

## National and Global Petroleum Assessment

# Assessment of Permian Tight Oil and Gas Resources in the Junggar Basin of China, 2016

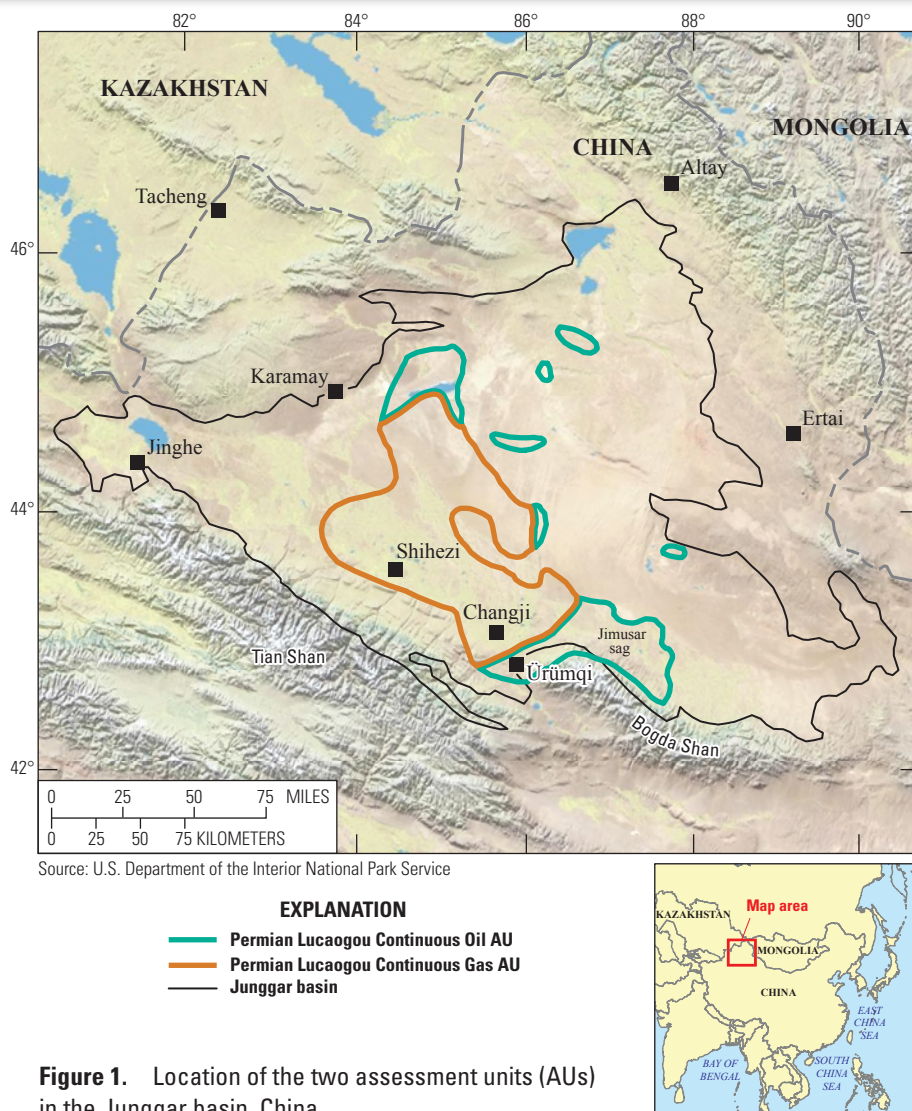
Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean resources of 764 million barrels of oil and 3.5 trillion cubic feet of gas in tight reservoirs in the Permian Lucaogou Formation in the Junggar basin of northwestern China.

## Introduction

The U.S. Geological Survey (USGS) quantitatively assessed the potential for continuous (unconventional) oil and gas resources within organic-rich shale and associated tight reservoirs in lacustrine deposits of the Junggar basin of China (fig. 1). The assessed stratigraphic interval was laminated, organic-rich shale of the Lower Permian Lucaogou Formation (Yang and others, 2010; superseding an Upper Permian age assigned by previous researchers, such as Carroll and others, 1992). The Permian lacustrine formations of the Junggar basin were likely deposited in a foreland basin north of a north-directed thrust belt in the Tian Shan at the basin's southern margin (fig. 1) (Wartes and others, 2002). The Junggar was an intracratonic sag basin in the Mesozoic and Paleogene and is again in a foreland setting in Neogene to present time (Bian and others, 2010).

The focus of this assessment is the potential for oil and gas retained in tight reservoirs interbedded within the Permian Lucaogou lacustrine shales. Tight reservoirs are generally considered to be nonshale reservoirs that require artificial stimulation such as hydraulic fracturing to produce hydrocarbons because of low permeability of the reservoir (generally near 0.1 millidarcies or lower, criteria met by the Lucaogou reservoirs according to Cao and others, 2016). Current exploration and production of tight oil from the Lucaogou Formation are focused on the Jimusar sag, a relatively shallow part of the basin (fig. 1). At present, there are 16 wells producing "industrial tight-oil flows" from the Lucaogou in the Jimusar sag (Hu and others, 2016).

Within the Permian Lucaogou Total Petroleum System, we defined two assessment units (AUs): the Permian Lucaogou Continuous Oil AU and the Permian Lucaogou Continuous Gas AU (fig. 1). The thickness, organic matter content and type, and thermal maturity of the Lucaogou all suggest the potential to produce continuous oil and gas. The Permian Lucaogou Continuous Oil AU corresponds to areas where the Lucaogou Formation is currently at depths



**Figure 1.** Location of the two assessment units (AUs) in the Junggar basin, China.

shallower than 5 kilometers on shelves around the margins of the basin (for example, Jimusar sag; fig. 1). Gradual burial of the basin's shelves and shallow marginal sags led to oil being generated in the Permian Lucaogou Formation in the Late Jurassic to middle Cretaceous (Kuang and others, 2012). The Permian Lucaogou Continuous Gas AU corresponds to the areas where organic-rich shale lies at depths greater than 5 kilometers. This part of the basin experienced voluminous nonmarine sedimentation nearly continuously from the Permian to the Neogene. Oil was generated in latest Permian and earliest Triassic (Kuang and others, 2012) and cracked to gas later in the Mesozoic. Continuous oil and gas accumulations in the United States were used as analogs in this assessment. Table 1 lists principal input data for the assessment.

## Undiscovered Resources Summary

The USGS quantitatively assessed the Permian Lucaogou Continuous Oil AU and the Permian Lucaogou Continuous Gas AU within the Permian Lucaogou Total Petroleum System in the Junggar basin, northwest China (table 2). The mean total for continuous oil resources is 764 million barrels of oil (MMBO) with an F95–F5 range from 171 to 1,675 MMBO. The mean total for continuous gas resources is 3,465 billion cubic feet (BCFG) with an F95–F5 range from 633 to 9,123 BCFG. The mean total for natural gas liquids is 66 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 11 to 178 MMBNGL. These estimates are for undiscovered, technically recoverable resources of oil, gas, and natural gas liquids and do not reflect economically recoverable resources.

**Table 1.** Key assessment input data for two continuous assessment units in the Junggar basin, China.

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

Assessment input data	Permian Lucaogou Continuous Oil AU				Permian Lucaogou Continuous Gas AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	1,000	1,300,000	2,671,000	1,324,000	1,000	3,000,000	6,300,000	3,100,333
Average drainage area of wells (acres)	40	80	120	80	80	120	160	120
Percentage of area untested in AU	100	100	100	100	100	100	100	100
Success ratios (%)	10	50	90	50	10	50	90	50
Average EUR (MMBO, oil; BCFG, gas)	0.04	0.085	0.2	0.091	0.08	0.2	1.2	0.256
AU probability	1.0				1.0			

**Table 2.** Assessment results for two continuous assessment units in the Junggar basin, China.

[MMBO, million barrels of oil; BCFG, billion cubic feet of gas; NGL, natural gas liquids; MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. For gas accumulations, all liquids are included in the NGL 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 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
Permian Lucaogou Total Petroleum System														
Permian Lucaogou Continuous Oil AU	1.0	Oil	171	675	1,675	764	45	192	542	230	0	1	2	1
Permian Lucaogou Continuous Gas AU	1.0	Gas					588	2,448	8,581	3,235	11	48	176	65
Total undiscovered continuous resources			171	675	1,675	764	633	2,640	9,123	3,465	11	49	178	66

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### For More Information

Assessment results are available at the USGS Energy Resources Program website at <http://energy.usgs.gov/>.

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