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

observed in Shark Bay, Western Australia.

The Joachim Dolomite is a dolostone intermixed with variable quantities of detrital quartz grains. Halite hoppers present in the intertidal veneer unit suggest that the initial dolomitization of the sediments was induced by evaporative pumping of metahaline and hypersaline water into the prograding carbonate banks. Later, successive influxes of mixed meteoric-marine and meteoric waters converted the marine protodolomite matrix into dolomicrite and eliminated the primary marine porosity.

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Sedimentary Structures Associated with Mississippi River Delta-Front Deposits

Hydraulically controlled sediment-distribution patterns in Mississippi River delta-front environments are continually being modified by mass-movement processes, and sediments are constantly being redistributed. Numerous deformational features have been identified and mapped by the combined use of side-scan sonar and high-resolution seismic profiles coupled with accurate navigational control. Major deformational features include diapirs, faults, slumps, and various types of complex mudflows that have many geomorphic components, from slumped upslope source areas to distal overlapping depositional lobes. As a result of mass-movement processes, sediments are redeposited as blocks, flows, and completely remolded masses, all of which can occur on a variety of scales. Although surface and subsurface expressions of deformational features are commonly clear, sedimentary structures and inclusions characteristic of each major deformational form have not been systematically evaluated.

By means of X-ray radiography, subtle inhomogeneities in texture and density changes associated with postdepositional chemical products describe structures and inclusions typical of deformed sedimentary sequences. Various types of fractures and microfaults, sedimentary gas expansion voids and migration paths, flow structures, convolute bedding, grain flows, diagenetic features, and organically derived structures are arranged in combinations that define components of a complex mudflow system. Using the structures and inclusions found in delta-front sediments, criteria have been developed for differentiating disturbed and nondisturbed sedimentary sequences within the delta-front environment.

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Hosston Trend, Mississippi

Since the 1974 discovery of commercial gas and condensate from deeper Hosston sands below 15,000 ft (4,592 m) at Bassfield field, the exploration effort seeking similiar reservoirs in the Hosston trend in south Mississippi continues to grow. From 1951 through 1970, a total of 30 new fields were discovered from Sligo-Hosston reservoirs: 28 oil and 2 gas. However, from 1971 through 1979, 33 new fields were discovered, of which 28 are gas and 5 are oil. The striking relation of more recent gas discoveries rather than oil is significant.

The increase in exploration activity for gas reservoirs was due to three major factors: the critical national energy shortage, the favorable success of finding commercial gas below 15,000 ft (4,572 m), and the continued increase in the value of an Mcf of gas, which skyrocketed from 15 to 20¢ per Mcf prior to the early 1970s to more than $3 per Mcf in recent months.

A series of very fine-grained tight sandstones is present in the top 1,000 ft (305 m) of the Hosston Formation. The most favorable objective is the Booth Sand found about 600 ft (183 m) below the top. However, other sands (above and below) have recently been proven to be equally favorable in distribution and thickness, as well as in productivity. Productive Hosston sands have a porosity range from 7 to 15%; permeability ranges up to 1,000 md and although occasionally may be higher, generally averages in the low hundreds.

Many fields produce formation water along with gas condensate having 100,000 to 160,000 ppm chlorides. Water yields range from less than 1 bbl/MMCFG to 115 bbl/MMCFG. Condensate yields range from less than 1 bbl/MMCFG to 80 bbl/MMCFG. Productive sand thickness ranges from 5 to 70 ft (1.5 to 21 m). Commercial production depends more on sufficient permeability than net thickness of pay. Flow rates in some of the better fields have sustained production of more than 4 MMCFGD per well. Recoverable reserves per 640-acre (256 ha.) unit for an average Hosston reservoir having 20 ft (6.1 m) effective pay will range 5 to 9 BCFG and 100 to 200 MBC.

As long as operators continue to find new fields of this magnitude, the efforts will continue to escalate and indications are that the future still looks encouraging for many more years to come. We have only begun to "scratch the surface."

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Occurrence of High Gravity Oil in an Oligocene Vicksburg Sandstone in Jim Hogg County, Texas

On October 1, 1979, the Guardian Oil Co. E-1 Mestena oil and gas well was completed in an Oligocene Vicksburg sandstone. The initial potential was 245 BOPD of 75° API gravity oil from a 10/64-in. choke with a flowing tubing pressure of 223 psi. A hydrocarbon analysis of a sample obtained from the E-1 well revealed an oil composed primarily of propane and butane with a significant part of pentane to heptane range material which accounts for the exceptionally high gravity of the liquid hydrocarbons. This analysis further showed that the E-1 well is producing almost no methane, ethane, or other hydrocarbons of greater molecular weight than nonane. Several faults, adjacent to the well, delineated by seismic evidence could have provided a path of migration for the hydrocarbons. A detailed analysis of the butane to heptane fluid produced by the E-1 well indicated the fluid contained a large amount of compounds characteristic of an immature crude. Coal fragments present in the cuttings from a nearby well and the regional geology of the Vicksburg formation suggest that one possible source for the hydrocarbons of the E-1 well could have been lipid-rich cannel-type coal.