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National and Global Petroleum Assessment

Assessment of Undiscovered Continuous Gas Resources of the Ordos Basin Province, China, 2015

Using a geology-based assessment methodology, the U.S. Geological Survey estimated mean resources of 28 trillion cubic feet of tight gas and 5.6 trillion cubic feet of coalbed gas in upper Paleozoic rocks in the Ordos Basin Province, China.

Introduction

The U.S. Geological Survey quantitatively assessed the potential for technically recoverable resources of continuous (unconventional) natural gas in the Ordos Basin Province of China as part of the assessment of priority basins worldwide. Large volumes of tight gas and coalbed gas have been discovered and produced from upper Paleozoic rocks of the Ordos Basin Province. Data on the number of wells and well productivity are, however, publicly unavailable. Limited access to data contributed to the large uncertainty in the resource estimates.

The assessments were completed using a methodology developed by the U.S. Geological Survey. This methodology uses Monte Carlo simulation to calculate resource volumes based on probabilistic estimates of assessment unit (AU) area, average well drainage area, percent of AU area that is untested, well success ratio, average estimated ultimate recovery per well, and average coproduct ratios (Charpentier and Cook, 2010). Inadequate data pertaining to the numbers of wells and well productivity in the Ordos Basin Province required that these input distributions be based on the range of behavior in the complete set of analog tight gas and coalbed gas plays that have been assessed in the United States.

Two AUs were defined using published geologic studies and the IHS Energy (2014) database. The Upper Paleozoic Tight Gas AU covers 147,409 square kilometers of the central part of the Ordos Basin Province that gently dips (less than 1 degree) to the west (fig. 1). The western and southern boundaries of the AU are defined by fault zones. The northern boundary is defined as the transition between the gas-water zone and the updip water zone (Xiao and others, 2005). The eastern boundary, which separates the tight gas AU from the Upper Paleozoic Coalbed Gas AU, is the −1,200 meter subsurface depth contour. The sources of the gas are the coal beds in the Taiyuan and Shanxi Formations. Reservoirs are mainly low-permeability sandstones, especially in the Shanxi and lower Shihezi Formations. The accumulation is a basin-center, gas-charged zone with an updip water leg. Future potential is envisioned as extending into facies with poorer porosity and permeability than what is being currently developed.

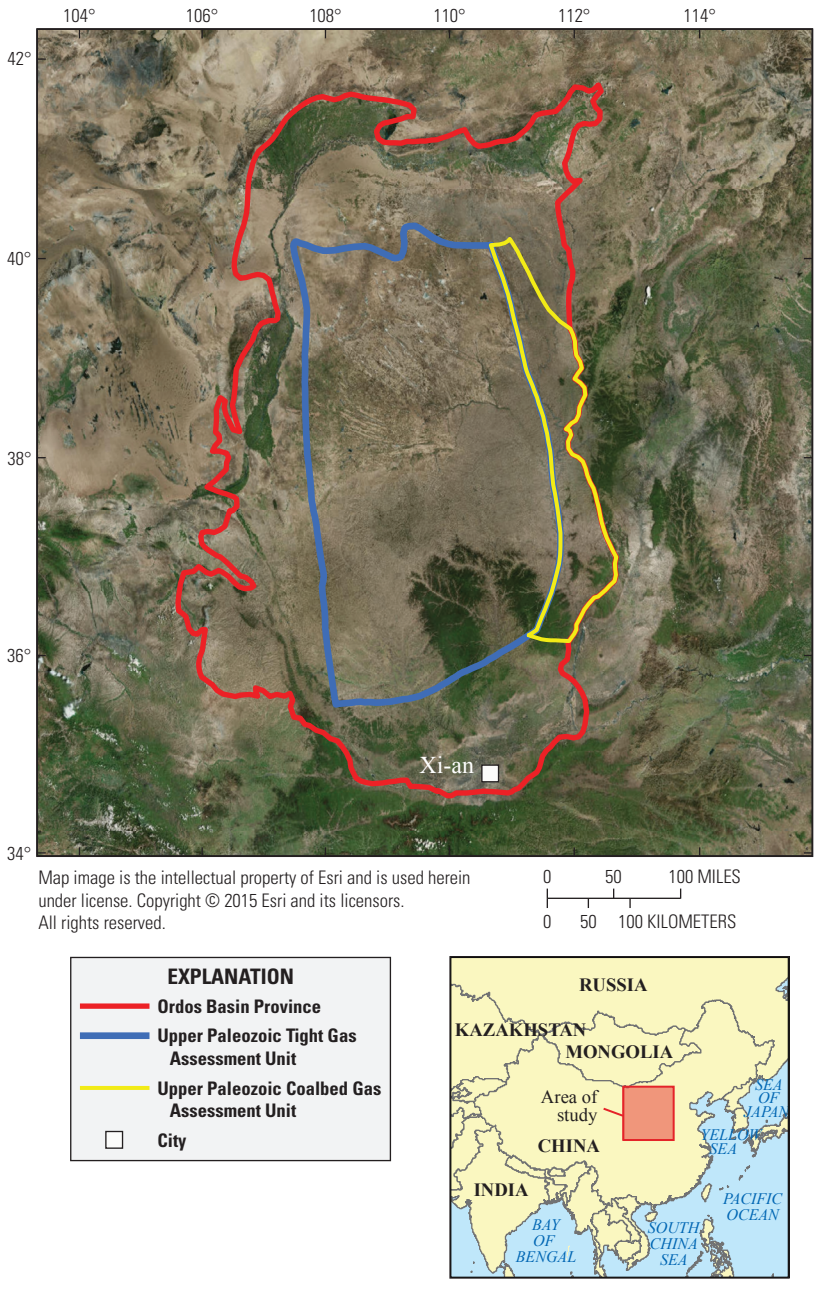

Figure 1. Map showing the extent of the Ordos Basin Province, China, and the two assessments units defined in this study.

The Upper Paleozoic Coalbed Gas AU covers 24,410 square kilometers of the eastern part of the Ordos Basin Province (fig. 1). The eastern boundary of the AU is the basin structural boundary. The northern boundary is defined as the transition from the gas and water zone to the updip water zone (Xiao and others, 2005), which corresponds to the 0.8 percent coal vitrinite reflectance contour. The southern boundary is the 5-meter net-coal isopach. The western boundary, which separates the coalbed gas AU from the tight gas AU, is the −1,200 meter subsurface depth contour. The coals in the Taiyuan and Shanxi Formations are both the source of the gas and the reservoir.

The assessment input data for the two AUs are summarized in table 1.

Table 1. Key assessment input data for the two continuous assessment units in the Ordos Basin Province, China.

[AU, assessment unit; %, percent; EUR, estimated ultimate recovery per well; BCFG, billion cubic feet of gas. The EUR, well drainage area, and success ratios are taken from U.S. shale-gas analogs. The average EUR input is the minimum, median, and calculated mean. Shading indicates not applicable]

Assessment input data	Upper Paleozoic Tight Gas				Upper Paleozoic Coalbed Gas			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	6,200,000	12,400,000	18,200,000	12,266,667	2,000,000	3,000,000	5,000,000	3,333,333
Average drainage area of wells (acres)	100	120	200	140	70	100	160	110
% area untested in AU	77	92	96	88	94	99	100	98
Success ratios (%)	30	50	90	57	25	50	95	57
Average EUR (BCFG)	0.2	0.6	1.4	0.637	0.1	0.3	1.0	0.337
AU probability	1.0				1.0			

Table 2. Assessment results for continuous gas resources in Ordos Basin Province, China.

[AU, assessment unit; 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 under the NGL category. F95 represents a 95 percent chance of at least the amount tabulated. Other fractiles are defined similarly. Fractiles are additive under assumption of perfect positve correlation. Shading indicates not applicable]

Total petroleum system and AU	AU probability	Accumulation type	Total undiscovered resources							
			Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean
Paleozoic Composite Total Petroleum System										
Upper Paleozoic Tight Gas AU	1.0	Gas	13,172	25,831	50,005	27,964	25	60	147	70
Upper Paleozoic Coalbed Gas AU	1.0	Gas	2,302	4,960	11,311	5,622	0	0	0	0
Total undiscovered unconventional resources			15,474	30,791	61,316	33,586	25	60	147	70

Resource Summary

Resource estimates are summarized in table 2. The mean resource estimates for the Upper Paleozoic Tight Gas AU are 27,964 billion cubic feet of gas (BCFG), with a F95 to F5 fractile range from 13,172 to 50,005 BCFG, respectively and 70 million barrels of natural gas liquids (MMBNGL), with a F95 to F5 fractile range from 25 to 147 MMBNGL, respectively. The mean resource estimate for the Upper Paleozoic Coalbed Gas AU is 5,622 BCFG, with a F95 to F5 fractile range from 2,302 to 11,311 BCFG, respectively. The mean estimate of the number of wells that would be required to develop the resources in the tight gas and coalbed gas AUs are 44,880 and 17,258 wells, respectively.

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Ordos Basin Assessment Team

Ronald R. Charpentier, Timothy R. Klett, Christopher J. Schenk, Michael E. Brownfield, Stephanie B. Gaswirth, Phuong A. Le, Heidi M. Leathers-Miller, Kristen R. Marra, and Tracey J. Mercier.

For Further Information

Assessment results are available at the U.S. Geological Survey Energy Program Web site at http://energy.usgs.gov/OilGas/.

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