
SANTA BARBARA and VENTURA BASINS

**Tectonics, Structure, Sedimentation, Oilfields
Along an East-West Transect**

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COVER PHOTO: Meandering stream deposits of the upper Sespe Formation in the South Mountain anticline. Designated as facies D by J. L. Howard, this lithofacies is characterized by repeated sequences of fining upward, cross-bedded sandstone and hematite-stained siltstone deposited as point bars. *Photo by A. G. Sylvester*

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PREFACE

by

Arthur G. Sylvester and G. C. Brown
Editors

The Santa Barbara and Ventura basins are active areas, not only tectonically, but also economically. They have always been one of the most important oil producing regions in California since petroleum was discovered here in the late 19th century.

Numerous field trips have visited various parts of these basins in the past, and guidebooks for those trips have highlighted what was known at the time about the geology of one or another oil field, of refinements in the stratigraphic understanding of the basin, or of the wonderfully complex structure as new well, seismic, and geologic information accumulated, was analyzed and synthesized. An evolutionary history of the development of geological and geophysical ideas can be traced through them together with the history of exploration, exploitation, and exhaustion of individual oil fields.

We add our chapters to that history with this guidebook which focuses on the structural and sedimentological aspects of the two main structural trends in the basins: The Rincon-Ventura anticlinorium and the Oak Ridge-South Mountain uplift.

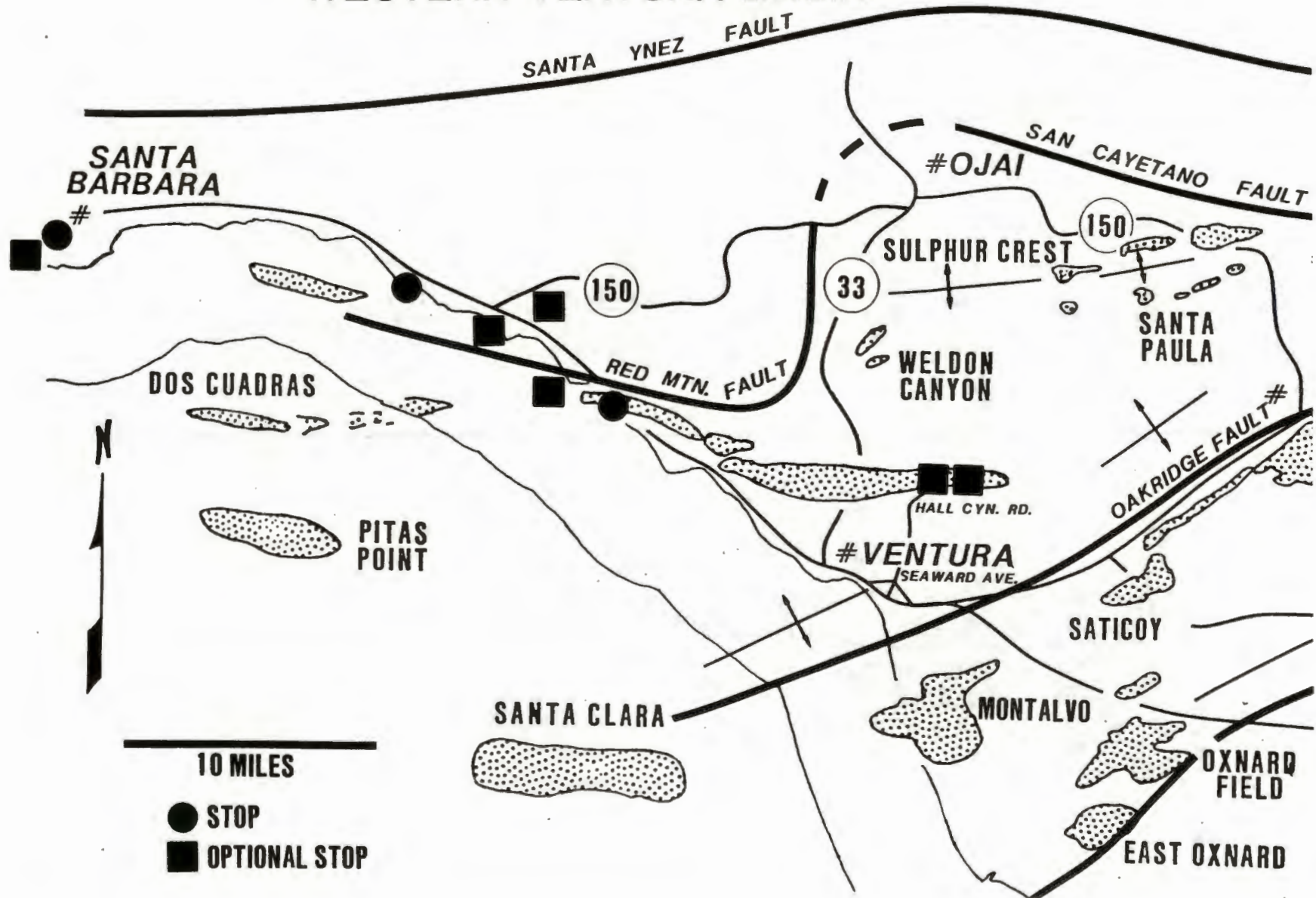
The Roadlog summarizes salient features of the main stops as well as others that may be visited another time at the reader's convenience. We made a concerted effort to leave out exhaustive references to the literature, to each cattleguard and boulevard stop sign, and to every creek crossing that characterize many guidebooks. Participants on the field trip for which this guide is written will not need to keep track of all the cultural features. We shall do that, although interested people who wish to follow parts of this roadlog on their own need to know that entry into each of the oil fields requires the individual permission of the operators of the oil fields.

Section Two focuses on the sedimentation of the principal reservoir and source rocks in the main oil fields in Santa Barbara and Ventura basins. We have abridged quite heavily the contributions about the Sespe Formation by J. L. Howard (1987), the Pliocene turbidites by Hsü and others (1980), and Barbara Haner's article on the modern Redondo fan (1971) to emphasize sedimentation. Scholars wishing a deeper understanding of these topics must refer to Howard's PhD dissertation, to Hsü and others' (1977; 1980) original AAPG Bulletin articles, and to Haner's (1971) GSA bulletin article, respectively. Gregg Blake's contribution about the Monterey Formation is original for this volume.

Section Three presents four original papers on the structure of one old and one new oil field and on the tectonics of parts of the Ventura basin by Robert S. Yeats and his students. All geologists are indebted to Bob Yeats and his many students who have brought to light much of what we know about the geology and neotectonics of the entire basin from Goleta to Castaic, and from the early Miocene to the present. We express our thanks to him, Gary Huftile and Brian Grigsby and also to Gregg Blake, Jeff Howard, Barbara Haner, and Ken Hsü and his colleagues for their direct or indirect contributions.

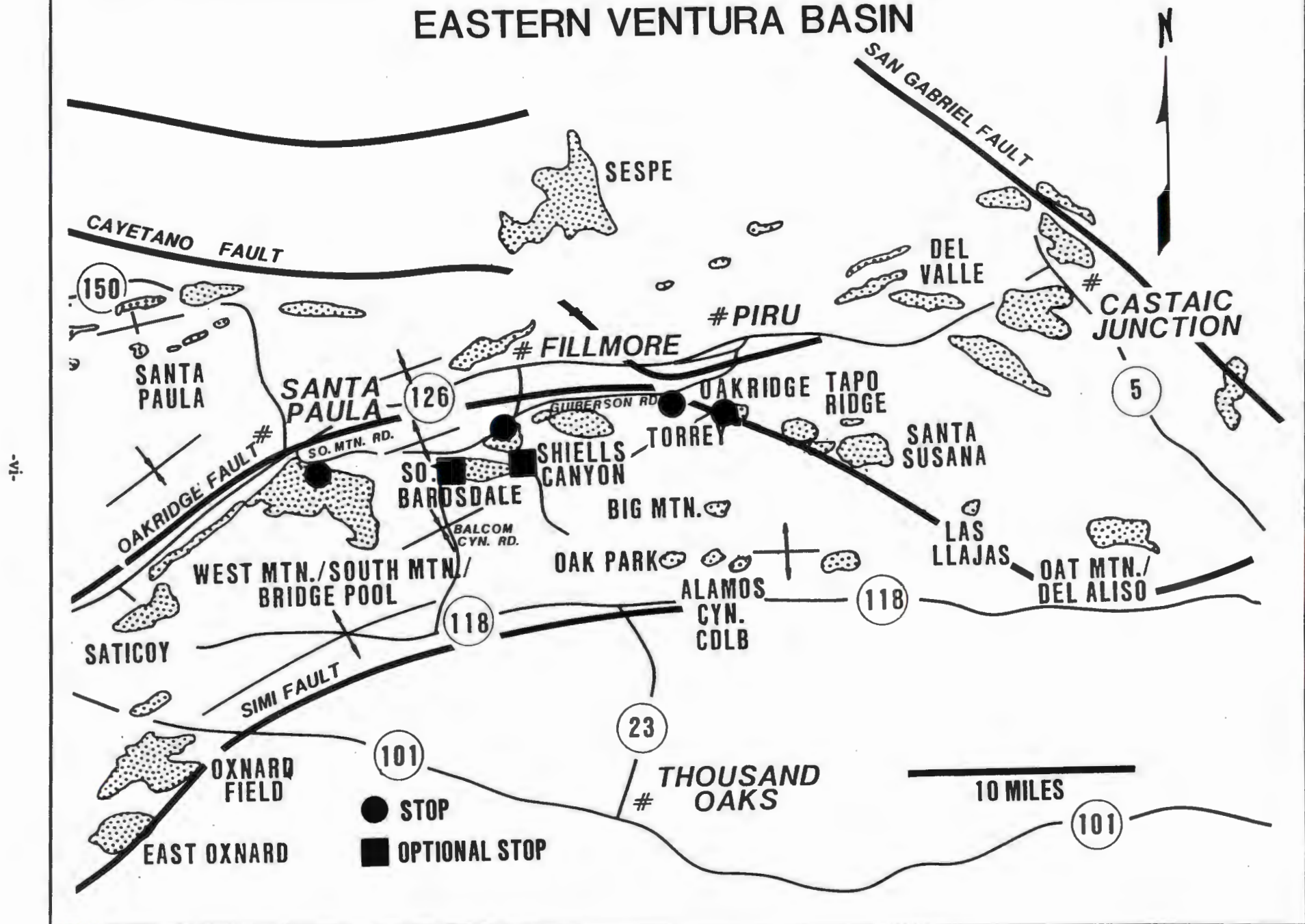
Thanks are due also to Conoco Inc., Texaco USA, Unocal, Chevron USA, and KEYT Television Studios for permission to enter their facilities. The Coast Geological Society sponsored this guidebook and field trip. Casey Davis of Unocal drafted some of the figures.

WESTERN VENTURA BASIN



FIELD TRIP INDEX MAP

EASTERN VENTURA BASIN



FIELD TRIP INDEX MAP

SANTA BARBARA AND VENTURA BASINS

The trip commences on Lavigia Hill where we gain an overview the physiography of the Transverse Ranges and to consider the framework and petroleum activity of the Santa Barbara Channel. The route proceeds westward from Santa Barbara to active tar seeps and exposures of fractured Monterey Formation at Carpinteria. Then we visit Conoco's San Miguelito oil field to see the magnificent anticline in the core of the field and to examine turbidite sedimentation. We cross the axis of the fabled Ventura Avenue oil field, drive through Ventura, and turn northeast on to Hwy 126 and follow the Santa Clara River Valley up to Santa Paula. There we visit Texaco's South Mountain oil field to observe depositional features of part of the Sespe Formation in the anticline. We continue to the Bardsdale oil field to consider the unique structure of the central Ventura basin and to reflect on the early history of its exploration and development. The trip concludes at the Torrey Canyon oil field where the remarkable geologic structure of the Ventura basin is clearly displayed.

INTRODUCTION TO THE WESTERN TRANSVERSE RANGES

A great variety of geologic features is clearly displayed in this part of the Transverse Range physiographic province, a region of east-west trending mountains and intermontane valleys. Geologically the province is characterized by E-W trending folds and faults in Cretaceous and Tertiary sedimentary rocks (Fig. 1.1). The Ventura basin, a particularly complex structural unit in the geologic framework of this province, is an elongate, east-trending trough in which one of the thickest known Tertiary sequences anywhere in the world of dominantly clastic sedimentary rocks has accumulated. The total stratigraphic thickness of upper Cretaceous through Tertiary strata exceeds 55,000 feet, representing the combined effects of major tectonic episodes of rapid subsidence and prolific sedimentation along this part of the California margin. Subsidence rates reach as much as 10 mm/yr. Like most of the other structural features in the province, this basin lies athwart the characteristic northwest structural trend of most of California.

The area consists entirely of highly folded sedimentary rocks of Cretaceous to Recent age that are interbedded locally with sparse volcanic rocks. The Cenozoic geologic record is unusually complete, and within a 3-mile radius of a single site in the basin near Fillmore, one can study rocks representing at least a part of every epoch since the beginning of Eocene time. A 20,000 foot section of continuous Pliocene and Pleistocene marine strata near Santa Paula is believed to be the thickest in California and one of the thickest in the world (Fig. 1.2).

The recency of folding is one of the most striking geologic features in the Ventura basin. Extensive thrust faults and numerous folds exhibit the influence of north-south crustal shortening as the major factor in the development of the structures (Fig. 1.2). Such structural features may be viewed at many places in the Ventura basin.

In late Mesozoic time, the Santa Barbara-Ventura region was the site of a forearc basin. The formation of the proto-Ventura basin probably initiated in Paleocene time when the western half of southern California was affected by a large downwarp related to the impingement of the East Pacific Rise against the North American Plate. Deposition of marine sediments occurred over a vast area. During Oligocene time - from about 38 to 35 my. ago - that part of the basin now represented by the central Transverse Ranges underwent a period of tectonic transition, still incompletely understood, dominated by nonmarine sedimentation. By 20 my. ago, the San Andreas transform system developed, so that a slivered strike-slip regime has predominated from then to present. By the end of Miocene time the San Gabriel, Santa Monica, Santa Ynez and Topatopa Mountains developed, splitting the single proto-basin into several smaller ones, including the Los Angeles, Ventura, and Santa Maria basins. Faunal evidence indicates that by early Pliocene time, the central part of the Ventura basin was covered by a sea 5,000 feet deep. The basin continued to sink even until Recent time, although at a reduced rate with terrigenous sedimentation exceeding the rate of subsidence; basin filling was rapid. Uplift and deep erosion began less than 1 my. ago. North-south crustal

shortening closed the Santa Clara trough and formed such major structures as the Ventura-Rincon trend and the San Cayetano, Oak Ridge, and Red Mountain thrusts which, themselves, may be reactivated normal or strike-slip faults from earlier tectonic events that affected the western Transverse Ranges region in Mesozoic and Paleogene time.

The first oil well in the Ventura basin, and perhaps the first commercially successful well drill in California, was completed in 1866 by the California Petroleum Company about 8 miles east of Ojai (Yerkes and others, 1969). Oil and gas were found in 1885 in the Ventura River where it crosses the axis of the fabled Ventura Avenue anticline. High fluid pressures, which are almost unique in California, however, characterize several of the oil fields in the 25 mile-long Rincon-Ventura anticlinorium and frustrated development of the Ventura anticline until rotary drilling methods and heavy drilling muds were brought in. The first offshore production in the Santa Barbara Channel region commenced in 1896 with the extension of the Summerland oil field. Today cumulative production from the Rincon-Ventura trend exceeds 1.5 billion barrels (Table I) ranking it among the super giant producers.

The Oak Ridge trend has a number of small oil fields to accompany the great South Mountain oil field (Fig. 1.3) whose production is nearly equal to that of the Rincon field (Table I), and which is estimated to have a billion barrels of oil remaining in place. Discovery of the South Mountain oil field in 1914 preceded the commercial discoveries in the Rincon-Ventura trend by a few years and is one of the oldest prolific producers in California. Prolific oil seeps led to the earliest discovery of the Torrey Canyon oil field in 1889, which was followed shortly thereafter by the Bardsdale field. Shallow production played out fairly soon, and each field has a history of deeper discoveries and development. The most recent discovery is the Chaffee Canyon oil field in 1980.

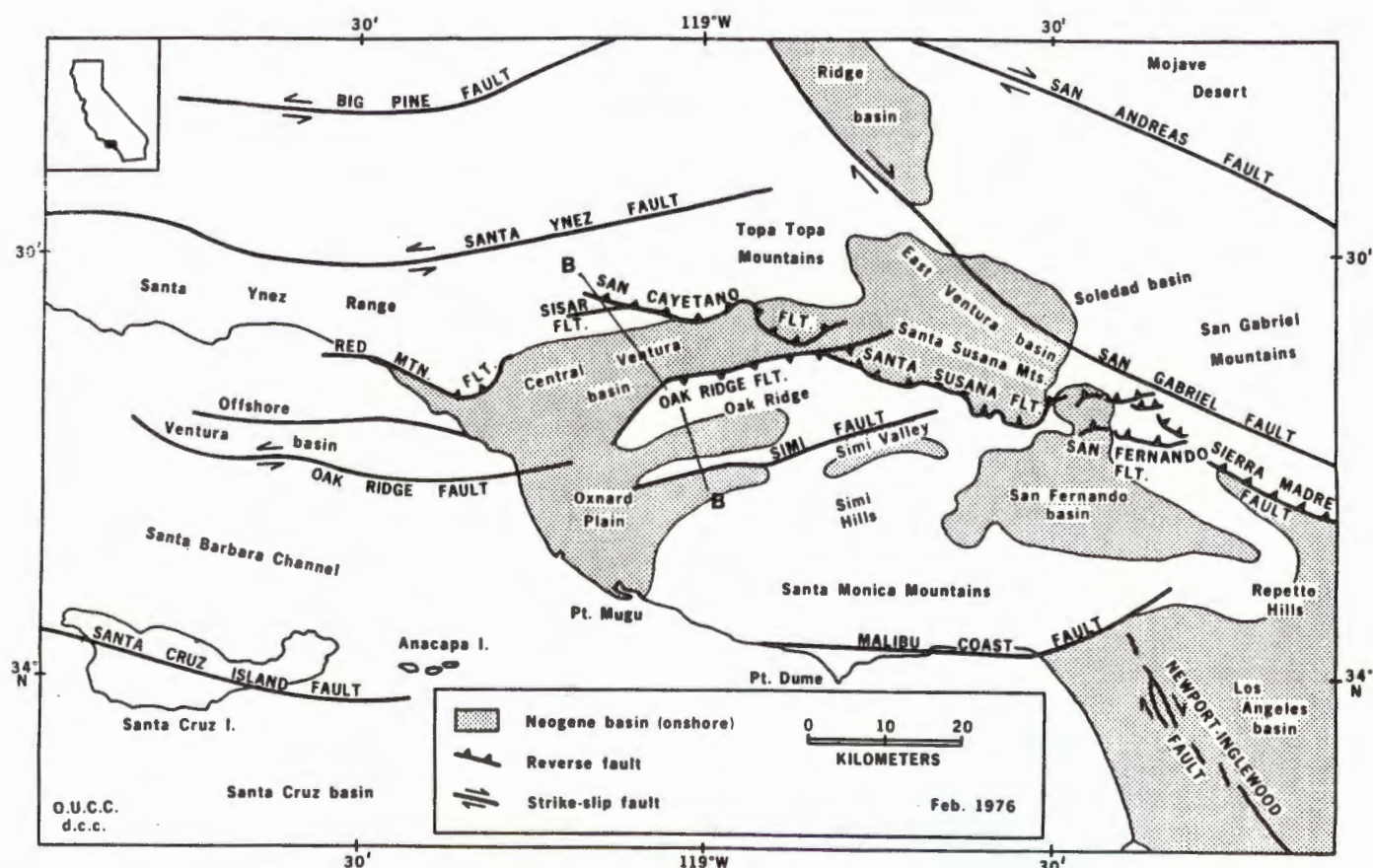


Figure 1.1 Tectonic map of the central Transverse Ranges showing onshore Neogene basins and lowlands (shaded) and major Neogene faults (heavy lines) (Yeats, 1983). Line B-B' is cross section in Figure 1.2.

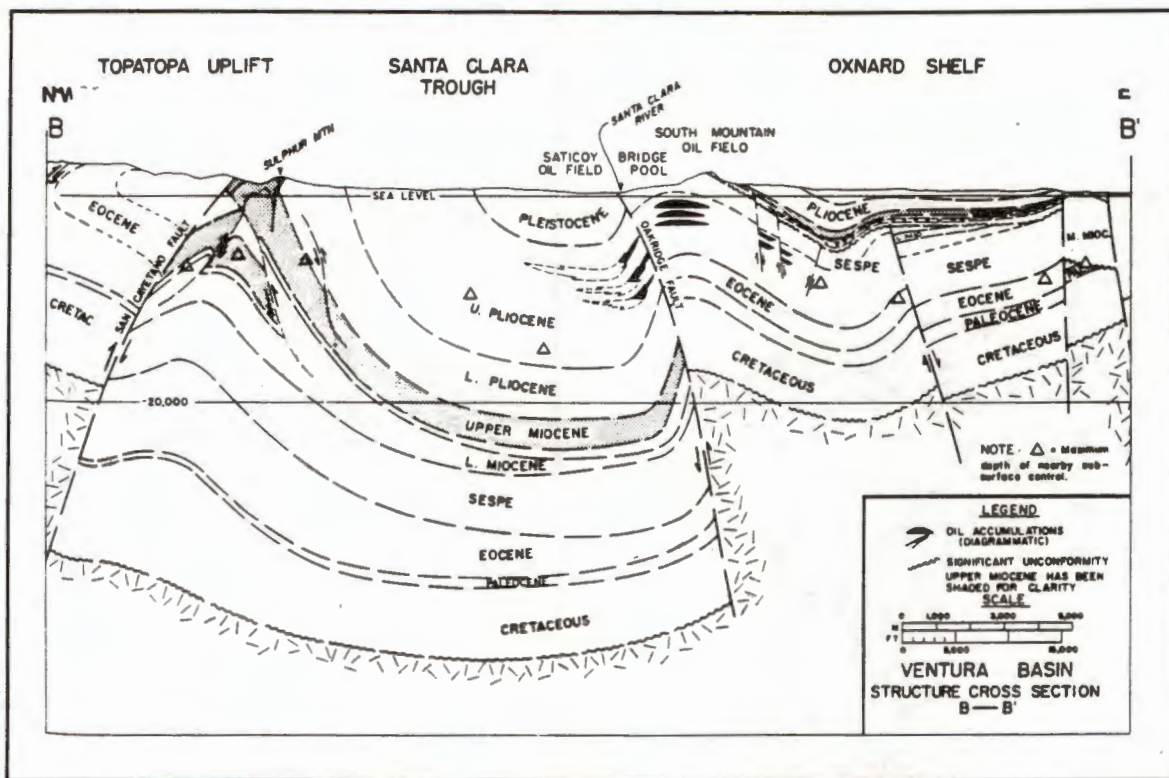


Figure 1.2. North-south structure section across Ventura basin (Nagle and Parker, 1971). Location shown in Fig. 1.1

OIL PRODUCTION OF SELECTED FIELDS IN SANTA BARBARA AND VENTURA COUNTIES THROUGH 1992

(CCCOP, 1992)

FIELD	DISCOVERY DATE	PRODUCING WELLS	CUMULATIVE PRODUCTION IN 10 ⁶ bbls	AVG bbl/day	AVG WELL DEPTH (ft)
Summerland		abandoned	3.2		
RINCON-VENTURA TREND					
Dos Cuadras F-OCS	1969	141	226.1	9,047	2,300
Carpinteria Offshore	1966	49	94.7	3,344	4,000
Rincon	1931	160	152.6	2,544	10,000
San Miguelito	1931	66	89.3	3,394	9,000
Ventura	1917	432	934.0	16,198	9,000
OAK RIDGE TREND					
Saticoy	1955	23	22.0	302	7,500
South Mountain	1914	332	148.7	1,932	8,000
Bardsdale	1892	78	14.2	230	4,000
Shiells Canyon	1911	40	27.3	303	5,000
Torrey Canyon	1889	40	21.4	254	9,000
Total California			23,485,895,445 bbls		

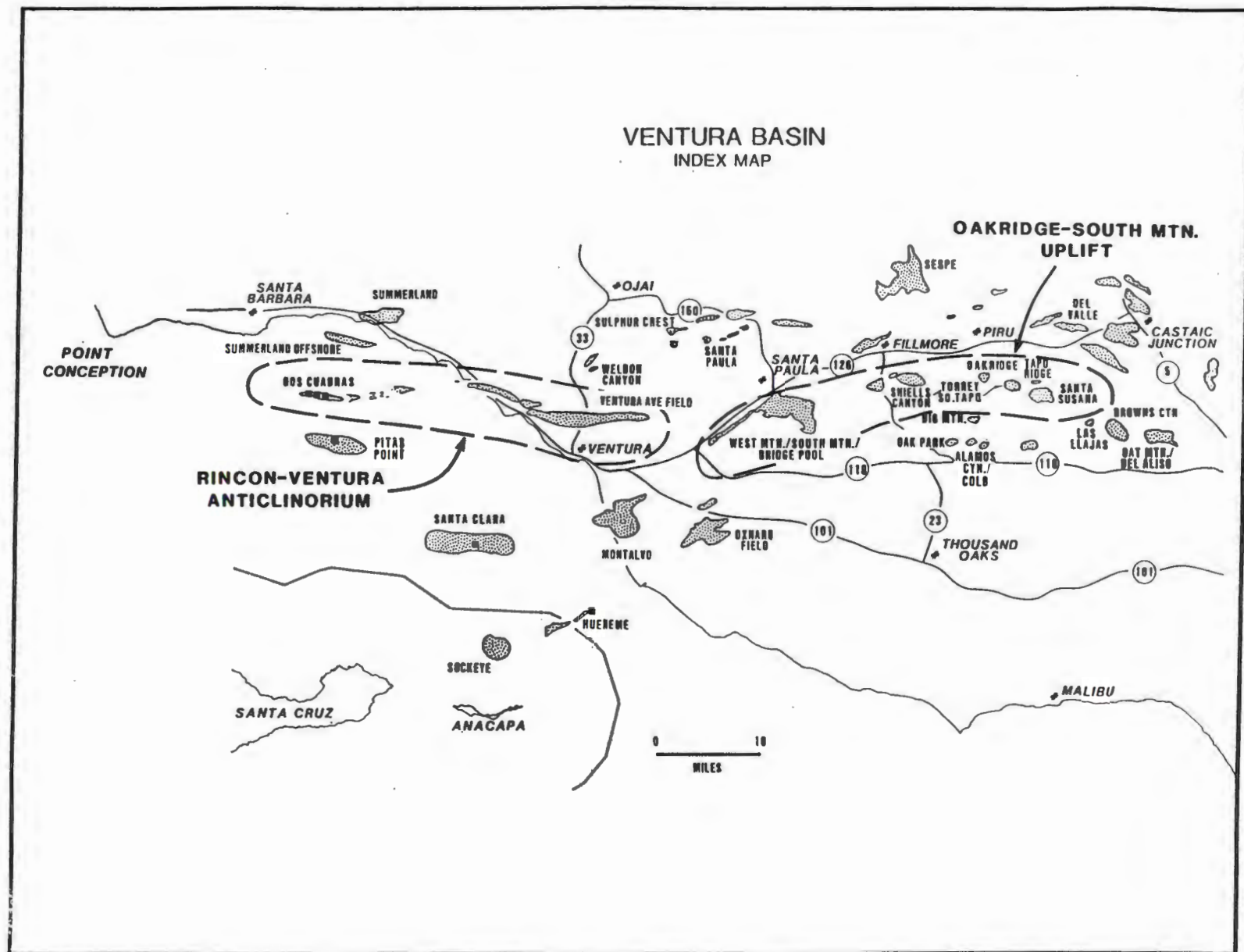


Figure 1.3. Map of oil and gas fields in the Santa Barbara area, California.