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National and Global Petroleum Assessment

Assessment of Continuous Oil and Gas Resources of the South Sumatra Basin Province, Indonesia, 2016

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean resources of 689 million barrels of continuous shale oil and 3.9 trillion cubic feet of shale gas in the South Sumatra Basin Province in Indonesia.

Introduction

The U.S. Geological Survey (USGS) completed an assessment of undiscovered, technically recoverable continuous oil and gas resources within the South Sumatra Basin Province (fig. 1), one of a series of backarc basins associated with subduction along the western margin of Sumatra, Indonesia. The Sumatra backarc realm underwent extension and rifting in the Eocene to early Oligocene that formed a series of horsts and grabens (Pulunggono, 1986; Ginger and Fielding, 2005). The grabens were filled with typical synrift nonmarine facies, including fluvial, deltaic, marginal lacustrine sandstones, and shallow to deep water lacustrine shales. The thickest petroleum source rocks are found within the graben system. One of the petroleum source rocks in the South Sumatra Basin Province is within the synrift Eocene-Oligocene Lemat Formation, which includes organic-rich lacustrine shale of the Benakat member (Rashid and others, 1998; Bianchi and others, 2007). Following cessation of rifting, regional thermal relaxation led to a sag phase with increased accommodation space and deposition. Petroleum source rocks reached thermal maturity for oil and gas generation beginning in the Miocene (Sarjono and Sardjito, 1989; Reksalegora and Riadinjo, 2013). Compression from middle Miocene to Pliocene related to subduction dynamics resulted in numerous structures within the basin, many of which formed traps for conventional oil and gas accumulations.

For this assessment, a continuous source-reservoir rock system contains (1) greater than 2 weight percent total organic carbon, (2) the proper thermal maturity window for oil or gas generation, (3) greater than 15 meters of organic-rich shale, and (4) Type I or Type II organic matter. The assessment unit (AU) areas outlined in figure 1 represent continuous oil- and gas-prone areas that are interpreted to satisfy these geologic criteria. The range of uncertainty on assessment unit areas (table 1) reflects uncertainty on the extent and thickness of source-rock facies within the grabens and the extent and level of thermal maturation of the source rock.

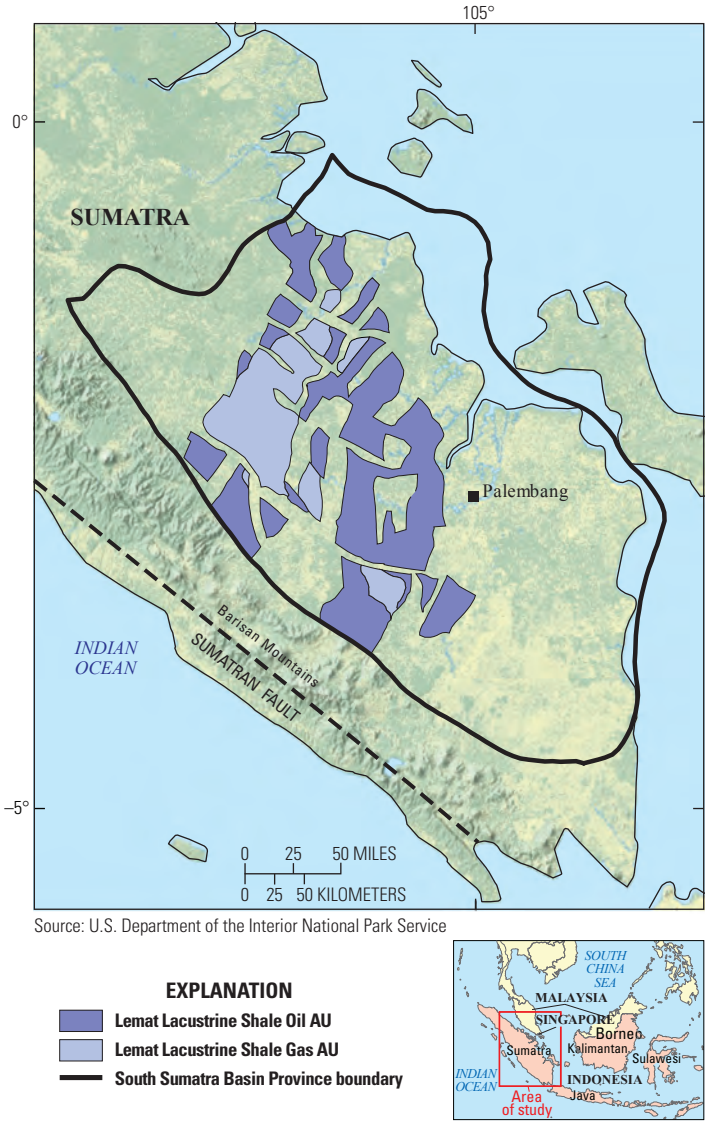

Figure 1. Map showing the location of the South Sumatra Basin, Indonesia, and the two continuous assessment units (AUs) defined in this study.

Total Petroleum System and Assessment Units

For the South Sumatra Basin Province, the USGS defined the Lemat Lacustrine Total Petroleum System (TPS). The Lemat Lacustrine Shale Oil AU and the Lemat Lacustrine Shale Gas AU define the boundary of this TPS (fig. 1). The AU boundaries were developed from published maps depicting structure, facies, and thermal maturity (Ginger and Fielding, 2005; Rudd and others, 2013). The geologic model proposed in this study is for oil and gas to have been generated within the Lemat Formation source rock in the graben system and for some portion of the oil and gas to have been retained in the source rock following petroleum migration. Retention represents the major source of geologic risk in this assessment.

Assessment input data for each assessment unit are shown in table 1. Well drainage areas, estimated ultimate recoveries, and success ratios were guided by U.S. shale-oil and shale-gas analogs, including the lacustrine petroleum system of the Eocene Green River Formation in the Uinta Basin, Utah (Johnson and others, 2015).

Undiscovered Resources Summary

The USGS quantitatively assessed undiscovered continuous oil and gas resources within the South Sumatra Basin Province (table 2) of 689 million barrels of continuous shale oil with an F95–F5 range from 142 million barrels of oil (MMBO) to 1,581 MMBO; 3,886 billion cubic feet of (shale) gas (BCFG), or 3.9 trillion cubic feet of gas, with an F95–F5 range from 793 to 9,062 BCFG; and 88 million barrels of natural gas liquids (MMBNGL) with an F95–F5 range from 16 to 213 MMBNGL.

For the Lemat Lacustrine Shale Oil AU, the estimated mean resources are 689 MMBO with an F95–F5 range from 142 to 1,581 MMBO, 2,069 BCFG of associated gas with an F95–F5 range from 403 to 4,950 BCFG, and 41 MMBNGL with an F95–F5 range from 7 to 102 MMBNGL.

For the Lemat Lacustrine Shale Gas AU, the estimated mean resources are 1,817 BCFG with an F95–F5 range from 390 to 4,112 BCFG and 47 MMBNGL with an F95–F5 range from 9 to 111 MMBNGL. The major source of geologic risk for the presence of recoverable continuous oil and gas resources is the retention of oil or gas in the source rock following migration, which may be related to Neogene compression and structural inversion.

Table 1. Key assessment input data for two continuous assessment units in the South Sumatra Basin Province, Indonesia.

[AU, assessment unit; %, percent; EUR, estimated ultimate recovery per well; MMBO, million barrels of oil; BCFG, billion cubic feet of gas. EUR, well drainage area, and success ratios are 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—Continuous AUs	Lemat Lacustrine Shale Oil AU				Lemat Lacustrine Shale Gas AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	1,000	1,805,000	5,471,000	2,425,667	1,000	1,111,000	3,000,000	1,370,667
Average drainage area of wells (acres)	80	160	220	153	80	120	160	120
Success ratios (%)	10	50	90	50	10	50	90	50
Average EUR (MMBO, oil; BCFG, gas)	0.04	0.08	0.2	0.086	0.1	0.3	0.7	0.319
AU probability	1.0				1.0			

Table 2. Assessment results for two continuous assessment units in the South Sumatra Basin Province, Indonesia.

[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 within 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 probability	Accumulation type	Total undiscovered resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Lemat Lacustrine Total Petroleum System														
Lemat Lacustrine Shale Oil AU	1.0	Oil	142	585	1,581	689	403	1,719	4,950	2,069	7	34	102	41
Lemat Lacustrine Shale Gas AU	1.0	Gas					390	1,563	4,112	1,817	9	40	111	47
Total undiscovered resources			**142**	**585**	**1,581**	**689**	**793**	**3,282**	**9,062**	**3,886**	**16**	**74**	**213**	**88**

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For More Information

Assessment results are available at the USGS Energy Resources Program Web site at http://energy.usgs.gov.

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