ment of the individual coccoliths. Most cylinders are open at both ends, but one specimen illustrated by electron micrographs with one end nearly closed reveals significantly smaller coccoliths at the ends. These smaller, simpler coccoliths probably did not articulate as tightly as those on the rest of the cell and were easily detached. Because of the difference in size and morphology, these terminal coccoliths may have previously been assigned to other taxa. A coccosphere of *Braarudosphaera bigelowi*, not previously illustrated from the fossil record, is also documented in this study.

The stagnant, anoxic benthic environment prevalent during these intervals of Niobrara deposition also fostered the preservation of monospecific coccolith clusters that represent coccospheres formed of nonarticulated coccoliths. These clusters, representing 35 different species, including *Lithraphidites carniolensis, Bolevetelum* sp., *Microrhabdulus belgicus,* and *Rhagodiscus angustus,* provide information on the minimum number of coccoliths originally present on the living cell. Such may prove valuable for determining the total biomass of the living populations based on the abundance of individual coccoliths in the fossil record.

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Arctic Reconstruction from Alaskan Viewpoint

Field, seismic, structural, and stratigraphic data were used to reconstruct the geologic history of the Arctic in 10 m.y. time slices from the present to mid-Jurassic—the time of initial opening of the Arctic Ocean. A basic assumption used for the reconstruction is that Lomonosov Ridge, Alpha Ridge, Mendeleyev Ridge, and Chukchi Plateau are all foundered continental plates.

Opening of the Arctic occurred in 2 stages: Late Jurassic–Cretaceous for the Canada basin, and Neogene for the Eurasian basin. Opening was facilitated by 2 subparallel transform shears: the Arctic (Kaltag-Porcupine) on the east and the Chukchi on the west. Deformation was essentially tensional on the Barents side of the Arctic, and shear-compressional on the Alaska side.

The development of Chukotsk, the North Slope, Brooks, Range, northwestern Canada, Seward Peninsula, and central Alaska can be sequentially related to Arctic opening, modified by impingement of allochthonous terranes (the Pacific plates of Tintina, Denali, Orca, Anadyr, Khatyrka, Kolyma) arriving from the south.

The North Slope of Alaska—a passive, rifted, subsided margin—was aligned with a similar margin on Alpha Ridge. Northeastern Alaska (the Romanzoff Mountain area) lined up opposite the north end of the Sverdrup Rim, near Prince Patrick and Borden Islands.

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Reaction of Organic Material to Progressive Geologic Heating

The generation of oil is a process that begins to occur at some point during the burial history of a source rock. This "onset of maturation" is dictated largely by temperature and residence time. However, the nature of the source rock itself also influences the hydrocarbon product being expelled from the source rock. The vast majority of the world's oil can be ascribed to source rocks of the following types. (1) Marine mudrocks deposited in anoxic conditions and dominated by phytoplankton organisms; this type of source rock can have a carbonate or clay inorganic matrix and total organic carbon values from 1 to 30% (commonly 4 to 10% when immature). Examples of this classical oil source rock would be the source rocks of western Canada, the Middle East, and the North Sea. (2) Specific coal facies such as torbanites and cannel coals, which contain a mixture of hydrogen-rich plant detritus (e.g., spores, pollen, cuticle, resin, and algae); deposition was probably in open-water areas of an overall coal-swamp environment. Examples of hydrocarbons from this type of source include the Gippsland basin, Canadian Beaufort Sea, and Southeast Asia. (3) Lacustrine organic-rich deposits, rich in freshwater algae, which ultimately result in high-wax crude oils. Examples are relatively rare, but include major source rocks in the Uinta basin and China.

The effect of increasing maturity on marine mudrocks of the Devonian Duvernay Formation of Alberta illustrates oil generation from this type of source rock. The data base in this unit consists of 40 conventional cores, ranging from immature to completely overmature, and 80 oils from separate accumulations sourced from the Duvernay. An illustration of oil generation in a coaly source rock is provided by a single core from the Lower Cretaceous of the Beaufort-Mackenzie basin plus many of the oils and condensates reservoired in that area.

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Benthic Foraminiferal Morphology: New Approach to Paleodepth Interpretations in Northern Gulf of Mexico

Variation in benthic foraminiferal morphology is a potentially powerful tool in paleoenvironmental and paleobathymetric interpretations. Recognition of distribution patterns of particular morphologic characters in modern Gulf of Mexico taxa will enable these distributions to be applied to bathymetric interpretations of Tertiary core samples.

The morphology of the 295 most commonly recorded benthic foraminiferal species in the northern Gulf of Mexico was scored into 68 categories describing test shape, chamber shape, chamber arrangement, apertural characteristics, and surface sculpture. Cluster analyses of these data at 300 localities resulted in maps showing the distribution of particular sets of morphologic features. Many of these "morphologic biofacies" are depth relatable. Canonical variate analysis was used to determine which morphologic variables were most important in distinguishing the various biofacies.

This approach to paleobathymetric interpretations should be applicable throughout the Cenozoic and perhaps into the Mesozoic, as morphology can be considered as an adaptive response to environmental factors. Even though different taxa are involved throughout the Cenozoic, similar morphologic characters can indicate adaptations to similar environments. Hence, this modern data set can be applied to determine paleobathymetry in older samples.

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Molecular Thermal Maturity Indicators in Oil and Gas Source Rocks

Detailed chemical parameters have been proposed as indicators of thermal maturity in oil and gas source rocks. Certain classical maturity parameters involving carbon preference indices and compound class ratios such as HC/EOM and EOM/TOC are infrequently used today, having been largely replaced by detailed molecular parameters. Among these parameters, the molecular distributions of metalloporphyrins, cyclic hydrocarbons, low molecular weight hydrocarbons, and gases are most commonly used. Recent instrumental advances have allowed the measurement of detailed molecular ratios in geochemical organic matter, stimulating the development of biologic markers, such as steranes, hopanes, and metallated tetrapyrroles, as thermal maturity indicators. Increased chromatographic resolution of source rock hydrocarbons has also promoted the use of low molecular weight hydrocarbons, methylphenanthrenes, and aromatized steranes as maturity indicators.

The future use of molecular thermal maturity indicators in source rocks is expected to increase significantly. In addition to further advances in understanding the significance of biologic marker hydrocarbons, metalloporphyrins, and thermally generated light hydrocarbons, the use of other nonhydrocarbons as maturity determinants will probably develop.

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Paleoecology of Foraminifera of Lower Castle Hayne in Southeastern North Carolina

Foraminiferal fauna present in the lower Castle Hayne biomicrudite exposure northeast of Wilmington, North Carolina, suggests a depositional environment in a transitional zone between the open-marine outer continental shelf and the upper continental slope. Evidence that supports