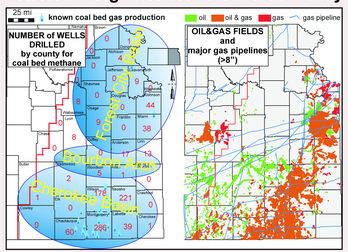
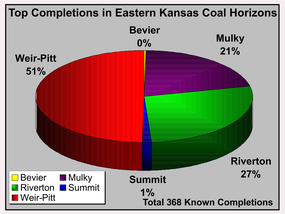
Abstract

In southeastern Kansas, the Middle Pennsylvanian Cherokee Group contains thin coal beds (0.2 to 1.5m) within numerous depositional sequences. Cherokee coals compose a large portion of an estimated 48 billion metric tons of deep (greater than 30 meters) coal resources in eastern Kansas. Cherokee coals are of high-volatile bituminous A and B rank. With sufficient overburden and thick seals they have high potential for coalbed gas production. In Kansas, economic coalbed gas production requires identification of coals of higher gas content, seams generally thicker than 0.5 meters, and multiple coals within close proximity to pipeline infrastructure.

Structure and isopach maps, along with cross sections, were constructed from cores, outcrops and well logs to provide a better understanding of the lateral variability and extent of the major coal bearing sequences. Core descriptions were integrated with well logs to determine depositional environments. Coal samples from core holes within the study area were desorbed to determine total gas content. Gas content varies widely (from 50 to more than 250 scf/ton). Variations in coal quality, thickness, and lateral distribution can be understood by placing Cherokee Group coals within a sequence stratigraphic framework. Cherokee Group coals accumulated in a variety of depositional settings such as marshes, back marine barrier (lagoonal), fluvial floodbasin, and interdistributary deltaic environments. An improved geologic understanding of the Cherokee Group coals can aid in coalbed-gas exploration and development in southeastern Kansas.

Petroleum Significance - Active CBM Play





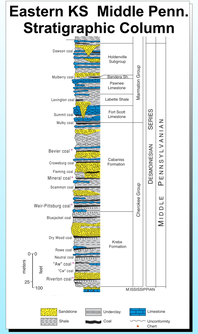
Conventional petroleum production in the Cherokee basin that began in the late 19th century continues to present, although in decline for the past fifty years. Since the mid-1980's and early 1990's unconventional shale and coal gas wells have reported cumulative production greater than 300 MMCF. Recent demands for natural gas, increasing prices, and new technologies have turned the Cherokee basin into an active energy play. Up to 14 relatively thin coals beds may be encountered in any one well. The key to a successful coalbed play is to identify numerous coals with higher gas contents located near pipeline infrastructure.

Coals in the Cherokee basin are less than 2,500 feet deep, so drilling costs are relatively low. Top reported completions intervals are in the Mulky coal and overlying Excello Shale, Weir-Pittsburg coal, and Riverton coal. Many producers are completing in coals that are less than 2 feet thick with promising results. The Mulky coal on average is much thinner than other coals, but the combination of a thick black shale with moderate absorbed gas capping the coal, provides an economic target.

Study Area

Location map of Elk, Wilson, Neosho, Crawford, Chautauqua, Montgomery, Labette, and Cherokee counties in relation to major structural features.

Eastern KS Middle Penn. Stratigraphic Column



Stratigraphic column of Middle Pennsylvanian (Desmoinesian) strata in the study area.

Geologic Background

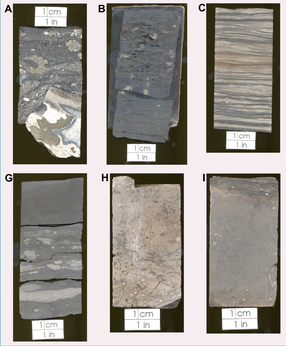
The Cherokee basin is located on the western flank of the Ozark dome, which is part of the northward extension of the elongated Oklahoma platform (Moore, 1979). The Cherokee basin is bounded by the Bourbon arch to the north, the Nemaha uplift to the west, and the Ozark dome to the east. Cherokee Group rocks gradually thicken to the south into the deeper Arkoma basin (Ham and Wilson, 1967;).

During the early to mid-Desmoinesian the Cherokee basin was influenced by the orogenic activity of the convergent Ouachita system in present-day southeastern Oklahoma (Ham and Wilson, 1967). Deposition of the Cherokee Group occurred while the area was part of the slowly subsiding, intracratonic basin (Staton, 1987). Sediment of the Cherokee Group was deposited disconformably upon the karst surface of the Mississippian limestone in southeastern Kansas and adjacent areas (Saueraker, 1966).

Depositional Environments

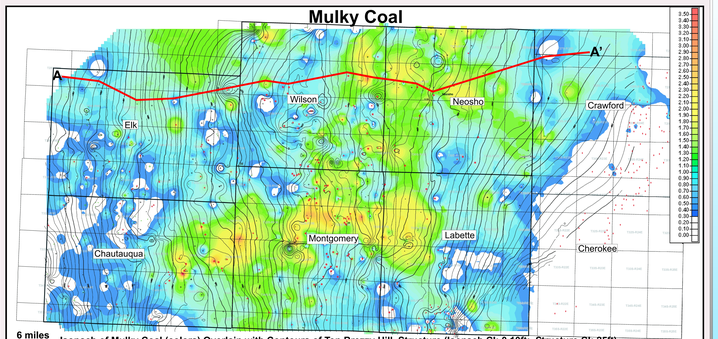
Depositional environments of many coals are not necessarily directly related to the environments of the overlying or underlying sediments due to significant hiatus in deposition (McCabe, 1984). Depositional environments of coals are reflected by their geometry, average thickness, areal extent, orientation, ash content, and sulfur content. However, to better understand variations in coal quality, thickness, and lateral extent of coals within a sequence stratigraphic framework, depositional environments of overlying and underlying sediments must be identified.

Cherokee Group Facies



Slabbed core samples of Cherokee Group; (A) Mississipian-Pennsylvanian Unconformity; (B) Pyritic black shale, interpreted as a marsh; (C) Interlaminated sandstone and shale, interpreted as tidal rythmites; (D) Silty shale with siderite bands, interpreted as central basin of an estuary; (E) Cross ripple laminated sandy shale, interpreted as a muddy tidal flat; (F) Pedogenically altered shale, interpreted as a paleosol; (G) Phosphatic black shale, interpreted as a shelf shale; (H) Bioclastic wakestone-packstone, interpreted as open marine below wave base; (I) Peloidal grainstone, interpreted as open marine above wave base.

Mulky Coal



Isopach of Mulky Coal (colors) Overlain with Contours of Top Brezzy Hill Structure (Isopach CI: 0.10ft; Structure CI: 25ft)

Mulky Coal

Proximate Analysis:

	As Received Range	As Received Average	Moisture Free Range	Moisture Free Average
Moisture	0.49% - 1.79%	0.94%		
Ash	15.82% - 32.97%	32.97%	15.9% - 33.57%	25.45%
Sulfur		11.69%		11.90%
Volatile Matter		28.95%		29.48%
Fixed Carbon		36.29%		36.95%
BTU/lb		9,622		9,797

Volumetrics (Area West of Crawford and Cherokee Counties):

Volume, coal > 1.5'	511,071.42 Acre-FT
	1800 Tons (short)/acre-ft
	919,928,556 Tons (short)
Avg. scf/ton	130 scf/ton
OGIP	**120** bcf gas

Excello Shale

Ash Content:

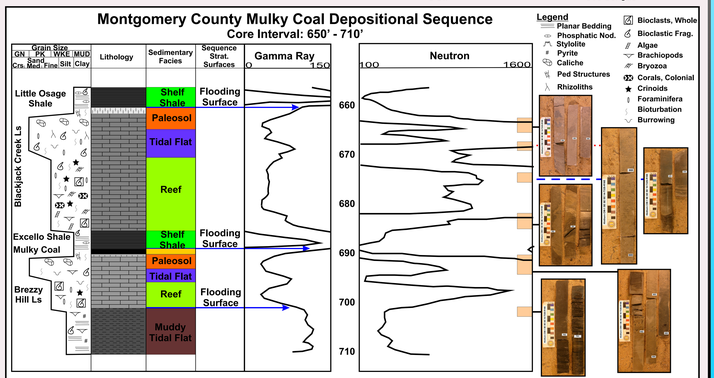
	As Received Range	As Received Average	Moisture Free Range	Moisture Free Average
Moisture	0.77% - 1.42%	1.06%		
Ash	81.15% - 83.43%	83.43%	82.28% - 84.08%	82.90%

Volumetrics (Area West of Crawford and Cherokee Counties):

Volume	12,080,067.37 Acre-FT
	2850 Tons (short)/acre-ft
	34,428,192,005 Tons (short)
Avg. scf/ton	15 scf/ton
OGIP	**516** bcf gas

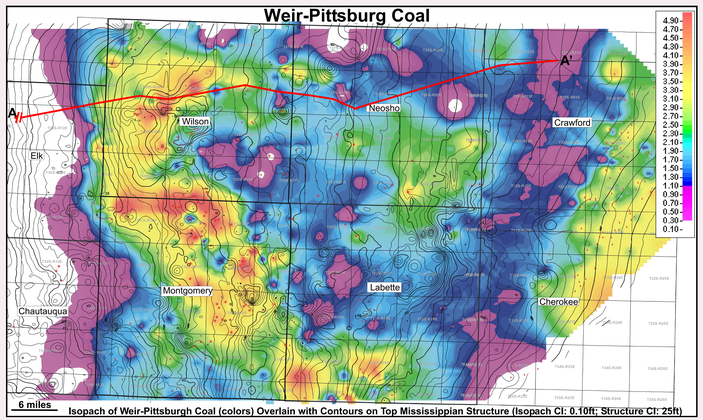
Montgomery County Mulky Coal Depositional Sequence

Core Interval: 650' - 710'



Isopach map (in color scale) overlain with contours of top Brezzy Hill structure. Proximate analysis, volumetrics and the typical depositional sequence of the Mulky coal and Excello Shale are based on cores from southeastern Kansas. The coal tends to thicken on structural highs. In structural lows the Mulky tends to be carbonaceous shale or high-ash coal rather than a pure coal. The close association with marine carbonate sediments can explain the high-ash and carbonaceous nature of the coal. Peat growth in the lows with admixed marine mud is interpreted to be the cause of the carbonaceous shale or high-ash coals, while low-ash coal develops in mires on highs protected from marine influence.

Weir-Pittsburg Coal



Isopach of Weir-Pittsburgh Coal (colors) Overlain with Contours on Top Mississippian Structure (Isopach CI: 0.10ft; Structure CI: 25ft)

Proximate Analysis:

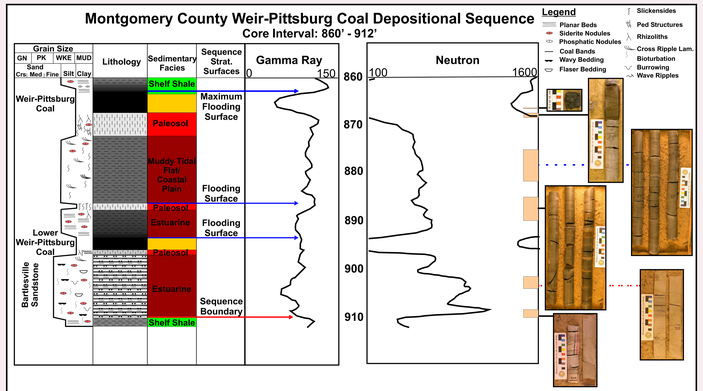
	As Received Range	As Received Average	Moisture Free Range	Moisture Free Average
Moisture	0.78% - 2.16%	1.47%		
Ash	8.56% - 32.41%	20.49%	7.51% - 32.66%	20.70%
Sulfur		4.51%		4.60%
Volatile Matter		35.72%		36.51%
Fixed Carbon		39.44%		54.74%
BTU/lb		13,570		13,869

Volumetrics (Area West of Crawford and Cherokee Counties):

Volume, coal > 1.5'	3,028,844.30 Acre-FT
	1800 Tons (short)/acre-ft
	5,451,919,740 Tons (short)
Avg. scf/ton	200 scf/ton
OGIP	**1,090** bcf gas

Montgomery County Weir-Pittsburg Coal Depositional Sequence

Core Interval: 860' - 912'



Isopach map (in color scale) overlain with contours of top Mississippian structure. Proximate analysis, volumetrics and the typical depositional sequence of the Weir-Pittsburg coal are based on cores from southeastern Kansas. Note the trend of the Weir-Pittsburg coal follows the strike of the Mississippian structure indicating a possible relationship with the paleo-shoreline. Areal extent, thickness and geometry of the coal indicate a coastal depositional setting.