

Assessment of Undiscovered Oil and Gas Resources of the Mississippian Sunbury Shale and Devonian–Mississippian Chattanooga Shale in the Appalachian Basin Province, 2016

Using a geology-based assessment methodology, the U.S. Geological Survey estimated mean undiscovered, technically recoverable continuous resources that total 464 million barrels of oil and 4.08 trillion cubic feet of gas in the Lower Mississippian Sunbury Shale and Middle Devonian–Lower Mississippian Chattanooga Shale of the Appalachian Basin Province.

Introduction

In 2016, the U.S. Geological Survey (USGS) completed a geology-based assessment of the undiscovered oil, gas, and natural gas liquids (NGL) resources of the Sunbury Shale and Chattanooga Shale in the Appalachian Basin Province. The assessed area comprises parts of Alabama, Georgia, Kentucky, Maryland, Mississippi, New York, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia (fig. 1). The assessment is based on the geologic elements of the Devonian Shale–Middle and Upper Paleozoic Total Petroleum System (TPS), including (1) hydrocarbon source rocks (source-rock richness and levels of thermal maturation, and associated oil and gas generation, adsorption, and migration); (2) reservoir rock type (continuous or conventional), distribution, and properties (composition, porosity, permeability, brittle/fissile); and (3) types and distribution of reservoir traps and seals, including timing relative to petroleum generation and migration. The Sunbury and Chattanooga primarily consist of organic-rich marine shales, and the contained hydrocarbon resources are considered self-sourced based partly on levels of thermal maturation compared to hydrocarbon productive areas. Milici and Swezey (2006) include background information on the Sunbury and Chattanooga. Assessment unit (AU) boundaries and resource potential also were determined using reservoir/source strata thickness, depth, composition, and distribution. Input data applied to assess these continuous assessment units are listed in table 1. Using this geologic framework, the USGS defined one TPS, with five continuous AUs, and quantitatively estimated undiscovered, technically recoverable oil, gas, and NGL resources for four of the five AUs (tables 1 and 2). The unassessed Chattanooga Plateau Shale Oil AU is categorized as hypothetical because data were insufficient for quantitative resource assessment.

Undiscovered Resources Summary

The USGS quantitatively assessed undiscovered continuous (unconventional) oil and gas resources in four AUs within the Devonian Shale–Middle and Upper Paleozoic TPS (table 2). For total undiscovered resources, the

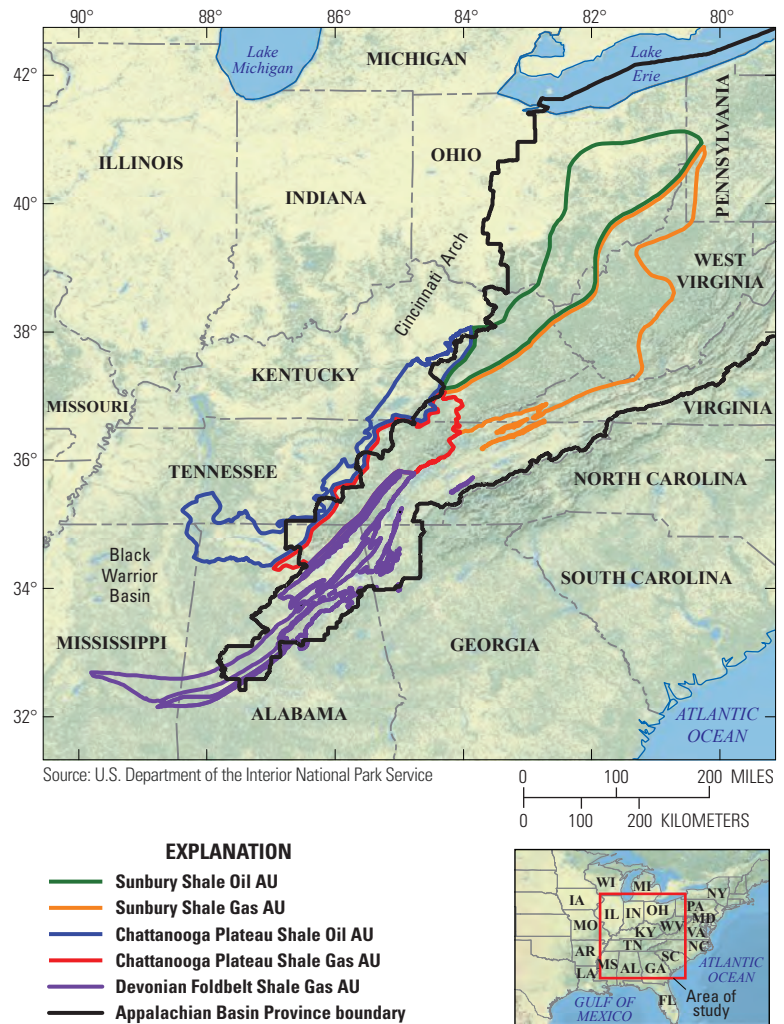


Figure 1. Map showing the boundaries for five assessment units (AUs) in the Lower Mississippian Sunbury Shale and the Middle Devonian to Lower Mississippian Chattanooga Shale in the Devonian Shale–Middle and Upper Paleozoic Total Petroleum System (boundary not shown) in the Appalachian Basin Province.

estimated means are 464 million barrels of oil (MMBO) with an F95–F5 range from 104 to 1,012 MMBO; 4,084 billion cubic feet of gas (BCFG), or 4.08 trillion cubic feet of gas liquids, with an F95–F5 range from 730 to 9,792 BCFG; and 76 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 13 to 189 MMBNGL.

For shale-oil resources, the estimated means for the Sunbury Shale Oil AU are 464 MMBO with an F95–F5 range from 104 to 1,012 MMBO, 1,237 BCFG with an F95–F5 range from 259 to 2,800 BCFG, and 37 MMBNGL with an F95–F5 range from 7 to 88. For shale-gas resources,

the estimated means for the Sunbury Shale Gas AU are 1,098 BCFG with an F95–F5 range from 250 to 2,386 BCFG and 13 MMBNGL with an F95–F5 range from 3 to 30. Estimated means for the Chattanooga Plateau Shale Gas AU are 610 BCFG with an F95–F5 range from

102 to 1,552 BCFG and 15 MMBNGL with an F95–F5 range from 2 to 39. For the Devonian Foldbelt Shale Gas AU, the estimated means are 1,139 BCFG with an F95–F5 range from 119 to 3,054 BCFG and 11 MMBNGL with an F95–F5 range from 1 to 32 MMBNGL.

Table 1. Key assessment input data for four continuous assessment units (AUs) in the Appalachian Basin Province. A fifth continuous AU, the Chattanooga Plateau Shale Oil, was not quantitatively assessed because of insufficient data.

[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				
Sunbury Shale Oil AU	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	3,000	4,000,000	9,300,000	4,434,333
Average drainage area of wells (acres)	80	120	240	147
Success ratio (%)	5	30	50	28
Average EUR (MMBO)	0.03	0.05	0.1	0.052
AU probability	1.0			
Sunbury Shale Gas AU	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	5,000	6,000,000	12,000,000	6,001,667
Average drainage area of wells (acres)	80	120	200	133
Success ratio (%)	5	30	50	28
Average EUR (BCFG)	0.04	0.08	0.2	0.086
AU probability	1.0			
Chattanooga Plateau Shale Gas AU	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	2,000	785,000	4,325,000	1,704,000
Average drainage area of wells (acres)	80	120	180	127
Success ratio (%)	10	50	90	50
Average EUR (BCFG)	0.04	0.08	0.3	0.092
AU probability	1.0			
Devonian Foldbelt Shale Gas AU	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	1,000	220,000	5,300,000	1,840,323
Average drainage area of wells (acres)	60	80	120	87
Success ratio (%)	10	50	90	50
Average EUR (BCFG)	0.04	0.1	0.25	0.107
AU probability	1.0			

Table 2. Assessment results for four continuous assessment units (AUs) in the Appalachian Basin Province. A fifth continuous AU, the Chattanooga Plateau Shale Oil, was not quantitatively assessed because of insufficient data.

[MMBO, million barrels of oil; BCFG, billion cubic feet of gas; MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. For gas accumulations, all liquids are included under the NGL (natural gas liquids) 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
Devonian Shale—Middle and Upper Paleozoic Total Petroleum System														
Sunbury Shale Oil AU	1.0	Oil	104	410	1,012	464	259	1,065	2,800	1,237	7	31	88	37
Sunbury Shale Gas AU	1.0	Gas					250	968	2,386	1,098	3	11	30	13
Chattanooga Plateau Shale Oil AU		Oil	Not quantitatively assessed											
Chattanooga Plateau Shale Gas AU	1.0	Gas					102	479	1,552	610	2	11	39	15
Devonian Foldbelt Shale Gas AU	1.0	Gas					119	873	3,054	1,139	1	9	32	11
Total undiscovered continuous resources			104	410	1,012	464	730	3,385	9,792	4,084	13	62	189	76

Reference Cited

Milici, R.C., and Swezey, C.S., 2006, Assessment of Appalachian Basin oil and gas resources—Devonian Shale—Middle and Upper Paleozoic Total Petroleum System: U.S. Geological Survey Open-File Report 2006–1237, 70 p., accessed October 6, 2016, at <http://pubs.usgs.gov/of/2006/1237/of2006-1237.pdf>.

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For More Information

Assessment results are available at the USGS Energy Resources Program Web site at <http://energy.usgs.gov>.