assemblages define depth zones. A seventh faunal assemblage occurs within two sublittoral depth zones where it is restricted to shelly, gravelly mud on submarine banks of truncated Pleistocene rocks. The study is based on 112 stained samples from stations between 15 and 1,350 m depths along transect lines across the shelf and slope between Cape Yakataga and Yakutat, and from within Yakutat Sea Valley and Yakutat Bay. Where data are adequate for depth zonation on live populations, zones determined on live and live-plus-dead populations are approximately the same.

The Yakataga-Yakutat area shelf and slope foraminiferal depth-zonation assemblages correspond in depth to depth-zonation assemblages from other areas of the northeast Pacific margin; the only marked difference is the deeper limit of the inner and middle sublittoral zone transition at 40-50 m, approximating the limit of inner-shelf sandy substrates. This depth limit is the same as that off Washington-Oregon and is significantly deeper than off southern California, reflecting the deeper reach of winter storm waves in the higher latitudes in the northeast Pacific.

Yakutat Sea Valley, a glaciated trough with a floor 100 to 150 m below the shelf, arcs across the shelf toward the mouth of Yakutat Bay. Yakutat Sea Valley is inhabited by outer sublittoral and upper bathyal benthic assemblages associated with abundant planktons. The distribution pattern of the assemblages is related more importantly to factors that vary with depth than to factors that vary with distance from shore or substrate type.

Yakutat Bay is a deep glacial bay with a sill depth of 75 m. The Yakutat Bay fauna developed between depths of 55 and 260 m resembles the open shelf fauna from between 50 and 75 m, suggesting that foraminiferal distribution in the bay is controlled by sill depth.

There are some notable differences in species distribution patterns between faunas in the Gulf of Alaska and those farther south in the northeast Pacific. For example, in the Gulf of Alaska, *Epistominella pacifica* is an outer sublittoral to bathyal species instead of being exclusively bathyal, and *Uvigerina peregrina* remains costate instead of changing to hispido-costate with increasing depth in the bathyal zone.

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Member Sands of Winters Formation

Six member sands are defined for the Winters Formation in the subsurface of the Sacramento Valley of California. Relations between these member sands and the S-5 member of the Starkey sands provide the basis for reconstruction of geologic events and basin geometry.

Two subbasins are recognized. Deposition of the Winters sands was concentrated in the northern subbasin where a more complete reconstruction of events is possible, though the largest gas field producing from the Winters sand is at Union Island in the southern subbasin.

The lower sands (Staten Island and Walnut Grove members) are inner bathyal deposits and part of an oblique tangential depositional pattern. These lower members are overlain unconformably by the S-5 member of the Starkey sands.

Due to partial filling of the basin, depositional conditions changed and subsequent sands (Putah Sink, Mound, and Unit members) are recognized as the deeper water facies of the S-5 member of the Starkey sands with an intervening area of shale representing deposition along the gentle prograding slope. For the uppermost part (McCune member), the basin filling had progressed to where there was no intervening shale between the Winters sand facies and the S-5 Starkey sand facies. The prograding slope can no longer be identified and the dividing line between the two sands is poorly defined.

Distributary channels served as conduits feeding sand into the central part of the basin where the Winters sands were deposited. For the lower members, stratigraphic trends associated with these distributary channels are favored areas for gas accumulation. For the higher members, gas accumulation is controlled primarily by faulting.

Discoveries to date total about 750 million Mcf recoverable reserves of which 400 million Mcf is estimated to be in the Union Island gas field. Future discoveries are anticipated in traps similar to those associated with existing discoveries.

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Mass Movement Effects on a Bathyal Macrofaunal Population, California Borderland

The benthic macrofauna of Santa Cruz basin, a dysaerobic bathyal basin in the California borderland, is subject to frequent substrate disturbances that erode the muddy surficial deposits, bury more deeply burrowing infauna, and transport shallow-water fauna to deeper environments. The effects on infaunal distributions have been examined through trophic-group and life-habit analyses.

X-ray radiography and textural distributions of surficial sediments recovered at 211 box-core stations are complemented by acoustic profiling records. These data indicate that the basin is presently filling by both hemipelagic sedimentation and gravity-induced mass movements. Failures are frequent, and many dislocations involve the uppermost 1 cm of the sediment pile.

A single ridge-crest to basin-floor transect of 10 stations has been quantitatively analyzed for macrofauna (>0.5 mm). Species richness, density, and standing crop decrease from the ridge crest across the slope and fluctuate on the basin floor proper. Polychaetous annelids dominate the benthic macrofauna; crustaceans are second in abundance on the slopes, and mollusks are second on the basin floor.

The sand-and-gravel covered crest is equally partitioned by epifaunal suspension feeders and surface-deposit feeders. In comparison, the silty slope is dominated by infaunal, surface, and subsurface deposit feeders. Upper slope populations are evenly divided among sessile and motile species; motile species become more common toward the base of the slope. The basin floor is dominated by motile, infaunal surface-deposit feeders.

Substrate instability produces confused and patchy

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 com-