National and Global Petroleum Assessment

Assessment of Undiscovered Continuous Oil Resources of the East Gobi, Nyalga, Tamtsag-Hailar, Erlian, and Yingen Basins of Mongolia and China, 2018

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean continuous resources of 1.1 billion barrels of oil and 674 billion cubic feet of associated gas in the East Gobi, Nyalga, Tamtsag-Hailar, Erlian, and Yingen basins of Mongolia and China.

Introduction

The U.S. Geological Survey (USGS) quantitatively assessed the potential for undiscovered technically recoverable continuous (unconventional) shale-oil resources in the East Gobi, Nyalga, Tamtsag-Hailar, Erlian, and Yingen basins of Mongolia and China (fig. 1). Middle Jurassic and Late Jurassic–Early Cretaceous extension formed a regional system of extensional basins which were filled with synrift nonmarine facies (Changsong and others, 2001; Meng, 2003; Meng and others, 2003; Wilhem and others, 2012). Following cessation of rifting, a thermal sag phase led to increased accommodation space and deposition, resulting in local source-rock maturation and oil migration. The sag phase of deposition was interrupted by regional compression, uplift, and erosion in the Late Cretaceous, which inverted many of the extensional structures, and largely curtailed the thermal maturation of source rocks.

Each of these five basins considered in this study contains groups of basins, or subbasins. For potential shale-oil resources to be assessed in a subbasin, a self-sourced shale reservoir must have Type I or Type II kerogen, have greater than 2 weight percent total organic carbon, have greater than 15 meters of organic-rich source rock, and be within the thermal windows for oil or gas generation. In these subbasins, the limiting geologic factor appears to be the level of thermal maturation, as the thermal threshold for oil generation was not reached in many subbasins, which are not shown in figure 1. This assessment focused on the subset of subbasins that are interpreted to have entered the oil-generation window based on published information.

Total Petroleum Systems and Assessment Units

For potential continuous oil resources, the USGS defined five total petroleum systems (TPSs) and a shale-oil assessment unit (AU) within each of the five TPSs. The AUs are the East Gobi Basin Zuunbayan Shale Oil AU in the East Gobi Basin Zuunbayan TPS, the Nyalga Basin Khuren Dukh Shale Oil AU in the Nyalga Basin Khuren Dukh TPS, the Tamtsag-Hailar Basin Nantun Shale Oil AU in the Tamtsag-Hailar Basin Nantun TPS, the Erlian Basin Upper Aershan-Lower Tengger Shale Oil AU in the Erlian Basin Upper Aershan-Lower Tengger Shale Oil TPS, and the Yingen Basin Bayingebi Shale Oil AU in the Yingen Basin Bayingebi TPS. Each AU area encompasses the area of those subbasins that are interpreted to have thermally mature source rocks given the available information. Not all of the subbasins within a basin have resource potential. In the subbasins within these five basins, petroleum source rocks are organic-rich, deep-water lacustrine shales (Traynor and Sladen, 1995; Graham and others, 2001; Johnson and others, 2003; Johnson, 2004; Prost, 2004; Ding and others, 2015; Hasagawa and others, 2018; Luo and others, 2018). Source rocks are mainly Type I kerogen (with minor Type III kerogen), organic carbon content is as much as 10 weight percent, hydrogen index values are as much as 600 milligrams of hydrocarbon per gram of organic carbon, and thickness is as much as 700 meters. The uncertainty on the potential production area of the assessment unit (table 1) reflects the uncertainty on the extent of source-rock facies within the grabens, level of thermal maturation of the source rocks, and retention of oil following compressional deformation.

Assessment input data are summarized in table 1. Input data for drainage areas of wells, success ratios, and estimated ultimate recoveries are from geologic analogs in the United States.

Undiscovered Resources Summary

The USGS quantitatively assessed shale oil and associated gas resources in five assessment units (table 2) in the East Gobi, Nyalga, Tamtsag-Hailar, Erlian, and Yingen basins of Mongolia and China. For undiscovered, technically recoverable continuous resources, the estimated mean totals are 1,121 million barrels of shale oil (MMBO), or 1.1 billion barrels of oil, with an F95–F5 range from 0 to 2,941 MMBO; 674 billion cubic feet of associated gas (BCFG) with an F95–F5 range from 0 to 1,789 BCFG; and 2 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 0 to 7 MMBNGL. Of the mean estimated shale-oil resource of 1,121 MMBO, about 75 percent is in the Erlian basin (515 MMBO or 46 percent) and Tamtsag-Hailar basin (326 MMBO or 29 percent).

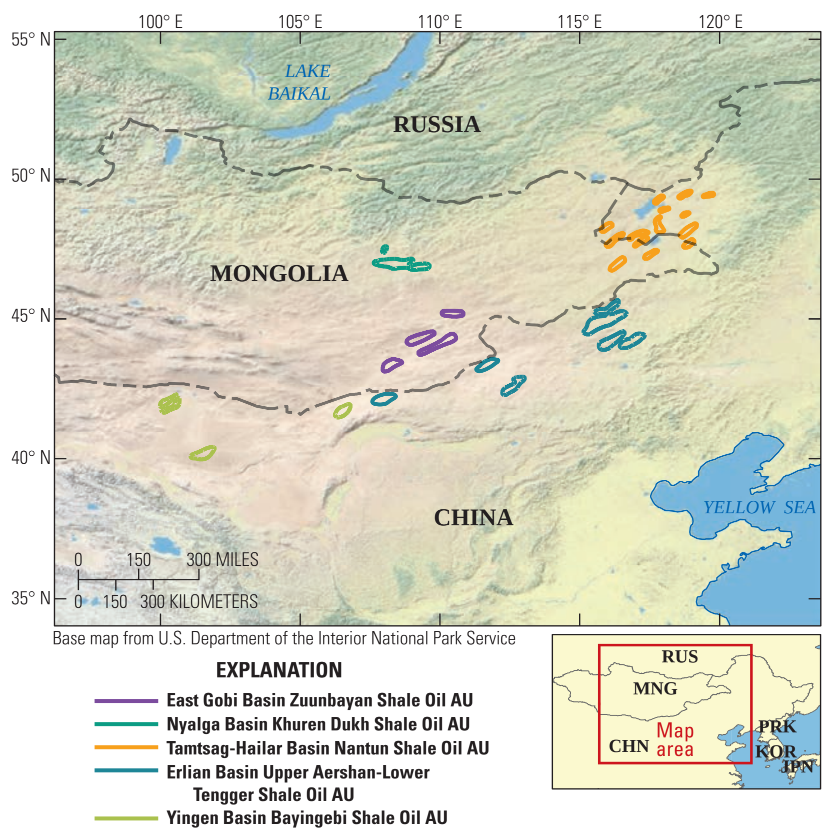

Figure 1. Map showing the five continuous assessment units (AUs) in the East Gobi, Nyalga, Tamtsag-Hailar, Erlian, and Yingen basins of Mongolia and China.

Table 1. Key input data for five continuous assessment units (AUs) in the East Gobi, Nyalga, Tamtsag-Hailar, Erlian, and Yingen basins of Mongolia and China.

[AU, assessment unit; %, percent; EUR, estimated ultimate recovery per well; MMBO, million barrels of oil. Well drainage area, success ratio, and EUR are defined partly using U.S. shale-oil analogs. The average EUR input is the minimum, median, maximum, and calculated mean. Shading indicates not applicable]

Assessment input data—Continuous AUs	East Gobi Basin Zuunbayan Shale Oil AU				Nyalga Basin Khuren Dukh Shale Oil AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	200	891,000	1,782,000	891,067	200	215,000	431,000	215,400
Average drainage area of wells (acres)	60	100	140	100	60	100	140	100
Success ratio (%)	10	40	80	43.3	10	40	80	43.3
Average EUR (MMBO)	0.01	0.04	0.15	0.046	0.01	0.04	0.1	0.043
AU probability	0.9				0.7			

Assessment input data—Continuous AUs	Tamtsag-Hailar Basin Nantun Shale Oil AU				Erlian Basin Upper Aershan-Lower Tengger Shale Oil AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	200	1,088,000	2,176,000	1,088,067	200	1,974,000	3,948,000	1,974,067
Average drainage area of wells (acres)	60	100	140	100	60	100	140	100
Success ratio (%)	10	50	90	50	10	40	80	43.3
Average EUR (MMBO)	0.01	0.06	0.2	0.067	0.01	0.06	0.2	0.067
AU probability	0.9				0.9			

Assessment input data—Continuous AU	Yingen Basin Bayingebi Shale Oil AU			
	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	200	648,000	1,296,000	648,067
Average drainage area of wells (acres)	60	100	140	100
Success ratio (%)	10	40	70	40
Average EUR (MMBO)	0.01	0.04	0.15	0.046
AU probability	0.8			

Table 2. Results for five continuous assessment units (AUs) in the East Gobi, Nyalga, Tamtsag-Hailar, Erlian, and Yingen basins of Mongolia and 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. 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 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
East Gobi Basin Zuunbayan Total Petroleum System														
East Gobi Basin Zuunbayan Shale Oil AU	0.9	Oil	0	130	414	158	0	77	252	95	0	0	1	0
Nyalga Basin Khuren Dukh Total Petroleum System														
Nyalga Basin Khuren Dukh Shale Oil AU	0.7	Oil	0	23	81	28	0	14	49	17	0	0	0	0
Tamtsag-Hailar Basin Nantun Total Petroleum System														
Tamtsag-Hailar Basin Nantun Shale Oil AU	0.9	Oil	0	271	845	326	0	160	514	196	0	1	2	1
Erlian Basin Upper Aershan-Lower Tengger Shale Oil Total Petroleum System														
Erlian Basin Upper Aershan-Lower Tengger Shale Oil AU	0.9	Oil	0	426	1,335	515	0	252	813	309	0	1	3	1
Yingen Basin Bayingebi Total Petroleum System														
Yingen Basin Bayingebi Shale Oil AU	0.8	Oil	0	77	266	94	0	45	161	57	0	0	1	0
Total undiscovered continuous resources			**0**	**927**	**2,941**	**1,121**	**0**	**548**	**1,789**	**674**	**0**	**2**	**7**	**2**

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For More Information

Assessment results are also available at the USGS Energy Resources Program website at https://energy.usgs.gov.

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