

that the nepheloid layer rarely rises to depths of 75 m. The 80-m depth contour marks a major boundary between biologic communities. That depth separates the turbid water fauna below from the clear water fauna and flora above.

The east and west Flower Garden Banks serve as modern analogs of Tertiary reefs, such as the Oligocene reef at Damon Mound, Brazoria County, Texas. The sediment facies are similar, even to the muddy *Porites* gravels and *Heterostegina* sands that were deposited under an Oligocene nepheloid layer.

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Foraminiferal Stratigraphy and Paleoecology of Blufftown Formation (Santonian-Campanian) of Georgia and Eastern Alabama

Fifty-two species of Foraminifera belonging to 35 genera are recorded from Georgia and Alabama. Of these, one species and one genus are new. Two distinctive foraminiferal assemblages are recognized: one consists mostly of benthic species (upper and lowermost middle Blufftown); the other contains associated benthic and common planktonic Foraminifera (middle and upper part of middle Blufftown). Some benthic individuals represent the arenaceous families Lituolidae and Ataxophragmoidae, but most belong to the calcareous families Anomaliniidae, Cibicididae, and Nodosariidae.

Absence of foraminiferal assemblages in the lower Blufftown sands indicate a marginal marine environment of deposition. The fossiliferous clayey middle Blufftown represents deposition in a middle neritic environment of a transgressive sea. The silty upper Blufftown member represents a regressive marine deposit. Because of the fluctuating marine conditions, only the more tolerant species could survive so foraminiferal distribution is not uniform throughout the section. The presence of few species but abundant individuals supports this interpretation.

On the basis of the planktonic Foraminifera and diagnostic megafossils, the Blufftown Formation is Santonian to early Campanian in age.

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Diagenesis by Kohout Convection in Carbonate Platform Margins

Kohout convection is a large-scale, long-lived ground-water flow system in the margins of steep-sided active carbonate platforms. It was first postulated to occur in the subsurface of Florida by Francis Kohout in the 1960s. The flow is driven by buoyancy arising from subsurface differences in salinity, temperature, or both. Temperature differences alone drive Kohout convection in isolated platforms. Cold, dense seawater surrounding a platform at depth migrates inward, displacing warmer pore waters at the same elevation. This inflowing density current is, in turn, warmed within the platform and is buoyed upward to discharge on the platform shelf or margin. The result is a giant convective "half-cell" of circulating seawater occupying the platform margin. In carbonate shelves, where regional meteoric ground-water flow may be present, the meteoric water mixes by dispersion with the convecting seawater, resulting in an increase of buoyancy enhancing the flow rate. Kohout convection may be modeled by systems of differential equations governing the fluid flow, heat transfer, and dispersive mass transfer. Approximate analytical and numerical solutions of these equations in the isolated platform setting show the effects of platform margin geometry and subsurface permeability on flow rates and flow patterns of Kohout convection.

Kohout convection may be an important agent of mesogenetic diagenesis because it affects rocks deeply buried in a stratigraphic sense. Porosity may be developed and modified by dissolution by inflowing seawater undersaturated with respect to calcium carbonate phases, by cementation as the seawater warms and rises, and by dolomitization (if possible in these waters), leading to reservoir conditions in platform margins.

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Environments of Sand Deposition, Southwest Louisiana Continental Shelf

A synthesis of approximately 20,000 km of high-resolution seismic profiles, coupled with vibracores and industrial platform borings, shows that various large sand bodies are present in the late Pleistocene and Holocene sediments of the southwest Louisiana continental shelf. Sand-deposition patterns have been largely controlled by glacio-eustatic sea level fluctuations, paleogeomorphology, subsidence, and salt tectonism.

Sand deposits of the area fall into two categories: (1) those associated with sea level lowstands, or regressive deposits, and (2) those associated with rising sea levels, or transgressive deposits. Regressive facies include fluvial and deltaic sands, whereas transgressive sands are largely formed by the reworking of regressive deposits.

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Petrology and Sedimentology of Mississippi Fan Cores, DSDP Leg 96

Pleistocene sediments were cored at nine middle and lower Mississippi fan sites, in water depths from 2,500 to 3,300 m (8,200 to 10,825 ft). Radiography, thin-section, SEM, and XRD studies provided data from which the fan's major depositional environments can be described.

Sands and minor gravels are concentrated in middle and lower fan channel fills, and in lower fan channel-mouth deposits. Silts and clays occur in overbank deposits, passive channel fills, and interbeds associated with coarser facies. Graded bedding of varying thickness is the dominant sedimentary structure in all environments.

Granule and pebble gravels are composed of well-rounded chert and polycrystalline quartz, with minor metamorphic and igneous rock fragments. Moderately to well-sorted sands are mainly fine and very fine feldspathic litharenite, sublitharenite, and subarkose. Sands commonly have thin-section porosities between 20 and 35%; woody organic contents range from 0.7 to 7.9 total organic carbon.

Authigenic minerals occur in sands and muds, but are most abundant in silts and clays. Smectite, illite, dolomite, calcite, pyrite, and gypsum are the main authigenic phases.

At this stage in their depositional history, the sands are clean, have high porosities and permeabilities, show only minor pore-reducing diagenetic effects, and thus have excellent hydrocarbon reservoir potential.

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Effects of Diagenesis on Reservoir Properties and Log Response, Upper Jurassic Taylor Sandstone, Cotton Valley Group

The Taylor Sandstone in Terryville field, Lincoln Parish, Louisiana, is one of many tight gas-bearing sandstones of the Upper Jurassic Schuler Formation, Cotton Valley Group. This coastal strand-plain sandstone is fine to very fine grained, well sorted, with grains that are subrounded to well rounded. It is highly quartzose with an abundance of carbonate cement and lesser concentrations of quartz cement, clay precipitates, and pyrite.

Mechanical compaction has caused a 10% reduction in primary porosity with increasing overburden. Chemical diagenesis has altered the texture and composition of the sandstone and has affected porosity and permeability through cementation, dissolution, and authigenic clay precipitation. Early stages of diagenesis included pyritization, mechanical compaction, and hinderance of compaction by precipitation of quartz cement at grain contacts. The middle stages were dominated by carbonate cementation, which replaced large amounts of detritus and quartz cement and reduced primary porosity to irreducible limits. Finally, the latest stages of diagenesis included development of secondary porosity by localized dissolution of replacive and interstitial carbonate and reduction of porosity by precipitation of pore-lining and pore-filling illite and illite/smectite clays. Poor permeabilities in the sandstone are a direct consequence of incomplete dissolution of carbonate in pore throats and the obstruction of voids by the late clay precipitates.

The conductive property of authigenic pyrite has affected the response of the deep induction resistivity log, consequently causing abnormally high calculated water-saturation values in the Taylor Sandstone. The effect pyrite has on formation resistivity can be clearly seen on R_t - ϕ plots (Pickett method). Formation resistivity is affected even at low percentages of pyrite, and shows an exponential decrease with increasing pyrite concentration. A correction of resistivity was made possible by determin-

ing pyrite concentrations in the laboratory. Furthermore, the R_p - ϕ plot may confirm the presence of pyrite in a sandstone where core samples are not available.

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Pleistocene Meander-Belt Ridge Pattern near Houston, Texas

Meander-belt ridges are the most enduring depositional features of the Pleistocene outcrop near Houston, where those on the Beaumont Formation (seaward from Buffalo Bayou) are evident on most early aerial photographs and soils maps, especially the U.S. Geological Survey 1-ft contour-interval topographic sheets of Galveston and Harris Counties, surveyed in 1915-1926. These show the meander-belt ridges as drainage divides between the modern streams, which developed later on the intervening lowlands (except for upper Mustang Bayou). This systematic transposition of the drainage makes it possible to identify the eroded older ridges farther inland as well as those near the Gulf of Mexico.

In the coastal sector from the Brazos River east to Galveston Bay and the San Jacinto River, the meander-belt ridges deflect eastward from successive fluvial terraces along the Brazos Valley and repeatedly branch downslope to the southeast. They belong to four major systems (one of which consists of three subsystems), within each of which the ridge pattern is internally consistent and distinct from contiguous systems. The major systems are separated by the sector's four longer streams, which head just outside the Brazos Valley and flow nearly east: Cypress Creek is the simplest example, and Buffalo Bayou the most complex. These streams flow almost parallel with the nearest meander-belt ridges on their south sides, whereas the ridges from the north approach at much higher angles and are cut off abruptly by the stream. Each such stream evidently formed along the landward edge of an eastward-prograding increment of coastal plain, where it gathered the blocked drainage off the older plain to the north. As a result, these streams closely follow the unconformable contacts between successive coastal-plain increments, and so mark the approximate landward edges of a succession of distinct unconformity-bounded sequences of strata, each of which is expressed at the surface by its meander-belt ridge system.

Substantially greater ages of the sequences farther inland are indicated by successive increases in the average slope of the ground and amount of erosion and weathering and, for the Beaumont units, by contrasting directional rates of meander-belt slope and quality of channel preservation. However, the boundaries of these formations as shown on the *Geologic Atlas of Texas* maps are not closely related to the corresponding eastward-flowing streams that fairly well define the stratigraphic sequences. Also, immediately west of the Brazos River and along the San Jacinto River some of the equivalent ridge systems are elongated in the dip direction, which makes the larger regional outcrop pattern much more complex than that described between these rivers.

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Regional Organic Geochemistry of Offshore Louisiana

Geochemical analyses of well cuttings from offshore Louisiana reveal trends in organic matter characteristics that mimic thermal alteration effects, but are in fact related to depositional environments. Sediments deposited on the continental slope contain organic matter that is considerably higher in hydrogen content than organic matter from adjacent environments. These chemical variations are reflected in headspace composition of canned cuttings. Slope sediments, at or near the top of the oil window over a widespread area, are commonly encountered near the base of the penetrated section, leaving the greater part of the principal zone of oil generation unsampled. Active petroleum generation must occur deeper than 8,000-15,000 ft, depending on local geothermal gradient. Model calculations of thermal maturity, used in conjunction with burial history analysis, are consistent with our empirical observations of the maturation of organic matter based on vitrinite reflectance and geothermal gradient.

In the absence of direct evidence from the source beds of Gulf of Mexico oils, detailed biomarker analysis can provide information on the nature and thermal history of the organic matter from which the oils were

generated. Thermal maturity of the oils increases from west to east, indicating that source beds of eastern oils are older than those of western oils. Oils produced from the eastern offshore region were probably generated from early to middle Miocene sediments. The depocenter was located to the northwest, and deposition of oil-generating sediments enriched in marine organic matter occurred in deep water. Oils produced from the western offshore region were probably generated from Pliocene sediments. The depocenter was located close to where the oils are found today; hence, the oils are enriched in components derived from land plants deposited in oxygenated sediments. Oils produced from two locations close to the present-day shelf edge are significantly different from the other offshore oils. These were probably generated from middle to late Miocene sediments deposited in anoxic basins with high bacterial input.

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Thermal Regimes of Balcones-Ouachita Trend, Central Texas

Local ground-water temperatures and bottom-hole temperatures for oil and gas wells present two lines of evidence indicating regional high geothermal anomalies along the Balcones-Ouachita trend in central Texas. Analysis of the variables in the heat-flow equation, however, indicates that these anomalies are probably not due to conductive heat flow; most of the rock units for which data exist are limestones and sandstones, and thus, should have high thermal conductivities and low geothermal gradients. Measurements of heat flow are few along this trend, but because the strata for which bottom-hole temperature data exist generally contain fluids, it is reasonable to assume that hydrodynamics also is a factor in creating these apparent thermal anomalies. In short, Darcy's law, not the heat-flow equation, may control thermal conditions: rocks having high thermal conductivities generally also have high hydraulic conductivities, so upwelling warm waters may account for the observed thermal anomalies. Since upwelling waters also may be important conveyors of hydrocarbons, these geothermal and/or hydrodynamic anomalies also indicate promising areas for petroleum exploration.

Detailed investigations, however, demonstrate that these regional anomalies have high-frequency perturbations; local areas within a regional high may have anomalously low temperatures. Local faulting not discernible on a regional scale may control detailed hydrodynamic conditions, and in effect, these faults may form structural traps for hydrothermal fluids as well as for hydrocarbons. However, they can also localize downwelling recharging waters that impart a low thermal anomaly. Clearly, a radius of influence exists within which any well "senses" the ambient thermal regime. Within a fault zone, this radius is probably small, dictated by detailed stratigraphic dislocations. Although complex perturbations affect the prevailing thermal regime in ways not yet completely understood, some of these geothermal anomalies indicate general loci of long-term upwelling from deep within the Gulf Coast basin. Studied in detail, thermal anomalies may prove to be indicators of economic geothermal resources. They also may indicate hydrodynamic traps, in which warm waters might have filtered through a trap zone during the process of petroleum accumulation. In this way, these thermal anomalies may point toward hydrocarbons in a downstructure direction.

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Evidence for Large-Scale Vertical Migration of Dissolved Fatty Acids in Louisiana Oil Field Brines: Iberia Field, South-Central Louisiana

Interest in the origin and distribution of dissolved volatile fatty acids (VFAs) in oil field brines has developed as a result of the recognition of the role these compounds may play: (1) in subsurface acid attack and porosity enhancement, (2) as precursors of natural gas, and (3) as possible proximity indicators of hydrocarbon accumulations. The detailed study of the distribution of dissolved VFAs on a field scale provides useful information on processes of generation, transport, and degradation of these compounds.

At Iberia oil field, in the Tertiary section of south-central Louisiana, spatial variations in pore-water compositions and temperatures indicate the presence of an ongoing, dynamic, subsurface circulation system.