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National and Global Petroleum Assessment

Assessment of Undiscovered Continuous Oil and Gas Resources in the Upper Ordovician Point Pleasant Formation and Utica Shale of the Appalachian Basin Province, 2019

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable continuous mean resources of 1.8 billion barrels of oil and 117.2 trillion cubic feet of gas in the Upper Ordovician Point Pleasant Formation and Utica Shale of the Appalachian Basin Province.

Introduction

The U.S. Geological Survey (USGS) completed a geology-based assessment of undiscovered, technically recoverable continuous oil and gas resources in the Upper Ordovician Point Pleasant Formation, Utica Shale, and correlative units—Antes Shale and Indian Castle Member of the Utica Shale—of the Appalachian Basin Province (U.S. Geological Survey, 2002). The assessed area includes parts of Maryland, New York, Ohio, Pennsylvania, Virginia, and West Virginia (fig. 1).

This assessment was based on the geologic elements of the Ordovician Point Pleasant/Utica-Lower Paleozoic Total Petroleum System (TPS) (Enomoto and others, 2019), including: (1) hydrocarbon source rocks (source-rock richness and levels of thermal maturation and associated oil and gas generation and adsorption), (2) reservoir rock-type distribution and properties (mineral composition, porosity, permeability, brittleness), and (3) timing of petroleum generation. The assessed Upper Ordovician strata primarily consist of organic-rich mudstones, calcareous shales, and argillaceous limestones deposited in a marine environment. The strata containing oil-prone Type II kerogen are preserved within the Upper Ordovician Point Pleasant Formation, Utica Shale, and correlative units in the Appalachian Basin. Thermal maturation in hydrocarbon productive areas indicates that the hydrocarbon resources are self-sourced. The regional structure of the strata is east–southeast dipping; therefore, downdip is to the east–southeast, and thermal maturation increases to the east–southeast.

Using this geologic framework, the USGS defined five continuous assessment units (AUs) within the Ordovician Point Pleasant/Utica-Lower Paleozoic TPS and quantitatively estimated undiscovered, technically recoverable oil, gas, and natural gas liquids (NGL) resources for two of the five AUs (tables 1 and 2). The Point Pleasant-Utica Foldbelt Gas AU, Logana Shale Oil AU, and Logana Shale Gas AU were not quantitatively assessed because of insufficient evidence of movable oil or gas in these shales from production data or production test data. Input data used to assess two of the continuous AUs are listed in table 1.

Definition of Assessment Units

All Point Pleasant-Utica shale AUs include the areal extent of the Upper Ordovician Point Pleasant Formation, Utica Shale, and correlative units—Antes Shale and Indian Castle Member of the Utica Shale—where at least one of the formations has at least 1 weight percent total organic carbon (TOC) (Wallace and Roen, 1989; Ryder and others, 1998; Repetski and others, 2008; Riley and others, 2012; Eble and others, 2015).

The areal extent of the Point Pleasant-Utica Shale Oil AU also includes where these formations are mature for oil generation, as indicated by measured and modeled vitrinite reflectance equivalent (VR_e) values from 0.6 to 1.3 percent (Eble and others, 2015). The western and eastern boundaries of the AU are defined by the 0.6 and 1.3 percent VR_e contours in Eble and others (2015). The northern boundary of the AU is the United States-Canada border, and the southern boundary of the AU is where the mudstone and shale of the formations grade southward into carbonate-dominated rocks.

The areal extent of the Point Pleasant-Utica Shale Gas AU also includes where these formations are interpreted to be mature for gas with natural gas liquids and dry-gas generation, as indicated by measured and modeled VR_e values greater than 1.3 percent (Eble and others, 2015). The western boundary is defined by the 1.3 percent VR_e contours of Eble and others (2015), and the downdip, southeastern boundary of this AU is defined by the Allegheny structural front, including the eastern Pennsylvania section as illustrated in Faill and Nickelsen (1999). Most of the northern boundary of the Point Pleasant-Utica Shale Gas AU is defined by thermal maturity greater than 1.3 percent VR_e and TOC greater than 1 weight percent, but part of the northern boundary of the AU is the United States-Canada border. The southern boundary of the AU is placed where the mudstone and shale of the formations grade southward into carbonate-dominated rocks.

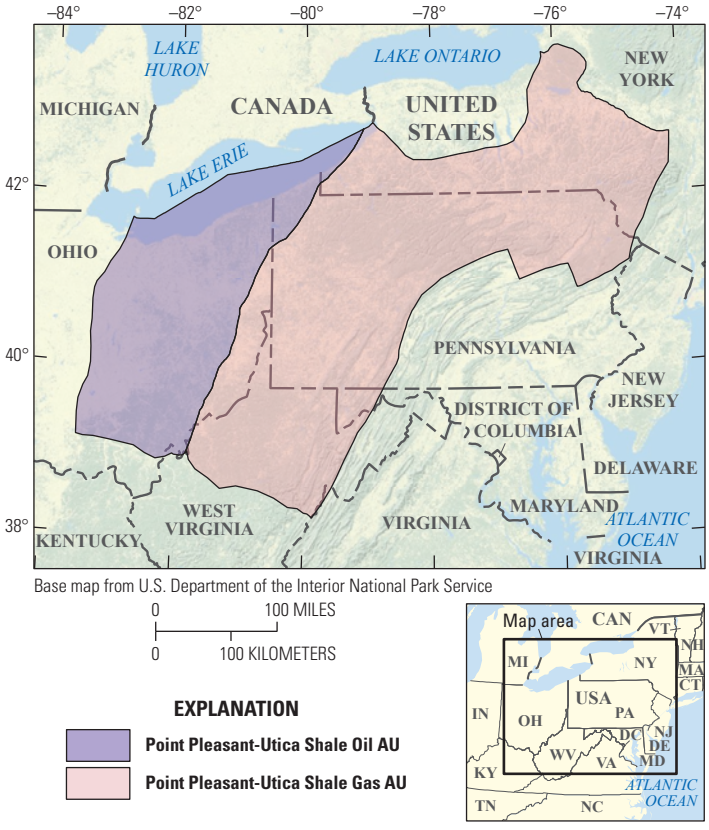

Figure 1. Map showing the boundaries of the two assessment units (AUs) that were quantitatively assessed in the Point Pleasant Formation and Utica Shale of the Appalachian Basin Province (U.S. Geological Survey, 2002).

Table 1. Key input data for two continuous assessment units in the Point Pleasant Formation and Utica Shale of the Appalachian Basin Province.

[AU, assessment unit; %, percent; EUR, estimated ultimate recovery per well; MMBO, million barrels of oil; BCFG, billion cubic feet of gas. The average EUR input is the minimum, median, maximum, and calculated mean. Shading indicates not applicable]

Assessment input data—Continuous AUs	Point Pleasant-Utica Shale Oil AU				Point Pleasant-Utica Shale Gas AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	50,000	2,550,830	16,500,000	6,366,943	84,000	4,652,315	37,000,000	13,912,105
Average drainage area of wells (acres)	80	120	180	126.7	80	120	180	126.7
Success ratio (%)	40	60	80	60	40	60	80	60
Untested area in AU (%)	90	95	99	94.7	90	95	99	94.7
Average EUR (MMBO, oil; BCFG, gas)	0.04	0.06	0.12	0.063	0.5	1.5	4.5	1.656
AU probability	1.0				1.0			

Table 2. Results for two continuous assessment units in the Point Pleasant Formation and Utica Shale of the Appalachian Basin Province.

[MMBO, million barrels of oil; BCFG, billion cubic feet of gas; NGL, natural gas liquids; MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. For gas accumulations, all liquids are included in the NGL category. F95 represents a 95-percent chance of at least the amount tabulated; other fractiles are defined similarly. Fractiles are additive under the assumption of perfect positive correlation. Shading indicates not applicable]

Total petroleum system and assessment units (AUs)	AU probability	Accumulation type	Total undiscovered resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Ordovician Point Pleasant/Utica-Lower Paleozoic Total Petroleum System														
Point Pleasant-Utica Shale Oil AU	1.0	Oil	388	1,588	4,008	1,819	3,047	12,621	32,369	14,556	81	360	1,059	438
Point Pleasant-Utica Shale Gas AU	1.0	Gas					18,277	84,451	248,739	102,655	79	415	1,463	547
Total undiscovered continuous resources			**388**	**1,588**	**4,008**	**1,819**	**21,324**	**97,072**	**281,108**	**117,211**	**160**	**775**	**2,522**	**985**

Undiscovered Resources Summary

The USGS quantitatively assessed undiscovered continuous oil and gas resources in two AUs within the Ordovician Point Pleasant/Utica-Lower Paleozoic TPS (table 2). The estimated means for total undiscovered resources in the AUs are 1,819 million barrels of oil (MMBO), or 1.8 billion barrels of oil, with an F95–F5 range from 388 to 4,008 MMBO; 117,211 billion cubic feet of gas (BCFG), or 117.2 trillion cubic feet of gas, with an F95–F5 range from 21,324 to 281,108 BCFG; and 985 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 160 to 2,522 MMBNGL.

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For More Information

Assessment results are also available at the USGS Energy Resources Program website at https://energy.usgs.gov.

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