

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 dehiscentis* 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 anti-

ipated. 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 Foraminifera 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 Foraminifera-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 Foraminifera 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

sediments followed as a second lobe formed on the east flank.

3. Development of southeast lobe began in 1933 at the mouth of an artificially leveed channel that extended 1/2 mile beyond the southern edge of the existing delta plain. After a period of adjustment to this unnatural channel, a normal sequence of prodelta and delta-front environments and associated subenvironments developed and prograded east-southeastward.

4. In 1936 the discharge channel was extended through Matadorda Peninsula, and the Colorado River began discharging directly into the Gulf of Mexico. Distributaries into the southeast lobe remained open but could divert only a fraction of the total discharge. This decrease in volume of discharge was accompanied by lower flow velocities, a slower progradation rate, and the deposition of generally finer sediments.

5. The lobe entered its destructional phase in 1941, when all distributaries were closed. Wave action has removed most of the subaqueous delta front, beaches and interdistributary bays have formed, and a flourishing marsh has developed.

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ORIGIN AND CHRONOLOGY OF ALABAMA RIVER TERRACES

Investigation of high fluvial terraces along the Alabama River indicates that the highest terraces (115+ m above the floodplain) may predate the Citronelle Formation. Preliminary radiometric age determinations suggest that all of Quaternary history may be represented by those terraces less than 50 m above the present floodplain. The Citronelle surface in southwestern Alabama shows differential warping caused by subsidence of the Gulf Coast geosyncline and uplift of the adjacent upland. Rates of uplift were roughly 1.2 cm/10³ years.

The average rate of river entrenchment prior to North American Pleistocene glaciation was about 2.5 cm/10³ years. During glacial Pleistocene time, the maximum net rate of river entrenchment may have been as great as 7 cm/10³ years. Observation of fluvial features, such as meander scrolls, shows that, in terraces more than 60 m above the floodplain (*i.e.*, more than 1.1×10^6 years old), meander scrolls have been obliterated. Likewise, terrace surfaces are mostly destroyed where more than 1.6×10^6 years old. In deposits more than 3.5×10^6 years old, primary structures have been obliterated and the only evidence of these oldest terrace deposits is chaotic blankets of alluvium.

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LOGARITHMIC SPIRE IN PLANKTONIC FORAMINIFERIDA: ITS USE IN TAXONOMY, EVOLUTION, AND PALEOECOLOGICAL

Studies of several species of planktonic Foraminifera indicate that the spire of the generated coil is an important measure of species. The spire is easily measured and is logarithmic. Test and chamber growth dimensions measured in relation to the spire show that all species thus far studied exhibit nearly perfect geometric growth. Growth measurements taken in this manner allow the growth plan of individuals or assemblages of species to be compared statistically.

Such studies lead to a better understanding of variation within species and of the distinguishing morphologic characteristics of a species. Evolutionary change is better understood by investigating changes in growth

dimensions with respect to the logarithmic spire. In paleoecologic studies of species populations, geographic variation can be quantified to yield a more precise analysis of paleoenvironmental parameters.

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GEOLOGY AND GEOPHYSICS OF EAST NANCY FIELD, CLARKE COUNTY, MISSISSIPPI

East Nancy field, discovered in April 1968, produces from 2 zones. The upper Smackover reservoir is oolitic limestone. The lower reservoir is a sandstone generally called Norphlet by the industry, but included in the Smackover in this paper.

Accumulation is the result of closure on a low-relief salt anticline. The structure is "buried," exhibiting no reversal on beds above the Cotton Valley. Consequently, shallow subsurface and gravity interpretations offer little aid in delineating the anomaly. East Nancy was first drilled, and apparently condemned, by Southwest Gas Producing Company in 1959, following an extensive conventional seismic program. The discovery well was located on the basis of CDP data, which defined the structure.

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PETROLOGY AND SEDIMENTATION OF HACKBERRY SEQUENCE OF SOUTHWEST LOUISIANA

Recent discoveries in the Hackberry of southwest Louisiana have created new interest in the high-risk, deep Hackberry section. Petrographic examination of 3 conventional cores and hundreds of sidewall cores, together with previously completed isopach studies, has established that the lower Hackberry sandstones are turbidites. Within the area, the lower Hackberry sandstone interval shows two depositional patterns: an up-dip north-south channel pattern, and a downdip blanket-type sandstone pattern. Cores in the lower Hackberry show the following graded sequence from bottom to top: (1) a coarse-grained conglomeratic sandstone which grades upward into finer laminated sandstones; (2) crossbedded and convoluted sandstone; (3) siltstone; and (4) finely laminated shale. The sandstone is bimodal and trimodal, commonly containing 30-50% clay matrix. The microfaunal assemblage within the lower Hackberry cyclic sequence indicates depth ranges of 300-3,000 ft (Zones 5, 6).

Because of the turbidite nature of the sediments, production within the channels has been small, except where the channels have encountered salt domes and have been deflected around them. In such channels, the turbidity currents lost velocity, and important sandstone bodies were deposited, reworked, and locally winnowed. In the downdip area where the channels spread out into a blanket pattern, production is controlled by the topographic and structural configuration of the unconformity surface on and around which the turbidity currents deposited sediments.

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NEW PLEISTOCENE MARINE FOSSIL LOCALITY IN CHAMBERS COUNTY, TEXAS

A well-preserved marine invertebrate fauna of late Pleistocene age represented by 48 species has been found in Ingleside barrier island, southeastern Texas.