cite, require many changes of pore fluid. The number of pore volumes required is much greater than can be derived from compaction alone. Free convection, if it exists, is an attractive process in accounting for these observations. Three lines of evidence indicate that free convection is occurring in at least some Gulf Coast reservoirs. First, Rayleigh-Darcy calculations were made for a variety of reservoir thicknesses, permeabilities, and thermal gradients. Reasonable Gulf Coast values were selected and thermally sensitive parameters were allowed to vary with temperature. Critical Rayleigh numbers were exceeded for thick Gulf Coast sands. Depending on site-specific conditions, diagenetic reduction of permeability may create a preferred depth range for the occurrence of free convection. The second line of evidence includes pore-fluid density, silica content, and temperature data for Frio Formation waters. These data are consistent with a freely convecting system. Third, areal distribution of thermal gradients within a Frio reservoir exhibits a geometric pattern completely consistent with Bénard-type convection cells: central, upward-moving, heated plumes surrounded by polygonal zones of cooler, down-flowing waters. Therefore, free convection in Gulf Coast reservoirs is consistent with both field data (as demonstrated in the Frio Formation) and theoretical calculations.

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Glacial-Eustatic Control of Virgilian Cyclothems in North-Central Texas

Virgilian strata in north-central Texas consist of repetitive sedimentary sequences called cyclothems. These cyclothems were caused by waxing and waning of glaciers in the southern hemisphere (Gondwana). During the transgressive phase, deltas were drowned, forming estuaries, and the oxygen-minimum zone responsible for the black shales in the Midland basin rose to a position well up on the shelf area, resulting in a sequence of lithofacies and corresponding biofacies which indicate a water column with stratified dissolved oxygen content. During early regression, the oxygen-minimum zone and the characteristic lithofacies and biofacies began retreating toward the Midland basin. Deltas began prograding well out onto the outer shelf, and the resulting lithofacies and biofacies depended upon the relationship between paleogeography and the prograding deltas. During maximum regression, the oxygen minimum zone was restricted to the Midland basin, and the shelf-edge carbonates were subaerially exposed, resulting in extensive freshwater diagenesis, which was responsible for enhancing secondary porosity.

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Coarsening-Upward Tidal Sequences in Wilcox Group in East Texas

Most exploration concepts for the Wilcox Group are based on paleogeographic reconstructions derived from maps of net sand or sand percent. Coarsening-upward tidal sequences exposed in the highwalls of two lignite mines in east Texas show the shortcomings of these reconstructions. In the past, the coarsening-upward sequences have been interpreted as prograding floodplain splays because they occur in an area of supposed fluvial sedimentation (conventional paleogeographic reconstructions show a large river system occupying the East Texas embayment during the deposition of the Wilcox Group). Recognition of the tidal origin of the coarsening-upward sequences suggests an embayed coast or a shoreline within the East Texas embayment at the time the coarsening-upward sequences were deposited—information which has exploration implications. Paleogeographic reconstructions based on maps of net sand or sand percent show time-averaged conditions. The search for the subtle trap requires paleogeographic maps based on smaller stratigraphic intervals than present reconstructions provide. These intervals can be defined by using the principles of sequence stratigraphy and tracing unconformities in the subsurface.

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Structural Analysis of Southwest End of Dagger Flats Anticlinorium, Marathon Region, Texas

No abstract submitted.

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Depositional Environments and Basinal Setting of Cretaceous Woodbine Sandstone, Central and Northeast Texas

The Upper Cretaceous (Cenomanian) Woodbine Sandstone of central and northeast Texas has long been one of the largest oil and gas producers in Texas. North of the Angelina-Caldwell flexure, production is at moderate depths of 3,000-6,000 ft from fluvial and subaqueous deltaic facies. South of the flexure, the undifferentiated Woodbine–Eagle Ford interval produces from depths between 10,000 and 15,000 ft from fractured turbiditic channel siltstones and sandstones.

This investigation (1) more precisely defined environments of deposition, (2) determined their relationships to development of the East Texas basin, and (3) related these environments to hydrocarbon production. Much greater control was used than in previous studies, including an extensive core study (approximately 70 cores), close well control (approximately 1,200 electric logs), and an outcrop study.

In general, the depositional environments of the updip Woodbine change progressively from a complex fluvial system in the northeastern portion of the study area to delta plain, delta front, and prodelta shelf in a southwestward direction. Major fluvial axes are oriented north-northeast to south-southwest. The fluvial system includes (1) a braided stream facies, (2) a distributary channel facies, and (3) a meander belt facies. The two principal recognizable facies of the delta front are coastal barrier sands and progradational channel-mouth bar sands.

Woodbine deposition ended with transgression of Eagle Ford seas and subsequent deposition of marine shales. These shales provide a potential hydrocarbon source and seal for Woodbine reservoirs.

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Petroleum Source Rock Potential of Arbuckle and Ellenburger Groups, Oklahoma and North Texas

Oil and gas have been produced from the Cambro-Ordovician Arbuckle and Ellenburger Groups in Oklahoma and Texas for more than 50 years, but as yet no studies have addressed the question of petroleum source beds within these units. The solution of this problem is important in determining whether significant petroleum accumulations can be expected to be found deep within this thick and relatively unexplored section of carbonate rocks.

Detailed studies of the composition of oils produced from Arbuckle fields compared with those from Pennsylvanian fields show no discernible differences. These studies, which include determination of the composition of gasoline-range and C_{15+} saturate hydrocarbons and also saturate/aromatic/asphaltic ratios, strongly suggest that very similar source beds generated all the oils. Similar analyses of the bitumen present in nonreservoir Arbuckle and Ellenburger rocks show that very distinct differences exist between the oils and the rock bitumens. Arbuckle and Ellenburger rocks apparently were not the source beds for any of the oils investigated in this study.

Further studies of thermal maturity and organic richness of Arbuckle and Ellenburger rocks by use of pyrolysis–gas chromatographic methods reveal that this part of the section is thermally mature, and has generated at least some hydrocarbons; however, hydrocarbon and organic carbon contents are very low, indicating that commercially significant amounts of petroleum have not been generated or expelled. The lack of adequate amounts of organic matter is interpreted to be the reason that these rocks have not acted as significant petroleum sources. Based on this geochemical evidence, other, younger, rocks have generated the oils found in the Arbuckle and Ellenburger Groups.

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Upper Strawn and Canyon Cratonic Depositional Systems of Bend Arch, North-Central Texas

Terrigenous clastic and carbonate depositional systems comprising the upper half of the Strawn Group and the complete Canyon Group (Pennsylvanian) were deposited within the Forth Worth basin and on the Bend arch of north-central Texas. The stratigraphic interval involves 12 major format cycles of deltaic progradation and marine transgression. These units subdivide the outcrop and subsurface section into mappable genetic units. Variations in the rate of subsidence for the Fort Worth basin, Knox-Baylor trough, and Bend arch, as well as the initiation of subsidence to form the Midland basin, were responsible for the lithofacies geometry of individual depositional systems and gave rise to the "cyclothemic" cyclic sedimentation pattern. The effects of eustatic sea level changes have not been recognized from facies-derived evidence in north-central Texas.