Utica-Point Pleasant Shale Geology, Drilling Activity and Resource Assessment in Ohio

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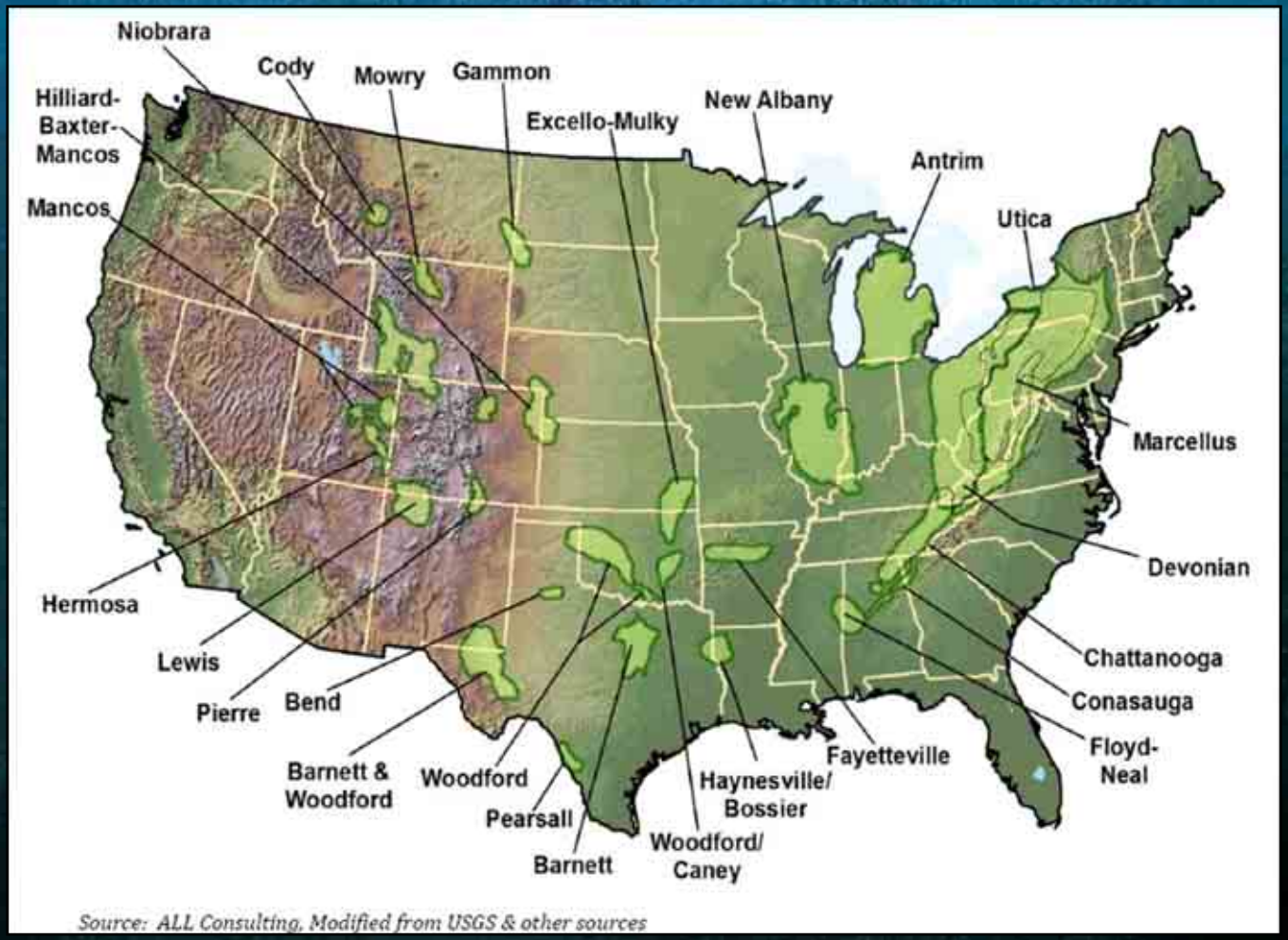
Ohio Department of Natural Resources
Division of Geological Survey

SOOGA Annual Trade Show
September 15, 2011

Ohio is not alone.

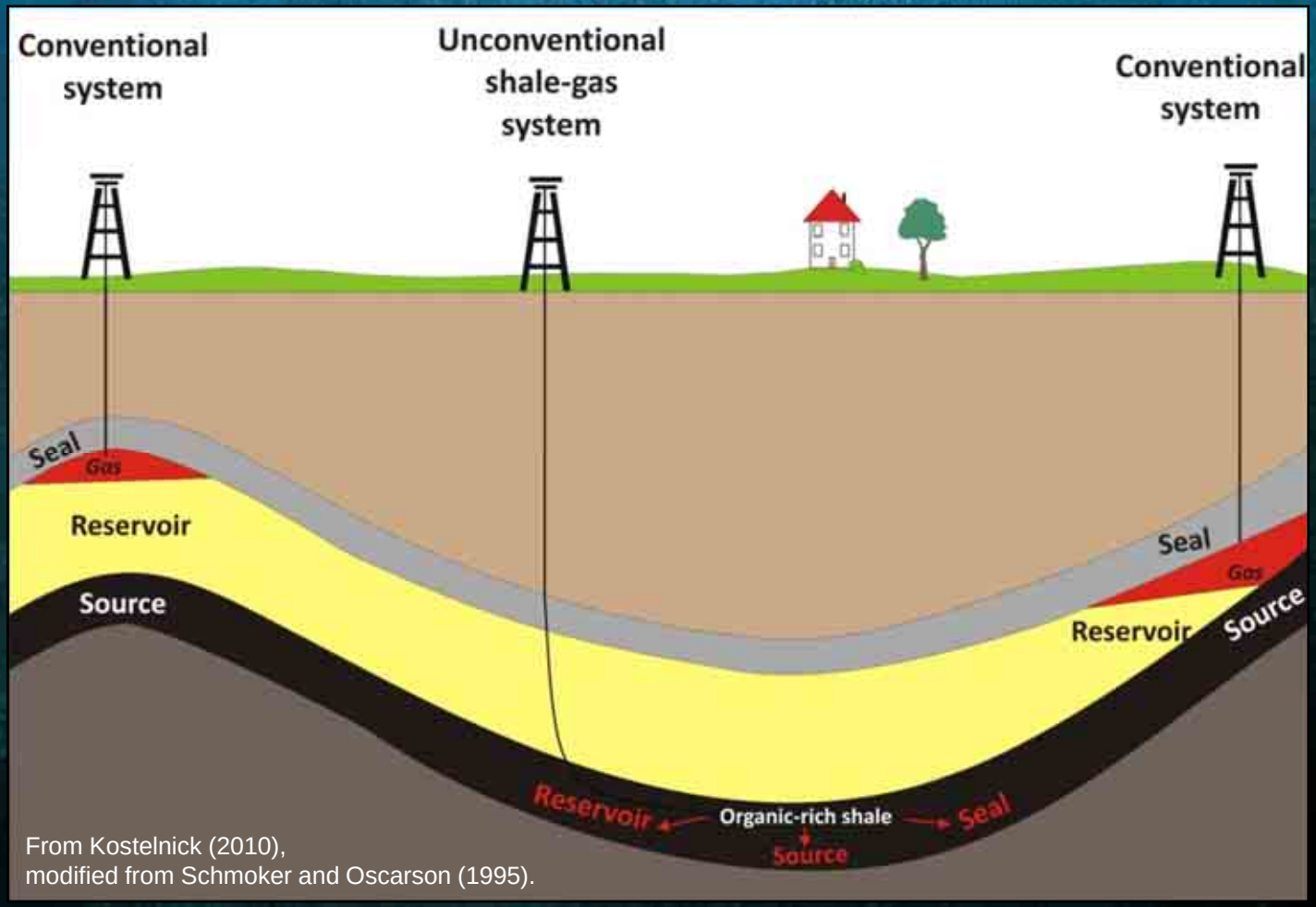


The advent of drilling long horizontal laterals combined with the ability to perform multiple stage hydraulic fracture treatments have allowed many shale gas plays to develop across the United States.

Why Ohio May Be The Focus of the Utica Play

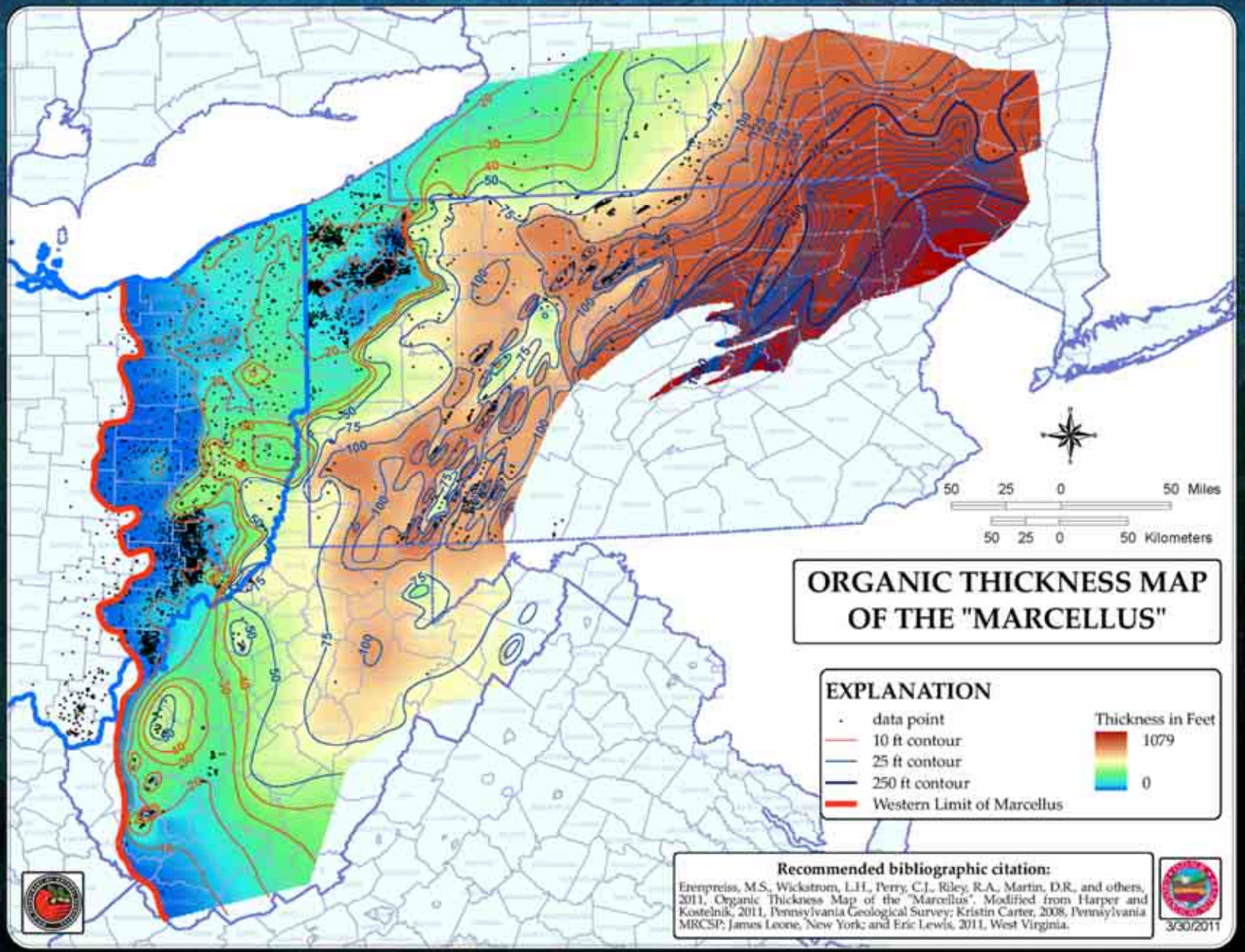
- Thus far, Ohio is friendly to drilling
  - HB133 – drilling on State Lands
  - Conducive and strong regulatory environment
    - But it only takes one bad actor or accident to spoil it
- Ohio has UIC primacy and an adequate number of brine injection wells – with more on the way
- NJ, NY and Quebec moratoriums
- Drilling depths in Ohio ~3,500 to 10,000’
- Interlayered carbonate and shale in Ohio
- Maturation indices and kerogen types indicate liquids and oil in Ohio vs dry gas in most of PA and NY

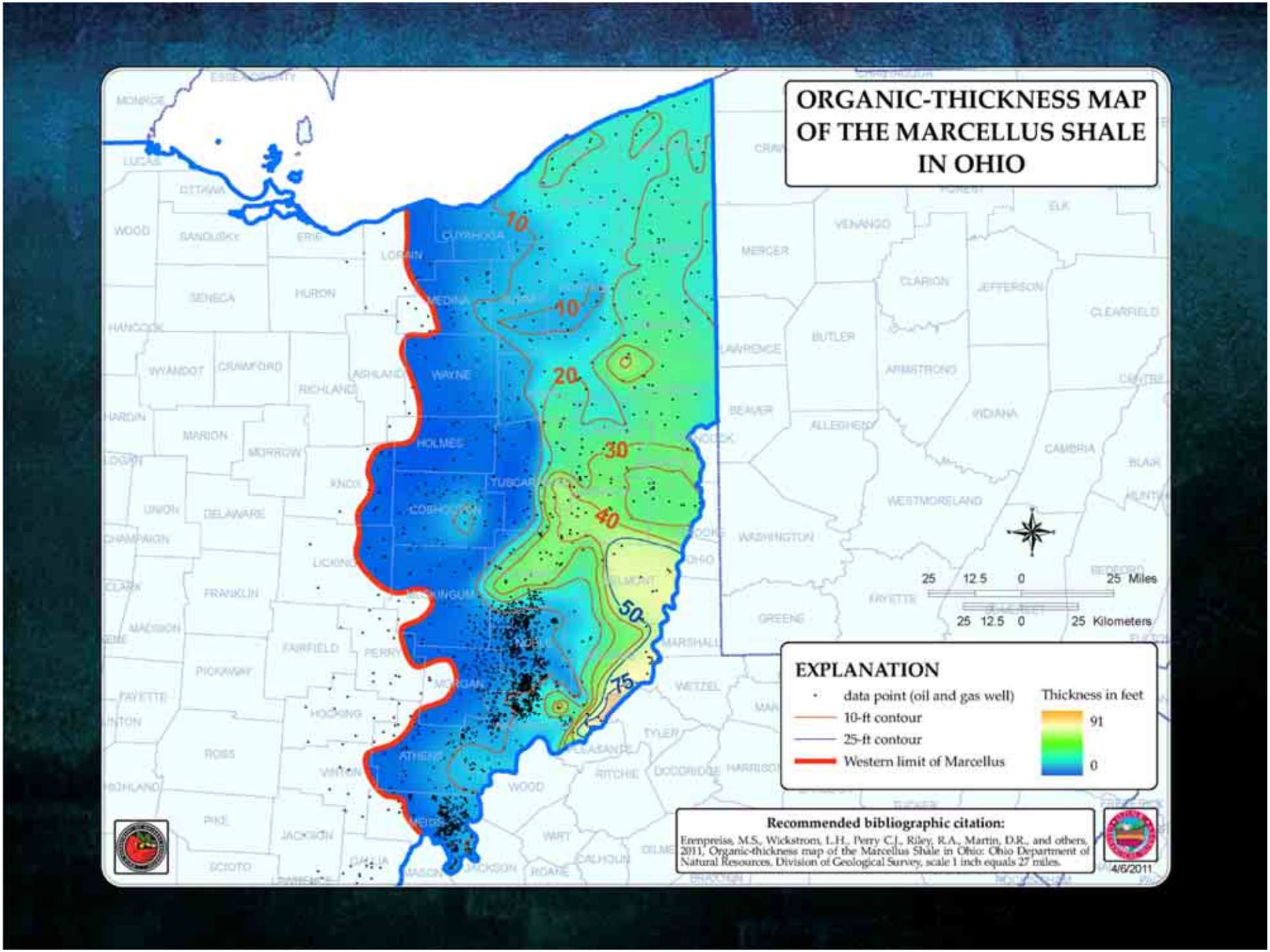
Drilling and producing from organic-rich shales represents a large paradigm shift for the oil and gas industry.

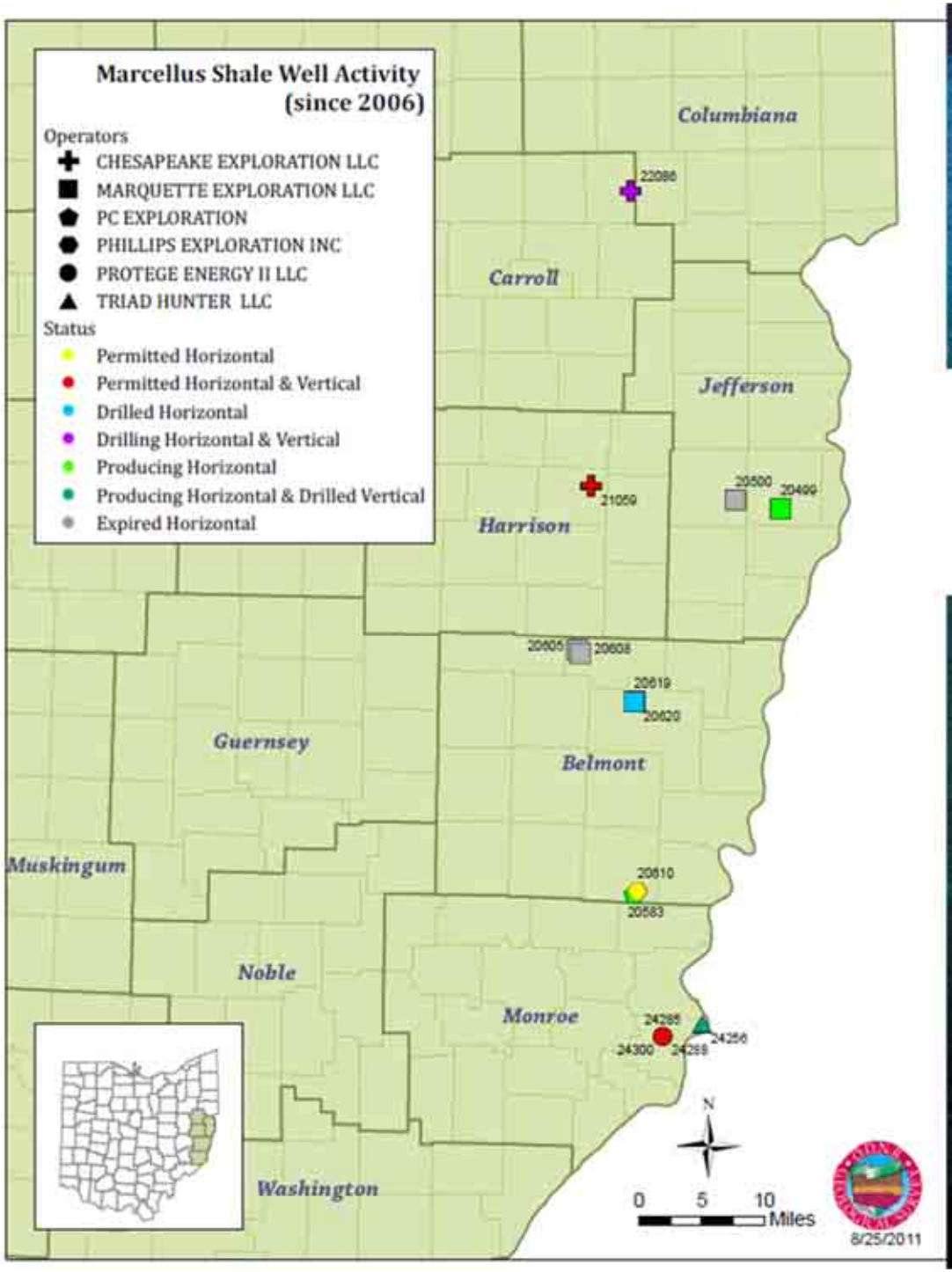


From Kostelnick (2010),
modified from Schmoker and Oscarson (1995).

Prior to the late 1990s these shales were thought of principally as the source of oil and gas that would then migrate slowly over time into “conventional” reservoirs.

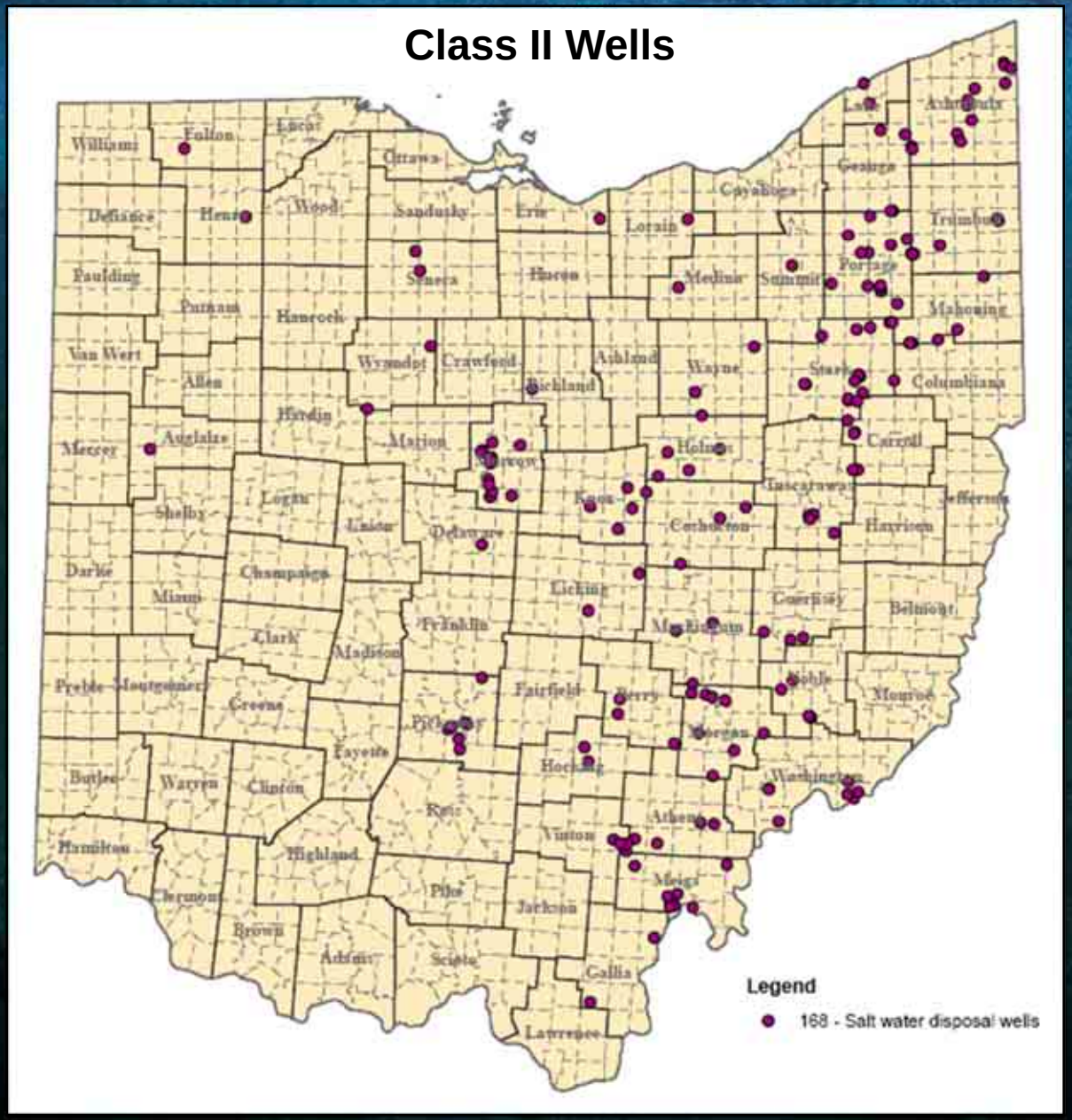

50 25 0 50 Miles
50 25 0 50 Kilometers
ORGANIC THICKNESS MAP OF THE "MARCELLUS"
EXPLANATION
data point
10 ft contour
25 ft contour
250 ft contour
Western Limit of Marcellus
Thickness in Feet
1079
0
Recommended bibliographic citation:
Ettensohn, M.S., Wickstrom, L.H., Perry, C.J., Riley, R.A., Martin, D.R., and others, 2011, Organic Thickness Map of the "Marcellus". Modified from Harper and Kostelnik, 2011, Pennsylvania Geological Survey; Kristin Carter, 2008, Pennsylvania MRCSP; James Leone, New York; and Eric Lewis, 2011, West Virginia.
3/30/2011


ORGANIC-THICKNESS MAP OF THE MARCELLUS SHALE IN OHIO
10
10
20
30
40
50
75
25 12.5 0 25 Miles
25 12.5 0 25 Kilometers
EXPLANATION
data point (oil and gas well)
10-ft contour
25-ft contour
Western limit of Marcellus
Thickness in feet
91
0
Recommended bibliographic citation:
Ettensohn, M.S., Wickstrom, L.H., Perry C.J., Riley, R.A., Martin, D.R., and others, 2011, Organic-thickness map of the Marcellus Shale in Ohio: Ohio Department of Natural Resources, Division of Geological Survey, scale 1 inch equals 27 miles.
4/6/2011



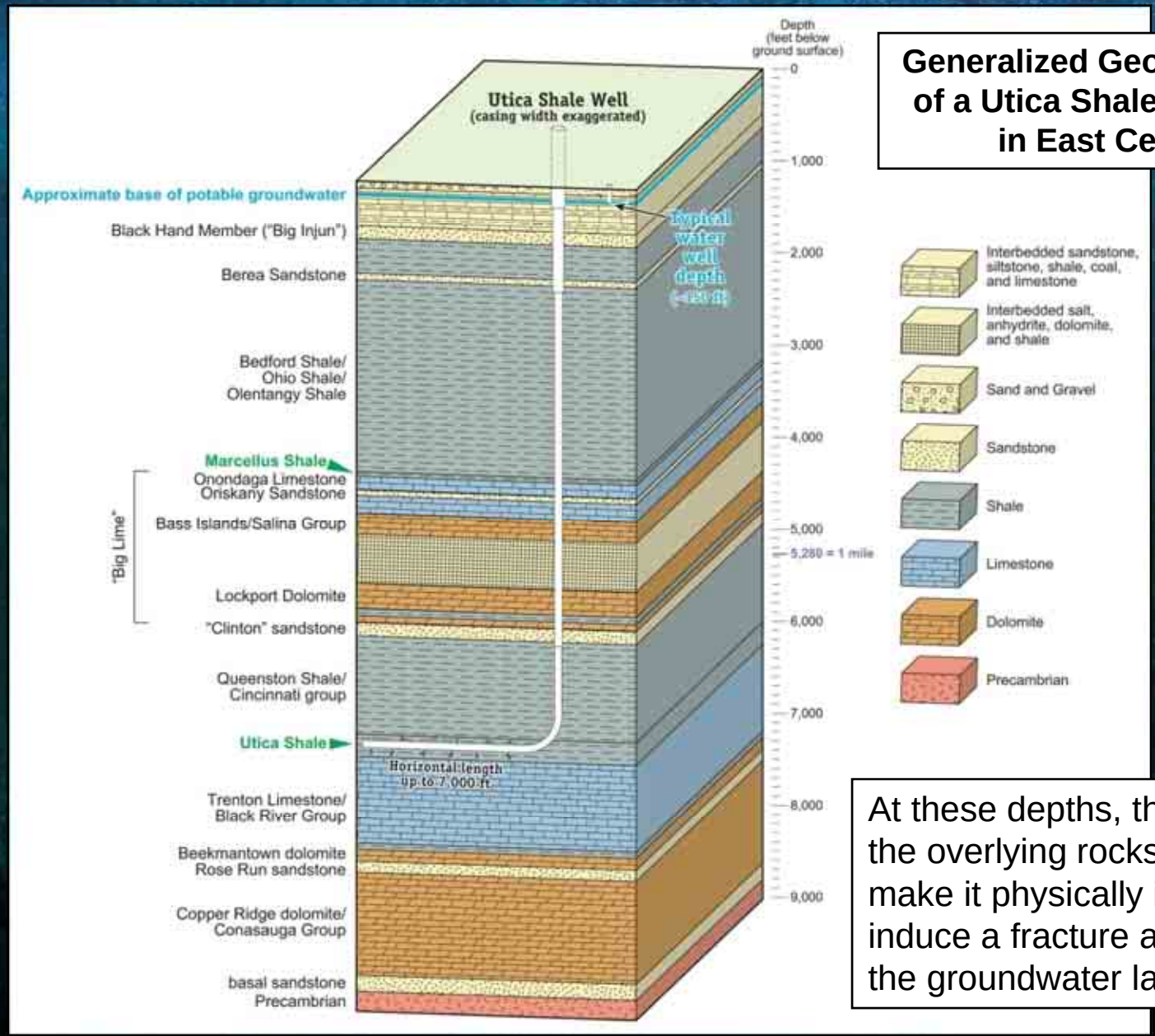
Horizontal Permits: 13
Horizontal Wells Drilled: 6
Stratigraphic Test Wells: 5
Stratigraphic Test Wells Drilled: 2

Permit information from the Division of Mineral Resources Management

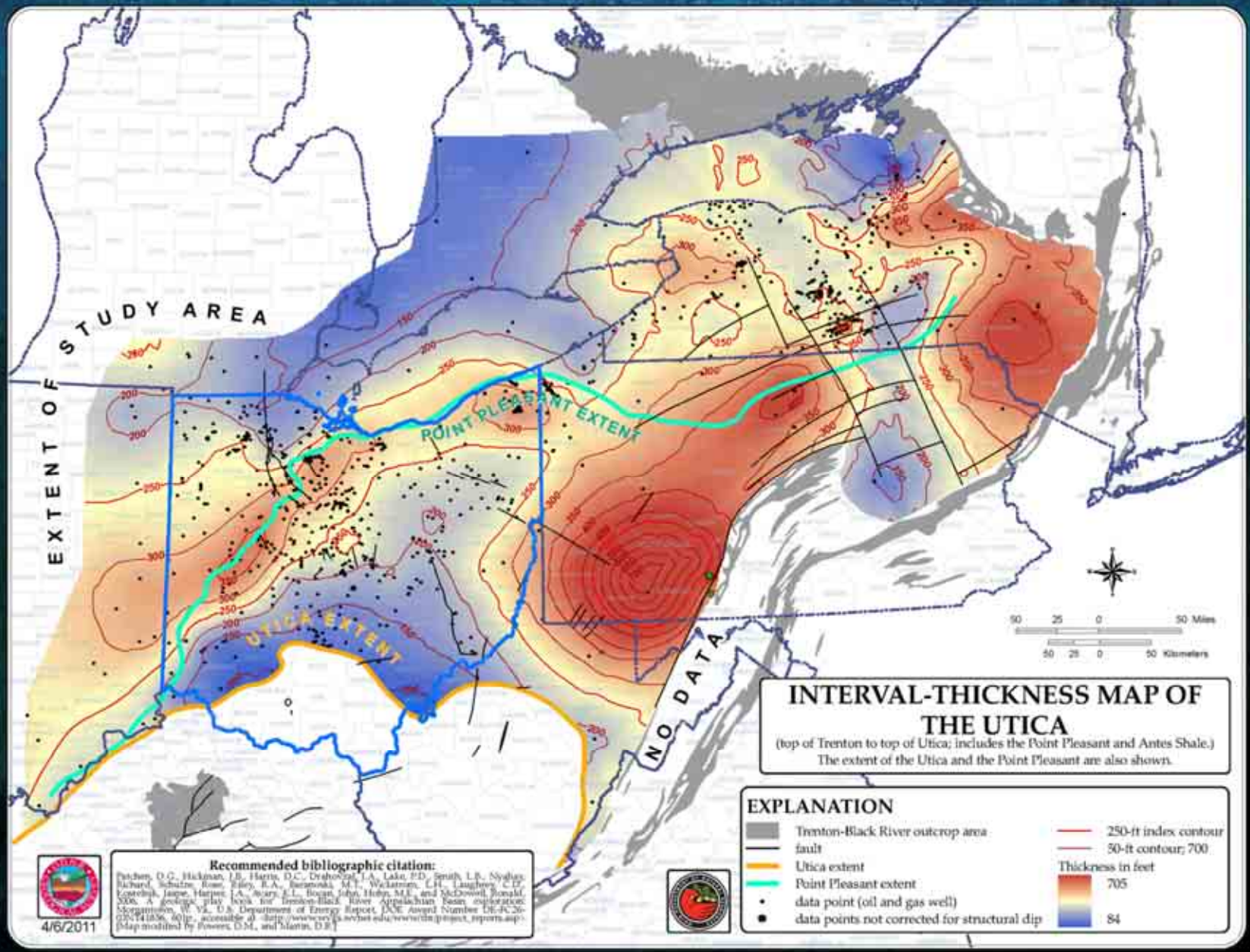


Ohio has regulatory primacy of its brine injection wells; Pennsylvania does not.

Generalized Geology and Profile of a Utica Shale Well Prototype in East Central Ohio



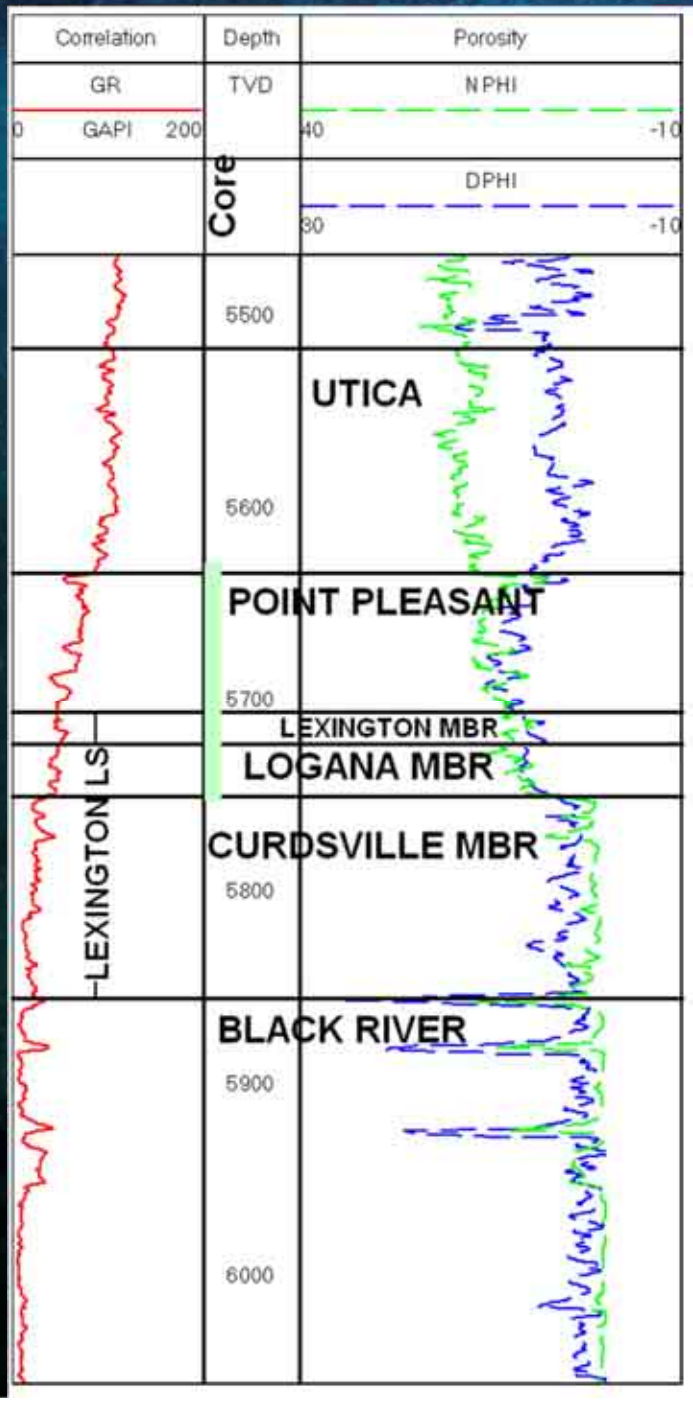
At these depths, the pressure from the overlying rocks and fluids make it physically impossible to induce a fracture all the way up to the groundwater layers.

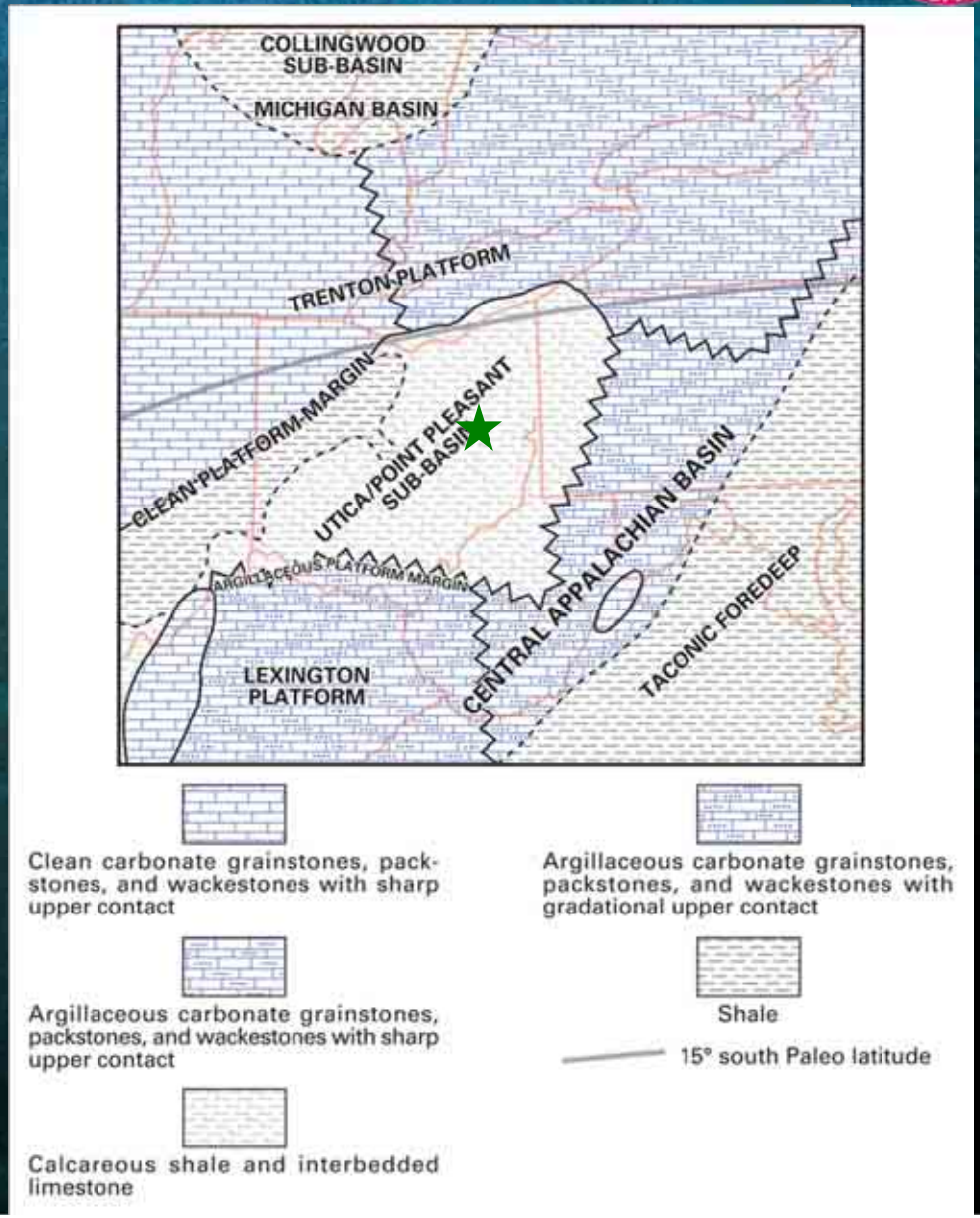

EXTENT OF STUDY AREA
POINT PLEASANT EXTENT
UTICA EXTENT
NO DATA
50 25 0 50 Miles
50 25 0 50 Kilometers
INTERVAL-THICKNESS MAP OF THE UTICA
(top of Trenton to top of Utica; includes the Point Pleasant and Antes Shale.)
The extent of the Utica and the Point Pleasant are also shown.
EXPLANATION
Trenton-Black River outcrop area
fault
Utica extent
Point Pleasant extent
data point (oil and gas well)
data points not corrected for structural dip
250-ft index contour
50-ft contour; 700
Thickness in feet
705
84
Recommended bibliographic citation:
4/6/2011

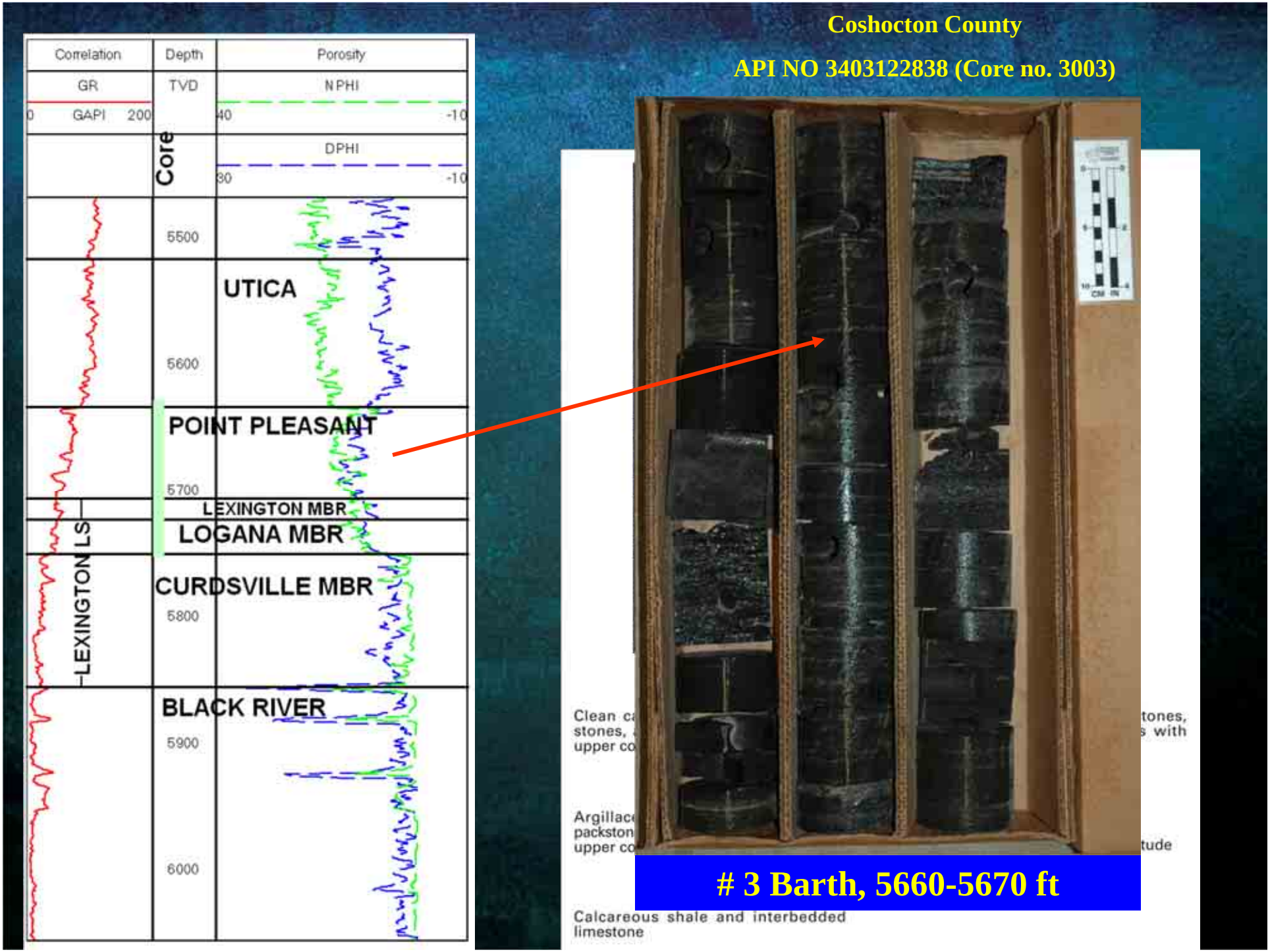
Coshocton County

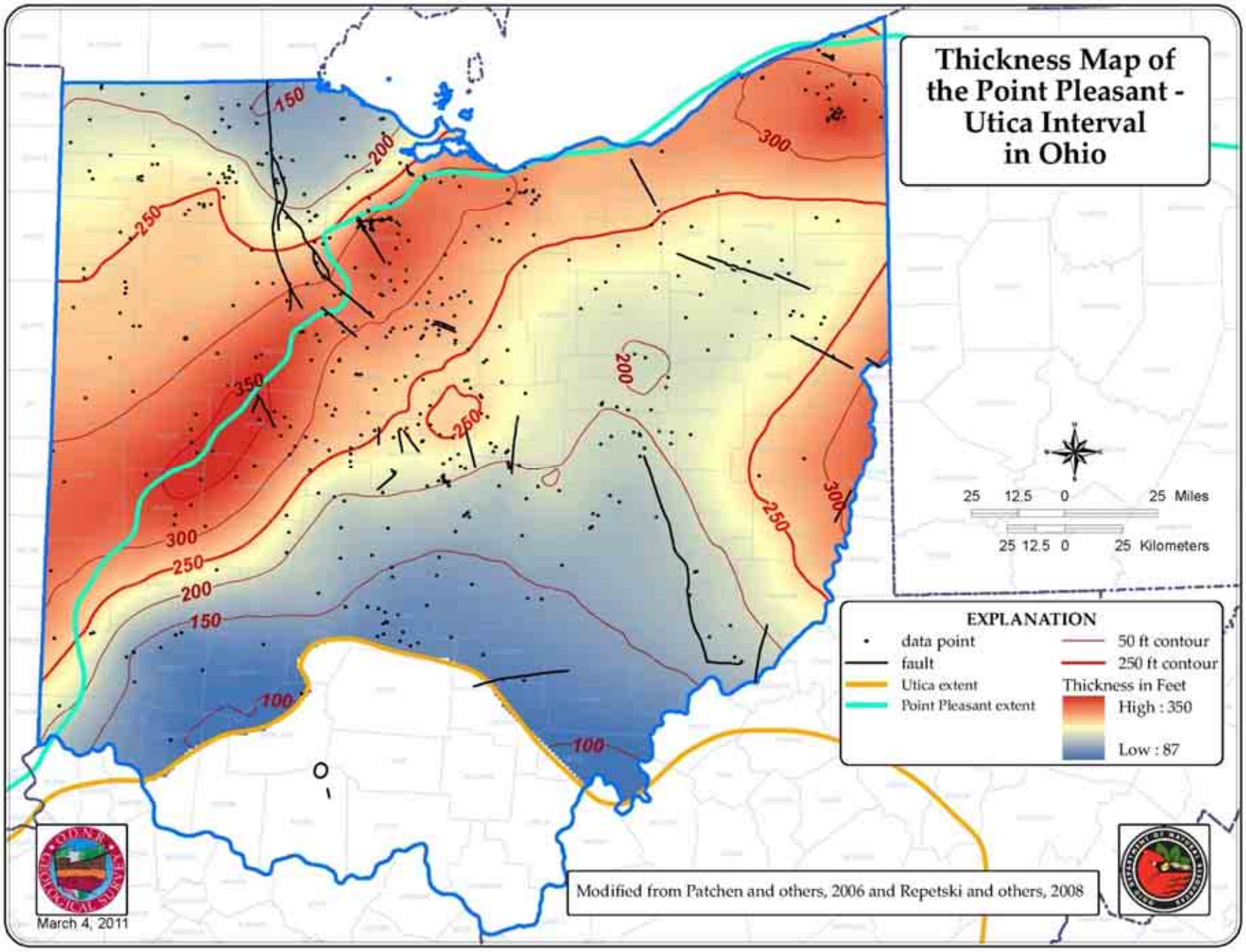
API NO 3403122838 (Core no. 3003)

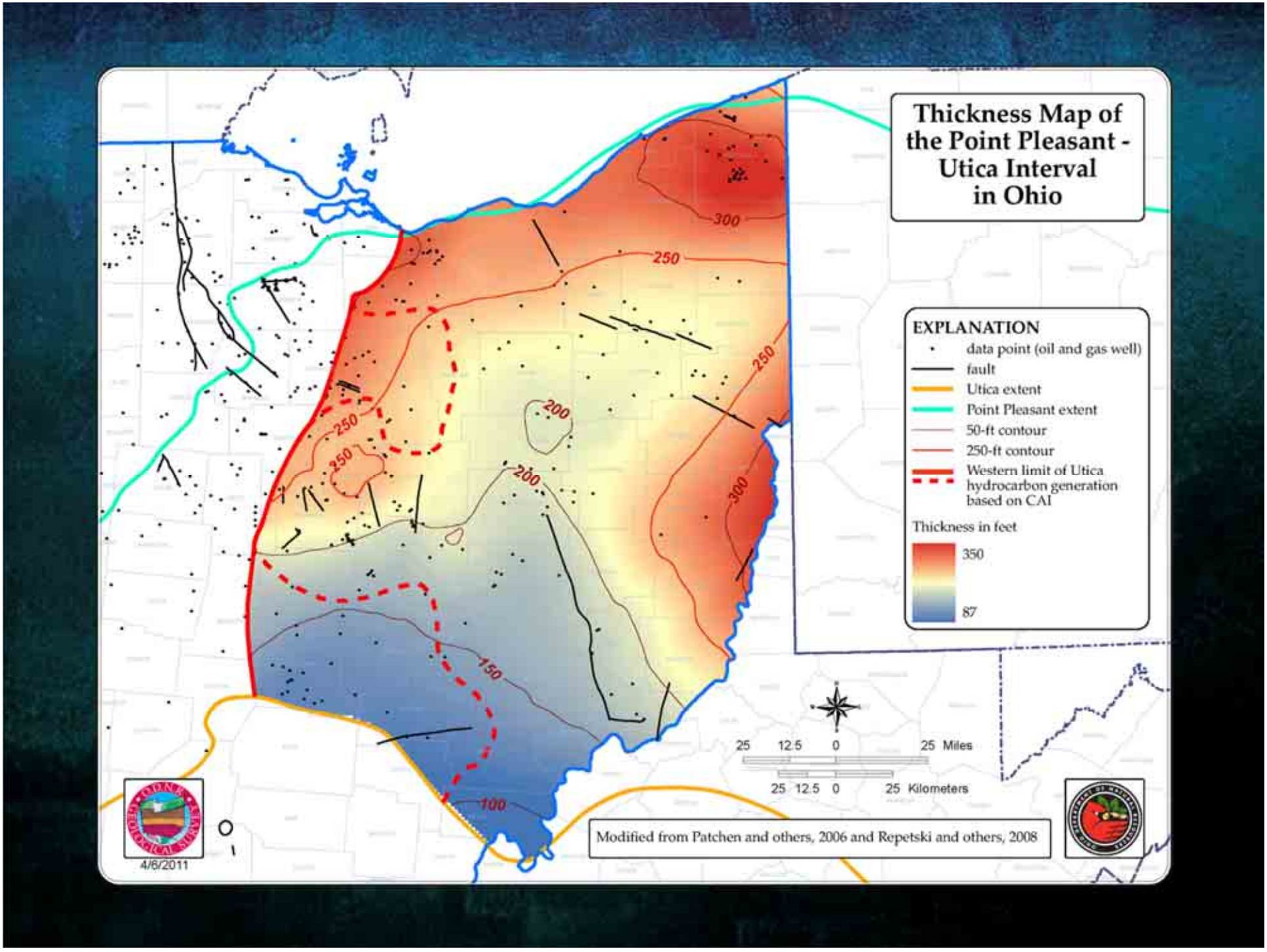
 # 3 Barth well

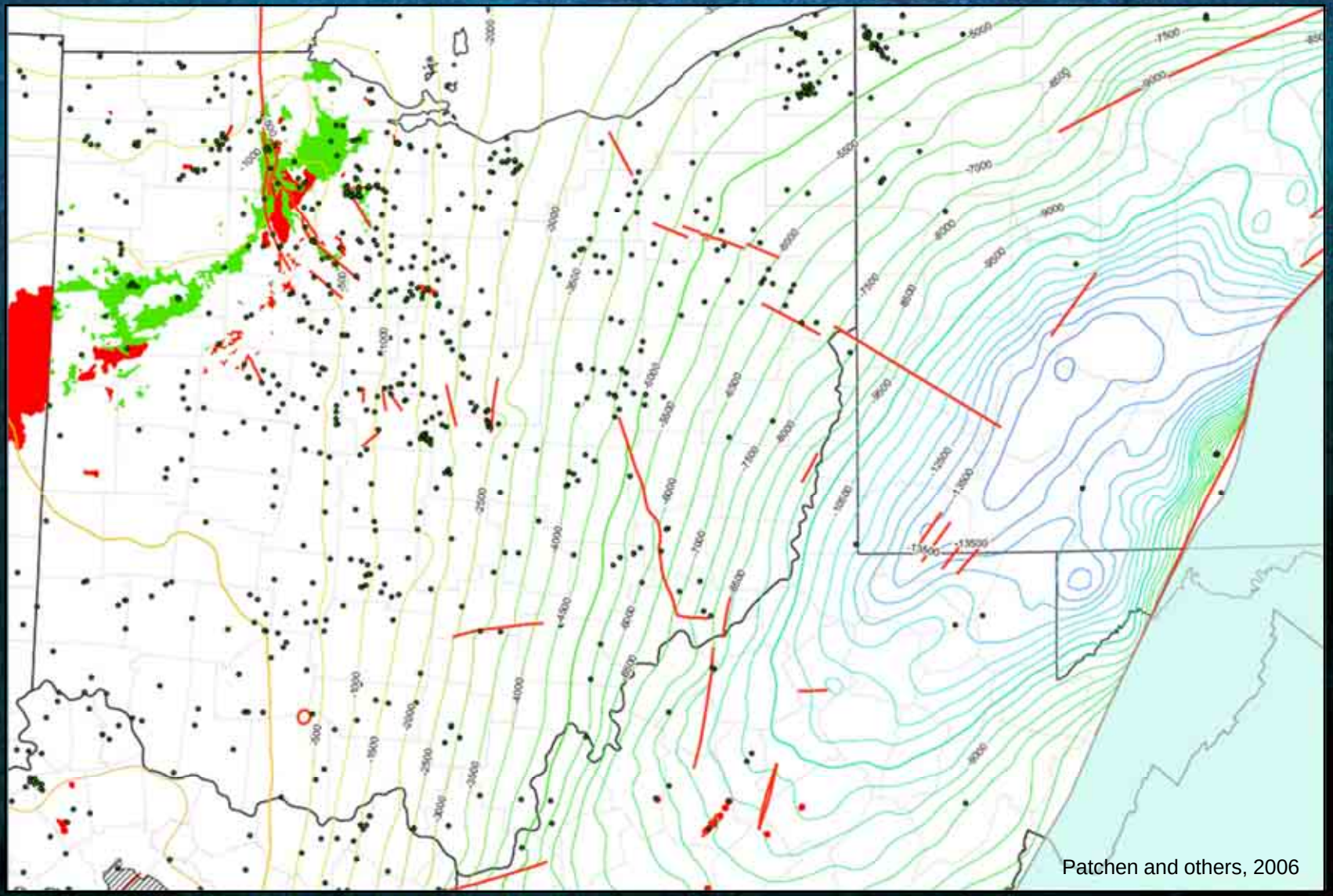





Coshocton County
API NO 3403122838 (Core no. 3003)
Correlation
Depth
Porosity
GR
TVD
NPHI
0 GAPI 200
40 -10
Core
DPHI
30 -10
5500
UTICA
5600
POINT PLEASANT
5700
LEXINGTON MBR
LOGANA MBR
LEXINGTON LS
CURDSVILLE MBR
5800
BLACK RIVER
5900
6000
3 Barth, 5660-5670 ft
Calcareous shale and interbedded limestone

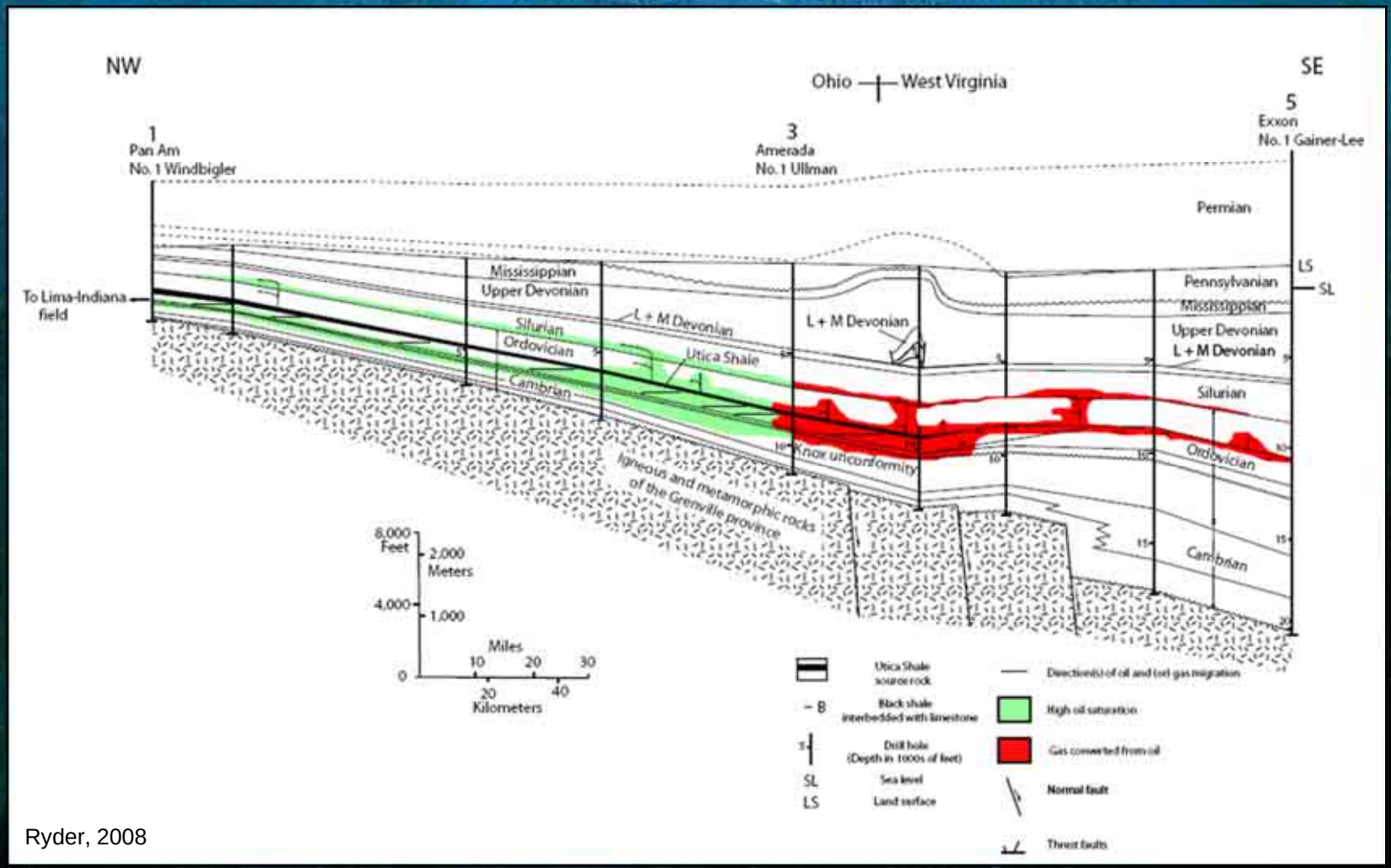

Thickness Map of the Point Pleasant - Utica Interval in Ohio
150
200
250
300
350
100
25 12.5 0 25 Miles
25 12.5 0 25 Kilometers
EXPLANATION
data point
fault
Utica extent
Point Pleasant extent
50 ft contour
250 ft contour
Thickness in Feet
High : 350
Low : 87
Modified from Patchen and others, 2006 and Repetski and others, 2008
March 4, 2011


Thickness Map of the Point Pleasant - Utica Interval in Ohio
EXPLANATION
data point (oil and gas well)
fault
Utica extent
Point Pleasant extent
50-ft contour
250-ft contour
Western limit of Utica hydrocarbon generation based on CAI
Thickness in feet
350
87
300
250
200
150
100
25 12.5 0 25 Miles
25 12.5 0 25 Kilometers
Modified from Patchen and others, 2006 and Repetski and others, 2008
4/6/2011



Structure on the Trenton Limestone. Add topographic elevation to derive approximate drilling depths through the Utica-Point Pleasant interval.

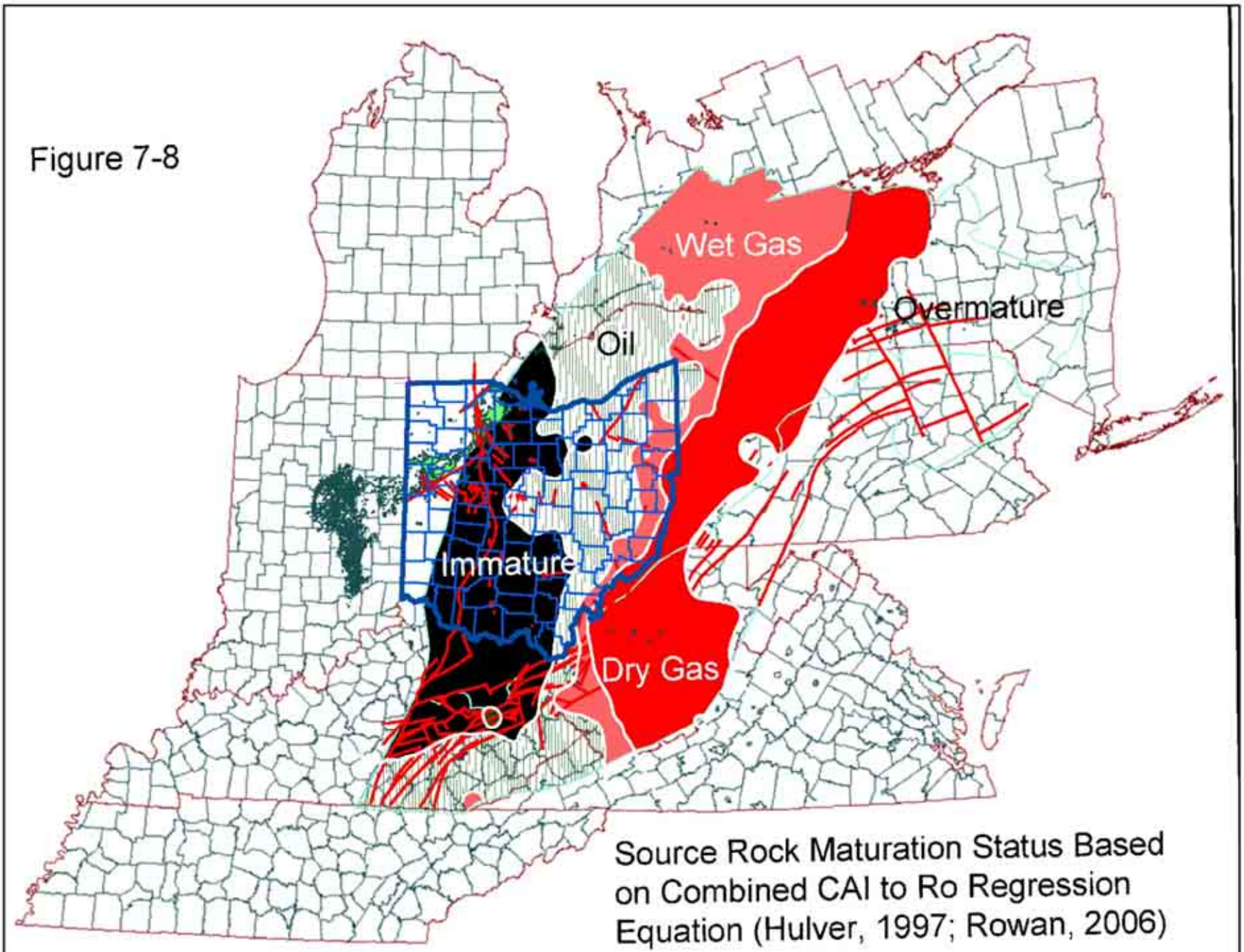
Why Ohio may be the Focus of the Utica-Point Pleasant Play



Ryder, 2008

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 illustrated by this NW–SE-oriented schematic cross section by Ryder illustrating the results of geochemical analyses of well samples.

Figure 7-8



Source Rock Maturation Status Based on Combined CAI to Ro Regression Equation (Hulver, 1997; Rowan, 2006)

“Wet” Gas

- Data and early drilling indicate much of the Utica-Point Pleasant production will be “wet” gas – that is natural gas (methane = CH4) with a large percentage of natural gas liquids associated with it.
- Natural gas liquids (NGL) can be differentiated by the number of hydrogen atoms they contain--for example, ethane (C2H6), propane (C3H8), butane (C4H10) and natural gasoline (C5 and higher)
- Most gas production in Ohio previously has been dry gas, which required little or no processing prior to being accepted into the gas pipeline system.

TABLE 1.—Select physical properties of hydrocarbons including natural gas liquids.
Modified from Lyons and Plisga, 2005.

Compound	Formula	Molecular Mass	Boiling Point, ° C.	Density Air = 1	Compressibility
Methane	CH_4	16.04	-161.5	0.554	0.9981
Ethane	C_2H_6	30.07	-88.6	1.038	0.9915
Ethylene	C_2H_4	28.05	-103.8	0.9686	0.9938
Propane	C_3H_8	44.1	-42.1	1.5225	0.9810
Butane	C_4H_{10}	58.12	-0.5	2.0068	0.9641
Pentane	C_5H_{12}	72.15	36.1	2.4911	0.942
Hexane	C_6H_{14}	86.18	68.7	2.9753	0.91
Heptane	C_7H_{16}	100.21	98.4	3.4596	0.852

NGL’s add value

- Historically, the price of a barrel of NGLs has tracked the price of crude oil more closely (albeit NGLs as a whole track at about 60% the price of crude oil) than the price of natural gas. 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.
- Very little processing capability and no fractionation plants exist in Ohio. This segment of the industry could have a large economic impact in the state.

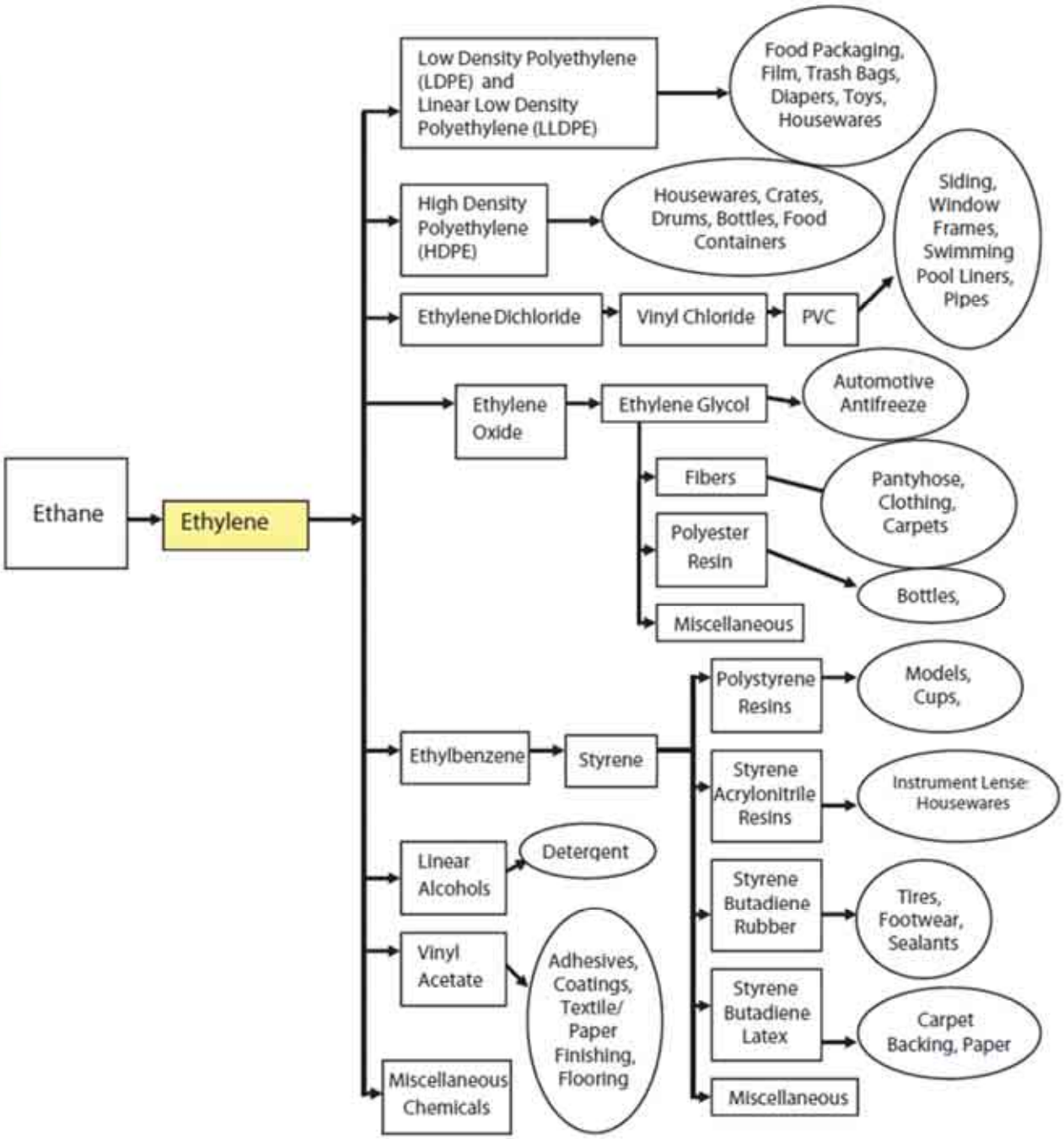
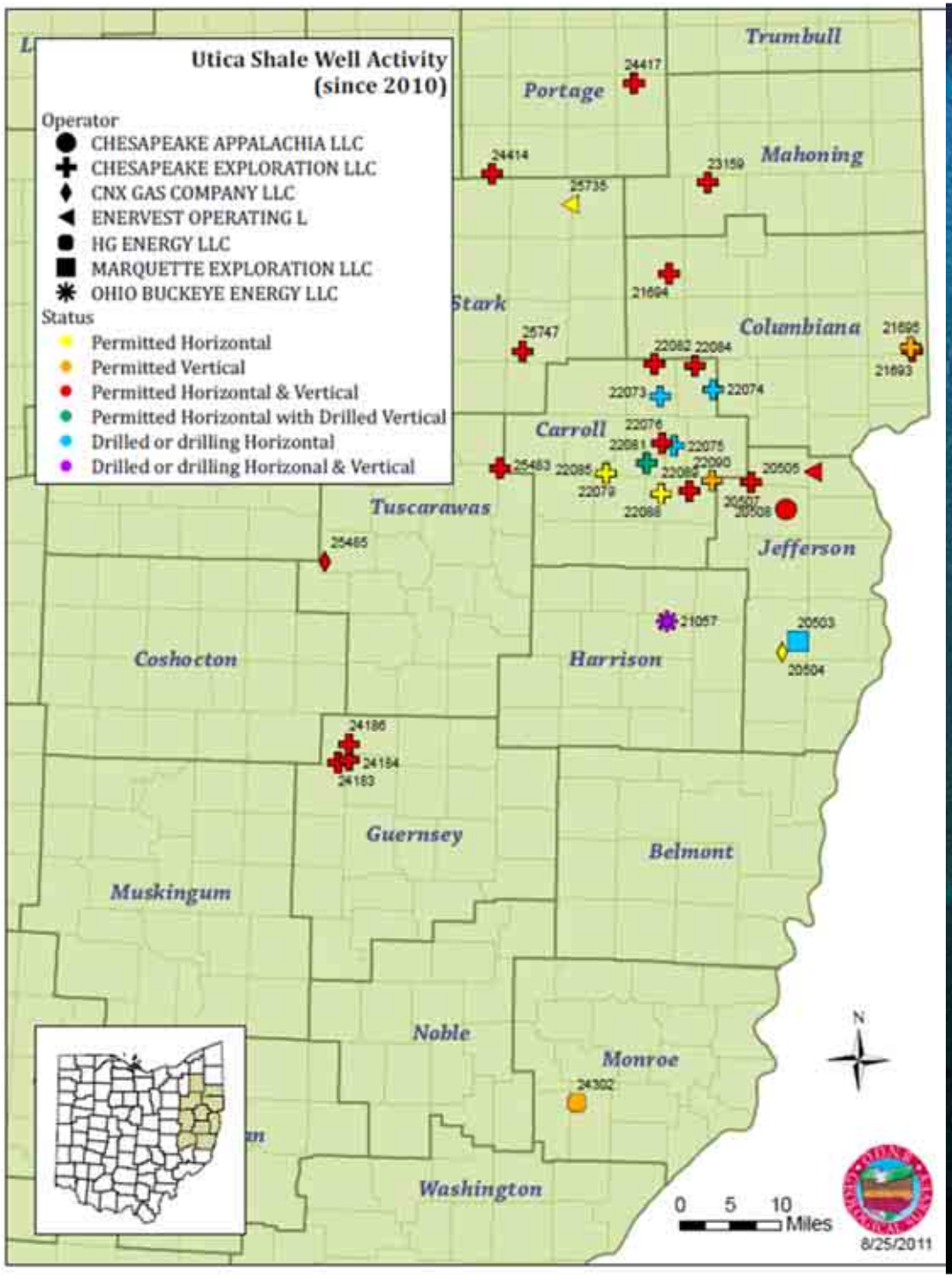


FIGURE 1.—A simplified flow chart illustrating the ethylene supply chain from ethane feedstock through petrochemical intermediates and final end use product. Modified from Economics & Statistics American Chemistry Council, 2011.



Horizontal Permits: 43
Horizontal Wells Drilled: 9
Stratigraphic Test Wells: 27
Stratigraphic Test Wells Drilled: 7
** permits issued since December 2009*

Permit information from the Division of Mineral Resources Management

The size of the shale operations is much bigger than we are used to in Ohio

Chesapeake Exploration, Neider #3H
Photo courtesy of DMRM

Marcellus Shale Activity
Pennsylvania

2011: 515 Through April

2010: 1,454 Marcellus Wells Drilled

2009: 763 Marcellus Wells drilled

2008: 195 Marcellus Wells Drilled

2004: Range Resources Drilled the First Horizontal Marcellus Shale Wells

Method for Calculating Utica Oil Resource Assessment

(Wallace and Roen, 1989)

$$Q_t = V \times D \times TOC \times C \times \%R$$

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

Resource Assessment for the Utica/Point Pleasant in the Entire Appalachian Basin (Wallace and Roen, 1989)

D = 2.65 x 10^3 kg /m
TOC = 1.34 percent
C = 10 percent
%R = 3 percent

Qt = 13.26 billion barrels of oil migrated to conventional reservoirs

Utica/Point Pleasant Recoverable Reserve Potential Estimate for Ohio

D = 2.70 x 10^3 kg/ m^3
TOC = 2.50 percent
C = 10 percent
%R = 1.2 percent* – recoverable from the interval
Qt = 1.96 billion barrels of oil or equivalent

D = 2.70 x 10^3 kg/ m^3
TOC = 2.50 percent
C = 10 percent
%R = 5 percent - recoverable from the interval
Qt = 8.2 billion barrels of oil or equivalent

* Value used for Bakken Oil Shale recoverability by: Pollastro and others, 2008

Utica/Point Pleasant Recoverable Reserve Potential Estimate for Ohio

IF we assume $^{1}/_{3}$ of volume will be gas and $^{2}/_{3}$ is oil, then…

%R = 1.2 percent—*recoverable from the interval*
Qt = 1.96 billion barrels equivalent
= 3.75 TCF gas and 1.31 Billion barrels oil

%R = 5 percent—*recoverable from the interval*
Qt = 8.2 billion barrels equivalent
= 15.7 TCF and 5.5 Billion barrels oil

“If we are to believe CEO Aubrey McClendon -- and we do -- the value of CHK's Utica Shale holdings might equal the current market cap of the entire company.

McClendon thinks the Utica Shale could mean 25 billion BOE overall.

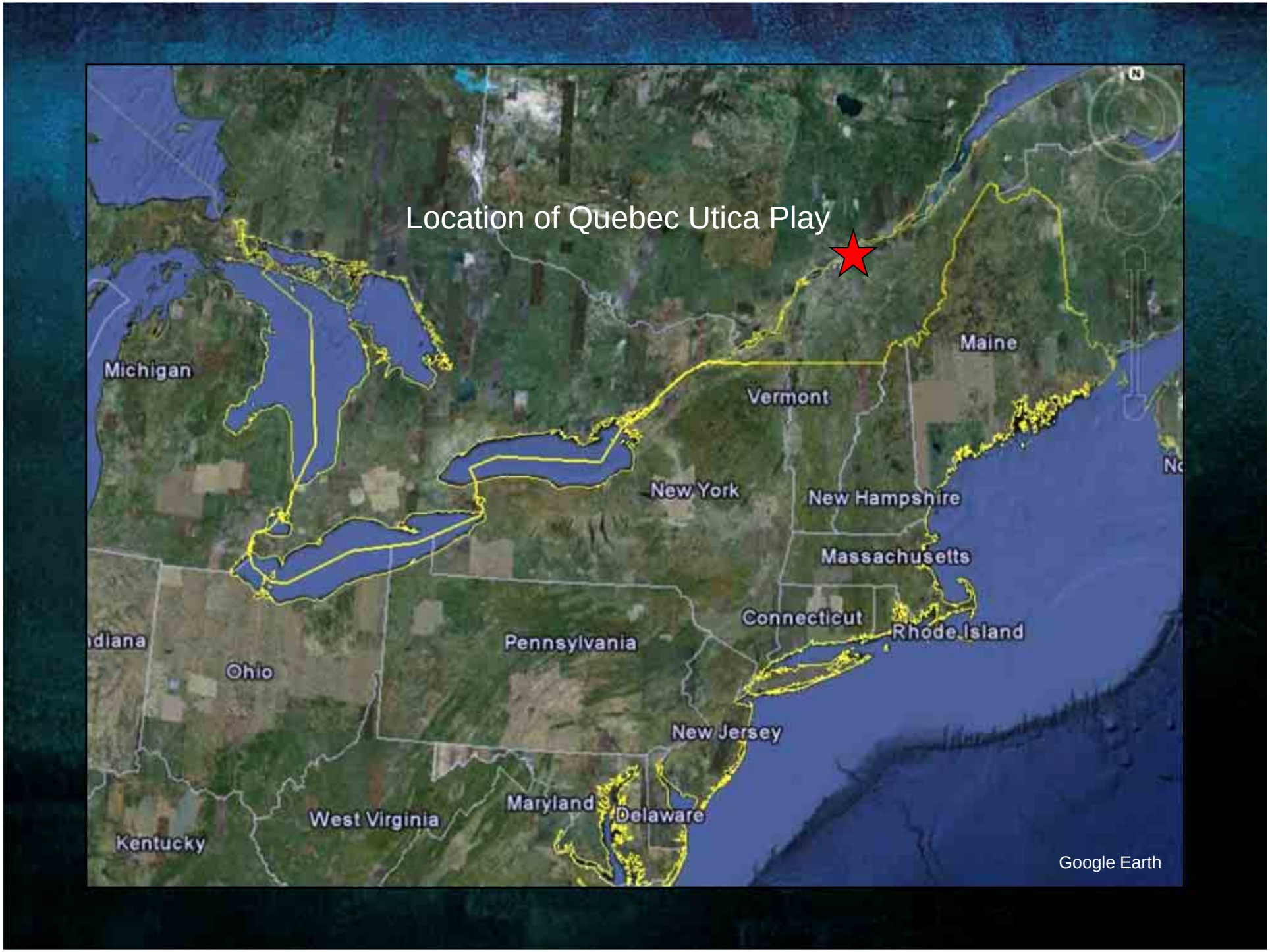
Chesapeake Energy thinks the Utica Shale will be economically superior to the Eagle Ford play. “

From SeekingAlpha.com September 8, 2011

http://seekingalpha.com/article/292408-utica-shale-oil-play-update

DISCLAIMER

- One of the mandates of the ODNR Division of 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.
- This volumetric reserve calculation is only an educated guess as to the ultimate recoverable reserves from this interval. The ODNR Division of Geological Survey will continue to gather data and provide updated assessments when possible.


Location of Quebec Utica Play
Michigan
Maine
Vermont
New York
New Hampshire
Massachusetts
Connecticut
Rhode Island
Pennsylvania
Ohio
New Jersey
Maryland
Delaware
West Virginia
Kentucky
Google Earth

www.OhioGeology.com

The ODNR Division of Geological Survey is continually posting new information on the shale plays on its website.

Water Usage

- Stimulation of a horizontal shale wells requires 0.5 to 5 million gals
- Much of the water will be purchased from municipal supplies
- 20-30 percent of water used in stimulation process returns promptly to surface as “flow-back” water
- All fresh/flow-back water stored in lined impoundments or tanks at location
- All flowback and produced water will be re-used or disposed of via injection wells in Ohio

Water Usage

- Peak drilling activity not likely for nearly 10 years
- Peak water use may be on the order of 50 million gallons/day
- At peak, water use will remain less than ONE PERCENT of state's daily water consumption
- MUCH less than the water used to irrigate Ohio golf courses

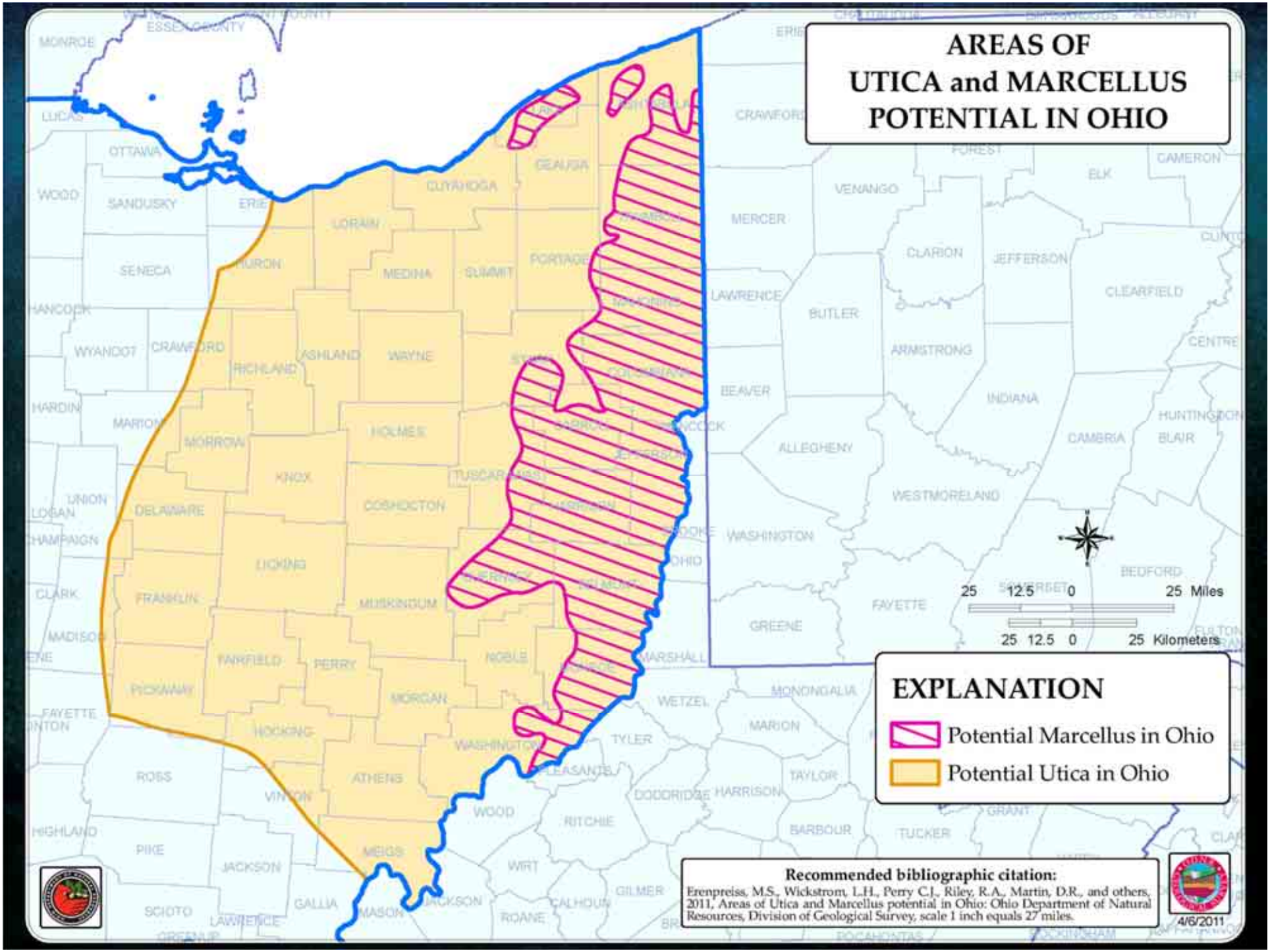
Water Usage at Golf Courses

There are now approximately 16,000 courses in the United States — about half the total in all the world — and if you laid them out together, they would be as large as Delaware. And that Delaware of golf courses uses water, lots of it. They call them "greens" for a reason, don't they?

Audubon International estimates that the average American course uses 312,000 gallons per day. In a place like Palm Springs, where 57 golf courses challenge the desert, each course eats up a million gallons a day. That is, each course each day in Palm Springs consumes as much water as an American family of four uses in four years.

Frank DeFord, NPR, 5-23-11

312,000 gals/day x 365 = 114 million gallons/yr/golf course


AREAS OF
UTICA and MARCELLUS
POTENTIAL IN OHIO
25 12.5 0 25 Miles
25 12.5 0 25 Kilometers
EXPLANATION
Potential Marcellus in Ohio
Potential Utica in Ohio
Recommended bibliographic citation:
Erenpreiss, M.S., Wickstrom, L.H., Perry C.J., Riley, R.A., Martin, D.R., and others, 2011, Areas of Utica and Marcellus potential in Ohio: Ohio Department of Natural Resources, Division of Geological Survey, scale 1 inch equals 27 miles.
4/6/2011

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  http://www.dnr.state.oh.us/portals/10/pdf/OpenFileReports/OFR_2005-1.pdf
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Beautiful 1803 Ohio
Birthplace of Aviation
OHIO Rocks!
000000
OhioGeology.com
O.D.N.R.
GEOLOGICAL SURVEY