



Figure 1. Oil rigs lining Venice Beach in 1952.
Credit: Library of Congress.

Los Angeles: A Megacity of 12 Million People Living Over the World's Richest Oil Field

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When most people think of giant oil fields, the image that comes to mind is of the Saudi Arabian desert or the West Texas plains, not Beverly Hills or Venice Beach (Fig. 1). But Los Angeles, California, USA, is a megacity built on one of Earth's richest oil and gas deposits; the Los Angeles Basin contains more oil per unit volume of rock than any sedimentary basin on Earth (Biddle, 1991).

The first commercial oil well was drilled in the Los Angeles Basin in 1892, and 300 more wells followed in the next three years. Starting in the 1960s, the surface area of the production sites was greatly reduced by consolidating wells and cleverly disguising them to blend into the urban ecosystem. Today, the basin's 40 oil fields produce ~18 million barrels per year from 5,000 wells. But as 2022 gave way to 2023, in response to growing public health and environmental concerns, both the City and County of Los Angeles banned new drilling. The city also set a 20-year timetable to phase out all existing operations (Johnson and Shamasundar, 2023). *Warren E&P, Inc. v. City of Los Angeles*, No. 23STCP00060 (Cal. Super. Ct. Los Angeles County [2023]) is pending to determine if the city council's actions were legal, but the era of urban oil in LA is waning.

THE MAKING OF A GIANT OIL FIELD: THE MONTEREY FORMATION AND PLATE BOUNDARY TECTONICS

Most organic source material for oil and gas was deposited during the middle-to-late Paleozoic and the middle-to-late Mesozoic. By contrast, the source rock for the Los Angeles Basin petroleum is unusually young. The Miocene, organic-rich Monterey Formation was deposited between ~18–5 Ma in offshore basins at water depths between 500 and 2300 m. These basins formed as California evolved from a subduction to a transform plate margin (Behl, 1999), giving birth to the San Andreas Fault.

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The Monterey Formation is highly siliceous, thanks to the abundance of diatoms that flourished in surface waters fed by nutrient-rich upwelling along the California Current. The basin floors were episodically oxygen deficient, producing petroleum source rocks with high total organic carbon contents up to 23% (Behl, 1999).

Plio-Pleistocene shortening produced rapid subsidence in the Los Angeles Basin and uplift of adjacent areas, which shed sediments that rapidly buried the Monterey Formation to several kilometers' depth, into the "oil window"—the temperature and pressure regime where liquid petroleum and natural gas is formed and partially liberated from its host rock. That tectonism also produced en-echelon anticlines that formed structural traps for the petroleum, although some of it leaked onto land and into the sea through faults and fractures.

THE LA BREA TAR PITS: A PLEISTOCENE TIME CAPSULE

Oil was seeping to the surface at the future location of Los Angeles by the Pleistocene at the famous La Brea Tar Pits. Starting 60,000 years ago and continuing for thousands of years, sticky "tar" entrapped animals and entombed surrounding vegetation, fossilizing them in asphalt. This unusual fossilization process preserves collagen, cellulose, and other biological materials so exquisitely that scientists can analyze biogeochemical signatures that are usually unattainable (IUGS, 2022). The Tar Pits lie within Wilshire Boulevard's "Miracle Mile," a contemporary creative center and a historic district that epitomizes LA's rise as an engine of commerce.

More than four million fossil plants, invertebrates, and vertebrates have been recovered since the first excavation in 1875. Marquee fossils include saber-toothed cats, giant sloths, dire wolves, mammoths, and mastodons (Fig. 2). Whole ecosystems were entombed together, providing scientists unprecedented windows into Pleistocene ecosystem dynamics, species adaptation and extinction, and the impact of Earth processes like climate change on biological dynamics (IUGS, 2022).

The seminal importance of this, the planet's richest Pleistocene fossil site, has earned the tar pits international

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recognition. In 1951, they were designated the type locality defining the RanchoLaBrea North American Land Mammal Age; in 1963, they were named a U.S. National Natural Landmark; and in 2022, the International Union of Geological Sciences (IUGS) named them one of its first 100 "Geological Heritage Sites," a list of especially significant geological locations around the world (IUGS, 2022).

Hollywood production centers and sound stages overlook the tar pits, which have featured in numerous movies and TV shows. In 2018, José Roberto Villaseñor, an interpreter for the Natural History Museum of Los Angeles, compiled a list of 89 popular culture references to the tar pits. He noted that these references are, unfortunately, rife with scientific misconceptions. They commonly use the tar pits for comic effect, such as Homer Simpson's 1994 entrapment, or as the source of impending disaster, most famously as the site of a volcano that devastates Los Angeles in the 1997 movie *Volcano* (Villaseñor, 2018). The recent science fiction TV

series *La Brea* (2021–2024) portrayed the tar pits as a portal for time travel.

HUMAN USES OF PETROLEUM AND BIRTH OF THE LOS ANGELES OIL INDUSTRY

The area's petroleum has been a valuable resource to humans ever since they migrated to what would become Los Angeles. The Indigenous Tongva and Chumash peoples used asphalt as waterproof caulking for boats and containers and to set broken bones (Witt, 2022). A 1769 Spanish expedition noted its value for caulking ships and the flavor it imparted to creek water. When Edward Doheny arrived in Los Angeles in the 1890s, he saw locals burning the asphalt as fuel, which inspired him to drill LA's first commercial oil well. Doheny went on to riches and infamy as an oil baron who inspired a scathing portrayal in Upton Sinclair's 1927 book *Oil!*, which was loosely adapted into the acclaimed 2007 movie *There Will Be Blood* (Tormey and Middaugh, 2014; Witt, 2022).

LA's oil industry was born when the area was largely rural. The city's



Figure 2. A fossil of the iconic saber-toothed tiger (*Smilodon californicus*), recovered from the La Brea tar pits. Credit: James St. John/Creative Commons.

economic growth during the first half of the twentieth century was fueled largely by the oil industry; wells were common sites on beaches and in the backyards of homes (Fig. 1). Massive oil strikes in the 1920s at Wilmington, Huntington Beach, and Inglewood—fields that together contain over 2.4 billion barrels of oil and more than 2.2×10^{12} cubic ft of natural gas—supercharged the industry (Biddle, 1991). At that time Los Angeles supplied a quarter of the world's oil (Witt, 2022). That oil legacy was such a point of pride that through the 1960s California's license plates were black and gold to symbolize the state's twin natural resource pillars: oil and gold (Tormey and Middaugh, 2014). But by the 1960s Los Angeles was in the midst of an aerospace, manufacturing, and entertainment boom—all land-hungry new economic engines for the area. The city accommodated the new growth along with ongoing resource extraction by developing rich new offshore oil and gas fields and by infrastructure consolidation at onshore ones.

CAMOUFLAGING OIL INFRASTRUCTURE

In the late 1960s, the City of Los Angeles stipulated that all drilling must be consolidated into a few drilling “islands,” whose infrastructure must be compatible with the community in which it is located; it can't be unsightly, loud, or generate dust, odor, or harmful substances (Tormey and Middaugh, 2014). The result is that many contemporary Angelenos and tourists drive by concealed nests of oil wells every day without realizing it (Fig. 3).

These urban drill sites are literally hiding in plain sight. None are more than an acre in size, and most are less than half an acre. They use submersible pumps, allowing a 20–60-well oil field to line up the well heads within oil cellars and to access the subsurface pool by slant and horizontal drilling. There is one dedicated workover rig that is difficult to hide without a multi-story disguise. For example, within one commercial district, there is what looks like a seven-story office building covering the field; it is a shell painted to merge with the surrounding offices, but without windows. Another rig is camouflaged to resemble the bell tower



Figure 3. The “Flower Tower” used to conceal an oil rig on the Beverly Hills High School campus. The floral pattern was designed by two artists who were school alums and painted by terminally ill children who were being treated in local hospitals (Tormey and Middaugh, 2014). This photo was taken during repair of the rig, which is visible behind the Flower Tower. Both the rig and its Flower Tower camouflage were dismantled in 2020. Credit: EricF2000 via Flickr.

of a synagogue; this site won a design award from the City of Los Angeles. Adjacent to the running track at Beverly Hills High School, the oil developer reached out to the community for ideas on how to disguise the workover rig, and the Flower Tower was born (Fig. 3). Each side of the disguise was painted by the community to represent the four seasons. With time, Angelenos came to know the structure simply as the Flower Tower, with little memory that a drill rig lay within.

DECLINING PUBLIC SUPPORT FOR URBAN DRILLING

Despite efforts by the city and petroleum producers to minimize the impact of oil operations, public concern about industrial mishaps and the long-term health effects of living next to active drill sites has progressively grown (Johnson and Shamasundar, 2023), amplified by national concerns about hydraulic fracturing (which is not conducted in the Los Angeles Basin) and several high-profile disasters over the years. One was the 1963 failure of the

Baldwin Hills Dam, which triggered a flood that destroyed 277 homes and killed five people. The dam was adjacent to the Inglewood oil field, and public suspicions abounded that petroleum extraction had caused ground disturbances that triggered the dam's collapse. Although a later study by the California Department of Water Resources concluded that was not the case, not everyone was convinced (Tormey and Middaugh, 2014).

Then, in 1969, a blowout at Union Oil's offshore platform Alpha spilled three million gallons of oil into the Santa Barbara channel. The oil killed fish, marine invertebrates, seals, dolphins, and seabirds. National public outrage was intense; the Santa Barbara oil spill was seminal to the establishment of the current national environmental regulation regime, including passage of the National Environmental Policy Act (NEPA) in 1969 and establishment of the Environmental Protection Agency (EPA) in 1970 (Clarke and Hemphill, 2002). The next disaster to erode public confidence occurred in 1985, when methane filled the basement of a clothing store above the Salt Lake oil field near the La Brea Tar Pits. The ensuing fire injured 23 people and prompted the Los Angeles City Council to adopt new methane monitoring and venting regulations (Tormey and Middaugh, 2014).

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Then, in 2003, Erin Brockovich (made famous by a Hollywood movie depicting her successful 1993 lawsuit against Pacific Gas and Electric) filed a class action lawsuit alleging that emissions from the oil wells on the Beverly Hills High School campus (Fig. 3) were responsible for elevated cancer rates in the school's teachers and alumni. However, several studies concluded that emissions were well below California health guideline limits, and the suit was dismissed. Still, concerns about the health effects of drilling persisted. In 2010, the Los Angeles City Attorney

filed a lawsuit against a Las Cienegas oil field operator because of persistent neighborhood complaints of noxious odors, headaches, nosebleeds, and asthma. The operator reached a settlement requiring the implementation of environmental improvements (Tormey and Middaugh, 2014). Those health worries, coupled with growing concern about climate change, have turned the tide of Los Angeles public opinion from the pride of the black and gold license plates to rejection of continuing operations, ultimately resulting in the 2022–2023 city and county decisions to stop issuing new drilling licenses.

The story of Los Angeles oil and gas has evolved. It includes early elation about an economic bonanza, patriotism regarding the resource's importance for winning World War II, pride in the combination of technological innovation and artistic creativity that enabled the area to grow while still maintaining oil and gas development at hidden urban drill sites, and concern about both adverse health effects and climate change. Like a thought-provoking Hollywood movie, there are layers

of meaning that are open to different interpretations. Just as the camouflaging of workover rigs has caused many Angelenos to be unaware that they live atop a giant oil field, the approaching end of Los Angeles drilling risks the disappearance of this multilayered history from our collective memory. This is where geoheritage steps in to celebrate, remember, and teach from this story.

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