AN ABSTRACT OF THE THESIS OF

PATRICK ALLAN JACKSON for the degree of MASTER OF SCIENCE

Title: STRUCTURAL EVOLUTION OF THE CARPINTERIA BASIN, WESTERN TRANSVERSE RANGES, CALIFORNIA

Abstract approved: Redacted for Privacy

Dr. Robert Yeats

The Pleistocene Carpinteria basin is an east-trending northward-verging, faulted syncline containing up to 1220m of partially intertonguing Santa Barbara and Casitas Formations deposited on previously folded pre-Pleistocene strata with up to 80$^{o}$ discordance. Structures subcropping against the unconformity indicate most of the deformation in the Santa Ynez Range prior to deposition of the Santa Barbara Formation approximately one Ma ago was by folding. During that time, the Carpinteria area was the northern margin of the offshore Ventura basin; subsequent uplift north of the Red Mountain fault (RMF) isolated the Carpinteria basin during middle to late Pleistocene time.

Quaternary faults in the area are either south-dipping reverse faults related to bedding-slip in pre-Pleistocene strata or north-dipping reverse faults that truncate bedding and are seismically active. The Rincon Creek fault (RCF) dips 35$^{o}$-60$^{o}$ south steepening to near-vertical at depth, where it apparently passes into bedding within the upper Sespe Formation. It offsets late Pleistocene marine terraces and is itself deformed by the RMF. The RMF dips 55$^{o}$-63$^{o}$ north at the surface and steepens to 75$^{o}$ north with depth; and also steepens westward south of the Summerland Offshore oil field to 85$^{o}$ north. Vertical separation decreases westward from 4500m north of the Rincon field to 350m at Rincon Point. The main branch of the RMF offsets a 45,000yr marine terrace, but not a 4,500yr terrace.

The Summerland Offshore oil field occurs within a disharmonically folded anticline in which incompetent, severely deformed Miocene mudstone overlies competent, broadly folded Oligocene sandstone. Because the anticline formed after deposition of the Santa Barbara Formation, the age of oil migration into the field was post-Santa Barbara during middle to late Pleistocene time.

# Structural Evolution of the Carpinteria Basin, Western Transverse Ranges, California

by

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in charge of major

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Dean of Graduate School

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Typed by Vincent P. Benabese for Patrick Allan Jackson

TABLE OF CONTENTS

## LIST OF ILLUSTRATIONS

TABLE

# LIST OF PLATES

| Plate | (Sections in Pocket) | Pocket (Section in Text) |
| --- | --- | --- |
| XVI | Cross Section Sf - Sf' | |
| XVI | Cross Section Sh - Sh' | K - K' |
| XVII | Cross Section Sn - Sn' | L - L' |
| XVIII | Cross Section Sq - Sq' | M - M' |
| XVII | Cross Section Y - Y' | |

# PREFACE

This report consists of two parts. The first part, consisting of the text and small scale figures (including Plate IA), is an article to be submitted for publication in the Bulletin of the American Association of Petroleum Geologists. The second part, consisting of the large scale plates (I to XVIII), expands on this report, and is included in a United States Geological Survey Semi-Annual Technical Report for Contract Number 14-08-0001-19173. This report will be published as a U.S. Geological Survey Open-File Report.

# STRUCTURAL EVOLUTION OF THE CARPINTERIA BASIN, WESTERN TRANSVERSE RANGES, CALIFORNIA

## INTRODUCTION

The Carpinteria basin is a narrow Pleistocene trough located along the northeastern coast of the Santa Barbara Channel between the Santa Ynez Mountains and Ventura basin (Fig. 1). It was formed on folded Miocene and older strata of the Santa Ynez Range and Pliocene strata of the northern margin of the Ventura basin. Erosion of the Pliocene sequence prior to Pleistocene deposition removed northward-overstepping Pliocene strata of the Ventura basin from the Carpinteria area. The Carpinteria basin was subsequently filled with Pleistocene shallow marine and nonmarine sediments at least in part equivalent to the Pleistocene sequence of the Ventura basin. To the east, the transition between the uplifted Santa Ynez and Topatopa Mountains and the downdropped central Ventura basin is marked by the Red Mountain and San Cayetano reverse faults. However, south of Carpinteria, the Red Mountain fault lies within the Ventura basin rather than at its northern border. Pleistocene uplift along the Red Mountain fault exposed Miocene strata on the sea floor, separating the Ventura basin from its northern margin at Carpinteria.

The north-dipping Red Mountain fault is the westernmost segment of a major system of north-dipping, seismically active, reverse faults that transect the Transverse Ranges Province from Santa Barbara to the San Andreas fault east of the San Gabriel Mountains. Although movement along the Red Mountain fault is responsible for the structural isolation of the Carpinteria basin from the Ventura basin to the south, several south-dipping reverse faults within the Carpinteria basin actually control its shape. Similar south-dipping faults are found to the east in the Oak View-Ojai area and near the town of Santa Paula. The Oak Ridge fault south of Santa Paula, is the largest known analogous south-dipping reverse fault in the central Ventura basin with a fault length greater than 100 km and a maximum separation of 5.2 km (Yeats, 1976). In the Carpinteria basin area, north- and south-dipping reverse faults converge, permitting the study of their mutual relationships and their effect on adjacent structures. Our interpretation of the structural evolution of the Carpinteria basin is partially based on an understanding of the uplifted structures between these inwardly facing, roughly contemporaneous faults.

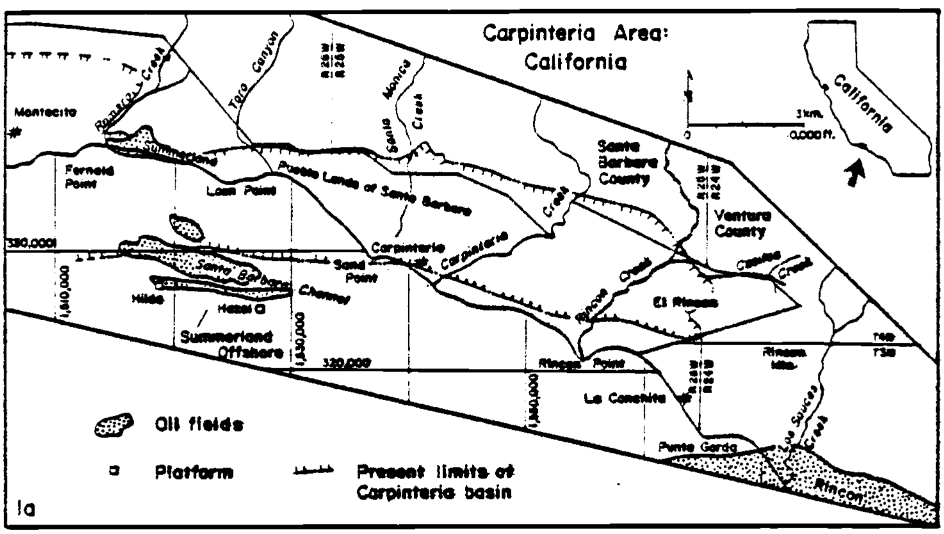
The Rincon Creek fault, largest of the local south-dipping faults, offsets the south flank of the Carpinteria basin and is traced from Rincon Mountain westward to the Summerland Offshore oil field. In the northern Santa Barbara Channel region, 20 oil or gas fields produce from Oligocene sandstone, folded and faulted beneath impermeable and structurally incompetent Miocene mudstone. The Summerland Offshore oil field is the easternmost of these fields, producing from a gently folded anticline in the footwall of the Rincon Creek fault and a small drag fold in the hanging wall. Because the anticline can be dated with respect to the Quaternary sequence of the Carpinteria basin, some constraints can be placed on the time of oil migration into the Summerland Offshore oil field, and by analogy, into other fields in the northern Santa Barbara Channel region. The Summerland Offshore anticline, at the southern margin of the Carpinteria basin, is also a well-documented example of disharmonic folding between incompetent, strongly deformed strata and underlying, more competent strata.

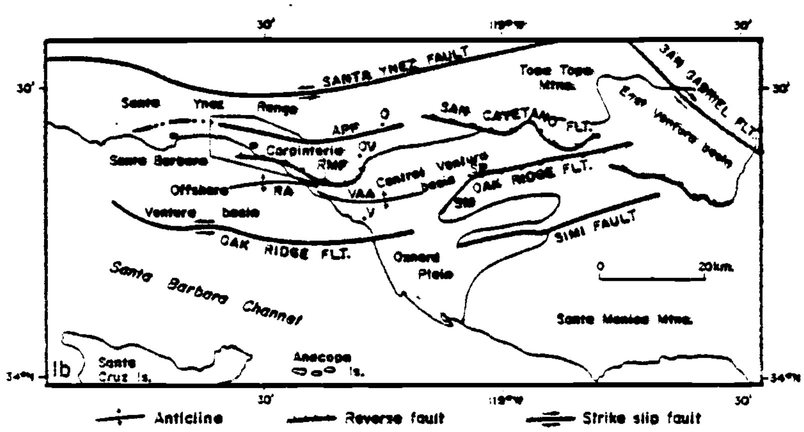
Determination of the structural evolution of the Carpinteria basin is enhanced by a large amount of surface and subsurface data. Onshore surface geology of the Carpinteria basin was mapped by Dibblee (1966), Lian (1952), and Upson (1951). The surface map presented

Figure 1a and 1b:

a. Location of Carpinteria basin. Base map modified from U.S. Geological Survey, Santa Barbara quadrangle, 1:100,000. Offshore grid is zone five of the California coordinate system. Oil field limits from the California Division of Oil and Gas, Offshore Regional Wildcat Map #WO-1.

b. Regional tectonic map modified from Yeats (1976) and Jennings (1977). APF, Arroyo Parida fault; O, Ojai; OV, Oak View; RA, Rincon anticline; RMF, Red Mountain fault; SM, South Mountain; SP, Santa Paula; V, Ventura; VAA, Ventura Avenue anticline.


Carpinteria Area:
California
California
Montecito
Romero Creek
Toro Canyon
Santa Monica Creek
Summerland
Fernald Point
Loon Point
Santa Barbara County
Ventura County
Carpinteria
Carpinteria Creek
Sand Point
Santa Barbara Channel
Hilda
Hazel
Summerland Offshore
Rincon Creek
El Rincon
Casitas Creek
Rincon Point
Rincon Mtn.
La Conchita
Punta Gorda
Los Sauces Creek
Rincon
Oil fields
Platform
Present limits of Carpinteria basin
1a


SANTA YNEZ FAULT
Santa Ynez Range
Topa Topa Mtns.
SAN CAYETANO FLT.
SAN GABRIEL FLT.
East Ventura basin
Santa Barbara
Carpinteria
Central Ventura basin
OAK RIDGE FLT.
Offshore
Ventura basin
SIMI FAULT
OAK RIDGE FLT.
Oxnard Plain
Santa Barbara Channel
Santa Monica Mtns.
Santa Cruz Is.
Anacapa Is.
1b
Anticline
Reverse fault
Strike slip fault

in this paper (Fig. 2) was compiled from this earlier work and field checked during 1979 and 1980, with additional mapping at critical contacts. Lithologic and paleontologic data from dart cores, collected by the oil industry, and interpretations of seismic profiles by Hoyt (1976) were used to construct the geologic map of the offshore part of the Carpinteria basin. Sarna-Wojcicki et al. (1979) and Lajoie et al. (1979) dated coastal terraces on Rincon Mountain and determined separation rates for the Red Mountain fault and uplift rates for marine terraces dated at 45,000 and 4,500 years of age. The onshore Summerland oil field was described by Arnold (1907), and a short description of the Summerland Offshore field was published by the California Division of Oil and Gas (1974). Subsurface data from 289 oil wells, 12 water wells, and eight engineering geology reports were integrated with surface geology and seismic profiles to construct 19 cross sections (14 reproduced here) and structure contour maps of the top of the Vaqueros Formation, base of the Pleistocene sequence, and the Red Mountain, Rincon Creek, and Carpinteria faults. A paleogeologic map of the unconformity at the base of the Pleistocene was constructed to determine pre-Pleistocene structural patterns.

The maps and cross sections in this report are generalized versions of more detailed, larger-scale illustrations in which the cross sections show wells with lithologic description and electric logs. These will appear as a U.S. Geological Survey open-file report. Subsurface data were collected from the California Division of Oil and Gas (CDOG), individual oil companies, engineering geology firms, and the communities of Montecito, Summerland, and Carpinteria. Of special importance was the release to the public by the CDOG of most of the electric logs and well histories in the Summerland Offshore oil field.

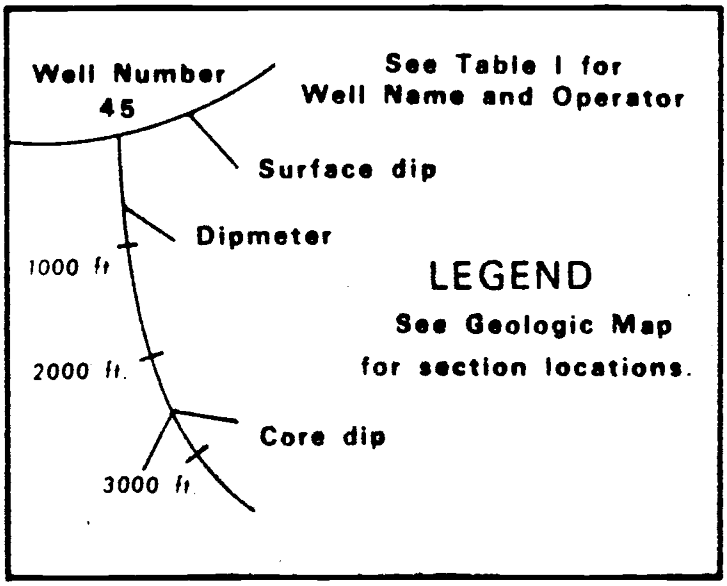
GEOLOGIC MAP

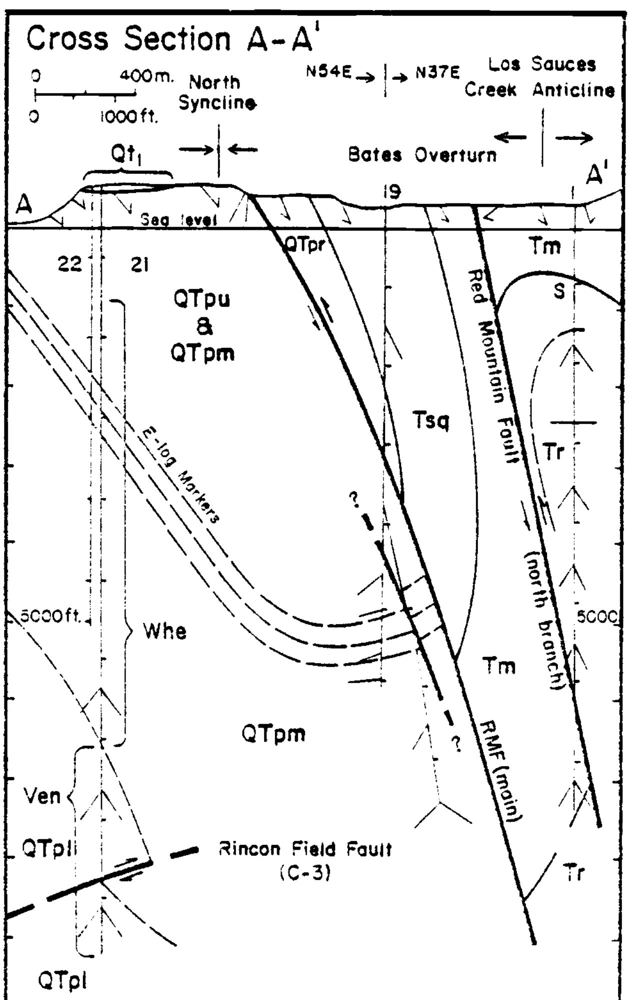
IN

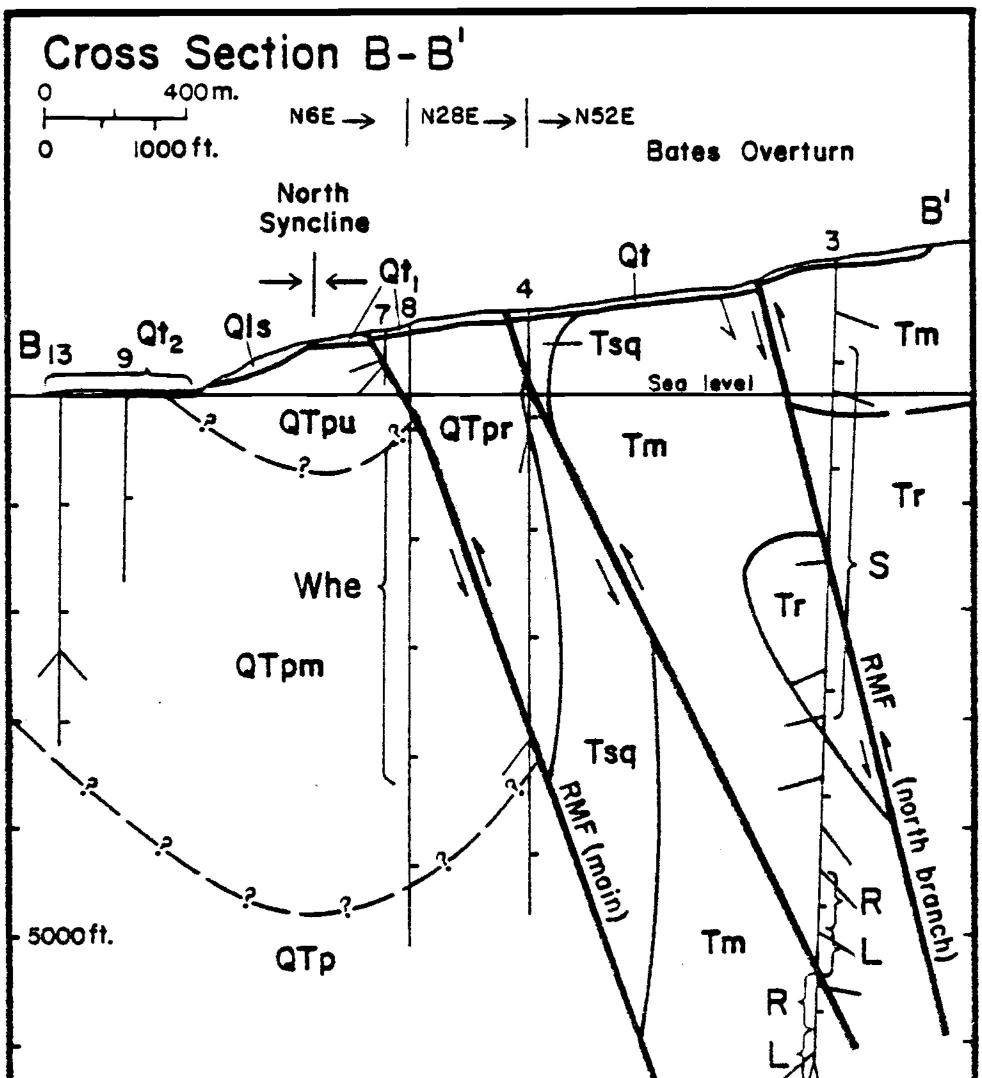
POCKET

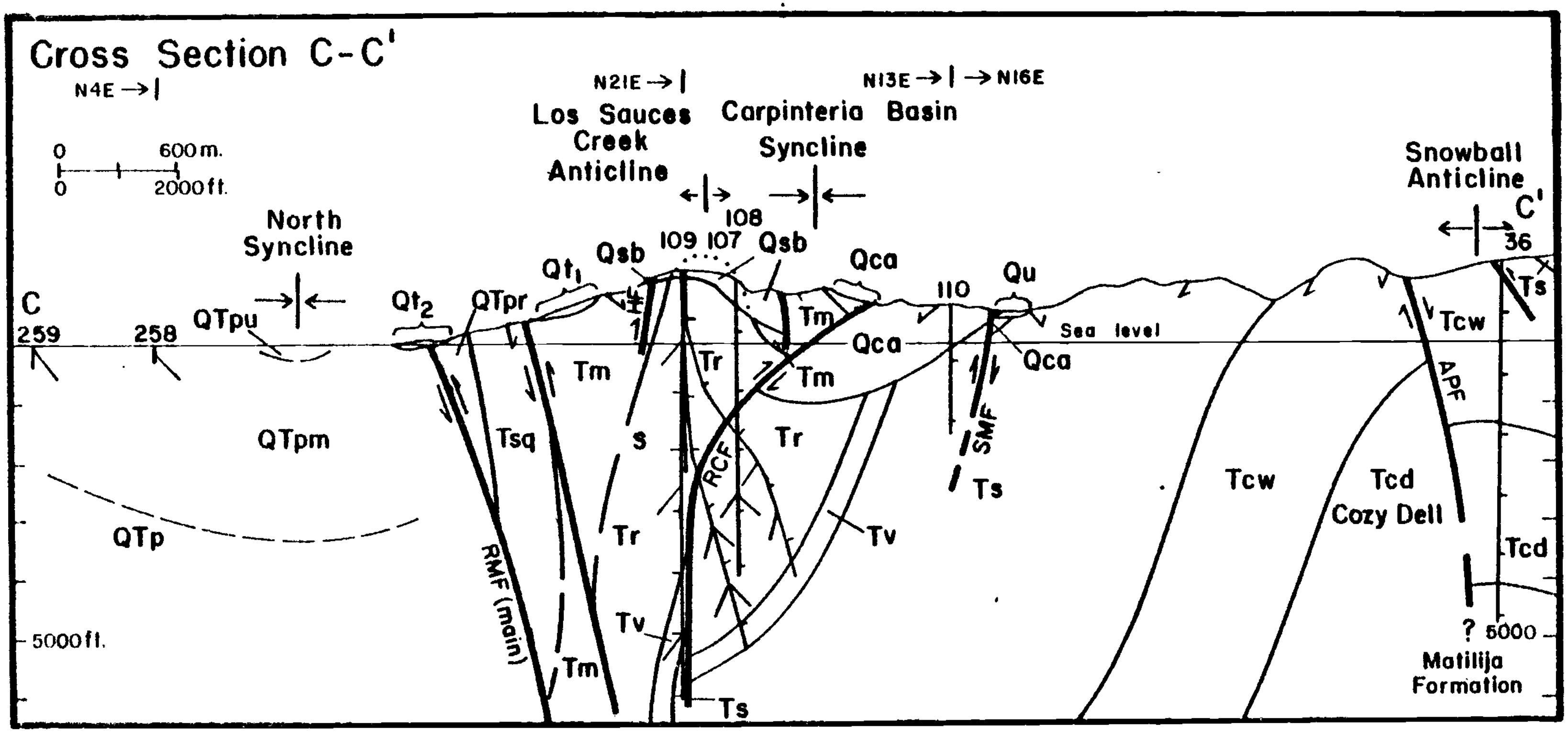
Figure 2: Geologic map of the Carpinteria area, California, compiled and modified from Upson (1951), Lian (1952), Chauvel (1958), Dibblee (1966 and 1980), Weber et al. (1973), Geotechinical Consultants Inc. (1968 and 1974), Hoyt (1976), Lajoie et al. (1979), Woodward-Clyde Inc. (1979), and Sarna-Wojcicki (personal commun., 1979). Relizian, Luisian, and Mohnian Stages are those of Kleinpell (1938). APF, Arroyo Parida fault; CF, Carpinteria fault; HF, Holloway fault; RCF, Rincon Creek fault; RMF, Red Mountain fault, SMF, Shepard Mesa fault; SF, Syncline fault.

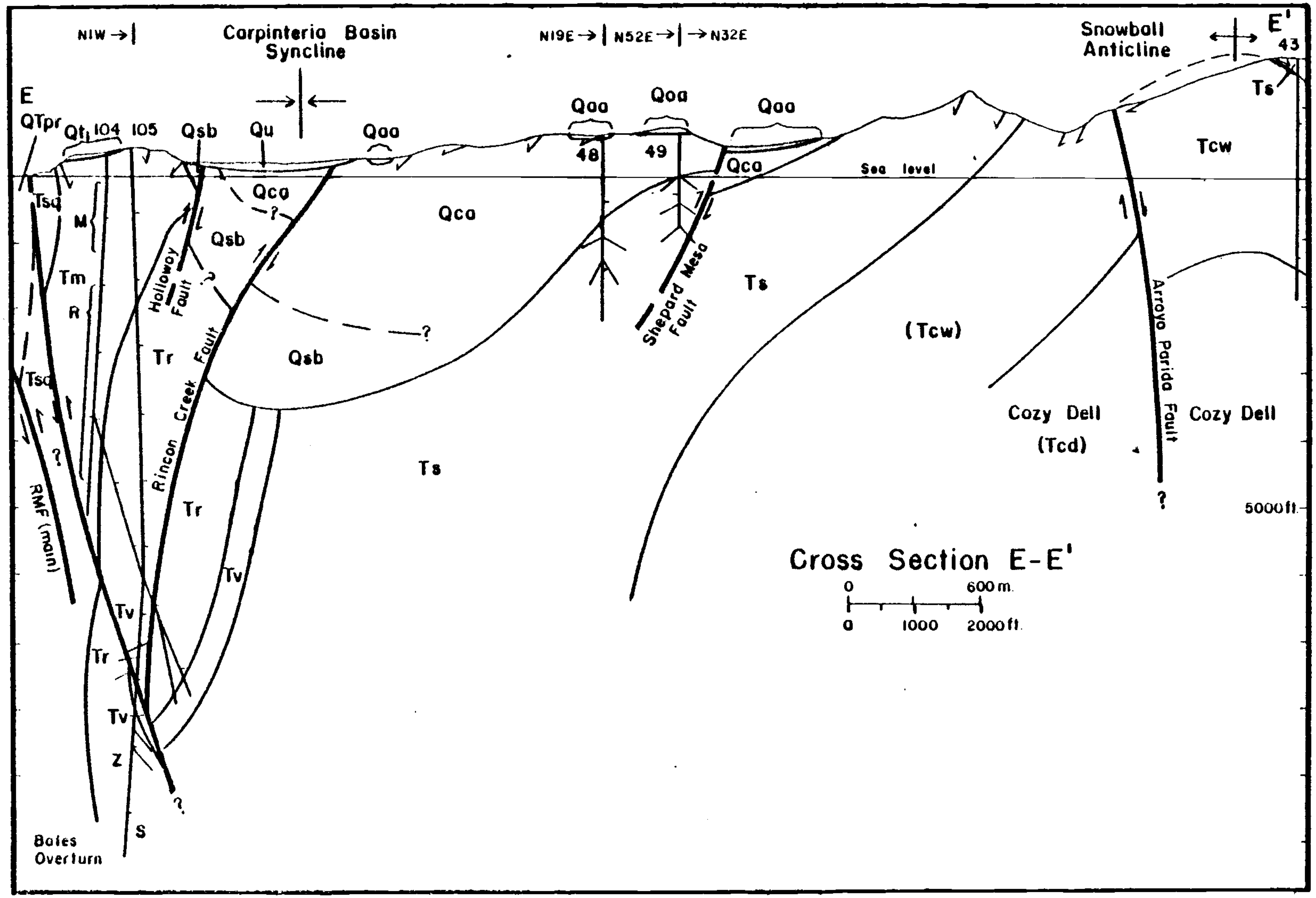
Figure 3: Cross Sections A-A' through M-M'. Location of cross section lines and formation abbreviations are shown on geologic map (Fig. 2). Microfauna Stages Zemorrian (Z), Saucesian (S), Relizian (R), Luisian (L), Mohnian (M), and Delmontian (D) are those of Kleinpell (1938). Microfaunal Stages Repettian (Rep), Venturian (Ven), Wheelerian (Whe), and Hallian (Hall) are those of Natland (1953) Aquifers A,B,C, and D are from Slade (1975). For well names see Table 1.
APF, Arroyo Parida fault; CF, Carpinteria fault; HF, Holloway fault; NFF, North Flank fault; OF, Ortega fault; RCF, Rincon Creek fault; RMF (main), main branch of Red Mountain fault; SF, Sincline fault.
Dotted contact above Summerland anticline in Section M-M' is between lower and middle subdivisions of the Rincon Formation based on surface paleontologic data (Lian, 1952). The dashed Casitas marker through wells 140 and 139 in the same section represents the decollement folding of the Ortega anticline (cf. Treadwell Wharf Section; Arnold, 1907).


Well Number
45
See Table I for
Well Name and Operator
Surface dip
Dipmeter
1000 ft
LEGEND
See Geologic Map
for section locations.
2000 ft.
Core dip
3000 ft

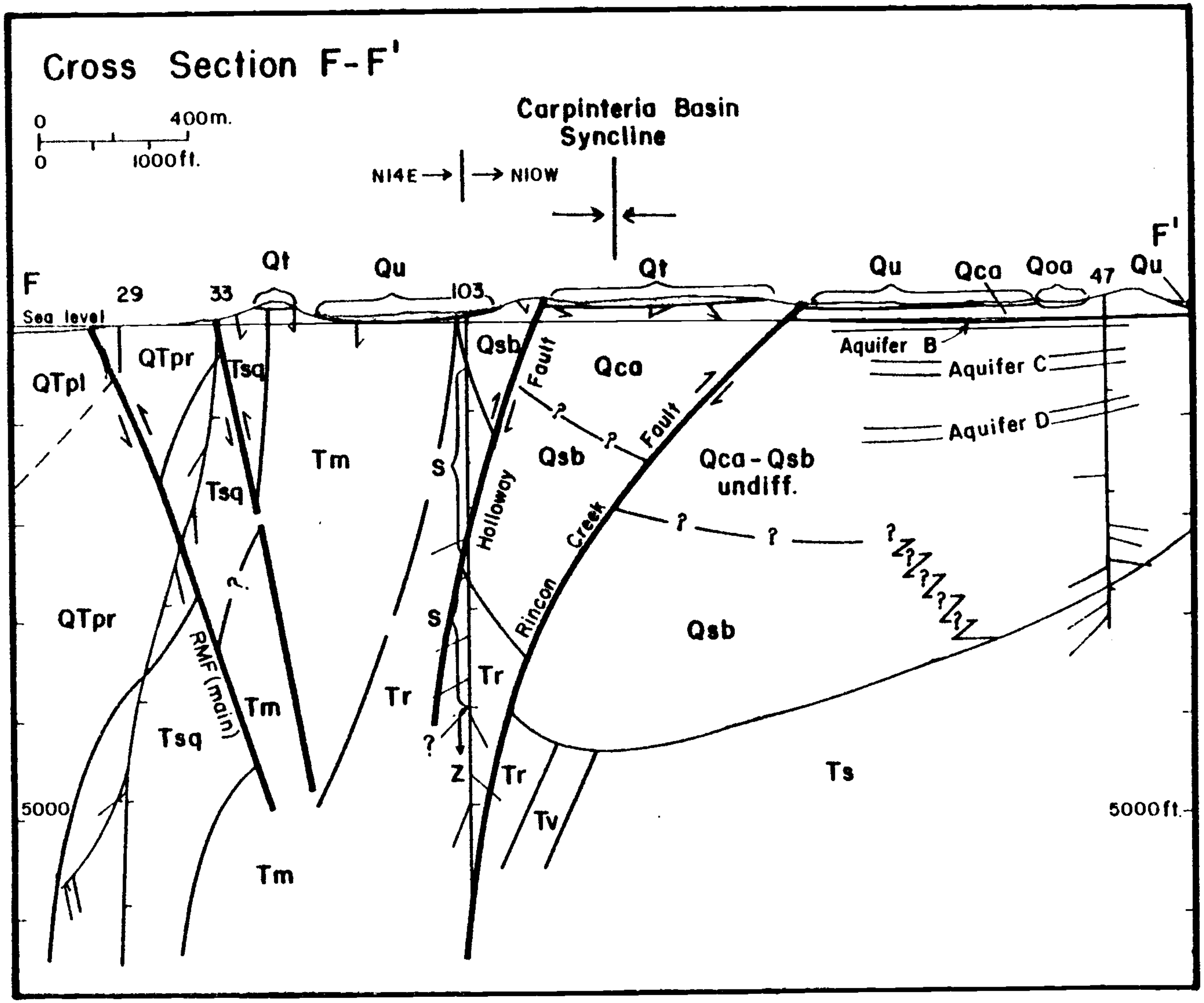

Cross Section A-A'
0 400m.
0 1000 ft.
North
Syncline
N54E
N37E
Los Sauces
Creek Anticline
Bates Overturn
Qt1
A
A'
Sea level
19
22
21
QTpr
Tm
S
QTpu
&
QTpm
Red Mountain Fault
E-log Markers
Tsq
Tr
(north branch)
5000 ft.
Whe
Tm
QTpm
RMF (main)
Ven
QTpli
Rincon Field Fault
(C-3)
Tr
QTpl

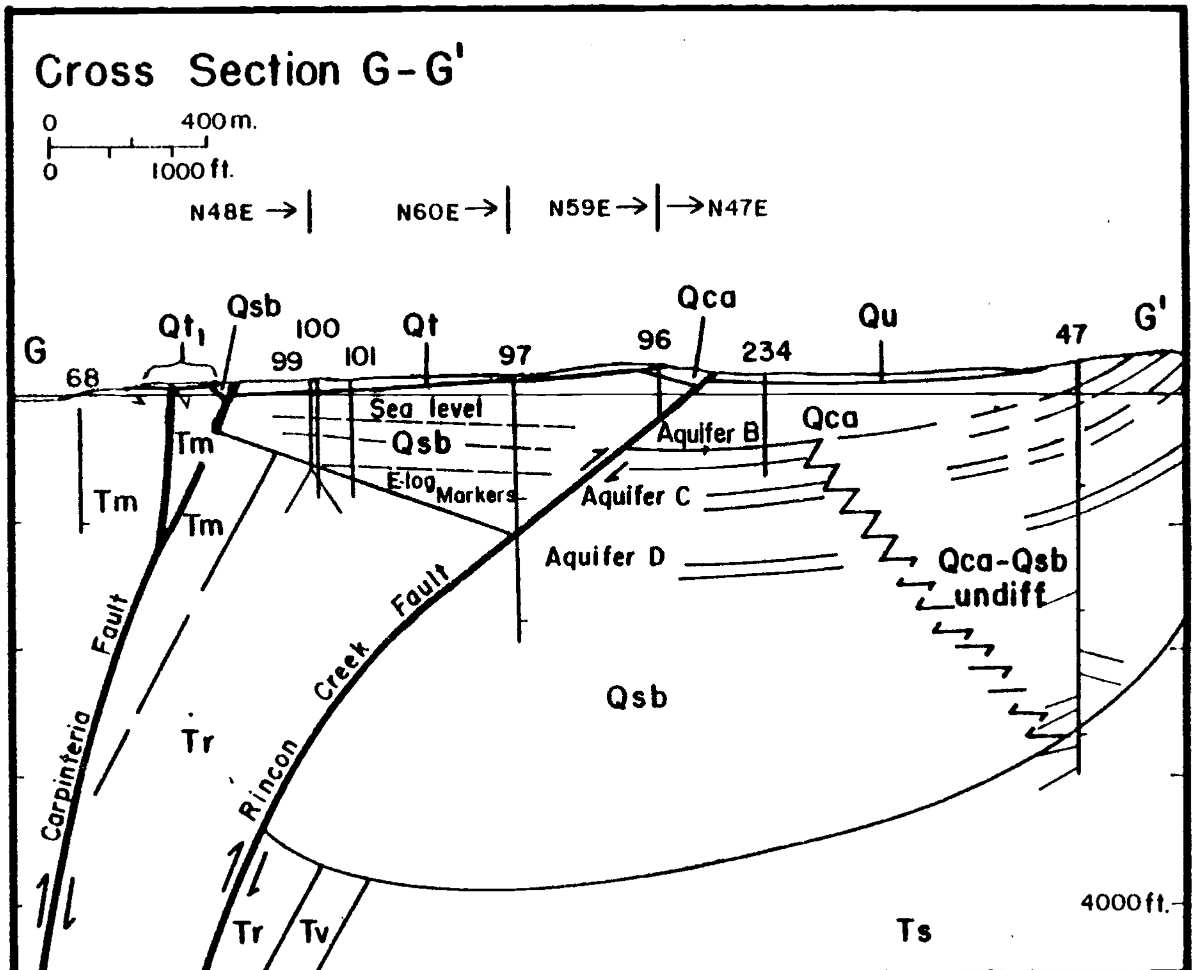

Cross Section B-B'
0 400 m.
0 1000 ft.
N6E
N28E
N52E
Bates Overturn
North Syncline
B'
B
13
9
Qt2
Qls
Qt1
7
8
4
Qt
3
Tsq
Tm
Sea level
QTpu
QTpr
Tm
Tr
Whe
S
Tr
QTpm
RMF
Tsq
(north branch)
RMF (main)
5000 ft.
QTp
Tm
R
L
R
L


Cross Section C-C'
N4E →|
N21E →|
N13E →| → N16E
Los Sauces Creek Anticline
Carpinteria Basin Syncline
North Syncline
Snowball Anticline
0 600 m.
0 2000 ft.
C
C'
259
258
108
109 107
110
36
QTpu
Qt2
QTpr
Qt1
Qsb
Qca
Qu
Sea level
Tm
Tr
Tsq
S
QTpm
QTp
RCF
SMF
Ts
Tv
Tcw
Tcd
Cozy Dell
APF
RMF (main)
5000 ft.
5000
? 
Matilija Formation

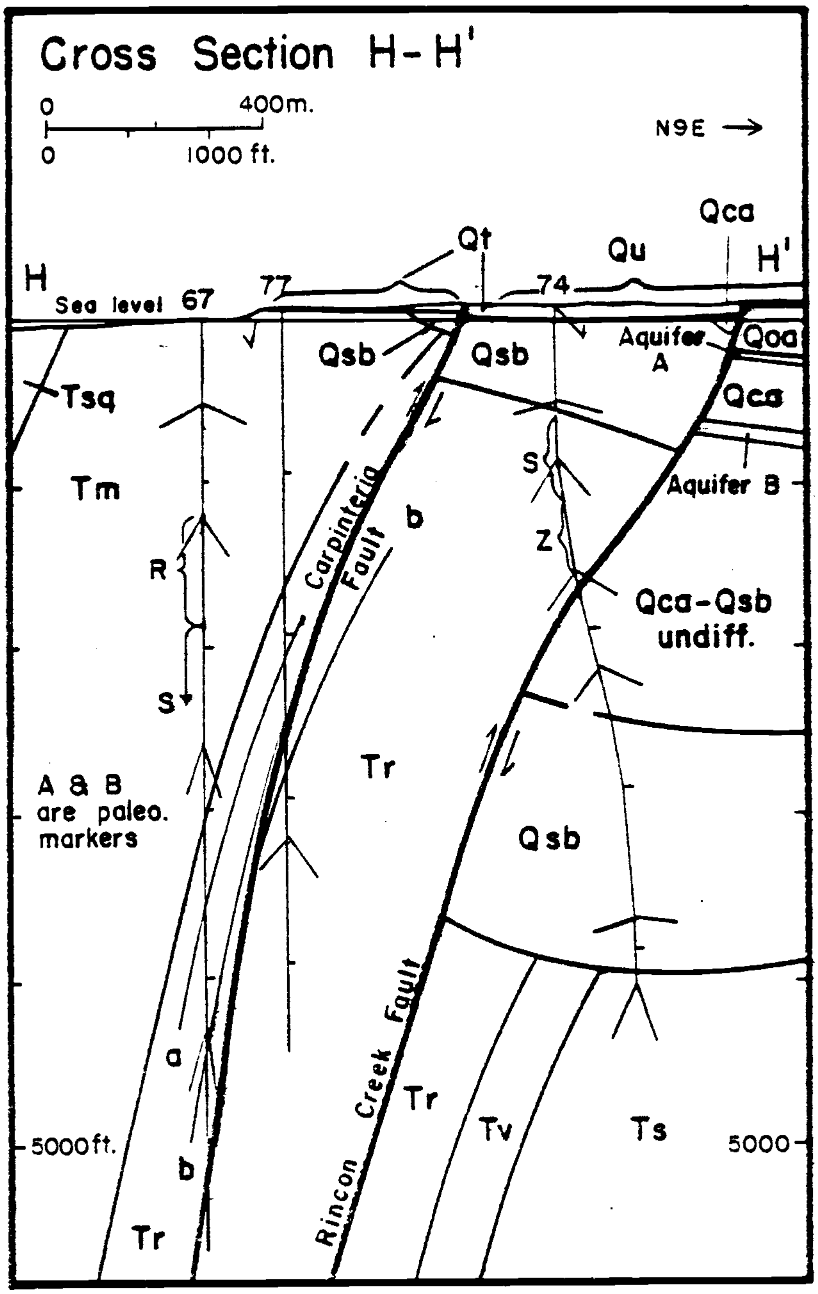


Cross Section E-E'
0
600 m.
0
1000
2000 ft.
E
E'
N1W
Carpinteria Basin
Syncline
N19E
N52E
N32E
Snowball
Anticline
43
QTpr
Qt
104
105
Qsb
Qu
Qaa
Qaa
Qaa
Qaa
48
49
Qca
Qca
Qca
Sea level
Tcw
Ts
Tsq
M
Tm
R
Tr
Tsq
Holloway
Fault
Rincon Creek Fault
Qsb
Qsb
Shepard Mesa
Fault
Ts
(Tcw)
Cozy Dell
(Tcd)
Arroyo Parida Fault
Cozy Dell
Ts
5000 ft.
RMF (main)
Tr
Tv
Tv
Tr
Tv
Z
S
Bates
Overturn

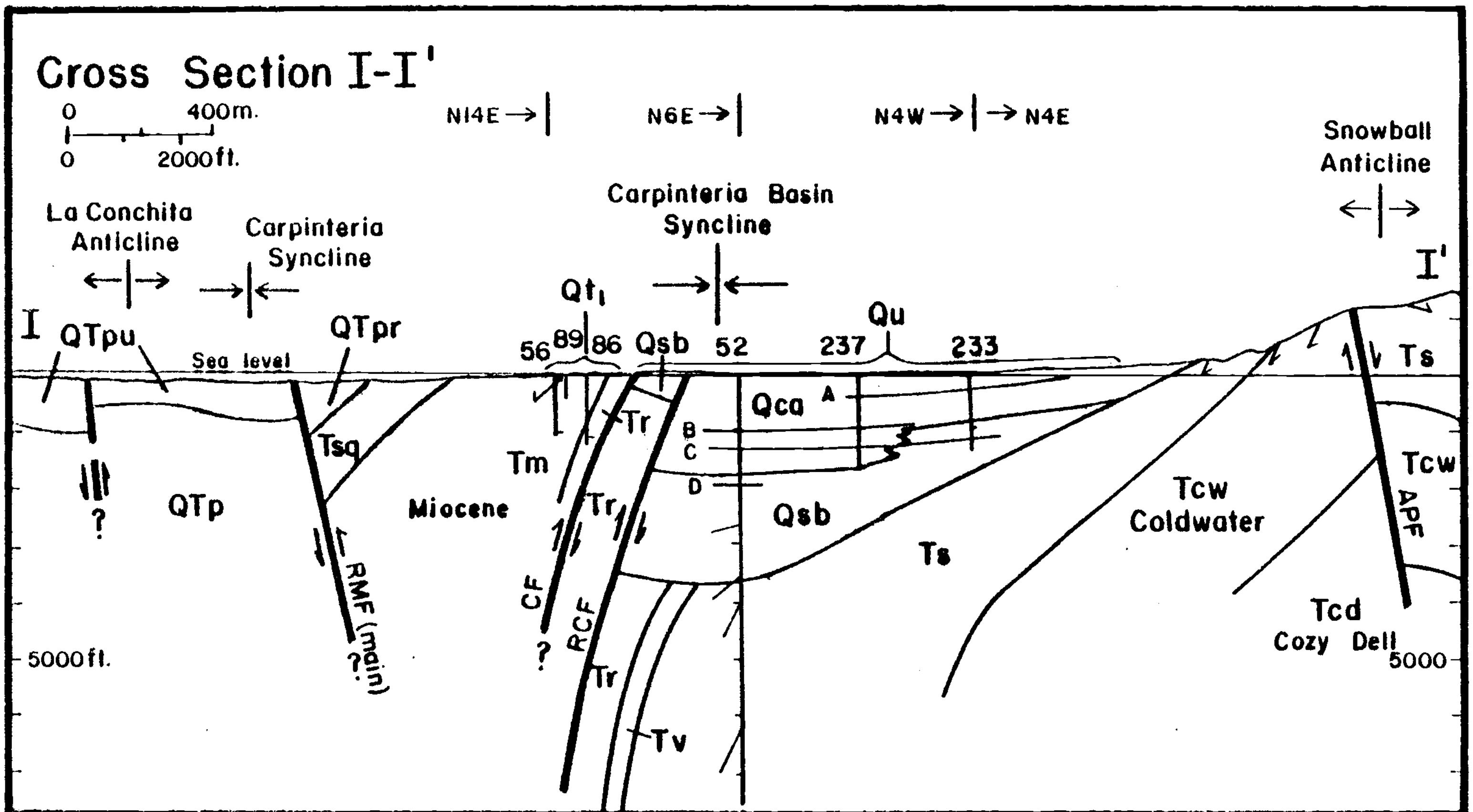

Cross Section F-F'
0 400m.
0 1000ft.
Carpinteria Basin Syncline
N14E
N10W
F
F'
Sea level
29
33
103
47
Qt
Qu
Qt
Qu
Qca
Qoa
Qu
QTpl
QTpr
Tsq
Tm
S
Qsb
Fault
Qca
Qsb
Fault
Aquifer B
Aquifer C
Aquifer D
Qca-Qsb undiff.
Holloway
Creek
Rincon
Tsq
QTpr
RMF (main)
Tm
Tr
S
Tr
Qsb
Tsq
Tm
Z
Tr
Tv
Ts
5000
5000ft.
Tm

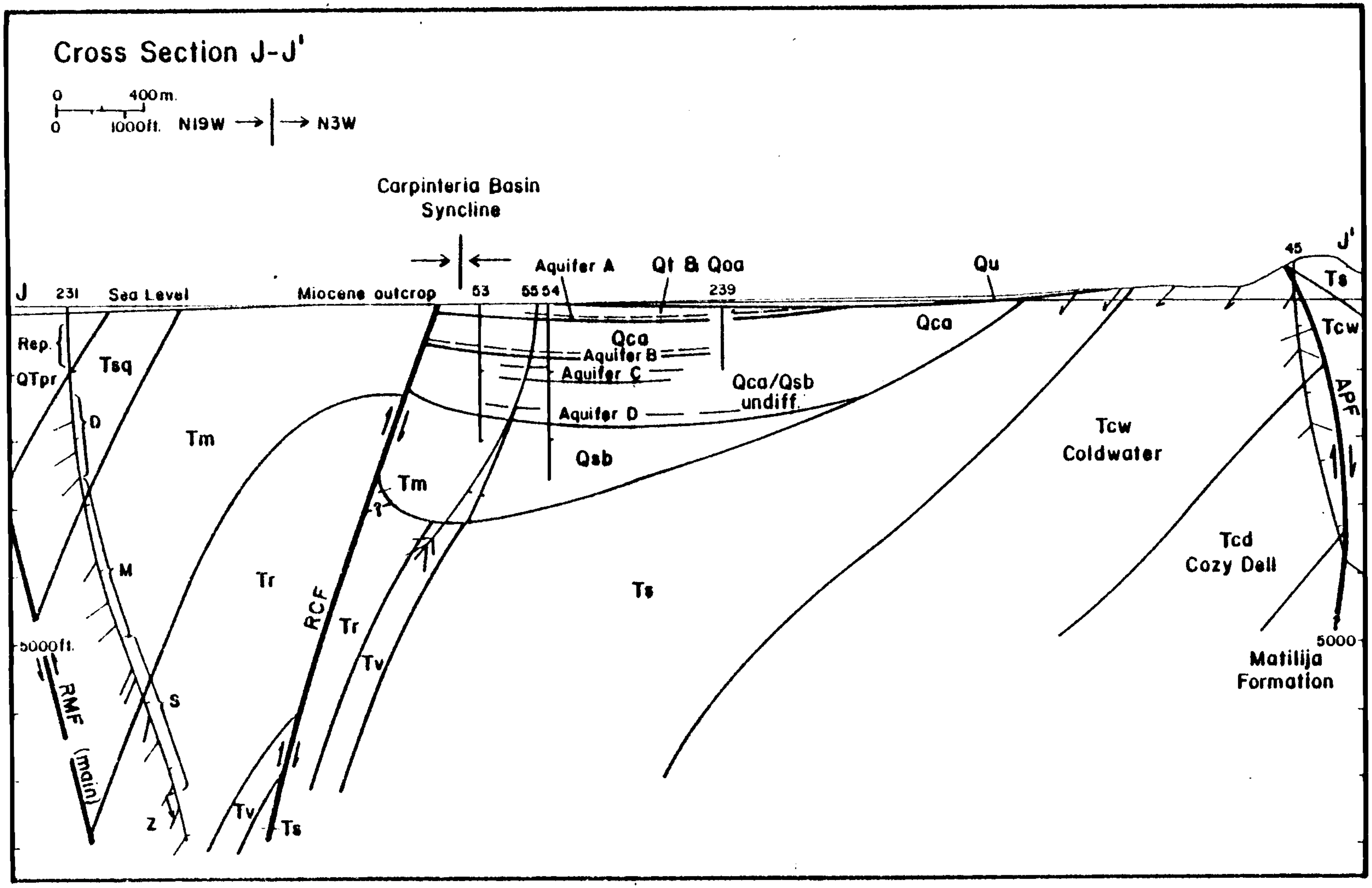


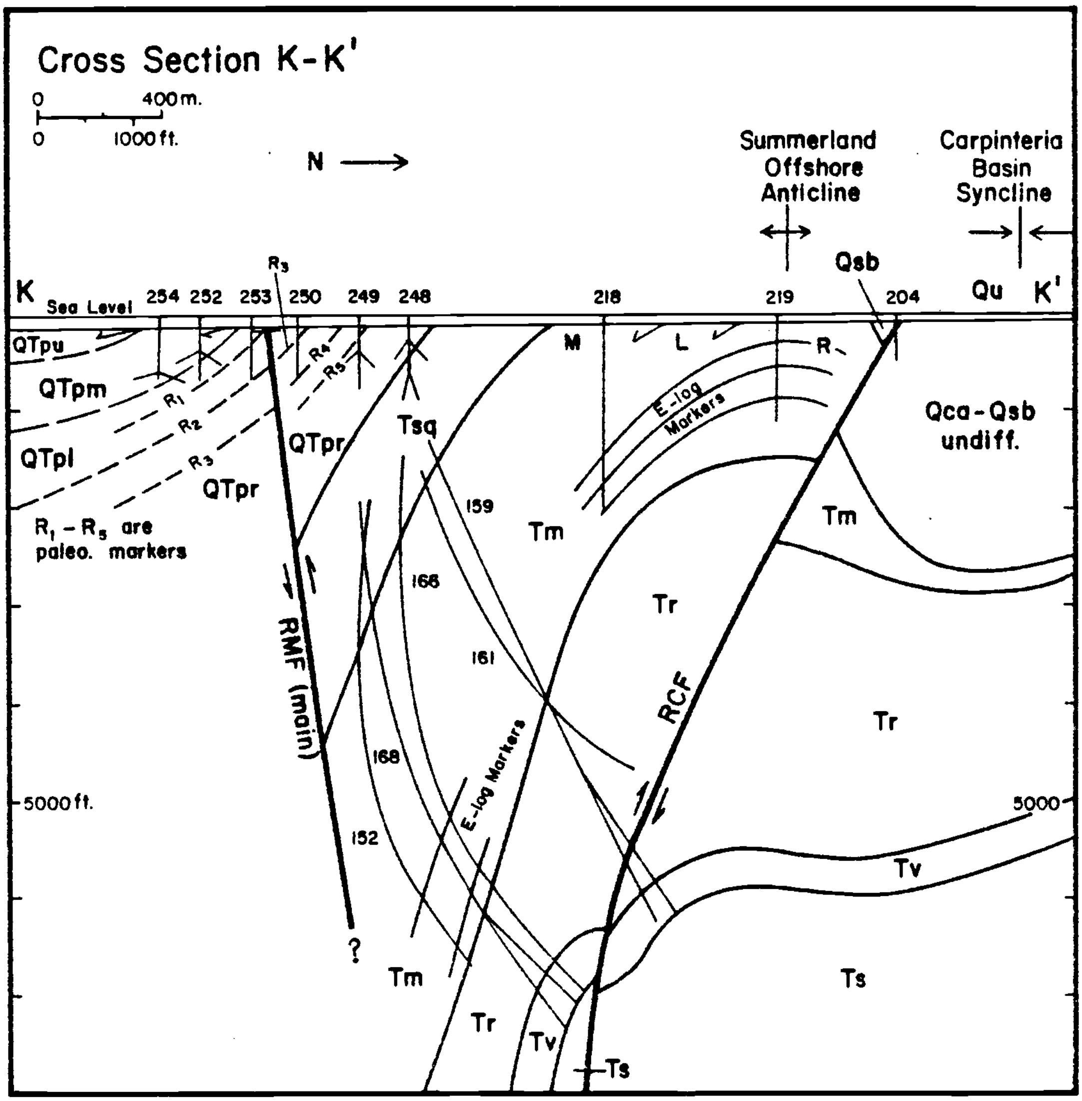
Cross Section G-G'
0 400 m.
0 1000 ft.
N48E →
N60E →
N59E →
→ N47E
G
G'
68
Qt1
Qsb
100
99
101
Qt
97
96
Qca
234
Qu
47
Sea level
Qsb
E-log Markers
Tm
Tm
Tm
Aquifer B
Qca
Aquifer C
Aquifer D
Qca-Qsb undiff
Carpinteria Fault
Rincon Creek Fault
Tr
Qsb
Tr
Tv
Ts
4000 ft.

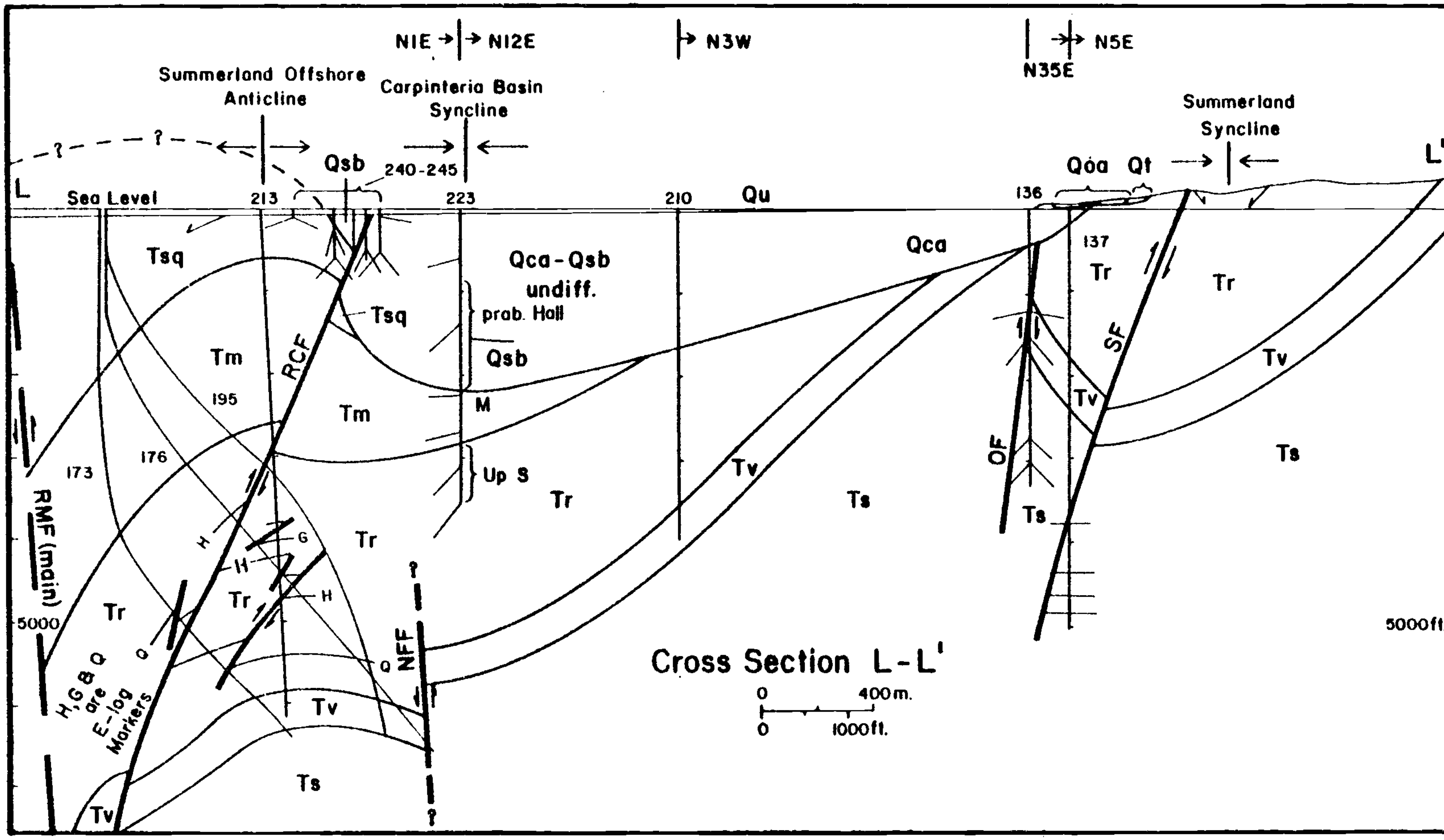


Cross Section H-H'
0
400m.
0
1000 ft.
N9E →
Qca
Qt
Qu
H
H'
Sea level
67
77
74
Qsb
Qsb
Aquifer A
Qoa
Tsq
Qca
Tm
S
Aquifer B
b
Carpinteria Fault
Z
R
Qca-Qsb undiff.
S
Tr
A & B are paleo. markers
Qsb
Rincon Creek Fault
a
Tr
Tv
Ts
5000 ft.
5000
b
Tr


Cross Section I-I'
0 400m.
0 2000ft.
N14E →
N6E →
N4W → | → N4E
Snowball Anticline
La Conchita Anticline
Carpinteria Syncline
Carpinteria Basin Syncline
I
I'
QTpu
Sea level
QTpr
Qt1
56 89 86
Qsb
52
237
Qu
233
Ts
Qca
A
B
C
D
Tsq
Tr
Tm
QTp
Miocene
Qsb
Ts
Tcw Coldwater
Tcw
APF
RMF (main)
CF
RCF
Tv
Tcd Cozy Dell
5000ft.
5000


Cross Section J-J'
0 400m.
0 1000ft. N19W → | → N3W
Carpinteria Basin
Syncline
J
231
Sea Level
Miocene outcrop
53
55 54
Aquifer A
Qt & Qoa
239
Qu
45
J'
Ts
Tcw
APF
Rep.
QTpr
Tsq
D
Tm
Qca
Aquifer B
Aquifer C
Aquifer D
Qca/Qsb
undiff.
Qsb
Tcw
Coldwater
Tm
M
Tr
RCF
Tr
Tv
Ts
Tcd
Cozy Dell
5000ft.
RMF
(main)
S
Z
Tv
Ts
5000
Matilija
Formation


Cross Section K-K'
0 400m.
0 1000ft.
N
Summerland Offshore Anticline
Carpinteria Basin Syncline
K
Sea Level
254 252 253 250 249 248 218 219 204
R3
Qsb
Qu
K'
QTpu
QTpm
QTpl
QTpr
R1 - R5 are paleo. markers
R4
R5
Tsq
M
L
R
E-log Markers
Qca-Qsb undiff.
Tm
Tr
159
166
161
168
152
RMF (main)
RCF
E-log Markers
5000 ft.
5000
Tv
Ts
?



Cross Section L-L'

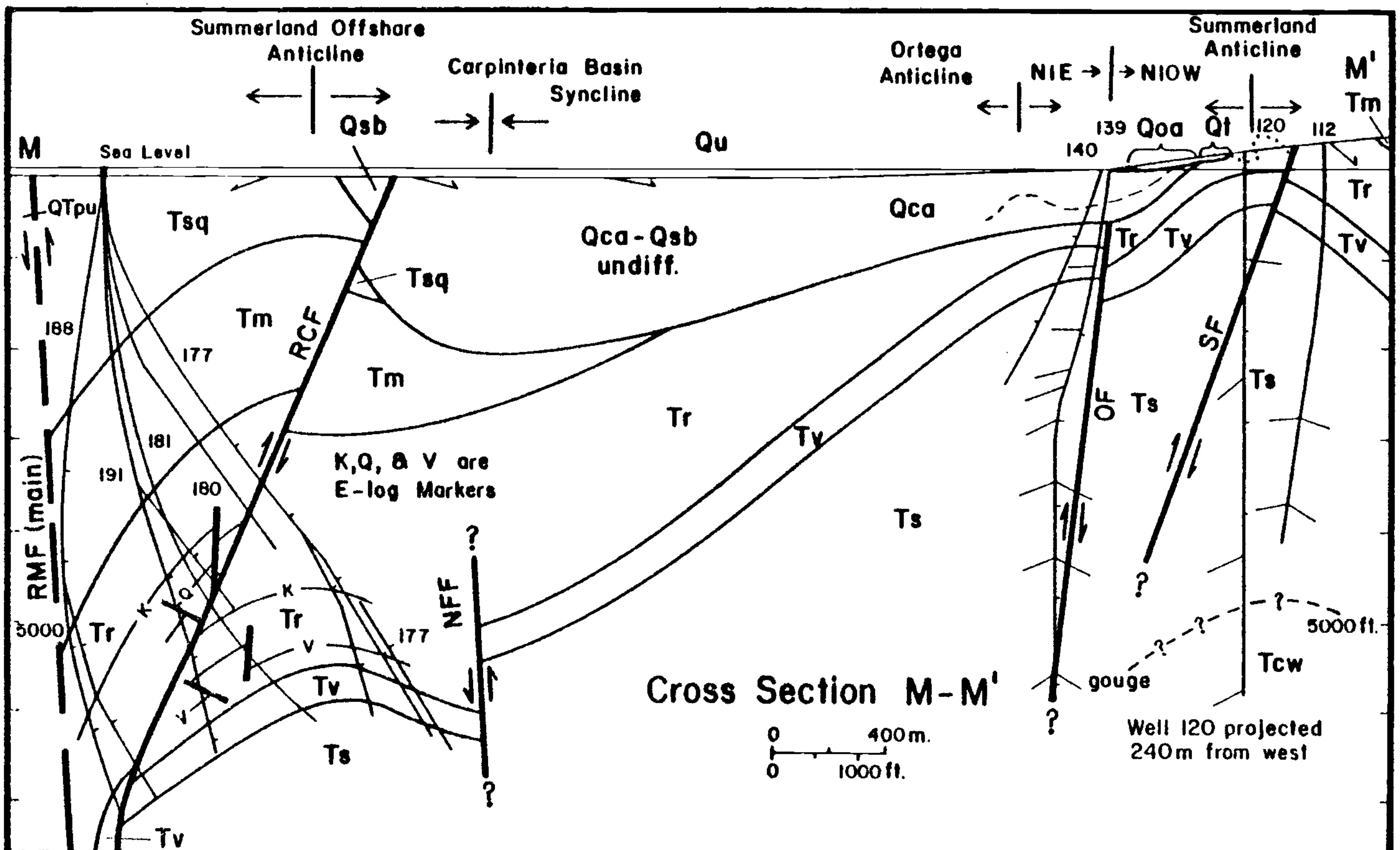
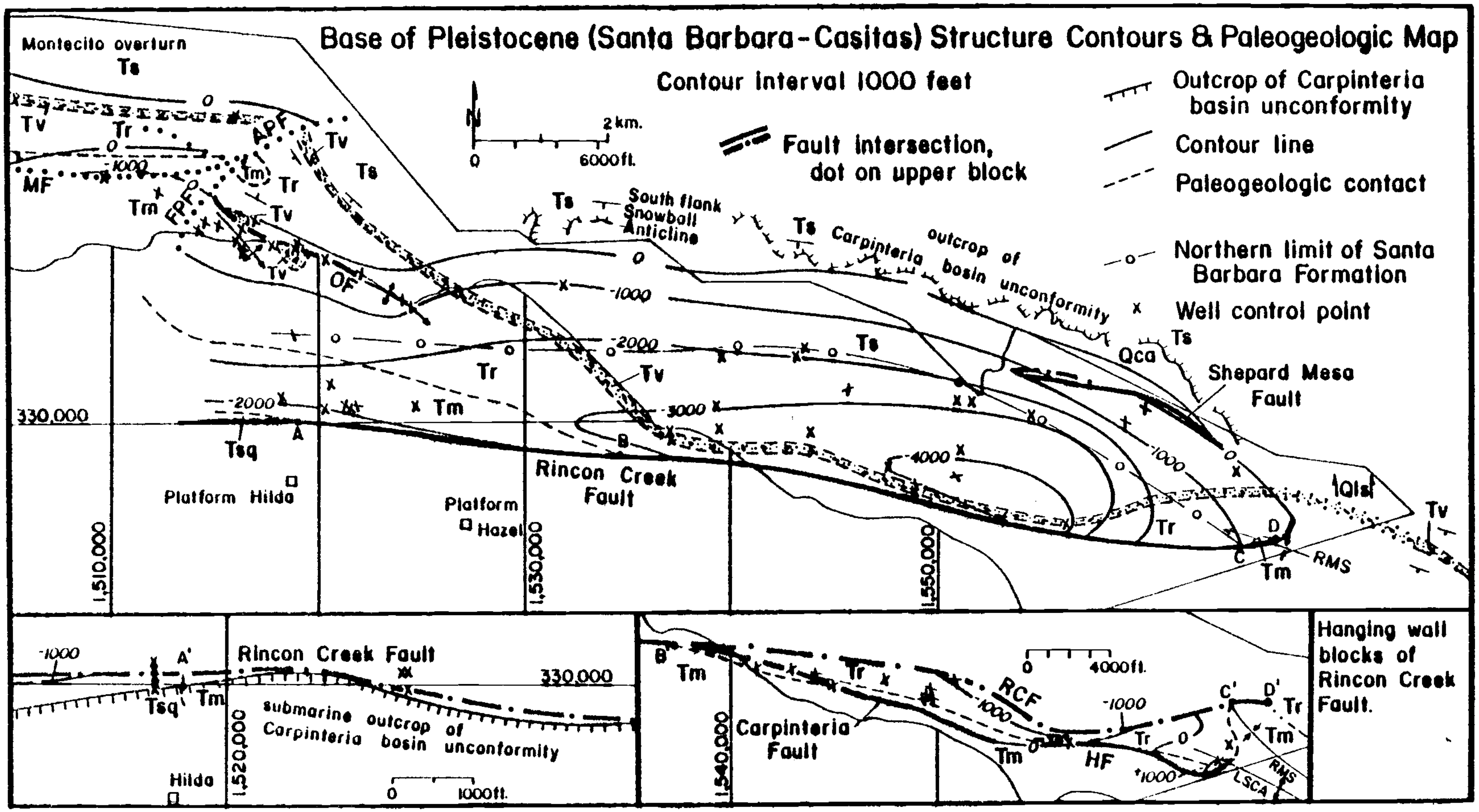

Summerland Offshore Anticline
Carpinteria Basin Syncline
Ortega Anticline
NIE
NIOW
Summerland Anticline
M
M'
Sea Level
Qsb
Qu
Qoa
Qt
139
140
120
112
Tm
Tr
Tv
QTpu
Tsq
Qca-Qsb undiff.
Qca
Ty
Tsq
188
177
Tm
RCF
Tm
Tr
Ty
SF
Ts
OF
Ts
RMF (main)
191
181
180
K,Q, & V are E-log Markers
Ts
5000
Tr
K
Q
K
Tr
V
177
NFF
V
Tv
Ts
Tv
gouge
5000 ft.
Tcw
Cross Section M-M'
0
400 m.
0
1000 ft.
Well 120 projected 240 m from west

Figure 4: Structure contour map of the unconformity at the base of the Pleistocene Santa Barbara and Casitas Formations including paleogeology of the formations subcropping against the unconformity. Formation abbreviations explained in Fig. 2. The Pleistocene unconformity is offset by all faults, except the Ortega fault (OF). A-A', B-B', C-C', D-D', and the axis of the Rincon Mountain syncline (RMS) document point to point offset of pre-Pleistocene formations suggesting little or no strike separation on the Rincon Creek fault (RCF). APF, Arroyo Parida fault; FPF, Fernald Point fault; HF, Holloway fault; LSCA, Los Sauces Creek anticline; MF, Montecito fault.


Base of Pleistocene (Santa Barbara-Casitas) Structure Contours & Paleogeologic Map
Contour interval 1000 feet
2 km.
0
6000 ft.
Fault intersection, dot on upper block
Outcrop of Carpinteria basin unconformity
Contour line
Paleogeologic contact
Northern limit of Santa Barbara Formation
Well control point
Montecito overturn
Ts
Tv
Tr
Tm
MF
FPF
APF
OF
Tsq
South flank Snowball Anticline
Carpinteria outcrop of basin unconformity
Qca
Shepard Mesa Fault
Rincon Creek Fault
Platform Hilda
Platform Hazel
330,000
1,510,000
1,530,000
1,550,000
-1000
-2000
-3000
-4000
Qls
RMS
Rincon Creek Fault
submarine outcrop of Carpinteria basin unconformity
Hilda
1,520,000
1000 ft.
4000 ft.
RCF
Carpinteria Fault
HF
LSCA
1,540,000
Hanging wall blocks of Rincon Creek Fault.

# PRE-PLIOCENE EVOLUTION AND STRATIGRAPHY

More than 7,300 m of late Cretaceous to late Miocene strata are exposed in the Santa Ynez Mountains and along the northern margin of the Santa Barbara Channel (Dibblee, 1966). These rocks were deposited during several periods of subsidence and uplift in basins that encompassed most of the western Transverse Ranges Province. In the Carpinteria area pre-Pliocene rocks cut by wells are divided into two sequences based on their structural competence.

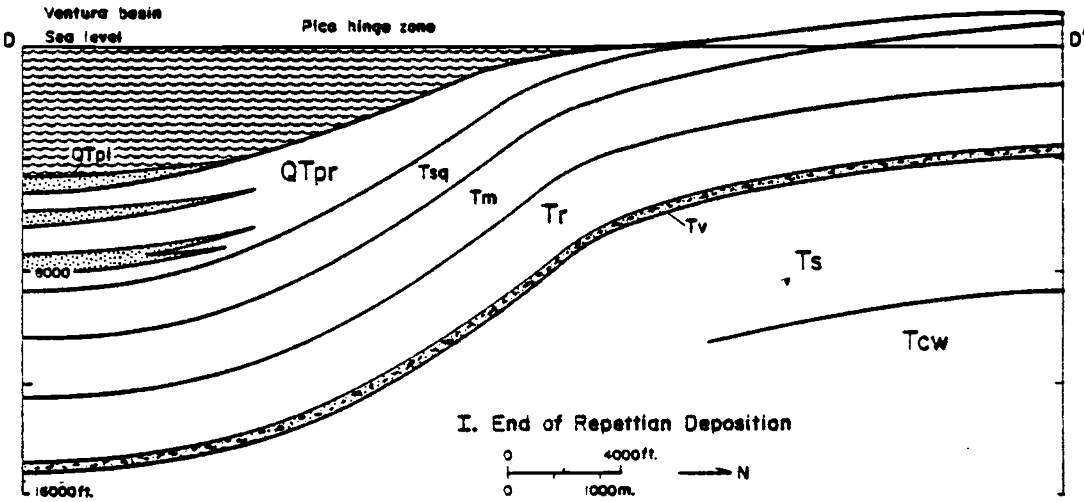
The lowermost sequence, composed of 300+ m of Matilija Sandstone, 600 to 820 m of Cozy Dell Formation, 820 m of Coldwater Sandstone, 1,370 to 1,600 m of Sespe Formation and 115 m of Vaqueros Formation, is structurally the most competent. Except for the Cozy Dell "Shale" and the upper Sespe Formation, these rocks are predominantly well indurated, medium- to coarse-grained, thick-bedded sandstone and conglomerate which allows them to react more competently to deviatoric stress than the overlying finer-grained Miocene mudstone. Electric log interpretation of wells 52 and 179 and surface descriptions (Lian, 1952) indicate that the upper part of the Sespe Formation is composed of thin-bedded claystone, siltstone, and sandstone. Although the upper

Sespe is less competent than the rest of this sequence, it is still more competent than the overlying Miocene strata. The Matilija, Cozy Dell, and Coldwater Formations (Vedder, 1972) are of Eocene age. The Sespe Formation (Kew, 1924) and Vaqueros Formation (Edwards, 1971) are of Oligocene age. Except for the Cozy Dell and Sespe Formations which thin westward (Figs. 3c-3j and 3m), stratigraphic thicknesses are relatively uniform. The shallow marine upper section of the Matilija Formation and the non-marine Sespe Formation record two episodes of regression, each followed by renewed subsidence and transgression.

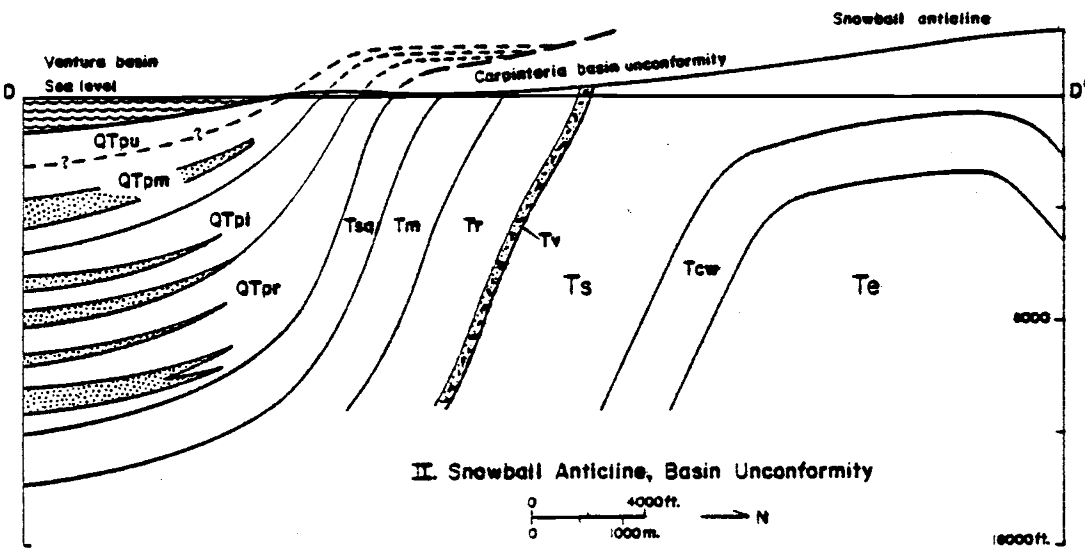
The Vaqueros Formation was deposited in a shallow marine environment at the edge of the subsiding Santa Barbara Embayment during transgression of the late Oligocene sea (Edwards, 1971). It contains megafossils of the Vaqueros Stage of Addicott (1968) and microfossils of the Zemorrian Stage of Kleinpell (1938). Because it has relatively high permeability and porosity and lies beneath a thick sequence of impermeable mudstone, the Vaqueros Formation has been a major objective of past oil exploration. In the Carpinteria area, more than 40 wildcat wells have attempted to find oil in this formation. The Summerland Offshore oil field, discovered in 1957 at the southwestern edge of the Carpinteria basin, as of 1978, had produced more than 25 million barrels of oil from Vaqueros sandstone (California Division of Oil and Gas, 1978). In the field, the Vaqueros consists of gray, fine- to medium-grained, moderately sorted, subrounded to subangular, soft, friable, fossiliferous, arkosic sandstone interbedded with gray, sandy siltstone. The beds are thick to laminated with some cross-bedding; the cement is calcite. Megafossils, chert and quartzite pebbles, thin limestone beds, and carbonaceous layers also are present. The Vaqueros Formation concordantly overlies the Sespe Formation and is itself conformably overlain by Rincon mudstone.

Overlying the competent section is a sequence of fine-grained, incompetent Miocene mudstones and claystones deposited in marine environments ranging from shelf to bathyal basin plain (Ingle, 1978). The sequence is divided into the Rincon Formation (Edwards, 1971) containing microfauna of the upper Zemorrian and Saucesian Stages, and the Monterey Formation (Bramlette, 1946) with microfauna of the upper Saucesian, Relizian, Luisian, and Mohnian Stages. Stage names are from Kleinpell (1938). These rocks crop out north of Summerland and on Rincon Mountain; they subcrop against the Pleistocene unconformity throughout the offshore part of the basin, and onshore south of the surface trace of the Rincon Creek fault. They are composed predominantly of gray to brown, siliceous mudstone, claystone, siltstone, and shale, and are typically folded and faulted. The normal stratigraphic thickness of the Rincon and Monterey Formations combined is approximately 1,150 m, however, variation from thickening at fold axis and thinning along fold limbs is common. In the Summerland Offshore anticline, after subtracting the amount of repetition caused by the Rincon Creek fault, the apparent thickness at the fold axis is 1,340 m, whereas in the south limb it is approximately 700 m (Fig. 3 1).

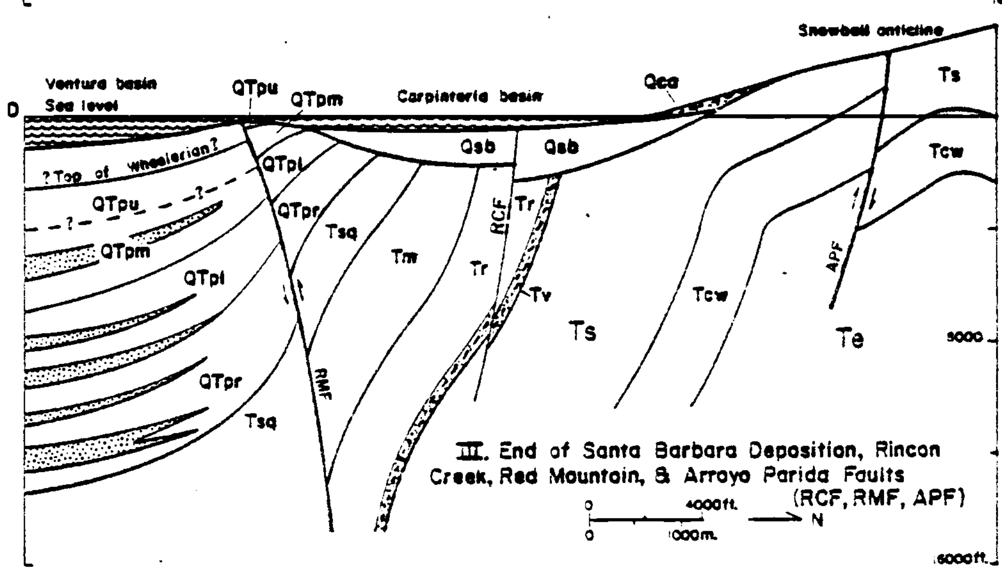
Figure 5: Palinspastic restoration of Section D-D'. APF, Arroyo Parida fault; HF, Holloway fault; RCF, Rincon Creek fault; RMF, main branch of Red Mountain fault. Present cross section (VI) is partially diagrammatic. Location of section on geologic map. For formation symbols, see Fig. 2. Te, Eocene formations older than the Coldwater Formation. Terraces and landslides not shown.



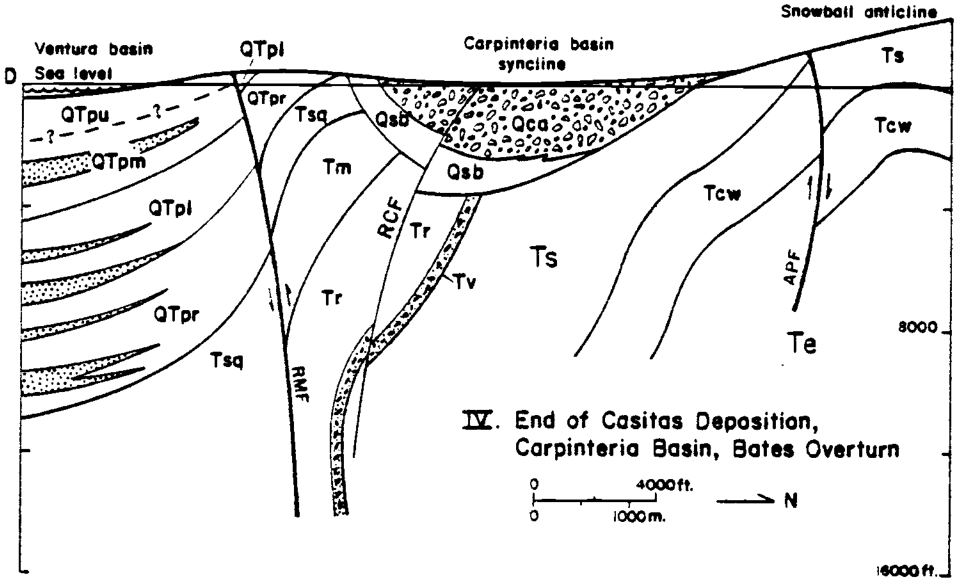

I. End of Repettian Deposition



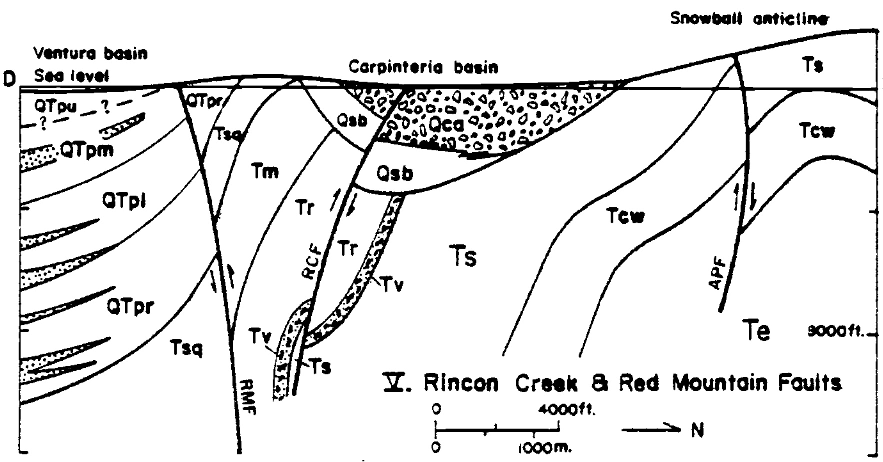

II. Snowball Anticline, Basin Unconformity



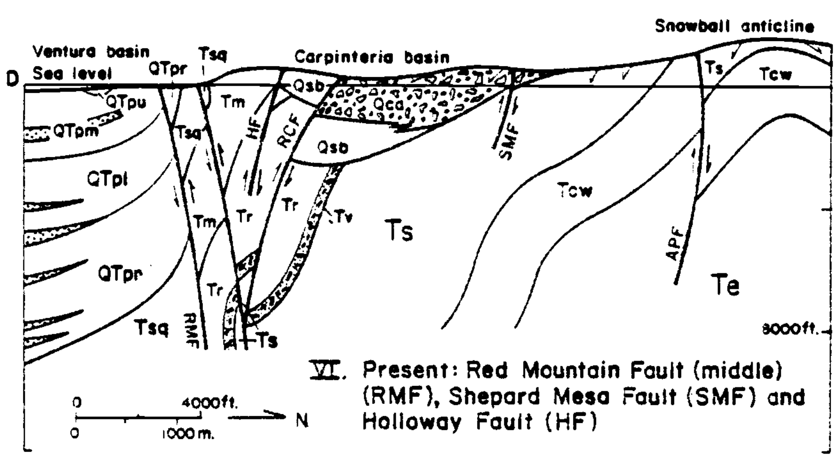

III. End of Santa Barbara Deposition, Rincon Creek, Red Mountain, & Arroyo Parida Faults (RCF, RMF, APF)




IV. End of Casitas Deposition, Carpinteria Basin, Bates Overturn

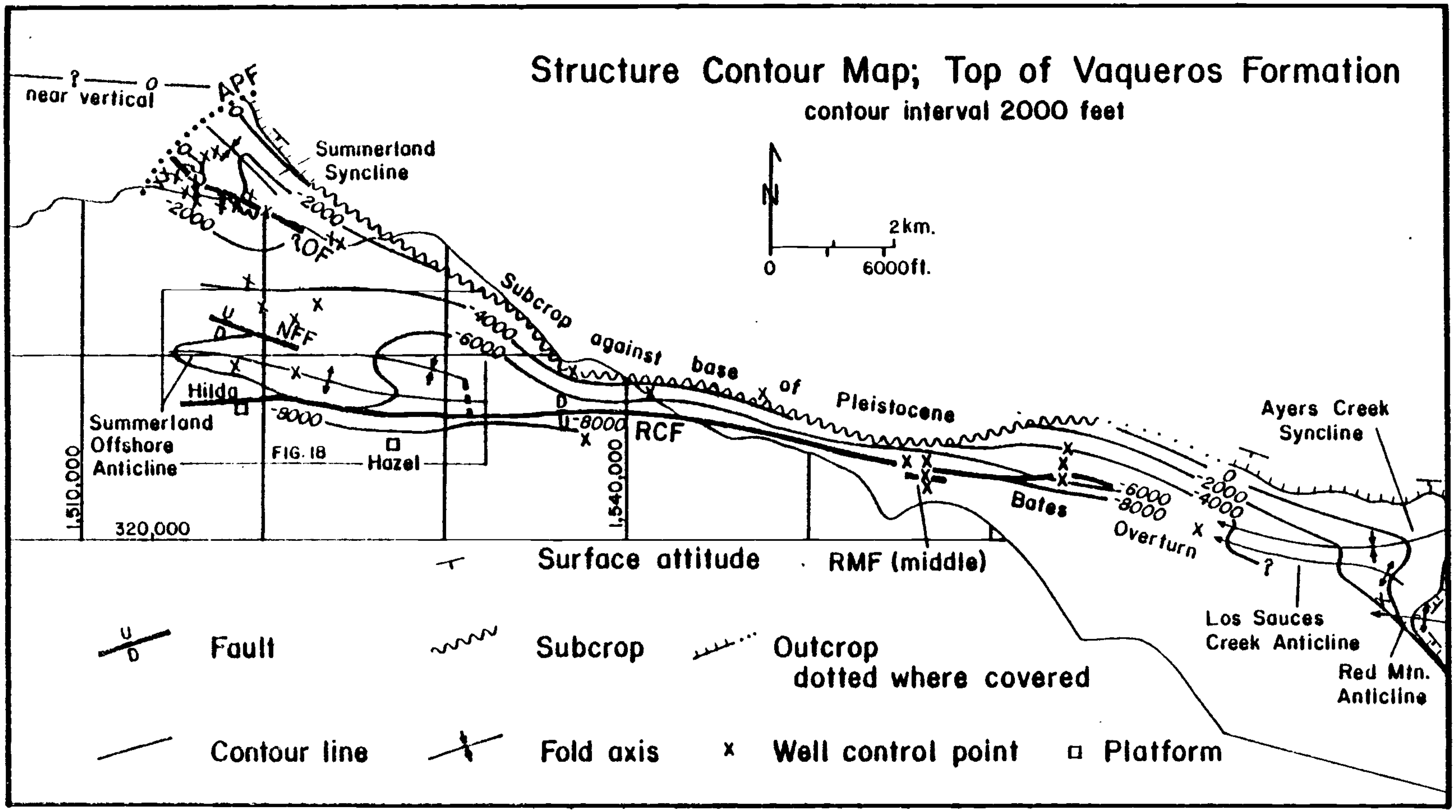



V. Rincon Creek & Red Mountain Faults




VI. Present: Red Mountain Fault (middle) (RMF), Shepard Mesa Fault (SMF) and Holloway Fault (HF)

Figure 6: Structure contour map; Top of Vaqueros Formation. Rectangle around Summerland Offshore anticline locates a more detailed map shown as Fig. 8. For fault abbreviations, see Fig. 2.


Structure Contour Map; Top of Vaqueros Formation
contour interval 2000 feet
near vertical
APF
Summerland Syncline
-2000
OF
Subcrop against base of Pleistocene
-4000
-6000
-8000
NFF
Hilda
Summerland Offshore Anticline
FIG. 18
Hazel
RCF
1,510,000
1,540,000
320,000
N
2km.
0
6000ft.
Ayers Creek Syncline
Bates
Overturn
Los Sauces Creek Anticline
Red Mtn. Anticline
Surface attitude
RMF (middle)
Fault
Subcrop
Outcrop dotted where covered
Contour line
Fold axis
Well control point
Platform

# PLIOCENE STRATIGRAPHY AND REGIONAL FRAMEWORK

In the Carpinteria area, the Sisquoc Formation which is part of the incompetent sequence, contains upper Mohnian and Delmontian Stage microfauna and was deposited mainly during the Pliocene as diatomaceous siltstone, mudstone, and claystone. It thins northward from 640 m in the Rincon oil field, where it is reported as "Santa Margarita" by Stewart (1943), to 300 m in the Summerland Offshore anticline and near Rincon Point (Figs. 3f, 3k). This northward thinning is partial evidence for the initial rise of the Santa Ynez Mountains during the Delmontian stage. By the end of the Delmontian Stage, the Santa Ynez Mountains and Ventura basin were identifiable structural units.

The Neogene Ventura basin extends from the San Gabriel fault westward to the Santa Barbara Channel continental slope, and from the Santa Monica Mountains northward to the Red Mountain-San Cayetano fault system (Yeats, 1976). The basin is characterized by high rates of subsidence and sedimentation. Near Ventura, during the Pliocene, approximately 2,600 m of interbedded mudstone, sandstone, and conglomerate were deposited as the basin subsided at a rate of 1.4 mm/yr. (Yeats, 1978). The Pico Formation (Kew, 1924) of Pliocene and Pleistocene age is approximately 4,000 m thick in the center of the basin. It was deposited as a series of deep water turbidite flows containing microfauna characteristic of the Repettian, Venturian, and Wheelerian Stages as defined by Natland (1953). Based on industry use in this area, the Pico Formation is informally divided into "Repetto" strata having microfauna of the Repettian Stage, "Lower Pico" strata containing microfauna of the Venturian Stage, and "Middle and Upper Pico" strata with microfauna of the Wheelerian Stage. Along the northern margin of the Ventura basin, the Pico Formation thins abruptly northward. In the Rincon oil field, it consists of 1,097 m of "Repetto," 823 m of "Lower Pico" and 1,430 m of "Upper and Middle Pico" (Paschall, 1954); whereas on Rincon Point "Repetto" strata are approximately 610 m thick (Fig. 3f) and offshore in wells 252-254, "Lower and Middle Pico" combined are only 365 m thick (Fig. 3k).

South of Carpinteria, we infer that the northward-thinning Pico Formation oversteps the underlying Sisquoc strata. Unfortunately, movement along the Pleistocene Red Mountain fault, east of Rincon Point, has overturned this contact and destroyed its original dip. However, a possible analogy to these relationships is located south of the Oak Ridge fault on the south side of the Ventura basin, where "Repetto" slope shale and younger Pico Formation overstep Miocene strata at a steep (up to 75$^{\circ}$) north-facing slope. This is the basis for the relationships illustrated in Section II of Fig. 5.

A northeastward facies change from turbidite sandstone to mudstone in Pico strata containing Wheelerian Stage microfauna is observed in wells 8 and 19-24. These relationships and similar facies changes south and east of the eastern Red Mountain fault (Yeats, Lee, and Yerkes, in press) suggest the area north of the Red Mountain fault was more positive than areas to the east and south during deposition of the Pico Formation. This is analogous to the South Mountain seaknoll southeast of Santa Paula, where coarse-grained Pico turbidite flows deflected around the more positive seaknoll and deposited their sediment in deeper water (Yeats, 1965).

In early or middle Pliocene time, the Santa Ynez Mountains became emergent (Dibblee, 1966). The mountain range is a southward-dipping homocline uplifted on the north along the oblique-slip Santa Ynez fault. The fault, on which the south side is relatively up with respect to the north side, demonstrates from two km (Link, 1971) to 37 km (Edwards, 1971) of left-lateral separation and two to three km of vertical separation (Dibblee, 1966). Preceding the formation of the Pleistocene unconformity, folding along the southern margin of the Santa Ynez Mountains formed many of the structures seen beneath the Carpinteria basin.

# PRE-BASIN DEFORMATION OF SANTA YNEZ COASTAL MARGIN

Prior to deposition of the Pleistocene Santa Barbara and Casitas Formations, structures on the southern flank of the Santa Ynez Mountains were primarily folds. The East Fork syncline, located north of the Carpinteria basin, is an overturned, southward-verging fold involving Sespe and Coldwater strata (Fig. 2). West of Toro Canyon, it is overlain with angular unconformity by older alluvium and truncated by the Arroyo Parida fault. The westward continuation of the overturned north limb is supported by wells 309 and 311 which encountered steeply dipping, overturned Vaqueros (?) strata beneath older alluvium.

The Snowball anticline, located south of the syncline, is an open, slightly asymmetric fold with vergence to the south (Figs. 3c, 3e). The southern limb, partially overlain with angular unconformity by Pleistocene strata, is uplifted relative to the fold axis by the Arroyo Parida fault. East of Loon Point, south-dipping Sespe, Vaqueros, and Rincon strata subcrop against the Pleistocene unconformity and are part of the south limb of the anticline. These beds steepen towards the axis of the Carpinteria basin to $60^{\circ}$-$70^{\circ}$ south (Figs. 3i, 3j). Near Rincon Point, south-dipping Miocene strata on the south flank of the anticline are conformably overlain by Sisquoc and "Repetto" strata, and unconformably overlain by the Pleistocene Santa Barbara Formation (Fig. 3f). This suggests that the Snowball anticline was folded after deposition of the "Repetto", but before deposition of the Santa Barbara.

In the Summerland area, the Summerland syncline, Summerland anticline and Ortega fault involve Miocene and older formations and are partially covered by Pleistocene strata. The Summerland syncline (Fig. 3 L), located north of Summerland, is a N65W-trending, northward-verging fold. Its southern limb is offset by the Syncline fault and passes southward into the Summerland anticline. The axis of the anticline, covered by terrace, older alluvium, and the Pleistocene Casitas Formation, trends S65E and was drilled by well 120 (Fig. 2). Surface mapping and paleontology by Lian (1952) and subsurface data in wells 112 and 120, suggest the Rincon Formation is locally folded into several smaller folds above more broadly folded Vaqueros and older strata. This is demonstrated in Figure 3m, where the contact between Lians lower and middle subdivisions in the Rincon Formation (dotted) is disharmonically folded above Vaqueros strata at the axis of the Summerland anticline. Beneath Summerland, south of the anticlinal axis, the Ortega fault subcrops against the Pleistocene unconformity and uplifts the southern limb of the fold relative to the axis. Prior to deposition of the Casitas Formation, Rincon and Vaqueros strata were exposed at the axis of the anticline and on the south flank of the fold south of the fault (Fig. 4).

In Figure 3 L gently south-dipping Casitas Formation unconformably overlies Rincon strata in well 210 and north-dipping Rincon strata in well 137. The Rincon-Monterey contact, subcropping against the unconformity, dips to the south, whereas on the north flank of the Summerland anticline it dips to the north (Fig. 3m). These indicate that the Summerland anticline and the Summerland syncline were folded prior to deposition of the Casitas Formation. Similar to the Rincon Point area, Miocene strata in the Summerland Offshore oil field are concordantly overlain by the Pliocene Sisquoc and "Repetto" Formations and unconformably overlain by the Santa Barbara Formation. Prior to folding of the Pleistocene Summerland Offshore anticline, these strata were part of the south flank of the Summerland anticline which was folded after deposition of the "Repetto", but before deposition of the Santa Barbara. East of Summerland, wells 144 and 148 encountered south-dipping, unfaulted Casitas, Rincon, Vaqueros and Sespe strata, suggesting that the Summerland folds and the Ortega fault die out on the south flank of the Snowball anticline. To the west, the folds and fault are cut off by the Arroyo Parida and Fernald Point faults.

On the Rincon Mountain the Rincon Mountain syncline and Los Sauces Creek anticline also began to form prior to deposition of the Santa Barbara Formation (Fig. 2). Subcropping against the Pleistocene unconformity, the Rincon Mountain syncline is unconformably overlain by the Santa Barbara Formation between wells 108 and 110, suggesting a pre-Santa Barbara age of formation for the syncline (Fig. 4). The Monterey-Rincon contact crops out north of well 109 and subcrops against the Pleistocene unconformity south of well 109, demonstrating a similar age of formation for the Los Sauces Creek anticline (Fig. 4). These structures are within the incompetent Miocene formations which overlie faulted and more broadly folded Vaqueros and older strata (Fig. 7). The pre-Pleistocene folds die out near the Ventura-Santa Barbara County line where all pre-Pleistocene dips are southward (Figs. 3e, 5).

# QUATERNARY STRATIGRAPHY

## Santa Barbara Formation

The Santa Barbara Formation (Woodring, Stewart, and Richard, 1940) in the Carpinteria basin north of the Red Mountain fault is primarily a shallow marine sandstone; whereas in the central Ventura basin south of the Red Mountain fault, as described by Weber et al., (1973), it is made up of mudstone, siltstone, and shale. In both areas the formation is correlated to the type Santa Barbara section using megafossils. Near Ventura, deposition of these strata began less than 1.2 Ma ago, based on their stratigraphic position with respect to the radiometrically dated Bailey ash. Subsequent uplift of the hanging wall block of the Red Mountain fault separated the formation into the two basins and obscured their exact facies relations. In the northern Ventura basin, south of the Ventura Avenue anticline, "Upper" Pico and Santa Barbara Formation contain several ash beds dated between 1.2 Ma (Bailey ash, Izett et al., 1974) and 0.7 Ma (Bishop ash, Dalrymple et al., in review). Ash beds have not been found in the Santa Barbara in the Carpinteria basin.

In the Carpinteria basin, the Santa Barbara Formation is exposed northeast of Rincon Point and on the sea floor north of Platform Hilda. It oversteps Miocene and Oligocene strata and is itself overlapped by younger nonmarine strata north of a line connecting wells 210, 233, 47, and 108 (Fig. 4). At the basin unconformity, angular discordance with pre-Pleistocene strata increases southward and eastward from near $0^{\circ}$ to $70^{\circ}$ south (Figs. 3i, 3l). The Santa Barbara Formation consists of tan to red, fine-to medium-grained, soft, friable, fossiliferous sandstone and siltstone interbedded with thin layers of claystone and lenses of conglomerate. Clasts in the conglomerate include Eocene sandstone, Sespe sandstone, reworked crystalline clasts from Sespe conglomerate, and lesser amounts of Monterey "Shale" (Lian, 1952). The Santa Barbara Formation grades laterally and upward into the Casitas Formation north of the Rincon Creek fault, and is unconformably overlain by terrace material and alluvium south of this fault (Figs. 3g, 3h). In the subsurface, the contact between the Santa Barbara and Casitas Formation is picked at the first occurrence of fossils. Although intertonguing relationships make thickness measurements questionable, fossils found within Aquifer B (Slade, 1975; wells 233 & 234, Fig. 3i) at the top of the formation, suggest the maximum thickness of the Santa Barbara Formation is approximately 1080 m (Fig. 3g). East of Sand Point, Santa Barbara strata lap onto the unconformity on the north and south sides of the basin whereas to the west, bedding is parallel to the unconformity (Fig. 3L). The north slope of the unconformity, as shown in Figure 3g, indicates that the eastern part of the Carpinteria basin was uplifted and separated from the main Ventura basin to the south prior to deposition of the Santa Barbara Formation.

## Casitas Formation

As the basin shoaled, the nonmarine Casitas Formation of Pleistocene age gradually covered Santa Barbara strata from the north, apparently as a large alluvial fan complex. The Casitas Formation is found throughout the basin north of the Rincon Creek fault; its type section is located at the junction of Casitas and Rincon Creeks (Upson, 1951). The formation unconformably overlies Sespe, Vaqueros, and Rincon strata, grades downward and laterally into Santa Barbara strata, and is unconformably overlain by terrace deposits and alluvium. It consists of a lower section of red to tan, thin-bedded, fine-grained, unfossiliferous sandstone, siltstone, and conglomerate, and an upper section of yellow brown, poorly sorted, massive to crudely stratified pebble to boulder conglomerate (Upson, 1951; Lian, 1952). Clasts are predominantly from Eocene and Sespe Formation exposed in the mountains to the north and east. Although subsurface variation does not allow electric log correlation of individual beds over long distances, Aquifers A to D are correlated within a limited area north of the Rincon Creek fault (Figs. 3f-3j; Slade, 1975). Aquifer A is contained in late Pleistocene terrace deposits, whereas Aquifers B, C and D transect the facies boundary between the Casitas and Santa Barbara Formations. The inability to differentiate the two formations without lithologic descriptions necessitates considering them together in the subsurface. The Casitas Formation increases in thickness to the south and east and is lithologically similar to the Saugus Formation of the Ventura basin. The now abandoned Summerland oil field which produced from "Main" sands within the Casitas at an average depth of only 67 m was discovered in 1896 and is considered the first offshore field in the United States (Arnold, 1907).

## Surficial Deposits

Late Pleistocene to Holocene marine terraces unconformably overlie older formations east and south of the city of Carpinteria. Terrace exposures also are present on Loon Point and near Summerland. They consist of a fossiliferous basal conglomerate deposited on wave-cut platforms and overlain by beach, aeolian, and alluvial sediments. Thicknesses rarely exceed 30 m, however, undifferientiated terrace and older alluvial deposits are up to 90 m thick near Sand Point (Fig. 3j). Terraces on Rincon Mountain (Putnam, 1942) have been dated utilizing open-system uranium-series, amino acid racemization, $^{14}C$, and paleontological techniques. The Punta Gorda terrace is approximately 45,000 years old and the Sea Cliff terrace is approximately 4,500 years old (Kaufman et al., 1971; Wehmiller et al., 1978; Lajoie et al., 1979). The Punta Gorda terrace, which slopes westward to below sea level at Carpinteria (Putnam, 1942) is approximately 200 m above sea level near Los Sauces Creek. Uplift rates based on elevations of these dated terraces also decrease westward towards Carpinteria (Lajoie et al., 1979).

Alluvial deposits are separated into younger and older units based upon degrees of deformation and dissection. Mammalian fossils collected from older alluvium west of Santa Barbara indicate a late Pleistocene age (Dibblee, 1966).

# QUATERNARY STRUCTURES

Whereas pre-Santa Barbara structures were limited mainly to folds, structures formed during the late Quaternary include both folds and faults.

The shape of the Carpinteria basin is defined by the unconformity at the base of the Pleistocene (Fig. 4). This horizon was a relatively featureless, south-dipping surface eroded into strongly deformed pre-Pleistocene strata of the coastal margin of the Santa Ynez Mountains during or after deposition of the "Upper Pico" Formation. If the deposition of the Santa Barbara Formation in the Carpinteria and Ventura areas was comtemporaneous, the Pleistocene unconformity is less than 1.2 Ma in age.

## Arroyo Parida Fault

The Arroyo Parida fault is exposed in the foothills north of Carpinteria and covered by alluvium west of Toro Canyon. To the east, it is exposed as a normal fault which dips $60^{\circ}$ - $74^{\circ}$ north, juxtaposing Coldwater strata on the north against Coldwater and Sespe strata on the south (Figs. 3c, 3e). Dip separation of the Sespe-Coldwater contact measured along the fault ranges between 200 m and 825 m (Chauvel, 1958). Left-lateral separation, similar to that on the Santa Ynez fault to the north, is suggested by Dibblee (1966) and Chauvel (1958) based on the apparent left-lateral deflection of Carpinteria Creek and left-laterally offset structural highs near Rincon Creek and west of well 45. Subsurface data do not support this interpretation; the Vaqueros (?) subcrop beneath the Casitas Formation near Romero Creek is not laterally offset by the fault (Figs. 4, 6). In addition, several streams, including Toro and Rincon Creeks are not deflected by the fault.

However, a normal fault should not develop in a compressional regime. One possible solution to this problem is that the Arroyo Parida fault is a folded reverse fault that originally dipped south (Lian, 1952; Chauvel, 1958; Sec. III, Fig. 5). This is supported by relations in well 45 (Fig. 3j) which intersected the fault zone at 107-115 m and encountered gouge and sheared rock at 1255 m and 1315 m. The lower gouge zones may be the fault as it curves back to a south dip. If this interpretation is correct, initial movement along the north-dipping segment of the fault may have occurred prior to formation of the Carpinteria Basin syncline, permitting the fault to be folded during formation of the syncline (compare sections III and

IV, Fig. 5). It may have formed as a bedding plane fault, within the Eocene section, as suggested in Fig. 5.

West of Toro Canyon, the Arroyo Parida fault offsets Casitas strata and older alluvium, and forms a 75 m north-facing scarp. Surface geology, trenching, seismic refraction data, and groundwater data indicate the fault dips south and juxtaposes Miocene strata on the south over "fanglomerate" or older alluvium on the north (Hoover, 1978). The Montecito and Fernald Point faults branch to the south and are similar to the Arroyo Parida fault in the Montecito area. The latest movement along this segment of the Arroyo Parida fault was during the late Pleistocene after deposition of the older alluvium, but before deposition of younger alluvial deposits.

## Carpinteria Basin Syncline

The Carpinteria Basin syncline, defined by the Pleistocene unconformity, involves Casitas and Santa Barbara strata and previously folded Miocene and older strata. It was formed primarily on the south flanks of the Snowball and Summerland anticlines, and is not related to pre-Santa Barbara structures. Most of the folding occurred after deposition of the Casitas Formation, however, overlying terrace and alluvial deposits dip towards the axis of the syncline suggesting continuation of folding into the late Quaternary. The syncline is a relatively simple fold, traced from Rincon Mountain to Sand Point and offshore to well 223 (Fig. 4). The fold is asymetric, verging to the north, with the south limb cut by the Carpinteria, Holloway, and Rincon Creek faults (Figs. 3f, 3i, 3m). The north limb dips 15°-35° south, except where it is steepened by the south-dipping Shepard Mesa reverse fault (Fig. 3e); the south limb dips 20°-70° north depending on the amount of displacement along the Rincon Creek fault. Comparison of Figs. 3e, 3h, 3j, and 3l suggest that where separation along the fault is the greatest the south limb of the syncline dips the least. Similarly, the deepest part of the syncline corresponds to the area of the largest separation along the Rincon Creek fault (Fig. 3h). This suggests that the asymmetric shape of the syncline, and therefore, the shape of the Carpinteria basin is partially controlled by movement along the Rincon Creek fault.

## Ortega Anticline

Near Summerland on the north limb of the Carpinteria Basin syncline the Ortega anticline was folded after deposition of the Casitas Formation (Fig. 2). The anticline folds Casitas strata to dips up to $59^{\circ}$ northeast at the surface, however, pre-Casitas strata subcropping against the Pleistocene unconformity dip $0^{\circ}$ to $15^{\circ}$ south (Fig. 3m). A possible solution to this problem is that the Ortega anticline is a decollement fold, where clay-rich Casitas strata detached from the "Gypsiferous clayey shale" of the Rincon Formation (cf. Treadwell Wharf section of Arnold, 1907) and folded as it moved down the north limb of the Carpinteria Basin syncline.

## Summerland Offshore Anticline

Between the Rincon Creek and Red Mountain faults, the Summerland Offshore anticline exposes Santa Barbara strata, the Pleistocene unconformity, and beds containing Repettian to Saucesian microfauna (Fig. 7). In the subsurface, the fold also involves Oligocene strata, and may be divided into an upper section composed of disharmonically folded Rincon, Monterey, and Sisquoc strata, and a lower section of a more competent Vaqueros and Sespe strata. Uplift of the Miocene section as the anticline was folded during the Pleistocene Epoch was partially responsible for separation of the Carpinteria and Ventura basins.

Figure 7: Summerland Offshore anticline, surface geology. For formation names and abbreviations, see geologic map (Fig. 2). Dart and core data from Hoyt (1976). Rincon Creek fault surface trace based on scarp shown by 5 ft. bathymetric contours. Saucesian, Relizian, Luisian, Mohnian, and Delmontian Stages are those of Kleinpell (1938); Repettian Stage is that of Natland (1953).

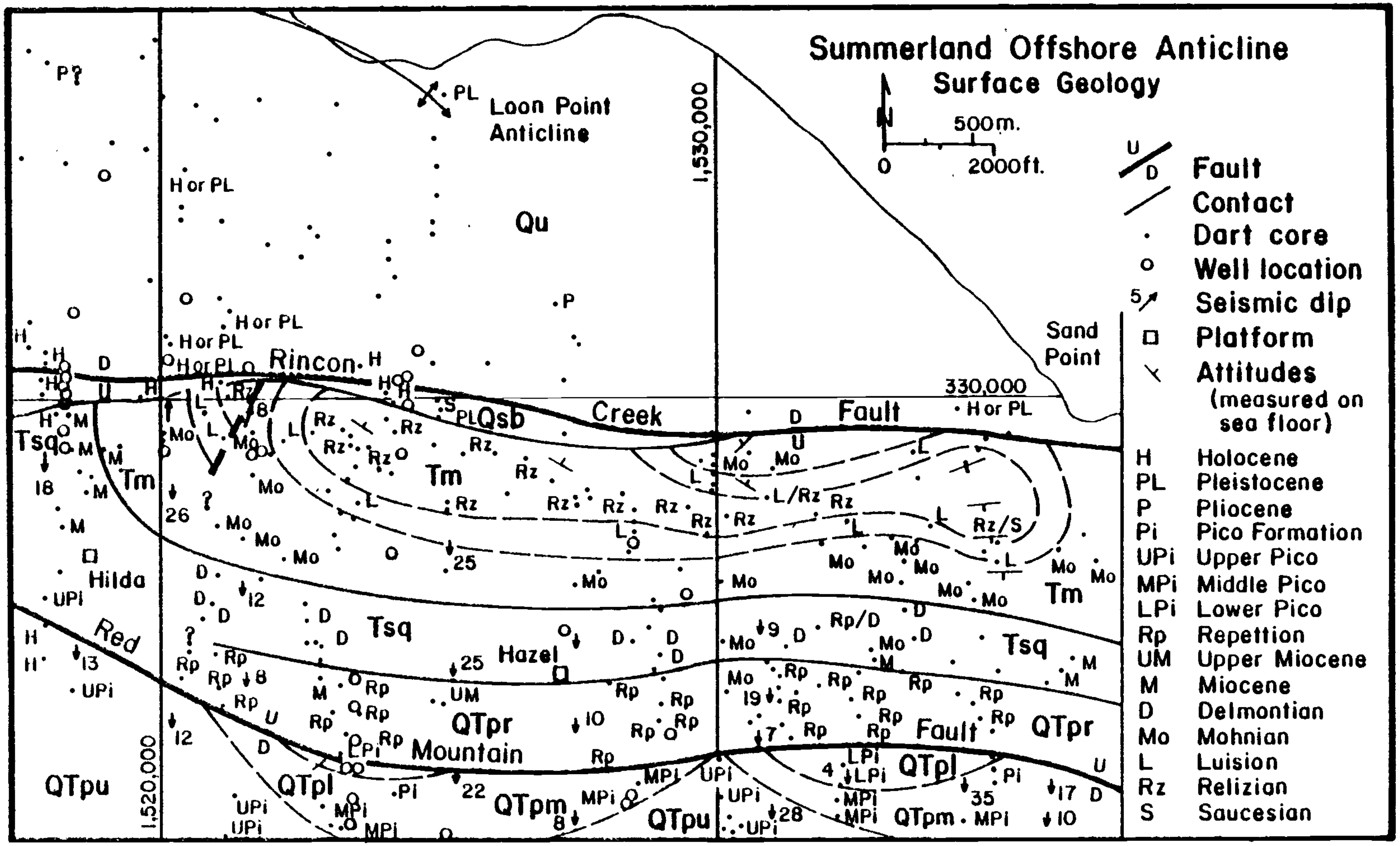
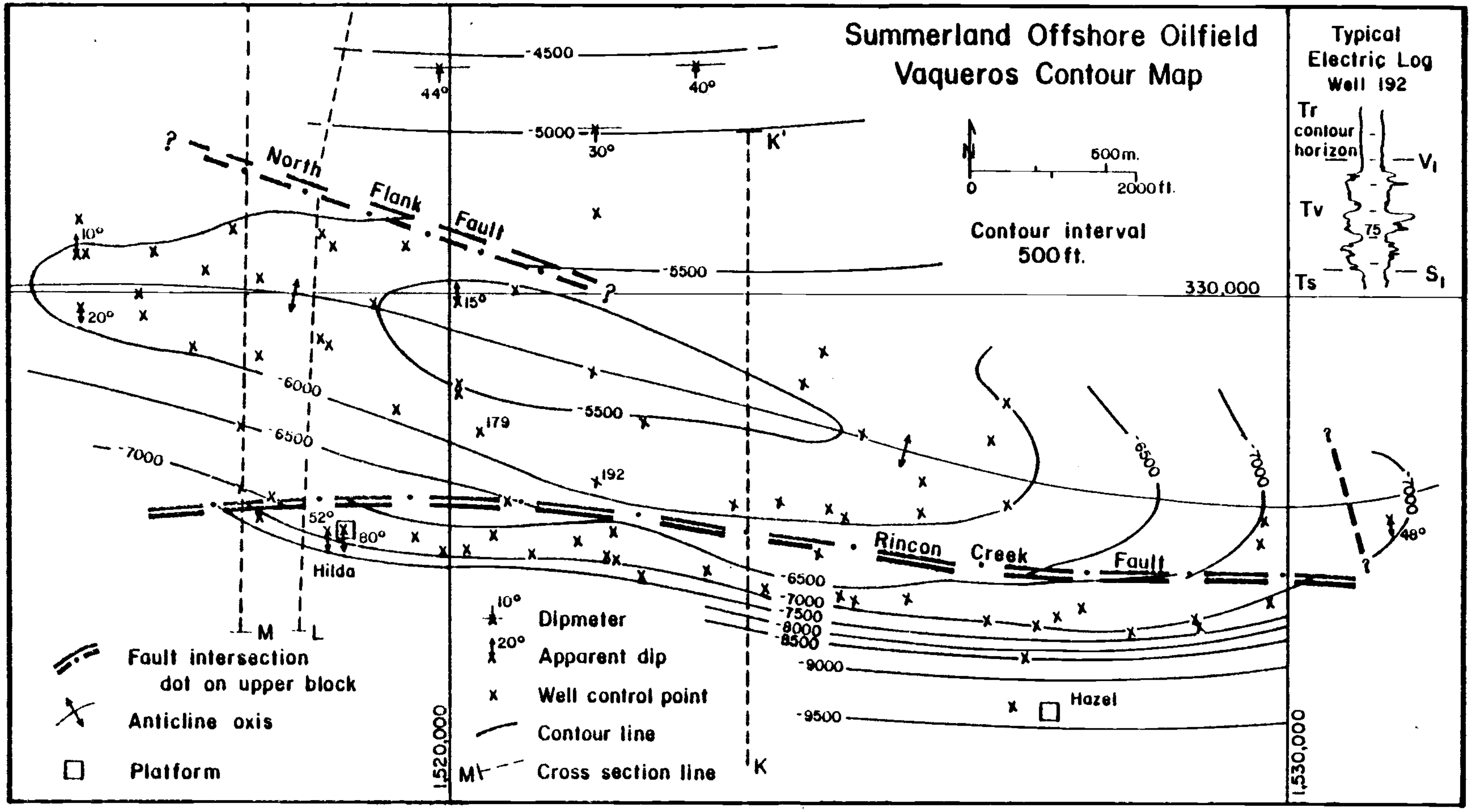

Summerland Offshore Anticline
Surface Geology
N
0 500m. 2000ft.
Loon Point Anticline
Qu
Rincon Creek Fault
Qsb
Sand Point
Tm
Tsq
Hilda
Hazel
Red Mountain Fault
QTpr
QTpl
QTpm
QTpu
1,530,000
1,520,000
330,000
U D Fault
Contact
Dart core
Well location
Seismic dip
Platform
Attitudes (measured on sea floor)
H Holocene
PL Pleistocene
P Pliocene
Pi Pico Formation
UPi Upper Pico
MPi Middle Pico
LPi Lower Pico
Rp Repettion
UM Upper Miocene
M Miocene
D Delmontian
Mo Mohnian
L Luision
Rz Relizian
S Saucesian

Figure 8: Summerland Offshore oil field, top of Vaqueros contour map. Contours relative to sea level. Location in Fig. 4.


Summerland Offshore Oilfield
Vaqueros Contour Map
Typical Electric Log Well 192
Tr
contour horizon
V1
Tv
75
Ts
S1
N
500m.
0
2000ft.
Contour interval 500ft.
330,000
North Flank Fault
Rincon Creek Fault
-4500
-5000
-5500
-6000
-6500
-7000
-7500
-8000
-8500
-9000
-9500
44°
40°
30°
10°
20°
15°
52°
80°
48°
179
192
Hilda
Hazel
K'
K
M
L
1,520,000
1,530,000
Fault intersection dot on upper block
Anticline axis
Platform
Dipmeter
Apparent dip
Well control point
Contour line
Cross section line

Along the coastal margin of the Santa Ynez Mountains, the Summerland Offshore oil field, operated by Chevron, U.S.A. Inc., is the easternmost field producing from Vaqueros sandstone. The field is structurally similar to the Molino Offshore, Elwood, and South Elwood Offshore fields (California Division of Oil and Gas, 1974). Although the Summerland Offshore field is still being developed and a full discussion of its structure is premature, well data released by the California Division of Oil and Gas are sufficient to describe the anticline in general.

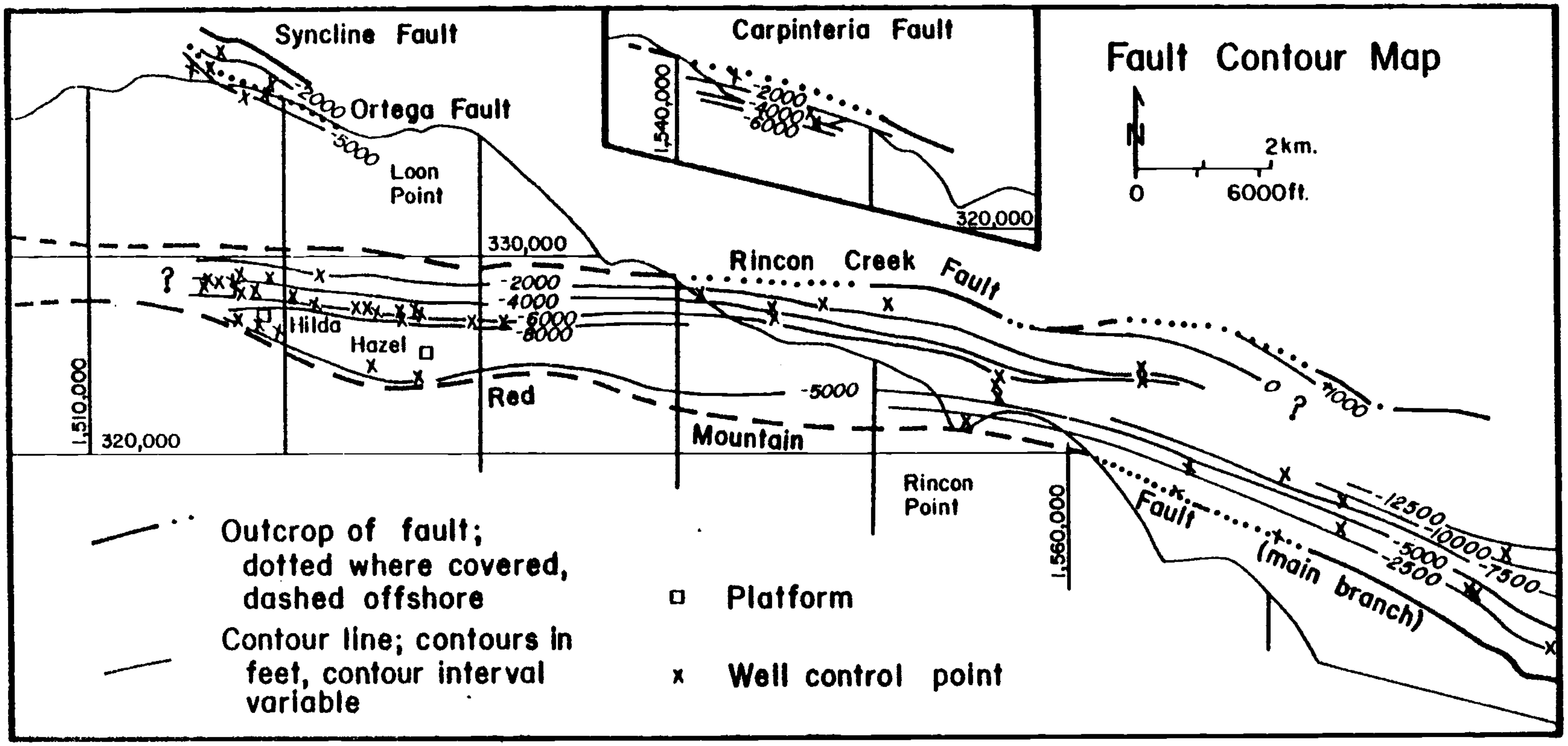
The fold within the Vaqueros and Sespe Formation is slightly asymmetric and doubly plunging. The north flank dips $5^{o}$-$20^{o}$ north and is offset by the North Flank fault, which is mapped based on possible cuts in wells 176 and 182, and on the position of the -5,000 a -6,000 foot Vaqueros contours (Figs. 31, 8). The south limb of the fold dips up to $80^{0}$ south and is cut at a slightly oblique angle by the Rincon Creek fault. These beds pass eastward near Rincon Point into the Bates overturn.

The upper section of the fold is composed of fine-grained, more tightly folded Rincon, Monterey, and Sisquoc strata. Tectonic thickness variations within this upper section, especially within the Rincon Formation, are the reason for the disharmonic nature of the fold. The accumulation of Rincon strata at the axis of the anticline in Fig. 3k, where it is four times thicker than on the south flank, is accomplished by ductile flow and small scale faulting. The complexity of this faulting is documented in Figs. 3l and 3m, where individual concretionary siltstone beds are traced locally through the Rincon Formation. The disharmonic nature of the anticline is also demonstrated by comparing the surface geologic map to the Vaqueros contour map (Figs. 7, 8). The culmination of the anticline at the Vaqueros level is over 1220 m west of the culmination at the surface.

Although the outcrop pattern in Figure 7 suggests that the Summerland Offshore anticline was formed after deposition of the Santa Barbara Formation, relations in wells 241-245 (Fig. 3l) indicate that Santa Barbara strata are parallel to the unconformity and that most of the anticline was formed after Santa Barbara deposition. This marked the structural separation of the Ventura and western Carpinteria basins.

In the Summerland Offshore oil field, production comes from the "North Flank", "Main", and "South Flank" pools. The "Main" pool, discovered in 1957 and developed from Platforms Hilda and Hazel, produces from the central part of the anticline at -5,000 to -6,000 feet below

Figure 9: Fault contour map. Structural contours on the Syncline, Ortega, Rincon Creek, Carpinteria, and main branch of the Red Mountain faults. Contours relative to sea level.



Fault Contour Map
N
2km.
0
6000ft.
Syncline Fault
Ortega Fault
-2000
-5000
Loon Point
Carpinteria Fault
1,540,000
-2000
-4000
-6000
320,000
330,000
Rincon Creek Fault
-2000
-4000
-6000
-8000
Hilda
Hazel
Red
Mountain
-5000
0
1000
1,510,000
320,000
Rincon Point
1,560,000
Fault (main branch)
-12500
-10000
-7500
-5000
-2500
Outcrop of fault; dotted where covered, dashed offshore
Contour line; contours in feet, contour interval variable
Platform
Well control point

sea level (Fig. 8). The "South Flank" pool produces from a drag fold associated with the Rincon Creek fault on the south limb of the anticline (Fig. 3k). Because oil could not be trapped until after the anticline was formed, the age of oil migration into the Summerland Offshore oil field was after deposition of the Santa Barbara Formation.

## Rincon Creek Fault

In the Carpinteria area, two types of faults are present: south-dipping reverse faults associated with bedding-slip, and north-dipping reverse faults that truncate bedding and steepen with depth.

The south-dipping Rincon Creek reverse fault intersects the Pleistocene unconformity and brings Rincon and Monterey strata into fault contact with the Santa Barbara and Casitas Formations (Figs. 3c, 3h, 3j, 3m). At the surface, immediately west of Rincon Creek, the fault raises a north-facing 30 m scarp and offsets terrace gravels (Fig. 10); offshore from Sand Point it uplifts a smaller, 2-3 m north-facing scarp. Interpretations of seismic profiles by Hoyt (1976) suggest the fault may continue to the City of Santa Barbara as the Mesa fault.

Although displacement along the fault varies both horizontally and vertically the offset paleogeologic contacts subcropping against the Pleistocene unconformity demonstrate that the sense of movement is essentially parallel to the dip of the fault (cf. A-A', B-B', C-C', and D'D'; Fig. 4). Vertical variation is illustrated in Figure 31, where the dip separation of electric log marker Q is approximately 225 m and separation of the Rincon-Vaqueros contact is only 25 m. From west to east, the dip separation of the Vaqueros-Rincon contact varies from 25 m in the Summerland Offshore anticline to 560 m near Rincon Creek (Fig. 3c). The maximum dip separation along the fault is approximately 950 m, as measured on the repeated Pleistocene unconformity in well 74 (Fig. 3h).

East of Carpinteria, the fault plane dips from 35° to 65° south at the surface to near vertical at a depth of approximately 1,200 m (Figs. 3e, 9). In the Summerland Offshore anticline, it dips from 65° south in the Miocene section to 85° south in the Sespe Formation (Fig. 3k). Below the Pleistocene unconformity, the Rincon Creek fault is generally parallel to Miocene bedding, and although it seems more plausible that it would pass into incompetent Miocene strata, the

Figure 10: Rincon Creek fault exposed east of Rincon Creek along California State Highway 150. The south-dipping Rincon Creek fault forms a gouge zone over nine meters wide and offsets a late Pleistocene terrace. View is westward.


Gouge
Zone
Qf
Qca

fault cuts across Vaqueros strata and lies parallel to bedding in the upper Sespe Formation (Figs. 3c, 3k).

If the facies relationships between the Santa Barbara and Casitas Formations are correct, Figure 3g indicates that the Rincon Creek fault began to form during deposition of the Santa Barbara Formation and has continued to form in the eastern part of the basin during Casitas deposition and the folding of the Carpinteria Basin syncline (cf. Fig. 5, Sections IV-VI). The folded shape of the fault supports this hypothesis (Fig. 9). In the Summerland Offshore anticline the dip of the fault with respect to bedding in the Miocene and Oligocene formations is constant, indicating that the fault was folded at the same time as the beds, which suggests folding of the anticline post-dates the fault (Fig. 3l). East of Carpinteria, the fault becomes more folded and the dip of the fault plane is not constant with respect to Pleistocene bedding suggesting that the fault was formed during deposition of the Santa Barbara and Casitas Formations. (cf. Figs. 3e, 3f, and 3h). If the fault first broke during deposition of the Santa Barbara, the rate of dip separation at the point of maximum separation along the fault would be 0.74-.95 mm/yr., which compares more realistically with separation rates observed to the south on the western Red Mountain fault.

The degree to which the Rincon Creek fault is folded and the asymmetry of the Carpinteria Basin syncline increases to the east as separation along the Red Mountain fault also increases. This suggests that the folding of the Rincon Creek fault and the asymmetric shape of the eastern Carpinteria basin is controlled by uplift of the hanging wall block of the Red Mountain fault.

The Carpinteria and Holloway faults are located en echelon to one another along the southern border of the basin in the hanging wall block of the Rincon Creek fault (Fig. 4). They are both south-dipping reverse faults that juxtapose Miocene and Pleistocene strata and are associated with bedding slip within the steeply south-dipping Monterey or Rincon Formations (Figs. 3f, 3g, 3h). The Carpinteria fault is exposed two miles south of Carpinteria in deep road cuts along U. S. Highway 101, where it dips nearly $90^{\circ}$ and displaces a marine terrace that may be correlated to the northwesterly tilted Punta Gorda terrace (Fig. 11). The location of the intersection of the Rincon Creek and Carpinteria faults is based on air photo lineations in the offshore kelp beds south of Sand Point (Whittier College Fairchild Collection, flight 4950, frames 128-130, 137, 138).

Figure 11: Carpinteria fault on the west side of U.S. Highway 101 three km southeast of Carpinteria. The Pleistocene unconformity between Monterey (Tm) and Santa Barbara (Qsb) Formations is unconformably overlain by a late Pleistocene marine terrace (Qt), which is itself offset by the Carpinteria fault. View is westward.


Qt
Tm
Fault plane exposed
Qt
Tm
Tm
Qsb

West of Rincon Creek, the Holloway fault uplifts marine terrace deposits and the Santa Barbara Formation, and is mapped at the base of a 20-25 m north-facing scarp (Fig. 3c).

Because the Red Mountain (main and middle branch), Holloway, Carpinteria, and Rincon Creek faults all cut late Pleistocene terraces, latest movements along these structures were contemporaneous.

## Red Mountain Fault

The main branch of the Red Mountain fault is a north to northeast-dipping reverse fault that extends from the Ventura River (7 km east of the mapped area) to La Conchita, and continues offshore to south of the Summerland Offshore oil field. East of well 27, it has up to 7500 m of reverse separation, juxtaposes Eocene and Pleistocene formations, displaces late Pleistocene to Holocene deposits, and is seismically active (Yeats, Lee and Yerkes, in press). The structure contour map of the main branch of the fault presented in this report (Fig. 9) is a westward continuation of Red Mountain fault contours shown in Figure 2 in Yeats, Lee, and Yerkes (in press).

West of well 27, the main trace of the Red Mountain fault dips 55° to 63° north-northeast at the surface, forms a southwest-facing scarp, and juxtaposes "Repetto" and younger Pico strata. On the north side of Los Sauces Creek, "Repetto" mudstones are faulted over Punta Gorda terrace with up to 22 m of vertical separation (Geotechnical Consultants Inc., 1968). Late Pleistocene separation rates for the fault in this area were therefore, 0.5 - 0.6 mm/yr. Near the northwest part of the Ventura Avenue anticline, vertical separation rates based on similar criteria were 0.5-1.6 mm/yr. (Sarna-Wojcicki and others, 1979). North of La Conchita, four exploratory holes drilled through the 4,500 yr Sea Cliff terrace (Section C-C', but not shown at this scale) indicate the fault dips 55°-65° north and brings "Lower Pico" over "Middle Pico" (Woodward-Clyde Consultants Inc., 1979). The main trace of the fault apparently does not cut this terrace suggesting latest movement along this strand of the fault occurred between 4,500 and 45,000 years ago.

In the subsurface, wells 19, 20 and 27 indicate the fault plane dips approximately 75° north-northeast at depths below -2,100 m (Figs. 3a, 9). In addition to steepening with depth, the fault plane increases in dip westward to at least 85° north (Figs. 3m, 9).

The hanging wall consists of near vertical "Repetto", Sisquoc, and Monterey strata, whereas the footwall is composed of south to southeast-dipping Pico Formation. Estimated stratigraphic separation of the "Repetto"-Sisquoc contact decreases to the west from 4,570 m (well 27) to 365 m near Rincon Point (Fig. 3f). South of the Summerland Offshore oil field, reverse separation of fossil marker R3 is 150 m (Fig. 3k).

The north and middle branches of the Red Mountain fault are located in the hanging wall block of the main trace, and although well control is poor, they dip approximately $70^{o}$ to $80^{o}$ north-northwest and displace vertical to northeast-dipping Miocene strata in the Bates overturn (Figs. 3a-3f). Both faults offset late Pleistocene marine terraces and are mapped on Rincon Mountain along highly dissected southwest-facing scarps. The middle branch of the Red Mountain fault, is tentatively mapped at Rincon Point based on possible marine terrace offsets. Although lithologic differences in the Rincon Point terraces north and south of the fault do not permit correlation, terrace offset is approximately 26 m, which agrees with measured offsets to the east (Woodward-Clyde Consultants Inc., 1979).

Although no direct evidence is available to date the age of the initiation of the Red Mountain fault, restoration of vertical separation at rates observed on the 45,000 yr terrace, assuming these rates were constant during the whole history of the fault, suggest the fault originated during deposition of lower Santa Barbara strata. Rates of 0.9 and 1.1 mm/yr. and 1,035 m of vertical separation were used in the reconstruction in Fig. 5. The assumption that separation rates were constant throughout the Quaternary Period may not be valid. Near Ventura, subsidence rates of the Ventura basin approximately doubled between 1.0 Ma and 0.5 Ma ago (Yeats, 1978). If the 0.5 to 1.6 mm/yr. separation rates represent faster rates of separation than in the past, the initial movement of the Red Mountain fault may have been prior to Santa Barbara deposition. However, as separation along the fault decreases to the west, either separation rates or the age of the fault must also decrease. Folding of the Rincon Creek fault and offset of the Punta Gorda terrace indicate strong late Pleistocene movement on the Red Mountain fault.

## Ventura Basin Structures

In the footwall block of the Red Mountain fault, the Pico Formation is folded into the Carpinteria and North synclines and the La Conchita and Rincon anticlines. These folds were formed approximately at the same time as the Summerland Offshore anticline and the Carpinteria Basin syncline during late Pleistocene time, and although significant, they have little effect on Carpinteria basin structures.

# CONCLUSIONS

Prior to formation of the unconformity at the base of the Pleistocene Santa Barbara and Casitas Formations, the Carpinteria area was the northern margin of the Ventura basin. Abrupt northward thinning of the Sisquoc and Pico Formations and a facies change from Pico turbidite sandstones northeastward to mudstones suggest a south-facing positive area located north of the Red Mountain fault. On the south side of the Ventura basin this is seen in mirror image in the South Mountain and Oxnard Plain areas (Yeats, 1965, 1976, 1977). Analogous facies changes from turbidite sandstone to mudstone next to the Oak Ridge fault in the Saticoy field (Schultz, 1960) and in the McGrath pool of the West Montalvo field may have a northern counterpart adjacent to the Red Mountain fault which has not been adequately explored for hydrocarbons.

The Pleistocene unconfomrity at the base of the Santa Barbara Formation permits separation of Carpinteria structures into pre-basin and post-basin categories. If Santa Barbara strata in the Carpinteria basin are time-equivalent to the Santa Barbara sequence in the Ventura basin, the Pleistocene unconformity beneath the Carpinteria basin is between 0.6 and 1.2 Ma old, based on ash bed and amino acid dating of Santa Barbara strata on the south flank of the Ventura Avenue anticline (Sarna-Wojcicki et al., in review). In contrast to post-basin structures, which are large displacement reverse faults and asymmetric, disharmonic folds, pre-basin structures in the Carpinteria area are relatively open folds. Formation of the Snowball anticline, East Fork syncline, Summerland syncline, Summerland anticline, Rincon Mountain syncline, and Los Sauces Creek anticline suggests that Pliocene and early Pleistocene deformation on the south flank of the Santa Ynez Mountains was primarily by folding. This is supported by evidence in the Ojai area indicating both the Reeves syncline and the Lion Mountain anticline were folded prior to the deposition of the Pleistocene Saugus Formation (Schlueter, 1976). These relations suggest that much of the folding throughout the Santa Ynez Range, occurred prior to Santa Barbara deposition, in contrast to folding within the main Ventura basin which is much younger.

The Pleistocene unconformity defines the shape of the Carpinteria basin. This basin is a faulted syncline formed on previously folded Miocene and Oligocene strata after deposition of the Casitas Formation. Although pre-basin folds trend approximately N65°W, the Carpinteria Basin syncline trends west, parallel to the Rincon Creek fault. The southward overstepping relationship between the Pleistocene Santa Barbara Formation and the previously folded Miocene strata illustrated in Figs. 3g and 3h and the lack of a similar relationship to the west, indicates that the eastern part of the Carpinteria basin began to separate from the Ventura basin because of the rise of a positive area prior to Santa Barbara deposition. The shallow marine Santa Barbara Formation grades laterally and vertically into the nonmarine Casitas Formation, both of which are unconformably overlain by late Pleistocene marine terraces.

Quaternary faults in the Carpinteria area are large displacement, north- and south-dipping reverse faults that produce scarps and cut late Pleistocene marine terraces. The south-dipping Rincon Creek, Carpinteria, Holloway and Shepard Mesa faults offset Pleistocene strata at relatively high angles and pass into bedding plane faults below the Pleistocene unconformity. In the Oak View area, east of the Carpinteria basin, south- to southeast-dipping reverse faults that offset the 40,000 year old Oak View Surface are produced by flexural-slip folding of a large syncline (Yeats et al., in press). These are analogous to the south-dipping faults of the Carpinteria basin only because they are related to bedding plane slip. The faults in the Carpinteria area occur relatively close to the axis of the Carpinteria Basin syncline and offset the Santa Barbara Formation. Some of these faults pass into bedding in incompetent Miocene formations, however the Rincon Creek and Shepard Mesa faults cut part of the competent Oligocene section and become parallel to bedding in the thin-bedded siltstones and sandstones of the upper Sespe Formation. At the east end of the basin, the Rincon Creek fault is folded within the hanging wall of the Red Mountain fault.

The Red Mountain fault is a north-dipping reverse fault that steepens with depth to 75$^{\circ}$ north-northeast at the limit of well control, and steepens to the west to 85$^{\circ}$ north south of the Summerland Offshore oil field. It loses separation to the west from 4,570 m in well 27 to 365 m near Rincon Point and is seismically active east of the mapped area. Recognition that the fault plane steepens offshore may be useful in assigning seismic events to specific faults further west in the Santa Barbara Channel where, for the most part, fault dips are unknown. For example, the 1978 Santa Barbara earthquake is not assignable to a particular fault from the data available (Lee et al., 1978). By analogy, however, if their Fault Y dips 80$^{\circ}$ northeast, as does the western Red Mountain fault, it is a likely candidate for the source of the 1978 earthquake. The structural dominance of the Red Mountain fault is demonstrated by the structures in the hanging wall block. Formation of the Bates overturn, folding of the Rincon Creek fault, uplift of the Punta Gorda terrace, folding of the Los Sauces Creek and Summerland Offshore anticlines, and isolation of the Carpinteria basin from the Ventura basin are in general controlled by movement along this fault.

North of the Carpinteria basin, the Arroyo Parida fault dips north at the surface with normal separation, suggesting one of two possibilities. Either it is a left-lateral fault similar to the Santa Ynez fault, or it was originally a south-dipping reverse fault subsequently folded during formation of the Carpinteria syncline and at depth may become parallel to bedding in Eocene strata.

The Summerland Offshore anticline is a large, disharmonic fold composed of structurally incompetent Miocene strata above more competent, less severely deformed Oligocene strata. The Summerland Offshore oil field produces from the Vaqueros Formation and may be analogous to other fields along the northern margin of the Santa Barbara Channel. Because the anticline was not folded until after deposition of the Santa Barbara Formation, the age of oil migration into this field, and perhaps into the other northern Santa Barbara Channel fields, was during the middle-late Pleistocene after deposition of the Santa Barbara. A middle to late Pleistocene age of oil migration into this field is also supported by the existence of the Summerland onshore field which produced from the Casitas Formation. It is suggested that Vaqueros hydrocarbon-bearing structures along the coastal margin of the Santa Ynez Mountains formed in middle or late Pleistocene time, rather than during the Pliocene-early Pleistocene pre-basin period of folding. Knowledge of the timing of oil migration with respect to formation of the Summerland Offshore anticline, and recognition of the problems involved with oil exploration in disharmonic structures, should aid future prospecting in the northern Santa Barbara Channel.

Table 1: Key to well numbers used in text. Elevations and depths in feet. GL, Ground level, KB, Kelly bushing; OH, Original hole; OS, Offshore; RD, Redrill; RT, Rotary table, SOF, Summerland Offshore oil field.

| Well No. | Operator | Well Name | Location | Elevation | Depth |
|---|---|---|---|---|---|
| 1 | Arco | Woodrow #1 | 4-3N-24W | 350 | 7611 |
| 2 | McCarthy O & G | Hobson #1 | 5-3N-24W | 1971 KB | 5515 OH<br>5665 RD 1 |
| 3 | Conoco | Rincon Investment #1 | 6-3N-24W | 1260 GL | 7464 |
| 4 | Elmer Co. | Elmer #3 | 6-3N-24W | 1000 | 5597 OH<br>3886 RD 1 |
| 7 | Texaco | Core Hole #3 | 6-3N-24W | 585 | 670 |
| 8 | Mobil | Standard Rincon 1-6 | 6-3N-24W | 663 KB | 5770 |
| 9 | C.G. Perry Co. | Glenora #1 | 7-3N-24W | 50 | 1756 |
| 13 | Italo Pet. | Hickey #1 | 7-3N-24W | 15 | 3200 |
| 19 | Union | Hobson A1 | 8-3N-24W | 272 RT | 6073 OH<br>9500 RD 1<br>7581 RD 2<br>6685 RD 3 |
| 20 | Union | Hobson B-1 | 8-3N-24W | 748 | 11020 |
| 21 | Shell | Tomson #1 | 8-3N-24W | 577 | 9696 OH<br>8670 RD 1 |
| 22 | Bond Development Corp. | Rincon #1 | 8-3N-24W | 573 | 5480 |
| 23 | Amerada Hess | H & S #1 | 9-3N-24W | 485 KB | 4514 OH<br>6615 RD 1 |
| 27 | Shell | Shell Hoffman Trust #1 | 10-3N-24W | 1438 | 11879 OH<br>13790 RD 1 |
| 29 | Lancaster Midway Oil Co. | #1 | 2-3N-25W | 0 | 580 |
| 33 | Signal O & G | Signal Bates CH #1 | 2-3N-25W | 56 KB | 6635 OH<br>6242 RD 1 |
| 36 | Maurice T. Grubb | U.S. Snowball #1 | 19-4N-24W | 1402 | 6416 |
| 43 | Montecito Oil Prod. | Castaneda #1 | 13-4N-25W | 1720 | 3685 |

| Well No. | Operator | Well Name | Location | Elevation | Depth |
|---|---|---|---|---|---|
| 45 | Shell | Fithian | 18-4N-25W | 648 | 4389 |
| 47 | Tesoro Pet. | Gobernador #1 | 26-4N-25W | 235 KB | 3310 |
| 48 | Chevron | Shepard #1 | 26-4N-25W | 598 | 2774 |
| 49 | Chevron | Shepard #2 | 26-4N-25W | 690 | 1492 |
| 52 | Guiberson-Cudahy | Shepard #1 | 29-4N-25W | 40 KB | 8519 |
| 53 | Western Oil Royalties | #1 | 29-4N-25W | 4 | 2023 |
| 54 | Santa Barbara Oil Co. | SB #1 | 29-4N-25W | 54 | 2569 |
| 55 | Gulf | Bryce #1 | 30-4N-25W | 0 | 3639 OH<br>3930 RD 1 |
| 56 | G.A. MacDonald | 120-1A | 32-4N-25W | 15 | 1024 |
| 67 | Conoco | 124-1 | 33-4N-25W | 28 | 5735 |
| 68 | Conoco | 125-1 | 33-4N-25W | 15 | 1046 |
| 74 | Texaco | Carpinteria Community Lease #3 | 33-4N-25W | 73 | 4208 |
| 77 | Conoco | K.C. Bailard #1 | 33-4N-25W | 65 | 4535 |
| 86 | Searoad Asphaltum Oil | #1 | 33-4N-25W | 75 | 1383 |
| 89 | W.W. Gregg | #1 | 33-4N-25W | 20 | 360 |
| 96 | Texaco | Core Hole #3 | 34-4N-25W | | 410 |
| 97 | Thornbury Drg. Co. | Canfield #1 | 34-4N-25W | 125 | 2169 |
| 98 | Century Oil | Core Hole Hall #1 | 34-4N-25W | 100 | 714 |
| 99 | Imperial Gypsum Co. | Bailard #1 | 34-4N-25W | 135 | 702 |
| 100 | W.C. Hamilton | Tyler Hamilton #1 | 34-4N-25W | 135 | 930 |
| 101 | Linc Con Oil | #1 | 34-4N-25W | 135 | 959 |

| Well No. | Operator | Well Name | Location | Elevation | Depth |
|---|---|---|---|---|---|
| 103 | Moriqui Exp. | Holloway #1 | 35-4N-25W | 86 | 5829 |
| 104 | Shell | Bates #1 | 35-4N-25W | 321 | 5320 OH<br>8838 RD 1<br>8415 RD 2 |
| 105 | Shell | Bates #2 | 35-4N-25W | 400 | 10891 |
| 106 | Scott Pet. | Rincon #1 | 35-4N-25W | 50 | 5115 |
| 107 | Getty | Honolulu Signal<br>Bates | 36-4N-25W | 1125 | 3400 OH<br>5558 RD 1<br>6361 RD 2 |
| 108 | Superior | Delwiche #1 | 36-4N-25W | 1137 KB | 4960 |
| 109 | Chanslor-<br>Western | Bates 1-36 | 36-4N-25W | 1162 KB | 7114 OH<br>5979 RD 1 |
| 110 | Tesoro Pet. | Delwiche-<br>Dabney #1 | 36-4N-25W | 597 KB | 2145 |
| 112 | Ortega Oil | Williams #1 | 16-4N-26W | 350 KB | 4583 |
| 120 | Chevron | Ortega Comm. #1 | 16-4N-26W | 180 | 5987 |
| 136 | Seaside Oil | #1 | 22-4N-26W | 12 | 3310 |
| 137 | R.L. Williams | Summerland #1 | 22-4N-26W | 30 | 5041 |
| 139 | Getty | Seaside State #1 | 22-4N-26W | 62 KB | 6191 |
| 140 | Chevron | Standard Tide-<br>water State #1 | 22-4N-26W | 59 | 2255 |
| 144 | Loon Point Oil | Bailard #1 | 23-4N-26W | 60 | 2602 |
| 148 | Pacific Drg.<br>Co. | Lelande #1 | 24-4N-26W | 21 RT | 1369 |
| 152 | Chevron | SHSS 1824 4 | SOF | 78 | 6994 |
| 159 | Chevron | SHSS 1824 11 | SOF | 78 | 8080 OH |
| 161 | Chevron | SHSS 1824 14 | SOF | 78 | 9230 |
| 166 | Chevron | SHSS 1824 27 | SOF | 78 | 9321 OH |
| 168 | Chevron | SHSS 1824 33 | SOF | 78 | 9139 OH<br>9270 RD 1 |
| 173 | Chevron | SHSS 1824 17 | SOF | 78 | 7200 |
| 176 | Chevron | SHSS 1824 21 | SOF | 78 | 8030 |

| Well No. | Operator | Well Name | Location | Elevation | Depth |
|---|---|---|---|---|---|
| 177 | Chevron | SHSS 1824 22 | SOF | 78 | 7950 OH<br>8100 RD 1<br>7500 RD 2 |
| 179 | Chevron | SHSS 1824 26 | SOF | 78 | 12123 |
| 180 | Chevron | SHSS 1824 28 | SOF | 78 | 7800 |
| 181 | Chevron | SHSS 1824 29 | SOF | 78 | 7350 |
| 182 | Chevron | SHSS 1824 30 | SOF | 78 | 8500 |
| 188 | Chevron | SHSS 1824 40 | SOF | 78 | 7900 OH<br>8040 RD 2 |
| 191 | Chevron | SHSS 1824 43 | SOF | 78 | 7068 OH<br>7319 RD 1 |
| 192 | Chevron | SHSS 1824 44 | SOF | 78 | 7650 |
| 195 | Chevron | SHSS 1824 47 | SOF | 78 | 7420 |
| 204 | Chevron | Core Hole 8R-11 | OS | 27 | 442 |
| 210 | Chevron | Core Hole 8R-33 | OS | 27 | 3960 |
| 213 | Chevron | SHSS 1824 Core Hole 3 | OS | 60 KB | 6250 |
| 218 | Exxon | H8R-1 | OS | 9 KB | 2005 |
| 219 | Exxon | H8R-2 | OS | 9 KB | 1200 |
| 223 | Arco | Summerland Core Hole 1 | OS | 7 KB | 3580 |
| 231 | Texaco | Texaco-Monterey Core 8-D-55 | OS | 27 KB | 8080 |
| 233 | Geotechnical Consultants Inc. | Test Hole #2 | 20-4N-25W | 35 GL | 1400 |
| 234 | Geotechnical Consultants Inc. | Test Hole #3 | 27-4N-25W | 134 GL | 1002 |
| 237 | Geotechnical Consultants Inc. | Test Hole #1 | 28-4N-25W | 61 GL | 1458 |
| 239 | Geotechnical Consultants Inc. | Water Well D7 | 29-4N-25W | 25 GL | 982 |

| Well No. | Operator | Well Name | Location | Elevation | Depth |
|---|---|---|---|---|---|
| 240 | | CH8-258 | OS | | 575 |
| 241 | | CH8-275 | OS | | 500 |
| 242 | | CH8-295 | OS | | 615 |
| 244 | | CH8-254 | OS | | 500 |
| 245 | | CH8-255 | OS | | 130 |
| 248 | | CH8-223 | Os | | 613 |
| 249 | | CH8-213 | OS | | 631 |
| 250 | | CH8-212 | OS | | 632 |
| 252 | | CH8-209 | OS | | 644 |
| 253 | | CH8-211 | OS | | 633 |
| 254 | | CH8-208 | OS | | 636 |
| 258 | | CH8-23 | OS | | 258 |
| 259 | | CH8-21 | OS | | 397 |
| 309 | Montecito Municipal Water District | Test Hole #2 | 7-4N-26W | 275 | 952 |
| 311 | Montecito Municipal Water District | Test Hole #4 | 9-4N-26W | 250 | 437 |

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# APPENDIX I

## Complete Well List

## Key to Abbreviations Used in Appendix I

| | |
|---|---|
| TD | Total Depth |
| KB | Kelly Bushing |
| RT | Rotary Table |
| OH | Original Hole |
| GL | Ground Level |
| RD | Redrill |
| S.L. | Sea Level |
| Note | All elevations and total depths are in feet. |

| Map No. | Company | Name | Elevation | | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|---|
| | | **Sec. 4 - T3N - R24W** | | | | | | |
| 1 | Arco | Woodrow 1 | 350 | | 7611 | | | |
| | | **Sec. 5 - T3N - R24W** | | | | | | |
| 2 | McCarthy Oil & Gas | Hobson 1 | 1971 | KB | 5515 | 5665 | | |
| | | **Sec. 6 - T3N - R24W** | | | | | | |
| 3 | Conoco | Rincon Investment 1 | 1260 | GL | 7464 | | | |
| 4 | Elmer Co. Ltd. | Elmer 3 | 1000 | | 5597 | 3886 | | |
| 5 | Texaco | Core Hole 1 | 638 | | 1004 | | | |
| 6 | Texaco | Core Hole 2 | 647 | | 830 | | | |
| 7 | Texaco | Core Hole 3 | 585 | | 670 | | | |
| 8 | Mobil | Standard Rincon 1-6 | 663 | KB | 5770 | | | |
| | | **Sec. 7 - T3N - R24W** | | | | | | |
| 9 | C. G. Perry Co. | Glenora 1 | 50.5 | | 1756 | | | |
| 10 | Mobil | Oland 1 | 25.30 | | 3421 | | | |
| 11 | Davis & Irwin | No. 1 | 40 | | 390 | | | |
| 12 | Humble (Exxon) | Hickey 1 | | | | | | |
| 13 | Italo Petro. Corp. | Hickey 1 | 15 | | 3200 | | | |
| 14 | Petroleum Explor. Co. | Hickey 1 | 22 | | 6342 | | | |
| 17 | Cabot Oil & Gas | State 429 1A | 29 | | 1021 | | | |
| 18 | Rincon Oil Co. | Shuddle 1 | | | 2115 | | | |
| | | **Sec. 8 - T3N - R24W** | | | | | | |
| 19 | Union | Hobson Al | 272 | RT | 6073 | 9500 | 7581 | 6685 |
| 20 | Union | Union-Std.-Hobson Bl | 708.25 | RT | 11020 | 8958 | 7353 | |

| Map No. | Company | Name | Elevation | | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|---|
| | | **Sec. 8 - T3N - R24W (cont.)** | | | | | | |
| 21 | Shell | Tomson 1 | 577.3 | DF | 9696 | 8670 | | |
| 22 | Bond Development Corp. | Rincon 1 | 573 | | 5480 | | | |
| | | **Sec. 9 - T3N - R24W** | | | | | | |
| 23 | Amerada Hess | H & S 1 | 485 | KB | 4514 | 6615 | | |
| 24 | Ridge Oil Co. | Fox 1 | 500 | DF | 8000 | | | |
| 25 | Kellerman & Vigus | No. 1 | 950 | DF | 2300 | | | |
| | | **Sec. 10 - T3N - R24W** | | | | | | |
| 26 | Amerada Hess | R C 1 | 1652 | KB | 4067 | 2762 | | |
| 27 | Shell | Shell Hoffman Trust 1 | 1438 | | 11879 | 13790 | | |
| | | **Sec. 2 - T3N - R25W** | | | | | | |
| 29 | Lancaster Midway Oil | No. 1 | 0 | | 580 | | | |
| 30 | Lancaster Midway Oil | No. 2 | 5 | | 540 | | | |
| 31 | Lancaster Midway Oil | No. 3 | 7 | | 400 | | | |
| 32 | Lancaster Midway Oil | No. 5 | 7 | | 1525 | | | |
| 33 | Signal Oil & Gas | Signal Bates CH 1 | 56 | KB | 6635 | 6242 | | |
| | | **Sec. 12 - T3N - R25W** | | | | | | |
| 35 | Indian Petroleum Corp. | Boone 1 | | | 2027 | | | |
| | | **Sec. 19 - T4N - R24W** | | | | | | |
| 36 | Maurice T. Grubb | U. S. Snowball 1 | 1402.8 | | 6416 | | | |

| Map No. | Company | Name | Elevation | | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|---|
| | | **Sec. 28 - T4N - R24W** | | | | | | |
| 37 | Getty Oil | Honolulu-SunRay-Dunshee 1 | 1911 | KB | 7594 | | | |
| 38 | Getty Oil | Honolulu-SunRay-MidCont-Dunshee 2 | 1906 | GL | 3210 | | | |
| | | **Sec. 29 - T4N - R24W** | | | | | | |
| 39 | JLM & Assoc. | Laguna Rch 2 | | | | | | |
| 40 | JLM & Assoc. | Laguna Rch 3 | | | | | | |
| 41 | JLM & Assoc. | Laguna Rch 4 | | | | | | |
| 42 | JLM & Assoc. | El Diablo Laguna Rch 1 | 1707 | KB | 2799 | | | |
| | | **Sec. 13 - T4N - R25W** | | | | | | |
| 43 | Montecito Oil Prod. | Castaneda #1 | 1720 | | 3685 | | | |
| | | **Sec. 17 - T4N - R25W** | | | | | | |
| 44 | Tony Carnero | Fithian 1 | 970 | | 1035 | | | |
| | | **Sec. 18 - T4N - R25W** | | | | | | |
| 45 | M. B. Fithian (Shell) | Fithian | 647.8 | | 4389 | | | |
| 46 | Carpinteria Oil Co. | Carpinteria 1 | | | 1000 | | | |
| | | **Sec. 26 - T4N - R25W** | | | | | | |
| 47 | Tesoro Petro. Corp. | Gobernador 1 | 235 | KB | 3310 | | | |
| 48 | Chevron | Shepard 1 | 598 | | 2774 | | | |
| 49 | Chevron | Shepard 2 | 690 | | 1492 | | | |

| Map No. | Company | Name | Elevation | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|
| | | **Sec. 34 - T4N - R25W** | | | | | |
| 50 | Texaco | Core Hole 1 | | 448 | | | |
| | | **Sec. 29 - T4N - R25W** | | | | | |
| 51 | T. N. Fish | 163-1 | 15 | 51 | | | |
| 52 | Guiberson-Cudahy | Shepard 1 | 40 KB | 8519 | | | |
| 53 | Western Oil Royalties | No. 1 | 4 | 2023 | | | |
| 54 | Santa Barbara Oil Co. | SB 1 | 54 | 2569 | | | |
| | | **Sec. 30 - T4N - R25W** | | | | | |
| 55 | Gulf | Bryce 1 | | 3639 | 3930 | | |
| | | **Sec. 32 - T4N - R25W** | | | | | |
| 56 | G. A. McDonald | 120-1A | 15 | 1024 | | | |
| 57 | R. H Caspers | 130-1A | 15 | 1029 | | | |
| 58 | J. S. Snow | 190-1 | 0 | 502 | | | |
| 59 | H. B. Fish | 164-1 | 15 | 51 | | | |
| 60 | Lester L. Pederson | Core Hole 1 | 20 | 120 | | | |
| 61 | Lester L. Pederson | Core Hole 2 | 15 | 108 | | | |
| 62 | Lester L. Pederson | Core Hole 3 | | 68 | | | |
| 63 | Carpinteria Oil Co. | Carpinteria 1 | 10.5 | 3413 | | | |
| 64 | Columbian Oil & Asphalt | No. 1 | | 1100 | | | |
| | | **Sec. 33 - T4N - R25W** | | | | | |
| 65 | B. F. Bailard (Conoco) | 127-1 | 15 | 1056 | | | |
| 66 | Texaco (Conoco) | 126-1 | 15 | 1028 | | | |
| 67 | Conoco | 124-1 | 28 | 5735 | | | |

| Map No. | Company | Name | Elevation | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|
| | | **Sec. 33 - T4N - R25 (cont.)** | | | | | |
| 68 | Myrtle Bailard (Conoco) | 125-1 | 15 | 1046 | | | |
| 69 | Kittie C. Bailard (Conoco) | 124-1A | 15 | 418 | | | |
| 70 | T. Franklin | 123-1 | 15 | 1050 | | | |
| 71 | Thornbury Drg. Co. | Carpinteria Comm. 1 | | | | | |
| 72 | C. M. Higgins (Conoco) | 122-1 | 15 | 1018 | | | |
| 73 | L. M. Higgins (Conoco) | 121-1 | 15 | 1045 | | | |
| 74 | Texaco | Carpinteria Community Lease 3 | 72.94 | 4208 | | | |
| 75 | Northern Cons. Oil | No. 1 | | 250 | | | |
| 76 | Columbia Oil & Asphalt | No. 2 | | 3200 | | | |
| 77 | Conoco | K. C. Bailard #1 | 65 | 4535 | | | |
| | | **Sec. 33 - T4N - R25W** | | | | | |
| 78 | Conoco | Franklin 1 | 60 | 4169 | | | |
| 79 | Thornbury Drg. Co. | Carpinteria Comm. 2 | 6 | 1221 | | | |
| 80 | Thornbury Drg. Co. | Carpinteria Comm. 3 | 60 RT | 1807 | | | |
| 81 | Rahns Cons. Oil | No. 1 | | 2100 | | | |
| 82 | D. S. Fletcher | Catlin Fletcher 1 | 40 | 1564 | | | |
| 83 | P. C. Higgins | No. 1 | | 350 | | | |
| 84 | J. F. Nugent Oil Co. | No. 1 | 49.8 | 3678 | | | |
| 85 | J. F. Nugent Oil Co. | No. 2 | 50.4 | 4567 | | | |
| 86 | Searoad Asphaltum Oil | No. 1 | 75 | 1383 | | | |
| 87 | Searoad Asphaltum Oil | No. 2 | 40 | 1490 | | | |
| 88 | Searoad Asphaltum Oil | No. 4 | 25 | 1200 | | | |
| 89 | W. W. Gregg | No. 1 | 20 | 360 | | | |
| 90 | Nixon & Bosig | No. 1 | | 189 | | | |

| Map No. | Company | Name | Elevation | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|
| | | **Sec. 34 - T4N - R25W** | | | | | |
| 91 | Casitas Oil Co. | 202-1 | 16 | 2038 | | | |
| 92 | Casitas Oil Co. | 202-2 | 27 | 3312 | | | |
| 93 | C. E. Bailard (Conoco) | 120-1 | 15 | 1031 | | | |
| 94 | M. B. Hall (Conoco) | 128-1 | 15 | 1066 | | | |
| 95 | Texaco | Core Hole 2 | | 706 | | | |
| 96 | Texaco | Core Hole 3 | | 410 | | | |
| 97 | Thornbury Drg. Co. | Canfield 1 | 125 | 2169 | | | |
| 98 | Century Oil | Core Hole Hall 1 | 100 | 714 | | | |
| 99 | Imperial Gypsum Co. | Bailard 1 | 135 | 702 | | | |
| 100 | W. C. Hamilton | Tyler Hamilton 1 | 135 | 930 | | | |
| 101 | Linc Con. Oil | Lin Con 1 | 135 | 959 | | | |
| 102 | Carpinteria Oil Co. | No. 1 | 230 | 1703 | | | |
| | | **Sec. 35 - T4N - R25W** | | | | | |
| 103 | Moriqui Explor. | Holloway 1 | 86.2 | 5829 | | | |
| 104 | Shell | Shell Bates 1 | 320.8 | 5320 | 8838 | 8415 | |
| 105 | Shell | Shell Bates 2 | 400.2 | 10891 | | | |
| 106 | Scott Petro. Prop. Inc. | Rincon 1 | 50 | 5115 | | | |
| | | **Sec. 36 - T4N - R25W** | | | | | |
| 107 | Getty Oil | Honolulu Signal Bates 1 | 1125 | 3400 | 5558 | 6361 | |
| 108 | Superior Oil | Delwiche 1 | 1137 KB | 4960 | | | |
| 109 | Chansler Western Oil | Bates 1-36 | 1162 KB | 7114 | 5979 | | |
| 110 | Tesoro Petro. Corp. | Delwiche-Dabney 1 | 597 KB | 2145 | | | |

| Map No. | Company | Name | Elevation | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|
| | | **Sec. 16 - T4N -R26W** | | | | | |
| 111 | Oil Group Inc. | Hyland 1 | | 2086 | | | |
| 112 | Ortega Oil Co. | Williams 1 | 350 KB | 4583 | | | |
| 113 | Adobe Hills Oil | Adobe 1 | 365 KB | 4358 | | | |
| 114 | T & T Oil Co. | Brambilla 1 | 215 KB | 1712 | | | |
| 115 | Mrs. H. A. Meyer | Meyer 1 | 83.69 | 1532 | | | |
| 116 | Russell L. Williams | Williams 1B | 250 | 4121 | | | |
| 117 | Russell L. Williams | Williams 1 | | 455 | | | |
| 118 | Russell L. Williams | Williams 2 | | 450 | | | |
| 119 | Southern Exploration | Brooks 1 | 200 | 414 | | | |
| 120 | Chevron | Ortega Comm. 1 | 180.05 | 5987 | | | |
| 121 | Chevron | Williams 1 | 197 | 3700 | | | |
| | | **Sec. 21 - T4N - R26W** | | | | | |
| 122 | Southern Exploration | No. 1 | 190 | 1221 | | | |
| 123 | Southern Exploration | No. 2 | 130 | 517 | | | |
| 124 | H. E. Purdum et ux | Kilb 1 | 105 RT | 390 | | | |
| 125 | S. P. Land Co. | SP Summerland 1 | 66 | 1317 | | | |
| 126 | Russell L. Williams | Becker Fee 1 | 13 | 1295 | | | |
| 127 | Russell L. Williams | Becker Fee 2 | 13 | 1458 | | | |
| 128 | Russell L. Williams | Williams 1 | 15 | 1417 | | | |
| 129 | Russell L. Williams | Williams 2A | 15 | 1460 | | | |
| 130 | Russell L. Williams | Williams 3A | 15 | 2738 | | | |
| 131 | Russell L. Williams | Williams 3 | | 1100 | | | |
| 132 | Russell L. Williams | State Lease 16 Getty 1 | | 1682 | | | |
| 133 | Russell L. Williams | State Lease 16 Getty 11 | 15 | 1474 | | | |
| 134 | Russell L. Williams | State Lease 16 Getty 21 | 15 | 1552 | | | |

| Map No. | Company | Name | Elevation | | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|---|
| | | **Sec. 22 - T4N - R26W** | | | | | | |
| 135 | Submarine Oil Co. | No. 1 | 35 | | 790 | | | |
| 136 | Seaside Oil Co. (Getty) | No. 1 | 12 | | 3310 | | | |
| 137 | Russell L. Williams | Summerland 1 | 30 | | 5041 | | | |
| 138 | Sandoma Gasoline | State Lease 18 Sandoma 1 | 15 | | 1174 | | | |
| 139 | Getty Oil Co. | Seaside State 1 | 62 | KB | 6191 | | | |
| 140 | Chevron | Standard Tidewater State 1 | 59.53 | | 2255 | | | |
| | | **Sec. 23 - T4N - R26W** | | | | | | |
| 141 | J. B. Treadwell | No. 1 | | | 500 | | | |
| 142 | Clark-Stevens-Duncan | No. 1 | | | 50 | | | |
| 143 | Loon Point Oil | Bailard 1 | 60 | | 2602 | | | |
| 144 | Loon Point Oil | Bailard 2 | 65 | | 2647 | | | |
| 145 | J. K. Fischer | No. 1 | | | 120 | | | |
| 146 | Churchill & Weber | No. 1 | | | 550 | | | |
| 147 | Aquarium Oil Co. | No. 1 | 8 | | 1240 | | | |
| | | **Sec. 24 - T4N - R26W** | | | | | | |
| 148 | Pacific Drilling Co. | Lelande 1 | 21 | RT | 1369 | | | |

| Map No. | Company | Name | Elevation | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|
| | | Offshore | | | | | |
| 149 | Chevron | SHSS 1824 1* | 78 | 7540 | 7750 | | |
| 150 | Chevron | SHSS 1824 2 | 78 | 7700 | 7950 | | |
| 151 | Chevron | SHSS 1824 3 | 78 | 8640 | 8400 | 8020 | |
| 152 | Chevron | SHSS 1824 4 | 78 | 6394 | 10600 | | |
| 153 | Chevron | SHSS 1824 5 | 78 | 8420 | 7870 | | |
| 154 | Chevron | SHSS 1824 6 | 78 | 7450 | | | |
| 155 | Chevron | SHSS 1824 7 | 78 | 9500 | 7750 | 7500 | |
| 156 | Chevron | SHSS 1824 8 | 78 | 4350 | 3800 | | |
| 157 | Chevron | SHSS 1824 9 | 78 | 8990 | 8480 | | |
| 158 | Chevron | SHSS 1824 10 | 78 | 7680 | 7600 | | |
| 159 | Chevron | SHSS 1824 11 | 78 | 8080 | 8630 | | |
| 160 | Chevron | SHSS 1824 12 | 78 | 4000 | | | |
| 161 | Chevron | SHSS 1824 14 | 78 | 9230 | | | |
| 162 | Chevron | SHSS 1824 15 | 78 | 8670 | 8475 | | |
| 163 | Chevron | SHSS 1824 16 | 78 | 7352 | | | |
| 164 | Chevron | SHSS 1824 19 | 78 | 8100 | | | |
| 165 | Chevron | SHSS 1824 24 | 78 | 8070 | 8220 | | |
| 166 | Chevron | SHSS 1824 27 | 78 | 9321 | 9284 | | |
| 167 | Chevron | SHSS 1824 32 | 78 | 8130 | 7840 | | |
| 168 | Chevron | SHSS 1824 33 | 78 | 9139 | 9270 | 8911 | 9245 |
| 169 | Chevron | SHSS 1824 34 | 78 | 6970 | | | |
| 170 | Chevron | SHSS 1824 36 | 78 | 8450 | 8370 | | |
| 171 | Chevron | SHSS 1824 41 | 78 | 9150 | 8700 | | |
| 172 | Chevron | SHSS 1824 25 | 78 | 10500 | | | |
| 173 | Chevron | SHSS 1824 17 | 78 | 7200 | | | |
| 174 | Chevron | SHSS 1824 18 | 78 | 7000 | | | |
| 175 | Chevron | SHSS 1824 20 | 78 | 6680 | | | |
| 176 | Chevron | SHSS 1824 21 | 78 | 8030 | | | |

| Map No. | Company | Name | Elevation | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|
| | | Offshore (cont.) | | | | | |
| 177 | Chevron | SHSS 1824 22 | 78 | 7950 | 8100 | 7500 | |
| 178 | Chevron | SHSS 1824 23 | 78 | 7650 | | | |
| 179 | Chevron | SHSS 1824 26 | 78 | 11538 | | | |
| 180 | Chevron | SHSS 1824 28 | 78 | 7800 | | | |
| 181 | Chevron | SHSS 1824 29 | 78 | 7350 | | | |
| 182 | Chevron | SHSS 1824 30 | 78 | 8500 | 7653 | 7220 | 6600 |
| 183 | Chevron | SHSS 1824 31 | 78 | 8000 | 8100 | | |
| 184 | Chevron | SHSS 1824 35 | 78 | 7900 | 7510 | | |
| 185 | Chevron | SHSS 1824 37 | 78 | 8060 | 7700 | 8200 | 8059 |
| 186 | Chevron | SHSS 1824 38 | 78 | 7613 | 7600 | | |
| 187 | Chevron | SHSS 1824 39 | 78 | 7695 | 7600 | | |
| 188 | Chevron | SHSS 1824 40 | 78 | 7900 | 7900 | 8040 | |
| 190 | Chevron | SHSS 1824 42 | 78 | 8550 | | | |
| 191 | Chevron | SHSS 1824 43 | 78 | 7068 | 7319 | 7095 | |
| 192 | Chevron | SHSS 1824 44 | 78 | 7650 | | | |
| 193 | Chevron | SHSS 1824 45 | 78 | 8080 | 8560 | 8400 | 8420 |
| 194 | Chevron | SHSS 1824 46 | 78 | 9070 | 8470 | 8470 | |
| 195 | Chevron | SHSS 1824 47 | 78 | 7420 | | | |
| 196 | Chevron | SHSS 1824 48 | 78 | 8100 | | | |
| 197 | Chevron | SHSS 1824 49 | 78 | 7900 | 7796 | | |
| 198 | Chevron | SHSS 1824 50 | 78 | 7300 | 7420 | | |
| | *Standard Humble Summerland State Lease | | | | | | |
| 201 | Chevron | Core Hole 8R-1 | 27 | 605 | | | |
| 202 | Chevron | Core Hole 8R-2 | 27 | 555 | | | |
| 203 | Chevron | Core Hole 8R-3 | 27 | 609 | | | |
| 204 | Chevron | Core Hole 8R-11 | 27 | 442 | | | |
| 205 | Chevron | Core Hole 8R-12 | 27 | 2570 | | | |
| 206 | Chevron | Core Hole 8R-13 | 27 | 2560 | | | |

| Map No. | Company | Name | Elevation | | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|---|
| | | **Offshore** (cont.) | | | | | | |
| 207 | Chevron | Core Hole 8R-15 | 27 | | 2540 | | | |
| 208 | Chevron | Core Hole 8R-16 | 27 | | 3100 | | | |
| 209 | Chevron | Core Hole 8R-30 | 27 | | 5995 | | | |
| 210 | Chevron | Core Hole 8R-33 | 27 | | 3960 | | | |
| 211 | Chevron | SHSS 1824 Core Hole 1* | 60 | | 8450 | | | |
| 212 | Chevron | SHSS 1824 Core Hole 2 | 60 | KB | 7360 | | | |
| 213 | Chevron | SHSS 1824 Core Hole 3 | 60 | KB | 6250 | | | |
| 214 | Chevron | SHSS 1824 Core Hole 51 | 65 | | 7506 | | | |
| 215 | Chevron | SHSS 1824 Core Hole 52 | 65 | | 6215 | | | |
| 216 | Chevron | SHSS 1824 Core Hole 53 | 65 | | 6900 | | | |
| 218 | Exxon | H8R 1 | 9 | KB | 2005 | | | |
| 219 | Exxon | H8R 2 | 9 | KB | 1200 | | | |
| 220 | Exxon | H8R 3 | 9 | KB | 1248 | | | |
| 221 | Exxon | H8R 4 | 9 | KB | 1500 | | | |
| 222 | Exxon | H8R 5 | 9 | KB | 1500 | | | |
| 223 | ARCO | Summerland Core Hole 1 | 7 | KB | 3580 | | | |
| 224 | ARCO | Summerland Core Hole 2 | 7 | KB | 3641 | | | |
| 225 | Getty Oil Co. | 8S-1 | | | 578 | | | |
| 226 | Getty Oil Co. | 8S-2 | | | 427 | | | |
| 227 | Texaco | Core Hole 8 Loon Point 1 | 7 | KB | 1938 | | | |
| 228 | Texaco | Core Hole 8 Loon Point 2 | 8 | KB | 1210 | | | |
| 229 | Gulf | 8-GW-7 18 | | | 524 | | | |
| 230 | Conoco | State 4031 1A | 25 | KB | 8620 | | | |
| 231 | Texaco | Texaco-Monterey Core Hole 8-D-55 | 27 | KB | 8080 | | | |
| | | **Sec. 20 R3- T4N-R25W** | | | | | | |
| 233 | Geotech. Consult. Inc. | Test Hole #2 | 35 | GL | 1400 | | | |

| Map No. | Company | Name | Elevation | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|
| | | **Sec. 27 P5 - T4N - R25W** | | | | | |
| 234 | Geotech. Consult. Inc. | Test Hole #3 | 134 GL | 1002 | | | |
| | | **Sec. 27 F2 - T4N - R25W** | | | | | |
| 235 | Geotech. Consult. Inc. | Test Hole #4 | | 1057 | | | |
| | | **Sec. 27 F3 - T4N - R25W** | | | | | |
| 236 | Geotech. Consult. Inc. | Smillie #1 | 126 KB | 1156 | | | |
| | | **Sec. 28 F7 - T4N - R25W** | | | | | |
| 237 | Geotech. Consult. Inc. | Test Hole #1 | 61 GL | 1458 | | | |
| | | **Sec. 28 F8 - T4N - R25W** | | | | | |
| 238 | Geotech. Consult. Inc. | Lyons Well | 61 | 1270 | | | |
| | | **Sec. 29 D7 - T4N - R25W** | | | | | |
| 239 | Geotech. Consult. Inc. | Water Well D7 | 25 GL | 982 | | | |
| | | **Offshore** | | | | | |
| 240 | | Core Hole CH8 258 | S.L. | 575 | | | |
| 241 | | Core Hole CH8 275 | S.L. | 500 | | | |
| 242 | | Core Hole CH8 295 | S.L. | 615 | | | |
| 243 | | Core Hole CH8 296 | S.L. | | | | |
| 244 | | Core Hole CH8 254 | S.L. | 500 | | | |
| 245 | | Core Hole CH8 255 | S.L. | 130 | | | |
| 246 | | Core Hole CH8 224 | S.L. | 212 | | | |

| Map No. | Company | Name | Elevation | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|
| | | **Offshore (cont.)** | | | | | |
| 247 | | Core Hole CH8 225 | S.L. | 229 | | | |
| 248 | | Core Hole CH8 223 | S.L. | 613 | | | |
| 249 | | Core Hole CH8 213 | S.L. | 631 | | | |
| 250 | | Core Hole CH8 212 | S.L. | | | | |
| 251 | | Core Hole CH8 210 | S.L. | | | | |
| 252 | | Core Hole CH8 209 | S.L. | 644 | | | |
| 253 | | Core Hole CH8 211 | S.L. | | | | |
| 254 | | Core Hole CH8 208 | S.L. | 636 | | | |
| 255 | | Core Hole CH8 90 | S.L. | | | | |
| 256 | | Core Hole CH8 91 | S.L. | | | | |
| 257 | | Core Hole CH8 42 | S.L. | 284 | | | |
| 258 | | Core Hole CH8 23 | S.L. | 258 | | | |
| 259 | | Core Hole CH8 21 | S.L. | 397 | | | |
| 260 | | Core Hole CH8 106 | S.L. | 1004 | | | |
| 261 | | Core Hole CH8 49 | S.L. | 827 | | | |
| 262 | | Core Hole CH8 51 | S.L. | 146 | | | |
| 263 | | Core Hole CH8 50 | S.L. | 276 | | | |
| 264 | | Core Hole CH8 87 | S .L. | | 744 | | |
| 265 | | Core Hole CH8 102 | S.L. | 504 | | | |
| 266 | | Core Hole CH8 77 | S.L. | | | | |
| 267 | | Core Hole CH8 78 | S.L. | | | | |
| 268 | | Core Hole CH8 79 | S.L. | | | | |
| 269 | | Core Hole CH8 80 | S.L. | | | | |
| 270 | | Core Hole CH8 81 | S.L. | | | | |
| 271 | | Core Hole CH8 82 | S.L. | | | | |
| 272 | | Core Hole CH8 24 | S.L. | | | | |
| 273 | | Core Hole CH8 48 | S.L. | | | | |
| 274 | | Core Hole CH8 67 | S.L. | | | | |
| 275 | | Core Hole CH8 65 | S.L. | | | | |
| 276 | | Core Hole CH8 64 | S.L. | | | | |

| Map No. | Company | Name | Elevation | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|

<u>Offshore</u> (cont.)

| Map No. | Company | Name | Elevation | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|
| 277 | | Core Hole CH8 52 | S.L. | 259 | | | |
| 278 | | Core Hole CH8 53 | S.L. | 517 | | | |
| 279 | | Core Hole CH8 25 | S.L. | | | | |
| 280 | | Core Hole CH8 39 | S.L. | | | | |
| 281 | | Core Hole CH8 43 | S.L. | | | | |
| 290 | | Core Hole CH8 26 | S.L. | | | | |
| 291 | | Core Hole CH8 27 | S.L. | | | | |
| 292 | | Core Hole CH8 28 | S.L. | | | | |
| 293 | | Core Hole CH8 29 | S.L. | | | | |
| 294 | | Core Hole CH8 30 | S.L. | | | | |

<u>Sec. 22 - T3N - R24W</u>

| Map No. | Company | Name | Elevation | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|
| 300 | Union | Santa Barbara Core Hole 13 | 10 RT | 7086 | | | |
| 301 | Continental | CCMO Hobson A1 | 296 | 8648 | 7247 | | |
| 302 | Continental | No. 1 | 244 | 7002 | | | |

<u>Sec. 15 - T3N - R24W</u>

| Map No. | Company | Name | Elevation | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|
| 303 | Continental | No. A6 | 360 | 5426 | | | |
| 304 | Continental | No. A35 | 329 | 12295 | | | |
| 305 | Continental | No. A5 | 333 | 6237 | | | |
| 306 | Continental | No. A1 | 369 | | 6390 | | |
| 307 | Continental | Hobson A3 | 565 | 7291 | | | |

<u>Sec. 17 K1 - T4N - R26W</u>

| Map No. | Company | Name | Elevation | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|
| 308 | Montecito Municipal Water District | Test Hole #1 | 85 | 1150 | | | |

| Map No. | Company | Name | Elevation | Orig. Hole TD. | RD. 1 TD. | RD. 2 TD. | RD. 3 TD. |
|---|---|---|---|---|---|---|---|
| | | Sec. 7 R1 - T4N - R26W | | | | | |
| 309 | Montecito Municipal Water District | Test Hole #2 | 275 | 952 | | | |
| | | Sec. 16 M1 - T4N - R26W | | | | | |
| 310 | Montecito Municipal Water District | Test Hole #3 | 60 | 772 | | | |
| | | Sec. 9 Q1 - T4N - R26W | | | | | |
| 311 | Montecito Municipal Water District | Test Hole #4 | 250 | 437 | | | |
| | | Sec. 18 H1 - T4N - R26W | | | | | |
| 312 | Montecito Municipal Water District | Test Hole #5 | 160 | 175 | | | |
| | | Offshore | | | | | |
| 313 | | Core Hole CH8 37 | S.L. | | | | |
| 314 | | Core Hole CH8 33 | S.L. | | | | |
| 315 | | Core Hole CH8 34 | S.L. | | | | |