

in 13 sections of late Paleocene and early Eocene strata yields a series of possible subdivisions. These subdivisions may be considered analogous to biostratigraphic zones, but they are defined in terms of a given level of the probability that a particular sequence is due to nonrandom distribution of species occurrences. Considering 144 species, and using a level of probability greater than 0.8, sequential relations exist between the lowest occurrences of 87 and between the highest occurrences of 86 of the species. Eleven stratigraphic intervals can be recognized using lowest occurrences exclusively and 9 intervals using highest occurrences exclusively. The limits of each interval can be defined in terms of mutually random occurrences of several different species.

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STONE CITY AND COOK MOUNTAIN (MIDDLE EOCENE)  
SCAPHOPODS FROM SOUTHEAST TEXAS

Middle Eocene exposures on the Brazos and Little Brazos Rivers yield numerous specimens of a wide variety of fossils, especially mollusks. Although this fauna has been known to paleontologists for many years, relatively few of the fossil groups have received a detailed analysis.

Eighteen species of scaphopods have been found in the Stone City and Cook Mountain (Claibornian) Formations of the Brazos River valley. These include 11 species of *Cadulus*, 4 of *Dentalium*, and 3 of *Fustiaria*. Of these, 10 species are new.

Apical fragments show that some scaphopods truncate their apices by periodically discarding a significant portion of the test. By some mechanism or process, probably absorption, shell material is removed at a distance from the apex. The configuration of this shell removal is such that apical slits or grooves are already formed when truncation occurs. After truncation a pipe or sheath, which extends from the orifice of the truncated apex, may develop.

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STRATIGRAPHIC ANALYSIS OF DIPLOGS

Recently, the diplog has been used to estimate stratigraphic conditions of the formations penetrated by a borehole. In particular, the diplog frequently can be utilized to predict the trend, direction of thickening, and movement of depositing currents in channel- and barrier-bar sandstones.

Because of compaction and bifurcation, channel sands tend to be more complex and difficult to interpret using a diplog. However, barrier-bar sands commonly can be interpreted correctly from the diplog.

Many thick sequences of fluvial sands do not exhibit channel-dip patterns. In some problems, the use of statistical analysis is useful. In many instances, the determination of the type of sand from a diplog in fluvial sequences will be difficult.

Barrier-bar sands exhibit several different types of crossbedding depending on the relative importance of tides, longshore currents, and onshore winds in forming and modifying these deposits. The present interpretational techniques for this type of deposit use differential compaction of the overlying shales as a key to the analysis.

The general interpretation of diplogs for stratigraphic information requires the use of statistical plots. The polar coordinate (modified Schmidt) and azimuth frequency plots especially are useful in the analysis of certain stratigraphic anomalies.

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OCURRENCE AND ALTERATION OF CLAY MINERALS IN CARIBBEAN SEA

Both vertical and horizontal trends in clay mineralogy are examined in cores from the southwestern and central Caribbean. X-ray diffraction, differential thermal analysis, infrared spectroscopy, and electron micrography are used to determine the clay mineralogy. Montmorillonite, vermiculite, mica, kaolinite, chlorite, halloysite, allophane, and gibbsite are identified by the above methods.

Alteration of clay minerals in the marine environment is examined by noting the trends between cores for various selected ratios. Diagenesis of a clay mineral is defined as the alteration of the mineral in such a way that it loses its identifying characteristics. Gibbsite and allophane probably alter to halloysite in the marine environment. Ratios for vermiculite and mica show a decrease in vermiculite with distance from the river mouth. Ratios for montmorillonite to mica show an increase in montmorillonite with distance from the river mouth. The chlorite to mica ratio also shows a decrease in a seaward direction, probably the result of both the alteration of chlorite and the increase in mica. A slight decrease is seen in the ratios for kaolinite and mica in a seaward direction due to mica forming at a faster rate than kaolinite. The chlorite to kaolinite ratio decreases in a seaward direction due to both the alteration of chlorite and development of kaolinite. The clay mineral ratios for the vertical profiles show an irregular pattern. Changes in source area or climate are stronger factors than marine alteration in determining the vertical trends in surface sediment cores.

Differential transport is seen in the montmorillonite and halloysite concentrations. Both minerals increase in a seaward direction. Their small particle size causes them to avoid coarsenate formation and flocculation upon initial entrance into the marine environment.

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INTERACTIVE GRAPHICS IN PETROLEUM EXPLORATION

During the past 10 years the digital computer has been used to assist in many of the discrete functions of petroleum exploration. However, the total petroleum exploration process requires that many discrete activities be carried out in varied and complex combinations to achieve the goal of anomaly isolation and evaluation. This process can be enhanced by a geologist operating interactively with a computer to select and control the sequence of functions. Communication between man and machine can be carried out by means of a cathode ray tube display.

KOERNER, R. J.

WHERE WE ARE IN NUCLEAR POWER DEVELOPMENT

No abstract available.

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MISSISSIPPI AND MEKONG DELTAS—A COMPARISON

The areal extent, the recent geologic history, and the landforms that have developed in the Mekong and Mississippi deltas generally are similar. Discharge, velocities, and stage variation are reasonably alike. Sinuosity, the rate of bank migration, delta growth and subsidence, and shoreline configuration and growth are

markedly dissimilar. A partial parallel in the 2 river systems is the upstream diversion of a sizable part of the Mekong's flow by the Bassac and of the Mississippi's flow by the Atchafalaya. Flood relief afforded by the Tonle Sap, a massive sump more than 200 mi upstream from the mouth of the Mekong has no counterpart in the Mississippi system. The effect of this sump in smoothing stage differences in the river downstream from the point of diversion may be one important reason for the differences between the river systems. The Tonle Sap also may affect sediment concentrations in the Mekong, concentrations which are not only lower than on the Mississippi but are also strikingly different from the standpoint of coarse-to-fine ratios. Two additional reasons for the dissimilarity in the amount and nature of sediment load reaching the sea are the marked difference in tidal variation affecting the river systems and the fact that the Mississippi essentially is confined between artificial levees. The Mekong largely is unweeded and a large proportion of its suspended fine sediments is deposited overbank before they reach the sea.

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#### SIGNIFICANT STUDIES OF MODERN AND ANCIENT DELTAIC SEDIMENTS

A critical analysis of the geologic literature of ancient deltaic sediments reveals that there has been a noticeable increase in the number of significant papers since 1959. During the 80-year period prior to 1959 only 8 papers on ancient deltas appeared in print. These early contributions were by Gilbert (1885, 1890), Barrell (1912), Barton (1930), Twenhofel (1932), Busch (1953), Pepper *et al.* (1954), and Nanz (1954). During a 5-year period beginning in 1959, 12 significant publications on ancient deltaic deposits of the United States, England, Scotland, and Brazil appeared in print. In the past 8 years an additional 14 papers have been published. Thus, during the 13-year period since 1959, the publication of significant delta papers has been at the rate of about 2 papers per year.

A review of the literature on the geology of modern deltas also is quite revealing. Prior to World War II only 7 papers on modern deltas of North America were published. These were: Johnson (1920, 1921) on the Fraser delta of northwest Canada; Trowbridge (1930), Russell (1936), and Russell and Russell (1939) on the Mississippi delta; and Sykes (1937) and McKee (1939) on the Colorado delta of southern California and Mexico.

Following World War II there was a steady increase in the studies of modern deltas beginning with Fisk's work on the Mississippi delta (Fisk, 1944, 1947, 1952, 1954, 1955, 1958, 1961). Other important studies of modern deltas were: Moore and Scruton (1957), Scruton (1960), and Welder (1959) on the Mississippi delta, and Kruit (1955), Van Straaten (1961), and Laajaaj and Kopstein (1964) on the Rhone delta of southern France.

Post-World War II research on the Mississippi and Rhone deltas and other studies of modern deltas provided reliable criteria for recognition of sedimentary rocks of deltaic origin and also established much needed concepts of deltaic sedimentation. The increase in the number of publications on ancient deltas since 1959 clearly reflects the extensive application of these criteria and concepts to the study of older rocks. This ability to interpret ancient deltaic sediments is one of the greatest achievements in the field of stratigraphy and sedimentology in the past several decades.

On the basis of the writer's 30 years of experience in the field of clastic sedimentology, he has selected what he considers to be the most significant contributions to our present understanding of modern deltas and ancient deltaic deposits.

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#### ENVIRONMENTAL MODELING—USEFUL EXPLORATION TOOL IN CARBONATE ROCKS

The areal distribution of hydrocarbon-producing fairways within any particular carbonate shelf results from the imprints left in the rocks by climate, wind, tide, and contemporaneous tectonic history. Carbonate shelves marginal to the oceanic basins are different from those which formed adjacent to the cratonic basins.

Combinations of the above factors produce a spectrum of environments which can be interrelated within the framework of an environmental model.

Holocene carbonate-depositional models such as Bahama-Florida, British Honduras, Persian Gulf, Shark Bay, and others have provided clues needed to analyze the ancient carbonates and to recognize the appropriate environmental model. The comparison of Holocene models provides a cause-and-effect relation between different factors.

During the early stages of exploration in a carbonate province one should attempt to select an appropriate environmental model from petrologic study of surface and subsurface data. Such a model can be molded to fit the tectonic framework of the basin. The resulting paleoenvironmental model is useful for extending productive fairways and for predicting new trends.

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#### DELTAIC AND ASSOCIATED FACIES OF DIFUNTA GROUP (LATE CRETACEOUS TO PALEOCENE), PARRAS AND LA POPA BASINS, COAHUILA AND NUEVO LEON, MEXICO

The Difunta Group is gray calcareous mudstone, siltstone, and sandstone that interfingers with wedge-shaped redbed units. These complexly interfingering units are divided into 13 formations and many members, tongues, and lentils; the group has a thickness of 10,000 ft.

Low-sinuosity, high-bedload streams transported volcanic and sedimentary rock debris from the Sierra Madre Oriental eastward to the ancestral Gulf of Mexico. Separate rivers fed the Parras and La Popa basins. Sediment accumulated in arcuate, wave-dominated deltas that prograded slowly into water several hundred feet deep. Some sediment was transported by marine processes to shallow delta-flank environments.

Delta-plain lake and interfluvial deposits are bioturbated mudstones containing sparse leaves, charophyte oögonia, dinosaur bones, and oyster debris. Many beds were reddened by postdepositional oxidation of iron-bearing minerals. Delta-front sheet sands are 20–60 ft thick, well sorted, flat bedded, and have sparse *Ophiomorpha*. Delta-platform deposits are characterized by sequences of ball-and-pillow structure and a sparse molluscan fauna. Prodelta deposits are interbedded graded sandstone and bioturbated mudstone; the sandstone beds were deposited by turbidity currents generated at the delta front by hyperpycnal inflow.

Carbonate banks up to 1,000 ft thick developed in distal prodelta (shelf) environments on submarine