to the clay platelets and as replacement ions in the lattice of carbonate minerals. Samples obtained from near the mouth of the bay contained a greater amount of shell material, and, therefore, the barium contents were expectedly higher.

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Composition and Diagenesis of Upper Cretaceous San Miguel Sandstone, Northern Webb County, Texas

In northern Webb County, Texas, the Upper Cretaceous San Miguel Formation of the Maverick basin contains sandstones that range in composition from feldspathic litharenites to lithic arkoses. Data include petrographic analysis of sidewall cores from two wells and cuttings from two additional wells. Volcanic rock fragments represent the predominant lithic constituents and consist of trachytic keratophyres. Plagioclase phenocrysts occur in a trachytic groundmass of albite-oligoclase laths and microlites.

Known Late Cretaceous volcanics, which have been reported from eruption centers to the north and northwest, consist of labradorite-olivine-basalt, nephelite-melilite "basalts," phonolite, nephelinite, and serpentinized basalts. This assemblage suggests that the keratophyric grains were derived from a different volcanic province. The most likely potential source areas for these keratophyric volcanic centers existed to the west or southwest, probably in Mexico. No Late Cretaceous keratophyric volcanics have been reported within this area. Perhaps such eruption centers did exist in Mexico and subsequently were buried or obscured by Cenozoic volcanic centers.

Sandstones from the superjacent Olmos Formation, in the same area, contain only 5 to 10% keratophyric rock fragments. This small percentage suggests that the keratophyric volcanic center had become dormant or extinct by the end of San Miguel "time," and the eroded volcanic centers were shedding much less debris during Olmos "time."

Major porosity-occluding cements in the San Miguel are chlorite, kaolinite, and ferroan calcite. Much secondary porosity was created by partial to complete solution of plagioclase and volcanic rock grains. In many intervals large primary and secondary voids are lined by chlorite and filled by kaolinite.

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Jurassic Petroleum Geology of Southwestern Clarke County, Mississippi

Electric logs from wells in southwestern Clarke County, Mississippi, illustrate the structural and stratigraphic relations which affect hydrocarbon production. The fields studied (West Nancy, Nancy, East Nancy, Prairie Branch, and Lake Utopia) are coincident with salt-cored structures and are aligned from northwest to southeast, parallel with the updip limit of the salt. Production depths increase basinward and southwesterly. The fields produce from primary porosity in oolitic grainstones of the upper Smackover Formation. Prairie Branch and East Nancy also produce from siliciclastic sands of the underlying Norphlet Formation, whereas West Nancy has additional production from oolitic grainstones of the overlying Buckner Member of the Haynesville Formation.

The general depositional sequence that controlled hydrocarbon accumulations is: deposition of siliciclastic sands of the Norphlet; accumulation of carbonate muds of the lower Smackover and initiation of salt movement; and formation of offlapping shingles of oolite sands of the upper Smackover on faulted salt-cored structures. Structural movement was complete by the end of Haynesville deposition. Hydrocarbon migration most likely occurred during Haynesville deposition, because most Smackover and Norphlet pay zones coincide with Smackover highs and not with Haynesville structures.

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Gray Sandstones (Jurassic) in Terryville Field, Louisiana—Basinal Deposition and Exploration Model

Deep (~ 13,000 ft, 4,000 m) hydrocarbon production at Terryville field is from various zones within Upper Jurassic siliciclastics that are referred to informally as the "gray sandstone" section. This sequence of interbedded sandstones and shales occurs in the Smackover section or within the lower Bossier shale seaward of the Upper Jurassic shelf edge, and is correlative to and coeval with inner shelf facies deposited north of the field area.

The "Gray" section at Terryville field consists of at least four sandstone bodies separated by black shales and silty to sandy shales. The shales are thinly bedded and harbor a locally abundant ichnocommunity of *Chondrites, Planolites,* and *Scalarituba*; small ammonoids and bivalves are present locally in these beds. Thin layers and lenses of sandstones (lenticular and flaser bedding, partial Bouma sequences) are intercalated with the shales locally, and commonly are heavily bioturbated by *Teichichnus* and *Arenicolites.* The sandstones are fine grained, feldspathic sublitharenites, locally conglomeratic (shale clasts), with rare ooids and comminuted skeletal fragments. The four sandstones in the field area are of stacked, lobate geometry. The lobes consist internally of anastomosing lenses of sandstones and conglomeratic sandstones interbedded with and replaced laterally by shales and sandy shales. The long axes of these lobes and lenses are oriented normal to regional upper Smackover shelf-edge trends. Stacked "megasedimentation packages" are recognized within each sandstone lobe. These packages consist internally of repetitive second-order sedimentation units, including partial Bouma sequences, locally conglomeratic graded beds (normal and reverse), massive textureless beds, and coarse rhythmites. The thickness and internal grain size of these component units have a tendency to decrease systematically upward from the base of and laterally within each megasedimentation package. Stacked packages within and immediately surrounding the depoaxes of each lobe coarsen upward from repetitive units of sandstones to conglomeratic sandstones.

The areal distribution, vertical stratigraphy, geometry, bedform characteristics, and texture of the "Gray" sandstones, and their regional relation to upper Smackover carbonate facies to the north, suggest their formation as progradational submarine-fan complexes deposited in a basinal environment. The sandstones and conglomeratic sandstones are interpreted as braided distributaries and associated facies deposited in upper and midfan environments. At distances from these distributaries, the thinner sandstone packages and the interbedded shales and sandstones represent proximal overbank to midfan deposits. The intervening shales are interpreted as basin plain and distal overbank deposits.

Although trapping at Terryville field is mainly structural, sandstone trends and geometries control reservoir occurrence, and this aspect of stratigraphic entrapment should be expected in future "Gray" sandstone fields in this area. Reservoir permeabilities in the "Gray" sandstones are limited because of the presence of pore-filling chlorite, illite-smectite, and dolomite.

The pore system is almost entirely of secondary origin, having resulted from the partial dissolution of labile framework grains and carbonate cements. The most effective stimulation of these reservoirs appears to be an acid-enhanced hydraulic fracture.

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Lithofacies and Depositional Environments of Middle Ordovician Shelf Carbonates in Southern Appalachians

Detailed field and laboratory observations are the basis for the description of 13 lithofacies in the Middle Ordovician Chickamauga Group in Jefferson County, Alabama. These lithofacies, including stromatolitic, fenestral and bioturbated mudstones, and varieties of skeletal and peloidal wackestones, packstones and grainstones, represent deposition in seven major environments: high intertidal, low intertidal, tidal channel, subtidal wave baffle, subtidal bar, subtidal bank, and subtidal level bottom. Middle Ordovician deposition began on the extremely irregular karstic surface of the Cambro-Ordovician Knox Dolomite. A lag deposit of reworked dolomite and chert clasts (Attalla Member) is overlain by intertidal deposits. High and low intertidal lithologies vary laterally in thickness in response to deposition over highs present on the irregular Knox surface. With continued transgression, shallow-water facies were succeeded by a suite of subtidal deposits composed dominantly of level-bottom lithologies deposited below wave base. Changes in sedimentation and/or subsidence led to a gradual shallowing and deposition above wave base. Coarse-grained, high-energy tidal bars and skeletal bank deposits dominate this part of the sequence. In the southern part of the study area, subtidal level-bottom lithologies dominate the upper part of the Middle Ordovician sequence. To the north, these lithologies grade laterally into shallower subtidal and intertidal lithologies. The sequence is unconformably overlain by the Upper Ordovician Sequatchie Formation.

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Toward a Better Understanding of Gulf Coast Miocene Deep-Water Sediments

Deep-water sands are known from many localities in the lowest Miocene of the Gulf Coast. They are recognized by a combination of paleontologic, conventional core, wireline log, and regional setting criteria. Almost invariably, subsurface geologic interpretations are difficult to make because of correlation problems. Turbidite deposition probably took place in deep-sea fan environments in most cases, but conventional models for these fans are over-simplified for application in studies of the Gulf Coast Miocene. The Miocene outer continental shelf and slope were not characterized by smooth, simple topography, but were extremely irregular, due principally to salt and shale tectonics. Thus the Walker and Mutti and Ricci-Lucchi fan model is inadequate and serves only as a starting point for Miocene studies.

Turbidite sand bodies in this setting can be classified into three major types: major channel deposits, levees, and suprafan lobes. In the Walker model, major incised channels with levees are characteristic of the upper fan, and suprafan lobes in the mid-fan, but in the Miocene they occur together in a complex manner. In the simplest cases we might anticipate that the channels cut through the lobes, resulting in rapid lateral facies change.

Recommended procedure for mapping and interpretation involves preparation of panel diagrams after initial correlations have been made as completely as the data permit. Reduced-scale log segments are pinned on a large-scale base map, channel trends are identified, and the channel sands contoured, to the exclusion of other data. Lobe sand bodies are then contoured as a secondary operation and a composite sand or net sand isopach prepared. Abrupt changes in contour trend will occur where lobe and channel sands meet, and the two stage contouring process will yield much more accurate isopachs, and give a better tool for prediction of sand body extensions.

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Recent Foraminifera Around Petroleum Production Platforms on Southwest Louisiana Shelf

In the spring, summer, and winter of 1978-79, 673 samples were taken from around petroleum production platforms and control sites on the southwest Louisiana continental shelf to assess the effects of long-term petroleum exploration, drilling, and production activity on marine organisms. The 64,326 living Foraminifera recovered represent 51 species and 35 genera.

Standing crops are high (up to 3,294 living Foraminifera per 10 cm^2), because of the large quantities of available food supplied by the Mississippi River, and because a wet picking method was used that preserved juvenile and delicate tests. Species diversity is generally low; two species, *Nonionella basiloba* and *Buliminella bassendorfensis,* account for nearly 76% of the total population. The species composition varies somewhat with season, water depth, and physical conditions.

The statistical analyses show little negative effects of petroleum operations on the benthic Foraminifera of this area. The foraminiferal populations are controlled by the physical parameters of this naturally stressed environment, especially by water depth, temperature and salinity fluctuations, sediment movement, and dissolved oxygen values. Proximity to platforms appears to cause no adverse effects on the organisms.

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Grain Shape Analysis—Application to Problems of Sediment Source and Transport

The shapes of quartz grains contain a valuable record of their source and transport history. Grain shape can be measured with a Fourier series in closed form, which calculates the relative contribution, or amplitude, of 20 separate shape components (harmonics) to the total grain shape. Subsequent analysis of these grain shape data can determine the number of grain shape types (end members) present in a suite of samples and their relative contribution in percentages to each sample; a knowledge of the nature and mixing proportions of end members, contributes to a better understanding of the source, transport history, depositional environment, and stratification of basin fill.

Two studies have been used to illustrate this technique. The first is a study of the Pleistocene sediments of the Hatteras basin, in which grain shape was used to monitor the input of sediments from two sources. The second is a study of the St. Peter Sandstone of Minnesota, in which grain shape was used to map eolian and aqueous beds in three massive, homogeneous sections of the formation.