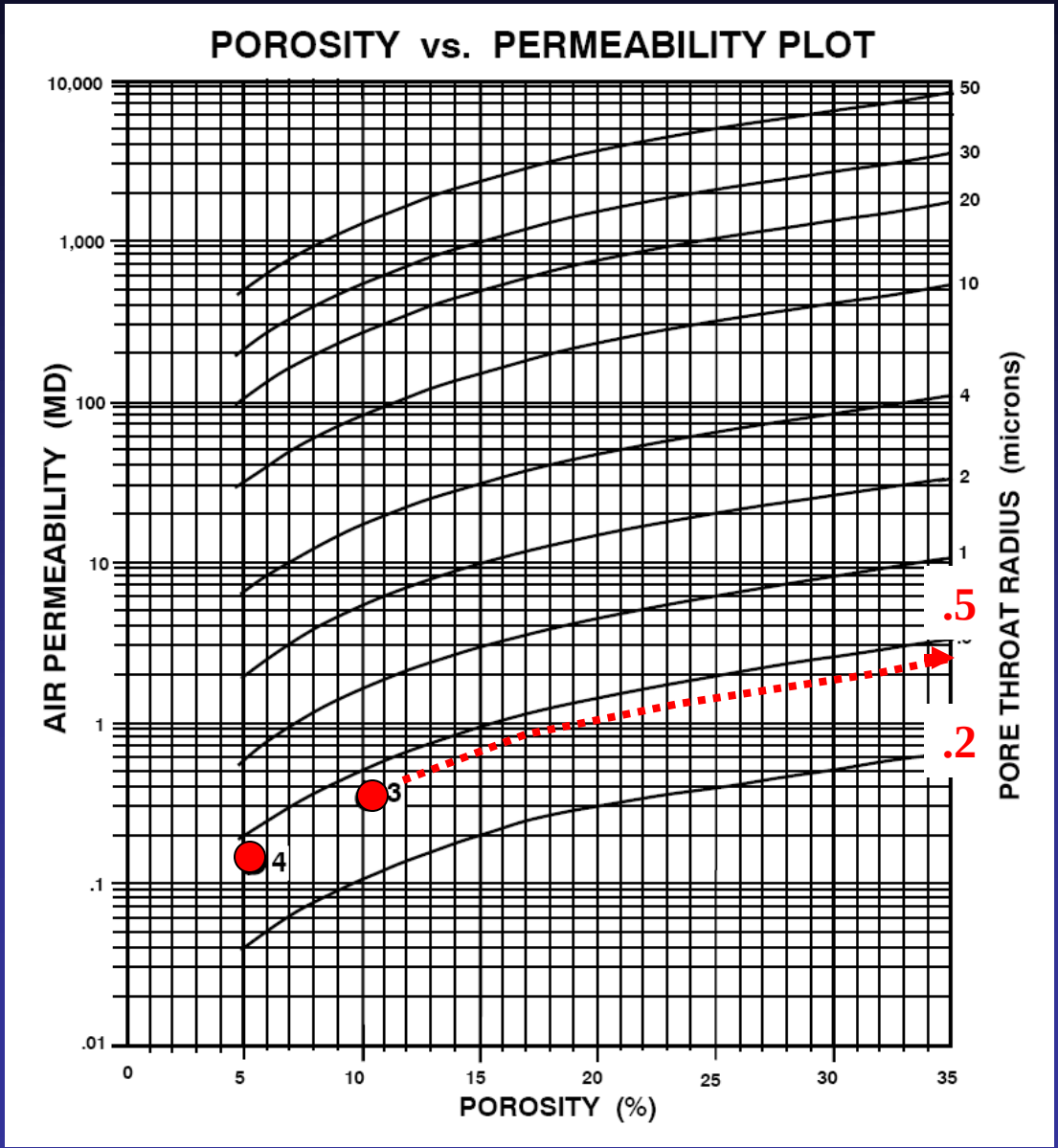
DST: Open 30 min., Well died, **Recovered 2 liters oil** and WC

Top: Mississippian Mission Canyon Fm

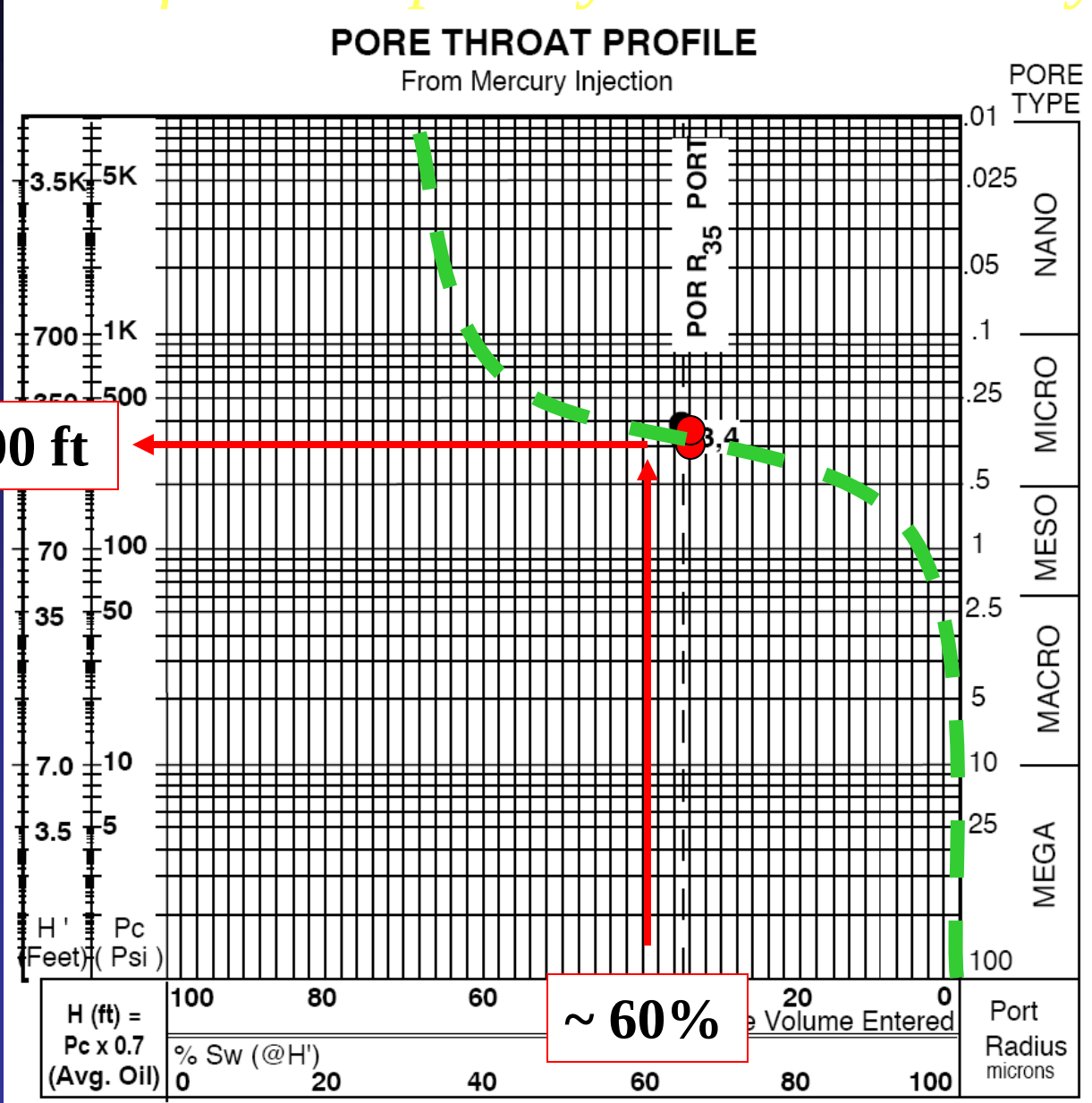
(Williston Basin)

Martin, Solomon and Hartmann, 1997

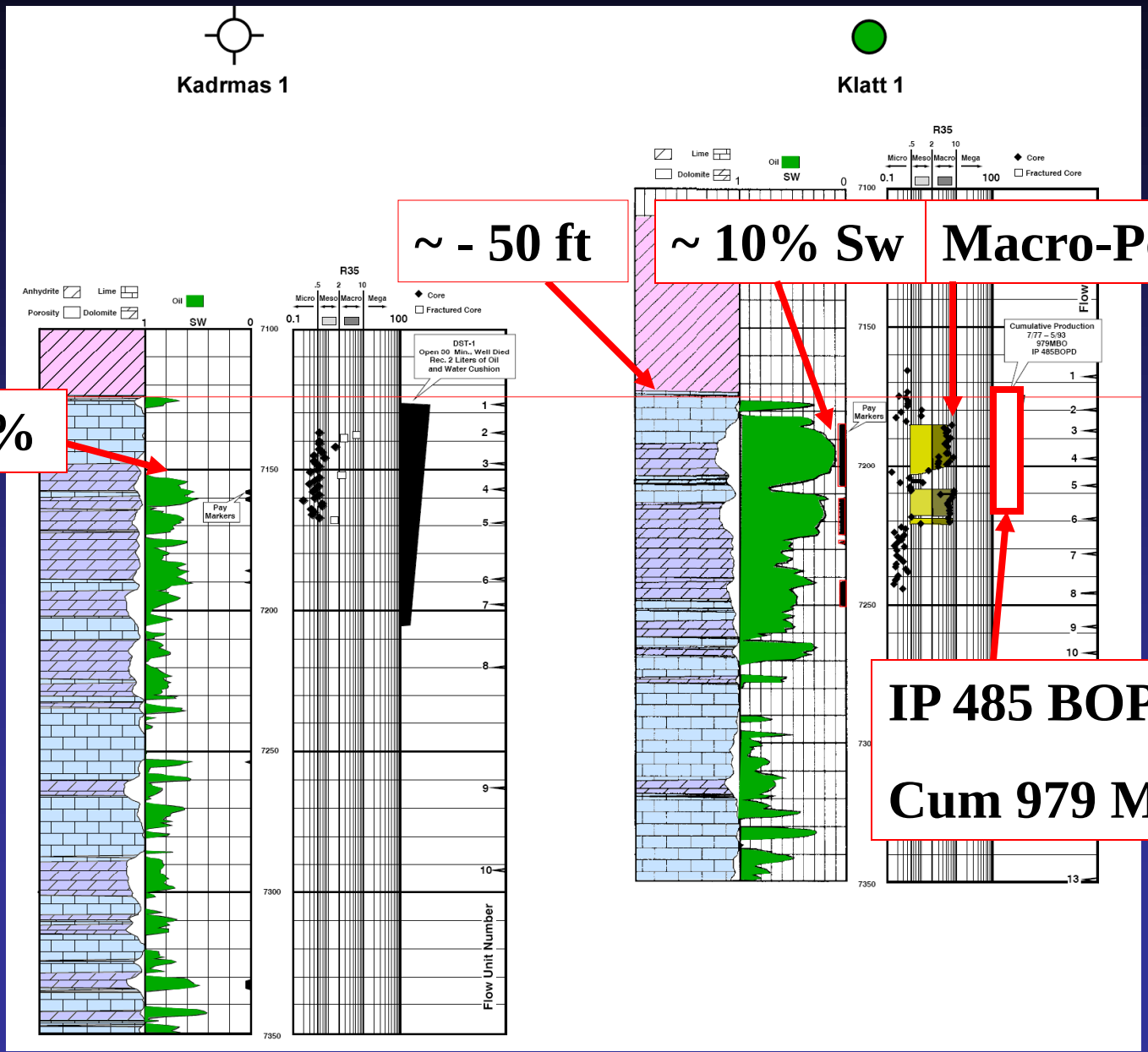
Winland Plot



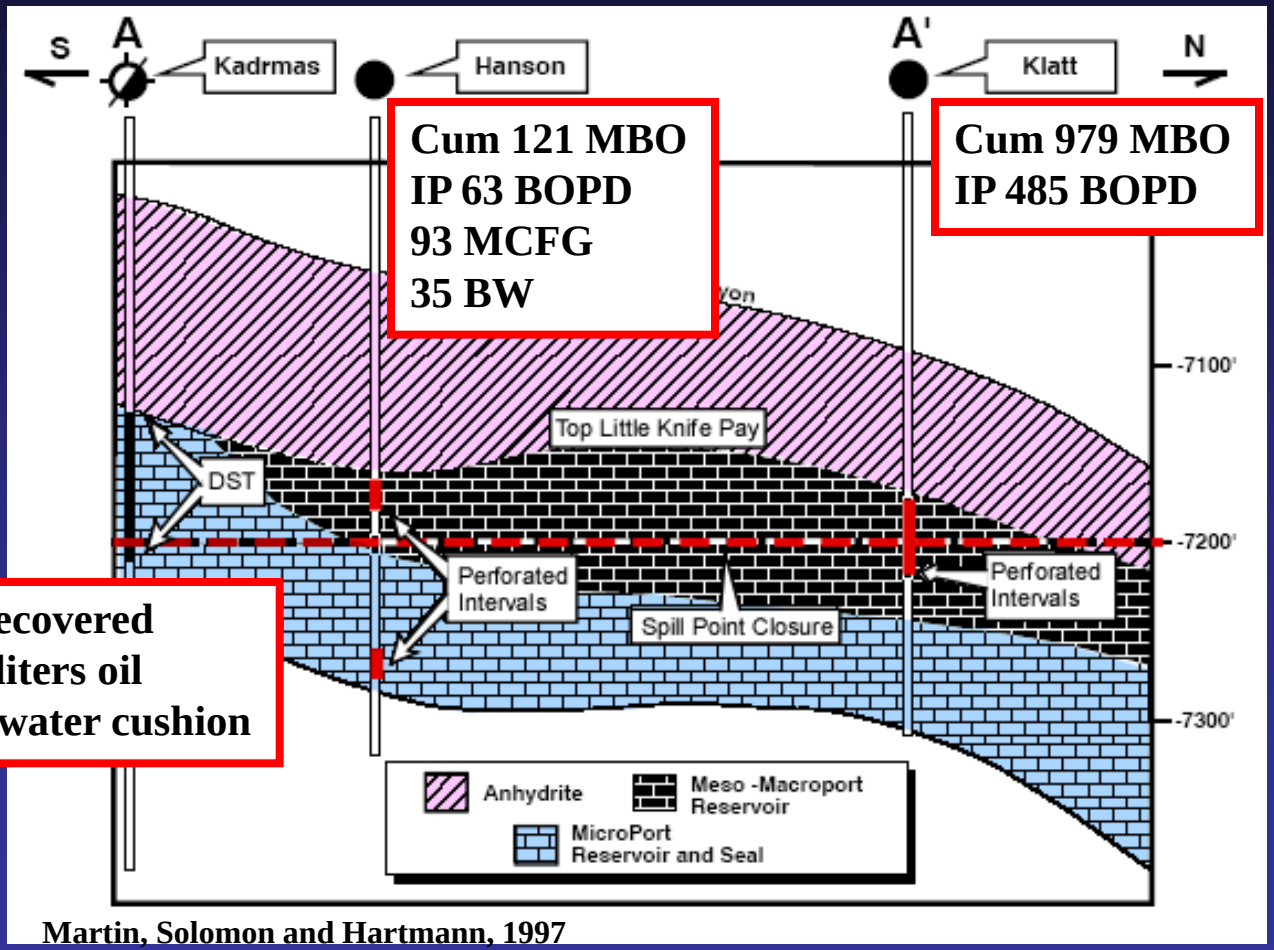
Clues from Capillary Pressure Analysis



Downdip Offset



Little Knife Dip Cross Section

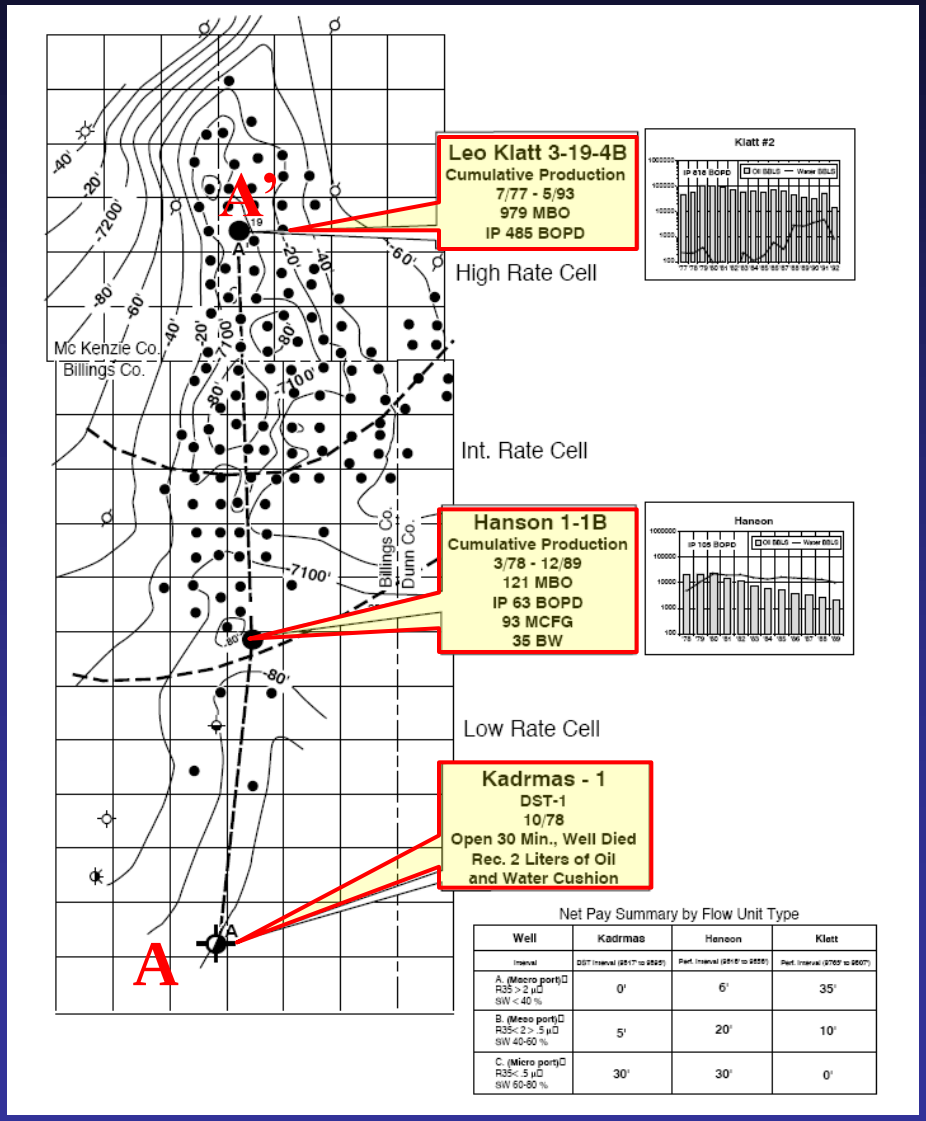


Martin, Solomon and Hartmann, 1997

- Porous grainstone basinward of anhydrite and tite packstones
- 100 million BO downdip to 60% Sw
- 150 ft oil column
- 50 ft seismic closure

Little Knife Field, Williston Basin

Exploring with petrophysical data



Well	Kadrmas	Hanson	Klatt
Interval	DST Interval (9517' to 9525')	Perf. Interval (9518' to 9558')	Perf. Interval (9765' to 9807')
A. (Macro port) R35 > 2 µ SW < 40 %	0'	6'	35'
B. (Meso port) R35< 2 > .5 µ SW 40-60 %	5'	20'	10'
C. (Micro port) R35< .5 µ SW 60-80 %	30'	30'	0'

Downdip

Along Came Ted!

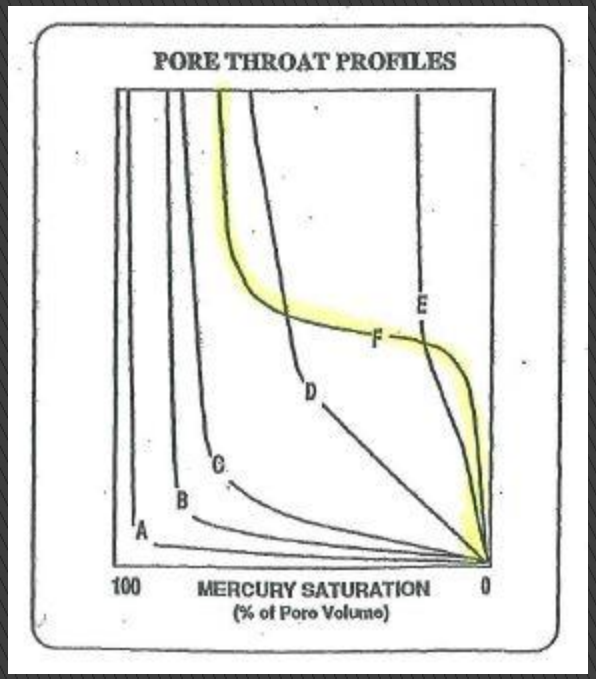
- Searching for a reason to drill “One more well”
- Ted Beaumont gave an OCGS tech talk
- Buoyancy Pressure/Capillary Pressure Relationships
- Meet with Ted for “Coaching”
- Apply the Petrophysics to our Prospect
- What is the petrophysics telling us?

From Ted's "Gameboard": Pore Geometry/Pore Throat Profiles

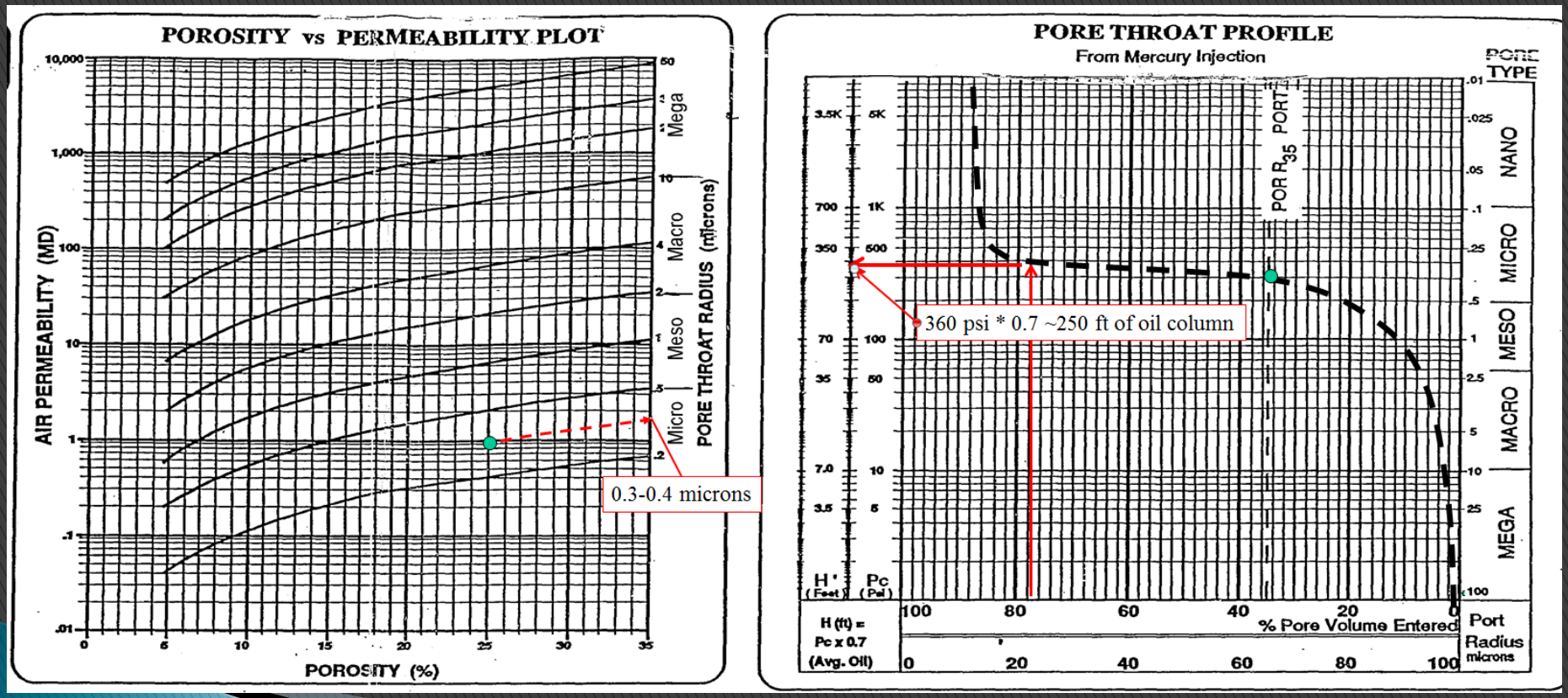
PORE GEOMETRY CLASSIFICATION CHART

PORE SHAPE	INTERGRANULAR			INTERCRYSTALLINE			VUGGY/ MOLDIC		FRACTURE	
PORE THROAT SIZE / (PORT)	MACRO	MESO	MICRO	MACRO	MESO	SUB MICRO	1 MACRO	2 MICRO	MACRO	MICRO
R_{35} (microns)	> 2.0	2.0-0.5	< 0.5	> 2.0	2.0-.5	<.2 / .2-.5	2.0	<0.5	2.0	<0.5
K / Ø RATIO	high-v-high	mod high	low	high	mod	low - v-low	v-high	low	v-high	mod
PORE THROAT PROFILE	A - B	C - D	E,F	B	C	D, E, F	A,B	C,F	A	D,E
IMMOBILE SW 3	20%	20-45	45-90	15-20	30-40	40- 80 / 30-60	10 -30	20 -60	<10 %	>10 %
INTIAL FLOW RATES	high	med	low	high	med	low / low	v -high v -low	low	v-high	low - med
PRIMARY RECOVERY 4	max	Interm	min	max	Interm	none / min	max	min	max	Interm
MAGNIFICATION TO "SEE" PORES	10X	50X	500X	30X	100X	2500 / 1000	0 -10X	30 - 1000X	0 -10X	50 - 100X

2. Dispersed Pores/Molds
4. For a given drive mechanism

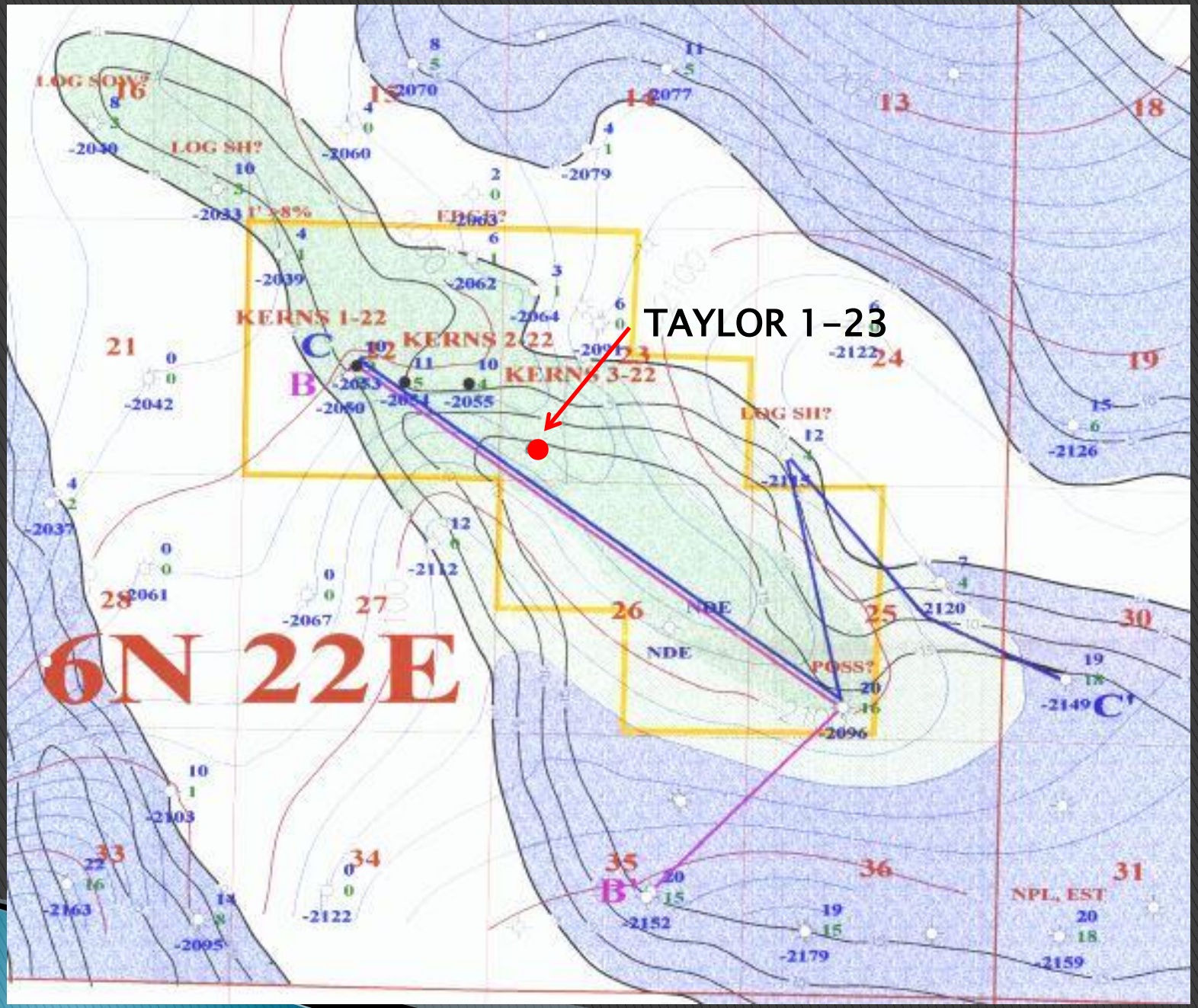


Calculating oil column height



What can we learn from this exercise?

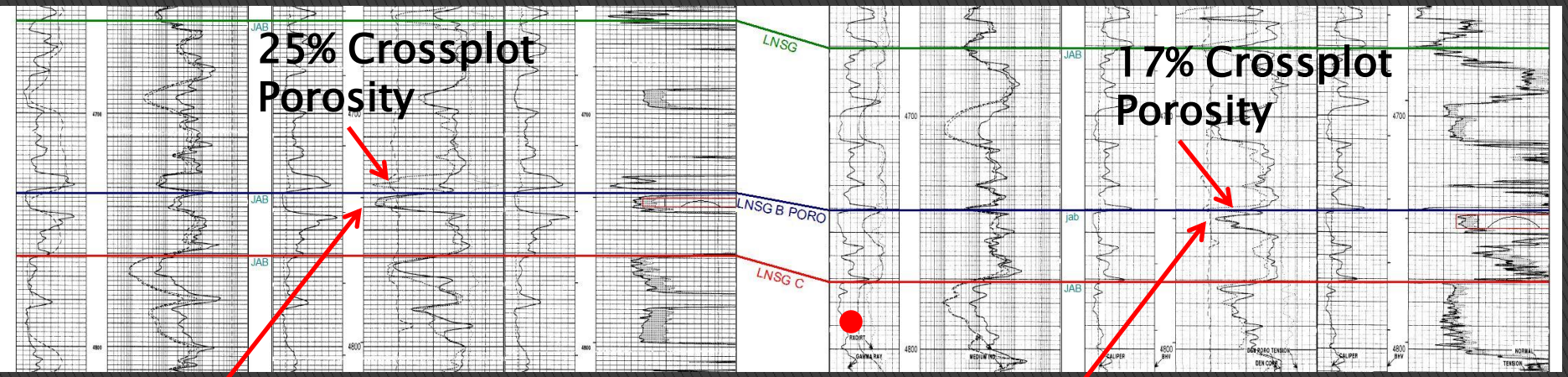
- Poorly connected Moldic porosity is suggesting a low permeability vs. porosity relationship.
- If the reservoir is homogeneous (which it is not), the oil height required to “squeeze” the oil into the low-perm rock would need to be 250’ in height.
- The control suggests 250’ oil column is impossible.
- There must be some better reservoir, with more connected pore throats, exerting the necessary buoyancy pressure.
- Yes- DRILL ONE MORE WELL!


TAYLOR 1-23
KERNS 1-22
KERNS 2-22
KERNS 3-22
6N 22E
LOG SH?
NDE
POSS?
NPL, EST

Finally Economic!

Kerns 1-22

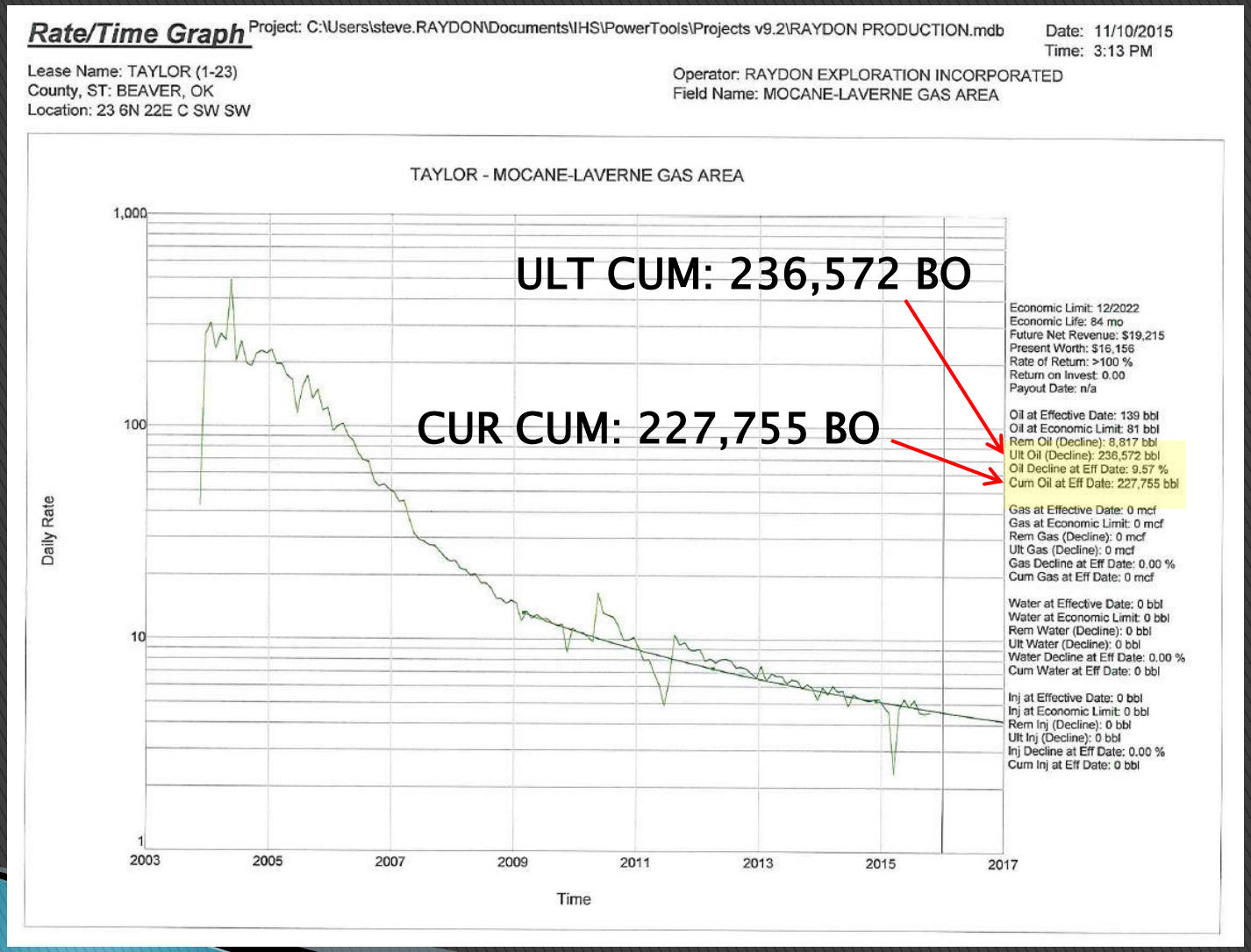
Taylor 1-23

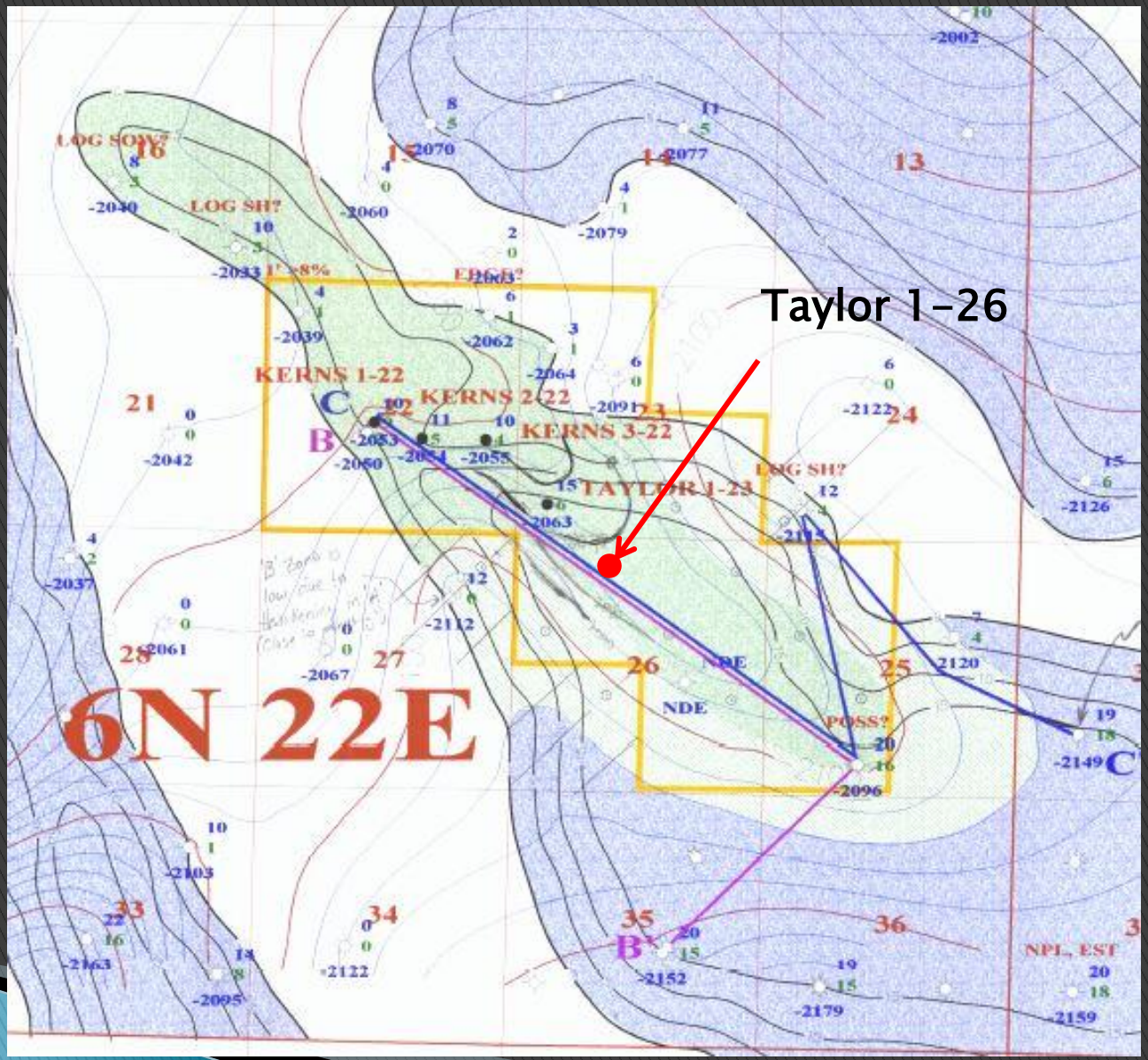


Pumped 35 BOPD
Cum: 18,208 BO
Ult: 18,208 BO

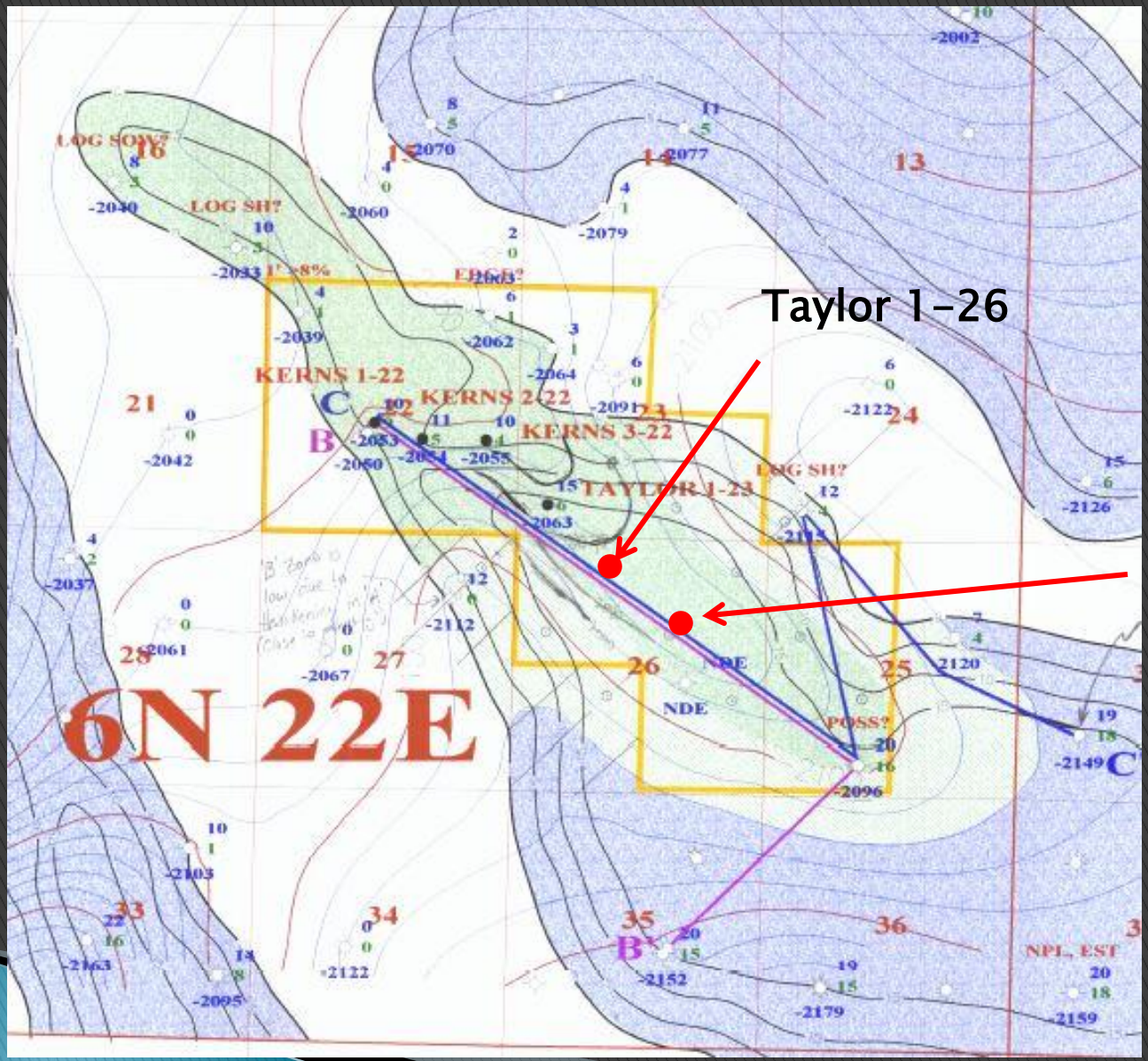
Flowed Oil to Surface on DST
Flowed over 200 BOPD
Cum: 227,755 BO
Ult: 236,572 BO

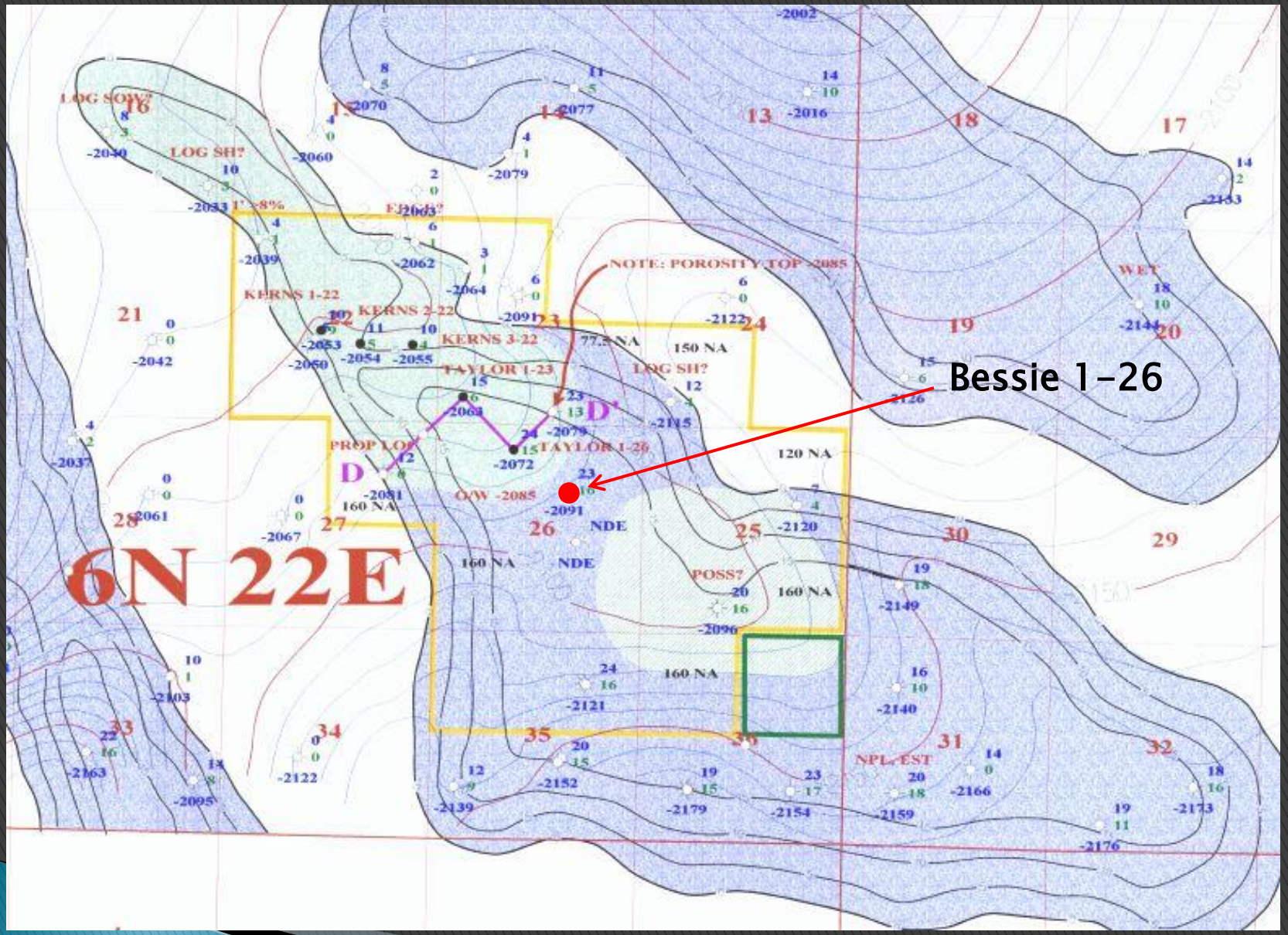
Taylor 1-23 Decline Analysis

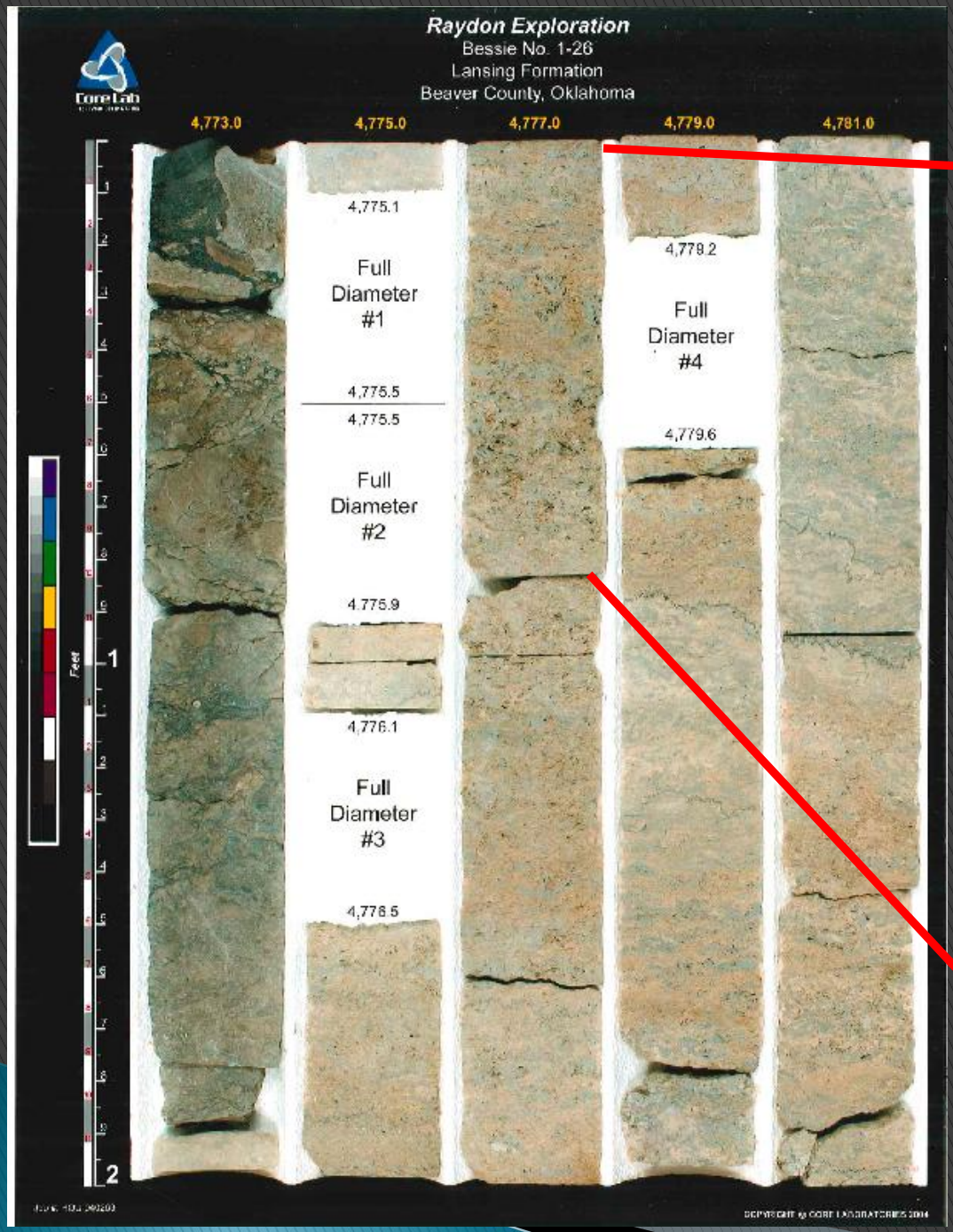



Taylor 1-26
KERNS 1-22
KERNS 2-22
KERNS 3-22
TAYLOR 1-23
LOG SH?
NDE
POSS?
6N 22E

Taylor 1-26 Decline Curve Analysis

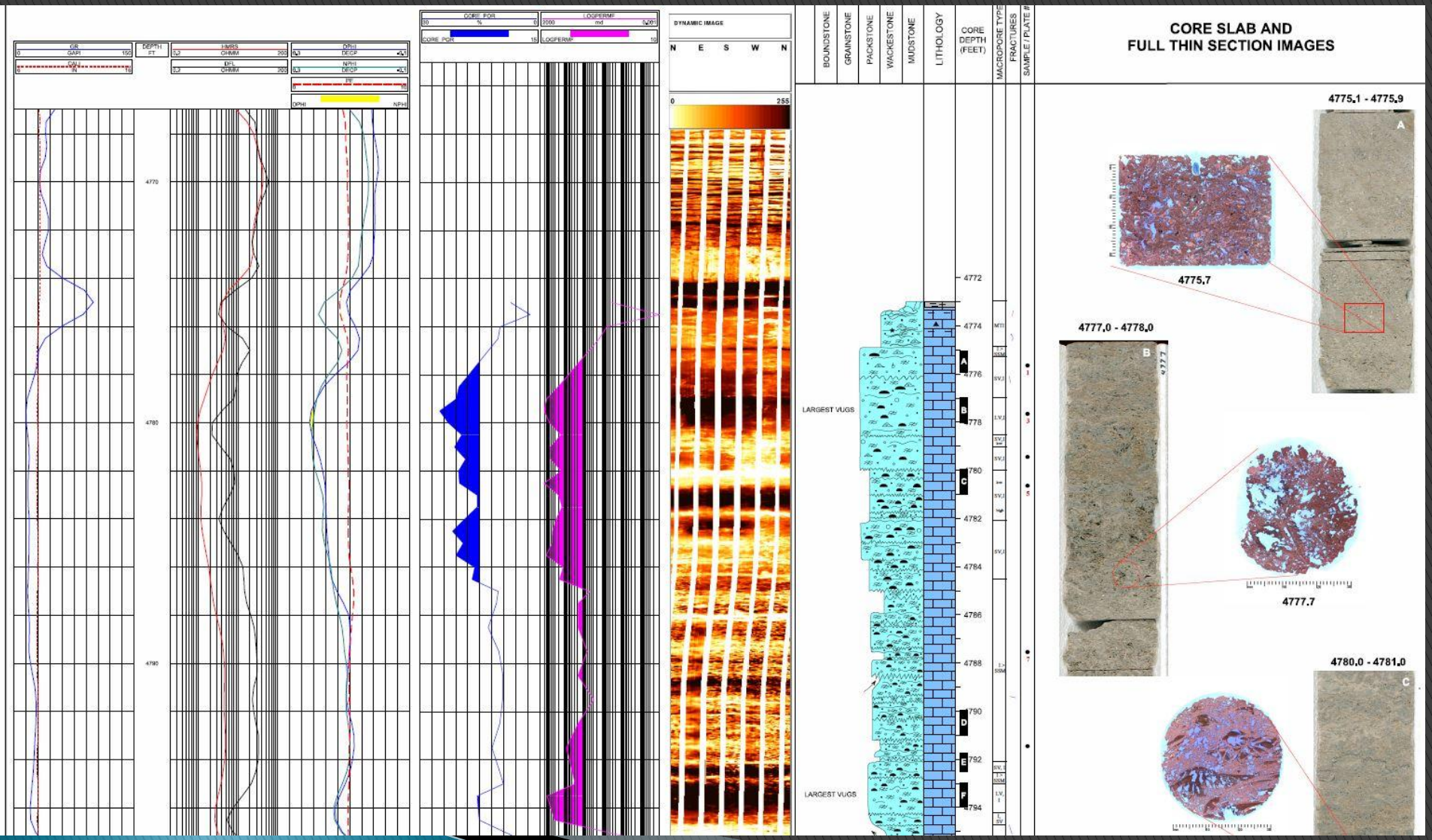

Taylor 1-26
Bessie 1-26: Core for water-flood analysis
KERNS 1-22
KERNS 2-22
KERNS 3-22
TAYLOR 1-23
6N 22E
LOG SH?
NDE
POSS?
NPL, EST

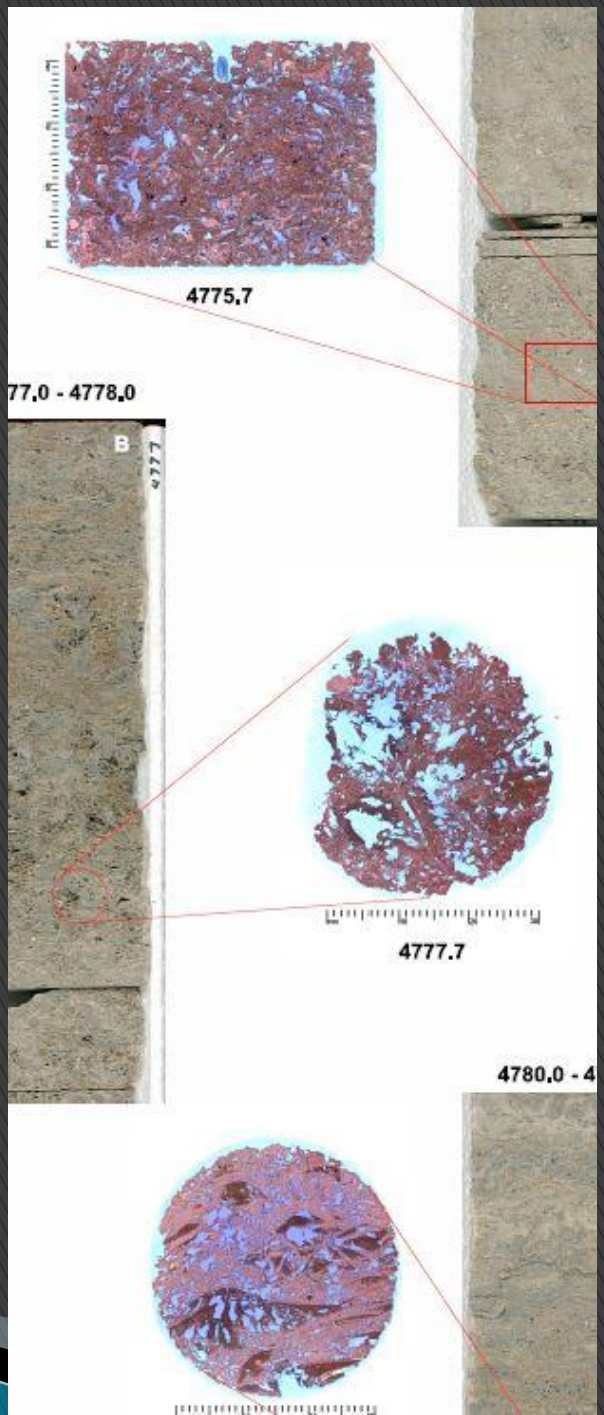

Bessie 1-26
6N 22E
KERNS 1-22
KERNS 2-22
KERNS 3-22
TAYLOR 1-23
TAYLOR 1-26
NOTE: POROSITY TOP -2085
LOG SH?
LOG SOW?
PROP LOG
O/W -2085
NDE
POSS?
NPL, EST
WET
150 NA
120 NA
160 NA
77.5 NA
D
D'

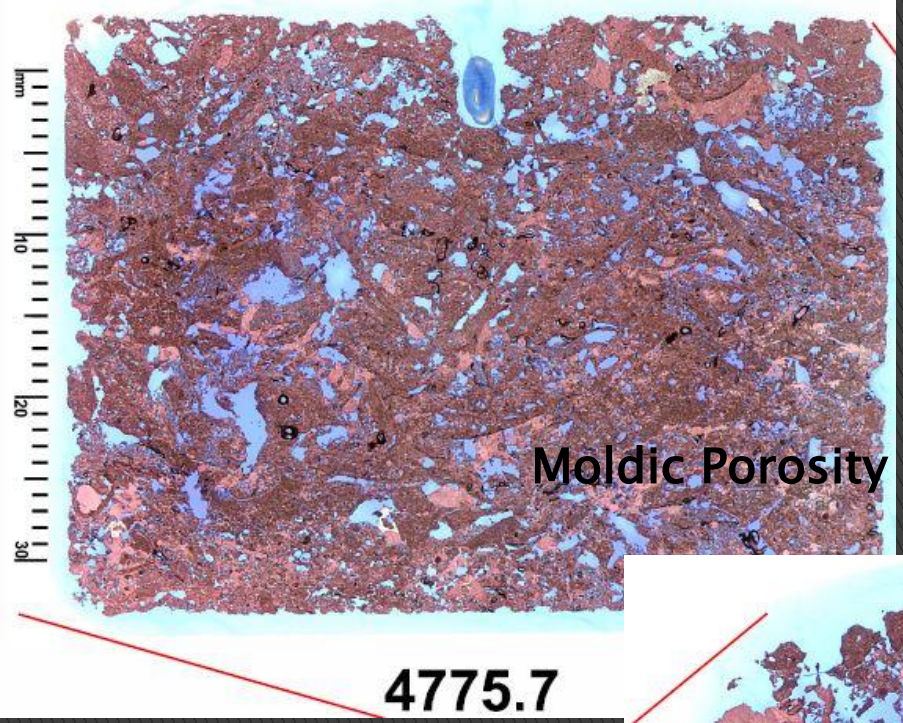

Raydon Exploration
Bessie No. 1-26
Lansing Formation
Beaver County, Oklahoma
4,773.0
4,775.0
4,777.0
4,779.0
4,781.0
4,775.1
Full Diameter #1
4,775.5
4,775.5
Full Diameter #2
4,775.9
4,776.1
Full Diameter #3
4,776.5
4,778.2
Full Diameter #4
4,779.6
Feet
1
2

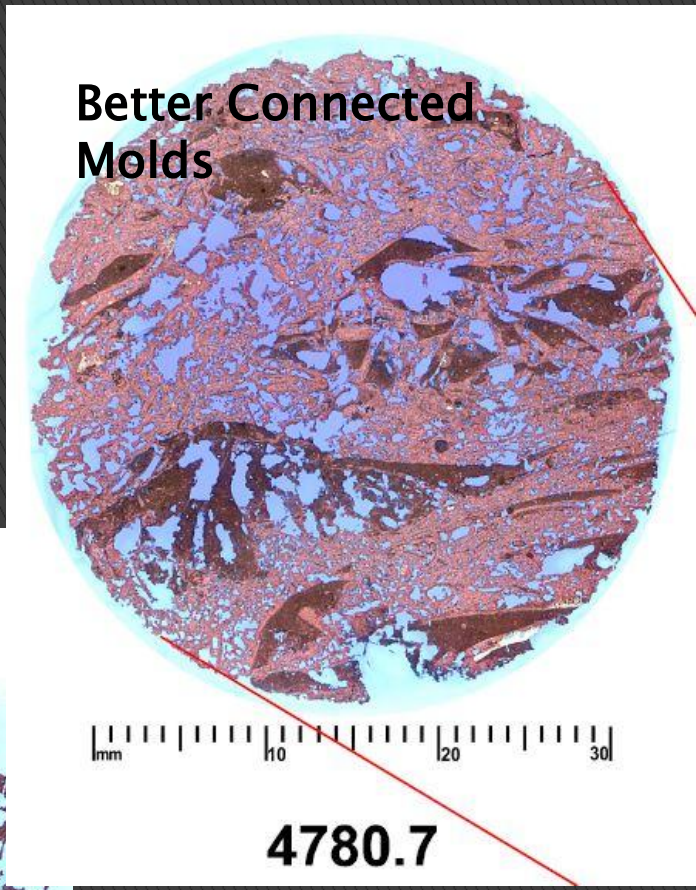
4,777.0

1’

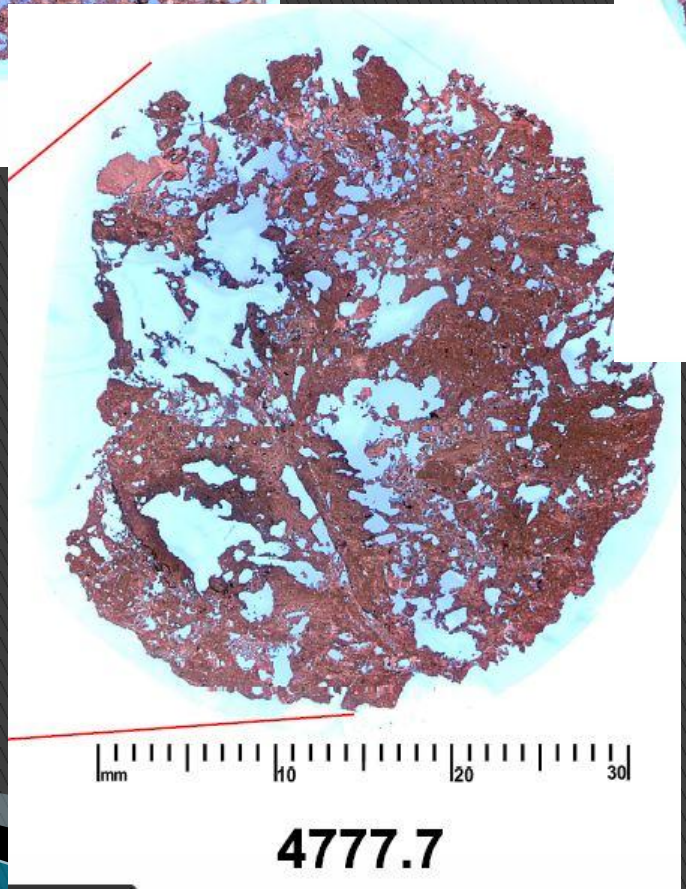

GR
GAPI
DEPTH
FT
HMRS
OHMM
DFL
OHMM
DPHI
DECP
NPHI
DECP
RHOB
NPHI
CORE_POR
%
LOGPERMF
md
DYNAMIC IMAGE
N E S W N
0
255
BOUNDSTONE
GRAINSTONE
PACKSTONE
WACKESTONE
MUDSTONE
LITHOLOGY
CORE DEPTH (FEET)
MACROPORE TYPE
FRACTURES
SAMPLE / PLATE #
LARGEST VUGS
LARGEST VUGS
4770
4780
4790
4772
4774
4776
4778
4780
4782
4784
4786
4788
4790
4792
4794
A
B
C
D
E
F
CORE SLAB AND
FULL THIN SECTION IMAGES
4775,1 - 4775,9
4775,7
4777,0 - 4778,0
4777,7
4780,0 - 4781,0


4775.7
77.0 - 4778.0
B
4777
4777.7
4780.0 - 4

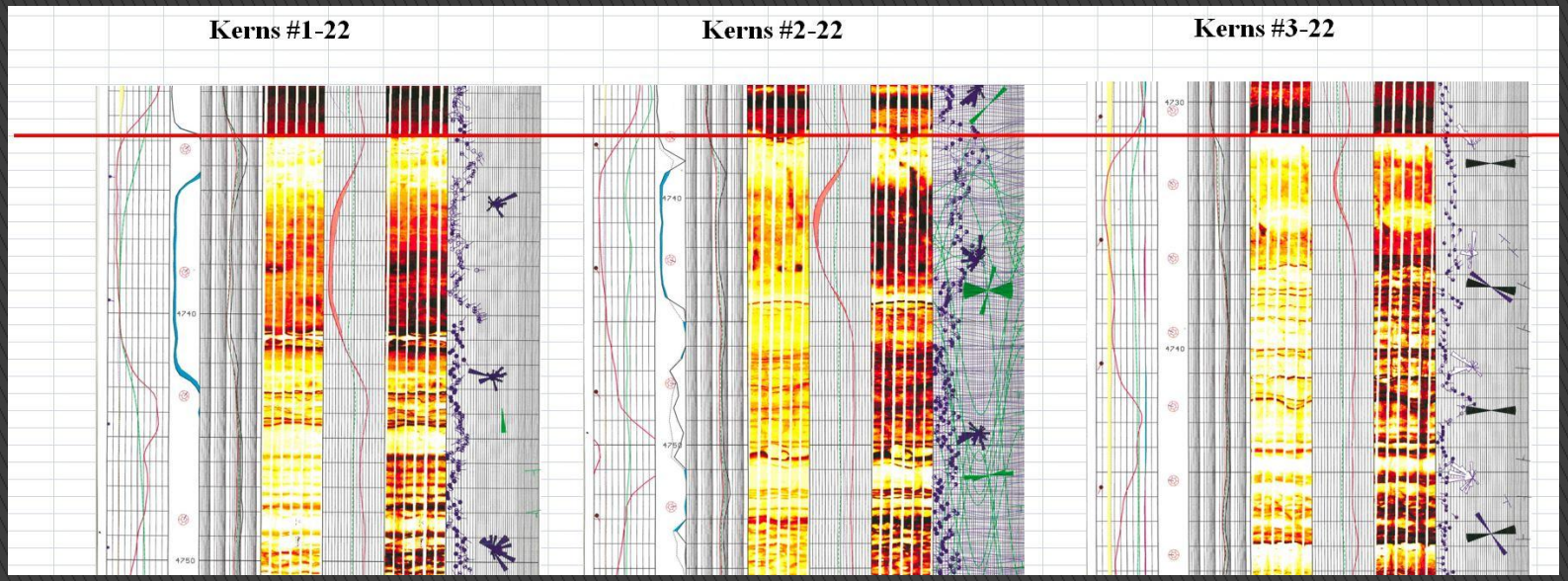


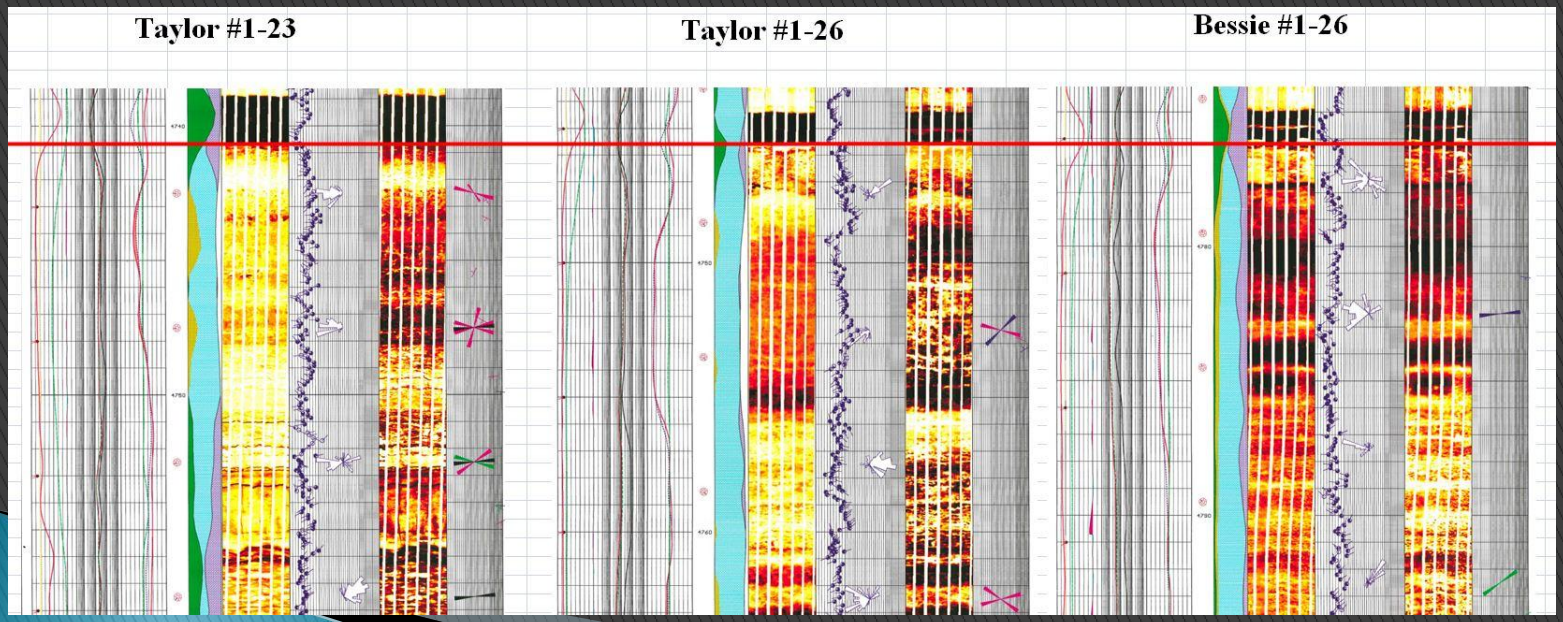


Well Connected Molds

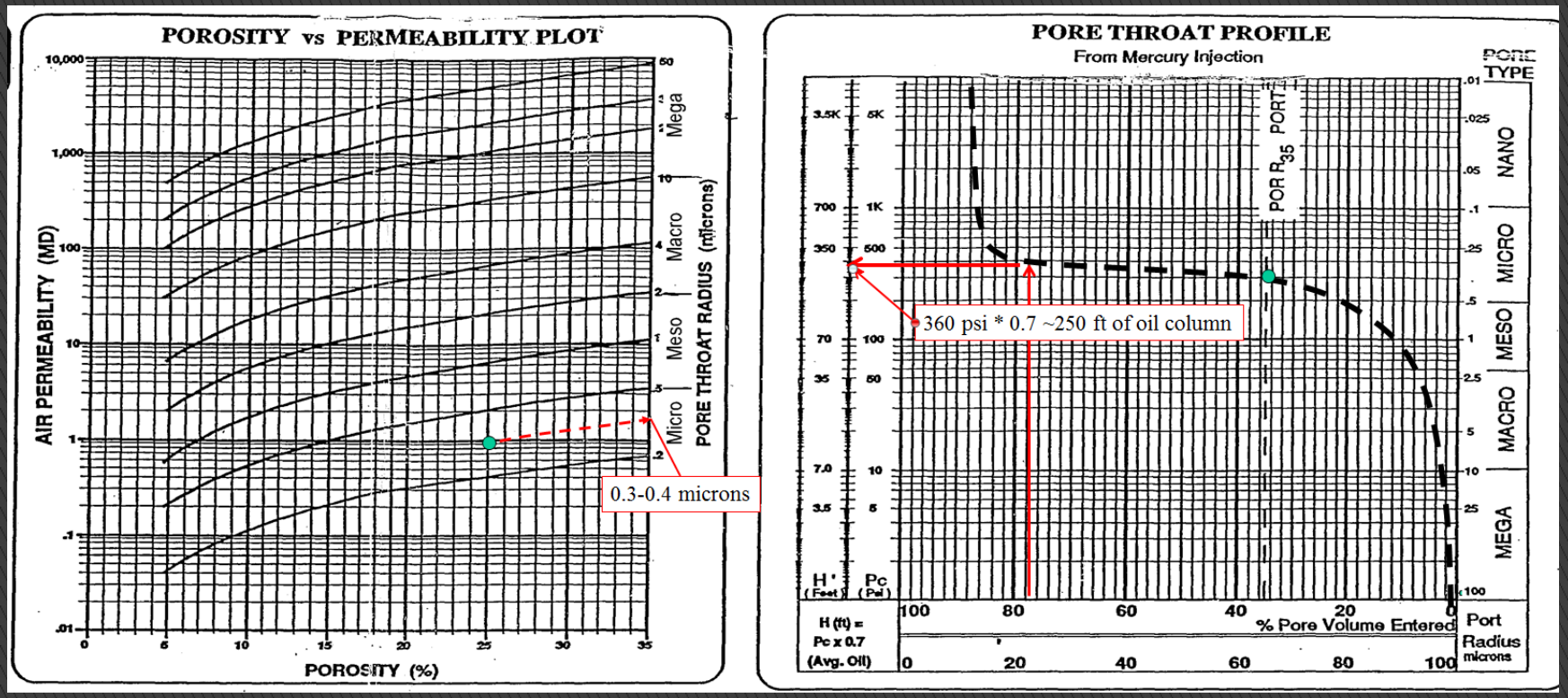


Pore-Throat Connectivity has huge impact on productivity


Kerns #1-22
Kerns #2-22
Kerns #3-22


Taylor #1-23
Taylor #1-26
Bessie #1-26

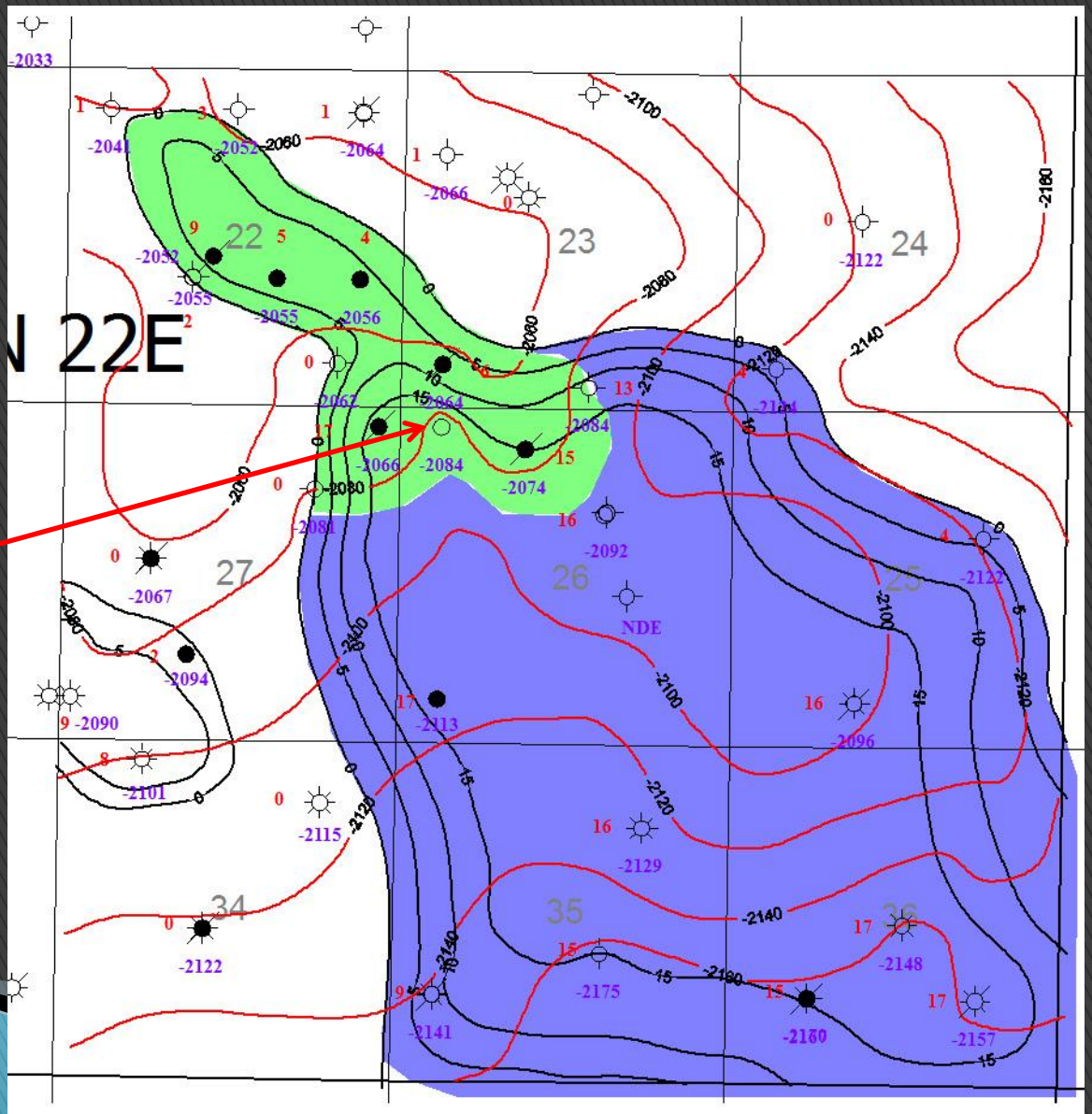
Porosity vs Perm Plots are important



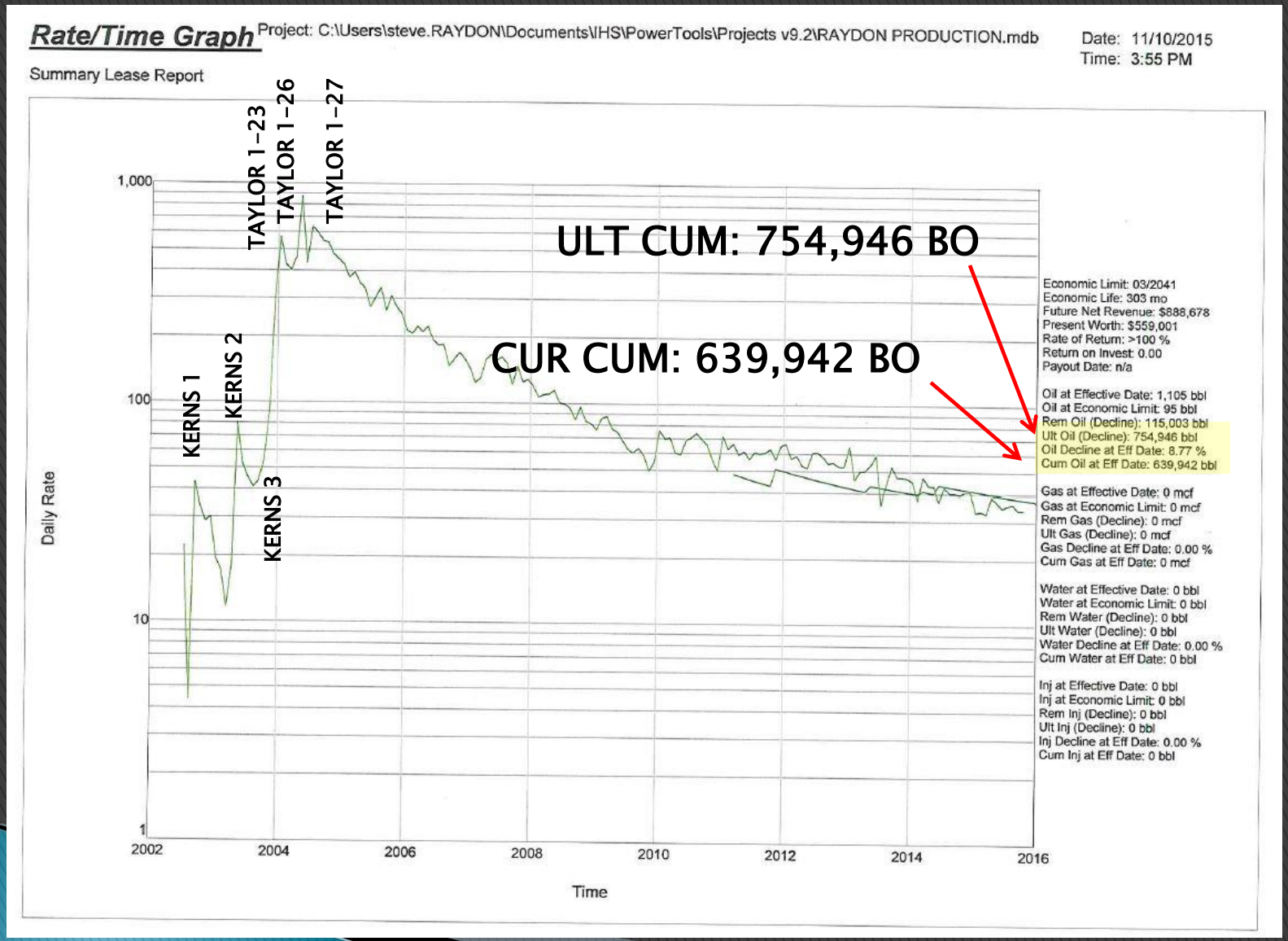
“Brett”-isms

- The Petrophysical (engineering) parameters matter! Use them and never ignore them.
- The permeability vs. porosity relationships should always be considered.
- If the permeability is relatively low vs. porosity, look downdip of an oil show.
- If the permeability is relatively high vs. porosity, look updip of an oil show.
- Buoyancy pressure matters! Capillary pressure matters! They offer valuable clues to finding traps.

Interpretation prior to Taylor 2-26



Hacksaw Field Decline Curve Analysis



Conclusion

- Go to all the technical talks and seminars possible.
- Always try to have at least one “walk-away” thought.
- Listen to “smart guys” like Ted Beaumont.

IT JUST MIGHT PAY DIVIDENDS!

Acknowledgements

- Raydon Exploration, Inc.
- Steve Raybourn, Tom Gray

“Gameboard”

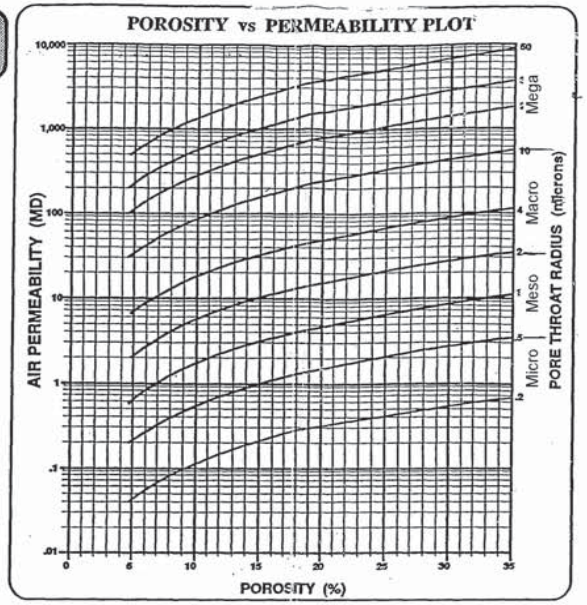
PETROPHYSICAL EVALUATION

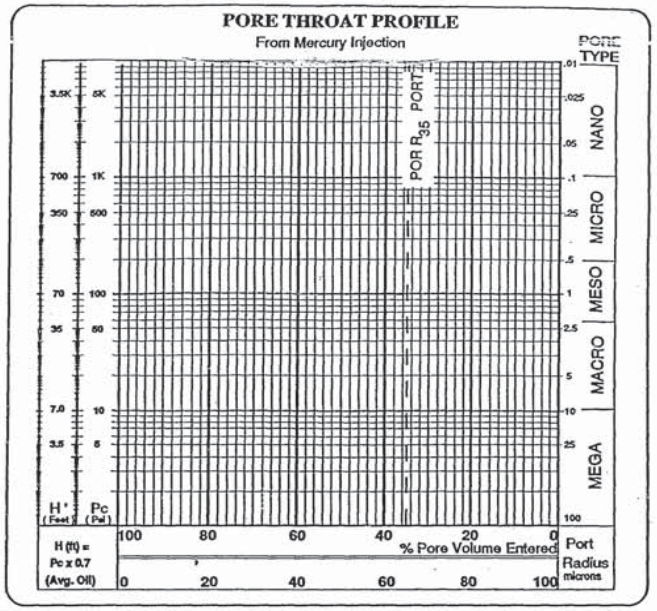
Wellname

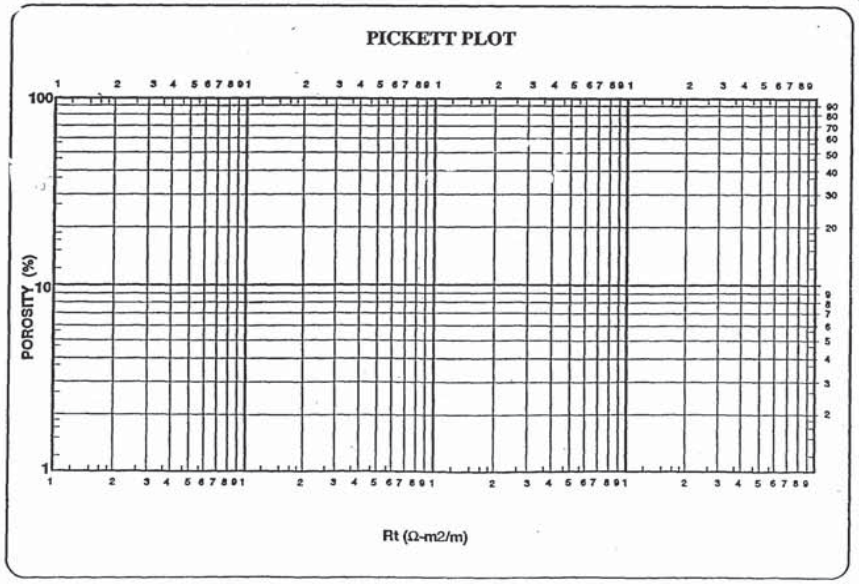
Location Formation

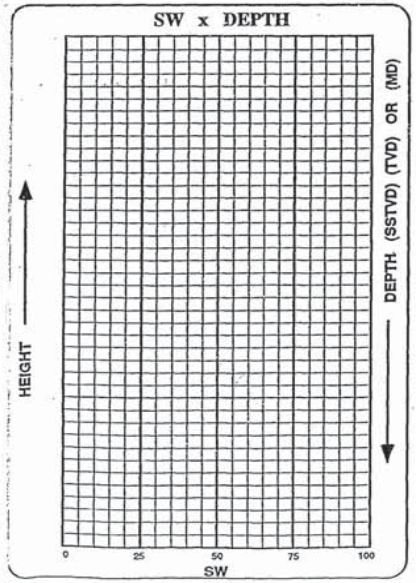
Date Name

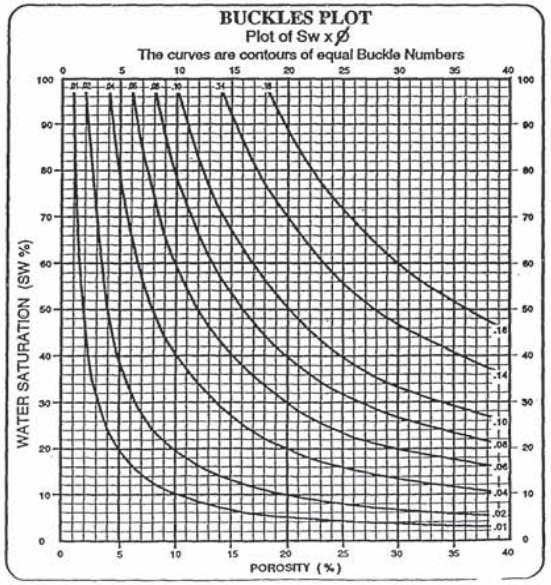
Notes

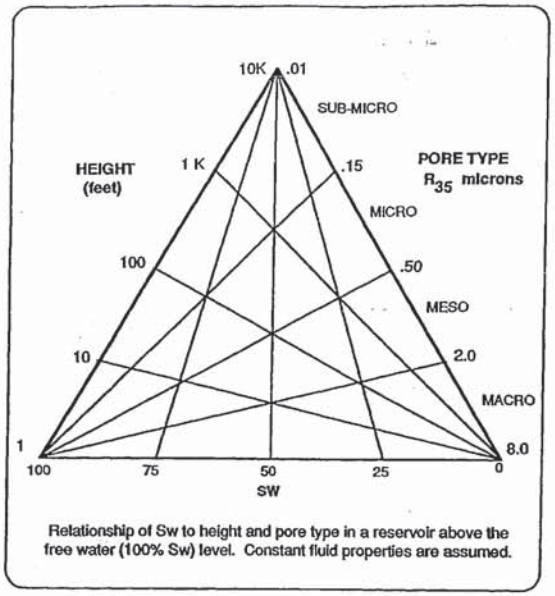




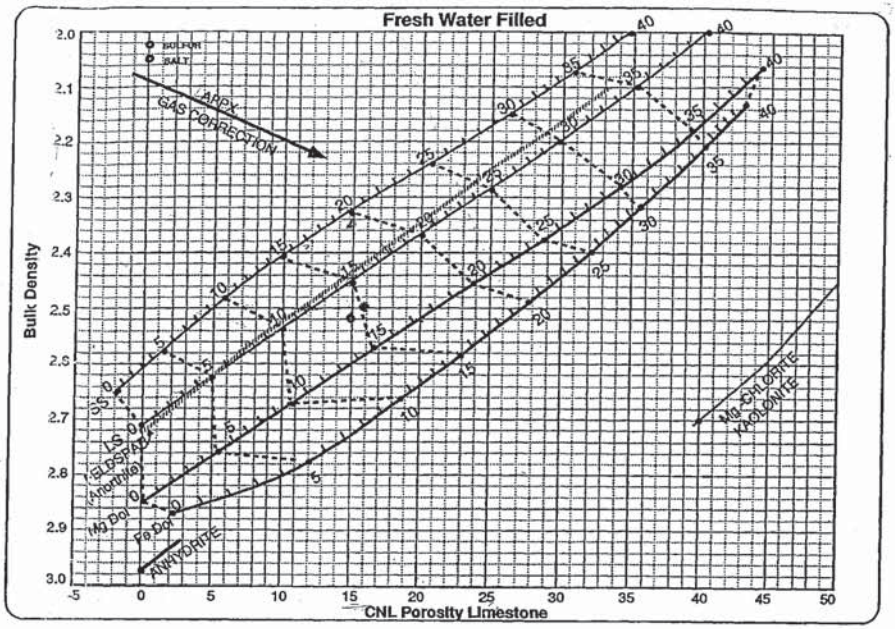




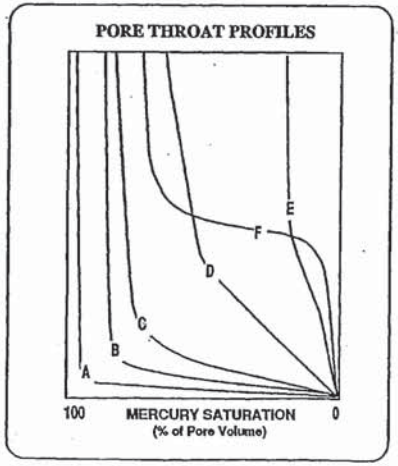


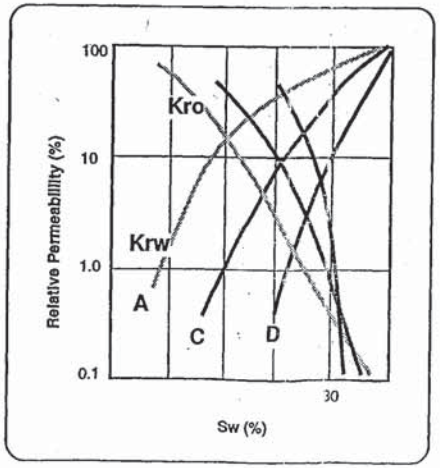


Relationship of Sw to height and pore type in a reservoir above the free water (100% Sw) level. Constant fluid properties are assumed.



Gameboard design: Dan Hartmann





PORE GEOMETRY CLASSIFICATION CHART

PORE SHAPE	INTERGRANULAR			INTERCRYSTALLINE			VUGGY/ MOLDIC		FRACTURE	
PORE THROAT SIZE / (PORT)	MACRO	MESO	MICRO	MACRO	MESO	SUB MICRO	1 MACRO	2 MICRO	MACRO	MICRO
R_{35} (microns)	> 2.0	2.0-0.5	< 0.5	> 2.0	2.0-.5	<.2 / .2-.5	2.0	<0.5	2.0	<0.5
K / Ø RATIO	high-v-high	mod high	low	high	mod	low - v -low	v-high	low	v-high	mod
PORE THROAT PROFILE	A - B	C - D	E,F	B	C	D, E, F	A,B	C,F	A	D,E
IMMOBILE SW 3	20%	20-45	45-90	15-20	30-40	40- 60 / 30-60	10 -30	20 -60	<10 %	>10 %
INTIAL FLOW RATES	high	med	low	high	med	low / low	v -high v -low	low	v-high	low - med
PRIMARY RECOVERY 4	max	interm	min	max	interm	none / min	max	min	max	interm
MAGNIFICATION TO "SEE" PORES	10X	50X	500X	30X	100X	2500 / 1000	0 -10X	30 - 1000X	0 -10X	50 - 100X

1. Linked pores/molds
2. Dispersed Pores/Molds
3. From water wet capillary pressure
4. For a given drive mechanism
5. Matrix porosity = 0%