Discounted cash-flow rates of return for the 7 fields ranged from 1.1 to 19.5%. Under the 2 specified conditions set up for the model (a 20-year and a 30-year oil depletion model), the rates of return are 17.2 and 13.7%, respectively.

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ORIGIN OF CRISTOBALITE-RICH TERTIARY SEDIMENTS IN ATLANTIC AND GULF COASTAL PLAIN

Chemically precipitated alpha-cristobalite is a common matrix constituent of many fine-grained siliceous Tertiary rocks of the Atlantic and Gulf coastal plains. It forms as a low-temperature authigenic mineral having a free growth morphology of fine blades arranged in spherulitic clusters 3–12 microns in diameter called "lepispheres." Cristobalite lepispheres have been observed via scanning electron microscopy of fracture surfaces through a wide variety of lower to middle Tertiary flint clays, claystones, "opal claystones," "buhrstones," and "pseudobuhrstones." Microspherulites of identical morphology also compose moderate to large percentages of offshore Caribbean-North Atlantic sediments of equivalent age including cherts, silicified limestones, and chalks. The source of silica for these deep-water sediments is thought to be fossil diatom and radiolarian tests.

The immediate source of silica precipated as low-temperature cristobalite in coastal plain sediments generally has been ascribed to supposed volcanic sources in the Gulf Coast or Caribbean areas. Volcanic ash accumulations or direct precipitation from silica-rich bottom waters circulating above such ashes have been postulated. In major ocean basins explored by the Deep Sea Drilling Project, however, cristobalitic cherts are seldom associated directly with ash sequences although some diatom and radiolarian remains usually are preserved in these cherts. Scanning electron micrographs and petrographic studies of opaline claystones from South Carolina (Black Mingo Formation) have revealed many molds or tests of siliceous fossils preserved in a cristobalitic matrix of lepispheres similar, if not identical to, the matrix of deep-sea cristobalitic cherts thought to be derived from the *in situ* dissolution and reprecipitation of siliceous microfossils. These findings suggest a biogenous source of silica for most of the cristobalitic matrix of these Atlantic coastal plain sediments, an observation supported by the paucity of zeolites in the units. Siliceous tests also are observed in the Tallahatta Formation of Alabama, an indication that a biogenous source was important in the silicification of some Gulf coastal plain sediments as well.

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ESTIMATE OF ANNUAL INPUT OF PETROLEUM TO MARINE ENVIRONMENT FROM NATURAL MARINE SEEPAGE

Part of the oil now present in the world's oceans results from the direct discharge of submarine seeps into the water. Proper assessment of the present "hydrocarbon load" carried by the oceans, as well as the evaluation of the proportion contributed by other sources (both natural and by man), requires a reliable estimate of the yearly worldwide seepage rate from marine seeps. Although only a few marine oil seeps presently are known and located, all evidence suggests that with further investigation, many more will be found. In view of the limited observations, only a few cursory estimates of total worldwide annual-marine seepage have been made; there appears to be no substantiation for any of these estimates. This paper, which represents a first documented approach based on geologic considerations, presents an estimate of yearly oil input into the oceans from naturally occurring marine seepage.

A geologic model based on structural styles, recent earthquake activity, and sediment thicknesses was used to classify the continental margins into areas of high-, moderate-, and low-seepage potential. Flow-rate data for each of the 3 type potential areas were fitted to a log-normal probability distribution and seepage volumes were determined.

The probable range of seepage into the marine environment is 0.2 to 6.0 million metric tons per year. Within this range the best estimate for present marine seepage worldwide is *0.6 million metric tons per year.* Based on this estimate, areas of high-seepage potential contribute about 45% of the worldwide seepage. In the Pacific Ocean, high-seep potential areas are by far the major contributors. In the Atlantic and Indian oceans, moderate-seep potential areas are most significant. The circum-Pacific area is the area of greatest seepage; it is estimated to contribute about 40% of the world's total.

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CALCAREOUS NANNOFOSSIL DATUM LEVELS ASSOCIATED WITH PLIOCENE-PLEISTOCENE BOUNDARY

The extinction horizon of *Discoaster brouweri,* or datum, commonly is applied by calcareous nannofossil workers as a criterion for placement of the base of the Pleistocene in deep-sea cores. Investigators also have said that at Le Castella, Italy, gephyrocapsids having a distinct central-bar area (*Gephyrocapsa caribbeanica*) appear first at a horizon several meters below the extinction horizon of *D. brouweri.* Deep-sea cores taken on the Nicaragua Rise in the Caribbean also support this relation. Analyses of piston cores from the southern ocean, however, show that the life ranges of *D. brouweri* and *G. caribbeanica* are not concurrent at high latitudes, and here the *Coccolithus doroncoides* zone was erected to span the interval between the datum levels of these species. This interval zone subsequently has been observed in southern California, the equatorial Pacific (defined there as the *Emeliania annula* subzone), and in deep-sea cores from the northern Atlantic and northeast Pacific Oceans, and in the Tyrrhenian basin west of Naples, Italy.

The magnitude of this interval at high latitudes seemingly is greater because of an earlier last occurrence of *D. brouweri* in boreal regions about 2.5 m. y. ago (Deep Sea Drilling Project core 173 offshore northern California, where the interval is 75 m). Therefore, it is suggested, that the first appearance of *G. caribbeanica* provides a better approximation of the base of the Pleistocene than does the last occurrence of *D. brouweri.*

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PRE-JURASSIC GEOLOGIC FRAMEWORK, NORTHERN GULF BASIN

The early history of the Gulf basin is conjectural. It once was believed the basin formed by late Paleozoic foundering of Llanoria, a postulated large offshore landmass occupying much of the present basin area.

Currently, there are two schools of thought: (1) the basin has existed since late Precambrian; or (2) it was formed by early Mesozoic sea-floor spreading in the Gulf, a product of the general breakup of Pangea into continental blocks.

Late Paleozoic orogeny, in phase with or a part of a west-southwestward continuation of Appalachian folding, created a northern structural rim for the basin which strongly influenced subsequent sedimentation and structural trends. Postorogenic tension faulting along and south of this rim was particularly active during the Triassic. Jurassic sediments along the flank and gulfward from the structural rim overlie this faulted basin floor and are in unconformable contact with rocks ranging in age from Triassic to Mississippian.

Triassic sediments are fluvial to deltaic redbeds. Paleozoic deposits include both "Ouachita facies" and unmetamorphosed fluvial to offshore marine clastic rocks and highly fossiliferous shallow-water carbonate rocks. Seismic data suggest Triassic and/or late Paleozoic sediments underlie the Jurassic throughout the Gulf basin. These pre-Jurassic rocks comprise a large, very sparsely tested frontier for oil and gas.

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PROBABILITY-BASED ANALYSIS OF AREA-TIME DISTRIBUTION OF OLIGOCENE CALCAREOUS NANNOFOSSILS

Computer-processed, probability-based statistical analysis of the published stratigraphic information on 25 common calcareous nannofossil species present in 51 long sections of Oligocene strata indicates that the 5 Oligocene zones of the standard Paleogene zonation of Martini (1970) are very reliable. However, the available number of subdivisions is far greater than previously supposed and is likely to increase as more sections are studied. It also is evident from this study that the sequence of biostratigraphic datum surfaces for an area is dependent on both evolution and the environment in which it is found, so that sequences differ significantly among biogeographic provinces.

In this analysis, water depth and latitudinal position were used to separate 51 sections from the equatorial region and Northern Hemisphere into 4 overlapping groups. The sections first were separated into high and low-latitude groups, neritic and oceanic groups, and into the combinations of these, making a total of 8 groups. A most probable biostratigraphic sequence of datum surfaces was found for each of these groups and compared with each other, and with the composite based on all by means of cross sections and a fence diagram.

It is suggested that maximum gain in biostratigraphic resolution will result from intensive study of new and previously described sections with the aim of separating as many datum surfaces as possible from each other. The description of new species and detailed taxonomic classification, although important to local problems, will add little to global biostratigraphic resolution.

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EVOLUTION OF NORTHERN GULF COAST DEDUCTED FROM GEOPHYSICAL DATA

Seismic refraction data from the western part of the northern Gulf Coast of the United States indicate that the uppermost crust of the Gulf region consists of a thick sequence of sedimentary rocks locally ranging up to 17 km thick. Beneath the sedimentary sequence a layer with velocities ranging from 5.2 to 6.0 km/sec probably consists of high-velocity sedimentary rocks (salt and carbonates) possibly overlying a thin upper crustal layer. The combined thickness of the sedimentary sequence and the 5.2–6.0 km/sec layer is between 15 and 20 km. The deeper crust is 12–20 km thick beneath the interior of the coastal plain and thins seaward. The velocity of this crust (6.45–6.9 km/sec) is comparable with that of oceanic crust.

From available data for the north Gulf Coast, we have constructed 3 profiles across the coastal plain to the Sigsbee Deep. From these profiles, we have reconstructed former Gulf coastal margins for 3 epochs of the Mesozoic and Cenozoic, based on the assumption that the region has remained in close isostatic equilibrium. We have postulated the evolution of the Gulf Coast geosyncline, the continental shelf, and the transition from continental crust to oceanic crust at this margin since the Mesozoic.

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SHORELINE AND BEACH CHANGES ON HONEYMOON ISLAND, PINELLAS COUNTY, FLORIDA, 1967–1971

The southwest shoreline of Honeymoon Island, an arcuate barrier feature, was extended seaward by a dredge-fill operation in 1969. During the project, 1.5-million yd of material composed predominantly of boulder-size limestone was dredged from 1,500 ft offshore to bring the southwest beach to an elevation 5 ft above mean sea level.

A series of aerial photographs taken between 1967 and 1971 indicates cyclic patterns of erosion and deposition prior to and following the dredge-fill operation. Significant alterations evident in the photographs include marked erosion of the southwest shoreline of the island and the deposition of a series of curved spits or hooks along the northwest shoreline.

Erosion of the southwest shoreline by southeasterly longshore littoral drift is substantiated by the following data collected during a 6-month period: (1) current measurements taken around the island, (2) grain-size and roundness studies of sediment samples collected monthly from 10 sampling locations, and (3) monthly field observations and measurements of shoreline configuration and sediment composition of the foreshore. Formation of the hooks is related to flood-tide currents and storms.

Data indicate that the dredge-fill operation enhanced erosion of the southwest shoreline and that continued erosion in that area can be anticipated. The methodology of this study could be utilized in evaluating the potential effects of similar dredge-fill projects.

SAN ANTONIO IS SITE OF NEXT ANNUAL CONVENTION

The charming city of San Antonio, home of The Alamo, Spanish missions, and the famous Paseo del Rio —River Walk—will be the site for the Association's 59th annual convention, April 1–3, 1974. Hosts for the meeting are the South Texas Geological Society and the Gulf Coast Association of Geological Societies.

Although there is no overall theme for the convention, the AAPG technical program will emphasize "exploration for stratigraphic traps," methods, new techniques, types of programs, application of regional stud-