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National and Global Petroleum Assessment Project

Assessment of Undiscovered Conventional and Continuous Oil and Gas Resources of the Baltic Depression Province, 2014

The U.S. Geological Survey estimated mean volumes of undiscovered, technically recoverable resources of 282 million barrels of conventional oil, 576 billion cubic feet of conventional gas, 1.3 billion barrels of continuous oil, and 4.6 trillion cubic feet of shale gas in the Baltic Depression Province.

Introduction

As part of the U.S. Geological Survey's (USGS) National and Global Petroleum Assessment Project, the USGS completed an assessment of the conventional and continuous (unconventional) oil and gas resources of the Baltic Depression Province (fig. 1). The Baltic Depression Province is an area of approximately 232,410 square kilometers (km^2) that exists partly offshore and includes areas of onshore Poland, Russia (Kaliningrad), Lithuania, Latvia, Estonia, and Sweden.

For this study, the Lower Paleozoic Composite Total Petroleum System (TPS) was defined to include lower Paleozoic source rocks and conventional oil and gas reservoirs. The Lower Paleozoic Reservoirs Assessment Unit (AU) was bounded, in part, by the Silurian outcrop (Poprawa and others, 1999) and the 500-meter (m) isopach of Cambrian rocks (Shogenova and others, 2009). Discovered conventional oil and gas accumulations in the province (IHS Energy, 2013) provide evidence for: (1) the existence of a viable petroleum system containing lower Paleozoic source rocks, (2) the generation of hydrocarbons, and (3) the migration of hydrocarbons into lower Paleozoic conventional reservoirs. At the time of this assessment, the Baltic Depression Province contained 45 conventional oil and 6 conventional gas accumulations (IHS Energy, 2013), which exceed the minimum assessment size of 1 million barrels of oil (MMBO) and 6 billion cubic feet of gas (BCFG) used in this assessment.

The USGS assessment methodology for continuous (unconventional) resources requires that potential source rocks in the AU must: (1) contain greater than 2 weight percent total organic carbon (TOC); (2) contain Type I or Type II organic matter; (3) be within the oil and gas thermal generation window; and (4) contain organic-rich shale greater than 15 m in thickness (Charpentier and Cook, 2011). Using these geologic criteria, the USGS defined two continuous TPSs: (1) the Cambrian-Ordovician TPS containing the Cambrian-Ordovician Continuous Oil AU and the Cambrian-Ordovician Shale Gas AU, and (2) the Silurian TPS containing the Silurian Continuous Oil AU and the Silurian Shale Gas AU (fig. 1). The assessment input data for each continuous AU is shown in table 1.

Petroleum generation from Cambrian, Ordovician, and Silurian source rocks began in the Late Silurian prior to the Devonian to Carboniferous Hercynian orogeny. Uplift and erosion during this orogeny removed at least 1,000 m of lower Paleozoic rocks and potentially affected the retention of hydrocarbons within the source-reservoir rock systems (Ulmishek, 1990), which constitutes a major source of geologic uncertainty in the assessment.

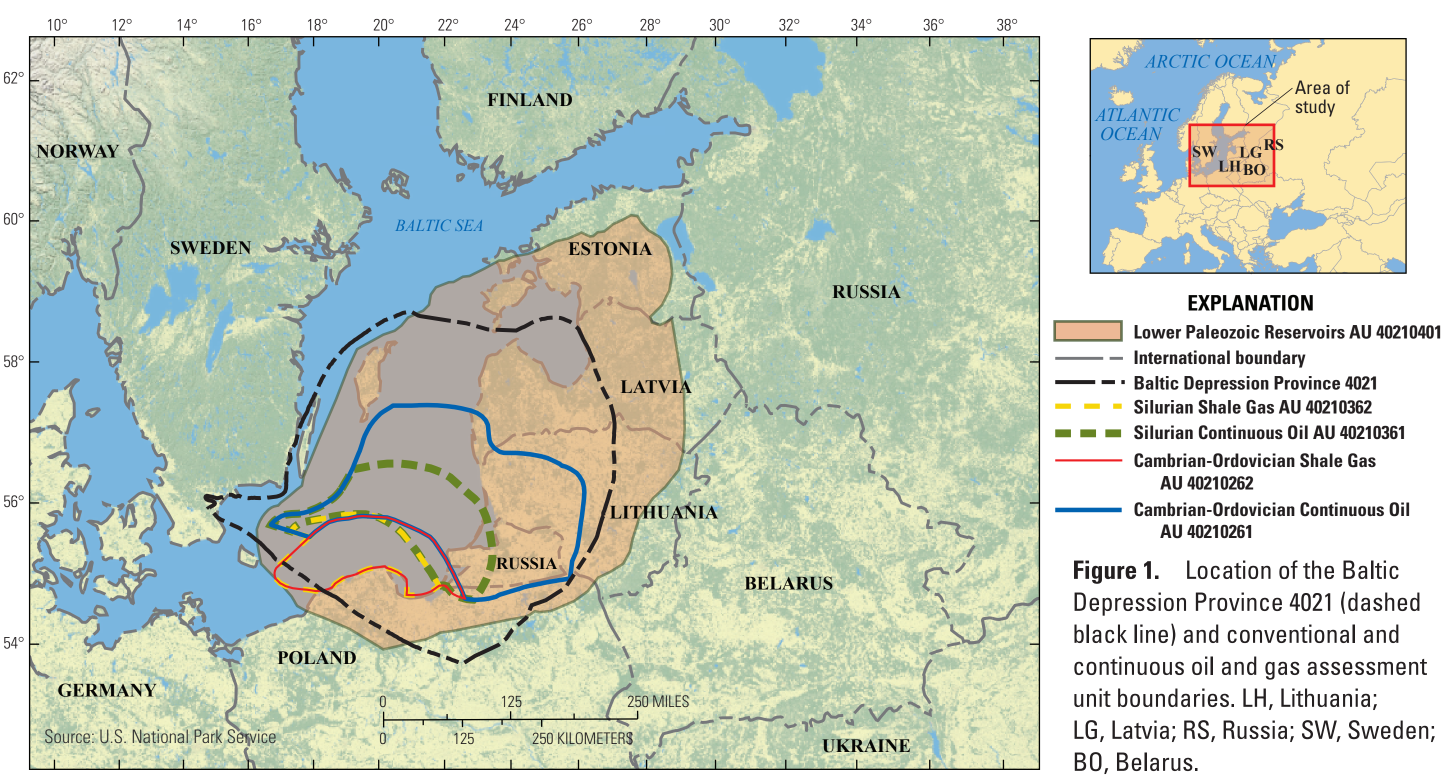

Figure 1. Location of the Baltic Depression Province 4021 (dashed black line) and conventional and continuous oil and gas assessment unit boundaries. LH, Lithuania; LG, Latvia; RS, Russia; SW, Sweden; BO, Belarus.

Table 1. Key assessment input data for the four continuous assessment units in the Baltic Depression Province.

[EUR (estimated ultimate recovery per well), well drainage area, and success ratios are from U.S. shale-gas and shale-oil analogs. MMBO, million barrels of oil; BCFG, billion cubic feet of gas; AU, assessment unit; %, percent. The average EUR input is the minimum, median, maximum, and calculated mean.]

Assessment input data	Cambrian-Ordovician Continuous Oil AU				Cambrian-Ordovician Shale Gas AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	0	4,943,700	19,774,800	8,239,500	0	1,427,120	5,708,460	2,378,527
Average drainage area of wells (acres)	120	160	220	167	120	160	220	167
Success ratios (%)	10	50	90	50	10	50	90	50
Average EUR (MMBO, oil; BCFG, gas)	0.01	0.03	0.1	0.034	0.1	0.2	1	0.245
	Silurian Continuous Oil AU				Silurian Shale Gas AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	78,500	1,962,570	7,850,270	3,297,113	50,370	1,259,180	5,036,720	2,115,423
Average drainage area of wells (acres)	120	160	220	167	120	160	220	167
Success ratios (%)	10	50	90	50	10	50	90	50
Average EUR (MMBO, oil; BCFG, gas)	0.02	0.05	0.2	0.058	0.1	0.4	1.3	0.447

Resource Summary

The USGS quantitatively assessed oil and gas resource volumes in one conventional AU and four continuous AUs within the Baltic Depression Province (table 2). For conventional resources, the mean totals for the Lower Paleozoic Reservoirs AU are 282 million barrels of oil (MMBO), 576 billion cubic feet of gas (BCFG), and 6 million barrels of natural gas liquids (MMBNGL). For continuous resources, the mean totals are 1,313 MMBO (continuous oil), 4,619 BCFG (shale gas), and 42 MMBNGL for the four assessment units.

For Further Information

Assessment results are available at the USGS Central Energy Resources Science Center website: http://energy.cr.usgs.gov/oilgas/noga/.

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Table 2. Assessment results for conventional and continuous oil and gas resources in the Baltic Depression Province.

[MMBO, million barrels of oil; BCFG, billion cubic feet of gas; MMBNGL, million barrels of natural gas liquids; TPS, total petroleum system; AU, assessment unit. 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 systems (TPS) and Assessment Units (AU)	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
Cambrian-Ordovician TPS 402102														
Cambrian-Ordovician Continuous Oil AU 40210261	0.9	*Oil*	0	587	2,028	744	0	118	442	156	0	3	14	5
Cambrian-Ordovician Shale Gas AU 40210262	0.9	*Gas*					0	1,162	4,337	1,540	0	9	36	12
Silurian TPS 402103														
Silurian Continuous Oil AU 40210361	1.0	*Oil*	104	445	1,462	569	20	89	321	119	1	2	10	3
Silurian Shale Gas AU 40210362	1.0	*Gas*					510	2,235	7,094	2,804	4	17	60	22
Total unconventional resources			104	1,032	3,490	1,313	530	3,604	12,194	4,619	5	31	120	42
Lower Paleozoic Composite TPS 402104														
Lower Paleozoic Reservoirs AU 40210401	1.0	*Oil*	131	264	498	282	23	53	112	58	1	1	3	2
		Gas					211	474	977	518	1	3	7	4
Total conventional resources			131	264	498	282	234	527	1,089	576	2	4	10	6
Total undiscovered resources			235	1,296	3,988	1,595	764	4,131	13,283	5,195	7	35	130	48

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ISSN 2327-6916 (print)
ISSN 2327-6932 (online)

http://dx.doi.org/10.3133/fs20153015