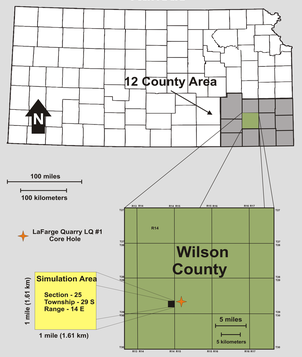
Abstract

The Cherokee basin in southeastern Kansas is a productive region for coalbed natural gas (CBNG). Production is generally from multiple high-volatile A and B bituminous coals, 1 to 3 ft thick, in the Middle Pennsylvanian (Desmoinesian) Cherokee and Marmaton Groups, at depths of 500 to 1,500 ft.

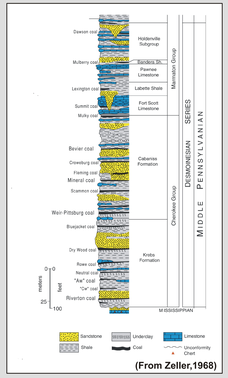
Enhanced coalbed natural gas (ECBNG) technologies provide possible methods to increase CBNG production, and at the same time sequester CO_2. At 5% of global CO_2 production the cement industry is a major anthropogenic source of CO_2. Kiln gas, which is principally N_2, CO_2, and water vapor from the calcination process, can potentially be utilized as the injected gas for an ECBNG recovery project.

The development of an ECBNG recovery project utilizing kiln gas requires a reservoir model to understand its effects on reservoir performance. Attendant to this task, well-log and core data of the Cherokee and Marmaton Groups within Wilson County, Kansas, were used to create a detailed structural and stratigraphic framework in the vicinity of a large cement plant. Production and completion data from nearby CBNG wells also were needed for determining coal-seam permeability. Desorption tests determined gas content of coals. These tests were followed by laboratory analyses of the coals to determine their gas saturation and swelling in the presence of kiln gas. A series of reservoir simulations were run to investigate methods to improve CBNG recovery, as well as assessing the geological and economic feasibility of sequestering cement-kiln emissions in subsurface coal seams.

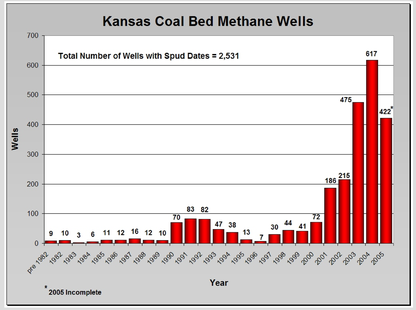
Map of the StudyArea



Stratigraphic Column

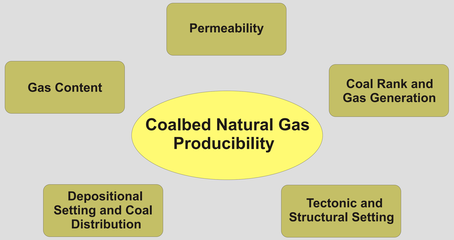


CBNG Activity in Kansas



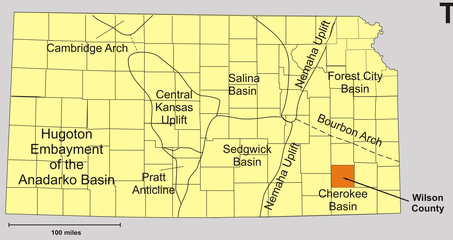
CBNG activity in Kansas has been increasing rapidly over the past several years. This can be attributed mainly to fact that natural gas prices have also been on the rise. The first spike in activity during the early 1990's is related to tax incentives, which have now expired. The success of CBNG in Kansas has led to the increased interest in other unconventional opportunities, such as shale gas and the possibilities of CO_2 sequestration in subsurface coalbeds.

CBNG Exploration Model



(Modified from Scott,1999)

Numerous factors determine the producibility of CBNG, and consequently affect the potential for CO_2 sequestration. Scott (1999) proposed a model to examine the complex interactions of six controls affecting the producibility of CBNG, including: depositional systems and coal distribution, tectonic and structural setting, coal rank and gas generation, gas content, permeability and hydrodynamics. This study analyzes five of these controls, only omitting the hydrodynamic control because it is one of the least understood factors in this region. Each of these controls has a complex and important influence on the others. It is important to understand these interactions when characterizing a CBNG reservoir, so that an accurate model can be constructed for simulation purposes.



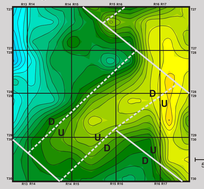
Tectonic and Structural Setting

The Cherokee Basin, located in southeastern Kansas, is the northernmost extent of the Arkoma foreland basin. This province formed in response to the convergent Ouachita orogeny during Early Pennsylvanian time. The Cherokee basin is bounded by the Nemaha Uplift to the west, the Bourbon Arch to the north, and the Ozark Dome to the east.

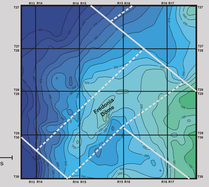
Adjustment to tectonic influences within the basin resulted in vertical displacement of basement fault blocks along an orthogonal set of faults, trending northeast-southwest and northwest-southeast. Basement features are translated upward through the stratigraphic section and are expressed by antiformal structures in the Phanerozoic sedimentary cover. Stratigraphic evidence suggests that movement along these faults took place throughout Pennsylvanian and into the Permian time.

Tectonic and structural activities play not only an important role in the development, accumulation, and preservation of coal-forming peat, but also affect development and orientation of cleats in coals. The understanding of both past and current stress regimes is important for predicting the extent and orientation of cleats.

Magnetic Data of Wilson County



Mississippian Structure in Wilson County



Magnetic data of Wilson County indicate a high striking northeast-southwest through the middle of the county. A similarly oriented structural feature, called the Fredonia Dome, can be seen on the Mississippian structure. This feature is propagated throughout the stratigraphic section and can be seen on the surface. Structures such as these play an important role in the development of cleats in coals.

Depositional Setting

Depositional setting is a key control of coal distribution, thickness, and coal quality. A continuous core from Wilson County was used to collect coal samples and to help identify lithotypes within the study area. The core was described and broken into 10 lithofacies. Interpretations into processes and environments were made. A variety of depositional settings were determined, ranging from subaerial exposure to deep-water environments. The distribution and occurrence of lithofacies within the Cherokee and Marmaton groups indicates cyclic fluctuations in relative sea level. The following table outlines the facies, processes, and environments found in the Cherokee and Marmaton groups in the study area.

Facies	Process	Environment
Sandstone	Tidal currents	Estuary
Mud-Supported Carbonate	Low energy accumulation of carbonate mud and bioclasts	Open Marine (below fair weather wave base)
Grain-Supported Carbonate	Higher energy reworking of carbonate material by waves and tides	Marine (above fair weather wave base)
Heterolithic	Low-energy tidal and sediment fallout	Lagoon or Estuary
Conglomerate	Exposure and reworked parent rock	Contintal Transgression
Gray Shale	Sediment fallout	Offshore
Black Shale	Sediment fallout	Offshore (anoxic conditions)
Coal	Peat accumulation	Mire
Blocky Mudstone	Pedogenesis	Subareal Exposure, Paleosol
Shelly Lag	Transgressive reworking	Transgressive surface