in the sediments is primarily pelecypod shell fragments. Concentration of carbonate material is a function of currents and wave activity. A few species of Foraminifera and Ostracoda which can tolerate severe fluctuations of salinity comprise the microfauna.

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Quartz Microtextures as Indicators of Subaqueous Density Flow

Quartz samples from density flow deposits from the Colombia basin (Caribbean Sea) were analyzed for surficial microtextural associations using the scanning electron microscope. Microtextural abrasion patterns were found to vary in the "A" division of turbidites, grain-flow deposits, debris-flow deposits, and in material resulting from washover on the Magdalena deep-sea fan. The observed microtextural patterns are useful criteria for the identification of the transport mechanisms of other deposits assumed to have resulted from density flows.

Relative distances of travel of contemporaneous turbidites could be ascertained from impact densities on "A" division sand grains. The limiting conditions on such analyses are a minimum of postdepositional alteration of the mechanical textures of the grains and a lack of intense abrasion features received during episodes of predensity-flow transport.

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Geology of Suwannee Basin Interpreted from Geophysical Profiles

The Suwannee basin developed in Mesozoic time as a broad syncline on a smoothly eroded Paleozoic terrane. It is in the eastern Gulf Coast area and includes parts of Florida, Alabama, and Georgia. Its axis extends northeasterly from Apalachicola, Florida, into southwestern Georgia.

Deep drilling in the eastern Gulf Coast region has penetrated the Tertiary and Mesozoic section, but wells seldom have extended very deeply into pre-Mesozoic rocks. Geophysical Service Inc. conducted a survey in the Suwannee basin consisting of reflection-seismic profiles plus gravity and magnetic readings. The seismic sections provided the basic framework for a geologic interpretation. Drilling information helped to establish control for the upper part of the sections, and also aided in verifying interval-velocity determinations. Velocity analyses were spaced one mi apart, with about 14 interval determinations at each point. These computations permitted display of the sections in depth as well as time. Models of gravity and magnetic fields were generated by computer programs which permitted comparison of interpreted and observed fields. Thus the geologic interpretation could be altered to test various hypotheses, and refinements continued until data were reconciled.

Our interpretation shows Tertiary and Cretaceous sedimentary rocks lying upon a remarkably smooth unconformity developed across Paleozoic and Triassic rocks. The unconformity dips southward from a depth of 2,560 m near the Alabama-Florida boundary to about 3,600 m near Panama City, Florida. Below the unconformity is a folded and faulted sequence of lower Paleozoic rocks and Triassic continental strata accompanied by volcanic flows or intrusives. Paleozoic rock types appear to include volcanics, quartzite, and a sandstone-shale sequence. Individual structures are large and varied, and include broad anticlines developed above thrust faults. The Paleozoic rocks are correlated with African counterparts, and it is suggested that their hydrocarbon potential warrants further investigation.

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Stratigraphic Relations and Petroleum Potential of Smackover-Buckner Sequence (Jurassic), Clarke County, Mississippi

In eastern Mississippi, the upper member of the Smackover Formation and the lower member of the Buckner Formation represent a major regression of the Jurassic shoreline. The upper Smackover carbonate strata were deposited under shallow open-marine conditions, and the vertical sequence indicates progressive shoaling and basinward progradation of environments. The overlying lower member of the Buckner Formation consists of thick units of nodular anhydrite with interbedded dolomite, and is inferred to be the supratidal equivalent of the upper Smackover marine carbonate rocks.

The principal reservoir rocks in the Smackover Formation are oolitic grainstones with primary depositional interparticle porosity. The high-energy oolitic deposits formed by tidal action on shoals which were aligned roughly parallel with the coastline. An understanding of the structural and sedimentologic factors which controlled the location of the oolite shoals is critical to exploration in adjacent areas. The oolitic deposits appear to have built up as a consequence of the intersection of wave base and a gently sloping sea floor, as there is no indication of a controlling shelf break.

Although there is strong evidence of penecontemporaneous growth of salt-cored anticlines during deposition of the upper Smackover sediments, these structures are not thought to be the principal factor in controlling the location of the high-energy shoals.

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Early Cretaceous Stuart City Shelf Margin of South Texas: Its Depositional and Diagenetic Environments and Their Relation to Porosity

The Stuart City trend, South Texas, represents a climax biogenic development along the Early Cretaceous (late Aptian, Albian, and early Cenomanian) shelf margin. Landward of this trend, a wide variety of shallow-water shelf carbonate sediments accumulated on a broad, relatively flat platform. Seaward, the entire section consists of dark planktonic foraminifer-bearing argillaceous carbonate sediments. The sediments of the Stuart City trend make up the Stuart City limestone, which attains a total thickness of 2,000 to 2,500 ft. Time-equivalent rocks which crop out in central Texas are the Glen Rose and Edwards Formations. Between 1954 and 1961 many wells ranging in depth from 11,000 to 20,000 ft were drilled with the Stuart City Formation as their final objective. Of the 19 wells from which cores were obtained for this study, 12 were considered gas wells with initial production ranging from 1.5 to 36.5 MMCFGD. Six of these wells still produce gas. Depositional facies and environments and their relation to the diagenesis and porosity development provide a model for further hydrocarbon exploration along the Stuart City and the deeper Sligo trends.

The Stuart City carbonate rocks have been assigned to five major environments of deposition: shelf lagoon, shelf margin, upper shelf slope, lower shelf slope, and open marine. The shelf-lagoon facies include miliolid wackestone, mollusk wackestone, toucasid wackestone, and mollusk-miliolid grainstone. These facies accumulated in generally low-energy condition in water depths from 0 to 20 ft. In contrast, the narrow band of shelf-margin carbonate rocks is made up of coral-caprinid boundstone, requienid boundstone, and rudist grainstone, all of which accumulated in moderate to high-energy conditions and in less than 15 ft of water as a complex of reefs, banks, bars, and islands. Seaward of the shelf margin, the upper shelf-slope environment comprises the caprinid-coral wackestone and coral-stromatoporoid boundstone facies, the lower shelf slope, the intraclast-grainstone, echinoid-packstone, and echinoid-mollusk-wackestone facies. Farther seaward in water depths greater than 60 ft, the open-marine environment is represented by the planktonic-foraminifer wackestone basins.

Porosities in the carbonate rocks of the Stuart City trend are divisible into two main types, those which are fabric related and those which are nonfabric related. Primary fabric-related types consist of intraparticle and interparticle. Primary intraparticle porosity, openings within the body chambers of the rudists, is present in the caprinid-coral wackestone, coral-caprinid boundstone, and requienid boundstone. Primary interparticle porosity was originally very high (greater than 30 percent) in the rudist grainstone facies but cementation soon after deposition—submarine, phreatic, and meteoric—reduced the porosity to less than 10 percent, and late subsurface cementation filled the remaining porosity. Primary interparticle porosity now is present only in a few very thin intervals.

Secondary fabric related porosity consists of solution-enlarged interparticle and moldic. Both occur in the boundstone and grainstone facies but in very thin restricted units. The poor development of solution enlarged interparticle and moldic porosity reflects the minor role that subaerial exposure played during the development of Stuart City trend.

Nonfabric related porosity consists of vertical fractures. This type of porosity is present in abundance in several studied wells in the form of open, nonlined, vertical fractures.

The low porosities along the Stuart City Trend are the result of two processes—(1) lack of significant periods of subaerial exposure for development of secondary porosity types and (2) massive cementation which destroyed primary porosity. Further exploration along this trend should be aimed at identifying areas which may have been exposed soon after deposition and developed secondary porosity or areas which subsided more rapidly and have preserved primary porosity.

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Analysis of Water-Level-Rise Effects on Littoral Transport

A computer project has included evaluation of the effects of changes in wave height, wave period, wave-approach angle, bottom slope, and water depth on beach erosion. This work is primarily applicable to large lakes where long-term changes in water level may be as much as one or two m. The change in potential erosion is expressed as a ratio of littoral power values. The most important independent variable entering into this ratio is the change in water level. An increase in level of one or two m can give ratios in the range of 100 to 250 and even higher. A ratio of 100 means that, after the rise in level, the littoral component of power, and hence the amount of sand eroded and transported, is initially 100 times as great as prior to the rise.

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Environmental Geologic Atlas, Texas Coastal Zone: Role of Geology in Land-Use Planning

The *Environmental Geologic Atlas of the Texas Coastal Zone*, which required 25 man-years of research, was initiated in 1969 to meet a growing need for basic land resource information about one of the most rapidly developing regions of Texas. The coastal zone, covering about 20,000 sq mi, is not only an area of accelerating, competitive, and, sometimes, conflicting land use, but it is also a region of dynamic natural processes and delicately balanced environments. The coastal zone is underlain by a wide variety of Pleistocene and Holocene/modern facies with differing physical properties and land-use capabilities. Large-scale mapping (1:24,000) of first-order units, including substrates, biology, processes, and man-made features, resulted in the principal environmental resource document—the Environmental Geology Map. This map, at a scale of 1:125,000, displays the distribution of 130 units, which comprise both Pleistocene and Holocene/modern fluvial, deltaic, barrier-strandplain-chenier, offshore, bay-lagoon-estuary, marsh-swamp, eolian, and man-made coastal systems.

A series of 8 Special-Use Environmental Maps at a scale of 1:250,000 were, in part, derived from the Environmental Geology Map, and, in part, compiled from other extensive data sources. The special-use map series includes: Physical Properties; Environments and Biologic Assemblages; Current Land Use; Mineral and Energy Resources; Active Processes; Man-Made Features and Water Systems; Rainfall, Stream Discharge, and Surface Salinity; and Topography and Bathymetry. These maps, which contain about 150 units, were designed for the special requirements of various users; an almost unlimited number of such special-use and thematic maps can be generated from the basic map data.

A further step toward application of environmental geologic information in land-use planning was derivation of fundamental planning units based on carrying capacity. These units alternately have been termed resource-capability units and land-resource units. Each land-resource unit is an areally defined entity that exhibits a unique set of properties, which limits or sustains its use for the wide variety of human activities. The properties of land-resource or resource-capability units, which can be quantified and digitized, may serve as principal input into land-use inventory and planning systems being devised to support future land-use decisions. A land-use planning system that is based realistically upon the nature and variability of natural systems and coastal substrates can provide a commonsense, flexible, and fair approach to land-use planning. Such a system provides potential users with options long before development becomes a reality, enabling users to plan for necessary engineering improvements and/or economic trade-offs. Fundamental geology is a critical element in such a land-use decision system.

BRYANT, W. R., WILLIAM E. HOTTMAN, and PETER K. TRABANT

Permeability of Unconsolidated and Consolidated Marine Sediments, Gulf of Mexico

Permeability of a large number of natural marine sediment samples from the Gulf of Mexico was determined through the use of laboratory consolidation tests. The samples were divided into groups as follows. Group 1, sediment consisting of more than 80 percent clay (material 2μ or less in size); Group 2, sediment containing from 60 to 80 percent clay-size material; Group 3, silty clays with less than 60 percent clay; Group 4, silts and clays that have a significant sand-size fraction present (more than 5 percent sand). The permeabilities of the groups ranged from 10^{-5} to 10^{-10} cm/sec with 35 ppm normal seawater being used as the saturating fluid.

A statistical analysis of the natural log of permeability versus porosity was used to develop the permeability prediction equation for each of the groups listed. The equation for Group 1 is $k = e^{P(15.05) - 27.37}$, for Group 2 $k = e^{P(14.18) - 26.50}$, for Group 3 $k = e^{P(15.59) - 26.65}$, for Group 4 $k = e^{P(17.51) - 26.93}$, and for all data $k = e^{P(14.30) - 26.30}$, where P is the porosity (in decimal) and k is the coefficient of permeability.

These equations are useful for predicting changes in permeability with depth in fine grained sediments of the Gulf of Mexico. The ability to predict permeability in a continuous sequence, where the deposition history is known, may explain the large variations that we see in the physical properties in sediments similar in grain size and mineralogy.

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Recognition of New Potential of Swan Lake Field, Jackson County, Texas

A new geologic evaluation of Swan Lake field led to the discovery of 24 new reservoirs. The field originally was found in March 1950; initial development drilling ended in 1957. Sun Oil Co. took over operations in 1970. A new lower Frio structural