

## National and Global Petroleum Assessment

# Assessment of Undiscovered Conventional Oil and Gas Resources in the Lower Paleozoic of the Williston Basin Province, 2020

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean resources of 83 million barrels of oil and 351 billion cubic feet of gas in lower Paleozoic strata of the Williston Basin Province, North Dakota, Montana, and South Dakota.

## Introduction

The U.S. Geological Survey (USGS) quantitatively assessed the potential for undiscovered, technically recoverable conventional oil and gas resources in lower Paleozoic total petroleum systems (TPSs) of the Williston Basin Province in North Dakota, Montana, and South Dakota (fig. 1; Anna, 2013). Six geologic assessment units (AUs) were defined within the Ordovician Winnipeg TPS and Ordovician Red River TPS in the lower Paleozoic stratigraphic section. Each AU was assessed for undiscovered conventional oil, gas, and natural gas liquids.

The current structure of the Williston Basin Province began forming during the Middle Ordovician when the reactivation of a complex set of Proterozoic faults provided accommodation space for Ordovician Winnipeg Group sandstone and shale deposits.

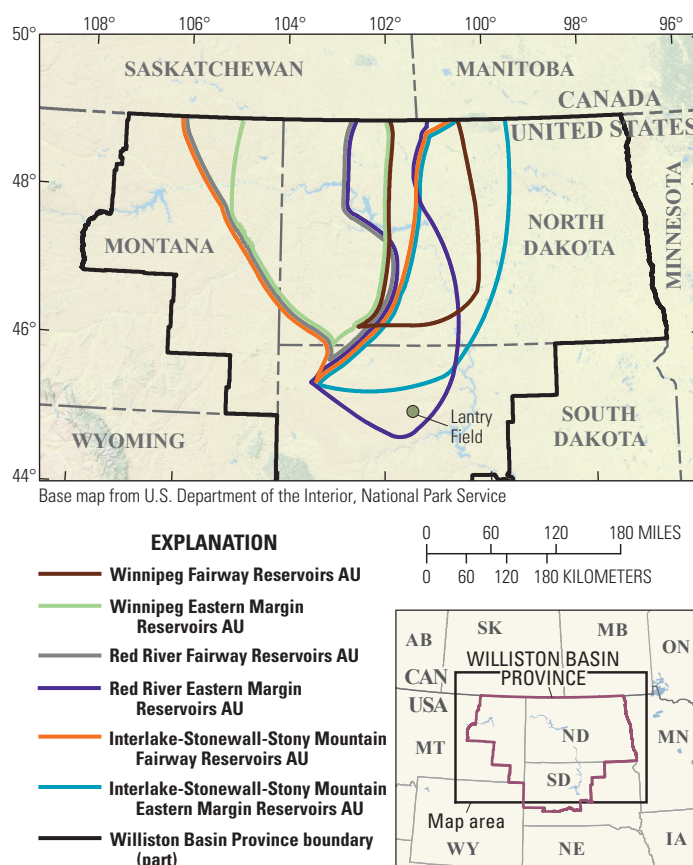
Continued fault movement through the Late Ordovician and Silurian resulted in deposition of shallow marine carbonates of the Red River, Stony Mountain, and Stonewall Formations of the Bighorn Group and the Interlake Formation of Baillie (1951). Organic-rich shales within the Icebox Formation of the Winnipeg Group and within the Red River Formation are interpreted as the main petroleum source rocks (Osadetz and Snowden, 1995; Jarvie, 2001; Khan and others, 2006; Lillis, 2012; Nesheim, 2017a, b).

The Winnipeg Fairway Reservoirs AU, Red River Fairway Reservoirs AU, and Interlake-Stonewall-Stony Mountain Fairway Reservoirs AU were defined to encompass an area within the central part of the basin (fairway) in which fluid migration is predominantly vertical rather than lateral (fig. 1). All oil and gas production from the Ordovician Winnipeg TPS and Ordovician Red River TPS are from within the fairway. The geologic model for the three fairway AUs is that oil and gas generated from Icebox Formation and Red River Formation organic-rich shales migrated into Cambrian sandstones of the Deadwood and the Winnipeg or up faults into dolomitic reservoirs within the Red River, Stony Mountain, Stonewall, and Interlake Formations (Longman and others, 1992; Nesheim, 2017a).

In contrast, the Winnipeg Eastern Margin Reservoirs AU, Red River Eastern Margin Reservoirs AU, and the Interlake-Stonewall-Stony Mountain Eastern Margin Reservoirs AU were defined to include areas to the east and southeast of the fairway where lateral migration of oil or gas sourced from Icebox Formation or Red River Formation organic-rich shales might have formed oil or gas accumulations. Evidence of lateral migration of oil from the fairway is provided by Lantry Field (fig. 1), which was discovered in 1970 about 100 miles southeast of Red River Formation fairway production and was shut in after production of 140,000 barrels of oil (Bogle and others, 1998). Key input data for the six conventional AUs are shown in table 1.

## Undiscovered Resources Summary

The USGS quantitatively assessed undiscovered conventional oil, gas, and natural gas liquid resources within the lower Paleozoic strata of the Williston Basin Province, in North Dakota, Montana, and South Dakota (table 2). The fully risked mean totals are 83 million barrels of oil (MMBO) with an F95–F5 fractile range from 44 to 144 MMBO, 351 billion cubic feet of gas (BCFG) with an F95–F5 range from 178 to 632 BCFG, and 45 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 21 to 82 MMBNGL.



**Figure 1.** Map showing the location of six assessment units (AUs) in the lower Paleozoic of the Williston Basin Province, North Dakota, Montana, and South Dakota. Adjacent lines indicate a shared boundary at the outermost line.

**Table 1.** Key input data for six conventional assessment units in the lower Paleozoic of the Williston Basin Province, North Dakota, Montana, and South Dakota.

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

Assessment input data— Conventional AUs	Winnipeg Fairway Reservoirs AU				Winnipeg Eastern Margin Reservoirs AU				Red River Fairway Reservoirs AU			
	Minimum	Median	Maximum	Calculated mean	Minimum	Median	Maximum	Calculated mean	Minimum	Median	Maximum	Calculated mean
Number of oil fields	1	3	9	3.2	1	2	6	2.1	1	50	100	51.2
Number of gas fields	1	20	40	20.5	1	4	12	4.3	1	10	20	10.3
Size of oil fields (MMBO)	0.5	0.7	8	0.9	0.5	0.7	5	0.8	0.5	0.7	5	0.83
Size of gas fields (BCFG)	3	5	48	6.3	3	5	30	5.8	3	5	48	6.3
AU probability	1.0				0.5				1.0			
Assessment input data— Conventional AUs	Red River Eastern Margin Reservoirs AU				Interlake-Stonewall-Stony Mountain Fairway Reservoirs AU				Interlake-Stonewall-Stony Mountain Eastern Margin Reservoirs AU			
	Minimum	Median	Maximum	Calculated mean	Minimum	Median	Maximum	Calculated mean	Minimum	Median	Maximum	Calculated mean
Number of oil fields	1	15	45	16.0	1	25	50	25.6	1	10	30	10.6
Number of gas fields	1	5	15	5.3	1	5	15	5.3	1	2	6	2.1
Size of oil fields (MMBO)	0.5	0.7	12	1.0	0.5	0.7	10	0.9	0.5	0.7	12	1.0
Size of gas fields (BCFG)	3	5	72	6.8	3	5	72	6.8	3	5	72	6.8
AU probability	0.5				1.0				0.5			

**Table 2.** Results for six conventional assessment units in the lower Paleozoic of the Williston Basin Province, North Dakota, Montana, and South Dakota.

[Results shown are fully risked estimates. F95 represents a 95-percent chance of at least the amount tabulated; other fractiles are defined similarly. Gray 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 systems and assessment units (AUs)	AU prob- ability	Accumu- lation type	Total undiscovered resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Ordovician Winnipeg Total Petroleum System														
Winnipeg Fairway Reservoirs AU	1.0	Oil Gas	1	3	6	3	1	3	6	3	0	0	0	0
							80	125	191	129	6	9	14	10
Winnipeg Eastern Margin Reservoirs AU	0.5	Oil	0	0	3	1	0	0	3	1	0	0	0	0
		Gas					0	0	38	12	0	0	3	1
Ordovician Red River Total Petroleum System														
Red River Fairway Reservoirs AU	1.0	Oil	28	41	60	42	28	41	60	42	3	4	6	5
		Gas					38	62	100	64	7	12	19	13
Red River Eastern Margin Reservoirs AU	0.5	Oil	0	4	24	8	0	4	24	8	0	1	3	1
		Gas					0	9	60	18	0	2	12	4
Interlake-Stonewall-Stony Mountain Fairway Reservoirs AU	1.0	Oil	15	23	35	24	16	25	39	26	2	2	4	2
		Gas					15	32	70	36	3	6	14	7
Interlake-Stonewall-Stony Mountain Eastern Margin Reservoirs AU	0.5	Oil	0	3	16	5	0	3	16	5	0	0	2	1
		Gas					0	3	25	7	0	1	5	1
Total undiscovered conventional resources			44	74	144	83	178	307	632	351	21	37	82	45

## For More Information

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

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