trends at the slope–basin floor boundary. For example, population explosions of the oweniid *Myriochele* at the base of the slope suggests opportunism related to substrate instability. Significant macrofaunal populations are supported throughout this environment. Repeated disturbance by mass movements produces a downslope trend toward an infaunal, motile life habit.

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Sedimentary Processes Active on Slopes of California Borderland

The slopes of the California borderland are an important pathway for sediments transported from the mainland shelf, bank tops, and island platforms to the adjacent basin floor. Sedimentologic conditions on the slope are governed by a complex interplay of depositional and mass movement processes which are controlled by driving forces and stabilizing factors. Driving forces are predominantly external to the sediment mass and include oceanographic, biologic, and tectonic factors. Sedimentologic and geotechnical properties of sediments, as well as certain environmental parameters such as declivity, may provide a stabilizing influence to the sediments. These same factors, however, may be an influence in decreasing the stability and enhancing the influence of the driving mechanisms. Declivity, an environmental property commonly considered a major factor controlling failure, is less important than either proximity to active sediment sources or the influence of external driving forces.

We have conducted field studies at different scales of examination including high resolution acoustic profiling, sediment sampling, bottom photography, and observations from manned submersibles. These data show that failures themselves are greatly varied in scale, ranging from large features kilometers on a side and approximately 50 m thick, through smaller scale failures tens to hundreds of meters on a side, and about 1 m thick, to very small displacements composed of locally contorted and deformed sediment layers only a few centimeters thick.

We regard these small displacements as being more important in the basin filling process than has been previously recognized. In a detailed study of an acoustically defined failure zone on the mainland slope off San Mateo Point, we observed the zone itself to be composed of numerous narrow slumps. Cores from these deposits contain combinations of hemipelagic sediments and small-scale mass flow deposits exhibiting internal plastic deformation and basal scour. Vertical stacking of these sediment packets show that small-scale displacements can occur repeatedly at a given locality. Continued, episodic loading of the sediments through time produces locally inhomogeneous, weakened sediment masses which, in conjunction with driving forces, may contribute to the generation of large-scale failures. Such large-scale features are those commonly identified by conventional acoustic techniques.

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Intermargin of Southern California Borderland—Quaternary Tectonics, Seismic Stratigraphy, Sedimentation, and Evolution

No abstract.

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Petroleum Potential of Great Basin

The discovery in 1976 of Trap Spring oil field in Railroad Valley, Nevada, and the 1979 discovery of West Rozel oil field in the Great Salt Lake, Utah, have focused attention on the Great Basin. To date, five fields have been discovered which include, in addition to the mentioned fields, the Rozel Point (circa 1904), Eagle Springs (1954), and Currant oil fields (1978). All fields produce from either Tertiary lake sediments or fractured volcanic rocks. Accumulations occur in truncation-fault traps or in drape-over faulted structure.

Exploration for Tertiary hydrocarbon accumulations consists of (1) mapping basin source rocks with proper depth for maturity, (2) presence of good reservoir rocks, and (3) delineation of traps by photogeologic-geomorphic techniques, gravity surveys, and seismic shooting.

Wells drilled in many basins have recorded good shows of oil and gas both in Tertiary and Paleozoic rocks. Other oil and gas indications include the Bruffey oil and gas seeps (Pine Valley, Nevada), the Wells oil seep (west of Wells, Nevada), an asphaltite dike in Mississippian rock in the Pinon Range east of Pine Valley, and the West Brigham City and Farmington gas area (Carson Sink, Nevada). Oil source units include the various Cretaceous to Tertiary lake deposits (Sheep Pass Formation, Elko shale, Kinsey Canyon formation, Newark Canyon Formation, and King Lear Formation), Mississippian Chainman Shale, Devonian Pilot Shale, and Ordovician Vinnini shale.

In addition to Tertiary prospects, some Paleozoic plays exist, which include the Mississippian Diamond Peak (Illipah, Scotty Wash) sandstone facies change to the east into the Chainman Shale, occurring in central Nevada east of the Antler orogeny. Structural prospects exist in the Basin and Range province, with potential Paleozoic reservoirs. In addition, reef prospects may be present in the Silurian and Devonian of Nevada. Continued exploration for both Tertiary and Paleozoic prospects should result in significant discoveries of oil and gas.

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Sedimentologic History and Characteristics of Continental Margin Basins—California Borderland

Sediments are delivered to continental margin basins via several paths. Major process types are mass movement, turbidity currents, discrete particle settling, and nepheloid flow. Some are episodic, others are continuous, and all vary in rate and magnitude depending on distance from source, variations in climate and oceanographic conditions, relief of source terranes, and trapping or storage within the basin systems which are commonly 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