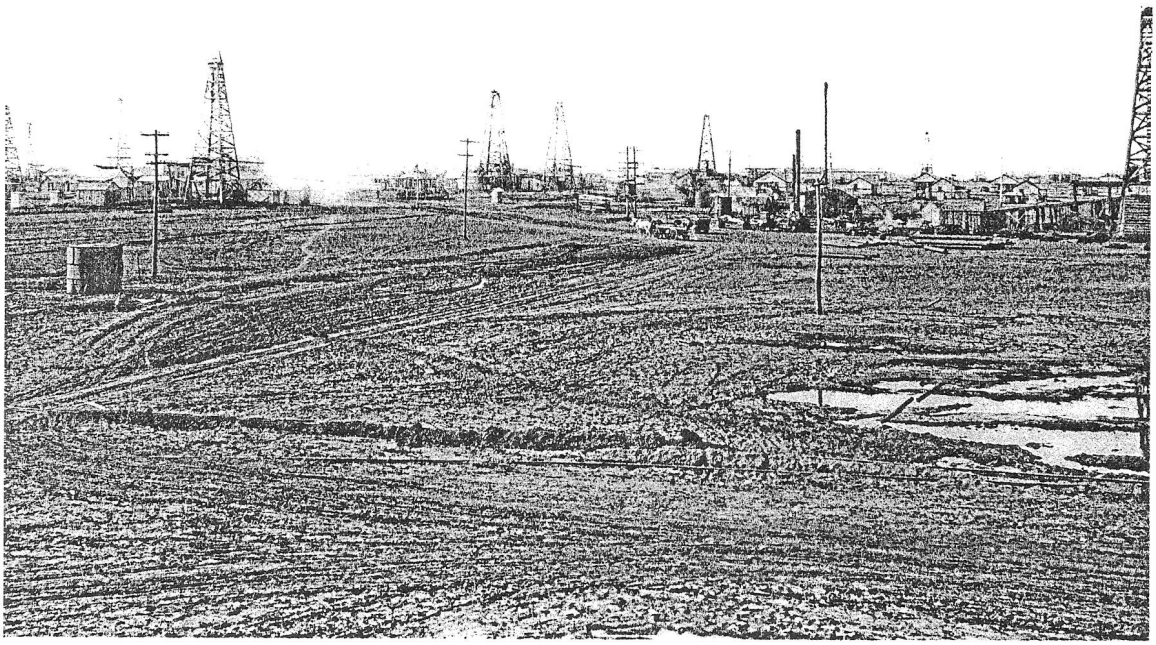
Oil-Industry History

A publication of the Drake Well Foundation



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GEOLOGIC PERCEPTIONS REGARDING OIL PROSPECTS AND FUTURE GROWTH AND DEVELOPMENT OF CALIFORNIA IN THE POST-GOLD RUSH ERA

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ABSTRACT: The post-gold rush era represented the first major phase of oil exploration and production in California. During this period, the California legislature became concerned about a declining economic climate and was searching for a means to spur the economy and encourage future growth and development. This decline reflected in part a transition from surficial placer to underground lode mining and the continued influx of immigrants.

Prior to establishment of the California Geological Survey under J.D. Whitney in 1860, several individuals commented on the presence of bitumen in California. Early reconnaissance by several individuals was performed from 1849 through 1854. Observations and optimistic predictions were reported and subsequently published by Philip T. Tyson (1851), John B. Trask (1853 and 1855), William P. Blake (1857) and T. Antisell (1857).

In April of 1864, promoters requested Benjamin Silliman, Jr., to assess the economic potential of oil resources in California. Silliman had former practical experience in the Pennsylvania oil fields, and after a short investigation predicted a great future for oil deposits in southern California, a conclusion wholly supported by his former student Blake. Silliman's report sparked the first but short-lived oil boom in California from 1865-1866. Failure to obtain a large high-grade crude oil supply in comparison to cheap Pennsylvania oil arriving in San Francisco during the post-Civil War period resulted in a decline in exploration and production activities from 1866-1875. The drilling of shallow wells in the Pico Canyon area in 1875, use of steam machinery in 1877, and the completion of the Southern Pacific Railroad from San Francisco to Los Angeles County in 1876, contributed to the revival of exploration and production activities.

Following the formation of the Survey (1860-1874), Whitney along with his assistant Brewer, the latter also a former student of Silliman, had little to no desire to assist mining and oil promoters in their activities. Whitney and Brewer did not endorse the wave of optimism associated with oil speculation in the mid-1860's and viciously attacked Silliman, and to some degree, Blake, on the economic viability of oil and mineral resources in California. Blake, a formidable opponent of Whitney throughout their respective professional careers, continued his opposition to Whitney on a number of other important geologic issues, and maintained his optimistic prospects regarding the future of oil in California.

Others shared Whitney's pessimistic attitude regarding the future economic potential for oil in California, including as of 1885 the United States Geological Survey. History, however, has demonstrated that Blake and Silliman were correct in their persistent optimism pertaining to the future of oil in California. Their observations and evaluations encouraged speculation in exploration and production, and helped prepare California for the 20th Century.

INTRODUCTION

The post-gold rush era represented the first major phase of oil exploration and production in California. The 1850's marked an economic transition period for California reflecting a change from predominantly surficial placer mining to underground lode mining, with a continued influx of immigrants. It was during the mid-1850's that the California legislature became concerned about a declining economic climate and pursued means to spur its economy, and encourage future growth and development. With the discovery of oil by Edwin Drake in Titusville, Pennsylvania, in 1859, interest in the production of petroleum-derived kerosene as fuel for oil lamps commenced. Kerosene was a cheaper and cleaner burning fuel in comparison to camphene lamp oil, and cost less than whale oil. Further, with the onset of the Civil War, the availability of oil and kerosene derived from the east declined, resulting in increased interest in exploring for oil in California.

Interest in the exploration and development of oil resources in California during the latter half of the 19th Century was episodic in that societal factors such as economics, transportation, technology and market needs all played a role. The willingness of promoters, investors and prospectors to pursue exploration and development of California's oil resources was dependent upon the evaluation set forth by a few individuals. Although petroleum science was at its infancy, with little understanding of petroleum chemistry and its origin and occurrence, let alone its potential uses, certain individuals remained steadfast in their optimistic prospects, despite much controversy.

From a refining and production perspective, the post-gold rush era presented a change from the use of whale oil to camphene for illumination and lubricating purposes. This was followed by the use of kerosene-based oils and the increasing need for fuels by the turn of the century. From an exploration and development perspective, and some of the major events that drove it, this period can divided into four general phases: Early Reconnaissances (1849 - 1864), First California Oil Boom (1865 - 1866), Doldrums (1866 – 1875), and Revitalization Period (1875 - 1900) (Table 1).

EARLY RECONNAISSANCES (1849-1864)

Early reconnaissance of California during the height of the gold rush and during the following decade spurred early interest in petroleum. Observations and optimistic comments

Table 1. Summary of Key Events for the California Oil Industry during the 19th Century

Date	Key Event
Early Reconnaissances (1849-1864)	
Tyson conducts a reconnaissance of parts of northern California	
1853	Trask conducts a reconnaissance of portions of the Sierra Nevada and Coast Mountains.
	Trask conducts a geological reconnaissance of the Los Angeles area.
	William Blake as part of the Pacific Railroad Survey later conducts reconnaissance of California from the San Francisco Bay area to northern Mexico
1854	Thomas Antisell as part of the Pacific Railroad Survey produces first geologic map of California showing thirteen significant surficial asphaltum seeps
	Natural gas discovered at Stockton.
1856	Andreas Pico distilled oil in a copper still and worm for use in illuminating the San Fernando Mission from surface seepage in Pico Canyon, northern Los Angeles County
1857	George Dietz and Company erects a Camphene still in San Francisco
	George Gilbert aided by Charles Hosmer began distilling liquid bitumen and asphaltum first at San Francisco, then in a small refinery on the Ojai Ranch near San Buena Ventura becoming the first successful commercial petroleum refinery in California (produced about 400 barrels of marketable oil)
	Charles Morrell erects a distilling plant near the maltha seepage in vicinity of Carpenteria in Santa Barbara County, and produces illuminants (coal oil) without commercial success
	W. W. Lankin, W. C. Wiley and S. Lyon visit Pico Canyon and encountered petroleum at Pico, Hooper, Sespe, Castaic or Pine, and Piru Canyons.
1860	California Geological Survey established under Josiah D. Whitney.
1861	First actual well drilled for the purpose of producing oil on the Davis Ranch, Humboldt County.
1864	Benjamin Silliman, Jr. arrives in California and his optimistic report sparks California's first oil boom (1865-66).
	Natural gas first developed from an artesian well in Stockton.
California's First Oil Boom (1865-1866)	
1865	Tunnels driven by the Stanford Brothers and Hayward & Coleman at Sulphur Mountain north of Santa Paula.
	Union Mattole Oil Company of San Francisco completes first oil producing well on North Fork of Mattole River, three miles east of the community of Petrolia.
	Some 65 oil companies operating from Humboldt County south to Ventura County.
1866	Josiah Stanford first to establish commercial production of petroleum in California.
	Buena Vista Petroleum Company (formed in 1864) erects still at a spring three miles northwest of McKittrick.
The Doldrums (1866-1875)	
1867	Thomas R. Bard first to establish sustained production of petroleum from a drilled well on the Rancho Ojai near Ventura. Well Ojai No. 6 extending to a depth of 550 ft and producing 15-20 bpd is first to yield extended production on a profitable basis in California.
	First oil boom ends. Following the Civil War, Pennsylvania kerosene production increases,dropping price from over $1.70 per barrel to $0.54 or less within two years.
	California exhibits oil specimens at the Paris Exposition of 1867.
1869	First work done at Pico Canyon by Hughes who put down a spring-pole well called the Pico Well.
	Transcontinental railroad completed.
1870	First producing oil and gas well in Pico Canyon near Newhall in Los Angeles County.
1871	Oil found on Augmentation Ranch, Santa Cruz County, and Livermore Valley, Alameda County.
1872	Continued work at Sulphur Mountain with better success.
1873	Star Oil of Los Angeles built first still in San Francisco and shipped it to Los Angeles.
1874	California Geological Survey terminated.
Revitalization Period (1875-1900)	
1876	California Star Oil Works Company completes Pico No. 4 extending 300 feet in depth and producing 30 barrels per day; the first truly commercial oil well in Pico Canyon, southern California.
	Southern Pacific Railroad extended south to Los Angeles
1880	Oil discovered in the Los Angeles basin.
	California State Mining Bureau established with a State Mineralogist, Mr. Henry G. Hanks, Esq., in charge.
1887	Coalinga field started.

1891	Jewett and Blodgett refinery established at Old Sunset.
1892	E. L. Doheny brought in the Los Angeles discovery well. Before 1901, over 1000 wells situated in northwest part of the city.
1893	Southern Pacific Railroad extends spur line to the community of McKittrick (then known as Asphalto).
1895	Oil boom in Los Angeles
1898	McKittrick oil field discovered. Milton McWhorter built small refinery at McKittrick
	John B. Treadwell completes Summerland Treadwell Wharf extending into Santa Barbara Channel; first offshore oil well completed extending 390 feet in depth and 200 feet from shore. By 1900, 19 wells operate on pier.
	Earliest formed geological department within an oil company, the Union Oil Company of California, under W. W. Orcutt.
1899	Kern River and Brea Canyon oil fields discovered; first drilled well in the Kern River completed about seven miles north of Bakersfield; over 200 oil companies formed shortly afterwards.
1903	Pipeline completed from Kern River field to Point Richmond near Martinez (280 miles, 8-inch line), with branch line from Coalinga field to Standard Oil Company refinery.

California becomes nation's top oil-producing state (24,382,000 barrels/year).

(Compiled from several sources including California State Mining Board, 1885; Latte, 1949; Stalder, 1943; White, 1962; Rintoul, 1978 and 1990).

Table 2. Petroleum Production during the Revitalization Period (1875-1900)

Date	Production (In barrels)	Value (In dollars)	Major oil field discovered (All from surface seepage)
1875	175,000	$472,500	Pico Canyon; Ex-Mission
1876	12,000	$30,000	
1877	13,000	$29,250	
1878	15,227	$30,454	
1879	19,858	$39,719	
1880	40,552	$60,828	Puente
1881	99,862	$124,828	
1882	128,636	$257,272	Tapo Eureka
1883	142,857	$285,714	
1884	262,000	$655,000	
1885	325,000	$750,750	Sisar-Silverthread
1886	377,145	$870,205	Half-Moon Bay
1887	678,572	$1,357,144	Hopper Canyon; Sespe; Wiley Cyn
1888	690,333	$1,380,666	Puente
1889	303,220	$368,048	Elsmere Canyon; Newhall; Rise Cyn
1890	307,360	$384,200	
1891	323,600	$401,264	
1892	385,049	$561,333	Conejo; Los Angeles
1893	470,179	$608,092	
1894	783,078	$1,064,521	Bardsdale; Summerland
1895	1,245,339	$1,000,238	
1896	1,257,780	$1,180,793	Torrey Canyon
1897	1,911, 569	$1,918,269	
1898	2,249,088	$2,376,420	McKittrick; Modelo; Whittier
1899	2,677,875	$2,660,793	Brea Canyon; Kern River
1900	4,329,950	$4,152, 928	East Coalinga; Temblor Ranch

(Data derived from Pemberton, 1943)

were reported and subsequently published by several individuals including Tyson (1851), Trask (1853 and 1855), Blake (1857; formerly Williamson 1856) and Antisell (1857).

Philip T. Tyson - 1849

Philip T. Tyson of Baltimore came to California with T. Butler King who was sent by the United States Government (Fig. 1). Tyson was the first to write about the geology of California after the discovery of gold in 1848. In 1849 Tyson performed a hasty four-month geological reconnaissance of parts of northern California from Benicia to the American and Calaveras Rivers. Focused more on the mineral resources of the area during the delirium of gold fever, Tyson did briefly comment on bitumen:

> "There are large springs of mineral tar on the southern coast, especially near Santa Barbara". (Tyson 1851, p. 89)

Figure 1. Philip T. Tyson (1799-1877) of Baltimore arrived in California in 1849 and prepared the first official report pertaining to geologic features of California.

Dr. John Boardman Trask - 1853

Dr. John B. Trask was born in Roxbury, Massachusetts, in 1823, and studied medicine at Yale (Fig. 2). Trask may have also attended lectures given by Benjamin Silliman, Sr., and James Dana. Trask arrived in southern California as part of the "California Company" headed by John W. Audubon (Leviton and Aldrich 1982). On May 6, 1853, the Senate and Assembly of the State of California passed a resolution authorizing a geological examination of some parts of the Sierra Nevada and Coast Mountains. It was Trask who performed this examination. Trask was also referred to as State Geologist, even though the office of State Geologist was not formally established in law until 1860.

Figure 2. Dr. John B. Trask (1823-1879) arrived in California with John W. Audubon in 1853, and conducted several geological excursions throughout northern and southern California, making the public aware of the state's mineral resources.

His initial efforts produced a "*Report on the geology of the Sierra Nevada, or the California Range*" (Trask 1853). In May of the same year, a joint resolution was passed authorizing further geological examination of some parts of the Sierra Nevada and Coast mountains, and providing that a report of the results should be presented to the next Legislature (California State Mining Board 1884). On June 23, Trask commenced on the southern part of his excursion. For the next four months he journeyed through the counties of San Francisco, Santa Clara, Santa Cruz, Monterey, and the northern part of Luis Obispo returning from the east through the Monte Diablo Range in the west part of Tulare County, Mariposa, Tuolumne, Alameda, Contra Costa and San Joaquin. From October 1 to November 28, Trask would travel through Solano, Napa and Sonoma counties, producing a section from Napa across the basin of Sacramento, connecting it with examinations made two years earlier. Another section was made 18 miles south of Mount Diablo continuing across the San Joaquin. Trask concluded his examination investigating mining sections of Nevada and Calaveras counties.

Trask's work was important in the sense that it called public attention to the great economic value that could result from geologic work in California. Although Trask concentrated primarily on mineral resources, he was also particularly interested in bitumen.

> "Bituminous springs abound through the Coast Mountains, and in some places is much used in the construction of buildings, and walks in front of buildings; for the latter purposes it is admirably adapted in situations where the sun will not have too powerful an effect upon it,

as in such cases it is apt to become soft. In the counties of Santa Clara, Santa Cruz and Monterey, several of these springs occur, and further south are found more abundant. Information has been received of an extensive deposit of bitumen in Contra Costa, some six miles from the shores of the bay, but at what point I have as yet been unable to learn. This article has been used of late in the manufacture of gas, for illumination, and it possesses some advantages over the common oil or resin gas in general use; a sufficient quantity for the illumination of the country may be easily obtained and at low rates when required for this purpose." (Trask 1854, p. 59)

Trask's 1855 report devoted to the agricultural potential and mineral resources of the Los Angeles area, also showed interest in bitumen. He pondered that if native bitumen could be used for the manufacturing of illuminating gas in place of more expensive imported coal, he forecast a day when bitumen would surpass the cattle trade as the chief source of income for the southern counties (Trask 1855). Trask's vision was soon to be shared by a geologist with the Pacific Railroad Survey.

William Phipps Blake and the Pacific Railroad Survey - 1853

William P. Blake in 1853 was the geologist and mineralogist that accompanied Lieutenant Williamson of the Topographic Engineers from San Francisco to Yuma as part of the Pacific Railroad Survey (Fig. 3). Blake was a former student of Silliman, Jr., at the Yale Scientific School, and a distant cousin of Josiah D. Whitney. It was Whitney who mentioned Blake to Professor Spencer F. Baird, Assistant Secretary of the Smithsonian Institute, who recommended him to Williamson's Senior Officer, Lieutenant Amiel W. Whipple (Raymond 1911; Dill 1991; Testa 1996). The purpose of the survey was to explore the Sierra Nevada from Walker's Pass southward to the boundary, and ascertain the best and most accessible mountain passes, thus, most practicable route for a railroad.

Figure 3. William P. Blake (1826-1910) arrived in California in 1853 serving as geologist and mineralogist for the Pacific Railroad survey under Lt. Williamson. A former student of Silliman, Blake would perform geologic examinations of mining and oil prospects on behalf of Silliman and others.

Prior to arriving in San Francisco to join the survey party, Blake sailed north along the California coastline, recording in his field notebook "bituminous effusions" he found along the coast for some 300 miles south of San Francisco (Blake 1853; field notebook Vol. 15). Leaving Benicia on July 8, 1853, the party made a continuous reconnaissance proceeding to the Tejon and Walker's Pass, passing through Livermore Valley, the San Joaquin Valley, the Tulares, before proceeding southeast to Walker's Pass, the Tehachapi, Tejon, Canada de las Uvas (the grapevine), the passes north of Los Angeles, and the Cajon from the Mojave to San Bernardino. The explorations were extended southward along the mountains to San Bernardino, entering the Colorado Desert area through San Gorgonio Pass. The party would eventually head for Warner's Ranch to Vallecito, San Felipe and Carrizo Creek on to Fort Yuma.

In May of 1853, as Blake sailed north along the southern California coastline, and later in September when in the vicinity of Los Angeles, he reported:

"We cite some observations on Bitumen Springs – p. 68. It is an interesting fact, which I believe is not generally known, that there are numerous places in the Coast Mountains, south of San Francisco, where *bitumen* exudes from the ground, and spreads in great quantities over the surface. These places are known as *Tar Springs*, and are most numerous in the vicinity of Los Angeles. It is common to meet with large quantities of this material floating on the Pacific, west of Los Angeles, and northward toward Point Conception. I have seen it, when passing this point, floating about in large black sheets and masses. They are probably the product of submarine springs; or they may be floated down by small streams from the interior.

"Some of the springs I examined near Los Angeles were nothing more than overflows of bitumen or asphalt from a small aperture, around which it had spread out so as to cover a circular space of about thirty feet in diameter. This had hardened by exposure, and was covered and mingled with dust and sand, which quickly adheres to its clean and fluid surface. The outer portions were hard as a pavement; and the mass was highest towards the center, where it was soft and fluid, like melted pitch. It was thus evident that all the hard portions had risen in a fluid state, and by the heat of the sun had been gradually spread out over the surface. Being constantly exposed to the dust, it had become so thoroughly incorporated with the asphalt that the

compound had all the consistency of an artificial admixture.

"The spring that I have described is one of several similar ones, about seven miles from Los Angeles, on the banks of a small brook, and is underlain by bituminous shales. Bituminous shales are also exposed at the shores of San Pedro, near the base of vertical bluffs of the sedimentary formations of the slope." (Blake 1856, p. 284)

Blake would observe the residents of Los Angeles make use of large quantities of the material being used for covering their buildings and pavement.

"The value of this material for making pavements, roofs, cements, and in the manufacture of gas and oil, cannot be lightly estimated, and it should be regarded as one of the valuable mineral productions of the State." (Blake 1856, p. 285)

Blake produced the first geologic map of the State, and numerous geologic cross-sections that accompanied his report. He did not, however, locate any of the bitumen occurrences on his geologic map or cross-sections that accompanied his report.

Most notable is what Blake wrote in his field notebook on September 24, 1853 (Blake field notebook no. 22). Lt. J. G. Parke brought a specimen of asphaltum from a presumed unknown spring near Los Angeles to him. Blake wrote:

"There is a lake from which the residents take it in immense quantities for pavement & roofs. It becomes soft & fluid in the middle of the day, but in the morning heals readily with a conchoidal fracture & is chopped up into small pieces & spread up on the roof."

On the 28th, he profoundly states after performing a simplistic blowpipe field test:

"Asphaltum brought by Parke...In close tube, gives off quantities of inflammable gas burning with a bright flame & the coke. A dark oil or coal tar collects in the tube. Much nonvolatile carbon or coke (finer powder remains). This I suppose singular, but have not Dana by me for reference. This will of course be a valuable material for gas & fuel."

Thomas Antisell, M. D. and the Pacific Railroad Survey (1854-1855)

Following Blake's excursion that ended in December of 1853 was a potential railroad route from the San Francisco Bay area to Los Angeles, west of the Coast range led by Lt. J. G. Parke. The Scottish geologist who accompanied Parke was Thomas Antisell (Fig. 4). This survey departed Benicia on November 22, 1854, and continued to April 5, 1855, and would traverse

Figure 4. Thomas Antisell, (1817-1893) a medical practitioner, served under Lt. Parke with the Pacific Railroad Survey in 1854, and produced the first map of California showing most of the major locations of "bituminous effusions" in the Coast Range

five counties covering almost the whole shoreline of southern California: Santa Cruz, Monterey, San Luis Obispo, Santa Barbara and Los Angeles. Antisell, a physician and chemist, would single out for special comment thirteen areas where seepages were observed, of which several would become prominent oil fields (Antisell 1856).

Antisell wrote in Chapter XVI titled Bituminous Effusions:

"Bitumen is *par excellence* the mineral of southern California, being found in almost every county south of San Francisco... It is remarked of most of these deposits that they are situated close to the sea...On the shore at San Diego and at False Bay, north of Point Loma, masses of asphalt are washed ashore by the tidal action. The submarine exudation cannot lie far out"

Antisell specifically noted most of the known occurrences of bitumen, thirteen in all that he briefly described, and located them on his geologic map that accompanied his report (Fig. 5). This map indicates for the first time deposits of bitumen, or oil, in California. Antisell also provided illustrations and cross-sections to supplement his report. Internal and external views of geologic phenomena were constructed to suggest structure (Fig. 6). Asphalte Cliff, Santa Barbara, is where Benjamin Silliman, Jr., claimed to have discovered oceans of oil. Crude sections were also generated to suggest relationships of various rock strata.

Antisell offered an explanation as to the occurrence of bitumen. In regards to its occurrence, Antisell wrote that:

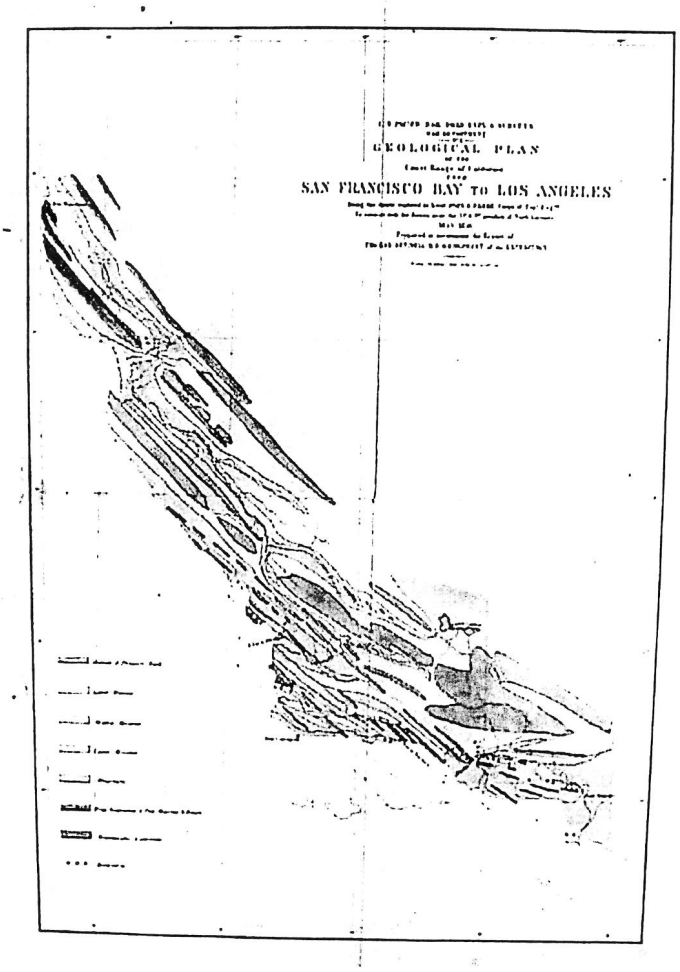
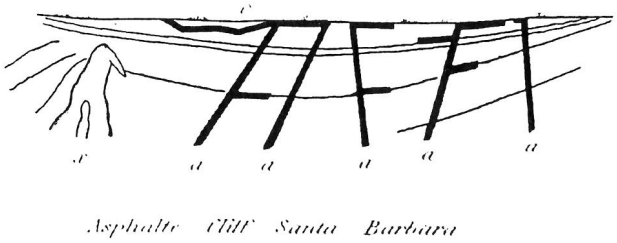


Figure 5. Antisell's map of California showing the preponderance of Miocene age rocks in the Coast Range south of San Francisco, and 13 locations of "bituminous effusions".

Fig. 3.



Asphaltic Cliff Santa Barbara

Figure 6. Schematic cross-section from Antisell's report showing his interpretation of the subsurface presence of asphaltum.

"...it appears evident that the beds in which it is found are accidental and not constant. From the outpouring being close to shore, it has happened more frequently that the softer and more recent of the deposits are those in which it is found; but that where it occurs inland it is met with infiltrated in a brownish yellow sandstone, which lies below the softer rocks along shore; in other words, it is sometimes met in the Santa Inez brownish sandstones, at the upheaval of trachyte and amygdaloidal greenstone, and almost in contact with this rock it is *at present* oozing out; showing that this elevating force is not yet quiescent. At Santa Barbara, east of Point Rincon, and a few other localities, where magnesian talcose rock or scoraceous lava is the upheaving cause, the action has ceased and the deposit is limited; lastly, it may be remarked that numerous as are the serpentine protrusions among the mountain ranges, constituting some of the most powerful uplifts in the Coast mountains, and occupying a breadth of surface which is not equalled by any other volcanic rock, yet nowhere is bitumen found close to it.

"It is idle to speculate on the ultimate source of the asphaltum. The generally attributed source, namely, a deposit of fossil vegetable matter, overheated by volcanic rock, does not occur here apparently. The strata through which it escapes are, where observed, almost destitute of vegetable matter; the brown sandstone wholly, and the greenish having a few traces of fucoids scattered sparingly throughout their structure. The tertiary rocks are in contact with the granite. The sedimentary strata are but a few hundred feet thick before primary rock is met with. There are no palaeozoic strata, no extensive beds of metamorphic shale, no carboniferous strata, to fall back upon to hypothecate its formation. There are no excessive fish remains whose decomposition could be supposed, even by a chemical imagination, capable of producing this mineral." (Parke and Campbell 1856, p. 113-114)

Of the early reconnaissances, Trask and Blake certainly recognized that bitumen was potentially a valuable mineral. Antisell, although he noted the occurrences of the major seeps, did not seem to regard them necessarily as economic deposits of petroleum. Roofing, flooring and paving of roads were the obvious uses. Trask believed that bitumen could also be used for the manufacturing of illuminating gas, a position certainly shared and supported by Blake, whereas, Blake thought their use could extend to fuels.

Other Stimulating Events – The Camphene Manufacturing Period (1851-1859)

After 1859 (and the completion of the Drake discovery well in Pennsylvania in 1861), increased interest in California

developed for the production of kerosene. Camphene was the first synthetic oil lamp illuminant utilized in America, and the dominant lamp illuminant in America during the 1840's (Williamson and Daum 1859). Prior to 1859, camphene was the principal illuminating fluid burned in lamps throughout California. Originally obtained by distilling turpentine over lime, the crude turpentine was imported from the southern states and brought around Cape Horn. In 1851, George Dietz and Company erected a camphene still in San Francisco, and by 1858, six similar plants were established in the city. Chief operators included George Dietz and Company, Stott and Company, Stanford Brothers and later Hayward and Coleman (Stalder 1943).

The production of kerosene quickly found its way to the various camphene stills in San Francisco. Attempts to refine a good lamp oil from California bitumen were performed by Charles Morrill. Morrill, a wholesale druggist and camphene manufacturer, built a half dozen retorts to distill oil from coastal deposits at Carpenteria. George S. Gilbert, a competitor of Morrill in 1860 began working with asphaltum or brea gathered from an old shaft. By the early 1860's, drilling and refining activities were taking place in central and northern California. In 1861, the first actual well in California was drilled in the northern part of the State on the Davis Ranch, Humboldt County. Exploration and drilling activities were not, however, restricted to the northern part of the state, and contemporaneous with this activity being performed in Humboldt County, attention was also being given to other oil seepage areas of California to the south.

FIRST CALIFORNIA OIL BOOM (1865-1866)

The first California oil boom initiated with the arrival of Benjamin Silliman, Jr., in California in 1864.

Benjamin Silliman, Jr. – 1864 through 1866

In 1855, Professor Benjamin Silliman, Jr., of Yale was hired by the Pennsylvania Rock Oil Company, the first oil company in the United States, to analyze their oil and find more extensive uses for it (Fig.7). Silliman would conclude that synthetic coal oil, or kerosene, could easily be refined from it for lighting homes, stores, and public buildings and streets and prophesied that many other useful by-products would eventually be extracted from petroleum (Silliman 1855). Williams and Daun (1969) would state:

> "Whatever its shortcomings in the light of contemporary or subsequent knowledge, Silliman's report was a landmark in its timeliness and critical perceptions of petroleum's possibilities...[Silliman] saw the probability that the various products of fractional distillation might be cracked." (Williams and Daun 1969, p. 71)

In 1857, George S. Gilbert aided by Charles Hosmer began distilling "liquid bitumen and asphaltum" first in San Francisco then in a small refinery on the Ojai Ranch near San Buena Ventura. The small refinery thus became the first successful commercial petroleum refinery in California producing about 400 barrels of marketable oil (Taylor and Welty 1950).

Figure 7. Professor Benjamin Silliman, Jr., of Yale in 1864 would prepare a report of his evaluation of the asphaltum deposits in Ojai, which would spark the first oil boom in California.

In 1864, Silliman arrived in southern California via Cape Horn, landing in San Buena Ventura. It is here where Gilbert showed Silliman seepages along San Antonio Creek and on the slopes of Sulphur Mountain. Silliman would soon write favorably to Thomas R. Scott of Philadelphia on July 2, 1864 (Taylor and Welty 1950, p. 33). He would later reiterate in his December 1864 report titled "*A description of the recently discovered petroleum region in California with a report on the same by Professor Silliman, December, 1864*" that

> "The oil is struggling to the surface at every available point and is running away down the rivers for miles and miles." (Silliman 1864)

Silliman's 1864 report included a general statement regarding petroleum in California and addressed labor, transportation to the coast and shipment, market for refined oil, market for crude oil, and conclusion. Silliman's attached report titled "*Report of Professor B. Silliman, Jr., upon the Outcrops of Mineral Oil, or Petroleum, which appear on the Ranch of Ojai near Buenaventura, in Santa Barbara County, California.*" Silliman's September 1, 1864, seventeen-page report was divided into the following sections:

Of the Buenaventura District
Geological Character of this Oil District

Section of the Buenaventura Oil District
Map of the Ojai Ranch, Showing its Relation to the Oil Bearing Range and to the Ocean (Fig. 8)
The Petroleum Wells – or Natural Outcrops of Rock Oil on the Ojai Ranch
Timber, Water, and Climate, on Ojai Ranch
Other Resources of the Estate
Probable Product of the Distillation of this Oil

Conclusion

The Appendix section dated September 2, 1864, was divided into the following:

Estimate of the Oil in One Square Mile of Asphaltum One Yard Thick
Estimate of the Quantity and value of Oil Given Out from a Certain Number of Artesian Borings
Considerations Affecting the Value of Oil Properties as Compared with Other Mining Adventures
On the Use of Petroleum as Fuel

In this report Silliman stated "...that the amount of oil capable of being produced here is almost without limit." Silliman noted six specific groups of outcrops, comprising over twenty discharges, on the accompanying map, and he would further state "and at least that many more where oil has flowed in former times."

The California Petroleum Company was thus formed with 100,000 shares valued at $100 per share, the money to be used for payment of the lands and one million dollars exclusively for development of the property. Based on Silliman's report, Thomas Scott purchased 277,000 acres of prospective oil property in California, including land situated on the northern flank of Sulphur Mountain (Nelson, 2001). Scott then sent his nephew, Thomas Bard, around Cape Horn with a steam-powered cable-tool drilling rig to begin exploration in Ventura County. The Stanford Brothers from San Francisco also were interested in Sulphur Mountain, leasing property on the south side. Stanford, a mining engineer, would take a different approach. Using Chinese labor, Stanford dug an 80-foot tunnel into the north-dipping Miocene strata of Saltmarsh Canyon (Fig. 9), producing about 20 barrels per day in 1866 (Nelson, 2001).

In 1865 Silliman would state:

> "Oil was so plentiful in California that it floated in the sea off Santa Barbara and rose to the surface inland at Ojai Ranch and numerous other places in great pools of asphaltum."

What resulted was that oil operations commenced on Maltole Creek in Humboldt County, the site of the first oil well drilled in California, in addition to other sites situated in Colusa, Contra Costa, Los Angeles, Santa Barbara, Santa Clara, San Joaquin, San Mateo and Tulare counties. It did not take long for establishment of about 65 oil companies that represented

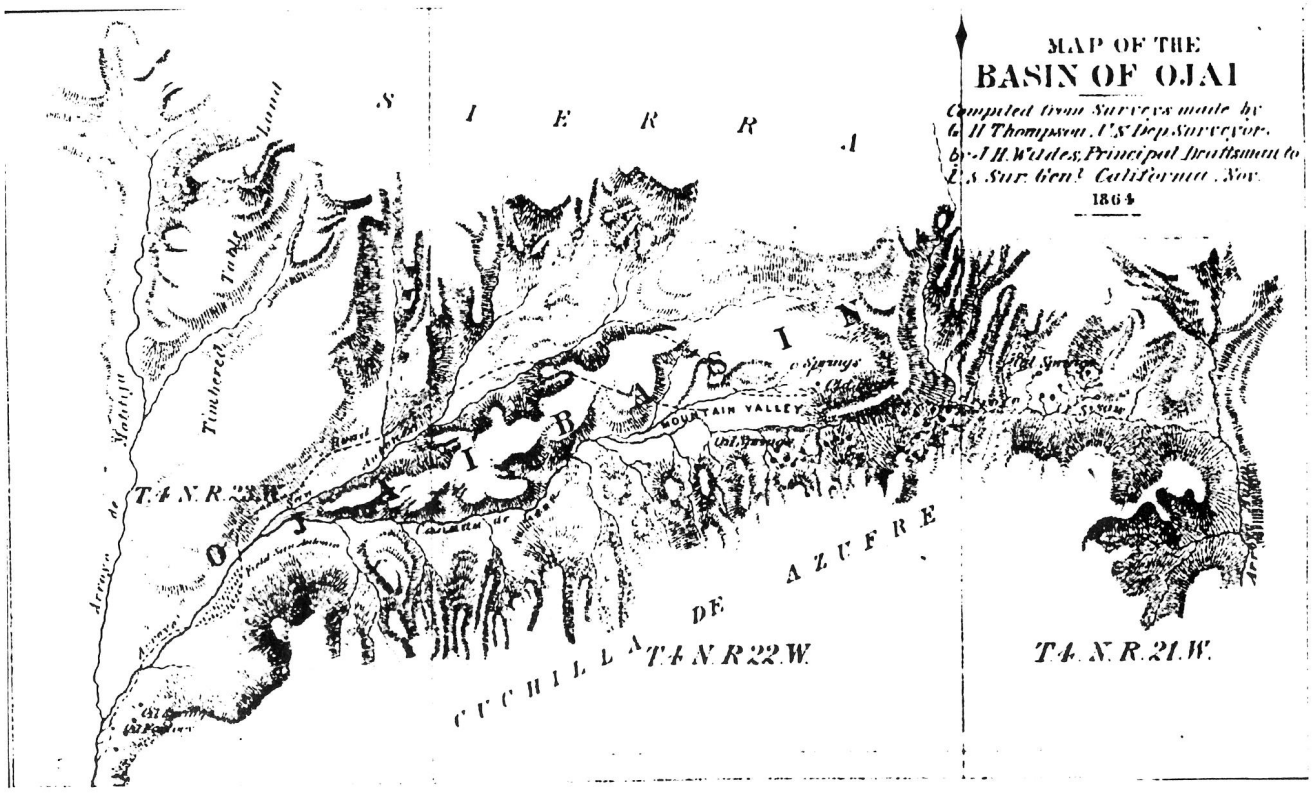


Figure 8. Professor Silliman, Jr.'s, map of the Ojai Valley showing the location of various oil seeps.

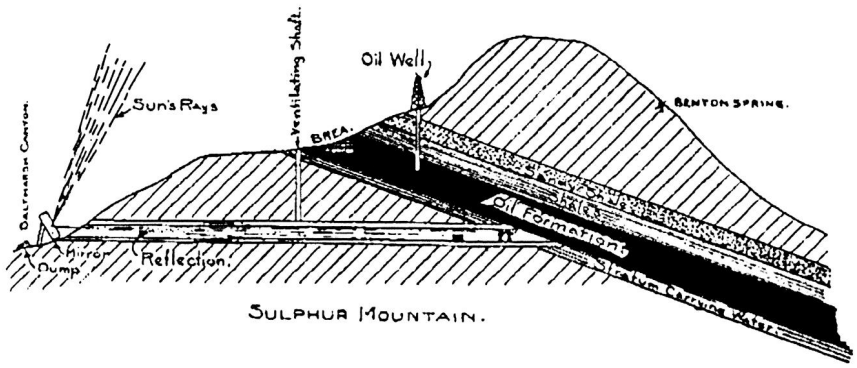


Figure 9. Cross-sectional diagram of an oil tunnel dug by Josiah Stanford on the south side of Sulphur Mountain (after Nelson 2001).

the industry. In 1866, two refineries were erected in San Francisco: one by Hayward and Coleman and the other by the Stanford Brothers, with no sustained success and were eventually abandoned. Polhemus in Los Angeles also erected a refinery.

Silliman would utilize his former students in some of his investigations for investors and promoters when the opportunity presented itself. In regards to mineral and oil prospects, Blake served this purpose, notably throughout the southwest. Blake in June 1865 would tour the oil region of Pennsylvania. He observed the various oil wells along Oil Creek about Titusville. By July, Blake was back in California and would write (Blake Collection, vol. 76):

> "Oil and fossils brought down by Col. Butterfield from Bear Valley east of Colusa about 25 miles. The 1st oil is 19 m[iles] w[west] of Colusa in Antelope district where there are 3 augers at work. Bear Valley pet[roleum] district is 5 miles beyond. There are several oil springs and mud gas."

For the next few months, Blake examined mines in the southern portion of the Mother Lode belt in the foothills of the Sierras, and stayed in touch with Silliman. On August 29, Blake would note in his field notebook of petroleum with bivalve shells, clams and oysters from an area about six miles west of Tulare Lake in the southern portion of San Joaquin Valley. In September he would visit Eureka in Humboldt Bay where oil was first discovered in California, and toured the Bear River and Matolle River. By October, Blake was back in the Big Trees in Calaveras County, where he would name one after Silliman, 19 paces around and standing next to trees named for Torrey, Gray and others.

DOLDRUMS (1866-1875)

Silliman's report sparked the first but short-lived oil boom in California from 1865-1866. It only lasted two years. Failure to obtain a large high-grade crude oil supply in comparison to cheap Pennsylvania oil arriving in San Francisco resulted in a decline in exploration and production activities from 1866-1875. Following the civil war, Pennsylvania kerosene production increased, dropping the price from over $1.70 per barrel to $0.54 or less within two years.

During this period, exploration and production, mainly from flowing springs, continued throughout the State. As more wells were being drilled, progress was slower. Oil specimens from various areas in California were obtained and displayed at the Paris Exposition of 1867 (California State Mining Board 1882). Included were samples from Humboldt, Los Angeles, Santa Barbara, Santa Cruz and Colusa counties. Unsuccessful efforts resulted from an attempt to distill oil from shale in San Joaquin County. In 1869, spring-pole wells were completed in Pico Canyon and Wiley Canyon, Los Angeles County. Spring-pole well had a diameter of about 2-2.5 inches and could attain depths of 300-400 feet.

In 1871, petroleum was discovered on the Augmentation Ranch, Santa Cruz County, and in Livermore Valley, Alameda County. Work continued at Sulphur Mountain by C. Scott in 1872, and into 1874. Most of the production was from flowing springs. The largest and possibly only significant demand was that by the Central Pacific Railroad, who used the product for lubricating purposes. In 1873, The Star Oil Company of Los Angeles built their first still in San Francisco, shipped it to Los Angeles, and by 1877 would be completing wells in Pico Canyon.

In his paper published in the prestigious American Journal of Science and Arts (Silliman 1867), Silliman reported on his chemical analysis of a specimen of "surface oil" from Santa Barbara County. It was Silliman's belief that California heavy tar (maltha) could not at the time compete with the oils of Pennsylvania at these relatively low prices, but believed that California heavy oils would eventually be extensively used as a fuel. This prediction would be sustained by history.

Other factors, however, were at play that also discouraged investors and promoters, and slowed down the exploration for further oil resources.

Josiah D. Whitney and the California Geological Survey (1860-1874)

The California Geological Survey was formed in 1860 from a legislative act to create the office of state geologist, and to define the duties thereof April 21, 1860 (Fig.10). The main objective of the California Geological Survey in 1860 was to make an accurate and complete geological survey of the state. The survey would develop state of the art mapping techniques that would later be adapted by King's Fortieth Parallel Survey and later the United States Geological Survey. The survey, however, would struggle with inadequate funding for the next decade for a variety of reasons, notably Whitney's inability to build support within the state legislature and public sector, and his unwillingness to encourage investment and promote development of the state's natural resources (Testa 2000).

The three main opponents to Silliman's optimism included Whitney, his assistants Brewer and Peckham, although Peckham would eventually soften his position toward Silliman in years to come (White 1968; Peckham 1882). When news of Silliman's report reached the Survey, Silliman's optimistic prospectus was not well received by Whitney. Whitney and Brewer were shocked and disgusted. It seemed to Whitney that if significant oil resources were present, his Survey would have reported upon it, describing the report as highly optimistic and irresponsible.

Brewer initially looked at petroleum favorably in 1861, contrary to the position taken by Whitney in 1864. Brewer stated in his journal on March 12, 1861, east of Santa Barbara:

> "We struck the coast about six miles from here, where asphaltum, a kind of coal-tar, comes out of the rocks and hardens in the sun. It is used for making roofs, by mixing with sand, boiling, and spreading on hot. It occurs in immense quantities and will eventually be the source of some considerable wealth."(Farquhar 1930, p. 59)

However, in response to Silliman's report, Brewer stood alongside his Director. In the Springfield Republican newspaper, Brewer would be quoted:

> "I am not aware that petroleum in the sense in which that term is used in Pennsylvania is found in California. I think that at the present state of our knowledge, good illuminating oils can not be profitably made in California from the asphaltum or its kindred substances..." (Springfield Republican 1865)

As far as Whitney was concerned,

> "If Silliman's reports are correct, I am an idiot and should be hung when I get back to California." (White 1968, p. 81).

Attacking Silliman's conclusions Whitney went on to state:

> "There is absolutely no evidence of existence of petroleum in Southern California. There is asphaltum there, but petroleum is never found in connection with asphaltum. Asphaltum precludes the existence of petroleum; they are actually different articles. There might be some petroleum north of San Francisco." (White 1968, pp. 82-83).

Another reason Whitney and other eminent geologists opposed Silliman's optimism may have been that:

> "...no such deposits of petroleum as those developed in Pennsylvania would be found in California, added to the discouragement...This opinion was based on the absence

Figure 10. The first California Geological Survey (1860-1874) under Josiah D. Whitney. From left to right, is Chester Averill, William M. Gabb, William Ashburner, Josiah D. Whitney, Charles F. Hoffmann, Clarence King and William H. Brewer.

> in California of extensive coal beds. The tilted condition of the rock, consisting largely of slate, was thought not to admit the retention of large quantities of oil in pools, such as occur in the horizontal sandstone strata of New York and Pennsylvania." (USGS 1886, p. 149)

The absence of significant coal beds undoubtedly encouraged many to pursue oil regardless.

Whitney was incorrect about the prospects and future of oil as later commented upon by Hill (1988) and Testa (2000). Whitney unfortunately could not ultimately save his Survey which was discontinued in 1874, although for all practical purposes it was dead by 1868, a result in part exacerbated by the petroleum controversy and dissatisfied promoters (Goetzman 1966, p. 387). In a letter to his brother William dated April 13, 1868, and struggling to keep the Survey going, Whitney wrote,

> "Petroleum is what killed us. By the word "petroleum", understand the desire to sell worthless property for large sums and the impolicy of having any body around to interfere with the little game." (White 1968; Brewster 1909, pp. 266-277).

Blake by the mid-1860s was recognized as a prominent mining consultant with a well established and deserving international reputation (Dill 1991). During his travels he would typically report on various mineral occurrences he either encountered or heard reports thereof from reliable sources. It was in 1867 that Blake, while traveling through the Tulare Valley, would later report on new mineral oil regions in the Tulare Valley, where he states:

> "Recent examinations of prospecting parties, have added largely to the well-known oil-bearing portions of the State. A district some sixty miles in length, on the inner slopes of the Coast mountains, towards the Tulare Valley, has been found to abound in oil springs, or indications of oil. Oil exudes from the surface in large quantities, and collects rapidly in small pits sunk by prospectors. The soil about these pits is very black and saturated with oil. The gases escaping from this soil are inflammable, and many of the prospectors have been startled to see flames spreading over the ground, beyond their camp fires…
>
> "The oil found gives an excellent article for lubricating purposes, and must be very similar to the oil near Zanesville, Ohio, according to the descriptions given of the latter." (Blake 1867)

Despite the overall decrease in exploration and production activities from 1866-1875, the understanding of petroleum occurrence was improving, albeit slowly. This situation would soon change as technology improved. A gas war in San Francisco in the late 1870's also helped.

REVITALIZATION PERIOD (1875-1900)

Most of the work accomplished up to this time was done blindly, and focused on surficial exposures of flowing springs. By the early 1880's, practical oil men and capitalists suspected that large quantities of petroleum of good quality existed, but required scientific guidance to assure some sense of success should significant dollars be invested. In 1884 alone, $130,000 was essentially lost by a Pennsylvania company in the drilling of six dry holes in Pico Canyon and one at Santa Paula. One producing well would have made up the loss – yet they continued with the drilling of another well in Pico Canyon. These early failures although financially disastrous in most cases, provided much benefit in increasing the understanding in the subsurface occurrence of petroleum.

By about 1875, ten years after the first oil boom, the oil business in California began to revive. The drilling of shallow wells in the Pico Canyon area (near present-day Magic Mountain) in 1875 by the Pacific Coast Oil Company, and the completion of the Southern Pacific Railroad from San Francisco to Los Angeles County in 1876, and use of steam machinery in 1877, all contributed to the revival of exploration and production activities (Stadler 1943). The end of the century recorded the early development of the Los Angeles oil field in Los Angeles County, Summerland oil field in Santa Barbara County and Coalinga oil field in Fresno County. The Los Angeles area would be dotted with 1000 to 1100 wells drilled within an area 2 ½ miles in length and less than ¼ mile wide, with wells extending in depth ranging from 600 to 1200 feet (Watts 1899). By 1895, Summerland would have 28 productive wells with the first well being drilled on Ortega Hill in 1890 by H. L. Williams (Fig. 11). The Coalinga oil field was first discovered in 1898 with the development of the Oil City field. The largest producing well showed an initial production of 700 barrels of oil per day, but by 1900 the average production would decline to between 15 and 20 barrels per day.

By the mid-1880s, drilling techniques changed and tools improved, replacing the former spring-pole system. These improvements reflected the experience being gained in the Pennsylvania oil field. Eight-inch diameter wells that diminished with depth were being drilled. The "modern" derricks rose 65 feet high. The drilling rigs with improved engines and mechanisms for driving and pulling casing, a system of pumps, piping and tanks systems for the movement of fluids, were all developed and being utilized in California.

Toward the end of the century, it was known that coal deposits throughout the State were inadequate to serve the increased demand for fuel. The greatest occurrence and development of the petroleum industry situated in areas south of San Francisco (Watts 1899), with the majority of the end product used for fuel. Petroleum occurrence in California was known to be found in rocks ranging from lower Cretaceous to Quaternary in age (Fig. 12). Productive strata would vary vertically. While

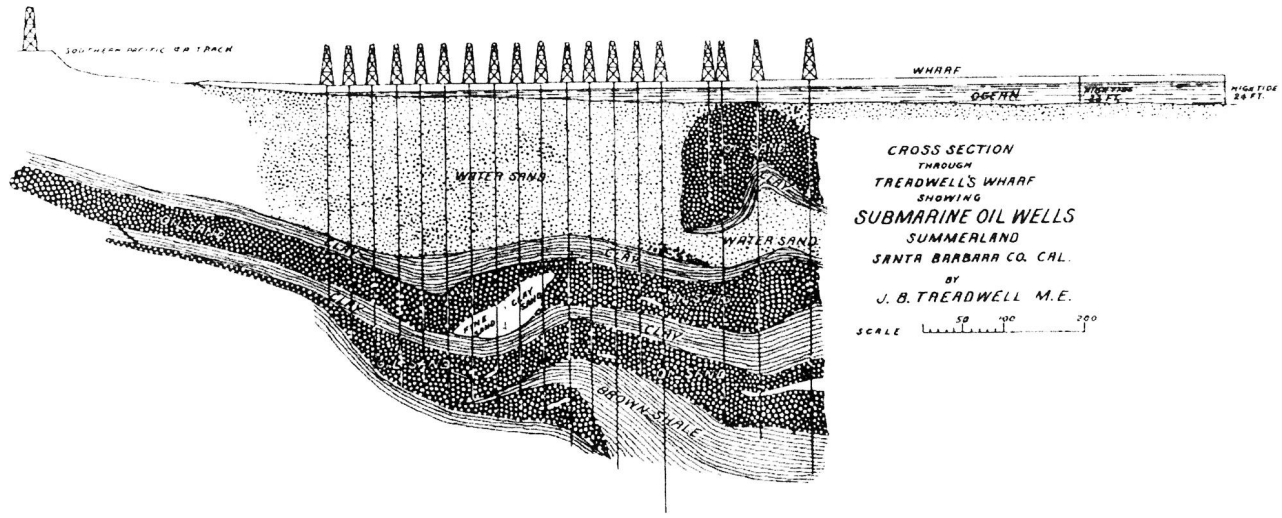


Figure 11. Profile prepared by J.B. Treadwell showing the character and structure of rocks beneath the Treadwell Wharf, and the number of wells drilled in the world's first offshore drilling location at Summerland, south of Santa Barbara (after Cooper 1899).

petroleum geology remained in its infancy, the origin of petroleum was becoming a very important issue. Cooper (1899) considered this issue to be of great importance and summarized the state of understanding of the genesis of petroleum and gas in California as follows:

> "If it is true that the bitumens are derived from terrestrial and marine vegetation, deposited in sedimentary strata, and then changed to carbonaceous matter, which was afterwards distilled by the heat of metamorphism, then we may expect to find petroleum oil or other bitumens in unaltered rocks lying above the metamorphic rocks, irrespective of the age of the unaltered rocks."

Thus through the drilling of wells,

> "...exploration can be continued to such depths so as to reach the metamorphic rock, and these explorations may be successful, or if the bitumens are indigenous to the rocks in which they are found, the depth to which they may extend is uncertain."

CONCLUSION

Most of the oil and gas in California occurs in the southern half of the State, notably, the southern half of San Joaquin Valley, the southwestern and southeastern corners of the Coast Range province, and the northwestern corner of the Peninsular Range

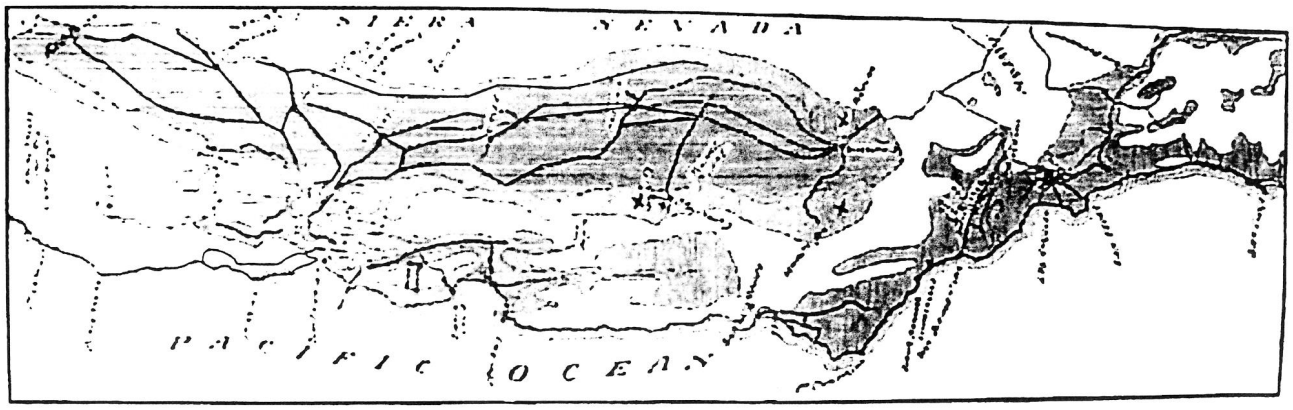


Figure 12. Sketch map from the San Francisco Chronicle roughly showing the area over which the oil-yielding formations of California extend, reaching north into unexplored territories not shown on the map (after Watts 1899). Parallel lines denote unaltered Cretaceous and Tertiary rocks, parallel vertical lines denote unaltered Quaternary and Recent rocks, and crosses indicate producing fields. Note the optimistic perspective in this illustration, which suggests the widespread occurrence of petroleum.

province, with the San Joaquin and Los Angeles basins being the most productive. The first actual well drilled in California, however, was on the Davis Ranch, Humboldt County in 1861. It was not until 1880 that oil was discovered in the Los Angeles basin.

During the 19th Century, the science of petroleum geology was in its infancy. The professional perceptions expressed during this period by those individuals that held the public's trust were important in providing sound judgment and confidence to investors and operators. By the end of the century, refineries were established in close vicinity of producing areas. Wells were comparatively shallow and confined to areas of surface seepages.

Twenty-five fields were discovered by 1900, all as a result of surface seepage, of which three were classed as major (Pemberton 1943): McKittrick oil field (1898), Kern River oil field (1899) and Brea Canyon (1899)(Table 2). It would not be until 1902 (Beverly Hills and Lompoc oil fields), and then 1909 (Cat Canyon oil field), before a field was discovered based on geology. Geophysics would not play a role until 1936 where such techniques were used to discover the Grape Vine (Tejon Ranch) oil field. The Santa Maria (Orcutt) and Casmalia oil fields, discovered by 1903 and 1904, respectively, were the last to be discovered solely by surface seepage. Photographs of many of these early fields are presented by Franks and Lambert (1985).

Between the period from 1860 to 1913, about 834 wildcat wells were drilled and 15 were abandoned, from which 55 oil fields and one gas field was discovered. The average well depth was on the order of 2,200 feet. From 1875 to 1899, 2,924 wells were drilled and in existence – 2,295 oil wells and 629 dry holes. Of these, 945 were actually producing wells.

In 1898, the total product generated was 2,249,088 barrels with a total value of $2,376,420. The impact from the Los Angeles field is shown in Fig. 13 where relative to other oil-producing counties, Los Angeles made up 65 percent of the total quantity of oil produced for that year. By the end of 1899, less than 15,000,000 barrels, or slightly less than 0.3% of the cumulative production at the end of 1938 (Pemberton 1943), had been produced. No prolific oil field was or has since been discovered in northern California.

Silliman in 1864 stated that:

> "...none suspected that the oil of this district was destined to add another product to the resources of the State, unequaled perhaps in value even by that of her wonderful mines of the precious metals."

In 1888, California would contribute less than three percent of the total amount of petroleum produced in the United States, well behind Pennsylvania and Ohio. By 1903, California would lead the nation in oil production, producing 24,382,000 barrels/year (about $24,598,559 in value), exceeding Pennsylvania, Ohio and West Virginia. By 1907, the Standard Oil Richmond refinery would produce nearly 1,600,000 barrels alone for domestic and export markets, and the value of petroleum to the state of California exceeded that of gold. The value associated with the production of natural gas would exceed that of gold by 1916.

At the threshold of the new century, it was oil that grew most drastically during this period. With the introduction of the oil burner in the early 1880's, industries, railroads and steamship lines increasingly turned to oil, with the conversion from coal to petroleum nearly complete by the early 1900's. The new discoveries of the late 1890's and thereafter caused the industry to burgeon.

In 1877, Brewer reiterated his view of 1865 and would write:

> "...yet a dozen years have obliterated so many of the marks, so many of the victims have dropped out of sight and others ceased to grumble, and meanwhile other matters have come in, that now few know and fewer still care who was right and who was wrong...". (White 1968, p. 221)

History, however, has demonstrated that Silliman along with Blake and Trask, were correct in their persistent optimism pertaining to the future of oil in California. Although considered by some as too optimistic, Whitney, Brewer and others were certainly overly pessimistic. Even the United States Geological Survey remained somewhat pessimistic in regards to oil prospects for several decades. As of 1909, for example, the United States Geological Survey would state "that within a very few years a marked decrease will be noted" not only in California but in Illinois and Oklahoma as well (USGS 1909, p. 45-46).

Of the original participants, Blake would get the last word. In an address to the Missouri School of Mines in 1903, Blake, known best as a mining geologist, talked about petroleum and

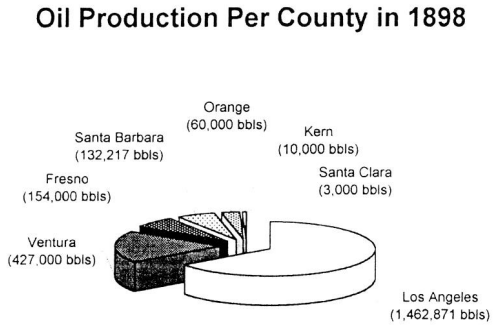


Figure 13. Pie diagram showing the quantity of oil produced in 1898 per county in southern California.

its impact on mining and civilization (Blake 1903). Blake talked of how the iron and steel industry, railways and mills have replaced coal with oil for fuel, modifying these industries resulting in the production of better products. He would state:

> "...the discovery of Drake not only opened the door to material wealth, but to new avenues of human activity, mental and manual ...Compare the original price of $20 per barrel for Drake's crude oil with the price of one dollar at the end of the century. Compare the cost of refined oil in 1860 at from 70 to 75 cents per gallon, with its present price of about 10 cents per gallon.... The industry of iron and steel has been modified, almost revolutionized, by their use. Better products have resulted. ...It is destined to play a most important part in the smelting of ores."

The increased drilling of oil wells by promoters, financed by the selling of stock or some other form of interest, was not based on investment but rather optimistic speculation. The observations and evaluations of individuals such as Silliman, Blake and Trask encouraged such speculation in exploration and production, and helped prepare California for the 20th Century where petroleum would serve as the primary energy source not only for the 20th Century, but into the 21st Century as well.

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OIL-INDUSTRY HISTORY

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SYMPOSIUM: HISTORY OF PETROLEUM RESERVOIRS

AUTHOR GUIDELINE INFORMATION

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