

Assessment of Undiscovered Oil and Gas Resources of the Los Angeles Basin Province, 2023

Using a geology-based assessment methodology, the U.S. Geological Survey estimated undiscovered, technically recoverable mean resources of 61 million barrels of oil and 240 billion cubic feet of gas in the Los Angeles Basin Province.

Introduction

The U.S. Geological Survey (USGS) assessed the potential for undiscovered, technically recoverable conventional and unconventional (continuous) oil and gas resources within the Los Angeles Basin Province of California (fig. 1). The tectonic evolution of the Los Angeles Basin Province is complex and related to the evolution of the continental margin from subduction to right-lateral transform motion of southern California (Wright, 1991; Nicholson and others, 1994; Ingersoll and Rumelhart, 1999; Sorlien and others, 2013). The structural configuration of the basin is due to two phases of extension in the Miocene and Pliocene that created the accommodation space for as much as 9 kilometers of sediment, in part consisting of world-class petroleum source and reservoir rocks (Biddle, 1991; Redin, 1991; Wright, 1991). Extension was followed by contraction in the late Pliocene to Pleistocene that resulted in the modification of many structures in the basin (Jung and others, 2015). This phase of deformation may have caused fracturing and loss of oil and gas from reservoirs, as shown by the numerous seeps throughout the basin (Biddle, 1991; Wright, 1991).

Total Petroleum System and Assessment Units

The USGS defined the Monterey Total Petroleum System (TPS) encompassing oil and gas generated from organic-rich Miocene Monterey Formation source rocks, and possibly from source rocks in the Miocene Puente and Modelo Formations. The Monterey Formation is characterized by Type II and Type IIS kerogen, total organic carbon (TOC) values as much as 18 weight percent, hydrogen index values as much as 600 milligrams of hydrocarbon per gram of TOC, thickness as much as 300 meters (Jeffrey and others, 1991; Jung and others, 2015), and a high silica content that readily fractures. The organic matter in the Monterey Formation is more sulfur rich (Type IIS) in the western side of the basin (Jeffrey and others, 1991; Tennyson and others, 2016). Onset of oil generation is modeled to have begun in the late Pliocene (Schultz and others, 2017).

The Central and Eastern Los Angeles Basin Monterey Shale Oil Assessment Unit (AU), the Central and Eastern Los Angeles Basin Monterey Shale Gas AU, and the Western Shelf Los Angeles Basin Monterey Shale Oil AU were defined to estimate the geologic uncertainty of, and potential for, shale-oil and shale-gas resources. The thermal window for oil generation from Miocene source rocks in the Central and Eastern Los Angeles Basin Monterey Shale Oil AU is

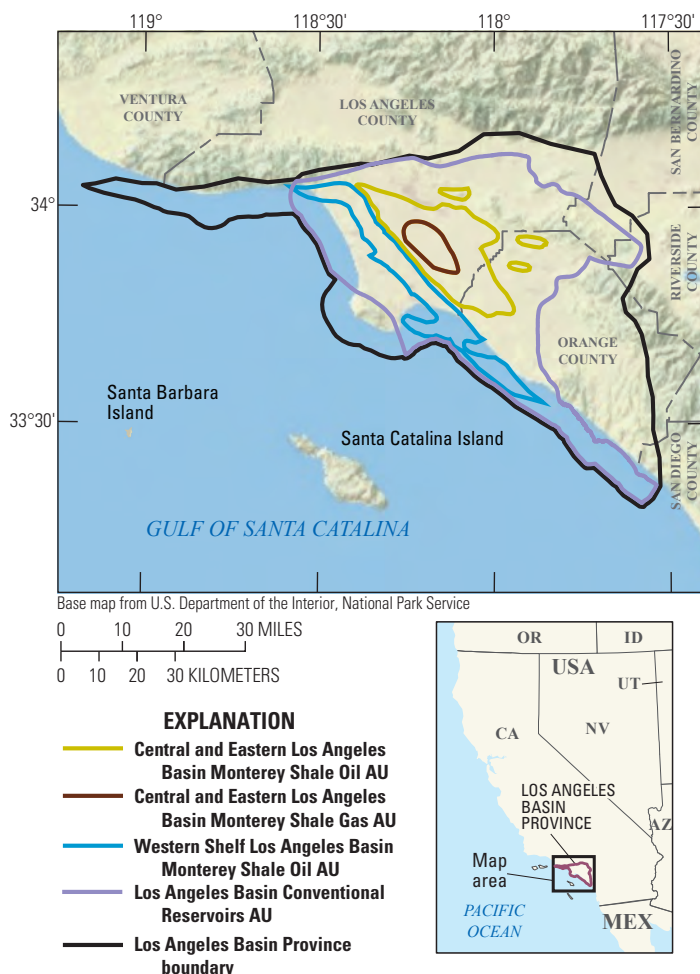


Figure 1. Maps showing location of four assessment units (AUs) in the Los Angeles Basin Province.

generally placed at the –12,000-foot (ft) structure contour near the base of the Monterey Formation (Tennyson and others, 2016, from the map of Wright, 1991). The thermal window for gas generation estimated from one-dimensional modeling for the Central and Eastern Los Angeles Basin Monterey Shale Gas AU is generally placed at about the –21,000-ft structure contour near the base of the Monterey Formation. These depths for the beginning of oil and gas generation are uncertain and represent approximations only. The Western Shelf Los Angeles Basin Monterey Shale Oil AU was defined to encompass oil generated from Miocene shales below a depth of about 9,000 ft, due to the early generation oil from Type IIS kerogen (Peters and others, 2016; Tennyson and others, 2016) compared to Type II organic matter in the eastern part of the basin. The geologic model for the three AUs is for oil and gas to be partially retained within the shales after

generation and migration. Siliceous shales of the Monterey Formation are commonly fractured, and oil and gas may have largely migrated along fractures and out of the shales and into conventional reservoirs or were lost to the surface.

The Los Angeles Basin Conventional Reservoirs AU encompasses most of the Los Angeles Basin Province (fig. 1). The AU was defined to include oil and gas generated from Monterey Formation and related organic-rich rocks to have migrated into conventional sandstone reservoirs within structural and stratigraphic traps. Reservoirs are deltaic and shallow marine sandstones, slope-channel sandstones, basin-floor sandstones, and possible sand injectites described from similar deepwater sandstone systems (Zvirtes and others, 2020). The assessment input data for four AUs are summarized in table 1 and in Schenk (2025).

Table 1. Key input data for four assessment units in the Los Angeles Basin Province.

[Gray shading indicates not applicable. The average estimated ultimate recovery (EUR) input is the minimum, median, maximum, and calculated mean. AU, assessment unit; %, percent; MMBO, million barrels of oil; BCFG, billion cubic feet of gas]

Assessment input data— Continuous AUs	Central and Eastern Los Angeles Basin Monterey Shale Oil AU				Central and Eastern Los Angeles Basin Monterey Shale Gas AU			
	Minimum	Mode	Maximum	Calculated mean	Minimum	Mode	Maximum	Calculated mean
Potential production area (acres)	1,000	90,000	180,000	90,333	1,000	15,000	30,000	15,333
Average drainage area (acres)	5	10	40	18.3	10	20	40	23.3
Success ratio (%)	5	10	40	18.3	10	30	50	30
Untested area (%)	100	100	100	100	100	100	100	100
Average EUR (MMBO, oil; BCFG, gas)	0.003	0.005	0.02	0.006	0.05	0.1	1.0	0.146
Assessment input data— Continuous AUs	Western Shelf Los Angeles Basin Monterey Shale Oil AU							
	Minimum	Mode	Maximum	Calculated mean				
Potential production area (acres)	20,000	55,000	127,000	67,333				
Average drainage area (acres)	5	10	40	18.3				
Success ratio (%)	5	10	50	21.6				
Untested area (%)	100	100	100	100				
Average EUR (MMBO, oil; BCFG, gas)	0.003	0.005	0.02	0.006				
Assessment input data— Conventional AUs	Los Angeles Basin Conventional Reservoirs AU							
	Minimum	Median	Maximum	Calculated mean				
Number of oil fields	1	12	30	12.5				
Number of gas fields	1	3	15	3.4				
Size of oil fields (MMBO)	0.5	0.7	500	4.0				
Size of gas fields (BCFG)	3	18	1,000	39.2				
AU probability	1.0							

Undiscovered Resources Summary

The USGS quantitatively assessed undiscovered oil and gas resources in three continuous AUs and one conventional AU in the Los Angeles Basin Province (table 2). The estimated total mean resources are 61 million barrels of oil (MMBO), with an F95–F5 range from 10 to 201 MMBO; 240 billion

cubic feet of gas (BCFG), with an F95–F5 range from 33 to 741 BCFG; and 5 million barrels of natural gas liquids (MMBNGL), with an F95–F5 range from 1 to 20 MMBNGL. Approximately 80 percent of the undiscovered oil and gas resources are estimated to be in the Los Angeles Basin Conventional Reservoirs AU.

Table 2. Results for four assessment units in the Los Angeles Basin Province.

[Results shown are fully risked estimates. F95 represents a 95-percent chance of at least the amount tabulated; other fractiles are defined similarly. Gray shading indicates not applicable. MMBO, million barrels of oil; BCFG, billion cubic feet of gas; NGL, natural gas liquids; MMBNGL, million barrels of natural gas liquids]

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
Monterey Total Petroleum System														
Central and Eastern Los Angeles Basin Monterey Shale Oil AU	1.0	Oil	1	5	15	6	2	7	23	9	0	0	1	0
		Gas												
Central and Eastern Los Angeles Basin Monterey Shale Gas AU	0.9	Oil												
		Gas					0	19	74	25	0	0	0	0
Western Shelf Los Angeles Basin Monterey Shale Oil AU	1.0	Oil	1	4	13	5	2	5	18	7	0	0	1	0
		Gas												
Total undiscovered continuous resources			2	9	28	11	4	31	115	41	0	0	2	0
Los Angeles Basin Conventional Reservoirs AU	1.0	Oil	8	28	173	50	10	36	224	65	1	2	11	3
		Gas					19	89	402	134	0	2	7	2
Total undiscovered conventional resources			8	28	173	50	29	125	626	199	1	4	18	5
Total undiscovered resources			10	37	201	61	33	156	741	240	1	4	20	5

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For More Information

Assessment results are also available at the USGS Energy Resources Program website, <https://www.usgs.gov/programs/energy-resources-program>.

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