The overlying structureless muddy sandstone may represent deposition in a vegetated back-beach environment. The redbeds of the Caliente Formation probably formed in coastal swamps, lagoons, or alluvial plains.

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GRAVITY AND STRUCTURE OF CONTINENTAL MARGIN: OREGON TO SOUTHEASTERN ALASKA

Reconnaissance surface-ship gravity measurements over the continental margin of western North America extend from northern California to southern Alaska. The gravity measurements, spaced approximately 2.5 km apart along tracklines approximately 40 km apart, have an estimated RMS uncertainty of approximately 5 mgl. A negative free-air anomaly along the base of the continental slope is attributed to the dip of the Mohorovičić discontinuity, lateral density variations in the upper mantle, and in some locations a sediment-filled trough. Off the north end of Vancouver Island a free-air anomaly greater than − 150 mgl occurs over the Scott Islands fracture zone, suggesting a sediment thickness in the fracture zone of 4–6 km. Hypothetical crustal cross sections of the continental margin constrained by the free-air anomalies and the available seismic refraction data suggest crustal thicknesses are approximately 20 km in western Oregon and Washington, and 25-30 km in the Insular Belt of British Columbia and the Alexander Archipelago. The relatively thin crust in the region between the continental shelf and Coast Mountains of British Columbia and the Cascade Range in Oregon and Washington is characteristic of the transition from oceanic to continental structure in western North America.

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RINCONADA FAULT IN SOUTHERN COAST RANGES, CALIFORNIA AND ITS SIGNIFICANCE

The Rinconada fault near Santa Margarita is a major northwest-trending, high-angle fault that separates a terrane of granitic basement on the northeast from one of Franciscan basement on the southwest. Southeastward from Santa Margarita this fault extends continuously into the "Nacimiento" fault across Cuyama Gorge to intersect the Big Pine fault in the San Rafael Mountains. Northwestward the Rinconada fault does not extend into the Nacimiento fault near the Nacimiento River, as presumed, but veers northward through Paso Robles into a line of faults locally called San Marcos, Jolon, and Espinosa faults, nearly to Reliz Canyon west of King City.

Detailed mapping reveals that all these aligned faults are parts of one major fault, 160 mi long. Therefore, it is proposed to call it the Rinconada fault. It is separated by a 2-mi gap from the Reliz fault, aligned northwest along the base of Sierra de Salinas. The Rinconada fault, as defined herein, is nearly parallel with, and about 22 mi southwest, of the San Andreas fault. Southeastward from Santa Margarita the Rinconada fault is along the southwestern border of the Salinia block; northwestward from that town it extends into this block. Drag folding along and near the Rinconada fault indicates right-lateral movement. Much of this movement occurred before deposition of the Paso Robles Formation. Strata of Miocene and early Pliocene ages are offset about 11 mi near Paso Robles; those of Late Cretaceous-early Tertiary age are offset nearly 40 mi.

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USE OF PHOSPHATES IN SEARCH FOR OIL

Phosphatic facies are useful in oil exploration as tools for stratigraphic analysis, and as identifiable sources of hydrocarbons. Such discrete, near-continuous phosphate-bearing strata of mid-Eocene age have extended over 20,000 sq mi in southern and central California. Foraminiferal studies establish that correlative phosphate deposition began in Relizian time, was particularly widespread in the early Luisian, and continued locally in Mohnian time. Other extensive facies appear in late Eocene and in early late Pliocene beds.

The use of phosphatic facies in stratigraphic studies may be cited in four examples: (1) they may represent condensations of large thicknesses of strata, (2) differentiate between apparently similar formations, (3) establish equivalency of units on either side of major faults, and (4) have shown that formations of the same apparent lithology and foraminiferal age, juxtaposed across major faults, are not continuous.

Because phosphorus-rich waters nourish phytoplankton, underlying strata are commonly rich both in phosphate and organic remains. Five examples of phosphatic facies as source beds for the generation of oil of giant fields may be given: in California, in Colombia and Venezuela, in eastern Kansas, in Alaska, and in Wyoming. Other examples are known around the world. In California, the regional distribution of phosphate correlates with the regional distribution of petroleum.

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SIRENIANS IN WEST COAST MARINE STRATIGRAPHY

Sirenians are fairly common as fossils in many late Tertiary nearshore marine deposits of the West Coast. The general pattern of their evolution in the North Pacific from early Miocene to recent times is now known. With the exception of the early Miocene forms, all the known species are stratigraphically successive and seem to belong to a single, unbranching evolutionary sequence.

Their evolution was particularly rapid during the late Miocene and early Pliocene in response to changing climate, and the resulting morphologic changes were so profound that different evolutionary stages can be recognized, and rough stratigraphic correlations made, on the basis of quite fragmentary skeletal material. In at least two areas of California (Santa Cruz and Orange Counties), sea cows have been collected from several different zones near the Miocene-Pliocene boundary. These sequences of fossils well illustrate these rapid changes, and in the former case considerable evolution can be observed even within a single species. More detailed study of these and other sections may permit the use of sirenians in correlating widely separated marine deposits on the West Coast.

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DISCOVERY AND DEVELOPMENT OF SAWTELLE OIL FIELD

The Sawtelle oil field, discovered by Occidental Petroleum Corporation in 1965, is the westernmost of nine producing fields along a 15-mi trend of anticlinal oil accumulations distributed *en échelon* along the northerly margin of the Los Angeles basin.

Wells at Sawtelle confirm that the normal stratigraphic section has been disordered by approximately 7,000 ft of apparent vertical displacement along the northerly trending Santa Monica thrust fault zone. The mountainous hanging wall block is comprised of a thin veneer of recent sediments; nonproductive lower Pliocene and upper Miocene sandstone and shale; middle Miocene sandstone, shale, and volcanic rocks; and Mesozoic Santa Monica Slate. Beneath the fault zone, within the basinal footwall block, are lower Pliocene sandstones and shales, oil-bearing upper Miocene sandstone and shales, and middle Miocene sandstones and shales.

Production has been established in two pools: on the south in the upper Miocene "Rancho" sands within an asymmetric southeast-trending anticline where net pay exceeds 500 ft, and on the north where these same sands appear even thicker within the south limb remnant of a parallel anticline which has been dragged upward and overturned along the hanging wall block of the Santa Monica fault zone.

Thirteen wells have been completed beneath the Federal lands of the Sawtelle Veterans Hospital and an adjacent town-lot area on the north. Production through 1971 totals 6,470,000 bbl of oil and 5,790 MMcf of gas. Current production is 2,000 bbl of oil per day and 2,600 Mcf of gas per day. Average vertical depth to the top of the zone is 9,500 ft; initial pressures were hydrostatic. Porosity averages 18% and permeability averages 20 md. Connate water averages 27%; and oil gravity ranges from 18 to 26° API.

Minor exploration potential remains, but drilling costs are considered too high to justify additional work, and development is therefore considered complete.

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REEXAMINATION OF MOHNIAN TYPE SECTION

Examination of 471 samples collected from the Modelo Formation exposed along Topanga Canyon Boulevard has shown that two of the foraminiferal zones of the Mohnian as published by Kleinpell are in need of revision. As a result of detailed sampling, many more foraminifer-bearing samples allowed the reevaluation of the faunal ranges through the Modelo lithologic units described by Hoots.

The *Bolivina modeloensis* Zone contains a distinctive fauna represented by *Pulvinulinella gyroidinaformis, Baggina californica,* and *Valvulineria subinaequalis.* With the rare exception of a possibly reworked specimen, this faunal assemblage does not range any higher than Hoots' unit 5.

Bulimina unvigerinaformis, formerly considered not to range above unit 6, has been found through unit 8 and rarely in unit 9. *Bolivina sinuata alisoensis* was not found above unit 6.

The *Bolivina hughesi* Zone which included Hoots' units 7 through 16 is best represented in unit 9. Restricted to unit 9 are *Bolivina hughesi* and *Buliminella semihispida.* Above unit 9 foraminifers are very scarce. The faunal top of the Mohnian is in question because no foraminifers restricted to the Mohnian could be found higher than unit 13.

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LATE CENOZOIC STRATIGRAPHY AND STRUCTURE OF OREGON CONTINENTAL MARGIN IN FRAMEWORK OF PLATE TECTONICS

More than 8,000 km of seismic-reflection survey and 250 rock samples provide the basis for a discussion of late Cenozoic stratigraphy and structure of the Oregon continental margin, a critical boundary region between the North American plate and the Gorda-Juan de Fuca plate. Uplifted and faulted folds along the edge of the shelf, commonly manifested as banks, are dominant shallow structural features of the margin. A persistent, broad, relatively shallow syncline lies between the banks and the shore. The continental slope off southern Oregon is characterized by a major fault and fold system; benches result from the ponding of sediments behind anticlinal folds. The northern slope consists of a series of broad anticlinal folds and intervening synclinal basins with deeper underlying folded structure. Structural elements on the margin generally trend north-south and are either parallel or subparallel with it.

At least two regional unconformities establish a first-order subdivision of the stratigraphic column. The older separates late Miocene diatomaceous sediments from underlying rocks. The younger is Pliocene-Pleistocene. These unconformities appear to correlate with significant plate tectonic events. Second-order subdivision into stratigraphic units on the basis of gross lithologic and faunal trends, reflection characteristics, and stratigraphic succession indicates similarities to the Pullen, Eel River, and Rio Dell Formations of northern California. Generally rich foraminiferal faunas display affinities to the late Miocene to Pleistocene biostratigraphy of California.

Provenance and paleoenvironment of lower slope samples suggest a north component of motion for the Gorda-Juan du Fuca plate. Paleoenvironmental analyses indicate a total range of vertical tectonic movement since the late Miocene of approximately 1,200 m.

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STRUCTURE OF MIOCENE ROCKS IN SIERRA MADRE, NORTHEASTERN SANTA BARBARA COUNTY, CALIFORNIA

Folds in Miocene rocks of the central Sierra Madre commonly are northwest-trending, curvilinear, concentric, and symmetrical; asymmetry and overturning occur in the vicinity of reverse faults. Fold hinges undulate across the area and in places bifurcate or merge. Disharmonic folds and sandstone dikes occur locally in the Monterey Shale.

Faults are of three types: (1) along the northeastern edge of the range is a distributive fault zone consisting of parallel, longitudinal, reverse-slip faults which join both westward and downward and which have a subsurface distributive component that is now obscured by more recent deposits on the northeast; (2) southwest of the reverse-slip faults is a group of parallel, longitudinal, normal-separation faults; and (3) the remaining faults are mostly small, diagonal faults of different types; many are hinged at one or both ends and have slips or separations that indicate contemporaneous folding and faulting.

Folding began during late Miocene or Pliocene while Miocene sediment was still unconsolidated and water laden. Diagonal faulting, intrusion of sandstone dikes, and possibly disharmonic folding accompanied early deformation. Asymmetrical and overturned folds formed later and large reverse-slip faults developed along their hinges. Normal-separation faults possibly formed last as lag faults. Northeast-southwest shortening of the area averages about 22%.

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WHY EXPLORE THE NORTHEAST MARGINS OF LOS ANGELES BASIN?

Significant oil finds recently have been made in the northeasternmost Los Angeles basin. Exploration in the area has lagged because of supposed structural complexity and limited stratigraphic concepts. The development of stratigraphic concepts since the early 1950s now allows us to reinterpret and refine depositional patterns and resolve some of the structural complexity. Unlike other parts of the Los Angeles basin, land is still available in many areas and lease costs are reasonable, hence, a review of older records and recomputation of older geophysical work in addition to application of new and improved field and stratigraphic theory can lead to new oil finds. This is especially true along the basin edge with emphasis on source and distribution of sands. Exploration is best done before urbanization and attendant increased costs of operation.

The new West Mahala pool can be used as a case history. The pool was discovered by M. J. Castro as a stratigraphic trap in late Miocene, Puente Formation sediments. The producing measures are in fan and canyon turbidite deposits in upper to middle bathyal sediments (800-3,000-ft water depth). There are two producing zones—the Willis and Langstaff zones. The sandstone geometries suggest fan deposition for the Willis, and channel or canyon facies for the Langstaff. Recovery factors, gas drive, and decline rates are typical of sands given this interpretation. Porosity and permeability data support these contentions. Reworked and shallow-water foraminifers are con-