depths near or above the temperature level required for thermal generation of hydrocarbons. This observation suggests faults of these types are minor factors in draining hydrocarbons from deep shales within basins where thick overpressured sedimentary sections are present at shallow depths and where shale tectonism is the primary mechanism for structural development.

Microfracturing resulting from increased fluid pressure is indicated to be a primary mechanism for flushing fluids from deep basins where thick abnormally pressured sedimentary sections are present. This flushing process would be enhanced by clay diagenesis since water supplied from smectite would cause the processes to continue for longer periods of time and to extend to greater depths than could be attained if only remnants of the original pore water were present in the section. Large volumes of diagenetic water present within the microfracturing interval could also act as a vehicle for primary hydrocarbon migration, provided hydrocarbons are present in sufficient quantities to be transported.

BYBELL, LAUREL M., U.S. Geol. Survey, Reston, VA

Late Eocene to Early Oligocene Calcareous Nannofossils in Alabama and Mississippi

The Eocene-Oligocene boundary in the central Gulf coastal plain has been placed traditionally at the contact of the Shubuta Member of the Yazoo Formation and the Red Bluff Formation, or the contact of the Shubuta and the facies equivalents with the Bumpnose formation. Calcareous nannofossils were examined from six upper Eocene to lower Oligocene localities in Alabama and Mississippi. The Shubuta, Red Bluff, and equivalents have a very similar calcareous nannofossil flora, and both are in Martini's Zone NP21. However, from the base of the Shubuta up through the Red Bluff, 10 calcareous nannofossil extinction horizons can be used to subdivide the lower part of Zone NP21. *Discoaster saipanensis* Bramlette and Riedel, *D. barbadiensis* Tan Sin Hok, and *Reticulofenestra reticulata* (Gartner and Smith), which become extinct at or near the top of Zone NP20, are only rarely present in the 27 Shubuta samples examined, are poorly preserved, and are assumed to have been reworked. Below the Shubuta lies the Pachuta Marl Member of the Yazoo, which was examined at one locality in Mississippi and two in Alabama, and although the flora is poorly preserved, contains significant numbers of all three Eocene species.

If the Eocene-Oligocene boundary is assumed to correspond to the Shubuta-Red Bluff contact, this boundary, at least in the Gulf coastal plain, cannot be recognized using traditional calcareous nannofossil markers, because of its inclusion within Zone NP21. This contact, however, appears to coincide with the last occurrence of the planktonic foraminifer *Globorotalia cerroazulensis* s.l.; the extinction of *Hantkenina* spp. may occur slightly below the contact. The extinction of *Discoaster saipanensis* below that of the planktonic foraminifers has also been observed on several legs of the Deep Sea Drilling Project, where this offset is no more than a few meters. At the Red Bluff type locality, the separation approximates 65 ft (20 m). Clearly, in the study area, the extinctions of *G. cerroazulensis* and *D. saipanensis* do not define the same horizon.

CARAN, S. CHRISTOPHER, Bur. Econ. Geology, Univ. Texas at Austin, Austin, TX

Hydrothermal Mineralization Within Balcones and Luling Fault Zones of Texas

Occurrences of precious and base metals, in anomalous concentrations, have been reported for more than 100 years from sites within the Balcones and Luling fault zones. Recent field investigations supported by geochemical studies have corroborated some of these reports while casting others in doubt. Whole-rock and groundwater analyses confirm claims of cobalt, zinc, and lead mineralization, but reputed gold, silver, and mercury concentrations have not been substantiated. Although some metals are present at high levels in selected samples, the mineralized fraction of the host rock is minute, and there is no evidence to encourage hopes for a viable resource.

The source of these metals is problematic. Throughout the region, Lower Cretaceous limestones serve as the hosts and mineralization is clearly secondary. Late Cretaceous igneous activity was extensive in this area, including the vicinity of most sites of mineralization. However, none of the sites are directly associated with volcanic or intrusive bodies, and the bulk composition of these igneous rocks suggests that they would have been unsuitable as a source for these metals. Current evidence favors mineralization from hydrothermal fluids expelled, by compaction, from sedimentary basins nearby. Metallogenesis has occurred along faults and joints which may have served as conduits for the mineralizing fluids. In addition, formation waters are actively mineralizing porous Cretaceous limestones at depth in major fault zones of south Texas; these limestones contain traces of secondary galena, sphalerite, fluorite, and strontianite, and the waters are high in the corresponding solutes. This modern analog is the most suitable model for the known occurrences of mineralization.

CASEY, RICHARD E., Rice Univ., Houston, TX, JOAN M. SPAW, Reservoirs, Inc., Houston, TX, and FLORENCE R. KUNZE, Shell Oil Co., Houston, TX

Polycystine Radiolarian Distribution and Enhancements Related to Oceanographic Conditions in a Hypothetical Ocean

Radiolarian data from Holocene sediments of the world oceans were fitted to a hypothetical ocean exhibiting characteristics of all oceans. Warm-water sphere radiolarians exhibit major poleward boundaries to their distributions at subtropical and polar convergences. They exhibit poleward extensions in the westward boundary currents. Collosphaerids are enhanced in sediments under the anticyclonic gyres and eastern tropical regions. The *Dictyocoryne profunda-truncatum* group appears to be indicative of warm-water sphere mesotrophic conditions. Cold-water sphere radiolarians dominate sediments poleward of the polar convergences and occur in significant percentages under the eastern boundary currents and equatorial divergences. Intermediate and deep-water radiolarians appear to be enhanced under the polar cyclonic gyres, eastern boundary currents, and the oceanic divergences and convergences. These radiolarian indices of present oceanographic conditions (currents, divergences, convergences, and oligotrophic to eutrophic conditions) should aid in deciphering similar paleo-oceanographic conditions.

CHUBER, STEWART, Independent Geologist, Schulenburg, TX, and ROBERT L. BEGEMAN, Petroleum Geologist, San Antonio, TX

Productive Lower Wilcox Stratigraphic Traps from Entrenched Valley in Kinkler Field, Lavaca County, Texas

Subsurface data around Kinkler field define a shale-filled valley (lower Wilcox A delta), which causes multiple stratigraphic traps in the incised strata, the fill, and the overlying beds.

The channel is 1.5 mi (2.8 km) wide, 4 mi (7.4 km) long, and

360 ft (110 m) thick, trending N30°E and curving to the north at its updip end. The erosional surface becomes more areally and vertically extensive in Halletsville field, 2 mi (3.7 km) south, and correlates with the Lavaca channel erosional surface in Valentine field 9 mi (17 km) to the southwest.

Kinkler field was drilled originally as a seismically defined anticlinal structure, and the discovery well was completed from a sand deposited within the shale-filled channel. Two additional producers and 5 dry or marginal wells from this zone delineate the sand. It is 2.5 mi (4.6 km) long, about 1,500 ft (457 m) wide, and reaches a net sand thickness of 39 ft (12 m). We call this a bay margin sand.

Another productive sand occurs directly below the erosional surface. This upward-fining sand is part of a lower Wilcox A delta and distributary- channel complex, which can be correlated across several square miles. Because individual reservoirs are discontinuous we think this is a point bar with clay drapes separating depositional lobes.

A compaction closure exists over the east margin of the channel. The structure is caused by counter-regional dip into the shale-filled channel on the west, in combination with regional dip to the southeast. Although the amount of closure, 25 ft (7.6 m), is small, the structure may have influenced overlying meander points and channel migration. Two overbank sands produce oil 700 ft (213 m) above the channel, and the compaction feature may have influenced the deposition of a gas-productive upper Wilcox sheet sand 3,000 ft (914 m) above.

The inferred geologic history suggests the lower Wilcox A section is an upward-coarsening progradational deltaic sequence ending in a delta- plain environment. Sea level lowering of several hundred feet caused the river to incise deeply into the flat-lying surface at about the end of lower Wilcox A deposition, resulting in an entrenched valley. Subsequent rapid marine transgression created a drowned valley that received fine clastics both from its marine and fluvial-deltaic ends. Sand spits developed along the valley margin as filling took place.

A present-day analog of the Kinkler field model is Lavaca Bay, a Pleistocene entrenched valley, with a documented record of erosion and sedimentation.

CLARK, H. C., Rice Univ., Houston, TX

Ouachita Orogenic Complex, Central Texas—Geophysical Measurements and Basement Offset

The outline of the buried Ouachita orogenic belt in Texas follows an ancient continental edge that has been involved in lithosphere plate interaction since late Precambrian time. Gravity and magnetic measurements along the central Texas part of the trend, combined with limited seismic and well information, indicate that the complex has been offset along a persistent zone of weakness during its history. The offset relationship of the gravity and magnetic anomaly patterns and their relationship, in turn, to the geology of this zone of weakness indicate a series of basement displacements through time. A broad negative gravity anomaly is related to the overthrust package developed during the collision phase. Broad magnetic anomalies are related to slivers of basement caught up in the collision. A belt of positive gravity anomalies is related to a concentration of dense rocks created during the collision phase, or to a mantle welt created during the pull-apart phase. Short-wavelength dipole magnetic anomalies are related to shallow volcanics extruded during this pull-apart phase. The detail in these patterns may provide a framework for interpretation of basement uplift and fracture patterns involved in the offset zone.

COLE, MARY LOU, and JOHN B. ANDERSON, Rice Univ., Houston, TX

Detailed Grain Size and Heavy Mineralogy of Sands of Northeastern Texas Gulf Coast—Implications with Regard to Coastal Barrier Development

The large volume of literature available on Gulf Coast sedimentology, along with recent advances in computerized analytical methods, now enables more detailed work to be accomplished. Numerous grain-size (automated settling tube) and heavy mineralogical analyses have been conducted on sand samples from the northeastern Texas Gulf Coast. Analyses of local point-bar samples result in the delineation of major river sand sources in the region. Kyanite/garnet/hornblende + pyroxene ratios seem to be the most useful criteria for distinguishing these sources. Grain-size data show combinations of discrete modes characteristic of each river system, whereas the subaerial delta lobes of these rivers consist of finer, better sorted sands, which are believed to represent the coarsest particles transported in suspension. Beach sands are slightly finer and much better sorted than wave-dominated delta sands.

The oldest sands of Galveston Island were derived from the Trinity River, implying a possible deltaic origin for the island. However. most of the island is comprised of Mississippi River, Brazos River, and Trinity-Sabine River sands, mixed in approximately equal proportions, suggesting an offshore Pleistocene source for these features. These sands were deposited on an irregular Pleistocene erosional surface, resulting in dramatic thickness variations. Modern offshore sands and those currently being accreted to barriers, contain a high proportion of Mississippi River sand. This change results from the depletion of offshore mixed sands and marks the onset of barrier retreat.

COLEMAN, J. M., and D. B. PRIOR, Coastal Studies Inst., Louisiana State Univ., Baton Rouge, LA, and JOHN F. LINDSAY, Exxon Production Research, Houston, TX

Formation of Mississippi Canyon

The most prominent submarine physiographic trough in the northern Gulf of Mexico is the Mississippi Canyon. This submarine trough has an average width of 5 mi (8 km), length of 75 mi (120 km), and bathymetric relief of 985 ft (300 m). Its origin has generally been attributed to channel entrenchment of the Mississippi River during lowstands of sea level and erosion of the more distal parts by turbidity currents or submarine gravity flows. In the last 2 years, a dense, high-resolution seismic and side-scan sonar grid 1,000 ft (305 m), together with deep borings utilized to obtain samples for carbon-14 dating, has been used to establish a time-stratigraphic framework and origin for this feature. Nine horizons, chosen from borings and dated by carbon-14 and paleontologic methods, have been traced laterally on the seismic lines. These horizons range in age from Illinoian (~400,000 years B.P.) to late Holocene (3,500 years B.P.). During the interval from Illinoian to late Pleistocene (25,000 to 27,000 years B.P.), the Mississippi River deposited a series of fluvial and deltaic deposits of approximately 3,300 ft (1,000 m). There is no evidence that a submarine canyon existed in the vicinity of the present feature during this time interval. Approximately 25,000 years ago, a carbon-14-dated horizon was truncated by the initial formation of the submarine canyon. Samples dated by carbon-14, obtained near the base of the canyon fill, show that by 20,000 years B.P., canyon fill had commenced. Thus, this major submarine trough had, at most,