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Remaining Recoverable Petroleum in Ten Giant Oil Fields of the Los Angeles Basin, Southern California

Using a probabilistic geology-based methodology, a team of U.S. Geological Survey (USGS) scientists recently assessed the remaining recoverable oil in 10 oil fields of the Los Angeles Basin in southern California. The results of the assessment suggest that between 1.4 and 5.6 billion barrels of additional oil could be recovered from those fields with existing technology.

Oil derricks and houses in central Los Angeles, 1905. USGS photo by Ralph Arnold.

The Los Angeles Basin is a deep structural feature that began forming near the margin of the North American and Pacific Plates about 7 million years ago, during Late Miocene time (Wright 1991). The basin is bounded on the northwest by the Santa Monica Mountains, on the southeast by the San Joaquin Hills, on the east by the Puente Hills, and on the west by the Palos Verdes Peninsula. The basin's small areal extent, prolific source rocks, thick sandstone reservoirs, and large anticlinal traps constitute a nearly ideal petroleum system. As a result, the Los Angeles Basin has one of the highest concentrations of crude oil in the world. Sixty-eight oil fields have been named in an area of about 450 square miles, including 10 accumulations that each contain more than 1 billion barrels of oil. One of these, Wilmington-Belmont, is the fourth largest oil field in the United States.

Development of the oil fields during the twentieth century went hand in hand with rapid population growth and extensive urbanization of the Los Angeles Basin. Competing land use practices and evolving community priorities have constrained petroleum development throughout the history of the basin. In spite of abundant in-place resources and famously high local demand for refined petroleum products, recovery efficiency remains low and basinwide production continues to fall. Many small to medium-size oil fields have already been shut-in or abandoned, and recovery of oil from larger fields is increasingly restricted by State, County, and local policies and by competing commercial interests.

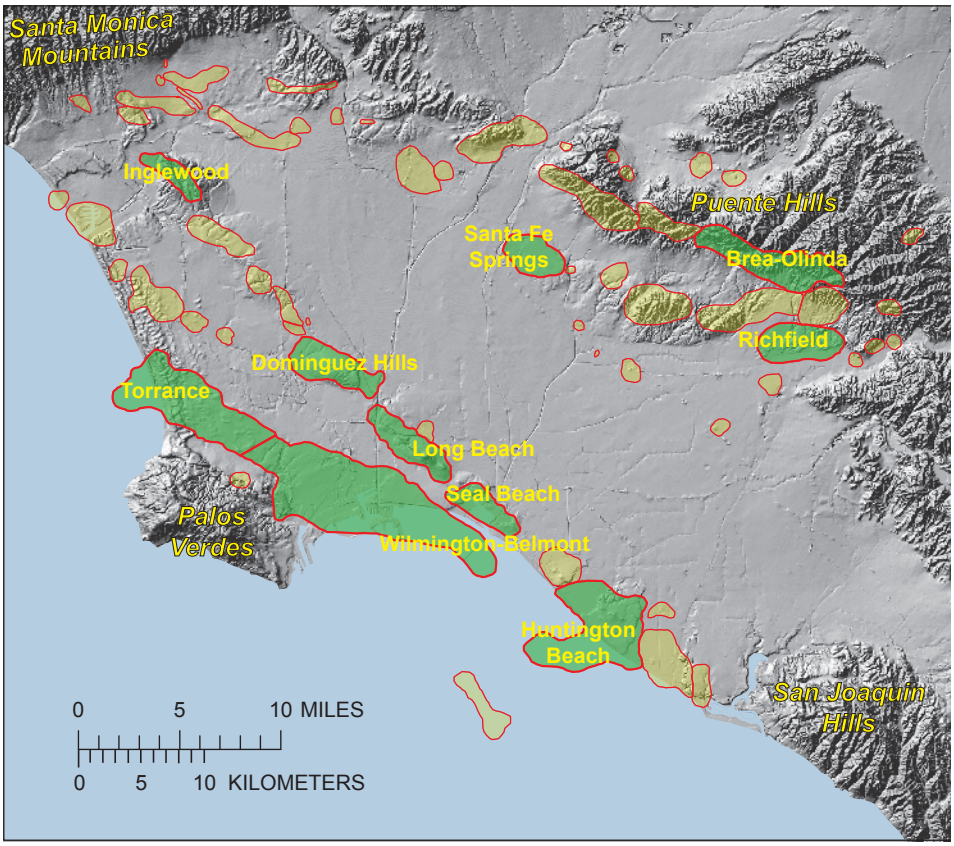
A team of U.S. Geological Survey (USGS) scientists has assessed the remaining recoverable oil in the 10 giant oil fields in the Los Angeles Basin using a probabilistic geology-based methodology (Klett and others, 2011) and reserves and production data from the California Division of Oil, Gas, and Geothermal Resources (2007). The team analyzed the geology of each field and reviewed its engineering-development history. Probability distributions for original oil in place (OOIP) were estimated for each field, and the fraction of the OOIP already developed was calculated. The probable range of maximum potential recovery efficiency (RE_{max}) was evaluated on the basis of recovery efficiencies that have been modeled in engineering studies, achieved in similar reservoirs elsewhere, or indicated by laboratory results reported in technical literature. Probability distributions of OOIP and RE_{max} were combined in a Monte Carlo simulation to estimate remaining recoverable oil.

On the basis of this assessment of remaining oil in place and potential recovery efficiency, between 1.4 and 5.6 billion barrels of additional recoverable oil are estimated to remain in the 10 analyzed fields, with a mean estimate of approximately 3.2 billion barrels. Substantial recovery of these resources would require field redevelopment and unrestricted application of current best-practice technology, including improved imaging and widespread application of directional drilling, combined with extensive water, steam, and CO_2 floods.

Beyond the resources in the fields assessed here, additional recoverable oil may also remain in the other 58 existing oil fields in the Los Angeles Basin, in yet-to-find conventional oil fields, and in unconventional resources in petroleum source rocks (shale oil). Given the highly urbanized condition of the Los Angeles Basin, unrestricted development is hard to envision. Nevertheless, significant petroleum resources could probably be developed if needed.

U.S. Department of the Interior
U.S. Geological Survey

Fact Sheet 2012–3120
Revised February 2013



Map of the Los Angeles Basin, showing oil fields (outlined in red). Fields evaluated in this study are shaded green and labeled by name.

References Cited

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Table 1. Assessment results for volumes of remaining recoverable oil in selected oil fields of the Los Angeles Basin, California (technically recoverable resources).

[Known recoverable oil is the sum of cumulative production and reported remaining reserves; mean estimates add to a total mean, but fractile values for individual fields are not additive; fractiles (nonadditive) for the entire group of fields are shown in the bottom row, highlighted in yellow. OOIP, original oil in place; MMBO, million barrels of oil. F95 denotes a 95-percent chance of at least the amount tabulated; F50 denotes a 50-percent chance; F05 denotes a 5-percent chance]

Field	Known recoverable oil (MMBO)	Estimated OOIP (MMBO)			Estimated recovery efficiency (percent)			Remaining recoverable oil (MMBO)			
		Minimum	Median	Maximum	Minimum	Mode	Maximum	F95	F50	F05	Mean
Brea-Olinda	431	1,200	1,600	2,400	35	40	45	81	209	407.6	221.9
Dominguez Hills	274	1,000	1,200	1,450	35	40	50	146	224	321.2	227.7
Huntington Beach	1,164	3,250	3,500	6,000	35	40	55	117.1	371.5	866.2	416.2
Inglewood	430	1,000	1,400	2,500	40	45	55	67.2	224.6	520.2	249.9
Long Beach	946	3,000	3,100	3,600	35	40	55	207.9	392.2	663.5	410.3
Richfield	206	800	1,000	2,400	26	30	45	48.2	134.5	356.5	158.7
Santa Fe Springs	634	2,100	2,378	2,700	30	35	40	96.7	197.5	308	199.6
Seal Beach	221	850	900	1,000	35	40	50	109.4	152.9	210	155.7
Torrance	232	900	1,000	2,000	35	40	55	127.8	207.7	394.3	226.7
Wilmington-Belmont	2,984	7,600	9,000	12,000	35	40	55	199.9	909.8	1,948.1	972.6
All evaluated fields	7,522							1,443	3,079	5,565	3,239