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National and Global Petroleum Assessment

Assessment of Undiscovered Continuous Gas Resources in the Amu Darya Basin Province of Turkmenistan, Uzbekistan, Iran, and Afghanistan, 2017

Using a geology-based assessment methodology, the U.S. Geological Survey estimated mean undiscovered, technically recoverable continuous resources of 35.1 trillion cubic feet of gas in the Amu Darya Basin Province of Turkmenistan, Uzbekistan, Iran, and Afghanistan.

Introduction

The U.S. Geological Survey (USGS) completed an assessment of undiscovered, technically recoverable continuous (unconventional) gas resources in the Amu Darya Basin Province of Turkmenistan, Uzbekistan, Iran, and Afghanistan (fig. 1). The Amu Darya Basin is a mosaic of Early to Middle Jurassic horsts and grabens formed in an extensional back-arc realm as north-directed subduction and an associated volcanic arc formed during the Early Jurassic following the Late Triassic closure of the paleo-Tethys Ocean (Otto, 1997; Ulmishek, 2004; Smit and others, 2013; Brunet and others, 2014). Initially, the grabens were sites of thick successions of nonmarine clastics, coals, and carbonaceous shales. As extension decreased and thermal sag occurred after the Middle Jurassic, transgression led to a succession of Middle Jurassic marine sediments (Bathonian and Callovian), culminating in the development of extensive Upper Jurassic (Oxfordian) carbonate platforms on the horsts, and thick sequences of organic-rich shales in the deep grabens (Ulmishek, 2004). In the Late Jurassic (Kimmeridgian–Tithonian), up to 900 meters of evaporites of the Gaurdak Formation were deposited, which covered and sealed the older rocks. Marine conditions were reestablished following transgression in the Early Cretaceous (Barremian), and marine back-arc conditions persisted until the Oligocene with up to 7 kilometers of sediment deposited in some grabens, such as the Murgab depression, in the central part of the basin. The collision of India with Eurasia and the closure of the neo-Tethys Ocean in the Oligocene led to a regional unconformity and minor uplift (Otto, 1997). The formation of the north-directed Kopet Dag fold belt along the southern margin of the Amu Darya Basin in the Neogene (Robert and others, 2014) resulted in a foredeep that further thermally matured Jurassic source rocks. Lower Jurassic coals and carbonaceous shales and Upper Jurassic calcareous, organic-rich shales are the principal petroleum source rocks in the basin (Ulmishek, 2004) and are the basis for the definition of two total petroleum systems (TPSs).

Total Petroleum Systems and Assessment Units

In the Amu Darya Basin Province, the USGS defined an Oxfordian Shale TPS and an Oxfordian Shale Gas Assessment Unit (AU) within this TPS and a Lower–Middle Jurassic TPS and a Lower–Middle Jurassic Tight Gas AU within this TPS (fig. 1).

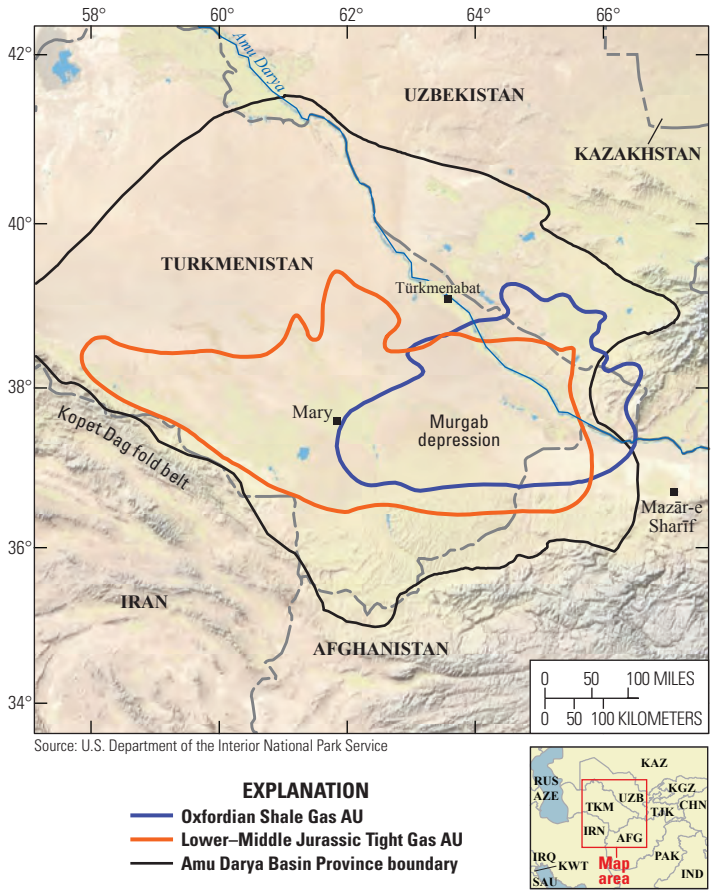

Figure 1. Location of the Amu Darya Basin Province in Turkmenistan, Uzbekistan, Iran, and Afghanistan, and the two assessment units (AUs) defined in this study.

The Oxfordian shales are up to 250 meters thick and are described as black, organic-rich, and bituminous. Organic matter in the shales is oil-prone Type II and IIS with total organic carbon values up to 15 weight percent (Ulmishek, 2004). Gas in the Amu Darya Basin, presumably sourced by these shales, can contain up to 8 percent hydrogen sulfide. Oxfordian shales achieved thermal maturation for oil generation during the Late Cretaceous and for gas generation during the Neogene (Ulmishek, 2004). The geologic model for the Oxfordian Shale Gas AU is for oil to have been generated (and subsequently thermally cracked to gas) from organic-rich Oxfordian marine shales in the deep, central part of the basin. Some portion of the gas was retained within the shales following migration to form potentially recoverable resources.

The geologic model for the Lower–Middle Jurassic Tight Gas AU is for gas generated from gas-prone Type III organic matter in coals and carbonaceous shales to have migrated locally into, and to have been trapped within, low-permeability, nonmarine sandstones and siltstones. This tight gas AU may span a stratigraphic interval up to 1,600 meters thick and is greater than 5 kilometers deep. This model predicts the presence of a regional tight-gas system in these rocks primarily within the central part of the basin.

Assessment input data for the two AUs are shown in table 1.

Undiscovered Resources Summary

The USGS quantitatively assessed undiscovered continuous shale-gas and tight-gas resources in the Amu Darya Basin Province (table 2). For undiscovered gas resources, the estimated mean totals are 35,105 billion cubic feet of gas (BCFG), or 35.1 trillion cubic feet of gas, with an F95–F5 range from 4,879 to 103,529 BCFG and 235 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 37 to 658 MMBNGL. For the Oxfordian Shale Gas AU, the estimated mean is 21,278 BCFG with an F95–F5 range from 4,879 to 45,856 BCFG and 170 MMBNGL with an F95–F5 range from 37 to 381 MMBNGL. For the Lower–Middle Jurassic Tight Gas AU, the estimated mean is 13,827 BCFG with an F95–F5 range from 0 to 57,673 BCFG and 65 MMBNGL with an F95–F5 range from 0 to 277 MMBNGL. The range of resource estimates reflects the geologic uncertainty on this relatively underexplored, deep central part of the Amu Darya Basin Province.

Table 1. Key assessment input data for two continuous assessment units in the Amu Darya Basin Province of Turkmenistan, Uzbekistan, Iran, and Afghanistan.

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

Assessment input data—Continuous AUs	Oxfordian Shale Gas AU				Lower–Middle Jurassic Tight Gas AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	800	9,695,000	19,390,000	9,695,267	400	3,300,200	33,002,000	12,100,867
Average drainage area of wells (acres)	80	120	160	120	40	120	210	120
Success ratios (%)	10	50	90	50	10	50	90	50
Average EUR (BCFG)	0.2	0.5	1.1	0.528	0.2	0.5	1.1	0.528
AU probability	1.0				0.5			

Table 2. Assessment results for two continuous assessment units in the Amu Darya Basin Provincen of Turkmenistan, Uzbekistan, Iran, and Afghanistan.

[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 systems and assessment units (AUs)	AU probability	Accumulation type	Total undiscovered resources							
			Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean
Oxfordian Shale Total Petroleum System										
Oxfordian Shale Gas AU	1.0	Gas	4,879	18,914	45,856	21,278	37	147	381	170
Lower–Middle Jurassic Total Petroleum System										
Lower–Middle Jurassic Tight Gas AU	0.5	Gas	0	0	57,673	13,827	0	0	277	65
Total undiscovered continuous resources			**4,879**	**18,914**	**103,529**	**35,105**	**37**	**147**	**658**	**235**

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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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