

# Assessment of Undiscovered Oil and Gas Resources of the Levant Basin Province, Eastern Mediterranean

The U.S. Geological Survey estimated a mean of 1.7 billion barrels of recoverable oil and a mean of 122 trillion cubic feet of recoverable gas in the Levant Basin Province using a geology based assessment methodology.

## Introduction

As part of a program aimed at estimating the recoverable oil and gas resources of priority basins around the world, the U.S. Geological Survey (USGS) estimated the undiscovered oil and gas resources of the Levant Basin Province. The Levant Basin Province encompasses approximately 83,000 square kilometers (km<sup>2</sup>) of the eastern Mediterranean area (fig. 1). The area is bounded to the east by the Levant Transform Zone, to the north by the Tartus Fault (Roberts and Peace, 2007), to the northwest by the Eratosthenes Seamount, to the west and southwest by the Nile Delta Cone Province boundary, and to the south by the limit of compressional structures in the Sinai. 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 and to assess the potential for undiscovered oil and gas resources in each of the three assessment units defined for this study—Plio-Pleistocene Reservoirs, Levant Sub-Salt Reservoirs, and Levant Margin Reservoirs.



**Figure 1.** Location of the three assessment units (AU) in the Levant Basin Province in the Eastern Mediterranean. The boundaries of the Levant Sub-Salt AU and the Plio-Pleistocene Reservoirs AU are coincident.

## Composite Petroleum System and Assessment Units

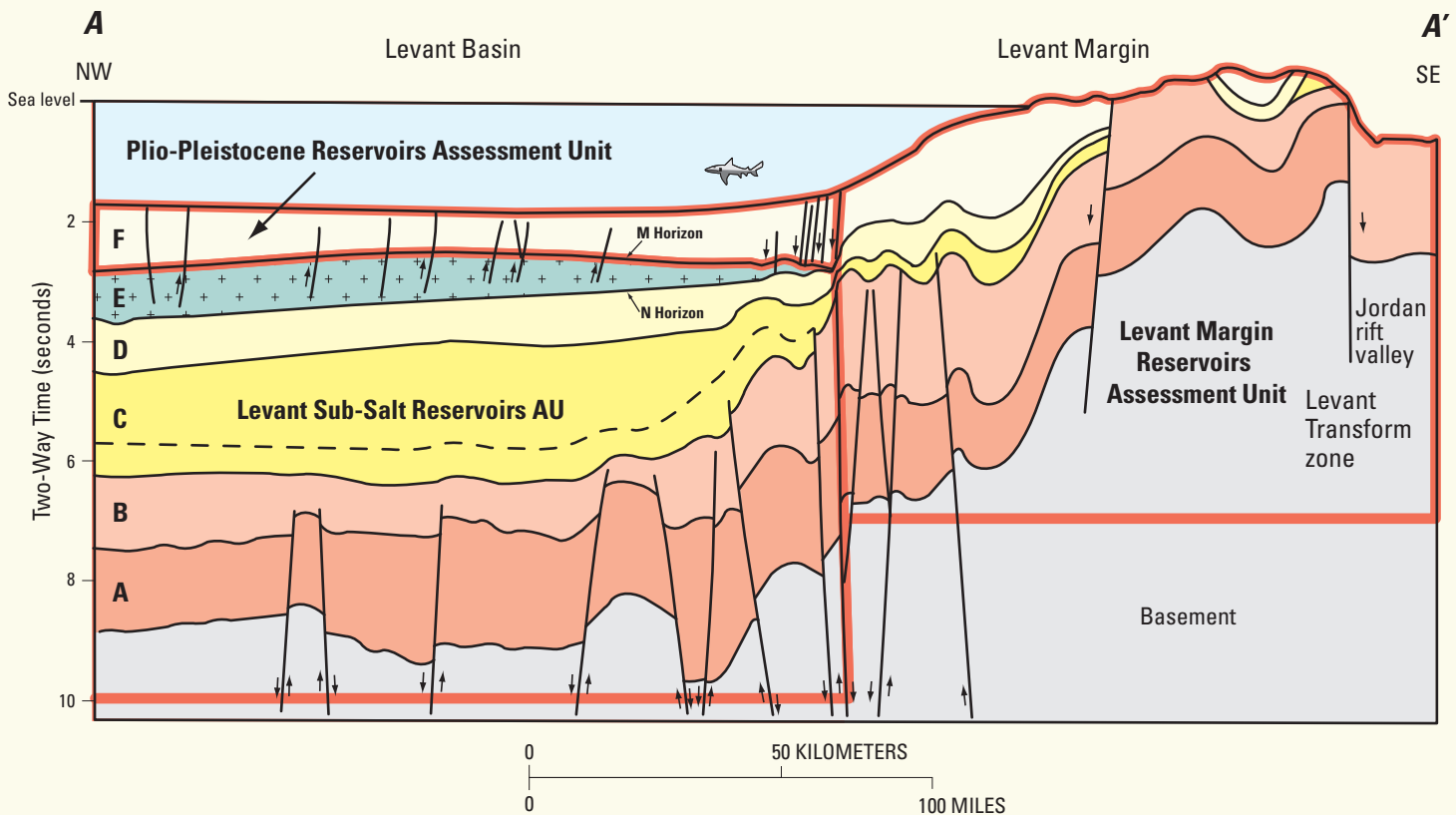
For this assessment the Mesozoic-Cenozoic Composite Petroleum System was defined to include the possibility of viable petroleum source rocks of Triassic, Jurassic, Lower Cretaceous, Upper Cretaceous, Miocene, and Plio-Pleistocene ages, all of which have been suggested as potential source rocks within this province. This composite petroleum system was defined to encompass all petroleum fluids and mixtures of these fluids in the Levant Basin Province because we could not completely discriminate between genetic families of oils or gases with available geochemical data.

Three assessment units (AU) were defined geologically within the composite petroleum system. The Levant Margin Reservoirs AU encompasses all reservoirs, from basement rocks to the Pleistocene, occurring east of the pinch-out of Messinian-age salt and west of the Levant Transform (fig. 2). Reservoirs include Jurassic and Cretaceous shelf-margin carbonates, nearshore marine sandstones, and deep-water slope and fan sandstones. The Levant Sub-Salt Reservoirs AU encompasses all reservoirs within and below continuous Messinian-age salt west of the eastward pinch-out of the salt (fig. 2). Reservoirs are mainly Mesozoic and Paleogene sandstones ranging from incised valley deposits to deep-water slope and fan sandstones (Gardosh and others, 2006; 2008). The Plio-Pleistocene Reservoirs AU includes all reservoirs younger than Messinian-age

salt west of the pinch-out of salt, and reservoirs mainly are incised channels, and deep-water slope and fan sandstones (Aal and others, 2000; Bertoni and Cartwright, 2006) (fig. 2). The Plio-Pleistocene Reservoirs AU is thought to be sourced mainly by biogenic gas, but this assessment includes the possibility of thermogenic gas and oil that migrated vertically from sub-salt source rocks. The Levant Margin Reservoirs AU contains four oil and four gas fields, the Plio-Pleistocene Reservoirs AU includes eight gas fields, and the Levant Sub-Salt Reservoirs AU has two discoveries (Tamar, Datil) that were used in the assessment but are so new that there is no independent reference as to the size of these discoveries. For this assessment a minimum undiscovered field size of 5 million barrels of oil equivalent (MMBOE) was used for the offshore assessment and a 1 MMBOE minimum was used for the onshore assessment.

## 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 about 1,689 MMBO, with a range from 483 MMBO to 3,759 MMBO. For undiscovered gas, the total mean volume is 122,378 billion cubic feet of gas (BCFG), with a range from 50,087 BCFG to 227,430 BCFG. Of the 122,378 BCFG, 6,197 BCFG is estimated to be in the Levant Margin Reservoirs AU, 81,437 BCFG is in the



**Figure 2.** Geologic cross section of the southern part of the Levant Basin Province illustrating the definition of the three assessment units (AU) in this study. The areas of the Levant Sub-Salt Reservoirs AU and the Plio-Pleistocene Reservoirs AU are coincident, and neither AU overlaps with the Levant Margin Reservoirs AU. Dashed line separates Cenozoic (above) from pre-Cenozoic rocks. Messinian-age salt (between the M and N seismic horizons) is shown in green. Location of schematic section (A-A') shown in figure 1. A, Permian to Aalenian age; B, Bajocian to Turonian age; C, Senonian to Early Oligocene age; D, Oligocene to Late Miocene Age; E, Late Miocene (Messinian) age; F, Plio-Pleistocene age rocks. Modified from Gardosh and Druckman (2006) and Cartwright and Jackson (2008).



Eocene nearshore marine sandstones and limestones, Wadi Degla, northern Egypt.

**Table 1.** Levant 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. Largest mean oil field in MMBO; largest mean gas field in BCFG. F95 represents a 95 percent chance of at least the amount tabulated. Other fractiles are defined similarly. TPS, total petroleum system; AU, assessment unit. Gray shading indicates not applicable]

Total Petroleum Systems (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
Levant Basin Province, Mesozoic-Cenozoic Composite TPS														
Levant Margin Reservoirs AU	Oil	177	278	763	1,765	857	340	944	2,202	1,062	7	19	45	22
	Gas	1,074					1,678	4,559	10,594	5,135	51	142	333	160
Levant Sub-Salt Reservoirs AU	Oil	184	148	460	1,242	548	179	569	1,559	679	4	12	32	14
	Gas	12,238					32,462	74,210	150,573	80,758	1,006	2,309	4,721	2,519
Plio-Pleistocene Reservoirs AU	Oil	130	57	217	752	284	68	265	933	351	1	5	19	7
	Gas	4,756					15,360	32,066	61,569	34,393	157	328	633	353
Total Conventional Resources			483	1,440	3,759	1,689	50,087	112,613	227,430	122,378	1,226	2,815	5,783	3,075

Levant Sub-Salt Reservoirs, and 34,744 BCFG is in the Plio-Pleistocene Reservoirs AU (table 1). 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 Levant Basin Province assessment is in progress. Assessment results are available at the USGS Energy Program website, <http://energy.cr.usgs.gov/oilgas/>.

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