and litharenite (13%). Modal analyses of 41 thin sections show that framework grains consist of quartz (80%), rock fragments (15%), feldspar (5%), and trace amounts of micas and heavy minerals. Porosity of Chita Sandstone units ranges from 0 to 35%; mean percent of cement (mostly chalcedony, cristobalite, and opal) is 12.8%.

The Catahoula Formation is unique in that it records the last significant influx of volcanic detritus supplied to Gulf Coast sediments. Volcanic contributions include (1) abundant volcanic quartz (22% of total quartz); (2) rock fragments consisting mostly of silicic shards, felsite clasts, and tuffaceous clay clasts; (3) fresh sanidine (sanidine/orthoclase ratio = 1.2); and (4) a heavy mineral suite dominated by euhedral, elongated zircons. Onalaska Clay consists of mudstone and clay-ball lithoarenite beds composed mostly of montmorillonite, volcanic ash, and quartz silt. Volcanic ash in the Onalaska Clay is a likely source of most of the uranium mineralization in contiguous sandstone units. Silica leached from volcanic ash in the Onalaska Clay has been redeposited as pore-filling sequences of chalcedony (length slow and length fast), cristobalite, and opal cement in Chita Sandstone units.

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Creation and Application of Variable Density Grids to Oil Exploration Data

A significant problem in automatic interpolation procedures is that of honoring data points exactly. When maps of subsurface structures are made by computer, contours can pass on the wrong side of well data points or, where the well log depth is the same as the contour, not pass through them. They will be misplaced a varying amount depending on the grid size employed during interpolation. Honoring the data points can be guaranteed only if the rectangular or triangular grid base has as some proportion of its nodes the wells themselves. Therefore, the concept of a variable size grid is introduced using either rectangles or triangles, with the cell size decreasing in areas of closely clustered boreholes. By using locally defined functions it is possible to maintain a continuous surface over the whole map area and create a faithful representation of the structures in the map. FELIX, a minicomputer mapping and analysis system, is one system used to interpolate the subsurface structure of an oil field where the wells are distributed unevenly over the test area. In the triangular case in this system, it seems likely that little time need be spent searching for optimal triangular networks and a relatively simple algorithm is substituted.

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Paleoecologic Evaluation of Late Eocene Zonations of West Coast

Investigations of the late Eocene benthic forams along the West Coast indicate that the current zonal schemes can be modified to accommodate the constraints imposed on the organisms by ecologic conditions and thus become less provincial. The benthic foraminiferal assemblages of northwestern Oregon and southwestern Washington are used to develop a series of ecologic facies indicative of bathymetry and/or water mass. Upper depth limits, trends, clines, and morphologic variations of this group provide tools for determining ecology. The faunas of the type sections of the California and Washington stages, zones, and subzones, when analyzed in terms of this ecologic model illustrate some of the deficiencies inherent in these schemes. The late Eocene zones of California have a strong association with depth; that is, Narizian zones are lower or middle bathyal whereas Refugian zones are outer neritic or upper bathyal. The late Eocene zones of Washington are diagnostic of middle bathyal depths with considerable transport; as a result partial rather than total ranges are used in the development of these zones.

Although no new zones are proposed, it is possible to revise the existing zones to recognize the total ranges and bathymetric or other ecologic controls. The late Narizian Stage encompasses a bathyal and neritic facies. The bathyal facies is correlative with a modified *Bulimina corrugata* Zone of California and the *Uvigerina* cf. *U. yazooensis* Zone of Washington. The neritic late Narizian facies corresponds to a modified *Bulimina schencki–Plectofrondicularia* cf. *P. jenkinsi* Zone of Washington and a modified *Amphimorphina jenkinsi* Zone of California. The Refugian Stage can also be divided into a neritic and bathyal facies. However, the early and late subdivision of this stage is weak. The Refugian is equivalent to the modified versions of the *Cibicides haydoni* Subzone, *Uvigerina atwilli* Subzone, and the *Uvigerina vicksburgensis* Zone of California and a modified *Sigmomorphina schencki* Zone of Washington. The *Cibicides haydoni* Subzone is the neritic facies of the Refugian whereas the faunas of the *Uvigerina atwilli* Subzone, *Uvigerina vicksburgensis* Zone, and *Sigmomorphina schencki* Zone represent the bathyal Refugian facies.

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Computer Drafting—Its Application in Petroleum Exploration

Conventional or manual drafting of exploration data has been used since the early 1900s. Within the past 4 or 5 years, the use of small computer and digitizing equipment to supplement proved methods has saved time, improved accuracy, and simplified modifications.

Maps, charts, cross sections, etc, can be captured, edited, and drawn by plotters in half the time of conventional methods. Once in digital form, documents can be edited and easily combined with other graphics. Maps with different scales and projections can be transformed to common projections and scales.

Phillips Petroleum Co. uses a Bendix 100/101 digitizing-drafting system which consists of a Nova 100 computer with tape drive and disk pack, a Bendix cursor and table, and a Tektronix 4014-1 CRT. Output can be generated for both a Calcomp 748 plotter and/or a Versatec 42-in. electrostatic plotter. This type of system is not a replacement for manual drafting, but is a supple-