

# Assessment of Continuous Gas Resources of the North Caspian Basin Province, Kazakhstan and Russia, 2018

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean resources of 84.5 trillion cubic feet of continuous gas in the North Caspian Basin Province of Kazakhstan and Russia.

## Introduction

The U.S. Geological Survey (USGS) quantitatively assessed the potential for undiscovered, technically recoverable continuous (unconventional) gas resources in the North Caspian Basin Province of Kazakhstan and Russia (fig. 1). The North Caspian Basin Province contains 20 kilometers of mainly Paleozoic sediment, making it one of the deepest basins in the world. The tectonic evolution of the basin is not well constrained given the extreme depth and the sparseness of data from the deep central part of the basin (Nevolin and Fedorov, 1995; Brunet and others, 1999; Ulmishek, 2001; Volozh and others, 2003; Okere and Toothill, 2012). Initiation of rifting and subsidence in the North Caspian Basin may have been as early as the Neoproterozoic (Brunet and others, 1999), but most likely began in the Ordovician, and rifting and subsidence were related to the opening of the Uralian Ocean (Ulmishek, 2001). Renewed and continuous subsidence from the Late Devonian to Early Permian may have been because of back-arc extension (Brunet and others, 1999), which resulted in the deposition of hundreds of meters of organic-rich source rocks in basinal areas; shallow-water platform carbonates that rimmed the basin are of similar age (Cook and others, 1999). Collision of terranes along the southern margin of the North Caspian Basin during the Early Permian partially isolated the basin and resulted in the deposition of as much as 5 kilometers of evaporites that partially seal the underlying Late Devonian–Early Permian source rocks. The progressive closure of the Uralian Ocean from late Carboniferous to the Triassic formed the Ural fold belt and the adjacent foreland, which filled with several kilometers of orogenic clastic sediments. This pulse of deposition resulted in the maturation of Late Devonian–Early Permian subsalt source rocks by burying them into the oil-generation window and into the gas window in the deep central part of the basin.

## Total Petroleum System and Assessment Unit

For potential continuous oil and gas resources, the USGS defined a Paleozoic Composite Total Petroleum System (TPS) and a Paleozoic Subsalt Continuous Gas Assessment Unit (AU) within this TPS. Although deep-water, organic-rich shales ranging from the Late Devonian to Early Permian are cited as the major source rocks in this province, there is limited geochemical data on which to base this composite petroleum system, as samples are restricted to the basin margins (Ulmishek, 2001). Based on limited data, the shales contain Type II kerogen, have

total organic carbon values of as much as 8 weight percent, have hydrogen index values of as much as 400 milligrams of hydrocarbon per gram of organic carbon, and are as much as several hundred meters thick (Pairazian, 1999; Ulmishek, 2001; Barde and others, 2002). In the central part of the basin, these shales are within the gas-generation window at depths greater than about 7,000 meters (Ulmishek, 2001).

The geologic model for the Paleozoic Composite TPS is for oil, generated from Late Devonian–Early Permian source rocks because of Permian–Triassic foredeep burial, to have cracked to gas with continued subsidence in the deep, overpressured central part of the basin. Gas from these source rocks migrated locally into, and was partially retained within, low permeability sandstones and shales, forming a regional, pervasive, continuous gas



**Figure 1.** Map showing one continuous gas assessment unit (AU) in the North Caspian Basin Province of Kazakhstan and Russia. Province boundary is from Klett and others, 1997.

accumulation in the deep central part of the North Caspian Basin (Ulmishek, 2001). Uncertainty in the assessment is related to the degree of retention of gas within the subsalt section following generation and migration.

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

**Table 1.** Key input data for one continuous assessment unit (AU) in the North Caspian Basin Province of Kazakhstan and Russia.

[AU, assessment unit; %, percent; EUR, estimated ultimate recovery per well; BCFG, billion cubic feet of gas. Well drainage area, success ratio, and EUR are defined partly using U.S. shale-gas analogs. Shading indicates not applicable]

Assessment input data—Continuous AUs	Paleozoic Subsalt Continuous Gas AU			
	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	400	30,341,000	60,682,000	30,341,133
Average drainage area of wells (acres)	40	100	160	100
Success ratio (%)	10	50	90	50
Average EUR (BCFG)	0.1	0.5	1.5	0.55
AU probability	1.0			

## Undiscovered Resources Summary

The USGS quantitatively assessed continuous gas resources in one assessment unit (table 2) in the North Caspian Basin Province of Kazakhstan and Russia. For undiscovered, technically recoverable continuous gas resources, the mean

totals are 84,543 billion cubic feet of gas (BCFG), or 84.5 trillion cubic feet of gas, with an F95–F5 fractile range from 17,797 to 196,412 BCFG, and 338 million barrels of natural gas liquids (MMBNGL) with an F95–F5 fractile range from 67 to 819 MMBNGL.

**Table 2.** Results for one continuous assessment unit (AU) in the North Caspian Basin Province of Kazakhstan and Russia.

[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 system and assessment unit (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										
Paleozoic Subsalt Continuous Gas AU	1.0	Gas	17,797	71,488	196,412	84,543	67	278	819	338
<b>Total undiscovered continuous resources</b>			<b>17,797</b>	<b>71,488</b>	<b>196,412</b>	<b>84,543</b>	<b>67</b>	<b>278</b>	<b>819</b>	<b>338</b>

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## For More Information

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