Yaquina River sediments are poorly to well sorted, angular to subangular, and range in grain-size from silt to coarse sand. Sediments within the bay range in size from silt to medium-grained sand, are angular to subangular, and are poorly to well sorted. Beaches and dunes consist of well-sorted fine sand. Well-sorted, fine detrital sand covers the inner continental shelf (0-50 fms.), and grades laterally into poorly-sorted, glauconite-rich, clayey silt on the outer shelf (50-100 fms.). Clayey silt with small amounts of Foraminifera, radiolarians, diatoms, and sponge spicules covers the continental slope. Silty clay is predominant at the base of the slope of the abyssal plain (1,500 fms.).

From an areal standpoint, the beach, dune, and inner-shelf sediments are more uniform than those of the river, bay, outer shelf, and upper slope. Beach and dune sediments are best sorted. Within the bay, sorting is better toward the coast line. Most river and bay sediments are positively skewed; beach and dune sands mainly are negatively skewed. Offshore, the median diameter generally decreases with depth, and sorting becomes poorer. Skewness is negative for the inner-shelf sediments, positive for the deposits of the outer shelf and continental slope, and negative for abyssal-plain sediments.

Similarities of texture and fauna of Recent sediments with those of middle and late Tertiary rocks in the area indicate that comparable textural trends existed.

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Southern California and Offshore Tertiary Basins

The pattern of southern California Tertiary basins has been formed, changed, and controlled by the trends of many major lateral faults. Their dominant northwest-southeast trends are interrupted by an ancient belt of east-west lateral faults which also caused basins to form across the region.

The structural pattern and, therefore, the erosional and depositional patterns were changing almost continuously during the Tertiary. Broad Eocene land and sea features were broken up by regional emergence and block faulting during the Oligocene. However, the general structural pattern lasted into early Miocene, when regional submergence began. Regional transgression continued through Miocene time, with few interruptions, over an increasingly irregular terrane formed by a developing complex fault-block pattern of basins and ranges. Great reversals of vertical relations between blocks and great lateral offsets occurred through Miocene and Pliocene times. Many islands or high land masses, deep embayments, and basins were formed at different times only to founder or be broken up. The depositional areas and types varied greatly and constantly with most of the coarser clastic sediments being deposited as submarine slides and turbidites.

New general block deformation ended the Miocene, and the Pliocene began with a different pattern of emergences, although many existing basins were deepened. Marine sediments of the entire region, because of this rapidly changing geography, were mostly coarse clastics derived from land; lithofacies became increasingly divergent and restricted. However, thick organic deposits were formed over large areas during times of greatest submergence in middle and late Miocene times. Considerable non-marine deposition occurred in coastal as well as interior valleys through Tertiary time except during early Pliocene. Most of the Tertiary basins were similar to those of the present. Even the ecology of some Tertiary basins is similar to that of modern basins, including the Gulf of California and the Imperial Valley.

The comparatively meager subsurface data from the 15,000-square-mile area offshore indicate that the same structural, erosional, and depositional histories took place there in the Tertiary as in the Tertiary basin region now emerged onshore. Offshore structural features are much less eroded or obscured, and sediments there are generally finer, thinner, and more organic.

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Mioclines in Space and Time

Many continental margins are capped by wedge-shaped prisms of Cretaceous to Recent shallow-water marine strata. These prisms were deposited on down-flexing continental margins, presumably subsiding because of regional isostatic compensation caused by the growth of adjacent continental-rise prisms. The writers equate these continental-terrace wedges with miogeosynclines of the past, which are wedge-shaped as now preserved and which probably were never synclinal in form—hence the shortened term "miocline." Modern mioclines thicken toward the ocean and terminate by "thickening-out" against water at the continental slope; it is presumed that ancient ones did also. Ancient mioclines thicken toward, and abut, a deformed eugeosynclinal lithofacies. These are interpreted to be collapsed continental rises deposited synchronously with the adjacent miocline and later accreted to the continent.

Mioclines probably have been formed by marginal sedimentation throughout geologic history, the outer limits being former continental boundaries before the accretion of new fold belts. The Appalachian miocline may be one Paleozoic example and the Millard miocline of the western United States may be another. More speculatively, Precambrian examples of mioclines may be the Huronian metasedimentary sequence abutting the Grenville fold belt in Canada and the Witwatersrand Series in South Africa.

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Gravity Survey and Analysis of San Diego Embayment, Southwest San Diego County, California[1]

A reconnaissance study of the San Diego, La Jolla, and western one-thirds of the El Cajon and Jamul 15-minute quadrangles was conducted to determine the depth to basement, using gravity meter, available well data, and surface geology. A Worden gravimeter was used to occupy 368 stations with ½-mile spacing; drift, latitude, and elevation corrections were made; basement-sediment density contrasts range from 0.3 to 0.5 mgals.

Geologic units and gravity contours trend north-northwest as do the Peninsular ranges. Anomalies over areas underlain by batholithic rocks range from −6 to −26 mgals. Irregularities and small closures occur along the belt of dense (±2.85 gm./cc.) Santiago Peak

[1] Supported by National Science Foundation Grant No. GE-1209.

volcanic rocks. At the south end of San Diego Bay, a gravity anomaly of —36 mgals. and well data indicate the presence of a sedimentary basin ±6,000 feet deep. A +4 mgal. anomaly at Point Loma and near-zero anomalies at La Jolla reflect a positive westerly gradient.

At the surface, Santiago Peak volcanic rocks, a discontinuously exposed belt of Upper Jurassic and Lower Cretaceous(?) meta-volcanic and meta-volcaniclastic rocks, roughly separate mid-Cretaceous batholithic rocks at the northeast from Upper Cretaceous, Eocene, and Pliocene clastic sedimentary rocks at the southwest. The Campanian-Maestrichtian Rosario Formation crops out at La Jolla and Point Loma. Most surface exposures of undifferentiated Eocene rocks are north of Mission Valley. At the south, the Pliocene San Diego Formation overlaps the Eocene.

An irregular basement surface (batholith and older) dips west; it is elevated slightly under Point Loma and flattened under La Jolla. The Rosario Formation reaches a maximum thickness of ±4,000 feet at La Jolla and Point Loma. Undifferentiated Eocene sedimentary rocks attain a maximum thickness of ±2,500 feet south of San Diego Bay where they are overlain by more than 2,000 feet of the San Diego Formation.

Four distinct post-batholith structural blocks are delimited by an east-west Mission Valley hinge line and the north-south-trending Rose Canyon fault. The northeast stable block (Kearny mesa) received mostly Eocene sediments. The northwest block (La Jolla) and southwest block (Point Loma), separated by synclinal Mission Bay, received mostly Upper Cretaceous and Eocene sediments, and later were uplifted, faulted, and tilted. The southeast block (San Diego mesa) probably subsided continuously, receiving more than 2,000 feet of Upper Cretaceous, Eocene, and Pliocene sediments.

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Authigenic Silicates in Marine Spencer Formation at Corvallis, Oregon

Segments of the petroleum industry are actively exploring the Tertiary rocks of offshore Oregon and Washington; several wells are being drilled and others are projected. It is noteworthy (1) that amphibole and pyroxene occur in sandstone beds of one of the potential reservoir formations under conditions that require an authigenic origin and (2) that the rocks have not been metamorphosed. These minerals, which usually are presumed to have formed in conditions of much higher temperatures than those of diagenesis, are found in the Spencer Formation of late Eocene age at Corvallis, Oregon. The best-preserved examples of these minerals are found in a graded sedimentation unit rich in molluscan fossil fragments, basic volcanic glass, and zeolitic concretions. The marine shell fragments are replaced by thomsonite which contains many idiomorphic crystals and tangled needles of actinolite and clinopyroxene.

Reconstruction of the diagenetic environment suggests a formation temperature near 140°F., solutions somewhat less saline than sea water, a pH of slightly less than 7.0, and an Eh near —0.2.

Formation of thomsonite, actinolite, clinopyroxene, and rare analcime, rather than a suite such as clinoptilolite or heulandite, orthoclase, and abundant analcime, is thought to have been caused by a supply of basic volcanic glass and molluscan calcite rather than acid glass and soda-rich brines.

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Diving Geology

A remarkably large amount of "surface geology" has been done in the California offshore areas using both "Hard Hat" and "SCUBA" divers. Considerable oil has been found as a result of this work, but there have been some notable failures.

In the areas where the diving method is applicable, it is a very effective and relatively inexpensive way to explore for oil. In areas of steep dip and in shallow water, it has some distinct advantages over conventional seismic techniques.

Future use will be dependent on the choice of suitable areas for exploration and on improvements in the technique. Suggested improvements include the use of (1) sonar bottom-scanning devices and (2) submersibles to extend the depth of observation.

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Stratigraphy of Montesano Formation, Washington

The Montesano Formation is known to occur over about 250 square miles of Grays Harbor basin. Eight stratigraphic sections were measured along the branches of the Wishkah and Satsop Rivers, the Wynoochee River, and the Canyon River. Exposures of the Montesano Formation along the Middle Fork of the Wishkah River are designated the type section. There it is 2,500 feet thick and is composed of 1,500 feet of fine-grained sandstone, with small amounts of pebble conglomerate and mudstone, overlain by 1,000 feet of tuffaceous mudstone and sandy siltstone. Toward the east the thickness of the formation averages only 1,800 feet, and it is composed principally of fine- to medium-grained sandstone, pebbly sandstone, and conglomerate. Along the West Fork of the Satsop River, an abnormally thick sequence of thin-bedded to laminated, tuffaceous mudstone and very fine-grained sandstone at least 1,100 feet thick contributes to a formation thickness that may exceed 3,000 feet.

Deposition took place in a sea which was transgressing eastward across a broad, east-west-trending embayment. Estimated water depths ranged from sea-level to more than 3,000 feet. The upper parts of the eastern sections apparently represent a regressive phase. Turbidite deposition in a partly closed basin was the principal cause of the abnormally thick accumulation of the thin-bedded sequence mentioned previously.

Foraminiferal evidence places the Montesano Formation mainly in the upper Miocene. It is unconformable on the lower Miocene Astoria and Oligocene Lincoln Formations. A unit sometimes referred to as the Satsop Formation, and questionably considered to be Plio-Pleistocene, overlies the Montesano unconformably.

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An Upper Cretaceous Fault-Line Coast

From northern San Diego County, California, to