monly important hydrocarbon reservoirs.

Based on detailed field sampling, simple models for the growth of both fine- and coarse-grained deposits can now be described. It is evident that contemporary field samplings will miss geologically significant events and are biased in their recovery owing to the rarity of major events on a human time scale and the dimensions and efficiency of the samplers. However, study of contemporary sediments and their modes of formation and later alteration show us much about the three-dimensional character of the deposits actively forming and, when combined with studies of the ancient analogs exposed in outcrop, can yield a very complete story of the typical history of a deep marine sedimentary basin.

Fine-grained sediments come from two dominant sources—the overlying waters and the adjacent land sources. The terrigenous contribution is usually the dominant contributor in all environments open to its influence. The biologic components raining from the overlying water masses yield information about environmental characteristics and oceanographic circulation patterns as well as time markers. Benthic faunas provide depth data and also add deep-water environmental data. All usually pass through the surficial zone of bioturbation active in all but the least aerated basins and so the record preserved tends to be smeared.

Where time dimension can be defined and the rates of individual component sedimentation defined the picture that emerges usually clearly defines the major sources and their regional influence. When we examine the recent sediments we can directly measure these factors and then check them against the patterns preserved in the basin floor materials. Simple first-order models have been developed that explain the major features of the continuously depositing fine basin sediments. Second-order models have also been described which add the influence of current action within and over the basin. These are described and their results compared to the actual sediments presently collecting.

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Results of Exploratory Drilling, Northern Fallon Basin, Western Nevada

In the early 1970s, Chevron and Amoco began investigating the oil and gas potential of Tertiary basins in western Nevada. Reconnaissance geologic studies focused interest on the large area of the Fallon basin with its numerous reported hydrocarbon shows. The two companies acquired leases and jointly ran seismic and gravity surveys in the northern part of the basin. At a location based on survey results, the Standard-Amoco 1 S.P. Land Co. well was drilled to 11,000 ft (3,353 m) as a stratigraphic test of the Tertiary section.

The oldest rocks in outcrop around the basin are a 12,000 ft (3,658 m) thick section of Upper Triassic to Middle Jurassic marine siltstones and shales interbedded with lesser amounts of sandstone, limestone, and conglomerate. The Mesozoic rocks are intruded by an Upper Jurassic gabbroic lopolith and Cretaceous and Tertiary granitic plutons. An 8,300-ft (2,530 m) thick section of Tertiary volcanic rocks and nonmarine sediments overlies the Mesozoic rocks in outcrop. The Tertiary section is divided into a lower volcanic member, a middle fluviolacustrine and volcanic-derived sedimentary member, and an overlying "capping basalt" unit.

Seismic data show that in the subsurface the northern Fallon basin is bisected by a northerly trending subsurface high. The maximum subsurface section of Tertiary to Recent sediments and volcanic rocks is 6,000 ft (1,829 m) thick west of the structural high and is over 13,000 ft (3,902 m) thick east of the high.

The Standard-Amoco 1 S.P. Land Co. well penetrated highly organic playa-lake sediments from the surface to 6,900 ft (2,103 m). From this depth to 11,000 ft (3,353 m) T.D., the well penetrated subsurface equivalents of the Tertiary outcrop section and bottomed near the base of the lower volcanic member. Oil and gas shows including free oil in vugs at the top of a basalt core at 8,168 ft (2,490 m) were present in the well, but results of formation tests of selected intervals showed that reservoir rocks were absent.

The results of the exploration work show that (1) the northern Fallon basin contains a large volume of highly organic oil-prone source rocks, (2) subsurface temperatures in these rocks are too low to generate significant amounts of oil, and (3) extensional faulting and the formation of basin and range structure over a broad area of western Nevada have occurred in the last 4 to 6 m.y.

The period of marked extension in western Nevada and probably of the basin and range as a whole is approximately time-coincident with the late Neogene offset of the San Andreas, and with the development of most of the oil-producing structures of the west-side San Joaquin Valley and of the Santa Barbara Channel–Santa Clara trough.

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Quaternary Styles of California Submarine Fans

The morphology and sedimentation patterns of large, deep-ocean submarine fans along the California coast, like Monterey fan, differ from that of smaller borderland or slope-basin submarine fans like the Navy and La Jolla fans. Small borderland fans feature areas of channels, isolated depressions, and a convex upward profile which are characteristic of the area defined as a suprafan and regarded as the location of active sand deposition.

Large submarine fans are not simply scaled-up versions of small fans but seem to have certain features that suggest a composite of many small fans. On large fans, the basin shape and basin topographic features are a significant factor in the location of active turbidite depositional areas and the duration of these areas as principal sites of deposition. Bathymetric highs act as dams, restricting fan progradation, or deflecting the transport of fan sediments. Continued deposition commonly results in breeching topographic barriers, producing a rapid shift of primary depocenters to more distal regions. What was formerly a lower-fan environment may become the site of a middle-fan depositional lobe, and lower-fan deposition moves further seaward. Owing to these abrupt large-scale changes of fan deposition, it is difficult to recognize classic middle-fan environments on large submarine fans. Extensive channel systems result in sediment bypassing the old middle-fan region. At the lower end of the main valleys on Monterey fan, channels and isolated depressions are observed but the characteristic morphology of suprafans is not clearly developed. Large sediment waves are present on the upper fan valley levee and at various locations on Monterey fan, but are absent on the smaller Navy and La Jolla fans.

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Holocene Mollusk Distribution Patterns in Northern Gulf of Alaska

Three recurring mollusk association types are defined in the northern Gulf of Alaska: (1) the shallow-water *Yoldia-Siliqua-Lyonsia* sand association; (2) the shallow to intermediate depth *Cyclocardia*-boreal turrid mud association (with a typical phase developing in offshore muds and a *Clinocardium-Nitidella* nearshore mud phase developing in Yakutat and Icy Bays); and (3) the deep-water *Cadulus*-thin shelled protobranch mud association. Associations are defined from 148 bottom samples containing 113 species.

Substrate exerts a strong influence on shallow-water species composition. An unidentified depth-related factor, independent of substrate type, influences both species composition and taxonomic structure. Dramatic changes in taxonomic structure that occur with depth on fine-grained glacial marine sediments in the Gulf of Alaska provide a model for paleobathymetric interpretation of high latitude late Cenozoic fossil mollusk faunas. The major structural shifts include: decrease in the proportion of heterodont, suspension-feeding bivalves; increase in the proportion of thin-shelled, deposit-feeding protobranch bivalves; and increase in the proportion of carnivorous neogastropods, particularly small-shelled, toxoglossate turrids.

The most abrupt and most readily recognized faunal break occurs at 200 m, separating the typical *Cyclocardia*-boread turrid mud association from the *Cadulus*-thin shelled protobranch mud association. Although the two associations have species in common, many species drop out as the 200-m isobath is approached and others appear at or not far below it. More precise definition of this faunal break should be explored because of its potential application in paleoecologic analysis.

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Benthic Foraminiferal Biofacies of Eastern Pacific Margin Between 32°S and 32°N

Quantitative analyses of benthic foraminifera from the Peru-Chile Trench area, off Central America, and the Gulf of California allow assessment of general faunal trends between 32°S and 32°N along the eastern margin of the North Pacific and South Pacific. Six widespread faunal divisions can be recognized in this broad region reflecting major variations in substrate and water-mass character across the neritic-to-abyssal gradient. The 50-m isobath represents the average line of wave touchdown on open shelves, in turn separating inner and outer neritic substrates, mixing, and biofacies. Inner neritic biofacies (<50 m) are characterized by *Bulimina denudata, Hanzawaia nitidula, Nonionella basispinata,* and *N. stella.* The 100 to 150-m depth interval encompasses the base of the mixed (surface) layer, the base of the effective photic zone, and average point of shelf-slope declivity in turn separating outer neritic and upper bathyal biofacies. Outer neritic biofacies (50 to 150 m) include *Cancris panamensis, Cassidulina* spp., *Uvigerina juncea,* and *Valvulineria inflata.* A well developed oxygen minimum layer intersects the upper and middle slope areas between depths of 150 and 1,500 m with the core of this feature commonly found at depths of 200 to 600 m. Upper bathyal biofacies (150 to 500 m) reflect this association and include high relative and absolute abundances of *Bolivina interjuncta, B. rankini, B. seminuda, Buliminella exilis tenuata, Martinotiella communis, Suggrunda eckisi,* and *Trifarina carinata.* Middle slope faunas are influenced by the deeper portions of the oxygen minimum, the base of the permanent thermocline, and the presence of Pacific deep water. Middle bathyal biofacies (500 to 2,000 m) include *Bulimina striata mexicana, B. rostrata, Cassidulina cushmani, Cibicides mckannai, Uvigerina peregrina dirupta,* and *U. hispida.* A lower-slope bathyal biofacies (2,000 to 4,000 m) includes *Gyroidina neosoldani, Melonis pompilioides,* and *Uvigerina senticosa.* Increasing relative and absolute abundances of agglutinated species between 3,000 and 4,000 m reflect the elevated calcium carbonate lysocline and compensation depth in this region with the abyssal biofacies (>4,000 m) dominated by various species of *Alveolophragmium, Bathysiphon, Cystammina, Glomospira, Reophax, Rhabdammina, Spiroplectammina,* and *Trochammina.* Deviations from these general trends occur in conjunction with substrate anomalies, complex water-mass associations (i.e., double oxygen minima), and in marginal basins where sill depth effectively controls water-mass character, substrate, and biofacies.

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Monterey Rocks Along Santa Barbara Coast, California

Along the Santa Barbara coast, field characteristics of individual Monterey rock vary greatly, relating to two principal factors: silica phase and bulk chemical composition.

In terms of silica phase, field characteristics are most affected by whether silica is dominantly biogenous (opal-A) or diagenetic (either opal-CT or quartz). Diatomaceous rocks differ from compositionally equivalent rocks bearing abundant diagenetic silica in hardness, density, cohesiveness, surface texture, and resistance to erosion. By contrast, opal-CT rocks differ from compositionally equivalent quartz rocks mainly in bulk density, and differentiation between the two groups is usually impractical in the field.

Monterey rocks contain: biogenous or diagenetic silica (5-90%), detrital minerals (5-70%), carbonate rocks (0-80%), apatite (0-30%), and (carbonaceous) organic matter (1-25%). Field characteristics are affected mainly by the silica/detrital ratio. As this ratio decreases among diatomaceous rocks, bulk density and color saturation (darkness) tend to increase. As the ratio de-