Northeast Oklahoma Shelf Coalbed-Methane Activity and Issues, 1994-2012

Brian J. Cardott
Oklahoma Geological Survey
Oklahoma Coalfield

Modified from Friedman (2006)
Modified from Johnson (1974)
OKLAHOMA COAL RANK Generalized for all coals, at or near the surface
Hartshorne Coal Rank Map

Cardott, in press
Thermal anomaly recorded in Woodford Shale (Late Devonian-Late Early Mississippian) in Osage County

High Volatile Bituminous = 0.5-1.1% Ro

Cardott, 2012
Coal Resources


Bulletin 67.-Geology and mineral resources of Haskell County, Oklahoma, by M. C. Oakes and M. M. Knecht. 134 pages, 8 figures, 6 plates. 1948. (Photocopy*)

Bulletin 68.-Geology and coal and natural gas resources of northern Le Flore County, Oklahoma, by M. M. Knecht. 76 pages, 1 figure, 7 plates, 3 tables. 1949. (Photocopy*)

Bulletin 140.-Coal geology of Craig County and eastern Nowata County, Oklahoma, by L. R. Cooper. 131 pages, 9 figures, 8 plates, 2 tables. 1986. $22.00.

Bulletin 144.-Coal geology of Rogers County and western Mayes County, Oklahoma, by L. R. Cooper. 118 pages, 12 figures, 8 plates, 2 tables. 1989. Clothbound, $30.00; paperbound, $24.00.

Map GM-33.-Coal geology of Tulsa, Wagoner, Creek, and Washington Counties, Oklahoma, by L. R. Cooper. 3 sheets (plates 1-5), scale: 1:63,600 (shows mined areas in gray), accompanying text. 1990. $13.00, folded in envelope.


Special Publication 98-2.-Coal geology of Muskogee County, Oklahoma, by L. R. Cooper. 111 pages, 7 figures, 3 plates, 2 tables. 1998. $12.00.

Special Publication 98-6.-Coal geology of McIntosh County, Oklahoma, by L. R. Cooper. 74 pages, 8 figures, 2 color plates, 2 tables. 1998. $16.00.

Map GM-23.-Map showing potentially strippable coal beds in eastern Oklahoma, by Samuel A. Friedman. 4 color sheets (plates 1-4), scale: 1:250,000 (shows mined areas in gray). Prepared in cooperation with Oklahoma Department of Mines, 1982. $5.00, folded in envelope.

## Generalized Stratigraphy of Northeast Oklahoma Shelf Coal-Bearing Strata

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<th>System</th>
<th>Series</th>
<th>Group</th>
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**From Hemish (1988)**
Surface to Subsurface Correlation of Methane-Producing Coal Beds, Northeast Oklahoma Shelf

LeRoy A. Hemish
Index Map Showing Location of Wells and Lines of Cross Sections for NE Oklahoma Shelf CBM Subsurface Study
Type Log for Northern Part of NE Oklahoma Shelf Area

Hemish, 2002
Figure 14. Stratigraphic markers in upper part of Senora Formation (Cabaniss Group). Excerpt from Perry No. 3 Pierce well, NE¼ sec. 30, T. 25 N., R. 11 E., Osage County. For explanation of lithologic symbols, see Figure 19.
Index Map Showing Location of Wells and Lines of Cross Sections for NE Oklahoma Shelf CBM Subsurface Study (annotated logs by Hemish, unpublished). Well records for cross sections A-D are in the OGS online Coal Stratigraphic Database (http://www.ogs.ou.edu/coaldb.php).
Cleat
(natural fractures in coal)

Crowenburg coal, Morris, OK
CLEAT SPACING AND COAL RANK

Modified from Law (1993)

Scott, 1995
Cleft Orientation

Face Cleft: Extension fractures formed parallel to maximum compressive stress.

Butt Cleft: Strain-release fractures formed parallel to fold axes.

Cardott, 2002
Rose diagrams of cleat orientations in coal beds (Hemish, 2002)

Craig & Nowata counties

Rogers & Mayes counties

Tulsa & Wagoner counties
Gas generation exceeds storage capacity

Scott, 1995
CBM Tax Incentive from IRS

Phase One of IRS Section 29 Tax Credit (Non-Conventional Fuels):

Tax credit on gas produced from new coal gas wells drilled from January 1, 1980 to December 31, 1992.

Phase Two of IRS Section 29 Tax Credit:

Tax credit on gas produced from recompleted wells drilled from January 1, 1993 to December 31, 2002.
Oklahoma CBM Well Completions History

- 5,976 CBM Completions 1988-2011
- 114 wells in 2009
- 78 wells in 2010
- 27 wells in 2011
Cardott, in press
Oklahoma CBM Completions by Year (1988-2011) (5,976 wells) [updated October 2012]
Oklahoma CBM Completions by Year Highlighting 2011 (Blue Stars)

(27 wells)

1 Allied Operating (Rowe)
3 Bratco Operating (Rowe; Riverton)
1 Bullseye Operating (Riverton)
7 Canaan Resources (Hartshorne)
1 CEP Mid-Continent (Mulky et al.)
1 NEOK Production Co. (“Penn.”)
13 Postrock Midcontinent (Mulky et al.; Riverton)
Oklahoma CBM article was published in the 2010 Oklahoma Geology Notes (v. 70, p. 4-14)

1. Horizontal CBM
2. Gas fields by county
3. Recompletions (OWWO)
4. Mulky coal problem
5. CBM with noncoal
6. “Pennsylvanian” CBM
7. Commingled CBM
Coalfield: 4,104 vertical wells;

Shelf: 28 horizontal/8 directional wells by Amvest Osage & CEP Mid-Continent (2004-2008);

Arkoma: 1,567 horizontal wells
CBM Field Boundaries: coals are continuous reservoirs extending beyond gas field boundaries. CBM fields overlap existing fields or are new fields.

OGS Map GM-36 (from Boyd, 2002)
Oklahoma Corporation Commission added “County CBM Gas Area” field names in 2001

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Old Well Workover (OWWO) completed as CBM wells beginning in 1991 (Hartshorne) & 1994 (NE OK shelf)

727 (13%) of 5,707 wells

[caution obtaining production data]
Mulky “Coal” Problem

Mulky-only coalbed-methane production is primarily Excello Shale gas production.
506 Mulky-Only CBM wells
Excello Shale Stratigraphy
(<16 ft thick)

Ece (1989)
Figure 13. Stratigraphic positions of the Bevier coal, the Iron Post coal, and the Mulky coal, and correlation of beds in northwestern Craig County, Oklahoma, southern Labette County, Kansas, and eastern Crawford County, Kansas. The stratigraphic interpretation of Branson and others (1965) contrasts with the interpretation of this report. Thickness of units approximate.
Approx. southern limit of Excello Shale

Coal Mine

Cassidy (1968)
Excelsior Shale and Breezy Hill Limestone contact with no Mulky coal in Nowata County coal mine
Coal commingled with thin noncoal (shale or sandstone) beginning in 1992:

341 (6%) of 5,707 wells
Examples of Noncoal

Sandstone
Bartlesville
Burgess
Cleveland
Peru
Red Fork
Skinner
Tucker/Cushing

Limestone
Big Lime
Oswego
Pink Lime
Verdigris

Shale
Little Osage
Nuyaka
Oakley
Summit

Recent “CBM” wells with primarily noncoal perforations have been excluded from the OGS CBM Completions database.
Multiple coals commingled as “Pennsylvanian” CBM on NE OK shelf beginning in 2006

248 (4%) of 5,707 wells
COMMINGLED: There are more than 40 named and unnamed coals in NE OK. Numerous CBM wells have commingled more than 3 coals on the NE OK shelf beginning in 1999 (only shallowest coal symbol is plotted on map)
Generalized Stratigraphic Column for Northeast Oklahoma Shelf (13 common coals in NE OK CBM wells)

Modified from Hemish (1988)
Deepest CBM completion on shelf 2,962 ft Dawson coal

3,234 CBM Completions ("Pennsylvanian" included as unnamed)
Theoretical decline curve for CBM well

From Schraufnagel (1993)
Northeast Oklahoma Shelf

Depth: 179-2,616 ft, ave 1,075 ft
IP: 1-1,801 Mcfd, ave 34 Mcfd

2,654 pairs
Arkoma Basin (1988-2011)

2,742 CBM Completions

[updated October 2012]
COAL AND COALBED METHANE
OKLAHOMA GEOLOGICAL SURVEY

Coal is an organic-rich rock derived from plant material deposited in a swamp, marsh, or bog. Coal varies by grade (percentage of mineral impurities), type (organic composition), and rank (level of coalification). Rank describes the transformation from peat (unconsolidated plant remains) through lignite, subbituminous, bituminous, semianthracite, and anthracite coal (rock) from increasing burial pressure, temperature, and time.

The coalfield in eastern Oklahoma is divided into the northeast Oklahoma shelf and the Arkoma Basin based on physiographic and structural differences. The commercial coal belt contains coal beds > 10 in. thick that are mineable by surface methods at depths < 100 ft and coal beds > 14 in. thick that are mineable by underground methods. The noncommercial coal-bearing region has limited information on coal thickness and quality or contains coals that are too thin, of low quality, or too deep for surface mining.

The age of commercial coal-bearing strata in the Oklahoma coalfield is Carboniferous (Middle Pennsylvanian). Generalized stratigraphic columns of the northeast Oklahoma shelf and Arkoma Basin show about 40 named and several unnamed coal beds and their range in thickness measured from outcrops, mines, and shallow core samples.

Coal rank, generalized for all coals at or near the surface, ranges from high-volatile bituminous in the northeast Oklahoma shelf and western Arkoma Basin to medium-volatile bituminous and low-volatile bituminous in the eastern Arkoma Basin in Oklahoma. Rank increases from west to east and with depth in the Arkoma Basin, attaining semianthracite in Arkansas.

Remaining identified bituminous coal resources in beds > 10 in. thick total 8.8 billion short tons (1 short ton equals 2,000 pounds). In 19 countries in eastern Oklahoma, an area of approximately 8,000 square miles. About 1.5 billion short tons of bituminous coal reserves (the economically recoverable part of coal resources) remain in Oklahoma. Oklahoma ranks 18th of 32 coal-bearing states in the U.S. based on coal reserves. From 1873-2008, 292 million short tons of bituminous coal were produced from underground and surface mines in the Indian Territory and Oklahoma. Peak annual coal production was 5.73 million short tons in 1981, with smaller production peaks during and immediately following World War I and World War II.

There are many uses for coal, primarily in combustion (generation of used to make steel), conversion (gasification and liquefaction), and used in Oklahoma in electric power plants and lime and cement kilns.

Coal generates and stores large quantities of natural gas (methane). Oklahoma is in the northeast Oklahoma shelf and Arkoma Basin.

Example of coal and coalbed-methane information available on the OGS Web site
(http://www ogs ou edu/coaldb.php)
OGS Coal and CBM Bibliographies

Bibliography of Oklahoma Coalbed Methane
Bibliography of Oklahoma Coal
Bibliography of Oklahoma Coal Resources
Bibliography of Oklahoma Coal Chemistry
Bibliography of Oklahoma Coal Mining
Bibliography of Oklahoma Coal Mine Disasters
Bibliography of Oklahoma Coal Structure Maps
Bibliography of Oklahoma Underground Coal Mines
Bibliography of Oklahoma Paleobotany
Bibliography of Oklahoma Palynology
COAL DATABASES
(OKLAHOMA DATA)

Available for download:
Analytical Header (Documentation)
Analytical Data (Documentation)
Coalbed Methane Completions
Coal Production database (Documentation)
Stratigraphic Data (Documentation) 25,518. View or download in Excel.
Stratigraphic Header (Documentation) 4,496 sample points. View or download in Excel.

Abbreviations:
- OWWO: Old Well Workover
- MCFGPD: Thousand Cubic Feet of Gas Per Day
- BWPD: Barrels of Water per Day
- CBM: Reported as Coalbed-Methane Well

8/8/12
5,976 records (1988-2011)
Coal Maps and Illustrations

OK Coalfield—Map of Oklahoma coalfield.

Northeast Oklahoma Shelf Stratigraphic Column Upper & Column Lower - Generalized stratigraphy of coal-bearing strata of the northeast Oklahoma shelf.


Coal Role — Generalized rank of all coal beds at or near the surface in the Oklahoma coalfield.

Harshorne Coal Rank Harshorne coal rank map based on vitrinite reflectance of surface and subsurface samples of Harshorne coal (Cardott, 2012).

Coral Production Graph showing coal production in Oklahoma from 1873 to present

CBM Completions Histogram


[Coaled-Methane Completions by Year 1988-2011]


