lower Hawthorn, upper Chattahoochee (upper Tampa), or Fort Preston Formations in Liberty and adjoining counties.

The Torreya assemblage has little in common with the Tampa fauna, but is affiliated closely with that of the Chipola Formation. The pre-Chipola, post-Tampa stratigraphic position was determined by the presence in the fauna of miogypsinids, which to date have been reported only from sediments older than those containing the Chipola fauna, and by the supraposition of the Chipola fauna on a weathered remnant of the Torreya Formation.

The data suggest that this new unit was deposited in a marine to brackish-water bay that appears to have been centered in Georgia and open only to the Atlantic Ocean. The Gulf trough into the Apalachicola embayment apparently was closed by a land bridge presumed to be an exposed carbonate bank. Since deposition of the new unit, the presumed carbonate bank has wasted away, whereas the Torreya Formation with similar elevation persisted as a highland area.

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REINSTATEMENT OF *Nummulites heilprini* HANTKEN, 1886

The foraminifer *Nummulites heilprini* Hantken is shown to be a senior synonym for *Operculina trinitatensis* Nuttall and *Camerina jacksonensis* Gravell and Hanna. The test morphology of *N. heilprini* is quantitatively and qualitatively different from *N. willcoxi* Heilprin, the first reported American nummulite.

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PLATE TECTONICS AND ORIGIN OF GULF COAST BASIN

A suggested hypothesis is that the basement under the eastern United States consisted of many "miniplates," and that movements of these "miniplates" were responsible for many of the structures in the Gulf Coast basin. Geologists working in the eastern United States have found evidence of continual compressive forces from the southeast during much of the Paleozoic Era. Compression was replaced by tension after the Allegheny orogeny.

The Gulf Coast basin miniplate lies between the Texas megashear, or a closely related fault, and another megashear which extends from under the eastern Gulf of Mexico to the east end of the Ouachita Mountains near Little Rock. A stable miniplate, of which the Llano uplift is a part, acted as a buttress against the northwest movement of the Gulf basin plate.

The Gulf basin plate is believed to have moved more than 400 mi during the pre-Mesozoic compressional cycle. Rebound followed the cessation of compressional forces and a Mesozoic basin was formed over most of the Gulf basin plate. Many of the structures in the post-Paleozoic sediments resulted from rebound associated tension acting on zones of strength and weakness in pre-Mesozoic rocks.

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DEEP-WATER DEPOSITION OF UPPER WILCOX SANDSTONES, KATY FIELD, TEXAS

Lower Eocene Wilcox sandstones were studied in a continuous core from a depth of 10,357 to 10,607 ft. The sandstones are 6–30 ft thick, very fine grained (0.11 mm), and generally thinly laminated. They consist of quartz, 52%; feldspar, 16%; rock fragments, 7%; other grains, 7%; and clay matrix, 18%. Interbedded shales are dark gray to black, massive, and rarely silty and bioturbated.

Sandstones are composed of thin beds that are 1–3 ft thick and commonly show a vertical bedding sequence of (1) a thin, basal zone that contains small, siltstone clasts 1–5 mm in long diameter, (2) a dominant middle zone of inclined laminae that dip at angles of about 5°, and (3) a thin upper zone of horizontally laminated siltstone. Grain size decreases upward from 0.16 mm to 0.05 mm within the thin beds. These units appear to represent a turbidite sequence corresponding to a basal graded unit (B_1), a middle laminated unit (B_2), and an upper laminated unit (D). A thin pelite unit (E) may be present at the top. The ripple-laminated unit (C) is missing or poorly developed. Contorted bedding is present in several intervals. A minor amount of sandstone also occurs in ripple lenses that are thinly interlaminated with dark-gray, pelagic shales. A deep-water origin is postulated for this section because of the turbiditelike bedding sequence and graded texture, scarcity of organic reworking, and regional location beyond the limits of mapped Wilcox deltas.

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DEPOSITIONAL SYSTEMS OF ALABAMA-MISSISSIPPI COASTAL ZONE

The northeastern Gulf of Mexico, from the Mississippi River to Desoto Canyon, is a complex of interrelated depositional systems. Alluvial-deltaic, estuarine, barrier-island, and marine-shelf systems characterize this part of the Gulf. The Pearl, Pascagoula, and Mobile fluvial-deltaic systems are major sources of sediment to the area. This complex is similar to that of the Texas coastal zone, but specific facies, geometry, and spatial relations differ.

Mobile Bay and Mississippi Sound are the most striking of the several estuaries in the area. Mobile Bay is shallow (average depth, 11 ft) and elongate (31 by 10 mi). Salinity varies locally within the bay and at any particular location between periods of high and low stream flow. Most of the bay is floored by clay and silty clay, with the shallow periphery underlain by sand. Sedimentation rates of 1.7 ft per century have been calculated.

Mississippi Sound is a shallow, bar-built estuary approximately 85 mi long and 7–15 mi wide, bounded on the south by a chain of barrier islands. The mainland side of the sound is fronted by grassy tidelands and artificial beach. Current patterns are complex due to the influence of the tidal passes; however, there is a slow westward longshore current. Most of the sound is floored by silt and clay, with the shallow periphery underlain by fine sand.

The Mississippi-Alabama barrier-island system is part of a chain of small, low-relief, barrier islands and spits that extend from Cat Island, Mississippi, to Choctawhatchee Bay, Florida. Westward-flowing longshore currents accrete sediments to the western ends of the islands while eroding the eastern ends. The rate of accretion is greater than that of erosion so that the islands lengthen and migrate westward.

The Mississippi-Alabama shelf system is that part of the shelf between the Mississippi River delta and Desoto Canyon. The topography of the shelf bottom is relatively smooth and has uniform slope. Minor topographic irregularities occur at depths of 100–150 ft. Wave action is of moderate intensity and sediment transport mainly the result of longshore currents. Sediments on the shelf occur as 6 well-defined facies: (1) the Alabama-Mississippi sand facies; (2) The Alabama-Mississippi reef and interreef facies; (3) the St. Bernard prodelta facies; (4) the Chandeleur Islands sand facies; (5) a facies transitional between facies 1 and 3; and (6) an estuary-influenced fine-grained facies.

Recognition of these aspects of the Alabama-Mississippi coastal zone depositional systems is an important consideration in planning and developing a petroleum exploration program.

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Leveed Channel Deposits, Turbidites, and Contourites in Deeper Part of Gulf of Mexico

Several leveed channels can be observed on bathymetric charts from the middle and outer fan of the Mississippi delta apron. Shallow seismic surveys indicate a complexity of shallow channels and associated low levees, although cores show only minor differences between subenvironments. The levees normally contain a higher plant debris content and finer material than the channels. The irregular surface smooths southeastward, and small ripples are present locally on its surface. These deposits are interpreted as contourites; fine sands and silts that are redeposited by deep-water bottom currents.

Off the Mississippi delta apron toward the west, the flat abyssal plain is present. The subbottom reflectors are dense and parallel with the surface, the cores indicate a general increase in sand-clay ratio followed by a decrease farther west. The deposits can be interpreted as distal turbidites.

Although the variation in aspect and the density of each sedimentary property differs little among the 3 depositional areas, the combination of lithologic alternations, sedimentary structures, high-resolution subbottom profiling, and bottom photography provide information for the development of interpretive models of recent and ancient sediments.

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Role of Geologist in Environmental Impact Study

The influence of shell dredging in San Antonio Bay, Texas, on the Aransas National Wildlife Refuge and surrounding bays was investigated by a team from Texas A&M University in order to prepare an environmental impact statement for the U.S. Army, Corps of Engineers. More than 60 scientists and technicians from the Wildlife and Fisheries, Biology, Meteorology, Geology, and Oceanography Departments were involved. The data indicate that shell dredging has no significant, irreversible effects on the ecosystem of the bay.

In addition to sedimentologic and subbottom studies, the geologists undertook most of the circulation, flushing, remote sensing, foraminiferal, and chemical studies. Some also were involved in investigating economics, reef silting, and dredge discharge.

San Antonio Bay has an average depth of 4 ft and contains numerous large and small reefs. As a result of the bay's shallowness, the circulation and flushing are controlled primarily by wind and river discharge, and therefore patterns of these aspects are erratic. Nevertheless, certain consistent patterns can be distinguished on the bay bottom as well as in the shallow subsurface. Heavy-mineral distributions and clay-mineral studies present complementary information. The distribution of modern reefs differs little from that of buried reefs. These distributions and several borings reveal the gross topography of the buried Pleistocene surface.

It is clear that in such an environmental impact study, a thorough investigation of the geologic, physical, and economic aspects is equally as important as understanding the biologic aspects of a coastal ecosystem.

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What Has Apollo Program Found Out about the Moon?

The moon was formed 4.6 b.y. ago at about the same time as the earth and meteorites. At the time of accretion, temperatures probably were below the solidus in the deep interior and at, or above, those of the liquids in the outer part. The material that formed the outer part of the moon was richer in some refractory elements and poorer in iron and some volatile elements than was the earth. From 4.6 to about 4.0 b.y. ago, a lunar crust about 65 km thick was formed; this highland crust is rich in anorthositic gabbro and other rocks of anorthositic affinity. During the period of highland formation and differentiation, the moon was bombarded heavily by asteroid-size bodies and circular mare basins were formed by the impact. The heavy bombardment caused considerable mixing of rock types and breccia formation. Pristine highland rocks and radiogenic clocks were reset during this period, so that crystallization ages greater than 4 b.y. are rare. Partial melting at depths between 150 and 400 km occurred from about 3.8 to 3.1 b.y. ago and produced pyroxenite basalts that filled the mare basins predominantly on the lunar front side.

Controversy exists as to whether the alumina-rich lunar crust is accretional in origin or was developed by widespread differentiation process in which a pyroxene-rich upper mantle and alumina-rich crust were formed. Surface magmatic activity virtually had ceased by 3 b.y. ago.

Lunar heat flow is about half that of earth; the bulk of potassium, uranium, and thorium is concentrated in the lunar crust. From 4 to 3.2 b.y. ago, the lunar surface was exposed to a magnetic field of at least 2,000 gammas, which was produced either externally or internally.

Seismic data indicate that the mantle is ultramafic (velocities 8–9 km/sec) and presently is rigid at temperatures below the solidus to a depth of 800 km. Below 1,000 km the mantle is partly molten and a small metal-rich core may exist. The moon has a bulk density of 3.35 g/cu cm and a coefficient of moment of inertia of about 0.4.

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Coccoliths from Desoto Canyon Region, Gulf of Mexico.

Coccolith assemblages from the northwest slope of the Florida coast indicate sedimentation rates and temperature variations during the past. Time counts of *Gephyrocapsa oceanica* from 4 cores produced correlative curves that reflect the sedimentation rate. Ratios of the frequencies of *Ceratolithus* species and *Discolithina* species indicate that these genera were affected by similar parameters; a ratio of *Discolithina* morphotypes yields an apparent temperature curve. A magnetic intensity change correlates with a significant decrease in coccolith frequency.