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

John A. Brett, III1, E.A. (Ted) Beaumont2, and Dan J. Hartmann3

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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


"Application of an OCGS Presentation results in economic production"

John A. Brett, III
Upper Pennsylvanian Lansing “Satellite” View (Blakey, 2011)
Original Prospect maps
Lansing A net Isopach
Lansing Structure Map w/ Lansing A updip limit
Kerns #1–22

Lansing ‘B’ Rec. free oil on DST, IPP: 35BOPD
Initial Hand Map
(Remember those!)
Kerns 1–22 Decline Curve
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?

Microporosity
K < 0.35 md

Sw 60%

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

Top:
Mississippian Mission Canyon Fm
(Williston Basin)

Martin, Solomon and Hartmann, 1997
Clues from Capillary Pressure Analysis

~ 200 ft

~ 60%
Downdip Offset

~ 50 ft

~ 10% Sw

Macro-Porosity

Sw 60%

IP 485 BOPD

Cum 979 MBO
Little Knife Dip Cross Section

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

Martin, Solomon and Hartmann, 1997
Little Knife Field, Williston Basin
Exploring with petrophysical data
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**

<table>
<thead>
<tr>
<th>Pore Shape</th>
<th>Intergranular</th>
<th>Intercrystalline</th>
<th>Vuggy/Moldic</th>
<th>Fracture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pore Throat Size (µm)</td>
<td>Macro</td>
<td>Medio</td>
<td>Micro</td>
<td>Macro</td>
</tr>
<tr>
<td>R̄ₙₙ (µm)</td>
<td>&gt;2.0</td>
<td>2.0-0.5</td>
<td>&lt;0.5</td>
<td>&gt;2.0</td>
</tr>
<tr>
<td>K/Φ Ratio</td>
<td>high-v-high</td>
<td>high</td>
<td>low</td>
<td>high</td>
</tr>
<tr>
<td>Pore Throat Profile</td>
<td>A-B</td>
<td>C-D</td>
<td>E,F</td>
<td>B</td>
</tr>
<tr>
<td>Immobile SW (°C)</td>
<td>20%</td>
<td>20-45</td>
<td>45-90</td>
<td>15-20</td>
</tr>
<tr>
<td>Initial Flow Rates</td>
<td>high</td>
<td>mod</td>
<td>high</td>
<td>high</td>
</tr>
<tr>
<td>Primary Recovery</td>
<td>max</td>
<td>Inter</td>
<td>Inter</td>
<td>max</td>
</tr>
<tr>
<td>Magnification to See Pores</td>
<td>10X</td>
<td>50X</td>
<td>600X</td>
<td>30X</td>
</tr>
</tbody>
</table>

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

**Pore Throat Profiles**

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MERCURY SATURATION
(µm of Pore Volume)
Calculating oil column height

- 0.3-0.4 microns

- 360 psi * 0.7 ~ 250 ft of oil column
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!
Finally Economic!

Kerns 1–22
- Flowed Oil to Surface on DST
- Flowed over 200 BOPD
- Cum: 227,755 BO
- Ult: 236,572 BO

Taylor 1–23
- Crossplot Porosity: 17%

Kerns 1–22
- Crossplot Porosity: 25%

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

ULT CUM: 236,572 BO
CUR CUM: 227,755 BO
Taylor 1-26 Decline Curve Analysis

ULT CUM: 400,913 BO
CUR CUM: 307,216 BO
Taylor 1–26

Bessie 1–26: Core for water–flood analysis
Bessie 1–26
Raydon Exploration
Beasie No. 1-20
Lansing Formation
Beaver County, Oklahoma

Full Diameter #1
4,775.0

Full Diameter #2
4,775.3
4,775.9

Full Diameter #3
4,778.5

Full Diameter #4
4,779.2
4,779.6

1"
Pore–Throat Connectivity has huge impact on productivity.
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

ULT CUM: 754,946 BO
CUR CUM: 639,942 BO
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”
PORE TYPE

PORE THROAT PROFILES

PORE THROAT SIZE (m)

PORE THROAT RATIO

INTERCRYSTALLINE

VUGGY/MOLDIC

FRACTURE

PORE GEOMETRY CLASSIFICATION CHART

Relative Permeability (%)

Fresh Water Filled

DNL Porosity Limestone

PORE SHAPE

INTERGRAINULAR

INTERCRYSTALLINE

VUGGY/MOLDIC

FRACTURE

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