

# *Oil-Industry History*

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Oil Fields of Long Beach, California, c1930s; See Page 9.



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# THE HISTORY OF OIL ALONG THE NEWPORT-INGLEWOOD STRUCTURAL ZONE – LOS ANGELES COUNTY, CALIFORNIA

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**ABSTRACT:** Following the Los Angeles City Oil Field boom of the 1890s, other fields throughout the Los Angeles Basin were subsequently discovered and developed. During the Roaring Twenties, California became the most oil productive state in the country, and by 1923, one of every five barrels of oil was produced from the Los Angeles Basin. Notably, thirteen fields have since been discovered along what is referred to as the Newport-Inglewood Structural Zone (NISZ). The northwest-southeast oriented Newport-Inglewood Structural Zone is an active series of faults characterized by major right-lateral movement in the southeastern portion of the Los Angeles Basin. Over 3.4 billion barrels of oil have been produced from these fields since the first field, the Beverly Hills oil field, was discovered in 1900. Most of the subsequent production was derived from discovery of the super giant Huntington Beach and Long Beach oil fields in 1920 and 1921, respectively. Nearly 40 percent of the total oil production for Southern California has come from fields situated along this structural zone. Dramatic production and decline trends during the 1920s and 1930s directly reflected the closely spaced town lot drilling campaigns and unrestricted wasting of reservoir pressure. Today, a mixed usage of land in a densely populated urban environment exists, including wetlands habitat, parklands, and commercial, industrial and residential developments. Current environmental issues along this zone are multi-faceted and pertain to seismic hazards, groundwater withdrawal and utilization, ongoing barrier projects via injection to manage salt water intrusion, gas leakage and adverse impact of the petroleum industry to overall groundwater quality. In 1957, Los Angeles celebrated its rich oil heritage of Signal Hill with the symbol of oil derricks on the Seal of the County. Political correctness concerning the county's faith-based heritage resulted in this symbol's removal in 2004.

## INTRODUCTION

It is not often when one gets an opportunity to celebrate a fault – an active fault for that matter; however, the NISZ is such a physical entity that deserves recognition. The NISZ was responsible for the Long Beach earthquake in 1933 which resulted in 115 deaths and six million dollars in loss. However, the NISZ is has also played a significant historical role in the discovery and production of oil and gas in California and the nation.

The NISZ is predominately a right-lateral slip structural zone that is oriented N45-65W, and is about 40 miles long in extent, and ranging from about 1.5 to 2.5 km in width (Fig. 1). The zone serves as a partial barrier to groundwater flow and saltwater intrusion, and separates the east and west groundwater basin on the Los Angeles Coastal Plain. Topographically, the zone is characterized by an alignment of topographic highs on the Los Angeles coastal plain. From northwest to southeast, there are the Cheviot Hills, Baldwin Hills, Rosecrans Hills, Dominguez Hills, Signal Hill, Alamitos Heights, Landing Hill, Huntington Beach Mesa and Newport Mesa. These topographic highs are separated by topographic lows referred to as gaps. The oldest of the oil fields along the trend is the Beverly Hills oil field. The Cheviot Hills oil field is preferred over the name Beverly Hills since it was believed by Poland *et al.* (1956) that the NISZ does not actually underlie this field but rather veers westward in the vicinity of the Cheviot Hills. Regardless, the Beverly Hills oil field is included in this discussion.

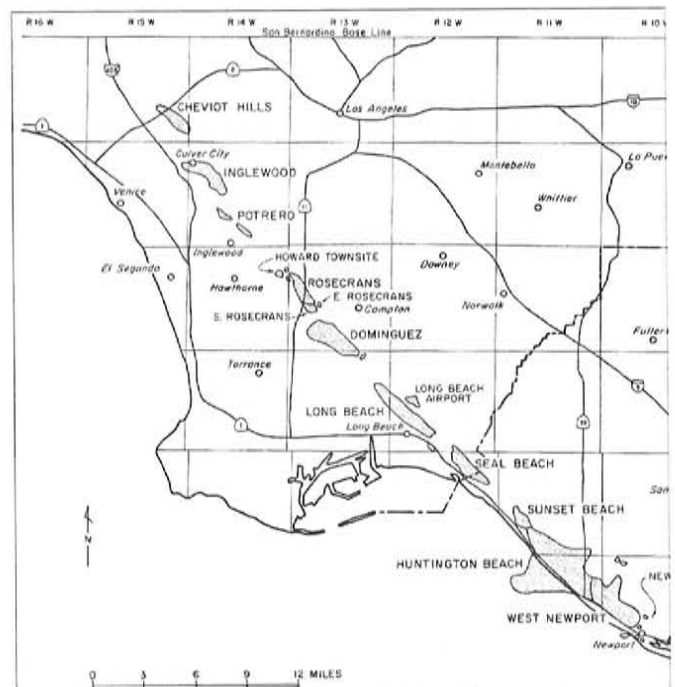


Figure 1. The Newport-Inglewood Structural Zone (NISZ) showing the alignment of twelve of the thirteen oil fields discussed in this paper. Not shown is the Beverly Hills oil field which is located immediately north of the Cheviot Hills oil field and no longer considered underlain by the NISZ (Barrows 1974).



The discovery of the Los Angeles City oil field by Edward Doheny, Jr. and Charles Canfield in 1892, sparked a flurry of activity in the search for oil throughout southern California, and notably, in the Los Angeles Basin. The Roaring Twenties would not only represent a period of more liberal social behavior and attitudes, but also would rank California first among the oil producing states from 1923 through 1926, and second from 1920 through 1922, 1927 and 1929, and third in 1928 (Franks and Lambert, 1985). Also during this period, six great oil fields would be discovered in the Los Angeles Basin. What is most interesting about this fact is that five of the six fields were situated along a single structural zone, the NISZ. These five fields were Huntington Beach in 1920, Long Beach in 1926, Dominguez in 1923, Inglewood in 1924, and Seal Beach in 1924. Other smaller oil fields would also be discovered along this structural trend in the 1920s, those being the Newport (1922), Rosecrans (1924), and Potrero (1928), and between 1900 and 1958, a total of thirteen oil fields would be found to align themselves along this zone (Fig. 2a, b). One would be hard pressed to find a more historically significant structural feature in regards to the pursuit of oil than the NISZ (Tables 1 and 2).

The most recent summation of the early history of oil activity along the NISZ was presented by Allan G. Barrows, a geologist with the then California Division of Mines and Geology (now the California Geological Survey). Barrows reviewed the geology and earthquake history of the NISZ (Barrows, 1974). Drilling along the NISZ commenced in the late 1880s in the Rosecrans Hills, an area referred to as the *Rosecrans Tract* (Goodyear 1887). The 135-foot deep well was drilled and *...at a depth of eighty-five feet quite a strong flow of gas was struck...* which provided the owner, Mr. Thomas, enough gas for all domestic uses in his house.

Studies under the auspices of the United States Geological Survey would be undertaken in the 1900s. Mendenhall (1905, p. 15) characterized the subsurface structural aspects of this zone as *...the broad fold in the sands and clays of the coastal plain...*, but even by 1907 no mention of the significance of this structure as forming traps for the accumulation of oil was not evident. Further studies by the United States Geological Survey (Poland *et al.*, 1956) would produce the most detailed reports on this zone, and detailed studies by the California Department of Water Resources (Zeilbauer *et al.* 1961 and 1962) would provide accounts of the zone to act as a barrier to the landward intrusion of sea water into fresh water aquifers. In regards to the potential of oil in the Los Angeles Basin, this lack of recognition of the NISZ for its oil-trapping potential was further emphasized by Eldridge and Arnold (1907, p. 197) who noted:

*Outside of the...Los Angeles oil field there is little or no evidence of remunerative oil deposits in the immediate*

*vicinity of Los Angeles. Were it not for the great thickness of Pleistocene sand and gravel, which covers the great Los Angeles Plain from the Santa Monica Mountains and Rappetto [sic] Hills to the Ocean, it would be more than likely that productive territory could be developed over this plain. At least it is almost certain that the oil-bearing strata underlie it, but whether or not the structural conditions are at any place conducive to the accumulation of gas and oil in paying quantities can be determined only by costly exploitation with the drill.*

Further drilling was conducted in the 1900s at different locations along the zone (Prutzman 1913). Two wells were drilled in the city of Long Beach and gave indications of oil, though this was never followed up (Prutzman 1913). Gas was also encountered in a well drilled at an asbestos plant at a depth of 350 feet, which was enough to run the plant. A water well drilled for one of the laundries encountered a little gas and oil at a depth of about 375 feet. About a dozen wells were drilled mostly in the vicinity of the Howard Summit and the Rosecrans tract. These wells along with two water wells exhibited *...showings of oil...* and a slight production of gas in most of these wells. Prutzman (1913, p. 332-333) stated:

*Even these slender indications are of interest in connection with the fact that these wells are located along a little ridge, perhaps 100 feet in height, a continuation of the Tijera (Baldwin) Hills. This low roll is the only interruption of the continuity of the plain between Los Angeles and the ocean, and has the same position relative to the Santa Monicas as have the Coyotes to the Puente Hills. Where the summit of this raise is cut through by the Long Beach electric line, an anticlinal structure is plainly shown, and it seems strange that (as far as could be learned) no prospecting has ever been done along this ridge. It seems quite certain that, if any oil is to be found between Los Angeles and the ocean, a point along the ridge between Palms and Compton would be the most favorable place at which to drill.*

In Orange County to the south, exploratory wells would be drilled in the vicinity of Newport Bay, and as far south as Laguna Beach and San Juan Capistrano (Prutzman 1913). Of note was no less than seven companies drilling in the Newport Bay area: Balboa Oil Company, Newport Bay Oil Company, Kettleman Oil Company, Clyde Jackson Oil Company, Tidewater Oil Company, Newport Oil Company (or Port Orange Asphalt Company) and the Santa Ana Oil Company. Eighteen miles southeast of the city of Long Beach, the town is situated on flat land about one mile wide behind which *...is a bluff perhaps 100 feet in height, above which is a flat mesa stretching away for a long distance to the north...* (Prutzman 1913, p. 335). Although not found, these bluffs were reported showing signs of seepage. Furthermore, the bluffs were suspected of being of fault origin instead of being formed by





Figure 2a. Circa 1940s oblique aerial view of the Los Angeles Coastal Plain showing the Newport Inglewood Structural Zone clearly demarcated by derricks (viewing northwest).

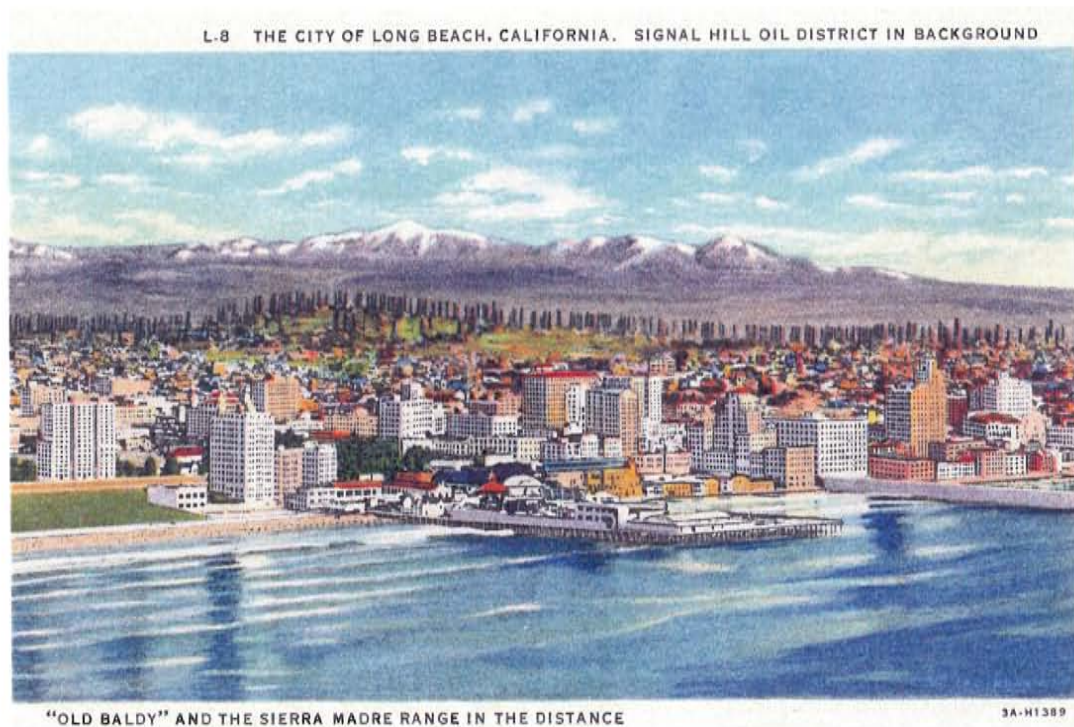


Figure 2b. Early vintage postcard showing view of the Los Angeles Coastal Plain. The line of derricks mark the position of the Newport Inglewood Structural Zone, with Signal Hill to the left of center.

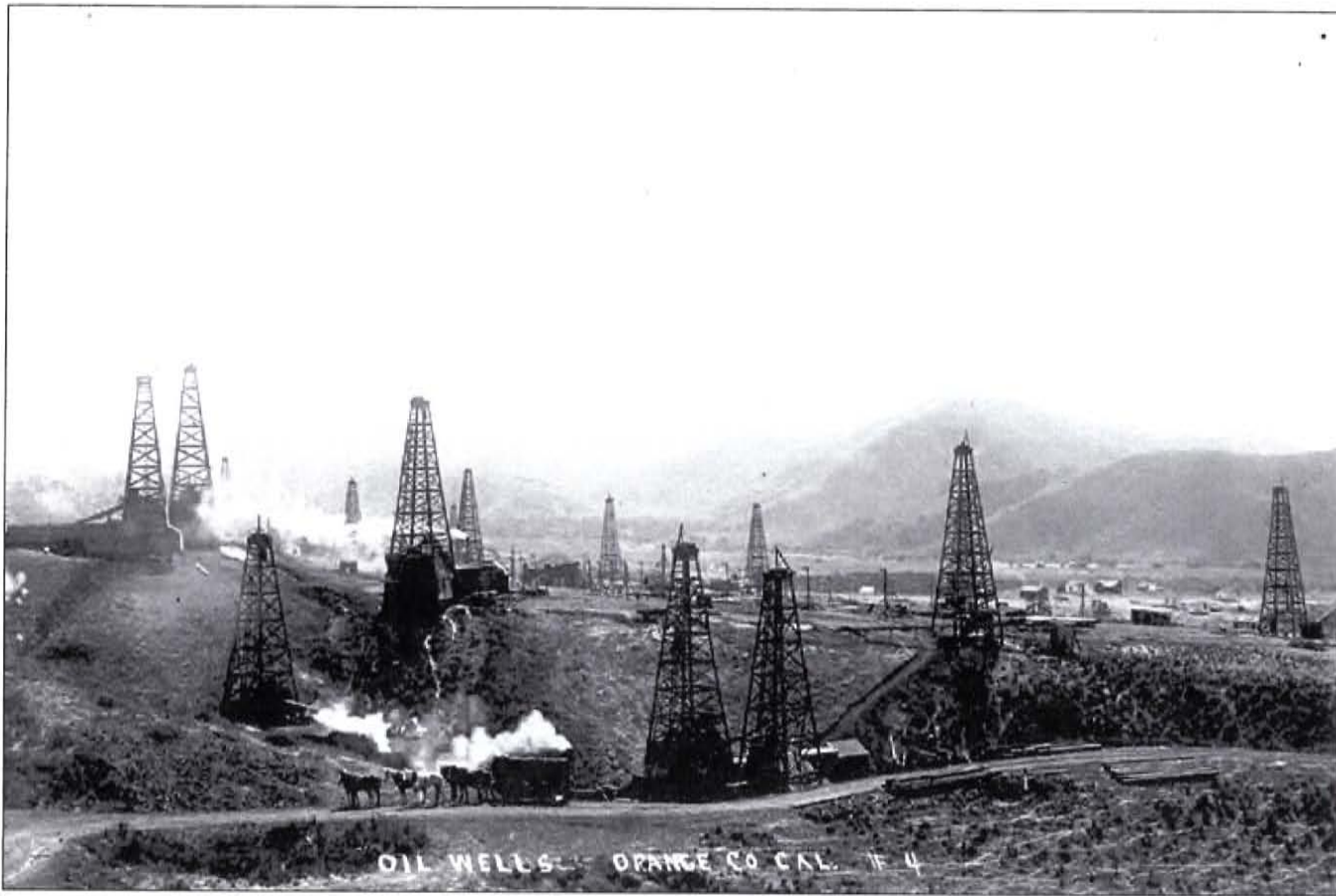


Figure 3. Early photograph of oil wells in Orange County.

wave action. By the 1920s, several operating wells would exist on this mesa (Fig. 3). Much gas was produced, and heavy oil was encountered in a well drilled by the Balboa Oil Company to a depth of 2,974 feet. Three wells drilled by the Newport Bay Oil Company between 1906 and 1910 to depths ranging from 2,640 to 3,442 feet encountered heavy oil, but all three wells were soon abandoned due to casing collapse, hole instability or the oil encountered being too heavy to pump; the company dissolved shortly thereafter. Efforts by other companies during this time would also have similar results. No indications of oil or gas would be found in Laguna Beach or San Juan Capistrano to the south.

In 1914, C. A. Waring (McLaughlin and Waring 1914, p. 357) postulated that the Beverly Hills oil field lies on an anticlinal ridge which:

*...is probably the northern end of the low ridge which passes just east of Inglewood and extends southeastward through Howard Summit, Dominguez Hill and Los Cerritos... [Signal Hill].*

Waring further suggested (p. 315) that:

*...there are possibilities that future drilling may develop considerable areas, particularly along the series of low hills extending from Beverly to Los Cerritos, near Inglewood, Howard Summit and the Dominguez Hills.*

Some drilling activity was reported prior to 1920 in the Inglewood and Dominguez fields, with most of these exploratory wells being shallow, with no oil production initiated by any of them. The California State Oil and Gas Supervisor R. P. McLaughlin in his second annual report (Kirwan, 1918a, p. 171) noted:

*...four new wells were commenced in the vicinity of the cities of Long Beach and Compton, in the Dominguez and San Pedro ranchos on the southern extremity of the range of hills of generally low relief extending from Beverly Hills in the Salt Lake field to Signal Hill, Long Beach.*

Companies operating in the Dominguez Field were the Highland Development Company, Standard Oil Company,



Union Oil Company and the General Petroleum Company. In the Inglewood Field, Bartolo Oil Company commenced drilling a well in August 1916, with drilling still in progress at the time of the report being published. In McLaughlin's third annual report published the same year (Kirwan, 1918b) he reported that Standard Oil Company's Irvine Well No. 1 commenced drilling in the Newport Field, which was to be terminated and shut off water above the first oil sand. Union Oil Company's Bixby Well No. 1 situated in the Dominguez Field was abandoned. In the Inglewood Field, six test wells were drilled by Bartolo Oil Company, two by Jordan Crude Oil Company, and two by the Amalgamated Oil Company.

Between 1920 and 1924, prospecting activities would increase, and six major fields would be discovered and were producing. Barrows (1974) would note that the discovery of so many closely spaced fields helped delineate the NISZ both in length and width. Numerous papers pertaining to the structural history and tectonic setting were written during the 1920s and 1930s, and discussions as of 1974 of the various hypotheses developed to account for features observed and inferred, were originally proposed during this earlier period.

#### OIL FIELDS ALONG THE NEWPORT INGLEWOOD STRUCTURAL ZONE (NISZ)

Thirteen major and historically significant oil fields exist along the NISZ. Their discovery commenced with the Beverly Hills field in 1900 to the Cheviot Hills field in 1958. A brief discussion of their early history, in order along the NISZ from northwest to southeast, is presented below.

##### Beverly Hills oil field

Beverly Hills was formed about a year following the acquisition of a part of the former Rancho Rodeo de Aguas for \$670,000 by Burton E. Green, a real estate man from Beverly Farms, Massachusetts. Green was head of the Rodeo Land and Water Company, and with Max Whittier and Charlie Canfield, was confident there was oil there. Essentially bean fields, 30 dry holes were drilled before and there not being enough money in beans, they subdivided and founded the town of Beverly Hills in 1906. To avoid the havoc that was experienced in the Los Angeles oil field, restrictive covenants to every deed was added that prohibited the exploration and drilling of wells. In 1911-1912, the Beverley Hotel was built in the middle of grain and bean fields which served as a meeting place for the fledging film industry. A hunting lodge became the home of Mary Pickford and Douglas Fairbanks, and soon thereafter other actors such as Charlie Chaplin, Harold Lloyd, Will Rodgers, Gloria Swanson and Fredric March, would follow. Initial efforts to lessen noise pollution arose in this field in the 1940s, with the necessity of eliminating outside

noise while shooting movies. Local zoning regulations in the 1940s required all drilling rigs to be soundproof. This was accomplished by covering the rigs with two layers of vinyl-coated glass cloth with fiberglass filling (Figs. 4a, b).

The Beverly Hills oil field is the oldest of all the fields which lie along the NISZ. Discovered in July of 1900, W. W. Orcutt drilled the first well into the field. The field initially incorporated an area where several wells were drilled on a southeastern spur of the Santa Monica Mountains, which lies less than 100 feet above the plain, situated in the southeastern corner of the former Rancho San Jose de Buenos Ayers and in the western part of Rancho Rodeo of Los Angeles. Universal Consolidated Oil Company drilled *Twentieth Century Fox 1* in February 1954 producing 525 barrels of oil per day from the Main zone (Soper 1943). The deepest well, drilled in 1964, was Gulf Oil Corporation of California *Aladdin 27E*, which extended to a depth of 12,000 feet. In the eastern section, Standard Oil Company of California S-54 extended to a depth of 12,683 feet.

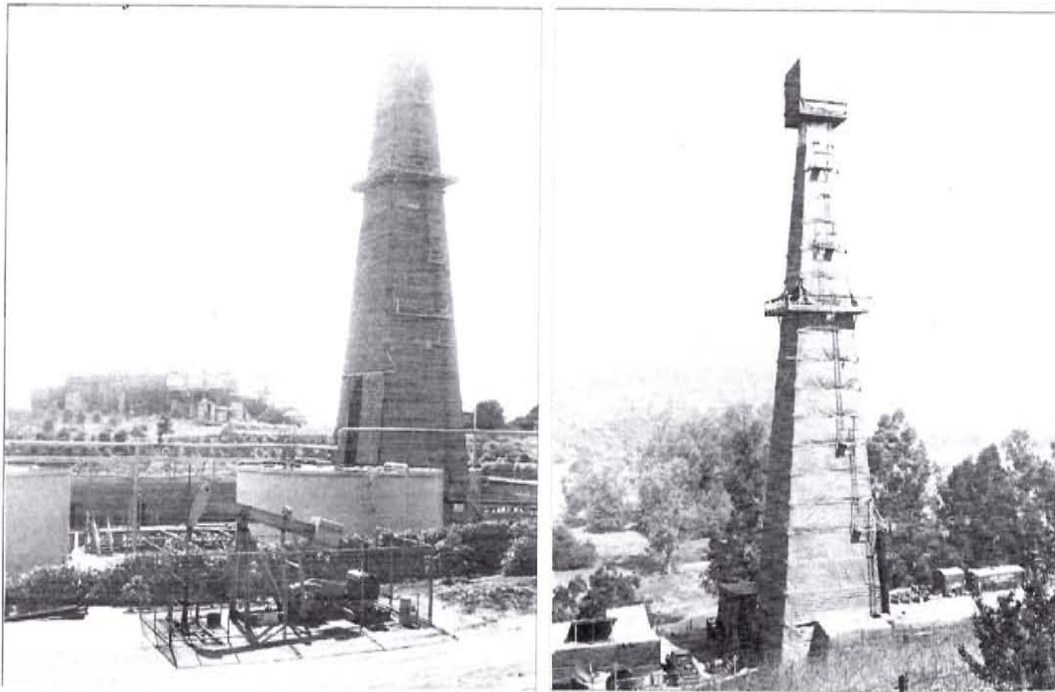
The wells are situated on a faulted anticlinal ridge, with an axis oriented approximately N 40° W, and as of 1914 suspected as being the northern extension of the ridge that ran just east through Howard Summit, Dominguez Hill and Los Cerritos (i.e., as part of the NISZ; Waring, 1914). The production zone lies between 2,000 and 3,000 feet in depth. Structurally, several small folds, in lieu of one anticlinal fold, exist which tended to disseminate accumulations of oil, and caused the need for additional wells.

As of 1914, only three companies were operating within the confines of the field. The Amalgamated Oil Company, the West Coast Oil Company and Kansas Crude. The Amalgamated Oil Company had seven producing wells along the southwest boundary of the Rodeo lease, with wells northwest of this lease line abandoned. The West Coast Oil Company had eight producing wells in the east-central part of the Wolfskill lease, and two wells in the northeastern corner of the Gillis lease. Kansas Crude had two wells also, though their location was uncertain.

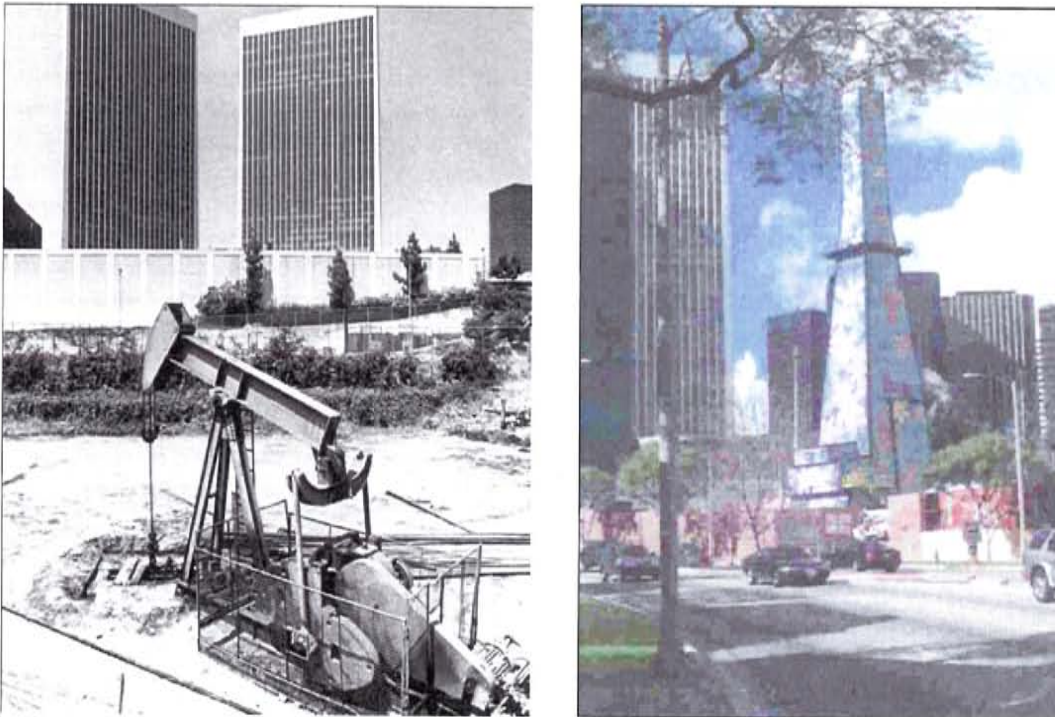
##### Cheviot Hills oil field

In contrast to the Beverly Hills oil field, the Cheviot Hills field was the last major field to be discovered along the NISZ. Discovered in 1958, it was discovered indirectly when directional holes drilled in an attempt to extend the limits of the adjacent Beverly Hills field led to a discovery across a fault, which proved to be a production barrier between the two fields (Crowder 1968). The discovery well drilled by Signal Oil and Gas Company called *Signal-Richfield-Rancho* commenced on May 28, 1958, and was drilled to a depth of 12,688 feet. The





*Figure 4a. A soundproof drilling rig operation in the Beverly Hills oil field. The 20th Century-Fox movie set is in the background. Initial efforts to lessen noise pollution arose in this field in the 1940s, with the necessity of eliminating outside noise while shooting movies. The pump in the foreground is from a well completed in the first decade of the 20th Century. When the Sansinena Field was opened in May, 1945, local zoning regulations required all drilling rigs to be soundproof which was accomplished by covering the rigs with two layers of vinyl-coated glass cloth with fiberglass filling.*



*Figure 4b. Beverly Hills High School oil pump operated by the Beverly Hills Oil Company dated 1978, and the present Venoco's drill site.*



Miocene "B" zone or Rancho zone, a sand zone between 8,355 and 9,288 feet, was shut in. Production tests on September 23, 1958, indicated 465 barrels of 34.2 gravity oil and 3,200 Mcf. of gas. In 1964, an older Pliocene zone was discovered by Signal Oil and Gas Company, producing an initial daily rate of 114 barrels of 22.7 gravity oil between 6,057 and 6,548 feet, and referred to as the Repetto. The field was fully developed by 1964, with 73 wells drilled, of which 17 of them drilled from a site in the Beverly Hills field. Thirteen wells have similarly been drilled into the Beverly Hills field from 2 of the Cheviot Hills drill sites.

The Cheviot Hills field lies within a wedge formed by the Malibu-Raymond Avenue and San Gabriel frontal fault systems, which probably intersect northwest of the field. The structure is an easterly trending, faulted anticline, combined with a syncline which buttresses against a fault to the north (Crowder 1968). Formations penetrated range in age from Recent to middle Miocene.

The important producing zones are within the Repetto and Miocene "B" zones. Peak production was in 1963, with an average daily rate of 10,200 barrels of oil and 58,500 Mcf. of gas. This field has produced over 26,950,000 barrels of oil and 142,279,000 Mcf of gas from 1,230 acres (DOGGR 2001)<sup>1</sup>.

### Inglewood oil field

The Inglewood field is situated in the Baldwin Hills, the most prominent topographic feature along the NISZ which rises to an height of about 300 feet above the surrounding plain. This group of hills forms a block, rectangular in shape, with steep escarpments along the north and west sides. The east and south sides slope gradually to the plain of the Los Angeles Basin.

Drilling commenced in this area in 1916 to a depth of 4,500 feet with no oil found (Huguenin 1926). A second well drilled in 1919 to a depth of 5,010 feet encountered only a small showing of heavy oil at the bottom. Both of these wells were subsequently abandoned. Gas was initially discovered in two wells drilled in 1920 in the extreme northwest end of the hills. Although no town-lots areas are within the boundaries of the field, this field developed rapidly by six large companies that practically controlled it, with the limits along three sides defined within six months of its discovery. The first actual discovery occurred on September 28, 1924, with a well drilled by Standard Oil Company of California. The discovery well terminated at a depth of 2,134 feet, with an initial production of 145 barrels of 19-degree gravity oil. Rapid development

followed a second successful well drilled by W. W. Bush during the same year.

The Inglewood oil field was atypical in that unlike many other fields in the Los Angeles Basin, wells in this field were regularly spaced since most of the 875 producing acres were owned by only five oil companies. However, this is only one of the few examples of an orderly development of a well field in lieu of the typical rush for small town lots in other areas. The field was also unique from previous major fields discovered in that it is relatively shallow. Structurally, the field reflects an elongated dome approximately two miles long by 3500 feet wide, along an axis striking northwest-southeast. Faulting with displacement on the order of 350 to 400 feet exist along the east edge, with a smaller fold east of the fault.

As of 1927, all but the east side has been defined, with the field encompassing 875 acres, with production from depths of 1,200 to 3,150 feet. Although rapidly developed, this field had been carefully drilled, as noted by no idle wells and few abandoned wells as of 1926 (Fig. 5). This was in marked contrast to other fields previously developed within the Los Angeles Basin. It would be noted that this field typified *...the most recent and best engineering methods of oil field development...* (Huguenin 1926). Being just 20 months old, the field would produce approximately 25,500,000 barrels of oil, equivalent to a yield of 29,145 barrels per acre. The largest initial production from this field was 4,614 barrels of 24.7-degree gravity oil, which was completed on June 13, 1925, at a depth of 2,455 feet.

### Potrero oil field

Topography on the Potrero field area is relatively flat, with an average ground elevation of about 120 feet above sea level. Due to residential and commercial development, the area necessitated directional drilling from a central drilling site, following commercial discovery. Discovered in 1928, this field is noted for its high gravity oil (32 to 51 degree API). Despite a disappointing outlook at the close of 1927, Associated Oil Company brought in well No. *Cypress 2* in April and *Cypress 3* in December of 1928. These wells proved the existence of a highly prolific structure with each well flowing at a rate of 1000 barrels of 46-48 degree gravity oil per day (Huguenin 1929).

Drilling in the city of Inglewood area began in 1931 by Ring Exploration with the drilling of two dry holes (Crowder 1958). Drilled to depths of 4,385 and 5,489 feet, they were too shallow and situated south of what would become the producing area. Actual discovery of the Potrero field occurred on October 18, 1946. The Basin Oil Company of California drilled *Standard Brick 1* which was completed at a depth of 10,418 feet, with

<sup>1</sup> California Division of Oil, Gas, and Geothermal Resources, 2001.



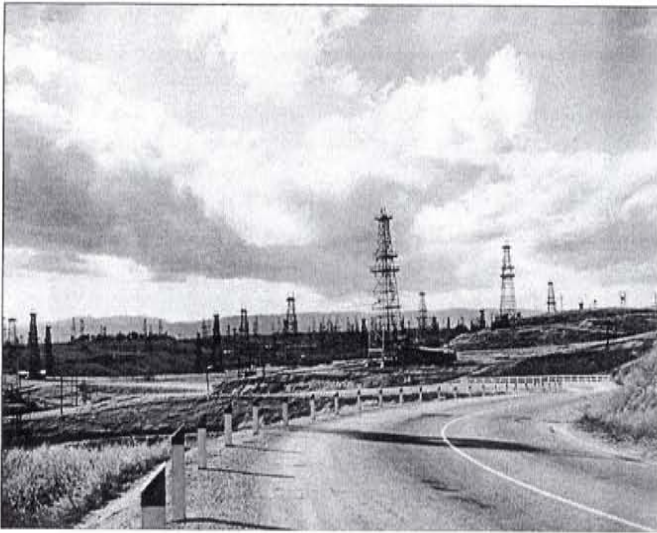


Figure 5a. The Inglewood oil field was atypical in that unlike many other fields in the Los Angeles Basin, wells in this field were regularly spaced since most of the 875 producing acres were owned by only five oil companies. However, this is only one of the few examples of an orderly development of a well field in lieu of the typical rush for small town lots in other areas.



Figure 5b. Inglewood oil well fire at the Inglewood Country Club dated December 31, 1958.

selected intervals between 9,613 and 10,418 feet, referred to as the *City Zone*. Upon completion, the well flowed at a rate of 170 barrels of 37.1-degree gravity oil, 15 barrels of water and 1,940 Mcf of gas. Over the next two and one-half years 12 wells would be completed.

On April 26, 1949, Basin Oil Company of California would discover the Seventh and Eighth zones with the drilling

of *Inglewood Community 2-2*. This well was a multiple completion from the *City Zone* (9,640 to 10,130 feet) and the overlying Seventh (8,890 to 9,280 feet) and Eighth zones (9,400 to 9,552 feet). The initial daily rate was 29 barrels of 37.3-degree gravity oil, 10 barrels of water and 210 Mcf of gas.

The Lower Zins zone was discovered on January 21, 1952, also by Basin Oil of California with the redrilling of *Inglewood Community 2-2* to a total depth of 8,459 feet. Perforated from 8,299 to 8,458 feet, the well produced 32 barrels of 30-degree gravity oil and 1,400 Mcf of gas.

This portion of the Potrero field is a faulted homocline striking northwest-southeast, and dipping about 18 degrees to the southwest. Production is limited to the southwest by a fault that parallels the field and has a vertical displacement of about 130 feet.

By 1958, the Inglewood City area of the Potrero field was fully developed. As of 1958, the proved acreage was on the order of 153 acres with 16 producing wells. Four producing zones exist (Lower Zins, Seventh, Eighth and *City zones*), of which the Lower Zins, Seventh and Eighth zones were named after equivalent zones in the Rosecrans and South Rosecrans fields. The youngest Lower Zins zone is within Pliocene sands, producing about 19 percent of the oil from this portion of the field. The Seventh, Eighth and lower *City zones* are of upper Miocene. The *City zone* is the primary producer in this portion of the field, having yielded 79.5 percent of all oil produced in the area as of 1958.

#### Howard Townsite oil field

Lying northwest of the Rosecrans oil field, the producing area was situated south of Imperial Highway and east of Venture Avenue in an unincorporated area. The productive acreage encompasses about 165 acres of relatively flat ground except for two erosion gullies. Surface elevation range from 140 to 220 feet above sea level (Mathews, Jr. 1954). The site was originally drilled in 1919, although production was not achieved until 1940.

Officially designated the Howard Townsite field by the State Oil and Gas Supervisor in 1951, by 1954, the original drill sites of three abandoned wells that produced only small amounts of oil was then a business and residential area. The first producing well was J. E. Pettijohn well No. *Westmore Land Co. 1*, completed on May 30, 1940. This well produced 60 barrels a day of 32.8-degree gravity oil, cutting 19 percent water, from an interval of 8,630 to 9,000, and was abandoned on January 14, 1946. J. Paul Getty completed the second well, *Westmore 1*, on July 15, 1944, for an initial production of 35



barrels per day. This well would be abandoned on January 1, 1946. The General Exploration Company completed well No. *Johnson 1* on June 9, 1945, and although this well produced an initial rate of 21 barrels of oil, it was redrilled to the south with no gain in structural position, and subsequently abandoned on October 11, 1951. Aggregate production of these three wells by this time totaled 45,000 barrels of oil. It was not until Shell Oil Company drilled well No. *Union-Poindexter* on May 5, 1947, that the field was deemed discovered. Nine wells would be drilled in 1948 and another eleven wells in 1949. In the four years from 1950 through 1953, only five more wells were completed.

The State Spacing Act (Act) was applied since the discovery of this field. Challenged in 1949 by a landowner who filed a notice of intent to drill a well on a parcel of land containing 4/10 of an acre, and since the Act provided for the inclusion of less-than-acre parcels in surrounding community leases, the property owner was given *...an adequate means of protection or substitute for his right to extract oil from his property.* Another litigation case of interest was *Wotton vs. Bush* where a landowner contended that the Howard Townsite oil field was part of the Rosecrans oil field. The Supreme Court of California unanimously decided that they were separate and distinct, a conclusion that was in agreement with that exercised repeatedly by the Division of Oil and Gas

The area is underlain by sands and gravels of Pleistocene age which grade into the underlying Pliocene beds. The Pliocene-Miocene contact at the top of the structure is at about 7,200 feet. The structure is a faulted anticlinal nose trending to the northwest, with faulting in the Miocene inferred to be separate and distinct from that within the Pliocene strata. The principal producing zone is the O'Dea zone of upper Miocene (Delmontian) age. The zone itself is a friable, fine-to-medium-grained silty sand. Permeabilities are low (20 to 30 millidarcys), with porosity about 20 percent. A slightly deeper zone named the eight zone was also productive. These two zones are correlated with the seventh and eighth zones, respectively, of the Rosecrans oil field.

Production from Shell Oil Company well No. *Union-Poindexter 1* was from the "O'Dea zone (or sometimes referred to as the seventh zone) from a depth interval of 8,455 to 8,630 feet; whereas, later wells obtained production from the Zins zone of Pliocene age, at depths of about 6,600 feet. Producing intervals range from 300 to 1,000 feet, with a majority of the wells producing from 700 feet or more of zone.

### Rosecrans and South Rosecrans oil fields

Discovered in 1925 and 1939, respectively, this district near the city of Compton was named after the Union army general,

William S. Rosecrans, who settled that area after the Civil War, serving as a southern California congressman from 1880 to 1884. As of 2000 the Rosecrans oil field produced over 83,541,000 barrels of oil and 167,358,000 Mcf of gas from 745 acres; whereas, the South Rosecrans oil field has produced over 9,021,000 barrels of oil and 20,738,000 Mcf of gas from 195 acres (DOGGR 2001).

### Dominguez oil field

Located on Dominguez Hill, part of the former Rancho San Pedro, the Dominguez oil field is located about 14 miles due south of downtown Los Angeles (Fig. 6). This hill is one of the outstanding topographic features marking the general line



Figure 6. Oblique aerial view of the Dominguez oil field with the City of Compton in the foreground dated April 19, 1930.

of folding extending from Beverly Hills on the northwest to the San Joaquin Hills on the southeast. About 2 1/4 miles in length and 5/8 of a mile in width, this field covers about 850 acres. Almost entirely controlled by three companies, this field was developed in a manner insuring the greatest economy and likely the greatest ultimate recovery with the least waste of gas (Dodd 1926). As such wells, were uniformly spaced about 600 feet apart.

The first drilling operations commenced with the Highland Development Company's well No. 1 on the south flank of the structure within the productive limits of the field. Spudded with rotary tools in January 1916. Other companies, Standard Oil Company, General Petroleum Corporation and Marland Oil Company of California, also started and completed test wells in the area in 1916, and Union Oil Company and Oak Ridge Oil Company, in 1922. These attempts were all abandoned as efforts to locate the structure still believed to



lie under or near Dominguez Hill failed to produce significant production. It was after completion of Union Oil Company of California well No. *Callendar 1*, when drilling was started in October 1, 1922, did the development of the field proceed rapidly. Completed on September 1, 1923, initial production was 1300 barrels per day, and after thirty days produced at a daily rate of 1193 barrels of oil from depths of 3787 and 4068 feet. BY 1926, the field would be the scene of five serious blow-outs.

Recognized by petroleum geologists for a number of years prior to the discovery of the field, the structure is an elongated dome with the major axis extending in a northwest-southeast direction. Despite the lack of seeps or other surface indications of oil or gas, understanding of the structure of the Los Angeles Basin led to the belief that the hill was a favorable location for a prospect well. With practically no surface evidence of the existence of the underground structure, the presence of the actual subsurface structure was entirely based in data obtained by drilling. Subsurface units penetrated included Alluvium and upper Pleistocene deposits, Saugus formation of Upper Pliocene and Lower Pleistocene age, Upper Pico formation of Lower Pliocene age, at least a portion of the Lower Pico formation of Lower Pliocene age.

The Dominguez oil field peaked in 1925 and produced 26,454,373 barrels of oil between the date of discovery, September 1, 1923, and October 1, 1926. Exceptionally high in gasoline content, most of the oil produced had been obtained from flowing wells, with a large percentage of them flowing as late as 1926. The Dominguez oil field has produced over 273,965,000 barrels of oil and condensate, and 386,762,000 Mcf of gas from 1670 acres (DOGGR 2001).

### Long Beach

The Long Beach field is situated partly in the corporate city boundaries of Long Beach and Signal Hill. Long Beach is the second largest city on southern California. Signal Hill, part of the former Rancho Los Alamitos, is the most prominent topographic feature in the area at 365 feet above sea level, which allows a view of the Los Angeles Harbor area. Originally considered for expensive view lots, everything changed in 1921 when an oil gusher erupted on Temple Avenue and Hill Street, attracting tourists and making Los Angeles County the world's fifth largest oil producer. The 1,400 acres had the appearance of a forest of derricks, and this field became the richest oil field in U. S. history (Figs. 7a-g).

The first well drilled within the present boundaries was Union Oil Company of California No. *Bixby 1* (Ingram 1968). Drilling commenced in 1916 and extended to a depth of 3,449, at a location southeast of the intersection of Long Beach

Boulevard and Wardlow Road. Almost five years would pass before the Shell Oil Company drilled discovery well *Alamitos 1* in March 1921. This well was drilled on the southeast flank of Signal Hill near Temple Avenue and Hill Street. Drilled to a depth of 3,114 feet, and completed on June 25, 1921, the producing interval from 2,729 and 3,114 feet produced an initial 483 barrels of clean 21.9 degree gravity oil.

An intensive townlot drilling campaign followed, but was limited to the southeast flank, with the assumption that the field did not extend a significant distance to the west due to steeply dipping outcrops along the northwest flank. This would change soon when Shell Oil Company drilled *Horsch 1* ½-mile northwest of the discovery well, quickly expanding the production area.

Later in December 1921, Shell Oil Company discovered a productive zone above that encountered by *Alamitos 1*, with *Wilbur 1* situated northeast of Cherry Avenue and 23<sup>rd</sup> Street. The Wilbur zone would initial produce 36 barrels of 23-degree gravity oil and 7,000 Mcf of gas from the interval 2,396 and 2,461 feet. During 1922, the Brown zone situated below *Alamitos 1* was discovered, and the field would be extended about three miles long and one mile wide. The Petroleum Midway Company *Ryder 1* was first to produce from a substantial portion of it, produced a daily rate of 3,650 barrels through perforations from 2,223 to 3,885 feet. The brown zone would be found to extend in excess of 1,500 feet in thickness, with some wells drilled as deep as 5,000 feet. All three zones, the Alamitos, Wilbur and Brown zones, would reach a peak of 259,000 barrels of oil per day in 1923.

In 1926, a zone below the Brown was discovered when the United Oil Company drilled well *Hass 8* southeast of Willow Street and Orange Avenue. Completed on November 17, 1926, the well produced a flowing 2,500 barrels of 29.8-degree gravity oil per day through perforation from 4,055 to 5,317 feet. This well sparked a deep-drilling campaign, with over 300 wells drilled into this zone by the end of 1929.

Other discoveries would follow. On April 1, 1938, the Upper Wilbur was discovered. In June of 1938, the deeper De Soto zone was discovered. The De Soto Oil Company drilled *De Soto 1* southeast of Gundry Avenue and 25<sup>th</sup> Street, to a depth of 10,157 feet. Initial production was 300 barrels of 28.9-degree gravity oil with less than 1 percent water. A second shallow Wilbur zone was discovered 1950 with the drilling of *Enterprise 1* by Jack C. Rogers. Then in 1951, a new pool was discovered by Golden Dome Oil Company with the completion of well *Wardlow 1*, which extended to a depth of 7,445 feet, and on April 16 flowed at an initial rate of 750 barrels of 33.5-degree gravity oil and 1,700 Mcf of gas through perforation between 6,655 and 7,315 feet. Although later determined to be correlative to the Deep zone, by the end





Figure 7a. Spencer air photo of the Signal Hill oil field dated 1930.



Figure 7b. Atlantic and 28th Street situated within the Signal Hill oil field circa 1930.

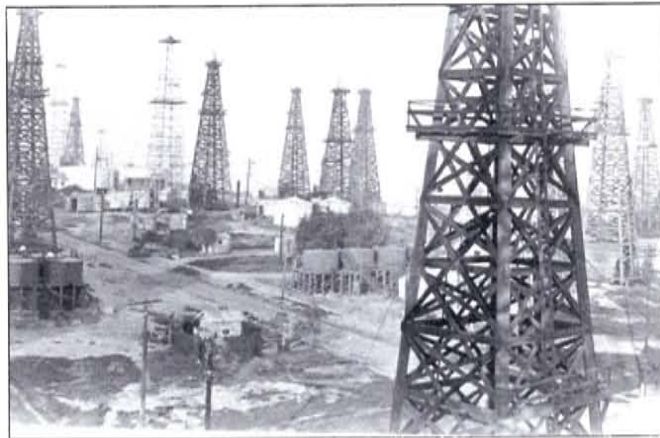


Figure 7c. Signal Hill oil field circa 1930s.



Figure 7d. Signal Hill oil field circa 1930s.

of 1952, 20 additional wells produced at rates from 300 to 1,400 barrels of oil per day.

By 1957, the California Division of Highways began acquiring and abandoning wells across the northern half of the field, along the proposed route of the San Diego Freeway. Seventy-seven wells were subsequently abandoned or re-abandoned during the next three years. In 1964, Texaco, Inc. started a pilot water-flood of the Brown zone.

The elongated asymmetric faulted anticline trending N 55° W is pronounced with strata exposed on the southern flank with a dip of 45 degrees and strata along the northern flank is dipping 15 to 20 degrees. Four major faults exist within the field: Cherry Hill, Pickler, Northeast Flank and Wardlow.

As of 2000, this field has produced nearly one billion barrels of oil and over 282,888,000 Mcf of gas from 1,725 acres, with over 14,000,000 barrels of oil estimated to still be recoverable (DOGGR 2001). Likely the richest oil spot on earth with over 500,000 barrels of oil per acre produce (in comparison with

the nearby super-giant Wilmington oil field which produces about 200,000 barrels of oil per acre).

### Seal Beach oil field

Thirteen dry holes were drilled by various California oil companies over a five and one-half year period before drilling and completion of the discovery well in 1924, at an approximate cost as high as \$2,500,000 (Barnes and Bowes 1930). Three of the dry holes did produce some oil prior to commercial discovery. Many of the dry holes though were situated immediately northeast of the NISZ.

The Seal Beach field was actually discovered by a study of topography combined with correlations using data from dry holes, and favorable evidence of oil is some of these dry holes (Barnes and Bowes 1930). The stratigraphy of the Seal Beach field is similar to that of other fields along the NISZ. The Pico and Repetto formations are represented by thicknesses of approximately 2,900 and 2,600 feet, respectively. It is the





Figure 7e. Signal Hill oil field in 1941.



Figure 7f. On the top of Signal Hill is the billed 'World's Smallest Lease' measuring 46 feet by 36 feet.

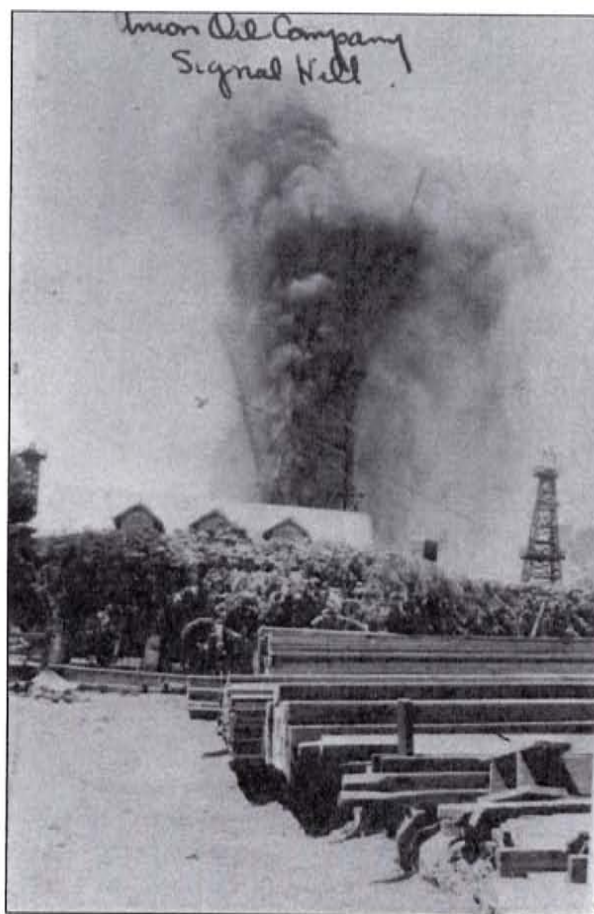


Figure 7g. An oil gusher on Signal Hill.



lower 1,400 feet portion of the Repetto formation, consisting of coarse to fine grained sands and shales, that the major accumulation of oil exist. The main producing zones are from top to bottom the Bixby (discovery well), Selover, Wasem and McGrath zones.

Structurally, the field is characterized as a high-angle faulted anticline, consisting of two domes, elongated to the northwest, and separated by a saddle. The easterly dome is larger and more elongated of the two domes. The high angle fault parallels the fold and bisects the structure for its entire length, and has a downward displacement of over 150 feet on the northeast of the easterly dome.

Very little of this field is deemed unproductive. As of February 1931, 4½ years after its discovery, the field had produced 52,833,556 barrels of oil from 206 production wells. Proved area as of 1931 was 440 acres, producing about 120,076 barrels of oil per acre. The first and greatest peak occurred in June 1937, producing about 75,000 barrels of oil per day, and was coincident with flush Selover zone development. Close spacing of wells within the Alamitos Heights area caused premature exhaustion of gas and early encroachment of edgewater. The second peak was in September 1927 and contemporaneous with flushing the Wasem zone producing about 70,000 barrels of oil per day. The third peak reflected Wasem zone development in the Main Field in July 1929 producing about 50,000 barrels per day of oil. As of 1930, about 16,500 barrels of oil per day was being produced from 113 wells among approximately 145 potential producers. Repressuring commenced in September 1927 by the Continental Oil Company, with increased production.

#### Sunset Beach oil field

The Sunset Field located in Orange County lies between the Seal Beach and Huntington oil fields. The area's history extends back to the Gabrielino Indians and although once having the reputation for drinking, gambling and brothels during the Prohibition Era, it is the home of the Naval Weapons Station and has set aside about one-fifth of the land as a wetlands National Wildlife Preserve. Several dry holes were drilled along the trend of the NISZ prior to the completion of the discovery well, Bert Aston well No. *Lomita 1* (later referred to Atlantic Oil Company well No. *F.A. F. L-2*), on June 24, 1954. Originally completed with a flow of about 500 to 600 barrels per day of 29 gravity oil and 2.8 percent water, after flowing for one month, the well was placed on the pump and yielded 190 barrels per day of 30-degree gravity oil with 16 percent water (Allen and Hazenbush 1957). This well was completed in the interval from 7,052 to 7,052 feet, and later determined to be in the lower Ramser zone. Later wells in 1954 and into 1955 would be completed Atlantic Oil Company, Warren L.

Meeker, Jack B. Wood and the Superior Oil Company. The field was drilled in a series of flurries following discovery, many being drilled simultaneously. Uncurtailed production resulted in abnormally rapid decline in both the Ramser and Lomita Lands zones.

The Sunset field extends in a northwest-southeast direction for approximately one-and-one-half miles. Production was mostly from the upper portion of the Miocene and fault controlled. Structurally, the Ramser zone was limited to the west portions of the field. The Lomita Lands zone is an elongated anticline with a small saddle at the northwest end.

Cumulatively, production through June 1957, was 3,898,146 barrels of oil and 6,620,651 Mcf. of gas. Within the interbedded sands, sandy silts and shales of the Ramser zone, about 85 to 140 feet of saturated stringers was evident in approximately 220 feet of the section. Within the Lomita Lands zone, production in the Meeker pool was from about 50 feet of saturated sand in a 100-foot interval at the top of the zone, From the Main pool, production was from about 50 to 150 feet of saturated sand from an interval varying from 80 to 300 feet in thickness. Now abandoned, as of 2000, about 6,791,000 million barrels of oil and 9,591,000 Mcf of gas has been produced (DOGGR 2001).

#### Huntington Beach oil field

The Huntington Beach field is situated just north of the town of Huntington Beach and the group of hills just northeast of town known as Los Bolsas (Figs. 8a-f). This giant oil field is occupied by dense residential and commercial developments. Oil interest in the area began with natural gas was being noticed in local water wells. Because of public safety concerns, the California Division of Oil, Gas and Geothermal Resources (DOGGR) created the Construction Project Site Review and Abandonment (CPSRWA) program to assist developers and landowners working with old oil field properties. This program essentially requires old wells to be found, surveyed, and checked for proper abandonment. Wells are required to be properly abandoned if found not to be. The field was developed through a series of discoveries often in widely separated areas, followed by intensive drilling campaigns (Hazenbush and Allen 1958). Oil was first discovered on May 24, 1920, by Standard Oil Company of California discovery well *Huntington A 1* which was completed in the Bolsa sand series at a depth of 2,381 feet producing 45 barrels of 14-degree gravity oil, then re-completed in the Ashton sands producing 70 barrels per day.

This low rate of production caused little excitement. Another well completed on November 13, 1920, referred to as *Bolsa Chica 1* produced an initial 2,000 barrels of 28-degree gravity





Figure 8a. Oblique aerial view of the Huntington Beach oil field dated 1940s.

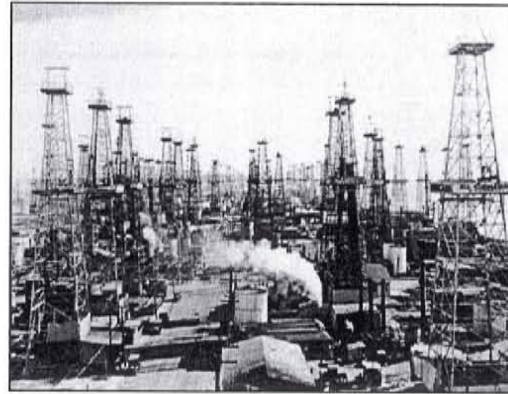


Figure 8b. Downtown Huntington Beach.

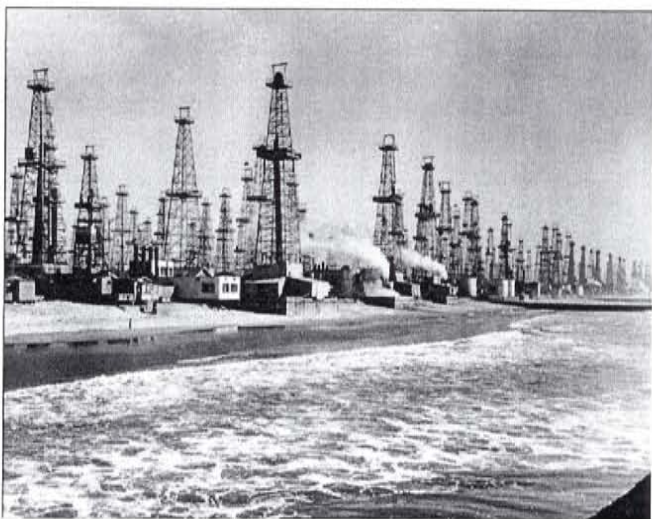


Figure 8c. Beach front property along the Huntington Beach oil field.

oil per day at a depth of 2,549 feet. Bolsa Chica 1 touched off the rush to the area. This rush accelerated development down-dip to the northeast with the drilling of *Ashton 1* by the Eddystone Oil Corporation to a depth of 3,455 feet. Located one-half mile northeast of *Bolsa Chica 1* this well initially produced 1,300 barrels of 21-degree gravity oil per day. A rapid drilling campaign followed resulting in the first of several rapidly developed areas of closely spaced wells in the Huntington Beach field.

By April 1923, production north of the NISZ reached a peak of 119,000 barrels of oil per day from 100 wells, with the productive limits of this portion of the field fairly well established, and activity subsequently declined. Other portions of the field were being developed however. The Barley field area situated northwest of 23<sup>rd</sup> Street between Ocean Avenue and Circle Drive, was being slowly developed between 1922 and 1926 by Standard Oil Company of California. With

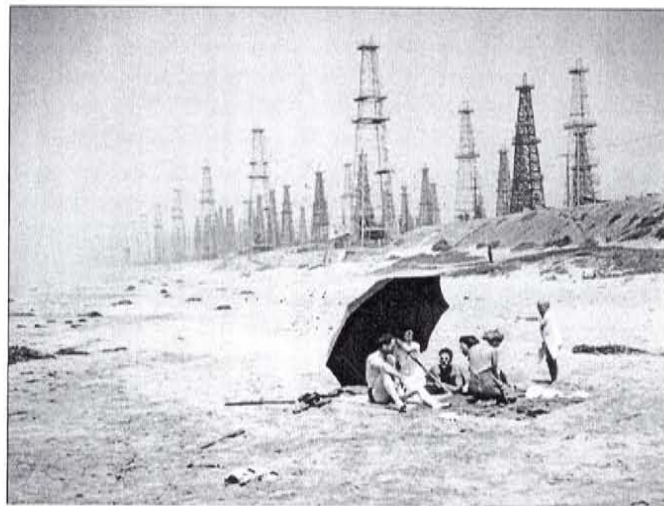


Figure 8d. Enjoying the sunshine adjacent to the Huntington Beach oil field.

drilling restrictions lifted in the Townlot area between 17<sup>th</sup> and 23<sup>rd</sup> Streets, a new zone was encountered at 3,063 feet. This zone, the Jones zone (later referred to as the Stray sand), was followed on September 14, 1926, by the Wilshire Oil Company discovery of the Lower or Main zone via deepening of their well *H. B. 1* to a depth of 4,074 feet, producing 700 barrels of 42.6-degree gravity oil per day. Intensive drilling followed with a mild drilling campaign also being initiated toward shallow sands containing heavy oil.

By 1927, five producing areas were known, with small unproductive or unproved areas intervening. By December 1923, the Old Field area, the oldest area situated northeast of the NISZ, was almost wholly developed on the northeast flank (Graser 1927). The second oldest, the Main Street area, situated southwest of the NISZ, the extreme southeast part called the Surf zone, the Barley Field area which occupies the western part of the field, and the Seventeenth Street area, the





*Figure 8e. Enjoying the sunshine adjacent to the Huntington Beach oil field; note the wave-cut cliff at the rear of the beach.*



*Figure 8f. More bathers see the sun adjacent to the Huntington Beach oil field*



last to be developed, and situated within the city of Huntington Beach.,

The first offshore pools were discovered in May 1930 by the Superior Oil Company who re-drilled *Babbitt 1*. In June 1933, Superior Oil also re-drilled *Jones 1*. Both these wells had perforated intervals of 3,828 to 4,313 feet and 3,695 to 4,185 feet, respectively, and initial production from 346 to 550 and 329 to 900 barrels per day. Both wells were ultimately found to terminate offshore under State tidelands. By early 1933, other operators were directing wells offshore, with some wells producing in excess of 2,000 barrels per day. In September 1933 a temporary injunction was filed by the State of California, and in March 1938 the State Lands Act was passed and more orderly offshore development followed. Between 1933 and 1958 operators would continue drilling toward the west, re-drilling and deepen abandoned wells, resulting in better production and discovery in 1958 of a new pool referred to as the "C" zone. Overall five zones were recognized. From top to bottom, they are the Bolsa sands, Upper and Intermediate Ashton, "C" zone and Main zone.

The Huntington Beach field is characterized by three distinct structural features: a relatively simple anticline offshore, a faulted central portion lying between the offshore anticline and the NISZ, and a northeasterly dipping flank northeast of the NISZ. Vertical displacements along the NISZ within the field range from none near the center of the field to about 1200 feet at the southeast end.

As of 1921 (Leck 1921), twelve wells were producing with a total daily production of 8,000 barrels, or daily yield of 666 barrels per well. The first production peak was in April 1923, three years following discovery, with an average daily production of 111,547 barrels per day. Production would fluctuate with the natural decline and discovery of new zones between 1923 and 1927 (Grasser 1927). The peak year of production would occur in 1927 with 26,364,399 barrels of oil and 27,800,000 Mcf of gas produced. As of 1957, the field produced a cumulative 613,723,624 barrels of oil and 570,574,590 Mcf of gas (Hazenbush and Allen 1958). As of 2000, over a billion barrels of oil and 845,000,000 Mcf of gas has been produced (DOGGR 2001), with about 36 percent of the production from offshore.

As an interesting note, one section of the Huntington Beach oil field became known as the Encyclopedia Section. This name was derived when a land promoter subdivided a small acreage of land overlooking the Pacific Ocean, and subdivided it into twenty-foot by Twenty-five foot lots for sale to potential homeowners. Due to a slump in the real estate market, the land promoter joined with a New England-based encyclopedia company to offer land as a bonus for individuals who purchased sets of encyclopedias. The aggressive sales

campaign resulted in the sale of most of the lots. Interested more in the books than the lots, many of the property deeds were filed and forgotten, and in some cases sold for as little as one hundred dollars a lot. Once it was noted that the Encyclopedia Section contained some of the most valuable oil lands in the area, these lots were now worth hundreds of thousands of dollars.

### West Newport oil field

The West Newport oil field is located in Orange County, just northwest of the Newport oil field, and near the southeast end of the Newport Inglewood Structural Zone. The presence of seepages and outcrops caused numerous wildcat wells to be drilled in this area, with some dating back to 1904 (Corwin 1946). The discovery well, as of 1946 known as Macco Corporation well No. *Banning 1*, which led to the discovery of a commercial field, was drilled on the Banning property in April 1943 by D. W. Elliott. The well was completed at a depth of 2404 feet, with an initial production of 40 barrels per day of 14.5-degree gravity oil.

Signal Oil and Gas Company in November of 1943 would drill *Banning 2*, later referred to as Macco Corporation well No. *Banning 2*, located approximately 1000 feet northeast of the discovery well. Completed at a depth of 2,497 feet with an initial production of 12 barrels per day, these wells derived their production from what became known as the "B" and "C" zones.

By 1946, well No. *Anaheim-Sugar 7-1* was drilled by A. W. Lyddon in the northerly portion of the field. Initial production was between depths of 5500 and 5550 feet, and production was on the order of 1000 barrels per day of 17.5-degree gravity oil. Signal Oil and Gas would also in 1946 drill well No. *Callens 1* producing an estimated 10000 barrels per day of 22.5-degree gravity oil.

Structurally and geomorphically expressionless, a fault boundary occurs here such that the usually N45-60W right lateral fault has a strike change of 15 to 20 degrees, and the zone widens as it breaks into numerous splays of shorter length. These are collectively referred to as the *North Branch Splays*.

As of 2000, 62,727,000 barrels of oil and 8,169,000 Mcf of gas has been produced (DOGGR 2001). Estimated reserves are on the order of 3,229,000 barrels of oil and 12,000 Mcf of gas.



### Newport Beach oil field

Formerly simply a sand-clogged harbor, the Newport Beach oil field (or Newport District as of 1921) is situated at the extreme southwestern end of the NISZ. Following harbor development, the area became the dock site for boats owned by film stars such as John Wayne, Errol Flynn, James Cagney and Shirley Temple. The boom years of the Roaring Twenties would start with the Newport oil field. Initial attempts to find oil was by the Walker Brothers Oil Company, and although they drilled a dry hole, wildcatters continued the efforts along the Newport Mesa and tidal flats for the next fifteen years. In 1922 and 1923 the Fulkerson group drilled the discovery well *Fulkerson* No. 1 in the tidal flat and the Newport oil field was formally recognized. This well produced fifteen barrels a day from a depth of 775 feet (Franks and Lambert 1985). No wells of commercial value were reported in 1921, and it was deemed doubtful that more favorable results would be obtained (Leck 1921). Several outcrops of tar were exposed along the road on the east side of Newport Bay. Leck (1921) reported the overall structure as a monocline dipping to the northwest, and this accounted for the less than commercial presence of heavy tar. A poorly developed anticline was noted and any further development was recommended along the axis of this structure.

As of 1921, this district was deemed unproven. Approximately ten wells were drilled as of 1921, and nearly all encountered heavy tar, but no commercial production was achieved. As of 2000, this field has produced 187,000 barrels of oil and condensate, and 888,000 Mcf of gas (DOGGR 2001). Although this field was plagued by water and poor quality oil, its historical significance is that it kept oil interest in the region alive. It would not be long before the potential of the Huntington Beach oil field was evident. The Newport Beach Field was only marginally economical from the beginning and only three production wells remain in this field (Clarke *et al.* 2003).

### CONCLUSIONS

Following the Los Angeles City Oil Field boom of the 1890s, other fields throughout the Los Angeles Basin were subsequently

discovered and developed. During the early 1920s, California became the most oil productive state in the country, and by 1923, one of every five barrels of oil was produced from the Los Angeles Basin. Notably, thirteen fields have since been discovered along what is referred to as the NISZ. The northwest-southeast oriented Newport-Inglewood Structural Zone is an active fault characterized by major right-lateral movement in the southeastern portion of the Los Angeles Basin. Over 3.4 billion barrels of oil have been produced from these fields since the first field, Beverly Hills, was discovered in 1900. Most of the subsequent production was derived from discovery of the super giant Huntington Beach and Long Beach oil fields in 1920 and 1921, respectively. Nearly 40 percent of the total oil production for Southern California has come from fields situated along this structural zone. Dramatic production and decline trends during the 1920s and 1930s directly reflected the closely spaced town lot drilling campaigns and unrestricted wasting of reservoir pressure.

Today, a mixed usage of land in a densely populated urban environment exists, including wetlands habitat, parklands, and commercial, industrial and residential developments. Current environmental issues along this zone are multi-faceted and pertain to seismic hazards, groundwater withdrawal and utilization, ongoing barrier projects via injection to manage salt water intrusion, gas leakage and adverse impact of the petroleum industry to overall groundwater quality (Testa 1992). In 1957, Los Angeles celebrated its rich oil heritage of Signal Hill with the symbol of oil derricks on the Seal of the County. Political correctness concerning the county's faith-based heritage resulted in this symbol's removal in 2004.

### ACKNOWLEDGEMENT

I wish to express my appreciation to my wife Lydia who assisted me with the 2007 annual meeting of the Petroleum History Institute, the field trip along portions of the Newport-Inglewood Structural Zone, and with editorial assistance with this manuscript. Thanks are also given to Don Clarke and John Jepson, and others, who coordinated and conducted the May 20, 2003, field trip along the zone, and continue to educate others in the historical and current day importance of this oil and gas producing region.



**Table 1**  
**Summary of Oil Field Statistics along the Newport Inglewood Structural Zone**  
**From Northwest to Southeast**

| Field Name       | Trap Style                              | Date Discovered | Maximum Production Area (acres; offshore in parens) | Production per Day (bbl; mcf/day in parens) | Cumulative Production (bbl as of 2000) | Active Wells (Idle) | Idle Wells | Abandoned Wells |
|------------------|---|-----------------|---|---|--|---------------------|------------|-----------------|
| Beverly Hills    | Structural and stratigraphic            | 1900            | 1,230   | 4354  | 138,788,000                            | 86, 143 wf          |            | 70              |
| Cheviot Hills    | Structural                              | 1958            | 1,230   | 279   | 26,855,000                             | 13                  |            | 43              |
| Inglewood        | Structural                              | 1924            | 1,215   | 6,950                                       | 370,712,000                            | 0                   | 6          | 700             |
| Potrero          | Structural                              | 1928            | 365   | 0   | 15,200,000                             | 4                   | 11         | 108             |
| Howard Townsite  | Structural                              | 1947            | 195   | 34  | 5,963,000                              | 56                  | 56         | 33              |
| Rosecrans-South  | Structural/structural and stratigraphic | 1924            | 745   | 600   | 93,000,000                             | 3                   |            | 336             |
| Rosecrans        |   |                 | 195   |   |  |                     |            |                 |
| Dominguez        | Structural                              | 1923            | 1,670   | 7   | 274,000,000                            | 3                   |            | 604             |
| Long Beach       | Structural                              | 1921            | 870   | 4,430                                       | 932,200,000                            | 268; 53 wf          | 269        | 2,300           |
| Seal Beach       | Structural                              | 1924            | 280   | 1420  | 210,928,000                            | 133                 | 42         | 413             |
| Sunset Beach     | Structural                              | 1954            | 3,930 (2,365)                                       | NA  | 6,791,000                              | Abandoned           |            | 120             |
| Huntington Beach | Structural                              | 1920            |   | 8267  | 1,311,518,000                          | 324; 64 wf;         | 437        | 2,878           |
| West Newport     | Structural                              | 1945            | 1,248 (80)  | 360   | 63,000,000                             | 66                  |            | 820             |
| Newport Beach    | Structural                              | 1922            | 90  | (94)  | 187,000                                | 3 gas wells         |            | 67              |



**Table 2**  
**Summary of Pertinent Historical Events per Oil Field**  
**From Northwest to Southeast Along the Newport-Inglewood Structural Zone**

| Date                        | Description of Event  |
|-----------------------------|---|
| <b><u>Beverly Hills</u></b> |   |
| 1900                        | W. W. Orcutt drills discovery well developing shallow Pliocene sands, thought at the time to be a western port of the Salt Lake oil field.  |
| 1912                        | Peak daily production reached at 246,000 barrels from 20 wells, with an average of 33 barrels per day per well.   |
| 1923                        | Last well drilled for 30 years, until the installation of backlot drill sites in 1953. Total number of producing wells until 1953 was 32.   |
| 1953                        | Universal Consolidated Oil Company discovers deeper production in the Miocene zone, and drills from a central site on the Twentieth Century Fox movie studio backlot.   |
| 1965                        | Exploratory core hole leads to discovery of the eastern portion of the Beverly Hills oil field. Occidental Oil and Gas Company develops the eastern portion of the field from its West Pico drill site at Pico and Doheny Streets in Los Angeles.   |
| 1968                        | Chevron builds the Packard drill site at Pico and Packard Streets, to develop its portion of the Beverly Hills oil field.   |
| 1980                        | Beverly Hills Oil Company develops the last urban drill site on the southwest corner of the Beverly Hills High School athletic field. Currently operated by Venoco Oil Company, this site is the only oil drilling location in the City of Beverly Hills.   |
| 1981                        | Chevron takes over the 3 Century City drill sites through its acquisition of Gulf Oil.  |
| 1990                        | Chevron commences abandonment operations on 36 wells located on three urban drill sites.  |
| 2002                        | Breitbart Energy Company makes major modifications to the West Pico drill site, including an enclosed drilling rig designed to be quiet as possible due to its close proximity to residential areas. The rig is operated by electric motors driving a rack and pinion lifting system. The driller controls the various rig systems via the use of a joystick. |
| <b><u>Cheviot Hills</u></b> |   |
| 1900                        | Production commences in the adjacent Beverly Hills field from shallow Wolfskill zone of Pliocene age.   |
| 1954                        | Wells drilled on the Twentieth Century-Fox movie studio develop the deeper Miocene zone. A production barrier caused by faulting is encountered to the southeast.   |
| 1958                        | Signal Hill Oil and Gas Company drills discovery well to a measured depth of 12,688 feet from a location on the Rancho Park golf course.  |
| 1964                        | Cheviot Hills is fully developed with 73 wells from 4 drill sites. Seventeen wells were drilled from a site on the Beverly Hills oil field; whereas, 13 wells were drilled from the Cheviot Hills oil field back to the Beverly Hills oil field.  |



**Inglewood**

- 1916 Cable tool well is used to drill 4,500 feet then abandoned in one section to the southeast of the field.
- 1918-1923 Four dry holes drilled on the east, north and west of the Inglewood anticline.
- 1924 Standard Oil's discovery well "L. A. Investment 1", situated in the extreme southeasterly edge of the field, completed in March producing 145 barrels per day. W. W. Bush drills a second production well almost 2 miles to the northwest, producing 250 barrels per day and starting a drilling boom.
- 1925 Peak production of 105,000 barrels per day from 147 wells occurs in June. Petroleum Securities Company brings in largest producer, "Rubel 9" at 4,600 barrels per day.
- 1926 Although developed rapidly, State Division of Oil and Gas determines field to be carefully drilled, and exemplifies the most recent and best engineering methods in oil field development. No idle wells and few abandoned wells exist within proved area, in contrast to most wells within the Los Angeles Basin.
- 1953 Standard Oil commences water-flooding in the Vickers zone.
- 1964 Cyclic steaming of wells in the Vickers zone commences, and lasts until 1970.
- 1992 Stocker Resources takes over operations of the Chevron property in the Inglewood field, which is later acquired by Texaco Property.

**Potrero**

- 1923 Exploratory drilling commences.
- 1928 Associated Oil drills discovery well "Cypress 1" producing 15 barrels per day, and 30 barrels per day of water. Second well "Cypress 2" produces more than 1,000 barrels per day.
- 1929 George Getty Company drills well P-1 which has the highest initial production at 1,700 barrels per day of 46 degree API oil, declining to 48 barrels per day in three months.
- 1930s Production is found in four fault-bounded blocks, with at least 8 productive zones in each block.
- 1946 Production northwest of the City of Inglewood produces 170 barrels of 37 gravity per day at 1,000 feet.
- 1947 Twelve wells directionally drilled from a central location at the Hollywood Park racetrack.
- 1995 Vertek's "Turf 2" well on the grounds of the Hollywood Park racetrack is redrilled northeast to the cemetery, outside the Potrero oil field. Well abandoned due to non-commercial amounts produced.

**Howard Townsite**

- 1947 Field discovered.

**Rosecrans**

- 1924 Potter Oil Company drills discovery well "Howard Park 1".
- 1927 Barnsdall Oil drills Upper Zins zone producing 1,600 barrels per day,
- 1932 Lower Zins discovered producing 250 barrels per day.
- 1939 South Rosecrans field discovered south of a fault barrier. Spacing Act applies.



- 1940 St. Anthony Corporation records production of 2,700 barrels per day from the South Rosecrans oil field, being the highest producer in both fields.
- 1948 Union Oil drills deepest well to 11,884 feet.
- 1957 East Rosecrans discovered.

**Dominguez Field (Giant Oil Field producing 274 million barrels)**

- 1915 Highland Development Company drills first well, but a gas blow out at 680 feet collapsed the casing. Another well drilled a short distance away drilled to 3,650 feet, and then abandoned in 1918. This well was 200 feet short of the productive zone.
- 1916 Several wells drilled on the flanks of the field with no commercial oil deposits noted.
- 1923 Union Oil completes "Callender 1" producing 1,300 barrels per day in September, This well takes 11 months to drill to 4,100 feet.
- 1924 Shell Oil Company drills "Reyes 27" on the south corner of Wilmington and Victoria Streets. Gas blow outs and water occur for 13 days, forming a crater that eventually swallows the derrick and drilling equipment. No oil produced since the flow was from a shallow gas sand situated above the oil zone. Water production measured at 100,000 barrels per day. Peak oil production at 57,000 barrels per day from 44 wells, averaging 1,300 barrels per day.
- 1926 Shell Oil Company and Union Oil develop a gas injection pilot program on the Union Oil "Callender" lease, to store excess gas and improve declining reservoir pressure, with construction beginning on 1924.
- 1935 Gas Plant fully operational.
- 1946 Water-flooding commences on the Shell "Reyes" lease.
- 1992 Crater of "Reyes 27" excavated prior to development and construction of large warehouses on Reyes lease.
- 2003 Three wells remain following abandonment operations.

**Long Beach**

- 1866 Rancho Los Cerritos encompassing 27,000 acres sold to Flint, Bixby and Company for \$20,000 (less than 0.75 cents per acre).
- 1880s John Bixby and I. W. Hellman forms Alamitos Land Company for farming, ranching and real estate development. Large portions of the flat land on and around Signal Hill are subdivided.
- 1906 Streets and sidewalks constructed on Signal Hill.
- 1916 Union Oil drills 3,500 feet dry hole, 300 feet short of first oil sand, on Bixby's Holdings at intersection of Long Beach Boulevard and Wardlow Street.
- 1919 Standard Oil geologist recommends a "position" on the Signal Hill but is over-ruled by management, due to the large number of small tracts and subdivisions.
- 1920 Discovery of the Huntington Beach field ignites leasing interests on Signal Hill. Shell leases 240 acres on the southeast hillside from the Alamitos Land Company Others notice and lease many of the large tracts and subdivided lots. City of Long Beach moves to prohibit oil drilling within the city limits, but most of Signal Hill was located in unincorporated county land.



THE HISTORY OF OIL ALONG THE NEWPORT-INDGLEWOOD STRUCTURE ZONE... - Testa

- 1921 On March 23, Shell Oil spuds "Alamitos 1" at Temple and Hill Streets. After retrieving an oil-saturated core, Shell leases additional property on the hill leading to a land rush as other companies acquire rights to remaining parcels. Concurrently, Initial production was 500 barrels per day for several days, and increased to 1,500 barrels per day.
- One of the greatest oil booms in the world begins. Four wells are completed in 1921 producing 97,000 barrels of oil.
- 1922 20 million barrels are produced from 144 wells. General Petroleum's well "Blake and Drake 1" near Willow and Walnut Streets, becomes a dramatic gusher. Located 1000 feet west of Cherry Street, this well indicated large production was possible west of the crest of Cherry Avenue. The limits of the field are extended 3 miles to the northwest and up to a mile width.
- 1923 Production peaks at 224,450 barrels per day in December from 329 producing wells, two and one-half years after discovery. Annual total was on the order of 68 million barrels producing from three zones: Wilbur, Alamitos and Brown.
- California becomes leading oil producing state in the country, with the Los Angeles Basin production accounting for almost 80 percent of the state's total.
- 1924 To prevent annexation and oil production taxes by the City of Long Beach, operators support incorporation of the City of Signal Hill, with an area of 2 square miles and a population of 2000. Lack of spacing and gas conservation regulation leads to over production. Townlot drilling, gas wastage and uncontrolled "flush" production causes rapid decline in reservoir pressure and well performance.
- 1926 Deep zone discovered below 5,000 feet. 300 wells drilled in the deep zone over the next 3 years results in a second field peak.
- 1933 1000 wells producing.
- 1938 De Soto zone discovered below 10,000 feet.
- 1945 Shell Oil drills "Alamitos 48-A" to a depth of 15,000 feet. No deeper zones encountered.
- 1952 Recreation Park drillsite situated in a golf course along the surface trend of the NISZ developed with 8 wells.
- 1957 State of California commences abandonment of 71 wells within the right-of-way for the San Diego Freeway.
- 1964 Texaco commences first pilot waterflood project in the field.
- 1972 Waterflooding success leads to operators to utilize the major portion of the field north of the NISZ into the West, Central and East Units, operated by Texaco, ARCO and Shell, respectively.
- 1984 Signal Hill Petroleum acquires Signal Hill East Unit from Shell Oil and the Central Unit from ARCO in 1986.
- 1990 Chemoil Corporation acquires the last refinery situated in Signal Hill, the MacMillan Ring-Free Refinery.
- 1994 The last refinery situated in the City of Signal Hill, Chemoil Corporation, was dismantled.
- 2000 Major redevelopment of the top of the hill begins.



**Seal Beach**

- 1921 Standard Oil drills first of 11 dry holes.
- 1922 Shell Oil drills "Bryant 1" with an initial production of 100 barrels per day. Two gas blowouts occurred during drilling. The well was drilled just north of the NISZ, and missed most of the productive oil sand. This well was abandoned in 1926 due to increasing water production.
- 1923 Shell Oil follows up with "Bixby 1" located immediately south of "Bryant 1" encounter. Although numerous oil shows were noted, once completed 3,000 barrels of hot salt water was produced.
- 1926 Marland Oil drills "Bixby 2", which will be the first commercial high production well on the south side of the NISZ, and in the middle of the field. Production begins at 1,240 barrels per day and quickly increases to 2,400 barrels per day.
- 1927 Peak production reached at 75,000 barrels per day in June. Marland Oil initiated a pressure maintenance project using "Bixby 3" as a gas injection well.
- 1954 Hancock Oil discovers the North Block East Extension area, with a discovery well producing 4000 barrels per day. This well is the first of 29 wells drilled from a man-made island in the tidal flats of Anaheim bay.
- 1960 Water-flooding commences on the Continental Oil "McGrath" lease.
- 1979 Elliot & Ten Eyck Company develops the Marine Area of the Seal Beach oil field from a drill site adjacent to the marine stadium waterway, Nine wells currently producing from this area.

**Sunset Beach**

- 1954 Bert Aston drills discovery well "Lomita 1" producing 500 barrels per day. Five months later Atlantic Oil drills another 500 barrels per day well 3000 feet to the southeast.
- 1955 The production from 55 wells results in overproduction and rapid pressure depletion within all three zones is reached. No townlot spacing due to Spacing Act.
- 1956 Production peaks at 4,400 barrels per day with 80 wells, followed by rapid decline.
- 1990 Abandonment of all wells commences.

**Huntington Beach (Super Giant – 1.3 billion barrels produced)**

- 1900 Gas entry into water well being drilled to irrigate alfalfa fields.
- 1904 Pacific City undergoes a name change to Huntington Beach in honor of Henry Huntington, developer of the Pacific Electric interurban rail line through the city. The Huntington Beach Company is formed to promote and develop the area.
- 1919 Standard Oil leases 500 acres of mesa lands from the City of Huntington Beach.
- 1920 Standard Oil completes its discovery well "Huntington A-1" producing 75 barrels per day on May 24, near the corner of Goldenwest and Summit Drive. Oil scouts take notice when Standard Oil pays \$200,000 for an additional 900 acres of leases from the Huntington Beach Company.
- Standard Oil's second well "Bolsa Chica 1" blows over the top at 2,000 barrels per day on November 13, which starts the Huntington Oil boom..



THE HISTORY OF OIL ALONG THE NEWPORT-INDGLEWOOD STRUCTURE ZONE... - Testa

- 1923 Maximum production of 119,000 barrels per day reached in April from 100 wells.
- 1926 Drilling restrictions lifted on the townlot area between 17<sup>th</sup> and 23<sup>rd</sup> (now Goldenwest) Streets. 78 wells drilled within 6 months, producing 67,000 barrels per day. Standard Oil drills Pacific Electric lease, which parallels Pacific Coast Highway for one mile.
- 1928 Local geologists believe the Townlot pool to be a limb of an anticline with a dome in the offshore.
- 1930 Superior Oil re-drills "Babbit 1" out to the tidelines in May producing 345 barrels per day. By August, production increases to 1,450 barrels per day. Independent operators McVicar and Rood develop the "removable whipstock" to deflect the drill bit towards the offshore tidelands.
- 1931 City of Huntington Beach proposes to lease the offshore tidelands, with half of the profit going to the State. Proposal is passed by the legislature, but vetoed by Governor Rolph after lobbying from Standard Oil.
- 1933 Wilshire Oil's "HB 15" well at 18<sup>th</sup> and Pacific Coast Highway is illegally drilled into the tidelands and produces 4,800 barrels per day. Upon surveying the well was found to be bottomed 1,400 feet from shore. State litigates the Termo Company for illegal production from the State's tideland oil. All tidelands' wells are ordered to be tested with a "deflection detector".
- 1936 Townlot tar zone developed.
- 1938 The State Lands Commission is created. A tideland lease is awarded to Southwest Exploration Company which leases the strip along Pacific Coast Highway north of Goldenwest Street from Standard Oil. Southwest was a partnership 75% owned by Signal Oil. During the next 30 years over 800 wells were directionally drilled, many up to 80 degrees.
- 1940 Bolsa Chica wetlands drilled during push for World War II oil supplies. Large steel derricks are skidded to each well site for drilling.
- 1953 Southeast extension of the Townlot area discovered, east of Main Street with a re-drill of a previously abandoned well. The well produced 500 barrels per day, with a rapid decline.
- 1954 Subsequent wells drilled to the Main and Jones zones produces between 250 and 750 barrels per day, and touch off the last Huntington Beach oil boom. In the next several years 216 wells are drilled in a 30-block area. Many are directionally drilled under the Main Street business district. Many houses are moved to make room for drilling locations. The high number of wells result in a rapid decline rate and the average production is 15 barrels per day per well after several months.
- 1962 Platform Emmy installed to develop the offshore extension of the field. Water flooding commences in the strip area.
- 1964 Stream-flooding commences in the tar zone.
- 1970s Rising oil prices and increasing land values leads Standard Oil to abandon it's old wells and drill replacements from central drillsites. Drillsite consolidation opens up its fee property for redevelopment as home sites and a golf course. Overall, 19 drillsites are created and 120 wells new wells are drilled.
- 1990 Angus Oil Company drills 23 wells from the last drillsite in Huntington Beach on California Street north of Adams Avenue.
- 1998 The new operator of the Angus drillsite, The Termo Company, suspends production due to poor waterflood conformance (*i.e.*, the inability to shut off high permeability "thief zones" which take a large portion of the injection water and cycle it back to the producers.

- 1999 State purchases the Bolsa Chica wetlands for restoration as Wildlife habitat.
- 2001 Ocean Colony homes are built at the northwest edge of the Huntington Beach mesa, adjacent to producing oil wells. The tract homes now sell for over \$1 million dollars.

**West Newport**

- 1943 Field discovered.
- 1944 Gas production encountered 1 mile northwest in City of Huntington Beach
- 1946 Two wells completed in northern portion of field producing 1,000 barrels per day.
- 1950 Two directional wells drilled by Jergins Oil from wetlands back into City of Newport Beach.
- 1954 Monterey-Humble Company drills 15 wells from tidelands to the Seaside Colony tract, and discovers off-shore production
- 1959 Macco Corporation initiates enhanced fire-flooding using air injection wells.
- 1979 Enhanced stream-flooding using 12 gravity oil on the Banning lease.
- 1992 Enhanced water-flooding.
- 1993 West Newport Oil Company commences abandonment on the Banning lease.
- 2001 City of Newport commences water-flooding in their offshore wells.

**Newport Beach**

- 1900 Field discovered.
- 1912 Peak production of 675 barrels per day from 20 wells reached.
- 1924 Peak production of 20,000 barrels produced by 4 wells.
- 1920-1955 Only a couple of wells producing from shallow oil sands.
- 1945 Field abandoned.
- 1976 Shallow gas wells drilled.



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#### Photograph Sources:

1. All photographs are courtesy of the Los Angeles County Library, with the exception of Figures 4a and 4b which are from Franks and Lambert (1985) - the photograph is current.
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**Stephen M. Testa**, a native of Fitchburg, Massachusetts, received his Bachelor and Master degrees in Geology from the California State University at Northridge. A consultant for over 25 years specializing in engineering and environmental geology, in the summer of 2005 he went into public service and currently serves as the Executive Officer of the California State Mining and Geology Board. He is past president of the American Institute of Professional Geologists, American Geological Institute, and the Los Angeles Basin Geological Society, and served as the 2007 Chairman of the Annual Meeting of the Petroleum History Institute.



