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National and Global Petroleum Assessment

Assessment of Continuous Oil and Gas Resources of the Timan-Pechora Basin Province, Russia, 2018

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean resources of 1.4 billion barrels of oil and 46 trillion cubic feet of gas in the Timan-Pechora Basin Province of Russia.

Introduction

The U.S. Geological Survey (USGS) quantitatively assessed the potential for undiscovered, technically recoverable continuous (unconventional) oil and gas resources in the Timan-Pechora Basin Province of Russia (fig. 1). The development of three petroleum systems in the province is related to the tectonic history (Otto and Bailey, 1995; Ismail-Zadeh and others, 1997; Martirosyan and others, 1998; Lindquist, 1999; Fossum and others, 2001; O'Leary and others, 2004; Sliaupa and others, 2006). The progressive closure of the Uralian Ocean in the Late Permian to Early Jurassic led to the formation of the Ural fold and thrust belt and a west-facing foredeep along the fold belt. As much as 8 kilometers of sediment in the foredeep resulted in the thermal maturation of petroleum source rocks into the gas-generation window and into the oil-maturation window west of the foredeep. Compressional deformation in the Cretaceous effectively ended the maturation process and resulted in erosion of as much as 800 meters. Mild compression in the Oligocene was likely related to the far-field effect of the India-Eurasia plate collision. Uncertainty in this assessment relates to the retention of oil or gas in the reservoirs following compressive deformation and migration.

Total Petroleum Systems and Assessment Units

For potential continuous oil and gas resources, the USGS defined a Domanik Total Petroleum System (TPS) and a Denisov-Khoreyver Domanik Shale Oil Assessment Unit (AU) and an Izhma-Pechora Domanik Shale Oil AU within this TPS, an Ordovician–Lower Devonian Composite TPS with a Denisov-Khoreyver Shale Gas AU, and a Paleozoic Composite TPS with the Ural Foredeep Continuous Gas AU. Where thermally immature, shales of the Domanik TPS contain Type II kerogen, have total organic carbon (TOC) content of as much as 20 weight percent, have hydrogen index (HI) values of as much as 700 milligrams of hydrocarbon per gram (mg HC/g) of organic carbon, and are as much as 60 meters thick (Pairazian, 1993; Banks and others, 1997; Martirosyan and others, 1998; Abrams and others, 1999; Tuttle and others, 1999; Fossum and others, 2001; He and others, 2012). The geologic model for the Domanik TPS is for oil generated from Domanik shales to have been partially retained within the shales following migration. Ordovician–Lower Devonian Composite TPS shales contain Type II kerogen, have TOC contents of as much as 5 weight percent, have HI values of as much as 660 mg HC/g of organic carbon, and are as much as 800 meters thick (Pairazian, 1993; Abrams and others, 1999; Fossum and others, 2001). The geologic model for the Ordovician–Lower Devonian Composite TPS is for gas, generated from cracked oil within Ordovician, Silurian, and Lower Devonian source rocks, to have been partially retained within the source rocks following migration. The Paleozoic Composite TPS was defined to include all petroleum generated from any of several source rocks, including Ordovician, Silurian, Devonian, Carboniferous, and Permian shales. The geologic model is for oil to have cracked to gas upon burial in the foredeep, and gas from these source rocks migrated locally into low-permeability sandstones, forming a regional, continuous gas accumulation. Source rocks within this TPS are variable and contain Type II and Type III kerogen, have TOC contents of as much as 6 weight percent, have HI values of as much as 580 mg HC/g of organic carbon, and are as much as 800 meters thick. Source rocks in this TPS possibly include coal beds (Ulmishek, 1982; Abrams and others, 1999).

Assessment input data are summarized in table 1. Input data for drainage areas, success ratios, and estimated ultimate recoveries are taken from geologic analogs in the United States.

Undiscovered Resources Summary

The USGS quantitatively assessed shale oil, associated gas, and continuous gas resources in four assessment units (table 2) in the Timan-Pechora Basin Province of Russia. For undiscovered, technically recoverable continuous resources, the mean totals are 1,425 million barrels of shale oil (MMBO), or 1.4 billion barrels of oil, with an F95–F5 fractile range from 330 to 3,099 MMBO; 45,721 billion cubic feet, or 46 trillion cubic feet of gas (BCFG), with an F95–F5 fractile range from 8,679 to 98,647 BCFG; and 737 million barrels of natural gas liquids (MMBNGL) with an F95–F5 fractile range from 115 to 1,708 MMBNGL. Of the mean total of 45,721 BCFG, about 78 percent, or 35,511 BCFG, is estimated to be in the Ural Foredeep Continuous Gas AU.

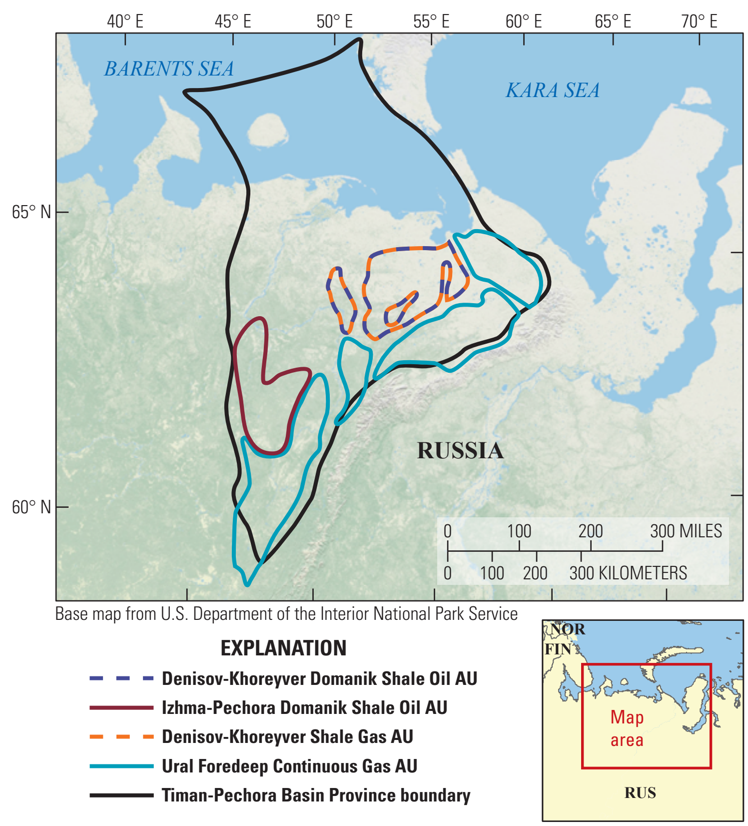

Figure 1. Map showing the four continuous assessment units (AUs) in the Timan-Pechora Basin Province of Russia. Province boundary is from Klett and others, 1997.

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Table 1. Key input data for four continuous assessment units (AUs) in the Timan-Pechora Basin Province of Russia.

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

Assessment input data— Continuous AUs	Denisov-Khoreyver Domanik Shale Oil AU				Izhma-Pechora Domanik Shale Oil AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	1,200	4,310,000	8,620,000	4,310,400	1,200	3,614,500	7,229,000	3,614,900
Average drainage area of wells (acres)	120	180	240	180	120	180	240	180
Success ratio (%)	10	50	90	50	10	50	90	50
Average EUR (MMBO)	0.03	0.06	0.15	0.065	0.03	0.06	0.15	0.065
AU probability	1.0				1.0			
Assessment input data— Continuous AUs	**Denisov-Khoreyver Shale Gas AU**				**Ural Foredeep Continuous Gas AU**			
	Minimum	**Mode**	**Maximum**	**Calculated mean**	**Minimum**	**Mode**	**Maximum**	**Calculated mean**
Potential production area of AU (acres)	800	4,500,000	9,000,000	4,500,267	800	11,734,000	23,468,000	11,734,267
Average drainage area of wells (acres)	80	120	160	120	60	80	120	86.7
Success ratio (%)	10	50	90	50	10	50	90	50
Average EUR (BCFG)	0.2	0.5	1.0	0.522	0.2	0.5	1.0	0.522
AU probability	0.9				1.0			

Table 2. Results for four continuous assessment units (AUs) in the Timan-Pechora Basin Province of Russia.

[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. 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 systems 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
Domanik Total Petroleum System														
Denisov-Khoreyver Domanik Shale Oil AU	1.0	Oil	180	683	1,695	777	170	662	1,765	777	3	13	37	16
Izhma-Pechora Domanik Shale Oil AU	1.0	Oil	150	573	1,404	648	139	556	1,461	649	3	11	30	13
Ordovician–Lower Devonian Composite Total Petroleum System														
Denisov-Khoreyver Shale Gas AU	0.9	Gas					0	8,003	20,180	8,784	0	155	420	175
Paleozoic Composite Total Petroleum System														
Ural Foredeep Continuous Gas AU	1.0	Gas					8,370	31,889	75,241	35,511	109	455	1,221	533
Total undiscovered continuous resources			**330**	**1,256**	**3,099**	**1,425**	**8,679**	**41,110**	**98,647**	**45,721**	**115**	**634**	**1,708**	**737**

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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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