coal resource estimates is proposed. This model is based upon defining the area of influence of bore holes in different depositional settings with respect to consistency of coal thickness and coal quality. The model is being developed through evaluation of lignite occurrences in the Texas Gulf Coast Tertiary basin. In this basin, lignites occur in three Eocene stratigraphic units, the Wilcox Group, Yegua Formation, and Jackson Group, as component facies of three depositional systems—fluvial, deltaic, and strand plain/lagoonal. Within a particular depositional setting, densely-drilled deposits are being compared with areas of sparse drilling to characterize variability and, thus, determine the optimum spacing necessary to define seam geometry. Geostatistical analyses such as variograms, which estimate the range of influence of a bore hole as a measure of spacing, should aid in determining optimum spacing for a specific degree of certainty, within a given depositional setting. In this way, certainty ranges could be established for different depositional systems within a given coal basin. It is anticipated that this evaluation could lead to more reliable coal resource estimates.

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Geologic Setting and Oil and Gas Potential of Eastern United States Continental Margin North of Cape Hatteras

Two sedimentary basins, the Georges Bank basin off New England and the Baltimore Canyon Trough off the Middle Atlantic states, have been examined for geologic setting and hydrocarbon potential. Georges Bank basin, a complex-shaped trough, is on a block-faulted basement of igneous, metamorphic, and sedimentary rocks. The deepest part of the basin (deeper than 8 km) and the oldest sediments are restricted to south-central Georges Bank. Toward the northeast and southwest, the sedimentary section thins to less than 2 km over the Yarmouth Arch-LeHave platform and the Long Island platform. The only deep wells in the area are the COST G-1 and G-2; data from these wells will not be released until 60 days after the first oil and gas lease sale. Seismic correlation with the Shell Mohawk B-93 well on the Scotian Shelf indicates that most of the sedimentary rocks in the Georges Bank basin are Jurassic and older. Jurassic sandstone and limestone units serve as potential reservoir rocks. Potential hydrocarbon traps may occur on structural highs associated with draping of Jurassic and basal Lower Cretaceous strata over basement blocks.

The Baltimore Canyon Trough is an elongated northeast-trending basin that contains at least 14 km of Jurassic and younger marine and nonmarine sedimentary rocks. Lithologic and stratigraphic data from the COST B-2 and B-3 wells indicate that Lower Cretaceous and Jurassic rocks are predominantly nonmarine to shallow-marine sandstone and shale. Analyses of organic carbon and identification of low thermal maturity suggest that gas rather than oil will be produced. Nineteen wildcat wells have been completed; three are significant natural-gas discoveries. The largest discovery is probably associated with a large rollover trap on the downthrown block of a Cretaceous and Jurassic growth fault. Potential hydrocarbon traps in carbonate rocks beneath the present continental slope have not yet been explored.

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Definition and Development of Mackerel Field, Gippsland Basin, Australia

The Mackerel oil field, located offshore in the Gippsland basin, Australia, was discovered in April 1969. The field, which is a topographic-erosional feature, contains oil in high-quality Eocene-Paleocene reservoir sands which lie beneath an unconformity at the top of Latrobe Group, and is sealed by calcareous shales and mudstone of the Oligocene Lake's Entrance Formation. The initial definition of the field was based on 235 km of seismic data which had been shot in an irregular grid involving seven different surveys and on a total of four exploration wells. At the end of 1974, 145 km of high-resolution seismic data were shot over Mackerel to better define the top of Latrobe unconformity and the internal reservoir configuration. In 1976 a detailed pre-development structural interpretation was undertaken and a stratigraphic model of the field was constructed from detailed analysis of the seismic data.

The pre-development seismic structural and stratigraphic mapping was used to determine the final platform location and to choose the initial development well locations. These well locations were picked to gain early structural control on the top of Latrobe, to test the interpretation in the problem areas, and to investigate the internal geometry of the reservoir units.

Development drilling started in July 1977, and these well results have provided feedback to both the structural and stratigraphic models, which are being continuously updated. The pre-development mapping of the Mackerel field was successful in delineating the basic size and shape of the field and its internal stratigraphic configuration and in identifying all the geophysical and geologic problems which were subsequently encountered in the development drilling. Thus a rigorous seismic interpretation provided the geologists and engineers with a sound basis for field development planning.

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Phosphorite, Organic Carbon, and Hydrocarbons in Permian Phosphoria Formation, Western United States

The Permian Phosphoria Formation in the northwestern interior United States contains two phosphatic and organic carbon-rich shale members that include both phosphorite and petroleum source beds. The association suggests an intimate relation between factors which generate phosphorite deposits and hydrocarbon source beds. The two members, the Meade Peak Phosphatic Shale Member and the Retort Phosphatic Shale Member, were deposited at the periphery of a foreland basin between the Cordilleran geosyncline and the North American craton. The concentration, distribution, and coincidence of phosphorite, organic carbon,

and many of the trace elements within these shale members probably were coincident with areas of optimum trophism and biologic productivity. The paleogeographic relations suggest that the trophic regions were areas of upwelling in the Phosphoria sea adjacent to shoals near the eastern flank of the basin. The richest phosphorite beds, mostly pelletoidal, are near the base and the top of each shale member, and the organic carbon and the residual hydrocarbon contents of the phosphorite beds are low in comparison to the other strata. The beds richest in organic carbon are near the middle part of both members, where phosphorite content is low and residual hydrocarbon content is high. The deposition of both phosphorite and organic matter that is precursor to petroleum seems to be directly related to areas of inferred upwelling and biomass concentration, but the sediments have been differentiated into dominantly phosphorite beds and dominantly petroleum source beds by chemical or mechanical factors.

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Radiolarian Biostratigraphy and Paleoecology of Eastern Part of Southern Peninsula of Haiti

Radiolarian taxa, which occur intermittently in Upper Cretaceous to lower Paleogene pelagic calcareous sediments in the southern peninsula of Haiti, are found to correlate with those of the equatorial-tropical realms. Like these assemblages the Haitian taxa show high species diversity, despite secondary alteration of their compositional make-up that may be due to post-depositional diagenetic dissolution.

A small fraction of these taxa appear to be cosmopolitan species that overlap with boreal assemblages. Occurrences of the colder water taxa are erratic through time and show a positive relation with the acme of the recurrent assemblages.

The apparent rhythmic pattern of Radiolaria occurrence throughout the time span investigated suggests that paleoecologic conditions over the southern peninsula were similar to those that prevailed over most of the Caribbean Atlantic province from Cretaceous to the Paleogene.

Similarly, it is surmized that periodic fluctuations in the prevailing climatic conditions induced recurrent variations in the oceanic circulation patterns, which then gave rise to intermittent radiolarian productivity. These relatively short pulses of radiolarian productivity are less pronounced in the Haitian deposits than in their deep-sea counterparts not only because of the superimposed effects of diagenetic dissolution, but also because of their relatively higher carbonate content. This is interpreted to represent paleobathymetric differences in the paleo-Caribbean sea, with the site of the southern peninsula being then at relatively shallower depth with respect to the CCD.

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Importance of Secondary Porosity in Sandstones to Hydrocarbon Exploration

Terrigenous sandstones in many basins owe their reservoir quality to secondary porosity that developed by the dissolution of detrital framework grains (chiefly feldspar) and cement minerals (chiefly calcite and evaporite minerals). This dissolution event is responsible for changing tight sandstones to porous and permeable sandstones slightly prior to the major episode of hydrocarbon migration. Dissolution of most non-evaporite minerals is accomplished by formation water containing carbon dioxide generated during the thermal or bacterial breakdown of hydrocarbons. Dissolution porosity is commonly well developed at 6,000 to 9,000 ft (1,829 to 2,743 m), but gradually is lost during deeper burial stages by recementation (chiefly by ferroan calcite, ferroan dolomite, and kaolinite). During sandstone burial, variations in the simple scheme of cementation → decementation → recementation is complicated in basins with complex "plumbing" systems and those that experience uplift. For example, dissolution porosity in some uplifted sandstones develops during invasion by meteoric water flowing downdip.

Dissolution porosity in sandstones can be suspected from certain log responses and water-saturation characteristics, but is best identified from clues visible in thin sections made of dyed, epoxy-impregnated perm plugs. Clues to secondary porosity in thin section include: (1) oversized pores formed where framework grains have been dissolved; (2) patchy distribution of carbonate or evaporite cement; (3) honeycombed feldspar grains; (4) fossil molds; (5) grains whose margins were etched by previous cement; (6) broken silicate grains that formed when rapid compaction followed removal of cement minerals; and (7) quartz grains that have been reduced to shards when calcite, which invaded quartz along hairline fractures during cementation, was dissolved. Secondary porosity is not likely to develop good reservoir quality in sandstones whose primary porosity was lost chiefly by compaction. Sandstones with abundant clay clasts, fecal pellets, glauconite, or micaceous rock fragments can lose all effective porosity by ductile grain deformation. A knowledge of sandstone composition is important to predicting reservoir quality.

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Terrestrial Sedimentation Associated with Strike-Slip Fault Movement in Middle Carboniferous of Nova Scotia, Canada

The Carboniferous Minas basin of Nova Scotia developed along the dextral strike-slip Glooscap fault. During the early Namurian, the West Bay Formation was deposited in the Parrsboro area of this basin. This formation consists mainly of siltstone with symmetrical ripples and desiccation features and thin beds of detrital ferroan calcite and is interpreted as a playa lake deposit. To the northeast, lower Namurian lacustrine sediments of the Hastings Formation crop out over much of Cape Breton Island. The Hastings and West Bay Formations may have been deposited in the same lake complex, and the Parrsboro and Cape Breton areas, now 225 km apart, were probably adjacent.

During the middle Namurian, the West Bay Forma-