GEOLOGY AND OIL DEVELOPMENT HISTORY OF THE VENTURA BASIN

VENTURA-OJAI-SANTA PAULA-PIRU-CASTAIC JUNCTION

"History of a Changing Landscape"

Gregg Wilkerson

November, 2018

GEOLOGY AND OIL DEVELOPMENT HISTORY OF THE VENTURA BASIN

VENTURA-OJAI-SANTA PAULA-PIRU-CASTAIC JUNCTION

Gregg Wilkerson*

*yosoygeologo@gmail,com
www,greggwilkerson.com

Contents

OVERVIEW

This field trip examines the geology and natural history of the Coast Ranges in the area of the Ventura, Ojai Valley, Santa Paula, Filmore, Piru and Castic Junction. The program begins at the Channel Islands National Monument Visitor's Center.

This field guide starts with a description of the beach geology at Ventura Harbor. The field trip then goes to the Olivas Adobe and the Ventura Museum. Then we go Ojai and then to Santa Paula by way of the Silverthread oil seeps. We visit he Sulphur Mountain of oil mines of the late 1890's. After a tour of the Santa Paula (Union) Oil Museum we go to Bardsdale and then to Blue Point on Lake Piru to learn about the historic gold mining activities in that area.

This field guide relies heavily on the geologic mapping of Thomas Dibblee Jr. Copies of his maps are available through the Dibblee Foundation at http://www.dibblee.org. This guide also uses information contained in Coast Geological Society field trips of Sylvester and Brown (1988) and Brown and others (1996). Copies of these (and other) field guides can be ordered through the Coast Geological Society website at http://www.cs.sbcc.net/cgs/ or by mail from CGS, P.O. Box 3005, Ventura, CA 93006. This field guide was originally produced under a Memorandum of Understanding between the U.S. Bureau of Land Management and the Buena Vista Museum of Natural History, both of Bakersfield, California in February, 2001.

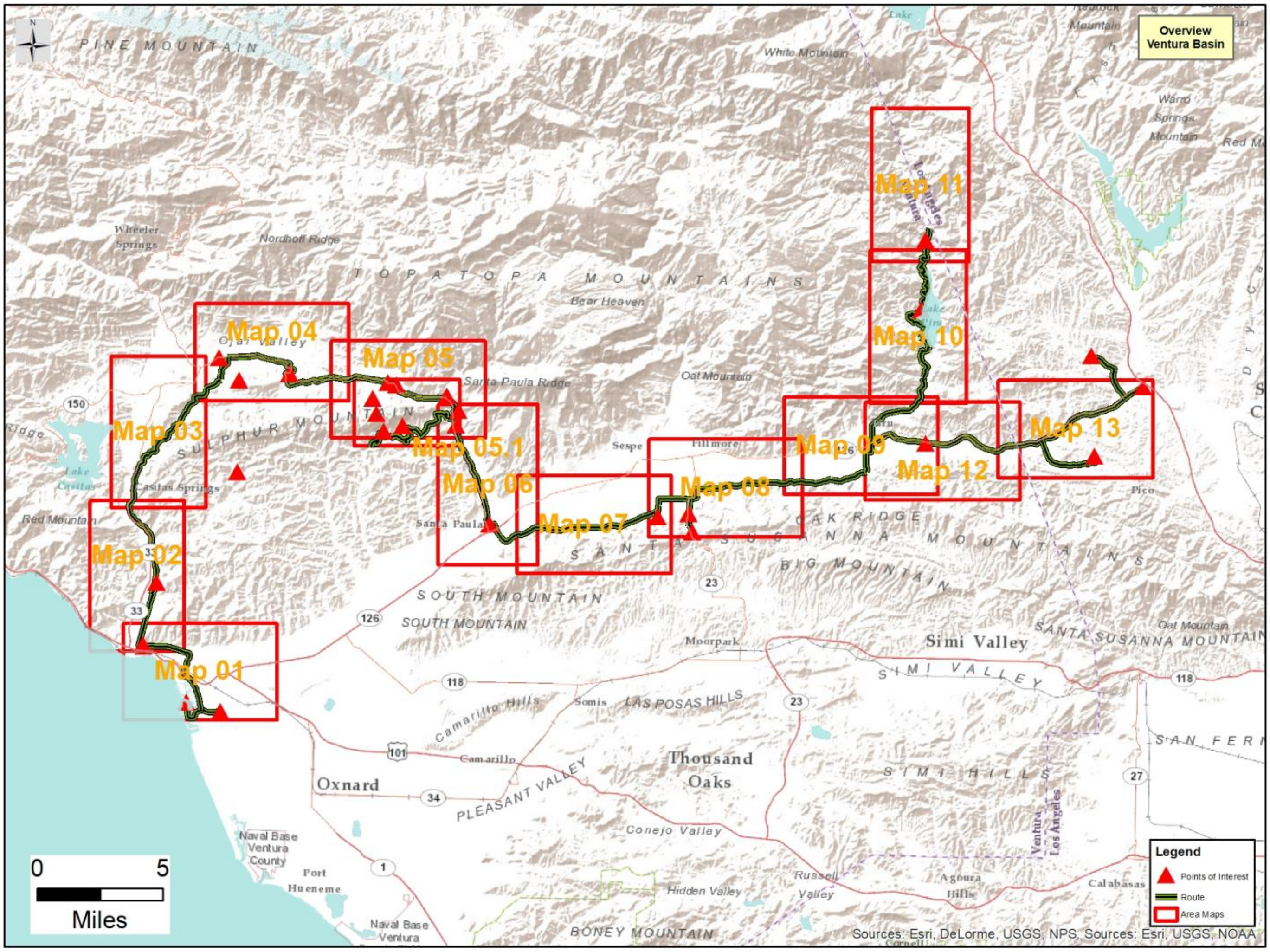


Figure 1. Overview map of field trip

Acknowledgement and Disclaimer

The information in this paper is taken largely from published sources. I have reproduced this material and present it pretty much as I found it, not trying to harmonize discrepancies in oil field, mine or geologic descriptions. I have changed verb tenses for readability and have used some paraphrase. I have expanded abbreviations or special characters with full text (e.g. feet instead of ft., inches instead of ") Italics indicate quotations. Authors of the original information are indicated at the end of each paragraph. Paragraphs without a citation are my own material. The maps in this report have been compiled and rectified from digital and paper copies of original sources that were made at different scales and in different geographic projections. Therefore, many of the maps had to be adjusted or stretched. They do not fit perfectly. Most are accurate to within 250 feet, but reproduction and projection errors can be as much as 300 feet for some of the maps. PLSS means Public Land Survey

System. That survey data was obtained from the U.S. Bureau of Land Management website.

MRDS, 2011, Mineral Resources Data System, U.S. Geological Survey, https://mrdata.usgs.gov/mrds/. This database relies on records that are, in many cases, are inaccurate or imprecise. For example, if a report describes a mine as being in “Section 9”, with no other information, MRDS plots the mine location in the center of the section. If a mine is reported in “SW ¼” of a section, MRDS plots the mine in the center of that SW quarter-section. Where I could confidently adjust an MRDS location of a mineral deposit to features identifiable in aerial photographs or topographic maps, I did so.

CDOGGR, 2014, California Division of Oil and Gas and Geothermal Resources. Well and oil seep locations are from the CDOGGR database. These locations are often inaccurate, especially for older wells. Data from Hodgeson’s report on oil seeps (1980) was also used.

Help me make this report better. If you have any photographs, memories or reports for this mine, please send them to me so I can incorporate in this paper.

Avenza. pdf

All the maps in this report are available as georectified .pdf files. These can be read in the field (without cell phone tower reception) on your smart phone with the Avenza.pdf app. It is downloadable at

https://www.avenza.com/avenza-maps/

This application takes my maps and puts a dot on your cell phone or tablet screen to show you where you are as you explore the areas covered by my maps. The free version only lets you load 3 maps a at time. Georectified maps can be obtained from me by request.

BASIC GEOLOGIC THEORY

Geologists that study sequences of rock strata are called stratigraphers. The science of stratigraphy is based on two principles identified in 1669 by Nicholas Steno, an Italian physician. They are called the Principle of Original Horizontality and the Principle of Superposition.

The first principle states that rock layers are originally laid down in a horizontal position. The second principle states that in an undisturbed sequence of rocks, the oldest are on the bottom and the youngest are on top. Using these suppositions, stratigraphers have identified and been able to distinguish many different rock layers in the Ventura Basin (and other regions) that can be mapped using various criteria.

By correlating rock layers of similar type and age around the world, geologists have built up the "Geologic Column" (See Table 1, page 3), a generalization about the age relationships of rocks of the earth's crust.

Geologists have found that each rock layer has an unique assemblages of fossils. In general, older fossils are smaller and simpler, younger fossils appear more like modern living forms and generally are more complex. By studying the fossils, determinations can be made where a rock layer would fit into the Geologic Column. In this way, relative ages for the sequence rocks can be determined. A stratigraphic table for the Ventura Basin is shown on page 4. A comparison of the stratigraphy of the northern Ventura Basin and the adjacent Cuyama and eastern Santa Maria Basins is shown on page 5.

The names used for past geologic ages can be found in the Geologic Column. The numerical ("absolute") ages for the geologic column are determined most often by the analysis of the steady decay or breakdown of radioactive minerals in the rocks.

GEOLOGICAL TIME SCALE

Era or Erathem	System or Period	Series (Epoch)	Age Estimates (boundary in millions of years ago)	Outstanding Events in Earth History
		Holocene	0.0 to 0.05	
	Quaternary	Pleistocene	0.05 to 1.8	Glaciers come as far south as Kernville. Pluvial lakes Coceran, Buena Vista and Kern fill much of the Southern San Joaquin Valley. Continued deformation of Coast Ranges. Pico Formation in Ventura Basin
		Pliocene	1.8 to 4.0	Formation of Coast Ranges. Deposition of Tulare formation.
Cenozoic	Tertiary	Miocene	4.0 to 22.5	San Andreas Fault forms, Monterey and other formations, Formation and rotation of transverse ranges
		Oligocene	22.5 to 37.5	Sespe and other continental formations
		Eocene	37.5 to 53.5	Coldwater, Matilija, Juncal and other marine units
		Paleocene	53.5 to 65.0	Uplift and erosion of ancestral Sierra Nevada
	Cretaceous		65 to 136	Deposition in marine basins, Panoche formation. Apex of dinosaurs
Mesozoic	Jurassic		136 to 195	Subduction, earliest granitic intrusives in Sierra Nevada
	Triassic		195 to 225	Pelona schist forms in ancestral Pacific Ocean, Frazer Mountain Gneiss and metamorphism of earlier units
	Permian		225 to 280	Limestone deposition and other sedimentary units in ancestral Pacific Ocean
	Pennsylvanian		280 to 320	Marine deposition (now destroyed or in pendants)
	Mississippian		320 to 345	Marine deposition (now destroyed or in pendants)
Paleozoic	Devonian		345 to 395	Marine deposition (now destroyed or in pendants)
	Silurian		395 to 430	Marine deposition (now destroyed or in pendants)
	Ordovician		430 to 500	Marine deposition (now destroyed or in pendants)
	Cambrian		500 to 570	Marine deposition (now destroyed or in pendants)
Precambrian				Some marine and non-marine deposition now preserved as remnants in Caliente Range

TABLE 1. Geological Time Chart. U. S. Geological Survey.

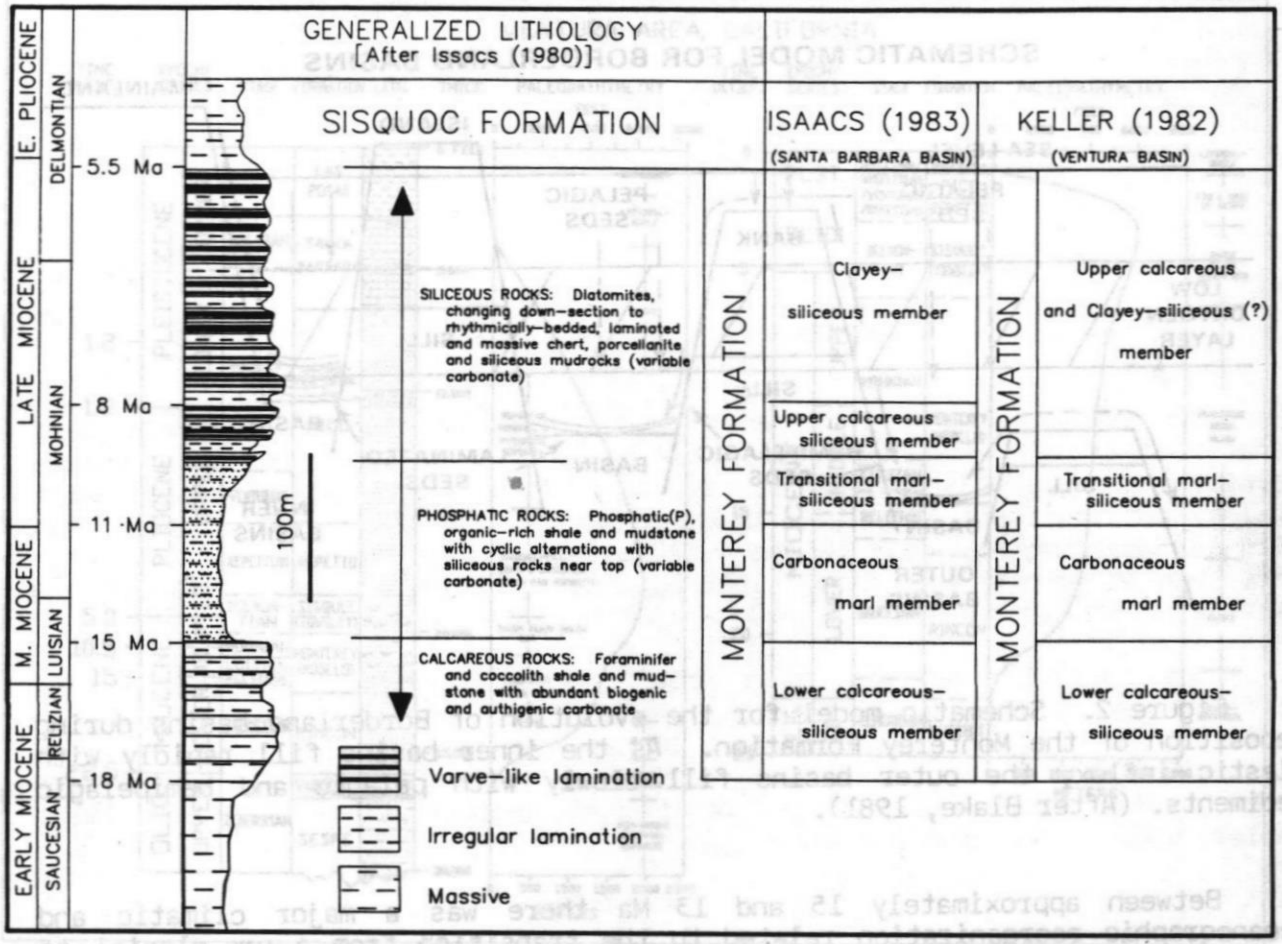


Figure 3. Generalized Monterey lithostratigraphic columns and correlations for Santa Barbara and Ventura basins. Correlations based on Keller (1982).

Stratigraphic Comparative Stratigraphic Table for the northern Ventura Basin, Cuyama Basin and eastern Santa Maria Basin

MAP 01

(Geology from Dibblee, 1988, 1992e; Jennings and Strand, 1969)

Stop 1: Channel Islands National Monument Visitor's Center

The Channel Islands National Monument Visitors Center is built on the apex of a sand bar. The Ventura Harbor has been dredged behind this natural feature. The breakwater retards the erosion of sand on the north side of the breakwater but encourages sand deposition on the south side of the breakwater, in the harbor. Channel Islands National Park was established in 1980.

Mile

0.0 Stop #1. Channel Islands National Monument Visitors Center. Go east on Spinnaker Road.

Figure 2. Channel Islands Visitor Center, Ventura Marina.

1.4/0.0 Harbor Boulevard. Go east through this intersection. As we cross this intersection we drive up onto older alluvial deposits that have washed down from surrounding hills.

Stop 2: Olivas Adobe

0.7 Stop #2. Olivas Adobe

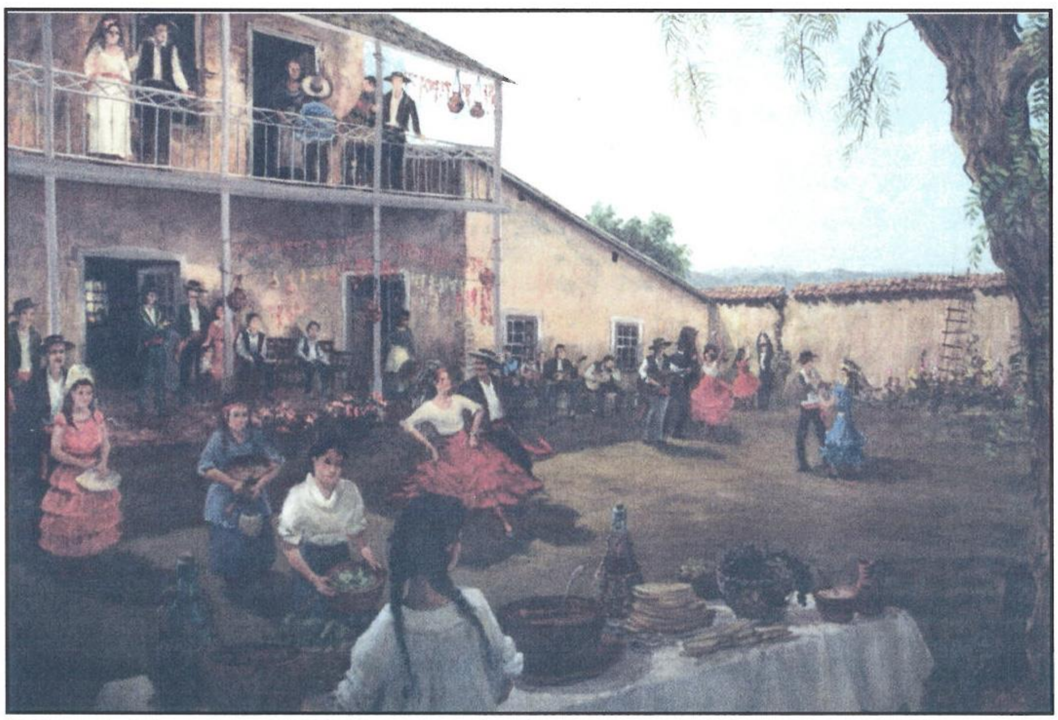
The hacienda of rancho San Miguel is operated by the City of San Buenaventura. The great house, *casa grande*, of Don Raymundo Olivas, his wife Teodora and their twenty-one children is today called Olivas Adobe. The construction of the Olivas Adobe began in 1847, led by a Chumash Indian named Juan de Jesus Tumamait. It was completed in 1849, but the Olivas home was not considered finished until it was blessed by a padre in 1851.

Figure 3. Los Olivos Adobe. From Ventura Museum.

In 1822, Mexico gained her independence from Spain. In 1833, Mexico secularized the missions in California, allowing land grants to be given to the military for services rendered. Don Rayundo and a friend were awarded a grant in 1841 by Governor Juan B. Alvarado. The grant consisted of 4,692 acres of which Don Raimundo took 2000. Conditions of the grant were to build a house, grow crops, and raise cattle. The land had originally belonged to the Mission San Buenaventura that had been founded in 1782 by Fray Junipero Serra.

For more information about the Adobe, visit their web site at:
http://www.geocities.com/BourbonStreet/Dixie/9959/OlivasAdobeHistoricParkCenter.html

Olivas Adobe in November, 2000. Photograph by Gregg Wilkerson.



Olivas Adobe, circa 1850. Photograph of museum exhibit by Gregg Wilkerson.

To the south of the Olivas Adobe is the Santa Clara River. The river follows a buried Oak Ridge fault noted on the 1:250K Los Angeles Sheet (Jennings and Rudolph, 1969). This fault marks the north boundary of South Mountain to the

Return to the intersection of Spinnaker road and Harbor Boulevard.

0.0 Reset odometer. Turn right and go north toward downtown Ventura.

0.5 Arundell Barranca. Harbor Boulevard at this point follows a geologic contact between Beach sand deposit (Qs) to the west and alluvium (Qa) to the east.

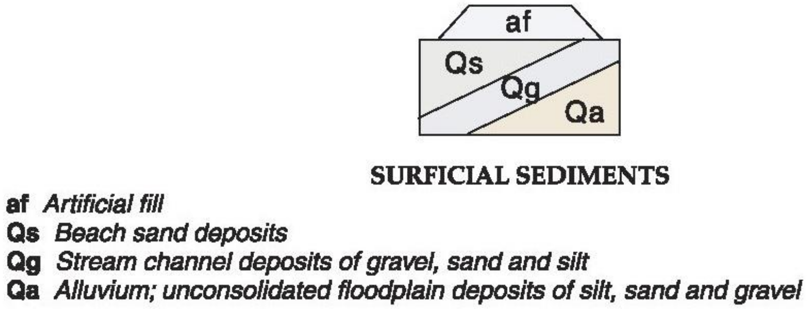


Figure 4. Lithological description of surficial units. From Dibblee, 1988

1.6 Harbor Boulevard and Seward Avenue. Turn right and go north, over Highway 101 to Main Street.

2.5 Main Street and Seward Ave. Turn left and go west Main, through old town to the Ventura County Historical Society Museum. The museum is just south of the Ventura Mission.

Stop 3: Ventura Museum

4.5 Ventura County Museum of History and Art

Built across Main Street from the San Buena Ventura Mission, this museum was established in 1913.

Near the site of the Mission, in 1855, George S. Gilbert built a crude refinery to boil off vapors of black petroleum which he collected from pits on the flanks of Sulfur Mountain (Taylor and Welty, 1950, p. 41).

After a tour of the museum we go to the Ventura Avenue Oil Field.

0.0 Reset Odometer. From the museum, go west on Main Street to Ventura Avenue. Turn right and go north on Ventura Avenue.

MAP 02

(Geology from Dibblee, 1988)

Ventura Basin

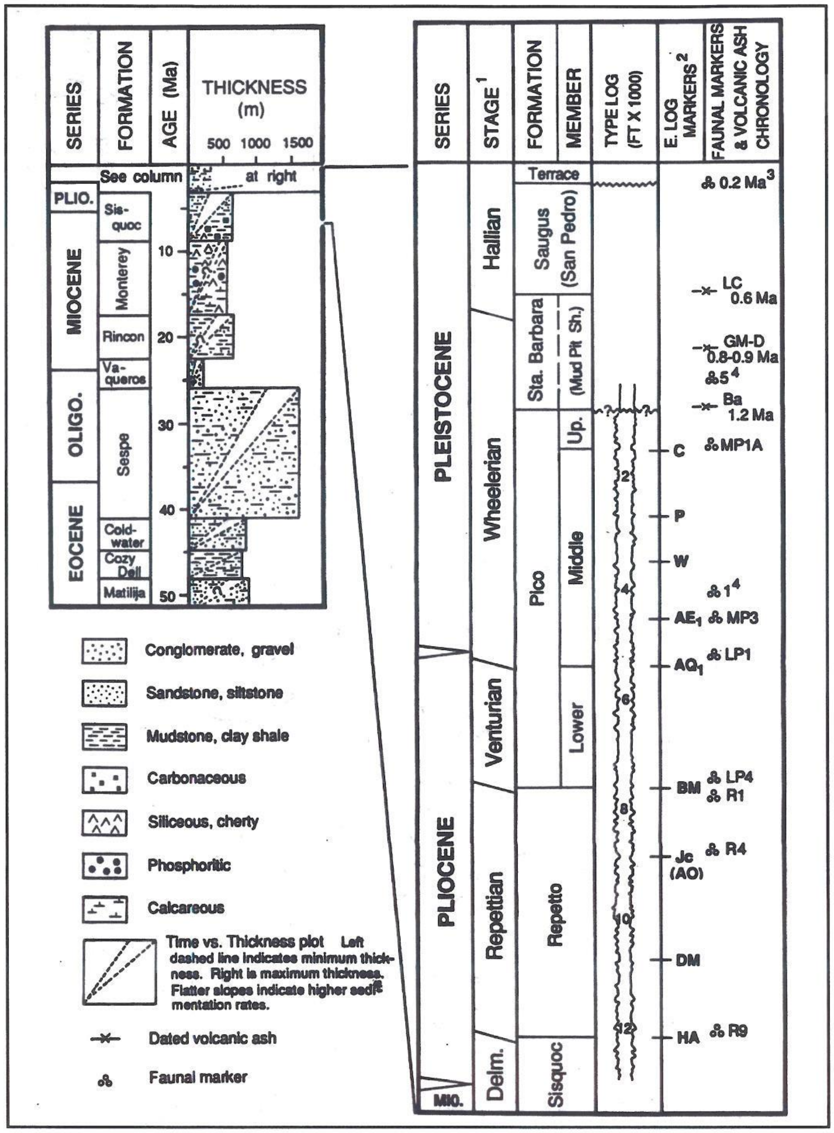
The Ventura Basin is a sedimentary basin formed mostly in Miocene time, between 22 and 4 million years ago. The basin was folded, faulted and uplifted in response to regional tectonic motions involving the San Andreas Fault, to the north, and formation by rotation and shear of the east-west trending Transverse Ranges and to associated forces forming the Coast Ranges to the northwest. A stratigraphic table for the Ventura Basin from Hopps (Fig. 2) is reproduced on page 5:

The Transverse Ranges originally formed in a more north-south orientation and have since then been rotated clockwise about 90º to their present positions beneath the Big Bend of the San Andreas fault between Palmdale and the Carrizo Plains in the past 16 million years (Hornafius and others, 1986).

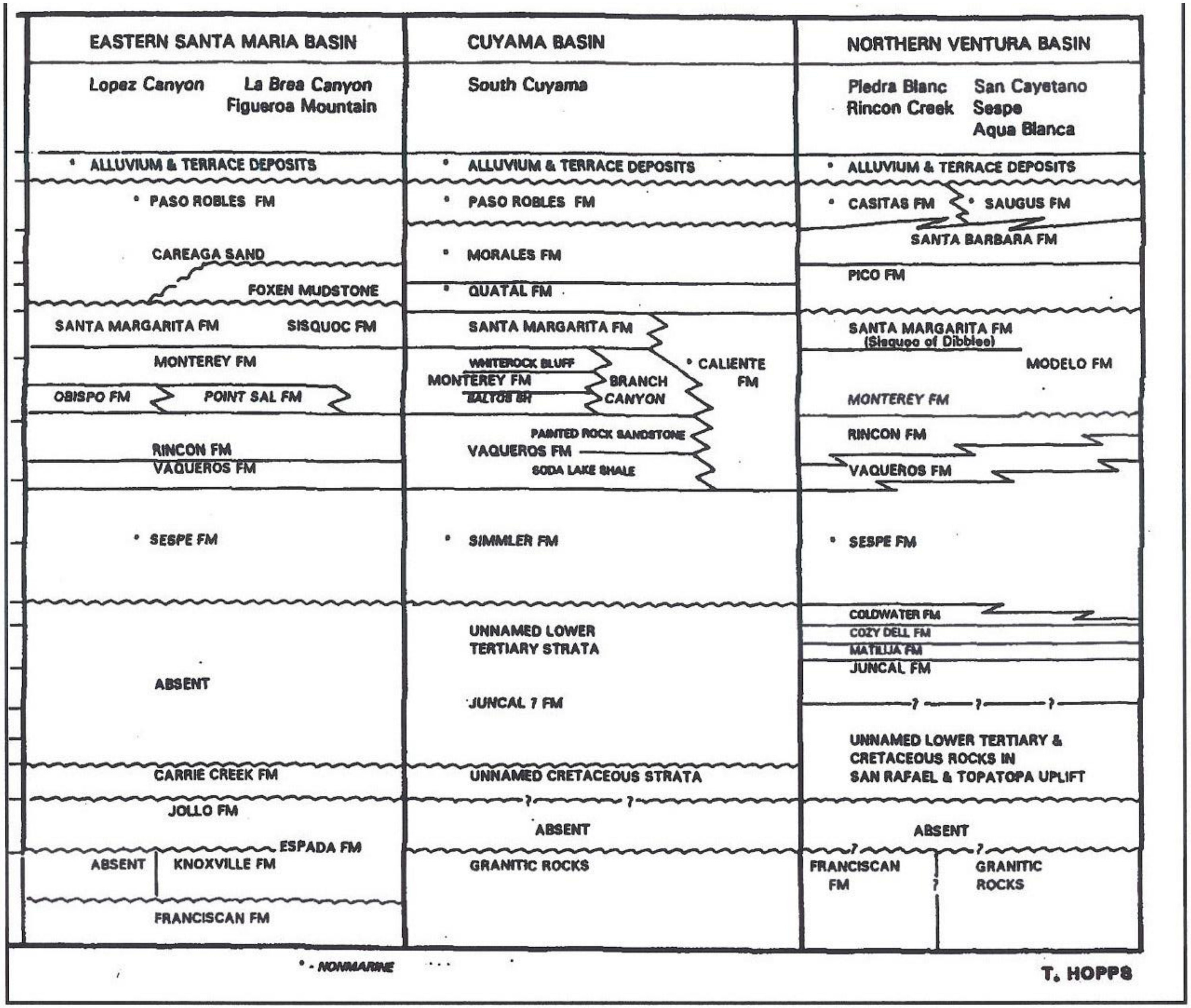
The Ventura Basin is a large fault-bounded syncline which is bounded on the north by the Red Mountain and Cayetano reverse faults, along which microearthquakes have been reported. The southern boundary of the Ventura Basin is the Oak Ridge Fault, which has no historic seismic signature, but which is probably seismogenic. The basin is underlain by a large low-angle fault (decollement called the Sisar Decollement (Yeats et al, 1988, p. 1112).

To the east is the Soledad Basin which is considered to be the non-marine deposition extension of the marine deposited Ventura Basin. The entire Ventura/Soledad structure is about 120 miles (190 kilometers) long and includes the Santa Barbara Channel between the Channel Islands and the Santa Ynez Mountains as the hilly area inland area between the Santa Monica and Topatopa Mountains.

The Ventura Basin was the site of a forearc basin of the East Pacific Rise. Sediments of Cretaceous and early Tertiary were deposited until the subduction of the East Pacific Rise within its trench system. About 22 million years ago (early Miocene), crustal stretching formed the Ventura Basin in which Miocene deposition occurred. About the 6 million years ago, renewed basin deepening occurred, with thick accumulation of Pleistocene deposits. The basin at times was under 5,000 feet (1524 meters) of water. The entire area was subjected to strong uplift, folding, and faulting during the middle Pleistocene. The Santa Barbara Channel was the only portion of the Ventura Basin not subject to uplift.



Stratigraphy of the Northern Ventura Basin between Ventura and Santa Barbara, including subsurface stratigraphy for the Plio-Pleistocene strata encountered at the Rincon and San Migualito oil fields. Volcanic ash bed abbreviations: Ba Bailey; GM-D, Mono-Glass Mountain; LC, Lava Creek. See Sarna-Wojcicki et al (1984) for discussion of ash bed-age determinations. 1) Benthic foraminiferal faunal stages of Natland (1957). 2) Pico Formation markers are those used by industry workers in the Rincon oil field; Repeto Formation markers are those used in San Miguellito oil field. “Jc” marker is equivalent to “AO” marker used at Ventura Avenue oil field (cf. Hall, 1977; Yeats, 1979; 1983). 3) Amino-acid racemization age determined for Prototheca mollusk shells in youngest preserved Saugus Formation (Lajoie et al., 1982). 4) Regional correlation horizons used by Yeats (1981), based on lithology and benthic foraminiferal biostratigraphy; XX 5 is a 1.0 Ma chronostratigraphic horizon . This figure is from Sylvester and Brown, 1988, Figure 2, p.115. Used by permission, Coast Geological Society and A. Sylvester.



Composite stratigraphic columns for the Eastern Santa Maria, Cuyama and Northern Ventura Basins. From Tom Hopps. Used by permission of Coast Geological Society

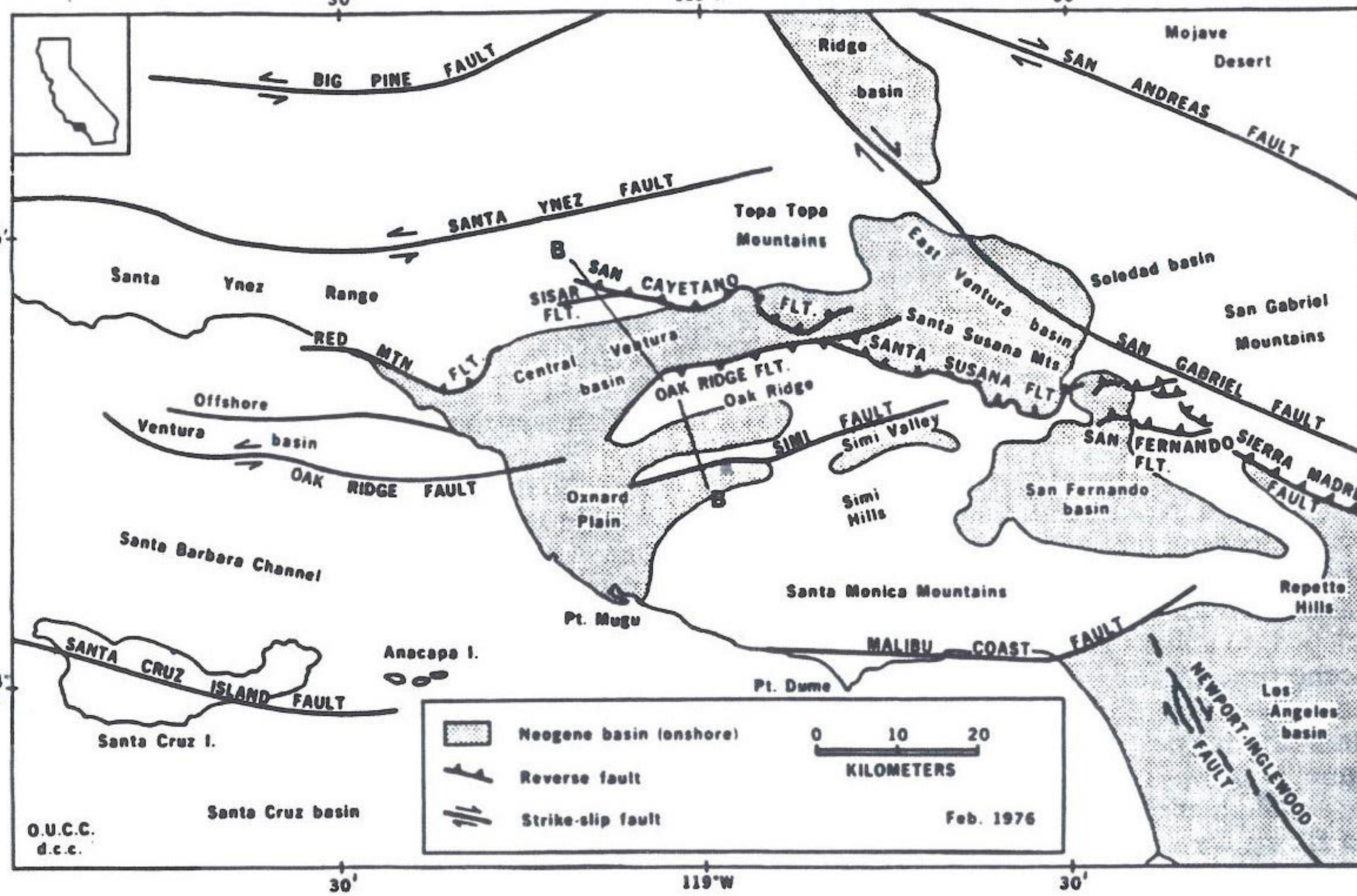


Figure 1.1 Tectonic map of the central Transverse Ranges showing onshore Neogene basins and lowlands (shaded) and major Neogene faults (heavy lines) (Yeats, 1983). Line B-B' is cross section in Figure 1.2.

-2-

Tectonic map of the central Transverse Ranges. From Sylvester and Brown, 1988, p. 2. Used by permission, Coast Geological Society and A. Sylvester.

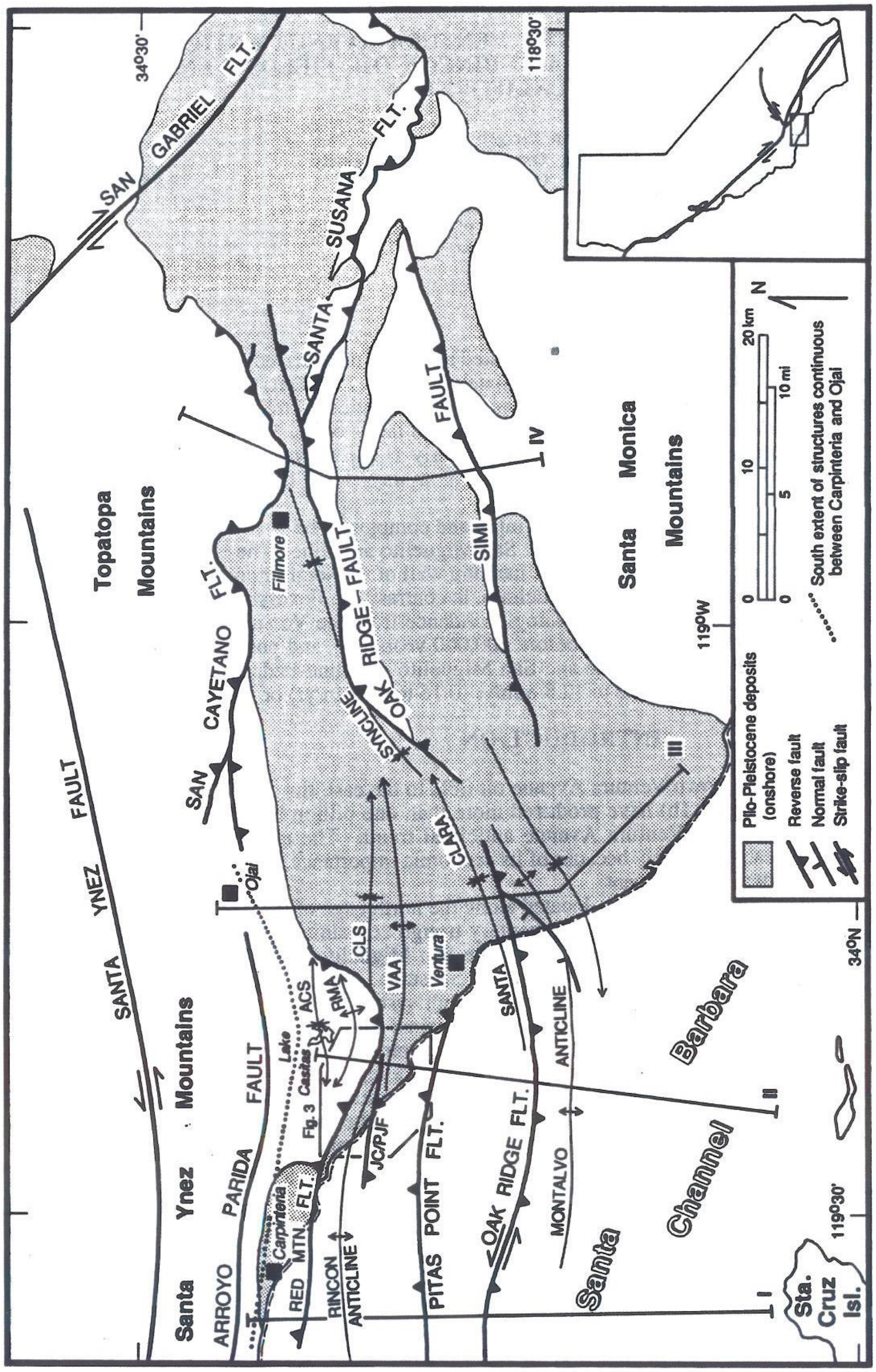


Figure 1: a) Regional tectonic map of western Transverse Ranges, California. Cross-sections I, III, and IV represent locations where Yeats (1981) calculated convergence across the Ventura basin. Cross-section II, shown in Figure 5, is the location where convergence was calculated by Grigsby (1986). ACS, Ayers Creek Syncline; CLS, Canada Larga syncline; JC/PJF, Javon Canyon/Padre Juan fault; RMA, Red Mountain anticline; VAA, Ventura Avenue anticline. b) Index map of Rincon, San Miguelito, and western Ventura Avenue oil fields area, California. Cross-sections A-A' and B-B' are referred to in text. Modified from Pitas Point, California and Ventura, California 7 1/2 minute U.S. Geological Survey topographic quadrangle maps. Oil field limits from Weber et al. (1983). Numbered wells are those drilled outside oil field boundaries; identification of those wells may be obtained from Grigsby (1986).

Regional tectonic map of the western Transverse Ranges. From Sylvester and Brown, 1988, p. 112. Used by permission, Coast Geological Society and A. Sylvester.

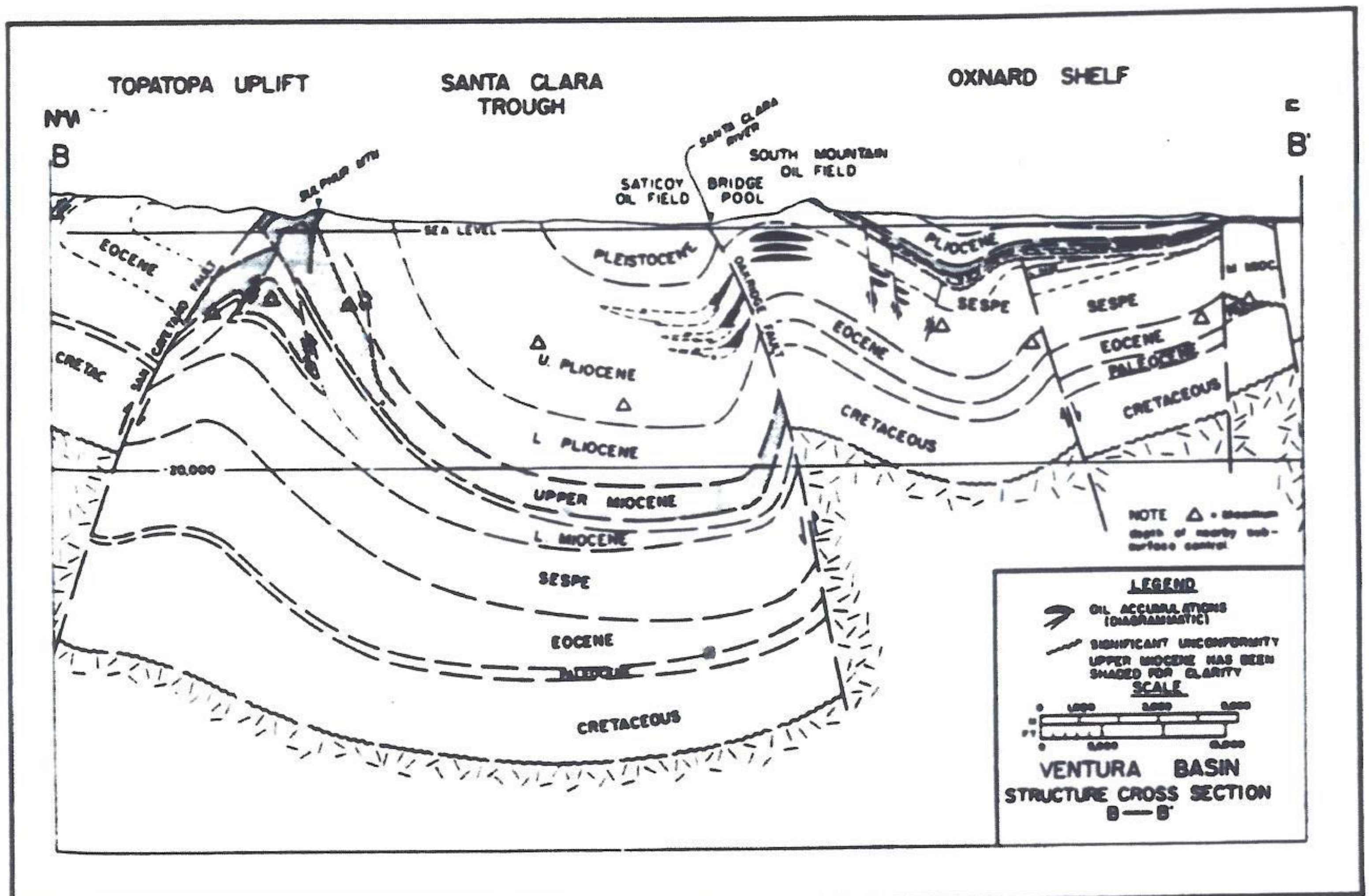


Figure 1.2. **North-south structure section across Ventura basin (Nagle and Parker, 1971). Location shown in Fig. 1.1**

North-south structure section across Ventura Basin. From Sylvester and Brown, 1988, p.2. Used by permission of the Coast Geological Society and A. Sylvester.

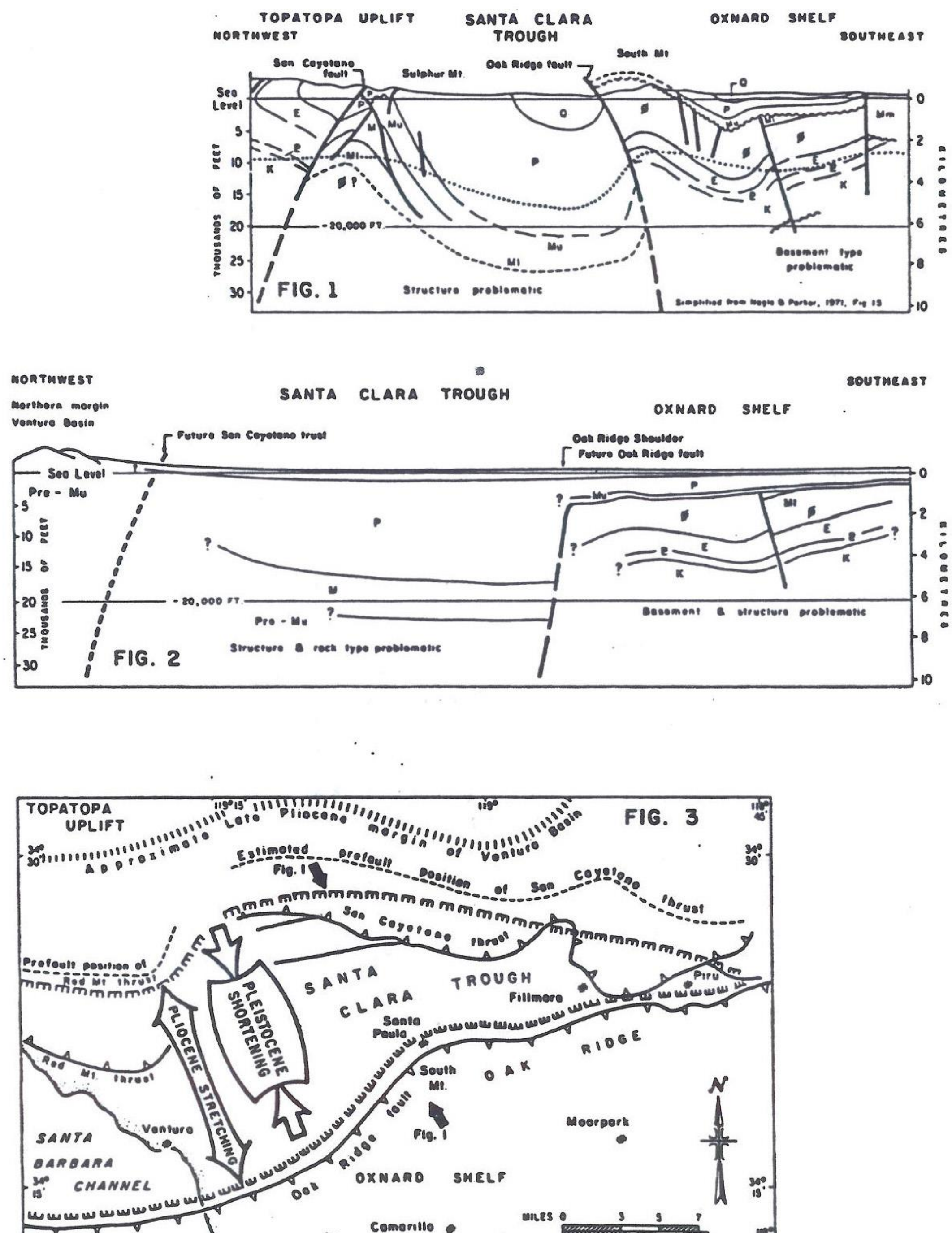


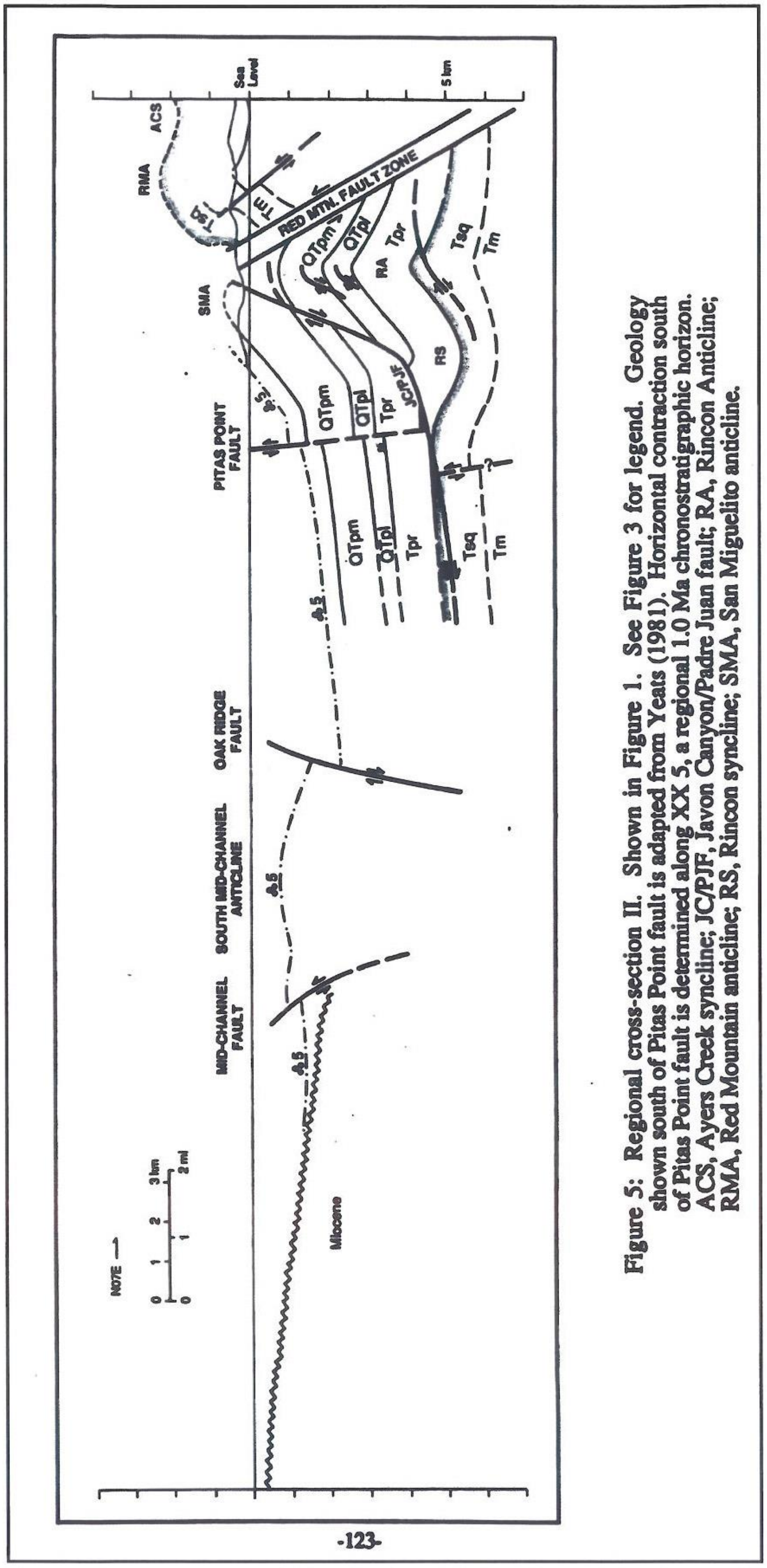
Figure 1.40. Stretching and shortening of the Ventura basin in Neogene time (Crowell, 1976).

A) Simplified cross-section after Nagle and Parker (1971) across Santa Clara trough and Oxnard Shelf showing present structural geometry

B) Palinspastic restoration of cross-section A to inferred pre-Miocene geometry.

C) Sketch map showing direction of Pliocene stretching and Pleistocene shortening.

Stretching and shortening of the Ventura Basin in Neogene time. From Sylvester and Brown, 1988, p. 47. Used by permission of the Coast Geological Society and A. Sylvester.



Regional cross section of the Ventura Basin. From Sylvester and Brown, 188, p.123. Used by permission of the Coast Geological Society and A. Sylvester.

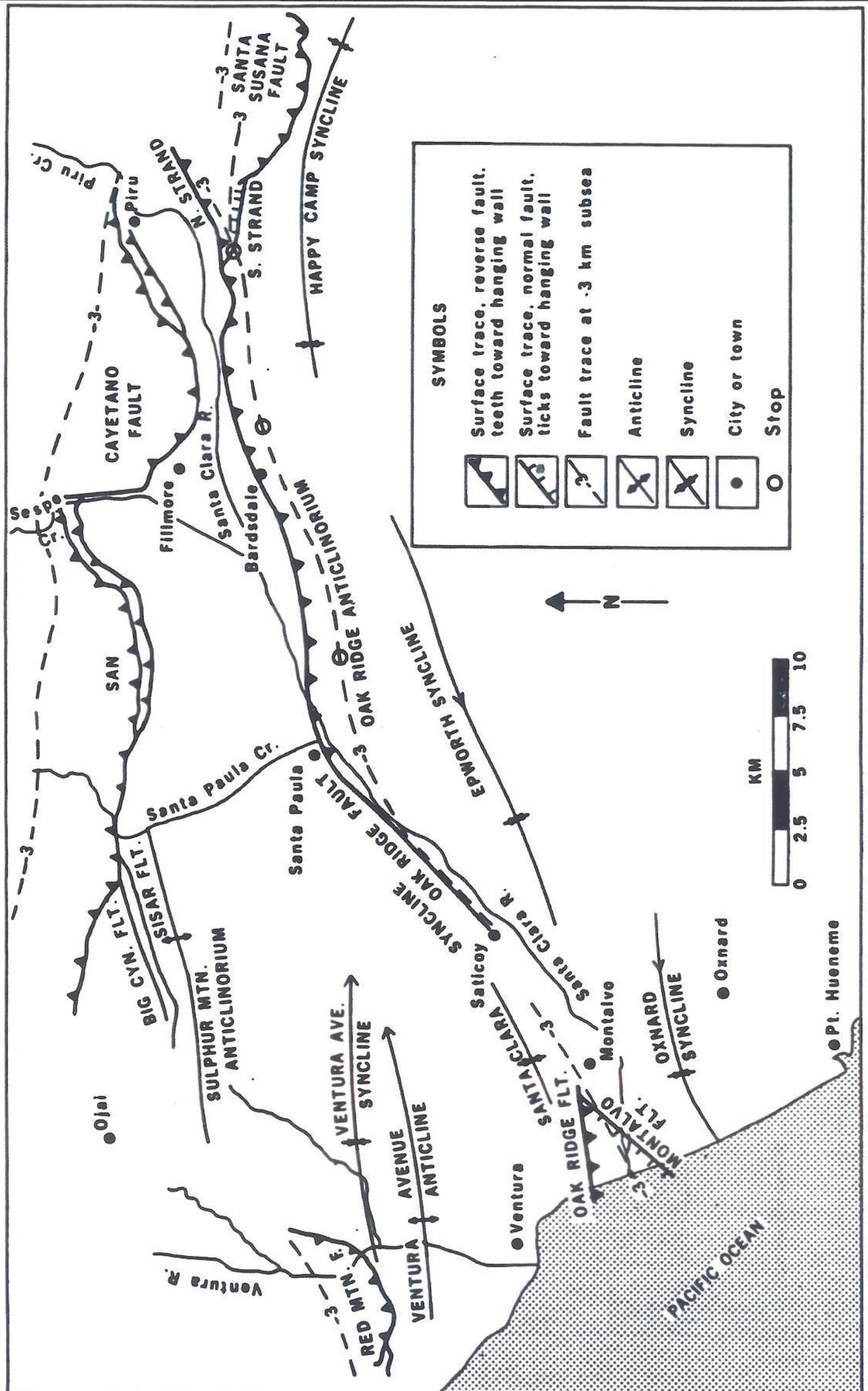


Figure 1.38. Tectonic map of central Ventura trough, comparing surface traces of the Oak Ridge, Red Mountain, San Cayetano, and Santa Susana faults (solids lines) with their subsurface traces at -3 km subsea (heavy dashed lines) (Yeats, 1976). Surface traces of faults are more sinuous than the subsea traces. Oak Ridge fault is en echelon and stepped right at Saticoy; fault dip is nearly vertical where strike is northeast and lower angle where the strike is more easterly. Santa Susana fault overrides the South Strand of Oak Ridge fault; San Cayetano fault overrides the Big Canyon and Sisar faults.

Tectonic map of central Ventura trough. From Sylvester and Brown, 1988, p. 45. Used by permission of the Coast Geological Society and A. Sylvester.

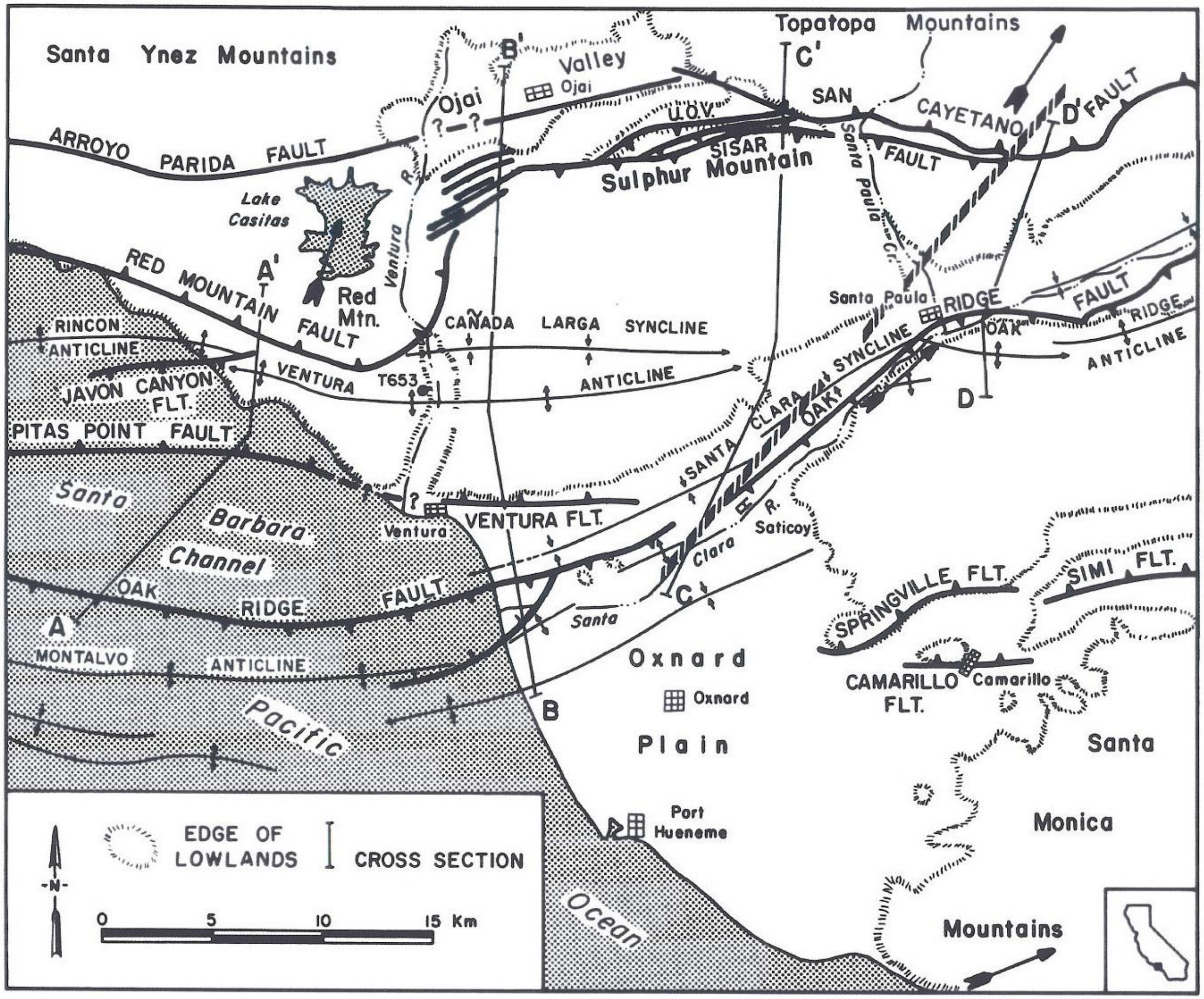


Figure 1. Tectonic map of central Ventura basin with lines of four cross sections shown in Figure 2. Arrows are slip vectors based on earthquake focal mechanisms (Red Mountain fault, San Cayetano fault, 1973 Point Mugu earthquake in western Santa Monica Mountains) and on piercing-point offset of facies boundary (1 Ma) by Oak Ridge fault. Heavy dashed line is domain boundary, west of which there is virtually no late Quaternary near-surface movement on Oak Ridge fault, and east of which there are no interbasin folds and thrusts. U.O.V. = Upper Ojai Valley. T653 locates Ventura Avenue anticline deep test well, projected onto section B-B′.

Tectonic map of the central Ventura Basin. From Yeats and others, 1988. Used by permission.

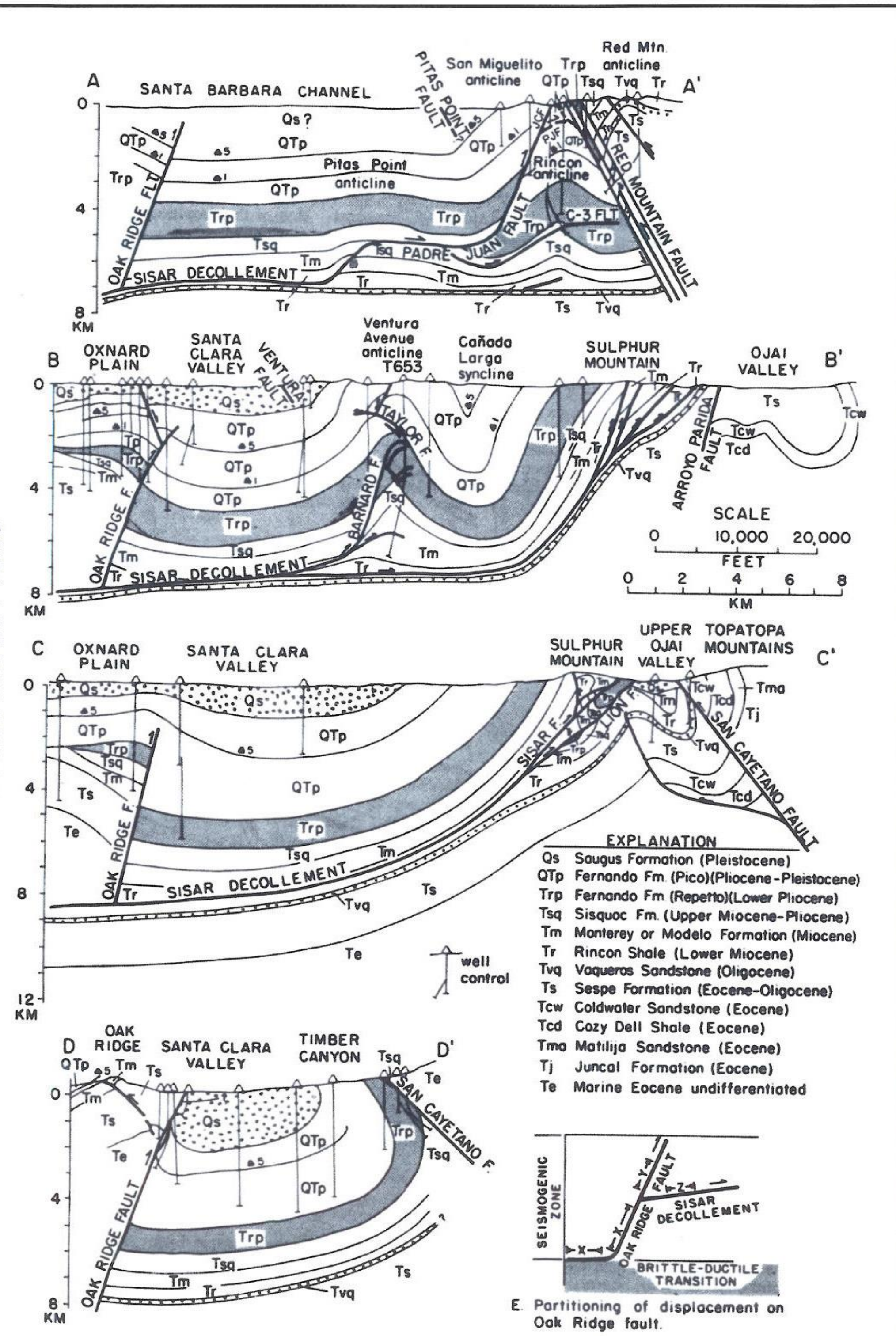


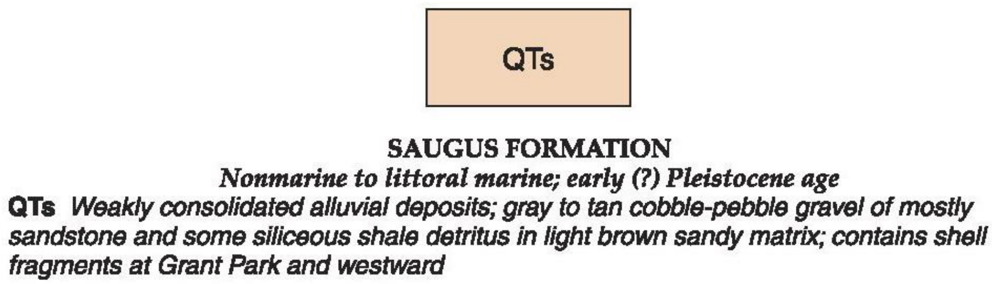
Figure 2. Cross sections through central Ventura basin; locations in Figure 1. Heavy lines = faults; light lines = depositional contacts. Biostratigraphic horizons 5 and 1 in Pico Formation are estimated as 1 and 2 Ma, respectively. No vertical exaggeration. Inset E shows how displacement at brittle-ductile transition (X) is transferred to Oak Ridge fault as ramp, and partitioned at shallow depths to shallow Oak Ridge fault (Y) and Sisar decollement (Z).

Cross sections through central Ventura Basin. From Yeats and others, 1988. Used by permission.

Mile

0.0 Ventura Avenue and Main Street. Driving north on Ventura Avenue, we follow the Ventura River Valley. This river has cut down through rock layers that trend east-west and dip toward the ocean (south) at an angle 25 to 40 degrees.

0.2 Just north of Main Street, and running parallel to it, is the **Ventura Fault** which forms the southern end of the Ventura Anticline. The rocks in the bluffs to our right (east) are Pleistocene **Saugus Formation**. They are composed of weakly consolidated alluvial deposits, gray to tan cobble-pebble gravel of mostly sandstone and some siliceous shale detritus (debris) in light brown sandy matrix. It contains shell fragments at Grant Park and westward (Dibblee, 1988).


QTs

SAUGUS FORMATION

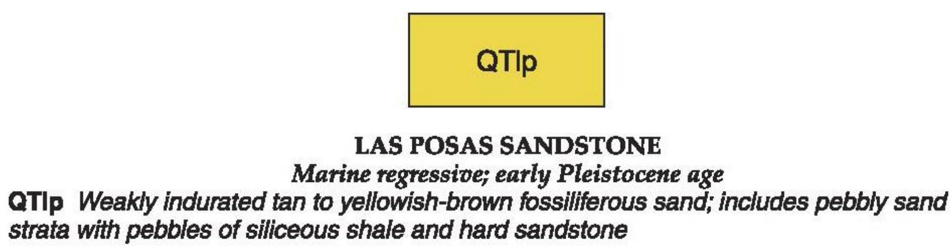
Nonmarine to littoral marine; early (?) Pleistocene age

QTs *Weakly consolidated alluvial deposits; gray to tan cobble-pebble gravel of mostly sandstone and some siliceous shale detritus in light brown sandy matrix; contains shell fragments at Grant Park and westward*

Figure 5. Lithological Description of the Saugus Formation. From Dibblee, 1988.

0.4 Ventura Avenue and Sheridan Way.

To the right (east) the south-dipping sedimentary rocks mark a contact between the Saugus Formation and underlying (older) Pleistocene **Las Posas Sandstone**. This is an early Pleistocene sand which formed during the early Ice Age. At this time in earth history, as the planet cooled and sea level fell the ocean receded southward because water accumulated in the continental ice caps. This recession was marked by deposition of this sandstone formation.


QTlp

LAS POSAS SANDSTONE

Marine regressive; early Pleistocene age

QTlp *Weakly indurated tan to yellowish-brown fossiliferous sand; includes pebbly sand strata with pebbles of siliceous shale and hard sandstone*

Figure 6. Lithologic description of Las Posas Sandstone. From Dibblee, 1988.

1.0 Foster School

At this point, as we drive into the **Ventura Avenue Anticline**, older and older formations are being exposed on both sides of the Ventura River. At the point of Foster School, on our right (east) is the contact between Las Posas Sandstone and underlying **Pico Formation**. On Dibblee's map (1988) he recognizes six separate units:

THE PICO FORMATION	
QT pm	Mudpit Claystone Member, early Pleistoce to possible late Pliocene age, massive to vaguely bedded gray claystone or mudstone
QT pmc	Mudpit Sandstone Zone. Included in QT pm, light gray sandstone and conglomerate with pebbles of hard sandstone and white siliceous shale
Tp	Pico Formation Claystone Member. Mostly gray claystone, vaguely bedded, and few thin strata of sandstone
Tps	Pico Formation Sandstone Member. Mostly light gray to tan sandstone, well bedded, in places pebbly; includes some interbedded claystone, as above
Tpsc	Pico Formation Conglomerate Member. Sandstone as above, and conglomerate of pebbles and cobbles of hard sandstone.
Tpr	Repetto Member: gray claystone, similar to Tp, but stratigraphically lower, contains microfauna of early Pliocene age.

The Pico Formation is named for the Pico Ranch. General Andreas Pico collected tar from natural tar pits at Newhall in 1855. The following year, Charles Morrel built a primitive distilling plant close to the asphalt seepages at Carpinteria (Taylor and Welty, 1950, p. 30).

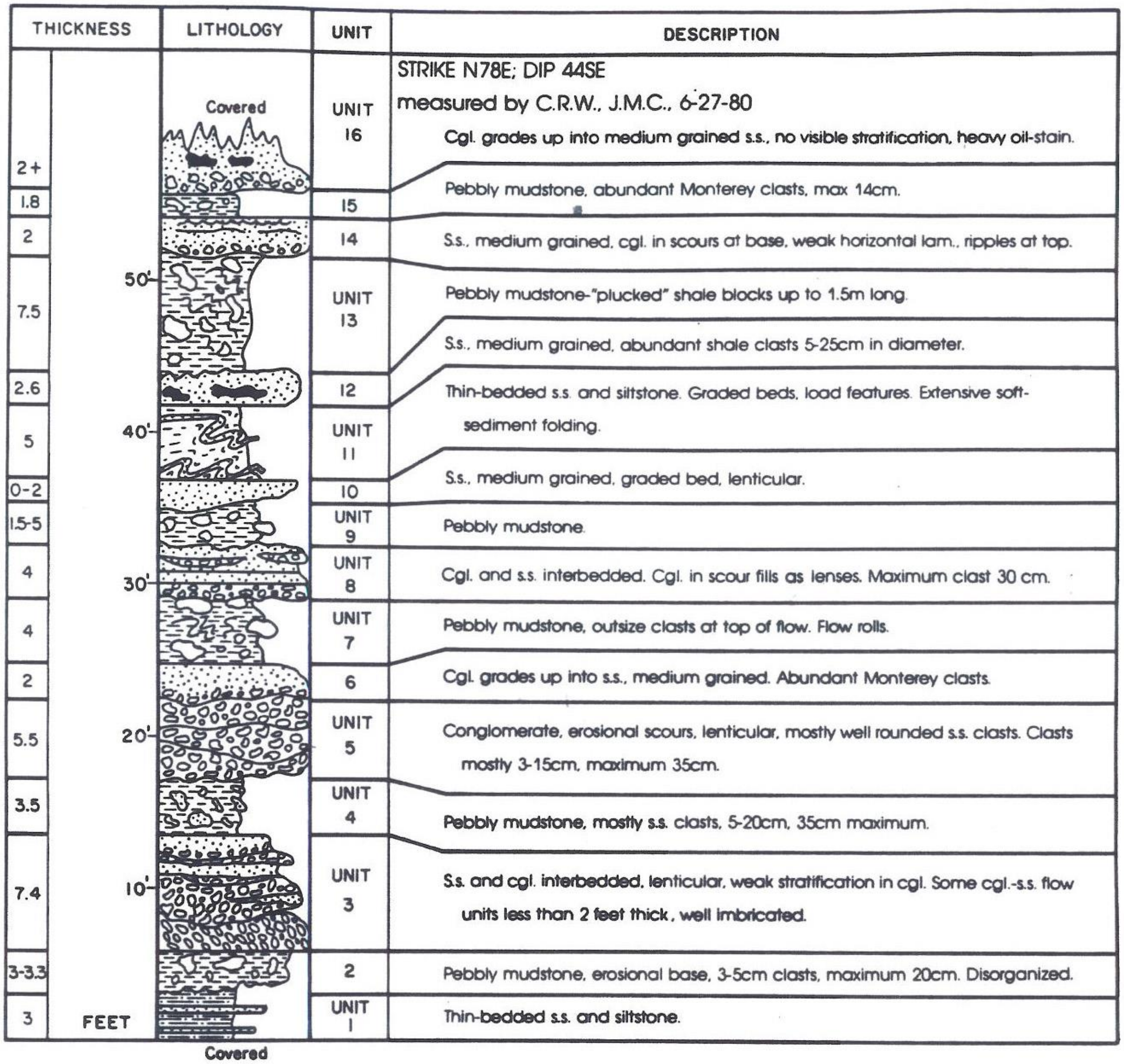


Figure 1.26. Measured stratigraphic section of the Pico Formation, Ventura Avenue oil field (Williamson, unpub. Unocal seminar report, 1980).

Measured stratigraphic section of Pico Formation, Ventura Avenue oilfield. From Sylvester and Brown, 1988, p.32. Used by permission of the Coast Geological Society and A. Sylvester.

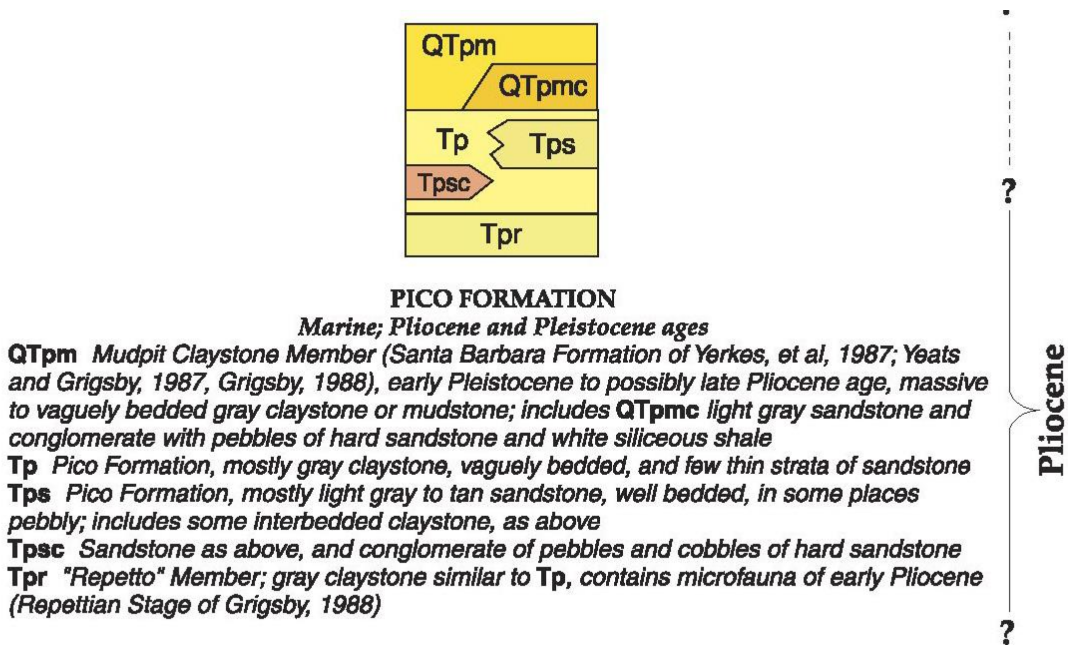


Figure 7. Lithologic description of the Pico Formation. From Diblee, 1988.

Mile

1.3 Jr. High School. To the east of the school is a landslide with conceals, from this vantage point, the contact between Mudpit Claystone and Pico Claystone members of the Pico Formation.

2.0 Joaquin Creek (Canada de San Joaquin) is to the right (east). The lower parts of the creek are filled with older Pleistocene alluvial deposits. The creek marks, approximately a contact between Pico Claystone to the south and Pico Sandstone to the North.

2.2 Shell Road to Highway 33 on the left (west). This street marks the approximate apex of the Ventura Anticline (an anticline is a fold in layered rocks that is convex upward). As we drive northward, rocks begin to dip northward instead of southward.

Stop 4: Ventura Avenue Oil Field

The Ventura Anticline, the most prominent onshore structure in Ventura County, trends east-west for a distance of more than 15 miles from the coast at San Miguelito to Wheeler Canyon. The vertical closure between the bounding synclines exceeds 7,500 ft. It has been estimated that the depth of the sedimentary basin at this structure is more than 50,000 ft, probably more than 60% sand. The deepest wells in the Ventura field have penetrated the Santa Margarita Formation (Miocene) and possibly have reached the Upper Mohnian. The Santa Margarita, as well as the lower Pliocene, sediments in this part of the Ventura Basin are basically turbidites. The Ventura Avenue field has produced 721,616,000 bbl of oil averaging 30° gravity and 1,896,455,000 mcf of gas, since it was discovered in 1918. Conservative estimates concede that the field will produce at least one billion barrels primary.

This field was discovered in March ,1922 by the Shell Western Exploration and Production Company's Gosnell No. 1 well. Production is from the Pliocene Pico formation at an average depth of 3,680 feet. Waterflood recovery of the field commenced in 1956. The 30-gravity oil is recovered mostly from the north flank of the east-west trending Ventura Anticline.

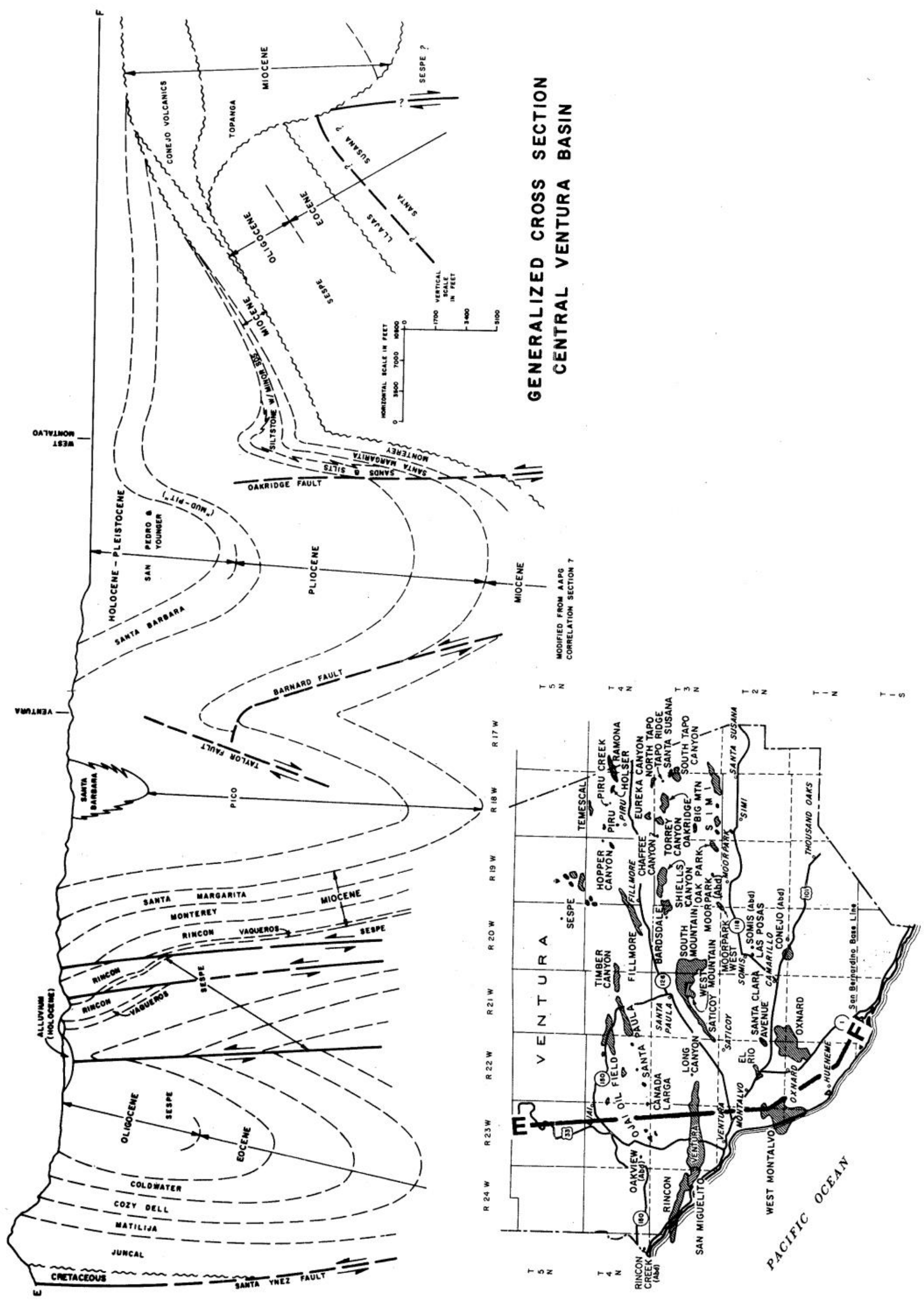


Figure 8. Cross Section, Central Ventura Basin. From CDOGGR, Summary of Operations, Volume 2, p. 11

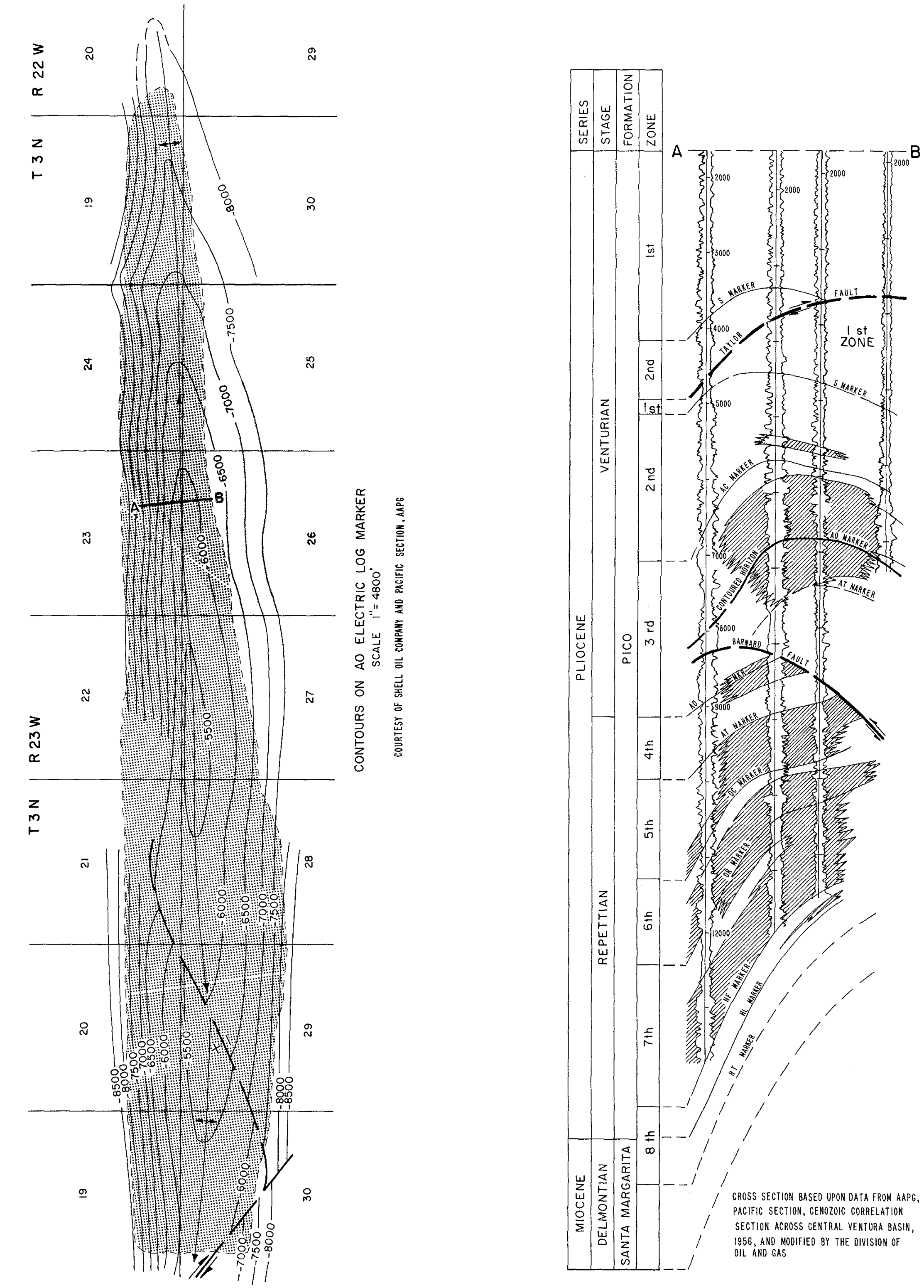


Figure 9. Cross Section and Structural Contour Map of the Ventura Oil Field. From CDOGGR, Summary of Operations, vol. 2, p. 572.

Mile

3.4 Manuel Canyon is on the right (east). A few hundred feet south of this canyon is the contact between older, underlying Pico Sandstone and younger, overlying Pico Claystone. As we drive northward, we are now driving through younger and younger rocks on the north flank of the Ventura Anticline. The canyon itself is filled with Older Alluvium (Qoa) and Older gravel deposits (Qog).

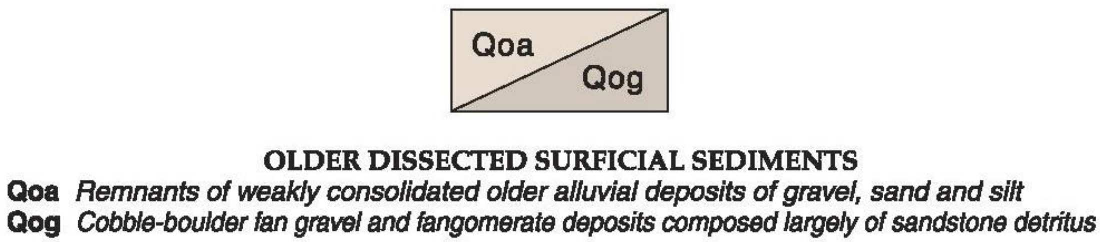


Figure 10. Older Dissected Surficial Sediments. From Dibblee, 1988.

3.9 Underpass of Ventura Avenue and Highway 33.

4.3 Cañada Larga. This large canyon, draining eastward, marks the approximate location of the axis of a syncline, a fold that is convex downward. Driving north of the synclinal axis, we drive through older and older rocks.

4.8 Underpass for Highway 33. Weldon Canyon is on the right, draining south-southwestward. At the mouth of Weldon Canyon, to the south is Pliocene Mudpit Conglomerate and to the north is Pliocene Pico Claystone.

The Weldon Canyon area of the Ojai Oil Field, in Section 3, Township 3 N, Range 23W, was discovered by the Union Oil Company of California, Weldon Canyon No. 2 well in June, 1951. Production of 28-30 gravity oil is from Pico Formation at an average depth of 3,161 feet. Production is from a near-vertical sand bed.

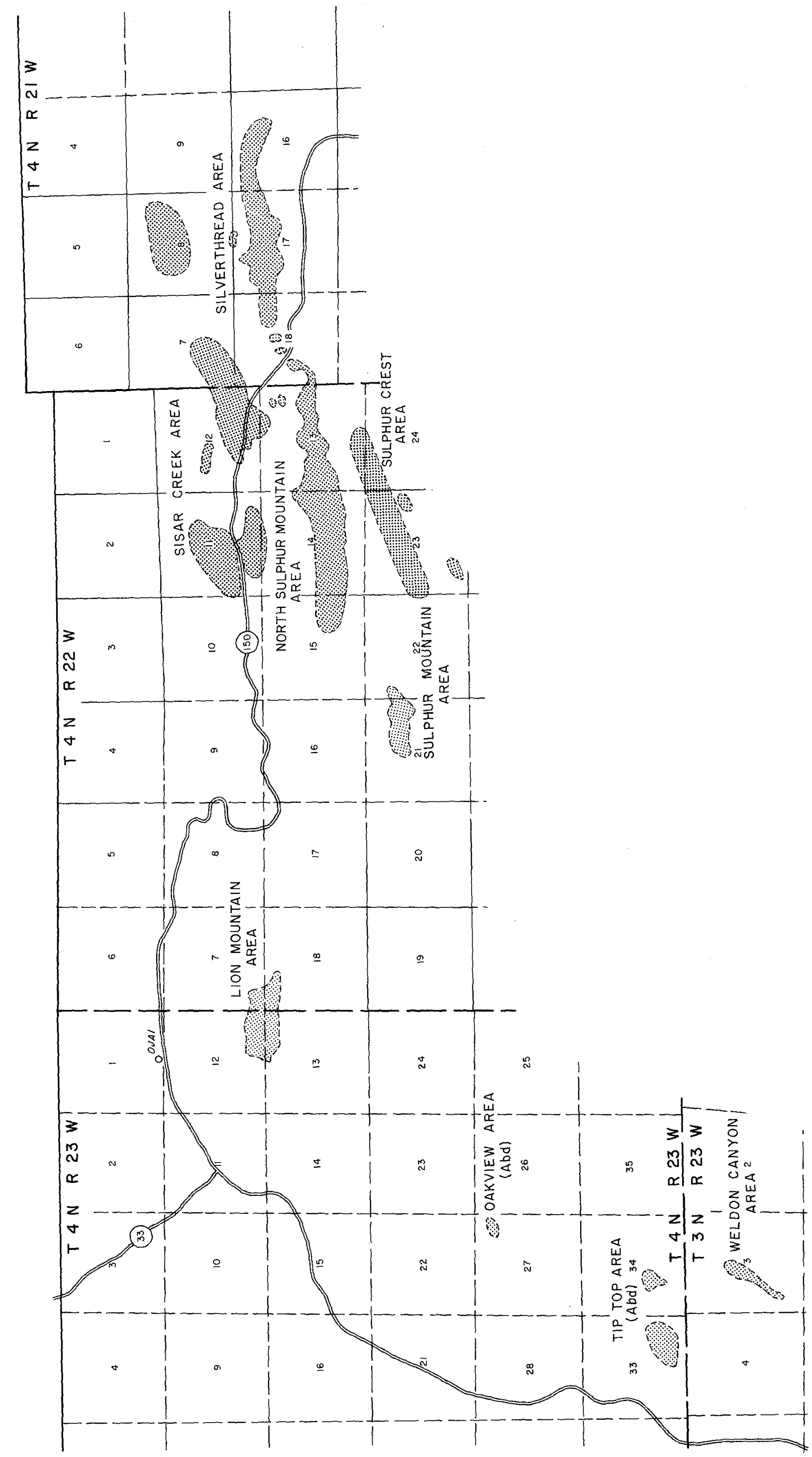


Figure 11. Index map for Ojai Oil Field. From CDOGGR, Summary of Operations, Vol. 2, p. 334.

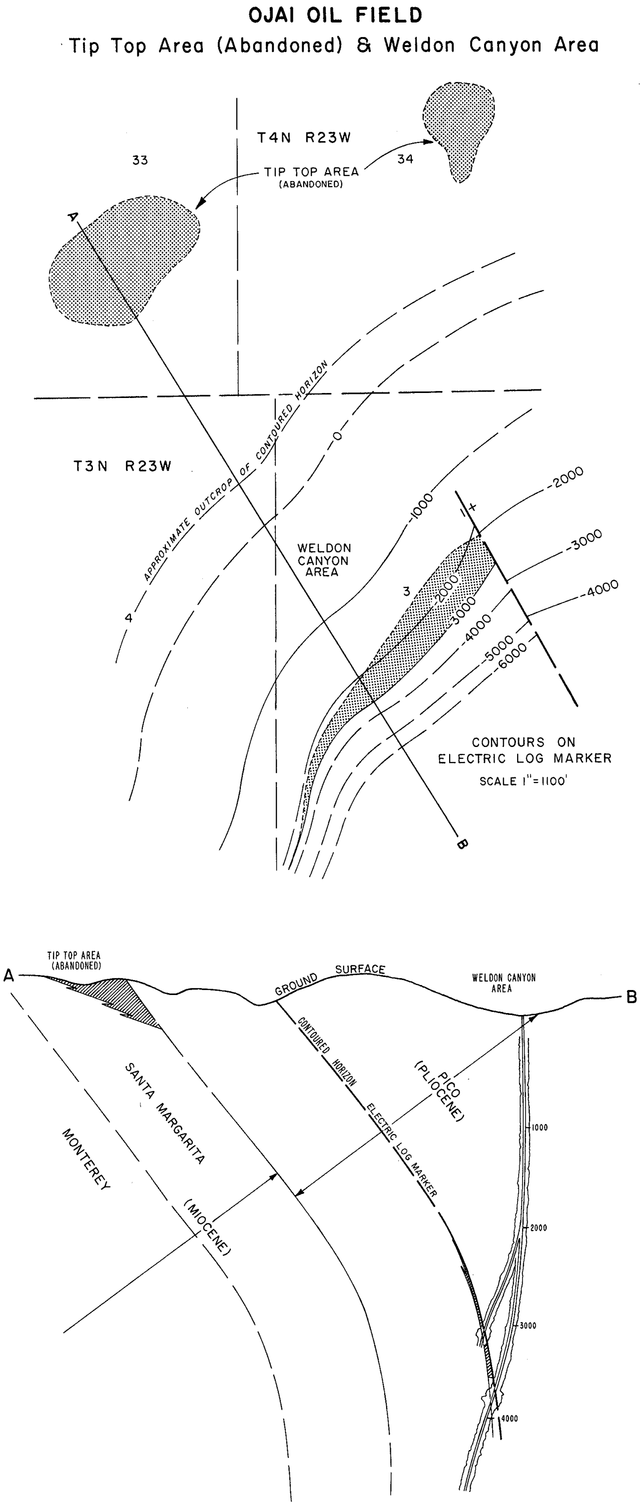


Figure 12. Cross section and structural contour map of the Tip Top and Weldon Canyon Areas of the Ojai Oil Field. From CDOGGR, Summary of Operations, Vol. 2, p. 352.

Mile

5.0 One third mile northward of Weldon Canyon, the roadway crosses the Red Mountain Fault Zone.This fault separates Pico Formation to the south and southeast from Sisquock Formation, Monterey Formation, and Rincon Shale to the north and northwest.

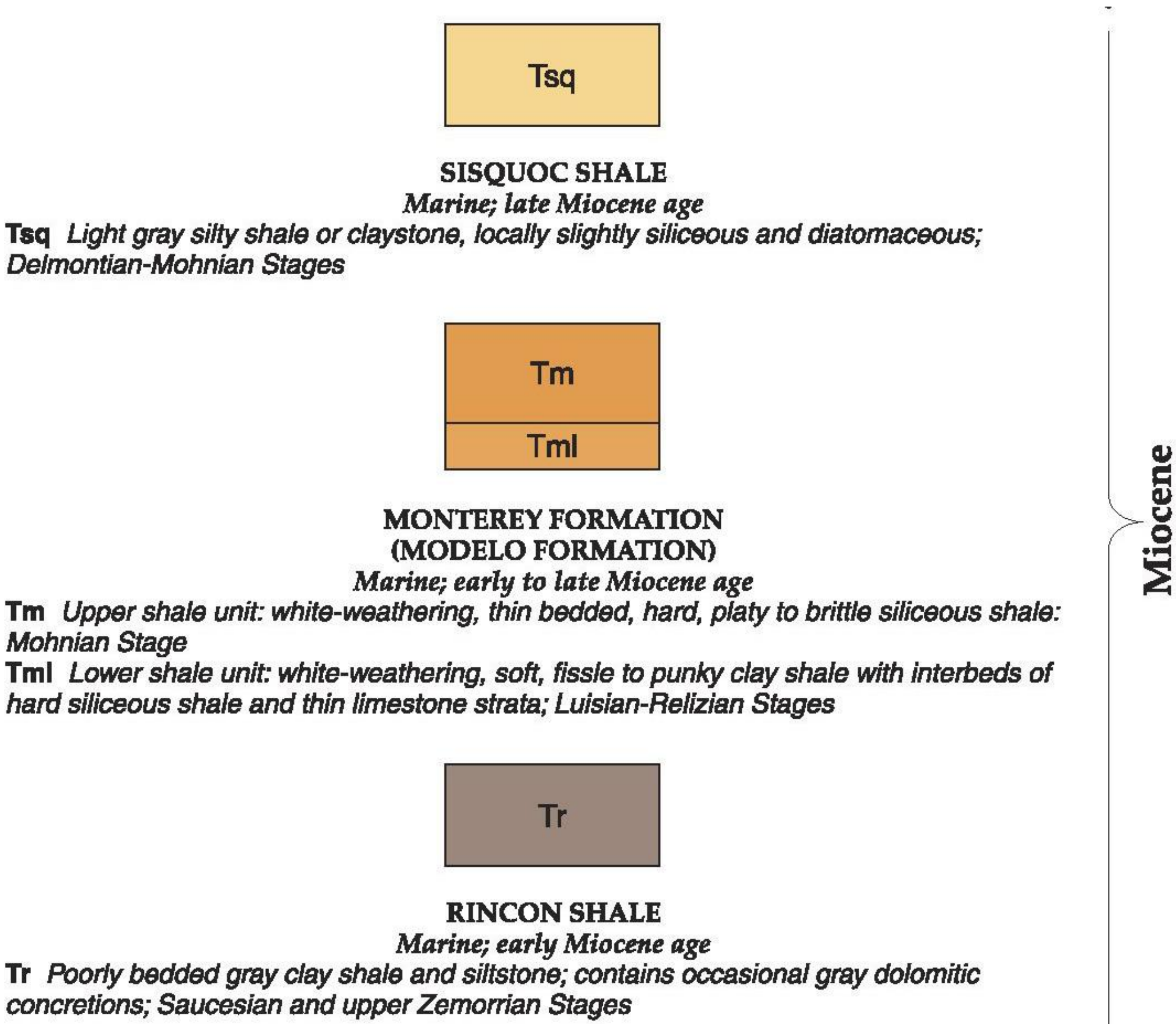


Figure 13. Lithological description of the Saugus, Monterey, and Rincon formations. From Dibblee, 1988.

The Pliocene-Miocene **Sisquoc Shale** is light gray silty shale or claystone, locally slightly siliceous and diatomaceous.

The Miocene **Monterey Formation** has been mapped in this area as the Modelo Formation. For the upper part of the formation, Dibblee (1988) recognizes a white-weathering, thin bedded, hard, platy to brittle siliceoius shale. The lower part of the Monterey, in this area, is also white-weathering, soft, fissile to punky clay shale with interbeds of hard siliceous shale and thin limestone strata. At Lompoc, 90 miles to the northwest, this unit is mined by Celite Corporation (formerly Johns Manville) for diatomaceous earth.

The Red Mountain Fault bends to the west at this point in our field trip. The red rocks on the west side of the Ventura River are mostly Sespe Formation. These Sespe beds are surrounded by relatively thin bands of Vaqueros Sandstone, Rincon Shale and Monterey Formation. Red Mountain, to the northwest, is a topographic expression of the Red Mountain Anticline.

Of these formations, the **Sespe** is the oldest, being of Oligocene Age. The Sespe is composed of braided river sediments, lake sediments, mud flows and other units that formed mostly on land. When they originally formed, they were 400 miles to the southeast, in what is now the Gulf of Mexico, as part of a great depositional system of the Ancestral Colorado River. Dibblee (1988) describes the Sespe in this area as pinkish-grey to light brown, moderately hard arkosic sandstone, locally pebbly and interbedded maroon-red siltstone and claystone. The red claystones are abundant near the top of the unit.

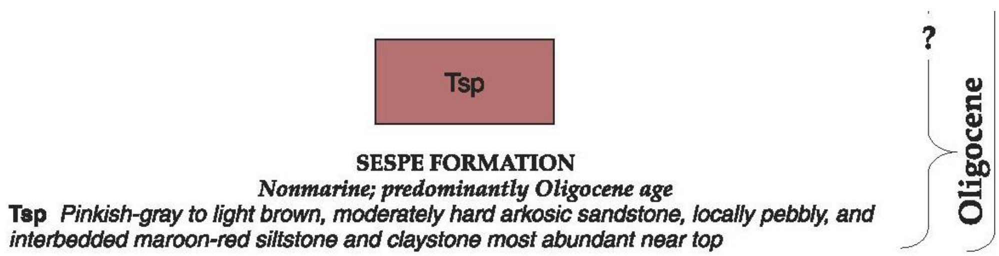


Figure 14. Lithological description of the Oligocene Sespe Formation. From Dibblee, 1988.

Beginning in the early Miocene, as the San Andreas system began to form, the land previously above sea level was depressed and the sea moved over the Sespe red beds in a marine transgression, forming the **Vaqueros Sandstone**. This shallow-water marine is massive to poorly bedded, light gray to tan, fine grained sandstone, locally calcareous (Dibblee, 1988)

VAQUEROS SANDSTONE

Shallow marine; early Miocene age

Tvq ***Massive to poorly bedded, light gray to tan, fine-grained sandstone, locally calcareous; Zemorrian Stages***

Figure 15. Lithological description of the Vaqueros Sandstone. From Dibblee, 1988.

As the Ventura Basin continued to subside in early Miocene time, the **Rincon Shale** was deposited. This unit was deposited above the Vaqueros. It is a poorly bedded grey clay shale and siltstone, containing occasional gray dolomitic concretions.

Further subsidence of the Ventura Basin, in the early to late Miocene, lead to formation of a deep, oxygen-starved ocean basin with very caustic bottom waters below the carbonate compensation depth (CCD). The CDD occurs about 3000 feet in most oceans and represents a chemical condition where, due to temperature and pressure, carbonate particles from shells and tests of plankton dissolve. Below the CDD, the calcium particles do not settle to the ocean floor to form calcareous ooze or clastic limestone sediments as they can do in more shallow ocean settings. Such was the condition of the Ventura Basin when the **Monterey Formation** was being formed. It=s lithology is described above. The chief ingredients of the Monterey are diatoms, the tests of near-surface marine algae. These are made of silica and survive the CDD, accumulating on the caustic early Miocene ocean floor. These conditions also were perfect for the burial or organic material which would oxidize and dissipate in ocean sediments in other depositional settings.

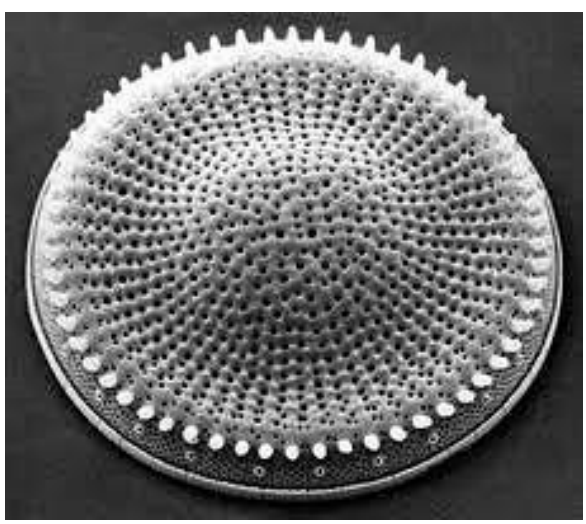
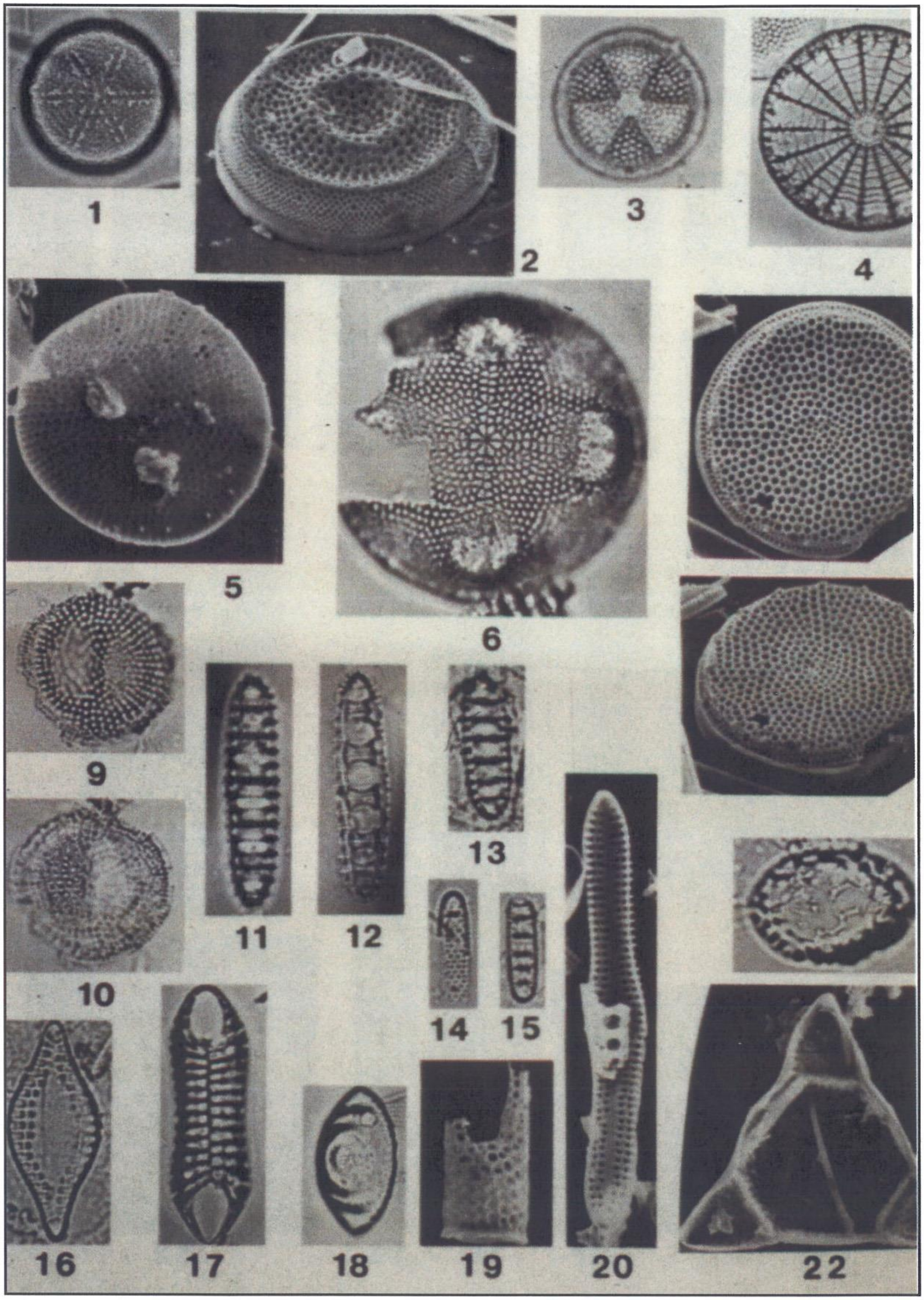
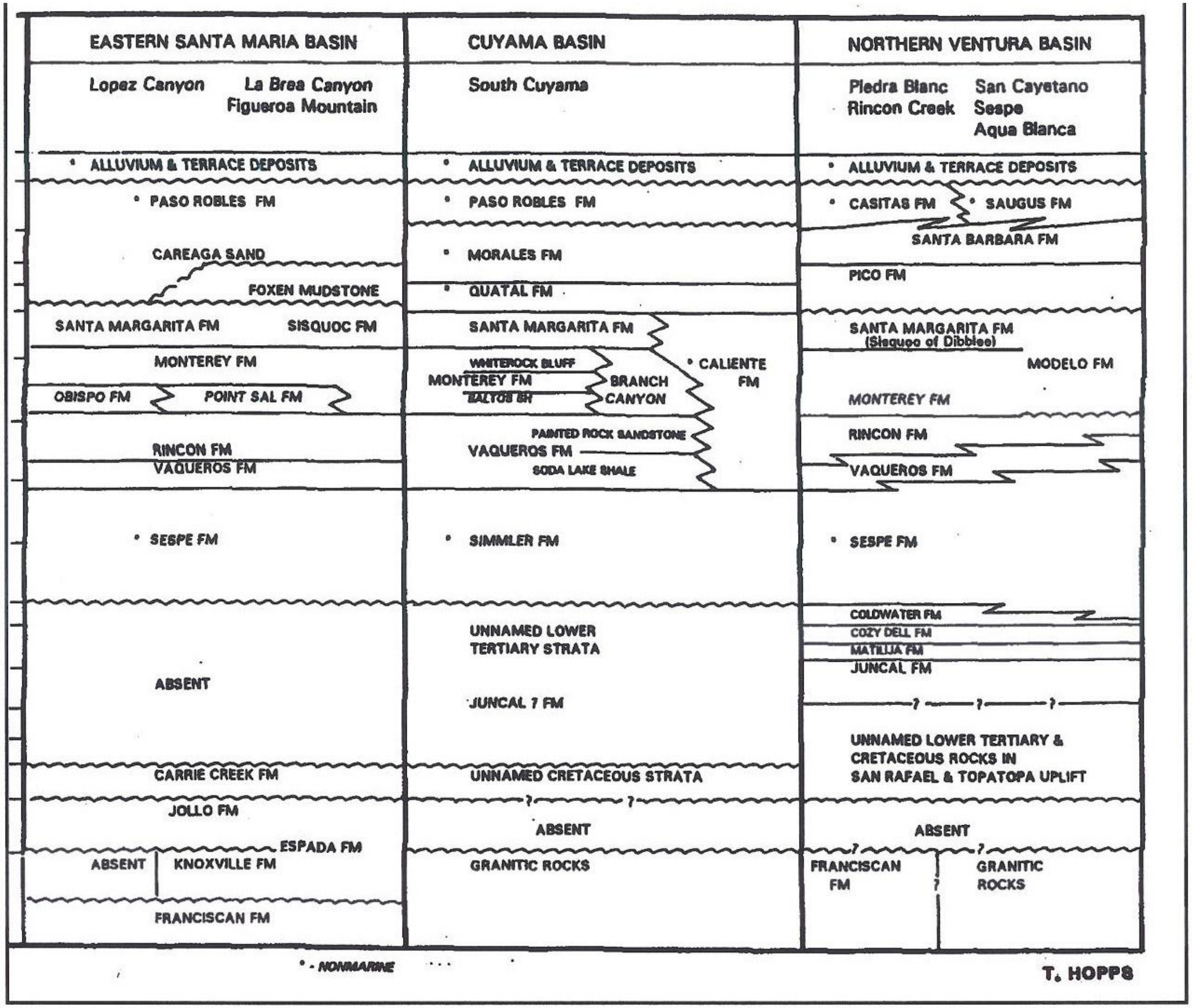


Figure 16. Diatom.



Diatoms, primary constituent of Monterey Diatomacious Shale



Composite stratigraphic columns for the Eastern Santa Maria, Cuyama and Northern Ventura Basins. From Tom Hopps. Used by permission of Coast Geological Society

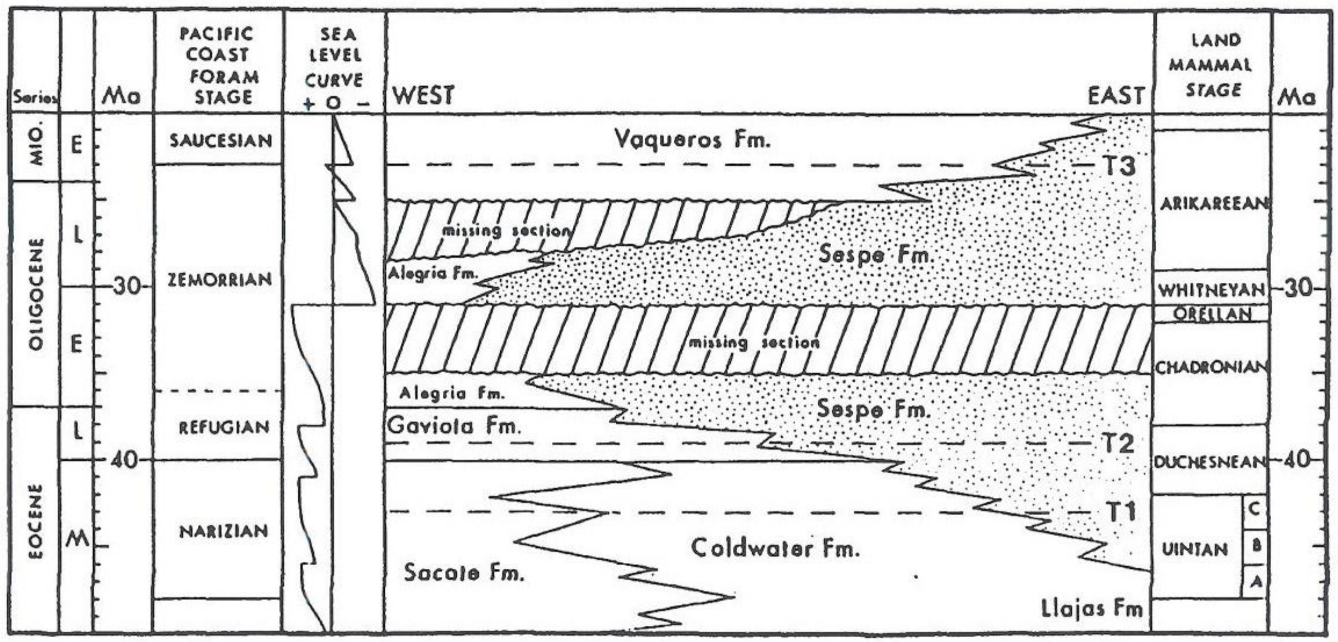


FIGURE 9: Lateral facies relations in mid-Tertiary across the Sespe basin. The Sespe Formation records two major episodes of sea level change. A major sedimentary regression correlative with sea level drop at the end of Eocene time, subaerial erosion during low-stand of sea level at about 31 million years BP, removing the early Oligocene section in the Santa Ynez Mountains and possibly throughout the basin. The upper Sespe and Vaqueros formations record a major transgression (T3) and backfilling of the basin during late Oligocene time

Lateral facies relations in mid-Tertiary across the Sespe basin. From Brown and others, 1996, p.21. Used by permission of the Coast Geological Society and A. Sylvester.

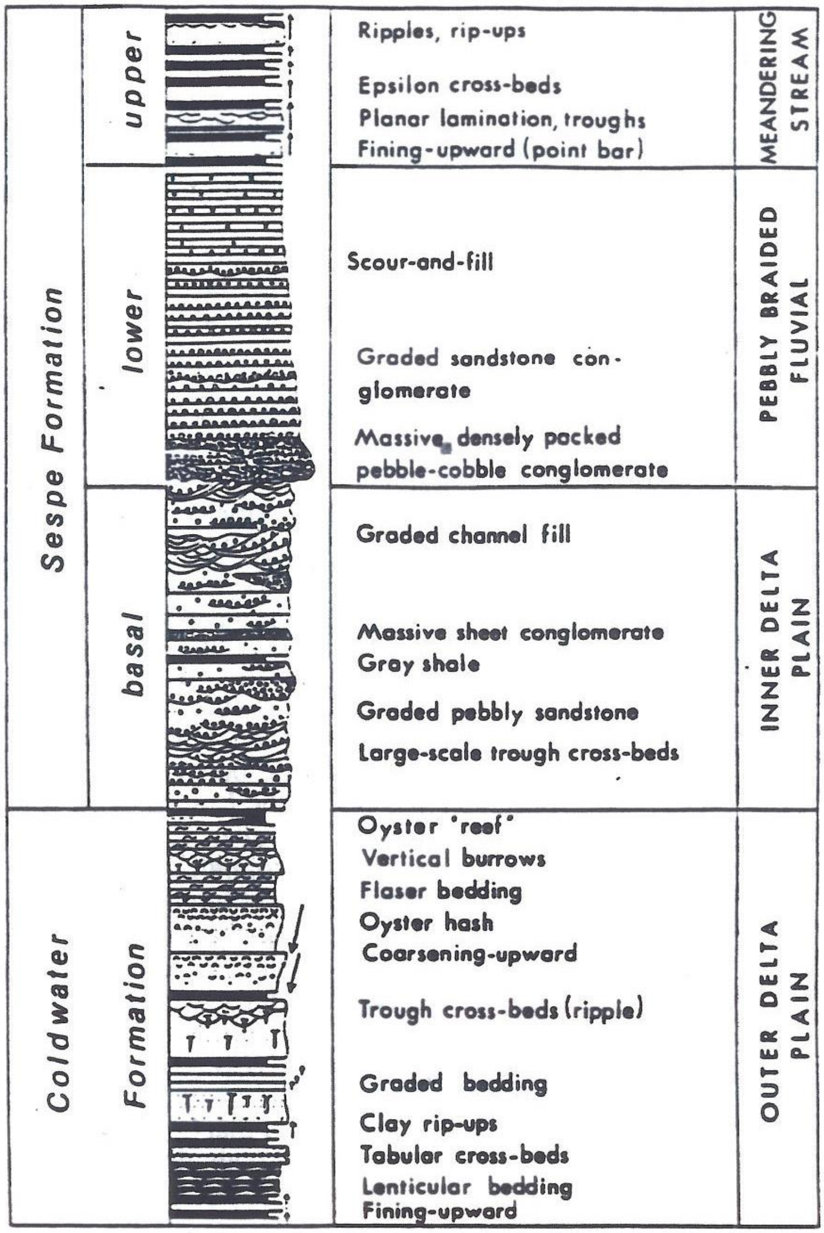


Figure 10. Stratigraphic column of the upper Coldwater and Sespe formations in the San Marcos Pass area of the Santa Ynez Mountains, southern California illustrating the marine-non-marine transition. Facies A comprising the basal Sespe Formation is interpreted as a braided delta distributary channel and lacustrine delta-fill deposit. It grades downward into fossiliferous marine rocks of the Coldwater Formation interpreted as a sequence of tidal channel and interdistributary bay-fill deposits. The lateral gradation of the basal Sespe Formation into a similar facies of the Gaviota Formation probably represents the transition from inner to outer delta plain depositional settings and marks the position of a late Eocene (Refugian) paleoshoreline in the Sespe basin.

Stratigraphic column of the upper Coldwater and Sespe Formations. From Sylvester and Brown, 1988, p.67. Used by permission of the Coast Geological Society and A. Sylvester.

Mile

5.7 Intersection of Highway 33 and Santa Ana Road to Foster Park. At this intersection, across the Ventura River, to the west, is Sespe Formation. The rocks on the right (east) are Vaqueros Sandstone, diping 45o east, and beyond them, uphill, is Rincon Shale. The first major peak to the east is Monterey Shale. To the northwest is Coyote Creek leading up to Casitas Dam and Lake Casitas. Stay to the right and continue northward on Highway 33.

5.9 Bend in roadway to the right.

MAP 03:

(Geology from Dibblee, 1988 and 1987a: Ventura and Matilija Quadrangles)

6.5 Road turns to the north.

6.8 Casitas Springs. This community is built on Quaternary alluvium of the Ventura River. To the east is Monterey Formation. To the west are Sespe Formation, Vaqueros Sandstone and Rincon Shale.

East of Casitas Springs, on the southwestern flank of Sulfur Mountain, in Sections 33 and 34 of Township 4N, Range 23W is the abandoned Tip Top area of the Ojai Oil Field. The Tip Top was discovered in February, 1918 by the E.L. Henthorn No. 1 well. The Tip Top is an example of a hydostatic oil field where oil migrated to the surface due to hydodynamic force. There is no trapping mechanism except for the pressure loss upon reaching the surface. This was, in effect, a large oil seep in Pico Sandstone. The near-surface oil was quickly extracted and the oil field abandoned.

7.2 Monterey Formation in roadcut to the right (east)

7.3 Sulfur Mountain Road on the right (east)

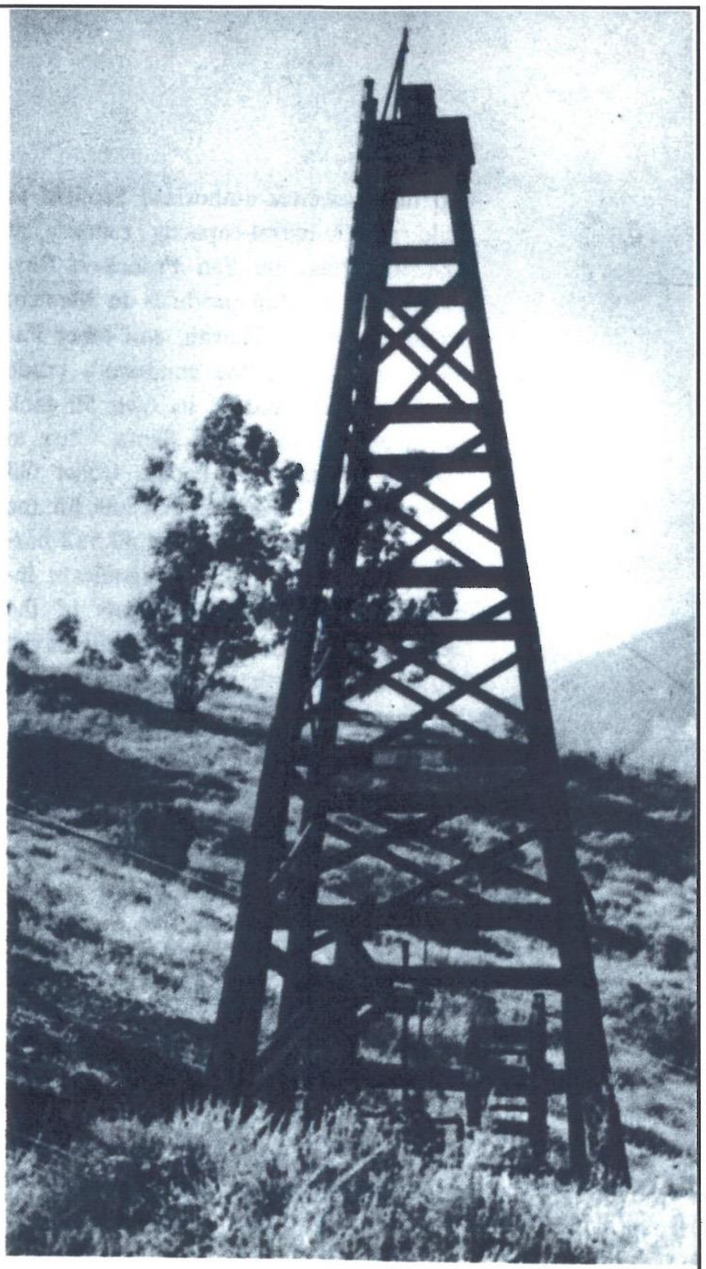
7.6 Highway 33 crosses San Antonio Creek.

At the confluence of San Antonio Creek, to the east, and the Ventura River, to the west, the area is underlain by Monterey Formation dipping to the south at 33-45^{o}.

It was on San Antonio Creek, in 1864, that Professor Benjamin Sillman studied oil seeps on the slopes of Sulfur Mountain which was part of the Rancho Ojai. He proposed that 10 wells be drilled, an astounding number in that day. Sillman=s reports contributed to the great California oil boom of 1865-1867. During that period of time, 70 companies capitalized at 45 million dollars had drilled 60 wells in California. It cost 1 million dollars in hard cash to produce 5,000 barrels of oil worth $10,000 (Taylor and Welty, 1950, p.

35). This point is also a lithologic contact between Quaternary older alluvium to the south and Monterey Formation to the north.

Following the professor's advice, Thomas Bard, a veteran of the Pennsylvania oil fields and future president of Union Oil Company, drilled 500 feet into a Brea pit on the east bank of San Antonio Creek, later re-named the Ventura River (Taylor and Welty, 1935, p.42).



One of the first wells drilled by Thomas Bard at Rancho Ojai, California, in the sixties.

From Taylor and Welty, 1950, p.43.

7.9 Monterey Formation in road cut to the left (west). Intersection of Ventura Avenue (Highway 33) and Creek Road. Turn right and to northeast on Creek Road. The community of Oak View is north of this intersection.

8.4 Monterey Formation in road cut to the north.

Oak View Area of the Ojai Oil Field

The **Oak View area** of the Ojai Oil Field, in Section 27 of Township 4 N, Range 23W, is now abandoned. It was discovered in December 1935 by the A.N. Macrata Riva- Kosman No. 1 well and produced from the Miocene Vaqueros Formation at an average depth of 3,900 feet. Average net thickness of the producing sand bed is 85 feet and covers and area of 10 acres. The gravity of the oil is 32º. Production was from a near-vertical fault-bound sliver of Vaqueros Sandstone trapped by overlying Rincon Shale.

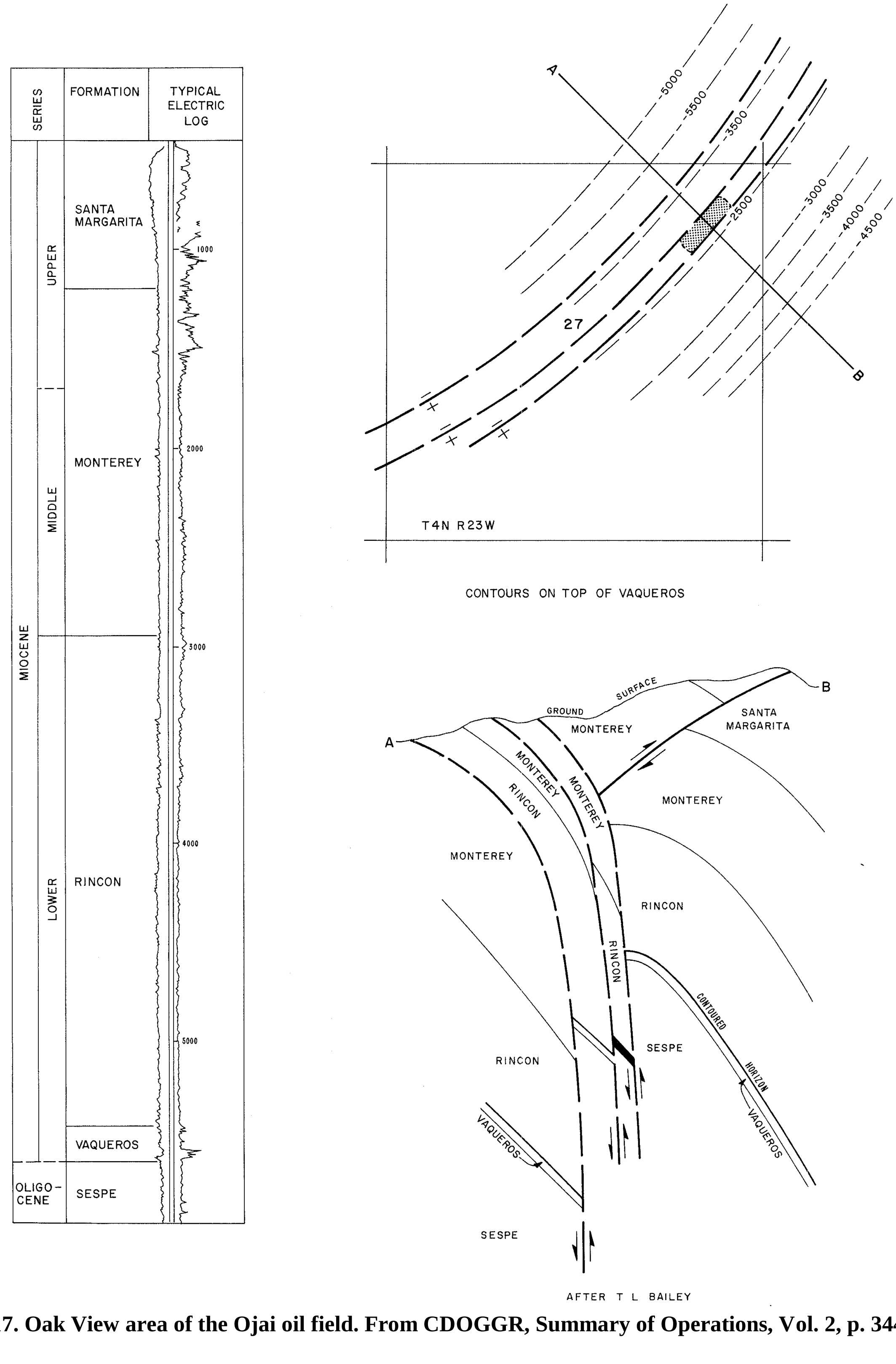
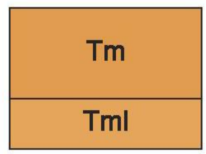


Figure 17. Oak View area of the Ojai oil field. From CDOGGR, Summary of Operations, Vol. 2, p. 344.

As we go up San Antonio Creek, we go through a series of faults and folds. The faults are trending northeast-southwest. The displacement on them is down on the north sides and up on the south sides of the faults.

Mile

9.4 Monterey Formation.



MONTEREY SHALE
(MODELO FORMATION)
Marine; early to late Miocene age

Tm *Upper shale unit: white-weathering, thin-bedded, hard, platy to brittle siliceous shale, locally cherty; Mohnian Stage*
Tml *Lower shale unit: white-weathering, soft, fissle to punky clay shale with interbeds of hard siliceous shale and thin limestone strata; Luisian-Relizian Stages*

Figure 18. Lithological description of Monterey Shale. From Dibblee, 1987a.

9.8 Monterey Formation on the left (west, Tm), Quaternary alluvium to the right (east, Qa).

10.2 Quaternary Alluvium (Qa) in Anton Creek.

10.5 Landslide on right (east).

11.0 Cross over the Lion Fault. To the south of the east-west trending Lion Fault is Rincon Shale. To the north is Quaternary cobble-bounder fan gravel or fanglomerate deposites composed largely of sandstone detrius (Dibblee 1987a).

MAP 04

(Geology from Dibblee, 1987a, 1987b: Matilija and Ojai 24K Quadrangles)

12.1 Camp Comfort

12.2 Intersection on Creek Road. Both sides of San Antonio Creek are underlain by Quaternary cobble-boader fanglomerate. Stay to the right and continue northeast on Creek Road.

12.7 Ojai Country Club is on the left (north). At this spot, the road intersection is underlain by **Rincon Shale**, exposed by the creek bed. Surrounding it is younger fanglomerate.

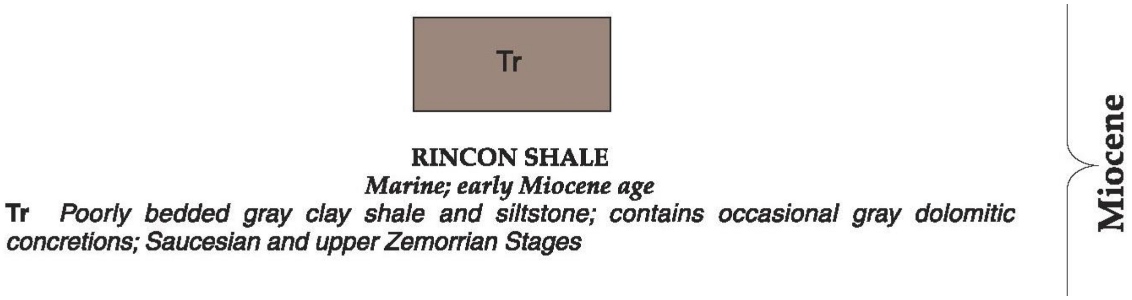


Figure 19. Lithological description of Rincon Shale. From Dibblee, 1987a.

Milr

13.0 Cross Santa Ana Fault. This fault marks the northern boundary of Black Mountain, composed mostly of Oligocene **Sespe Formation.**

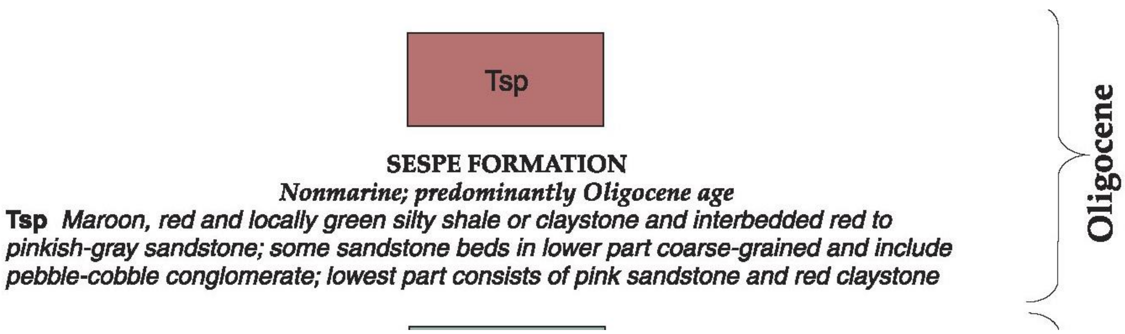


Figure 20. Lithologic description of Sespe Formation. From Dibbleee, 1987a.

Mile

13.1 Road Intersection. Turn to the north toward Ojai.

13.3 Intersection of Creek Road and Ventura Street. Turn left and go north on Ventura Street.

13.6 Intersection on Ventura Street. Sewage disposal facility for Ojai is to the right (east). This portion of the Ojai Valley is on Older Alluvium (Dibblee, 1987b). Continue north.

13.8 Cross railroad. The tracks approximate the geologic contact between Older Alluvium (Qoa) to the south and Quaternary Alluvium (Qa) to the north.

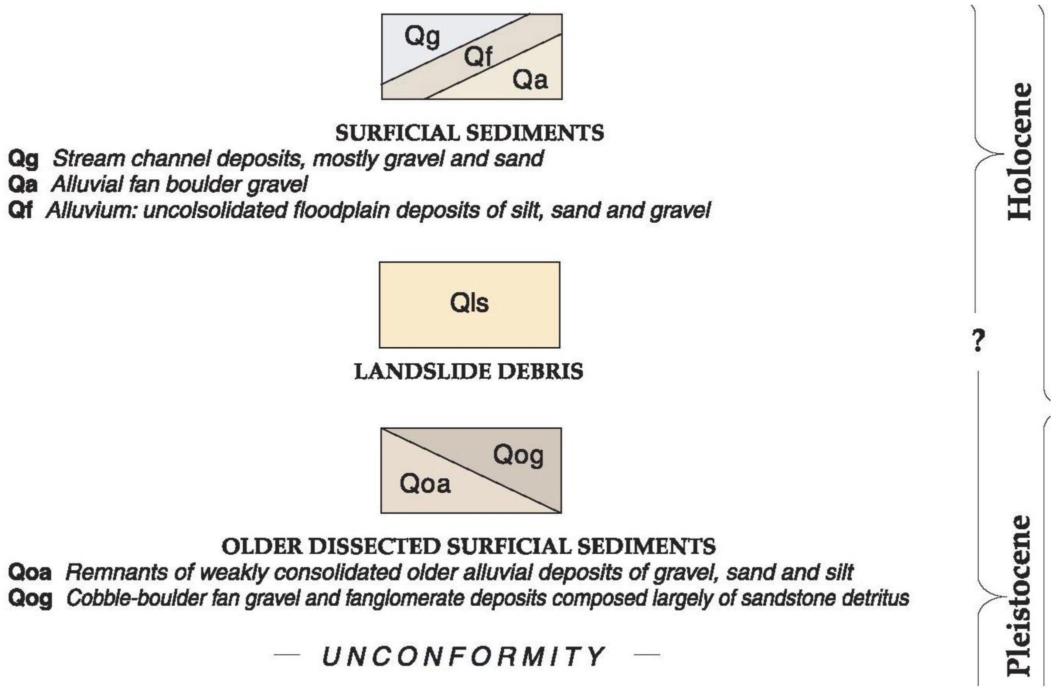


Figure 21. Lithological descriptions of surficial deposits. From Dibblee, 1987b

Mile

14.0/0.0 Intersection at Ojai Avenue. Turn right and go east on Ojai Avenue (Highway 150). Reset odometer

Stop 5: Ojai

The name Ojai, pronounced Oh-Hi, comes from an Indian word meaning 'the moon'. The town of Ojai was the setting for the 1937 movie "Lost Horizon".

In 1857, George S. Gilbert, a whale oil businessman, distilled liquid bitumen and asphaltum at a small refinery in the Ojai Ranch. He also built a refinery in San Francisco (Taylor and Welty, 1950, p.30).

Tectonic Activity

Tectonic activity in this area is dominated by small to moderate shocks occurring outside this vicinity. Damages have been none to moderate.

The December 21, 1812 earthquake was probably located off the shore of Santa Barbara. The damage was to the missions from Purisima Concepcion, near Lompoc (on the north), to San Fernando on the south. The tower of the San Buenaventura Mission was wrecked and much of the facade had to be rebuilt. Seismic sea waves were generated in heights of 30 to 50 feet (9-15 meters) on Santa Barbara-Gaviota beaches and 15 feet (4.5 meters) on Ventura beaches. An earthquake accompanied by seismic sea waves today would do considerable damage to heavily settled low areas along the coast.

The January 9, 1857 earthquake of Fort Tejon on the San Andreas Fault caused considerable damage buildings. The roof of the San Buenaventura Mission Church fell inward. The Santa Clara River had damages due to lurching, compaction, and liquefaction.

The 6.3 magnitude earthquake of June 6, 1925 destroyed the business section of Santa Barbara and caused damages in Ventura. A 5.9 Santa Barbara offshore shock on June 30, 1941 cracked walls and plaster, broke windows and dishes, and damaged store stock in Ventura. The February 9, 1971 San Fernando earthquake caused minor damage in Ventura.

The January 17, 1994 Northridge earthquake caused minor to moderate damage in Ventura. Overall the regional estimate is 30 billion dollars in damages to an estimated 50,000 buildings and other infrastructure such as highways and distribution systems. The 6.6 magnitude event was centered on a 11.3 miles (18 kilometer) focal depth on a 40E south dipping thrust fault close to Northridge. Most of the displacement was centered in an area 3 miles (4.7 kilometers) in diameter which rose about 12-20 inches (30 to 50 centimeters). Horizontal displacement was 2-8 inches (5-20 centimeters).

Ojai Oil Field

Along State Highways 150 east, the Ojai Oil Field, first explored in the 1860's, is developed within eight areas, named: Silverthread-Sisar Creek (1867), North Sulphur Mountain (1912), Sulphur Crest (1979), Sulphur Mountain (1916), Lion Mountain (1893), Oakview (1969), Tip Top (1918), and Weldon Canyon (1951). Cumulative production to 1992 has been over 31.6 million barrels of oil and over 55.9 billion cubic feet of gas. The Lion Mountain area of the Ojai Field is about one mile to the south at the base of Black Mountain. The Oakview, Tip Top, and Weldon Canyon areas of the Ojai Field are four to six miles to the southwest. West of Ojai is the abandoned Oakview Oil Field. Total production in 1955 was 726 thousand cubic feet of gas.

A description of the discovery of oil in California, and its consequences was made by William Fulton (1998, p,.58):

> The Philadelphia California Petroleum Company's Ojai No. 6 well was drilled in 1866 and encountered oil in the Saugus-Monterey formations at a depth of 420 feet. The oil was 22º.
>
> An 1866, only eighteen years after James Marshall=s discovery at Sutter=s Mill,

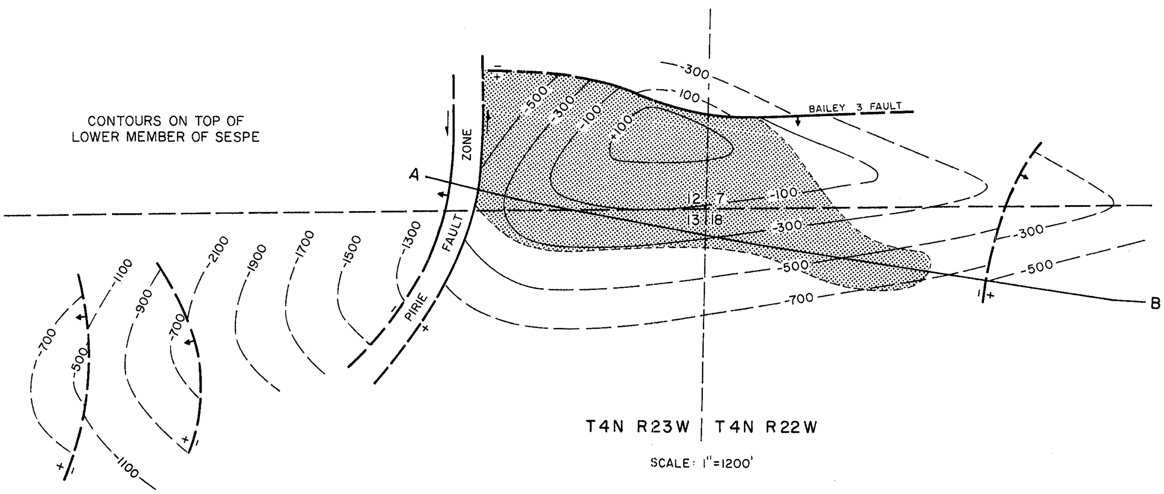
there was little question in anybody=s mind that the most valuable substance under California=s earth was gold. But this fact did not dissuade a twenty-five year old wildcatter name Thomas Bard from drilling into a hillside near Ojai to look for something else.

After several tries, Bard finally struck oil at well he called Ojai No. 6, which was soon producing fifteen to twenty barrels of oil a day, making it the first profitable oil well ever drilled in California. Bard's discovery came only seven years after the drilling of the first successful oil well in Pennsylvania, and it came at a time when there were only a few practical uses for oil in California's then-embryonic industrial economy

Ojai No. 6 proved to be a powerful agent for change for Bard, for Ojai, and ultimately for California. Within five years, Bard had become the most powerful politician in Santa Barbara County. Within ten years the economic clout created by Ojai No. 6 and its successors had forced Santa Barbara to carve an entirely new county Ventura County out of the hillsides and coastlines where the emerging oil fields were located. In 1890, Bard and several colleagues gathered in a small office in nearby Santa Paula to form the Union Oil Company. A decade later, he was elected to the U.S. Senate, playing a key role in the Progressive-era attack on the Southern Pacific Railroad.

Within a half-century of Bard's success in Ojai, oil had created in California a different kind of society, a society driven not by coal or wood but by oil and natural gas. Despite its isolation, California was self-sufficient in its fuel consumption, and was perfectly positioned to exploit the economic opportunities presented by the introduction of the automobile.@

To the south of Ojai is Lion Mountain and beyond that Lion Canyon. The **Lion Mountain area** of the Ojai Oil Field was discovered in 1893 by the Ezra Taylor No. 2 well in Section 14 of Township 4N, Range 23W. Production is from the Oligocene Sespe Formation at an average depth of 1,544 feet. Deeper drilling in this area lead to discovery of the late Eocene Coldwater zone in June 1949. Average depth to this zone is 4,101 feet. The upper Sespe zone has 18-27 gravity oil and the lower Coldwater zone is 25-29 gravity. Production is from sands at the crest (Coldwater) or on the western flank (Sespe) of the Lion Mountain anticline.



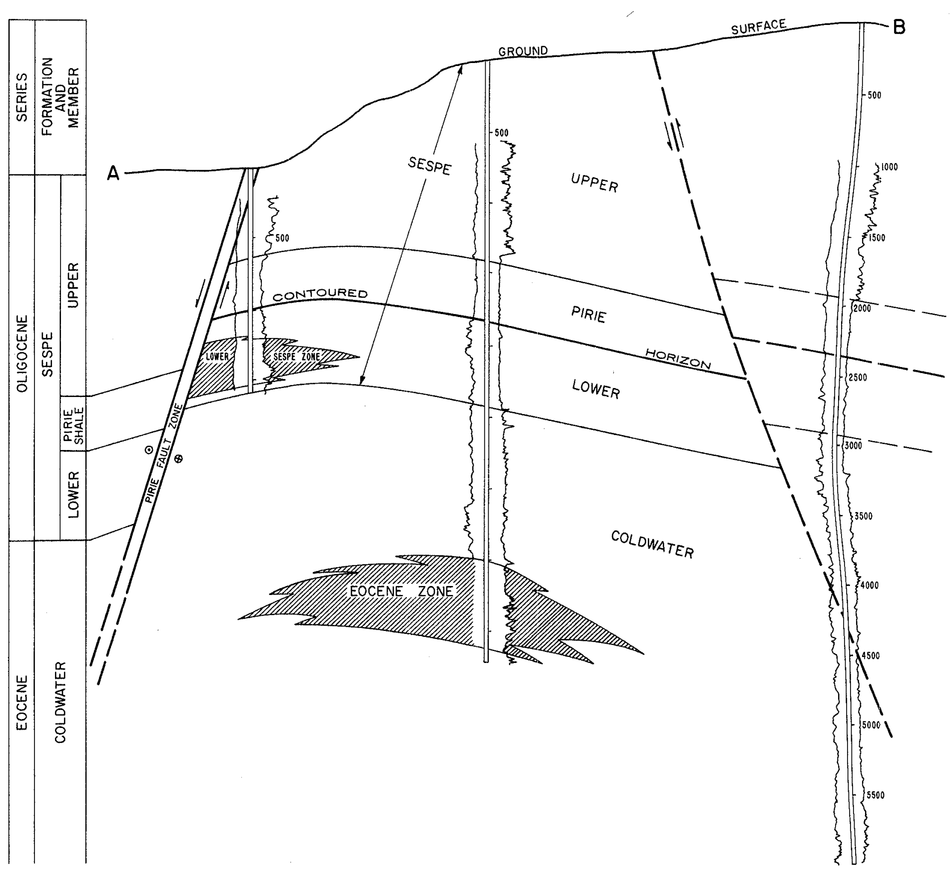


Figure 22. Cross Section and structural contour map of the Lion Mountain pool of the Ojai Oil Field. From CDOGGR, Summary of Operations, Volume 2, p. 345.

Mile

0.9 Intersection of Bryant Road and Highway 150. To the south is the heart of Black Mountain. The Santa Ana Fault forms the northern boundary of Black Mountain. This mountain, composed mostly Sespe Formation, has overturned beds on the north flank. Near the crest is the Black Mountain anticline with south-dipping beds on its south flank and bounded there by the Lion Fault (Dibblee, 1987b).

1.2 Cross San Antonio Creek. The mountains to the north are mostly Eocene sediments. Those of Black mountain, to the south are mostly Oligocene Sespe Formation.

1.3 To the left (south) is Solano Park.

1.5 Gorham Road.

2.1 Cross Thacher Creek.

2.3 Begin ascent up Black Mountain at Carne Road. At the base of the mountain is a sliver of Monterey Formation. The road quickly climbs through Rincon Shale, Vaqueros Sandstone and then Sespe Formation.

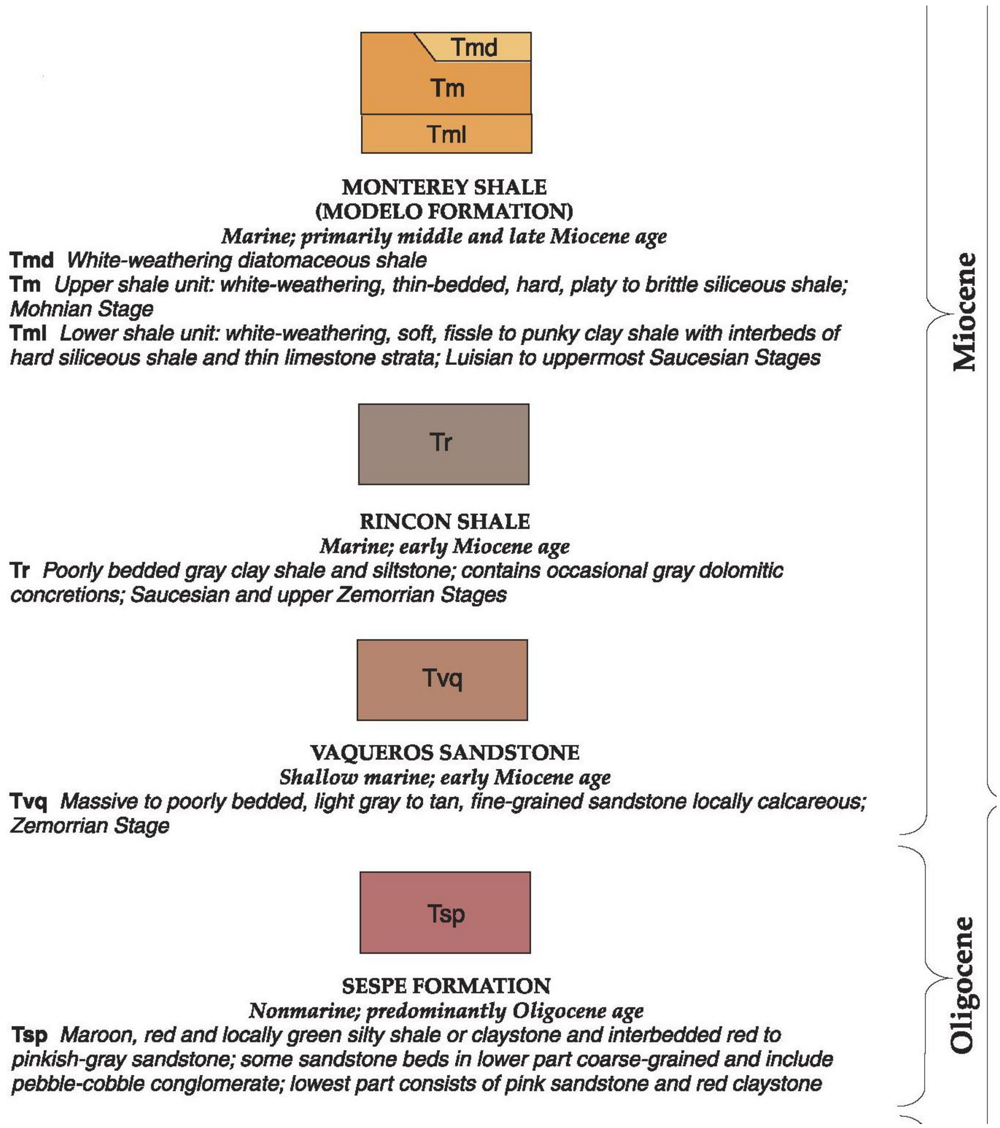


Figure 23. Lithological descriptions of Monterey, Rincon, Vaqueros and Sese formations. From Dibblee, 1987b.

Mile

3.0 Turnout on Sespe Formation.

Stop 6: Ojai Valley Overlook

3.5 Ojai Valley Overlook

The Ojai Valley is a structural depression and is filled with Pleistocene and Recent stream alluvium more than 700 feet thick. The structure is a syncline with overturned beds on each limb. The rocks at this stop are Sespe Formation.

To the north, the towering cliff-front of the Santa Ynez Mountains the beds have been folded and overturned so that they dip north. This structural feature has been named the Matilija overturn, and is part of the south limb of the intricately faulted anticlinal fold, nearly forty miles long, that lies on the southern slopes of the Santa Ynez Mountains. From the bottom of the far hillside to the top the formations are the younger Oligocene Coldwater- to older Eocene Cozy Dell-Matilija-Juncal. The overturned strata in the mountains can be traced westward to the Ventura River, where they are nearly vertical, and beyond where they revert to a normal south-dipping attitude.

The overlook is on the south slope of Black Mountain. At the southern base of Black Mountain is the Santa Ana Fault. To the west the fault joins with the Arroyo Parida Fault which continues into the Santa Barbara Channel. The Lion Fault is on the northern base of Black Mountain. The summit of Black Mountain is underlain by the nonmarine Oligocene Sespe Formation.

3.8 Outcrops of Sespe Formation red beds on north side of the road near the crest of the Lion anticline.

3.9 Dennison Park. This park is on the axis of the east-west plunging Lion Mountain anticline (also known as the Black Mountain anticline). Leaving Dennison park and going eastward, we come off the Sespe onto alluvial deposits of the Upper Ojai Valley.

Upper Ojai Valley

The upper Ojai Valley is a tectonic depression between opposing reverse faults. Its northern border is formed by the active, north-dipping San Cayetano fault and the southern border is formed by the Quaternary Lion fault set (Sisar, Big Canyon, and Lion faults). The ridge to the south is Sulphur Mountain.

The surface trace of the north-dipping San Cayetano thrust fault occurs midway up the hillslope north of the upper Ojai Valley. The fault has overturned (older formations are over younger formations) north-dipping Eocene Cozy Dell-Matilija-Juncal rocks in the hanging wall and Miocene Sisquoc-Monterey-Rincon rocks in the footwall.

The San Cayetano Fault is traced from east of Piru to western Ojai Valley. The fault is classified as a thrust fault with dips from 15 to 50E north. Dip-slip displacement as much as 20,000 feet (6100 meters) may be possible with the Topatopa mountain block (east of Ojai) riding up the fault plane in a southerly direction.

The mountain to the south of Ojai is Sulphur Mountain. At the base of Sulphur Mountain is the Lion thrust fault. To the west this thrust becomes parallel to the bedding-plane at the base of the Miocene Rincon Shale. The Lion fault cuts quaternary fan gravels in places suggesting it may be in part responsible the Holocene (Recent) uplift of Sulphur Mountain. The fault is interpreted to be a north-vergent back thrust that roots in the buried south vergent thrust uplift of Santa Ynez Range and other ranges northward to the San Andreas fault.

4.2 Lion Creek. On the north slope of Sulphur Mountain is the North Sulphur Mountain, Sulphur Mountain, and Sulphur Crest areas of the Ojai Oil Field. The Lion Fault is to the south at the base of Sulphur Mountain.

4.8 to 5.3 Riparian areas along Lion Creek.

6.1 Cross Lion Creek

6.6 Intersection of Sulfur Mountain Road and Highway 150.

On both sides of the roadway, in Section 11 of Township 4N, Range 22 W is the **Sisar Creek area** of the Ojai oil field. This field was discovered in 1900 by the Whidden Double Oil Company No. 2 well. Production is from the Pleistocene-Miocene Saugus-Monterey formations at an average depth of 750 feet. The gravity of the oil is 14º. The Monterey zone (average depth 3,680 feet) was discovered in December 1976 and the Saugus-Rincon zone (average depth 1,070 feet) was discovered in January 1977.

South of Highway 150, in this area, is **the North Sulfur Mountain** area of the Ojai Oil Field. It is located in in Sections 13, 14 and 15 of Township 4N, Range 22W. It was discovered by the Bard Oil and Asphalt Company AOjai 35" in 1912. Production is from the Miocene Monterey Formation at an average depth of 3,694 feet. Oil gravity is 19-27o. Production is within fault-trapped sands on the footwall of splays from the Big Canyon fault and from stratigraphic sand traps within the Monterey.

To the south of the North Sulfur Mountain area is the **Sulfur Mountain** area of the Ojai Oil field. Discovered in September, 1927 by the Bradford and Geis Trustees No. 1 well, this well is located in Section 21 of Township 4N, Range 22W. Oil gravity is 15-16o and is pumped from an average depth of 1,861 feet. Oil in this pool is trapped beneath the Sisar Fault in folded Monterey Formation.

To the southwest of North Sulfur Mountain area is the **Sulfur Crest area** of the Ojai Oil Field. This area is located in Section 23 of Township 4N, Range 22W. Production is from the Miocene at an average depth of 3,900 feet. Oil gravity is 24.7 to 29.7º. The field was discovered in August 1979 within the Miocene at an average depth of 3,900 feet. The pool is from fault-bounded sections of the Upper Miocene.

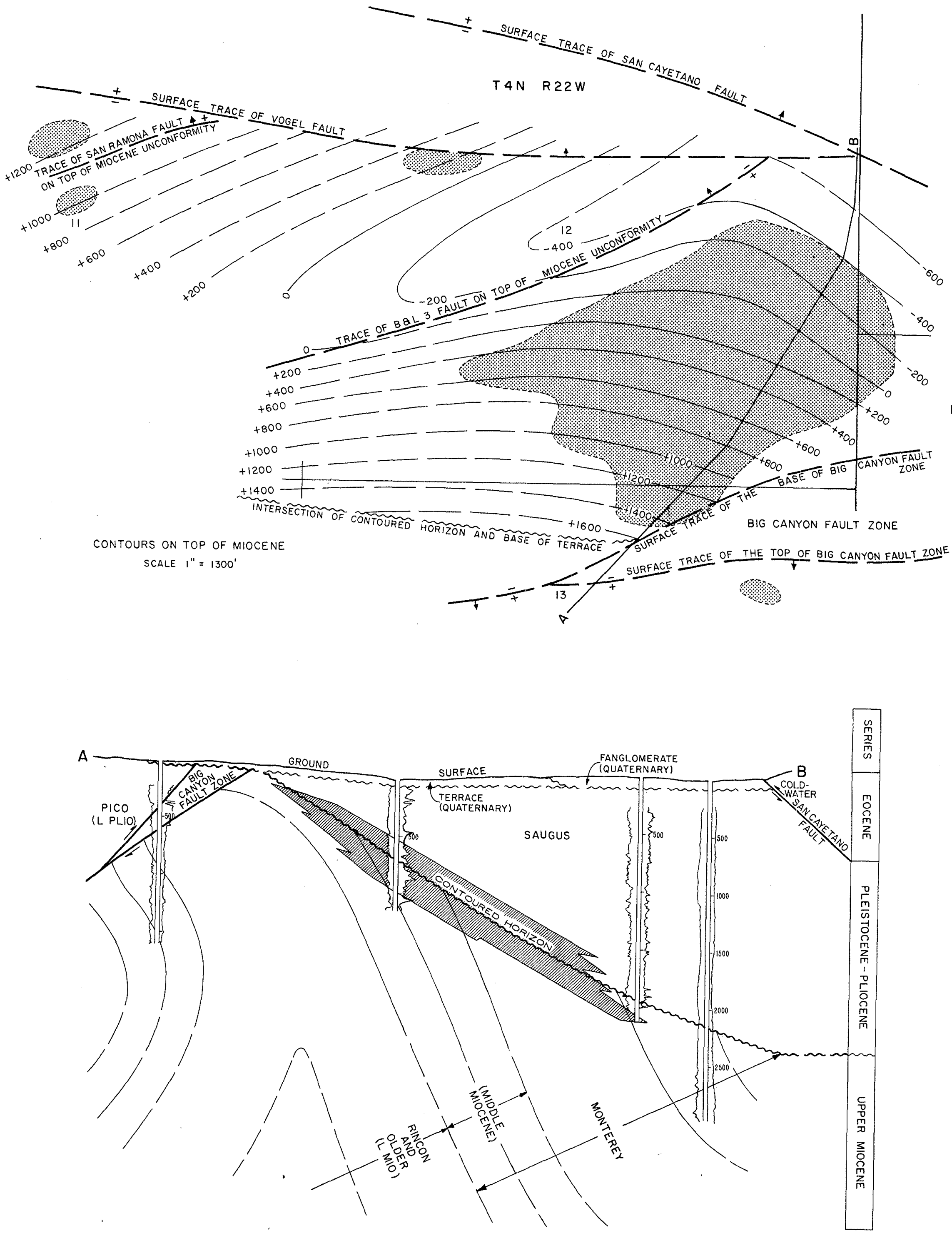


Figure 24. Sisar Creek Area of the Ojai Oilfield. From CDOGGR, Summary of Operations, Vol. 2, p. 349.

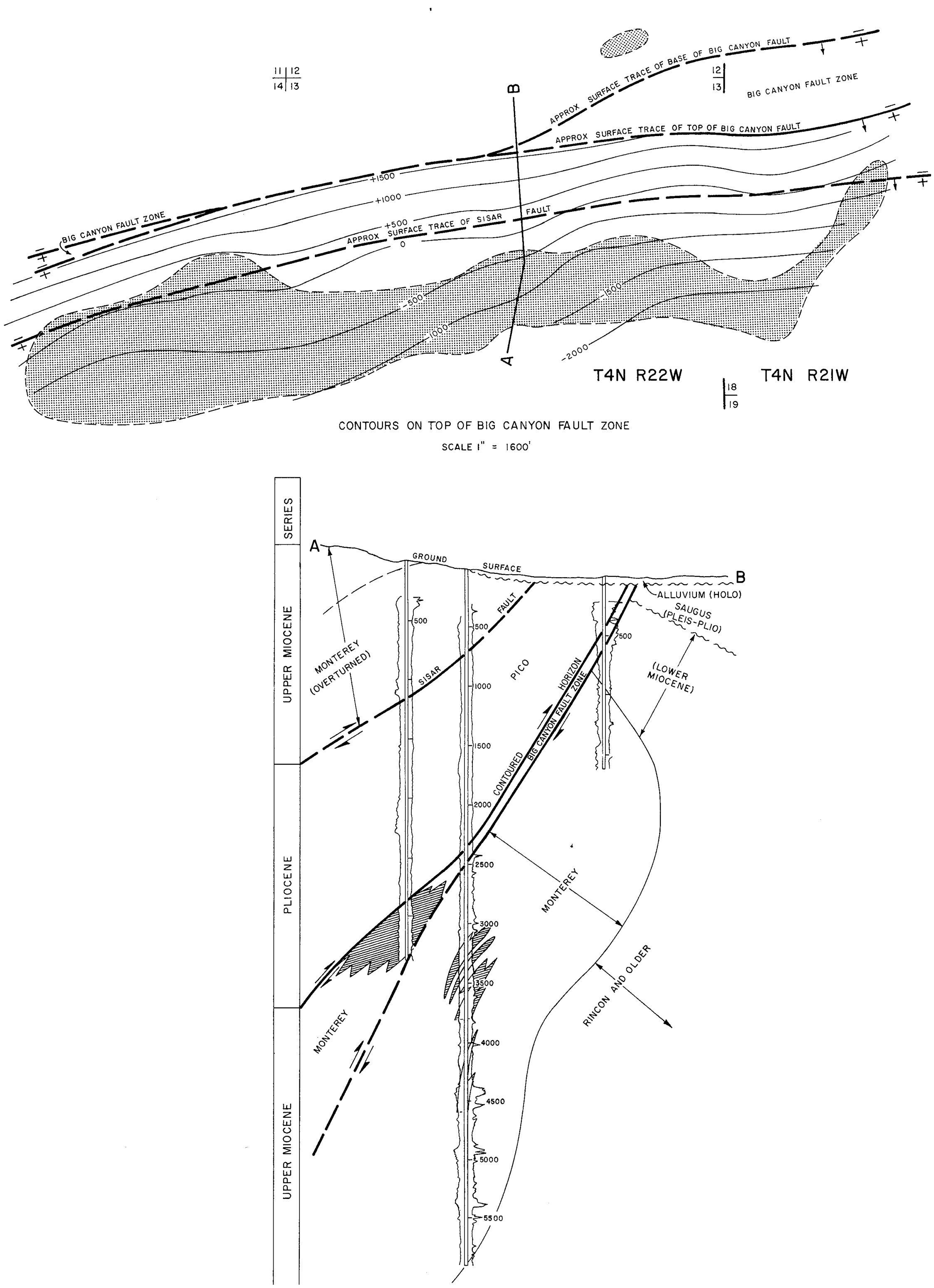


Figure 25. Cross section and structural contour map of the North Sulfur Mountain Area of the Ojai Oil Field. From CDOGGR, Summary of operations, Vol. 2, p. 346.

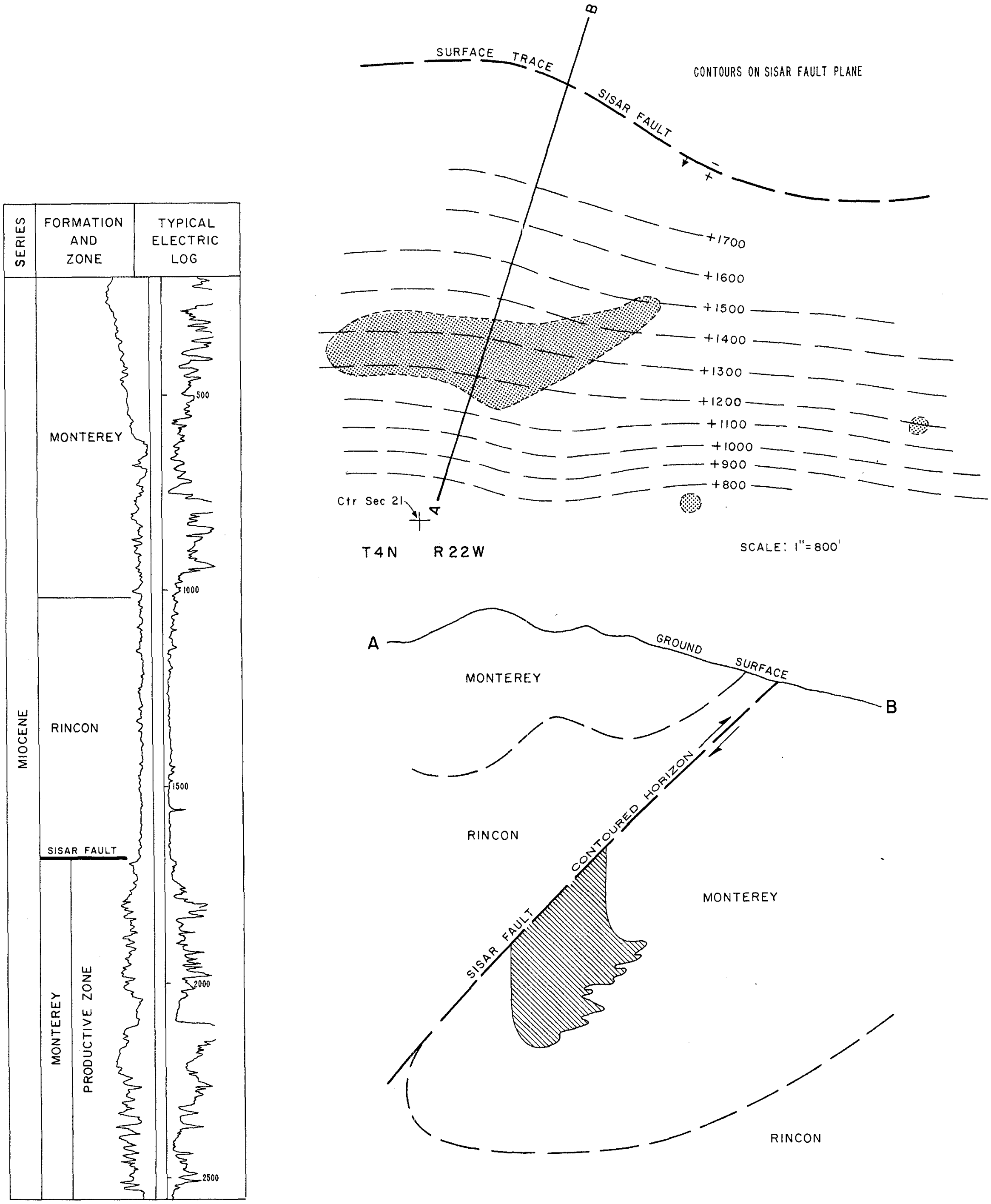
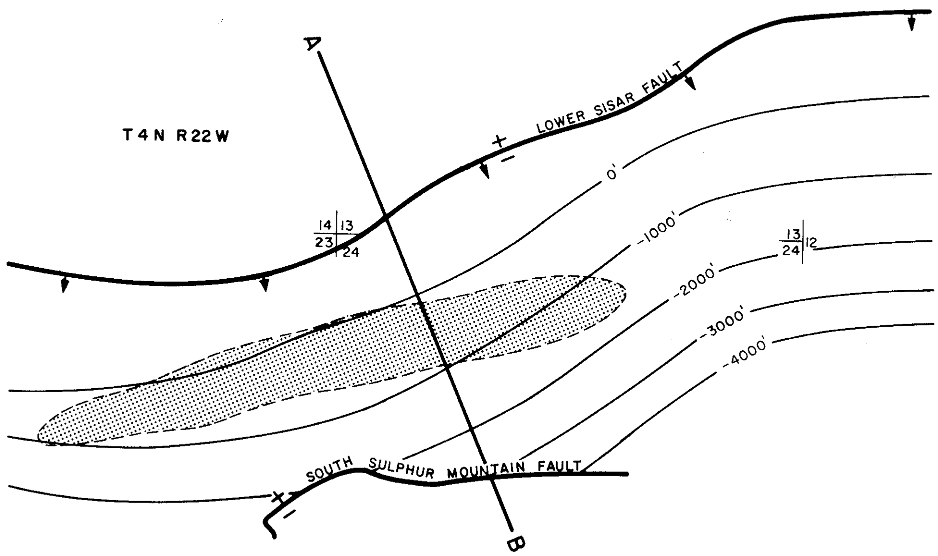


Figure 26. Cross section and structural contour map of the Sulfur Mountain Area of the Ojai Oil Field. From CDOGGR, Summary of Operations, Vol. 2, p. 351.



STRUCTURE CONTOURS ON UPPER SISAR FAULT

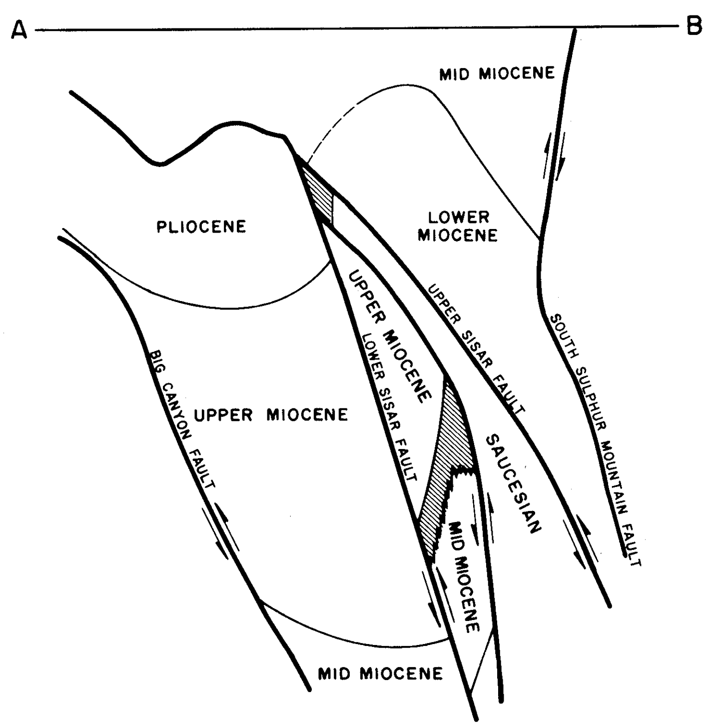


Figure 27. Cross section and structural contour map of the Sulfur Crest area of he Ojai Oilfield. From CDOGGR, Summar of Operations, Vol. 2, p. 350.

MAP 05

(Geology from Dibblee, 1990a)

Mile

7.0 Windmill

7.3 Road Intersection.

8.0 Sulphur Mountain Road at Summit School. The **Sisar-Silverthead areas** of the Ojai Field are located north of the road for the next several miles. Sisar Canyon is to the north. Reset odometer.

At the east end of the upper Ojai Valley is a fine example of Recent stream capture displayed in the Santa Paula Creek-Sisar Creek-Lion Creek drainage system. High terraces suggest that the waters of what today is the East Fork of Santa Paula Creek once flowed westward. Santa Paula Creek, eroding headward, captured first the East Fork, and then Sisar Creek.

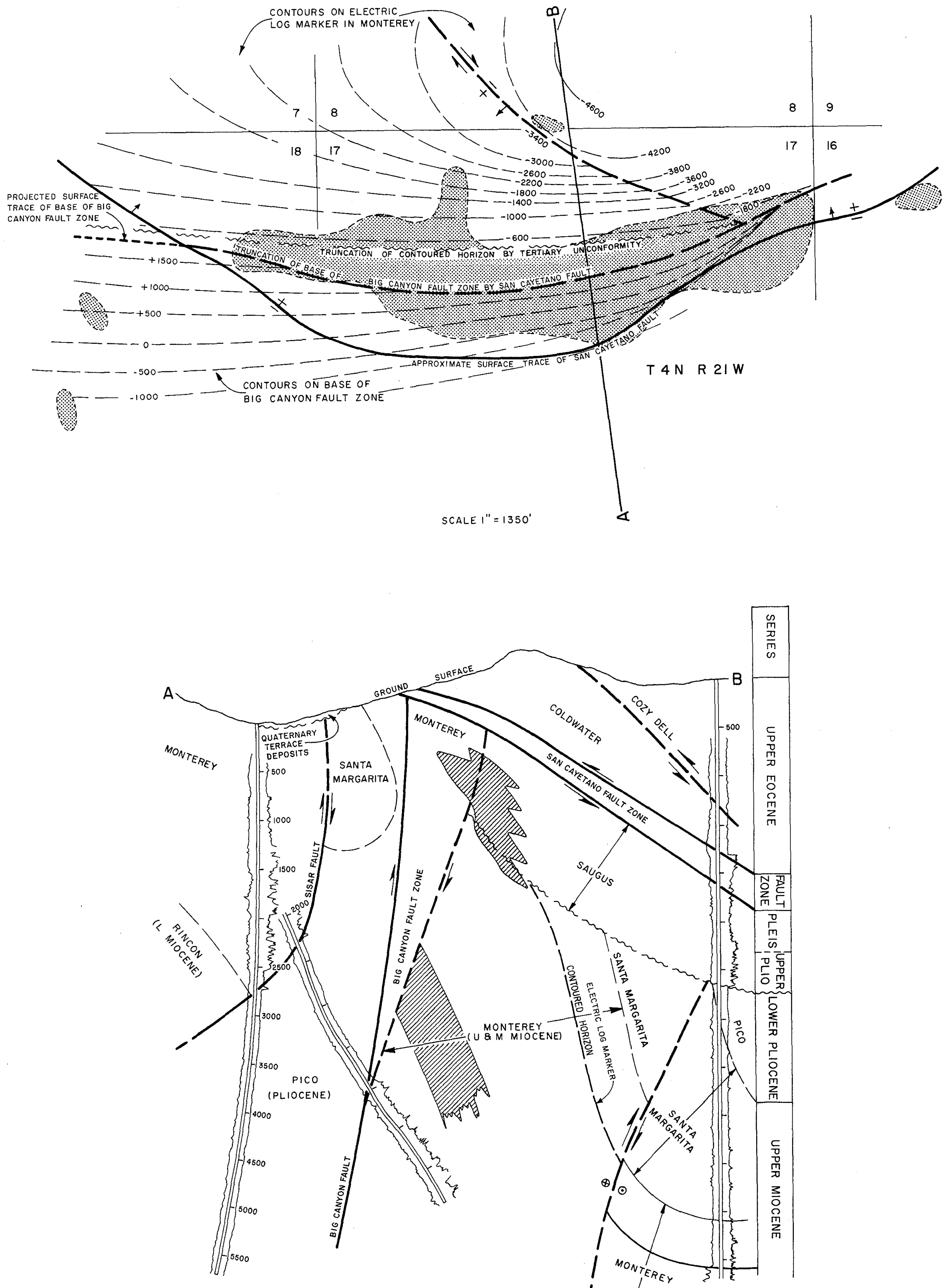


Figure 28. Cross section and structural contour map of the Silvertheread Area of the Ojai Oil Field. From CDOGGR, Summary of Operations, Vol.2, p. 348.

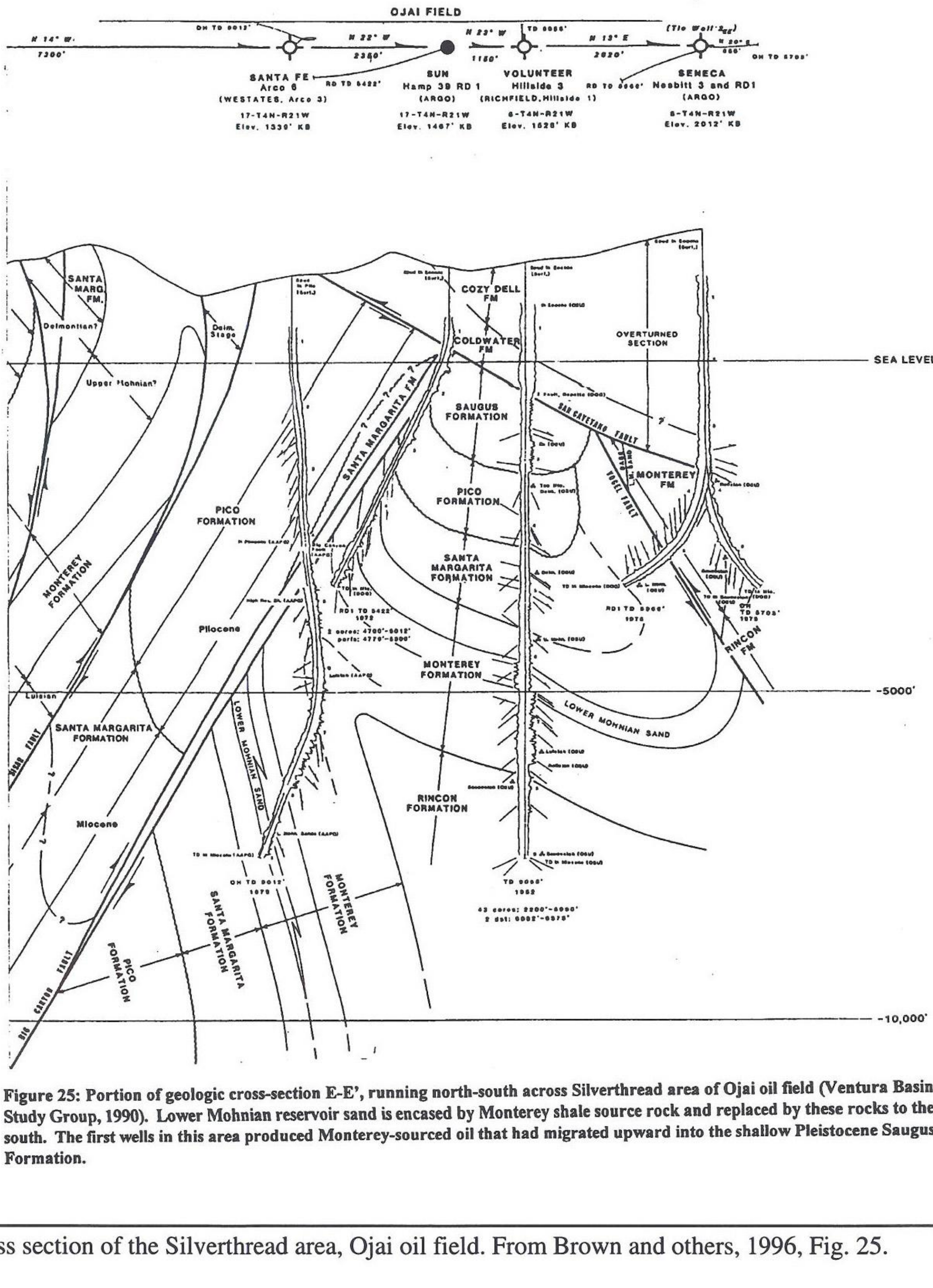


Figure 25: Portion of geologic cross-section E-E', running north-south across Silverthread area of Ojai oil field (Ventura Basin Study Group, 1990). Lower Mohnian reservoir sand is encased by Monterey shale source rock and replaced by these rocks to the south. The first wells in this area produced Monterey-sourced oil that had migrated upward into the shallow Pleistocene Saugus Formation.

Cross section of the Silverthread area, Ojai oil field. From Brown and others, 1996, Fig. 25.

Mile

8.4 Sissar Creek Oilfield, both sides of Highway 150.

8.7 Sisar Creek nearly touches Highway 150 on the left (north) at Koengstein Road. At this point, the roadway follows the Lion Fault. To the north of the Lion Fault is Monterey Formation which is bounded on the south by the Big Canyon Fault. On the south side of the Big Canyon Fault are beds of Pico Formation which are cut of, to the south, by the Sisar Fault. South of the Sisar Fault are overturned beds of the Monterey Formation. The Sulfur Mountain Anticline axis markes the crest of Sulfur Mountain. Monterey beds are again overturned on the southern flank of the anticline.

At this point we are crossing an unnamed fault. As we drive to the south-southeast we cross the Big Canyon Fault and the Sisar Fault (Dibblee, 1990a).

8.75 Cross over to Santa Paula Peak 7.5 minute Quadrangle (Dibblee, 1992a)

Stop 7: Oil Seeps at Sisar Creek

8.8 Tar seeps occur in the bedding planes of the fractured Miocene Monterey Formation on south side of road for a distance of 0.5 miles. These seeps caught fire in 2018.

Because of numerous active oil seeps and the outcrops of oil-impregnated sands along the south side of Sulphur Mountain, the area was one of the earliest to attract the attention of oil prospectors. Heavy oil accompanied by sulphurous water flows down the side of the mountain from outcrops of fractured Miocene Monterey shales between the Sisar and San Cayetano faults.

8.9 Osborg Road on the left (northeast).

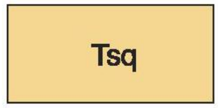
9.0 Crossing the Sisar and Big Canyon Faults.

9.3 Union Oil Company Historical Marker. Along State Highway 150 east the forerunner to the state's oil bonanza, oil well, Ojai No. 6, drilled in 1867. The well was the first well drilled that had extended production. Drilled to a depth of 550 feet by mechanical means, the well flowed by its own energy.

Oil Seeps at the Sisar Creek Bridge, near Thomas Aquinas College.
Photographs by Gregg Wilkerson, December, 2000.

Mile

9.4 Sisquoc Formation in road cut on right (south).

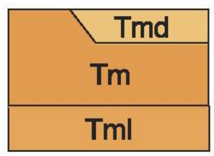


SISQUOC SHALE
(Santa Margarita Formation of Bailey and Jahns, 1954; Weber et al, 1973; Fine, 1954; included in Modelo Formation by Kew, 1924, east of this quadrangle)
Marine; late Miocene age
("Delmontian" – Mohnian Stages)

Tsq *Light gray silty shale or claystone, locally slightly siliceous and diatomaceous*

Figure 29. Lithologic description of the Sisquoc Shale. From Dibblee, 1990a.

10.1 Overturned Monterey Formation in road cut on the right (south).



MONTEREY FORMATION
(Modelo Formation of Kew, 1924, east of this quadrangle)
Marine biogenic; primarily middle and late Miocene age

Tmd *White-weathering diatomaceous shale*
Tm *Upper shale unit: white-weathering, thin bedded, hard, platy to brittle siliceous shale; Mohnian Stage*
Tml *Lower shale unit: white-weathering, soft, fissle to punky thin-bedded shale and interbeds of hard siliceous shale and thin limestone strata; Luisian to uppermost Saucesian Stages*

Figure 30. Lithological description of the Monterey Formation. From Dibblee, 1990a.

11.0/0.0 Sulfur Spring also called Ojai Sulphur Spring are situated within this canyon about a quarter of a mile west of the junction with Santa Paula Canyon. A large cold sulphuretted spring flows from a tunnel on the hillside 150 feet above the creek. A resort was established in 1905 to utilize the spring for a swimming plunge and baths. The hot springs are associated with a boundary fault that approximates the location of Highway 150 on the north side of Sulfur Mountain in this rea.

0.1 Thomas Aquinas College (formerly Sulfur Springs).

Figure 31. Thomas Aquinas College. From
http://newmansociety.org/portals/0/Thomas%20Aquinas%20College/2015/_MG_5360-edit%20(overview).jpg
Accessed Oct. 30, 2018

Stop 8: Oil Seeps Near Thomas Aquinas College

Pull into the parking lot of the college, then walk west, under the bridge for Highway 150. Here a unique ecosystem has developed along the active oil seeps. To the north of the college is the Sisar Fault. Between the Sisar and Highway 150 is Sisquoc Shale (Dibblee, 1990a). To the south of the highway is Monterey Formation. To the north of the Sisar Fault is a slice of Pico Formation and then the San Cayetano Thrust Fault. There is a parking area on the north side of Highway 150, between two bridges (Sisar Creek bridge to the west, the Santa Paula Creek bridge to the east). Stop here to view the oil seeps. Exploring under the eastern of the two bridges, the creek displays a white algae adapted to the oily environment. It has no chlorophyll, and lives off energy from the biological breakdown of hydrogen cyanide.

Mile

0.3 Cross the apex of the Sulfur Mountain Anticline in Monterey Formation rocks.

0.35 Santa Paula Creek. Santa Paula Ridge is seen to the northeast. This ridge trends east-west and lies to the north of Anlauf Canyon.

0.4 Overturned contact between Sisquoc (Tsq) and Monterey Formations (Tm) along road. Outcrops on left side of road are highly-deformed Monterey Formation on the north flank of Sulphur Mountain anticline. The Sulphur Mountain anticline occurs in the hanging wall of the south-dipping Sisar thrust. Pico Formation occurs in the footwall of the thrust. The surface trace of the Sisar thrust occurs a few hundred yards across the river to the right of the road. Production in Sulphur Mountain fields occurs along the Sisar thrust in Monterey Formation in the footwall block.

As Highway 150 descends Santa Paula Creek, we drive down the south flank of the Sulfer Mountain Anticline. Driving southward we cross overturned Monterey, Sisquoc and then Pico beds.

Santa Paula Oil Field

0.6 SANTA PAULA OIL FIELD.

The name Santa Paula Oil Field is applied to a group of small producing areas extending along the south side of Sulphur Mountain. The individual pools are Aliso Canyon, Wheeler Canyon (1885), Salt Marsh Canyon (1888), Adams Canyon (1870), Willoughby (1971), and Santa Paula Canyon (1861). In 1892, within the Adams Canyon field, the first prolific well in the state, the Union Oil # 28, was completed with production of 1500 barrels of oil per day.

The structure of the field is a south-dipping homocline with dips ranging from 45 to 60^{o}E. Production to 1992 for the entire field was over 59.9 million barrels of oil and 181.9 billion cubic feet of gas. The Santa Paula oil field was discovered in 1891 by the Wheeler, Trask and Coleman tunnel. Production was from seepage in the Pico and Santa Margarita (Sisquoc) Formations at depths below the surface of 150 to 2,000 feet (when wells supplanted the tunnels). The Mohnian zone of the Santa Paula oil field was discovered in December, 1977.

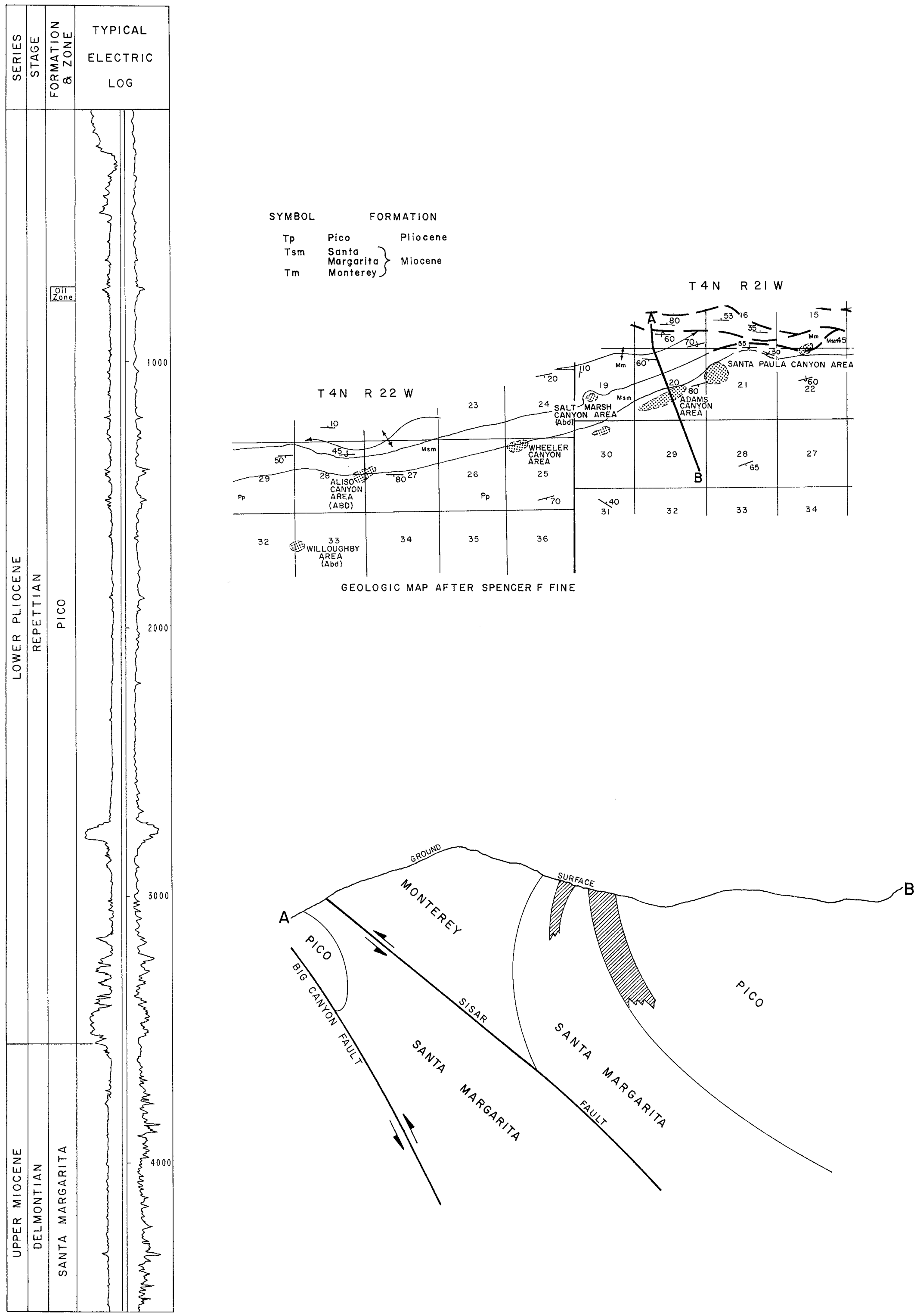


Figure 32. Cross section and structural contour map of the Santa Paula Oilfield. From CDOGGR, Summary of Operations, Vol. 2, p. 484

Mile

1.1 Outcrops of folded Miocene Sisquoc and Miocene Monterey Shale. Oil stains occur in the rocks.

1.2 TURNOFF TO SULFER MOUNTAIN OIL MINES. THIS IS PRIVATE PROPERTY. PERMISSION OF THE LAND OWNERS AND CALIFORNIA RESOURCES COMPANY ARE NECESSARY TO VISIT THE OIL MINES.

Stop 9: Sulphur Mountain Oil Mines

The Sulphur Mountain oil mines are the northern edge of the Mission Ex San Buenaventura Land Grant in projected T.4N, R.22W Sections 23 and 24 and T.4N, R.21W, Sections 19 and 20, Mount Diablo B&M. The mines are on the southern slope of Sulphur Mountain in Wheeler, Salt Marsh and Adams canyons.

An account of early oil mine development is given by Michael Nelson (American Association of Petroleum Geologists, 2001):

"Thomas Bard was a participant in this drilling boom when he arrived in Ventura County in 1865 to begin drilling on the north side of Sulphur Mountain. However, Bard was not alone in his interest in the Sulphur Mountain area. Another party was intent on finding a source of California oil - the Stanford Brothers illuminant business in San Francisco. The company imported and sold kerosene shipped from the east coast and had refined small amounts of scarce California oil in an attempt to produce kerosene. Josiah Stanford leased property on the south side of Sulphur Mountain hoping to find a steady source of California crude from which to refine kerosene for Stanford Brothers. Being a mining engineer, Stanford's approach was different than Bard's: Stanford tunneled for oil. Using Chinese labor from Ventura, Stanford dug an 80-foot tunnel into the deeply dipping Miocene strata of Saltmarsh Canyon and began producing 20 BOPD in 1866. *Crude shipments to the Stanford Brothers refinery in San Francisco began by boat in August of 1866. By tunneling, Josiah Stanford became the first person to establish commercial production of petroleum in the state" (*Nelson, 2001).

The first oil development in the Ojai-Santa Paula area was the drilling of an 80 foot tunnel completed by Leland and Josiah Stanford in 1866. Josiah was a mining engineer. In that year, 31 tunnels were excavated and produced 1 to 20 barrels a day (Taylor and Welty, 1950, p.50). Forty five tunnels of various lengths up to 1600 feet were eventually completed. The highest production was 60 barrels a day of oil. Reports indicate that one of the oil tunnels yielded a first month production of 900 barrels of oil when completed in 1889.

The "wells" were completed by tunneling *upward* into the formation. Individual tunnels generally were less than 1000 feet long with foot-board and track running their entire length. Built into the floor was a wooden gutter in which the oil and water flowed down to a separating tank. All the tunnel work was done by hand. Due to the volatile nature of the product, the tunnels were aligned and lighted by the use of mirrors which reflected sunlight. Caving ground and petroleum gases caused the deaths of several workers.

The present day lessee of the "oil mines" is California Resources Corporation which acquired them from Union Oil Company. Union's, predecessor companies originally developed them. Production of one barrel a day was being obtained from several of these mines several years ago. The "mines" were replaced by perforated and gravel-packed pipes. Oil still flowed into these pipes from the collapsed mine workings and is collected in tanks. These recovery systems were removed in 1996 and the tunnels cemented shut. Oil continues to ooze from some of them.

A listing of the twenty four tunnels in the Santa Paula area is given Crawford (1896) and is summarized below:

> *"A number of oil tunnels have been run on the southern slope of Sulphur Mountain, about 6 miles N.W. of Santa Paula, and are hereinafter described. The cost of running these tunnels is about $1.50 a foot for the first 100 feet, and $1 a foot more for every additional 100 feet, exclusive of the cost of timbering. Each foot of tunnel requires one plank, 2"x12"x16", for posts and cap; sometimes lagging is needed. The tunnels are usually 6' 4" high, 3' wide on top, and 4' on the bottom.   A foot-board and a track run the entire length of the tunnel. The track is made of either iron or pine scantling, 3"x4"x16"; for sleepers, 2"x12" plank is used. At the No. 6 Magie tunnel a combination track and foot-board are used. The foot-board is plank 2' wide and the track is formed by nailing, broad-side down along the upper edge of the foot-board, 1"x3" pine strips. The oil and water flow down a gutter in the floor of the tunnel to a separating tank, usually of 10 barrels. capacity, where the oil rises to a surface of the water, and is drawn off by a pipe-line, which conducts it to a receiving tank. The water escapes from an outlet at the bottom of the tank* (Crawford, 1896).
>
> *Some of the strata penetrated by these oil tunnels yield much inflammable gas, and various appliances have been used to force air into said tunnels. The apparatus most successfully employed for this purpose is the hydraulic air-compressor or water-blast* (Crawford, 1896).
>
> *A sheet-iron column, C B, about 35 feet long and supported by a light derrick, enters the top of wooden box D D E E, which is 6' long, 14" wide and 14" high at one end and 10" high at the other. A 6"x6" conduit of dressed lumber, G G F or 6" casing, is connected by a tapering box, F E, with the air end of the box E E D D, which is provided with a 1/2" slot, H, with a slinging gate, which regulates the escape of the water. Water is turned into the top of the column from a 1/2" nozzle, A, under a 200' head. Air is carried down with the water and forced*

through the tapering box and conduit to the face of the tunnel. The Magie No. 6 tunnel in a few hours fills with gas and it takes water-blast about half an hour to purify the air so that work can safely be commenced. When work is in progress, the tunnels are illuminated by reflected sunlight, or by incandescent electric light. The blasts are usually discharged by electricity, and air-compressors are used to ventilate workings." (Crawford, 1896) See diagram reproduced the figure, below.

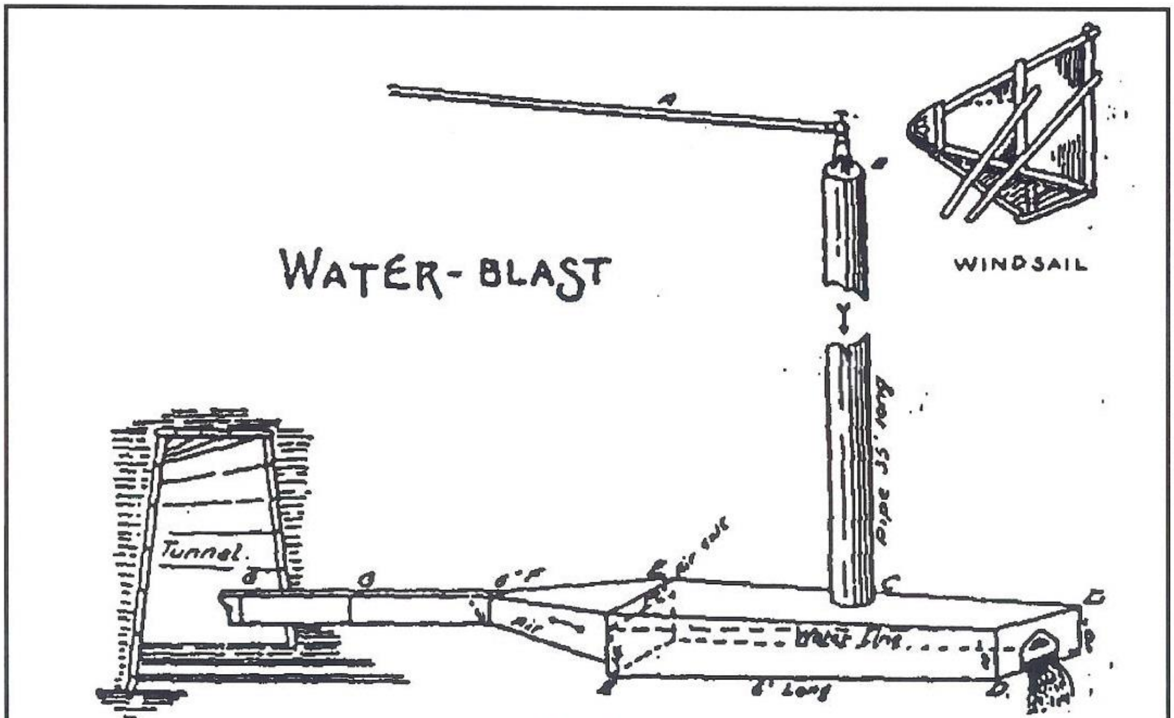


FIG. 23.

From Watts, 1896, p. 44

Geologist William Orcutt

The first geologist for Union Oil Company was William W. Orcutt, for whom the Orcutt field at Santa Maria is named. In 1896, Orcutt conducted a survey of the oil mines on the southern slopes of Sulphur Mountain. His original field notes are now at the Ventura County Museum of History and Art. I had the privilege of examining them in January 2001 and discovered many of the place-names which are found in the discussion of oil mines, below. The field notes corroborate information about the oil mines found in Watt (1898). Lyle Stewart, Orcutt's boss was a conservative churchman and religious philanthropist who did not tolerate smoking or drinking on the job. Amid Orcutt's survey notes, I found the following statement: "The force of habit. There was a man who smoked but he shall be nameless. He was 21 years of age and supposed to be sane when he commenced to smoke. The reason why he had not smoked before was because his mother had pneumonia." Apparently, Orcutt was in charge of enforcing moral standards within Union Oil Company.

Oil wells of the Sulfur Mountain area

The following information about wells in the Sulfur Mountain mine area is from Taylor and Welty's report (1950):

In addition to the oil mines, several oil wells were drilled in the Adams Canyon. E.A. Edwards drilled there in 1876. In 1890 there were 26 operating wells which collectively produced 84,421 barrels that year. This production dropped off over the next few years and there were problems with wells drilled down-structure draining oil out of previously-drilled wells located up - structure (Taylor and Welty, 1950, p.55).

With shallow production declining, Stewart and Hardison decided to try "deep" drilling at Adams Canyon in 1884. This was based on analogy with successful deep drilling in the Puente Field of Los Angeles the year before. Wells were put down to 3,000 feet. Each of these wells deep produced between 5 and 300 barrels per day (Taylor and Welty, 1950, p.56).

One of the most famous well in Adams Canyon was drilled in 1888. The Adams Canyon No.16 came in at an astounding rate of 800 to 900 barrels per day (Taylor and Welty, 1950, p.62).

*The Adams No. 16 was overshadowed by the Adams No. 28, drilled in February 1892. That well came in at 1 ,500 barrels per day and produced 40,000 barrels before settling down to a steady 200 barrels per day (*Taylor and Welty, 1950, p.69).

Adams Canyon (T.4N, R.21W, Sec 30)

The 900-foot Adams Canon Tunnel is located at the north end of West Fork of Adams Canon. A location map of some of the tunnels described in this field guide is provided at in the maps section of this field guide

The 650-foot Major Moutre Tunnel is situated at the north end of a gulch which extends in a northerly direction from the East Fork of Adams Canon. The tunnel when completed in 1889 yielded 900 barrels. of oil a month. In 1895 yield was 50 barrels. of oil a month.

Adams Canyon, part of the Santa Paula Oil Field, in 1890. From Taylor and Welty, 1950, p. 55.

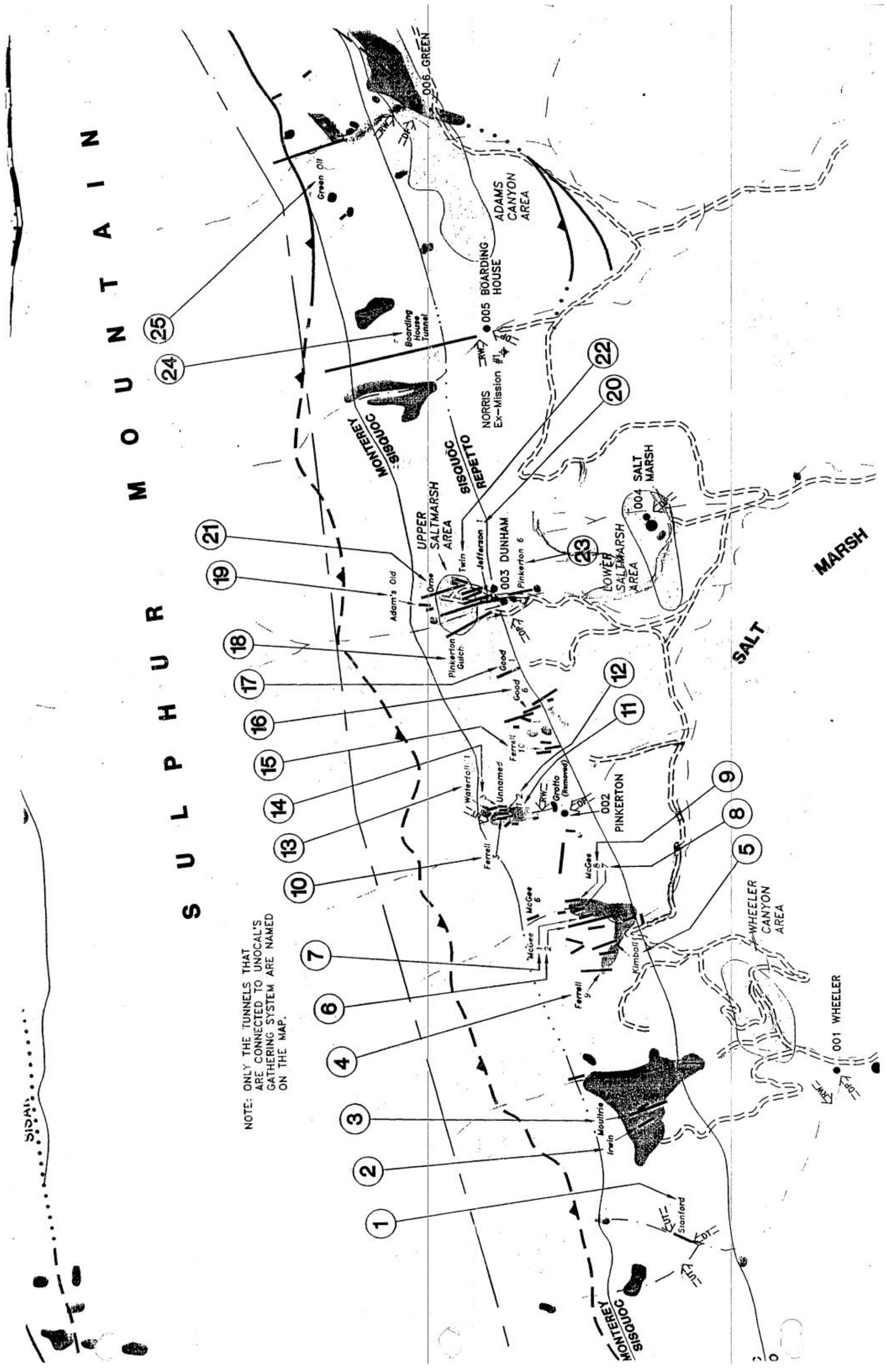


Figure 33. Sulfur Mountain Oil Mines. From Union Oil Company.


Oil Seeps in Adam's Canyon, 1994. Photo by Gregg Wilkerson.

Mud Creek Canyon **(T.4N, R.21W, Sec 23, 27)**

The 100-foot long Parker & Orne Tunnel is situated in Mud Creek Canon. The tunnel when completed in 1890, yielded of 60 barrels. of heavy oil per month. In 1895 the tunnel was partly caved with no oil production.

Salt Marsh Canyon **(T.4N, R.21W, Sec 29)**

The 325-foot Farrell & Kimball's West Tunnel is located on the West Fork of Salt Marsh Canyon. The yield in June, 1895 was 60 barrels. of oil and sulphuretted water.

Farrell & Kimball also own two other tunnels on the West Fork of Salt Marsh Canon. In August, 1895, each of these tunnels was 140 feet in length and yielded about 30 barrels. of a dark green oil per month.

The 120-foot Good's Lower Tunnel is located in Salt Marsh Canon. At the end of the tunnel is a spring of sulphuretted water and traces of oil.

The 425-foot Good's Middle Tunnel is about 150 feet above and 400 feet distant from the lower tunnel. The tunnel produced sulphuretted water, but practically no oil.

The 50 foot Good's Upper Tunnel is about 80 feet above and over 400 feet distant from the middle tunnel. A small quantity of oil was struck in a thin stratum of sandstone.

Good & Irwin's Tunnel is situated about 1000 feet S. of W. from the Pinkerton No. 1 Tunnel. In 1895 yield was 6 barrels. of heavy oil a month.

The Magie Tunnels are on the West Fork of Salt Marsh Canyon. The 200-foot Magie Tunnel No. 1 when completed in 1891, yielded 300 barrels. of oil a month. In 1895, yields were 15 barrels. of oil per month.

The 270-foot Magie Tunnel No. 3 in 1895 had a yield of 15 barrels. of green oil a month.

The 125-foot Magie Tunnel No. 4 is situated nearly 400 feet northeast of tunnel No. 1 at a higher elevation. Completed in 1894, yield was 30 barrels. of oil a month. In 1895, yield was 8 barrels. of oil per month.

The 560-foot Magie Tunnel No. 6 in June 1895 yielded 200 barrels. of green oil per month.

The 320-foot Pinkerton (Lower) Tunnel No. 1 is in one of the North Forks of Salt Marsh Canon. In 1894, when completed, yielded 45 barrels. of oil per month. In 1895, yield was 30 barrels. of oil of high specific gravity. The oil is accompanied by gas and sulphuretted water.

The 700-foot Pinkerton Tunnel No. 2 is about 400 feet N 15EW from No. 1 Tunnel and about 100 feet higher. Completed in 1892, yield was 150 barrels of oil. In 1895 the yield was 90 barrels. of oil a day. The well produced much gas and a mixture of green and black oil.

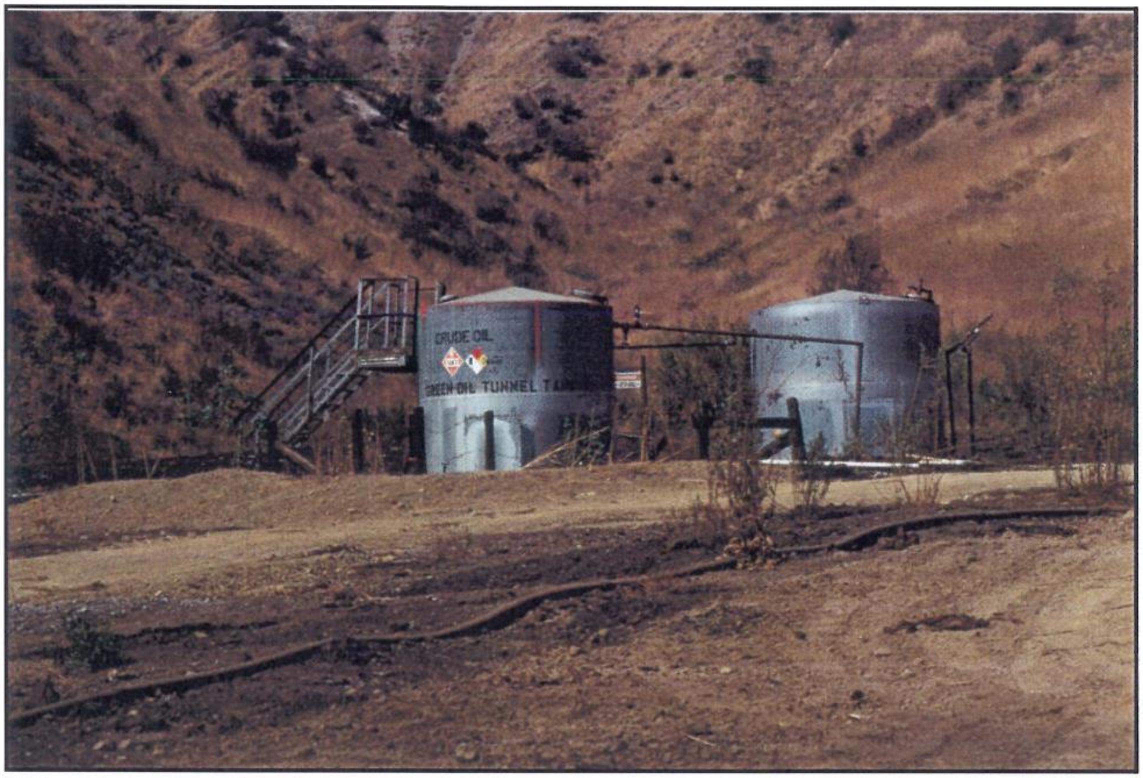
The 400-foot Pinkerton Tunnel No. 3, also known as the Jefferson, was completed in 1893 at a yield of 210 barrels. of green oil per month. In 1895, yield was 50 barrels. of oil per month.

The 200-foot Pinkerton Tunnel No. 4 is about 15 feet northwest of No. 3 and about 20 feet higher. The tunnel was completed in 1895 at the yield of 30 barrels. of rather heavy green oil a month, no water.

The 700-foot Pinkerton Tunnel No. 5, also known as the Orne Tunnel, is about 200 feet N 25EE of No. 4 and 40 feet higher. Finished in early 1895, this tunnel yielded 120 barrels. of oil a month for three months. In the later part of 1895, the flow was 50 barrels. a month.

Completed in 1880, the 75-foot Pinkerton Tunnel No. 6 also known as the Adams Tunnel is 400 feet N25E W of and about 100 feet higher than tunnel No. 5. Before No. 5 was completed the No. 6 yielded 30 barrels. of heavy oil a month. In 1895, the tunnel yielded practically nothing.

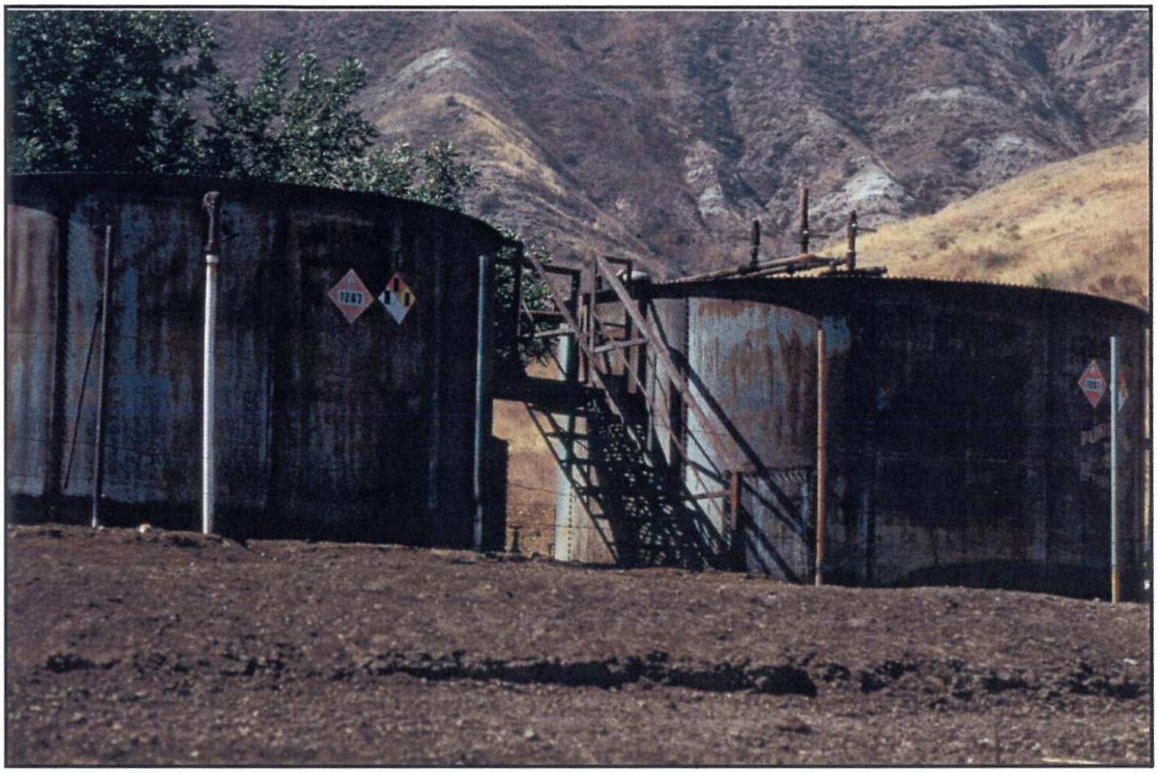
The 200-foot Pinkerton Tunnel No. 7 has been run a short distance N. of No. 5 Tunnel. When first completed, No. 7 yielded 120 barrels. of heavy green oil a month. In June 1895 yield was about 15 barrels. a month.



Oil seepage collection tanks, Adams Canyon, 1994. Photo by Gregg Wilkerson.

Wheeler Canyon **(T.4N, R.22W, Sec 25, 36)**

Three 600-foot tunnels have been completed within Wheeler Canon. The yield in 1895 is 300 barrels. a month.



Oil seepage collection tanks of Adams Canyon in 1994. All tanks and other oil recovery operations were removed in 1998. Photo by Gregg Wilkerson.

Santa Paula in 1888, with refinery of the Mission Transfer Company at extreme left.

Santa Paula, 1888. From Taylor and Welty, 1950, p. 51.

MAP 06

(Geology by Dibblee, 1990a, 1992a)

Return to Highway 150

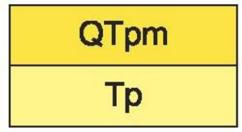
From the turnoff to the oil mines, continue southward on Highway 150. The Pico beds here, on both sides of the road, dip 50-65 degrees to the south.

Stop 10: Steckel Park

1.4 Steckel County Park. River terraces are to the east. The terraces were formed by the ancestral Santa Paula Creek, which flowed southward. The various levels reflect periodic rejuvenations of the stream, which is now actively cutting downwards.

Mile

2.75 Cross contact between (Tp) to north and (QTpm) to south.



PICO FORMATION

Marine; Pliocene and Pleistocene age

QTpm *Mudpit Claystone Member: massive to poorly bedded, soft, crumbly gray claystone or mudstone, bluish gray where unweathered; locally includes a few lenses of sandstone and brown conglomerate of sandstone cobbles in upper part; early Pleistocene and possibly late Pliocene age*

Tp *Pico Formation: vaguely bedded gray claystone and siltstone, soft, crumbly; bluish-gray where unweathered; includes strata of tan, semi-friable, bedded sandstone; mostly Pliocene age*

Figure 34. Lithologic description of Plio-Pleistocene Pico Formation. From Dibblee, 1990a.

3.2 Hupa School

3.5 Hills to the east are composed of south-dipping, Pliocene-age turbidites of the Pico Formation. Excellent outcrops of Pico occur along Santa Paula River to the right of the highway. The outcrops of Pico Formations in Santa Paula Creek are world famous. These outcrops were critical in proving the deep water origin of turbidites. Investigations showed the turbidites of the Pico Formation here to be intimately interbedded with mudstones containing deep water foraminifera.

3.6 Low hills to the west are composed of Pleistocene-age clastic strata of the Saugus Formation.

3.7 Cross over to the Santa Paula 7.5 minute quadrangle. Ojai Road (State Highway 150) becomes 10th Street.

4.7 Barbara Webster School

5.5 Railroad crossing. Santa Paula Station on the right (west)

Santa Paula Railway Station, 1999. Photo by Gregg Wilkerson.

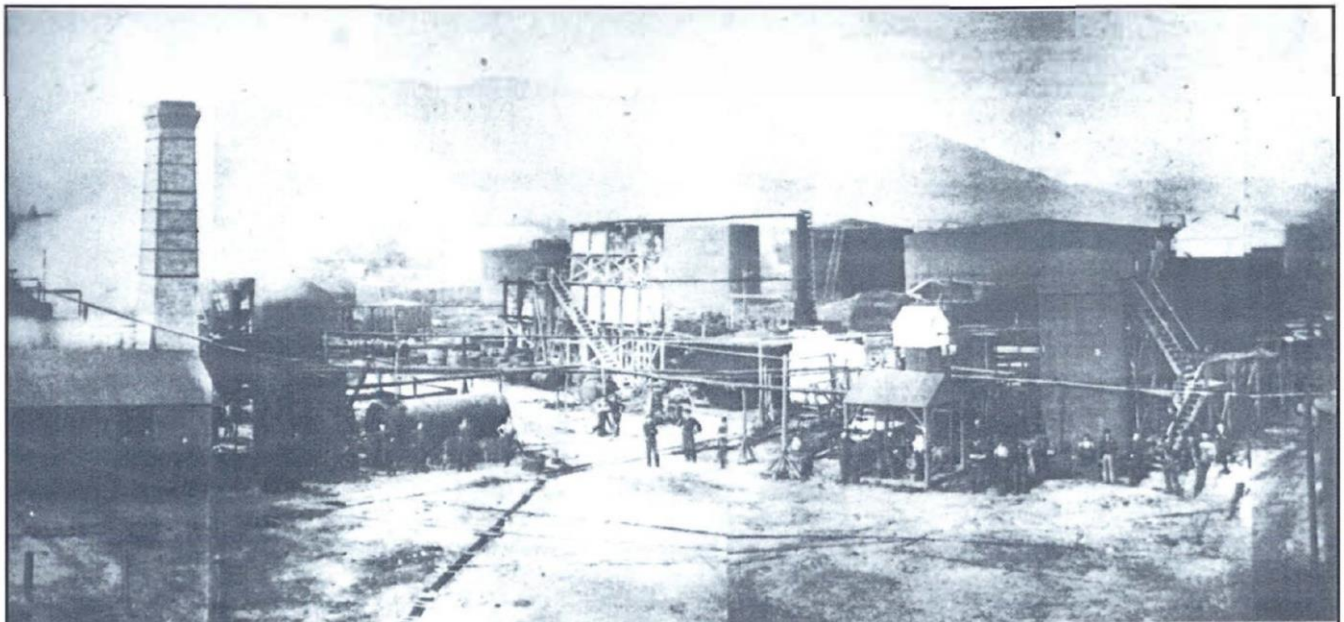
Mile

5.6/0.0 Turn east onto Main St. (State Highway 150).

Stop 11: Santa Paula Museum

The Santa Paula Oil Museum (Formerly the Union Oil Museum) is on the northeastern corner of the intersection of Main St. and 10th Street (State Highway 150). The museum was once the main offices in the area of the Union Oil Company founded in 1890. The museum contains equipment used in the early day of oil development in the region and the evolution to modern technology used to discover and produce an oil field.

The Stewart and Hardison Oil Company moved its headquarters to this building in 1886 to escape having their offices close to bars which Stewart found offensive to his Presbyterian tradition. Once the office was moved, a tavern opened across the street (Taylor and Welty, 1950, p.57). The building later became the main offices for the Union Oil Company founded in 1890. The museum contains equipment used in the early day of oil development in the region and shows the evolution to modern technology used to discover and produce an oil field. Santa Paula was the site of one of the earliest refineries and research facilities in California. In 1886 a pipeline was built by C.A. Burrows from the Santa Paula refinery to the Newhall Oil Field and to Ventura. This was the first oil pipeline built from inland oil sources to the sea. On June 29, 1896 the refinery burned and was then replaced {Taylor and Welty, 1950, p.57 and 108).



*Santa Paa/a refiner)· erect,•d in 1887 hv th,• HardISon & Stewart Oil Cn. Plant had **I** capanty Ihro ughp llI i/s first y,:ar of ahout I4,000 harre/s, llImlIlg mu lIch prndılu l al lIlpha/l ılm, /lı>ri-cant.l, gr,'cHe! and i//ıIIIIrwtilIr oi/1. Rt•fin,•r_y wm destroy,·,/ /,\· fire I>lI reh ııi/l.*

Santa Paula refinery, 1887. From Taylor and Welty, 1950, p.95.

Follow Main Street east to 12th Street.

Mile

0.2 Turn south onto 12th Street.

0.4 Go under Highway 126

0.6-0.7 Willard Bridge over the Santa Clara River. The river marks the location of the Oak Ridge Fault. It forms the northern boundary to South Mountain (Dibblee, 1992a).

Santa Clara River Syncline.

The Santa Clara River Valley is a synclinal trough within a graben that lies between two opposed thrust faults--the San Cayetano thrust on the north and the Oak Ridge thrust on the south. The axis of the syncline follows the southwesterly flowing Santa Clara River.

Santa Clara River

The Santa Clara River with headwaters near Palmdale drains most of central and southern Ventura County which includes the northwestern San Gabriel Mountains, Liebre Mountains, Sierra Pelona, and the Soledad Basin. The river is 75 miles (120 Kilometers) long. Until the 1970's Feather River Project, the Santa Clara river provided all the domestic and agricultural water needs for the Ventura-Santa Paula area.

Seven *en echelon* anticlines form a chain approximately twenty miles long on the Oak Ridge uplift, which lies south of the Santa Clara River between Santa Paula and Piru. These anticlines, from west to east are called the West Mountain, South Mountain, Bardsdale, Shiells, Wiley, Torrey, and Oak Ridge. All but the Wiley are productive.

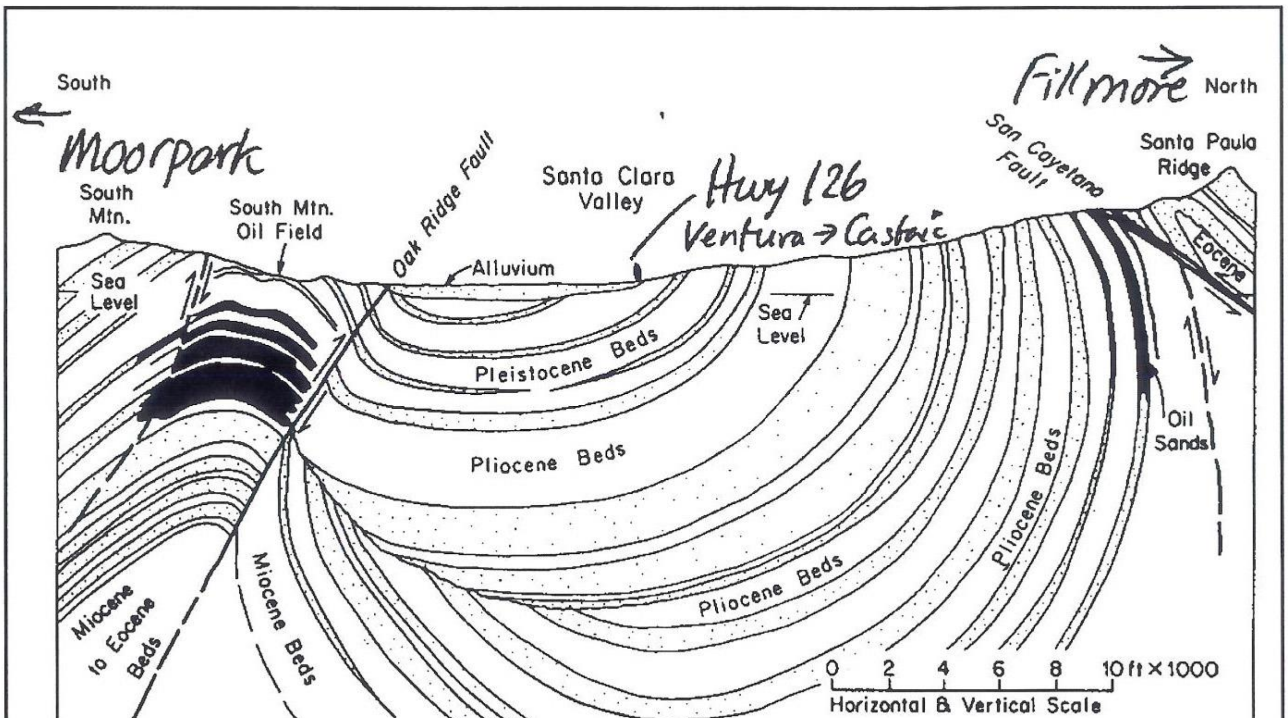


Figure C-2. Geological cross section of the Santa Clara River valley.

Geologic cross section if the Santa Clara River Valley. From Sharp, 1972, p.13.

Mile

0.8 North abutment of the Willard Bridge. The south dipping Oak Ridge fault surface trace is directly below the river alluvium.

Oak Ridge Fault

On the south side of the valley is the poorly exposed Oak Ridge Fault. The fault is traced twenty five miles offshore from the Santa Barbara Channel, through the mouth of the Santa Clara River, to west of the town of Piru. The fault is a high-angle reverse fault dipping to the south 60E or more. Quaternary terraces have been offset as well as the anticlinal folds of South Mountain and Oak Ridge have moved upward on the fault.

Mile

0.9 Proceed southeast on South Mountain Road. The road is on the upper plate of the Oak Ridge uplift. The red and white buff colored sands within the roadcut are the Miocene Sespe Formation.

The amount of displacement on the Oak Ridge Fault and the amount of crustal shortening associated with it increases from west to east as show in the table, below:

	A-A' Rincon	B-B' Ventura	C-C' Ojai	D-D' Timber Canyon
Pre-Saugus/Post-Pepetto Displacement on Oak Ridge Fault:	1100	2500	3960	2460
Shortening of the fold-thrust belt with respect to Paleogene competent sequence:	3300	2700+	6700	0

Displacements, in meters, on Oak Ridge fault and in interbasin fold belt along four cross sections shown on page 21. Adapted from Sylvester and Brown, 1988, p. 141.

To the northeast, within the gravels of the Santa Clara River, are the sites of the Southern Pacific, Asburry and the Santa Paula mines. These were formerly active gravel producers. Environmental regulations have since put them out of business, even though demand for sand and gravel in Ventura County is high. Most of the sand and gravel used to make cement in Ventura County is now imported, some of it by barge from Mexico. These mines had a renewable source of sand and gravel: the Santa Clara River. After the San Francesquito dam disaster, some corpses were found during subsequent mining operations here.

On the south slope of South Mountain near the top are beds of soft red shale used in mineral paint. The material is of a uniform brick-red color, is easily sawed, and pulverizes readily upon crushing, leaving little or no grit.

Gypsum

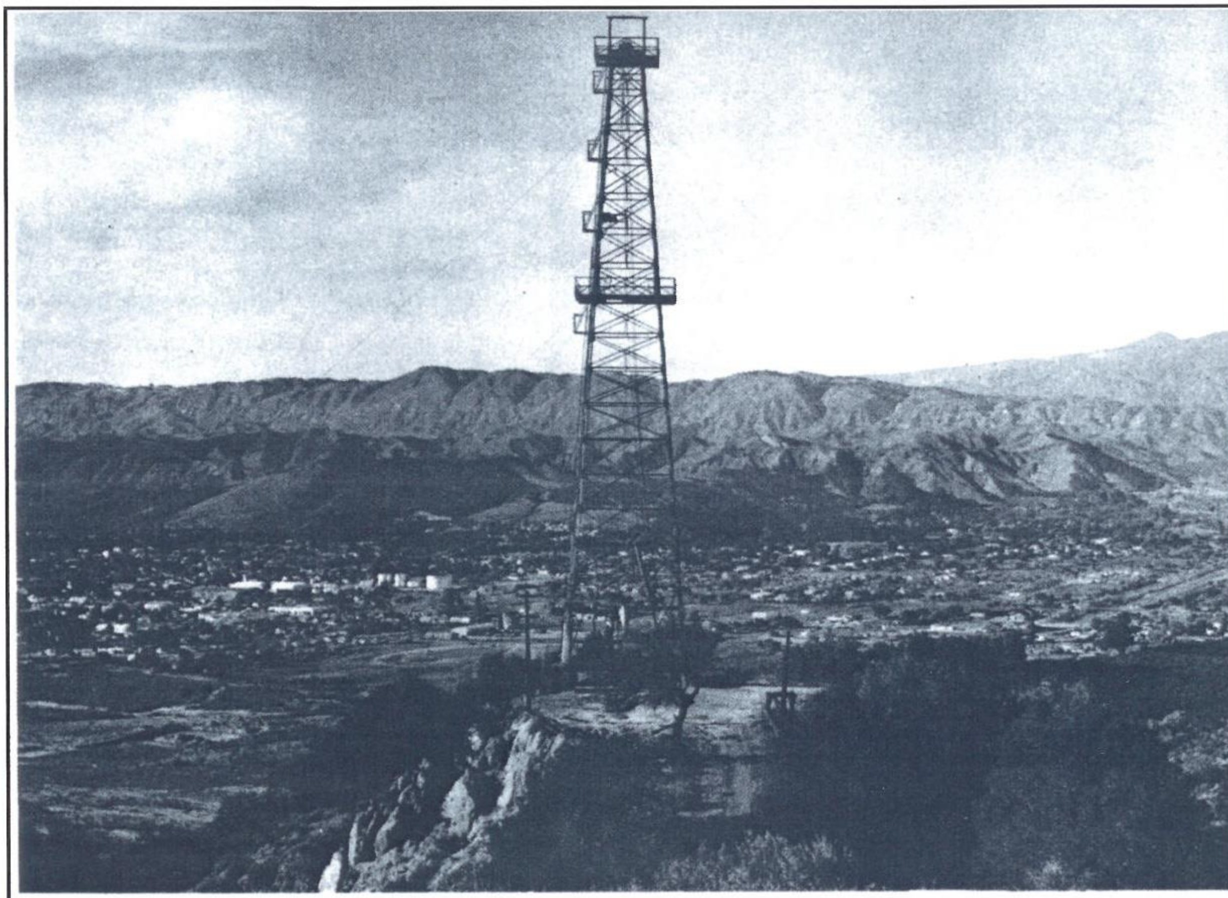
A deposit of gypsum is found on the south slope of South Mountain. The deposit is massive, impure, soft, white and granular in texture. It is interbedded with diatomaceous shales. At the turn of the century, thinly laminated beds of yellowish-white diatomaceous earth, striking east-west, were located on the south slope of South Mountain. The earth was permeated with a strong odor of petroleum. Hot gases exuded from between the beds at several places. The highest temperature was 146 ° F. A light coating of sulphate salts was being deposited at the site.

South Mountain Oil Field

Mile

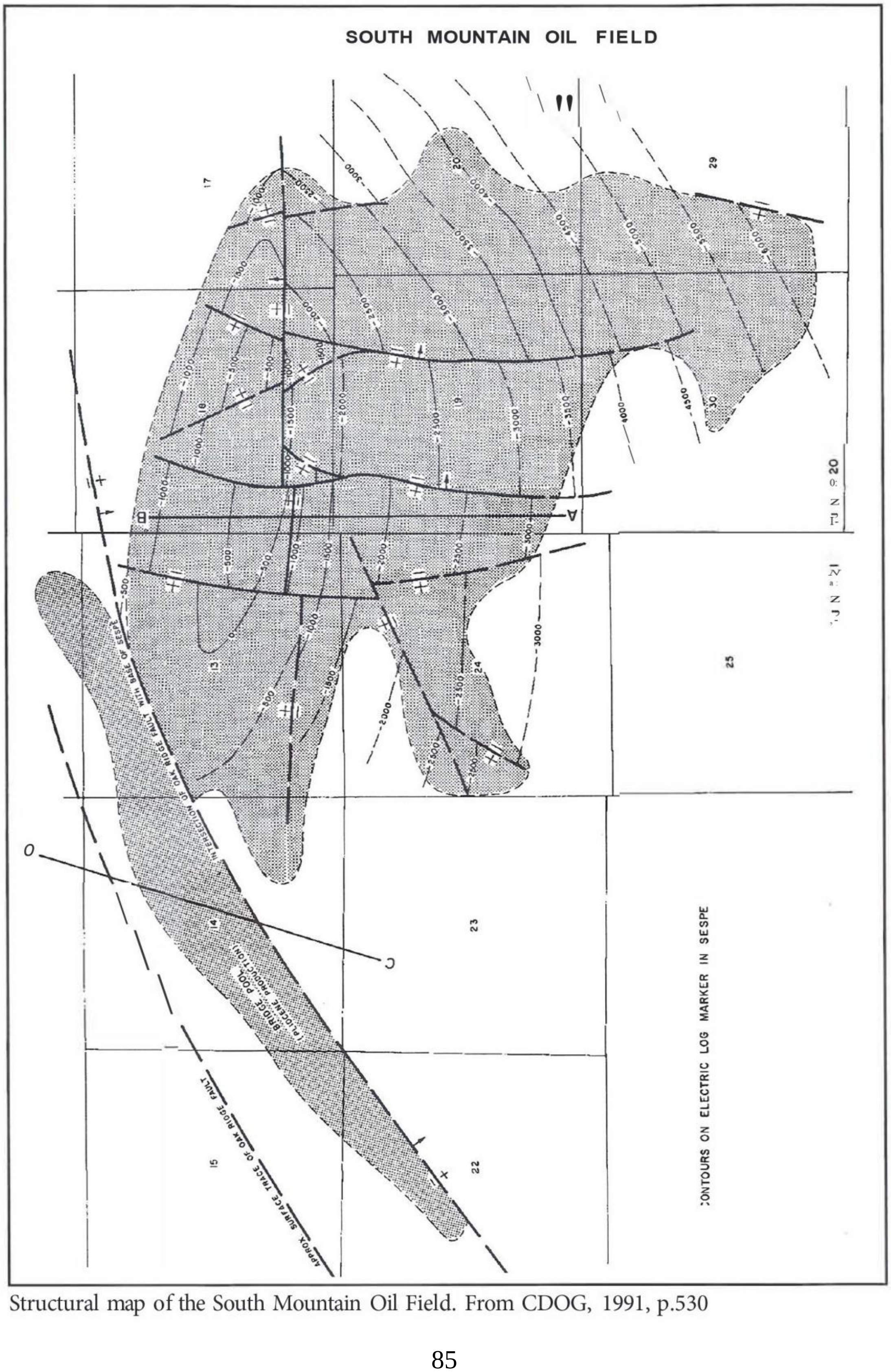
1.1 SOUTH MOUNTAIN OIL FIELD ENTRANCE.

The entrance to the **South Mountain Oil Field** at Richardson Canyon is to the south. The South Mountain Oil Field was discovered in April, 1916. Structurally the field is the largest and highest of a series of asymmetrical domes along the Oak Ridge anticline. Production is from the Pliocene and the Miocene Sespe with cumulative production of over 148.7 million barrels of oil and 300 million cubic feet of gas (1992 figures). The oil from the Sespe Formation is particularly high in paraffin content. This is due to the origin of the oil from planktonic algae (diatoms). The oil has to be heat treated to remove the paraffin.

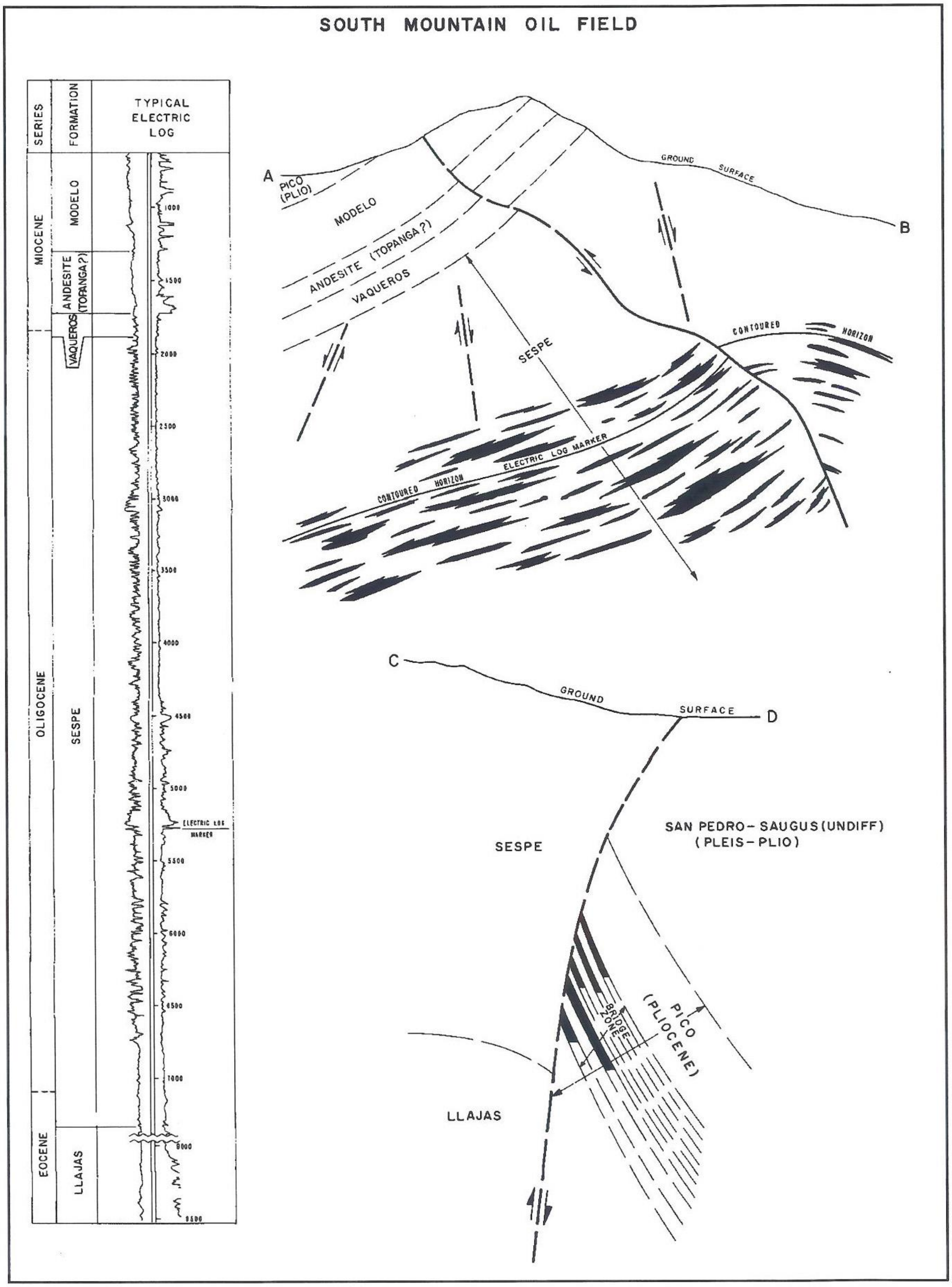


Santa Paula in 1950 as seen from the still-productive South Mountain Field.

From Taylor and Welty, 1950, p. 108.



Structural map of the South Mountain Oil Field. From CDOG, 1991, p.530



Cross sections of the South Mountain Oil Field. From CDOG, 1991, p. 531

Mile

1.4 Oligocene Sespe Formation on right to the south.

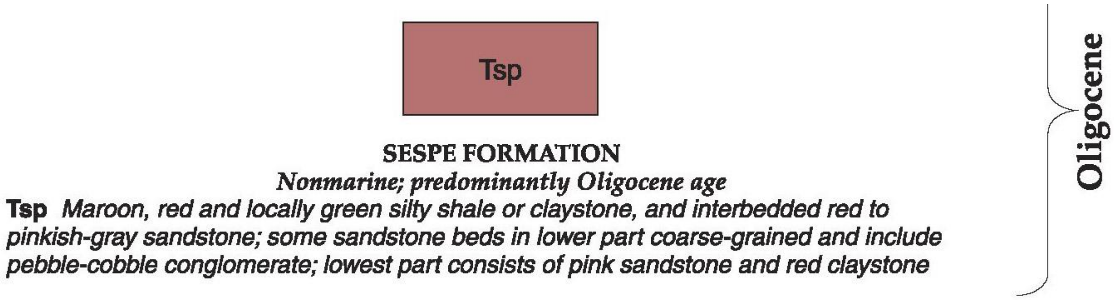
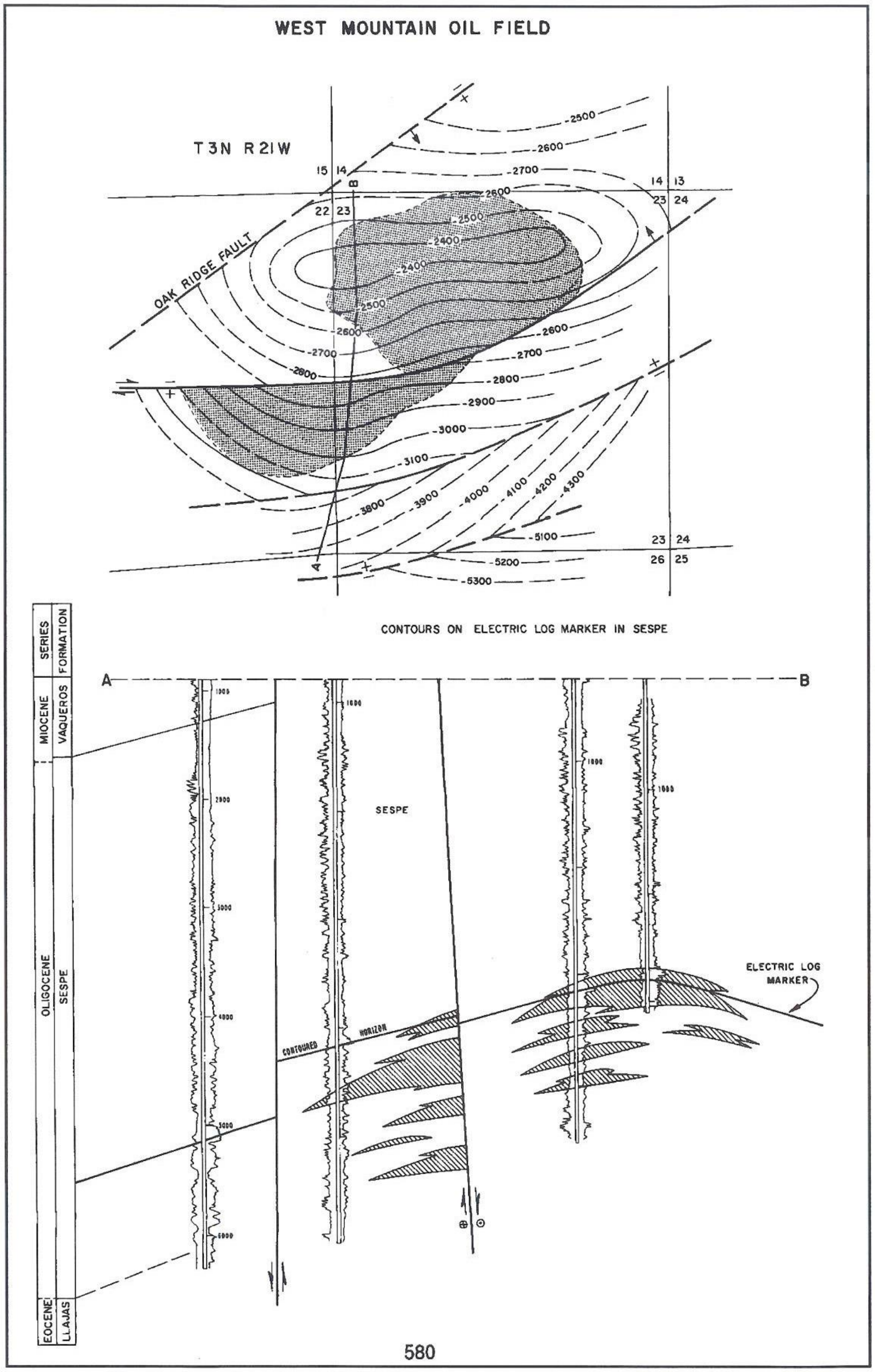


Figure 35. Lithological description of the Sespe Formation. Frm Dibblee, 1992a.

1.8. Morgan Canyon

The **West Mountain Oil Field** (cumulative 3.9 million barrels of oil) is directly south and the **Saticoy Oil Field** (cumulative 21.9 million barrels of oil) is directly west of the South Mountain Oil Field.



Structural contour map and cross section of the West Mountain Oil Field. From CDOG, 191, p. 580.

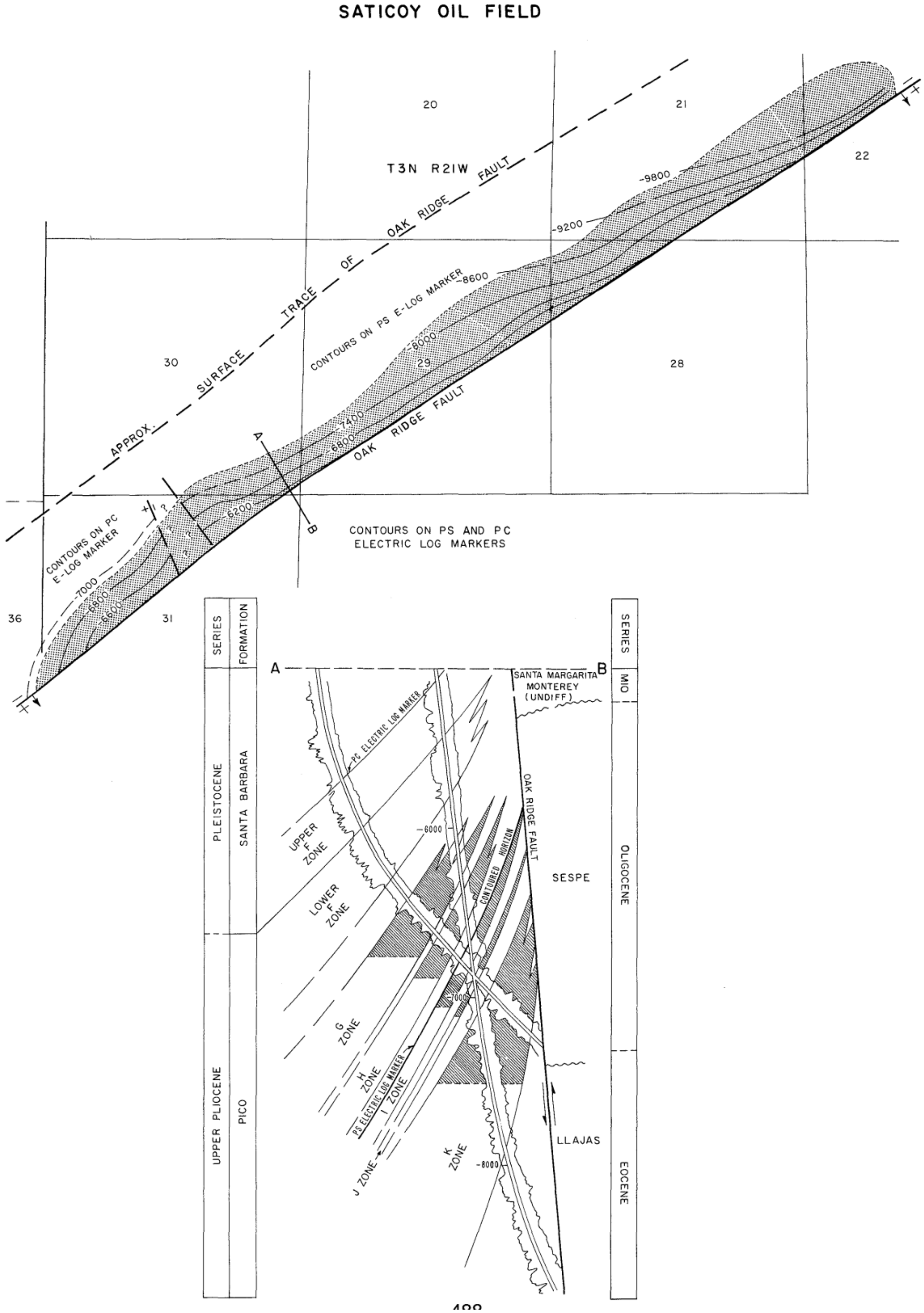


Figure 36. Structural contour map and cross section of the Saticoy Oil Field. From CDOGGR, Summary of Operations, Vol. 2, p. 488.

MAP 07

(Geology from Dibblee, 1992a and 1992b)

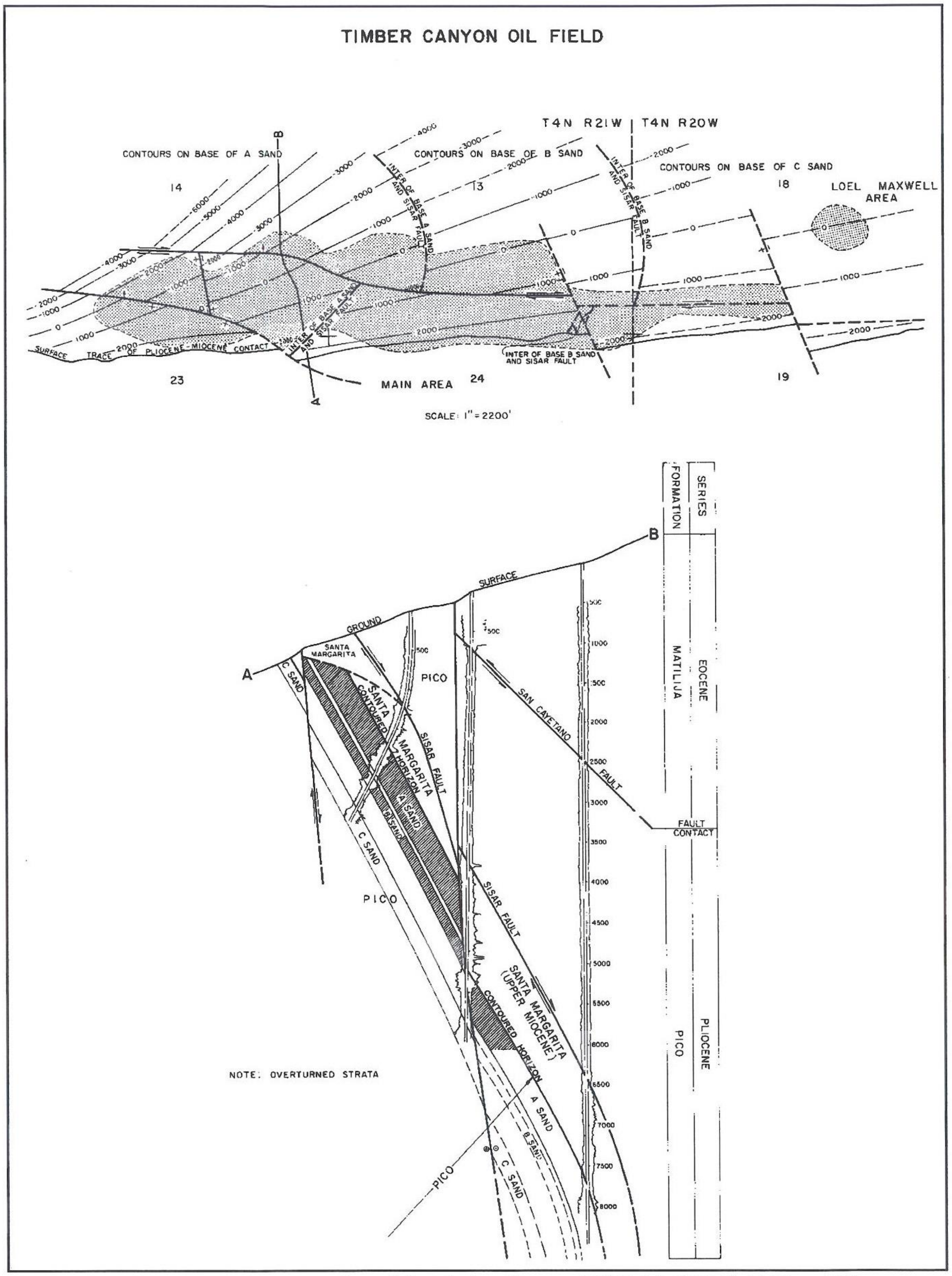
Mile

2.5 Vertical beds of Sespe Formation on right to the south. Between mile 2.5 and mile 3.6, the road follows the trace of the Oak Ridge Fault

2.7 Willard Canyon on right to the south.

3.0 Land slide on the right to the south

3.4 **Timber Canyon Oil Field** is to the 4.7 miles to the north on the south flank of Santa Paula Ridge. Discovered in 1898, the field has produced 6.7 million barrels of oil. It produces from high-angle, faulted, Santa Margarita Formation.



Structural contour map and cross section of the Timber Canyon Oil Field. CDOG, 1991, p. 554

Mile

3.5 Santa Paula Peak is to the north, elevation 4957 feet (1511 meters).

3.6 Land slide on right to the south.

3.8 Quaternary older Pleistocene alluvium to the south, Quaternary Holocene alluvium is to the north.

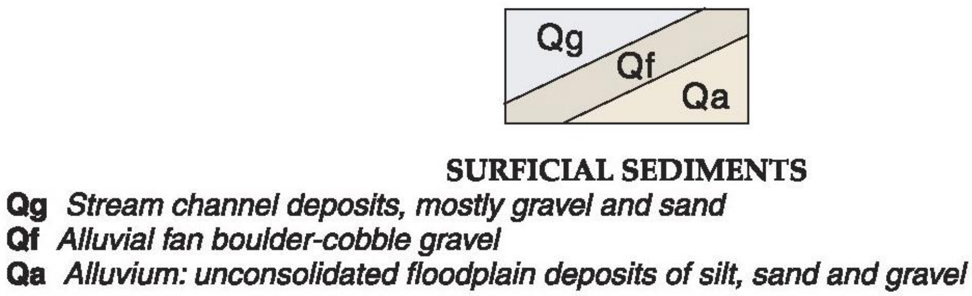


Figure 37. Surficial Sediments. From Dibblee, 1992a.

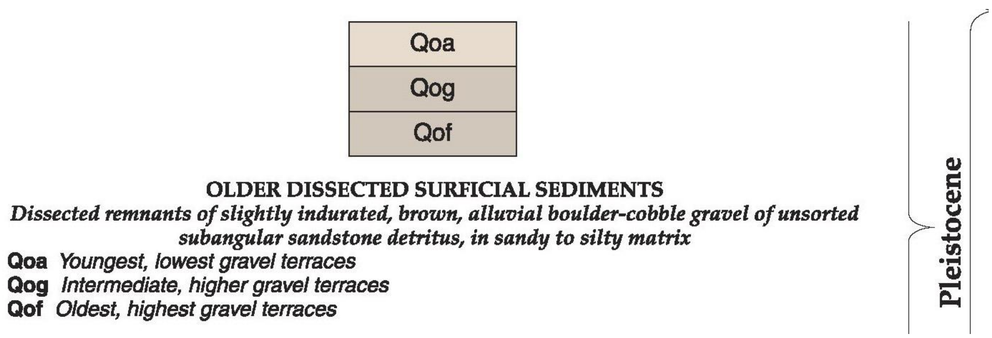


Figure 38. Older Dissected Surficial Sediments. From Dibblee, 1998a.

3.9 Cross over to the Moorpark 7.5 minute quadrangle (Dibblee, 1992b)

4.5 San Cayetano Peak is to the north, elevation 4181 feet (1274 meters).

The San Cayetano fault trace is approximately halfway up the slope where a change in color occurs in vegetation. The older Eocene Matilija Sandstone Formation is in the hanging wall (upper wall) and the younger Plio-Pleistocene Pico Formation is in the foot wall (lower wall). Under the Pico is the even younger Pleistocene Saugus Formation (Dibblee, 1992b) .

The Oak Ridge Fault trace is on the south rim of the Santa Clara Valley. The formations to the south are uplifted. South away from the fault is the Oligocene Sespe, Miocene Monterey, Pliocene Pico, and the Pleistocene Saugus Formations (Dibblee, 1992b).

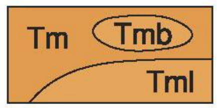
Mile

5.2 Balcom Canyon Road.

5.3 Road follows Oak Ridge Fault.

5.6 Land slide on right to the south.

6.0 Road to left, unnamed canyon in Monterey Formation to the south.



MONTEREY SHALE
(Modelo Formation of Kew 1924; Yeats 1987; same lithologic unit as Monterey Shale of northern Ventura basin)
Marine biogenic; middle and late Miocene age (Luisian and Mohnian Stages)

Tm *Upper part: white-weathering soft fissle to punky thin bedded semi-siliceous shale and interbeds of hard platy to brittle siliceous shale; includes thin calcareous strata in lower part*

Tmb *Burned siliceous shale; same as* **Tm**, *but shale once partly molten by underground fires causing shale layers to expand, partially melt and remobilize, and flow unevenly to frothy, finely pumiceous layers of varying bright colors, mostly red, tan, yellow-green, maroon, and black*

Tml *Lower part: soft, thin bedded clayey shale; includes some tan dolomitic concretions; probably middle Miocene age*

Figure 39. Lithological description of the Monterey Formation. From Dibblee, 1992a

6.6 Topanga Sandstone (Tts) on the right to the south, south of the Oak Ridge Fault.

7.1 San Cayetano Avenue

MAP 08

(Geology from Dibblee, 1990a, 1991, 1992a, 1992f)

7.4/0.0 Sespe Street. Turn south to the Bardsdale Cemetery (0.3 miles)

Stop 12: Bardsdale Cemetery.

The Bardsdale-Fillmore Bridge and several other structures were destroyed by the St. Francis Dam flood of March 12-13, 1928 (Nunis, 1995, p. 153). Several agricultural workers in this community were drowned in the flood, as well as many other residents, all of whom have grave markers indicating they died on the same day.

Figure 40. Gravestones at Bardsdale Cemetery showing deaths of whole families on December 12, 1921.

Return to Sespe Street and South Mountain Road.

Mile

0.5 Los Angeles Avenue

8.1 Turn east onto Bardsdale Road. Note concrete irrigation ditch on south side of road.

8.6 Ventura Street and Bardsdale Road. Proceed east on Bardsdale Road

9.3 Bardsdale Road and Grimes Canyon Road. Grimes Canyon is to the south. Grimes Canyon is the route for Highway 23 to Moorpark. Going up this canyon, we would go down-section, starting in Oligocene Sespe Formation, crossing the apex of the Oak Ridge Anticline, and then going uphill, but into younger rocks of the Monterey, then Pico, then Saugus formations.

The Bardsdale Oil Field is 0.8 miles south of this intersection. The rocks to the south, at the base of the first low hills is Sespe Formation. The Oak Ridge Anticline forms this hill.

Stop 13: Bardsdale Oil Field

The Bardsdale oil field is now operated by Vintage Petroleum. In the field is the remnants of Jack Leg drill system developed at the turn of the century. To view this historic equipment, contact Vintage South Mountain field office at 805-525-8008. After visiting the Bardsdale Oil field, return to the intersection of Bardsdale Road and Grimes Canyon Road.

Robertson Well No. 1 at Bardsdale in 1890. Standing, left to right: Ed Scholl and two children, John Millard, Ben Robertson, Ed Elkins and an unidentified visitor. Seated, left to right: E. E. Chamberlain, Charley Millard, unidentified, Robert Cruson and son, Tom.

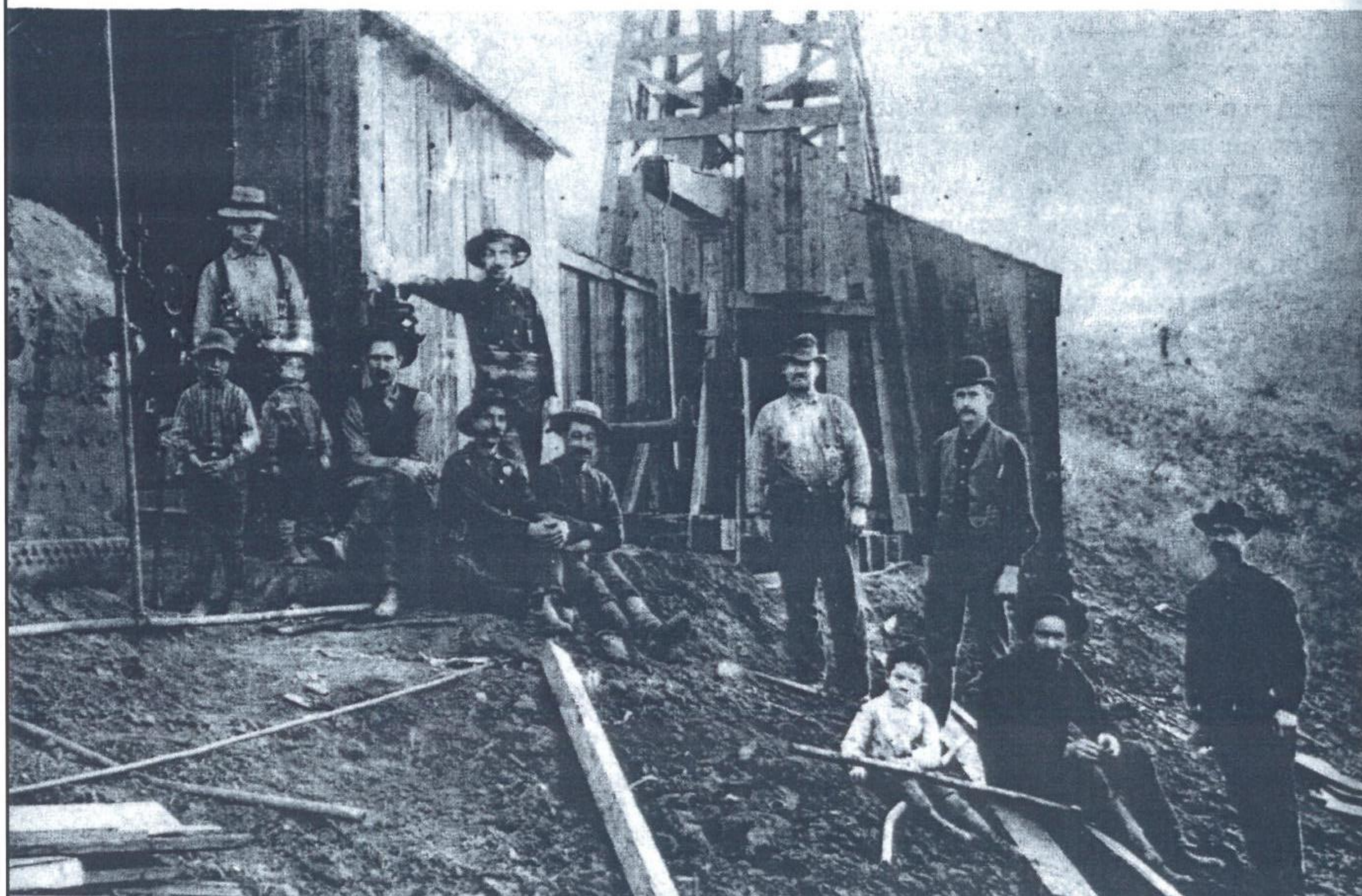
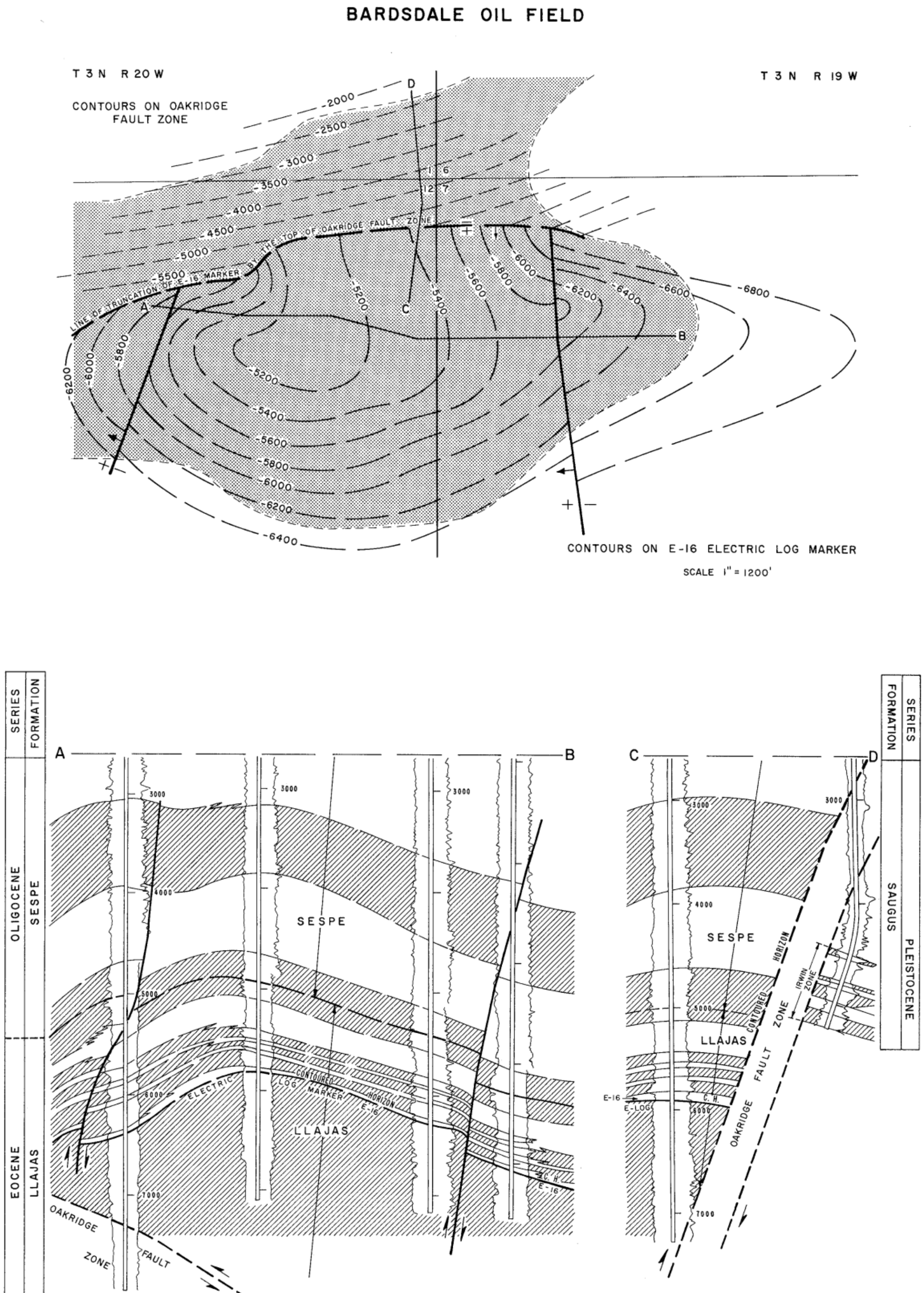
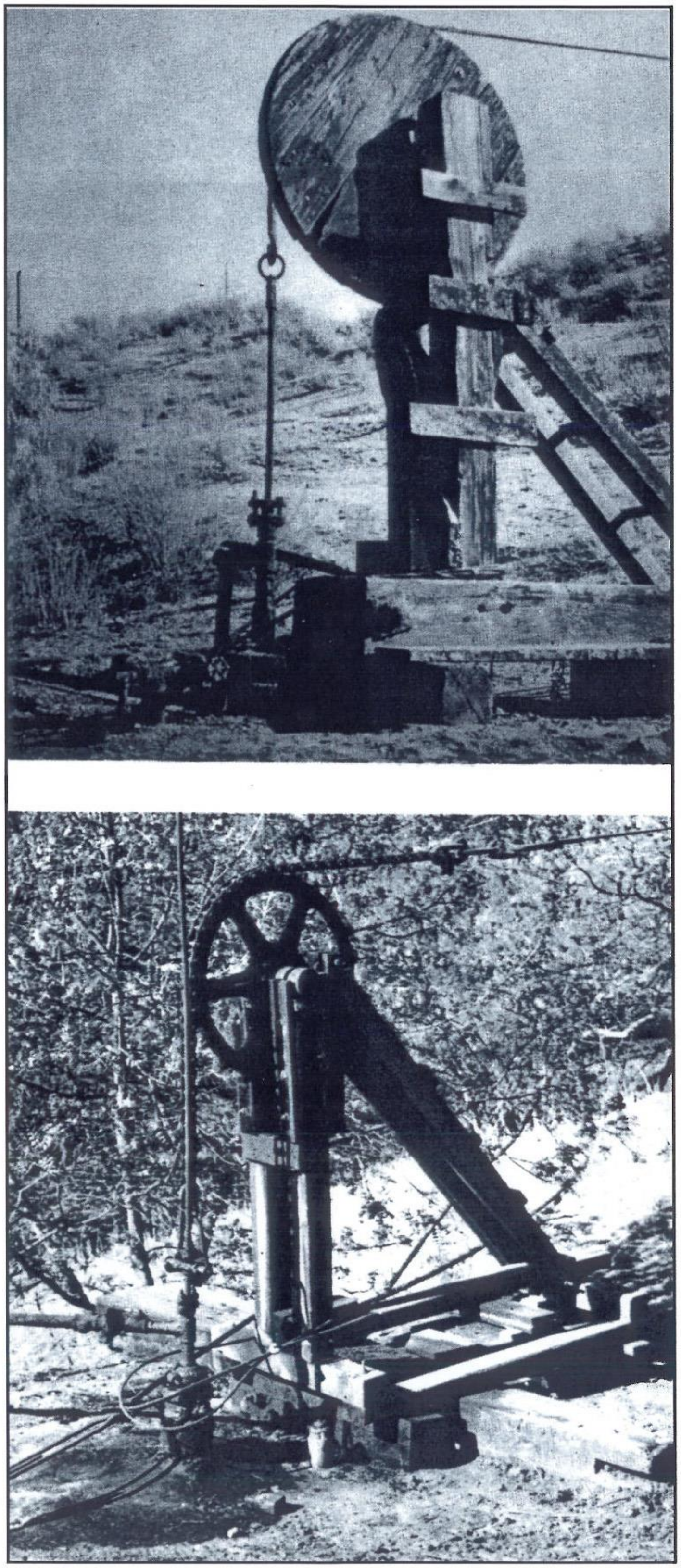


Photo from Taylor and Welty, 1950, p. 48.



40

Figure 41. Bardsdale oil field structural contour map and cross section. From CGOGGR, 1991, p. 40.



“Jack line” pump units. From Taylor and Welty, 1950, p. 39.

Stop 14: Grimes Canyon Baked Monterey Formation Tar Sands

South of the Bardsdale oil field is the Grimes Canyon Quarry. Wildfires have baked the fossil tar seeps here to form a beautiful banded rock. Return to the intersection of Grimes Canyon Road and Bardsdale Road.

Mile

1.9 / 0.0 Stop Sign. Go east on Bardsdale Road.

0.2 Turn north onto State Highway 23 at the Elkins Ranch Golf Course. South of the town in the Bardsdale Oil Field. Discovered in 1892, the field has produced 14.2 million barrels of oil.

0.4 Bardsdale Road. Cross over to the Fillmore Quadrangle (Dibblee, 1990b). City of Fillmore is to the north. The Sespe Condor Refugee is located several miles north of Fillmore.

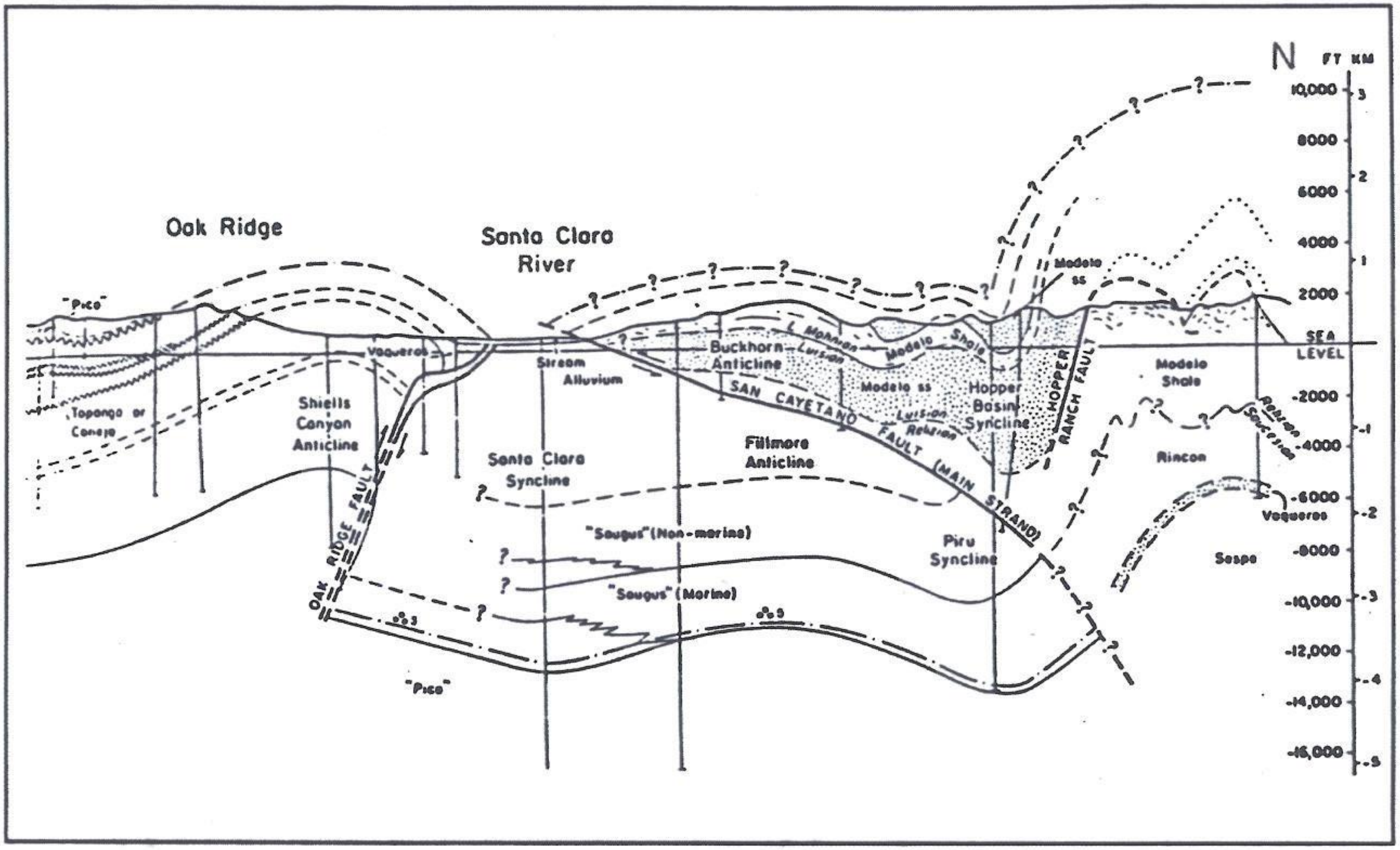


Figure 1.39. North-south cross-section through the Ventura basin between Fillmore and Piru, showing well control (Yeats and others, 1982). 5 and dot-dash pattern mark a horizon dated as one million years old near Ventura and correlated east to this region. Projection of this horizon north the the San Cayetano fault is highly speculative.

North-South cross section through the Ventura Basin. From Sylvester and Brown, 1988, p. 46

Northwest of Fillmore is the **Fillmore Oil Field** which was first discovered in 1954. This field produced from the Wheelerian turbidite sandstone of the Pliocene Pico formation at an average depth of 14,000 feet. The trap is a northward pinch-out of the turbidite sandstone into bathyal mudstone. The field was abandoned in 1973. In 1980, the field was reactivated based on the dynamic oil migration theory. When oil is removed from oil pools that have low permeability and relatively high viscosity, a drawdown condition forms were oil can not enter the well bore as fast as it is being pumped out. So the oil pool "dries up." When wells with larger diameters are re-drilled and placed on slower production rates, the pools "come alive" again. The first well re-drilled was recompleted producing 175 barrels of oil and 97,000 cubic feet of gas per day. Cumulative production to 1992 has been over 13.1 million barrels of oil and 18 billion cubic feet of gas.

Located north of the Fillmore Oil Field and south of the **Condor Refuge**, the **Sespe Oil Field** is one of the oldest in California. The discovery well was Union Oil Company "Tar Creek" 1 drilled to a depth of 965 feet in 1887. A unique situation is that the wells in the Sespe Forks area are drilled in the axis of a syncline (normaly wells are drilled at the apex of anticlines). Cumulative production to 1992 has been over 42.2 million barrels of oil. The Sespe Oil Field has several tar seeps, many of them in **Tar Canyon.**

Some wells have a long life. Tar Creek No. I drilled by Union Oil Company a half-century ago was still producing in 1950. A modun pumping unit has been placed at the well and a sue/ jackline s1retched out to pump another well several hundred yards away.

From Taylor and Welty, 1950.

On the north side of the Santa Clara River, near the railroad tracks, the surface trace of the San Cayetano thrust crosses Highway 126 and swings back to the northwest and follows the Sespe Creek northward for four miles before turning west and then southwest toward Santa Paula. On the south side of the river, Guiberson road is built atop the Oak Ridge Fault. South of this fault is Topanga Sandstone. The Topanga Standstone is a late Oligocene to early Miocene marine clastic unit, light grey to tan, semi-friable, vaguely bedded arkosic sandstone. South of the Topanga is Sespe Formation (Dibble, 1991).

0.6 Turn east on Guiberson Road.

1.5 Roadway follows the Oak Ridge Fault. Sespe formation to the south (right) and the Shiells Canyon Oil Field.

1.9 Road to the left (north) goes to the Santa Clara River. To the south(right) is Topanga Sandstone (Tts).

2.7 On the south is a landslide. 0.4 miles to the south of the roadway is the Shiells Canyon Oil Field discovered in 1911. Production comes from the Miocene Sespe Formation within the hanging wall of the Oak Ridge Fault. Guiberson road follows the surface trace of the Oak Ridge Fault in this area. Cumulative production to 1992 has been 27.3 million barrels of oil.

To the north, on the north side of the Santa Clara River, the formations are overturned. The older Miocene Monterey is above the younger Miocene Sisquoc (Dibblee, 1990b).

Brown Sandstone cliffs on north are residual oil sands consisting of the upper sandstone member of the Monterey Formation. Numerous wells have been drilled on this shallow trend. This section is on the over-thrust plate of the San Cayetano fault, which is overturned near the surface trace.

2.9 Cross over to the Piru quadrangle (Dibblee, 1991).

3.3 Calumet Canyon Road. This road provides access to the Shiells Canyon Oil Field.

3.5 The road crosses the Oak Ridge Fault and proceeds on the upper plate.

MAP 09

(Geology by Dibblee, 1991)

4.4 Cavin Road.

4.6 To the north, at about the curve in the road, on the north side of the Santa Clara River is the San Cayetano Fault is at the base of the Buckhorn Anticline. The red rocks to the south are the Oligocene Sespe below the Miocene-Oligocene Topanga Sandstone.

5.0 On the north is the Hopper Canyon drainage. The **Hopper Canyon Oil Field** discovered in 1884 is within the canyon. Cumulative production to 1993 has been 3.1 million barrels of oil. Low hills on north side primarily consist of siliceous and diatomaceous shales of the middle shale member of the Miocene Monterey Formation. Some outcrops of Pliocene-Repetto member occur east of Hopper Canyon in the San Cayetano fault zone.

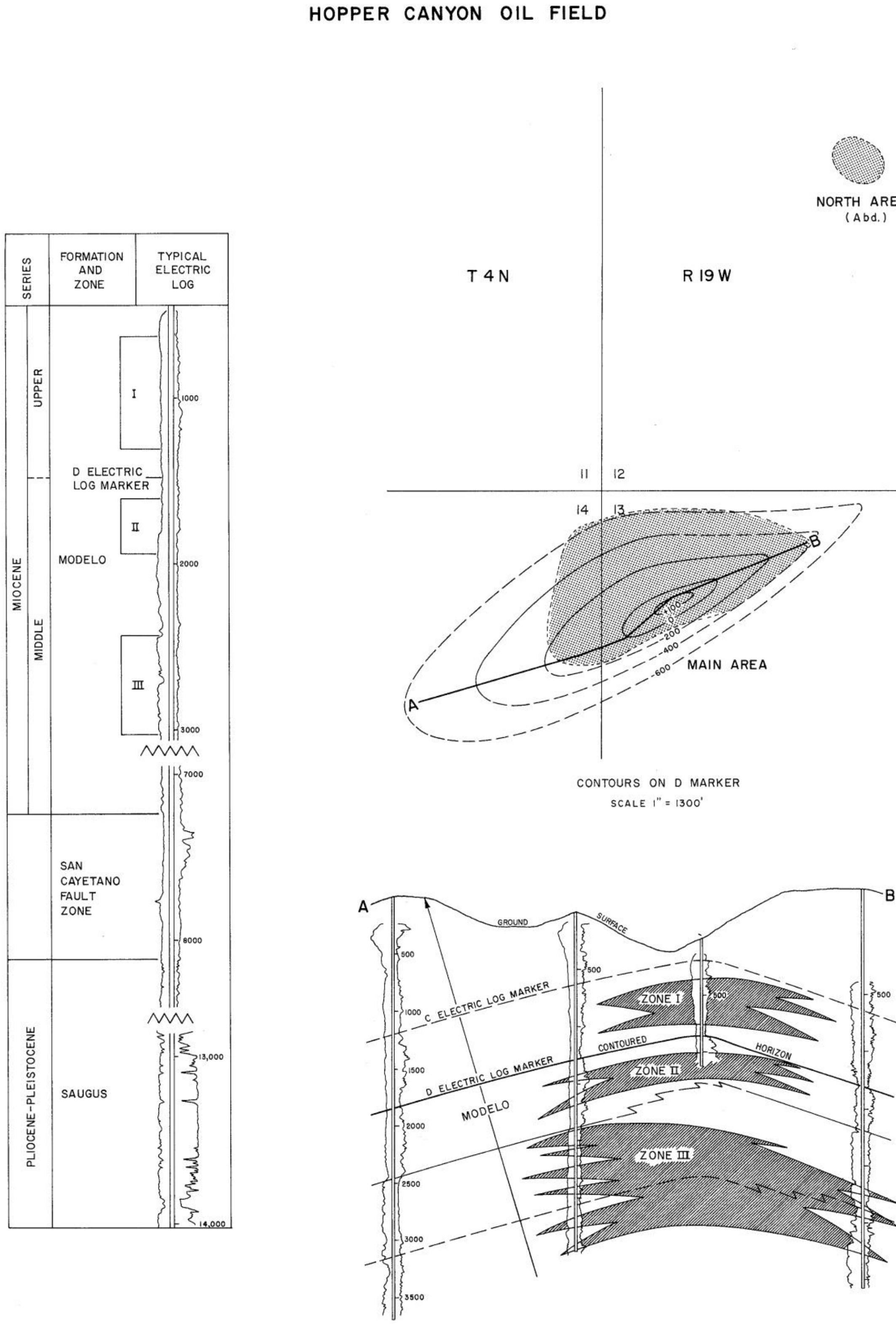


Figure 42. Structural contour map and cross section of the Hopper Canyon Oilfield. From CDOGGR, 1991, p. 174.

Mile

5.1 The **Chafee Canyon Oil Field**, discovered 1980, is to the south. Oil accumulates here from an anticline that formed to the south of the south-dipping Oak Ridge fault.

5.6 Fault contact on south side of roadway which places the Las Posas Sand to the north against the Rincon Shale to the south. The Rincon shale is exposed in outcrops on the south side of the roadway for the next mile. The roadway continues to follow the surface trace of the Oak Ridge Fault.

6.1 Cross the South Branch Fault. To the northeast is Monterey Formation, to the southwest is Topanga Sandstone.

6.6 Access to the Chaffee Canyon Oil Field is to the south (right).

7.7 To the southeast is the **Torrey Canyon Oil Field** discovered in 1889. Cumulative production has been 21.4 million barrels of oil (1992). North of the Torrey Canyon Oil Field is the **Eureka Canyon Oil Field**, discovered 1893. At this intersection, to the north is Quaternary Alluvium (Qa). To the south is Saugus Formation(QTs). Uphill of this is a sliver of .Las Posas Sand (QTlp), and then the Oak Ridge Fault, which is down to the north, up to the south.

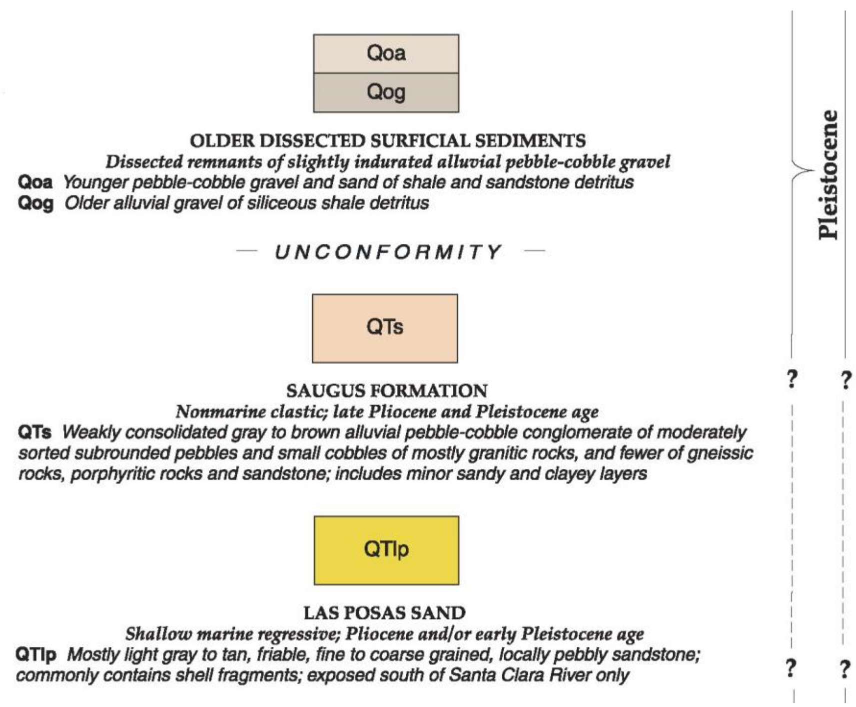
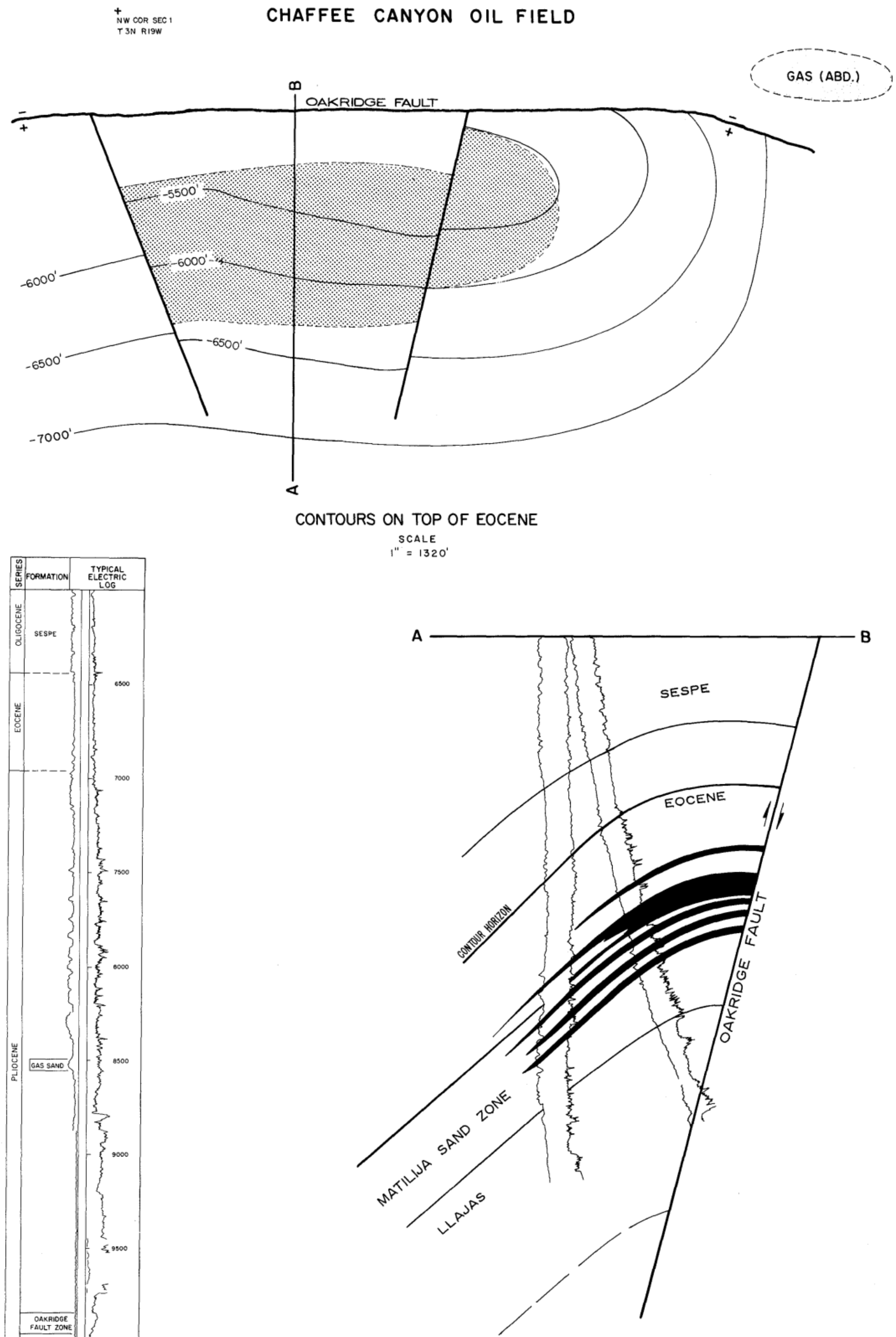


Figure 43. Lithological description of Quaternary Alluvium, Saugus Formation and Las Posas Sand. From Dibblee, 1991.



98

Figure 44. Structural contour map and cross section of the Chaffee Canyon Oil Field. From CDOGGR, 1991, p. 98.

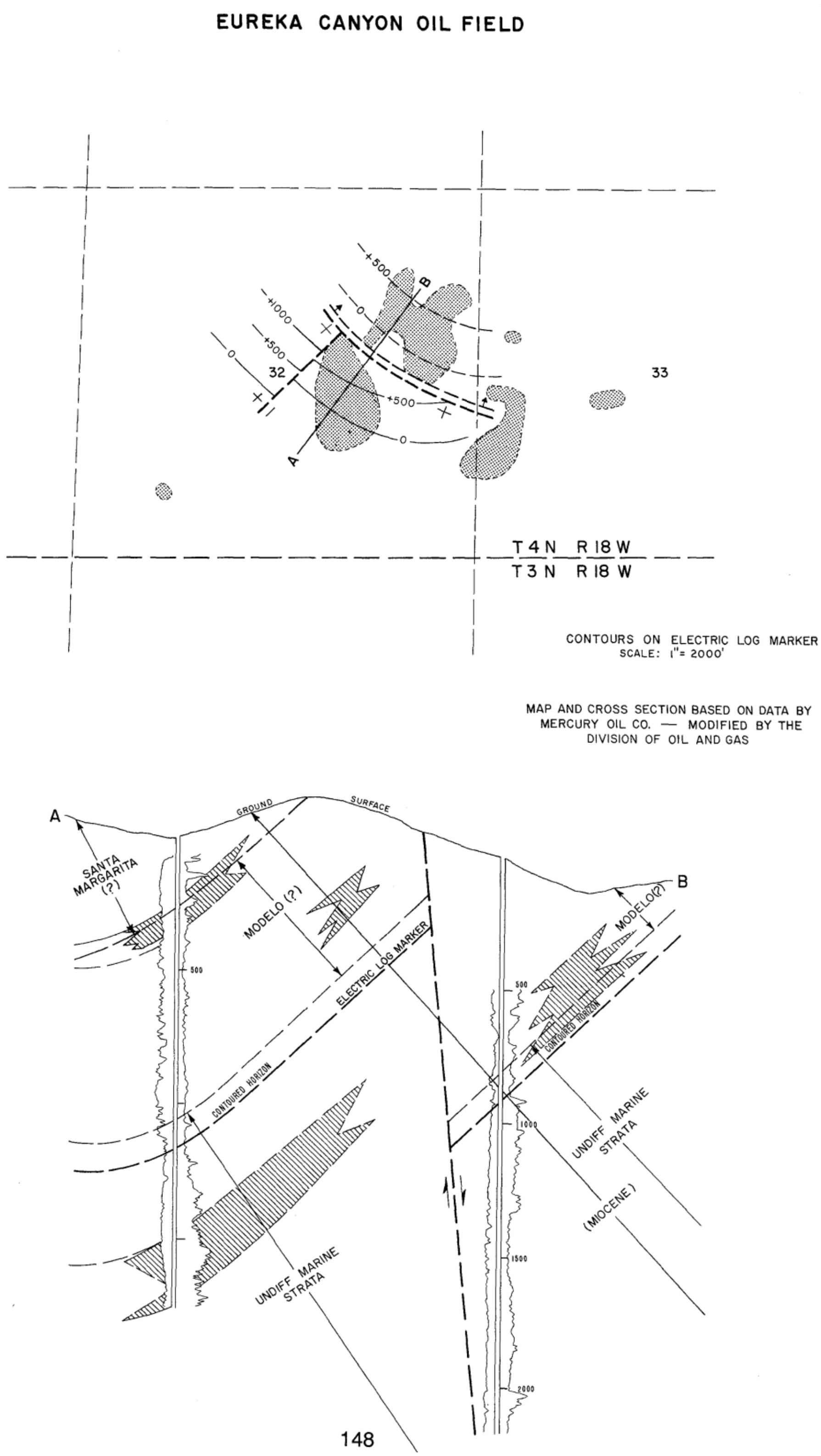
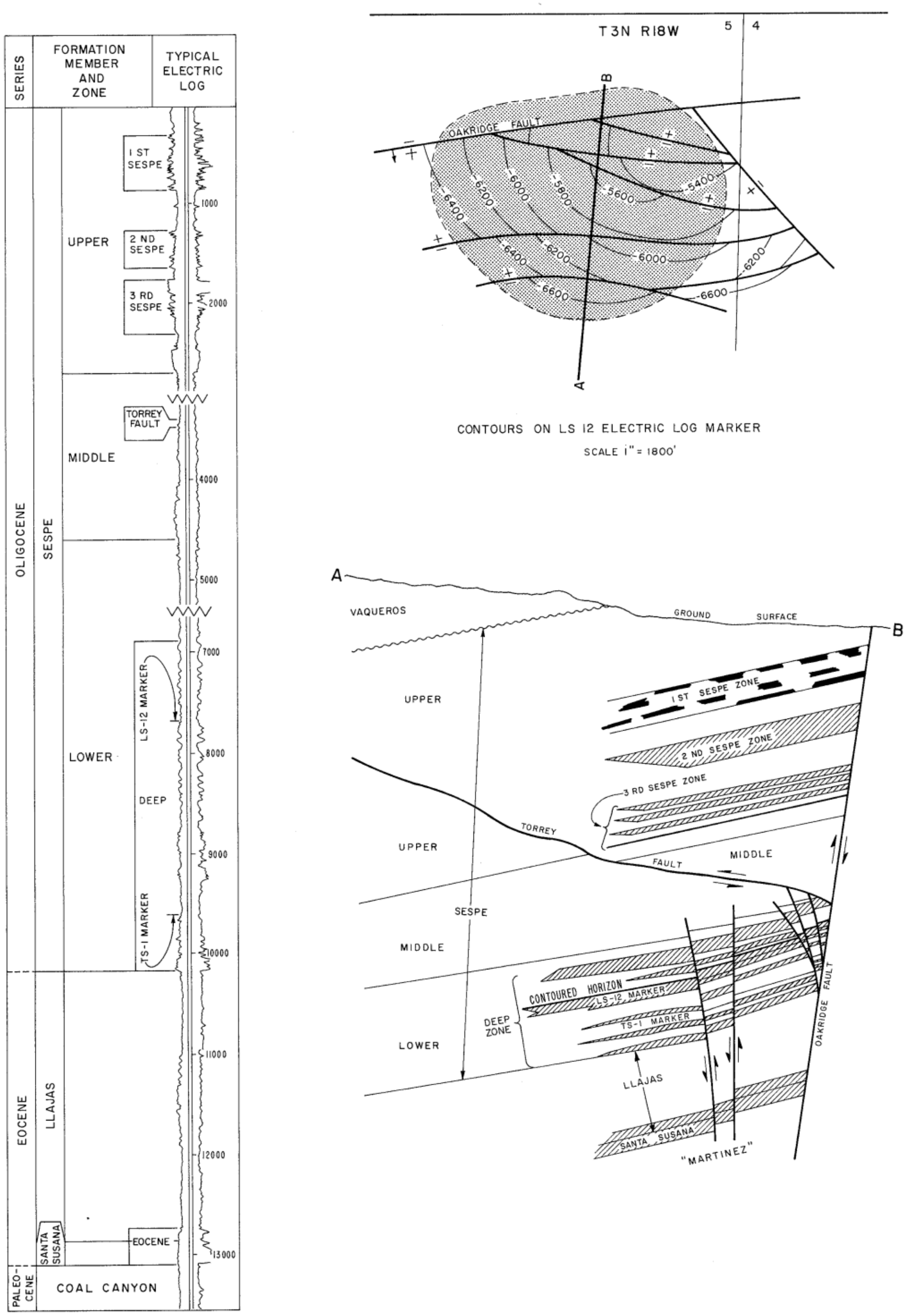


Figure 45. Structural contour map and cross section of the Eureka Canyon Oil Field. Fr CDOGGR, 1991, p. 148.

TORREY CANYON OIL FIELD



562

Figure 46. Structural contour map and cross section of the Torrey Canyon Oil Field. Fr CDOGGR, 1991, p. 502

Torrey Canyon field as it appeared in 1897 when Union Oil's entire production for the year was around 125,000 barrels, and 56,000 barrels of it came from these few wells.

From Taylor and Welty, 1950, p. 57. Used by permission McGraw-Hill.

8.1 Santa Clara River

8.6 Intersection with How Road. Turn east to stay on Torrey Road.

8.8 Turn north to continue on Torrey Road.

9.1/0.0 Reset Odometer. At the intersection of Torrey Road and State Highway 126, continue north on Torrey Road.

9.0/0.0 Highway 126. Go north. When Torrey Road crosses Highway 126, to the north, it becomes Main Street for the town of Piru.

0.5 Cross Railroad Tracks

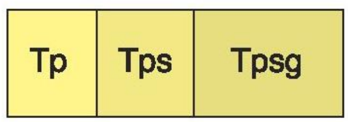
Piru

Mile

0.7 Center Street and Main Street. This intersection marks the point on the surface above the buried lower splay of the San Cayetano Fault. The rocks at the mouth of Piru Creek are massive sandstone and pebble conglomerate of the Pico Formation. Go straight on Main Street.

0.8 The San Cayetano Thrust Fault joins the roadway at this point. The road is built on top of the fault for the next 1.5 miles. North of the San Cayetano Thrust is Sisquock and Monterey Formations. To the south, on the south side of Piru Creek, is Pico Formation.

1.2 Cross contact between the sandstone member of the Pleistocene Pico Formation (Tpsg) to the south and claystone member of the Pico Formation (Tp) to the north.

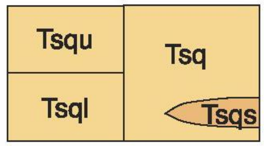


PICO FORMATION
(Of Kew 1924; Winterer and Durham 1962)
Marine clastic; Pliocene age

Tp *Gray micaceous claystone, bluish gray where fresh, weathers to brownish gray, crumbly, vaguely bedded to massive; locally includes thin sandstone beds*
Tps *Mostly light gray to tan, semi-friable, bedded sandstone*
Tpsg *Light gray to tan massive sandstone and pebble conglomerate of mostly granitic detritus*

Figure 47. Lithological description of the Pico Formation. From Dibblee, 1991.

1.25 Cross the San Cayetano Thrust Fault. Between mile 1.25 and 2.3, the roadway follows the trace of this fault. From mile 1.2 to 1.8 Sisquoc Formation (Tsq) is on our left (north)

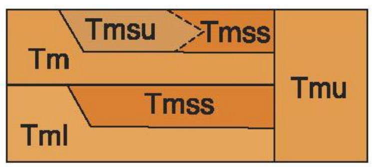


SISQUOC FORMATION
(Included in Modelo Formation by Eldridge 1907; Kew 1924; Bailey and Jahns 1954; Weber et al. 1973)
Marine clastic; late Miocene age (Mohnian-"Delmontian" Stages)

Tsqu *Upper part: dark to light gray clay shale and siltstone; crumbly with ellipsoidal to splintery fracture*
Tsql *Lower part: dark to light gray, similar to* **Tsqu**, *but includes some thin, light gray to tan platy, semi-siliceous layers*
Tsq *Undivided shale*
Tsqs *Light gray to tan, semi-friable sandstone*

Figure 48. Lithological description of the Miocene Sisquoc Formation. From Dibblee, 1991.

1.85 Vertical beds of Monterey Formation



MONTEREY SHALE
(Modelo Formation of Eldridge 1907; Kew 1924; Bailey and Jahns 1954; Weber et al. 1973; Stitt 1986)
Marine biogenic and clastic; middle to late Miocene age
(Uppermost Saucesian to Mohnian Stages)
Tmsu *Upper sandstone members: tan semi-friable, thick bedded arkosic sandstone - mapped as* **Tmss** *east of Piru Creek and in Val Verde Quadrangle*
Tm *Lower sandstone members: similar to Tmsu, tan, thick bedded, locally cavernous-weathering; prominently exposed in Hopper Canyon*
Tmss *Tan, semifriable sandstone with thin interbeds of silty shale*
Tml *Lower shale unit: white to tan weathering, soft, fissle to punky, thin bedded shale; interbedded harder siliceous shale and thin, tan dolomitic strata; uppermost Saucesian, Relizian, and Luisian Stages*
Tmu *Undivided shale south of Santa Clara River*

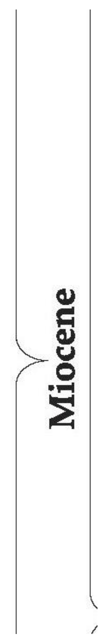


Figure 49. Lithological description of the Monterey Formation. From Dibblee, 1991.

1.9 Land Slide to the left (north)

2.1 Sisquoc Formation to the left (north), dipping 75 degrees south.

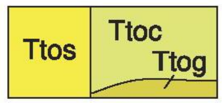
2.3 Modelo Canyon

2.6 Modelo Canyon Road and Piru Creek Road..

Mile

2.9 Fork in roadway. Main road stays to the right and crosses Piru creek.

Across the bridge, to the west, is a small patch of Towsley Formation (Ttoc) on a small hill formed from reverse topography and differential weathering of a syncline. The Towsley is a Pliocene or upper Miocene unit with three mappable members. The upper member is a sandstone, the middle member a claystone, and the lower member a conglomerate (Dibblee, 1991).



TOWSLEY (?) FORMATION
(Of Winterer and Durham 1958,1962; Stitt 1986; probably correlative with lowest part of Pico Formation to the west)
Marine clastic; latest Miocene age (Repettian and Mohnian-"Delmontian" Stages)
Ttos *Light gray to tan, semi-friable sandstone, locally pebbly, and thin interbeds of gray micaceous claystone pr siltstone; exposed south of Santa Clara River*
Ttoc *Gray, poorly bedded claystone; crumbly where weathered; few or rare thin sandstone lenses*
Ttog *Basal gray conglomerate of rounded cobbles and pebbles of mostly granitic rocks and few metavolcanic rocks in sandstone matrix*

Figure 50. Lithological description of the Towsley Formation. From Dibblee, 1991.

To the east is Section 15 of T.4N, R.18W and the site of discovery for the **Piru Creek Oilfield**. This field was discovered by the Texaco Temescal No. 33 in June, 1956 at a depth of 7.002 feet. Oil is from the Ramona anticline structure.

MAP 10

(Geology from Diblee, 1991, 1992, 193b, 1997)

3.1 The roadway crosses Piru Creek, now on the west side. River gravels are in Piru Creek, to the east is a plain of Quaternary Alluvium.

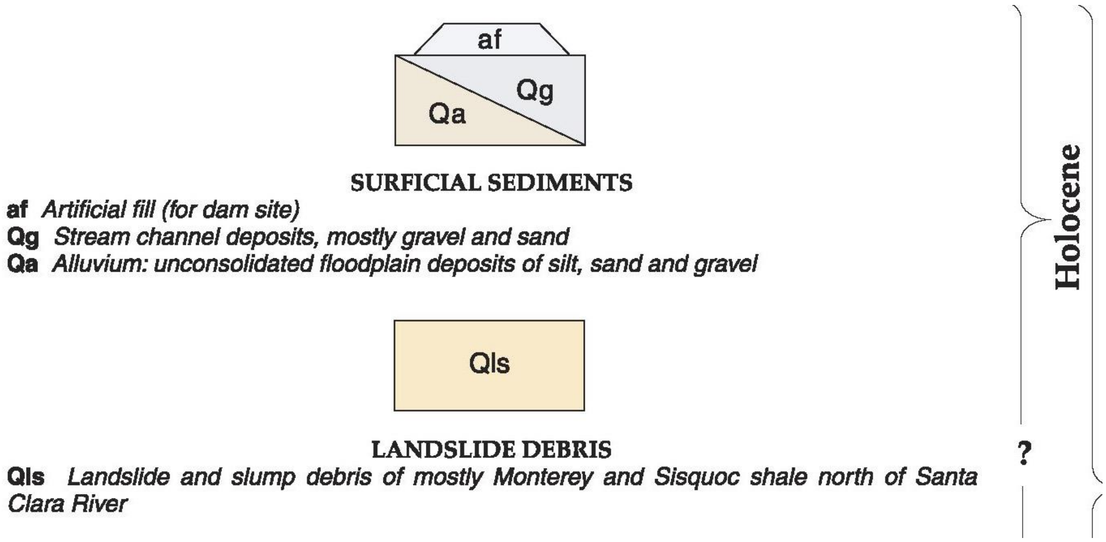


Figure 51. Lithological description of Surficial Sediments and Landslide Debris. From Dibblee, 1991.

Between mile 3.1 and 3.6 we are in the area of the abandoned Piru Creek Oilfield.

Anticline in Modelo Formation, Piru Creek. Photo by Gregg Wilkerson, Nov. 1999.

Mile

3.4 Cross the axis of the Modelo Anticline at the Piru Creek Oil Field (abandoned). Two miles to the northeast, in Sections 7 and 8 of T.4N, R.18W. is the Modelo Area of the **Piru Oil Field.** The Modelo area was discovered in 1897 by the Pacific Western Oil Company Crocker Fee #1-D (Section 7) and the Modelo Oil Company No. 1 (Section 8).

3.6 Road to Holser Canyon is to the right. Cross the axis of the Blanchard Syncline.

The **Holser Canyon Oilfield** in Section 14 of T.4N, R.18W was discovered by the Fortune Petroleum Jackson No. 1. Production came in at 5,228 feet in August 1942 at a rate of 124 barrels per day from the Modelo Formation.

4.0 Blanchard Canyon is to the left (west)

4.4 Road veers to the left (west). Tank farm on the right. Road on right follows the west bank of Piru Creek and goes to the base of Lake Piru Dam. Stay to the left.

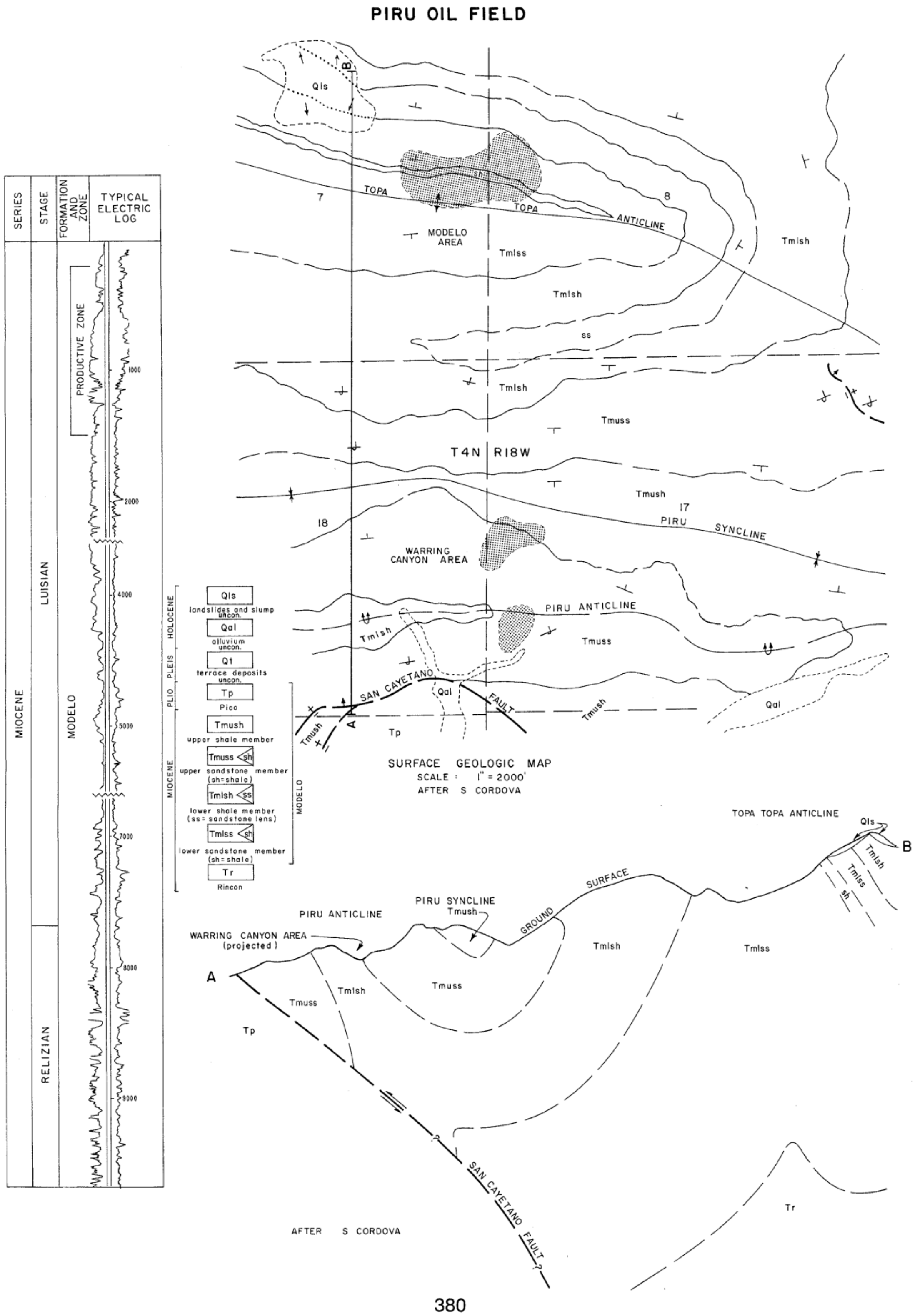


Figure 52. Map and cross section of the Piru Oil Field. From CDOGGR, 1991, p. 380.

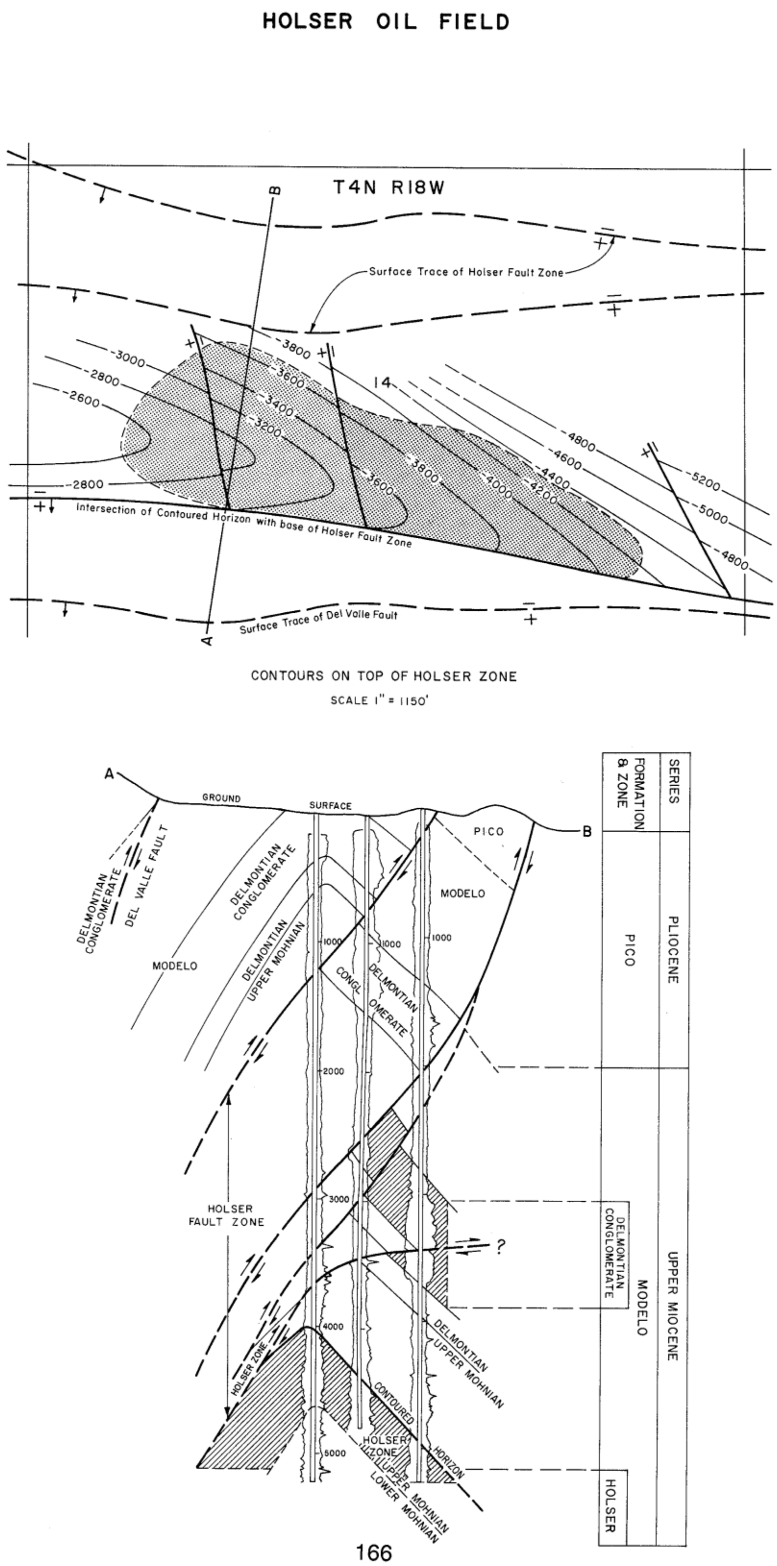


Figure 53. Structural contour map and cross section of the Holser Canyon Oil Field. From CDOGGR, 1991, p. 166.

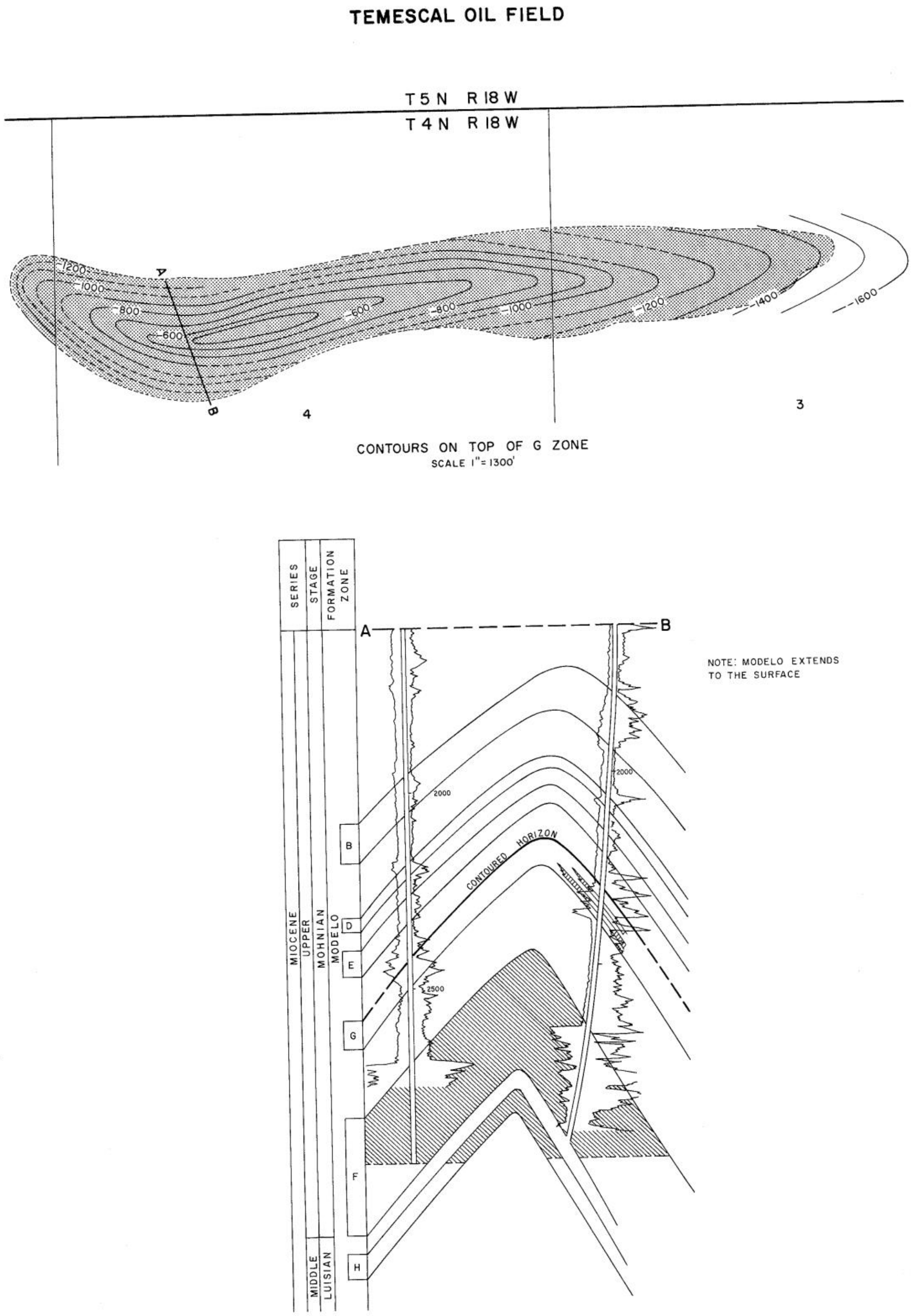


Figure 54. Structural contour map and cross section of the Temescal Oil Field. From CDOGGR, 1991, p. 552.

Mile

4.8 Access road on left (west) lead to oil wells in Lime Canyon and the **Temescal Oil Field.** This field was discovered in April 1946 by the B & L Oil Company No. 1. Initial production of 91 barrels per day was from the Miocene Modelo formation at a depth of 2,800 feet. Production is from the Temescal anticline.

5.5 Road to Santa Felicia Dam. Traversing the west side of the lake, we cross a series of folds trending east-west in Miocene Monterey Formation.

5.8 Cross axis of Temescal Anticline

6.4 Monterey Formation

6.0 Lake Piru Campground

7.9 Reasoner Canyon is on the left (west). There is a delta growing out into Piru Lake from Reasoner creek. To the north of this embayment is a mass of Townsley Formation, exposed as part of the core of the Santa Felicia Syncline. Except for this area, the drive from Piru Dam to the north end of the lake, the sediments are Miocene Monterey Formation.

8.6 Turnaround/Parking Area.

Due to presence of an endangered frog, vehicular access to Blue point is restricted. The journey to Blue Point will be made on foot.

The 2-mile walk up the roadway from Lake Piru Campground to Blue Point takes us through additional exposures of Monterey Formation. At blue point we encounter overturned beds of Monterey Basal conglomerate, Rincon Shale, Vaqueros Sandstone (Miocene), Sespe Formation (Oligocene), and then we cross a disconformity to the Matilija Sandstone (Eocene).

Stop 15: Piru Gold District

The Piru District is located beneath Pyramid Lake and in the upper and lower portions of Piru Creek. Placer mining was begun here in 1841 by Andrew Castillero, and gold from the district was shipped to the U. S. Mint in Philadelphia in 1842. Small scale placer mining continued intermittently through the 1890's, with more activity in the 1920's and 1930's.

The placer deposits are in and adjacent to the upper part of Piru Creek, chiefly in the vicinity of Lockwood Creek and to the east in the Gold Hill region. Gold has been recovered both from Recent stream gravels and old terrace deposits on the hills north of the Creek. The placer gold is often coarse-grained.

The lode gold is found in a number of north-striking gold-quartz veins that range from a few inches to about four feet in thickness. The veins occur in shear zones and usually in granitic gneiss or hornblende schist. The ore contains free gold and varying amounts of pyrite. Milling ore sometimes averaged 2 ounce of gold per ton. Among lode-gold mines, the principal operation was the Castaic mine, which had an estimated total output valued at about $160,000 (1970 figures).

Return to intersection of Highway 126 and Torrey Road.

MAP 11

(Geology by Dibblee, 1982, 1987)

The hike up to Blue Point is in Monterey Formation.

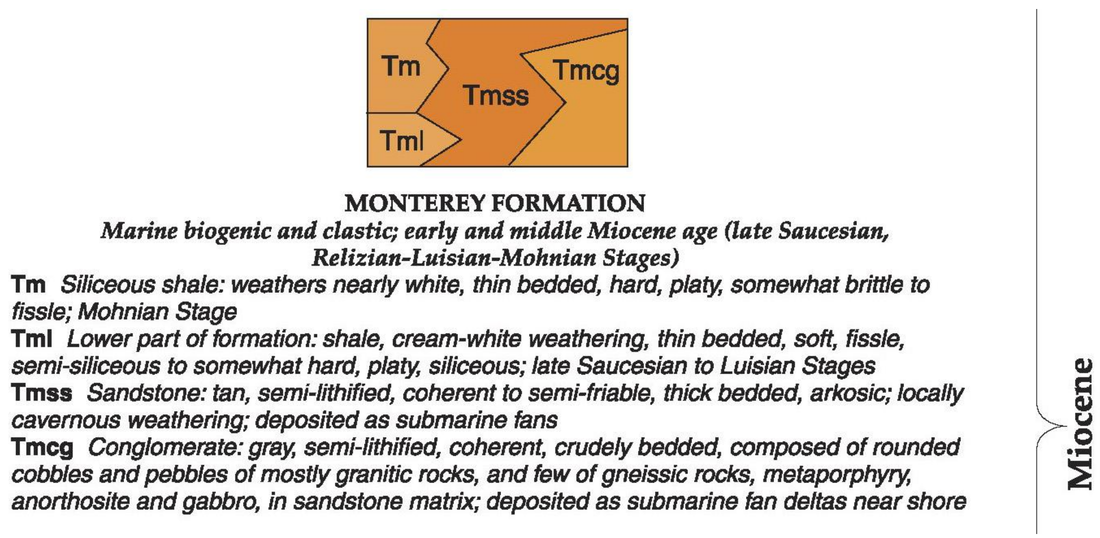


Figure 55. Lithological description of the Monterey Formation. From Dibblee, 1982.

MAP 12

(Geology from Dibblee, 1991, 1993b)

Mile

17.8/0.0   State Highway 126. Reset odometer and go east toward Castaic Junction.

Highway 126 parallels the surface trace of the north dipping **San Cayetano** thrust fault. The San Cayetano consists of two (2) main strands near the intersection of Torry Road and Highway 126. The Piru strand (lower Strand) surface trace is just north of Highway 126 and continues westerly for approximately two miles where it converges with the main strand of the San Cayetano thrust fault, which traces one-half mile north of the Piru strand surface trace.

North of the San Cayetano Thrust Fault is the 150 acre **Piru Oil Field** (see p. 117) which was discovered in 1897. The field is located four miles north of the town of Piru. The field produces within three zones of the Miocene Modelo Formation. Cumulative production has been 492,541 barrels of oil.

Oil fields located south of the Santa Clara River Valley between Torrey Canyon and the Ventura County line are the Eureka Canyon (1893), Oakridge (1952), North Tapo (1882), Tapo Ridge (1974), Santa Susana (1963), South Tapo Canyon (1950).

Mile

0.2 Piru Creek Bridge. The Sisquoc overlain by the Miocene Monterey Formation is to the north. The Pliocene Pico Formation is to the south. The Pico lies on the south side of the Oak Ridge Fault which marks the southern edge of the Santa Clara River Valley.

0.8 Highway crosses buried fault.

Stop 16: Rancho Camulos

2.3 Rancho Camulos Historical Marker. The Pico Formation is to the north. The Pico then the Towsley Formations are to the south.

Oil fields located north of the Santa Clara River Valley between Piru and the Ventura County line are the Temescal (1898), Piru Creek (1956), and Holser (1942).

2.5 Pass over to the Val Verde Quadrangle (Dibblee, 1993b).

4.9 Tapo Canyon is to the south. The **Ramona Oil Field** is 1.2 miles to the north. It covers 540 acres and was discovered in October, 1943. The field is located north of State Highway 126 in both Los Angeles and Ventura Counties. The production from the Miocene Modelo Formation within five zones. The oil is a trapped in a faulted anticline. The trapping thrust fault is Holser Fault and dips to the south

6.0 Incised river terrace to the south. This type of erosional landform indicates that the water table has been lowered in this area over the few centuries.

On the north side of the valley is the **San Cayetano Fault** which is traced from a point east of Piru to the eastern Ojai Valley. It is a thrust fault with dips from 15 to 50E north.

Dip-slip displacement as much as 20,000 feet (6100 meters) has occured. During this displacement the Topatopa mountain block has rode up the fault plane in a southerly direction. The **Oak Ridge fault**, dipping to the south, is on the south side of the Sanra Clara River Valley

The **North Ramona Oil Field** is 0.2 miles north of the Ramona Oil Field . It first produced in January, 1946 and was abandoned in March, 1947. It is a relatively small, 40 acre field. It is just within Los Angeles County. The field was reactivated in May, 1984. Oil is produced from a stratigraphic trap from two members of the Miocene Modelo Formations.

MAP 13

(Geology from Dibblee, 1993b)

Mile

7.3 Potrero Canyon is to the southeast. The road to the right (south) leads 2.8 miles south-southeastward to the **Newhall-Potrero Oil Field**. The 1080 acre Newhall-Potrero Oil Field was discovered in August, 1936. The field is located south of the Del Valle Oil Field and west of the Castaic Junction Oil Field. Oil is produced from seven zones within the Miocene Modelo Formation within an anticlinal structure.

7.8 San Martinez Grande Canyon Road. The Pico Formation is north and south of the highway.

The Santa Clara River Valley approximately coincides with the axis of the Santa Clara syncline which extends westward for several miles. Pliocene and upper Miocene rocks of at least 10,000 feet thick dip steeply northward town the center of the syncline. On the north side of Highway 126 the opposite flank of the Santa Clara syncline is exposed.

8.6 San Martinez Chiquito Canyon Road. This canyon leads up to the **Del Valle Oil Field** which was discovered in September, 1940. It is 720 acres in size. The field is located north of State Highway 126. Oil is produced from twelve zones within two pools of a southeastward plunging anticline closed by a fault within early Pliocene Pico and Miocene Modelo Formations.

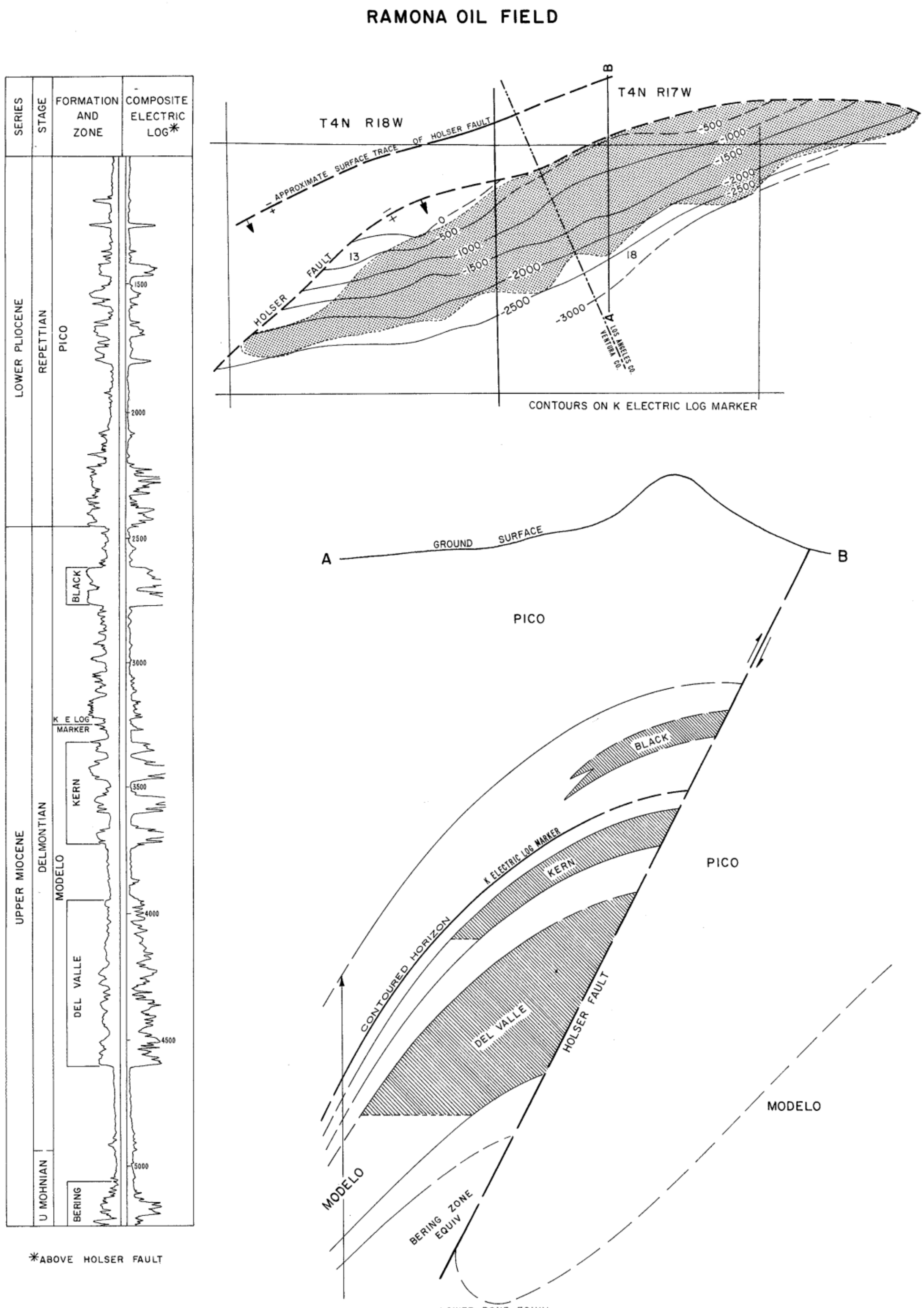


Figure 56. Structural contour map and cross section of the Ramona Oil Field. From CDOGGR, 1991, p.410

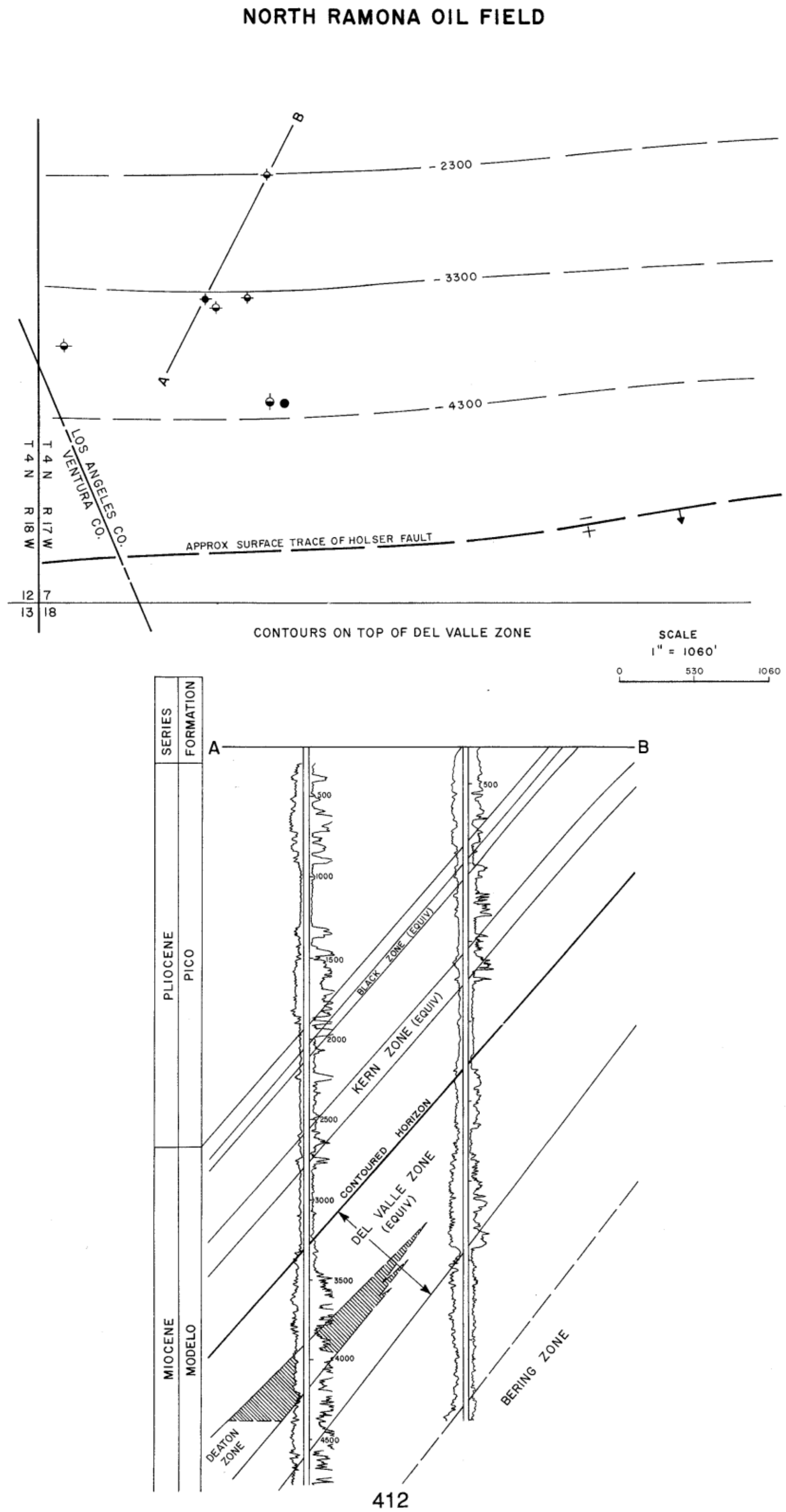


Figure 57. Structural contour map and cross section of the North Ramona Oil Field. From CDOGGR, 1991, p.412

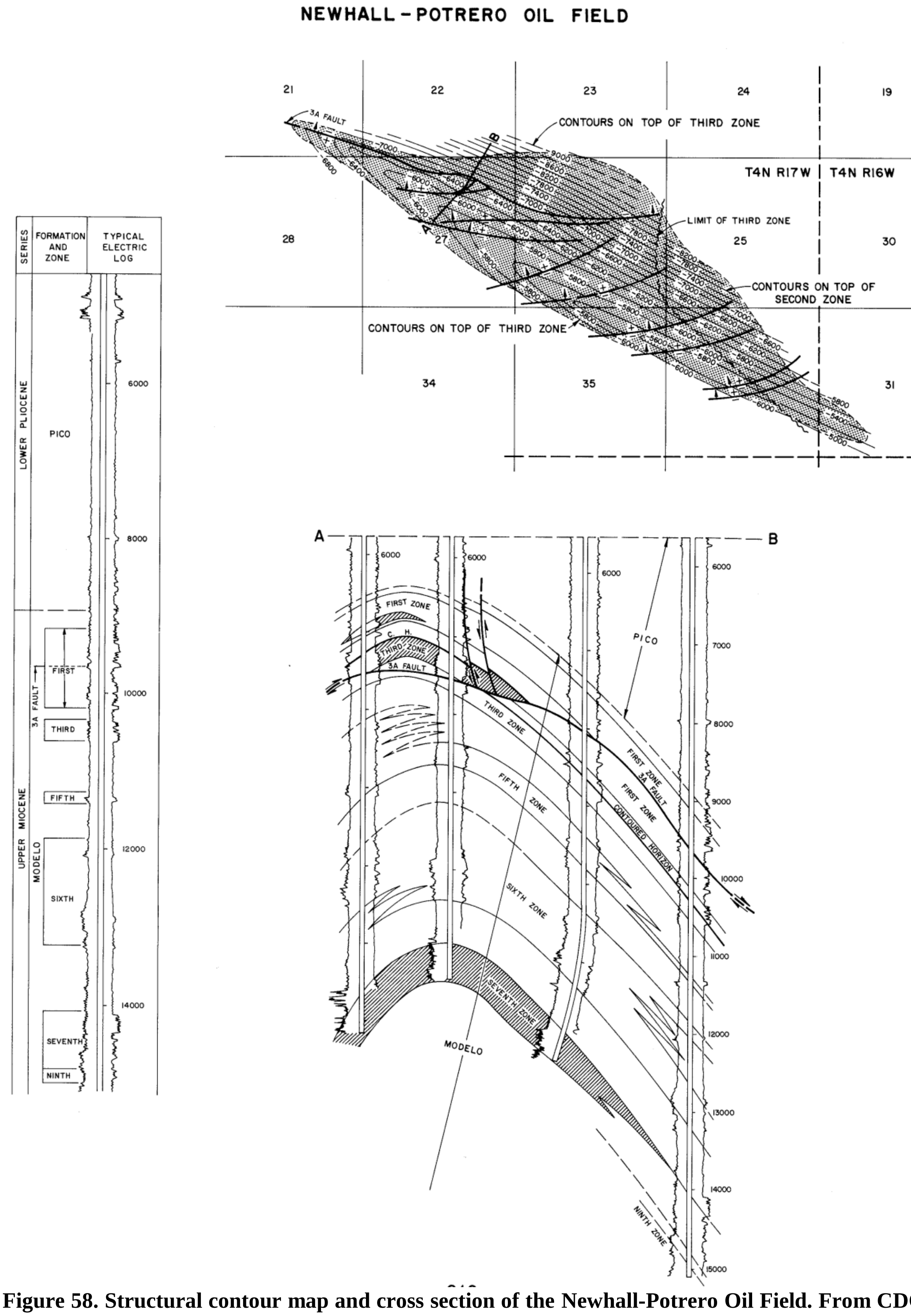


Figure 58. Structural contour map and cross section of the Newhall-Potrero Oil Field. From CDOGGR, 1991, p.310

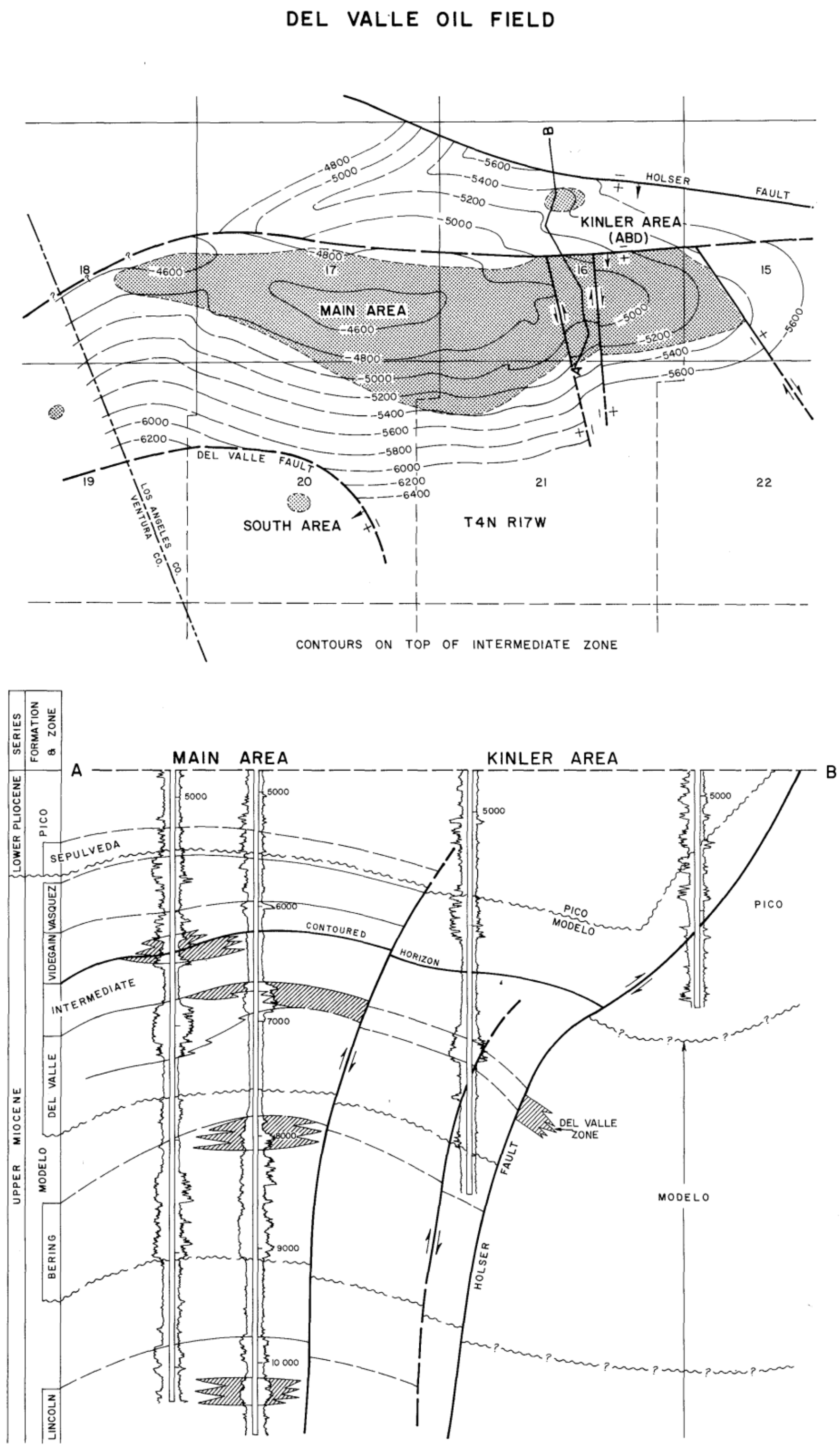


Figure 59. Structural contour map and cross section of the Del Val Oil Field. From CDOGGR, 1991, p.126

Mile

9.3 Ladlaw Waste Disposal Site. The Saugus Formation (QTs) is to the north.

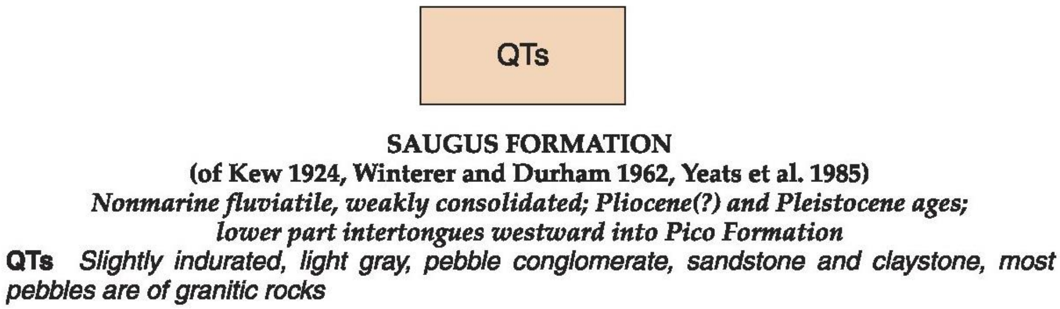


Figure 60. Lithological description of the Saugus Formation. From Dibblee, 1993b.

9.5 Del Valle anticline axis. Enter **Castaic Junction Oil Field** (abandoned).

10.0 Wolcott Way to the north.

10.6 Cross Castaic Creek.

10.9 Travel Village Campground.

11.8 Hasley Canyon Oil Field. The 190-acre Hasley Canyon Oil Field was located in December, 1944. The field is located four miles northwest of Castaic Junction. Oil is produced from a fault trap from one pool in the Miocene Modelo Formation.

Stop 17: Castaic Junction

12.3/0/0 Castaic Junction.

END OF FIELD GUIDE

BIBLIOGRAPHY AND REFERENCES

Bloom, A. L., 1978, Geomorphology, Englewood, New Jersey: Prentice-Hall, Inc.

Brown, G.C., T.E. Hopps and B.A. Sentianin, 1996, Depositional Environments, Structure and Tectonics of the Western Transverse Ranges, Ventura County, California, Coast Geological Society, Field Trip Guideboook, June 8, 1996.

California Division of Oil and Gas, 1992, California Oil and Gas Fields, Southern, Central Coastal, and Offshore California, Volume 2.

Carman, M. F., Jr., 1964, Geology of the Lockwood Valley Area, Kern and Ventura Counties, California, California Division of Mines and Geology Special Report 81.

Clahan, K.B., 2003, Geologic map of the Oxnard 7.5-minute quadrangle, Ventura County, California: A digital database.: California Geological Survey, Preliminary Geologic Maps, scale 1:24,000.

Clark, P.S., Scratch, W.S., Bias, G.W., Stander, G.B., Sexton, J.L., and Krawczak, B.J., 2008, Preliminary image map of the 2007 Ranch Fire perimeter, Whitaker Peak quadrangle, Los Angeles and Ventura Counties, California: U.S. Geological Survey, Open-File Report OF-2008-1083, scale 1:24,000.

Clark, W. B., 1970, Gold Districts of California, California Division of Mines and Geology, Bulletin 193.

Crawford, J. J., 1896, Thirteenth Report of the State Mineralogist, California State Mining Bureau, p. 586-593.

Crippen, R. G., Editor, et al, 1992, Annual Review of California oil and Gas Production 1990: Conservation Committee of California Oil and Gas Producers.

Crowell, J. C. Editor, et al, 1982, Geologic History of Ridge Basin Southern California, Los Angeles: The Pacific Section, Society of Economic Paleontologists and Mineralogists.

Cronise, Titus Fey, 1868, The natural wealth of California, H.H. Bancroft and Co.: San Francisco.

Coues, Elliott, 1900, On the trail of a Spanish pioneer. The diary and itinerary of Francisco Garces in his travels through Sonora, Arizona, and California, 1775-1776, 2 volumes. Francis P. Harper: New York.

Davis, T. L., Editor, et al, 1987, Structure Evolution of the Western Transverse Ranges, Los Angeles: The Pacific Section, Society of Economic Paleontologists and Mineralogists.

Dibblee, T. W., Jr., 1966, Geology of the Central Santa Ynez Mountains, Santa Barbara County, California, California Division of Mines and Geology, Bulletin 186.

Dibblee, T.W., 1979, Geologic maps of the San Guillermo, Lion Canyon, Topatopa Mountains, and Lockwood Valley quadrangles, California: U.S. Geological Survey, Open-File Report OF-79-1464, scale 1:24,000.

Dibblee, T.W. Jr., 1982, Geologic Map of the Cobblestone Mountain Quadrangle, California, U.S. Geological Survey Open File Report.

Dibblee, T.W., 1985, Geologic map of the Wheeler Springs quadrangle, Ventura County, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-01, scale 1:24,000.

Dibblee, T.W. Jr., 1987a, Geologic Map of the Matilija Quadrangle, Ventura County, California, Dibblee Foundation.

Dibblee, T.W. Jr., 1987b, Geologic Map of the Ojai Quadrangle, Ventura County, California, Dibblee Foundation.

Dibblee, T.W., and Ehrenspeck, H.E., ed., 1987c, Geologic map of the Lion Canyon quadrangle, Ventura County, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-14, scale 1:24,000

Dibblee, T.W. Jr., 1988, Geologic Map of the Ventura and Pitas Point Quadrangles, Ventura County, California, Dibblee Foundation.

Dibblee, T.W. Jr., 1990a, Geologic Map of the Santa Paula Peak Quadrangle, Ventura County, California, Dibblee Foundation.

Dibblee, T.W. Jr., 1990b, Geologic Map of the Fillmore Quadrangle, Ventura County, California, Dibblee Foundation.

Dibblee, T.W., and Ehrenspeck, H.E., 1990c, Geologic map of the Camarillo and Newbury Park quadrangles, Ventura County, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-28, scale 1:24,000.

Dibblee, T.W. Jr., 1991, Geologic Map of the Piru Quadrangle, Ventura County, California, Dibblee Foundation.

Dibblee, T.W. Jr., 1992a, Geologic Map of the Santa Paula Quadrangle, Ventura

County, California, Dibblee Foundation.

Dibblee, T.W. Jr., 1992b, Geologic Map of the Moorepark Quadrangle, Ventura County, California, Dibblee Foundation.

Dibblee, T.W., and Ehrenspeck, H.E., ed., 1992c, Geologic map of the Calabasas quadrangle, Los Angeles and Ventura Counties, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-37, scale 1:24,000.

Dibblee, T.W., and Ehrenspeck, H.E., ed., 1992d, Geologic map of the Santa Susana quadrangle, Ventura and Los Angeles Counties, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-38, scale 1:24,000.

Dibblee, T.W., and Ehrenspeck, H.E., ed., 1992e, Geologic map of the Saticoy quadrangle, Ventura County, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-42, scale 1:24,000.

Dibblee, T.W., and Ehrenspeck, H.E., ed., 1992f, Geologic map of the Simi quadrangle, Ventura County, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-39, scale 1:24,000. Note: Now named Simi Valley West Quadrangle.

Dibblee, T.W., and Ehrenspeck, H.E., ed., 1992g, Geologic map of the Oat Mountain quadrangle, Los Angeles, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-36, scale 1:24,000.

Dibblee, T.W., and Ehrenspeck, H.E., 1993a, Geologic map of the Thousand Oaks quadrangle, Ventura and Los Angeles Counties, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-49, scale 1:24,000.

Dibblee, T.W., and Ehrenspeck, H.E., 1993b, Geologic map of the Val Verde quadrangle, Los Angeles and Ventura Counties, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-50, scale 1:24,000.

Dibblee, T.W., and Ehrenspeck, H.E., 1996a, Geologic map of Devils Heart Peak quadrangle, Ventura County, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-61, scale 1:24,000.

Dibblee, T.W., and Ehrenspeck, H.E., 1996b, Geologic map of the Topatopa Mountains quadrangle, Ventura County, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-60, scale 1:24,000.

Dibblee, T.W., and Ehrenspeck, H.E., 1996c, Geologic map of the Newhall, Los angeles County, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-56, scale 1:24,000.

Dibblee, T.W., and Ehrenspeck, H.E., 1997a, Geologic map of the Whitaker Peak quadrangle, Los Angeles and Ventura Counties, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-63, scale 1:24,000

Dibblee, T.W., and Ehrenspeck, H.E., 1997b, Geologic map of the Warm Springs Mountain quadrangle, Los Angeles County, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-64, scale 1:24,000

Forbes, Alexander, 1839, California: a history of Upper and Lower California from their first discovery to the present time, comprising an account of the climate, soil, natural productions, agriculture, commerce, etc. Smith, Elder and Co.: London.

Fulton, W., 1998, California: Land and Legacy, Westcliffe Publishers, P.O. Box 1261, Englewood, Colorado, 80105, p. 58.

Garrison, R. E., Editor, et al, 1981, The Monterey Formation and Related Siliceous Rocks of California, Los Angeles: The Pacific Section, Society of Economic Paleontologists and Mineralogists.

Hale, W. N., et al, 1983, Mineral Investigation of the Sespe Frazier Rare II Area (No. 5002), Ventura and Los Angeles Counties, California, U. S. D. I. Bureau of Mines Open File Report MLA 78-83.

Hornafius, J.S., 1985, Neogene tectonic rotation of the Santa Ynez Range, western Transverse Ranges, California, suggested by paleomagnetic investigation of the Monterey Formation, Journal of Geophysical Research, v. 90, p. 12,503-12,522.

Issacs, C. M., Editor, et al, 1983, Petroleum Generation and Occurrence in the Miocene Monterey Formation, California, Los Angeles: The Pacific Section, Society of Economic Paleontologists and Mineralogists.

Jenkins, O. P., Editor, et al, 1943, Geologic Formations and Economic Development of the Oil and Gas Fields of California, California Division of Mines, Bulletin No. 118.

Jennings, C. W., et al, 1954, Geology of Southern California, Geologic Guide No. 2, Ventura Basin, California Division of Mines, Bulletin 170.

Jennings, Charles W. and Rudolph G. Strand, 1969, Geologic Map of California, Olaf P. Jenkins Edition, Los Angeles Sheet, California Division of Mines and Geology.

Longwill, W. D., 1982, Mineral Resources of the Sawmill-Badlands Rare II Area (No. 5134), Ventura and Kern Counties, California, U. S. D. I. Bureau of Mines Open File Report MLA 51-82.

Morton, D.M., 1976a, Reconnaissance surficial geologic maps of the Newhall, Oat Mountain, Santa Susana, and Val Verde 7.5' quadrangles, Los Angeles and Ventura Counties, southern California: U.S. Geological Survey, Open-File Report OF-76-211, scale 1:24,000.

Morton, D.M., 1976b, Reconnaissance surficial geologic maps of the Santa Paula, Santa Paula Peak, Saticoy, and Ojai 7.5' quadrangles, Ventura County, southern California: U.S. Geological Survey, Open-File Report OF-76-212, scale 1:24,000.

Morton, D.M., 1976c, Reconnaissance surficial geologic maps of the Fillmore, Moorpark, Piru, and Simi 7.5' quadrangles, Ventura County, southern California: U.S. Geological Survey, Open-File Report OF-76-210, scale 1:24,000.

Moser, F.G., and Frizzell, V.A., 1982, Geologic map of the Lion Canyon, Matilija, Ojai, Wheeler Springs, and White Ledge Peak quadrangles, California: U.S. Geological Survey, Open-File Report OF-82-818-A, scale 1:50,000.

Norris, R. M., et al, 1990, Geology of California, New York: John Wiley & Sons, Inc., 2nd Edition.

Nulty, G., Editor, 1982, Geologic Guide of the Central Santa Clara Valley Sespe & Oak Ridge Trend Oil Fields, Ventura County, California, Guidebook Number 53.

Nunis, D.B., 1995, The St. Francis Dam Disaster Revisited, Historical Society of Southern California, Los Angeles and Ventura County Museum of History and Art, Ventura.

Oakeshott, G. B., Editor, et al, 1955, Earthquakes in Kern County California During 1952, California Division of Mines Bulletin 171.

Real, C.R., DeLisle, M.J., McCrink, T.P., Greenwood, R.B., Irvine, P.J., Loyd, R., McMillan, J., Pridmore, C., Silva, M., Treiman, J.A., Reichle, M., and Smith, T.C., 1996, Reconnaissance seismic hazards map of the Simi 7.5' quadrangle, Ventura County, California: California Division of Mines and Geology, Open-File Report 96-01, scale 1:24,000.

Sylvester A. G. and G.C. Brown, 1988, Santa Barbara and Ventura Basins: Tectonics, Structure, Sedimentation, Oilfields along an East-West Transect, Coast Geological Society Guidebook 64, April 1988.

Taylor, F.J. and E.M. Welty, 1950, Black Bonanza, Whittlesey House, McGraw-Hill, New York.

Tan, S.S., Clahan, K.B., and Rosinski, A.M., 2004, Geologic map of the Saticoy 7.5-minute quadrangle, Ventura County, California: A digital database.: California Geological Survey, Preliminary Geologic Maps, scale 1:24,000

Tocher, D., et al, 1963, Guidebook for Seismological Study Tour China Lake, California: U. S. Naval Ordnance Test Station.

Vredenburgh, L. M., Unpublished 1993 Report, A Brief Sketch of the Mining History of the Western Mojave Desert and Southeastern Sierra Nevada.

Webb, T.H., and H. Kanamori, 1985, Earthquake focal mechanisms in the eastern Transverse Ranges and San Emigdio Mountains, Southern California and evidence for a regional decollement: Seismological Society of America, Bulletin, v. 75, p. 737-757.

Weber, F. H., et al, 1973, Geology and Mineral Resources Study of Southern Ventura County, California, California Division of Mines and Geology Preliminary Report 14.

Woyski, M. S., Editor, et al, 1977, Geological Guidebook to the Ridge Basin, South Coast Geological Society.

Yeats, R.S., 1983, Large scale Quaternary detachements in the Ventura Basin, southern California, Journal of Geophysical Research, v.88, p. 569-583,

Yeats, R.S., McDougal, J.W., and Stitt, L.T., 1986, Cenozoic structure of the Val Verde 71/2-minute quadrangle and south half of the Whitaker Peak 71/2-minute quadrangle, California: U.S. Geological Survey, Open-File Report OF-85-587, scale 1:24,000.

Yeats, R.S., 1987, Late-Cenozoic structure of the Santa Susana fault zone: U.S. Geological Survey, Professional Paper 1339, scale 1:48,000.

Yeats, R.S., G.J. Huftile and F.B. Grigsby, 1988, Oak Ridge Fault, Ventura fold belt, Sisar decollement, Ventura Basin, California, Geology, v.16, p. 1112-1116.

Yerkes, R.F., and Showalter, P.K., 1991, Preliminary geologic map of the Thousand Oaks 7.5' quadrangle, southern California: U.S. Geological Survey, Open-File Report OF-91-288, scale 1:24,00

Yerkes, R.F., and Campbell, R.W., 1995a, Preliminary geologic map of the Simi quadrangle, southern California: U.S. Geological Survey, Open-File Report OF-95-828, scale 1:24,000.

Yerkes, R.F., and Campbell, R.W., 1995b, Preliminary geologic map of the Santa Susana quadrangle, southern California: U.S. Geological Survey, Open-File Report OF-95-829, scale 1:24,000.

Yerkes, R.F., and Campbell, R.H., 1995c, Preliminary geologic map of the Val Verde 7.5' quadrangle, southern California: U.S. Geological Survey, Open-File Report OF-95-504, scale 1:24,000.

Yerkes, R.F., and Campbell, R.H., 1997a, Preliminary geologic map of the Santa Susana [Simi Valley East] 7.5' quadrangle, southern California: a digital database: U.S. Geological Survey, Open-File Report OF-97-258, scale 1:24,000.

Yerkes, R.F., and Campbell, R.H., 1997b, Preliminary geologic map of the Thousand Oaks 7.5' quadrangle, southern California: a digital database: U.S. Geological Survey, Open-File Report OF-95-88, scale 1:24,000.

Yerkes, R.F., and Campbell, R.H., 1997c, Preliminary geologic map of the Simi [Simi Valley West] 7.5' quadrangle, southern California: a digital database: U.S. Geological Survey, Open-File Report OF-97-259, scale 1:24,000

Yerkes, R.F., and Campbell, R.H., 1997c, Preliminary geologic map of the Val Verde 7.5' quadrangle, southern California: a digital database: U.S. Geological Survey, Open-File Report OF-95-699, scale 1:24,000

LITHOLOGY

SAN EMIGDIO MOUNTAINS, TEMBLOR RANGE, AND SAN JOAQUIN VALLEY

Quaternary
Pleistocene and Holocene

Alluvium-unconsolidated clay, silt, sand, and gravel; includes alluvial fan, flood plain, and streambed deposits.

Landslide deposits-earthflows consisting of chaotic mixture of different lithologic types; some detachment blocks which have preserved original subsurface structure and lithologic identity.

Tulare Formation-nonmarine, poorly consolidated, about 300 to 800 feet (91 to 244 meters) thick, conglomerate, sandstone, siltstone, and claystone coarsens westward.

Tertiary
Pliocene and Pleistocene(?)

Paso Robles Formation-nonmarine, poorly to moderately consolidated, about 2000 feet

(607 meters) thick, conglomerate, sandstone, siltstone, marly clay, and granitic gravel including boulders and cobbles.

Pliocene

San Joaquin Formation-brackish near shore marine deposition, about 350 to 750 feet (107 to 229 meters) thick, mostly silty sandstone, siltstone, and claystone coarsens westward toward the Diablo Range.

Etchegoin Formation-shallow marine, lagoonal, and fluvial, locally fossiliferous, about 4500 feet (1372 meters) thick, brown, mainly thick-bedded sandstone and interbedded siltstone, includes thin beds of pebbly sandstone, carbonaceous siltstone, and porcelanite coarsens westward and southward.

Pancho Rico Formation-marine, about 450 feet (137 meters) thick, sandstone, mudstone, and conglomerate, includes white sandstone at base.

Miocene

Santa Margarita Formation-marine and brackish deposition, about 0 to 250 feet (0 to 76 meters) thick, fossiliferous, white to gray calcareous arkosic sandstone, dark colored clay-shale, pebbly conglomerate, siltstone, and calcareous reefs.

Reef Ridge Shale-marine shelf, about 0 to 600 feet (0 to 183 meters) thick, soft clayey to silty mudstone, locally bentonitic; with subordinate beds of fine-grained silty sandstone.

Monterey Formation-

McLure Shale Member-marine, 60 to 1200 feet (18 to 366 meters) thick, porcelaneous mudstone and siliceous shale with a local conglomerate base.

Devilwater Shale Member-marine, about 0 to 250 feet (0 to 76 meters) thick, shale, calcareous shale, and siltstone.

Gould Shale Member-marine, about 0 to 60 feet (0 to 18 meters) thick, siliceous shale and calcareous shale.

Temblor Sandstone-shallow, near shore, deltaic, tidal, slope, basinal, and marine submarine fan grading into nonmarine to the north, about 0 to 1000 feet (0 to 305 meters) thick, gray, buff, and brownish, fossiliferous, calcareous sandstone, sandy siltstone, silty shale, conglomerate, and shale--mostly sandstone, with thin siltstone beds in the north and west, decreasing sand/shale ratio southeastward, and mostly shale in the west.

Tecuya Formation-terrestrial strata in Temblor and Pleito Formations (Ttc) red sandstone and clay and (Ttg) conglomerate.

Oligocene

Pleito (Tpl) (Tps) marine, thin bedded to massive buff colored sandstone, with cannon ball concretions, siltstone, and interbedded gray clay shale.

San Emigdio marine sandstone, siltstone, and clay shale (Tse) with mostly siltstone and clay shale, (Tss) with mostly sandstone, and (Tqd) with quartz diorite breccia.

Eocene

Tejon Formation-Reed Canyon Member-(Ttr) siltstone member.

SANTA CLARA VALLEY

Quaternary-Tertiary/Plio-Pliocene

Saugus-The upper part is non-marine, red brown conglomerate, sandstone and red green siltstone. The lower part is brackish to marine siltstone and conglomerate.

Tertiary/Pliocene

Pico-marine, gray siltstone with lenticular gray brown conglomerate and sandstone.

Tertiary/Miocene

Towsley-marine, a basal red-brown conglomerate, strata in which sandstone or conglomerate dominates, and strata in which siltstone or mudstone dominates.

Sisquoc Shale-marine, light gray silty shale or claystone, locally slightly siliceous and diatomaceous.

Monterey Formation-Modelo Formation, marine. The upper unit is white-weathering, thin bedded, hard, platy to brittle siliceous shale. The lower unit is white-weathering, soft fissile to punky clay shale with interbeds of hard siliceous shale and thin limestone strata.

Rincon Shale-marine, poorly bedded gray clay shale and siltstone, containing occasional gray dolomitic concretions.

Vaqueros Sandstone-shallow marine, massive to poorly bedded, light gray to tan, fine-grained sandstone, locally calcareous.

Oligocene

Sespe-maroon, red and locally green silty shale or claystone and interbedded red to pinkish-grey sandstone. Some sandstone beds in lower part are coarse-grained and include pebble-cobble conglomerate. The lowest part consists of pink sandstone and red claystone.

Eocene

Coldwater Sandstone-marine. The upper part is hard, tan, bedded arkosic sandstone with minor interbeds of greenish-gray siltstone and shale, local oyster shell beds common. The lower part is greenish-gray siltstone and shale with occasional interbeds of tan sandstone.

Cozy Dell Shale-marine. The upper part is dark gray, argillaceous to silty micaceous shale with minor light gray to tan arkosic sandstone. The lower part is light gray to tan arkosic sandstone with minor interbeds of gray micaceous shale.

Matilija Sandstone-marine. The upper part is hard, thick bedded, tan to mottled light greenish-gray arkosic sandstone with thin partings to thick interbeds of gray micaceous shale. The lower part is interbedded tan sandstone and micaceous siltstone or shale.

Juncal-marine. The upper part is dark gray micaceous shale with minor thin interbeds of hard gray-white to tan arkosic sandstone. The lower part is hard gray-white to tan arkosic sandstone with minor interbeds of dark gray micaceous shale.

Cretaceous

Unnamed marine strata.

Dark gray, micaceous clay shale with minor interbeds of tan arkosic sandstone.

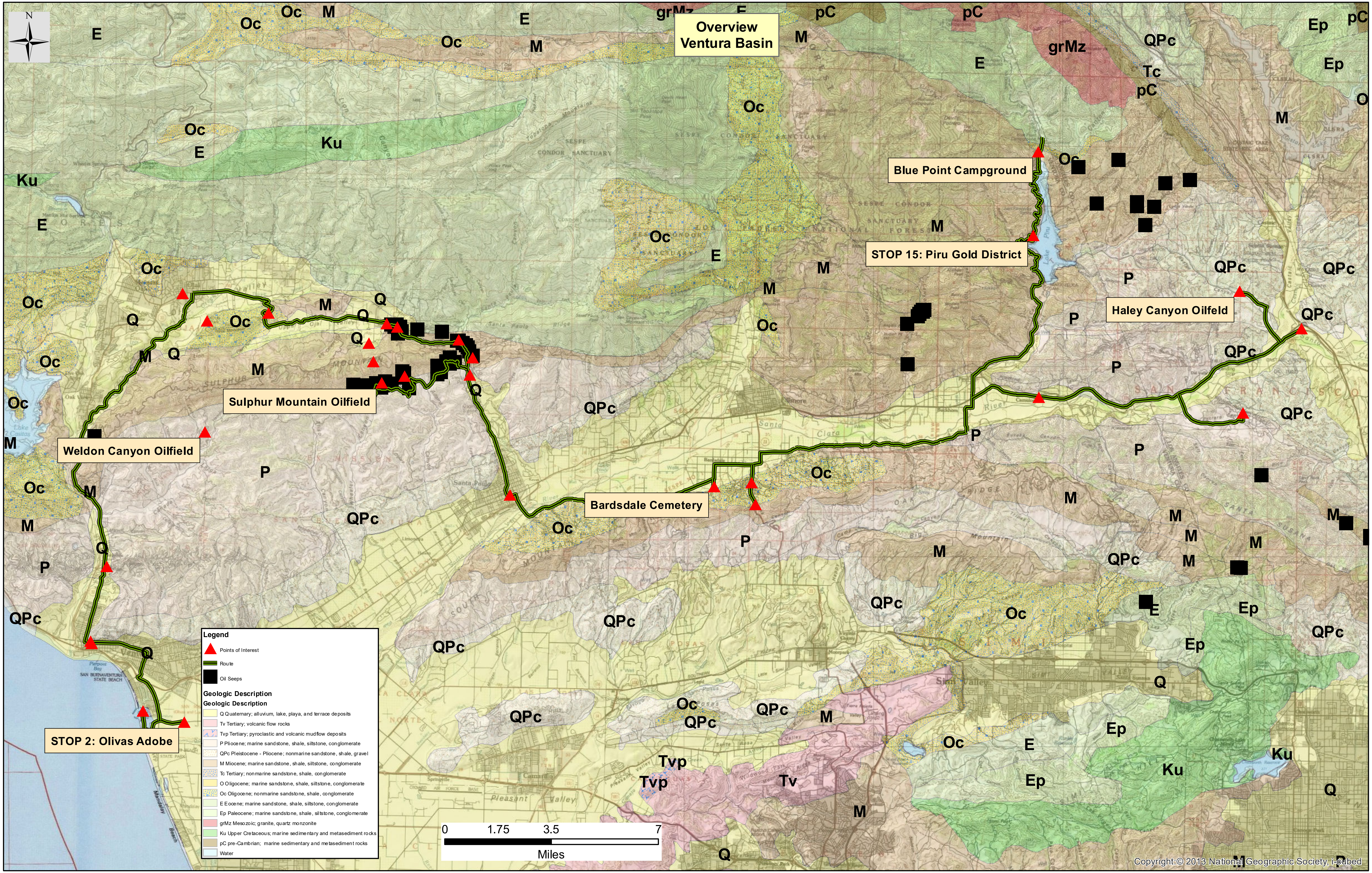
Hard, light gray to tan, arkosic sandstone with minor interbeds of micaceous shale.

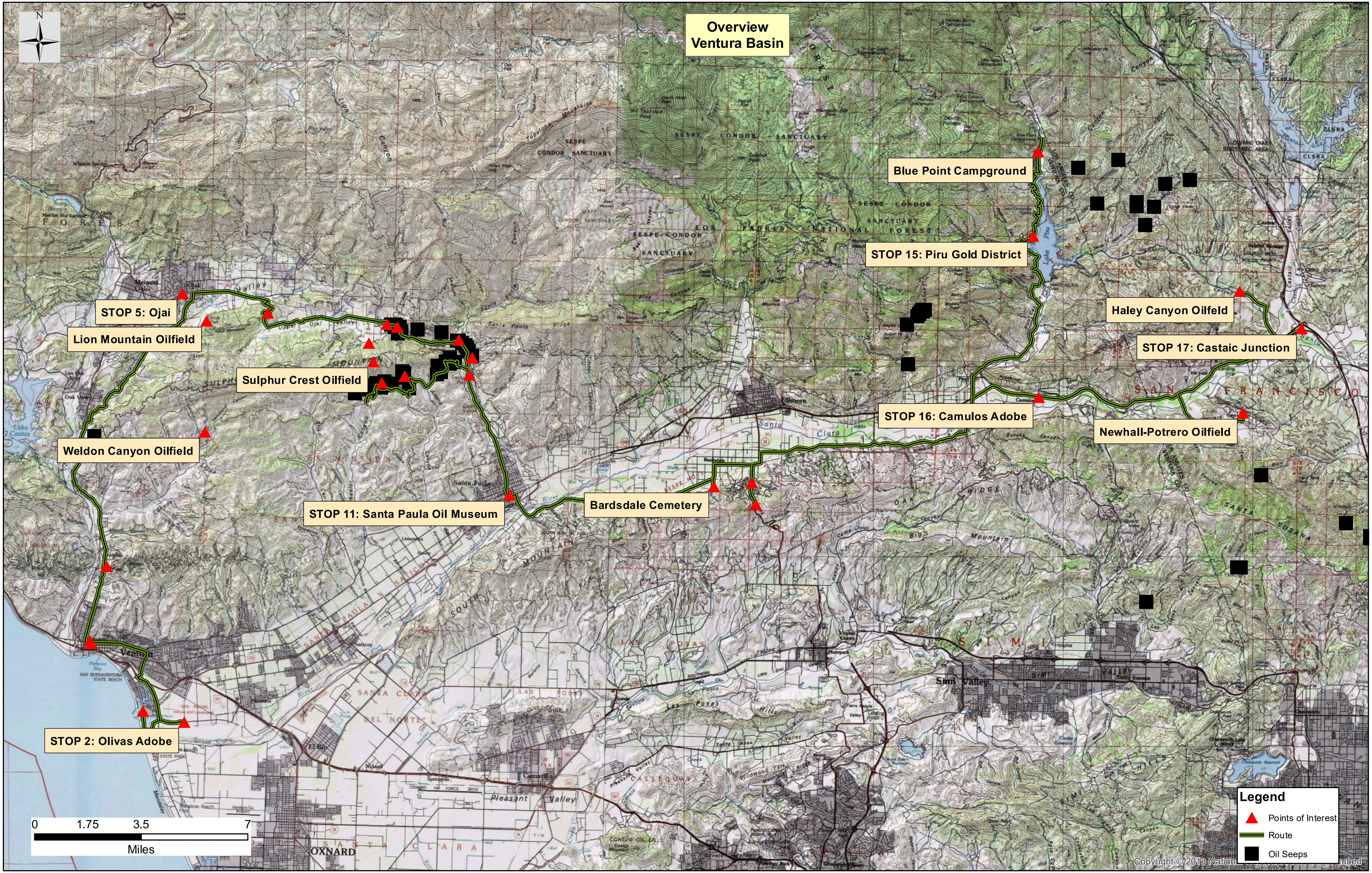
Gray to brown cobble conglomerate of granitic, porphyritic-andesitic and quartzite detritus in arkosic sandstone matrix.

MAPS

OVERVIEW MAPS

Topographic
Geologic

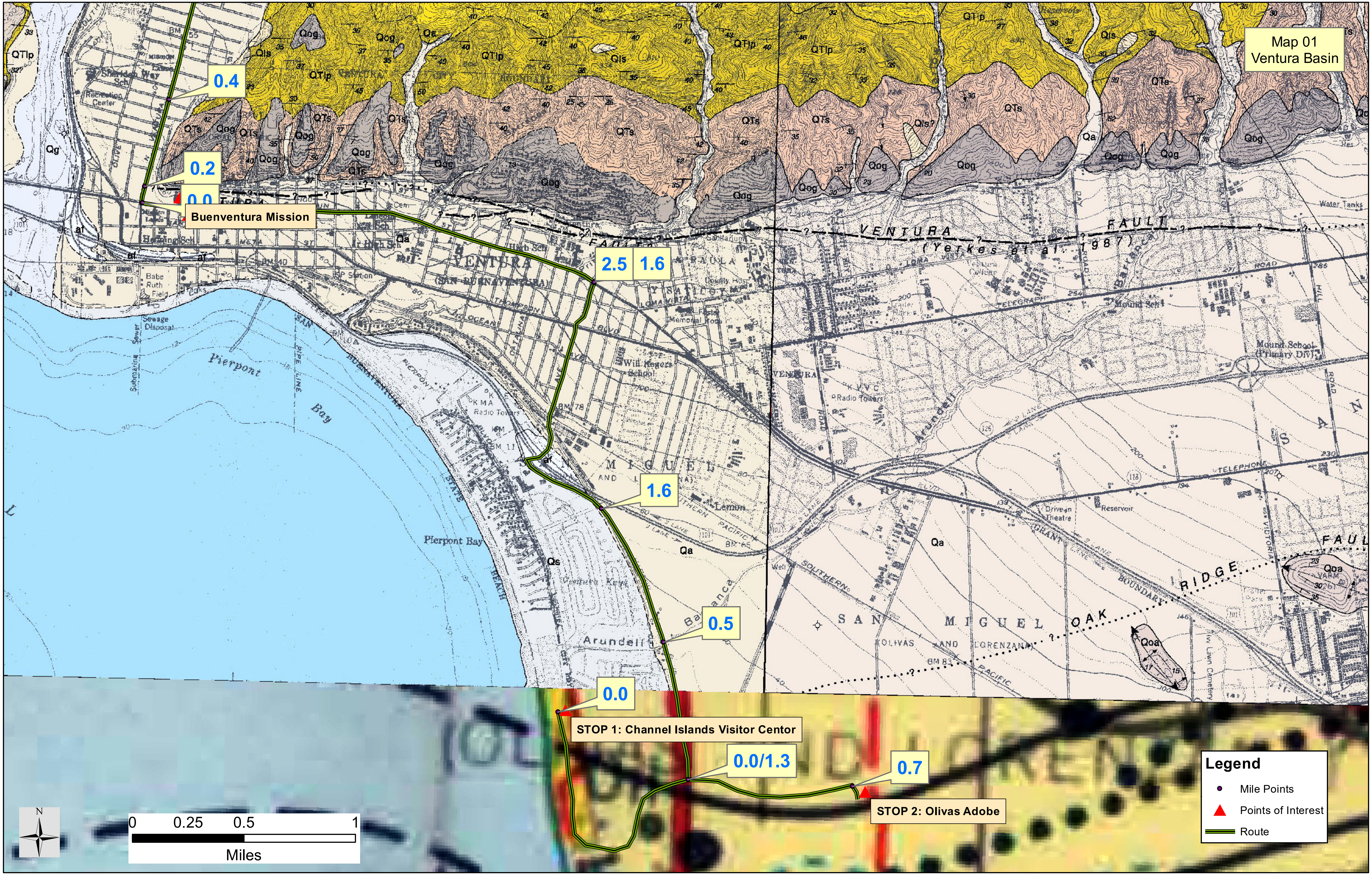

Overview
Ventura Basin
N
Blue Point Campground
STOP 15: Piru Gold District
Haley Canyon Oilfeld
Sulphur Mountain Oilfield
Weldon Canyon Oilfield
Bardsdale Cemetery
STOP 2: Olivas Adobe
Legend
Points of Interest
Route
Oil Seeps
Geologic Description
Geologic Description
Q Quaternary; alluvium, lake, playa, and terrace deposits
Tv Tertiary; volcanic flow rocks
Tvp Tertiary; pyroclastic and volcanic mudflow deposits
P Pliocene; marine sandstone, shale, siltstone, conglomerate
QPc Pleistocene - Pliocene; nonmarine sandstone, shale, gravel
M Miocene; marine sandstone, shale, siltstone, conglomerate
Tc Tertiary; nonmarine sandstone, shale, conglomerate
O Oligocene; marine sandstone, shale, siltstone, conglomerate
Oc Oligocene; nonmarine sandstone, shale, conglomerate
E Eocene; marine sandstone, shale, siltstone, conglomerate
Ep Paleocene; marine sandstone, shale, siltstone, conglomerate
grMz Mesozoic; granite, quartz monzonite
Ku Upper Cretaceous; marine sedimentary and metasediment rocks
pC pre-Cambrian; marine sedimentary and metasediment rocks
Water
0 1.75 3.5 7
Miles
Copyright:© 2013 National Geographic Society, i-cubed



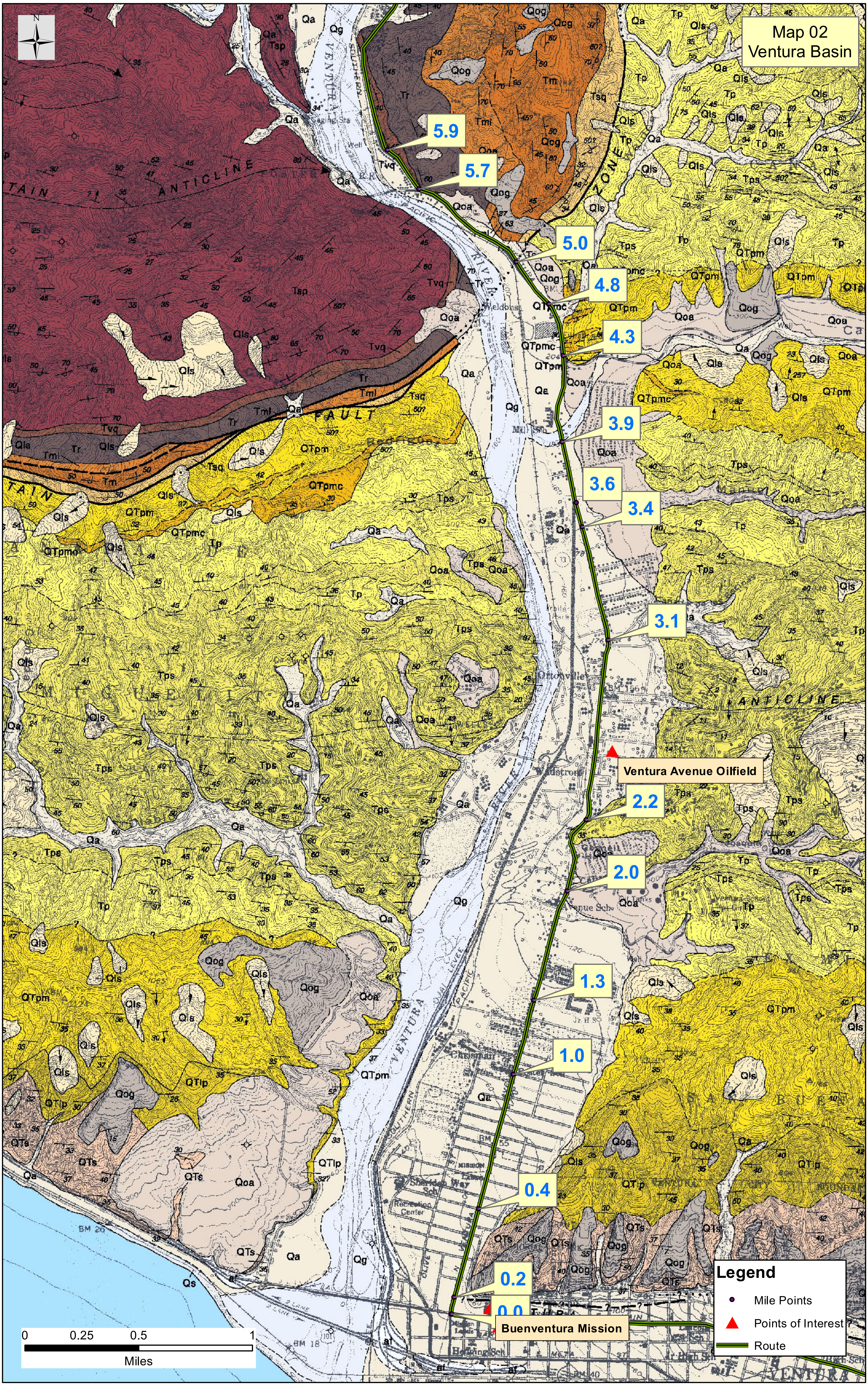
Overview
Ventura Basin
Blue Point Campground
STOP 15: Piru Gold District
STOP 5: Ojai
Lion Mountain Oilfield
Sulphur Crest Oilfield
Haley Canyon Oilfeld
STOP 17: Castaic Junction
STOP 16: Camulos Adobe
Newhall-Potrero Oilfield
Weldon Canyon Oilfield
STOP 11: Santa Paula Oil Museum
Bardsdale Cemetery
STOP 2: Olivas Adobe
0 1.75 3.5 7
Miles
Legend
Points of Interest
Route
Oil Seeps

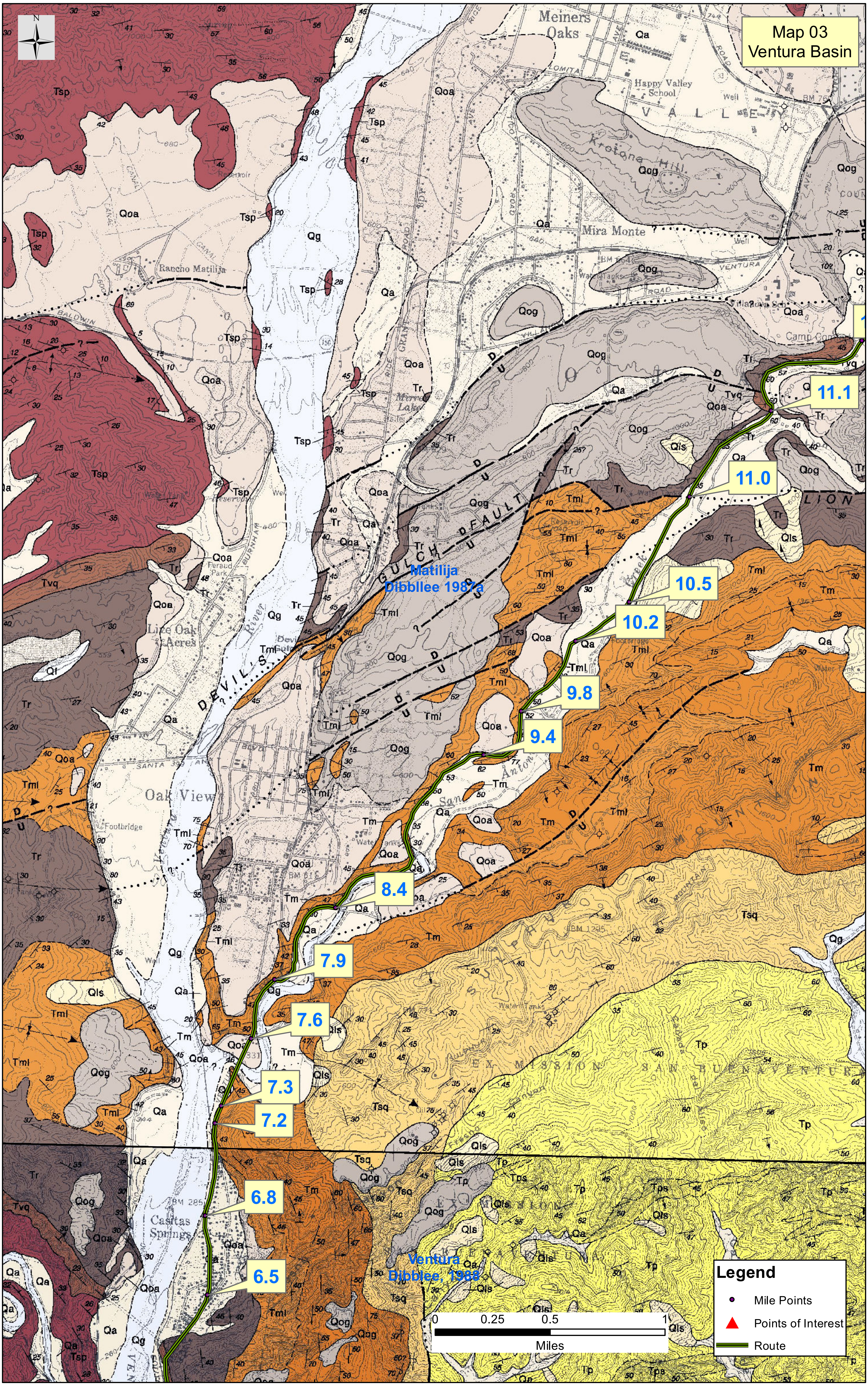
AREA MAPS

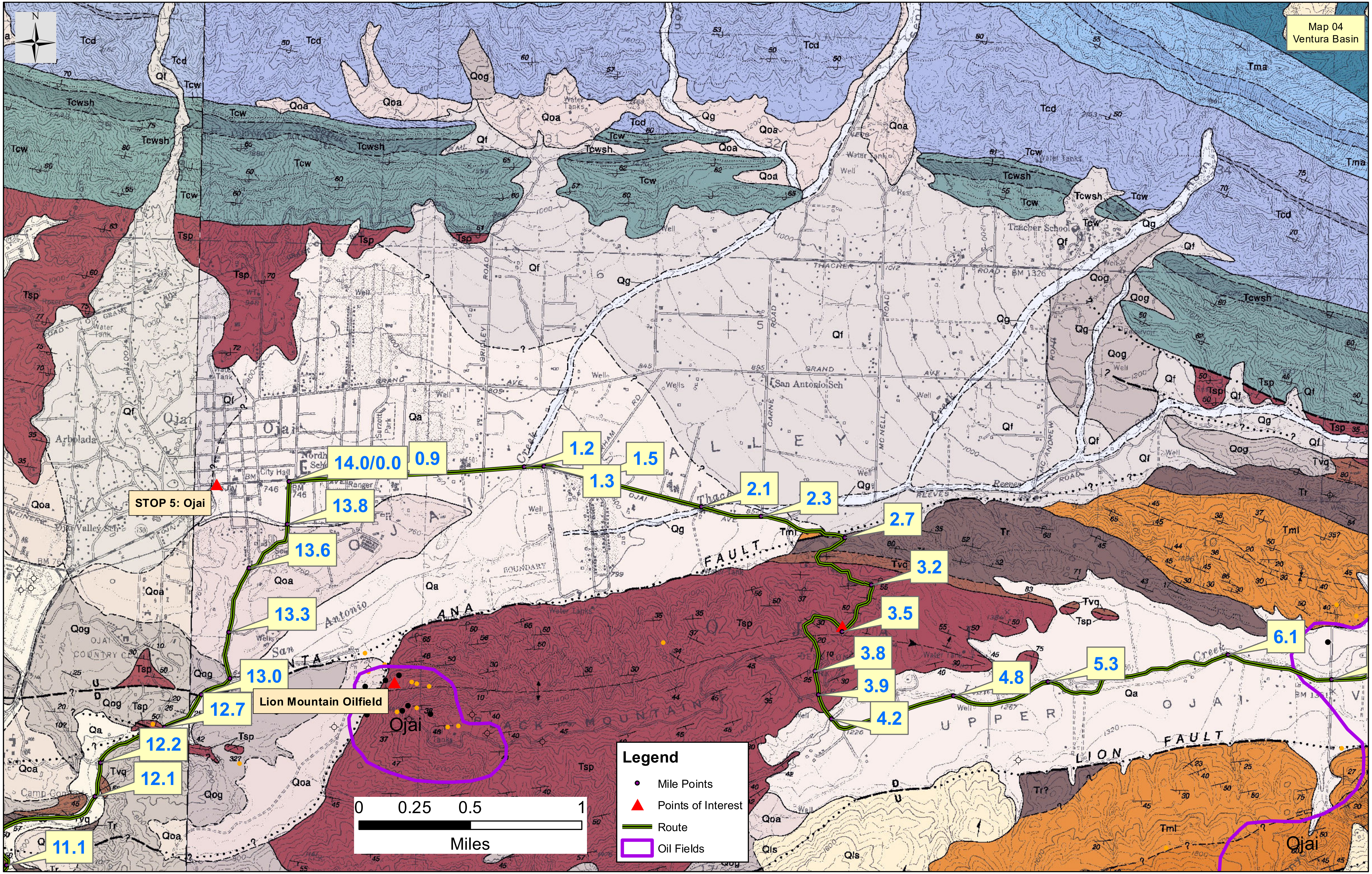
These maps are produced at a scale of 1:24,000. They are designed to be printed on landscape tabloid (11”x17”) paper.

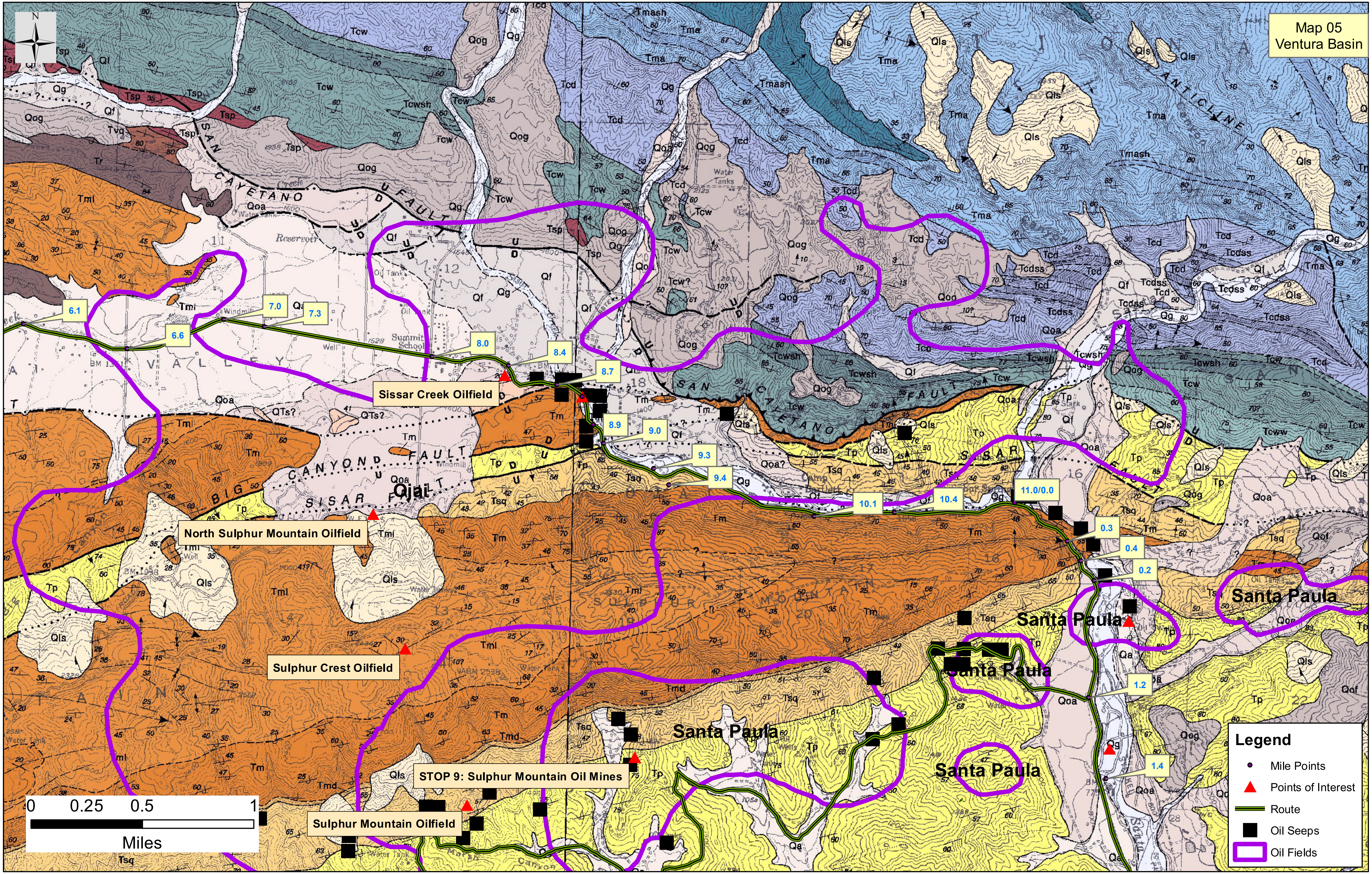


Map 01
Ventura Basin
0.4
0.2
0.0
Buenventura Mission
2.5
1.6
1.6
0.5
0.0
STOP 1: Channel Islands Visitor Centor
0.0/1.3
0.7
STOP 2: Olivas Adobe
VENTURA FAULT
(Yerkes et al. 1987)
OAK RIDGE
Pierpont Bay
Legend
Mile Points
Points of Interest
Route
0 0.25 0.5 1
Miles
N

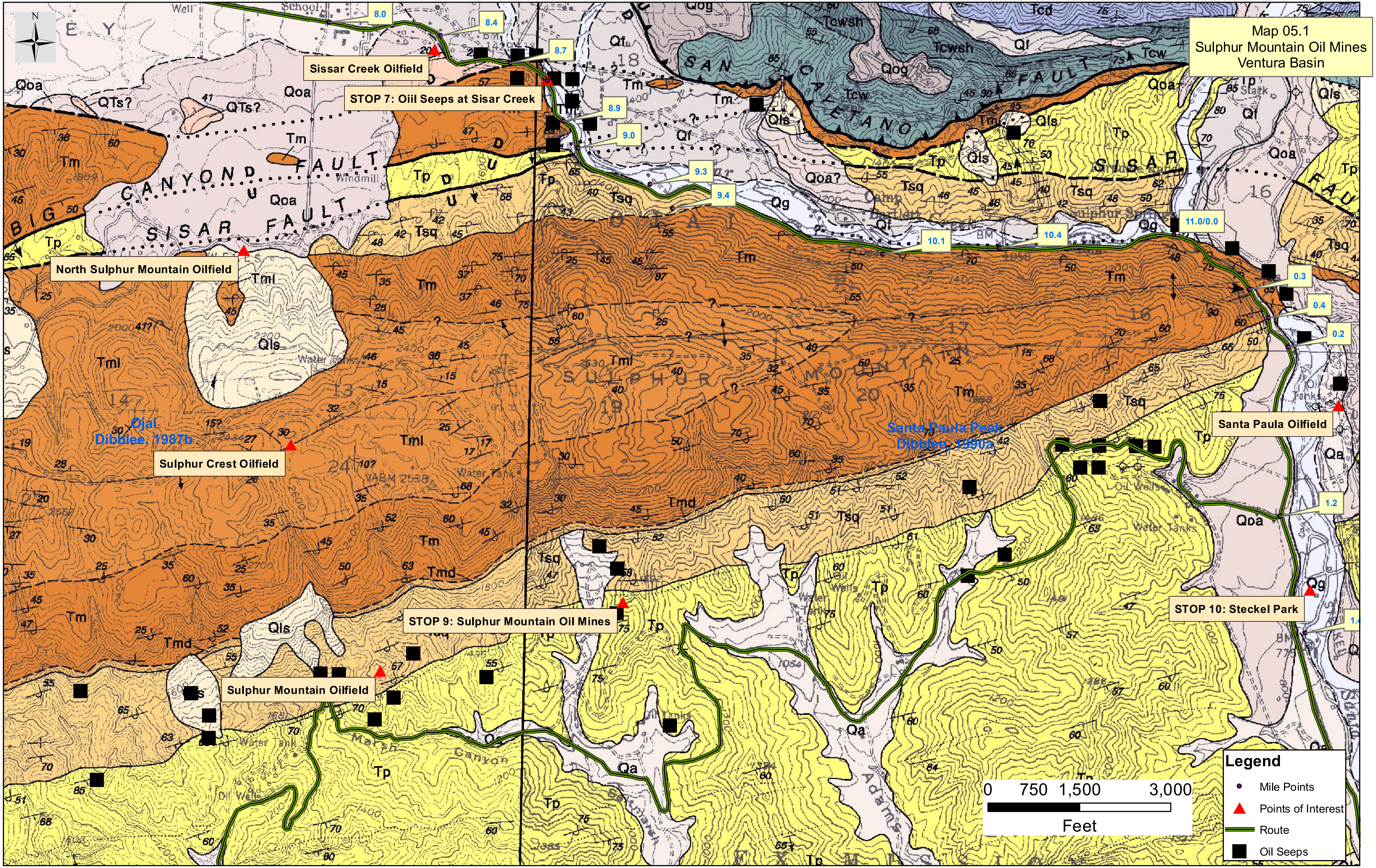

Map 02
Ventura Basin
5.9
5.7
5.0
4.8
4.3
3.9
3.6
3.4
3.1
Ventura Avenue Oilfield
2.2
2.0
1.3
1.0
0.4
0.2
0.0
Buenventura Mission
Legend
Mile Points
Points of Interest
Route
0
0.25
0.5
1
Miles

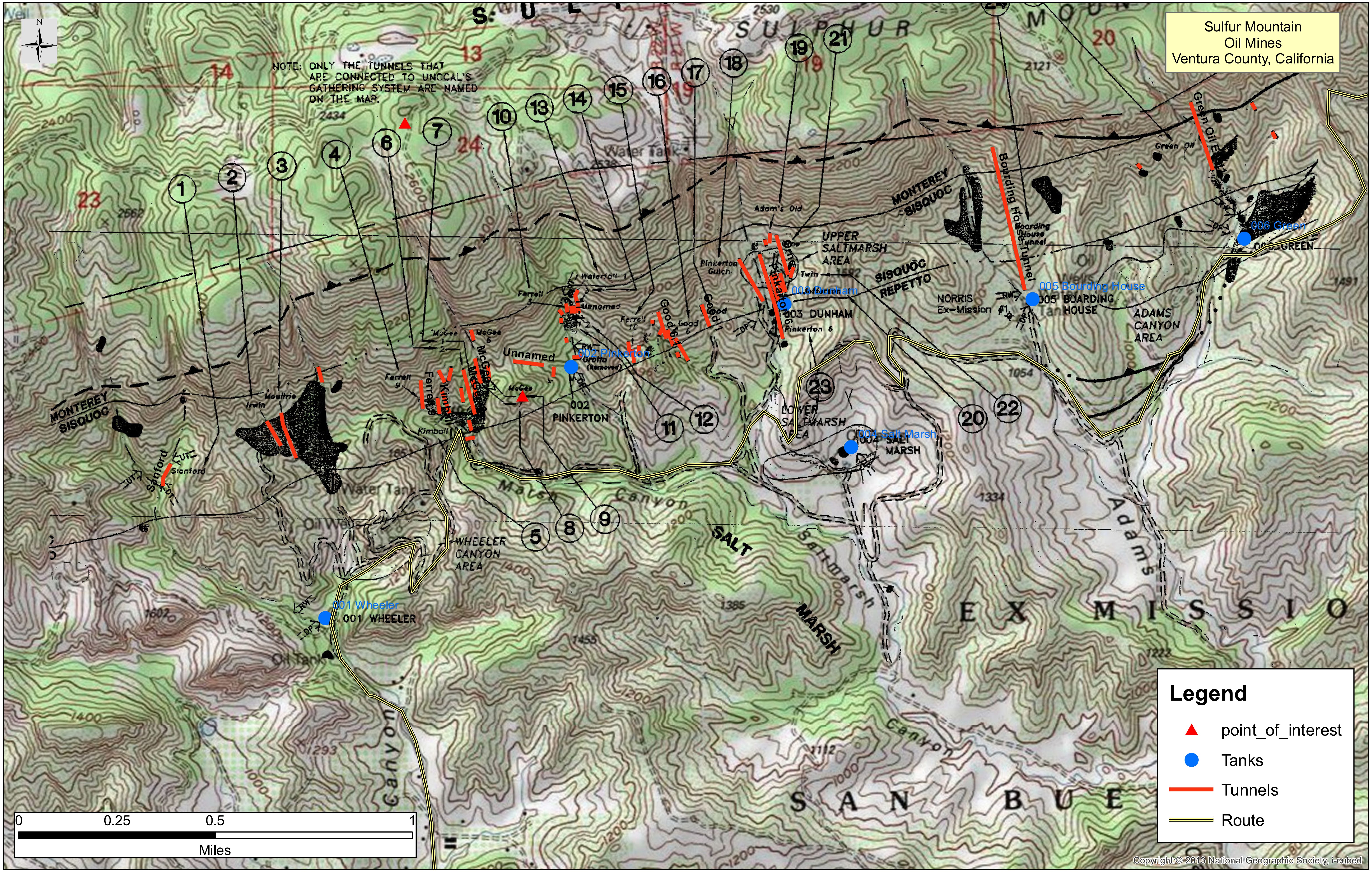

Map 03
Ventura Basin
N
Matilija
Dibblee 1987a
Ventura
Dibblee, 1988
11.1
11.0
10.5
10.2
9.8
9.4
8.4
7.9
7.6
7.3
7.2
6.8
6.5
Meiners Oaks
Happy Valley School
Krotona Hill
Mira Monte
Rancho Matilija
Mirror Lake
Oak View
Live Oak Acres
Casitas Springs
DEVILS GULCH FAULT
EX MISSION SAN BUENAVENTURA
Legend
Mile Points
Points of Interest
Route
0
0.25
0.5
1
Miles

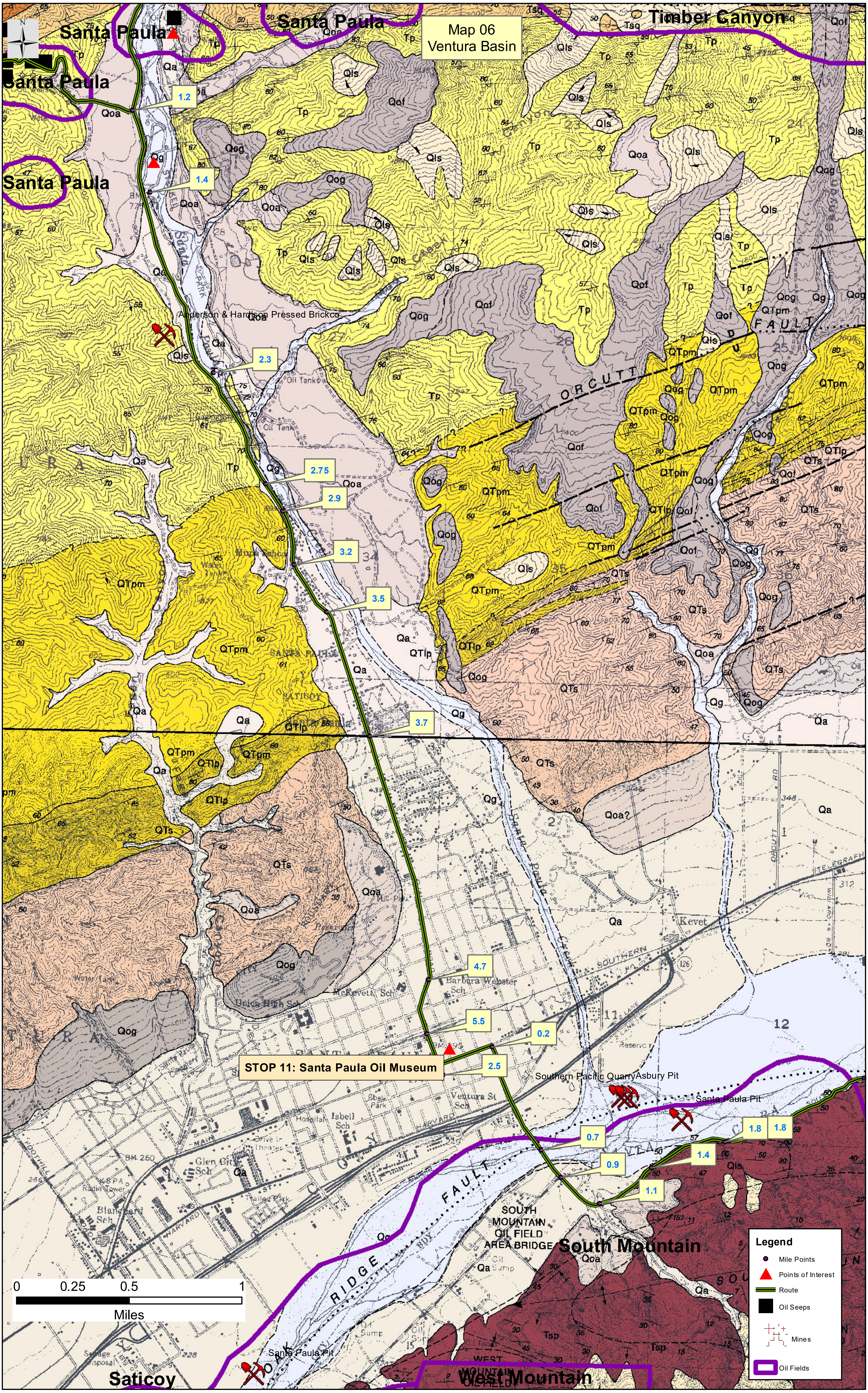

Map 04
Ventura Basin
N
STOP 5: Ojai
Lion Mountain Oilfield
14.0/0.0
0.9
1.2
1.3
1.5
2.1
2.3
2.7
3.2
3.5
3.8
3.9
4.2
4.8
5.3
6.1
13.8
13.6
13.3
13.0
12.7
12.2
12.1
11.1
Legend
Mile Points
Points of Interest
Route
Oil Fields
0
0.25
0.5
1
Miles
Ojai
Thacher School
San Antonio Sch
Arbolada
UPPER OJAI
LION FAULT
SANTA ANA FAULT



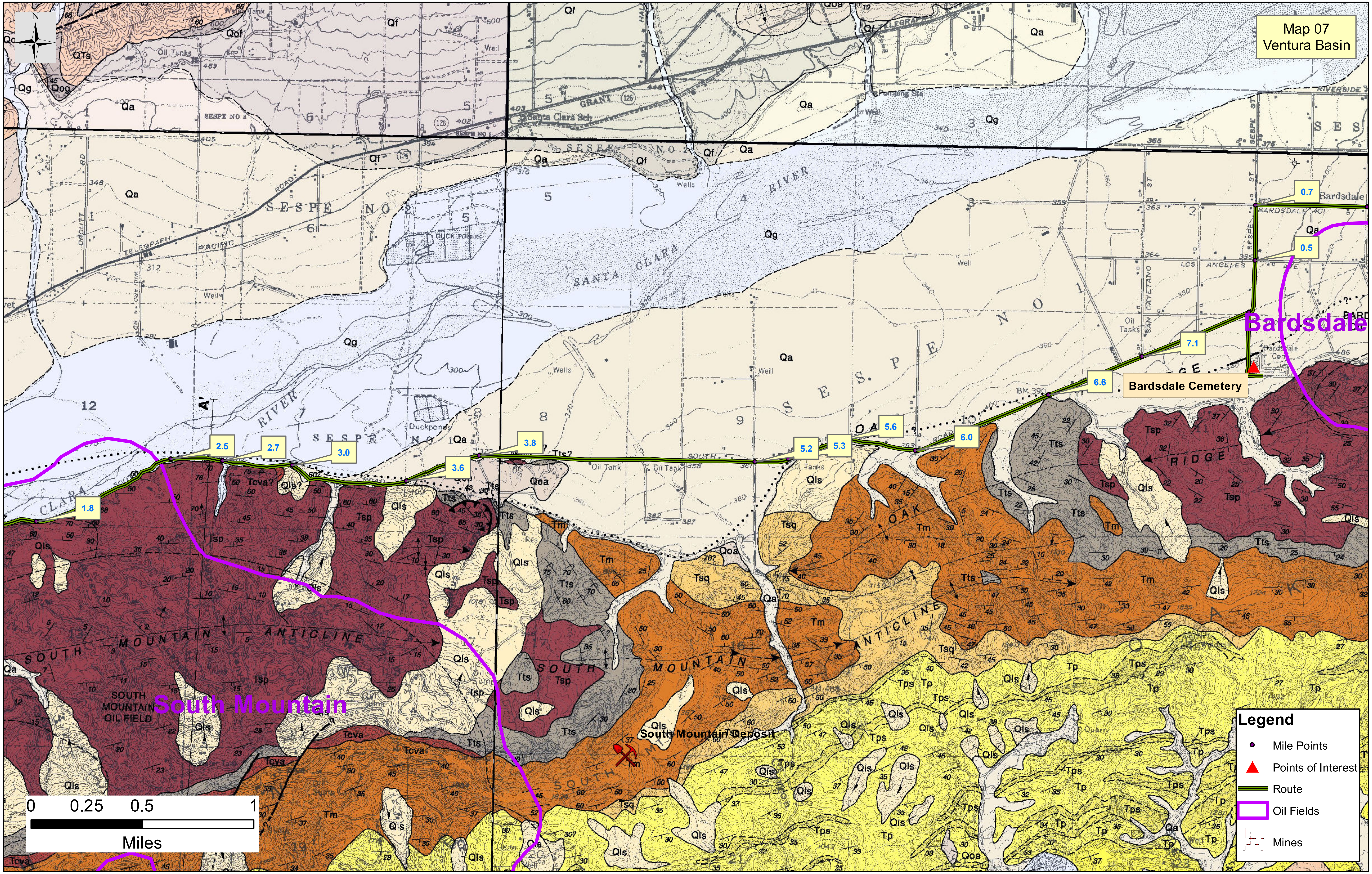
Map 05
Ventura Basin
N
Sissar Creek Oilfield
North Sulphur Mountain Oilfield
Sulphur Crest Oilfield
STOP 9: Sulphur Mountain Oil Mines
Sulphur Mountain Oilfield
Santa Paula
Santa Paula
Santa Paula
Santa Paula
Santa Paula
Ojai
SAN CAYETANO FAULT
BIG CANYON FAULT
SISAR FAULT
SULPHUR MOUNTAIN
6.1
6.6
7.0
7.3
8.0
8.4
8.7
8.9
9.0
9.3
9.4
10.1
10.4
11.0/0.0
0.3
0.4
0.2
1.2
1.4
0
0.25
0.5
1
Miles
Legend
Mile Points
Points of Interest
Route
Oil Seeps
Oil Fields


Map 05.1
Sulphur Mountain Oil Mines
Ventura Basin
Sissar Creek Oilfield
STOP 7: Oil Seeps at Sisar Creek
North Sulphur Mountain Oilfield
Sulphur Crest Oilfield
STOP 9: Sulphur Mountain Oil Mines
Sulphur Mountain Oilfield
Santa Paula Oilfield
STOP 10: Steckel Park
Ojai
Dibblee, 1987b
Santa Paula Peak
Dibblee, 1990a
SAN CAYETANO FAULT
BIG CANYON FAULT
SISAR FAULT
SULPHUR MOUNTAIN
8.0
8.4
8.7
8.9
9.0
9.3
9.4
10.1
10.4
11.0/0.0
0.3
0.4
0.2
1.2
0
750
1,500
3,000
Feet
Legend
Mile Points
Points of Interest
Route
Oil Seeps

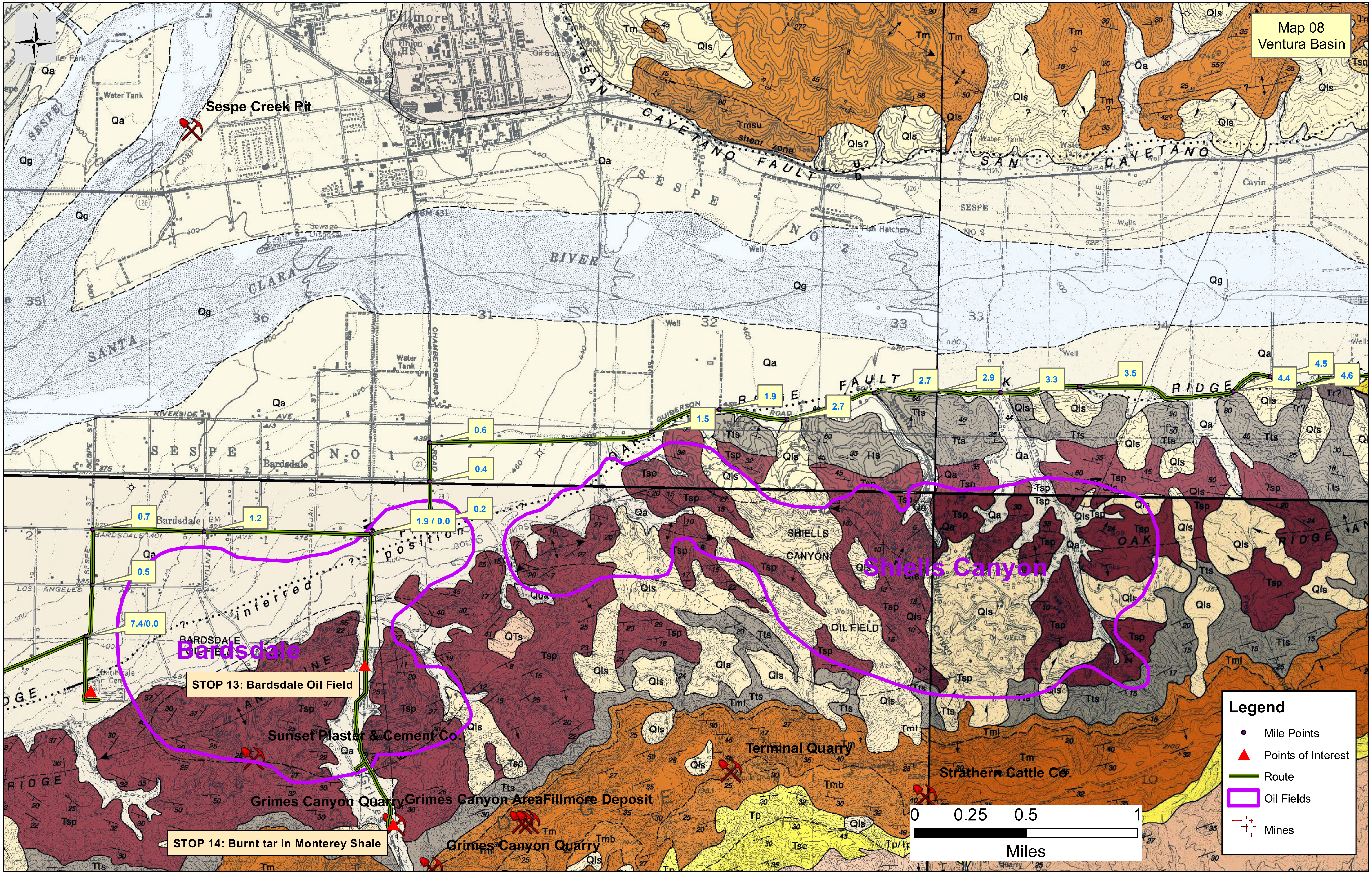

Sulfur Mountain
Oil Mines
Ventura County, California
NOTE: ONLY THE TUNNELS THAT ARE CONNECTED TO UNOCAL'S GATHERING SYSTEM ARE NAMED ON THE MAP.
MONTEREY SISQUOC
UPPER SALTMARSH AREA
SISQUOC REPETTO
NORRIS Ex-Mission #1
003 DUNHAM
005 BOARDING HOUSE
006 GREEN
ADAMS CANYON AREA
002 PINKERTON
Unnamed
LOWER SALTMARSH AREA
004 SALT MARSH
WHEELER CANYON AREA
001 WHEELER
Water Tank
Oil Tank
SALT MARSH
Adams
EX MISSIO
SAN BUE
Legend
point_of_interest
Tanks
Tunnels
Route
0 0.25 0.5 1
Miles
Copyright:© 2013 National Geographic Society, i-cubed



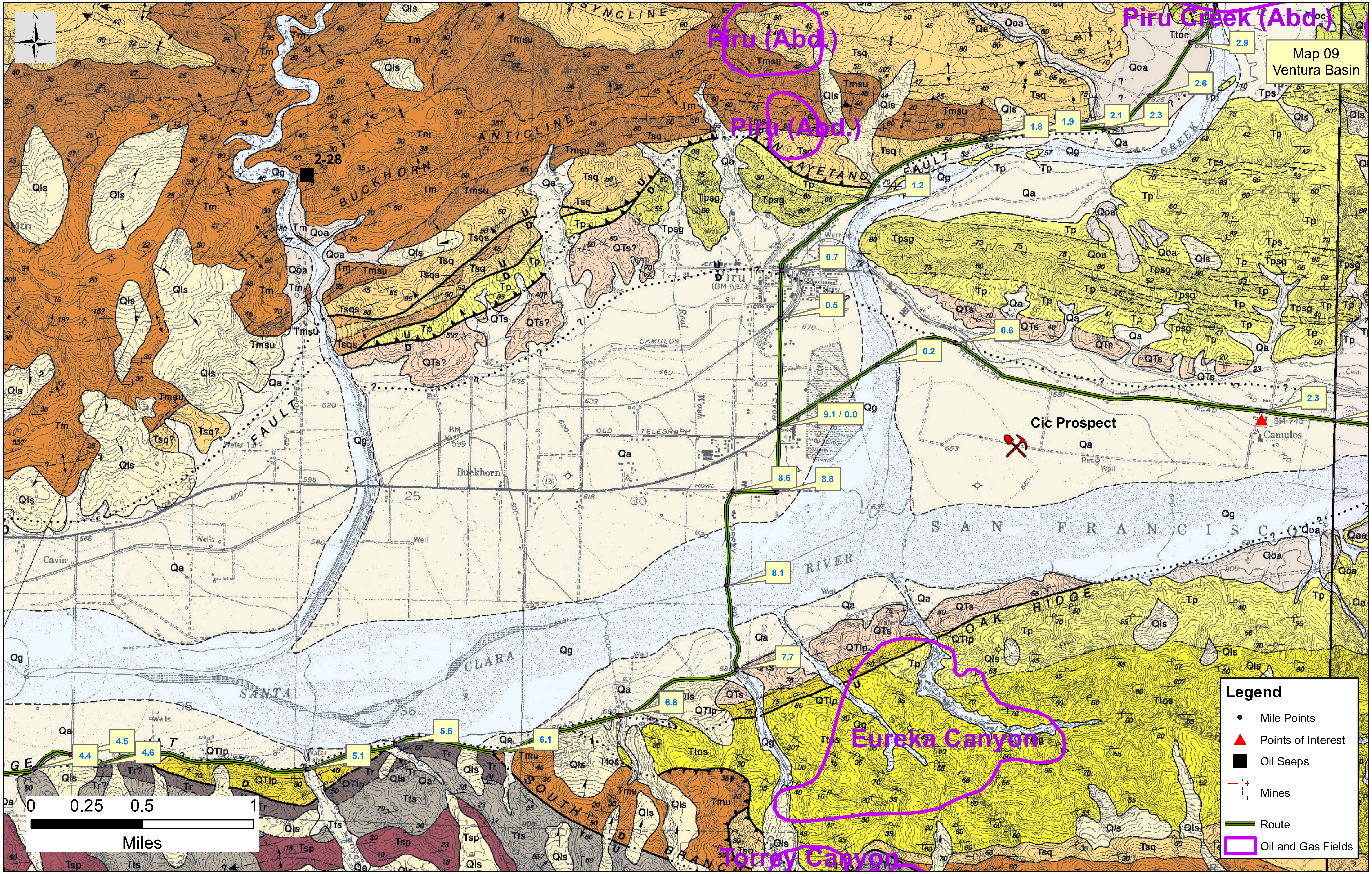
Map 06
Ventura Basin
Santa Paula
Timber Canyon
South Mountain
West Mountain
Saticoy
STOP 11: Santa Paula Oil Museum
Anderson & Hardison Pressed Brickco
Southern Pacific Quarry
Asbury Pit
Santa Paula Pit
ORCUTT FAULT
OAK RIDGE FAULT
SOUTH MOUNTAIN OIL FIELD
AREA BRIDGE
1.2
1.4
2.3
2.75
2.9
3.2
3.5
3.7
4.7
5.5
2.5
0.2
0.7
0.9
1.1
1.4
1.8
1.8
0
0.25
0.5
1
Miles
Legend
Mile Points
Points of Interest
Route
Oil Seeps
Mines
Oil Fields

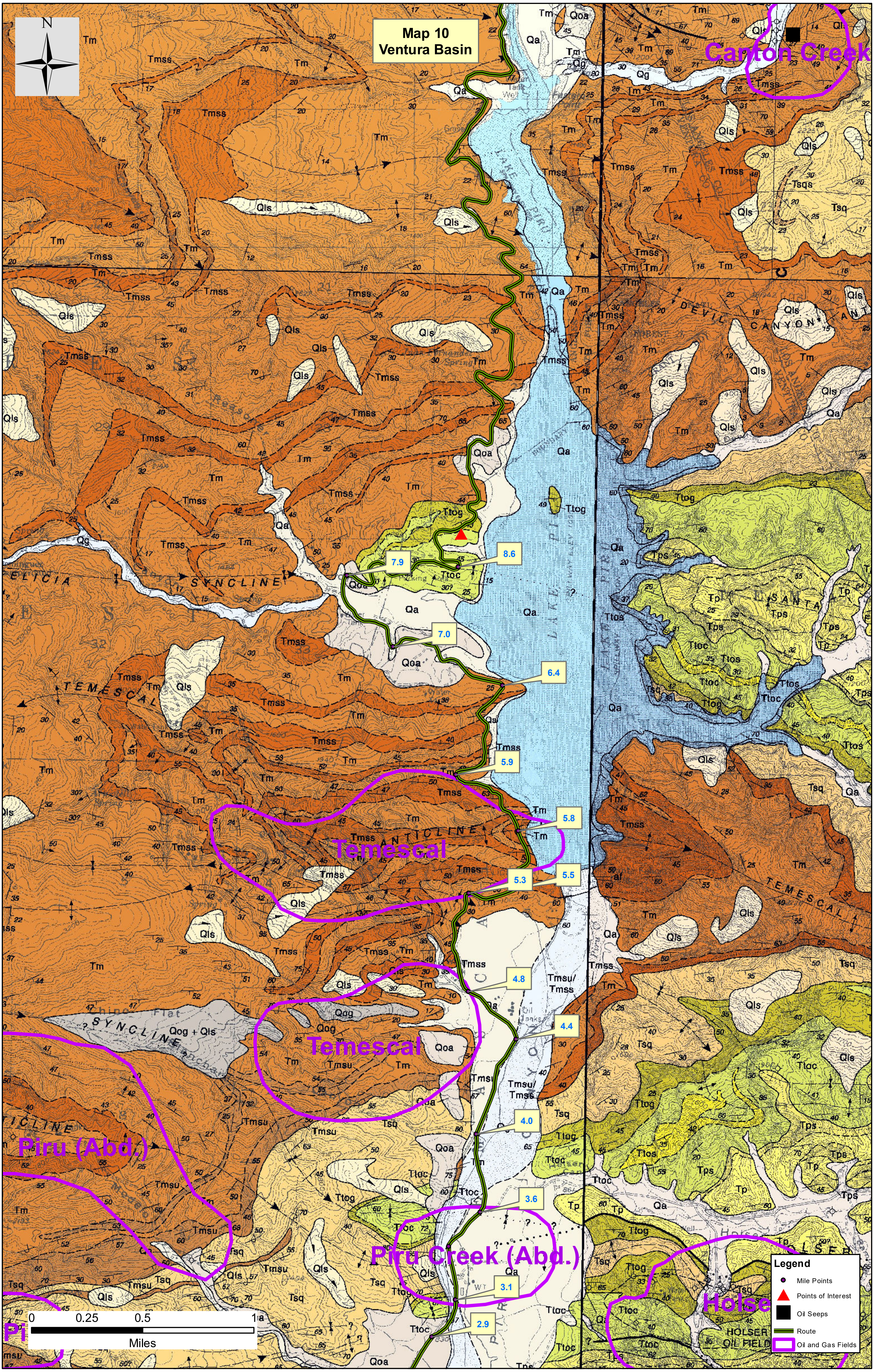


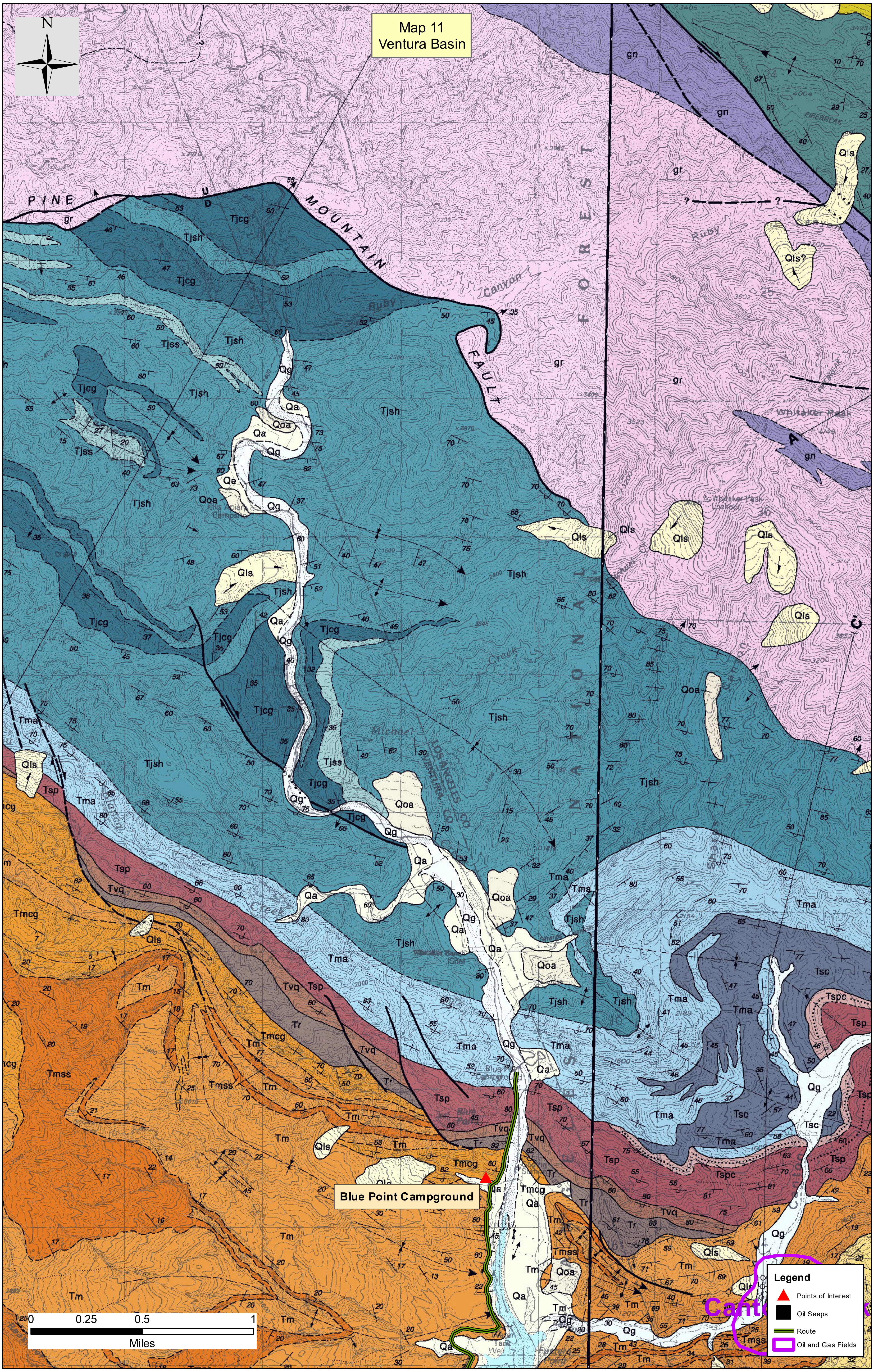
Map 07
Ventura Basin
Bardsdale
South Mountain
Bardsdale Cemetery
South Mountain Deposit
SOUTH MOUNTAIN OIL FIELD
SOUTH MOUNTAIN ANTICLINE
OAK RIDGE
SANTA CLARA RIVER
SESPE NO 2
0.5
0.7
1.8
2.5
2.7
3.0
3.6
3.8
5.2
5.3
5.6
6.0
6.6
7.1
Legend
Mile Points
Points of Interest
Route
Oil Fields
Mines
0 0.25 0.5 1
Miles



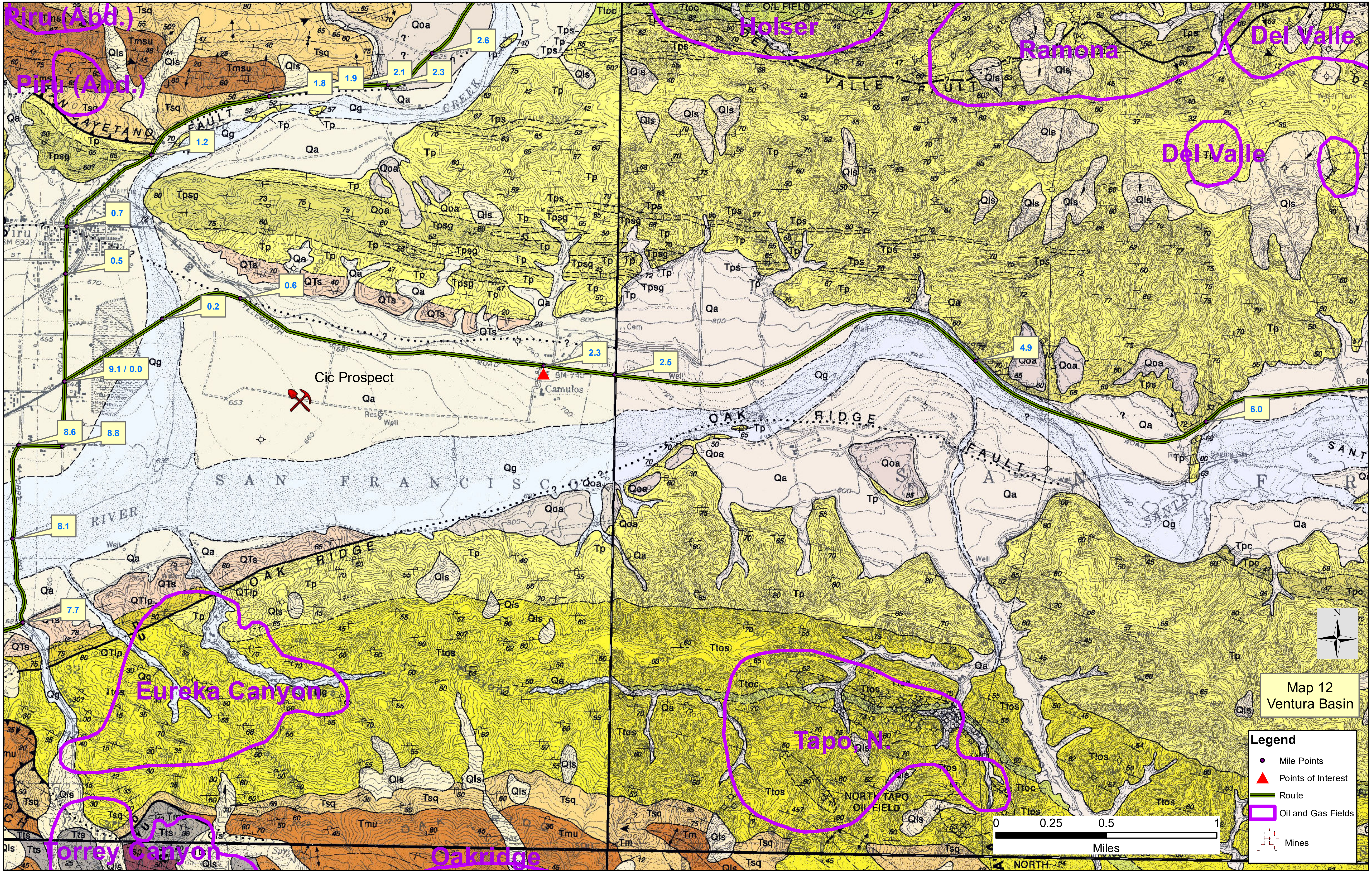
Map 08
Ventura Basin
Fillmore
Sespe Creek Pit
SAN CAYETANO FAULT
SESPE NO 2
SANTA CLARA RIVER
SESPE NO 1
OAK RIDGE FAULT
Bardsdale
Shiells Canyon
SHIELLS CANYON OIL FIELD
STOP 13: Bardsdale Oil Field
STOP 14: Burnt tar in Monterey Shale
Sunset Plaster & Cement Co.
Grimes Canyon Quarry
Grimes Canyon Area
Fillmore Deposit
Terminal Quarry
Strathern Cattle Co.
0.7
1.2
1.9 / 0.0
0.2
0.4
0.6
1.5
1.9
2.7
2.7
2.9
3.3
3.5
4.4
4.5
4.6
0.5
7.4/0.0
0 0.25 0.5 1
Miles
Legend
Mile Points
Points of Interest
Route
Oil Fields
Mines


Map 09
Ventura Basin
Piru Creek (Abd.)
Piru (Abd.)
Piru (Abd.)
Eureka Canyon
Torrey Canyon
Cic Prospect
Camulos
2-28
BUCKHORN ANTICLINE
SYNCLINE
SAN CAYETANO FAULT
OAK RIDGE
SAN FRANCISCO
RIVER
SANTA CLARA
SOUTH BRANCH
Buckhorn
Piru
2.9
2.6
2.1
2.3
1.8
1.9
1.2
0.7
0.5
0.6
0.2
2.3
9.1 / 0.0
8.6
8.8
8.1
7.7
6.6
6.1
5.6
5.1
4.4
4.5
4.6
0
0.25
0.5
1
Miles
Legend
Mile Points
Points of Interest
Oil Seeps
Mines
Route
Oil and Gas Fields

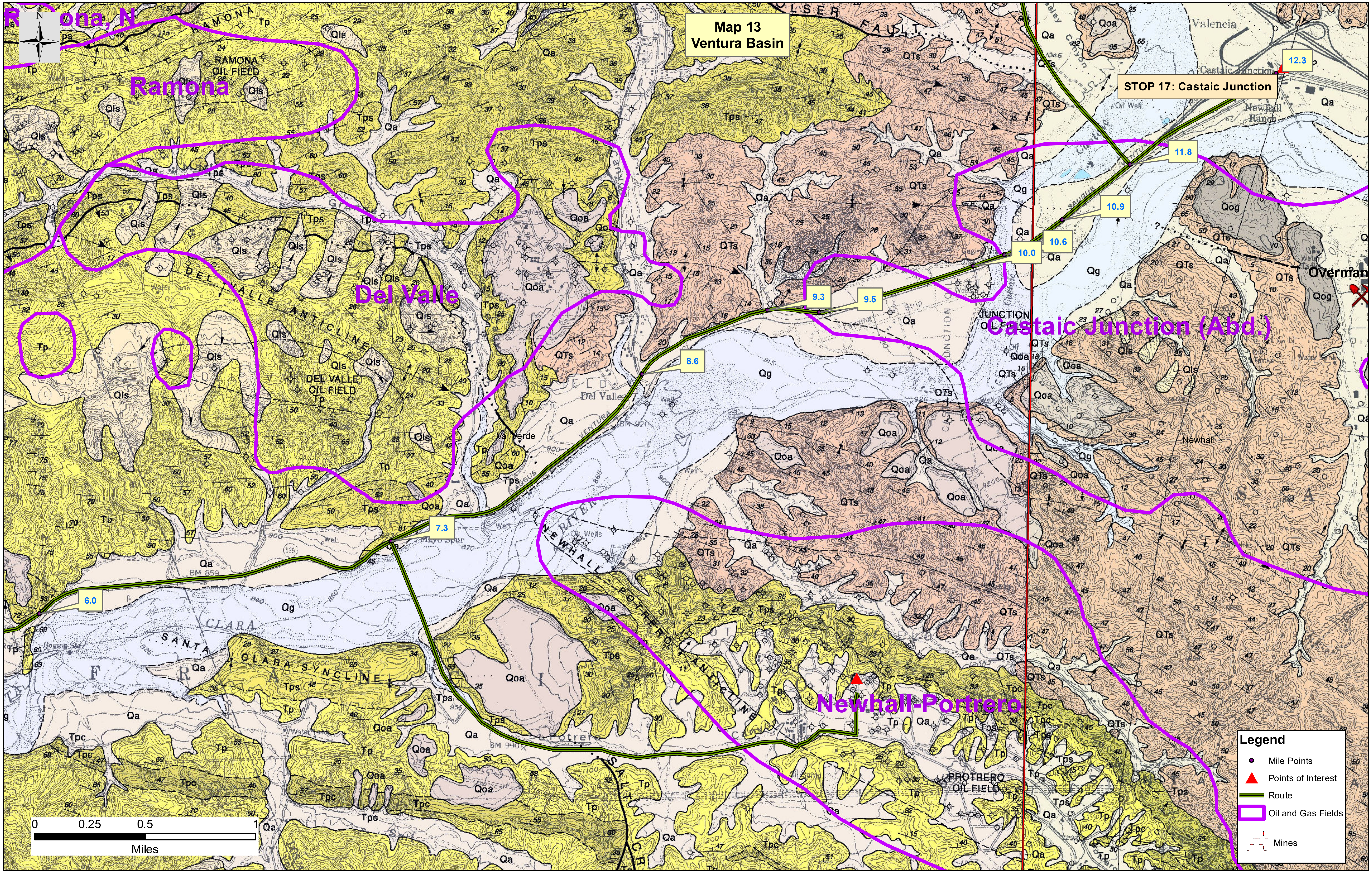

Map 10
Ventura Basin
N
Canton Creek
Temescal
Temescal
Piru (Abd.)
Piru Creek (Abd.)
Holser
LAKE PIRU
SYNCLINE
TEMESCAL
ANTICLINE
DEVIL CANYON
SANTA
HOLSER OIL FIELD
7.9
8.6
7.0
6.4
5.9
5.8
5.5
5.3
4.8
4.4
4.0
3.6
3.1
2.9
0
0.25
0.5
1
Miles
Legend
Mile Points
Points of Interest
Oil Seeps
Route
Oil and Gas Fields



Map 11
Ventura Basin
N
PINE MOUNTAIN FAULT
FOREST
NATIONAL
Blue Point Campground
Legend
Points of Interest
Oil Seeps
Route
Oil and Gas Fields
0 0.25 0.5 1
Miles



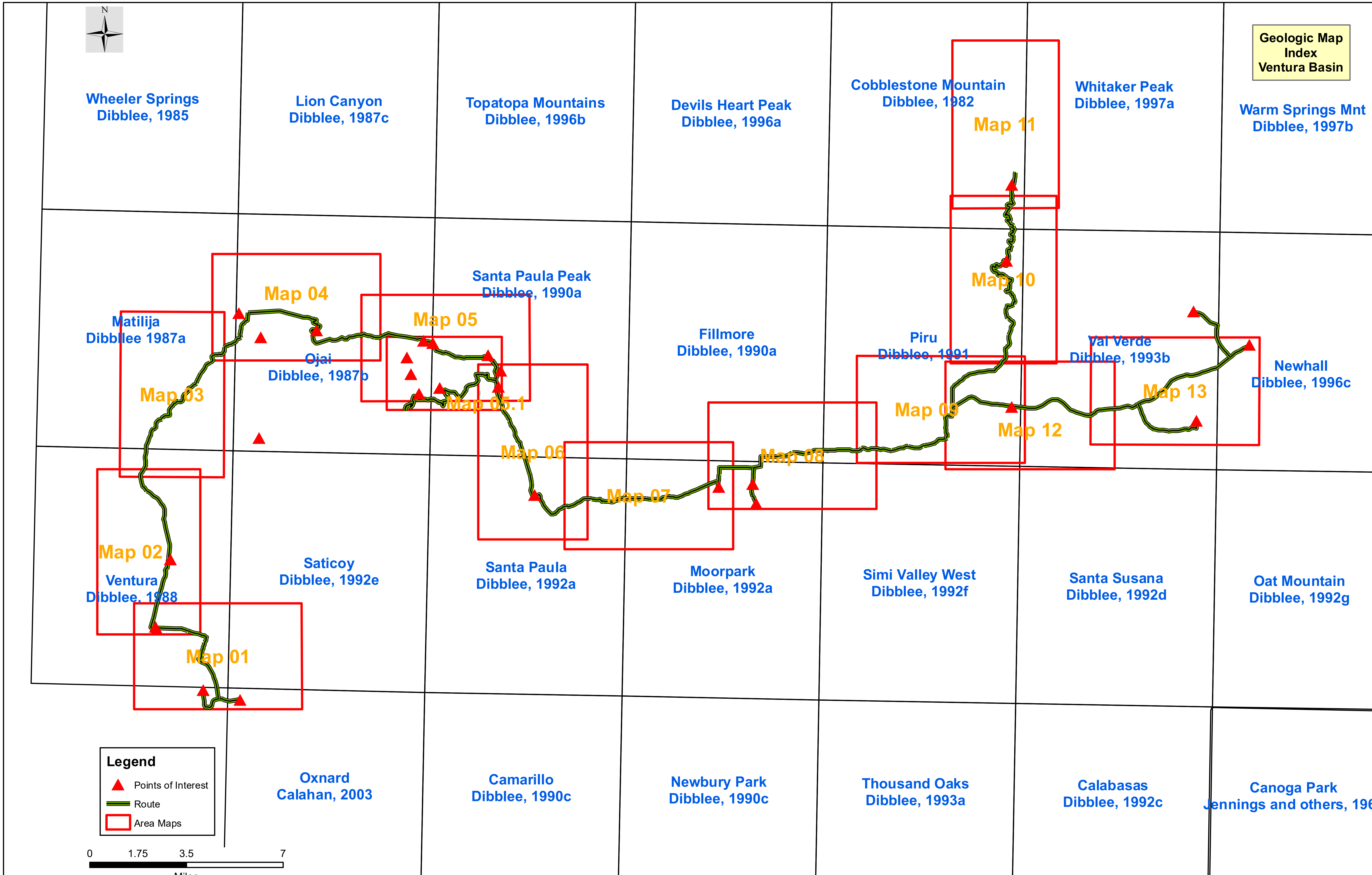
Map 12
Ventura Basin
Legend
Mile Points
Points of Interest
Route
Oil and Gas Fields
Mines
0
0.25
0.5
1
Miles
Piru (Abd.)
Piru (Abd.)
Holser
Ramona
Del Valle
Del Valle
Eureka Canyon
Tapo N.
Torrey Canyon
Oakridge
Cic Prospect
Camulos
NORTH TAPO OIL FIELD
SAN FRANCISCO RIVER
OAK RIDGE
OAK RIDGE FAULT
DEL VALLE FAULT
SAN CAYETANO FAULT
9.1 / 0.0
0.2
0.5
0.6
0.7
1.2
1.8
1.9
2.1
2.3
2.3
2.5
2.6
4.9
6.0
7.7
8.1
8.6
8.8



Map 13
Ventura Basin
STOP 17: Castaic Junction
Ramona, N
Ramona
RAMONA OIL FIELD
Del Valle
DEL VALLE OIL FIELD
DEL VALLE ANTICLINE
Castaic Junction (Abd.)
Newhall-Portrero
PROTRERO OIL FIELD
NEWHALL POTRERO ANTICLINE
SANTA CLARA SYNCLINE
Overman
Valencia
Newhall
6.0
7.3
8.6
9.3
9.5
10.0
10.6
10.9
11.8
12.3
Legend
Mile Points
Points of Interest
Route
Oil and Gas Fields
Mines
0
0.25
0.5
1
Miles

GEOLOGIC INDEX MAP

This map is designed to be printed on tabloid (11”x17”) paper.


Geologic Map Index Ventura Basin
N
Wheeler Springs Dibblee, 1985
Lion Canyon Dibblee, 1987c
Topatopa Mountains Dibblee, 1996b
Devils Heart Peak Dibblee, 1996a
Cobblestone Mountain Dibblee, 1982
Whitaker Peak Dibblee, 1997a
Warm Springs Mnt Dibblee, 1997b
Map 11
Map 10
Map 04
Map 05
Santa Paula Peak Dibblee, 1990a
Matilija Dibblee 1987a
Ojai Dibblee, 1987b
Fillmore Dibblee, 1990a
Piru Dibblee, 1991
Val Verde Dibblee, 1993b
Newhall Dibblee, 1996c
Map 03
Map 05.1
Map 09
Map 13
Map 12
Map 06
Map 08
Map 07
Map 02
Saticoy Dibblee, 1992e
Santa Paula Dibblee, 1992a
Moorpark Dibblee, 1992a
Simi Valley West Dibblee, 1992f
Santa Susana Dibblee, 1992d
Oat Mountain Dibblee, 1992g
Ventura Dibblee, 1988
Map 01
Legend
Points of Interest
Route
Area Maps
Oxnard Calahan, 2003
Camarillo Dibblee, 1990c
Newbury Park Dibblee, 1990c
Thousand Oaks Dibblee, 1993a
Calabasas Dibblee, 1992c
Canoga Park Jennings and others, 1969
0 1.75 3.5 7
Miles

GEOLOGIC MOSAIC OF THE VENTURA BASIN

This map mosaic is designed to be plotted on 36x42 inch (Arch E) size paper.

It can be downloaded at

https://www.academia.edu/37701569/Geologic_Mosaic_Map_of_the_Ventura_Basin_Ventura_and_Los_Angeles_Counties_California

This map is georectified and can be viewed on a tablet or cell phone with the Avenza.pdf application.

Geologic Mosaic
Ventura Basin
Blue Point Campground
STOP 15: Piru Gold District
STOP 5: Ojai
Lion Mountain Oilfield
Sissar Creek Oilfield
North Sulphur Mountain Oilfield
Sulphur Crest Oilfield
Santa Paula Oilfield
STOP 10: Steckel Park
Sulphur Mountain Oilfield
Weldon Canyon Oilfield
STOP 11: Santa Paula Oil Museum
Bardsdale Cemetery
STOP 14: Burnt tar in Monterey Shale
STOP 16: Camulos Adobe
Haley Canyon Oilfeld
STOP 17: Castaic Junction
Newhall-Potrero Oilfield
STOP 4: Ventura Avenue Oilfield
Buenventura Mission
STOP 1: Channel Islands Visitor Center
STOP 2: Olivas Adobe
sand
Oil wells
T 2 N
R 22 W
El Rio
OXNARD
US NAVAL CONSTRUCTION
BATTALION CENTER
area (small arms firing range)
Canoga Park
0 1.75 3.5 7
Miles
Legend
Points of Interest
Route