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National and Global Petroleum Assessment

Assessment of Undiscovered Conventional Oil and Gas Resources of the West Siberian Basin Province, Russia, 2020

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean conventional resources of 12.9 billion barrels of oil and 684.3 trillion cubic feet of gas in the West Siberian Basin Province of Russia.

Introduction

The U.S. Geological Survey (USGS) quantitatively assessed the potential for undiscovered, technically recoverable conventional oil and gas resources within the West Siberian Basin Province of Russia (fig. 1), the world's largest basin in terms of area and known volumes of conventional oil and gas resources (Ulmishek, 2003). Most onshore structural traps have been tested during several decades of exploration and many giant and supergiant oil and gas fields have been discovered. The offshore is far less explored and will likely be the focus of future explorations. Many large undrilled structures underlying the southern part of the Kara Sea are postulated to contain major undiscovered conventional gas resources. This assessment includes conventional oil and gas resources within the entire West Siberian Basin Province and provides an estimate of undiscovered oil and gas resources north of the Arctic Circle.

Total Petroleum System and Assessment Units

The USGS defined a Mesozoic Composite Total Petroleum System (TPS) that encompasses three assessment units (AUs): (1) the Southern West Siberian Basin Reservoirs AU, (2) the Northern West Siberian Basin Reservoirs AU, and (3) the South Kara Sea Offshore Reservoirs AU (fig. 1). The Mesozoic Composite TPS was defined because oil and gas in some areas of the West Siberian Basin Province cannot be positively correlated to any of several potential petroleum source rocks in the Mesozoic section, particularly in the northern part of the basin where most of the known resource is gas (Ulmishek, 2003). Petroleum source rocks within the Mesozoic Composite TPS include organic-rich facies of the (1) nonmarine Triassic Tampey Formation, (2) nonmarine and marine shales of the Lower to Middle Jurassic Tyumen Formation, (3) lacustrine shales of the Lower Jurassic Togur Formation, (4) marine shales of the Upper Jurassic–Lower Cretaceous Bazhenov Formation, (5) nonmarine shales of the Upper Jurassic Vasyugen Formation, and (6) nonmarine shales and coals of the Cretaceous Pokur Formation. However, most of the oil in the West Siberian Basin Province is sourced by organic-rich marine shales of the Bazhenov Formation. Secondary sources include shales of the Togur, Tyumen, and Tampey formations (Peters and others, 1993, 1994; Kontorovich and others, 1997; Hegre and others, 1998; Ulmishek, 2003; Yuri and others, 2008). In shales of the Bazhenov Formation, thermal maturity that is based on vitrinite reflectance measurements increases to the north due to the depth of burial in that part of the basin (up to 15 km) (Ulmishek, 2003). All potential petroleum source rocks in the northern part of the West Siberian Basin Province, including the shales of the Bazhenov Formation and coals of the Pokur andTyumen formations, are most likely major sources of gas (Ulmishek, 2003).

The geologic models for the three AUs share several characteristics, including overall tectonic history and stratigraphic evolution since Triassic time (Vyssotski and others, 2006; Schenk, 2018; Shemin and others, 2019). The geologic model for the Southern West Siberian Basin Reservoirs AU is for oil and minor gas generated from Mesozoic source rocks (mainly from the Bazhenov Formation) to have migrated vertically and updip into (1) sandstones within structural traps associated with paleotopography on complexly structured and rifted basement, (2) sandstones within stratigraphic traps in rifts, (3) sandstones deposited in Neocomian marine clinoforms, (4) sandstones in basin-floor fans, and (5) sandstones infilling incised valleys. Most oil fields are in sandstone reservoirs within clinoforms of the Lower Cretaceous Achimov Formation (Pinous and others, 2001).

The geologic model for the Northern West Siberian Basin Reservoirs AU is similar. However, much of its oil was thermally cracked to gas, adding to the gas content mainly generated from coals. Gas migrated into sandstones within structural and stratigraphic traps, possibly assisted by late Cenozoic uplift and gas expansion. Reservoirs include (1) Jurassic–Upper Cretaceous marine sandstones that underlie a regional Upper Cretaceous shale seal, (2) fluvial-deltaic to nearshore lacustrine sandstones in rifts, (3) fluvial to estuarine sandstones infilling incised valleys, and (4) fluvial to deep-marine sandstones associated with clinoforms. Although the largest structures have probably been tested in the Northern West Siberian Basin Reservoirs AU, few stratigraphic traps have been tested.

The geologic model for the South Kara Sea Offshore Reservoirs AU is for oil generated from Mesozoic source rocks to have migrated vertically and updip into reactivated structural traps that are associated with paleotopography on complexly structured basement and into stratigraphic traps within rifts, clinoforms, and incised

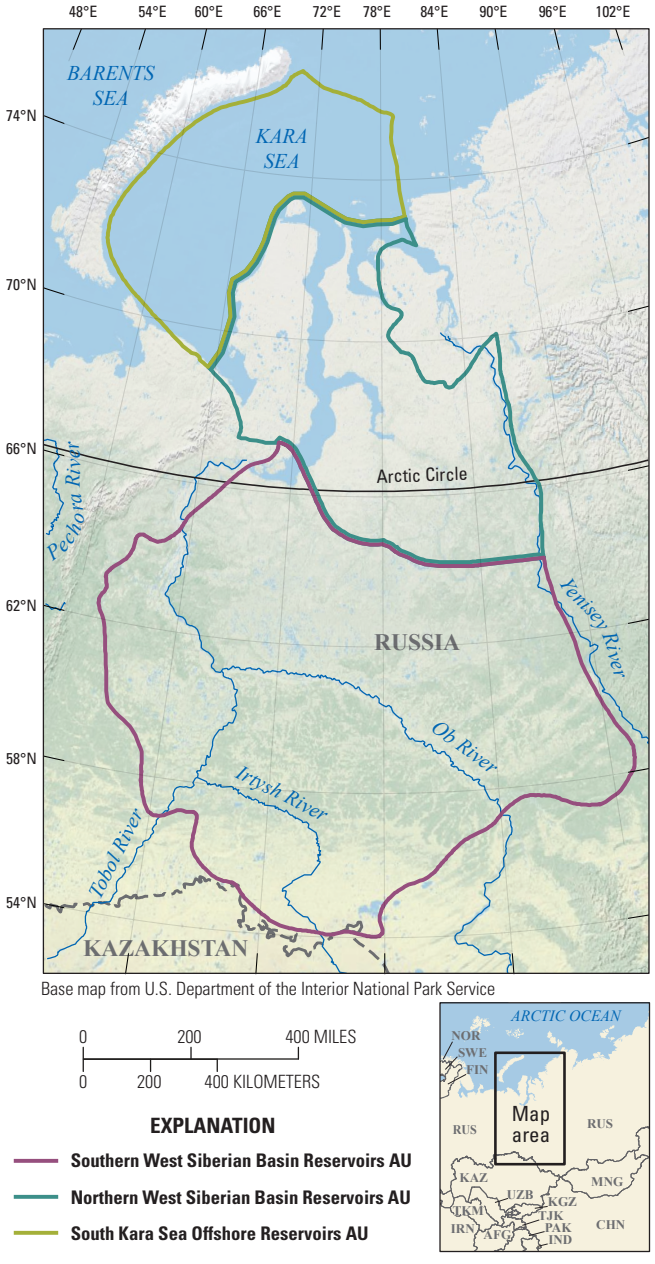

Figure 1. Map showing the location of three assessment units (AUs) in the West Siberian Basin Province, Russia. Modified from Schenk (2018).

valleys (Schenk, 2018). Oil was transformed into gas by thermal cracking. Like in the Northern West Siberian Basin Reservoirs AU, these reservoirs are mainly Upper Jurassic to Upper Cretaceous (1) nonmarine to marine sandstones, (2) fluvial-deltaic to nearshore lacustrine sandstones in rifts, (3) fluvial and estuarine sandstones infilling incised valleys, and (4) fluvial to deep-marine sandstones associated with clinoforms. Many large structures remain untested in this AU. Key assessment input data are summarized in table 1 and in Schenk (2022).

Undiscovered Resources Summary

The USGS quantitatively assessed undiscovered conventional oil, gas, and natural gas liquid resources within the West Siberian Basin Province (table 2). The fully risked mean totals are 12,898 million barrels of oil (MMBO), or 12.9 billion barrels of oil (BBO), with an F95–F5 fractile range from 7,616 to 21,004 MMBO; 684,279 billion cubic feet of gas (BCFG), or 684.3 trillion cubic feet, with an F95–F5 range from 292,363 to 1,237,301 BCFG; and 5,400 million barrels of natural gas liquids (MMBNGL), or 5.4 billion barrels of natural gas liquids, with an F95–F5 range from 2,586 to 9,316 MMBNGL. Of these totals for the West Siberian Basin Province, the estimated mean portions of potential resources north of the Arctic Circle are 2,731 MMBO, or 2.7 BBO, with an F95−F5 range from 899 to 6,308 MMBO; 651,940 BCFG, or 652 TCFG, with an F95−F5 range from 271,409 to 1,190,550 BCFG; and 4,690 MMBNGL, or 4.7 BBNGL, with an F95−F5 range from 2,127 to 8,289 MMBNGL.

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For More Information

Assessment results are also available at the USGS Energy Resources Program website, https://www.usgs.gov/energy-and-minerals/energy-resources-program.

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Table 1. Key input data for three conventional AUs in the West Siberian Province, Russia.

[Shading indicates not applicable, AU, assessment unit; MMBO, million barrels of oil; BCFG, billion cubic feet of gas]

Assessment input data—Conventional AUs	Southern West Siberian Basin Reservoirs AU				Northern West Siberian Basin Reservoirs AU			
	Minimum	Median	Maximum	Calculated mean	Minimum	Median	Maximum	Calculated mean
Number of oil fields	1	1,000	2,000	1,024.4	1	30	60	30.7
Number of gas fields	1	100	200	102.5	1	500	1,000	512.2
Size of oil fields (MMBO)	5	8	60	9.6	5	10	3,500	44.5
Size of gas fields (BCFG)	30	48	2,000	83.8	30	60	3,000	115.8
AU probability	1.0				1.0			

Assessment input data—Conventional AUs	South Kara Sea Offshore Reservoirs AU			
	Minimum	Median	Maximum	Calculated mean
Number of oil fields	1	30	60	30.7
Number of gas fields	1	300	600	307.3
Size of oil fields (MMBO)	5	12	4,000	54.1
Size of gas fields (BCFG)	30	72	420,000	1,971.5
AU probability	1.0			

Table 2. Results for three conventional assessment units and area of results above the Arctic Circle in the West Siberian Basin Province.

[Results shown are fully risked estimates. F95 represents a 95-percent chance of at least the amount tabulated; other fractiles are defined similarly. Shading indicates not applicable. AU, assessment unit; MMBO, million barrels of oil; BCFG, billion cubic feet of gas; NGL, natural gas liquids; MMBNGL, million barrels of natural gas liquids]

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
Assessment Results–Entire AU areas														
Southern West Siberian Basin Reservoirs AU	1.0	Oil	6,640	9,613	13,926	9,862	5,263	7,686	11,198	7,892	84	123	180	126
		Gas					5,305	8,341	12,751	8,591	127	200	306	206
Northern West Siberian Basin Reservoirs AU	1.0	Oil	438	1,116	3,212	1,367	261	666	1,941	820	3	7	19	8
		Gas					39,027	57,671	84,324	59,160	936	1,384	2,027	1,420
South Kara Sea Offshore Reservoirs AU	1.0	Oil	538	1,376	3,866	1,669	537	1,375	3,877	1,669	1	3	8	3
		Gas					241,970	562,198	1,123,210	606,147	1,435	3,369	6,776	3,637
Total undiscovered conventional resources			**7,616**	**12,105**	**21,004**	**12,898**	**292,363**	**637,937**	**1,237,301**	**684,279**	**2,586**	**5,086**	**9,316**	**5,400**
Conventional Resources North of Arctic Circle														
Southern West Siberian Basin Reservoirs AU	1.0	Oil	40	58	84	59	32	46	67	47	1	1	1	1
		Gas					32	50	77	52	1	1	2	1
Northern West Siberian Basin Reservoirs AU	1.0	Oil	321	819	2,358	1,003	192	489	1,425	602	2	5	14	6
		Gas					28,646	42,331	61,894	43,423	687	1,016	1,488	1,042
South Kara Sea Offshore Reservoirs AU	1.0	Oil	538	1,376	3,866	1,669	537	1,375	3,877	1,669	1	3	8	3
		Gas					241,970	562,198	1,123,210	606,147	1,435	3,369	6,776	3,637
Total undiscovered conventional resources above Arctic Circle			**899**	**2,253**	**6,308**	**2,731**	**271,409**	**606,498**	**1,190,550**	**651,940**	**2,127**	**4,395**	**8,289**	**4,690**