hilated Mesozoic calcareous nannoplankton floras. Highly diversified assemblages of Maastrichtian coccoliths were replaced by early Danian assemblages having only a few genera and species. Species diversity increased rapidly during the Paleocene, and by the middle Paleocene had reached a level comparable to that in the late Mesozoic. Discoasters, which due to their large size are very easy to observe and use stratigraphically, first appeared in the middle Paleocene. Late Paleocene, early and middle Eocene pelagic sediments contain a remarkable succession of rapidly evolving calcareous nannoplankton assemblages, culminating in a diversity maximum in the early Lutetian. Later in the Lutetian, a sudden decline in the number of species occurred, and the late Eocene is characterized by relatively monotonous, slowly evolving calcareous nannoplankton floras. Many species characteristic of the late Eocene became extinct in the very late Eocene or early Oligocene. Large calcareous nannofossils, particularly discoasters, are rare in the Oligocene, but forms bearing smaller coccoliths evolved rapidly. Early Miocene calcareous nannofloral assemblages were dominated by an abundance of stout asteroliths belonging to the *Discoaster deflandrei* plexus. In the middle Miocene, these were replaced by rich asterolith assemblages with many delicate forms having long, thin arms. The number of species of asteroliths and coccoliths again reached a maximum in the early Pliocene. During the Pliocene a number of species, particularly discoasters, declined and became extinct. The last asterolith, *Discoaster brouweri*, became extinct at the Nebraska-Aftonian boundary in the Gulf Coast region. During the Pleistocene, species bearing small coccoliths evolved rapidly, and modern assemblages are dominated by a species which first appeared in the Wisconsinan.

The zonation based on calcareous nannoplankton fossils, proposed here, approximates the stratigraphic resolution which can presently be achieved using planktonic Foraminifera. However, monographic studies have been completed only for the Paleocene-lower Eocene, and uppermost Pliocene-Pleistocene-Recent intervals. Stratigraphic resolution should be considerably improved when detailed studies of the middle Eocene-upper Pliocene interval, now in progress, are completed.

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HYPOTHESIS CONCERNING ORIGIN AND DEVELOPMENT OF SALT STRUCTURES IN GULF OF MEXICO SEDIMENTARY BASIN

Geologic and geophysical surveys conducted by Texas A & M University and Lamont Geological Observatory have established the existence of an extensive fold belt on the continental shelf and slope of eastern Mexico.

Indirect evidence suggests that evaporites are present beneath the fold belt and that they played a significant role in the origin and development of the fold belt.

The writers believe that the presence of the folds on the Mexican shelf and slope support Murray's (1966, p. 475) suggestion that the initial deformation of the salt was in the form of anticlines.

Based on the assumption that the initial deformation of the salt was in the form of anticlines, the writers suggest a possible sequence of events in the Gulf sedimentary basin: (1) the folds developed under only a relatively thin cover of sediments; (2) anticlinal ridges blocked sediment transport until they were completely buried; (3) secondary growth began from the crests of the anticlines when there was sufficient overburden to cause salt movement; (4) the development of secondary growth on the anticlines may have triggered the development of other salt stocks which are not directly related to the anticlines.

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GROUNDWATER FLOW AND GEOTHERMAL REGIME OF FLORIDA PLATEAU

Temperature surveys in oil-exploratory wells indicate that the geothermal profile underlying the Floridan Plateau is modified anomalously to a negative geothermal gradient (*i.e.*, the ground water becomes colder) to a depth of about 3,000 ft below sea level. The anomaly is related to cold ocean water below the thermocline in the Gulf of Mexico and the Florida Straits. At 3,000 ft below sea level the ground water has a temperature of about 70°F near the edge of the deep sea water bodies, and warms to more than 108°F toward the central axis of the Floridan Plateau. The horizontal and vertical temperature distributions suggest the possibility that cold, dense sea water flows inland through the cavernous dolomite in the deep part of the aquifer where it progressively becomes heated by upward geothermal heat flow. The reduction in density produces an upward convective circulation which brings the sea water into contact with fresh water recharged through sinkholes in the karst region of central Florida. The mixing with fresh water further reduces the density and the diluted salt water then flows seaward and discharges by upward leakage through confining beds into shallow aquifers and thence back to the sea or by discharge through submarine springs on the continental shelf and slope.

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STRATIGRAPHIC UTILITY OF SPHAEROIDINELLA CUSHMAN IN LOUISIANA

The evolutionary line which leads to the living *Sphaeroidinella dehiscens* (Parker and Jones) has been divided into two genera, at least six species, and several subspecies. The sequence of forms is discussed here as a temporal cline.

Irrespective of nomenclature, the evolutionary forms of *Sphaeroidinella s. l.* have proved stratigraphically useful in the upper Miocene and younger sediments of Louisiana. Development progressed from a trochospiral form with discrete, inflated chambers and a single aperture, to the living form in which the coiling pattern is obscure, the chambers are merged, and multiple apertures are present. Single aperture forms (*Sphaeroidinellopis* of Banner and Blow) disappeared at the end of the Pliocene. Late Miocene and earliest Pliocene specimens have a thickened apertural lip at maturity. Pleistocene and Recent specimens resemble irregularly ruptured spheres. The lips of the several apertures tend to be recurved and are never thickened. The coiling spiral becomes lower with time. Whereas there is a trend in the direction of fewer chambers in the final whorl of stratigraphically younger forms, this feature must be used with great caution as juveniles always have fewer chambers than adults. The safest single index to stratigraphic age is the degree of chamber separation. All stages of gradation between "species" can be observed.

If one uses the *Globorotalia fohsi* forms to mark time datums, then the stratigraphic ranges of *Sphaeroidinella* forms in Louisiana are not contemporaneous with their ranges in the Caribbean region. The evolution of *Sphaeroidinella* is apparently similar in both areas.

There is some evidence that *Sphaeroidinella dehiscens* is a deep-water variant of *Globigerinoides sacculifer*. Benthonic associates of fossil specimens suggest that *Sphaeroidinella* did not require great water depths in the past.

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SOURCE OF DETRITUS IN GUEYDAN (CATAHOULA) FORMATION, SOUTHERN TEXAS GULF COAST

The Gueydan Formation in outcrop is pastel-colored tuffaceous clay, sandstone, conglomerate, bentonite, and minor ash. The clay, bentonite, and ash are composed predominantly of silicic pyroclastic debris or the alteration products of such debris. Sandstone and conglomerate are composed largely of debris from volcanic and hypabyssal rocks plus minor detritus from sedimentary rocks and reworked Gueydan deposits.

Bailey (1926) reviewed the problem of the source of the igneous material and, although the evidence was inconclusive, favored a source near Duval and McMullen Counties. The writers' study suggests that sand and gravel debris of igneous rocks was derived from the Big Bend region of Texas and adjacent parts of northern Mexico; the fine pyroclastic material may have come from the same area or farther west.

Cross-bed data show that streams flowed east-southeast to the Gulf during the time of Gueydan deposition; hence, detritus was derived from terrane in an updip direction. Pebbles of soda-rich trachyte and trachyandesite (latite), rhyolite porphyry, and welded tuff in the Gueydan are similar in texture and composition to rocks exposed in the Big Bend region and adjacent Mexico. Although the Gueydan lacks detritus from some rocks exposed there, the rocks which are not represented as pebbles are mafic types that weather rapidly. Boulder-size clasts in the Gueydan were transported as stream bed-load and possibly for short distances by mudflows; they are not proof of a local source. Cretaceous foraminifers and rock fragments in the Gueydan show that pre-Tertiary bedrock was exposed locally across the drainage area.

Upper level winds today and presumably throughout the Tertiary moved eastward across Texas; hence, the source volcanoes were toward the west. Although ash may have travelled to the site of deposition by wind, much was reworked by streams after initial deposition and subsequently modified by soil-forming processes.

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ENERGY—PAST, PRESENT, AND FUTURE

(No abstract submitted)

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FUTURE HYDROCARBON PROVINCES OF GULF OF MEXICO-CARIBBEAN REGION

Future possible hydrocarbon provinces of the Gulf of Mexico-Caribbean region include: (1) offshore Late Jurassic-middle Cretaceous reef extension of the Golden Lane, eastern Mexico; (2) additional Pánuco-Ébano-type fields in Late Jurassic-middle Cretaceous basinal carbonate facies of eastern Mexico; (3) additional Poza Rica-type fields in intertonguing zones between Late Jurassic-middle Cretaceous reef carbonates and basinal carbonate facies of eastern Mexico; (4) Parras and similar types of basins, associated with structure and stratigraphic traps, in the Late Jurassic-Tertiary sequence of eastern Mexico; (5) new pay zones in the Rio Grande embayment; (6) Cretaceous reef buildups and other types of stratigraphic traps around the San Marcos arch, Sabine uplift, and Wiggins arch; (7) reef and stratigraphic traps along the Cretaceous trends of Texas and Louisiana in the areas between the arches and uplifts named, and extending offshore in the West Florida shelf area; (8) pre-Monroe "gas rock" plays in the Cretaceous, Jurassic, and Paleozoic of northeastern Louisiana, southeastern Arkansas, and northwestern Mississippi; (9) Jurassic-Cretaceous-early Tertiary reefs and sandstone trends in the Florida parishes of Louisiana; (10) exploration of the pre-Werner or pre-Louann Salt sequence along the interior part of the Gulf Coastal plain; (11) additional Poth Sand-type plays in the downdip marine Wilcox of southeastern Texas and southern Louisiana; (12) downdip sandstone trends in the post-Wilcox of the Gulf Coast geosyncline, both offshore and onshore; (13) deep-water drilling to both shallow and deep objectives beneath the outer continental shelf and the upper continental slope; (14) Cretaceous and Jurassic of Mississippi-Alabama-northern Florida; (15) offshore drilling for Jurassic, Cretaceous, and Tertiary reefing on the West Florida shelf; (16) Bahamas platform; (17) Mesozoic-Tertiary carbonates along the north coast of Cuba; (18) Late Cretaceous-Tertiary marine basins in Cuba, Jamaica, Hispaniola, Puerto Rico, Barbados, and Trinidad; (19) offshore drilling east and south of Trinidad; (20) Orinoco delta, both onshore and offshore; (21) Gulf of Paria; (22) further exploration in Barinas basin of southwestern Venezuela; (23) additional exploration of Cretaceous and Tertiary trends in Eastern Venezuela and Maracaibo basins, as well as drilling of the Gulf of Venezuela; (24) Tertiary basins of South Central America orogen; (25) Nicaragua Rise from Nicaragua-Honduras to Jamaica; (26) Tabasco (Mexico)-Petén (Guatemala) fold belt; (27) offshore and onshore British Honduras, including Sarstún embayment; (28) Yucatán Peninsula and Campeche Bank; and, ultimately, (29) exploration of the Sigsbee diapirs, central Gulf of Mexico.

Not all of these areas listed can be considered to have equal potential. Considering only those areas where 20 or less exploratory tests have been drilled, more than 250,000 sq mi, an area the size of Texas, is relatively unexplored. Including areas where exploratory drilling ranges from 21 wells to extensive drilling, more than 500,000 additional sq mi have not been explored completely. This is a total of 750,000 sq mi which remains to be explored carefully before pessimistic attitudes are justified.

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STRATIGRAPHY OF EDWARDS AND ASSOCIATED FORMATIONS, WEST-CENTRAL TEXAS

West-central Texas is strategically located along the Texas Comanche outcrop belt. On the east and north, the Comanche section is influenced by terrigenous