The transgressive cycle marks the drowning of the thrombolitic bioherm by a rise in sea level. Lithofacies recognized within the transgressive sequence C are: (1) millimeter-laminated micrite and biomicrite (subtidal shelf); and (2) tabular-bedded biosparite (open platform). The lateral expansion of the platform biosparite sands over the thrombolitic bioherm, intertidal, and supratidal environments coincides with the mass trilobite extinction between the deposition of the Mistaya and Survey Peak Formations.

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New Regional Magnetic and Gravity Maps of Central and Western Gulf of Mexico

As part of the regional synthesis phase of the proposed Ocean Margin Drilling Project, magnetic and gravity anomaly maps of the central and western Gulf of Mexico have been prepared from existing data, many of which have not been previously processed or interpreted.

Magnetic anomalies, derived by removal of the modified 1975.5 IGRF and average diurnal variation, are of relatively small amplitude, generally ±50 to 100 gammas, with wavelengths on the order of 50 to 200 km. Free air gravity anomalies have typical amplitudes of ±30 milligals and wavelengths of 50 to 200 km.

Distinctive linear magnetic and gravity anomalies parallel the northwest (Texas) Gulf Coast and the northwest margin of Campeche Bank. Such anomalies are poorly developed along the margins of the Bay of Campeche.

Over the central Gulf, low-amplitude linear magnetic anomalies are present. These anomalies are consistent both in trend and apparent offset with predictions based on hypothetical formation of the Gulf by sea-floor spreading synchronous with early opening of the central North Atlantic. Modeling of these anomalies and calculation of magnetic depth-to-source are in progress and should provide better insight into the origin of the Gulf of Mexico.

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Behavior of Some Common Clays in Response to Various Oil Field Fluids

The marginal or questionably productive nature of some hydrocarbon-bearing zones can be due to clays distributed within rock pores in a manner adversely affecting fluid flow. This research involves laboratory measurement of several clay rheological properties that are not commonly used in evaluating hydrocarbon-bearing reservoirs. Liquid, plastic, and shrinkage limits and plasticity indexes of a kaolinite, bentonite, and an illite are being determined using fresh water, salt water, methanol, xylene, and a non-ionic wetting compound as the moisture components.

Conclusions about the relative merits of each liquid as an oil-recovery enhancer may be drawn directly from the results of their effects on the plastic behavior, or indirectly when these results are applied in conjunction with other data concerning the rate of flow of reservoir fluids in the intergranular environment. When the liquid limit of attached clay particles is exceeded by the introduction of a stimulation fluid, they presumably become transient and change into a blocking phase. An attached clay can be induced to deform into new configurations that alter tortuosity if its plastic limit is exceeded. Differing ranges for the plasticity index would be expected to indicate preferential hydrofracture or stimulation fluids for certain reservoirs depending on type, position, and attachment status of the associated clays.

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Normalization of Well Log Data for Regional Stratigraphic Analysis

The normalization of well logs is a recognized technique for the removal of instrument and sensitivity errors.

This paper describes a project which used logs from 240 wells that penetrated Upper Cretaceous rocks in the Powder River basin of Wyoming. Normalization of the gamma ray, density, and conductivity curves was accomplished by adjusting each curve to a trend surface for the project area. Examples before and after normalization will be shown and alternate methods are discussed.

Processing and problems, data flow, and tabular results of discriminant analysis of the normalized log digits are discussed. The discriminant analysis relates to the evaluation of geologic models established for the Sussex and Shannon formations.

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Hydrogen and Carbon Isotope Analyses of Natural Gases from Candela, Italy—Case History of Mixing Gases of Different Origins

The gases of Candela, south Italy, have been investigated earlier and have been considered as an example of natural gas migration. In a new study, we have performed hydrocarbon and carbon isotope analyses on gases as well as GC-analyses up to the pentanes.

The gases range from -62 to $-42‰$ in the $^{13}C/^{12}C$ ratios and from -200 to $-170‰$ in their D/H ratios of the methane. The $\delta^{13}C$ and δD values are linearly correlated when cross plotted in a $\delta^{13}C/\delta D$ diagram. This relationship is strong evidence for mixing of two gases: (1) bacterial gas and (2) thermogenic gas. The compositional changes in the gases also follow mixing relationships.

These data are evidence that variations in the isotopic composition of gases are not necessarily the result of gas migration. Simple mixing of two sources in various proportions are likely to account for much of the observed variation in natural gases.

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Humid Alluvial Fans

Braided streams dominate environments characterized by high sediment load and flashy discharge. Although coarse-grained braided alluvium is most abundant today in association with semiarid to arid alluvial fans, several authors have speculated about the effects that a lack of terrestrial vegetation may have had on sedimentation prior to the late Paleozoic. It has been suggested that the increased flashiness of discharge and sediment yield associated with the lack of vegetation probably biased the pre-Carboniferous record toward braided alluvial deposits formed in humid areas.

A model for alluvial-fan sedimentation in a humid environment is based on the investigation of six fans formed in response to flooding associated with hurricane passage along the Sierra de

Omoa of northwest Honduras, Central America. This model and the similarities between the facies herein described and braided alluvial deposits formed in other humid settings (proglacial) suggest that the deposits of ancient humid alluvial fans may be readily distinguished from those of arid fans.

Humid fans differ from arid fans with respect to slope, gravel roundness, downfan changes in roundness, the patterns of imbrication and long axis orientation, and the abundance of debris flow deposits. Humid fans display a gentle, smoothly sloping concave-upward longitudinal profile, whereas arid fans are steeper and typically consist of segmented straight sections, producing a profile which is concave upward overall. Deposits consist largely of subangular to subrounded gravels and there is typically little change in gravel roundness downfan. Unlike arid fans, angular clasts are rare in humid fans. Imbrication and long-axis orientation transverse to flow are each well developed and, although each may be present on arid fans, their development in a humid setting is more striking. The principal difference, however, is the complete lack, among proximal sediments, of evidence for debris-flow deposition.

Proximal-fan deposits of humid fans are very poorly sorted, clast supported, and have a matrix of granular sand. Deposits generally have a crude horizontal stratification. Distally, there are transitions from clast-supported fine gravel, through sand matrix-supported gravel, to granular sands. In distal-fan areas, horizontal laminations are the dominant sedimentary structure, although high- and low-angle planar cross-stratification and trough cross-bedding may also be present.

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Upper Permian Evaporites of Dolomite Mountains, Northern Italy

The Bellerophon Formation (Upper Permian) of the Dolomite Mountains in Italy is composed of evaporite and carbonate facies. The former are both supratidal (sabkha) and shallow subaqueous in origin. The latter consists of limestone, evaporitic dolomites, and dolomitic arenites. The rocks are underlain by continental clastics of fluvial and overbank facies and are overlain by a predominantly open-marine, shallow-water carbonate sequence. The facies reflect climatic variation, sea-level fluctuation, and changing sedimentologic conditions.

This area has undergone postdepositional tectonic deformation. The deformation is, in part, recorded in a variety of structures in the Bellerophon Formation. Tectonic stylolites, as a response to stress, are widespread in the carbonate facies. In the evaporite facies, deformational fabrics are more varied. Flow structures and mylonitic textures clearly reflect bedding-parallel shear, whereas in the layered dolomite-evaporite parts of the sequence folding is a more common response to tectonic deformation.

Recognition of the extent and nature of these varied structures provides a greater understanding of the geologic history of this and adjacent regions. The deformation seen in the evaporites may provide clues to an understanding of fluid migration in other tectonically stressed areas in which evaporites are found.

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A Stable Isotope Study of Carbonate Cements in Sligo Formation

The Sligo Formation in Texas is an Early Cretaceous subsurface carbonate sequence representing the upper part of a transgressive cycle. The Sligo carbonates attain a maximum thickness of 305 m at the ancestral shelf edge where the sequence consists of rudistid boundstones and grainstones at depths of 4,570 m.

Porosity and permeability within the Sligo are controlled by the abundance of radiaxial fibrous calcite cement and/or coarse equant-calcite-spar cement. Other cements recognizable in thin section are meniscus calcite and clear euhedral dolomite. The equant calcite spar has an average of $\delta^{18}O$ relative to PDB of -1.92 and $\delta^{13}C$ of 2.80. The radiaxial fibrous calcite has average $\delta^{18}O$ of -1.77 and $\delta^{13}C$ of 1.61. The average whole-rock values are $\delta^{18}O$ of -1.52 and $\delta^{13}C$ of 2.61. The similarity between these values suggests isotopic homogenization due to diagenesis; however, the equant-calcite spar has a range in $\delta^{18}O$ of -4.98 to 0.29 indicating deposition by meteoric waters. The radiaxial fibrous-calcite cement has a narrow range in $\delta^{18}O$ of -2.10 to -1.70 consistent with an origin as an early marine replacement cement.

Intriguing correlations exist between modal abundances of cement types and their $\delta^{18}O$ and $\delta^{13}C$ values. These data provide important constraints for models predicting porosity and permeability evolution during carbonate diagenesis and have important implications for hydrocarbon exploration strategies.

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Tidal Deposition of Cypress, Ridenhower, and Bethel Sandstones (Chesterian, Late Mississippian), La Salle Anticlinal Belt, Lawrence and Crawford Counties, Illinois

Sandstones in the Chesterian (Late Mississippian), including those in the Cypress, Ridenhower, and Bethel, are major oil producers in the Illinois basin. Significant oil reservoirs occur as structurally influenced stratigraphic traps along the northwest-trending La Salle anticlinal belt of Lawrence and Crawford Counties, Illinois. Analyses of electric logs, sand thickness maps, and sedimentary structures show that these sandstones were deposited in tide-dominated deltaic, tidal-flat, and subtidal environments.

Coarsening upward, tide-dominated deltaic sequences inferred from spontaneous potential (SP) log signatures are composed of prodelta shales, delta-front shales and silts, and distributary-mouth bar sands.

Tidal-flat sand bodies are indicated by SP log signatures with blunt bases and tops. Cores from these 20 to 70-ft (6 to 21 m) thick, laterally discontinuous units contain: (1) fine to medium-grained, rippled sandstone with infrequent rippled shale laminations, (2) lenticular bedding with little bioturbation, (3) flaser bedding, (4) bioturbated sandstone and shale that were apparently horizontally bedded, (5) plant fragments in shale, and (6) channel lag consisting of deformed shale clasts and rounded carbonate mud pebbles.

Off the flanks of the anticlinal belt, the Cypress, Ridenhower, and Bethel coalesce into single massive sand units up to 200 ft (61 m) thick, distinguished by blocky SP log signatures with abrupt bases and tops. Sand thickness maps showing these units as long linear bodies aligned parallel with major anticlinal axes suggest that they are subtidal sand ridges.

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Role of Algal Assemblages in Middle Ordovician Deposits in St. Lawrence Lowlands