

Assessment of Continuous Oil and Gas Resources of the Maracaibo Basin Province of Venezuela and Colombia, 2016

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean continuous resources of 656 million barrels of oil and 5.7 trillion cubic feet of gas in the Maracaibo Basin Province, Venezuela and Colombia.

Introduction

The U.S. Geological Survey (USGS) completed an assessment of undiscovered, technically recoverable continuous oil and gas resources within the Maracaibo Basin Province of Venezuela and Colombia (fig. 1). The Maracaibo Basin Province is a structurally complex region encompassing approximately 58,000 square kilometers between the Sierra de Perijá and Cordillera de Mérida, with the northern boundary generally placed at the Oca-Ancón fault (Mann and others, 2006). More than 30 billion barrels of conventional oil have been produced from the basin, which ranks it as one of the top petroleum-producing basins in the world. Organic-rich shales of the Upper Cretaceous La Luna Formation are the main petroleum source rock, and La Luna shales have reached adequate thermal maturity for oil and gas generation throughout much of the basin (Talukdar and others, 1986; Talukdar and Marcano, 1994; Escalona and Mann, 2006). The purposes of this study are (1) to estimate the volumes of recoverable continuous oil and gas remaining in La Luna Formation source rocks following two phases of petroleum generation and expulsion and (2) to postulate the presence of gas resources in low-permeability (tight) sandstones. Although the La Luna Formation is mapped as being partly in the gas generation window, little information is available on potential gas resource distribution and the possible presence of gas resources remaining in the La Luna source rock or in deeply buried, tight sandstones.

Total Petroleum System and Assessment Units

For the Maracaibo Basin Province, the USGS defined a La Luna Continuous Total Petroleum System (TPS) and the La Luna Continuous Oil Assessment Unit (AU), the La Luna Continuous Gas AU, and the Maracaibo Tight Gas AU within this TPS. The major risk for the occurrence of recoverable continuous oil and gas in these AUs is retention of recoverable gas within the source rocks following migration. The geologic model proposed in this study is for some portion of the oil and gas to have been retained in the La Luna Formation source rock and for gas to potentially have migrated into tight sandstones, although the presence of tight sandstones is highly uncertain.

Assessment input data for each assessment unit are shown in table 1. Well drainage areas, estimated ultimate recoveries, and success ratios are taken from U.S. shale-oil, shale-gas, and tight-gas analogs.



Figure 1. Location of the Maracaibo Basin Province and the three continuous assessment units (AUs) defined in this study.

Undiscovered Resources Summary

The USGS quantitatively assessed undiscovered, technically recoverable continuous oil and gas resources within the La Luna Continuous TPS of the Maracaibo Basin Province, Venezuela and Colombia (table 2). For continuous resources, the total mean resources are 656 million barrels of oil (MMBO) with an F95–F5 range from 111 to 1,632 MMBO; 5,713 billion cubic feet of gas (BCFG), or 5.7 trillion cubic feet of gas, with an F95–F5 range from 208 to 17,128 BCFG; and 127 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 8 to 362 MMBNGL.

For the La Luna Continuous Oil AU, the mean estimates are 656 MMBO with an F95–F5 range from 111 to 1,632 MMBO, 1,314 BCFG of associated gas with an F95–F5 range from 208 to 3,389 BCFG, and 53 MMBNGL with an F95–F5 range from 8 to 137 MMBNGL.

Mean estimates for the La Luna Continuous Gas AU are 2,923 BCFG with an F95–F5 range from 0 to 8,173 BCFG and 59 MMBNGL with an F95–F5 range from 0 to 168 MMBNGL. Mean estimates for the Maracaibo Tight Gas AU are 1,476 BCFG with an

F95–F5 range from 0 to 5,566 BCFG and 15 MMBNGL with an F95–F5 range from 0 to 57 MMBNGL. For gas accumulations, zeros at F95 reflect the chance that gas might not exist in the AU, and the geologic AU probability (risk) was estimated to be less than one.

Table 1. Key assessment input data for three continuous assessment units in the Maracaibo Basin Province, Venezuela and Colombia.

[AU, assessment unit; %, percent; EUR, estimated ultimate recovery per well; MMBO, million barrels of oil; BCFG, billion cubic feet of gas. Well drainage areas, EURs, and well success ratios are taken from U.S. shale-oil, 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 assessment units (AUs)	La Luna Continuous Oil AU				La Luna Continuous Gas AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	800	1,000,000	6,200,000	2,400,267	1,200	1,000,000	6,000,000	2,333,733
Average drainage area of wells (acres)	40	80	120	80	80	120	160	120
Success ratios (%)	10	50	90	50	10	50	90	50
Average EUR (MMBO, oil; BCFG, gas)	0.02	0.04	0.1	0.043	0.1	0.3	1	0.337
AU probability	1.0				0.9			
Assessment input data— Continuous assessment units (AUs)	Maracaibo Tight Gas AU							
	Minimum	Mode	Maximum	Calculated mean				
Potential production area of AU (acres)	1,200	2,000,000	4,100,000	2,033,733				
Average drainage area of wells (acres)	40	120	200	120				
Success ratios (%)	10	50	90	50				
Average EUR (BCFG)	0.1	0.3	1	0.337				
AU probability	0.5							

Table 2. Assessment results for three continuous assessment units in the Maracaibo Basin Province, Venezuela and Colombia.

[MMBO, million barrels of oil; BCFG, billions of cubic feet of gas; MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. For gas accumulations, all liquids are included under the NGL (natural gas liquids) 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 system and assessment units (AUs)	AU prob- ability	Accu- mulation type	Total undiscovered resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
La Luna Continuous Total Petroleum System														
La Luna Continuous Oil AU	1.0	Oil	111	528	1,632	656	208	1,027	3,389	1,314	8	41	137	53
La Luna Continuous Gas AU	0.9	Gas					0	2,230	8,173	2,923	0	43	168	59
Maracaibo Tight Gas AU	0.5	Gas					0	223	5,566	1,476	0	2	57	15
Total undiscovered continuous resources			111	528	1,632	656	208	3,480	17,128	5,713	8	86	362	127

References Cited

- Escalona, Alejandro, and Mann, Paul, 2006, An overview of the petroleum system of Maracaibo Basin: American Association of Petroleum Geologists Bulletin, v. 90, no. 4, p. 657–678.
- Mann, Paul; Escalona, Alejandro; and Castillo, M.V., 2006, Regional geologic and tectonic setting of the Maracaibo supergiant basin, western Venezuela: American Association of Petroleum Geologists Bulletin, v. 90, no. 4, p. 445–477.
- Talukdar, S.C., and Marcano, Fernando, 1994, Petroleum systems of the Maracaibo Basin, Venezuela, in Magoon, L.B., and Dow, W.G., eds., The petroleum system—From source to trap: American Association of Petroleum Geologists Memoir No. 60, p. 463–481.
- Talukdar, S.C.; Gallango, Oswaldo; and Chin-A-Lien, Marcel, 1986, Generation and migration of hydrocarbons in the Maracaibo Basin, Venezuela—An integrated basin study: Organic Geochemistry, v. 10, nos. 1–3, p. 261–279.

For More Information

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

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