trend. It is possible that this reef extends southeastward into Franklin and Catahoula Parishes, but subsurface data is lacking to substantiate this. The lithology of the northern reef is similar to the main reef in that it contains about the same fossil assemblage in sparry, granular, or micrite matrix. Some zones within and on the north edge of the reef contain an abundance of oolites and algal pisolites. In part the limestone is slightly dolomitic, but there are no dolomite zones as in the main reef. In some localities within the northern reef, porosity and permeability are very high.

Commercial oil and gas production has not been found in the main biohermal trend in central Louisiana, but the possibilities have by no means been exhausted. In contrast, the Black Lake field in Natchitoches Parish was discovered in the northern bioherm in 1964. This is a major gas-distillate-oil field within a stratigraphic-structural trap, containing ultimate reserves of approximately 150 million bbl of oil equivalent. This discovery set off an active wildcat play in search of additional traps of the Black Lake type, so far without success.

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SURFACE FEATURES OF QUARTZ SAND GRAINS FROM NORTHEAST COAST, GULF OF MEXICO

The surface textures of quartz sand grains from locations along the Florida Gulf Coast have been compared with those from other environments. High-magnification studies consistently show the predominance of chemical over physical textural features, which is to be expected in low- to moderate-energy coastal environments. Because of multiple reworking of these sediments, detailed environmental interpretations are difficult but not impossible. Distinctions are commonly quite subtle.

The great influence of the crystal structure of quartz on the physical and chemical surface features precludes the normal method of rapid scanning of several grains per sample by the electron microscope. Therefore, a statistical approach is suggested using a combination of Nomarski differential interference-contrast microscopy and scanning electron microscopy. A relatively high percentage of the total surface areas of large numbers of grains can be studied in detail by this method.

Stereopairs of scanning electron micrographs illustrate numerous surface textural features produced by a variety of sedimentary processes and environments.

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GEOLOGY OF JURASSIC, FLOMATON-JAY AREA, ALABAMA AND FLORIDA

Flomaton field, in Escambia County, is the first major gas condensate discovery from the Jurassic Norphlet Formation in Alabama. Structurally the field is a NW-SE trending low-relief salt anticline bounded on the north and east flanks by a major down-to-the-basin fault which is part of the Pickens-Gilbertown-Pollard regional fault system. The Norphlet sandstone reservoir is about 60 ft thick within the field and produces CO_2 and sour gas with a high condensate yield.

The paleostructural history of the area indicates that early Louann Salt movement and faulting occurred, probably as a result of gravity slide and basinward salt creep, forming structures necessary for trapping hydrocarbons. Jurassic deposition was affected by these early structural features and pre-salt topography.

Norphlet clastics were derived from the northeast and deposited by braided stream systems. As the Smackover seas transgressed the area, the upper part of the Norphlet was partly reworked. In the Flomaton area, the Smackover Formation is a dark-brown, dense, micritic limestone. The overlying Haynesville Formation can be subdivided into an upper member consisting of predominantly red, coarse clastic material and a lower member consisting of fine, red clastics and evaporites. At Flomaton, over 300 ft of bedded salt has been drilled in the lower Haynesville causing many drilling and completion problems. The Cotton Valley Group marks the top of the Jurassic and consists primarily of coarse gravelly clastics.

Exploration activity in southwest Alabama during 1969, 1970, and 1971 led to additional discoveries from the Jurassic. Among these is Jay field in Santa Rosa County, Florida, 7 mi southeast of Flomaton field. Jay produces oil from Smackover dolomite and is the first Jurassic discovery in Florida. The discovery well produced 1,710 BOPD and has resulted in one of the most active exploration plays in the United States.

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LOWER MIOCENE STRATIGRAPHY AND PETROLEUM POTENTIAL, OFFSHORE GALVESTON AND JEFFERSON COUNTIES, TEXAS

Lower Miocene sediments in the southeast Texas coastal area can be divided into 2 distinct trends. The basal Miocene interval from the top of the Oligocene *Discorbis* upward to the *Robulus chambersi* is a predominantly regressive-marine sequence that reflects the gradual progradation of Miocene sands into this area. The overlying sequence from *Robulus chambersi* to *Amphistegina (B)* consists of deltaic and delta-related sediments that reflect continued marine regression and seaward progradation of a large early Miocene delta system.

In the nearshore Galveston and High Island areas, the basal Miocene interval contains a series of potential reservoir sandstones, most of which are above the abnormally pressured zones and occur at depths of less than 9,500 ft. Farther offshore, the younger *Amphistegina (B)* sandstones become favorable exploration objectives.

Several lower Miocene biostratigraphic zones are identifiable throughout the area and an attempt has been made to relate each zone to particular lithologic conditions or depositional environments. Because of the general southward movement of the shoreline during the Miocene and a relatively limited supply of sand, prospective Miocene sandstone trends in the southeast Texas offshore occur in narrow "belts" approximately parallel with the present coastline. Identification of these favorable trends is essential to a successful exploration program in this area.

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PLANKTONIC FORAMINIFERAL BIOSTRATIGRAPHY AND PALEOMAGNETICS OF LATE PLIOCENE AND EARLY PLEISTOCENE STRATA AT LE CASTELLA, ITALY

Late Pliocene to early Pleistocene stratal segments were measured and sampled along the coast at Le Castella, Italy, to determine their planktonic foraminiferal

biostratigraphy and geomagnetic polarity reversal patterns. The percentage distribution of warm- and cold-water planktonic species in the samples defines a warm late Pliocene (Plaisancian) *Globorotalia inflata* Zone, a cool Calabrian Stage (earliest Pleistocene), a warm Emilian Stage, and a cool Sicilian Stage. Occurrence of *Sphaeroidinella dehiscens* in late Pliocene suggests highest maximum temperature, and dominant left coiling *Globigerina pachyderma* in the Sicilian the lowest.

The paleomagnetic reversal pattern is partly obscured by covered and weathered intervals between the late Pliocene and Calabrian, and within the upper Emilian and Sicilian. The exposed late Pliocene and Calabrian strata show strong normal measured polarities, which suggest that the late Pliocene falls in the Gauss Epoch and that the exposed Calabrian falls either in the late Gauss Epoch or Olduvai event. Recommendations are made for the Committee on Mediterranean Neogene Stratigraphy to core the section continuously, to determine and define precisely the lithostratigraphic and biostratigraphic base of the Calabrian, and to record the complete paleomagnetic history in the type area of the Calabrian, earliest Pleistocene.

Plio-Pleistocene stages of the Mediterranean and Gulf of Mexico are correlated using planktonic foraminifers and climatic implications. The Nebraskan, Aftonian, and Kansan stages correlate with the Calabrian, Emilian, and Sicilian stages, respectively. Paleomagnetic correlations are not entirely clear at this time, except that late Pliocene strata of both regions seemingly fall within the Gauss Epoch.

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STORY OF BIG WELLS

Big Wells field is a rapidly developing oil field in northeastern Dimmit and southeastern Zavala Counties, Texas, approximately 75 mi southwest of San Antonio. Big Wells is a large and significant stratigraphic trap. Production is from a San Miguel sandstone of the upper Taylor Formation (Upper Cretaceous), a section noted for "tight" sandstone conditions and small —5–10 well—oil fields in anticlinal structures generally associated with small volcanic extrusives. This trend has been considered high risk for "economical" fields and therefore ignored by most operators, both large and small. Big Wells has instigated the expected flurry of activity when a "dead" trend suddenly springs back to life.

Ranging from 5,300 to 5,700 ft in depth, with a minimum of 200 ft or possibly 400 ft of oil column, the field was found by Sun Oil in January 1969. Development drilling began in the north part of the field where low-permeability sandstone was encountered casting doubt on the economics involved. Southward of the early drilling, much better sandstone reservoirs were found, resulting in full allowable flowing wells (142 BOPD in March 1971).

The sandstone reservoir is very fine grained, with an average porosity of 18–20% and permeability ranging from less than 1 md to 100 md, generally less than 5 md. The San Miguel sandstone in the Big Wells field area is a linear sandstone body interpreted to have been deposited as an offshore bar.

Today the field is 12 mi long and 3 mi wide. Nine rigs were operating in the field in March 1971. With 160 wells completed by the end of May 1971, the limits of the field are fairly well defined. Drilled on 80-acre spacing, approximately 200–250 wells are anticipated. Production in March 1971 was between 15,000–16,000 b/d of oil.

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STRATIGRAPHY OF *Cibicides carstensi* ZONE, MIOCENE OF LOUISIANA

The fundamental stratigraphic unit of Gulf Coast subsurface geology is the biostratigraphic zone. These zones are named after benthonic Foraminiferida and are widely used in a time-rock sense by most workers in the region. Zonal nomenclature has developed informally within competitive oil companies. The middle Miocene *Cibicides carstensi* Zone has been generally recognized for at least 15 years, but use of the name has been inconsistent, as no type section had been designated. The *C. carstensi* Zone of south-central Louisiana, at its type locality, consists of 4 subzones. Boundaries of the Zone and its components are defined on the basis of Foraminiferida-rich lentils and distinctive electric-log markers.

Percentage of foraminiferal tests per unit volume of sediment provides an index to rate of clastic deposition. Widely spaced lentils containing abundant Foraminiferida in a predominantly clastic sequence record episodes of relatively slow deposition. Abundance and composition of fauna in benthonic communities are controlled, in large part, by depositional rates and nature of substrate. Both of these factors are dependent upon tectonic history in the Gulf Coast. Stratigraphic thickness and sequence are closely related to faulting in this province. Episodes of fault movements can be dated accurately by their influence on depositional thickness and lithologies in equivalent strata on opposite sides of a fault. Stratigraphy, paleontology, and structural history are consequently inseparable. All 3 must be considered simultaneously in any geologic interpretation.

Hydrocarbons of the *C. carstensi* Zone accumulated in blanket sand bodies deposited under conditions of tectonic stability. Sandstones which have a sharp basal contact tend to be erratic and limited in areal distribution. These sands are thought to have been deposited on a steeply inclined or irregular submarine topography during or immediately following spasms of tectonic activity. Such sandstones rarely produce hydrocarbons.

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SEDIMENTS AND DEPOSITIONAL HISTORY OF SOUTHEAST LOBE OF COLORADO RIVER DELTA, TEXAS

Reconstruction of the depositional history of the Colorado River delta's southeast lobe is made possible by combining the delta's documented history, sedimentary and hydraulic principles, past and present depositional environments, and the present distribution of resultant sediment types.

Synthesis of these data makes possible reconstruction of the depositional history as follows.

1. Pre-1929 sedimentation was restricted to the slow accumulation of fine detritus in a reducing environment.

2. Deltation began in 1929, and by 1930 the initial delta lobe extended half-way across Matagorda Bay. Progressively siltier prodelta clays were deposited in the study area. Deposition of generally finer prodelta