

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 nanofossils, particularly discoasters, are rare in the Oligocene, but forms bearing smaller coccoliths evolved rapidly. Early Miocene calcareous nanofloral assemblages were dominated by an abundance of stout asteroliths belonging to the *Discoaster delandrei* 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.

B. R. JONES, Independent Exploration Co., Houston, Tex., J. W. ANTOINE, Texas A & M Univ., College Station, Tex., AND W. R. BRYANT, Texas A & M Univ., College Station, Tex.

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.

F. KOHOUT, U.S. Geol. Survey, Water Resources Div., Washington, D.C.

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.

W. P. LEUTZE, Atlantic Richfield Co., Lafayette, La.
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.