ing the latest Tertiary overlie and are controlled by fans (deltas). Slump scars, gullies, zones of nondeposition due to currents, debris flows, and levees are identified. The Skralinge, Christian, Pining canyons, and other significant features are mapped in greater detail. Paleo-shelves and slopes of the continental margin are defined in seismic profiles. Differential erosion by the canyons reveals lithologic differences which further delineate the older structures. Implications for structural traps and resource deposits are encouraging if technology becomes available for the challenge.

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Nova Scotia Shelf Mesozoic Carbonates—Summary of Canadian Data Useful for Analogy to the South

Except for a few wells such as the Cost No. G-2 on Georges Bank, Mesozoic carbonates along the United States Atlantic seaboard are known only from seismic interpretation or from shallow or outcropping data collected by research vessels. Other sources of information are analogy from Florida-Gulf of Mexico wells, from European-West African Tethyan facies, or from wells on the Nova Scotia Shelf. Nova Scotia data that may be useful for comparison to offshore U.S.A. follows.

(1) Carbonate and deltaic sedimentation are synchronous during much of the Late Jurassic and earliest Cretaceous. (2) Smaller scale cycles and younger large scale vertical facies changes indicate repeated relative sea-level changes. (3) Shelf-edge profiles vary from rimmed/platform to prograding ramp near the Sable Island Delta where slope carbonate-shale deposits have been drilled. (4) Shelf-edge platform profiles also vary from reef-rimmed to channel to possible open sediment-bypass margins with ooid sands. Some faulted margins occur. (5) From Early to Late Jurassic, there is a reduction in evaporitic sediments, an increase in biotic diversity, and an increase in coals indicating an increasingly humid climate. (6) Depositional facies zones are easily distinguished and may be of shallow or deeper water aspect at a particular location. In the upper Abenaki, the skeletal-rich shelf margin has invariably been preserved. (7) True reefs occur. (8) Along the upper Abenaki shelf edge, carbonate facies also vary to include reef complexes, mud mounds, islands, oolite shoals, skeletal and oncolitic sands. (9) Termination of Abenaki carbonate sedimentation is either diachronous burial by deltaic sands or widespread synchronous Valanginian drowning possibly immediately preceded by brief subaerial exposure. (10) Abenaki diagenesis is dominated by porosity reduction due to burial, but dolomitization and early intraformational leaching occur at the shelf edge. (11) Later subaerial (or submarine) erosion at the top of the Abenaki occurs in a few widely separated areas. (12) Hydrocarbon shows are rare but do occur in the carbonates on some salt domes or in geopressured zones.

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Tectonic Influence on Sedimentation of Lower Cretaceous Strata, East-Central Powder River Basin, Wyoming

Recurrent movement of basement fault blocks in the east-central Powder River basin has controlled the distribution of porous and permeable reservoir facies within Lower Cretaceous strata. Subsurface isopach data for Lower Cretaceous time-stratigraphic intervals show repetitive thickness variations for both marine (Skull Creek and Mowry shales) and nonmarine (Inyan Kara and Newcastle/Muddy sandstones) units. Thickness patterns seem to be controlled by recurrent Early Cretaceous structural movement. Paleostructures ranging in width from 2 to 10 mi (3.3 to 16.6 km) and in length from 10 to 30 mi (16.6 to 50 km) trend northeast, northwest and north, and include segments of the Black Hills and Fanny Peak monoclines, which bound the west flank of the Black Hills uplift.

Early Cretaceous paleostructures seem to control the distribution of Newcastle valleys which are incised into the underlying Skull Creek Shale and drain southwest and northwest (corresponding to the Clareton, Hilight, Osage, Fiddler Creek, and Rozet fields). Alluvial plain valley-fill deposits in Newcastle Formation outcrop show abrupt facies and thickness changes which coincide with evidence of structural control (e.g., drape folds, faults, sandstone dikes, geomorphic lineaments, and increased igneous activity). A depositional model, incorporating tectonic and sea-level adjustments, illustrates that Newcastle channel incisement and valley fill are generally restricted to topographic and structural low (graben) areas. This model has been confirmed by detailed analysis of seismic data.

A model for tectonic influence on sedimentation aids in petroleum exploration by helping to predict facies distribution and fluid flow.

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Basin to Platform Transition, Middle Cretaceous, Mexico

Discontinuous outcrops west of Xilitla, San Luis Potosi, Mexico, preserve a sequence of middle Cretaceous (Albian-Cenomanian) carbonate rocks more than 1,500 m thick consisting of the following. (1) (Base) Well-bedded, cherty lime mudstones and wackestones with calcispheres and globular foraminifera. (2) Fine-grained, partly silicified peloidal and bioclastic lime wackestones and thin intraclast layers. (3) Massive graded beds of peloidal-bioclastic lime packstone with abundant echinoid fragments and spines, coral and mollusk fragments, but no rudists. (4) Lime breccias in massive beds with a variety of bioclasts including stromatoporoids and rudistids that are increasingly common upward. Breccias are interbedded with finely laminated, ripple-laminated, or micrograded beds alternating with burrowed mudstones. Dolomitized intervals are present at the base of unit 3 and within unit 4. (5) Massive beds of coarse rudist-fragment lime packstone. (6) (Top) Massive beds of rudist boundstone. Unit 1 is typical of basinal limestones of the upper Tamaulipas Formation. Units 2-4 represent basin-margin facies, the Tamabra Formation. Units 5 and 6 are characteristic of the reefal platform-margin Taminul facies of the El Abra Limestone.

This succession from pelagic basinal limestone to true reefs represents progradation of the eastern margin of the large (200 by 300 km) Valles-San Luis Potosi platform. Such progradational sequences are rare in the middle Cretaceous of east-central Mexico because the platform margins were steep (to 45°, locally near vertical) and relief was great (to 1,000 m). Although some faults may be present, the apparent thickness of the section (>1,500 m) is comparable to the total thickness of platform sections elsewhere.

Porosity is nil in the transitional sequence except for vugs and intercrystalline pores in the dolomite and small vugs in some of the debris beds. Clasts and particles within the basin-margin debris indicate diagenetic stages in the source area ranging from unconsolidated through lightly cemented (both submarine and subaerial) to leached and secondarily cemented.

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Organic Matter Types and Depositional Environments in Thrace Basin, Turkey

The distribution of organic matter in the Eocene-Oligocene sequence of the Thrace basin, Turkey, may be used to help identify depositional cycles and environments. Four types of organic matter (amorphous, herbaceous, woody, coaly) were microscopically recognized and organic matter profiles were prepared for the Ceylan-1, Osmancik-1, and Abalar-1 wells.

Deposition of Tertiary sediments in the Thrace basin commenced with a middle Eocene transgression, resulting in the Sogucak and Ceylan formations. This transgression was followed by a regression and the Mezardere Formation (lower middle Oligocene) lagoonal sediments were deposited. A subsequent minor transgression is represented by the lower Osmancik Formation. The Oligocene ended with deposition of Danismen lagoonal-deltaic sediments. The organic matter profiles from the above mentioned wells correspond to the depositional cycles.

Amorphous organic matter is common in the Eocene sediments in the examined wells. The lower Oligocene regression was indicated by an increase in herbaceous and woody organic types. The Mezardere Formation shows differences in organic types in the examined wells. Abundance of amorphous organic matter in the Abalar-1 well instead of abundant terrestrial organic matter in the others indicates that marine influences were far greater at Abalar-1. The regressive and the transgression phases correspond to increases in the relative abundances of terrestrial and amorphous organic matter respectively. The increase in the abundance of amorphous type indicates a marine transgression at the base of Osmancik Formation. This was followed by a regressive period, which is indicated by abundant terrestrial matter with little or no amorphous organic matter.

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Variations in Structure and Salt Tectonics, Gulf of Mexico Continental Slope Basins

Detailed geophysical surveys were conducted over five intraslope basins on the northern Gulf of Mexico slope off Texas and Louisiana. Analysis of the seismic reflection data shows that these depressions are the result of coalescence of diapiric salt structures. They are filled with numerous thick sedimentary sequences with variable drape and onlapping relations. The difference in bedding attitudes which distinguish the sequences are believed to be a result of episodic salt movement. The five intraslope basins show great individual variability in the details of their physiography and structure. However, they may be classified into two main structural types: (1) eastern basins that are generally deep depressions with steepened slopes which display evidence of recent vertical motion and mass sediment movement and are underlain by salt at relatively shallow depths; and (2) western basins which are broad and shallow, formed between elongate ridge systems and which have undergone less deformation. The marked structural difference east to west is believed to be the result of differences in the thickness of the underlying salt. A thicker accumulation of salt to the east allowed for greater relative vertical motion in response to differential loading, and consequently more localized subsequent deposition. Differential loading on a thinner layer of salt may be expected to produce less vertical motion and broader basins, such as in the west. The composition and structure of the sedimentary sequences reflect complex interactions of sea-level fluctuations, thick sediment deposition, relative vertical motion of salt structures, related faulting, and mass sediment movement. Once formation of intraslope basins is initiated, they become the main loci of deposition for sediments reaching the continental slope.

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Clay Mineral Evidence for Movement of High Temperature Subsurface Fluids

The study of geopressured formations has provided considerable information on the probable pathways for subsurface fluid movement. The fluids have been traced and associated with structure, pressure distribution, salinity of formation waters, a variety of organic and inorganic diagenetic effects, and local changes in the geothermal gradient and the formation temperatures. The temperature changes may be measured directly or inferred from the presence of temperature-controlled reaction products such as the modification of illite/smectite.

Clay mineral changes are detected initially at temperatures as low as 50°C (122°F) and may extend to temperatures in excess of 300°C (572°F). The smectite-illite conversion is most pronounced in the range from 50°C to about 160°C. Significant changes in kaolinite and chlorite occur between 75°C and 250°C.

In shales from the Gulf Coast, the smectite-illite conversion is readily recognized, while kaolinite-chlorite reactions are most apparent in associated sands. In several examples, the development of kaolinite in sandstones is directly linked to the movement of high temperature fluids and the subsequent blocking of secondary porosity. Kaolinite is most abundant in those zones which experienced maximum flushing.

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Relevance of Cratonic Erosional Unconformities and Sedimentary Veneers to Mineral Exploration in Weathered Terranes

On stable platforms, erosional intervals may persist for great lengths of time either as continuously exposed planation surfaces or, when buried by sedimentary covers, as unconformities. On the West Australian craton, for example, erosional unconformities and thin sedimentary veneers are closely comparable in attitude and altitude. Repeated cycles of weathering, stripping or exhumation, and burial of shields constitute a morphogeodynamic pattern, a cratonic regime, which accounts for the slow but progressive lowering of cratonic erosion surfaces. Because phases of intense chemical weathering initiated in the later Mesozoic and continuing in Tertiary times tend to mask the presence of buried paleogeomorphic surfaces, specialized techniques are required for detection of degraded (weathered) unconformities. Application of stratigraphic principles to weathered zones and micromorphological analysis of paleosolic and weathered rock fabrics, as well as interpretation of geochemical and sedimentological data, facilitate reconstruction of paleoenvironments. Stone lines, saprolitic fabrics, gravel-clay interfaces, reverse weathering differentials, and etched or embayed skeleton grains showing the effects of epidiagenetic alteration are key to the detection of unconformities in strongly weathered cratons. Differentiation of soil-stratigraphic layers from sedimentary deposits requires proof of pedogenic existence and is in large part based on interpretation of boundaries between them, i.e., pedologic, lithologic, and geomorphic discontinuities. Paleogeomorphic reconstructions incorporating unconformities have practical application in mineral exploration