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National and Global Petroleum Assessment

Assessment of Continuous Oil and Gas Resources in the Upper Cretaceous Niobrara Formation in the Southwestern Wyoming Province, Wyoming and Colorado, 2024

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean continuous resources of 703 million barrels of oil and 5.8 trillion cubic feet of gas in the Niobrara Formation in the Southwestern Wyoming Province, Wyoming and Colorado.

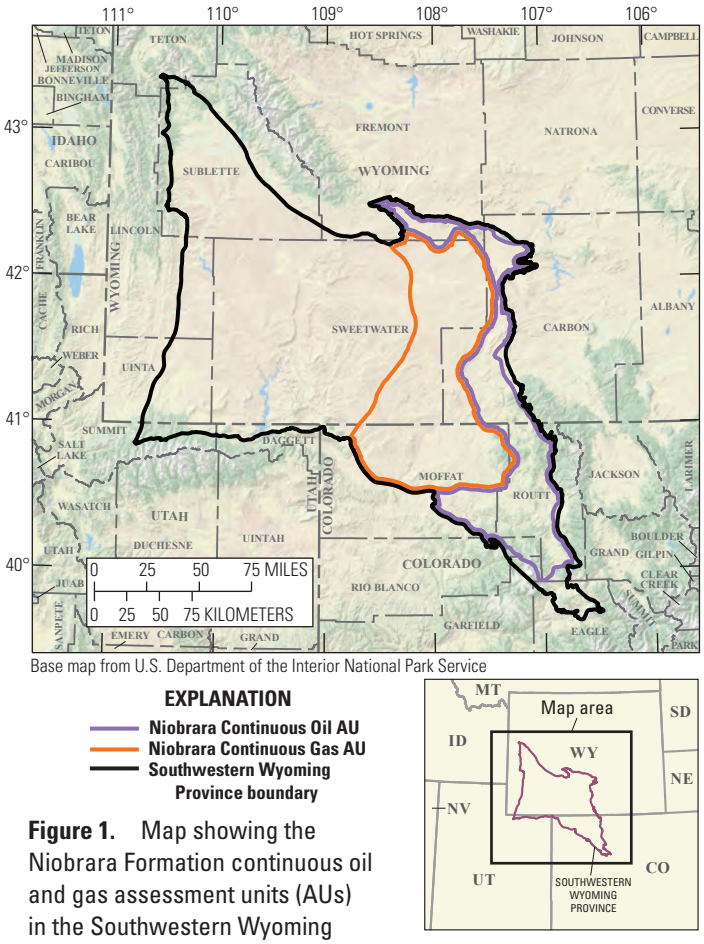
Introduction

The U.S. Geological Survey (USGS) assessed undiscovered, technically recoverable continuous (unconventional) oil and gas resources in the Upper Cretaceous (upper Turonian to lower Campanian) Niobrara Formation in the eastern part of the Southwestern Wyoming Province. The Niobrara Formation is present east of the Rock Springs uplift within the Sand Wash, Washakie, and Great Divide Basins in northwestern Colorado and southwestern Wyoming (fig. 1). The Niobrara Formation is regionally extensive due to deposition in the epicontinental Western Interior Seaway at a time when the seaway extended from the present-day Gulf of America, through central North America, and connected with northern boreal waters in the Canadian Rockies (Kauffman, 1977). Changes in sea level affected lithology within the seaway, and the Niobrara Formation records deposition of a third-order transgressive-regressive cycle (Barlow and Kauffman, 1985; Longman and others, 1998). Laramide-age tectonics (Late Cretaceous–Eocene) are responsible for the major structural elements that are currently present in the Southwestern Wyoming Province (fig. 1).

Total Petroleum System and Assessment Units

The Niobrara Total Petroleum System (TPS) is a self-sourced system whereby the source rock and reservoir are both within the Niobrara Formation. The Niobrara Formation within the Southwestern Wyoming Province contains different lithologies than the Niobrara Formation in the Powder River and Denver Basins. In this area, the Niobrara was deposited toward the western margin of the Western Interior Seaway (Drake and Hawkins, 2021). The Niobrara lithology is predominantly calcareous; however, because of its proximal location, substantial dilution of the calcareous components occurred from erosion of and sediment influx from the Sevier highlands to the west. As such, the formation is more calcareous in the east and thickens, becoming more argillaceous and siliceous westward, toward the Rock Springs Uplift where it transitions into the siliceous, argillaceous Upper Cretaceous Baxter Shale.

In this province, the Niobrara contains multiple cycles of alternating calcareous mudstones/marls and silicious-calcareous mudstones with lesser amounts of shaley limestone. The most calcareous unit is the Fort Hays Limestone Member of the Niobrara, which represents the maximum sea level transgression during Niobrara deposition. Marine (oil-prone) organic matter is preserved primarily within the peloidal calcareous components whereas terrigenous (gas-prone) organic matter is preserved within the detrital silts and clays (Olson and others, 2022). Total organic carbon concentrations are greatest (as much as 4 weight percent) within the marls, which act as the source and principal reservoir for Niobrara hydrocarbon production in this region (Dellenbach, 2016). These marls are informally known as the Buck Peak, Tow Creek, and Wolf Mountain units or benches, and each is associated with an increase in gamma ray and resistivity on petrophysical logs. The interbedded mudstones and the younger, overlying Upper Cretaceous Mancos Shale effectively seal the reservoir units (Vincelette and Foster, 1992). Natural fractures in the Niobrara are typically associated with larger structures, such as synclines and anticlines, which formed during Laramide tectonic activity and were later reopened by Neogene extension. These open fractures have been shown to enhance hydrocarbon production in the region (Vincelette and Foster, 1992).



Base map from U.S. Department of the Interior National Park Service

EXPLANATION

- Niobrara Continuous Oil AU
- Niobrara Continuous Gas AU
- Southwestern Wyoming Province boundary

Figure 1. Map showing the Niobrara Formation continuous oil and gas assessment units (AUs) in the Southwestern Wyoming Province, Wyoming and Colorado.

The USGS defined one oil and one gas assessment unit (AU) for the region. The Niobrara Continuous Oil AU represents a region with a modeled source rock thermal maturity between 0.60 to 1.35 percent vitrinite reflectance (R_o). The Niobrara Continuous Gas AU represents an area where the thermal maturity is greater than 1.35 R_o. The eastern and southeastern boundaries of the TPS were defined by Finn and

Johnson (2005) to coincide with Niobrara or stratigraphically equivalent outcrops. The western boundary of the TPS was defined using source rock analyses (Dreier and Warden, 2021) to approximate where the predominant organic matter type transitioned from oil-prone marine kerogen to gas-prone terrigenous kerogen.

Assessment input data are summarized in table 1 and Timm (2025). Input data for oil estimated ultimate recoveries (EURs) from wells required analogs from other areas with Niobrara production. Oil EURs were based on data from the Sand Wash and the Powder River Basins. Gas EURs from vertical wells in the Denver-Julesburg Basin were used as analogs for Niobrara production in this province.

Table 1. Key input data for two continuous oil and gas assessment units in the Niobrara Formation.

[Gray shading indicates not applicable. The average estimated ultimate recovery (EUR) input is the minimum, mode, maximum, and calculated mean. AU, assessment unit; %, percent; MMBO, million barrels of oil; BCFG, billion cubic feet of gas]

Assessment input data—Continuous AUs	Niobrara Continuous Oil AU				Niobrara Continuous Gas AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area (acres)	1,000	1,600,000	2,600,000	1,400,333	1,000	1,900,000	3,700,000	1,867,000
Average drainage area (acres)	100	120	140	120	120	140	160	140
Success ratio (%)	20	40	90	50	10	50	90	50
Untested area (%)	98	99	100	99	100	100	100	100
Average EUR (MMBO, oil; BCFG, gas)	0.06	0.12	0.18	0.12	0.5	0.8	1.1	0.8
AU probability	1.0				1.0			

Undiscovered Resources Summary

The USGS quantitatively assessed oil and gas resources for the two continuous AUs in the Niobrara Formation (table 2). For undiscovered, technically recoverable continuous oil and gas resources, the mean totals are 703 million barrels of oil (MMBO) with an F95 to F5 fractile range from 195 to 1,375 MMBO; 5,847 billion cubic feet of gas (BCFG), or 5.8 trillion cubic feet of gas, with an F95 to F5 fractile range from 1,477 to 11,800 BCFG; and 180 million barrels of natural gas liquids (MMBNGL) with an F95 to F5 fractile range from 46 to 362 MMBNGL.

Table 2. Results for two continuous oil and gas assessment units in the Niobrara Formation.

[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 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
Niobrara Total Petroleum System														
Niobrara Continuous Oil AU	1.0	Oil	195	656	1,375	703	117	393	826	422	5	16	33	17
Niobrara Continuous Gas AU	1.0	Gas					1,360	5,000	10,974	5,425	41	150	329	163
Total undiscovered continuous resources			**195**	**656**	**1,375**	**703**	**1,477**	**5,393**	**11,800**	**5,847**	**46**	**166**	**362**	**180**

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For More Information

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

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