The Utica-Point Pleasant Shale Play of Ohio

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Ohio Oil & Gas Fields

Oil & gas is not new to Ohio.

Ohio currently has in excess of 64,000 producing oil & gas wells.

Production has been established in at least 70 of 88 counties.

Historically, over 250,000 wells have been drilled.

Lima-Indiana Trend of NW Ohio was one of the first true giant fields produced in the U.S. (1884-1934).
Drilling and producing from organic-rich shales represents a large paradigm shift for the oil-and-gas industry.

Prior to the late 1990s, these shales were thought of principally as the source of oil and gas. A small percentage of this petroleum would “leak” from the source beds and migrate into conventional reservoirs or traps. This small amount is what the world has produced for the last 150 years.

A Whole New Ballgame

The advent of drilling long, horizontal laterals combined with the ability to perform multiple-stage hydraulic fracture treatments has enabled the oil-and-gas industry to now produce from the source beds themselves, where >90% of the original reserves still reside. These technologies have allowed many shale gas plays to develop across the United States.

From EIA (2011).
Previously, to develop a 1-square-mile lease block (640 acres) in Ohio would require 16 vertical wells, each with about 2-acre drill sites plus all the lease roads and pipelines.

Today, using horizontal wells, this same square mile can be drained with 5-6 horizontal wells from a single 3- to 6-acre drill site.
Optimally, operators would like to have lease blocks of about 2 square miles contiguous to allow drilling in two directions from one central drill pad.

Most horizontals are being drilled in a NW-SE orientation in Ohio to intersect the natural NE-SW joints and fractures.
Example layouts of 3-D Horizontal Wells
(examples layouts)

Plan View
(viewed from above)

Cross-sectional View
(viewed from the side)
Why Ohio and the Upper Ohio River Valley is the Focus of the Utica Play

- Ohio is favorable to drilling:
  - HB133 - Drilling on State lands.
  - Conducive and strong regulatory environment:
- Ohio has Underground Injection Control (UIC) primacy and adequate geologic capacity to store oilfield waste.
- Quebec, NY, and other states issued moratoriums.
- Generally shallower depths than other shale plays:
  - Drilling depths in Ohio ~3,500 to 10,000 feet.
  - Interlayered carbonate and shale in Ohio - lends to “fracability” of the rock.
- Maturation levels, kerogen types, and drilling indicate more liquids and oil in Ohio.
The Point Pleasant is, in part, the lateral equivalent of the upper portion of the Trenton Limestone and is in a gradational relationship with the overlying Utica Shale, which thickens into the Appalachian Basin.

At the end of Trenton deposition time, the Point Pleasant was deposited within a restricted-circulation sub-basin, surrounded by carbonate platforms. As waters deepened, seas overrode the platforms, depositing the Utica Shale on top of the entire area.

Modified from Patchen and others (2006).
Idealized Platform-to-Basin Model and Major Facies

Cross-sectional view of the interplatform sub-basin model.
Geophysical log (left) and core photo illustrating the black, organic-rich nature and interlayered limestone & shale of the Point Pleasant.
Regional Thickness Map of the Utica-Point Pleasant

Explaination:
- Trenton-Black River outcrop area
- fault
- Utica extent
- Point Pleasant extent
- data point (oil and gas well)
- data points not corrected for structural dip

Interval-thickness map of the Utica:
- Top of Trenton to top of Utica includes the Point Pleasant and Antes Shale.
- The extent of the Utica and the Point Pleasant are also shown.

Recommended bibliographic citation:
Thickness of the Utica-Point Pleasant in Ohio

Thickness Map of the Point Pleasant - Utica Interval in Ohio

EXPLANATION
- data point
- fault
- 50 ft contour
- 250 ft contour
- Utica extent
- Point Pleasant extent
- Thickness in Feet
- High: 350
- Low: 87

Modified from Patchen and others, 2006 and Repetski and others, 2008
Structure drawn on top of the Trenton Limestone. Add topographic elevation to derive approximate drilling depths through the Utica-Point Pleasant interval.

From Patchen and others (2006).
Why Ohio may be the Focus of the Utica-Point Pleasant Play

Gas-prone areas of Utica Shale will be in the deeper portion of the basin. Much of Ohio may contain appreciable amounts of oil within Utica wells, as shown in this NW-SE-oriented cross section illustrating the results of geochemical analyses of well samples.

From Ryder (2008).
Recently, analyses by multiple companies have become public data. We are now starting to examine, interpret, and map this data.

We **NEED** operators to donate new core to our holdings for future use.

We can hold it **CONFIDENTIAL** for as long as necessary.
Levels of Maturation in the Utica-Point Pleasant Shale

New map with additional data for Ohio currently under development.

Modified from Patchen and others (2006).
Organic content in eastern Ohio is very high.

Organic matter is very rich and oil prone.

Maturity levels created a range of dry gas in the east to oil in the central part of the state, a 100-mile span.

Significant hydrocarbon generation has occurred across the area and the hydrocarbon content is quite high.

The majority of the hydrocarbons are being generated in the Point Pleasant, but the overlying Utica is also prospective.

The high carbonate content of the entire section suggests fracking could be very effective for production.
Acreage Positions of Various Energy & Petroleum Companies

<table>
<thead>
<tr>
<th>Company</th>
<th>Net Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chesapeake (CHK)</td>
<td>1,360,000</td>
</tr>
<tr>
<td>Chevron (CVX)</td>
<td>623,000</td>
</tr>
<tr>
<td>Range Res. (RRC)</td>
<td>357,000</td>
</tr>
<tr>
<td>(CNX/HES) JV</td>
<td>200,000</td>
</tr>
<tr>
<td>Anadarko (APC)</td>
<td>200,000</td>
</tr>
<tr>
<td>EVEP / Enervest</td>
<td>159,000</td>
</tr>
<tr>
<td>Devon Energy (DVN)</td>
<td>110,000</td>
</tr>
<tr>
<td>Hess (HES)</td>
<td>85,000</td>
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<tr>
<td>Rex Energy (REXX)</td>
<td>58,900</td>
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<tr>
<td>Gulfport (GPOR)</td>
<td>62,500</td>
</tr>
<tr>
<td>PDC Energy (PETD)</td>
<td>40,000</td>
</tr>
<tr>
<td>Magnum Hunter/MHR</td>
<td>16,000</td>
</tr>
<tr>
<td>Carrizo (CRZO)</td>
<td>1,500</td>
</tr>
<tr>
<td>ExxonMobil (XOM)</td>
<td>Unknown</td>
</tr>
<tr>
<td>Shell (RDS-A)</td>
<td>Unknown</td>
</tr>
</tbody>
</table>

Source: Company Data, modified Gulfport map, GHB Research

Modified from M. Bodino, November 2011, DUG East presentation
Range Resources drilled the first horizontal Utica well in the area and CNX drilled a vertical well in Belmont County, both in late 2010.

Chesapeake wells reported via press release.
Activity map updated regularly and available at: www.OhioGeology.com
One of the mandates of the Ohio Geological Survey is to “...collect, study, and interpret all available data pertaining to the origin, distribution, extent, use, and valuation of... natural resources such as... petroleum gas.”

Without actual production histories from existing Utica Shale wells, it is not possible to properly create a “probable” reserve estimate.

Thus a volumetric reserve calculation must be used at this stage of the play. Such a calculation is full of assumptions and should be viewed only as an educated guess as to the ultimate recoverable reserves from the interval.

The Ohio Geological Survey will continue to gather data and provide updated assessments when possible.
Volumetric Utica Oil Resource Assessment*

\[ Q_t = V \times D \times TOC \times C \times \%R \]

- \( Q_t \): Quantity of hydrocarbons trapped (metric tons)
- \( V \): Volume of rock (cubic meters)
- \( D \): Rock density (kg/m)
- \( TOC \): Total organic content (percent)
- \( C \): Hydrocarbon conversion ratio (percent)
- \( \%R \): Reservoir space with hydrocarbons (percent) (recoverable % from shale as reservoir)

1 metric ton = 7.1475 barrels

*Based on Wallace and Roen, 1989
Resource Assessment for the Utica-Point Pleasant in the Entire Appalachian Basin

\[ D = 2.65 \times 10^3 \text{ kg/m} \]
\[ \text{TOC} = 1.34 \text{ percent} \]
\[ C = 10 \text{ percent} \]
\[ \%R = 3 \text{ percent} \]
\[ Q_t = 13.26 \text{ billion barrels of oil migrated to conventional reservoirs} \]

Wallace and Roen, 1989
Area of Greatest Utica Potential in Ohio (Used for Reserve Calculations)
Utica-Point Pleasant Recoverable Reserve Potential Estimate for Ohio

IF we assume $\frac{1}{3}$ of volume will be gas and $\frac{2}{3}$ is oil, then:

$\%R = 1.2$ percent—recoverable from the interval
$Q_t = 1.96$ billion barrels equivalent
   = $3.75$ TCF gas and $1.31$ billion barrels oil

$\%R = 5$ percent—recoverable from the interval
$Q_t = 8.2$ billion barrels equivalent
   = $15.7$ TCF gas and $5.5$ billion barrels oil

TCF = trillion cubic feet
Ohio Oil & Gas Laws, Regulations, and Policies

- ODNR Division of Oil & Gas Resources Management (sole and exclusive authority).
- Uniform statewide regulation: permitting, well locations, spacing, site construction, drilling, completions, production, restoration, and waste disposal.
- Conservation and effective development of oil & gas resources to prevent waste.
- Public health, safety, and environmental protection (compliance and enforcement).
- Idle and orphan well plugging program.
- UIC Class II brine disposal program.
- Ohio EPA has drafted a General Air Emissions Permit for the production operations of horizontal shale wells.
Ohio has regulatory primacy of its brine injection wells and adequate geologic capacity.

New rules are being developed to further strengthen the program.
At these depths, pressure from the overlying rocks and fluids make it physically impossible to induce a fracture all the way up to the groundwater layers.
“Wet” Gas

- Data and early drilling indicate much of the Utica-Point Pleasant production will be “wet” gas—that is natural gas (methane = CH$_4$) with a large percentage of associated natural gas liquids.

- Natural gas liquids (NGLs) can be differentiated by the number of hydrogen atoms they contain. For example, ethane (C$_2$H$_6$), propane (C$_3$H$_8$), butane (C$_4$H$_{10}$), and natural gasoline (C$_5$ and higher).

- Most gas production in Ohio previously has been relatively dry gas, which required little or no processing prior to being accepted into the gas pipeline system.
## Select Physical Properties of Hydrocarbons Including Natural Gas Liquids

<table>
<thead>
<tr>
<th>Compound</th>
<th>Formula</th>
<th>Molecular Mass</th>
<th>Boiling Point, °C.</th>
<th>Density Air = 1</th>
<th>Compressibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>CH\textsubscript{4}</td>
<td>16.04</td>
<td>-161.5</td>
<td>0.554</td>
<td>0.9981</td>
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<tr>
<td>Ethane</td>
<td>C\textsubscript{2}H\textsubscript{6}</td>
<td>30.07</td>
<td>-88.6</td>
<td>1.038</td>
<td>0.9915</td>
</tr>
<tr>
<td>Ethylene</td>
<td>C\textsubscript{2}H\textsubscript{4}</td>
<td>28.05</td>
<td>-103.8</td>
<td>0.9686</td>
<td>0.9938</td>
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<tr>
<td>Propane</td>
<td>C\textsubscript{3}H\textsubscript{8}</td>
<td>44.1</td>
<td>-42.1</td>
<td>1.5225</td>
<td>0.9810</td>
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<tr>
<td>Butane</td>
<td>C\textsubscript{4}H\textsubscript{10}</td>
<td>58.12</td>
<td>-0.5</td>
<td>2.0068</td>
<td>0.9641</td>
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<tr>
<td>Pentane</td>
<td>C\textsubscript{5}H\textsubscript{12}</td>
<td>72.15</td>
<td>36.1</td>
<td>2.4911</td>
<td>0.942</td>
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<tr>
<td>Hexane</td>
<td>C\textsubscript{6}H\textsubscript{14}</td>
<td>86.18</td>
<td>68.7</td>
<td>2.9753</td>
<td>0.91</td>
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<tr>
<td>Heptane</td>
<td>C\textsubscript{7}H\textsubscript{16}</td>
<td>100.21</td>
<td>98.4</td>
<td>3.4596</td>
<td>0.852</td>
</tr>
</tbody>
</table>

Modified from Lyons and Plisga (2005).
Historically, the price of a barrel of NGLs has tracked the price of crude oil more closely than the price of natural gas (although NGLs as a whole track at about 60% the price of crude oil).

When gas prices are low relative to oil—a condition that prevails today—the sale of NGLs produced from gas can offer a meaningful boost to profitability.

When natural gas prices are high relative to the price of NGLs, it is less profitable to process natural gas because of the higher value and the increased cost of separating the NGLs.
Processing and Fractionation

- Natural gas processing involves the removal of impurities and NGLs from raw gas, while fractionation involves the separation of the NGL stream into distinct hydrocarbons.
- Both may be great economic opportunities for Ohio in the early years of Utica-Point Pleasant production as very little processing capability and no fractionation plants exist in Ohio.
Dominion and NiSource are both converting portions of their large transmission lines to accept wet gas for the short term, while additional processing and fractionation plants are built.

Natrium Processing Plant under development (Dec. 2012) to handle 200 MMCFGD and fractionate 36,000 bbl NGL—may expand to 400 MM and 59,000 bbl.

**MMCFGD = Million cubic feet of gas per day**

**Bbl = Barrels**
Products Created from NGLs

Simplified flow chart illustrating the ethylene supply chain from ethane feedstock through petrochemical intermediates and final end use products.

Modified from ACC (2011).
Petrochemical Products—Our Society is Built on Them

Photo courtesy National Geographic and OOGEEP.
The Ohio Geological Survey is continually posting new information on the shale plays on its website.
References Cited


Pope, M.C., and Read, J.F., 1997 High-resolution surface and subsurface sequence stratigraphy of late Middle to Upper Ordovician (late Mohawkian-Cincinnatian) foreland basin rocks, Kentucky and Virginia: AAPG Bulletin v. 81, no. 11, p. 1866-1893.


Further Reading


Cornell, S.R., 2000, Sequence stratigraphy and event correlations of upper Black River and lower Trenton Group carbonates of northern New York State and southern Ontario, Canada: Cincinnati, Ohio, University of Cincinnati, M.S. Thesis.


