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World Petroleum Resources Project

Assessment of Undiscovered Oil and Gas Resources of the Red Sea Basin Province

The U.S. Geological Survey estimated mean volumes of 5 billion barrels of undiscovered technically recoverable oil and 112 trillion cubic feet of recoverable gas in the Red Sea Basin Province using a geology-based assessment methodology.

Introduction

The U.S. Geological Survey (USGS) estimated the undiscovered technically recoverable oil and gas resources of the Red Sea Basin Province as part of a program to assess the recoverable oil and gas resources of priority basins around the world. The Red Sea Basin Province encompasses the Red Sea, Gulf of Suez, Gulf of Aqaba, and adjacent coastal areas (fig. 1), an area of about 486,000 square kilometers. The province includes parts of Egypt, Sudan, Eritrea, Yemen, Saudi Arabia, and Jordan. This assessment was based on published geologic information and on commercial data from oil and gas wells, fields, and field production. The USGS approach is to define petroleum systems and geologic assessment units (AU) and to assess the potential for undiscovered oil and gas resources in each of the five AUs defined for this study.

Composite Total Petroleum System and Assessment Units

For this assessment, the Mesozoic-Cenozoic Composite Total Petroleum System is defined to include the possibility of petroleum being sourced from organic-rich rocks of Late Jurassic, Late Cretaceous, early and middle Miocene, and Pliocene ages, all of which are interpreted as potential source rocks within the Red Sea Basin Province (Cole and others, 1995; Lindquist, 1999). This composite total petroleum system is defined to encompass all petroleum fluids and mixtures of these fluids in the province because genetic families of oils or gases could not be completely discriminated based on available geochemical data.

The geologic definition of AUs within the petroleum system directly relates to the tectonic evolution of the Red Sea Basin Province (Richardson and Arthur, 1988; Salah and Alsharhan, 1996; Younes and McClay, 2002; Ehrhardt and others, 2005; Khalil and McClay, 2009). In the late Oligocene-early Miocene, rifting began between the Arabian and African tectonic plates, leading to opening of the Gulf of Suez, Red Sea, and Gulf of Aqaba. Rifting through the Miocene led to the deposition of several thousand meters of syn-rift sediments that eventually became petroleum source rocks, reservoirs, seals, and traps. In mid-Miocene, rifting ceased in the Gulf of Suez—the structural regime of the Gulf of Aqaba changed from extension to strike-slip motion, and the Red Sea continued to open as the Arabian plate moved counterclockwise away from the African plate. Thick evaporite deposits formed during the late Miocene across much of the Red Sea Basin. Seafloor spreading commenced about 4 Ma (Pliocene) in the southern Red Sea area.

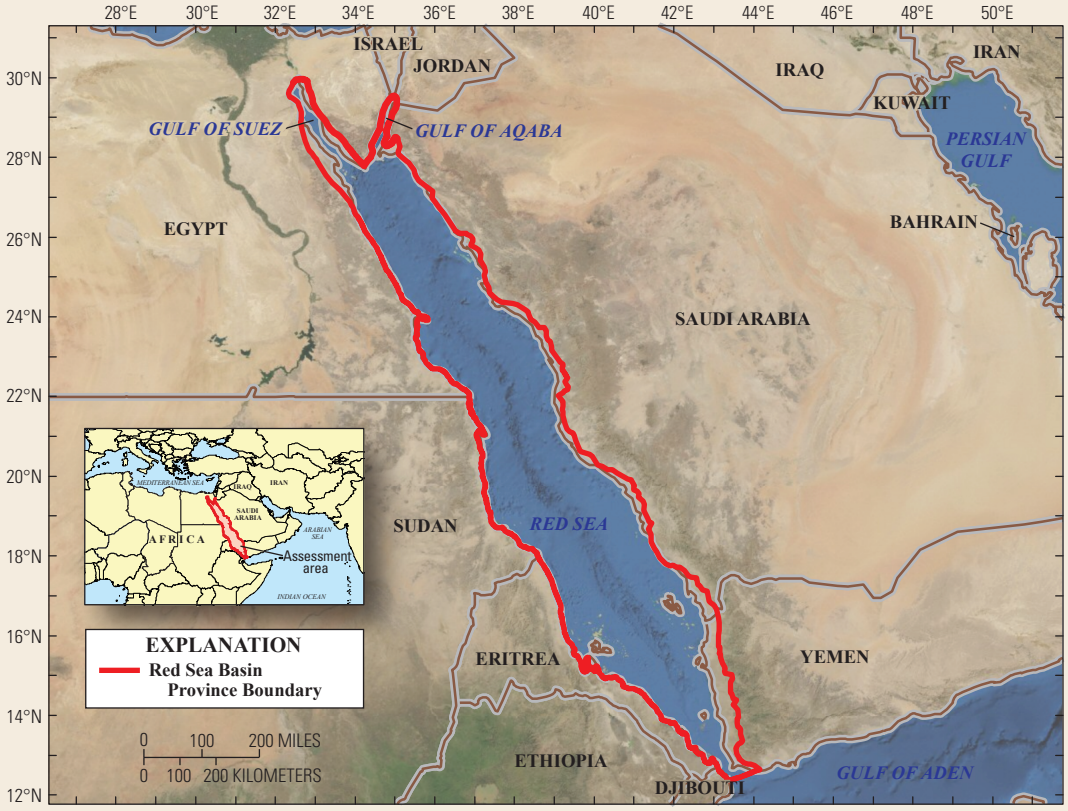

Figure 1. Location of the Red Sea Basin Province.

Table 1. Red Sea Basin Province assessment results.

[MMBO, million barrels of oil. BCFG, billion cubic feet of gas. MMBNGL, million barrels of natural gas liquids. Results shown are fully risked estimates. For gas accumulations, all liquids are included as NGL (natural gas liquids). Undiscovered gas resources are the sum of nonassociated and associated gas. F95 represents a 95 percent chance of at least the amount tabulated; other fractiles are defined similarly. Largest expected oil field in MMBO; largest expected gas field in BCFG. TPS, total petroleum system; AU, assessment unit. Gray shading indicates not applicable]

Total Petroleum System (TPS) and Assessment Units (AU)	Field type	Largest expected mean field size	*Total undiscovered resources*											
			Oil (MMBO)				*Gas (BCFG)*				*NGL (MMBNGL)*			
			F95	F50	F5	Mean	F95	F50	F5	Mean	F95	F50	F5	Mean
Mesozoic-Cenozoic Composite Total Petroleum System														
Gulf of Suez AU	***Oil***	127	309	610	1,120	649	305	654	1,392	727	14	30	67	34
	Gas	126					22	97	599	177	1	6	39	11
Gulf of Aqaba AU	***Oil***	143	35	149	752	237	28	144	860	264	1	6	41	12
	Gas	862					211	896	4,484	1,426	13	57	295	93
Red Sea Coastal Fault Blocks AU	***Oil***	237	530	1,156	2,313	1,254	696	1,721	4,025	1,960	18	46	111	53
	Gas	2,158					10,567	20,570	38,281	21,951	278	548	1,025	585
Red Sea Salt Basins AU	***Oil***	585	1,065	2,502	5,171	2,731	1,426	3,681	9,029	4,270	38	99	248	115
	Gas	6,414					36,967	71,538	131,599	76,215	977	1,906	3,517	2,031
Red Sea Axial Rifts AU	***Oil***	93	39	124	454	170	39	166	799	265	1	4	22	7
	Gas	1,349					1,879	4,572	10,114	5,094	49	121	275	136
Total Conventional Resources			1,978	4,541	9,810	5,041	52,140	104,039	201,182	112,349	1,390	2,823	5,640	3,077

Five AUs defined geologically in this study reflect the structures formed during these tectonic events—Gulf of Suez AU, Gulf of Aqaba AU, Red Sea Coastal Fault Blocks AU, Red Sea Salt Basins AU, and Red Sea Axial Rifts AU. The Gulf of Suez AU includes all extensional structures with the potential for containing pre-rift and syn-rift source and reservoir rocks. The Gulf of Aqaba AU includes all rift structures that might have been inverted as the Gulf of Aqaba changed from extension to transform motion in the middle Miocene. The Red Sea Coastal Fault Blocks AU encompasses all extensional structures with syn-rift source, reservoir, and seal rocks. The Red Sea Salt Basins AU includes all extensional and salt-related structures in the Red Sea. The Red Sea Axial Rifts AU includes all extensional structures in the axial part of the Red Sea, with Pliocene source and reservoir rocks.

Resource Summary

Estimates of volumes of undiscovered technically recoverable oil and gas resources are shown in table 1. The mean of the distribution for undiscovered oil is 5,041 million barrels of oil (MMBO), with a range from 1,978 MMBO to 9,810 MMBO. For undiscovered gas, the total mean volume is 112,349 billion cubic feet of gas (BCFG), with a range from 52,140 BCFG to 201,182 BCFG. About 80 percent of the mean undiscovered oil and more than 90 percent of the undiscovered gas are estimated to be in the Red Sea Coastal Fault Blocks AU and Red Sea Salt Basins AU (table 1). For this assessment, a minimum undiscovered field size of 5 million barrels of oil equivalent (MMBOE) was used for all assessment units. These estimates represent technically recoverable oil and gas resources; no attempt was made to estimate economically recoverable resources.

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For Further Information

A publication detailing the geology and the methodology for the Red Sea Basin Province assessment is in progress. Assessment results are available at the USGS Energy Resources Program website, *http://energy.cr.usgs.gov*.

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