

## National and Global Petroleum Assessment

# Assessment of Undiscovered Conventional Oil and Gas Resources of the Barents Sea Area, 2021

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean conventional resources of 7.3 billion barrels of oil and 463.7 trillion cubic feet of gas within the Barents Sea area.

## Introduction

The U.S. Geological Survey (USGS) quantitatively assessed the potential for undiscovered, technically recoverable conventional oil and gas resources in the Barents Sea area (fig. 1). The tectonic evolution of the Barents Sea area reflects the multiphase deformation of a structurally and spatially heterogeneous basement (Klitzke and others, 2015; Gac and others, 2016, 2018; Klett, 2017; Müller and others, 2019). Regional extension in the Devonian reactivated preexisting basement faults, producing a series of horsts and grabens that filled with up to 6 kilometers of synrift sediment. Thermal subsidence in the Carboniferous and Permian resulted in deposition of several thousand meters of continental to marine sediments, including widespread coal beds and organic-rich marine shales, both of which are potential petroleum source rocks.

In this report, the Barents Sea area is discussed in terms of the eastern part (comprising the North Barents basin and the South Barents basin) and the western part (comprising the Barents platform). Closure of the Uralian Ocean in the Permian formed a thrust belt, foredeep, and foreland basin in the eastern part of the Barents Sea area, resulting in deposition of several thousand meters of Permian orogenic sediments (Klitzke and others, 2016).

Permian salt structures are present in the western part of the Barents Sea area (Mattos and others, 2016), and are postulated to be in the eastern part. In the Middle Triassic to Early Jurassic, collision of the Kara terrane formed the Novaya Zemlya fold belt and a foredeep in the eastern part of the Barents Sea area. The foredeep developed into an ultradeep basin with up to 20 kilometers of sediment (Khlebnikov and others, 2011), with subsidence possibly assisted by mantle flow. In comparison, much of the western part of the Barents Sea area was a shallow platform in the Middle Triassic to Early Jurassic (Gac and others, 2018). A forebulge formed west of the foredeep, resulting in up to 1.5 kilometers of erosion in what is now the Barents platform (Müller and others, 2019). Contractural deformation in Novaya Zemlya formed a series of broad folds including anticlines that became important traps for oil and gas, particularly in what are now the Barents basin and Kolguev terrace. Thermal subsidence in the Cretaceous led to accommodation space that was filled by the westward progradation of several clastic sequences including fluvial to deep marine sandstone reservoirs (Klett, 2017). From the Late Cretaceous through the Oligocene, up to 3 kilometers of uplift and erosion in the western part of the Barents Sea area may have caused loss or remigration of oil and gas (Müller and others, 2019). Likewise, extension in the western part of the Barents Sea area associated with the Neogene opening of the Norwegian Sea may also have resulted in remigration or loss of trapped oil and gas. Key assessment input data are summarized in table 1 and presented in Schenk (2023).

## Total Petroleum System and Assessment Units

The USGS defined a Paleozoic–Mesozoic Composite Total Petroleum System (TPS) and five geologic assessment units (AUs) within it. Each AU was assessed for undiscovered resources of conventional oil, gas, and natural gas liquids. The Paleozoic–Mesozoic Composite TPS encompasses thermogenic gas from Carboniferous and possibly Permian coal beds and marine shales and oil and gas from organic-rich Triassic, Jurassic, and Cretaceous marine shales (van Koevorden and others, 2010). In the eastern part of the Barents Sea area, deep burial caused all source rocks to pass the thermal window for oil generation and into the thermal window for gas generation. In the western part of the Barents Sea area, source rocks are in the thermal windows for oil and gas generation. Triassic marine shales are hundreds of meters thick and have total organic carbon (TOC) values up to 12 weight percent, hydrogen index values up to 600 milligrams hydrocarbon per gram of TOC, making them the most viable source rocks in the east (Klett, 2017). Jurassic organic-rich shales are interpreted as the most viable source rocks in the western part of the Barents Sea area (Doré, 1995; Ohm and others, 2008). Additionally, coal beds are interpreted to be a significant source for gas in this assessment, particularly in the east.

The geologic model for the Kolguev Terrace Reservoirs AU, the South Barents-Ludlov Saddle Reservoirs AU, and the North Barents Reservoirs AU is for oil and gas generated during deep burial in the Permian to Cretaceous to have migrated into a spectrum of sandstone reservoirs within anticlines and other types of folds, faulted anticlines, and stratigraphic traps ranging from shelf to slope, as well as basin floor fans. Salt movement may have resulted in trapping configurations for oil and gas. Many large structures remain untested in these AUs (Doré, 1995). The geologic model for the Barents Platform North Reservoirs AU and the Barents Platform South Reservoirs AU is for oil and gas generated from Carboniferous coal beds and Permian, Triassic, and Jurassic marine shales to have migrated eastward into similar traps as in the east. The western part of the Barents Sea area has undergone several phases of uplift and erosion (Lerch and others, 2016), the most recent being associated with the Neogene opening of the Norwegian Sea. Uplift in the western part of the Barents Sea area in the Neogene may have resulted in erosion of reservoir intervals and may have resulted in remigration or loss of oil and gas from existing traps (Ohm and others, 2008). For readers interested in potential oil and gas resources within the Arctic region, the AUs defined and assessed in this study are entirely north of the Arctic Circle.



**Figure 1.** Map showing the location of five conventional assessment units (AUs) of the Barents Sea area assessed in this study.

# Undiscovered Resources Summary

The USGS quantitatively assessed undiscovered conventional oil, gas, and natural gas liquids resources within five geologic AUs of the Barents Sea area (table 2). The fully risked mean totals are 7,252 million barrels of oil (MMBO), or 7.3 billion barrels, with a F95–F5 fractile range from 1,647 to

19,210 MMBO; 463,712 billion cubic feet of gas (BCFG), or 463.7 trillion cubic feet, with an F95–F5 range from 101,255 to 1,129,949 BCFG; and 1,090 million barrels of natural gas liquids (MMBNGL), or 1.1 billion barrels, with an F95–F5 range from 269 to 2,627 MMBNGL. Most of the undiscovered oil (93 percent) and gas (98 percent) is estimated to be within the eastern part of the Barents Sea area.

**Table 1.** Key input data for five conventional oil and gas assessment units in the Barents Sea area.

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

Assessment input data— Conventional AUs	Kolguev Terrace Reservoirs AU				South Barents-Ludlov Saddle Reservoirs AU			
	Minimum	Median	Maximum	Calculated mean	Minimum	Median	Maximum	Calculated mean
Number of oil fields	1	8	32	8.8	1	30	90	31.9
Number of gas fields	1	12	48	13.2	1	100	300	106.3
Size of oil fields (MMBO)	5	8	600	16.9	5	8	10,000	68.9
Size of gas fields (BCFG)	30	48	4,000	105.4	30	72	400,000	1,903.8
AU probability	1.0				1.0			
Assessment input data— Conventional AUs	North Barents Reservoirs AU				Barents Platform North Reservoirs AU			
	Minimum	Median	Maximum	Calculated mean	Minimum	Median	Maximum	Calculated mean
Number of oil fields	1	60	180	63.8	1	5	15	5.3
Number of gas fields	1	120	360	127.6	1	5	15	5.3
Size of oil fields (MMBO)	5	8	10,000	68.9	5	8	400	14.8
Size of gas fields (BCFG)	30	72	400,000	1,903.8	30	48	1,000	69.9
AU probability	1.0				0.8			
Assessment input data— Conventional AUs	Barents Platform South Reservoirs AU							
	Minimum	Median	Maximum	Calculated mean				
Number of oil fields	1	30	60	30.7				
Number of gas fields	1	90	180	92.2				
Size of oil fields (MMBO)	5	8	400	14.8				
Size of gas fields (BCFG)	30	48	800	66.6				
AU probability	1.0							

**Table 2.** Results for five conventional oil and gas assessment units in the Barents Sea area.

[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. 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
Paleozoic–Mesozoic Composite Total Petroleum System														
Kolguev Terrace Reservoirs AU	1.0	Oil	39	115	379	149	43	127	418	164	1	1	5	2
		Gas					384	1,128	3,371	1,398	1	2	7	3
South Barents-Ludlov Saddle Reservoirs AU	1.0	Oil	357	1,451	6,771	2,186	461	1,886	8,797	2,842	5	21	97	31
		Gas					40,561	158,470	510,305	202,780	80	315	1,033	405
North Barents Reservoirs AU	1.0	Oil	1,011	3,448	11,121	4,400	1,311	4,485	14,447	5,720	14	49	159	63
		Gas					54,058	197,769	581,275	243,399	106	394	1,175	487
Barents Platform North Reservoirs AU	0.8	Oil	0	51	177	63	0	96	337	119	0	0	1	0
		Gas					0	274	730	297	0	4	11	4
Barents Platform South Reservoirs AU	1.0	Oil	240	426	762	454	456	810	1,447	863	2	3	6	3
		Gas					3,981	5,970	8,822	6,130	60	90	133	92
<b>Total undiscovered conventional resources</b>			<b>1,647</b>	<b>5,491</b>	<b>19,210</b>	<b>7,252</b>	<b>101,255</b>	<b>371,015</b>	<b>1,129,949</b>	<b>463,712</b>	<b>269</b>	<b>879</b>	<b>2,627</b>	<b>1,090</b>

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## For More Information

Assessment results are also available at the USGS Energy website, at <https://www.usgs.gov/programs/energy-resources-program>.

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