volume versus production histories and will influence pattern alignment and well spacing.

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Quaternary Eustatic Sedimentary Accretion of Southern Bahamas Archpelago

Surficial geologic mapping indicates that the southern half of the Bahamas Archipelago is forming by the accretion of discrete depositional sequences resulting from successive eustatic sea level changes: (1) multiple beach and dune ridges, (2) estuarine, (3) lacustrine, (4) shallow subtidal, (5) reef and reef rubble, and (6) megadune complexes. The lithologies are accreted along unconformable erosional-solutional contacts—marine terraces and subaerial caliche crusts. During periods of significant transgression, sequences 1-5 are accreted. Sediments are predominantly skeletal and peloid. During periods of significant regression, megadune complexes are accreted. Ooids are the dominant sediment.

Erosional-solutional features reflect areas of subaerial exposure and/or coastline erosion. Terraces at 10, 20, and 40 ft elevations are preserved along arid eastern Great Inagua Island. The calichification of Bahamian Quaternary carbonates has concentrated insoluble residues (quartz, feldspar, heavy minerals, crandallite, micrometeorites). Insoluble residue analysis provides a basis for the correlation of accreted eustatic sedimentary sequences.

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Potential Geologic Hazards of North Aleutian Shelf, Bristol Bay, Alaska

Federal OSC lease sale 92, North Aleutian shelf, Alaska, is scheduled for April 1985. The area, located in the southeastern Bering Sea, has 3 basins with sedimentary thicknesses in excess of 4 km.

Six geologic conditions that could cause problems during petroleum development are: (1) seismicity, (2) recent faulting, (3) gas-charged sediment, (4) bed forms and active sediment transport, (5) scours, and (6) volcanism.

Since 1953, the region has a history of at least 10 shallow earthquakes, including a 1971 back-arc event with a Richter magnitude of 5.2. The largest event impacting the entire region, a Richter magnitude 8.7 earthquake, occurred in 1938. Normal faults are located along the southern edge of the St. George basin, and on the northeastern edge of the Amak basin. Many exhibit increased offset with depth, surficial sags, and small surficial cracks. Surprising was the absence of any evidence of sea-floor sediment instability. "Sonar bright spots," and possible, near-surface gas-charged sediment occur west of Amak Island and north of Unimak Island. An area of megaripples and dunes covers more than 1,500 km^2. Bed forms have spacings of 20-50 m and heights of 1-3 m. Observations suggest that coarse sand may be actively transported. Thousands of scours, many linear and parallel, some greater than 800 m long, 250 m wide, and incised up to 5 m, were identified. Pavlof, an Alaskan Peninsula active volcano, located 45 km northeast of Cold Bay, has a continuous history of steam release and occasional eruption. Lahars, nuée ardentes, and other volcanogenic activities are possible, but their probabilities are unknown. None of the geologic conditions identified precludes petroleum development or production. The potential impact of these factors must, however, be included in planning for future petroleum activities.

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Shelf Storm-Deposited Sandstones, Upper Mancos Shale, San Juan Basin, New Mexico

Hummocky cross-stratified and amalgamated sandstone beds in the upper Mancos Shale of the San Juan basin record sedimentation on a storm-dominated shelf. Interbedded silty shale, siltstone, and sandstone form coarsening-upward cycles in Mancos shelf deposits. Abundance of cycles suggests storms were frequent, and preservation potential of shelf storm deposits is high.

Mancos storm beds typically have an erosional base with tool marks, and planar laminations overlain by hummocky cross-stratification (HCS). HCS comprises 20-90% of the primary sedimentary structures in these beds. Wave-ripple lamination commonly overlies HCS in ≤2-m thick beds high in the section. Less commonly, wave ripples overlie planar lamination in some thinner beds (5-15 cm) low in the section. In comparison, planar lamination commonly overlies HCS in storm sequences. Paleoflow trends are northeast to southwest, normal to presumed regional paleoshoreline.

Distal to proximal changes in the beds are seen in vertical section. Increases in sand to shale ratio, amagamated beds, abundance of sole marks, average grain size (from 0.05 to 0.125 mm), and wavelength of HCS are seen upsection. Bioturbation of beds decreases upsection. These trends reflect progressive shoaling of the Mancos shelf.

Upward-coarsening interbedded silty shale, siltstone, and sandstone intervals comprise the bulk of upper Mancos shelf deposits. A hummocky storm bed 30-100 cm thick caps each cycle, and contact with the overlying interval is sharp. Contact with the overlying Point Lookout shoreface sandstone is abrupt. The cycles indicate that episodic storm sedimentation characterized the Santonian-Campanian shelf in the study area.

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Upper Jurassic of East Texas, a Stratigraphic Sedimentologic Reevaluation

The Smackover-Haynesville of east Texas has long been modeled as a simple progradational carbonate-evaporite ramp. Recent data indicate that the conventional ramp model for this sequence should be abandoned in favor of an evolving rimmed shelf to platform model, forming in response to changes in rate of relative sea level rise during the Late Jurassic. Evidence for Smackover-Haynesville shelves include: (1) thick high-energy carbonates along the basin margin in the Smackover and throughout the Haynesville, (2) low-energy pellet-dominated lagoonal carbonates, evaporites, and evaporitic siliciclastics occurring landward of, and interfingering with, the Smackover and Haynesville basin-margin carbonate barriers, (3) deeper water, open-marine low-energy limestones with black shales seaward of the basin-margin barriers (Smackover-Gilmer undifferentiated), and (4) the Gilmer shale forms a siliciclastic wedge seaward of the Haynesville basin margin and its zero isopach defines the Kimmeridgian shelf margin. The Smackover and Haynesville seem to represent 2 distinct sedimentologic cycles, with each cycle reflecting an initial relative sea level rise during which a rimmed shelf and lagoon are developed, and a terminal sea level standstill during which the shelf evolved into a high-energy platform. Although these sedimentologic patterns seem compatible with accepted Jurassic sea level curves, they may also reflect differential basin-margin subsidence combined with variable carbonate production rates. Finally, the shelf-platform model more clearly defines future exploration strategies for Smackover-Haynesville targets in east Texas and perhaps across the Gulf of Mexico, if eustatic sea level changes were the dominant causative factor for shelf development in the Late Jurassic.

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Organic Facies and Petroleum Potential of Eastern North American Margin

Sufficient data now exist to permit reconstruction of the organic facies for Late Jurassic and middle Cretaceous times when the potential for source rock deposition was greatest on the eastern margin of North America. Three distinct and one mixed organic facies have been mapped for these 2 geologic intervals: facies B (oil-prone) amorphous organic material plus alginite and exinite deposited under marine anoxic conditions, facies C (gas-prone) terrestrial plant debris deposited in mildly oxic environments, facies B-C (waxy oils and gas condensate) mixed facies, and facies D (nonsource) degraded and/or recycled organic material.

Distribution of the Late Jurassic organic facies was greatly influenced by the relatively arid subtropical climate and the shelf-edge carbonate bank and reef that existed along most of the margin. Facies C and D are common on the shelf, C being particularly significant on and seaward of Late Jurassic deltas. Two submarine-fan complexes formed off present Nova Scotia and the Middle Atlantic states. Seasonal upwelling plus fan development produced mixed B-C and C facies along the margin. Facies D dominated the deep basin.

The middle Cretaceous organic facies reflect profoundly changed conditions from those that existed in the Late Jurassic. The continent had a warm, humid, temperate-tropical climate producing abundant vegetation. Ancestral rivers carried large volumes of detrital plant material to the sea. Thus, facies C is virtually ubiquitous except for the inner shelf and isolated parts of the ocean basin. Active reefs and carbonate-bank development at the shelf break was limited to the low latitudes. In the early Cenomanian, a major transgression substantially broadened the shelf and upwelling probably occurred on the middle shelf. Facies B-C is postulated to exist on the upper slope, locally, and in the basin where anoxia prevailed.

Exploration targets for oil are the buried carbonate bank and reef and related fore-reef talus deposits. Secondary objectives are interreef channels and their seaward extensions, the upper parts of submarine fans. The shelf and margin basins are dominated by facies C source rocks. In the Late Jurassic, however, locally ideal conditions permitted deposition of facies B source rocks.

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Significance of EOM/TOC Ratios in Identifying Possible Migration Fairways, NPRA, North Slope, Alaska

Analyses of 958 samples from 54 wells in the NPRA (National Petroleum Reserve in Alaska) for TOC (total organic carbon) and EOM (extractable organic matter) have been made available as part of an extensive exploration program sponsored by the U.S. Geological Survey. In the present study, these data have been analyzed using the equation: EOM(wt. %)/TOC(wt. %) $\times$ 0.80 = Generation Index. The ratio of EOM to TOC is generally used as an indicator of thermal maturation. Work done by D. R. Baker demonstrates, however, that values in excess of 0.05 are indicative of migrated hydrocarbons in the sample.

Initial results of mapping these ratios for 11 structural zones in the NPRA indicate younger strata (i.e., Nannushuk, Torok, Pebble Shale, Kingak, and Sag River formations) have a significant probable migration fairway developed along the trace of the north-south-trending Meade arch, and toward the eastern margin of the NPRA. Older strata (i.e., Shublik, Ivishak, Echooka, Lisburne, Endicott formations and basement) generally show ratios in excess of 0.05 along the northern and northeastern margins of the NPRA. Although not enough data are available for detailed EOM/TOC mapping of these older trends, they may be related, in part, to the juxtaposition of younger source rocks that unconformably overlie these older strata.

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Reexamination of Middle Eocene Genus *Cubitostrea* Based on Collections from Central Virginia Coastal Plain

Three species of oysters from the middle Eocene *Cubitostrea* lineage are used for local and regional correlation and zonation of sediments in the Gulf coastal plain. However, oysters from the middle Eocene Piney Point Formation in Virginia also include the co-occurrence of specimens that exhibit the morphologic characteristics of these 3 Gulf Coast species.

Examination of approximately 150 specimens from 8 bulk samples collected in a vertical sequence along the Pamunkey River revealed that, in addition to co-occurring, a continium exists from one form to the next. The general shape of the forms is related to size, with juvenile oysters characterized by a triangular shape and prominent ribs, whereas the adults are oval with large auricles and a saddle-shaped form.

Results indicate that the morphologic variation of oysters in the middle Eocene sediments of Virginia does not represent an evolutionary lineage with each form a species, as proposed for the Gulf coastal plain. Rather, the forms are related to the growth stages of the species *C. sellaeformis*. Therefore, the Gulf model is not applicable to the middle Eocene sediments of Virginia and possibly not to other depositional areas.

Oysters from the underlying Nanjemoy Formation (lower Eocene) previously included within the species *C. sellaeformis* should not be so designated. This distinction is based on the coarser and fewer number of ribs on the Nanjemoy oyster as compared to *C. sellaeformis* from the Piney Point Formation.

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Exploration Applications Through Remote Sensing of Ice-Wedge Polygons

Petroleum exploration is facilitated through remote-sensing techniques such as Landsat digital data processing and aerial photointerpretation. These techniques were applied to reconstruct past geologic environments and to analyze the present geomorphic setting of the Colville delta on the North Slope of Alaska. By examining differences in the distribution of selected characteristics of ice-wedge polygons, the positions of former fluvial channels and lake beds and the relative age of the surface could be determined.

Characteristics of ice-wedge polygons such as size, shape, central relief, and rim condition were delineated using aerial photography of various scales and dates. Maps of selected characteristics assisted in identifying outcrops of the Pleistocene Gubik Formation, frequently flooded areas, and the locations of former distributary channels and lake beds. Although Landsat digital data were not as effective as aerial photography in geologic mapping, primarily due to pixel resolution being one order of magnitude larger than an individual polygon, major surface features and outcrops could be identified from variations in vegetation and the surface water content of ice-wedge polygons. In addition, tundra surface with ice-wedge polygons could be differentiated from that without.

An understanding of ice-wedge polygon characteristics, which infer geologic environment and evolution, and the application of similar remote-sensing techniques can assist exploration geologist in determining past and present geologic environments in inaccessible periglacial regions.

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Williston Basin Seislog Study

This paper describes the results of Seislog® (trade name) processing and interpretation of an east-west line in the North Dakota region of the Williston basin. Seislog processing involves inversion of the seismic trace data to produce a set of synthetic sonic logs. These resulting traces, which incorporate low-frequency velocity information, are displayed in terms of depth and isotransit times. These values are contoured and colored, based on a standard stratigraphic color scheme.

The section studied is located just north of a dual producing oil pool from zones in the Ordovician Red River and Devonian Duperow Formations. A sonic log from the Long Creek 1 discovery well was digitized and filtered to match the frequency content of the original seismic data. This allows direct comparison between units in the well and the pseudosonic log (Seislog) trace nearest the well. Porosity development and lithologic units within the lower Paleozoic stratigraphic section can be correlated readily between the well and Seislog traces.

Anomalous velocity zones within the Duperow and Red River Formations can be observed and correlated to producing intervals in the nearby wells. These results emphasize the importance of displaying inversion products that incorporate low-frequency data in the search for hydrocarbons in the Williston basin. The accumulations in this region are local in extent and are difficult to pinpoint by using conventional seismic data or displays. Seislog processing and displays provide a tested method for identification and delineation of interval velocity anomalies in the Red River and Duperow stratigraphic sections. These techniques can significantly reduce risks in both exploration and delineation drilling of these types of targets.

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Use of Seislog for Basin Evaluation and Field Development

Generation of synthetic sonic logs (Seislogs) from seismic data can provide lithologic, porosity, and fluid-content identifications in a variety of