Seismic records show that the Holocene clayey silt, which is common on much of the shelf, is thin or absent on Pamplona Ridge and in the outer part of Bering Trough. Samples from these areas, in water depths ranging from 163 to 315 m, have abundances of *E. clavatum* of 10% or more, and *Buccella* is present. This fauna may indicate deposition at shallower depths during a Pleistocene lower stand of sea level.

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Depositional Environments Within High-Energy Tidally Dominated Embayments Along Pacific Margin, United States

Geophysical and sedimentological studies within lower Cook Inlet, Alaska, have revealed acoustic facies relations and sedimentologic depositional environments typical of large, tidally dominated estuarine systems along the Pacific margin of the United States. Since 1976, detailed high resolution seismic and sidescan sonar surveys, bottom underwater television, and bottom photography, together with sediment sampling, in lower Cook Inlet, have delineated six major depositional environments: high-energy tidal flat; trough-edge platform; trough slope; tidal trough (channel); channel-mouth plateau; and seaward progradational ramp. Within these environments are found lithofacies ranging from sand patches, sand ribbons, and mixed cobble-sand "hard bottom" to sand-wave bodies of both large- and small-scale and to sand-wave and shell-lag complexes. These facies appear to be primarily controlled by the modern hydrodynamic regime and the availability of sediment within lower Cook Inlet.

In lower Cook Inlet at present, sands and gravels are being deposited while older glacial sediments are being winnowed. Marine transgression since glaciation has resulted in a more energetic tidal environment in the present than existed in the past. Geophysical (evidence shows that deposition has occurred over a preexisting glacial topography consisting of an irregular surface cut by numerous shallow channels. In other areas, banks of till lightly covered by recent sediments appear to nearly crop out on the seafloor. Throughout lower Cook Inlet, however, modern sediments average approximately 30 to 40 m in thickness.

Four primary acoustic depositional facies are recognized in the shallow subsurface sediments. The upper two acoustic facies can be correlated with the modern lithofacies within lower Cook Inlet. Facies A, considered to represent unsorted tills, overlies the eroded glacial surface and is up to 75 m thick. It has a characteristically nearly transparent acoustic appearance on high resolution geophysical records. Overlying Facies A is Facies B which is characterized by a strong acoustic reflection. This facies is very thin and is thought to represent glacially derived outwash gravels and cobbles. Facies C overlies Facies B and it is acoustically identified by its pattern of multiple horizontal reflectors which is thought to represent a succession of alternating layers of silt and sand. Facies C is considered to have been deposited when lower Cook Inlet was a quiet bay. The uppermost acoustic facies, Facies D, appears limited to trough, plateau, or ramp environments and is composed of large-scale sand-wave complexes. Modern analogous sand-wave complexes can be presently found in parts of lower Cook Inlet.

Willipa Bay, Oregon, and San Francisco Bay, California, exhibit modern sediment facies which are similar in some ways to those described for lower Cook Inlet. Comparison of these Pacific margin embayments in terms of hydrodynamics, sediments, constructional history, and topography has led to a general facies model for high-energy tidally dominated estuarine systems.

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Foraminifera of Sangamon(?) Estuary, Central San Francisco Bay

Up to 30 m of muds deposited in a Sangamon(?) estuary are found in boreholes drilled for the proposed Southern Crossing of central San Francisco Bay. Microfossils and plant fragments in the core samples represent deposits of shallow estuarine and deeper marine environments.

The most abundant species is *Elphidium excavatum* (including its variants *E. selseyense, E. lidoense*, and *E. clavatum*). It occurs with *Elphidiella hannai* to comprise over 70% of the total population in all samples. *Bucella frigida, Elphidium gunteri*, and *Ammonia beccari* comprise at least 15-25% of the taxa in many samples. All other species occur with frequencies of less than 2%.

Two associations are defined: (a) one in which *E. excavatum* comprises over 50% of the total population, and *A. beccari* and *E. gunteri* are also abundant; and (b) one in which *E. excavatum* is common but less abundant, and *Elphidiella hannai* and *B. frigida* are also common. The *Elphidium excavatum* association is found in the lower samples in each core, the *Elphidiella hannai* association in the upper samples.

In the present bay, *E. hannai* is most abundant at depths greater than about 12 m, whereas *Elphidium excavatum* and associated species are the most common species at shallower depths, which suggests that the Sangamon(?) estuary was of moderate depth and gradually became deeper. The presence of *B. frigida*, a species not found in the present bay but common in inner netritic environments of the West Coast, suggests that the later Sangamon(?) bay may have had a more open-marine aspect. Foraminifera common to shallow-bay environments are apparently not preserved in the cores.

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Geological Assessment of Petroleum Potential of Tertiary Basin, Western Oregon and Washington

Recent drilling and the subsequent discovery of gas near Mist, Oregon, have stirred new interest in the large Tertiary basin of western Oregon and Washington. Developments in the understanding of the regional tectonic framework of the western North America continental margin over the last 10 years has clarified some aspects of the geology of this area. Our new-found insight into the mobile nature of the crust provides little new indication, however, of the possible volumes of hydrocarbons in the basin.

Our current work in the area indicates little that is dramatically new or different from other evaluations of this basin, and limitations due to vegetative cover, volcanic rocks, and scarce subsurface control still handicap any appraisal.

Potential structural traps and many potentially good reservoir intervals are present. The upper Eocene section contains abundant coal, which provides a potential source for dry gas, either by bacterial or thermal generation. A good source for oil, however, has not been documented. Some fine-grained units within the Oligocene and Miocene section do indicate areas of abundant organic productivity and some approach to the conditions necessary to generate at least 2 to 3 gallons of oil per ton of rock. Also, analogy with the Eocene-Oligocene section of the Gulf of Alaska suggests that a Poul Creek-type oil shale could well exist in this basin, with perhaps 100 to 300 million bbl of undiscovered reserves a reasonable, although highly speculative, forecast. Assuming that a kerogen-rich, potential oil source rock is present, it remains difficult to document areas where burial depths in this relatively low heat-flow basin have been sufficient for thermal maturation, especially for rocks younger than Eocene. We have little doubt, however, that areas of sufficient burial depth do exist and hope to document that in our current work.

The abundant shows of gas in wells, including Mist, and active seeps, over the entire basin, and a corresponding scarcity of significant oil shows, active seeps, tar deposits, or kerogen-rich shales, suggest that coal-derived gas may well be the primary hydrocarbon resource. Based on a thermal maturation model and the potential volumes of coal buried below about 15,000 ft (4,572 m), this resource could total a trillion cubic ft of gas. Low temperature, bacterial generation of methane from the low-rank coals could double that total, although the probability of retaining this gas within the system is less than for the thermally derived gas.

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Yowlumne Oil Field

No abstract.

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Sandstone Compositions Related to Plate Tectonic Settings

Sandstone compositions are a function of provenance and depositional basin and both of these are determined by plate tectonics. Modal analyses of major framework grain types—quartz, polycrystalline quartz, potassium feldspar, plagioclase, volcanic lithic grains, and sedimentary lithic grains—plotted on a series of four triangular diagrams can be used to distinguish between the main provenance types.

Quartz-rich sands come from cratonal sources and are deposited in basins on the craton and at quiet continental margins (miogeoclines and opening ocean basins). Arkosic sands are shed from uplifted blocks on continental basement into rift troughs and wrench basins associated with transform faults. Volcanic lithic sands have volcanic arc provenances and are deposited in trenches, forearc basins, and marginal seas. Undissected arcs produce very lithic-rich sand; more mature and eroded arcs produce a mixture of volcanic lithic and plutonic (mainly quartz and feldspar) detritus. Sands rich in quartz or chert plus sedimentary lithic grains come from subduction complexes, collision orogenic belts, and foreland uplifts and are deposited in closing ocean basins, successor basins, and foreland basins.

Data from both modern sands and ancient sandstones of known tectonic settings fit the above picture; influence of climate and diagenesis on sand composition must be less important than that of tectonic setting. Hence knowing the detrital modes of sandstones provides a way of determining the original tectonic setting of the rocks, and framework grain composition of sands can be predicted from their tectonic setting.

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Diagenetic Reactions in Monterey Formation, Pismo Syncline, California

The diagenesis of the Miocene Monterey Formation in the Pismo syncline can be described in five phases: (1) silica, (2) carbonate, (3) clay, (4) organics, and (5) seawater. During progressive diagenesis resulting from increasing temperatures due to burial, the reactions that characterize the four solid phases in contact with seawater are: (1) opal A $\rightarrow$ opal CT $\rightarrow$ quartz; (2) $2\ CaCO_3 + Mg^{++} \rightarrow MgCa(CO_3)_2 + Ca^{++}$; (3) Mg^{++} + Na-clay $\rightarrow 2\ Na^+$ + Mg-clay, and $2\ NH_4^+$ + Mg-clay $\rightarrow Mg^{++} + 2\ NH_4$-clay; and (4) $C_nH_{2n+1}COOH \rightarrow C_nH_{2n+2} + CO_2$, and $C_nH_{2n+2} \rightarrow \times\ CH_4 + 2C_{(n-x/2)}H_{n-x+2}$.

These reactions are not independent of one another, for example the opal A $\rightarrow$ opal CT $\rightarrow$ quartz reaction sequence is not strictly a function of temperature. In addition to temperature this reaction also appears to be influenced by at least the chemical potential of Mg^{++}. Thus, the reaction sequence is highly sensitive to the presence of other phases that compete for Mg^{++}.

Isotopic data suggest that most of the dolomitization of $CaCO_3$ occurs in the presence of light CO_2($\delta^{13}C = -13$ to -17). The light CO_2 is probably a result of decarboxylation reactions. The source of Mg^{++} during dolomitization appears to be concentrated subsurface fluids (seawater), with the rate controlling mechanism being dilution. The dilution in turn is a function of the opal A $\rightarrow$ opal CT $\rightarrow$ quartz reactions and the accompanying dewatering.

During early diagenesis the organics underwent both fermentation and sulphate reduction, but the most significant organic reactions were decarboxylation and cracking. The decarboxylation reactions appear to have been pervasive, whereas the cracking reactions have been documented only deep in the center of the syncline (>6,500 ft).

The clays, mainly smectites, were probably subjected to early cation exchange reactions and may have affect-