Geological and Geochemical Factors Influencing the Emerging Coalbed Gas Play in the Cherokee and Forest City Basins in Eastern Kansas

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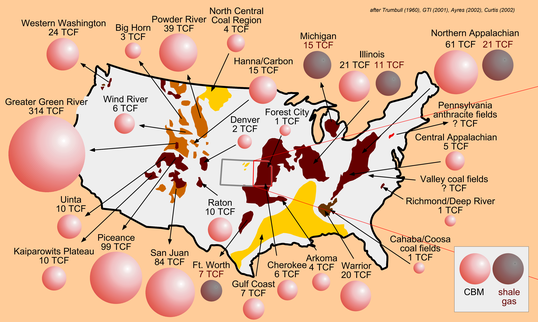
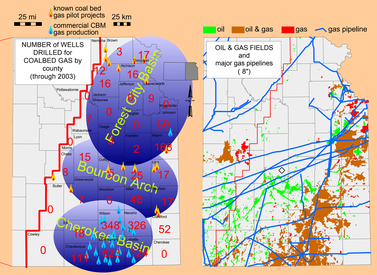
ABSTRACT

Coals and black shales in the Middle Pennsylvanian Cherokee and Marmaton Groups are becoming increasingly important commercial sources for unconventional gas in eastern Kansas, with over 200 wells being drilled in the last two years. Most of the development is in a five-county area in southeastern Kansas (i.e., Chautauqua , Labette , Montgomery, Neosho, and Wilson counties), but gradual expansion of this production northward and westward is anticipated, particularly along existing pipeline corridors. Initial data indicate that several coals can be perforated and produced in an individual well, but overall gas content may decrease NNE along regional strike and certainly eastward where strata rise updip onto the Ozark dome. Although gas content of the coals generally increases with depth and confining pressure to a maximum of 250 to 300 scf/ton, some shallow coals at less than 700 feet in depth have unexpectedly large gas contents (>100 scf/ton) exceeding that of immediately deeper coals. Compositional (i.e., hydrocarbon gas wetness) and isotopic analyses ($\delta^{13}C_1$-δD for methane) for desorption and production gases suggest that a microbial component to these gases may account for some of this local enrichment. Analyses of conventionally-produced gases from Pennsylvanian and Mississippian reservoirs in eastern Kansas indicate that these gases also can have a microbial component, with a thermogenic influence increasing with increasing depth into the Cherokee Basin. Unconventional gases are anticipated to also follow this pattern.

COALBED GAS DEVELOPMENT IN EASTERN KANSAS



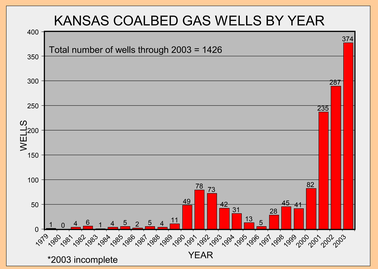
DEVELOPMENT ACTIVITY



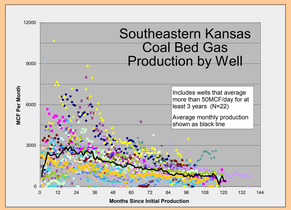
Higher gas prices, increasing demand for natural gas, and new technologies have turned coalbed gas into an active energy play in the U.S.A. Coalbed gas now represents approximately 8% of total dry gas production and 10% of dry-gas proved reserves of the U.S. (EIA, 2003). In the last two decades, the total coalbed gas production in the U.S.A. is in excess of 7 TCF -- a value of $156.1 billion at $2.23/mcf (Nelson, 1999). These values are expected to increase in the future.

Eastern Kansas comprises part of the Western Interior Coal Basin. The CBM potential of eastern Kansas is beginning to be realized, with major production starting in the early 90s.

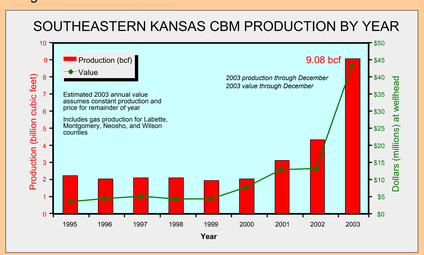
Most coalbed gas development in eastern Kansas is in the Cherokee basin, in a five-county area near the Oklahoma state line -- Chautauqua, Labette, Montgomery, Neosho, and Wilson counties. Several pilot projects have been initiated farther north in the Bourbon arch and Forest City basin, but the economic viability of these pilot projects has yet to be determined. One outpost of commercial development, by Osborn Energy, is present just south of the Kansas City metropolitan area in southern Johnson/northern Miami counties.



Most coalbed gas wells in eastern Kansas have been drilled since 2000, with the number of wells per year continuing at a rapid pace. The lesser surge of drilling in the early 1990s was largely due to now-expired federal tax credits. The present drilling boom is driven by the strong price of natural gas, and the recent excess capacity of pipelines crossing the state.



Southeastern Kansas coalbed gas wells hit their peak gas production from 12 to 36 months after their initial production. A long and gradual decline follows.



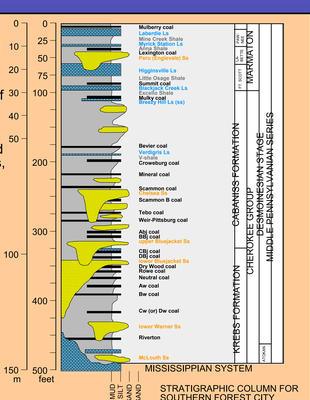
Coalbed gas production in southeastern Kansas has markedly increased, and is now approaching 10 bcf/year. The production rise is expected to continue for the next few years.

STRATIGRAPHY and RESOURCE BASE

Thirty-two coal beds, with thickness in excess of 14 inches (36 cm), are identified in the Middle Pennsylvanian stratigraphic column in eastern Kansas. Most of these coals are in the Cherokee group -- a cyclothemic unit composed of marine and terrestrial sandstones and shales, marine carbonates, and minor coal. Up to 14 coal beds can be encountered in a typical well. Most coals are less than 28" (71 cm) thick.

EASTERN KANSAS COAL RESERVES
(from Brady, 1997)

coal seam thickness	proved reserve
>56" *(>1.4m)*	0.1 billion tons
42"-56" *(1.1m-1.4m)*	1.9 billion tons
28"-42" *(0.6m-1.1m)*	6.3 billion tons
14"-28" *(0.4m-0.6m)*	45.3 billion tons

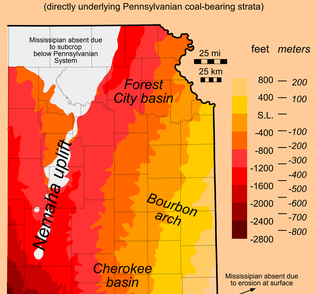


GEOLOGIC STRUCTURE

The Bourbon arch, which separates the Cherokee and Forest City basins is a subtle feature and not well expressed at Mississippian level. The Cherokee and Forest City basins have shallow eastern flanks that onlap the Ozark dome in south-central Missouri. The western flanks are steep and faulted against the Nemaha uplift. Pennsylvanian coal-bearing strata were possibly subject to movement of fresh water off the Ozark dome during their burial history.

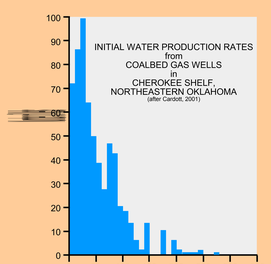
NEARBY TECTONIC FEATURES

MISSISSPPIAN STRUCTURE
(directly underlying Pennsylvanian coal-bearing strata)



WATER DISPOSAL

Water disposal for CBM production is not a problem in Kansas. Water production rates are significantly less that that of coals in western states. Water from CBM production is commonly disposed into porous and permeable zones in the upper part of the Cambrian-Ordovician Arbuckle Dolomite. This disposal zone takes water on a vacuum, hence no injection pumping is required. One disposal well can take the water from up to 10 production wells. Depth from the deepest coal to the Arbuckle disposal zone is as little as 200 ft (61 m) in southeastern Kansas, but this increases northward into the Forest City basin. However, other porous zones present in several Paleozoic units (e.g., Silurian-Devonian Hunton Dolomite, Ordovician Viola Limestone, and Ordovician St. Peter Sandstone) can also serve as disposal zones in the Forest City basin.



THICKNESS of STRATA BETWEEN BASE of PENNSYLVANIAN COAL-BEARING STRATA and TOP of ARBUCKLE DOLOMITE DISPOSAL ZONE