posed of miliolids, gastropods, and dasyclads occur in tidal channels, banks, and bars.

The lagoonal facies are overlain by tidal-flat deposits composed of an algally laminated, miliolid, pycnodont, gastropod, intraclastal, dolomitic mudstone and wackestone. Sabkha deposits of nodular or nodular-mosaic anhydrite overlie and are interbedded with the tidal-flat sediments.

The time of lower Sunniland deposition was characterized by a gradual transgression over the underlying Punta Gorda anhydrite resulting in an open, shallow-water shelf environment in which the patch reefs formed. Progradation of the open-marine and landward facies during a rapid eustatic fall in sea level probably resulted in this evolution of facies and eventually led to the anhydrites of the overlying Lake Trafford Formation ("upper massive anhydrite").

Subaerial exposure and freshwater phreatic diagenesis preserved high, primary interparticle porosity and resulted in good secondary moldic porosity in the grainstones and packstones of the shoal-water complex and shallow-water shelf sediments. Diagenetic similarities exist with four other producing facies identified from Sunniland fields. Other high-energy facies deposited and subaerially exposed during Sunniland deposition may also provide attractive exploration targets.

FIELDER, GORDON W., MARK P. DISTEFANO, and JAY N. SHEARER, Conoco Expl. Research, Ponca City, OK

### Depositional Influences in Sandstone Diagenesis of Lower Cretaceous Hosston Formation, Marion and Walthall Counties, Mississippi

Poor reservoir quality is a significant impediment to exploration success in the deep Hosston gas-condensate trend of south-central Mississippi. Regionally, depositional lithology of the Hosston exerts significant influence on cementation and porosity reduction. The primary variables are depositional carbonate content, quartz sand-grain size, and the presence of matrix clay. Feldspar content is a variable of lesser significance.

In Hosston fluvial and deltaic facies, carbonate content is low and coarser sediments are present in channel sandstones. These coarser sandstones preserve commercial porosities, whereas finer grained, shaly sandstones offer marginal porosities. Quartz overgrowths, pressure solution, and authigenic kaolinite are responsible for most diagenetic porosity reduction in this facies.

In Hosston marine prodeltaic sandstones, depositional carbonate is more common. Carbonate cements, dominantly ankerite and dolomite, are recrystallized from shell fragments and carbonate grains to occlude porosity. Quartz overgrowths, pressure solution, and stylolitization are also common in these finer sandstones. In distal marine shelf sandstones, depositional carbonate is abundant and quartz sand is very fine grained. Porosities are low in these lithofacies because of pervasive early carbonate cementation and later quartz overgrowths in intervals not cemented by carbonate.

The first stage of Hosston sandstone diagenesis was early calcite or quartz cementation. Calcite was later replaced by ankerite or dolomite. Deeper burial initiated plagioclase feldspar dissolution and the development of pore-filling kaolinite. Hydrocarbons subsequently accumulated in structural and stratigraphic closures and retarded further diagenetic porosity reduction in these sandstones. Deeper burial caused thermal degradation of oil reservoirs to dry gas and pyrobitumen. Minor galena, sphalerite, pyrite, and barite are present in open tensional fractures, associated with stylolites, and as intergranular cements. These sulfides and sulfates were probably precipitated from metalliferous brines common in the Hosston.

GALLOWAY, WILLIAM E., Bur. Econ. Geology, Austin, TX

### Depositional Framework of Early Miocene (Fleming) Episode, Northwest Gulf Coast Basin

The Fleming Group and its basinward equivalents constitute deposits of a major Cenozoic depositional episode of the northern Gulf Coast basin. The facies complex is bounded by the *Amphistegina* B shale and below by the Anahuac shale. Initially, lower Miocene (Oakville) progradation built across the broad, submerged shelf platform constructed during the earlier Frio depositional episode. At the Frio paleocontinental margin, the rate of outbuilding slowed as large-scale growth faulting created a narrow lower Miocene expansion zone. The later part of the episode was characterized by a stable to retreating shoreline and consequent aggradational to retrogradational deposition (Lagarto formation).

The lower Miocene depositional framework includes, in south Texas, the Santa Cruz fluvial system and the North Padre delta system. The bed-load fluvial complex fed a wave-dominated delta, constructing a broadly convex deltaic headland across the foundered Frio Norias delta system. Extensive wave reworking and longshore transport of sand and mud nourished a broad barrier/lagoon and strand-plain complex that extended along the central and much of the northeastern Texas coast. This well-known Matagorda barrier/strand-plain system was bounded updip by a coastal plain traversed by numerous small intrabasinal streams. Near the present Sabine River, westernmost deposits of a continental-scale, mixed-load fluvial and equivalent delta system extend beneath the Texas coastal plain and shelf from the Miocene depocenter in Louisiana. Here, the initial phase of early Miocene progradation was also complicated by the incision and filling of numerous submarine gorges.

Lower Miocene reservoirs have produced nearly 4 billion bbl of oil-equivalent hydrocarbons from nine identified plays in the Texas coastal plain and shelf. The most prolific play, the salt domes of the Houston embayment, accounts for most of the oil and more than two-thirds of the total production from the sequence. Four offshore plays offer the greatest discovery potential for substantial new reserves, primarily gas. To date, however, the yield per volume of reservoir sandstone for Miocene plays remains low, relative to more prolific units such as the Frio Formation.

GALLOWAY, WILLIAM E., Bur. Econ. Geology, Austin, TX

### Submarine Canyon System in Frio Formation of South Texas

Regional lithofacies mapping in south Texas and stratigraphic relationships, which are best documented in the Edinburg fault block, suggest the presence of a nested series of submarine canyons cutting the southern flank of the Frio (Oligocene) Norias delta system. Canyon fill consists of thick sequences of mudstone, locally containing interbedded siltstone and sandstone, that abruptly replace the normal section of deltaic coastal-barrier and delta-flank barrier-bar sandstones and prodelta or shelf mudstones. Individual canyon fills are several miles wide and as much as 2,000 ft (600 m) thick, making them comparable in scale to the late Quaternary Mississippi canyon. Canyon excavation and filling appear to have been recurrent processes during deposition of the lower and middle Frio depositional complex of south Texas; however, the best documented canyon fills predate cutting and infill of the Hackberry canyon complex of east Texas and Louisiana. The Edinburg canyon system, like its counterparts in the Cenozoic deposits of the Gulf Coast and Niger delta, occupies a paleogeographic setting at the flank of a major deltaic depocenter. This and similar canyon complexes offer deep exploration targets that have commonly been only sparsely tested and may be largely unrecognized.

GARTNER, S., and M. J. JIANG, Texas A&M Univ., College Station, TX

### Cretaceous-Tertiary Boundary in East-Central Texas

The Cretaceous-Tertiary boundary is exposed in a series of outcrops near and along the Brazos River near Eloise in Falls County. At the best known exposure, 400 m downstream from the Texas Highway 413 bridge over the Brazos River, the precise location of the boundary, based on a detailed study of nannofossils, is in a mudstone interval approximately 15 cm above a 50-cm thick prominent sandstone-mudstone-siltstone complex that has been used traditionally to designate the boundary. The complex consists of a basal friable sand lying on a scoured surface, a hard rippled calcareous sandstone, a thin soft mudstone, and a prominent hard chalk or siltstone. This same complex is exposed about 1 mi (1.6 km) downstream at the mouth of a gully, where the thickness and the character of the members of the complex are similar. Toward the head of the same gully, the sandstone complex is again exposed, but there, the rippled sandstone member is substantially thicker and more massive, although the other members of the complex retain their thickness and character. A short lateral distance downstream from the mouth of the gully, the sandstone complex becomes increasingly clayey and disappears quickly. The entire complex has been interpreted variously as a storm deposit or shelf turbidite. These, however, do not appear to offer an entirely satisfactory explanation of the depositional conditions.

At all of the sections in which the sandstone complex is present, the Cretaceous-Tertiary boundary is slightly above the complex. In these sections, deposition across the boundary is continuous although the biostratigraphic units may vary in thickness in the sections. A most reasonable explanation of the Cretaceous-Tertiary transition as expressed in these sections is that deposition of the sandstone complex, probably by several related processes, occurred in latest Cretaceous time. The biologically catastrophic boundary event occurred rapidly but somewhat later, and probably was not directly related to deposition of the sandstone complex.

GARY, ANTHONY C., Old Dominion Univ., Norfolk, VA (present address: Univ. South Carolina, Columbia, SC)

Relationship Between Test Morphology and Bathymetry in Recent *Bolivina albatrossi* Cushman, Northwestern Gulf of Mexico

An automated video digitizer and closed-form Fourier series analysis were used in this study to quantify benthic foraminiferal test morphology. This approach allows morphology to be described rapidly, objectively, and accurately and to be compared statistically to important environmental variables. Canonical discriminant analysis reduced the variable dimensions and revealed specific shape components relatable to bathymetry in Holocene specimens of *Bolivina albatrossi* Cushman from the northwestern Gulf of Mexico. Populations of *B. albatrossi* exhibit reduced test triangularity and increased surface sculpture relief with increasing water depth. Margin lobateness decreases with increasing depth. A depth classification algorithm using Fourier harmonic amplitudes divides the bathyal zone into four subzones. With further development this approach could allow paleoenvironmental reconstructions to be automated and quantified.

GLYNN, W. G., Wisenbaker Prod. Co., Tyler, TX, T. E. COVINGTON, Mobil Oil Co., Denver, CO, and R. G. LIGHTY and W. M. AHR, Texas A&M Univ., College Station, TX

Prolific Overton Field Gas Reservoirs Within Large Transverse Oolite Shoals, Upper Jurassic Haynesville, Eastern Margin of East Texas Basin

Late Triassic rifting along a northeast-southwest spreading center in east Texas resulted in basement highs along the eastern margin of the East Texas basin, which became sites of extensive ooid shoal deposition during the Late Jurassic. Reservoirs within oolite facies at Overton field contain more than 1 tcf of natural gas. These large shoals—each approximately 15 mi (24 km) long and 3 mi (5 km) wide—trend north-south as a group and northeast-southwest individually, oblique to the basin margin but most likely parallel with Jurassic diffracted tidal currents within the East Texas basin embayment of the Gulf Coast. Modern Bahamian ooid shoals of similar size, trend, and depositional setting occur at the terminus of the deep Tongue-of-the-Ocean platform reentrant. Overton field reservoirs are in ooid grainstone shoal facies and in transitional shoal margins of skeletal-oolitic-peloidal grainstones and packstones. Adjacent nonreservoir facies are peloidal-skeletal-siliciclastic wackestones and mudstones.

Early diagenesis of grainstone reservoir facies included meteoric dissolution and grain stabilization, resulting in abundant "chalky" intraparticle porosity, and equant and bladed calcite cements filling interparticle porosity. Subsequent burial diagenesis resulted in intense solution compaction and coarse equant calcite and saddle crystal dolomite that occluded remaining interparticle porosity. Whole-rock trace-element analysis indicates greatest diagenetic flushing (less magnesium and strontium) in porous zones. Stable isotopes for grains and cements show strong overprint of later burial diagenesis, with greater depletion of $^{18}O$ in reservoir facies. However, hydrocarbons were emplaced prior to late cementation, and unlike other Jurassic Gulf Coast reservoirs, deep burial diagenesis provided no late-stage formation of porosity.

GOSE, WULF A., and J. RICHARD KYLE, Univ. Texas at Austin, Austin, TX, and MARK R. ULRICH, Univ. Texas at Austin, Austin, TX (present address: Mobil Oil Co., Dallas, TX)

Preliminary Paleomagnetic Investigations of Winnfield Salt Dome Cap Rock, Louisiana

Quarrying operations at Winnfield salt dome in the North Louisiana basin provide access to calcite, gypsum, and anhydrite cap-rock zones. Sulfide laminae in the anhydrite zone are comprised dominantly of pyrrhotite with lesser amounts of sphalerite, galena, pyrite, and marcasite. Sulfides cement euhedral anhydrite grains and represent the products of the episodic introduction of metalliferous waters along the salt-anhydrite interface during halite dissolution and residual anhydrite accumulation. Thus, sulfide laminae provide a chronological record of anhydrite cap-rock accretion.

Two hundred oriented samples were collected in stratigraphic sequence, covering much of the exposed anhydrite section. Alternating field demagnetization readily revealed the magnetic polarity of most samples. Using only reversely magnetized samples with a well-defined stable magnetization ($N = 50$, $\alpha_{95} = 6.2°$) yields a pole position at 71.4°N, 125.7°E, which implies that the sampled cap-rock sequence formed in the Late Jurassic. This age is consistent with geologic evidence indicating that cap-rock formation began in the Late Jurassic and was most intense during the Early Cretaceous.

A densely sampled 45-ft stratigraphic interval contains a sequence of normal and reverse polarity zones. Assuming a constant formation rate, these zones can be compared with the M-anomaly sequence. A growth rate of about 67 ft/m.y. (20 m/m.y.) is indicated. This value is about 30 times less than estimates of salt dome growth rates. Because a 10 to 50-fold decrease in volume is associated with halite dissolution and anhydrite accretion, the paleomagnetically determined value for cap-rock formation rate is reasonable.

This investigation is the first such study undertaken. The results are encouraging and offer a unique approach for investigating the timing of various geologic processes related to salt dome formation.

GRUEBEL, RALPH D., Gruebel Energy, Houston, TX

Exploring Lower Tuscaloosa in Southwest Mississippi

The updip Tuscaloosa trend of southwest Mississippi is north of both the Lower Cretaceous shelf edge and the currently developing "intermediate" lower Tuscaloosa play in Florida, Louisiana, and Wilkinson County, Mississippi. The updip trend first became active in the 1940s with the discovery of major reserves at Brookhaven and Mallalieu fields in Lincoln County and Cranfield field in Adams County. Today, the trend is considered mature; however, it has become more active with the discovery of several new fields since 1981, including Olive, Liberty, and Friendship Church fields. A primary reason for several of these discoveries is the development of new seismic-stratigraphic methods integrated with detailed subsurface geologic interpretations. The fact that oil can be found at relatively shallow depths with reasonable drilling costs and minimal engineering problems has provided incentive to pursue this play.

HARGIS, RICHARD N., Statex Petroleum, San Antonio, TX

Proposed Stratigraphic Classification of Wilcox Group of South Texas

Numerous classifications and nomenclatures of the Wilcox section and various portions of that section in south Texas, determined on regional, subregional, and localized bases, lead to considerable confusion among geologists using different nomenclatures and the application of "upper," "middle," and "lower" designations to the section. An overall stratigraphic classification framework is proposed in which the various facies of the Wilcox and all other classifications and nomenclatures will fit, thereby standardizing recognition of the various facies and sections of the Wilcox throughout the south Texas area.

In the proposed informal classification, the Wilcox Group is subdivided in the updip subsurface, where the stratigraphy is primarily nonmarine, into the Indio Formation and the Carrizo Formation. The Carrizo Formation is further subdivided into the Wilcox-Carrizo Member, the Massive Carrizo Member, and the Carrizo-Bigford Member. In the downdip subsurface, where the stratigraphy is essentially marine, the Wilcox Group is subdivided into the lower, middle, and upper Wilcox Formations. The upper Wilcox Formation is divided into lower and upper members. The upper Member is further subdivided into the Massive, Mackhank, Luling, and Slick Sands in the areas where these sands are present.

Regional and area studies within the past 20 years, along with greater well control in sparsely or previously undrilled areas, have significantly increased our knowledge and understanding of Wilcox stratigraphy.