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National and Global Petroleum Assessment

Assessment of Potential Unconventional Lacustrine Shale-Oil and Shale-Gas Resources, Phitsanulok Basin, Thailand, 2014

Using a geology-based assessment methodology, the U.S. Geological Survey assessed potential technically recoverable mean resources of 53 million barrels of shale oil and 320 billion cubic feet of shale gas in the Phitsanulok Basin, onshore Thailand.

Introduction

The U.S. Geological Survey (USGS) assesses the potential for technically recoverable unconventional shale-oil, shale-gas, tight-oil, tight-gas, and coal-bed gas accumulations in priority geologic provinces worldwide. This report summarizes the geologic model and assessment of potential shale-oil and shale-gas resources of the Phitsanulok Basin, one of the largest of the Cenozoic extensional basins within onshore Thailand (fig. 1). The Phitsanulok Basin contains the Miocene Chum Saeng Formation petroleum system described in detail by Pinyo (2011). Geologic data depicted in a series of maps by Pinyo (2011) permit a unique opportunity to define assessment units and to assess potential unconventional shale-oil and shale-gas resources within a well-defined lacustrine petroleum system.

Figure 1. Locations of the Phitsanulok Basin and other Cenozoic basins in northern Thailand. Modified from Morley and others (2001).

Geologic Definition of Assessment Units

Assessment units (AUs) within unconventional accumulations are defined by the USGS using a set of geologic screening criteria based on well-known U.S. accumulations. The most viable shale-gas and shale-oil accumulations in the United States exhibit total organic carbon (TOC) values greater than 2 weight percent, contain predominantly Type I or Type II kerogen, are overpressured, reflect tens of meters of organic-rich shale source rock, and occur at depths necessary to retain adequate reservoir pressure. Thermal maturity values (as measured by vitrinite reflectance, R_o) between 0.55 to 1.1 percent R_o characterize potential shale-oil reservoirs, and R_o values greater than about 1.1 percent characterize potential shale-gas reservoirs. These geologic criteria, when applied to the data mapped by Pinyo (2011), allowed definition of the Phitsanulok Basin Shale Oil AU and the Phitsanulok Basin Shale Gas AU within the Synrift Lacustrine Total Petroleum System of the Miocene Chum Saeng Formation.

Geologic Model for Assessment

The geologic model used in assessment of the Miocene Chum Saeng Formation of the Phitsanulok Basin assumes oil and gas were generated within organic-rich (greater than 2 weight percent TOC), thick (greater than 15 meters), thermally mature (more than 0.55 percent R_o), overpressured (greater than 0.45 pounds per square inch per foot, psi/ft) lacustrine shales. The geologic model further assumes that recoverable oil and gas remain in the matrix of the source rock, even with known migration of oil from source rocks of the Chum Saeng Formation into several updip conventional oil fields, including Sirikit Field (Flint and others, 1988). Although recoverable shale oil has not been reported from the source rock, recoverable shale gas was tested from Chum Saeng source rock (Pinyo, 2011). Geologic and production analogs for lacustrine shale-oil and shale-gas reservoirs are quite limited from the United States, but recent drilling and production data from thermally mature lacustrine shales within the Eocene Green River Formation in the Uinta Basin, Utah, were used as partial geologic and estimated ultimate recovery (EUR) analogs. Other U.S. analog data were used to model drainage areas of wells and well success ratios. Key assessment input data are summarized in table 1. Uncertainty with respect to quantities of recoverable oil and gas in the Chum Saeng source rock led to modeled geologic probabilities of 0.90 for the Phitsanulok Shale Oil AU and 0.95 for the Phitsanulok Shale Gas AU (table 2).

Table 1. Key assessment input data for shale-oil and shale-gas assessment units for the Phitsanulok Basin, onshore Thailand.

[Estimated ultimate recovery (EUR) per well, well drainage areas, and well success ratios are taken from U.S. shale-gas and shale-oil analogs. The EUR input includes the minimum, median, maximum, and calculated means of the average EUR Abbreviations: BCF, billion cubic feet; MMB, million barrels; AU, assessment unit]

Assessment input data	Phitsanulok Basin Shale Oil AU				Phitsanulok Basin Shale Gas AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area of AU (acres)	100,000	205,000	250,000	185,000	10,000	173,000	200,000	127,667
Average drainage area of wells (acres)	80	120	160	120	100	140	180	140
Average EUR (BCF, gas; MMB, oil)	0.05	0.08	0.12	0.08	0.3	0.7	1.0	0.71
Success ratios (%)	10	50	80	47	10	50	80	47

Table 2. Shale-oil and shale-gas assessment results from Phitsanulok Basin, Thailand.

[Results shown are fully risked estimates. For gas accumulations, all liquids are included as natural gas liquids. Total undiscovered gas resources are the sum of nonassociated gas (that is, gas-in-gas accumulations) and associated gas (gas-in-oil accumulations). The notation "F95" represents a 95-percent chance of at least the tabulated amount being present; other fractiles are defined similarly. Fractiles are additive under the assumption of perfect positive correlation. Gray shading indicates "not applicable." Abbreviations: MMBO, million barrels of oil; BCFG, billions of cubic feet of gas; MMBNGL, million barrels of natural gas liquids; TPS, total petroleum system; AU, assessment unit; NGL, natural gas liquids]

Total petroleum system (TPS) and assessment units (AUs)	AU probability	Field type	Total undiscovered resources											
			Oil (MMBO)				Gas (BCFG)				NGL (MMBNGL)			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Synrift Lacustrine TPS														
Phitsanulok Basin Shale Oil AU	0.90	Oil	0	54	98	53	0	31	63	32	0	1	1	1
Phitsanulok Basin Shale Gas AU	0.95	Gas					0	278	559	288	0	4	9	4
Total unconventional resources			0	54	98	53	0	309	622	320	0	5	10	5

Unconventional Resource Summary

The USGS assessed potential technically recoverable shale-oil and shale-gas resources in the Phitsanulok Basin of Thailand, resulting in total estimated mean resources of 53 million barrels of oil (MMBO), 320 billion cubic feet of gas (BCFG), and 5 million barrels of natural gas liquids (MMBNGL) (table 2). The ranges of resource estimates (0 to 98 MMBO; 0 to 622 BCFG; 0 to 10 MMBNGL) reflect considerable geologic uncertainty in these unconventional assessment units, particularly with respect to quantities of petroleum potentially remaining in the Chum Saeng Formation source rock.

The Phitsanulok Basin represents one of the largest in a series of geologically complex Cenozoic-age extensional basins within onshore Thailand (Morley and others, 2001; Morley, 2009). Several other Cenozoic extensional basins, such as the Fang, Chiang Mai, Mae Sot, Petchabun, Suphan Buri, and Ayutthaya Basins, may also contain potential shale-oil or shale-gas resources, but geologic and production-test data are not yet available with which to complete a quantitative assessment.

For Further Information

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

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