landward margin of a broad shallow lagoon formed behind the Glen Rose reef. About 60% of the sedimentary volume consists of mudstone, silt, and sand, with brackish-water to hypersaline ostracod faunas believed to result from influx of flood waters from the Ouachita highlands a few miles to the north. The lower part of the formation contains discontinuous beds of gypsum, ranging in thickness from a few centimeters to composite beds > 3 m (10 ft), and displaying mosaic structure with vertically oriented, elongate nodules. These beds, which are lenticular, are interpreted to result from subaqueous precipitation of vertical selenite crystals (subsequently recrystallized) in discrete ponds and pools on microtidal-range mud flats. Intrastratal growth of gypsum nodules and displacive halite occurred at the margins of the pools.

The upper part of the formation contains no gypsum beds, but halite pseudomorphs at the base of and within some of the thin limestones suggest the presence of supratidal brine pools. Several minor unconformities exist, of which one has a regional extent and is underlain by red-brown mudstones. Algal-mat lamination, lenticular gypsum pseudomorphs (an intrastratal growth form), and syneresis cracks occur in the limestones, and a supratidal environment is envisaged for a significant proportion of the time of deposition.

The limestones generally have a restricted fauna of ostracods, bivalves, cerithid gastropods, serpulid worms, and miliolid Foraminifera, and range in texture from lime mudstones to grainstones. The most abundant grain types are pellets, superficial ooliths, and terrigenous quartz. A paucity of dolomite is a striking feature. Some of the thinner bedded units are rippled, and some ripples were truncated during periods of emergence. The limestones are believed to represent periods of shallow water, slightly hypersaline to slightly hyposaline conditions of variable energy. The regressive trend displayed by these two divisions continued with deposition of the overlying formation. The uppermost 3 m (10 ft) of the DeQueen consists of mudstone with a thin marl at the top. A conformable contact exists with the overlying Antlers formation, which has basal mudstones becoming more silt- and sand-rich upwards and finally giving way to the typical Antlers (Paluxy) sands.

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Depositional Setting and Characterization of Deep-Basin Oak Hill Lignite Deposit (Middle Paleocene) of Southwest Alabama

In southwest Alabama, deep-basin lignite with economic potential occurs in the Oak Hill Member of the Naheola Formation. This middle Paleocene lignite is the thickest (2 to 11 ft, 0.6 to 3.3 m) and most extensive lignite in the southwest Alabama region. The Oak Hill lignite deposit accumulated in lower delta plain coastal marshes located in interchannel areas behind of a barrier system. The source area for the deltaic sediments was probably to the west and/or northwest of Choctaw County, Alabama. The lignite occurs in a clay-dominated sequence. Oak Hill interdistributary bay ripple-laminated clays are interbedded with ripple-laminated, crevasse splay sands generally < 15 ft (5 m) in thickness. The glauconitic sands of the overlying Coal Bluff Member of the Naheola Formation represent marine encroachment into the interchannel basin area.

An estimated 8 billion short tons of hypothetical Oak Hill deep-basin lignite may be available in southwest Alabama. The lignite is of good quality and is characterized on an "as determined basis" as having 20 to 27% moisture, 8 to 10% ash, 0.8 to 3.0% sulfur, 0.1 to 1.0% pyritic sulfur, 30 to 39% volatile matter, and 28 to 36% fixed carbon. The calorific value of the lignite is 9,070 to 9,970 Btu/lb and averages 9,530 Btu/lb. Presently, this deep-basin lignite resource is beyond the depth for effective surface mining and, therefore, must be recovered by underground mining or in situ gasification or liquefaction recovery methods.

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Recognition of Sandstone Depositional Environment: A Grain-Shape Approach, With Example from North Padre Island

The shapes of 8,000 fine quartz sand grains from Malaquite Beach, North Padre Island, were analyzed with the Fourier shape technique. It was found with this technique that dune sands can be differentiated easily from beach sands on the basis of both their gross and fine (roundness) shape characteristics.

The analysis of samples from transects across the beach and dunes also reveals a high degree of grain-shape variation within these environments. This variation is due to the effects of hydrodynamic and aerodynamic sorting by swash and wind currents respectively.

The Fourier technique provides a rapid and objective manner to discriminate between beach and dune sands, and can be applied to ancient as well as modern sands with equal facility.

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Hydropressure Tongues Within Regionally Geopressured Lower Tuscaloosa Sandstone, Tuscaloosa Trend, Louisiana

A regional study of the Tuscaloosa Formation in Louisiana, undertaken to assess geopressured-geothermal potential, revealed lobate, downdip extensions of the hydropressured zone in lower Tuscaloosa massive sandstone facies below the regional top of geopressure. Normal pressure zones within geopressured section were identified by drilling-mud weights less than 13 lb/gal on electric logs of massive lower Tuscaloosa sandstone; cross sections demonstrated updip continuity of these zones with the regional hydropressured zone. These hydropressure "tongues" are permitted by the anomalously high permeabilities reported from the deep Tuscaloosa trend, and they are attributed to both primary and secondary porosity by investigators of Tuscaloosa sandstone petrography. The hydropressure tongues correspond with lobes of thick net sandstone, principally in Pointe Coupee, East Feliciana, East Baton Rouge, and Livingston Parishes in the central Tuscaloosa trend. Limited control suggests at least one hydropressure tongue in the Chandeleur Sound area to the east.

Dimensions of hydropressure tongues range up to 27 km (17 mi) parallel to strike and 17 km (11 mi) oblique to strike. In many places, tongues are terminated downdip by faults, which, by acting as pressure seals, prevent the tongues from extending to the downdip edge of the massive sandstone in the expanded sections of the downthrown blocks. The areal extent of geopressured Tuscaloosa sandstone is controlled updip by these fault zones, and downdip by pinch-out of the sandstone units basinward. Local hydropressure tongues diminish the geopressured-geothermal potential of the Tuscaloosa trend, but show no discernible relation to gas-productive areas.

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Unusual Calcite Cementing of Quartz Grains on Chandeleur Island Beach, Offshore Louisiana

A very unusual calcite cement was found in some beachchips from an unconsolidated beach surface of Chandeleur Island offshore approximately 35 nmi (65 km) south of Mississippi in the Gulf of Mexico. The beachchips are irregularly shaped and are well cemented by this unusual calcite. This calcite crystal structure has not been reported previously as existing in a marine environment. A similar cement has been found in freshwater lake beachrock and in some travertine samples. The calcite crystals are elongate parallel to the c-optic axis, and are composed of bunches of crystallite blades. The crystallite blades of each crystal bunch are pointed and are more bladed than freshwater cement crystals. The intercrystallite pore space contains no fine calcite silt as was observed in the lake samples. Fresh water provided by rainfall may be held in the pore spaces and bounded to the quartz-grain surfaces by ionic attraction. Marine spray above and saline water concentrated underneath form a sandwich effect at the micropore level, allowing rapid growth and precipitation of these very unusual calcite crystals in a single-phase low-salinity fluid.

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Regional Patterns of Diagenesis, Porosity Evolution, and Hydrocarbon Production, Upper Smackover of Gulf Rim

The exploration fairway of the Upper Jurassic Smackover, from the Rio Grande to the Panhandle of Florida, consists of a rather simple carbonate ramp depositional system characterized by thick, widespread blanket ooid sands. The ooid sand belt gives way landward to quartzose clastics, and locally to shales and evaporites. The high-energy ooid sand belt changes sharply into dark, fine-grained limestones and shales in a seaward direction. Early salt movement, buried basement structures, and growth faulting locally affected sedimentation patterns within the upper Smackover. Salt anticlines active during Smackover deposition leading to localization of favorable facies are particularly important along the east Texas and south Arkansas parts of the trend. Buried basement structures as well as salt structures controlled detailed sedimentation patterns in the Alabama-Florida parts of the trend, while growth faults controlled sedimentation along a narrow belt straddling the Arkansas-Louisiana border. Initial porosities and permeabilities were, however, generally high across the entire Smackover fairway prior to burial. Presently observed porosity-permeability trends are controlled generally by postdepositional processes including compaction, dissolution, cementation, and dolomitization. Regional differences in burial history along the Gulf rim, related in part to proximity to the isolated interior salt basins (Mississippi, north Louisiana, and east Texas salt basins), have resulted in striking differences in reservoir characteristics across the trend, reflecting significant regional differences in pathways of porosity evolution.

East Texas is a province dominated by dolomitized reservoirs, with production controlled by proximity to major fault trends, such as the Mexia-Talco, or to well-defined salt anticlines. Reservoir quality is tied inextricably to dolomitization. Dolomitization occurred early, associated with a regional fresh meteoric water system, hence reservoir characteristics were generally established prior to significant burial. Fracturing is a general feature of east Texas sequences, and there is evidence that fractures have acted as conduits for hydrocarbon migration. East Texas is generally a gas province, with oil migration occurring relatively early in the burial history of the sequence. Late burial diagenetic events in east Texas seem to have had little influence over ultimate porosity evolution.

Because of the depths involved, the south Texas Jurassic has been explored only superficially and no production has been established. Recent works by Loucks and Budd on the available material indicates strong similarity to east Texas relative to porosity evolution and general diagenetic framework. However, Loucks and Budd do note significant, late, subsurface, secondary porosity development.

South Arkansas, Louisiana, and Mississippi stand out in stark contrast to the Texas part of the trend. Reservoirs are generally limestones, with porosity either early fresh meteoric, secondary moldic, or preserved primary porosity. The early meteoric moldic porosity occurs in a predictable trend across the updip portion of the fairway. Reservoirs with preserved primary porosity occur in a band seaward of the secondary trend, and show no evidence of freshwater influence, or early diagenetic processes other than minor marine cements. Porosity preservation in this zone is a function of grain type (ooids versus pellets) and original sediment texture, and hence it is controlled ultimately by depositional processes. In the primary porosity zone, production is almost always associated with salt-related structures, while in the early secondary zone, updip permeability barriers (diagenetic and stratigraphic?) as well as salt-related structures are important. Late diagenetic events associated with migration of basinal derived fluids across the shelf during moderate burial include cementation dedolomitization, and calcite dissolution. All reservoirs in this part of the trend show ample evidence of significant porosity enhancement during this late solution phase. The limestone trend of Arkansas, Louisiana, and Mississippi is primarily an oil province with hydrocarbon migration taking place much later than to the west in Texas.

In Alabama and Florida, the trend is again toward dolomite reservoirs, with most dolomite and hence porosity permeability establishment early, and associated with meteoric water processes. Most large reservoirs such as Jay are associated with salt anticlines; minor production comes from updip basement structures. This part of the trend is mixed gas and oil. Hydrocarbon migration into reservoirs seems to have been a relatively late event.

The Jurassic upper Smackover of the Gulf rim is a simple sedimentologic system that has seen a complex and variable burial history along the trend which is distinctly reflected in major changes in diagenetic history, reservoir-porosity type, trap characteristics, and hydrocarbon migration timing.

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Cotton Valley Depositional Systems of Mississippi

The Jurassic Cotton Valley Group in Mississippi is considered generally to be one formation, roughly equivalent to the Schuler Formation of Louisiana. Gross changes in lithology and electric log characteristics are observed across the state of Mississippi. These lateral variations are best discussed in terms of the depositional systems operant during Cotton Valley sedimentation. Through use of sand percentage and sand isolith maps, various depositional systems can be discerned.

Two delta systems existed in Mississippi: a constructive delta in the west-central part of the state, and a destructive delta in the east-central part. An interdeltaic system in central Mississippi, between the two delta systems, was bounded possibly on the south by a barrier-bar system. Elevation above wave base, caused by positive influence of the Wiggins arch and Hancock County high, resulted in development of a strand-plain system in southeast Mississippi. Lack of well control precludes a definitive statement about depositional environment in the southwest part of the state. By geographic relationship to the other depositional systems, a shelf system is inferred.

Recognition of the Cotton Valley depositional systems in Mississippi aids in identifying potentially productive trends which have yet to be adequately explored.

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Tectonic Implications of Paleozoic and Mesozoic Igneous Rocks in Subsurface of Peninsular Florida

The extensive Mesozoic and Cenozoic sedimentary sequences of peninsular Florida rest unconformably upon a basement of dominantly volcanic rocks. Major and trace element analyses of samples from six deep oil test wells in north-central and south-central peninsular Florida suggest the existence of two distinct volcanic provinces. The northern province contains calc-alkalic andesitic to rhyolitic rocks similar to those found along modern convergent (ocean-continent) plate boundaries. The southern province is apparently a bimodal suite of basaltic and rhyolitic rocks. These rocks exhibit certain geochemical features which suggest they were generated in a continental rifting environment associated with a mantle plume. Available age data indicate the northern volcanic province is at least early Paleozoic in age, whereas the volcanism in the south occurred during early Mesozoic.

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Local Sea Level Change and Future of Louisiana Coast

The relative elevation of sea and land has been changing through time in response to two fundamentally different groups of factors. Global factors include changes in the volume of the ocean basins owing to tectonic processes and changes in the total amount of ocean water due to glaciation. Local factors include subsidence of continental margins and compaction of recent sediments. Over this century, global sea level (eustatic) appears to have been rising at a rate of 1.2 mm per year. Along the south-central Louisiana coast the land surface appears to be sinking at a rate of about 8 mm per year.

Recent global climatic modeling suggests strongly that we are about to enter a period of rapidly accelerating warming due to increased amounts of carbon dioxide in the atmosphere. As a consequence, eustatic sea level rise is predicted to accelerate because of both steric expansion of the ocean water and continued melting of polar ice caps. For the next 40 years the eustatic sea level rise may average 10 mm per year. The local relative sea level in coastal Louisiana would therefore rise at about twice its present rate over this time period. At this rate, local sea level will, in the year 2020, stand some 70 to 75 cm (2.3 to 2.5 ft) higher than at present.

The numbers presented above are average values for the Louisiana coastal plain. Local variability in subsidence rate appears to be related to the thickness of Holocene sediments. The highest rates of subsidence are found in the modern Mississippi (birdfoot) delta and in coastal Terrebonne Parish above the late Pleistocene Mississippi trench; in both areas the Holocene section is in excess of 200 m (650 ft) thick.

The high rate of local sea level rise along the Louisiana coast makes it imperative that plans for coastal development and protection consider the long-term consequences of sea level change.