

the origin and ecology of the region are products of deltaic processes, it can be described appropriately as a self-maintaining natural system.

Human activity has altered seriously the natural balance of the delta system. Massive environmental degradation has occurred during the past 30 years, and the entire system may soon collapse. Primary causes of deterioration include (1) flood-control and navigation improvement; (2) accelerated subsidence; (3) urban encroachment into wetlands; and (4) water pollution.

A pilot study in south-central Louisiana has reviewed the problem of restoring the system's balance and allowing for projected growth and development. A multi-use management plan based on analysis of natural and human processes operating in the area and land-use suitability has been proposed. Highways and other public-works projects provide the mechanism for directing growth and development to environmentally suitable areas. Renewable resource areas are identified, and management priorities and guidelines outlined. A water-resource management program calls for conservation of local runoff as well as directing Mississippi River water and sediment for environmental maintenance and enhancement. Controlled delta building and introduction of supplementary water into estuarine basins will partly restore the delta-system balance. Other features of the plan include identification of transportation and utilities corridors, man-made barrier islands as protection against erosion and storm surge, geometries for dredge cuts and spoil designed to create habitat diversity and optimize hydrology.

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CALCAREOUS NANNOFOSSIL STUDIES—STATE OF ART

Nannofossils commonly occur in astronomically large numbers in fine-grained marine deposits. This fact, coupled with the rapid evolution that characterizes the group and the succession of distinctive assemblages, makes them extremely useful for dating Mesozoic and Cenozoic marine strata.

Cenozoic nannofossils are best known; consequently zonation of this interval is the most satisfactory. Two recent compilations of Cenozoic nannofossil zones list 46 and 49 zones, respectively, for a time period of 65 million years. Most zones can be recognized in marine sediments of the different continents and ocean basins. Local and regional zonations are possible on a finer scale in many areas, because of the many "provincial" species present in hemipelagic sediments. However, the same "provincial" species are found in hemipelagic sediments on several continents.

Mesozoic nannofossils are less well known, although considerable work has been done on the diverse assemblages from Upper Cretaceous chalks and marls from which several hundred species have been described. Lower Cretaceous and Jurassic deposits contain appreciably less-diverse nannofossil assemblages. Several partial zonations have been proposed for the Jurassic and Cretaceous, but these are considered only preliminary and are not entirely satisfactory.

The immediate need in further nannofossil studies is for systematic studies in the Mesozoic for biostratigraphic purposes. In the Cenozoic the most profitable areas of research probably are to determine the environmental significance of the many "provincial" and hemipelagic species. In addition, much useful information can be derived from intensive studies on individual lineages such as have been undertaken with the genera *Chiasmolithus*, *Helicopontosphaera*, and *Sphenolithus*.

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RESULTS OF STUDY OF NATURAL HYDROCARBON SEEPAGE IN GULF OF MEXICO

The Department of Oceanography has been studying natural hydrocarbon seeps in the Gulf of Mexico for several years in cooperation with 11 oil companies and the Sea Grant program of the National Oceanic and Atmospheric Administration. Archaeological reports indicate that the Karankawa Indians used tar in their pottery making in pre-Columbian times; and survivors of DeSoto's group used tar found along the Texas-Louisiana coast to calk their boats. From 1902 to 1909 heavy oil slicks were noted in an area about 100 mi south of the Louisiana coast and the locations plotted on charts issued by the United States Coast and Geodetic Survey. Oil spouting into the air was reported in the same area in 1909, and oil ponds off the Sabine area were reported in a United States Geological Survey publication in 1903.

Reports of seeps in the Gulf of Mexico are numerous, and the Department's study has located several general areas of seepage within and around the Gulf. Tar samples from these areas, as well as samples found floating in the Gulf, have been collected and analyzed chemically.

The seep sites have been studied geologically and geophysically, and pertinent chemical, biological, and physical oceanographic characteristics were determined.

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POTENTIAL FOR SOLAR ENERGY APPLICATIONS

Future energy needs can determine the potential of solar energy applications. There are large-scale applications for energy production from wind, ocean thermal temperature differences, solar thermal power plants, and photovoltaic energy conversion. Near-term approaches, including house heating and cooling, have great potential for conserving energy. Solar heating and cooling costs will vary in different regions of the United States. Specific programs have been designed to introduce solar house heating and cooling on a substantial scale. New architectural approaches to incorporating solar heating and cooling systems have been determined.

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SCANNING ELECTRON MICROSCOPE APPLICATION TO FORMATION EVALUATION

The scanning electron microscope (SEM) can be utilized to relate rock type to pore geometry, log response, and fluid distribution in reservoir rocks. SEM photos have aided in properly evaluating other engineering and geologic data to establish production which normally might be overlooked. The alteration of sands by cementation can be documented, and original environments of deposition can be reconstructed by using the scanning electron microscope.

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PROBABILISTIC ANALYSIS OF DISTRIBUTION OF LATE PALEOCENE-EARLY EOCENE CALCAREOUS NANNOPLANKTON

Probabilistic analysis of a suite of internally consistent data on the distribution of calcareous nannofossils