gas. Thickness of the Pensacola Clay increases southwestward. The Miocene coarse clastics are micaceous, locally carbonaceous and fossiliferous, and contain numerous beds of small mollusk shells.

Within the Pensacola Clay and the overlying Miocene coarse clastics, three separate progradational marine sequences may be recognized. Generally, sediments within each sequence coarsen upward. The lowermost sequence, the Amos, contains the gas-productive Amos sand. The middle sequence, the Escambia, has the Escambia Sand at its top. The uppermost sequence includes the upper member of the Pensacola Clay, which contains the gas-producing Meyer sand, and the interfingering Miocene coarse clastics.

Foraminifera found in the Pensacola Clay are indicative of outer to inner-neritic environments. Foraminiferal species number and diversity, as well as number of planktonic species, generally decrease upward within each depositional sequence, indicating an increasingly restrictive marine environment and shallowing of the seas.

The presence of *Globorotalia fohsi fohsi, G. fohsi robusta, G. fohsi lobata*, and *G. praemenardi* in the Amos depositional sequence indicates a middle Miocene age for the sequence. A late Miocene age is indicated for the Miocene coarse clastics by *Rangia (Miorangia) microjohnsoni*. The three depositional sequences appear to correlate with the TM 2.2, TM 2.3, and TM 3.1 third-order cycles of sea-level change as proposed by Vail et al in 1977.

Isopach and net sand maps of the different depositional sequences are useful for petroleum exploration. Comparison of such maps for the Amos depositional sequence indicates that in Baldwin County, Amos sands (the most productive of the Miocene sands) occur where the depositional sequence is locally thicker, probably as a result of postdepositional compaction of clays surrounding sand bodies. Sands found at the top of the Amos depositional sequence are often productive because these sands have been transgressively reworked and are overlain by marine source beds.

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Landform Dynamics of Bayou Lafourche Barrier Shoreline

A three-dimensional morphodynamic model depicting temporal and spatial changes in barrier morphology is presented for the Bayou Lafourche barrier shoreline. Variations in overwash intensity generate a predictable sequence of barrier morphologies, with overwash intensity defined as the frequency and magnitude at which overwash events impact the shoreline. This model depicts continuous change in barrier morphology, with decreasing overwash intensity leading to onshore sediment transport, barrier accretion, and dune development. Increasing overwash intensity leads to barrier erosion, offshore sediment transport, and washover sheet formation.

The erosional sequence begins with stage 1, when a continuous foredune barrier is formed under low intensity overwash and fair weather conditions. Increasing overwash intensity erodes the stage 1 foredune and creates an offshore movement of sand. Increasing overwash intensity leads to foredune breaching, overwash, and the development of an eolian terrace, stage 2. During stage 3, the foredune is eventually destroyed, forming a washover terrace. Continued intense overwash activity finally results in the destruction of stage 3, and the formation of a washover sheet, stage 4.

The accretionary sequence begins with a stage 4 washover sheet generated by intense high-energy overwash conditions. With decreasing overwash intensity, an onshore movement of sediment is produced and the barrier begins to accrete, leading to stage 3. Continuing low overwash intensities lead to discontinuous foredune development and the formation of an eolian terrace, stage 2. Stage 1 is reached when the discontinuous foredunes coalesce to form a linear continuous foredune.

Spatially, longshore variation in sediment availability results in different barrier-beach stages occurring simultaneously along the Bayou Lafourche barrier shoreline. Position within the barrier island system determines sediment supply. Coastal tracts on the central headland and updrift, and of flanking barrier islands, are characterized by a negative sediment budget and the persistence of barrier stages 3 and 4. The downdrift flanks of the erosional headland and flanking barrier islands and spits have abundant sediment, with barrier stages 1 and 2 persisting. An intense overwash event associated with a major tropical cyclone impact would transform the entire Bayou Lafourche barrier shoreline into a stage 4 barrier and initiate a new accretionary sequence.

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Recurrent Species Associations and Species Diversity of Cytheracean Ostracodes in Upper Austin and Lower Taylor Groups (Campanian, Upper Cretaceous), Travis County, Texas

Assemblages of cytheracean ostracodes from the Dessau, Burditt, and Sprinkle formations of the upper Austin and lower Taylor Groups of Travis County, Texas, were examined in order to identify recurring species associations and the paleoenvironmental factors that control their stratigraphic distribution. From Q-mode cluster analysis, six sample groups were identified, all of which correspond closely to observable lithofacies. Four recurrent species associations were identified from the R-mode cluster analysis and were found to correspond to four of the six sample groups. Indices of species diversity and of its components, species richness and species equitability, show noticeable changes from one lithofacies to another, with the greatest changes occurring at the disconformable Dessau-Burditt and Burditt-Sprinkle (Austin-Taylor) contacts.

The stratigraphic distributions of cytheracean ostracode faunas in the upper Austin and lower Taylor appear to be controlled by the distribution of lithofacies. Some of the faunas, however, differ primarily in abundances of species, as opposed to containing different species. Such faunas can be differentiated by comparing values of species diversity and its components. Plotted trend-curves of the indices provide visual aids for this purpose. The parallel shapes of the trend-curves for two outcrops suggest potential use of diversity trend-curves for stratigraphic correlation, and major breaks in these curves at known disconformities show potential for detecting previously unrecognized disconformities. Appearances and disappearances of a few species, including *Alatacythere cheethami, "Hazelina" austinensis, Schuleridea travisensis,* and *Loxoconcha retiolata,* may be temporally significant.

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Petrologic Variation in Pliocene to Quaternary Gravels of Southeastern Louisiana

Grain-size analyses and chert-to-quartz ratios were studied on Pliocene and Quaternary gravel fractions from the Florida parishes of southeastern Louisiana to differentiate between gravels of different ages. Gravels are found in the following units: (1) Pliocene-Pleistocene Citronelle Formation; (2) Prairie Formation (< 35,000 y.B.P.); (3) Deweyville terrace deposits (30,000 to 17,000 y.B.P.); and (4) Holocene channel and bar deposits.

Petrologic studies show that the Citronelle gravels are easily distinguished from the younger terrace gravels by their coarser grain size, low granule content and high chert-to-quartz ratios. Prairie and Recent gravels have similar textures and composition indicating they were deposited under similar conditions. Both Prairie and Recent gravels were derived directly from the Citronelle (Bogue Chitto valley), whereas in others (Tangipahoa valley) they were cycled through the Prairie Formation.

In the Pearl River valley, Prairie and Deweyville gravels are significantly finer and contain higher granule content and lower chert-to-quartz ratios than other gravels in the Florida parishes; this suggests that the late Pleistocene Pearl River was mature and had high discharges, possibly due to an enlarged drainage basin that contained quartz-rich sources which are not available to the modern Pearl River. Post-Deweyville climatic and hydrologic changes have resulted in a smaller drainage basin and less discharge for the modern Pearl River.

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Paleogene Calcareous Nannoplankton Biostratigraphy: Mississippi, Alabama, and Tennessee

Distribution and abundance of calcareous nannoplankton in the Paleogene formations of Mississippi (MS), Alabama (AL), and Tennes-

see (TN) are reported in this study. These data have been used to assign each of the following nannoplankton-bearing formations and members to Martini's 1971 internationally recognized calcareous nannoplankton zones.

Formations and Members	*Zones*
Paynes Hammock Formation (MS)	NP 24
Chickasawhay Limestone (AL)	NP 24
Bucatunna Formation (AL)	NP 22
Byram Formation (MS)	NP 22
Glendon Limestone (MS)	NP 22
(AL)	NP 22
Marianna Limestone (MS)	NP 21, 22
(AL)	NP 21
Mint Spring Formation (MS)	NP 22
Forest Hill Formation (MS)	NP 21
Red Bluff Formation (AL)	NP 21
Bumpnose Limestone (AL)	NP 21
Crystal River Formation (AL)	NP 19/20
Yazoo Formation	
Shubuta Clay Member (MS)	NP 19/20, 20, 21
(AL)	NP 19/20, 20, 21
Pachuta Marl Member (MS)	NP 19/20
(AL)	NP 19/20
Cocoa Sand Member (AL)	NP 17, 18, 19
North Twistwood Creek Clay Member (AL)	NP 17
Moodys Branch Formation (MS)	NP 17
(AL)	NP 17
Gosport Sand (AL)	NP 17
Cook Mountain Formation	
Potterchitto Member (MS)	NP 16
Lisbon Formation	
"Upper" (AL)	NP 16, 17
"Middle" (AL)	NP 16
"Lower" (AL)	NP 15
Tallahatta Formation (AL)	NP 14, 15
Hatchetigbee Formation	
Bashi Marl Member (AL)	NP 9, 10
Tuscahoma Sand	
Bells Landing Marl Member (AL)	NP 9
Nanafalia Formation	
"*Ostrea thirsae*" beds (AL)	NP 7, 8
Salt Mountain Limestone (AL)	NP 7
Naheola Formation	
Coal Bluff Marl Member (AL)	NP 5
Porters Creek Formation (AL)	NP 3/4
Matthews Landing Marl Member (AL)	NP 3/4
Clayton Formation (TN)	NP 2, 3/4
McBryde Limestone Member (AL)	NP 3/4, 4
Pine Barren Member (AL)	NP 1, 2

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Basement Model for Panhandle of Florida

Core samples from deep boreholes in panhandle Florida form the basis of a basement model involving at least eight separate fault blocks and basins, each with a distinct depositional history. The dominant structures are a northwest-trending fault and a large, northeast-trending Triassic graben which encompasses several secondary fault blocks and forms the Southwest Georgia Embayment (Apalachicola Embayment). This graben as well as associated perpendicular (northwest-southeast) faults were formed in response to tensional forces related to the Mesozoic separation of North American and South American landmasses and the consequent formation of the Gulf of Mexico. Granitic basement blocks, perhaps early Cambrian in age, experienced differential subsidence and changing relationships with various sedimentary source terranes. Thus, the separate basins accommodated different combinations of Triassic Eagle Mills red beds and Jurassic deposits ranging from the Louann Salt to the Cotton Valley sandstones and shales.

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Red Bluff, Marion County, Mississippi: A Citronelle Braided-Stream Deposit

Red Bluff is an erosional escarpment located on the western margin of the Pearl River flood plain in northwestern Marion County, Mississippi. The bluff shows approximately 30 m (100 ft) of relief and is composed of alternating units of red-to-yellow sand and sandy gravel. The sand grains are composed primarily of quartz, with small amounts of heavy minerals and feldspar. The gravel is composed of varying percentages of chert, flint, jasper, rip-up clasts, quartz, and tripoli, including a small fraction of silicified Paleozoic fossils.

Grain-size analysis of the sediment and investigation of the sedimentary structures suggest a braided-fluvial environment of deposition. Particle sizes in the medium sand to pebble range predominate in all units; very little silt and clay is present. The largest "particles" present are boulder-size rip-up clasts. The most conspicuous sedimentary structures at Red Bluff are graded bedding, low-angle to medium-angle cross-bedding, and well-developed paleochannels.

A statistical comparison (discriminant analysis) of the seven most abundant heavy minerals of Red Bluff, with the same suite of heavy minerals found at the type section of the Citronelle Formation (Pliocene-Pleistocene), and outcrops of a known Miocene coarse clastic unit indicates a correlation of Red Bluff to the Citronelle Formation. These heavy minerals are kyanite, staurolite, rutile, tourmaline, zircon, black opaques (primarily ilmenite and magnetite), and white opaques (primarily leucoxene).

The suite of heavy minerals present at Red Bluff belongs to the east Gulf province. This metamorphic assemblage of heavy minerals implies the source area of the sediments at Red Bluff to be the southern Appalachians. The silicified pebble-size Devonian-Mississippian fossils were derived most likely from formations flanking the southern Appalachians in northern Alabama.

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Sedimentary Regimes of Upper Midway and Lower Wilcox Lignite in Alabama

Paleoenvironments favorable for lignite deposition existed in sedimentary regimes of the Naheola Formation (upper Midway Group) and in Midway-Wilcox transition sediments apparently assignable to the Nanafalia Formation (Wilcox Group). In addition, lignite horizons are recognized in the Tuscahoma Sand (Wilcox Group). Lignite of potential economic significance occurs within the Naheola Formation west of Butler County and within the Nanafalia Formation east of Butler County. Lignite horizons in the Naheola Formation west of Butler County probably are not stratigraphically or time equivalent to lignite horizons east of Butler County. Depositional environments of the Naheola west of Butler County were favorable for development of lignite deposits with extensive lateral continuity, whereas lignite depositional environments east of Butler County apparently favored variability in thickness and lateral continuity. Estuarine and back-barrier coastal marsh environments are suggested for the lignite.

Carbonaceous silt and clay in varying proportions are commonly associated with lignite in the Naheola Formation. Lithologic associations of lignite related to the Nanafalia Formation include quartzarenite, carbonaceous silt and clay, oyster beds, and limestone of the Clayton Formation (Midway Group).

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Diagenetic History of Cotton Valley Limestone at Teague Townsite Field, Freestone County, Texas

The Cotton Valley lime was deposited during a regressive phase of the Late Jurassic, in a shallow sea with an extensive platform. Mild salt tectonism has modified depositional and diagenetic environments through time. The Cotton Valley lime is composed of thick, massive oolitic, finely crystalline, micritic limestones which rim the west flank of the East Texas basin. The Cotton Valley lime at Teague Townsite field represents deposition within a shallow sublittoral marine sandbar environment and its associated laterally equivalent facies. Included within the sequence are as many as nine local shoaling upward cycles. Petrographically observed diagenetic features include products of neomorphism, compaction and pressure-solution, cementation, leaching, and replacement intergranular porosity was occluded early by rim and pore-filling cements. Intragranular porosity was produced as a result of early meteoric leaching, a feature abundant in porous zones, and occasionally accompanied by equant cement. Compaction is expressed mainly as pressure-solution features and stylolitization. It is inferred that early mineralogic stabilization and meteoric cementation armored grains in porous intervals against burial