

Assessment of Continuous Oil and Gas Resources of Solimões, Amazonas, and Parnaíba Basin Provinces, Brazil, 2016

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean continuous resources of 5 billion barrels of oil and 47 trillion cubic feet of gas in the Paleozoic Solimões, Amazonas, and Parnaíba Basin Provinces, Brazil.

Introduction

The U.S. Geological Survey (USGS) assessed undiscovered, technically recoverable continuous oil and gas resources within the Paleozoic Solimões, Amazonas, and Parnaíba Basin Provinces of Brazil (fig. 1). These Paleozoic basins share similar geologic characteristics that relate to oil and gas resource potential: (1) a progression from rifting, thermal sag, wrench faulting, and compression; (2) Devonian organic-rich shales deposited in the sag phase are the principal petroleum source rocks; (3) thermal maturation is a result of both burial and heating by widespread intrusives; and (4) geologic risk is based on the retention of oil and gas in the Devonian source rocks. The geologic definition of total petroleum systems (TPSs) and assessment units (AUs) reflect these common characteristics. For the Solimões Basin Province, the USGS defined a Devonian Jandiatuba TPS and the Solimões Jandiatuba Continuous Gas AU within this TPS. The Devonian Barreirinha TPS and the Amazonas Barreirinha Continuous Oil and the Amazonas Barreirinha Continuous Gas AUs were defined within the Amazonas Basin Province. The Devonian Pimenteiras TPS and the Parnaíba Pimenteiras Continuous Oil and the Parnaíba Pimenteiras Continuous Gas AUs were defined within the Parnaíba Basin Province. Published data on source-rock quality, thermal maturation, and thickness for the Solimões Basin (Mosmann and others, 1986; Mello and others, 1994), Amazonas Basin (Mosmann and others, 1986; Gonzaga and others, 2000), and the Parnaíba Basin (De Oliveira and Mohriak, 2003; Petersohn, 2011; De Miranda, 2014) were critical for TPS and AU definitions. These three TPSs share Devonian source rocks that are dominated by Type II marine kerogen; contain greater than 2 weight percent total organic carbon, as much as 8 weight percent; and have thicknesses of organic-rich shale greater than 15 meters.

Geologic Model for Assessment

With common geologic characteristics, the geologic model for the assessments summarized herein applies to each TPS. The geologic model is for oil and gas to have been generated by burial of source rocks beginning in the Permian and by the emplacement of dolerite dikes and sills in the Late Triassic to Early Cretaceous. In this model, oil and gas are partially retained within the matrix of organic-rich Devonian shales. Input for shale-oil assessment was modeled using vertical wells.

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

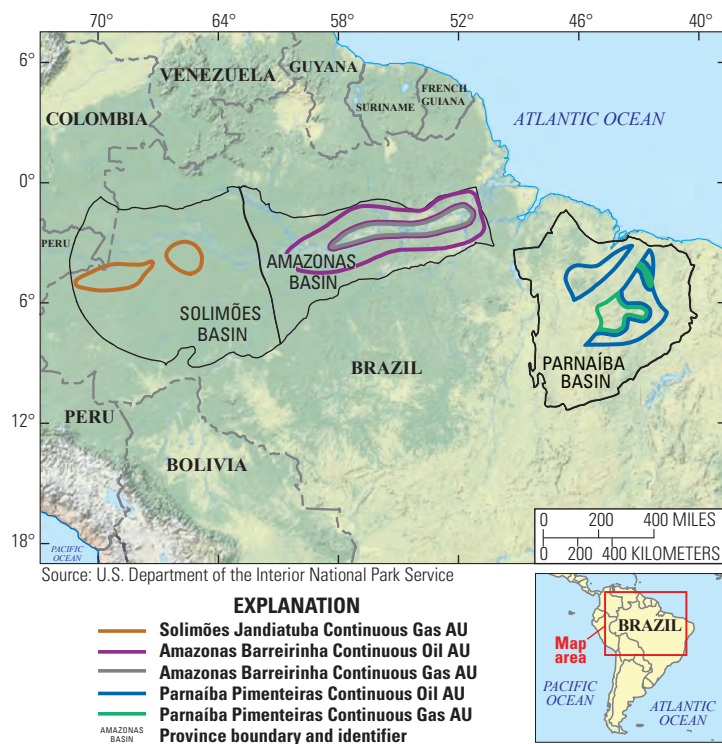


Figure 1. Location of the Solimões, Amazonas, and Parnaíba Basin Provinces, Brazil, and the five assessment units (AUs) defined in this study.

Undiscovered Resources Summary

The USGS quantitatively assessed undiscovered continuous oil and gas resources within the Solimões, Amazonas, and Parnaíba Basin Provinces of Brazil (table 2). For continuous oil resources, the estimated mean total is 5,019 million barrels of oil (MMBO), or 5 billion barrels of oil, with an F95–F5 range from 0 to 15,584 MMBO. For continuous gas resources, the estimated mean total is 47,201 billion cubic feet of gas (BCFG), or 47 trillion cubic feet of gas, with an F95–F5 range from 0 to 151,542 BCFG. For natural gas liquids, the estimated mean total is 897 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 0 to 3,006 MMBNGL. For oil and gas accumulations, zeros at the F95 fractile reflect the interpretation of geologic risk (AU probability less than 1.0) on the potential occurrence of one well of minimum EUR in the AU.

Of the total resources, 68 percent (3,437 MMBO) of the continuous oil and 72 percent (33,816 BCFG) of the continuous gas is in the Amazonas Basin Province. The major source of geologic risk for continuous resources is the retention of oil or gas in the source rock following structural deformation and emplacement of intrusives.

Table 1. Key assessment input data for five continuous assessment units in the Solimões, Amazonas, and Parnaíba Basin Provinces, Brazil.

[AU, assessment unit; %, percent; EUR, estimated ultimate recovery per well; BCFG, billion cubic feet of gas; MMBO, million barrels of oil; MMBNGL, million barrels of natural gas liquids. Well drainage areas, EURs, and success ratios are taken from 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	Solimões Jandiatuba Continuous Gas AU				Amazonas Barreirinha Continuous Gas AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	1,200	4,000,000	16,804,000	6,935,067	1,200	4,508,000	18,033,000	7,514,067
Average drainage area of wells (acres)	80	120	160	120	80	120	160	120
Percentage of area untested in AU	100	100	100	100	100	100	100	100
Success ratios (%)	10	50	90	50	10	50	90	50
Average EUR (BCFG)	0.08	0.2	1.2	0.256	0.08	0.2	1.2	0.256
AU probability	0.6				0.8			
Assessment input data	Amazonas Barreirinha Continuous Oil AU				Parnaíba Pimenteiras Continuous Oil AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	800	12,159,000	48,637,000	20,256,600	800	7,530,000	30,121,000	12,550,600
Average drainage area of wells (acres)	40	80	120	80	40	80	120	80
Percentage of area untested in AU	100	100	100	100	100	100	100	100
Success ratios (%)	10	50	90	50	10	50	90	50
Average EUR (MMBO)	0.01	0.03	0.1	0.034	0.01	0.03	0.1	0.034
AU probability	0.8				0.6			
Assessment input data	Parnaíba Pimenteiras Continuous Gas AU							
	Minimum	Mode	Maximum	Calculated mean				
Potential production area of AU (acres)	1,200	2,500,000	10,640,000	4,380,400				
Average drainage area of wells (acres)	80	120	160	120				
Percentage of area untested in AU	100	100	100	100				
Success ratios (%)	10	50	90	50				
Average EUR (BCFG)	0.08	0.2	1.2	0.256				
AU probability	0.6							

Table 2. Assessment results for five continuous assessment units in the Solimões, Amazonas, and Parnaíba Basin Provinces, Brazil.

[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 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
Devonian Jandiatuba Total Petroleum System														
Solimões Jandiatuba Continuous Gas AU	0.6	Gas					0	2,188	16,186	4,320	0	63	491	129
Devonian Barreirinha Total Petroleum System														
Amazonas Barreirinha Continuous Oil AU	0.8	Oil	0	2,649	10,009	3,437	0	17,734	82,378	27,522	0	279	1,185	385
Amazonas Barreirinha Continuous Gas AU	0.8	Gas					0	4,329	20,040	6,294	0	126	609	189
Devonian Pimenteiras Total Petroleum System														
Parnaíba Pimenteiras Continuous Oil AU	0.6	Oil	0	934	5,575	1,582	0	3,536	22,568	6,323	0	74	513	139
Parnaíba Pimenteiras Continuous Gas AU	0.6	Gas					0	1,404	10,370	2,742	0	27	208	55
Total undiscovered continuous resources			0	3,583	15,584	5,019	0	29,191	151,542	47,201	0	569	3,006	897

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For More Information

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

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