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National and Global Petroleum Assessment

Assessment of Continuous Oil and Gas Resources in the Beetaloo Basin, Australia, 2018

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean resources of 429 million barrels of continuous oil and 8 trillion cubic feet of continuous gas in the Beetaloo Basin of northern Australia.

Introduction

The U.S. Geological Survey (USGS) quantitatively assessed the potential for undiscovered, technically recoverable continuous oil and gas resources in the Beetaloo Basin of northern Australia (fig. 1). The Mesoproterozoic Roper Group in the basin contains the Velkerri and Kyalla Formations, two organic-rich source formations that possibly form some of the oldest viable petroleum systems in the world (Jackson and others, 1986; Silverman and Ahlbrandt, 2011; Cox and others, 2016). The shale units of the Velkerri and Kyalla were deposited between 1,400 and 1,300 million years ago (Yang and others, 2018). Limited drilling and production testing have shown that these rocks may contain recoverable oil and gas resources (Close, Cote, and others, 2017). For rocks of this age to potentially contain recoverable oil and gas indicates that throughout the long period between the Mesoproterozoic and the present, there has been limited deformation of the Beetaloo Basin, and generation might have been relatively late in the burial history. However, the tectonic evolution of the Mesoproterozoic Beetaloo Basin is largely unknown, and several hypotheses have been advanced that include rift basin, multiphase intracontinental basin, foreland basin, and epicontinental basin development (Silverman and Ahlbrandt, 2011; Cox and others, 2016; Close, Cote, and others, 2017; Yang and others, 2018). Rocks of the Roper Group have not been thermally stressed beyond the gas-generation window (Close, Baruch, and others, 2017).

Total Petroleum Systems and Assessment Units

The USGS defined the Proterozoic Velkerri Shale Total Petroleum System (TPS) with the Proterozoic Middle Velkerri Shale Gas Assessment Unit (AU) and the Proterozoic Lower Kyalla Shale TPS with the Proterozoic Lower Kyalla Shale Oil AU and the Proterozoic Lower Kyalla Shale Gas AU. Shales from the middle part of the Velkerri Formation are overpressured and can have as much as 12 weight percent total organic matter, have hydrogen indices as high as 730 milligrams of hydrocarbon per gram of organic carbon, and contain Type I and Type II organic matter (Crick and others, 1988; Warren and others, 1998; Law and others, 2010; McConachie and others, 2015; Revie, 2016; Close, Baruch, and others, 2017). Shales of the lower part of the Kyalla Formation are overpressured and can have as much as 8 weight percent total organic carbon, have hydrogen indices as high as 780 milligrams of hydrocarbon per gram of organic carbon, and contain Type I and Type II organic matter (Law and others, 2010; McConachie and others, 2015; Revie, 2016; Close, Baruch, and others, 2017). The interpretation of the extent of the oil and gas thermal generation windows in these shales is quite variable (Law and others, 2010; Revie, 2016; Close, Baruch, and others, 2017). In this study, the oil and gas thermal windows of Revie (2016) and Close, Baruch, and others (2017) were used in the definition of AU boundaries with the understanding that these boundaries are highly uncertain. The timing of oil and gas generation is also highly uncertain given what little is known of the tectonic evolution, burial history, and paleo-heat flow. Estimates of timing of generation range from essentially syndepositional to early Paleozoic (Crick and others, 1988) or as late as the Mesozoic (Silverman and Ahlbrandt, 2011).

The geologic model for the Proterozoic Middle Velkerri Shale Gas AU is for oil to have been generated from Type I and Type II organic matter and largely cracked to gas with some portion of the gas retained within the shales. The geologic model for the Proterozoic Lower Kyalla Shale Oil AU and Proterozoic Lower Kyalla Shale Gas AU is for these shales to have been buried to depths within the oil- and gas-generation windows; some portion of the oil and gas has been retained within the shales following migration. Uncertainty in the assessment is related to the retention of oil and gas in these shales and the mapped extent of the oil and gas thermal generation windows.

The assessment input data are summarized in table 1. There are no geologic analogs for these Mesoproterozoic organic-rich shales, so well drainage areas, success ratios, and estimated ultimate recoveries are roughly based on data ranges from U.S. shale-oil and shale-gas accumulations.

Undiscovered Resources Summary

The USGS quantitatively assessed the potential for continuous oil and gas resources within the Beetaloo Basin (table 2). The estimated mean totals for undiscovered resources are 429 million barrels of oil (MMBO) with an F95–F5 range from 0 to 1,135 MMBO; 8,044 billion cubic feet of gas (BCFG), or 8 trillion cubic feet of gas, with an F95–F5 range from 0 to 23,749 BCFG; and 278 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 0 to 867 MMBNGL.

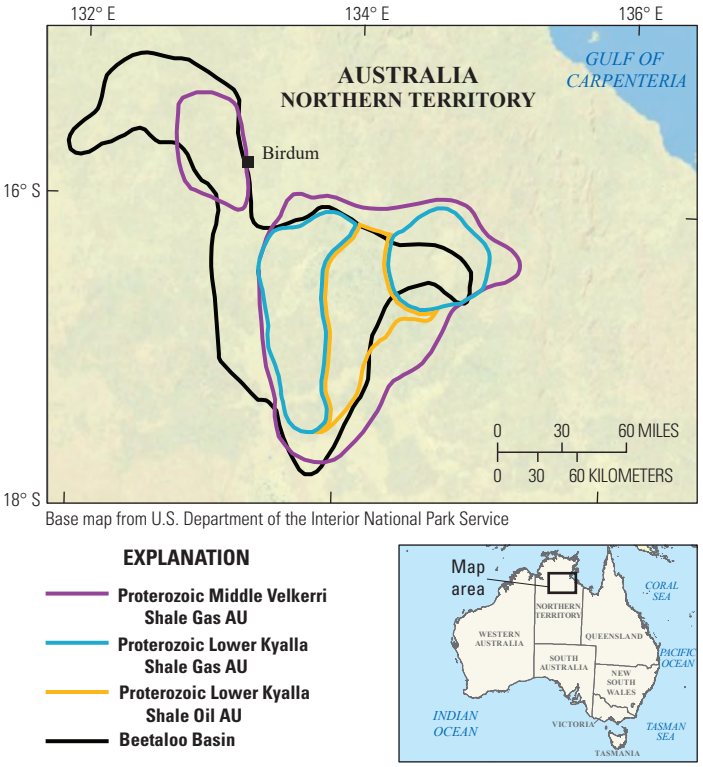

Figure 1. Map showing the location of three continuous assessment units (AUs) in the Beetaloo Basin of northern Australia.

Table 1. Key input data for three continuous assessment units in the Beetaloo Basin, northern Australia.

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

Assessment input data—Continuous AUs	Proterozoic Middle Velkerri Shale Gas AU				Proterozoic Lower Kyalla Shale Gas AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	240	3,436,000	6,873,000	3,436,413	240	2,686,000	5,372,000	2,686,080
Average drainage area of wells (acres)	60	120	180	120	60	120	180	120
Success ratio (%)	10	50	90	50	100	100	100	100
Area untested in AU (%)	100	100	100	100	10	50	90	50
Average EUR (BCFG)	0.04	0.4	2.0	0.488	0.04	0.1	1.5	0.169
AU probability	0.9				0.9			

Assessment input data—Continuous AU	Proterozoic Lower Kyalla Shale Oil AU			
	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	240	1,454,000	2,908,000	1,454,080
Average drainage area of wells (acres)	60	140	220	140
Success ratio (%)	10	50	90	50
Area untested in AU (%)	100	100	100	100
Average EUR (MMBO)	0.01	0.08	0.3	0.092
AU probability	0.9			

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For More Information

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

Table 2. Results for three continuous assessment units in the Beetaloo Basin, northern Australia.

[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
Proterozoic Velkerri Shale Total Petroleum System														
Proterozoic Middle Velkerri Shale Gas AU	0.9	Gas					0	4,631	17,544	6,155	0	145	617	205
Proterozoic Lower Kyalla Shale Total Petroleum System														
Proterozoic Lower Kyalla Shale Gas AU	0.9	Gas					0	982	5,490	1,631	0	37	227	65
Proterozoic Lower Kyalla Shale Oil AU	0.9	Oil	0	347	1,135	429	0	197	715	258	0	6	23	8
Total undiscovered continuous resources			**0**	**347**	**1,135**	**429**	**0**	**5,810**	**23,749**	**8,044**	**0**	**188**	**867**	**278**

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