[PS]Updates to the U.S. energy Information Administration Shale and Tight Formation Play Maps: Utica Petroleum System Mapping*

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Abstract

The U.S. Energy Information Administration (EIA) is in the process of updating maps of the major lowpermeability oil and gas plays of the lower 48 states using publically available data and commercial well-level databases (Drilling Info Inc. and IHS Inc.). As a part of these efforts EIA has generated updated maps that characterize the structure, thickness, and geologic setting of the Utica play. The Utica petroleum system includes the Utica Formation and the underlying Point Pleasant and Logana formations. Each formation holds its own significance and characteristics; so maps have been produced for each individually, and for the entire interval, as well. Data from 1479 producing oil and gas wells across New York, Ohio, Pennsylvania, and West Virginia were assessed for geologic properties related to initial production and daily production volumes. Production profiles, gas-to-oil ratios, and recovery factors vary laterally and across three major Utica play stratigraphic units, Utica, Point Pleasant, and Logana formations. EIA's collection of thematic maps helps explain the location of "sweet spots" within the play area, distribution of oil-rich and gas-rich wells across the play extent, as well as forecast production trends.

Reference Cited

U.S. Energy Information Administration (EIA), 2015, Lower 48 states shale plays. Website accessed October 21, 2016, http://www.eia.gov/oil_gas/rpd/shale_gas.pdf.

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Lower 48 states shale plays

Montana Thrust Belt
Niobrara*
Bakken***
Cody
Heath**
Williston Basin
Big Horn Basin
Powder River Basin
Three Forks
Hillard-Baxter-Mancos
Mowry
Greater Green River Basin
Niobrara*
Michigan Basin
Antrim
Unita Basin
Mancos
Park Basin
Denver Basin
Forest City Basin
Appalachian Basin
Utica
Marcellus
Illinois Basin
San Joaquin Basin
Manning Canyon
Hermosa
Piceance Basin
Monterey-Temblor
Paradox Basin
Excello-Mulky
Cherokee Platform
New Albany
Devonian (Ohio)
Pierre
Lewis
Monterey
San Juan Basin
Raton Basin
Anadarko Basin
Fayetteville
Chattanooga
Santa Maria-Ventura-Los Angeles Basin
Palo Duro Basin
Woodford
Arkoma Basin
Black Warrior Basin
Conasauga
Abo-Yeso****
Bend
Glorieta-Yeso****
Ardmore Basin
Floyd-Neal
Valley & Ridge Province
Bone Spring****
Ft. Worth Basin
Barnett
Haynesville-Bossier
Floyd-Chattanooga
Delaware**
Spraberry****
Permian Basin
Tuscaloosa
TX-LA-MS Salt Basin
Eagle Ford
Western Gulf

Current play - oldest stacked play
Current play - intermediate depth/age stacked play
Current play - shallowest/youngest stacked play
Prospective play
Basin

* Mixed shale & chalk play
** Mixed shale & limestone play
*** Mixed shale & dolostone-siltstone-sandstone play
**** Mixed shale & limestone-siltstone-sandstone play

Source: U.S. Energy Information Administration based on data from various published studies.
Updated: June 2016

Acknowledgment
The authors thank State Agencies for data sharing and expert opinion: Kristin Carter of PA Bureau of Topographic & Geologic Survey, Susan Pool and Phil Dinterman of WV Geological & Economic Survey, Ron Riley and Matt Erenpreiss of OH State Geological Survey, James Leone of NY State Geological Survey, and Scott Tinker of the BEG, TX. The authors are grateful for EIA internal peer-reviews provided by Kip Plato, Jim O'Sullivan, Barbara Mariner–Volpe, Neal Davis, Steve Grape, Jeff Little, Meg Coleman, Even Frye, Chris Peterson, Jozef Lieskovsky, Troy Cook, Jack Perrin, John Staub, Aloulou Faouzi, Shirley Neff, and Steve Harvey.

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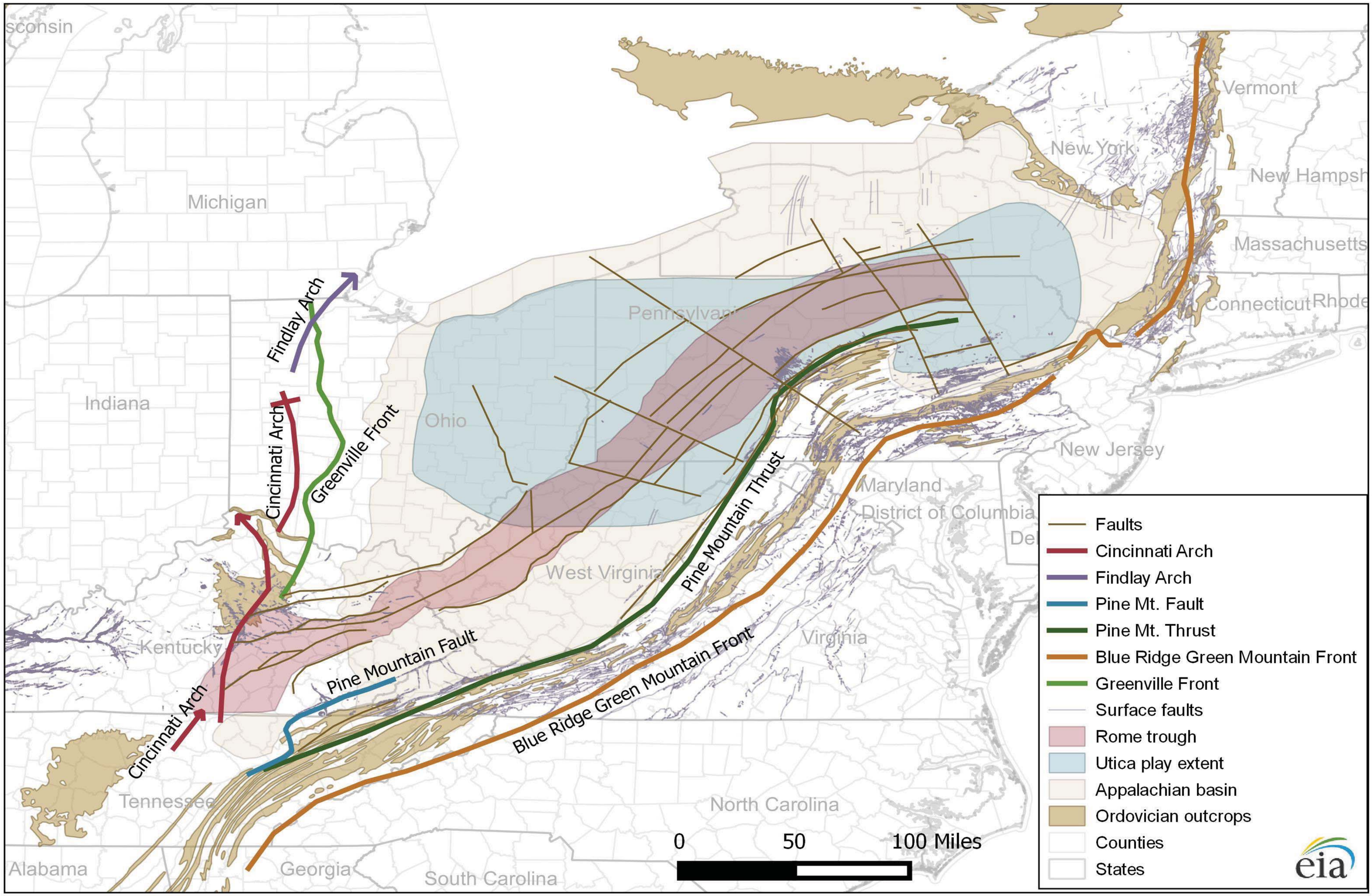
Major structural and tectonic features in the region of the Utica play



Source: U.S. Energy Information Administration, based on DrillingInfo Inc., IHS Inc., The Appalachian Oil and Natural Gas Research Consortium, and U.S. Geological Survey.

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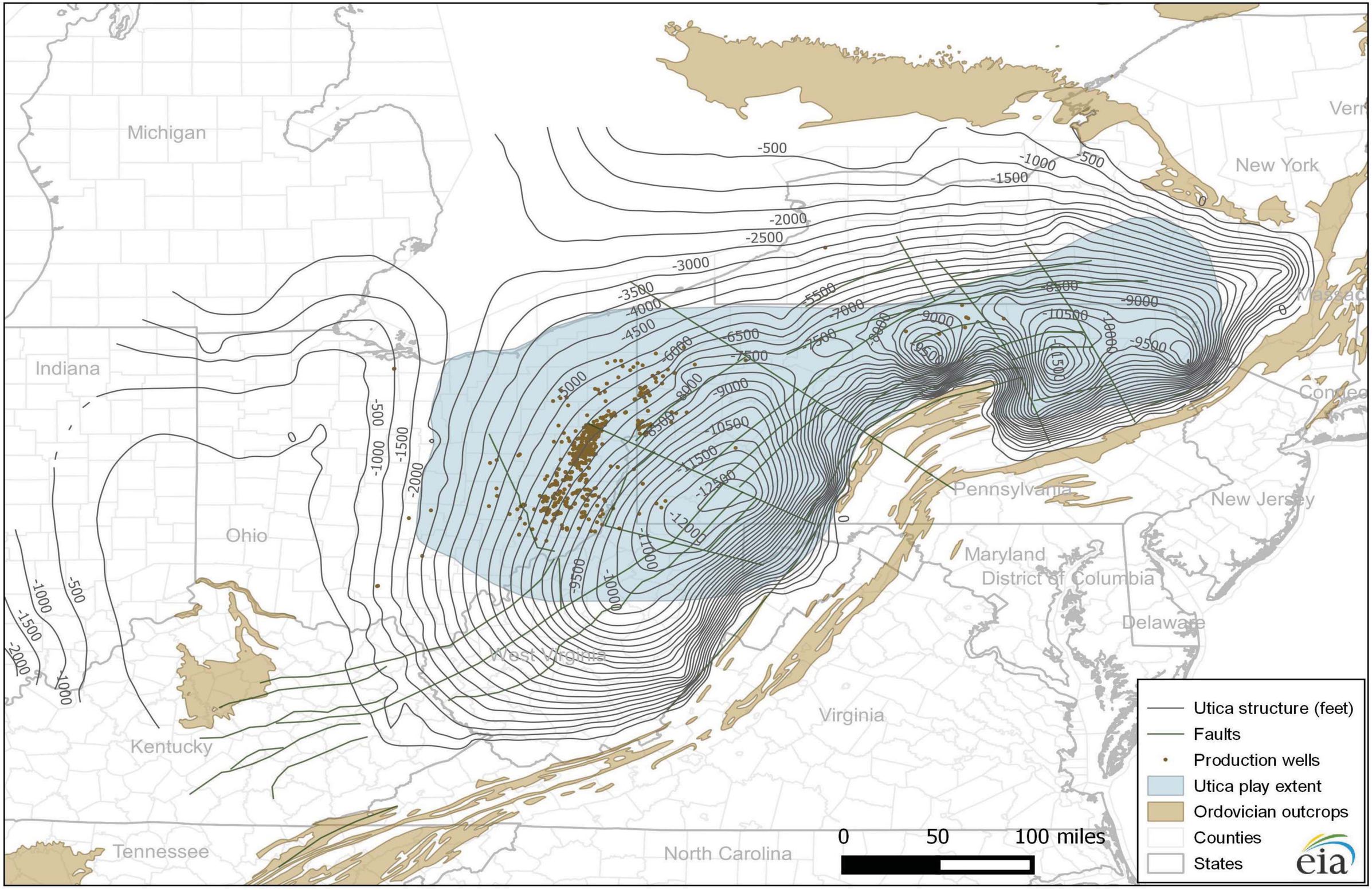
Structure map of the Utica Formation



Source: U.S. Energy Information Administration, based on DrillingInfo Inc., IHS Inc., The Appalachian Oil and Natural Gas Research Consortium, and U.S. Geological Survey.
Note: Map includes production wells from January 2010 through January 2016.

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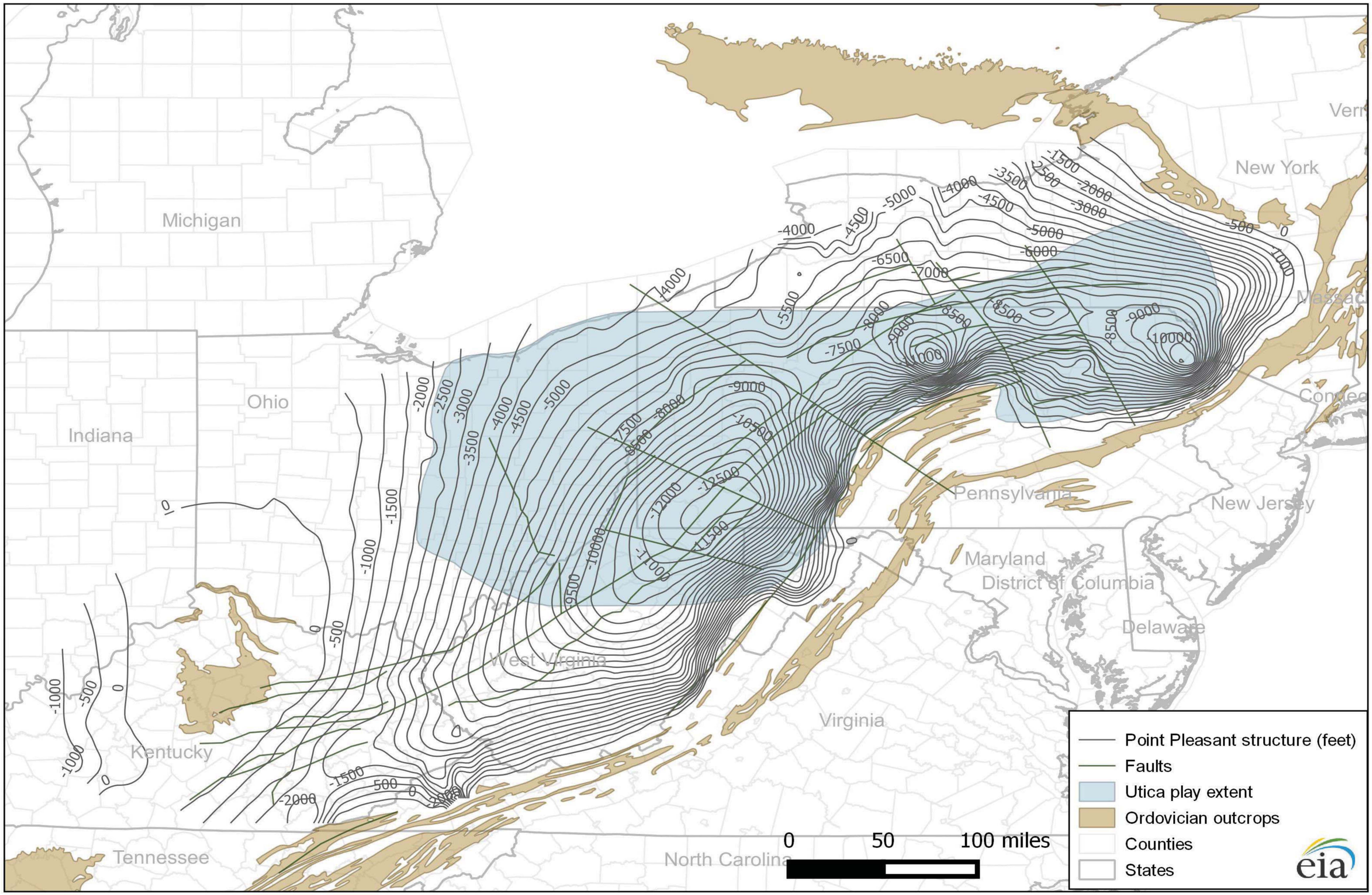
Structure map of the Point Pleasant Formation



Source: U.S. Energy Information Administration, based on DrillingInfo Inc., IHS Inc., The Appalachian Oil and Natural Gas Research Consortium, and U.S. Geological Survey.

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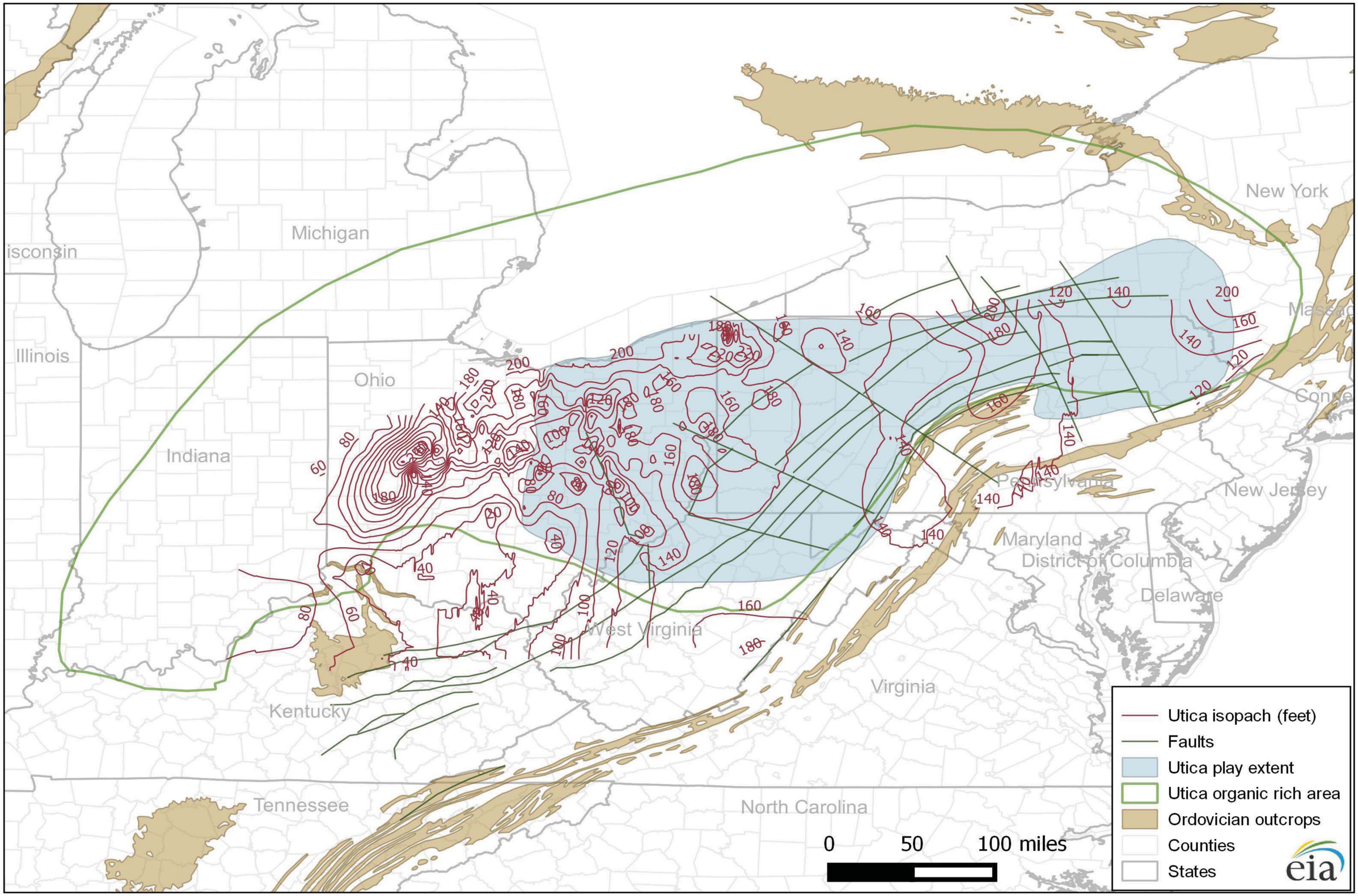
Thickness map of the Utica Formation



Source: U.S. Energy Information Administration, based on DrillingInfo Inc., IHS Inc., The Appalachian Oil and Natural Gas Research Consortium, and U.S. Geological Survey.

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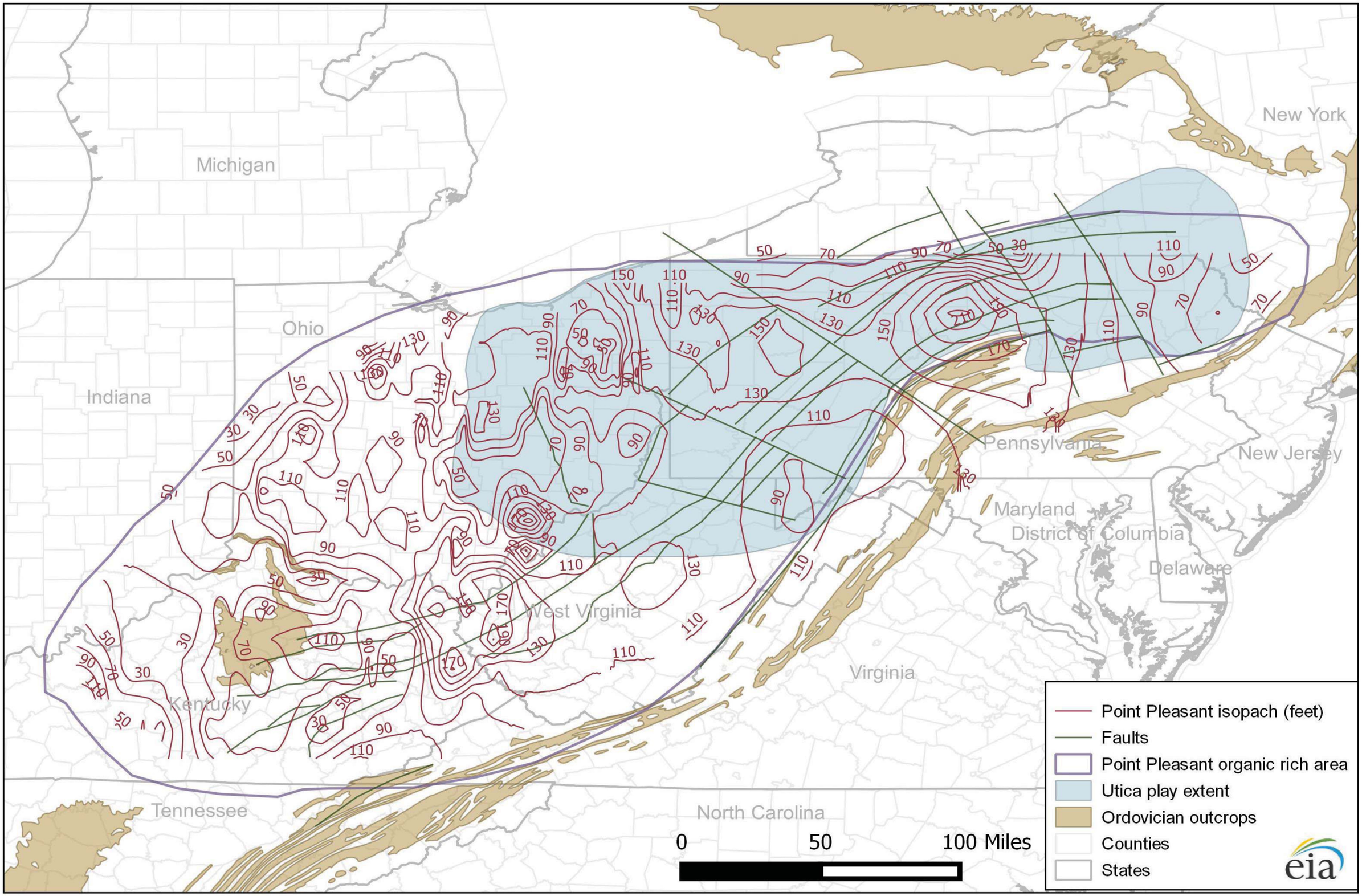
Thickness map of the Point Pleasant Formation



Source: U.S. Energy Information Administration, based on DrillingInfo Inc., IHS Inc., The Appalachian Oil and Natural Gas Research Consortium, and U.S. Geological Survey.

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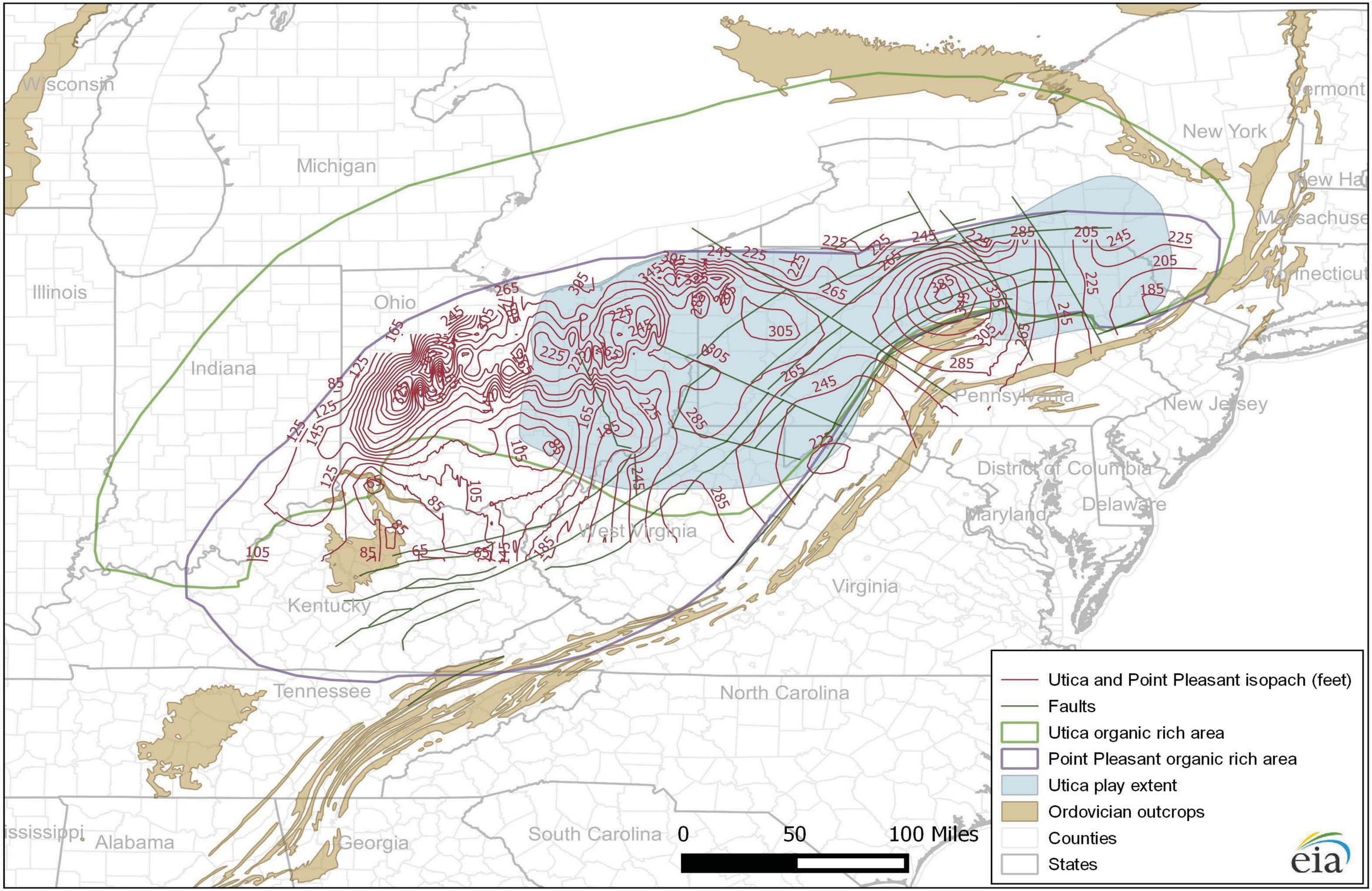
Thickness map of the combined Utica - Point Pleasant interval



Source: U.S. Energy Information Administration, based on DrillingInfo Inc., IHS Inc., The Appalachian Oil and Natural Gas Research Consortium, and U.S. Geological Survey.

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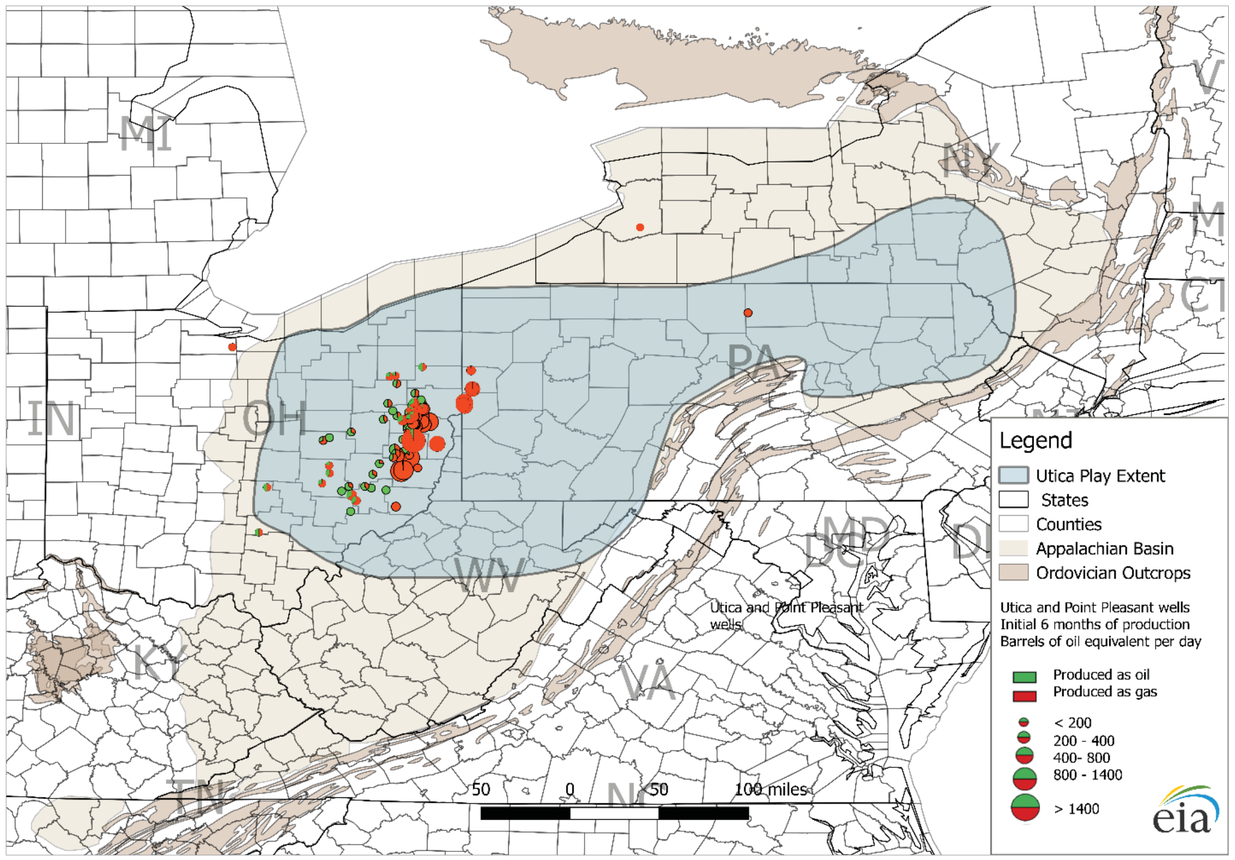
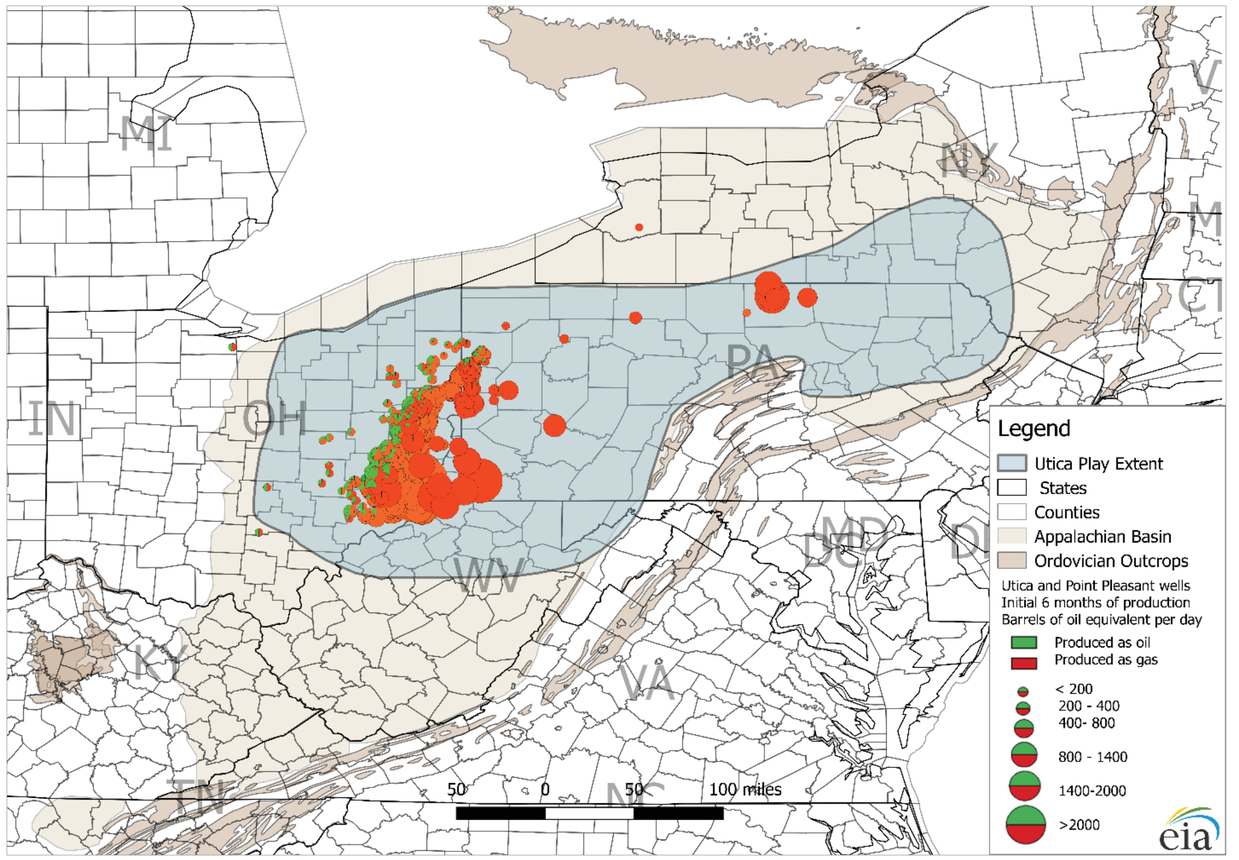
Utica and Point Pleasant Oil and Gas Production through December 2012



Source: U.S. Energy Information Administration and DrillingInfo Inc.
Note: EIA calculates the daily production rate for each well using the initial six contiguous months of liquid and gas production. The size of the bubbles in the map represents the relative size of production rate in terms of barrels of oil equivalent per day (BOE/d), where the gas quotient is represented by red color and respective oil quotient is represented by green color.

Utica and Point Pleasant Oil and Gas Production through June 2016



Source: U.S. Energy Information Administration and DrillingInfo Inc.
Note: EIA calculates the daily production rate for each well using the initial six contiguous months of liquid and gas production. The size of the bubbles in the map represents the relative size of production rate in terms of barrels of oil equivalent per day (BOE/d), where the gas quotient is represented by red color and respective oil quotient is represented by green color.

The Energy Information Administration has produced new maps that characterize the structure, thickness, and geologic setting of the Utica shale play. From 2011 production from the Utica play has increased with more than 1700 wells drilled by November 2015. In order to help understand these production trends, the maps herein provide information that illustrates the underlying geology. The play includes both the Utica Formation and the deeper Point Pleasant Formation. Each formation has its own significance and characteristics; so maps have been produced for each individually, and as one whole unit. Additionally, this collection of maps helps to explain the distribution of producing wells within the play and the distribution of oil-rich and gas-rich wells. This study explains the depositional environment and major geological and tectonic features, tprovides structure maps , and also provides thickness maps.

The structural and tectonic features map provides a visualization of the geologic setting of the play area. Covering approximately 60,000 square miles, the Utica play spans parts of Ohio, Pennsylvania, New York, West Virginia, Kentucky, and Indiana. The Utica section was deposited in the Late Ordovician period about 450 million years ago. Groups of associated fossils, fine layer sequences reflecting moving currents, and erosional surfaces indicative of recurrent storms point to a depositional environment that was a shallow marine area that experienced frequent storms and algal blooms. This environment led to a deposition of interbedded shale and limestone with unconformities representing periods of erosion or non-deposition between the main layers.

The major structural features include the Cincinnati Arch, Findlay Arch, and Greenville Front that run in a north-south direction along the Western end of the formation. The Pine Mountain Fault, Pine Mountain Thrust, and the Blue Ridge Green Mountain Front run along the western edge of the Appalachian Mountains. The mountain building events during the deposition period left a number of faults in their wake that are important for oil and gas generation. There are Ordovician age faults and surface faults both in northeast-southwest and perpendicular northwest-southeast directions. A number of these faults coincide with subsurface features of the East Continent Rift Basin, Rome trough, and the Greenville Front. These major features represent points of weakness that often allow for enhanced movement and accumulation of oil and gas.

Utica is a stacked play and includes both the Utica Formation and the underlying Point Pleasant Formation; however, Point Pleasant is currently the targeted drilling formation because it is more productive. As each formation holds its own significance, subsea elevation contour maps representing the top surface of each have been constructed using point data from wells and outcrop data from the U.S. Geological Survey. These maps represent subsea depths and only roughly approximate drilling depth to reach the top of each formation.

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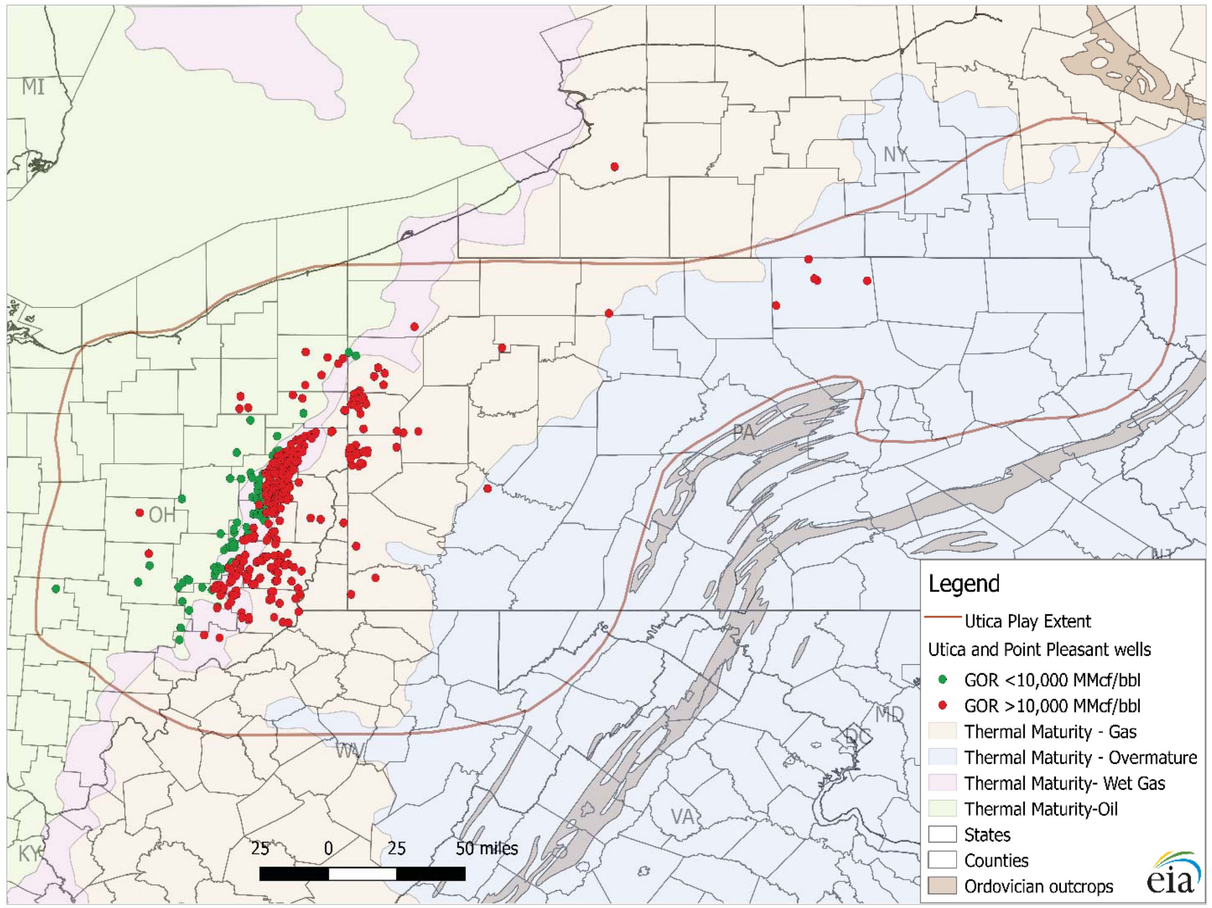
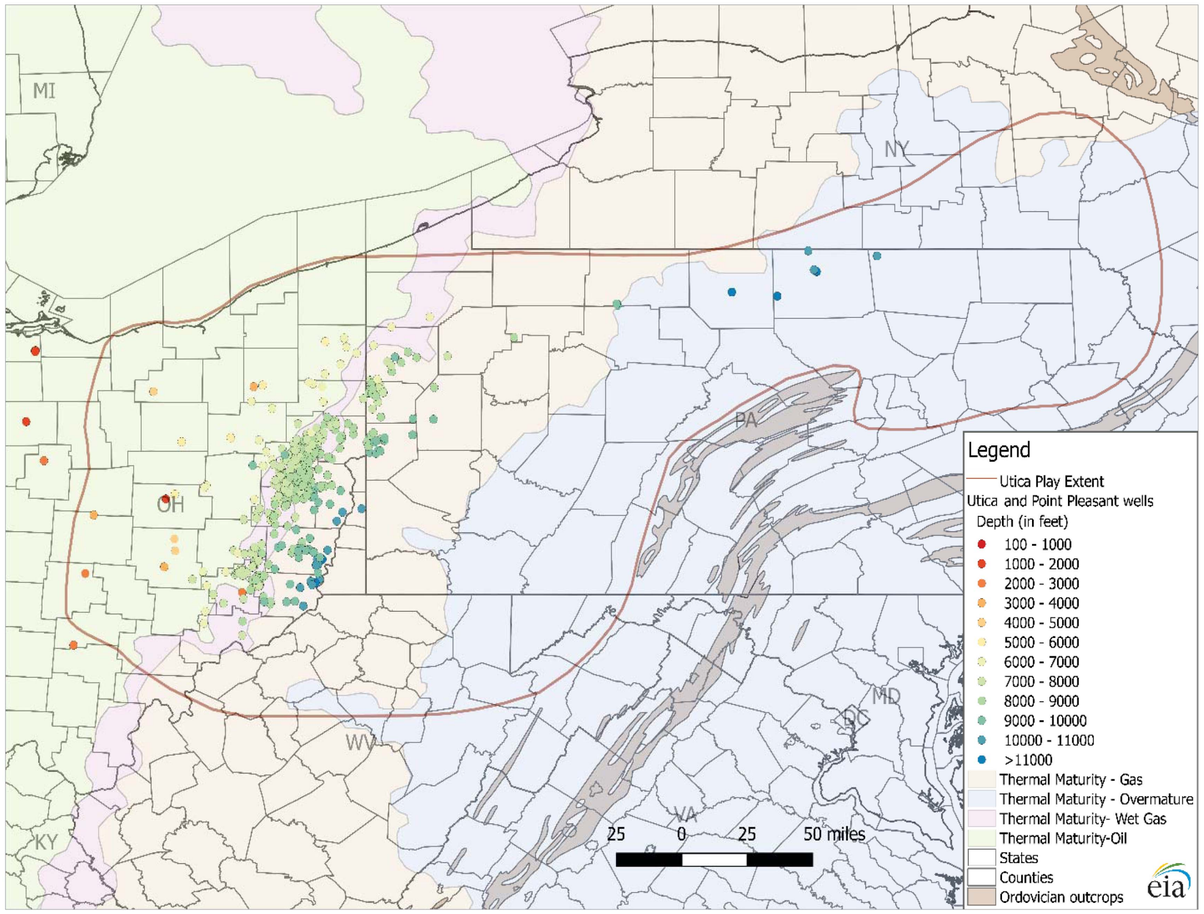
Initial gas-to-oil ratios (GORs) of Utica and Point Pleasant wells through June 2016



Depth to the top of the Utica Formation in feet



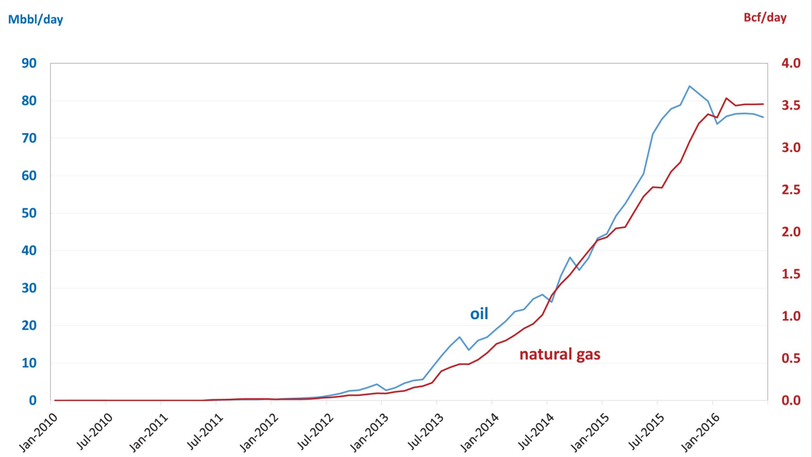
Source: U.S. Energy Information Administration based on DrillingInfo Inc., New York State Geological Survey, Ohio State Geological Survey, Pennsylvania Bureau of Topographic & Geologic Survey, West Virginia Geological & Economic Survey, Appalachian Oil and Natural Gas Research Consortium, and U.S. Geological Survey. **Note:** EIA calculates GOR for each well using the initial six contiguous months of liquid and gas production.

In the southwest corner of Pennsylvania, the Point Pleasant Formation reaches subsea depths of up to -13,000 feet and is shallowest at the junction of Ohio, Indiana, and Kentucky and along the outcrops. The Utica Formation reaches subsea depths of up to -14,000 feet in a northeast-trending arc though Pennsylvania and also reaches its Initial gas-to-oil ratios (GORs) of Utica and Point Pleasant wells through June 2016, shallowest at the junction of Ohio, Indiana, and Kentucky and along the outcrops. The area where most producing wells are found has a subsea depth ranging from -2,000 to -11,000 feet. Structure maps not only provide valuable drilling information, but they also lend insight into the distribution of oil and gas throughout the play. Temperature and pressure play a part in determining the amount oil and gas in the formation and are a function of depth. These maps give a general idea of the spatial distribution of oil and gas based upon the depth to the top of the formation.

Thickness maps (isopach) for each formation individually and for the Utica play as a whole were constructed using point data from wells. For the Utica Formation map, the difference between the top of the Utica Formation and the top of the Point Pleasant Formation was used as a proxy for the Utica thickness. For the Point Pleasant thickness map, the top of the Point Pleasant Formation and the top of the underlying Trenton Formation were used to define the thickness of the Point Pleasant. The top of the Utica and the top of the Trenton were used to determine the combined thickness.

The Utica Formation is thickest in western Ohio and the northwest corner of Pennsylvania, at 200-300 feet, and thins out to 50 or less feet in southern Ohio and northern Kentucky. The Point Pleasant Formation reaches a thickness of 200+ feet in central Pennsylvania and thins to less than 20 feet in the eastern half of Kentucky. The combined thickness of Utica and Point Pleasant is as thin as 100 feet or less where Ohio, West Virginia, and Kentucky meet. The thickness reaches over 300 feet in northwest and central Pennsylvania, and northeast and central Ohio. The area where the most producitve wells are located has a thickness of 150 feet or more. The outlined area of highest organic content shows the continuous reservoir where productive wells would likely be drilled. This area has relatively high levels of total organic carbon (an indication of the amount of hydrocarbon in the rock) which is important for successful wells. Like structure maps, isopach maps provide valuable drilling information since thickness of the reservoir is one component of the decision to drill a well and the subsequent success. The above maps provide an idea of the potential thickness in a given area of the play. The Utica is one of several oil and natural gas formations with updated geologic detail. EIA earlier updated geologic maps for the Marcellus and Eagle Ford plays. Additionally, EIA published updated shapefiles for the following plays: Abo-Yeso, Bone Spring, Delaware, Glorieta-Yeso, and Spraberry; Bakken and Three Forks; Eagle Ford; Marcellus; Utica; and Niobrara.

Utica Play oil and natural gas production



Disclaimer
EIA play maps not intended for exploration geologists but are geared towards large scale analysis and assessment of technically recoverable resource.

EIA is currently in the process of updating maps of major tight oil and shale gas plays, including the Eagle Ford and Marcellus plays;, this will help to better characterize the geology of key areas of production in the United States. EIA's most recent maps focus on shale and tight oil plays, and characterize plays based on geologic characteristics, including rock type and age. Understanding geologic history and processes helps exploration and production companies reduce the risk of drilling dry, nonproducing wells and better understand hydrocarbon resource potentials.

Source: U.S. Energy Information Administration, based on data from various published studies
http://www.eia.gov/oil_gas/rpd/shale_gas.pdf