

Assessment of Undiscovered Continuous Oil and Shale-Gas Resources in the Bazhenov Formation of the West Siberian Basin Province, Russia, 2016

Using a geology-based assessment methodology, the U.S. Geological Survey estimated mean continuous resources of 12 billion barrels of oil and 75 trillion cubic feet of gas in the Bazhenov Formation of the West Siberian Basin Province, Russia.

Introduction

The U.S. Geological Survey (USGS) quantitatively assessed the potential for undiscovered, technically recoverable continuous oil and shale-gas resources in the West Siberian Basin Province of Russia (fig. 1). This study focuses on the geologic evaluation and assessment of oil and gas source-reservoir rock systems and potential resources of the Upper Jurassic Bazhenov Formation.

For this study, the USGS defined continuous oil and shale-gas source-reservoir rock systems. These systems (1) contain at least 2 weight percent or more total organic carbon, (2) occur within the thermal maturity window for oil or natural gas generation, (3) have 15 meters or more of organic-rich shale, and (4) contain Type I or Type II organic matter (Charpentier and Cook, 2011). Many studies have been published on the Bazhenov Formation, providing information on source rock characteristics, tectonic history, thermal history, and timing of maturation and generation of hydrocarbons. Several oil fields in the southern part of the West Siberian Basin Province produce continuous oil from the Bazhenov Formation (for example, Salym Field; Clarke and Rachlin, 1980). At the time of this study, no fields are known to produce shale gas from the Bazhenov Formation.

Two assessment units (AUs) were defined for this study (fig. 1). The Bazhenov Continuous Oil AU was delineated in the southern part of the basin where the Bazhenov source rock is thermally mature with respect to oil generation. The Bazhenov Shale Gas AU was delineated in the northern part of the province where the Bazhenov source rock is deeper and is presumably thermally mature with respect to gas generation.

Because detailed production data for continuous resources outside of the United States are difficult to obtain, the USGS assessment methodology uses analogs of continuous oil and shale-gas accumulations from the United



Source: U.S. Department of the Interior National Park Service

EXPLANATION
 — West Siberian Basin Province
 — Bazhenov Continuous Oil AU
 — Bazhenov Shale Gas AU



Figure 1. Map showing the Bazhenov Continuous Oil and Bazhenov Shale Gas Assessment Units (AU) in the West Siberian Basin Province, Russia.

States. Specifically, mean estimated ultimate recoveries from populations of continuous oil and shale-gas wells, the mean drainage areas of drilled wells, and ranges of average well success ratios were used to estimate the undiscovered continuous oil and shale-gas resources. Principal input data used in the assessment are listed in table 1.

Geologic Model

Continuous oil production from fractured Bazhenov Formation in the southern part of the basin has been reported. It is a self-sourced, organic-rich mudstone (total organic carbon content of at least 2 weight percent), contains mostly Type II kerogen, and is thermally mature with respect to oil generation (Ulmishek, 2003). The Bazhenov Continuous Oil AU area does not include areas of discovered accumulations and areas where undiscovered conventional accumulations might be present. Discovered continuous oil accumulations were also excluded from the AU. Undiscovered continuous oil accumulations most likely exist between structural highs.

No shale-gas production has been reported from the Bazhenov Formation. However, the part of the Bazhenov Formation in the northern part of the

basin is presumed to be similar to that in the southern part of the basin but thermally mature with respect to gas generation. As with the Bazhenov Continuous Oil AU, the Bazhenov Shale Gas AU area does not include areas of discovered and undiscovered conventional fields on structural highs. Undiscovered shale-gas accumulations most likely exist between structural highs.

Undiscovered Resources Summary

The USGS quantitatively assessed unconventional oil and gas resource in one continuous oil AU and one continuous shale-gas AU in the West Siberian Basin of Russia (table 2). For total undiscovered resources, the estimated means are 12,219 million barrels of continuous oil (MMBO), or 12 billion barrels of oil, with an F95–F5 range from 2,774 to 26,716 MMBO, 75,156 billion cubic

feet of natural gas (BCFG), or 75 trillion cubic feet of natural gas, with an F95–F5 range from 17,446 to 159,284 BCFG, and 1,615 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 354 to 3,602 MMBNGL.

For total continuous oil resources, the estimated means for the Bazhenov Continuous Oil AU are 12,219 MMBO with an F95–F5 range from 2,774 to 26,716 MMBO, 4,888 BCFG with an F95–F5 range from 1,106 to 10,721 BCFG, and 69 MMBNGL with an F95–F5 range from 14 to 158. For total shale-gas resources, the estimated means for the Bazhenov Shale Gas AU are 70,268 BCFG with an F95–F5 range from 16,340 to 148,563 BCFG and 1,546 MMBNGL with an F95–F5 range from 340 to 3,444 MMBNGL.

Table 1. Key assessment input data for the Bazhenov Continuous Oil and Bazhenov Shale Gas Assessment Units (AUs) in the West Siberian Basin Province, Russia.

[AU, assessment unit; %, percent; EUR, estimated ultimate recovery per well; BCFG, billion cubic feet of gas; MMBO, million barrels of oil. EUR, well drainage area, and success ratios are from U.S. continuous oil and shale-gas analogs. The average EUR input is the minimum, median, maximum, and calculated mean. Shading indicates not applicable]

Assessment input data	Bazhenov Continuous Oil AU				Bazhenov Shale Gas AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	1,000	66,500,000	137,500,000	68,000,333	1,000	32,250,000	64,500,000	32,250,333
Average drainage area of wells (acres)	120	180	240	180	80	120	160	120
Success ratios (%)	10	50	90	50	10	50	90	50
Average EUR (oil, MMBO; gas, BCFG)	0.03	0.06	0.15	0.065	0.2	0.5	1.0	0.522
AU probability	1.0				1.0			

Table 2. Assessment results for the Bazhenov Continuous Oil and Bazhenov Shale Gas Assessment Units (AUs) in the West Siberian Basin Province.

[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 within 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 (TPS) 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
Bazhenov Formation TPS														
Bazhenov Continuous Oil AU	1.0	Oil	2,774	10,725	26,716	12,219	1,106	4,286	10,721	4,888	14	58	158	69
Bazhenov Shale Gas AU	1.0	Gas					16,340	63,131	148,563	70,268	340	1,343	3,444	1,546
Total undiscovered resources			2,774	10,725	26,716	12,219	17,446	67,417	159,284	75,156	354	1,401	3,602	1,615

References Cited

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For More Information

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