U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

PRELIMINARY PETROLEUM GEOLOGY BACKGROUND AND WELL DATA FOR OIL SAMPLES IN THE COOPERATIVE MONTEREY ORGANIC GEOCHEMISTRY STUDY, SANTA MARIA AND SANTA BARBARA-VENTURA BASINS, CALIFORNIA

by

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CONTENTS

INTRODUCTION

This chapter outlines the petroleum geology of the Santa Maria and Santa Barbara-Ventura areas as background for the oil samples in the Cooperative Monterey Organic Geochemistry Study (CMOGS). CMOGS, its purposes and participants, are more generally described in the *Preface* (Chapter A, this report).

Oil samples in the study were taken from the onshore Santa Maria basin (oils #1-3, 5-9), offshore Santa Maria basin (oil #4), and Santa Barbara-Ventura basin (oils #10-11). Comments in this chapter mainly focus on the petroleum geology of these areas, including potential source rocks, reservoir rocks, traps, potential generative areas, and timing of trapping. Histories of the wells that produced the study oils are also outlined.

Discussion of potential source rocks is limited to information about their stratigraphic occurrence and general views of their economic importance. A review of published source-rock studies is not included.

BACKGROUND

Many questions were raised and new hypotheses offered about generation of oils from the Monterey Formation during the 1980s. Most prominent were ideas that the Monterey generated "early" or "immature" oil at low levels of thermal metamorphism (Milner and others, 1977; McCulloh, 1979; King and Claypool, 1983; Petersen and Hickey, 1983, 1987; Walker and others, 1983; Curiale and others, 1985) and that generation histories were closely linked to the abundance of sulfur in the source organic matter (Orr, 1986). Associated ideas are that a subset of Monterey strata actually sourced most oils (Orr, 1986) and that different sets of Monterey source-rocks with differing organic sulfur contents sourced oils representing two or more generation and migration events (e.g., Heasler and Surdam, 1989; Lillis and King, 1991).

Ideas about oil generation from the Monterey have far-reaching consequences for future exploration and development of the oil potential in many areas of California, especially offshore California. What features can reliably distinguish early generation, biodegradation, facies differences, and differences in reservoir types or migration histories?

A major need to develop this understanding is study of well-identified oil samples having the least possible ambiguity in controlling geologic factors. "Monterey oils" are not all alike, and "immature" California oils are not necessarily all derived from the Monterey (e.g., Seifert and Moldowan, 1978), nor are all Monterey-derived oils "immature".

For future exploration and development, facies-related differences are of particular importance because the term "Monterey" does not actually designate a set of uniform homogeneous strata that are identical (or even very similar) in different basins, but is rather a term used for a wide variety of fine-grained Miocene strata deposited in separate basins with disparate sedimentological and tectonic histories (Bramlette, 1946; see also Cooperative Monterey Organic Geochemistry Study *Preliminary Geologic Background* p. 1-2 and *Geology Handbook* p. 3-5). For example, the favored source rock for offshore exploration is phosphatic marl (like KG-1 and KG-2) with TOC in the range 5-20% (Crain and Thurston, 1987), but such strata are not even present in the highly petroliferous San Joaquin basin, and rare even in the offshore Santa Maria basin (Isaacs and others, 1989). Are phosphatic marls the actual source rocks in the area? best source rocks? early source rocks? Are other Monterey or Rincon strata actual source rocks? Do actual source rocks have distinctive organic matter characteristics that are causally related to depositional conditions? Etc. etc.

To better understand the features that can reliably distinguish early generation, biodegradation, and differences in source facies from differences in reservoir types or migration histories, part of the purpose of the Cooperative Monterey Organic Geochemistry Study is to examine geologically well-identified oils in a variety of reservoir and trapping situations. Because of the multiplicity of likely source rocks in the Santa Barbara-Ventura area (see below), oils from the Santa Maria basin have been emphasized.

HYDROCARBON PRODUCTION IN CALIFORNIA

For perspective, about 23 billion barrels (Bbl) of oil and 33 trillion cubic feet (Tcf) of gas have been cumulatively produced through 1990 in the state of California as a whole (California Division of Oil and Gas, 1991a). The great majority of the oil (≈ 80%) and much of the gas (≈ 55%) have been produced from two major basins - the San Joaquin and Los Angeles basins. The Santa Barbara-Ventura basin is the third largest hydrocarbon-producing basin, with about 2.6 Bbl oil and 4.9 Tcf gas produced through 1990. Production totals in the onshore Santa Maria basin are about 0.8 Bbl oil, and about 0.8 Tcf gas (California Division of Oil and Gas, 1991a).

By official reserve estimates of developed fields (California Division of Oil and Gas, 1991a), California currently has 51 giant oil fields (those with estimated ultimate recovery exceeding 100 million barrels, or MMbl) including 7 supergiant oil fields (those with estimated ultimate recovery exceeding 1 Bbl). Of these, 8 giant oil fields (including one supergiant) are in the Santa Barbara-Ventura basin, and 3 giant oil fields (Cat Canyon, Santa Maria Valley, and Orcutt) are in the onshore Santa Maria basin.

Existing undeveloped discoveries in the offshore Santa Maria-Santa Barbara area are estimated to have total recoverable resources in the range 1-2 Bbl oil. With future development, both the Point Pedernales and Point Arguello oil fields in the offshore Santa Maria basin can be expected to be in the giant category. Estimates of potential recoverable production from other offshore discoveries are summarized by Crain and Thurston (1987).

PETROLEUM GEOLOGY BACKGROUND ON BASINS

The distribution of oil and gas fields in the onshore Santa Maria, offshore Santa Maria, and Santa Barbara-Ventura basins are shown in Plate 1, and characteristics of fields in much of the area listed in Table 1.

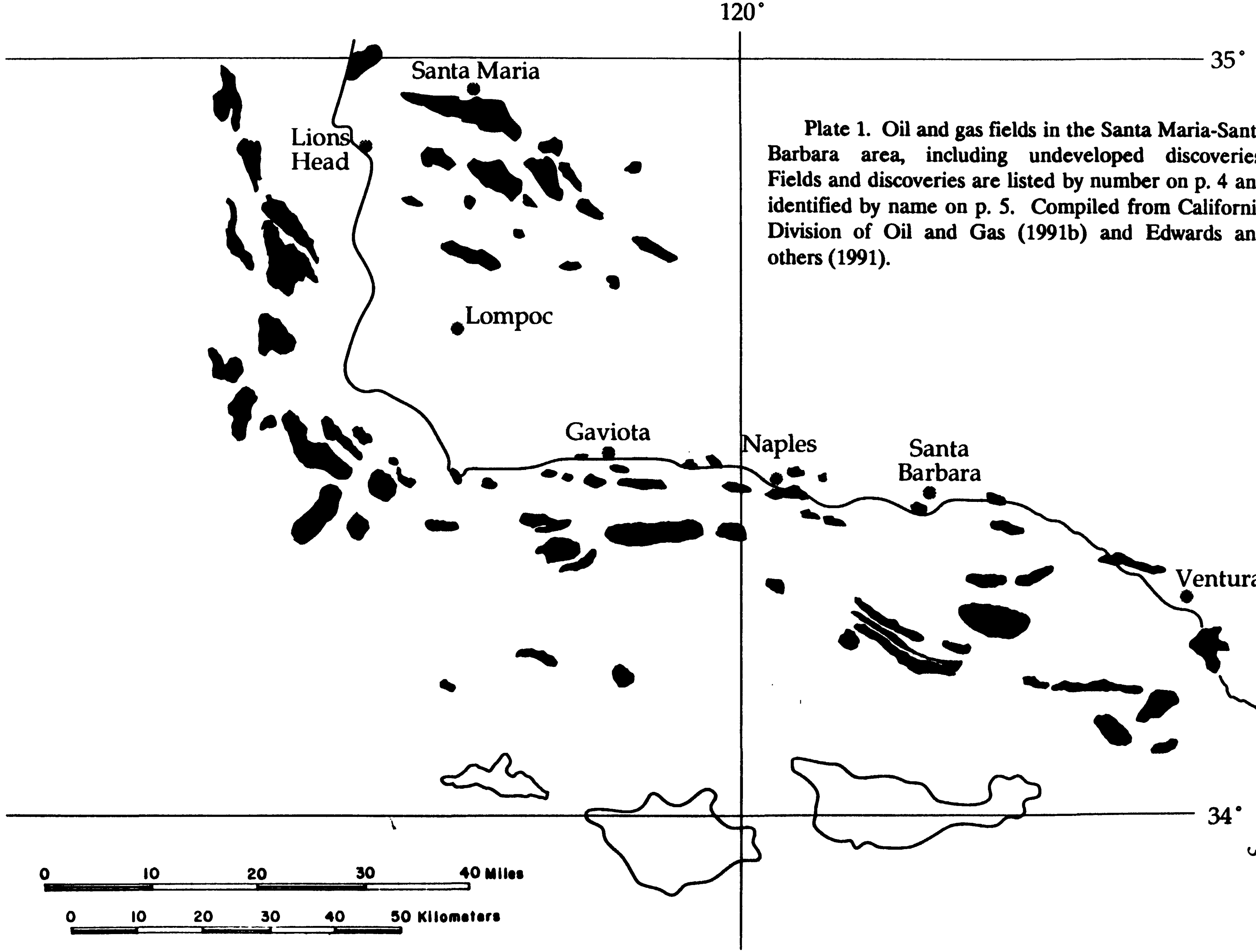
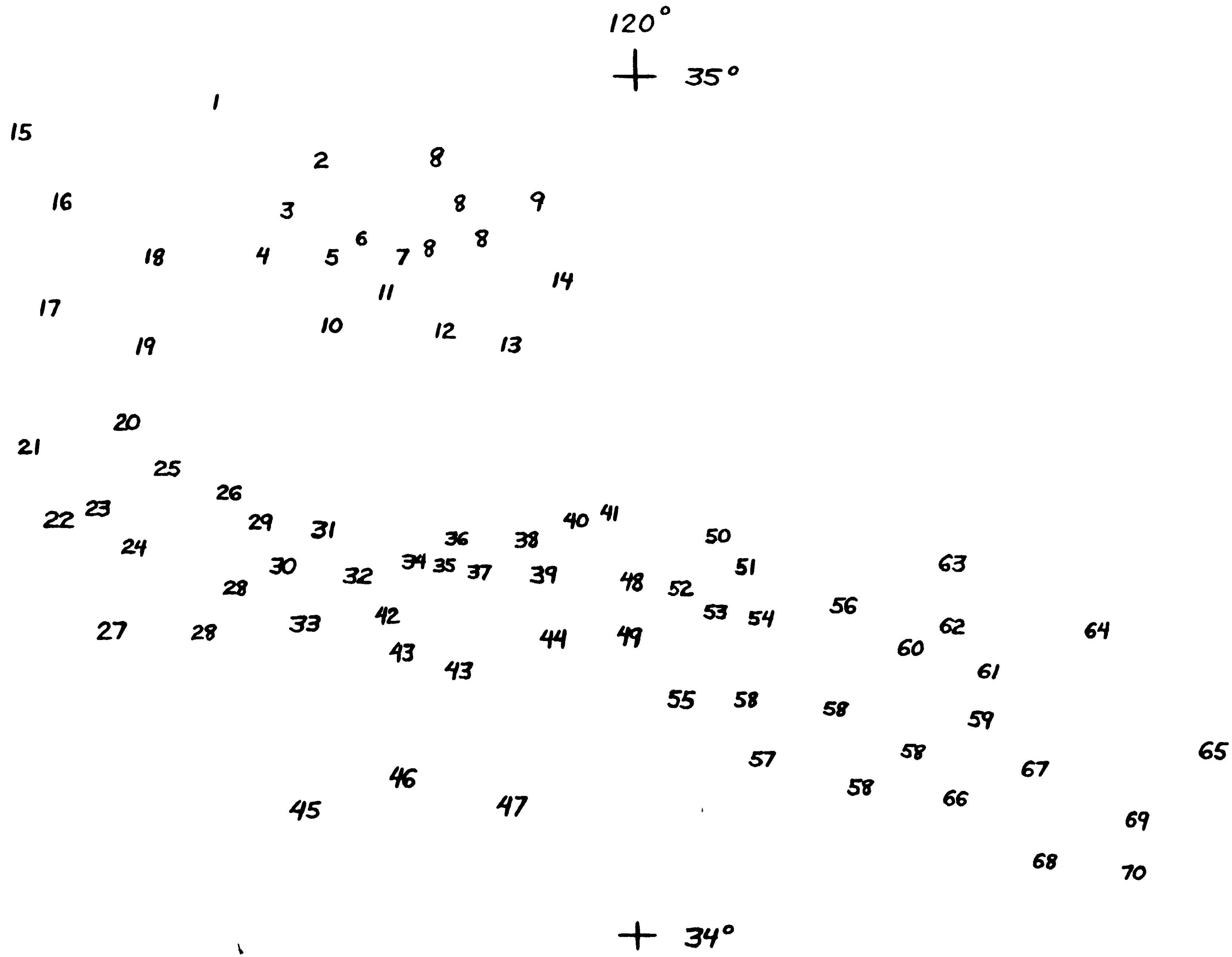


Plate 1. Oil and gas fields in the Santa Maria-Santa Barbara area, including undeveloped discoveries. Fields and discoveries are listed by number on p. 4 and identified by name on p. 5. Compiled from California Division of Oil and Gas (1991b) and Edwards and others (1991).


120°
35°
34°

FIELD NAMES

1 - Guadalupe
2 - Santa Maria Valley
3 - Casmalia
4 - Jesus Maria
5 - Northwest Harris Canyon (Abd)
6 - Orcutt
7 - Four Deer
8 - Cat Canyon
9 - Sisquoc Ranch (Abd)
10 - Lompoc
11 - Careaga Canyon
12 - Los Alamos
13 - Barham Ranch
14 - Zaca
15 - San Miguel
16 - Point Sal
17 - Santa Maria
18 - Purisma Point
19 - Unnamed 0435
20 - Point Pedernales
21 - Unnamed 0433
22 - Bonito
23 - Electra
24 - Point Arguello
25 - Rocky Point
26 - Jalama
27 - Sword
28 - Castle Rock
29 - Unnamed 0318
30 - Unnamed 0512
31 - Point Conception
32 - Conception Offshore (Abd)
33 - Government Point
34 - Cuarta Offshore (Abd)
35 - Alegria Offshore
36 - Alegria
37 - Caliente Offshore Gas
38 - Gaviota Offshore Gas
39 - Molino Offshore Gas
40 - Refugio Cove Gas (Abd)
41 - Capitan
42 - Sacate
43 - Pescado
44 - Hondo
45 - Unnamed 0176
46 - Wilson Rock
47 - Unnamed 0358
48 - Naples Offshore Gas
49 - Gato Canyon
50 - Goleta (Abd)
51 - Glenn Annie Gas (Abd)
52 - Elwood
53 - South Elwood Offshore
54 - Coal Oil Point Offshore (Abd)
55 - Unnamed 0335
56 - Mesa (Abd)
57 - Santa Rosa
58 - Smuggler's Cove
59 - Pitas Point
60 - Dos Cuadras
61 - Carpinteria Offshore
62 - Summerland Offshore
63 - Summerland
64 - Rincon
65 - West Montalvo
66 - Unnamed 0478
67 - Santa Clara
68 - Sockeye
69 - Unnamed 0479
70 - Hueneme

ONSHORE SANTA MARIA BASIN (oils #1-3, 5-9):

Source rocks: Most oil is assumed to be sourced from the Monterey Formation (or possibly from the underlying Point Sal Formation, which can be thought of as lower Monterey strata with turbidite sandstones).

Strata known to underlie the Monterey and Point Sal Formations include locally the non-marine Lospe Formation, Cretaceous sandstones and shales, and basement rocks of the Franciscan melange (Figure 1) - none of which are regarded as significant potential source rocks. However, there has been rumored speculation about a pre-Point Sal source rock locally present - for example in the deep part of the syncline south of the Orcutt oil field which extends eastward to near the Barham Ranch oil field (see Figure 4); in this area, comparatively light oil has been found in deep strata in the last decade. Most speculation centers on the idea that the Rincon Shale underlies the area (in the deepest part of the area, the Monterey extends to depths exceeding 13,000 ft and underlying strata have not been penetrated).

Potential source rocks overlying the Monterey Formation are the Pliocene diatomaceous Sisquoc Formation and the Pliocene Foxen Mudstone.

Reservoir rocks: According to Crawford (1971), 75% of production in the area is from fractured Monterey reservoirs, 2% from other fractured rock, and 23% from conventional permeable sandstone reservoirs in the Point Sal and Sisquoc Formations.

Traps: According to Crawford (1971), most oil in the onshore Santa Maria basin oil fields derives from two types of traps: (1) faulted anticlinal traps representing 58% of production (e.g., Lompoc and Orcutt oil fields - see Figure 2); and (2) onlap-truncation traps (consisting of truncated Monterey overlapped by Sisquoc; e.g., Santa Maria Valley oil field - see Figures 2 and 3) representing 38% of production.

Generative areas and timing of trapping: Deep potential generative areas for oil are principally (1) in the syncline between the Santa Maria Valley and Orcutt oil fields, and (2) in the syncline between the Orcutt and Lompoc oil fields, extending east to the area of the Barham Ranch and Four Deer oil fields (see Figure 4 and Plate 1). These presently deep areas generally show greatest diagenetic grade and thermal maturation (Pisciotto, 1981; Isaacs and Tomson, 1990).

The folding which formed the major anticlinal traps has generally been thought to have begun around the time of the Sisquoc-Monterey formational boundary (6 Ma), but Namson and Davis (1990) suggest that this folding did not begin until the middle Pliocene (c 3 Ma). In the latter case, overlap-truncation traps could contain earlier-generated oil than anticlinal traps (Lillis and King, 1991). Namson and Davis' (1990) analysis suggests (1) that a major part of the Monterey and Point Sal Formations in the basin entered "oil maturation depths" before the late Pliocene and Quaternary folding which created the main traps, but (2) that a pre-existing paleohigh along the Casmalia-Orcutt anticlinal trend (including the Casmalia, Orcutt, Zaca, and Four Deer oil fields) contributed to accumulation of migrating hydrocarbons in that area. A maturation model based on sulfur contents in kerogen has been published by Heasler and Surdam (1989) for the Los Alamos oil field.

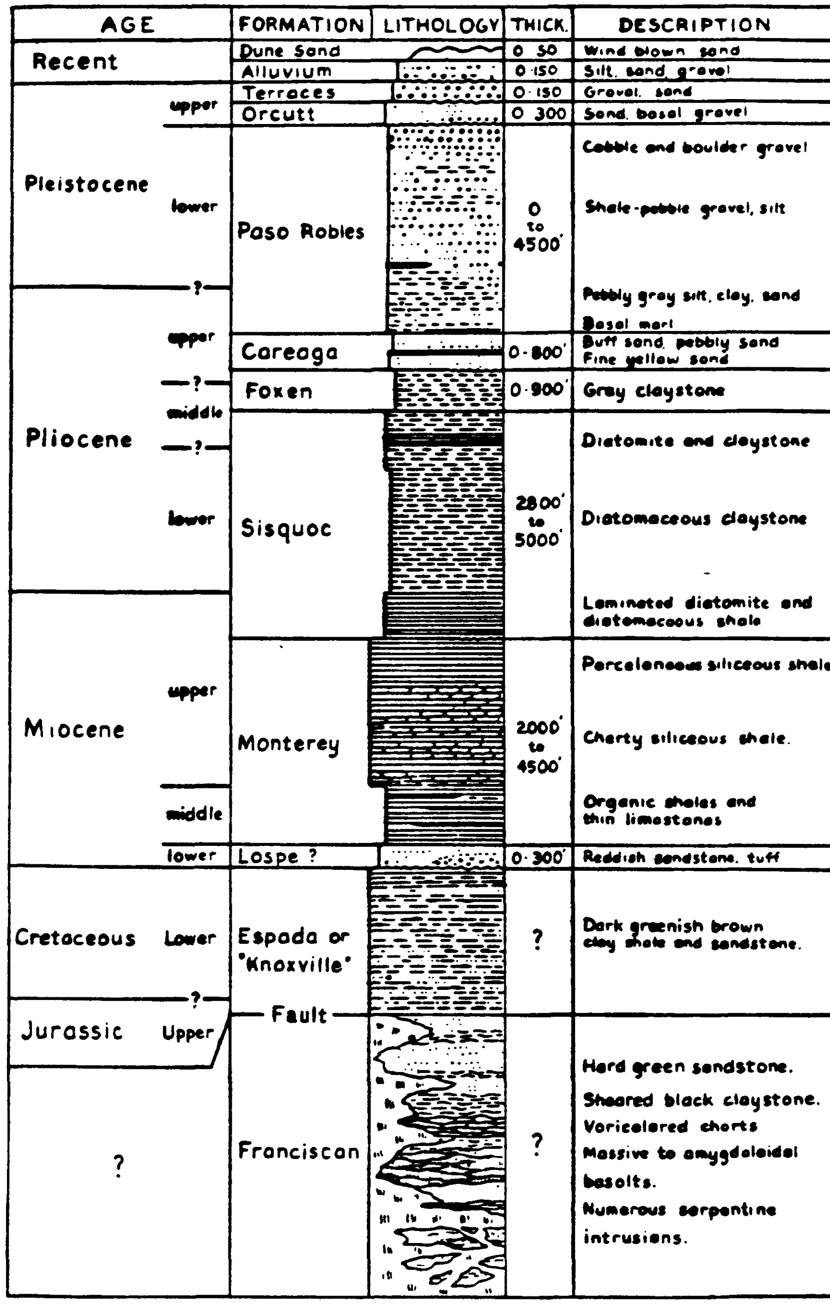


Figure 1. Stratigraphic sequence in the southern part of the onshore Santa Maria basin (from Dibblee, 1950; revised by Isaacs, 1989).

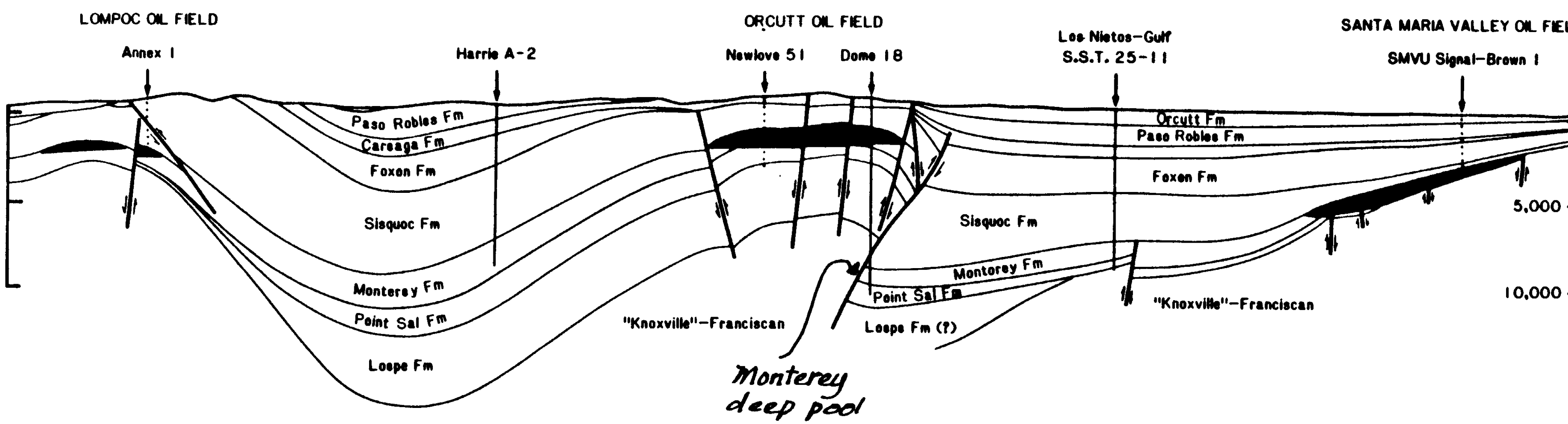


Figure 2. North-south cross-section across the central Santa Maria basin showing anticlinal traps in the Lompoc and Orcutt oil fields. (From Isaacs and Tomson, 1990; adapted from California Division of Oil and Gas, 1974, and Krammes and others, 1959).

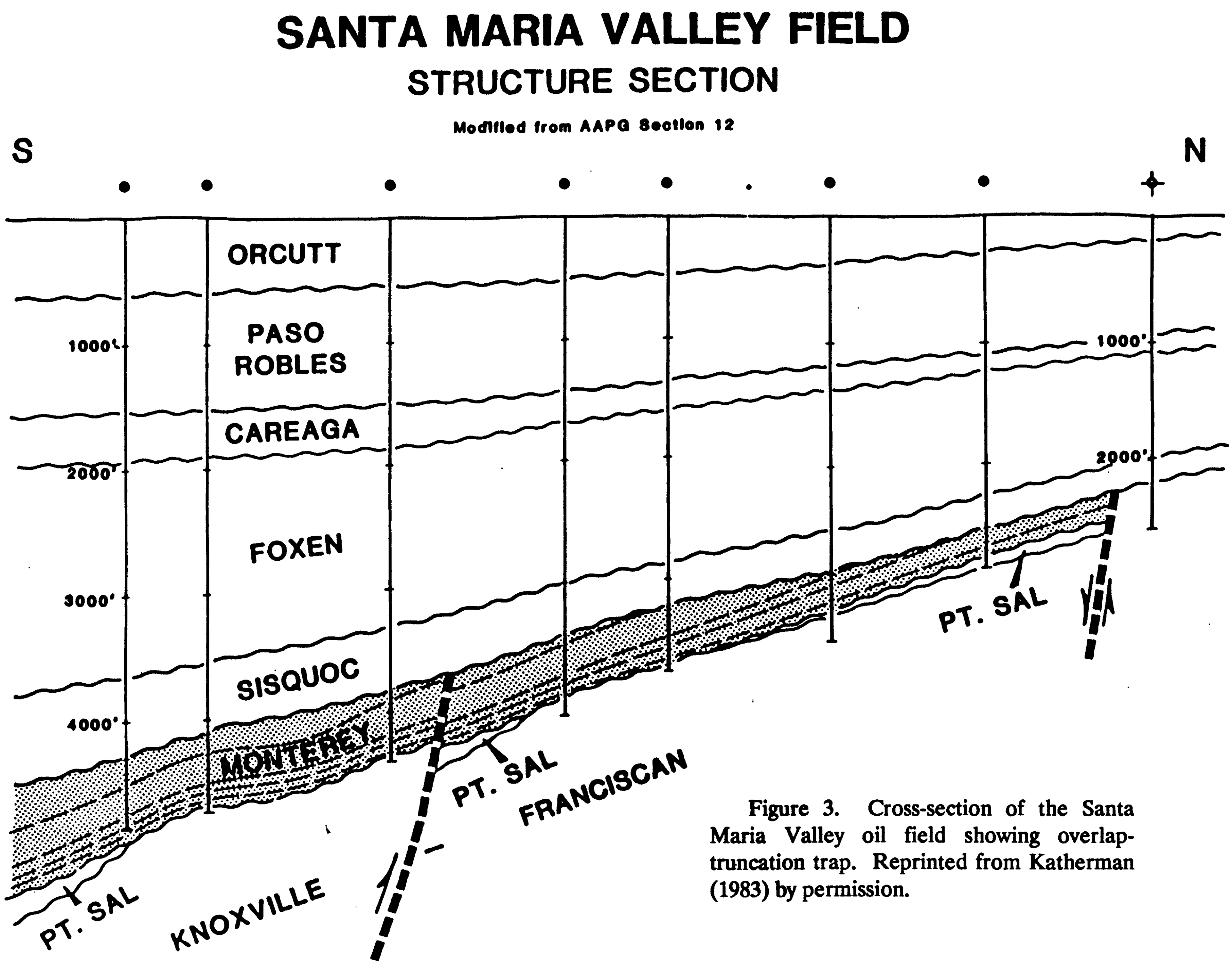


Figure 3. Cross-section of the Santa Maria Valley oil field showing overlap-truncation trap. Reprinted from Katherman (1983) by permission.

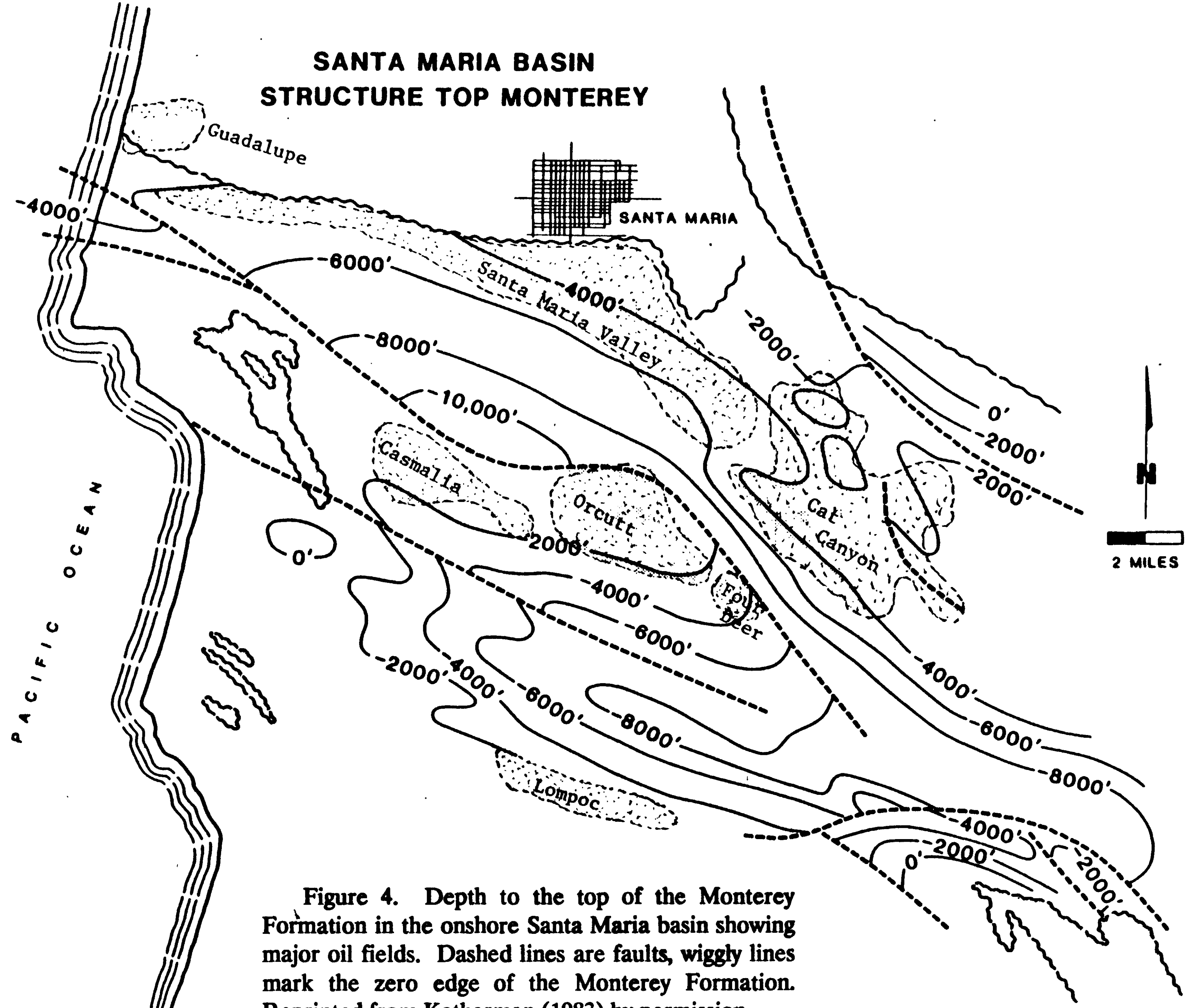


Figure 4. Depth to the top of the Monterey Formation in the onshore Santa Maria basin showing major oil fields. Dashed lines are faults, wiggly lines mark the zero edge of the Monterey Formation. Reprinted from Katherman (1983) by permission.

Geological references: For petroleum geology, see Crawford (1971), Katherman (1983), Namson and Davis (1990), and Dunham and others (1991).

Figures:

Figure 1 - Stratigraphic sequence in the southern part of the onshore Santa Maria basin (from Dibblee, 1950; revised by Isaacs, 1989).

Figure 2 - North-south cross-section across the central Santa Maria basin showing anticlinal traps (from Isaacs and Tomson, 1990; adapted from California Division of Oil and Gas, 1974, and Krammes, Curran, and others, 1959).

Figure 3 - Cross-section of the Santa Maria Valley field showing overlap-truncation trap (from Katherman, 1983).

Figure 4 - Depth to top of the Monterey in the onshore Santa Maria basin showing major oil fields (from Katherman, 1983).

OFFSHORE SANTA MARIA BASIN (oil #4):

Source rocks: As in the onshore Santa Maria basin, the Monterey is generally assumed to be the only significant source rock in the area. However, what is known about TOC values in the offshore suggest that they are much lower than in onshore, in the range 1-2% (Isaacs and others, 1989). According to Crain and others (1985), "Hydrocarbons in the Point Arguello field are believed to have been generated within the Monterey Formation on the basis of comparisons of carbon isotopes and chromatographic analyses of the oil and Monterey organic matter" (p. 545). For the most part, strata underlying the Monterey are Cretaceous sandstones and other basement rocks which are not likely source rocks (Figure 5).

Reservoir rocks: Nearly all reservoirs in the area are thought to be fractured Monterey reservoirs.

Traps: Anticlines and faulted anticlines are the principal traps identified in the offshore (Crain and others, 1985, 1987; Ogle and others, 1987; Crain and Thurston, 1987).

Generative areas and timing of trapping: Several deep potential generative areas for oil are present in the offshore, for example just northeast of the Point Arguello field where the top of the Monterey is as much as 11,000 ft deep (Crain and others, 1985, 1987). The Point Arguello structure is thought to have developed between late Miocene (about 6 Ma) and late Pliocene (2-3 Ma) (Crain and others, 1985, 1987), and the Monterey to have entered the oil window there about 6-7 Ma (Mero, 1991).

Geological references: For petroleum geology, see Ogle and others (1987), Crain and others (1985, 1987), and Crain and Thurston (1987). For some details on reservoir and hydrocarbon character in the Point Arguello field, see Crain and others (1985, 1987).

Figures:

Figure 5 - Stratigraphic correlation section for the offshore Santa Maria basin and part of the Santa Barbara Channel (from Ogle and others, 1987).

Figure 6 - Depth to top of the Monterey in the vicinity of the Point Pedernales oil field (from Ogle and others, 1987).

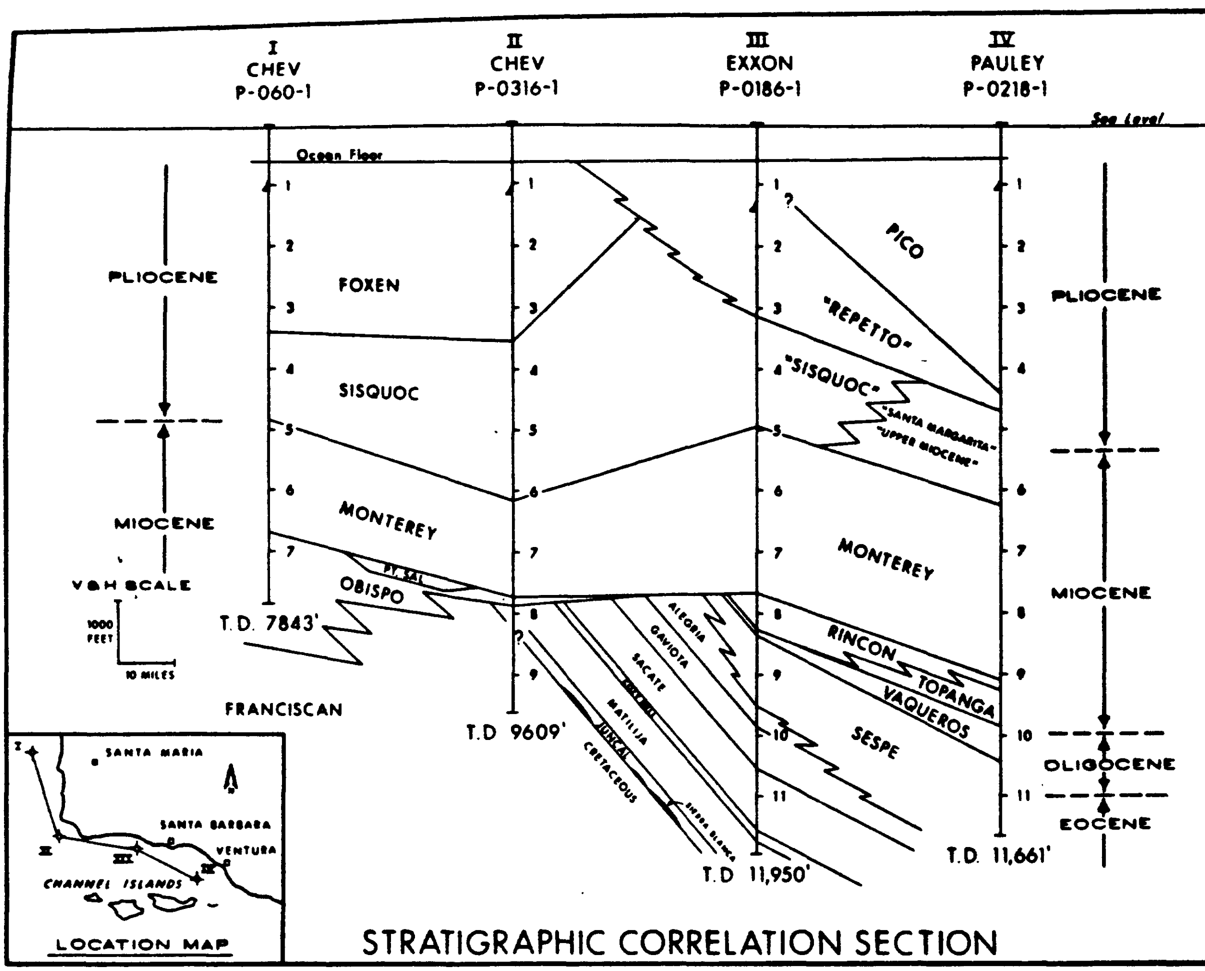


Figure 5. Stratigraphic correlation section for the offshore Santa Maria basin and part of the Santa Barbara Channel. Reprinted from Ogle and others (1987) by permission.

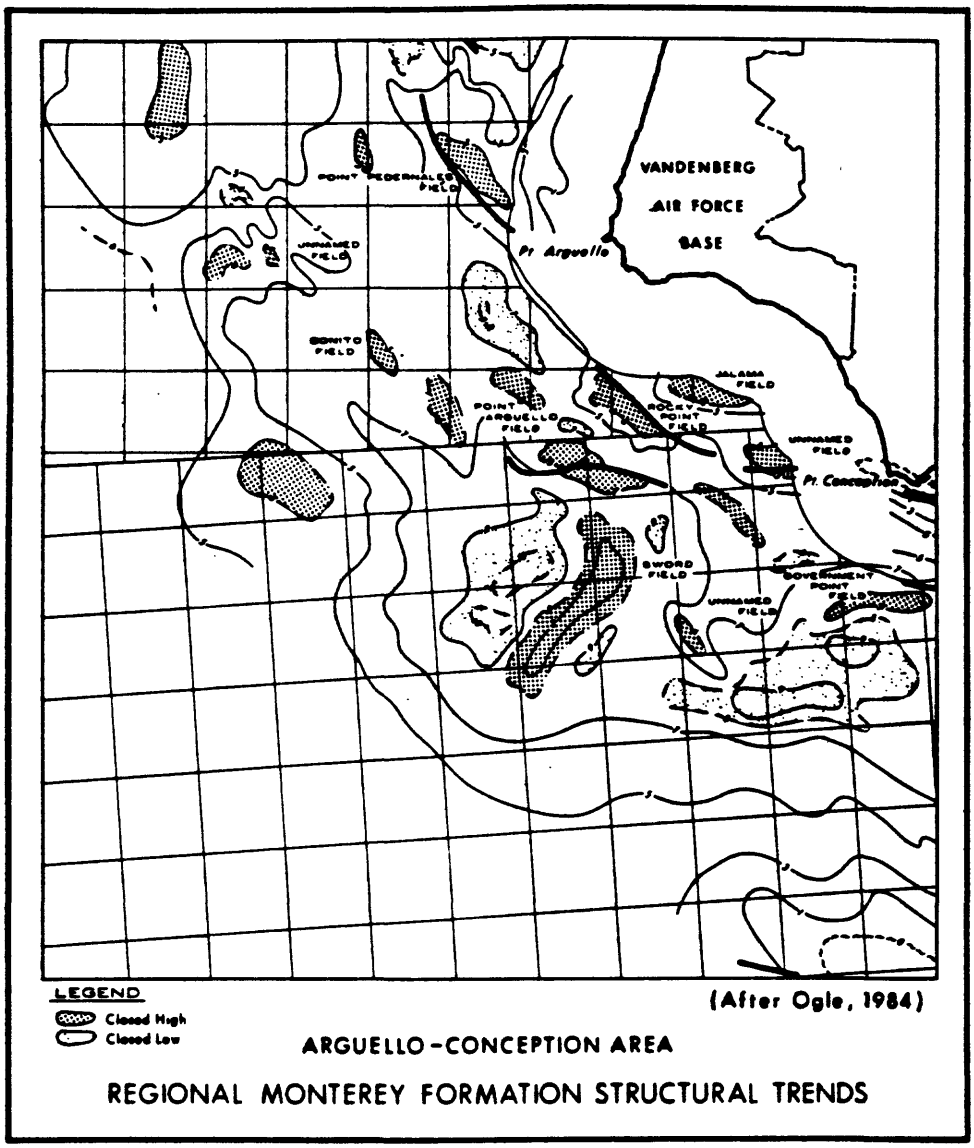


Figure 6. Depth to the top of the Monterey Formation in the vicinity of the Point Pedernales offshore oil field; contour interval is 2000 ft. Reprinted from Ogle and others (1987) by permission.

SANTA BARBARA-VENTURA BASIN (oils #10-11):

Source rocks: In contrast to the onshore Santa Maria basin, numerous potential source rocks are present in this area. Miocene sources (the Monterey Formation and Rincon Shale) are generally cited as the best potential hydrocarbon sources for the prolific oil largely reservoired in Pliocene sands and sandstones of the Ventura-Rincon trend (including Dos Cuadros offshore and Ventura oil fields; see Figure 9).

The hydrocarbons reservoired in pre-Miocene strata (about 10-15% of the total) almost certainly derived from Eocene sources though little information has been published on this topic (for a summary, see Keller, 1988). Crain and Thurston (1987) cite some bulk data from Chevron on potential Eocene source rocks and suggest that the Eocene Anita and Cozy Dell Formations are likely sources of hydrocarbons in the area (see Figure 10). Oils reservoired in Miocene and younger strata may also have been sourced (at least in part) by pre-Miocene strata.

Reservoir rocks: Most hydrocarbon production in the Santa Barbara-Ventura basin is from sand and sandstone reservoirs, primarily the deep-water Pliocene deposits of the Pico and Repetto Formations, and secondarily Oligocene and lower Miocene deposits in the non-marine Sespe Formation and marine Vaqueros Formation and Rincon Shale (see Figure 10). Producing fields with Monterey fractured reservoirs include the South Elwood field and Hondo field.

Traps: Anticlines and faulted anticlines are the principal traps in the area (Nagle and Parker, 1971; Keller, 1988).

Generative areas and timing of trapping: Deep potential generative areas for oil lie in east-west trends adjacent to anticlinal trends (e.g., Figure 8). According to Crain and Thurston (1987), potential trapping structures began to develop about 11 Ma, and a major compressive event in the Pleistocene was synchronous with or postdated hydrocarbon generation from Neogene source-rocks (Figure 10).

Geological references: For petroleum geology, see Curran and others (1971), Nagle and Parker (1971), Taylor (1976), Crain and Thurston (1987), Ogle and others (1987), and Keller (1988).

Figures:

Figure 7 - Stratigraphic sequence in the Santa Barbara-Ventura basin (from Dibblee, 1966; revised by Isaacs, 1989).

Figure 8 - Depth to top of Monterey in the Santa Barbara area (from Ogle and others, 1987).

Figure 9 - East-west cross-section across the Santa Barbara-Ventura basin (from California Division of Oil and Gas, 1991b).

Figure 10 - Schematic geohistory model for a hypothetical Santa Barbara Channel depocenter (from Crain and Thurston, 1987).

Figure 11 - Schematic generation model for Monterey oil types (from Ogle and others, 1987).

AGE			FORMATION	LITHOLOGY	THICKNESS	DESCRIPTION
QUATERNARY	RECENT		ALLUVIUM (N)		0-100'	Gravel, sand, silt
QUATERNARY	PLEISTOCENE	Upper	OLDER ALLUVIUM (N)		0-200'	Gravel, sand, silt
QUATERNARY	PLEISTOCENE	Upper	FANGLOMERATE (N)		0-100'	Boulder gravel
QUATERNARY	PLEISTOCENE	Lower	SANTA BARBARA		0-2000'	Fine yellow sand
?		?				NOT IN CONTACT
TERTIARY	PLIOCENE	Upper / Lower	PICO		0-2000'	Blue gray siltstone, fine sand; basal conglomerate
TERTIARY	MIOCENE	Upper	SISQUOC			Diatomaceous clay shale
TERTIARY	MIOCENE	Upper / Middle	MONTEREY		1700-2300'	Hard platy siliceous shale; soft fissile to hard platy siliceous shale; thin limestone beds
TERTIARY	MIOCENE	Lower	RINCON		1700'	Gray clay shale
TERTIARY	MIOCENE	Lower	VAQUEROS		300'	Buff sandstone
TERTIARY	? OLIGOCENE		SESPE (N)		2500'	Interbedded grey to buff sandstone and red to green grey siltstone
TERTIARY	OLIGOCENE		GAVIOTA		0-1000'	Buff sandstone
TERTIARY	? EOCENE	Upper	COLDWATER		0-2500'	Buff sandstone, thin beds of gray sandy siltstone
TERTIARY	EOCENE	Upper	SACATE		2500'-3000'	Gray clay shale; minor buff sandstone
TERTIARY	EOCENE	Upper	COZY DELL		1800'-4000'	Gray clay shale; minor buff sandstone
TERTIARY	EOCENE	?	MATILIJA		1000'-2000'	Buff sandstone
TERTIARY	EOCENE	Middle	ANITA		0-300'	Clay shale and buff sandstone
CRETACEOUS		Upper	JALAMA		4500'+	Dark gray clay shale; minor thin sandstone beds
						SANTA YNEZ FAULT

(N) Non-marine formation; all others marine

Figure 7. Stratigraphic sequence in the Santa Barbara-Ventura basin (from Dibblee, 1966; revised by Isaacs, 1989).

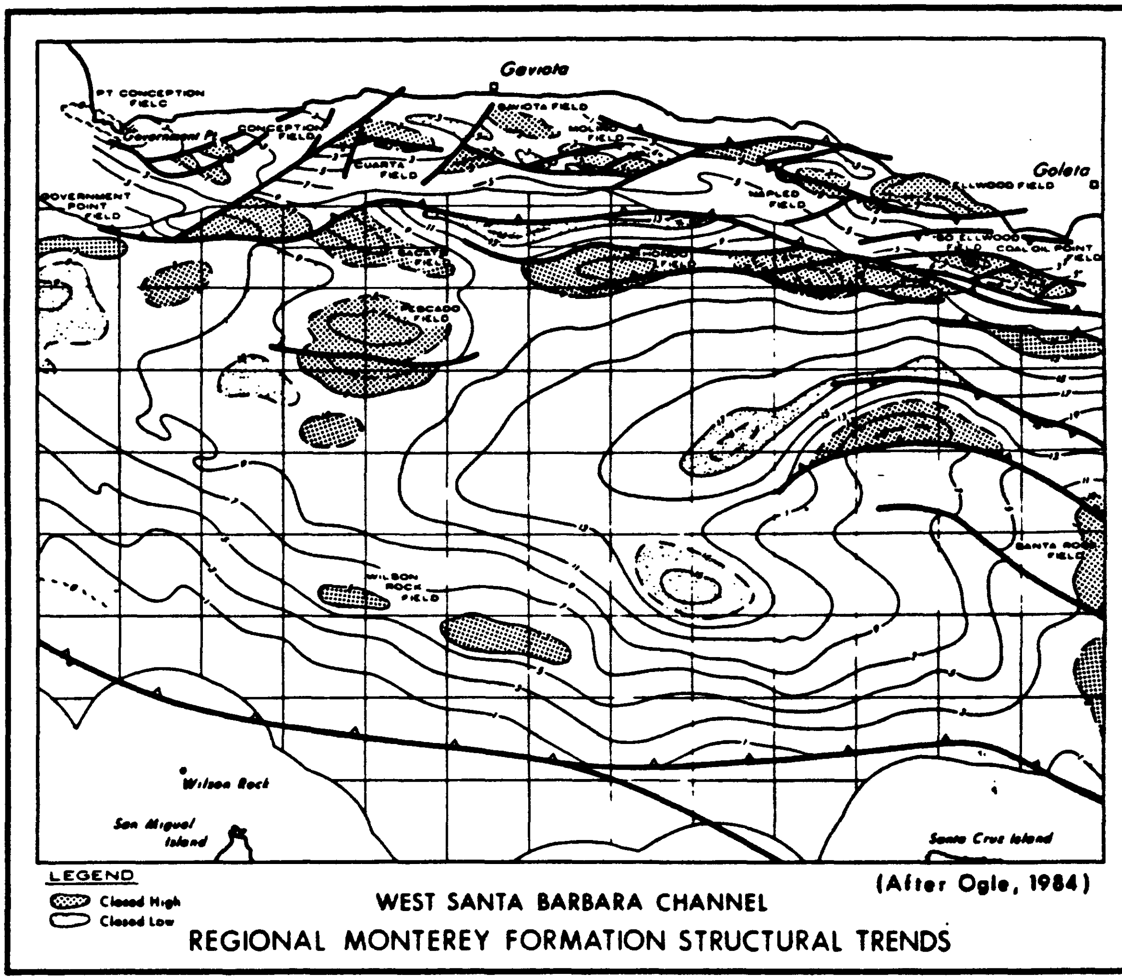


Figure 8. Depth to the top of the Monterey Formation in the western part of the Santa Barbara Channel; contour interval is 2000 ft. Reprinted from Ogle and others (1987) by permission.

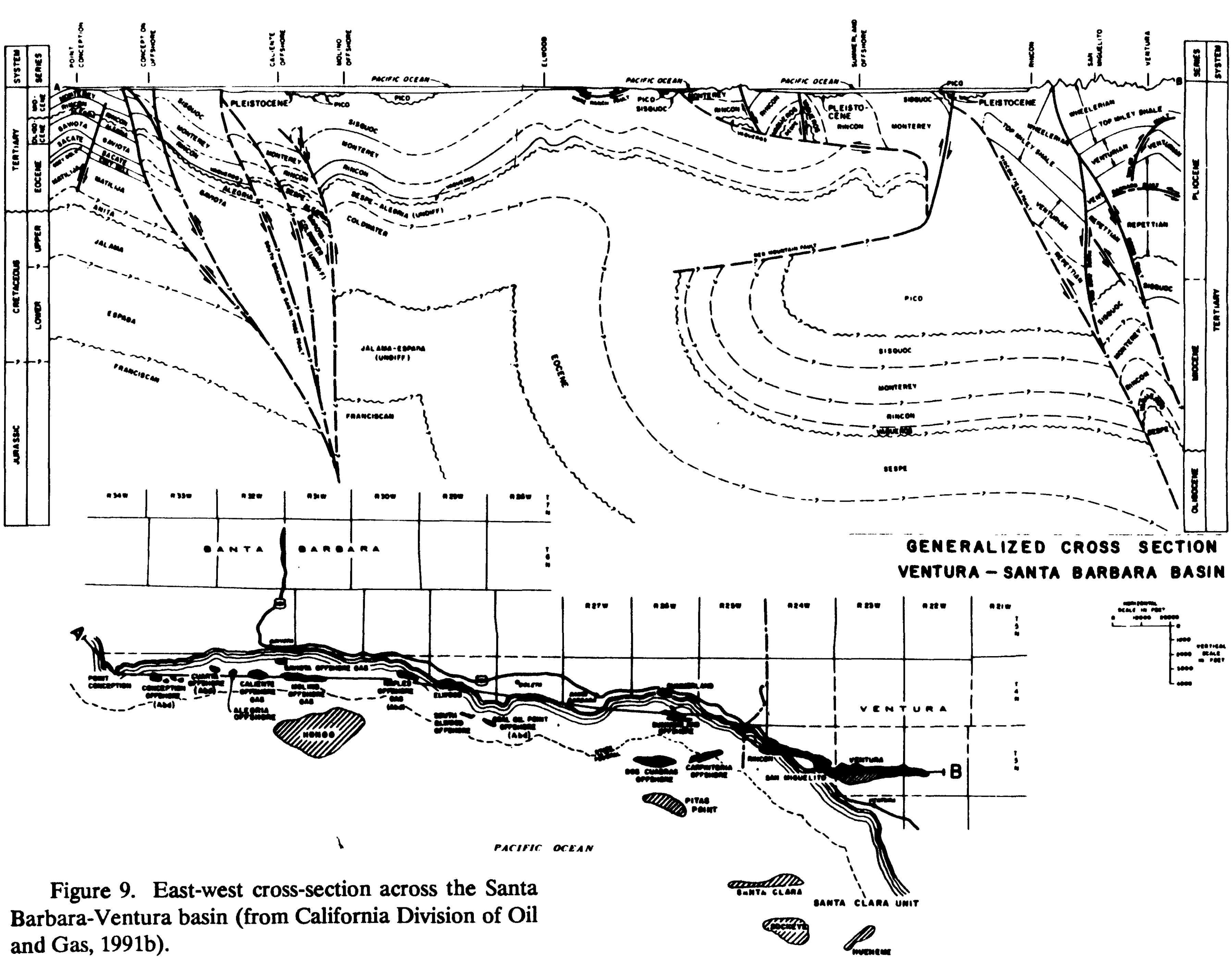


Figure 9. East-west cross-section across the Santa Barbara-Ventura basin (from California Division of Oil and Gas, 1991b).

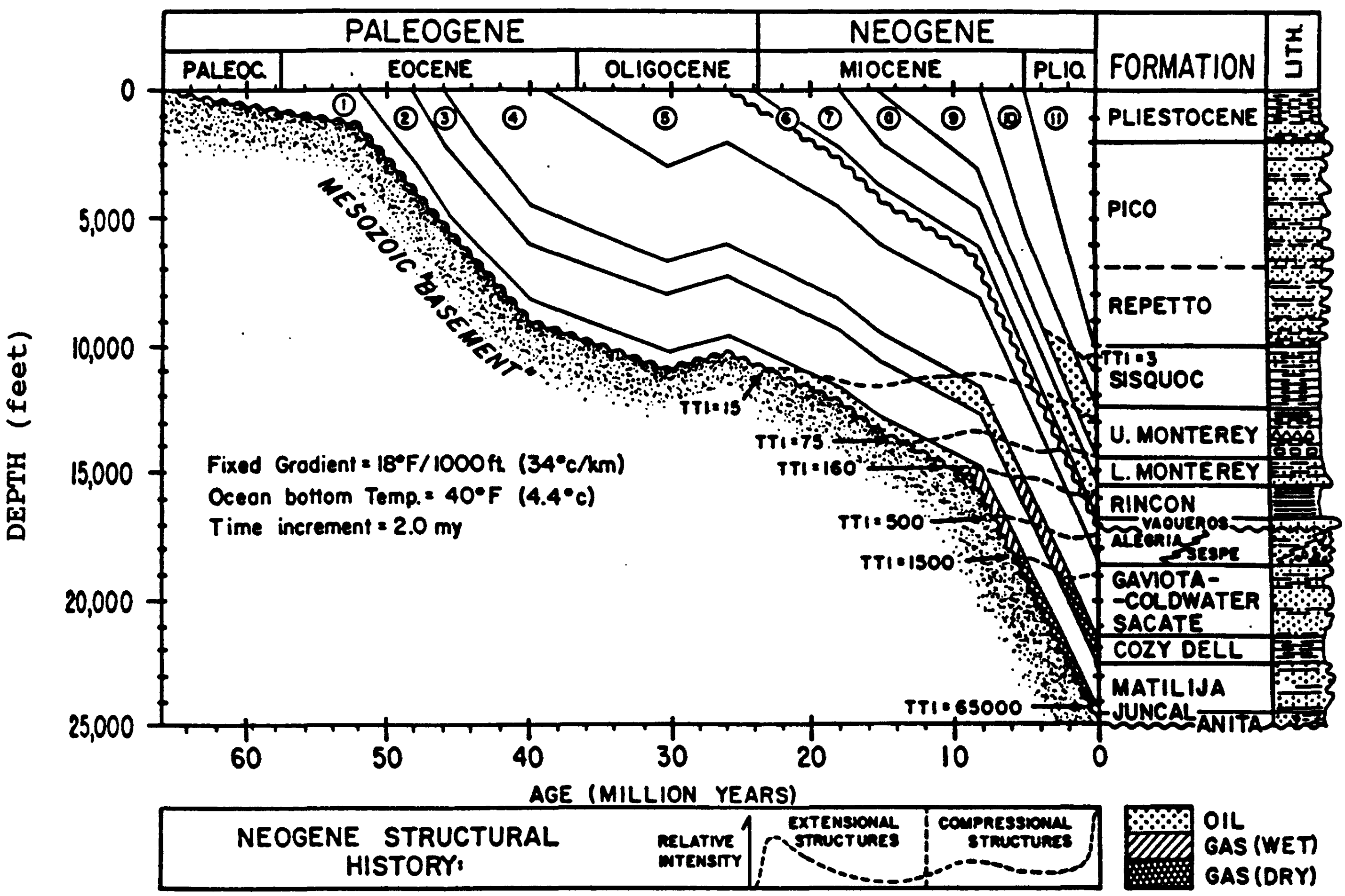


Figure 10. Schematic geohistory model for a hypothetical Santa Barbará Channel depocenter. Reprinted from Crain and Thurston (1987) by permission.

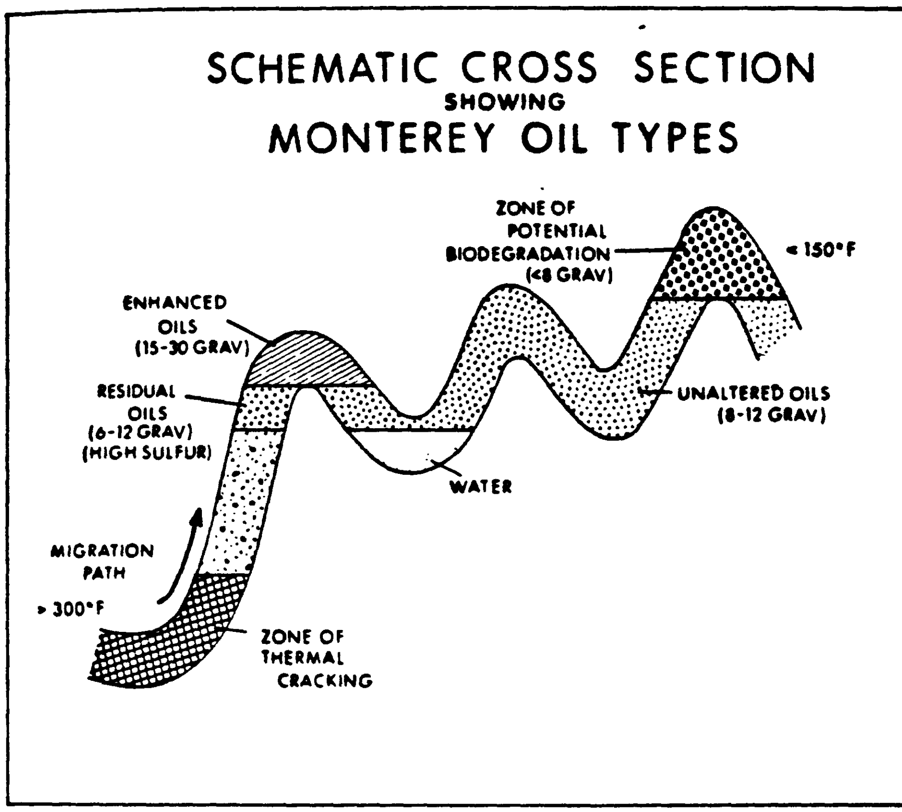


Figure 11. Schematic generation model for Monterey oil types. Reprinted from Ogle and others (1987) by permission.

PETROLEUM GEOLOGY BACKGROUND ON FIELDS AND OILS

ONSHORE SANTA MARIA BASIN

Orcutt Oil Field (oils #3 and #6):

The Orcutt oil field represents the largest oil field among the CMOGS oil sample set, being a giant oil field (>100 MMbbl oil) with total production plus proved reserves through 1990 at about 180 MMbbl oil and 285 Bcf gas, ranking 32nd in size among California oil fields (California Division of Oil and Gas, 1991a; see also Table 1).

The Orcutt field is a faulted, asymmetrical anticline with most production at 1700-2700 ft depth (Table 1). According to the California Division of Oil and Gas (1991a, 1991b; see Table 1), most production derives from (a) Monterey fractured reservoirs with average depth 1700 ft, average thickness 950 ft, average temperature 120-160° F, and average API gravity 14-17°; and (b) from sandstone reservoirs in the Point Sal Formation having average depth 2700 ft, average thickness 550 ft, average temperature 165° F, and API gravity in the range 22-24°. Katherman (1983) mentions three oil zones: (1) upper Monterey (arenaceous and cherty zones of the Monterey Formation) with API gravity 14-19°; (2) lower Monterey (bentonitic brown, buff and brown, and dark brown zones of the Monterey Formation) with API gravity 22-27°; and (3) Point Sal Formation with API gravity 24-29°. A new pool discovered in 1981 called the Monterey deep pool (see Figure 2) has much deeper average producing depth of 9295 ft, average reservoir temperature 245° F, and API gravity in the range 32-36° (Table 1).

Oil #3 from the Union Squires 4 well was chosen to represent an oil reservoired in "pure Monterey" (though production may in fact be commingled with Point Sal production), and oil #6 from the Union Newlove 73 well was chosen to represent an oil reservoired in the Point Sal. Production records (see notes Table 2) indicate a gravity of about 20° API for oil #3 and 24° API for oil #6.

Reference: See Katherman (1983) p. 16-17 for text and Figures IV-2 and IV-3 for structure contour map and cross-section of the Orcutt field. See p. 366-369 from California Division of Oil and Gas (1991b) for field data and another structure contour map and cross-section.

Casmalia oil field (oils #7 and #9)

The Casmalia oil field has cumulative production plus proved reserves through 1990 of about 50 MMbbl oil and 24 Bcf gas (California Division of Oil and Gas, 1991a; see also Table 1).

Like the Orcutt oil field, the Casmalia oil field is a faulted asymmetrical anticline. The original discovery (in 1905) was in Monterey fractured reservoirs with average reservoir depth 1275-2800 ft, average reservoir thickness 300-1000 ft, average reservoir temperature 100-180° F, and API gravity 8-25° (Table 1). Minor production since 1916 also derives from somewhat deeper reservoirs in Point Sal sandstones with (according to Katherman, 1983) API gravity 30-35°. Minor production since 1946 also derives from sandstones in the

Lospe Formation in reservoirs with average depth 3953 ft, average thickness 345 ft, average temperature 160° F, and (according to Katherman, 1983) API gravity 20-22°.

Oils #7 and #9 were chosen to represent the maximum contrasts in the Casmalia oil field. Oil #7 from the Union Morganti 1 well (drilled in 1934) was produced from the predominant Monterey fractured reservoirs, and oil #9 from the B.E. Conway Newhall 29-1 well (drilled in 1984) from deeper reservoirs in the Lospe Formation. Production records (see notes Table 2) indicate a gravity of about 9° API for oil #7 and 32° API for oil #9.

Reference: See Katherman (1983) p. 26-27 for text and Figures IV-19 and IV-20 for structure contour map and cross-section of the Casmalia field. See p. 78-79 from California Division of Oil and Gas (1991b) for field data and another structure contour map and cross-section.

Lompoc oil field (oil #5)

The Lompoc oil field has cumulative production plus proven reserves through 1990 of 48 MMbbl oil and 53 Bcf gas (California Division of Oil and Gas, 1991a; see also Table 1).

Like the Orcutt and Casmalia oil fields, the Lompoc oil field is a faulted asymmetrical anticline. The main field area (discovered in 1903) produces from fractured reservoirs in the upper part of the Monterey Formation, principally the cherty zone. This reservoir has average depth 2250-2750 ft, average thickness 450-500 ft, average temperature 160-180° F, and API gravity in the range 15-26° (Table 1).

Oil #5 from the Union Purisima 43 well (drilled in 1947) derives from the northern part of the main field area in the Purisima anticline. Production records (see notes Table 2) indicate a gravity of about 19° API for this oil.

Reference: See Katherman (1983) p. 18 for text and Figures IV-5 and IV-6 for structure contour map and cross-section of the Lompoc field. See p. 238-241 from California Division of Oil and Gas (1991b) for field data and another structure contour map and cross-section.

Zaca field (oil #8)

The Zaca oil field has cumulative production plus proved reserves through 1990 of 30 MMbbl oil and 3 Bcf gas (California Division of Oil and Gas, 1991a; see also Table 1).

Although classed by Crawford (1971) as an overlap-truncation trap, the Zaca field is generally described by authorities in the area as a faulted homocline on the south flank of an anticline (California Division of Oil and Gas, 1974; Katherman, 1983; Namson and Davis, 1990). The field (discovered in 1942) produces from fractured reservoirs in the lower part of the Monterey Formation. The reservoir has average depth 3500 ft, average thickness 1700 ft, average temperature 125-160° F, API gravity in the range 7-10.5°, and sulfur in the range 6.8-8% (Table 1; Katherman, 1983).

Oil #8 was produced from the Getty Davis 2 well (drilled in 1980) in the central part of the field area.

Reference: See Katherman (1983) p. 32-33 for text and Figures IV-27 and IV-28 for structure contour map and cross-section of the Zaca field. See p. 366-369 from California Division of Oil and Gas (1991b) for field data and another structure contour map and cross-section. See Namson and Davis (1990) for another cross-section and discussion of the structure of the field.

Four Deer Oil Field (oil #1)

The Four Deer oil field is comparatively small, with cumulative production plus proved reserves through 1990 of 2.3 MMbl oil and 4.7 Bcf gas (California Division of Oil and Gas, 1991a; see also Table 1). According to Katherman (1983), the Four Deer oil field is distinctive in producing the highest gravity oil from Monterey strata in the onshore Santa Maria basin.

Like the Orcutt, Casmalia, and Lompoc oil fields, the Four Deer oil field is another anticlinal trap with the structure described as an anticlinal nose (see contours in California Division of Oil and Gas, 1991b). The field was discovered in 1947 but more than doubled in size during the 1980s with exploration in the deeper subthrust Monterey on the east side of the field (Katherman, 1983, Figure IV-31). The reservoir has average depth 4800-6200 ft, average thickness 600-1100 ft, average temperature 190° F, average sulfur 1.6%, and API gravity 22-35° (California Division of Oil and Gas, 1991b). According to Katherman (1983), there are two reservoir horizons: (1) an upper Monterey horizon (arenaceous and cherty zones) producing oil with API gravity 30-36°; and (2) a lower Monterey horizon (bentonitic brown, buff and brown, and dark brown zones) producing oil with API gravity 27-29°.

Oil #1 was probably produced from the Chevron Los Flores 1 well (drilled in 1947) which was the discovery well for the field (see notes Table 2). Production records from that well indicate a gravity of about 36° API.

Reference: See Katherman (1983) p. 34-35 for text and Figures IV-30 and IV-31 for structure contour map and cross-section of the Four Deer field. See p. 152-153 from California Division of Oil and Gas (1991b) for field data and another structure contour map and cross-section.

Barham Ranch Oil Field (oil #2)

The Barham Ranch oil field is another comparatively small field, but it is growing. Cumulative production plus proven reserves through 1985 were only 0.26 MMbbl oil and 0 Bcf gas, but through 1990 are 1.5 MMbbl oil and 0.7 Bcf gas (California Division of Oil and Gas, 1991a; see also Table 1). In 1991, another 1.6 MMbbl oil and 1.3 Bcf gas were added to reserves (California Division of Oil and Gas, 1992). The growth is due to discovery of a new field area in 1983 called the La Laguna area.

The Barham Ranch oil field is a faulted anticline, and the new La Laguna area may represent a deeper subthrust Monterey reservoir. In the Old area of the field, production is from both basal Sisquoc and Monterey, with the two reservoirs having respectively average depths 1400 and 2800 ft, average thicknesses 500 and 200-400 ft, average temperatures 85° F and 100° F, average sulfur 1.3%, and API gravity 14-16° and 14° (Table 1). In the La Laguna area of the field, production is from fractured Monterey with average depth 4000 ft, average thickness 200 ft, and API gravity 30-33° (Table 1).

Oil #2 is from the Monterey in the Triton Blair 9 well (drilled in 1989) in the La Laguna area and is the discovery well for a field extension of that area (California Division of Oil and Gas, 1990). Production records (see notes Table 2) indicate a gravity of about 29° API for this oil.

Reference: See Katherman (1983) p. 38 for text and Figures IV-39 and IV-40 for structure contour map and cross-section of the Barham Ranch field. See p. 42-45 from California Division of Oil and Gas (1991b) for field data and another structure contour map and cross-section.

OFFSHORE SANTA MARIA BASIN

Point Pedernales Offshore Oil Field (oil #4)

The Point Pedernales oil field is a giant oil field with ultimate production informally estimated at as high as 300 MMbbl oil (Crain and Thurston, 1987). Production through 1990 was 24 MMbbl oil and 5 Bcf gas, with officially proved reserves through 1990 estimated at 49 MMbbl oil and 15 Bcf gas (California Division of Oil and Gas, 1991a; see also Table 1). The Point Pedernales offshore oil field was the only field in the offshore Santa Maria basin that had commercial production by the end of 1990.

The Point Pedernales oil field is a closed anticlinal trap (Ogle and others, 1987). In the presently developed part of the field reported by California Division of Oil and Gas (1991b), the reservoir is fractured Monterey with average depth 6600 ft and API gravity in the range 14-18°.

Oil #4 is from the Union Pedernales A-4 well drilled in 1986.

Reference: See California Division of Oil and Gas (1991b) p. 624-625 for the small amount of data released on this field.

SANTA BARBARA-VENTURA BASIN

South Elwood Offshore Oil Field (oils #10 and #11):

The South Elwood offshore oil field produced through 1990 45 MMbbl oil and 29 Bcf gas, and has official proved reserves of 22 MMbbl oil and 16 Bcf gas (California Division of Oil and Gas, 1991a; see also Table 1). The first discovery was a Rincon sandstone reservoir in 1965, followed by discovery of an underlying pool in Vaqueros and Sespe sandstones in 1967. The Monterey fractured reservoir was discovered only in 1969 but recently accounts for 95% of production from the field. (Informally acknowledged rumor indicates that the Monterey was originally cemented-in, and the reservoir was discovered only because of a leak.)

The South Elwood offshore oil field is a faulted anticline. In the presently developed part of the field reported by California Division of Oil and Gas (1991b), Sisquoc reservoirs have average depth 1350 ft, average thickness 10 ft, average temperature 99° F, and API gravity in the range 25-34°. Monterey reservoirs have average depth 3350 ft, average thickness 500 ft, average temperature 150° F, average sulfur 2.02%, and API gravity in the range 25-34°. Rincon reservoirs have average depth 5000 ft, average thickness 150 ft, average temperature 190° F, average sulfur 0.20%, and API gravity 32-34°. Underlying Vaqueros and Sespe reservoirs have average depth 5900-6000 ft, average thickness 60-150 ft, average temperature 208° F, and API gravity 33° (Table 1).

Oils #10 and #11 were produced from the South Elwood field and represent the extremes in gravity among a set of oils collected by Arco from the field in August 1982. Both oils are reservoired in the Monterey. Production records (see notes Table 2) indicate a gravity of about 24-28° API for oil #10 and 14-15° API for oil #11

Reference: Because of litigation between the state of California and the field operators during the late 1980s, release of oils or other data or information on this field was impossible during that period, and little has been published. See California Division of Oil and Gas (1991b) p. 658-659.

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Table 1. Oil field data for onshore Santa Maria basin, offshore Santa Maria basin, Santa Barbara coast, and Santa Barbara Channel (from California Division of Oil and Gas, 1991a, 1991b). Note that figures for "Production + reserves" (following field names) are less than anticipated ultimate recovery, especially for recent discoveries. Study oils are identified in the column at the far left.

	Geologic basin / Field (Product'n + Reserves) / Area / Pool	Pool Disc'y Date	Cumulative production oil and condensate (MMbbl) Field	Area	Pool	Cumulative Production Gas (Bcf)	Average Reservoir Depth (ft)	Average Reservoir Thickness (ft)	Pool API gravity	Sulfur Content (wt %)	Reservoir Temperature (degrees F)
	Onshore Santa Maria Basin (including all fields)										
	Cat Canyon (320.0 MMbbl)		290.8			169.9					
	East Area										
	Sisquoc	1953					3000	250	9–18	4.1	100–150
	Brooks	1909					3500	150	6–11	6.0	135
	Monterey	1953					–	–	6	–	–
	Central Area										
	Sisquoc	1956					2800	45	7–15	–	103
	Sisquoc Area										
	Foxen	1980					1750	50	9.4	–	79
	Sisquoc	1944					2750	500	6.0–8.0	4.5	105–120
	Thomas	1954					4900	70	8.0–16.0	–	130–120
	Monterey	1944					4000	500	6.4–11.0	–	180
	West Area										
	Sisquoc	1908					2800	600	13.0–16.5	3.03	105
	S6–S6A Gas	1960					3405	45	–	–	–
	Alexander	1953					3750	200	23.0	3.13	–
	Los Flores	1938					6000	1500	11.0–22.0	5.07	175–200
	Gato Ridge Area										
	Sisquoc	1937					2210	200	13	–	110
	Monterey	1915					3800	300	9–14	5.87	110–160*
	Tinaquaic Area										
	Monterey	1945					2020–3180	1200–3200	6–8	–	103
	Olivera Canyon Area										
	Sisquoc	1979					2550	20	8.4	–	–
	Monterey	1944					3000	1500	6.0–8.0	–	135*

	Geologic basin / Field (Product'n + Reserves) / Area / Pool	Pool Disc'y Date	Cumulative production oil and condensate (MMbbl) Field	Area	Pool	Cumulative Production Gas (Bcf)	Average Reservoir Depth (ft)	Average Reservoir Thickness (ft)	Pool API gravity	Sulfur Content (wt %)	Reservoir Temperature (degrees F)
	Santa Maria Valley (218.5 MMbbl)		200.2			254.8					
	Main Area			154.2		228.3					
	Foxen	1934					2000	200	16.5	–	–
	Sisquoc	1934					3330	75	12.0–17.0	–	–
	Monterey	1934					3360	960	12.0–17.0	3.0	–
	Point Sal	1936					4330	200	15.0	–	–
	Bradley Area			23.3		13.3					
	Basal Sisquoc	1972			22.6	13.1	5000	160	12–16	4.13	170–190
	Monterey	1972			0.74	0.28	5610	295	14	–	–
	Clark Area			8.2		3.1					
	Foxen	1974			<0.0005	0.000	2600	250	10.0	–	–
	Basal Sisquoc	1970			0.14	0.01	4500	250	8.5	4.35	118–150
	Monterey	1968			8.0	3.1	6725–7490	850	9.5	–	210
	North Area (abd)			0.001		0.000					
	Foxen	1965					2250	340	13	–	100
	Southeast Area			12.2		6.4					
	Foxen	1977			0.001	0.000	2600	315	10	–	–
	Basal Sisquoc	1941			6.4	4.2	4500	250	8–15	–	120
	Houk	1952			4.8	1.6	6000	1000	9–14	–	145–180
	Monterey	1956			1.0	0.55	7000	1000	8	–	195
	West Area			2.4		3.7					
	Foxen	1953					3490	160	14	–	90
	Sisquoc	1953					3610	280	19	–	–
	Monterey	1953					4410	200	14	0.6	170–185
	Franciscan	1953					4660	10–300	14	–	120
	Orcutt (179.1 MMbbl)		167.6			280.8	1700	950	14–17		
	Main Area			167.5		280.7					
	Diatomite	1979			0.03	0.04	1400	100	–	–	107
3	Monterey	1901				[illegible]	1700	950	14–17	–	120–160
	Monterey deep	1981			0.18	0.27	9295	400	32–36	–	245
6	Point Sal	1905					2700	550	22–24	–	165

	Geologic basin / Field (Product'n + Reserves) / Area / Pool	Pool Disc'y Date	Cumulative production oil and condensate (MMbbl) Field	Area	Pool	Cumulative Production Gas (Bcf)	Average Reservoir Depth (ft)	Average Reservoir Thickness (ft)	Pool API gravity	Sulfur Content (wt %)	Reservoir Temperature (degrees F)
	Careaga area			0.075		0.06					
	Monterey	1937			0.050	0.04	5020	1040	22–34	2.170	176
	Point Sal	1985			0.010	0.02	9020	120	28–30	0.614	230
	Lospe	1985			0.014	0.002	9676	100	31–34	1.648	255
	Casmalia (49.5 MMbbl)		39.6			16.5					
7	Monterey	1905					1275–2800	300–1000	8–25	2.80	100–180
	Point Sal	1916					2750	500	–	–	140
9	Lospe	1946					3953	345	–	–	160
	Lompoc (48.3 MMbbl)		45.5			48.5					
	Main area			44.4		47.7					
5	Monterey	1903					2250–2750	450–500	15–26	–	160–180
	Northwest area			1.1		0.79					
	Monterey	1983					2700	280	17.0–19.5	1.84	150
	Guadalupe (40.4 MMbbl)		38.3			25.2					
	Sisquoc	1948			38.0	25.2	2700	120	8–14	5.39	155
	Monterey–Point Sal	1955			0.011	0.006	3000	200	11–12	5.39	–
	Sisquoc–Monterey				0.326	0.000					
	Zaca (29.8 MMbbl)		27.5			2.9					
8	Monterey	1942					3500	1700	8.0	6.76–8.00	125–160
	Four Deer (2.3 MMbbl)		1.4			3.1					
1	Monterey	1947					4800–6200	600–1100	22–35	1.62	190
	Barham Ranch (1.5 MMbbl)		1.0			0.40					
	Old Area (0.26 MMbbl)			0.26		0.000					
	Basal Sisquoc	1945					1400	500	14.0–16.0	1.3	85
	Monterey	1943					2800	200–400	14.1	1.3	100
	La Laguna Area (1.2 MMbbl)			0.76		0.40					
2	Monterey	1983					4000	200	30–33	–	–
	Jesu Maria (0.49 MMbbl)		0.30			0.04					
	Main Area			0.29		0.02					
	Monterey	1948					2600–2900	290–500	8–12	–	110
	East Area			0.009		0.02					

Geologic basin / Field (Product'n + Reserves) / Area / Pool	Pool Disc'y Date	Cumulative production oil and condensate (MMbbl) Field	Area	Pool	Cumulative Production Gas (Bcf)	Average Reservoir Depth (ft)	Average Reservoir Thickness (ft)	Pool API gravity	Sulfur Content (wt %)	Reservoir Temperature (degrees F)
Monterey	1985					1950	220	11.5	–	–
Los Alamos (0.47 MMbbl)		0.35			0.20					
Monterey	1972					9300	550	34–38	–	206*
Careaga Canyon (0.37 MMbbl)		0.37			0.77					
Old Area			0.06		0.03					
Monterey	1976					7960	690	34	0.20	158
San Antonio Creek Area (abd)			0.30		0.74					
Monterey	1983					8400	235	34.9	0.47	244
Harris Canyon Northwest (abd)		0.010			0.000					
Monterey	1983					5600	50	30.4	–	–
Sisquoc Ranch (abd)		0.006			0.000					
Monterey	1980					1900	150	11–16	–	110
Offshore Santa Maria Basin – developed fields										
Point Arguello (estimated ultimate recovery 300–500 MMbbl)										
Pico								11–23		
Sisquoc										
Monterey	1980	0				7900	1000	20	0.8–5.0	245
Point Pedernales (72.8 MMbbl)*		24.2			5.0					
4 Monterey	1982					6600	–	14–18	–	–

*estimated ultimate recovery 100–300 MMbbl

Offshore Santa Maria Basin – undeveloped fields (data from Crain and Thurston, 1987)										
San Miguel (estimated ultimate recovery 300 MMbbl)										
Monterey	1983	0						8–12		
Rocky Point										
Sisquoc	1983	0								
Monterey	1983	0						25–36		
Point Sal Unit Area										

Geologic basin / Field (Product'n + Reserves) / Area / Pool	Pool Disc'y Date	Cumulative production oil and condensate (MMbbl) Field	Area	Pool	Cumulative Production Gas (Bcf)	Average Reservoir Depth (ft)	Average Reservoir Thickness (ft)	Pool API gravity	Sulfur Content (wt %)	Reservoir Temperature (degrees F)
Monterey	1984	0						10–16		
Bonito										
Monterey	1083	0						16–18		
Electra										
Monterey	1983	0						14–16		
Jalama										
Monterey	1983	0						12–18		
Sword (in-place heavy oil in deep water exceeds 1000 MMbbl)										
Monterey*	1978	0						12		
etc.										
Santa Barbara Channel and coastal area (excluding most of the Ventura area)										
OIL FIELDS:										
Dos Cuadros Offshore (266.6 MMbbl)		219.7			105.9					
Repetto	1969					2300	745	18–32	–	–
Monterey	1972					9500	46	34	–	–
Hondo Offshore Oil (201.9 MMbbl)		107.0			72.8					
Monterey	1968					8200*	1250	13–20	–	210
Rincon Oil (161.8 MMbbl)		150.6			215.5					
Offshore Area			34.2		34.4					
Miley (Pliocene)	1928					2615 @4500	380	32	0.2	123 @4000
Onshore Area			116.4		181.1					
Main Area (Pliocene Pico Fm)										
Shallow	1927					3400	140	30	–	–
Top	1927					4100	120	29	–	125
Intermediate	1929					4390	140	29	–	129
Miley	1928					4750	640	30	1.08	134
Upper Deep	1929					5550	2200	30	–	–
Deep	1929					7800	2600	26	–	–
Oak Grove Area										

	Geologic basin / Field (Product'n + Reserves) / Area / Pool	Pool Disc'y Date	Cumulative production oil and condensate (MMbbl)			Cumulative Production Gas (Bcf)	Average Reservoir Depth (ft)	Average Reservoir Thickness (ft)	Pool API gravity	Sulfur Content (wt %)	Reservoir Temperature (degrees F)
			Field	Area	Pool						
	Shallow	1931					5700	800	30	–	–
	Padre	1931					6600	1000	30	–	176
	Miley	1931					7700	1800	30	–	–
	Wood	1945					10700	700	30	–	–
	1st Grubb	1961					10900	1000	28	–	–
	2nd Grubb	1969					11900	1100	28	–	–
	3rd Grubb	1969					13000	1000	28	–	–
	Padre Canyon Area										
	Shallow	1936					3700	800	30	–	–
	Padre	1936					4350	390	30	0.2	130 @4400
	Miley	1936					5600	500	30	–	–
	Deep	1953					10800	1100	26	–	–
	Elwood Oil (107.9 MMbbl)		106.1			97.7					
	Onshore area (abd)			26.9		30.5					
	Rincon	1931					2600	1500	26	–	–
	Vaqueros	1928					3400	300	38	–	155
	Upper Sespe	1935					3700	100	36	–	–
	Bell 14	1931					4800	60	42	–	–
	Sespe Gas	1936					5200	100	–	–	–
	Lower Sespe	1936					5620	1000	34	–	–
	Offshore Area (81.0 MMbbl)			79.2		67.2					
	Rincon	1938					2100	900	26	–	–
	Vaqueros	1929					3400	320	38	–	120–155
	Upper Sespe	1935					3700	100	36	–	–
	Bell 14	1934					4500	60	42	–	–
	Sespe Gas	1936					5200	100	–	–	–
	Lower Sespe	1936					5620	250	34	–	–
	South Elwood Offshore Oil (67.0 MMbbl)		44.8			28.9					
	Sisquoc	1969					1350	10	25–34	–	99
10	& 11 Monterey	1969					3350	500	25–34	2.02	150
	Rincon	1965					5000	150	32–34	0.20	190

Geologic basin / Field (Product'n + Reserves) / Area / Pool	Pool Disc'y Date	Cumulative production oil and condensate (MMbbl) Field	Area	Pool	Cumulative Production Gas (Bcf)	Average Reservoir Depth (ft)	Average Reservoir Thickness (ft)	Pool API gravity	Sulfur Content (wt %)	Reservoir Temperature (degrees F)
Vaqueros (abandoned)	1967					5900	60	33	–	208
Sespe (abandoned)	1967					6000	150	33	–	208
Carpinteria Offshore Oil (45.8 MMbbl)		36.0			39.5					
Pico	1964					3800	920	26.2	–	124
Subthrust Pico	1967					6000	350	27.0	–	160
Santa Clara Offshore Oil (43.6 MMbbl)		23.3			48.8					
Pico	1983					4400	–	–	–	101
Monterey	1975					7900	–	28	–	188
Summerland Offshore Oil (29.7 MMbbl)		27.4			97.4					
Vaqueros	1957					7000	196	35	0.54	175
Sockeye Offshore Oil (28.2 MMbbl)		5.9			12.8					
Monterey	1970					4880*	–	16	–	150
Upper Topanga	1970					5200*	–	18	–	150
Lower Topanga	1970					5600*	–	29	–	167
Upper Sespe	1970					5600*	–	29	–	167
Middle Sespe	1970					6700*	–	–	–	180
Conception Offshore Oil (20.9 MMbbl)		20.9			12.3					
Vaqueros	1961					4600	30	32–42	–	160
Alegria	1961					3000	250–300	32–42	0.13	128–150
Gaviota	1961					4400	100	32–42	–	160
Capitan Oil (20.3 MMbbl)		20.1			14.8					
Onshore Area			20.0		14.7					
Vaqueros	1929					1100	100	19–23	0.69	98
Sespe Gas	1931					1600	650	–	–	110*
Erburu 8	1931					2300	150	41	–	120
Erburu 10	1931					2475	175	44	–	120
Middle Sespe	1935					2750	250	45	–	120
Covarrubias Gas	1946					3400	250	–	–	156
Gaviota	1945					3850	150	39	–	156
Coldwater Gas	1955					4400	250	–	–	155
Offshore Area (abd)			0.07		0.03					

Geologic basin / Field (Product'n + Reserves) / Area / Pool	Pool Disc'y Date	Cumulative production oil and condensate (MMbbl) Field	Area	Pool	Cumulative Production Gas (Bcf)	Average Reservoir Depth (ft)	Average Reservoir Thickness (ft)	Pool API gravity	Sulfur Content (wt %)	Reservoir Temperature (degrees F)
Vaqueros	1930					1250	100	16	–	–
Erburu 8	1932					–	–	43	–	–
Erburu 10	1932					–	–	43	–	–
Mesa Oil (3.7 MMbbl; abd)		3.7			0.008					
Main Area			3.7		0.008					
Vaqueros	1930					2200	50	18	0.45–0.55	–
Palisades Area			0.02		0.000					
Vaqueros	1929					2150	60	20–24	0.45	–
Summerland Oil (3.2 MMbbl)		3.2			1.7					
Onshore Area										
Main	<1894					140	100	7	–	–
Vaqueros	1929					1400	300	–	–	–
Sespe	1948					3200	1000	16	–	–
Offshore Area										
Main	1896					220	100	7	–	–
Vaqueros	1929					1400	300	16	0.54	–
Point Conception Oil (1.4 MMbbl)		1.3			0.74					
Offshore Area			1.1		0.65					
Sacate	1965					2800	500	30–33	–	110
Onshore Area			0.17		0.09					
Gaviota	1972					2500	200	29–30	–	105
Sacate	1972					2750	600	29–30	–	110
Coal Oil Point Offshore Oil (abd)		1.3			3.3					
(Estimated ultimate reserves >100 MMbbl but abandoned for environmental–political reasons)										
Old Area		0.001			0.02					
Vaqueros	1947					3130	10	30	–	90
Matilija(?)	1948					9245	25	32	–	222
Devereaux Area		1.3			3.3					
Monterey	1982					–	–	**	–	**
Vaqueros	1961					5450	50	29–30	–	**
Sespe	1961					5600	350	29–30	–	**

Geologic basin / Field (Product'n + Reserves) / Area / Pool	Pool Disc'y Date	Cumulative production oil and condensate (MMbbl) Field	Area	Pool	Cumulative Production Gas (Bcf)	Average Reservoir Depth (ft)	Average Reservoir Thickness (ft)	Pool API gravity	Sulfur Content (wt %)	Reservoir Temperature (degrees F)
Alegria Offshore Oil (1.0 MMbbl)		1.0			4.0					
Vaqueros	1962					3800	100	39–45*	–	129
Alegria	1962					3950	140	39–45*	–	–
Cuarta Offshore Oil (0.61 MMbl; abd)		0.61			18.8					
Vaqueros Gas	1959					4020	50–70	–	–	138
Alegria	1959					4080	150	28–38	–	140
Gaviota	1961					5300	250	32–55	–	161
Sacate	1961					6500	150	28–36	–	187
Cozy Dell	1961					6900	150	33–36	–	192
Goleta Oil (0.14 MMbbl; abd)		0.14			0.06					
Sespe	1927					400–1400	125	40–43	–	–
Rincon Creek Oil (0.04 MMbbl)		0.04			0.14					
Sespe	1982					6700	42	42	0	143
Alegria Oil (0.007 MMbbl; abd)		0.007			0.01					
Rincon	1958					1890–2350	50–100	12–25	–	–
Las Varas Canyon (0.005 MMbbl; abd)		0.005			0.28					
Erburu Gas (Sespe)	1928					1800	100	–	–	–
Erburu (Sespe)	1958					1885	50	38	–	–
Covarrubias (Sespe)	1958					2180	40	38	–	–
Barnsdall (Sespe)	1927					2450	50	41	–	–
GAS FIELDS:										
Molino Offshore Gas (440.0 Bcf)		4.6			249.9					
Vaqueros	1962					6200	140	–		190–212
Sespe–Alegria	1962					6400	250	–		190–212
Matilija	1983			0.17	11.3	10500	800	–		–
Pitas Point Offshore Gas (201.2 Bcf)		0.14			136.0					
Middle Pico	1977					5000–7000	–	–	–	155
Lower Pico	1978					10000–10500	–	–	–	211
Repetto	1978					10700–11500	–	–	–	229
Gaviota Offshore Gas (70.0 Bcf)					70.0					

Geologic basin / Field (Product'n + Reserves) / Area / Pool	Pool Disc'y Date	Cumulative production oil and condensate (MMbbl)			Cumulative Production Gas (Bcf)	Average Reservoir Depth (ft)	Average Reservoir Thickness (ft)	Pool API gravity	Sulfur Content (wt %)	Reservoir Temperature (degrees F)
		Field	Area	Pool						
Vaqueros-Sespe	1960					5100	450	62	–	195
La Goleta Gas (47.3 Bcf)		0.005			47.3					
Vaqueros	1932					3950	350	–	–	140–155
Caliente Offshore Gas (32.8 Bcf)					32.6					
Vaqueros	1962					6000–6200	200	–	–	220
Sespe–Alegria	1962					6400	75	–	–	220
Naples Offshore Gas (20.8 Bcf; abd)		0.22			20.8					
Vaqueros	1960					5700	200	–	–	–
Refugio Cove Gas (1.0 Bcf; abd)		0.003			1.0					
Vaqueros	1988					1500	20	–	–	–
Sespe	1946					2900	50	–	–	120
Glen Annie Gas (0.49 Bcf; abd)					0.49					
Vaqueros	1958					3350	80	–	–	108

abd=abandoned

* Vertical subsea depth

*Estimated
**Confidential

*Estimated
**Confidential

Table 2. Well identifications for study oils. Notes on production histories attached.

Oil #	Well	Field Area Pool	Section–Township–Range	API well number	Total depth** (ft)	Year Drilled	Producing interval (ft)
1	Chevron Los Flores 1*	Four Deer Monterey	4–33W–8N	04–083–01083	5998	1947	5238–5998
2	Triton Blair 9	Barham Ranch La Laguna area Monterey	3–32W–7N	04–083–22159	6150	1989	4053–6150
3	Union Squires 4	Orcutt Main area Monterey	26–34W–9N	04–083–02368	3140	1905	2350–3140
4	Union Pedernales A–4	Point Pedernales Monterey		56–45–20053	5612	1986	
5	Union Purisima 43	Lompoc Monterey	36–34W–8N	04–083–01935	2795	1947	2150–2270
6	Union Newlove 73	Orcutt Main area Point Sal	26–34W–9N	04–083–02322	3853	1947	3254–3853
7	Union Morganti 1	Casmalia Monterey	13–35W–9N	04–083–00891	1507	1934	1217–1507
8	Texaco Davis 2	Zaca Monterey	33–31W–8N	04–083–20414	5841	1971	4210–5841
9	B.E. Conway Newhall 29–1	Casmalia Monterey Monterey Lospe	29–34W–9N	04–083–21944	4624	1984	2600–2660 2705–2745 4390–4490
10	Arco Ames 3120–11	South Elwood Monterey	34–29W–4N	04–283–20268	8283	1979	6560–7883
11	Arco Ames 3242–10	South Elwood Monterey	34–29W–4N	04–283–20265–01	5650	1979	4705–5590

* Well identification and data tentative

** Measured depth, not true vertical depth

TABLE 2 NOTES ON PRODUCTION HISTORIES

1 Four Deer Field oil: The Four Deer oil field had only 9 wells in production in 1989, and the well identified by Chevron as the producer of oil #1 (Chevron Los Flores 1 well) was used as a waste-water well from 1980 to 1989 and was plugged and abandoned on 9/28/89. The oil might have been collected during abandonment procedures, but confirmation has not been made.

If correctly identified, the well (drilled in 1947) was the discovery well for the Four Deer oil field. The producing interval was 5238-5998 ft, gravity during intial production was 36° API. Study oil collected by Chevron circa 9/89.

2 **Triton Blair 9**: drilled 1989, cemented casing with water shut-off @ 3598 ft; production from slotted liner (perforations in cemented pipe) 4053-6150 ft. Top Monterey 4053 ft, unfaulted Monterey to total depth. Gravity: initial production (320 bbl/day) @ 28.9° API, after 30 days (193 bbl/day) @ 28.9° API. Study oil collected at the well-head while the well was pumping by Frank Getz (consultant) 8/89.

3 **Union Squires 4**: drilled 1905, casing never cemented; no major work since 1912. Probably producing horizon 2350-3140 ft. Top Monterey 2188 ft, top Pt. Sal tentatively about 2735 ft. Gravity: early production (early 1906) @ 26° Baume; in March 1932, 20.1° API. Study oil collected by Unocal 7/20/89.

4 **Union Pedernales A-4**: no information at the moment. Study oil collected by Unocal 7/89.

5 **Union Purisima 43**: drilled 1947, cemented casing with water shut-off @ 2318 ft, perforated in 1948 @ 2150-2270 ft; bridge-plug installed in 1978 @ 2295 ft (production changed from 417 bbl water and 4 bbl oil per day to 15 bbl water and 51 bbl oil); effective production now from 2150-2270 ft. Top Monterey @ 2128 ft. Gravity: initial production @ 20.1° API, after 8 days 20.0° API; after perforating (in 1948) @ 19.2° API. Study oil collected by Unocal 7/21/89.

6 **Union Newlove 73**: drilled 1947, almost continuously cored below 3260 ft; cemented casing with water shut-off @ 3254 ft., producing horizon 3254-3853 ft. Top Monterey 2335 ft, top Point Sal tentatively @ 3307 ft; Lospe not penetrated. Gravity: initial production @ 24.5° API, stabilized @ 23.9° API after 10 days. Point Sal in Orcutt field now in water flood. Study oil collected by Unocal 7/20/89.

7 **Union Morganti 1**: drilled 1934, cemented casing with water shut-off @ 897 ft; landed casing @ 1217 ft, effective producing horizon 1217-1507 ft. Well deepened to 1616 ft in 1972. Top Monterey @ 1078 ft. Gravity: initial production (1934) @ 9° API. Study oil collected by Unocal 7/89; and, due to excess water, re-collected 12/89-1/90.

TABLE 2 NOTES ON PRODUCTION HISTORIES - cont'd.

8 **Texaco Davis 2**: drilled in 1971 to 5284 ft, deepened in 1980 to 5841 ft; cemented casing with water shut-off @ 4120 ft; producing interval now 4210-5841 ft. Top Sisquoc @ 1400 ft, top Monterey tentatively about 4224 ft, top Point Sal tentatively about 5210-5260 ft. Gravity: not reported. Study oil collected by Texaco 7/89-8/89.

9 **B.E. Conway Newhall 29-1**: drilled 1984, initial production from Lospe (4390-4490 ft) @ 34.5° API; tested in Monterey only in 1987 @ 25.8° API; perforations in cemented casing in Monterey (2600-2660 and 2705-2745 ft) added 10/87 to produce commingled Lospe and Monterey with gravity tested @ 30.7-34.7° API (av 32) between 11/87 and 6/88. Top Monterey @ 2596 ft, top Lospe @ 4390 ft. Study oil collected by Conoco in 7/89.

10 **Arco Ames 3120-11**: drilled 1979, reworked 3/81 to add Monterey perforations @ 6560-7883 ft, *study oil collected 8/82*, later (1987) added perforations @ 5900 ft. Top Monterey 5673 ft, top Rincon 8130 ft. (date from Arco). Gravity: initial production after 1981 reworking @ 27.7° API, after 30 days 27.8° API; early 1984 @ 24.3° API, after 1984 reworking 29.4° API, after 1987 reworking 31.5° API. Study oil collected by Arco 8/26/82.

11 **Arco Ames 3242-10 redrill**: redrilled directionally in 1979, perforated in 3/82 in intervals within 4705-5590 ft. Gravity: in 1980 @ 15.9° API, 3/82 @ 14.2° API, *study oil collected 8/82*, in 1983 @ 15.5° API, in 1984 @ 16.5° API, after second completion in 1984 @ 18.6° API, etc. Study oil collected by Arco 8/26/82.