Although the entire Gulf of Mexico region can be regarded as having reached the mature stage of exploration, many areas have not even been explored. As a consequence, it is possible that only half of the potential reserves of the entire Gulf of Mexico region have been found.

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Petrographic, Stratigraphic, and Structural Study of Smackover Gray Sand (Jurassic), North Louisiana

The Smackover Gray Sand is the target of intense exploration activity in the north Louisiana area. The gas-producing Gray Sand, a dark gray to black, very fine-grained sand, occurs as three sand tongues in the lower member of the Smackover Formation in the subsurface of Bossier, Webster, Claiborne, and Lincoln Parishes, Louisiana. The majority of Gray Sand wells have been drilled in Bossier and Webster Parishes; however, the most active exploration presently is to the east in Claiborne and Lincoln Parishes.

Samples of the Gray Sand are classified as subchertarenites because of their high percentage of quartz and the dominance of chert fragments over plagioclase. Additional mineral constituents include muscovite and biotite; oolites are also present. A flaser-bedded silty shale facies indicates deposition on a mid-tidal flat environment.

Smackover deposition during the Jurassic in the study area was located on the gently dipping slope between a broad coastal shelf on the north and a basin on the south. The Gray Sand was deposited over the Norphlet Formation and Louann Salt before flowage and swelling of the Louann Salt began. Uplift and swelling of the Louann Salt later in the Jurassic created growing anticlines; sediment slumped off the structural highs of the growing salt anticlines into basinal muds and silts. By superimposing the isopachous map of the Gray Sand interval over the structure map of the Gray Sand, it can be seen that the thickest Gray Sand intervals lie on the flanks of the anticlinal structures in South Sarepta, Ivan, and Cotton Valley fields. Absence of the Gray Sand between Ivan and Cotton Valley fields indicates a facies pinch-out due to localized deposition of sand tongues on the structural highs.

The Gray Sand, because of its low porosity (7 to 10%) and permeability (0.5 md), must be stimulated through hydraulic fracturing to be productive. Extreme bottom-hole pressures and temperatures require the use of tailor-made high viscosity gels and high-strength proppants.

In Lincoln Parish fields, favorable structures for Gray Sand production are located by seismic exploration. The Smackover Gray Sand however continues to challenge exploration geologists because of the lateral pinch-out of its sand tongues.

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Nearshore Bars Along United States Gulf Coast

The microtidal, low-wave energy, United States coast of the Gulf of Mexico is characterized by an abundance of shoreface bars. Four distinct component bars can be identified, though interference patterns exist. Vertical air photos since 1945 and numerous overflights and field measurements during the last two years have shown that the equilibrium bar configuration at any given site is time-invariant. During storms, however, the bars go through cycles of change in a manner similar to those identified by Short.

Based on plan geometry the following four bar types are identified.

Multiple (10 or more) longshore bars—Multiple longshore bars, without interference from other bar types, occur on the low-tide platform in front of a steep beach face, along shoreline segments of convex plan form and low wave energy. The bars have a sinusoidal cross-profile, constant height, and constant spacing suggesting that they form in response to a standing wave pattern established through interference between incident wind waves and waves reflected from the steep beach face.

Transverse bars—Bars oriented at steep angles relative to the shoreline dominate in low energy environments (Mississippi Sound and other sheltered embayments) along the central Gulf coast. Intersecting transverse bars, forming an overall rhombic pattern, dominate the lagoonal platform behind the Mississippi-Alabama barrier chain. The mainland shoreface of Mississippi Sound, however, is dominated by intersecting transverse and multiple longshore bars.

Generally, transverse bar spacing appears to be proportional to bar amplitude. The transverse bar morphology reflects a complex interaction between incident, high-frequency waves and the resultant longshore currents.

Crescentic bars—The Gulf beaches of barriers and spits of the Florida panhandle, Alabama, and Mississippi are characterized by crescentic bars or single longshore bars. The crescentic form is best developed adjacent to, or between, shore-normal structures which might be jetties, groins, or natural headlands. This suggests that the crescentic bar morphology forms in response to a wave motion transverse to that of the incident waves, i.e., edge waves which are expectedly best developed trapped between reflecting shore-normal structures.

Longshore bars—These bars characterize the entire Texas coast and many Louisiana barriers. This coastline has the highest wave energy in the study area. The constant crest-to-trough water depth ratio, the asymmetric cross-profile, and the landward decrease in size and spacing suggest that these are breakpoint bars.

These four component bars, all resulting from different mechanisms of generation, occur either individually or in different patterns of superposition creating six commonly observable bar morphologies along the Gulf Coast barriers and mainland shores. Specific coastal subenvironments are characterized by time-invariant equilibrium bar configurations.

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Late Paleocene Planktonic Foraminiferal Biostratigraphy of Tuscahoma Marls, Southwest Alabama

Using vertical distribution of planktonic foraminifers contained in the marls associated with the Tuscahoma Sand of the Wilcox Group in southwest Alabama, most of the formation can be assigned to the two late Paleocene planktonic foraminiferal zones recognized worldwide. The occurrence of *Planorotalites pseudomenardii* (Bolli) in the unnamed lower marls places these beds in the *Planorotalites pseudomenardii* Range Zone. The Greggs Landing and Bells Landing Marl Members contain a diverse assemblage of planktonic foraminifers including, *Morozovella velascoensis* (Cushman), *Morozovella acuta* (Toulmin), and *Morozovella aequa* (Cushman & Renz). The presence of *M. velascoensis* and *M. acuta* and the absence of *P. pseudomenardii* put these marls in the latest Paleocene *Morozovella velascoensis* Interval Zone. The occurrence of *Morozovella subbotina* (Morozova) and *Pseudohastigerina wilcoxensis* (Cushman & Ponton) in the Bashi Marl Member of the Hatchetigbee Formation place this marl in the earliest Eocene *Morozovella subbotina* Interval Zone. Based on planktonic vertical distribution in southwest Alabama, the Paleocene-Eocene boundary occurs above the top of the Bells Landing Marl Member of the Tuscahoma Sand and probably near the base of the Bashi Marl Member of the Hatchetigbee Formation.

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Kurten Field—Discovered by Stratigraphic Prospecting

The Woodbine Kurten field trap is a stratigraphic sand lens surrounded by shale. This field is a significant discovery in Brazos, Grimes, and Madison Counties, Texas. Structure plays only a minor role in oil entrapment. The sand was deposited in a structural and topographic low demonstrated by comparing maximum pay sand thickness with a computer trend surface residual thick derived from Austin to Buda isopach map.

Sand migration southward down the East Texas trough was deflected westward by the Angelina-Caldwell flexure and caught in a sag at the Kurten field locality. The higher Madisonville nose to the northeast has essentially no sand at the crest. Structural elevation at Madisonville and on the Angelina flexure only serves to limit sand deposition.

Many porosity pod-type fields may result by looking for sags near a sand-shale regional boundary.

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Chemical and Isotopic Evidence of Origins of Natural Gases in Offshore Gulf of Mexico

The chemical and isotopic composition of natural gases from 55 fields in the offshore Gulf of Mexico province has been analyzed. The gases display a trend of more positive $\delta^{13}C_1$ values (-70 to -35 per mil) with increasing depth and age of producing reservoir. The mechanisms responsible for this fractionation are biogenic enrichment of $^{12}C_1$, thermal cracking, and mixing. Separate trends are present in Texas and Louisiana which suggest a higher geothermal gradient or different type of organic matter in offshore Texas. There is considerable scatter along the general trend because gases generated from deeper, thermally mature source rocks have commonly migrated to shallower immature reservoirs.

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Mineralogy, Diagenesis, and Porosity in Vicksburg Sandstones, McAllen Ranch Field, Hidalgo County, Texas

Average porosity from porosimeter analyses of Vicksburg sandstone core plugs from McAllen Ranch gas field is approximately 15%, but average porosity from point counts is only 6.5% due to exclusion of microporosity. Average permeability is less than 1.5 md. These low porosities and permeabilities are due to extensive diagenetic modification of a chemically unstable sand.

The Vicksburg Formation in Hidalgo County was deposited in a deltaic environment. Most of the reservoir sandstones are submature fine-grained lithic arkoses and feldspathic volarenites containing less than 30% quartz. Primary porosity was most commonly occluded by precipitation of authigenic minerals, predominantly calcite cement. The onset of extensive calcite precipitation occurred at relatively shallow burial depth, approximately 3,000 ft (915 m), in the Hidalgo County area. Carbonate cements are abundant in most samples to depths of more than 13,600 ft (4,145 m). Most porosity present is secondary porosity which formed by dissolution of cements and grains.

Diagenetic modification is much greater in Vicksburg sandstones of Hidalgo County than in other Tertiary sandstones of the Texas Gulf Coast. This is due to the chemically unstable mineral assemblage and the high thermal gradient in this area.

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Paleoenvironmental Analysis of Joachim Dolomite (Middle Ordovician), North Arkansas

The Joachim Dolomite (Middle Ordovician) crops out in an east-west trending belt across north-central Arkansas. This formation is the oldest of four members composing the post-St. Peter Ordovician carbonate sequence, which was deposited during an overall marine transgression. These units prograded in response to progressively deeper epeiric conditions caused by a relative rise in sea level near the low-relief, positive Ozark Dome.

The Joachim Dolomite ranges in thickness from 1 to 25 m and contains four units in a shoaling-upward sequence: subtidal basal sheet unit, subtidal bank unit, sublittoral sheet unit, and intertidal-supratidal veneer unit. These units represent an offlapping sequence of subtidal to intertidal to supratidal environmental zones. Marine sedimentation caused carbonate banks to shoal and prograde seaward, producing a local marine regression. Algal mat communities promoted carbonate bank progradation by forming a cohesive mat that stabilized substrates and resisted wave scour. These algal mats created cryptalgal fabrics, cryptalgal columnar structures and stratigraphic sequences analogous to those