Benchmarking Well Performance for Variable Geology and Engineering in the Utica/Point Pleasant Play*

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Abstract

Approaching its first thousand horizontal wells, the Utica/Point Pleasant play in Ohio, West Virginia, and Pennsylvania is a newcomer to the "unconventional club". While the Ohio oil and gas industry has a long history, the Utica and deeper Point Pleasant formations have only recently emerged as economically viable transitional gas-to-liquids targets. While these Ordovician-aged rocks do not have an exact analogue in any other North American unconventional play, many of the learnings from transitional phase plays like the Eagle Ford have provided general blueprints for effective field development. Depth, thickness, and geochemistry maps provide valuable insights into the west-east transition of the basin from liquids-rich to dry gas, near and beyond the Pennsylvania border. Rock cuttings and log data provide insights into the porosity and permeability characteristics of the Utica, Point Pleasant, and Marcellus, the latter largely shallowing to uneconomic depths in the area of this study. Sufficient well coverage is in place to correlate geologic measurements with fluid phase maps of gas-oil ratio and breakdown pressures measured during hydraulic fracturing. In combination, analytic characterization of geologic and fluid maps provide valuable insights into relative sweetspots and emerging opportunities in southern Ohio and in West Virginia. As in other unconventional plays, extensive experimentation is underway to "right-size" drilling and completions for variable rock and fluid characteristics. Starting 50% higher than the Eagle Ford historic average, Utica and Point Pleasant completions are placing an average of 6.5 million pounds of sand, with individual wells ranging beyond 17 million pounds. Fluid volumes are comparable to the Eagle Ford, at an average of 100,000 barrels. Horizontal well lengths generally fall between 4000 and 7000 feet, but do extend up to 9000 feet. Analytic studies of gas and liquids production in the Utica and Point Pleasant play indicate that the
geology and fluid mix are amenable to "high-intensity" hydraulic fracturing. Normalized to horizontal lengths, Eagle-Ford like hydraulic fracturing jobs of 1000–2000 pounds per foot of sand and 20–40 barrels per foot correlate to the best producing wells to date. Recent drilling results are also bearing out geologic prospectivity further south than the initial "core area" of east-central Ohio.

Reference Cited

BENCHMARKING WELL PERFORMANCE FOR VARIABLE GEOLOGY AND ENGINEERING IN THE UTICA/POINT PLEASANT PLAY

Murray Roth
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Utica/Point Pleasant Type Log

A Utica-Point Pleasant Type Log for Eastern Ohio

Source Rock Analyses

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Type</th>
<th>TOC</th>
<th>Rock Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>6064</td>
<td>core</td>
<td>0.48</td>
<td>Cincinnati gp</td>
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<tr>
<td>6141</td>
<td>core</td>
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<td>Utica Sh</td>
</tr>
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<td>core</td>
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<td>Point Pleasant Fm</td>
</tr>
<tr>
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<td>core</td>
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<td>Logana Mbr</td>
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<td>core</td>
<td>0.11</td>
<td>Wells Creek Fm</td>
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<td>Copper Ridge dol</td>
</tr>
<tr>
<td>8274</td>
<td>core</td>
<td>0.23</td>
<td>Conasauga gp</td>
</tr>
</tbody>
</table>

Utica/Point Pleasant
Study Objectives

• Identify key geologic drivers of production and the degree to which they impact performance
  – Depth
  – Thickness
  – GOR
  – Thermal Maturity
  – TMAX

• Benchmark engineering impact on performance for variable geology
Utica Depth
Point Pleasant Depth

Cumulative Production - Wells with Production (1,334)

- Cum 1 Month Oil
- Cum 3 Month Gas
Point Pleasant Depth
3 Month BOE/ft vs. Trenton Depth

3 Month BOE (Oil+Gas) per FT per Well vs. Trenton Depth (ft)

\[ r^2 = 0.392 \]
3 Month BOE/ft vs. Trenton Depth

3 Month BOE (Oil+Gas) per FT per Well vs. Trenton Depth (ft)

>7,000’
3 Month Oil/ft vs. Trenton Depth

3 Month Oil (bbl) per FT per Well vs. Trenton Depth (ft)
3 Month Oil/ft vs. Trenton Depth

3 Month Oil (bbl) per FT per Well vs. Trenton Depth (ft)

5,400’ – 7,000’
Utica/Point Pleasant Thickness
3 Month BOE/ft vs. Utica/Point Pleasant Thickness

3 Month BOE (Oil+Gas) per FT per Well vs. Thickness
3 Month BOE/ft vs. Utica/Point Pleasant Thickness

>195’
3 Month Oil/ft vs. Utica/Point Pleasant Thickness

3 Month Oil (bbl) per FT per Well vs. Thickness

\[ r^2 = 0.107 \]
3 Month Oil/ft vs. Utica/Point Pleasant Thickness

3 Month Oil (bbl) per FT per Well vs. Thickness
Point Pleasant GOR (Log)
3 Month BOE/ft vs. Pleasant GOR (Log)

3 Month BOE (Oil+Gas) per FT per Well vs. 1 Month GOR (mcf/bbl)

$r^2 = 0.270$
3 Month BOE/ft vs. Pleasant GOR (Log)

GOR > 80 Mcf/bbl
3 Month Oil/ft vs. Pleasant GOR (Log)

GOR < 15Mcf/bbl
Utica/Point Pleasant TMAX
3 Month BOE/ft vs. TMAX

3 Month BOE (Oil+Gas) per FT per Well vs. TMAX

$r^2 = 0.275$
3 Month BOE/ft vs. TMAX

3 Month BOE (Oil+Gas) per FT per Well vs. TMAX

> 450
3 Month Oil/ft vs. TMAX
3 Month Oil/ft vs. TMAX

450 - 465
Utica/Point Pleasant Thermal Maturity
3 Month BOE/ft vs. Thermal Maturity

The graph shows the relationship between 3 Month BOE (Oil+Gas) per FT per Well and Thermal Maturity. The data points are color-coded and show a positive correlation, indicated by the line of best fit with an R-squared value of 0.282.
3 Month BOE/ft vs. Thermal Maturity

3 Month BOE (Oil+Gas) per FT per Well vs. Thermal Maturity

> 1.21
3 Month Oil/ft vs. Thermal Maturity

3 Month Oil (bbl) per FT per Well vs. Thermal Maturity
3 Month Oil/ft vs. Thermal Maturity

3 Month Oil (bbl) per FT per Well vs. Thermal Maturity

Thermal Maturity

.8 – 1.2
Utica/Point Pleasant Total Organic Carbon
3 Month BOE/ft vs. TOC
3 Month BOE/ft vs. TOC

3 Month BOE (Oil+Gas) per FT per Well vs. TOC

> 1.65
3 Month Oil/ft vs. TOC
3 Month Oil/ft vs. TOC
WHERE ARE THE SWEETSPOTS?
Trenton Depth vs. Thermal Maturity

**Trenton Depth (ft) Map**
- P90.00 (8296.50)
- P70.00 (7174.66)
- P50.00 (6934.29)
- P30.00 (6724.98)
- P10.00 (6439.69)
- UTICA SHALE

**Thermal Maturity Map**
- P90.00 (1.78)
- P70.00 (1.58)
- P50.00 (1.23)
- P30.00 (1.13)
- P10.00 (0.96)
- UTICA SHALE

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Trenton Depth vs. Thermal Maturity by BOE/ft
Trenton Depth vs. Thermal Maturity by Oil/ft

Thermal Maturity vs. Trenton Depth (ft)

Thermal Maturity vs. Trenton Depth (ft) Heat Map
Thermal Maturity vs. TOC by 3 Month BOE/ft
Thermal Maturity vs. TOC by 3 Month BOE/ft

TOC vs. Thermal Maturity

TOC vs. Thermal Maturity Heat Map

Colors:
- Max
- Average
- Min

3 Month BOE (Oil+Gas) per FT per Well
Point Pleasant BOE Sweetspot

- **Trenton Depth**
- **Utica/Point Pleasant Thickness**
- **TOC**
- **Thermal Maturity**

The diagram shows a map with various data points and color-coded areas indicating different values for thermal maturity, TOC, and other geological parameters. The map is overlaid with a title indicating the focus on Point Pleasant BOE Sweetspot.
Point Pleasant Oil Sweetspot

Trenton Depth

Utica/Point Pleasant Thickness

TOC

Thermal Maturity

Sweetspot Map

3 Month Oil (bbl) p...
RIGHT SIZING ENGINEERING FOR GEOLOGY
Proppant/Length vs. Thermal Maturity by 3 Month BOE/ft

Average Proppant per Length (lbs/ft) vs. Thermal Maturity

- 3 Month BOE:
  - P90.00 (18.95)
  - P70.00 (12.23)
  - P50.00 (9.21)
  - P30.00 (7.59)
  - P10.00 (5.22)

3 Month BOE...

- ≥ 44.08
- ≤ 0.00

Colors:
- Max
- Average
- Min

Thermal Maturity
- 2.50k ≤ x ≤ 3.00k
- 2.00k ≤ x ≤ 2.50k
- 1.50k ≤ x ≤ 2.00k
- 1.00k ≤ x ≤ 1.50k
- 0.50k ≤ x ≤ 1.00k
- x ≤ 0.50k

3 Month BOE (Oil+Gas) per FT per Well

GROUNDTRUTH
IN THE END – WHAT DIFFERENCE DOES GEOLOGY MAKE?
BOE/ft Cumulative Production Curve by Trenton Depth

Cum BOE (Oil+Gas) per FT per Well vs. Production Month

Trenton Depth (ft)
- 4769.35 < x ≤ 5517.03
- 5517.03 < x ≤ 5773.59
- 5773.59 < x ≤ 6358.97
- 6358.97 < x

Production Month
Oil/ft Cumulative Production Curve by Trenton Depth

Cum Oil (bbl) per FT per Well vs. Production Month

- Cumulative Production Curve
- Cum Oil (bbl) per FT per Well vs. Production Month
- Trenton Depth (ft)
  - 4760.35 ≤ x ≤ 5517.03
  - 5517.03 ≤ x ≤ 5773.59
  - 5773.59 ≤ x ≤ 6358.97
  - 6358.97 ≤ x
BOE/ft Cumulative Production Curve by Thermal Maturity

Cum BOE (Oil+Gas) per FT per Well vs. Production Month

Thermal Maturity:
- \( x \leq 0.64 \)
- \( 0.64 < x \leq 0.77 \)
- \( 0.77 < x \leq 0.86 \)
- \( 0.86 < x \leq 0.92 \)
- \( 0.92 < x \leq 1.07 \)
- \( 1.07 < x \)
Oil/ft Cumulative Production Curve by Thermal Maturity

Cum Oil (bbl) per FT per Well vs. Production Month

- $x \leq 0.64$
- $0.64 < x \leq 0.77$
- $0.77 < x \leq 0.86$
- $0.86 < x \leq 0.92$
- $0.92 < x \leq 1.07$
- $1.07 < x$

Production Month

Cumulative Oil Production (bbl) per Foot per Well
Conclusions

• BOE Sweetspot defined by:
  – Trenton Depth (>7,000’)
  – Utica/Point Pleasant Thickness (>190’)
  – Thermal Maturity (>1.2)
  – TOC (>1.5)

• Oil Sweetspot defined by:
  – Trenton Depth (5,400’-7,000’)
  – Thermal Maturity (.8-1.2)

• Inside the sweetspots, wells with > 1,500lbs of proppant/ft have the best performance

• Outside the sweetspots, heavier engineering (> 2,000lbs/ft) may be required for optimal performance

• Geology can drive a 3-fold increase in well performance

• Optimizing engineering can provide an additional 2-fold increase in production