Mountain, lower Blakely, and upper Blakely sandstones of the Ouachitas are stratigraphically equivalent to the Oil Creek (Calico Rock), McLish (Newton), and Bromide (St. Peter), respectively.

The Everton/St. Peter is a mixed sandstone-carbonate association throughout most of the Arkoma but changes facies to carbonates in the eastern Arkoma basin and Mississippi embayment and is dominantly sandstone and shale in the southern and southwestern portions of the Arkoma basin in Arkansas. Similarly, the Simpson is a mixed sandstone-carbonate association in the Arkoma basin of Oklahoma, but is dominantly shale in the southern and southwestern portions of Oklahoma.

Sandstones of the Simpson and Everton/St. Peter were derived from a source to the north and were deposited in shifting strandline and shelf environments. Crystal Mountain and Blakely sands also were derived probably from the north but were deposited in deeper water fanlike environments via chutes on the downthrown sides of growth faults at the Arkoma basin (shelf) geosyncline transition. Substantial amounts of clay, however, were derived from a source to the south.

Regional cross sections, sand distribution maps, and paleogeographic maps are used to illustrate these ideas and to point out areas favorable for oil and gas exploration.

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Relationship of Epeirogeny and Sedimentation in Kansas

Regional subsurface and lithofacies mapping has revealed that epeirogenic movement, particularly involving subtle, periodic reactivation of preexisting structural weaknesses has affected sedimentation through time in the Mid-Continent. Similarly, regional outcrop studies have provided many examples where paleostructures have influenced sedimentation. Detailed measurements of the earth's gravity and magnetic field intensity, remote sensing, and geomorphologic analysis also have identified surface and subsurface features which can be used to infer discontinuities in the composition and structure of basement rocks. Faults, folds, and possible fracture systems have propagated up through the sedimentary section, are expressed in the topography of the present land surface, and control stream and river drainage patterns. Structural elements, large and small, appear to have influenced regional and local sedimentation, erosion, and diagenetic patterns through long periods of time, as suggested by the geologic record in Kansas.

In some situations, bathymetric and topographic highs related to preexisting structural elements have affected markedly the distribution of petroleum reservoir-quality carbonates and sandstones from the Cambrian through the Cretaceous. A review of four, vertically stacked carbonate-dominated cyclothems from the Upper Pennsylvanian Kansas City Group in central and western Kansas reveals an evolving display of time and location dependent features caused by the combined effects of epeirogenic and recurrent structural movement, sedimentologic controls such as clastic influx, and eustatic changes in sea level. Favorable reservoir facies trends of the carbonates and early freshwater diagenetic patterns can be explained, in part, by variations in the configuration of the Pennsylvanian epeiric shelf.

In addition to trap formation, subtle structural development also may affect indirectly the reservoir distribution by influencing markedly the processes of sedimentation and diagenesis. Inasmuch as the subtle expression of deep structure usually can be detected in shallow and surface records, it follows that remote sensing and geomorphologic analysis can assist conventional geophysics and subsurface geology in the development of new energy and mineral prospects.

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Red Fork Sandstones (Lower Pennsylvanian) in Deeper Parts of Anadarko Basin, Oklahoma

Red Fork sandstones in the deeper part of the Anadarko basin are the downdip equivalents of fluvial and deltaic sandstones in the Cherokee Group. The sandstones have repetitive, ordered sequences of sedimentary structures in vertical section. Individual bedsets display sharp basal contacts, gradational tops, and contorted bedding. The characteristics indicate these basinal sandstones were deposited by turbidity currents.

The sandstones occur as narrow, linear constructional channels that are dip-trending. The lateral change from channel-fill to overbank facies takes place abruptly. Channel sandstones display incomplete "AE" bedsets up to 12 ft (3.6 m) thick. Overbank deposits have thin "BE," "BCE," and "CE" Bouma sequences and generally are dominated by shale.

The sandstones are very fine-grained litharenites with an average composition of 58% quartz, 8% feldspar, 17% rock fragments, 5% other grains, and 12% matrix. Cement consists mainly of calcite ranging from 2 to 40% of the bulk volume. Quartz content tends to decrease upward and matrix increases upward within bedsets. The compositional grading is accompanied by a decrease in grain size upward within bedsets, indicating deposition during a decreasing flow-regime.

Red Fork sandstones are low-permeability reservoirs with an average porosity and permeability of 7.8% and 0.1 md, respectively. Natural gas reservoirs occur mainly in the thicker, channel sequences.

The bedding character of the channel and overbank facies is reflected in gamma-ray log responses. Log characters of the two facies are used to interpret turbidite sections of uncored areas. The interpretations are adapted to the East Clinton field for prediction of constructional channel reservoirs. The interpretation of dip-trending turbidite deposits may aid in exploration and development of the Red Fork sandstones.

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Shallow Gas in Arkoma Basin—Pine Hollow and South Ashland Fields

The Pine Hollow and South Ashland fields located in Pittsburg and Coal Counties, Oklahoma, established a combined reserve exceeding 200 bcf of gas. The Hartshorne Sandstone of early Desmoinesian (Pennsylvanian) age is the producing zone at a depth of 4,000 ft (1,200 m). Gas, probably of biogenic origin, migrated into the reservoir shortly after deposition. Subsequent folding and faulting of the Ashland anticline resulted in repositioning of the gas in a downthrown fault trap. The upthrown anticline portion of the Hartshorne is water-bearing. Moderate well costs and high individual reserves have resulted in excellent economics. Competitive bidding on federal leases has resulted in a high bid exceeding $1 million for one tract in the South Ashland field.