Recoverable Petroleum Beneath the City of Los Angeles*

Donald L. Gautier

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*Adapted from oral presentation given at Pacific Section AAPG Convention, Bakersfield, California, April 22-25, 2018. Please see closely related article, “Forgone Oil in the Los Angeles Basin: Assessment of Remaining Petroleum in Giant Fields of Southern California”, Search and Discovery article #20164 (2012).

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Abstract

Southern California oil accumulations, including those in the City of Los Angeles, are extraordinary because: (1) they exhibit what may be the world’s highest natural concentration of crude oil, and (2) they underlie a modern mega-city with tens of millions of inhabitants. In spite of L.A.’s early and enthusiastic embrace of both the petroleum industry and the gasoline-powered automobile, oil development and urbanization have been in conflict from the start. Early day town-lot drilling, competing land use practices, and fickle societal acceptance have conspired to severely limit production. As a result, recovery efficiency is low in nearly every accumulation and many fields have been abandoned prematurely, leaving large volumes of recoverable oil behind.

A new evaluation of the oil fields within the L.A. city limits suggests that about 1.6 BB of additional oil (mean estimate) could be recovered with existing technology. The study was done in two steps: First, previous USGS estimates of remaining recoverable oil in Inglewood, Torrance, and Wilmington-Belmont fields were allocated to the field areas falling within L.A. city limits. Second, the volumes of recoverable oil in the seventeen other L.A. basin oil fields within the city were assessed by means of a methodology similar to that used by the USGS. The original oil in place was calculated from a standard petroleum engineering equation using data from the California Department of Conservation, the USGS, and the peer-reviewed literature. Potential recovery efficiencies were estimated from recovery efficiencies modeled in engineering studies, achieved in similar reservoirs in other basins, or indicated by laboratory results reported in technical literature. Resource allocations to the City of Los Angeles were based on maps of historically productive areas within municipal boundaries, modified as necessary by other considerations.

Selected References


http://ccst.us/SB4


Eaton, J.E., 1923, Structure of the Los Angeles basin and environs: Oil Age, v. 20/6, p. 8-9, 52.

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RECOVERABLE OIL
BENEATH THE CITY OF LOS ANGELES

BY DONALD L GAUTIER PH.D.

Salt Lake oil field in 1905
USGS Images by Ralph Arnold
Panorama by Valley Design Group
Acknowledgement and thanks

• Scientists and engineers at CDOGGR
• Former colleagues at U.S. Geological Survey
• Students at USC Viterbi School of Engineering
68 named oil fields within $\sim 2200 \text{ mi}^2$
The richest petroleum basin

- Probably the world’s highest oil density
- Onshore area ~2200 mi² *
- Known oil >9 BBO (~4 MMB/mi²)*
- ~4 MMBOE/mi³ of sediment (Biddle 1991)¹
- OOIP: 30 to 50 BB (14 to 23 MMB/mi²)*

*D.L. Gautier estimate
¹K.T. Biddle, 1991, AAPG Memoir 52, pp. 5-24
A nearly ideal petroleum system

- Prolific Miocene source rocks
- Extremely high heat flow and active tectonics
- Thick stacks of sandstone reservoirs
- Large structural traps
- Imperfect seals that leak gas but retain oil

Nodular shale with phosphatic laminae:
Playa del Rey oil field; from Hoots et al. 1935
AAPG Bull. V.19, no. 2, pp. 172-205.
First 400 wells found ~90% of the known oil

Data sources: CDOGGR
First 400 wells found ~90% of the known oil

Mean discovery rate >21MMBO/well

Data sources: CDOGGR
Los Angeles (pop. 50,000) was mostly rural when petroleum development began.
Now it’s a megacity of >13 million people
Oil and urbanization at odds from day one

First Street, Los Angeles ca. 1895: Seaver Center Photo in the public domain
Consequences

• Damaged reservoirs
• Restricted access
• Low recovery efficiency
• Premature abandonment
• No exploration in more than 40 years
How much recoverable oil remains beneath the City of Los Angeles?
20 oil fields are within L.A. city limits

- Beverly Hills
- Boyle Heights
- Cheviot Hills
- El Segundo
- Hyperion
- Inglewood
- Las Cienegas
- Los Angeles City
- Los Angeles Downtown
- Playa del Rey
- Potrero
- Rosecrans
- Salt Lake
- Salt Lake South
- San Vicente
- Sawtelle
- Torrance
- Union Station
- Venice Beach
- Wilmington-Belmont
Methodology

1. Evaluate OOIP in each field
2. Determine current recovery efficiency
3. Estimate potential recovery efficiency
4. Calculate remaining recoverable oil
5. Allocate results to areas within L.A. city limits
\[ \text{OOIP} = 7758 Ah\phi (1-S_w)/B_o \]

\( A \) = productive area
\( h \) = net reservoir thickness
\( \phi \) = decimal porosity
\( S_w \) = decimal water saturation
\( B_o \) = formation volume factor
Mean OOIP per field (except Wilmington)

Sum of means = 7905 MMBO
Mean recovery efficiency $\sim 17.5\%$
Potential recovery efficiency varies by field

- Reported recovery from similar reservoirs
- Laboratory studies
- Reservoir modeling simulations
- Data from CDOGGR, USGS, AAPG, SPE, etc.
- Optimal recovery ranges from 30 to 60%
Allocation to areas within L.A. city limits

Map: Courtesy of the City of Los Angeles
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<th>Field Name</th>
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Summary of results

- OOIP in 20 fields ~ 17 BBO
- 13/20 fields have OOIP >100 MMBO
- Average recovery efficiency is now ~17.5%
- 6% increase in recovery efficiency adds >1BBO
- Mean recoverable oil in existing fields ~ 1.6 BB
- Estimates do not include yet-to-find oil
- Estimates do not include source-rock plays
The End

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