occurrences of fossils in a group of wells or natural sections can be ordered into an optimum sequence. In the statistical model used, the relative position of the events in the most likely sequence is an "average" of all the relative positions encountered. The frequency of cross-over (miscorrelation) of events in the sections correlated has been used to estimate average distances between successive events in the optimum sequence. The events can be clustered by using the estimated distances between them, which gives results similar to those of the assemblage zone approach in biostratigraphy.

The computer program prepared for the statistical model has been used to create a zonation for our Cenozoic benthonic and planktonic foraminiferal record (209 taxa) in 22 wells on the Canadian Atlantic continental margin between 43 and 60°. Northern and southern optimum sequences have been recognized containing 40 and 60 taxa, respectively, about half of which are in common. The southern sequence contains 11 Eocene and 7 Miocene planktonic foraminiferal species and the northern sequence contains 6 Eocene species. The difference reflects more pronounced post-Eocene latitudinal watermass heterogeneity and differential post-Eocene shallowing across the margin.

The northern and southern probabilistic zonations each consists of eight clusters of Paleocene through Pliocene-Pleistocene age.

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Implications of Geologic Structure and Regional Sedimentation Patterns for Rifting Geometry of Arctic Basin

The smooth, passive continental margin north of Alaska is geometrically more complex than its simple physiography suggests. Multichannel seismic reflection profiles across the continental shelf reveal three sectors of contrasting structure and stratigraphy. The Barrow sector of central northern Alaska is characterized by a prominent arch in lower Paleozoic metasedimentary basement rocks overlain by a southward-thickening wedge of Mississippian to Lower Cretaceous (Neocomian) shelf sediments and a northward-thickening prism of Lower Cretaceous (Albian) to Tertiary clastic sediments. The Chukchi and Barter Island sectors, lying respectively west and east of the Barrow sector, comprise Mesozoic and Tertiary basins so deep that acoustic basement was not reached. We suggest that this geometry (in which lower Paleozoic basement rocks extend much farther north in the central sector than they do in the east and west) is inherited from the configuration of the rift that opened the Arctic basin, probably beginning in Early Jurassic time. In this scheme, old, pre-rift highlands, originally continuous with the basement rocks of the central Barrow sector, were rotated northward away from Alaska along two sectors of the rift that lay well south of the present-day shelf edge. In these, the Chukchi and Barter Island sectors, the rift created room for the deep shelf basins observed there now. In the intervening Barrow sector, the rift opened along the present-day shelf edge, leaving a broad tongue of lower Paleozoic rocks, the site of upper Paleozoic and lower Mesozoic highlands, attached to Alaska.

Presumably the sector boundaries were ridge-ridge transform faults during nascent rifting. The Chukchi-Barrow sector boundary is well defined by the trend of the Northwind Escarpment and the abrupt termination of the Barrow arch against the North Chukchi basin. The Barrow-Barter Island boundary is more obscure and is inferred from the provenance and distribution of Mesozoic sediments in northeastern Alaska and Yukon Territory.

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Oil and Gas Potential of San Luis Basin, South-Central Colorado

Are there major oil and gas traps in the San Luis basin? Gas and oil seeps have been reported and used at ranches in this basin since the late 1800s. Despite the presence of porous and permeable sandstones, thick widespread clays for seals, and hydrocarbons, only 15 oil and gas tests have been drilled in 2,500 sq mi (4,023 sq km), most before 1955.

Recent seismic work has helped delineate the structure and stratigraphy of the eastern half of the basin where gas occurs in all water wells. A high on the Precambrian basement surface dominates the center of the basin with sediments faulted and dipping down to the east to a depth of about 20,000 ft (6,096 m) adjacent to the Sangre de Cristo Mountains. The basin fill is Tertiary clastic and volcanic rocks that can be divided into four units using seismic work, well samples, and palynology. The uppermost unit, the Alamosa Formation (Pliocene-Pleistocene), is green lacustrine clay and sandstone. The underlying Santa Fe Formation (Miocene-Pliocene) is red fluvial-lacustrine clay and sandstone with a few thin volcanic flows. An unnamed unit (middle Paleocene to Eocene) is angularly unconformable with the overlying Santa Fe and similar in lithology. The oldest unnamed unit consists of thick volcanic flows interbedded with volcaniclastics and claystones and is also unconformable with the overlying unit.

Potential trapping mechanisms are major sedimentary-rock pinch-outs and truncations in the unnamed unconformable units as well as in channels in the overlying fluvial sandstones. Porous volcanic rocks and sandstones on the fault blocks, fault traps, and structural closures are also possible traps in the oldest unit. The paucity of drilling and the presence of traps and hydrocarbons make the outlook optimistic for this basin.

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Siderite Textures in Cardium Formation, Ferrier Field, Alberta

Siderite in the Upper Cretaceous Cardium Formation of Alberta, Canada, is unusual not only because it is the dominant carbonate cement, but because it is more abundant in Cardium offshore sands and conglomerates than in similar Cretaceous stratigraphic and depositional units such as the Shannon, Sussex, and Gallup Sandstones or the Viking Formation. Core and thin sections have been studied to understand the occurrence of siderite in the Ferrier field (T38-42, R6-10W5).

On the basis of texture, the siderite in the Cardium can be divided into two groups. Siderite associated with shales and bioturbated siltstones is characterized by a nodular habit, fine-grained spherulitic texture, and calcite-filled fractures, in contrast to the coarse lozenge-shaped or anhedral siderite that rims voids and replaces pebbles and sand in conglomerates and sandstones.

Modular siderite is believed to form early in diagenesis, just below the water interface. Coated clay particles transport ferric oxides to the site of deposition, where they are precipitated in a colloidal gel; organic debris provides a source of carbonate ions and establishes reducing conditions. To insure low sulfide concentration, rapid sedimentation excludes marine sulphate ions which might otherwise be reduced by anaerobic bacteria to form HS^- or H_2S (the environment is abiotic).

Based on its replacive nature, the coarse siderite is interpreted to be late diagenetic. The source for iron and carbonate ions may be linked to mudstone diagenesis, or to remobilization of early siderite.

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Filament-Producing Hydrocarbons in Palynology Preparations

Palynologic preparations often contain solid hydrocarbons that are difficult to distinguish from resin cells, simple fungal spores, and some organic debris. A chemical-physical reaction by bitumens on prepared glass slides is accomplished by using two dissimilar mounting media. The resulting extrusions by "petrolic filament bodies" permit easy identification of "asphaltenes." Some asphaltenes appear to be secondary pore fillings, some suggest algal origin, and others apparently illustrate initial expulsion of generated hydrocarbons from amorphous kerogen.

The presence of solid hydrocarbons in palynology samples may have utility in petroleum exploration by identifying "minishows," suggesting possible hydrocarbon migration, identifying thrust faults, and in providing a warning of possible drilling-mud contamination.

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Cement Types and Cementation Patterns of Middle Ordovician Ramp-to-Basin Carbonate Rocks, Virginia

Middle Ordovician ramp-to-basin carbonate rocks of Virginia consist of peritidal fenestral limestone, shallow subtidal cherty wackestone, shallow ramp and downslope skeletal buildups, deep ramp shaly fossiliferous wackestone, and basinal black limestone and shale. Preburial marine cements in buildups include turbid rim cement on pelmatozoans, isopachous pseudoacicular cement, and coarsely crystalline neospar cement occurring on polycrystalline substrates. Line cavities predate other cement types and are interlayered with internal sediments. Later, nonferroan clear rim and equant cements fill remaining pore spaces in buildups. Nonferroan equant cement and internal sediments fill fenestrae in peritidal facies. These cements consist of several cathodoluminescent zones (from oldest to youngest): (1) nonluminescent black zone (in buildups) or nonluminescent passing into subzoned dull luminescent (in tidal flats); (2) thin, brightly luminescent zone; and (3) dull luminescent zone (or hydrocarbon or dolomite cement). Petrographic relations indicate that in buildups the black and thin bright zones are burial cements formed from formation waters expelled from compacting basinal facies prior to hydrocarbon migration whereas the dull zone is deeper burial in origin and is synchronous with or postdates oil migration and emplacement. In contrast, the bulk of the peritidal cement zones are preburial and formed from vadose to shallow phreatic waters. This is indicated by occurrence of black and bright cements that occur as pendant crystals or line fenestrae, presence of crystal silt which abuts all zones, and by erosion surfaces that truncate the dull cement zone.

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Deep Stratigraphy and Evolution of Baltimore Canyon Trough Based on Multifold Seismic Reflection, Refraction, Gravity, and Magnetic Data

A recent 48-channel seismic reflection profile (U.S. Geological Survey line 25) extends 330 km southeast off southern New Jersey and crosses the widest and deepest part of the Baltimore Canyon Trough (10 km southwest of the COST B-3 well). The profile has been migrated and converted to depth to reveal the deep sedimentary and basement structures across the ocean-continent transition zone. The sedimentary wedge thickens from 5 km nearshore to 17 km just landward of the East Coast Magnetic Anomaly (ECMA; 20 km landward of the shelf edge in this area). A strong, flat reflector about 10 km wide exists at a depth of 14 km, directly beneath ECMA. Acoustic basement becomes obscure and appears to rise to a depth of 5 km over the next 40 km to the southeast, beneath a Jurassic and lower Cretaceous carbonate shelf-edge complex which extends 20 km seaward of the present shelf edge. Landward-dipping continental rise sediments exist to a depth of at least 13 km on the seaward side of the Jurassic shelf edge. The top of oceanic basement is first seen as a set of prominent hyperbolic reflectors about 50 km seaward of the Jurassic shelf edge, where it occurs at 11 km depth and dips gently landward. It is obscured landward of this point by the prominent middle Jurassic (J_3) horizon.

A Jurassic and lower Cretaceous shelf-edge carbonate platform or reef complex prograded 40 km out over oceanic crust in this area. Greater differential subsidence and compaction of the basin west of the ECMA have produced back-tilted and arched horizons in the Jurassic and lower Cretaceous shelf edge units, creating a 20-km-wide anticline with 500-m closure beneath the upper continental slope. Other lines to the southwest indicate the anticlinal arch extends at least 40 km to the southwest. Similar "slope anticline" structures have been reported off northwest Africa.

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Petroleum Exploration of National Petroleum Reserve in Alaska (NPRA)

Naval Petroleum Reserve No. 4 was designated as the