EMD Annual Leadership Meeting
November 12, 2009
Gas Shale Committee Report
Brian Cardott, Harris Cander, Michael Cameron, Neil Fishman (Vice-Chairs)

1. **Active Gas-Shale Plays**

The EIA Active U.S. Gas Shale Plays, Barnett, Fayetteville, Haynesville, and Marcellus maps are available at [http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.htm](http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.htm). Recent summary reports are as follows:


There are too many potential gas shales to describe each in detail. Below are a few highlights.

**(a) Fort Worth Basin, Texas: Barnett Shale (Mississippian).** The Barnett Shale is still the most active gas-shale play in the United States. The EIA Barnett Shale map is available at [http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.htm](http://www.eia.doe.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.htm). According to the Texas Railroad Commission web site ([http://www.rrc.state.tx.us/data/fielddata/barnettshale.pdf](http://www.rrc.state.tx.us/data/fielddata/barnettshale.pdf)) as of September 8, 2009 there were a total of 12,135 Barnett Shale gas wells and 3,521 permitted locations in the Newark East Field (discovery date, October 15, 1981) of the Fort Worth Basin. The field produces in 21 counties. During calendar year 2008 (January through December), 1,563 billion cubic feet (BCF) gas was produced from the field (representing peak annual production), accounting for 23% of Texas gas production. Of a total of 234 operators in the Newark East Field, the top 10 operators are:

(1) Devon Energy Production Co., L.P.
(2) Chesapeake Operating, Inc.
(3) XTO Energy Inc.
(4) EOG Resources, Inc.
(5) Quicksilver Resources Inc.
(6) Encana Oil and Gas (USA) Inc.
(7) Range Production Co.
(8) Burlington Resources O&G Co. LP
(9) Denbury Onshore, LLC
(10) Williams Production Gulf Coast, L.P.
Newark, East (Barnett Shale) Well Count
1993 through 2008

Newark, East (Barnett Shale) Gas Well Gas Production
1993 through 2008

5.0 TCF Gas
Since 1993!

(Barnett Shale statistics charts are from http://www.rrc.state.tx.us/barnetshale/index.php)

The top five operators of the Fayetteville gas shale play as of September 2009 based on numbers of producing wells are:

1) Seeoco Inc. (1091 wells)
2) Chesapeake Operating Inc. (407 wells)
3) One TEC Operating, LLC (100 wells)
4) XTO Energy, Inc. (94 wells)
5) Petrohawk Operating Co. (55 wells)
6) KCS Resources Inc. (42 wells)

The Upper Mississippian Fayetteville Shale play is the current focus of a regional shale-gas exploration and development program within the central and eastern Arkoma Basin of Arkansas. Approximately 2.5 million acres have been leased in the Fayetteville Shale gas play.

Early estimates have indicated that there are over 40 TCF of gas reserves in the Fayetteville Shale. Estimated ultimate recovery (EUR) for a horizontal well is 2.9 BCF/well. As of September 2009, cumulative production of Fayetteville has totaled 609 BCF and initial production rates of horizontal wells average about 2,000 MCF/day.

Fayetteville Shale reports from the Arkansas Oil and Gas Commission have noted well increases from 24 in 2004, 33 in 2005, 129 in 2006, 428 in 2007 and 587 in 2008. As of September 2009 there are a total of 1,841 producing gas wells in the Fayetteville Shale play. Most Fayetteville Shale wells are horizontal wells and have been fracture stimulated using slickwater or cross-linked gel fluids. Horizontal lateral lengths are continually increasing in Fayetteville Shale wells. Horizontal wells drilled from 2008 to 2009 averaged 3,598 feet in lateral length with some wells up to 7,000 feet. Fayetteville Shale gas production generally ranges over a depth between 1,500 to 6,500 feet. The thickness of Fayetteville Shale varies from 50 feet in the western portion of the Arkoma Basin of Arkansas (fairway area) to 550 feet in the central and eastern regions (primary producing area). Southwestern Energy has been a major player since 2004 when production started. Chesapeake Energy and BP are also active in the Fayetteville play. BP acquired approximately a 25% interest in Chesapeake’s Fayetteville assets for $1.9 billion in late 2008. Southwestern holds approximately 875,000 net acres in the play area and estimates 11 TCF of recoverable gas for its acreage position. Chesapeake has about 600,000 net acres with about 9 TCF of recoverable gas. Other operators involved with Fayetteville Shale exploration and development
ventures include: One Tec, Petrohawk, KCS Resources, XTO, Hallwood Energy, Storm Cat Energy (USA) Operating, Edge Petroleum, Alta Operating and twelve other companies.

Fayetteville Shale producing region

Producing Fayetteville Shale wells by top 5 operators as of September 2009.
Location of current Fayetteville Shale well permits as of September 2009.

Additional information is available at the Arkansas Geological Survey web site (http://www.state.ar.us/agc/agc.htm).

(c) Arkoma Basin, Oklahoma: Woodford Shale (Late Devonian-Early Mississippian). According to the Oklahoma Geological Survey, as of September 24, 2009, there were a total of 1,260 Woodford Shale gas-well completions since 2004 (first application of advanced completion technology), primarily in the western part of the Arkoma Basin in eastern Oklahoma. Of a total of 944 horizontal Woodford Shale gas wells from 2005-2009, initial potential gas rates ranged from 3 to 11,875 thousand cubic feet of gas per day (MCFG/D) and lateral lengths of 10 to 6,599 ft. Excluding 38 old well workover completions, cumulative production from 1,042 Woodford Shale-only wells drilled from 2004-2009 is 421 BCF gas and 802,327 BBLs oil/condensate. A gas shale completions database, lists of references, maps, and several presentations are available on the OGS web site (http://www ogs ou edu/level3-oilgas php). The latest Woodford Gas Shale Plays presentation at the AAPG Mid-Continent Section meeting is available at http://www ogs ou edu/oilgaspres php. Of 43 operators active in calendar year 2008, the top ten operators (for number of wells drilled during 2008):

1. Newfield Exploration Mid-Continent Inc.
2. Coronado Great Plains
3. Devon Energy Production Co. LP
4. Continental Resources
5. Antero Resources Corporation
6. WCT Operating
Caney Shale (Mississippian) only-gas-well completions dropped from 24 in 2004 to 3 Caney-only in 2008 due to problems completing the clay-rich shale. Several companies are looking at less damaging completion fluids for Caney Shale wells. A number of wells completed both Caney and Woodford Shale (see chart below). New Woodford gas-shale plays are in the Ardmore Basin in southern Oklahoma, Anadarko Basin shelf in western Oklahoma, and northeast Oklahoma shelf. Presentations from the October 2008 Oklahoma Gas Shales Conference are available at [http://www ogs ou edu/ highlights php](http://www ogs ou edu/ highlights php).

[Hart Unconventional Natural Gas Report, February 2009 feature]
The Michigan Basin Antrim Shale play is almost 23 years old, having begun the modern phase of development in 1987. The total number of producing wells drilled in the play through June 2009 is approximately 11,113 with about 9,963 still online.

Total cumulative gas production reached 2.774 TCF through the first half of 2009. Michigan Antrim production is reported by project rather than by individual well or lease. Projects may be only a few wells or more than 70 wells. There were 775 separate projects at the end of May 2009. Cumulative production for the first 6 months of 2009 was 59,959,147 MCF of gas. That was an 8.2% decline from the first half of 2008.

There were 33 operators with production at the midpoint of 2009. There were 9,963 wells online at the end of May 2009. There were 126 new wells drilled in the first half of 2009. That is a 28% decrease in wells from the first half of 2008. Most of the production comes from a few operators. The top 10 operators produced 79.8% of the total Antrim gas in the first half of 2009.

Although some wells can initially produce up to 500 MCF/day, generally wells settle at less than 100 MCF/day. Play wide average production at the end of May 2009 was 35 MCF/day per well. Many Michigan Antrim wells begin with high water production and begin to increase gas production as the water is pumped off. Water production generally continues throughout the project life, although it usually declines through time. Play wide gas to water production ratio reached almost 3 MCF/BBL in 1998, in 2004 it was 2.21 MCF/BBL and the May 2009 ratio is 1.56 MCF/BBL. Play wide water ratios continue to increase relative to gas production as old wells decline in total gas and new wells start with high water cut.

CO2 is also an issue in the produced Antrim gas that is mostly of biogenic origin. Most wells begin with very low amounts of CO2 in the produced gas; however, the percentage of CO2 increases through time. Some projects that have a long production history may now exceed 30% CO2 in the produced gas. The play wide average was just over 12.4% CO2 in 2008.

Wells produce from depths as shallow as 350 feet to just over 3,000 feet, although the vast majority of wells are completed from 1,000 to 2,500 feet deep. Wells are typically drilled with water and an attempt is made to keep the well in balance or slightly under-balanced. Wells are fraced with water and sand. Some wells are fraced using nitrogen or foam.
Production and well data is available online at the Michigan Public Service Commission at [http://www.cis.state.mi.us/mpsc/gas/prodrpts.htm](http://www.cis.state.mi.us/mpsc/gas/prodrpts.htm)

Various kinds of oil and gas information is also available at the Michigan Office of Geological Survey site at [http://www.michigan.gov/deq/0,1607,7-135-3311_4111_4231---,00.html](http://www.michigan.gov/deq/0,1607,7-135-3311_4111_4231---,00.html)

Cores, samples and other kinds of data are available at the Michigan Geological Repository for Research and Education at Western Michigan University. That website is [http://wst023.west.wmich.edu/MGRRE%20Website/mgrre.html](http://wst023.west.wmich.edu/MGRRE%20Website/mgrre.html)

Top 10 Operators:
- Atlas Gas & Oil Company LLC
- Highmount Midwest Energy LLC
- Breitburn Operating Limited Partnership
- Belden & Blake Corp. DBA Ward Lake Energy
- Terra Energy Ltd
- Muskegon Development Co.
- Trendwell Energy Corp.
- Jordan Development Co. LLC
- Delta Oil Co. Inc.
- O I L Energy Corp.

Significant Trends – Production continues to decline at >8% per year even though the total number of wells added is increasing. Daily production per well also is still dropping, but not as fast as in previous years. The number of horizontal completions is increasing, but still represents less than 4% of total wells.

Issues – None

Legislation – None

**(e) Appalachian Basin, multi-state: Marcellus Shale (Devonian):** by Katharine Lee Avary (West Virginia Geological and Economic Survey, WVGES)

Interest in the Marcellus remains strong. A recent conference in Pittsburgh, originally planned for about 300 attendees, attracted over 1,300 and was re-located to a larger venue to accommodate the crowd. Issues with water supply sources for large volume fracturing, disposal of produced water and used frac water, and pipeline capacity are being addressed with a variety of approaches including new infrastructure construction to handle increased demands and recycling and reuse of frac water.
New York: There are 47 wells with Marcellus listed as producing formation; 15 in 2008 with production of 64,063 Mcf and 5,447 barrels of water. These wells were on line from 1 to 12 months. The NY Department of Environmental Conservation issued a draft of new regulations specific to Marcellus wells which is currently in a public comment period. There is also interest in the Ordovician Utica Shale.

Pennsylvania: During the first 9 months of 2009, 1,340 Marcellus wells were permitted. Of these, 913 are planned as horizontal wells. A total of 1,998 Marcellus wells have been permitted since 2003. About half of these wells have been permitted to 5 operators (Atlas Energy Resources, Cabot Oil and Gas, Chesapeake, East Resources, and Range Resources). Production records are held confidential in Pennsylvania for 5 years. Recently, lawmakers in Pennsylvania have discussed implementing a severance tax on gas and oil production and making production records public sooner than the current 5 year confidential period.

West Virginia: The West Virginia Geological and Economic Survey has identified more than 2,600 wells permitted since 2005 which may be targeting the Marcellus. The plats for some wells specifically list the Marcellus as the target formation, while others list “Devonian shale”. WVGES has records for nearly 1,200 of these wells. Preliminary production of about 4 Bcf for 2006, 8 Bcf for 2007, and 11.4 Bcf for 2008 can be attributed to wells with Marcellus reported as a pay. Total production from the Marcellus for 2006-2008 is about 24.4 Bcf. The Marcellus is completed in many wells along with additional shallower shales and sandstones. Two Marshall County wells had reported production of more than 0.5 Bcf in just 8 months in 2008. Through July 31, 2009, there were 325 wells permitted in West Virginia which may be Marcellus. Visit the following web sites for more information on the Marcellus.

http://www.wvgs.wvnet.edu/www/datastat/devshales.htm
http://www.mgs.md.gov/geo/marcellus.html
http://www.dec.ny.gov/energy/46288.html
http://www.dcnr.state.pa.us/topogeo/pub/pageolmag/pdfs/v38n1.pdf
http://www.dcnr.state.pa.us/topogeo/oilandgas/index.aspx
http://www.pamarcellus.com/

(f) Haynesville Shale (Jurassic), Louisiana and Texas: by Creties Jenkins (Degolyer and Macnaughton)
[Unconventional Natural Gas Report feature for September 2008]
The Haynesville Shale is located in western Louisiana and eastern Texas at depths ranging from 10,500 to 13,500 feet. It is an overpressured (0.7-0.9 psi/ft) Upper Jurassic-age shale bounded by the Cotton Valley Group sandstones above and Smackover limestones below. The Haynesville is overlain in the southeast portion of the play by the Bossier Shale which appears to be comparable to the Haynesville in terms of thickness and petrophysical properties, and is currently being tested by a few horizontal wells.

The Haynesville covers an area of approximately 9,000 square miles with an average thickness of 200 to 300 feet. The thickness and areal extent of the Haynesville has allowed operators to evaluate a wide variety of spacing intervals ranging from 40 to 560 acres per well. Original gas-in-place is estimated to be 717 TCF and technically recoverable resources are estimated at 251 TCF. A comparison of the Haynesville to other shale gas plays is shown in the table below (Reference: Modern Shale Gas Development in the United States: A Primer; U.S. Dept. of Energy; April 2009).

3-D seismic data have become increasingly important as operators try to quantify structural/stratigraphic complexities (faults, anticlines, thickness variations) as well as rock property variations (geomechanical and petrophysical properties) to steer wells into the best rock and understand their performance variability. Chesapeake, for example, is currently acquiring over 1,200 square miles of 3-D seismic data that will be available for use in 2010.

The biggest operators in the Haynesville, based on acreage position, are Chesapeake, Devon, EnCana, EOG Resources, Exco Resources, Forest Oil, Petrohawk, XTO Energy, and Plains Exploration and Production. As of September 3, 2009, there were 185 producing wells, 183 wells waiting on completion, 74 wells being drilled, and 167 wells permitted but not yet drilled.

Initial production rates range from less than 3 to more than 24 MMCF/D. Declines are very steep, exceeding 80% in the first year with estimated ultimate recoveries (EURs) ranging from 3 to 10 BCF per well. Drilling and completion costs range from 6-9 MM$ per well assuming lateral lengths of 4,500 feet, 12-15 fracture stimulation stages per well, and light sand fracture stimulations using either ceramic or resin-coated proppant.

The rate-of-return in the play is highly-dependent upon gas price and EUR. At a $5 NYMEX gas price, a 4.5 BCF well will have a rate of return of less than 10%, whereas a 8.5 BCF well will have a return of nearly 50% (Reference: Chesapeake’s 2009 Institutional Investor and Analyst Meeting, October 14, 2009). At the present time, it is difficult to predict
per well EURs because the most mature wells have only been on production for 1.5 years. The average EUR will depend in large part on whether reservoir permeability decreases with time and whether fracture conductivity diminishes as the well is produced.

Additional information on the Haynesville can be found at these websites:

http://geology.com/articles/haynesville-shale.shtml
http://oilshalegas.com/haynesvilleshale.html
http://loga.la/haynesville-shale-news/

<table>
<thead>
<tr>
<th>Gas Shale Basin</th>
<th>Barnett</th>
<th>Fayetteville</th>
<th>Haynesville</th>
<th>Marcellus</th>
<th>Woodford</th>
<th>Antrim</th>
<th>New Albany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Basin Area, square miles</td>
<td>5,000</td>
<td>9,000</td>
<td>9,000</td>
<td>95,000</td>
<td>11,000</td>
<td>12,000</td>
<td>43,500</td>
</tr>
<tr>
<td>Depth, ft</td>
<td>6,500 - 8,50082</td>
<td>1,000 - 7,00083</td>
<td>10,500 - 13,50084</td>
<td>4,000 - 8,50085</td>
<td>6,000 - 11,00086</td>
<td>600 - 2,20087</td>
<td>500 - 2,00088</td>
</tr>
<tr>
<td>Net Thickness, ft</td>
<td>100 - 60089</td>
<td>20 - 20090</td>
<td>200 - 30092</td>
<td>50 - 20093</td>
<td>120 - 22094</td>
<td>70 - 12095</td>
<td>50 - 10096</td>
</tr>
<tr>
<td>Depth to Base of Treatable Water, ft</td>
<td>~1200</td>
<td>~50097</td>
<td>~400</td>
<td>~850</td>
<td>~400</td>
<td>~300</td>
<td>~400</td>
</tr>
<tr>
<td>Rock Column Thickness between Top of Pay and Bottom of Treatable Water, ft</td>
<td>5,300 - 7,300</td>
<td>500 - 6,500</td>
<td>10,100 - 13,100</td>
<td>2,125 - 7,650</td>
<td>5,600 - 10,600</td>
<td>300 - 1,900</td>
<td>100 - 1,600</td>
</tr>
<tr>
<td>Total Organic Carbon, %</td>
<td>4.598</td>
<td>4.0 - 9.899</td>
<td>0.5 - 4.0100</td>
<td>3 - 12101</td>
<td>1 - 14102</td>
<td>1 - 20103</td>
<td>1 - 25104</td>
</tr>
<tr>
<td>Total Porosity, %</td>
<td>4 - 5105</td>
<td>2 - 8106</td>
<td>8 - 9107</td>
<td>10108</td>
<td>3 - 9109</td>
<td>9110</td>
<td>10 - 14111</td>
</tr>
<tr>
<td>Gas Content, scf/ton</td>
<td>300 - 350112</td>
<td>60 - 220113</td>
<td>100 - 330114</td>
<td>60 - 100115</td>
<td>200 - 500116</td>
<td>40 - 100117</td>
<td>40 - 80118</td>
</tr>
<tr>
<td>Water Production, Barrels water/day</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>5 - 500119</td>
<td>5 - 500120</td>
</tr>
<tr>
<td>Well spacing, acres</td>
<td>60 - 160121</td>
<td>80 - 160</td>
<td>40 - 560122</td>
<td>40 - 160123</td>
<td>640124</td>
<td>40 - 160125</td>
<td>80126</td>
</tr>
<tr>
<td>Original Gas-In-Place, tcf127</td>
<td>327</td>
<td>52</td>
<td>717</td>
<td>1,500</td>
<td>23</td>
<td>76</td>
<td>160</td>
</tr>
<tr>
<td>Technically Recoverable Resources, tcf128</td>
<td>44</td>
<td>41.6</td>
<td>251</td>
<td>262</td>
<td>11.4</td>
<td>20</td>
<td>19.2</td>
</tr>
</tbody>
</table>

NOTE: Information presented in this table, such as Original Gas-In-Place and Technically Recoverable Resources, is presented for general comparative purposes only. The numbers provided are based on the sources shown and this research did not include a resource evaluation. Rather, publically available data was obtained from a variety of sources and is presented for general characterization and comparison. Resource estimates for any basin may vary greatly depending on individual company experience, data available at the time the estimate was performed, and other factors. Furthermore, these estimates are likely to change as production methods and technologies improve.

Mcf = thousands of cubic feet of gas
scf = standard cubic feet of gas
tcf = trillion cubic feet of gas
# = For the Depth to base of treatable water data, the data was based on depth data from state oil and gas agencies and state geological survey data.
N/A = Data not available
(g) Black Warrior Basin, Alabama and Mississippi: Neal/Floyd Shale (Mississippian): by Kent A. Bowker (Bowker Petroleum, LLC)

The Geological Survey of Alabama (GSA) has recently updated (July 2009) their report on the activity in the Neal/Floyd (hereafter termed Neal) Shale play within Alabama. (The organic-rich portion of the Floyd is termed the Neal in Mississippi, and that term more properly reflects the objective of operators in the play.) This report can be found at: [http://www.ogb.state.al.us/documents/misc_ogb/Floyd%20Shale.pdf](http://www.ogb.state.al.us/documents/misc_ogb/Floyd%20Shale.pdf)

There continues to be relatively little activity in the Neal Shale play. The first sale of Neal gas occurred in 2008: the Jim Walter Resources, JWR #28-05-02 in Tuscaloosa County is the first productive Neal well in Alabama. The well averaged 98 Mcf/d and 780 Bw/d over 39-day production test in the spring of 2008, but has since been plugged.

The most active operator in the Mississippi portion of the play has been St. Mary Land & Exploration. Over the past year they have drilled a total of four vertical Neal wells in the state: two wells in Calhoun County and one each in Chickasaw and Pontotoc counties. These wells have been completed (details not reported), but there is no production reported for any of the four wells.

Jack Pashin (GSA geologist) has recently reported on the geology of the Neal Shale play; his excellent paper can be found at: [http://www.ogb.state.al.us/img/shale/0808%20Pashin.pdf](http://www.ogb.state.al.us/img/shale/0808%20Pashin.pdf)

The GSA is continuing its research on shale plays in the Black Warrior Basin via a grant from Research Partnership to Secure Energy for America grant. Information on this program can be found at: [http://www.ogb.state.al.us/gsa/shalegas.html](http://www.ogb.state.al.us/gsa/shalegas.html)

(h) Northern Shelf, Black Warrior Basin, Alabama: Chattanooga Shale (Devonian): by Kent A. Bowker (Bowker Petroleum, LLC)

For the past few years, GeoMet, Inc. has been testing and developing the Chattanooga Shale in Blount and Cullman counties in north-central Alabama (north shallow shelf of the Black Warrior Basin). In a presentation dated August 12, 2009 (accessed 10-26-09 at [www.geometinc.com](http://www.geometinc.com)), GeoMet states that they have 65,000 gross acres in the play and that they have drilled eight core holes, four vertical wells, and two horizontal wells. They have four Chattanooga wells currently on gas sales.

Details of this activity are available from the Geological Survey of Alabama (GSA) website in a report dated July 2009: [http://www.ogb.state.al.us/documents/misc_ogb/Floyd%20Shale.pdf](http://www.ogb.state.al.us/documents/misc_ogb/Floyd%20Shale.pdf)
The activity is centered on a northwest striking Chattanooga thickness trend at a drilling depth of approximately 2,000 ft. Jack Pashin (GSA geologist) has recently reported on the geology of this play; his excellent paper can be found at: http://www.ogb.state.al.us/img/shale/0808%20Pashin.pdf

The GSA is continuing its research on shale plays in the Black Warrior Basin via a grant from Research Partnership to Secure Energy for America grant. Information on this program can be found at: http://www.ogb.state.al.us/gsa/shalegas.html

GeoMet is currently seeking a 50% partner in this project.

(i) Chattanooga Shale, North-Central Tennessee (Appalachian Basin): by Kent A. Bowker (Bowker Petroleum, LLC)

"We are very excited about our shale program. We are enjoying first-mover status in the Chattanooga Shale in Tennessee. Our first horizontal well drilled there happens to be the most productive well in the history of that state (in an April 2008 investor presentation, the company stated the well IP'd for 3.9 MMcf/d). This well and subsequent wells have posted encouraging results," said Kent Wright, General Manager, Knox Energy (a wholly owned subsidiary of CNX Gas; CNX Gas homepage, accessed 10-20-09).

CNX has 244,000 net acres in the play, which is located in Scott, Campbell, Morgan, and Anderson counties in north-central Tennessee. At the end of 2008, CNX had booked 11 Bcfg proved reserves, probable and possible reserves of 32 Bcfg, and unrisked resource potential of 1.1 to 2.5 Tcfg on their acreage. As stated above, the first horizontal well had an initial rate of 3.9 MMcf/d, which CNX claims is the largest gas rate ever reported in Tennessee from any reservoir. They have drilled over 20 additional horizontal wells in the play, but none of these wells appear to have been nearly as successful as the first well. CNX is attempting to optimize the completion via increasing the number of frac stages (nearly every shale play benefits from an increase in frac stages).

CNX is active both foreland and hinterland to the Pine Mountain Thrust. It appears that the targeted Chattanooga is in the footwall of the thrust and is found at a drilling depth of between 1,000 and 7,000 ft in the four counties of CNX’s play area.

by Neil Fishman (U.S. Geological Survey)

The Upper Devonian-Lower Mississippian New Albany Shale play, long a target for gas exploration, extends over an area of >40,000 mi$^2$ (Ground Water Protection Council, 2009) in the Illinois Basin (southern Illinois, southwestern Indiana, and northwestern Kentucky). Gas production from the New Albany has occurred for more than 100 years (Hassenmueller and Comer, 1994); however, it wasn’t until the mid 1990’s that more modern methods of gas extraction were applied to improve production from the formation (Rupp, 2008). According to the Well Record Tables of the “Petroleum Database Management System” on the Interactive Maps portion of the Indiana Geological Survey web site (http://www.igs.indiana.edu/pdms/index.cfm), there are a total of 541 New Albany Shale gas wells in Indiana (as of October 22, 2009), with >240 having been drilled since 1/1/2000. No known commercial gas is currently being produced from the New Albany in Illinois (Hill and others, 2008). The New Albany, which is up to ~450 ft thick in the southern part of the basin, produces from relatively shallow wells (<2,000 ft deep). Although initial production rates typically range from 20-400 Mcfg/d, some wells have demonstrated higher IP’s (Rupp, 2008). Gas produced from the New Albany is either thermogenic or mixed thermogenic/biogenic in origin (Comer and others, 2006; McIntosh and others, 2008). The biogenic gas is probably internally sourced (McIntosh and others, 2008); the thermogenic gas is probably also internally sourced. The total organic carbon content of shales in the New Albany ranges from <1 to 25% (Hill and others, 2008). A recent USGS assessment indicates that there is an estimated (mean) 3.79 tcf of undiscovered, technically recoverable gas in the New Albany Continuous Assessment Unit (U.S. Geological Survey, 2007).


Sources of information:
https://scholarworks.iu.edu/dspace/handle/2022/712


An emerging shale-gas play in the Cretaceous (Cenomanian-Turonian) Eagle Ford Group of the Gulf Coast basin in southwestern Texas has caught the attention of many. The Eagle Ford disconformably overlies the Woodbine Group and is, in turn, disconformably overlain by the Austin Chalk (Dawson, 2000). The Eagle Ford, which contains a mixture of siliciclastic and carbonate lithologies and ranges up to 475 ft thick (Dawson, 2000), was deposited during a sea level highstand associated with a global transgression (Hancock, 1993). Although the TOC content of shales in the Eagle Ford are variable, they range up to 8% (Liro and others, 1994; Dawson, 2000), with the organics being marine or mixed marine and terrestrial in origin (Liro and others, 1994).
Much of the interest in the Eagle Ford is currently centered in Bee, Colorado, De Witt, Dimmitt, Karnes, La Salle, Lavaca, Live Oak, Maverick, McMullen, and Webb Counties. During 2009 (January – August), more than 310 wells had been completed in the Eagle Ford and 415 have been permitted (The Tobin Monthly, http://news.p2es.com/newspage.aspx?cid=540&vid=44&gid=37). Natural gas and condensate are produced from the formation at depths of 11,000+ ft, and in some places, oil is produced. Initial production rates of combined natural gas and condensate in excess of 6 MMcfe/d (million cubic feet of gas equivalents/day) are common, with some IP’s being reported as high as 9 MMcfe/d (http://www.oilshalegas.com/eaglefordshale.html). Several companies are active in this emerging play, including Anadarko, Apache, ConocoPhillips, Murphy Oil, Petrohawk, Pioneer Natural Resources, Rosetta Resources, St. Mary Land and Exploration, Swift Energy, and TXCO.


Overview: The Ordovician Utica, Dolgeville, and Flat Creek are the formations of interest. These shales and interbeded limestones range in TOC from 1- 5% in the dry gas window. They cover an area from Mohawk Valley south to the New York state boundary line with Pennsylvania and extend west to the beginning of the Finger Lakes region and east to the Catskill Mountain region. These three formations have a total thickness from 700 to 1,000 ft.

Current Activity: Eleven wells have been permitted to date with the Utica Shale as their target formation. From the eleven wells, five wells have been completed, one well temporarily abandoned, two with applications pending and three permits that have expired. Three out of the five wells have been drilled in Otsego County and the other two wells in Erie County. The wells in Otsego County have been drilled to a depth of 2,500 to 5,000 ft. The wells in Erie County have been drilled to a depth of 4,100 to 4,600
ft. The main operators have been Covalent Energy in Otsego County and US Energy in Erie County. In June 2009, Covalent Energy was granted a permit to drill a vertical well into the Utica to conduct an 80,000 gallon frac using the old SGEIS rules. The well has been drilled and awaits fracing. No production to date has come from the Utica.

**Issues:** No permits have been issued for horizontal drilling and high-volume hydraulic fracturing to develop the Marcellus Shale or the Utica Shale. The Department has released the draft Supplemental Generic Environmental Impact Statement on September 30, 2009 for horizontal drilling and high-volume hydraulic fracturing to develop the Marcellus Shale and all associated shales. There will be a sixty day comment period for all stake holders.

**Research:** Research is being performed on well cuttings and cores from the Utica in the New York State Museum collection under the direction of Taury Smith, State Oil & Gas Geologist, to determine the TOC and carbonate content. This study is being supported by NYSERDA and companies who subscribe for data from this study. NYSERDA is also sponsoring the Shale Enhanced Recovery Program and a study to determine if CO₂ can be trapped by shale when injected into it thereby displacing the methane for increased recovery from the shale.

**Web Sites:**

http://esogis.nysm.nysed.gov This is the website to go to for information on well logs, formation tops, core, and well samples. At this website many studies on New York reservoirs sponsored by NYSERDA can be downloaded for free.

http://www.dec.ny.gov/energy/205.html This is the website to find out information on wells being permitted, well spacing and all state regulations regarding oil and gas well drilling. This also is the website to download the 800 page draft Supplemental Generic Environmental Impact Statement.

**References**


Jacobi, R.D., and C.E. Mitchell, 2002, Geodynamical interpretation of a major unconformity in the Taconic Foredeep: Slide scar or onlap


(n) Utah Shale Gas Activity Update 2009: by Thomas C. Chidsey, Jr., (Utah Geological Survey)

Central Utah Mississippian Shale Gas Play Overview
Paleozoic shales in the Colorado Plateau and eastern Basin and Range Provinces have long been known for their potential as source rocks for hydrocarbons that have migrated into other formations but have not been considered as in-situ gas reservoirs. These include the Mississippian Manning Canyon and Delle Phosphatic Shales of central Utah. The Manning Canyon Shale is mainly claystone with interbeds of limestone, sandstone, siltstone, and mudstone, and has a maximum thickness of 2,000 ft (600 m). TOC varies from 1% to greater than 8% with type III (?) kerogen. In north-central Utah, the Manning Canyon was deeply buried by sediments in the Pennsylvanian-Permian-aged Oquirrh Basin and is therefore likely very thermally mature. The Delle Phosphatic Shale is a member of the Chainman Shale, Deseret Limestone, and Little Flat Formation. The Delle is composed of interbedded organic-rich phosphatic shale, siltstone, and limestone deposited in a starved basin at the foot of the Paleozoic carbonate ramp. The member is typically 100 to 200 ft (30-60 m) thick.
Although the organic content of some of these shales is partially known, the reservoir quality and the basic rock mechanic data so important to successful completions are virtually unknown. In addition, the distribution and thickness of these rocks are poorly mapped and the vertical succession and regional correlation of the Manning Canyon and Delle Phosphatic has not been interpreted in a sequence stratigraphic framework. The burial history of the Manning Canyon and Delle Phosphatic appears complex and probably varies widely from deep burial in the Permian Oquirrh Basin (>10,000 ft [3,000 m] of overlying Pennsylvanian and Permian strata) to shallower burial along the Paleozoic shelf of central Utah. There are no published studies of the best completion practices for the Manning Canyon and Delle Phosphatic shales. Exploratory efforts are just beginning to target this frontier gas shale play.

**Activity**

In 2008, Bill Barrett Corporation and its partner ConocoPhillips continued to acquire leasehold acreage in an area named “Hook” targeting the Manning Canyon Shale. Barrett (50% working interest with ConocoPhillips) drilled the 15-32-15-12 State well (section 32, T. 15 S., R. 12 E., Carbon County) to a total depth 7,585 ft (2312 m) in the Hook prospect targeting the Manning Canyon Shale. The Manning Canyon consisted of 589 ft (180 m) of shale over a total formation thickness of 816 ft (249 m), 422 ft (129 m) of which was cored. The well analysis indicated good gas shows and high gas contents from core samples. In May 2009, the company completed a horizontal well with a 3,700-foot (1,130 m) horizontal lateral offsetting the vertical well in the same section. No results have been announced. The Utah Division of Oil, Gas & Mining has approved Barrett’s request to drill a second horizontal well in the section. Barrett has locations staked for three additional Manning Canyon wells in Carbon and Emery Counties within its Hook prospect area. The company also plans to conduct a 3-D seismic program in the area covering 142 mi² (368 km²).

West of the Hook area, Shell Western Exploration & Production, Inc. drilled and cored the Manning Canyon Shale in the 5-12 Carbon Canal well (section 12, T. 16 S., R. 10 E., Emery County). The well is reported as a gas discovery with an initial flow rate of 468 MCFGPD and 1,750 bbls of water daily. Production is from three hydraulically fractured Manning Canyon intervals. Flow was gauged through chokes ranging from 16/64-inch to 64/64-inch. Flowing casing pressure ranged up to 5,200 psi. The well is currently shut-in. Shell has staked two additional 9,400 ft (2,900 m) wells to test potential Paleozoic shale gas reservoirs 3.5 mi (5.6 km) southwest and 6 mi west-northwest (9.7 km) in Emery and Carbon Counties, respectively.
Within the same area as Barrett is exploring, Chief Oil & Gas International Petroleum LLC has announced plans to drill a 7,287 ft (2,221 m) test of the Mississippian (section 3, T. 16 S., R. 12 E., Emery County) 1.5 mi (2.4 km) southwest of a Barrett location. The drill site is just west of Grassy Trail Creek oil field, which produces from the Triassic Moenkopi Formation. In Grassy Trail Creek field itself, Genesis Petroleum U.S. Inc. has plans to reenter a former Moenkopi producer and deepen it the Precambrian evaluating the Mississippian section.

Presentations


*Shale Gas and Oil Shale Resources of the Paradox Basin, Colorado and Utah* by Steven C. Schamel, presented at the AAPG Annual Convention in Denver, CO, poster June 9, 2009.


(o) Canada: by Jock McCracken (Egret Consulting)

Shale gas production in Canada is now more than a year and a half old after the announcement of new discoveries at the beginning of 2008. Therefore, the state of development for the shale plays still range from speculative to exploratory to emerging with only two plays being considered developing. In most cases, the majority of wells are still confidential so production numbers are limited. Information gathered in this report comes from some provincial government reports and the key operators.

**NORTHEAST BRITISH COLUMBIA**

Shale gas interest has dominated the sale of petroleum and natural gas (PNG) rights from the province in the last three years with the Horn River Basin, the Cordova Embayment and the Montney Play trend generating the most interest. Recently the Liard Basin or Beaver River Area has come on to the radar screen with most of the basin almost entirely licensed between July 2009 and the upcoming land sale in November. Land sales for these areas accounted for 41 to 49% of the 2008 bonus total. The PNG rights sales for the Montney Play, encompassing the southern Fort St. John region and the northern section of the Deep Basin region in the northeast British Columbia, have alone increased from $84.5
million to $1.32 billion from 2005 to 2008. British Columbia’s shales are now being recognized as potential reservoirs and are estimated to have the capacity to hold 250 to 1,000 trillion cubic feet (Tcf) of original gas-in-place.

**TABLE 1. POTENTIAL SHALE GAS FORMATIONS IN NORTHEAST BRITISH COLUMBIA**

<table>
<thead>
<tr>
<th>PROSPECTIVE HORIZONS</th>
<th>Formations</th>
<th>Description</th>
<th>Depth</th>
<th>Average Thickness</th>
<th>Total Organic Carbon</th>
<th>Gas in Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOWER CRETACEOUS</td>
<td>Wilrich and Buckinghorse shales</td>
<td>Potential interbedded sand/shalestone</td>
<td>800 to 1,200 metres</td>
<td>100 metres</td>
<td>2.3%</td>
<td>60 Bcf per section</td>
</tr>
<tr>
<td>JURASSIC</td>
<td>Nordegg and Femie shales</td>
<td>Recognized source rocks</td>
<td>1,200 to 2,500 metres</td>
<td>Up to 30 m organic rich section</td>
<td>up to 14%</td>
<td>&gt;20 Bcf per section</td>
</tr>
<tr>
<td>TRIASSIC</td>
<td>Dog, Dog, Phosphate and Montney</td>
<td>Monney turbidites may increase permeability</td>
<td>1,200 to 3,600 metres</td>
<td>300 to 500 metres</td>
<td>0.5 to &gt;10%</td>
<td>10 to 110 Bcf per section</td>
</tr>
<tr>
<td>DEVONIAN</td>
<td>Exshaw, Betsa River, Fort Simpson and Muskwa</td>
<td>Exshaw and Muskwa are widely distributed organic shales</td>
<td>1,800 to 3,500 metres</td>
<td>Huge thicknesses are common with some high TOC intervals</td>
<td>0.5 to &gt;10%</td>
<td>10 to 100 Bcf per section</td>
</tr>
</tbody>
</table>

The chart below shows this activity in the NE B.C. The steep decline in 2009 reflects the economic downturn and the low gas price but despite this some activity is still going on.
Devonian Muskwa Shale
Horn River Basin, Cordova Embayment and the Liard Basin
Of the three northern basins, the Horn River has the most activity. The following operators form the Horn River Producers Group: Encana Corporation, Apache Canada, Devon Canada Corporation, EOG Resources Inc., Nexen Inc., Quicksilver Resources Inc., Stone Mountain Resources Ltd., Imperial Oil Limited-ExxonMobil Canada Limited, ConocoPhillips, Suncor Energy (Petro-Canada), PenGrowth Energy Trust, Result Energy Inc. Other companies working this area are SMR Oil and Gas Ltd, Paramount Resources Ltd, Storm Exploration Inc., Ramshorn Canada Ltd., Crew Energy Inc., PetroBank Energy and Resources Ltd., Seven Generations Energy Corp., Great Plains Exploration among others.

Some significant events are as follows: Encana drilled 37 gross wells in this area in 2009 and has indicated IP rates of 5 to 10 MMcf per day. Prior to this year they drilled 16 gross wells. Some of their recent 15-day tests have rates of 9.5 to 11 MMcf per day with up to 14 stages. The well depth average is about 9,000 ft with 150 Bcf per section of gas-in-place. Apache with 17 wells is moving to full scale production by 2011-2012. They have been running with a maximum of 14 stage fracs and are currently producing at 80 MMcf per day. Nexen will have 2 vertical and 3 horizontal wells under production by 2009. Devon has drilled 1 vertical and 2 horizontals. EOG has drilled 7 horizontals in 2009 compared to 6 in 2008. They have been under production since July 2008. They consider the rock quality of the Horn River Shales better than the Barnett.

Figure 2. Annual bonuses collected from petroleum and natural gas rights sold in British Columbia.
Encana is working on its Cabin Lake processing facility, located 60 km north of Fort Nelson. The initial phase, by 2012, will process at 400 MMcf per day with the final 6th phase projected at 2.4 Bcf per day. Spectra Energy Corp. which has 2,800 km of pipeline in B.C. and transportation capacity of 2.2 Bcf per day is working on infrastructure efficiency. They have firm commitments from 10 customers for 791MMcf per day with staged in-service dates between 2009 and 2012 and onwards.

The Beaver River or Liard Basin area has had some activity by Questerre Energy and Transeuro. One of the wells is flowing at a facilities-constrained rate of around 5 MMcf per day from the Mississippian Mattson carbonate which is in direct communication with the surrounding shales. They hope to see evidence that the gas from the surrounding shale will contribute to the production.

Cordova embayment is moving a bit slower with most parcels purchased privately by land brokers. B.C. has an experimental scheme ownership where operations are kept confidential for three years. Nexen, Penn West Trust and Canadian Natural Resources Ltd. have operations in this category with Nexen having drilled one vertical and one horizontal and Penn West drilling two horizontals with one on stream.
Triassic Montney
Dawson Creek Area

The main Montney players are ARC Energy Trust, Encana Corporation, Murphy Oil Corporation, Storm Exploration, Shell Canada Ltd., Progress Energy Resources, Talisman Energy, and Crew Energy. There are numerous other operators as well.

Some significant events are as follows: ARC Energy Trust is the dominant producer in the Dawson Creek Field. By the end of 2008, ARC had 12 vertical and 3 horizontal wells awaiting tie-in with production reaching 48 MMcf per day. This field remains a key focus in 2009 with 79 producing wells. A gas plant with a 60 MMcf per day capacity is scheduled for first quarter 2010 with two more planned before 2014. Currently they are using a 25% recovery factor with 50% being the goal. Encana is ramping up its operations at Swan Lake area and now has 295,000 hectares of land at its Cutback Ridge resource play and is now producing 228 MMcf per day from 85 horizontals at Swan Lake. They are completing 8 staged fracs in 4 days where it would take that many days just to complete one a few years ago. Encana has identified 3.7 Tcf of OGIP or 25 to 40 Bcf per section. Murphy has concentrated their efforts in the Swan Lake and Tupper area and is now producing at 57 MMcf per day as of May 2009. Storm is working on its property at Parkland with their development plan being 4 horizontals per section with 6 to 8 fracs per well. In 2009 they are planning 4 horizontals and 5 to 6 verticals. Crocatta have been working on the Dawson and Tupper Fields. One horizontal flowed at over 5 MMcf per day with a final test rate of 2.5 MMcf per day on an extended flow test. Talisman is planning to drill up to 36 development wells in 2009 with horizontals drilled from pad locations. Crew has testing wells in the Septimus area with rates as high as 17.8 MMcf per day. They were producing at a restricted 7 MMcf per day. Commissioning of a 25 MMcf per day processing facility is planned for in October 2009.

The graph below shows the nonconfidential well production in the Montney.
The Cretaceous shale-gas activity is being assessed in the Fort St. John and Northern Foothills areas. Petro-Canada, Painted Pony Petroleum, Unconventional Natural Gas and Canadian Spirit have been a few of the players in the area, mostly with experimental schemes. Canadian Spirit, however, is the only one announcing production with 7 wells by year end. No production volumes reported yet.

B.C Shale information link:
http://www.empr.gov.bc.ca/OG/oilandgas/petroleumgeology/UnconventionalOilAndGas/Pages/Shale.aspx


ALBERTA
Cretaceous Colorado Group
Eastern Alberta
There is limited shale-gas activity and production reported in Alberta even though potentially large resources exist within various formations. Stealth Ventures http://www.stealthventures.ca/ announced their shale-gas project in the Wildmere region of eastern Alberta as commercial within the Colorado Group which is a mixture of biogenic gas-charged shales with silts and sand laminae. A typical well will IP at over 150 Mcf/d and reduce to 40 Mcf/d after 1.5 years. They currently have 120 shale gas wells with
production at 2.2 MMcf/d. They are negotiating to down space to 8 wells per section with 450 drillable locations being planned.

**Muskwa Shales**  
**Western Alberta**

Mooncor ([http://www.mooncor.com/](http://www.mooncor.com/)) is exploring for an Alberta S.E. extension of the Muskwa play of the Horn River Basin in N.E. B.C. They have re-entered a well and tested about one MMcf/d from a 12-25 metre thick shale. They plan to test this with a horizontal in the 4th quarter.

The Alberta Energy Resources Conservation Board (ERCB) just recently published a document to clarify the definition of shale for shale gas development and to identify the geological strata from which any gas production will be considered to be shale gas.  

The Alberta Government Royalty regime changes can be found at this site: [http://www.energy.gov.ab.ca/About_Us/1525.asp](http://www.energy.gov.ab.ca/About_Us/1525.asp)

Alberta Duvernay/Muskwa and Montney Formations Shale Analysis poster by the ERCB and Alberta Geological Survey.  

**SASKATCHEWAN**  
**Cretaceous Colorado Group – biogenic gas**  
**Central Saskatchewan**

Still no commercial discoveries and not much news out of Saskatchewan this year as a result of the lower gas price and the economic downturn. Between 2004 and 2008 more than 50 test wells were drilled for shale gas in all areas in the province, including Watrous, Moose Jaw, Strasbourg, Foam Lake, Smeaton, Shell Lake and Big River but no commercial discoveries have been announced. Some players are still operating, but at reduced or no activity.  

PanTerra Resource Corp. have drilled and cased thirty-six wells within their more than one million acres of land. They have been coring, logging and fracture stimulating but no rates have been announced to date.  

There has also been some activity in the Pasquia Hills in central east Saskatchewan. There have been about 23 wells drilled by various operators with gas shows and some limited gas tests. Nordic announced recently that survey work has now commenced for a five-well drilling program on the Company’s land in Preeceville. Nordic believes that with
new drilling technology available, it will be successful in unlocking the enormous reserves of shale and natural gas that the Hunt Oil consultants have confirmed is in the region. Drilling is expected to begin in September 2009. The Company’s Preeceville lands are on the northeastern flank of the Western Canadian Sedimentary Basin (WCSB) where it is believed that there is an abundance of shale gas. The Gas Technology Institute has concluded that the WCSB contains a large resource potential for shale gas and has estimated the hydrocarbon volume for these shales to be in the order of 86 Tcf. http://www.nordicoilandgas.com/preec.html

MANITOBA
Cretaceous Colorado Group
There is the potential of shale gas in Manitoba, but no activity. Nicholas and Bamburak, 2009.
http://www.geoconvention.org/2009abstracts/014.pdf

ONTARIO
Upper Devonian Kettle Point Shale (Antrim Shale Equivalent)
Middle Devonian Marcellus Shale
Upper Ordovician Blue Mountain and Collingwood Shale (Utica Equivalent)

Exploitation of these shales has been very quiet with only a few operators discussing the evaluation of these shale targets. These shales are mostly considered secondary targets but no wells have been drilled to test these zones to date. Mooncor and Greentree have discussed shale targets in the past but no drilling to date.

These shales have been described by Carter, Fortner and Béland-Otis “Ordovician and Devonian Black Shales and Shale Gas in Southwestern Ontario, Canada, 2009”

QUEBEC – ST. LAWRENCE LOWLANDS
Ordovician Lorraine and Utica Shale
The other bright light in Canadian shale exploration in 2008 was in Quebec within a 300 km by 100 km fairway between Montreal and Quebec. Both Forest Oil Corporation and their partners and Talisman and their partners have drilled about 11 wells to evaluate both the Lorraine (up to 6,500 ft thick) and the Utica (300 to 1,000 ft thick). Talisman with their partners and a 771,000 acre land position has drilled 6 vertical wells with tested rates at from 300 to 900 Mcf per day. In 2009 they drilled two horizontals which are currently being evaluated. Forest, after drilling two vertical wells with production rates up to 1 MMcf per day and three horizontals, is waiting for the rock work and the analysis before proceeding further. The horizontals rates range from 100 to 800 Mcf/d with
4 stage fracs. These are ten year leases. Forest estimated 4.1 Tcf resource potential at 20% recovery. These black shales of 1 to 3% TOC are 500 ft thick within the gas window. Canbrian, Gastem, Junex, Queسترere and Altai are among the other interest holders in this play. Quebec’s natural gas royalty, which currently is 12.5%, has been described as attractive by some of the players. As well, shale gas plays in the province’s St. Lawrence Lowlands enjoy another advantage in being close to the northeast U.S. gas market.

NEW BRUNSWICK
Lower Mississippian Fredrick Brook Shale
Moncton Basin
The Fredrick Brook shale is being tested by Corridor, with several wells into the shale and two small fracs with positive gas flow. Larger fracs are being planned into 2010 with two horizontals planned for 2010 with the hope for commercial development by 2013-2014. [http://www.corridor.ca/investors/documents/MNPSuppliersPresentationSept2009.pdf](http://www.corridor.ca/investors/documents/MNPSuppliersPresentationSept2009.pdf)
Petrsworth is also targeting shale gas production in the Fredrick Brook.

NOVA SCOTIA
Upper Devonian/Lower Mississippian Horton Bluff
Kennetcook Basin
Triangle Petroleum [http://www.trianglepetroleum.com/](http://www.trianglepetroleum.com/) has been working on this block since May 2007 with 2D and 3D seismic programs and 5 vertical exploration wells. Since then these wells have experimented on various fracture treatments with no success so far. On April 16, 2009, Triangle executed a 10-year production lease on its Windsor Block in Nova Scotia which covers 474,625 gross acres (270,000 net acres). They have agreed to drill at least 7 more wells in this block before 2014. They are currently conducting a 30 km 2D seismic program to try to pinpoint areas with structure for future shale targets.

NEWFOUNDLAND
Ordovician Green Point Shale
Western Newfoundland
Shoal Point Energy ([http://www.shoalpointenergy.com/](http://www.shoalpointenergy.com/)) and its partners encountered about 500 m with varying gas readings through the Ordovician Green Point Formation west of Stephanville, Newfoundland. This shale has been studied in outcrop by the Canadian Geological Survey and is summarized in Hamblin (2006). The companies are pursuing further testing of the concept. This play may be in the oil window as well.

[Canadian Society for Unconventional Gas](http://www.csug.ca/)
Key References and Information on Canadian Shales:

(p) European Unconventional Shale-Gas Activity:
by Dan Jarvie, Worldwide Geochemistry (danjarvie@wwgeochem.com)
Current address, Institut Francais du Petrole (daniel-m.jarvie@ifp.fr)

Introduction

Gas production in Europe is running about 11 Tcf with 75% of this gas coming from the United Kingdom, Norway and Netherlands. Peak production of 13.5 Tcf was reached in 2003 (Hertzmark, 2009). With natural gas consumption running at 20.5 Tcf in 2008 and with about 80% of the gas coming from Russia, there is a definite need for additional hydrocarbon resource development. Natural gas also has the attraction of reduced emissions as opposed to coal burning particularly in oxides of carbon and nitrogen.

Activity in unconventional shale gas has been underway for the last several years, although there has only been drilling activity as of 2009. As
has been described elsewhere on numerous occasions, European oil companies have taken an active position in several US shale gas basins. Those companies include Statoil (Marcellus), British Gas (Haynesville), Shell (Barnett, Haynesville, and others), and ENI (Barnett). Of course BP has also been active in US shale-gas plays.

While drilling costs are higher in Europe and land access more difficult, land costs and royalties are much lower, and gas prices much higher. Natural gas prices are linked to the cost of crude oil and petroleum products (Miller, 2009). Current pricing is running about $14.00/Mcf. Thus, the economics are considerably different than found in most US basins.

Reserves from shale has been estimated as high as 500 Tcf, but a recent report provides a more conservative but perhaps more realistic estimate that there is at least 230 Tcf in European shale gas systems (Doornenbal et al., 2009).

**Exploration Activity**

The following is a report by country drawn from a variety of public sources.

**Austria**

OMV is engaged in a three year project to evaluate drilling deep into the Vienna Basin, which contains Late Jurassic Posidonia Shale.

**Denmark**

A borehole is proposed to be drilled as a science well near Skelbro, Bornholm in early 2010 to take core of the Alum Shale. This is part of the GASH project.

**France**

There has been bid activity in southern France close to the Mediterranean. Total's CEO announced that shale oil and gas are now their priority. Total and Devon Energy have an agreement to explore for shale gas in France and are trying to obtain a concession on about 1.4 million acres (Financial Times, 2009).

It was also recently announced that Eurenergy Resource Corp. has been awarded 1.3 million acres in the East Paris Basin of France (see also Eurenergy, UK).
Germany

ExxonMobil has licenses on over 1.3 million acres in the Lower Saxony Basin, Germany for potential biogenic and thermogenic shale gas from the Wealden Shale and the Posidonia Shale. There was an article in the Wall Street Journal detailing some of their activity and plans for 10 wells and an extensive coring program. Shell is apparently a partner in at least part of this project. ExxonMobil has stated that they view the LSB as having world class hydrocarbon resources.

It is interesting to note that 6 wells were drilled in the Hils Syncline of the LSB in the 1980s as part of a funded research program at KFA, Julich, to study the Posidonia Shale for its source rock properties. Published results show TOC values averaging 10% with a Type II kerogen and maturity windows from 0.49 to 1.3%Ro (Mann, 1984).

Hungary

ExxonMobil and MOL have announced a joint exploration project in the Mako Trough in southeastern Hungary. This is likely an unconventional basin center gas play although it is sometimes referred to as a shale gas play. It is possibly like the combination tight gas sand / hybrid shale-gas play such as the Bossier Formation in East Texas-Western Louisiana as the play type varies across the basin. Falcon Oil & Gas, ExxonMobil's affiliate, Production Ventures East Hungary Kft, and MOL have agreed to fracture stimulate another section (Szolnok Formation) in the Foldeak-1 well located in the Mako Trough.

Also in the Mako Trough Falcon Oil & Gas, ExxonMobil's affiliate, Production Ventures East Hungary Kft, and MOL have agreed to fracture stimulate another section (Szolnok Formation) in the Foldeak-1 well. Again this may be a tight gas sand play, or perhaps a combination or hybrid shale-gas system.

Poland

There has been considerable activity for partnerships and concessions in Poland in the past year, although lesser known efforts were occurring earlier. ExxonMobil and ConocoPhillips signed separate deals on exploration acreage in Poland.

3Legs Resources and its subsidiary, Lane Energy Poland, acquired licenses on over 1 million acres in the Baltic Basin with prospective shale gas systems. A significant portion of their acreage has been packaged into agreement with ConocoPhillips, and ExxonMobil.
An ExxonMobil affiliate has obtained exploration acreage in the Podlasie and Lublin basins in Poland (Patrick McGinn, ExxonMobil spokesperson, October 13, 2009). The acreage position was not disclosed but it was acquired in December 2008.

ConocoPhillips has reached an agreement with Lane Energy targeting Silurian shales in northern Poland’s Baltic Basin. They have options on an additional 1 million acres in three areas of Poland.

BNK Petroleum has an agreement with Rohol-Aufsuchungs Aktiengesellschaft (RAG) and Sorgenia E&P S.p.A to farm out an 80% interest in three oil and gas concessions in the Gandsk Basin, identified as Starogard, Slupsk, and Slawno, covering 700,000 gross acres. BNK will receive a management fee and the work necessary to identify the first drilling location. BNK has identified characteristics compatible with successful shale gas plays such as good organic richness, thermal maturity in the gas window, and silica-rich mineralogy.

**Romania**

No known new activity although shales are present and producing gas in Romania. These are likely biogenic plays.

**Sweden**

Shell has begun drilling in Sweden for what is likely a Cambrian Alum Shale objective although there is potential in the Ordovician and possibly the Silurian. This activity is identified as the Colonussankan and Hollvikengraven areas of southern Sweden.

**Switzerland**

An agreement between Ascent Resource and Schuepbach Energy was made for an option to pursue Jurassic shale exploration in Switzerland. Schuepbach has a concession in the Canton of Fribourg adjoining Ascent’s concession in the Canton of Vaud. Ascent holds 90% of the Canton of Vaud concession with 10% held by SEAG of Switzerland.

The agreement specifies that Schuepbach will earn 75% interest in shales if the first well is drilled in the Canton of Vaud, and a 25% interest if the first well is drilled in Canton of Fribourg.

**United Kingdom**

Eurenergy announced plans to drill for shale gas in the Weald Basin, southern England. It has a five year concession on 123,000 acres there
with two shale horizons. A horizontal well is in the planning stages according to Eurenergy.

There is activity in the UK for unconventional shale gas but no public news was located. Shelley (1989; 2005)

Other Exploration News

Park Place Energy Corp. and Concessions International have identified two unidentified European shale gas opportunities. These are described only as in the EU and covering over 100,000 acres of land.

Meetings

AAPG European Region Annual Conference, Institut Francais du Petrole is hosting a two day meeting in Rueil-Malmaison, France on November 23-24, 2009. Go to: http://www.aapg.org/malmaison/program.cfm http://www.aapg.org/malmaison/docs/Malmaison_Flyer.pdf


European Geosciences Union (EGU) meeting in Vienna, Austria, May 2-7, 2010, will include an unconventional gas session. For information: www.egu2010/copernicus.org Abstracts are due January 2010.

Commercial and Research Studies

GASH
The Gas Shales in Europe project (GASH) is an interdisciplinary research project carried out by a multi-national expert task force. It is a 3 year research program and is funded with 7 participating oil companies. Current participants include ExxonMobil, Gaz de France, Marathon, StatoilHydro, Total, and Vermilion Energy (Williams, 2009). The project focuses on the potential gas shales of Europe. Importantly, it also integrates proven US gas shales (e.g. Barnett Shale) for calibration of key variables.

The GASH project will predict shale gas formation and occurrence in time and space because the geological evolution of gas shales is a key control of economic viability. The distribution of prospective shales will be ascertained using existing and enhanced regional databases. Physical, chemical and biological processes contributing to shale gas formation will be examined by experiment, monitoring, surveying and modelling. Seismic and magnetotelluric surveys will be employed for remote detection. Well
log correlations will be employed at the finer scale. Shale property
determinations will address both organic and inorganic constituents, and
involve their chemical, isotopic and physical characteristics. Regional
structural evolution and petroleum system modelling will be employed to
model generation, transport and rock-fluid interactions. GASH is no ivory
tower research marathon. It is goal-orientated and designed to meet the
short-, and longer-term needs of both sponsors and researchers alike.

The GASH team is mainly European, but with the right mixture of
American-based experience and know-how. The project is coordinated by
GeoForschungsZentrum Potsdam (GFZ), the national laboratory for
geosciences in Germany. Working alongside them are the Institut
Français du Pétrole (France) and TNO (The Netherlands). The universities
involved to date include Newcastle (UK), Aachen, FU Berlin, Clausthal,
Leipzig (all Germany), VU Amsterdam (The Netherlands) and MU Leoben
(Austria). National and state geological surveys play a key central role not
only in regional analysis and application, but also in basic research.

GeoEn
GeoEn is funded by the German ministry for research and education. This
is a six year project that will include black shales in Brandenburg and
Mecklenburg-Vorpommern, northern Germany (Williams, 2009).

Core Laboratories
Core Laboratories’ Integrated Reservoir Solutions Division has been
conducting a joint industry project for the past 4 years focused on
reservoir characterization and completion/stimulation of Gas Shales in
North America (Phase 1). Over 65 member companies are contributing
conventional core, well logs, completion, stimulation, and production data
for a total of 195 wells to date. Core Lab has performed 1) an extensive
core analysis program on each of these cores, 2) core-log calibration for
petrophysical models and OGIP calculations, and 3) evaluated the
completion, stimulation and production from these wells. In addition, Core
Lab has synthesized these data and made comparisons of various Gas
Shales in terms of the key factors that relate to a Gas Shale’s productivity.
All of these data and interpretations are provided in a web-enabled Oracle
database to the member companies and presented at periodic core
workshops and technical seminars.

Core Laboratories is expanding our industry-leading study of Gas Shales
to areas outside of North America as a Phase 2 to our original study.
Participants in the Phase 2 Study will receive all of the data and
interpretations from the North American Phase 1 Study and will contribute
core and data from their own Gas Shale reservoirs. The initial focus of the
project is on European Basins from Ireland to the Ukraine. Participants will
be able to leverage the North American data sets and technology in
evaluating and developing their own Gas Shale reservoirs. These integrated data sets and case histories will provide operators with the critical parameters to optimize their exploitation of these reservoirs and reduce finding and development costs.

This project will consist of the characterization and evaluation of numerous conventional cores, rotary sidewall cores, and drill cutting samples taken from multiple wells targeting potentially productive gas shale formations from around the world. Specifically, these prospective shale sections will be analyzed for geological, petrophysical, geomechanical, geochemical, and production properties. These data will be integrated with well logs, stimulation designs, and production test information as available. This large and searchable database will provide operators with valuable information not only on their own wells but also on other operator’s wells. The project will be focused on utilizing the experience of evaluating numerous North American gas shale wells in expanding the evaluation of gas shale reservoirs globally.

2. Gas Shale research and sources of funding. Gas shale research is being conducted by private industry, consortia, and government.

   (1) **Private Industry** (e.g., Devon Energy): not for public distribution.

   (2) **Consortia:**
      (a) **Core Lab** “Reservoir characterization and production properties of gas shales”
          “Haynesville and Bossier Shale Evaluation”
          “Eagle Ford Shale Study”
          “Global Gas Shales Study”
      (c) **Colorado School of Mines FAST** (Fracturing, Acidizing, Stimulation Technology) Consortium Project 9: stimulation of “shale” reservoirs
          ([http://www.mines.edu/fast/](http://www.mines.edu/fast/)).
      (d) **Humble Geochemical Services** ([http://www.humble-inc.com/](http://www.humble-inc.com/))
      (e) **GeoMark Research**
          Appalachian Basin Shale Gas Study (2005)
          ([http://www.geomarkresearch.com/studies_northamerica.cfm](http://www.geomarkresearch.com/studies_northamerica.cfm))
      (f) **Baseline Resolution**
          Black Warrior Basin Study
          ([http://www.baselinedgsi.com/contents/black_warrior_basin.htm](http://www.baselinedgsi.com/contents/black_warrior_basin.htm))
      (g) **GASH (Gas Shales in Europe)**
(h) GeoEn (Germany) [http://www.geoen.de/index.php/shale-gas.html](http://www.geoen.de/index.php/shale-gas.html)

3. **Government**
   (a) RPSEA (Research Partnership to Secure Energy for America) [http://www.rpsea.org](http://www.rpsea.org)
      
   
   (b) USGS. The U.S. Geological Survey is updating the National Assessment of Oil and Gas Resources [http://energy.cr.usgs.gov/oilgas/noga/](http://energy.cr.usgs.gov/oilgas/noga/)
      The USGS Eastern Energy Resources Team has initiated a project that pertains to the organic geochemistry of the Devonian shale formations in the Appalachian Basin. The project is being conducted in cooperation with the State geological surveys of Virginia, Kentucky, Ohio, West Virginia, and Pennsylvania. The State geological surveys are collecting samples of Devonian shale, which they ship to the USGS for analyses. The analyses are, for the most part, being conducted by a commercial laboratory. Newly obtained data will eventually be integrated with previously published analyses to prepare a regional summary of Devonian shale geochemistry.

4. **Sources of Information**
   (a) **References** (see gas shale bibliography on Gas Shale Committee website) [http://emd.aapg.org/members_only/gas_shales/gasshalereferences.pdf](http://emd.aapg.org/members_only/gas_shales/gasshalereferences.pdf)
   (b) **Trade Journals** (articles included in bibliography above)
(1) Powell Barnett Shale Newsletter
(http://www.barnettshalenews.com/)
(2) American Oil and Gas Reporter
(3) Oil and Gas Investor
(4) Oil and Gas Journal
(5) Hart’s E & P
(6) AAPG Explorer

(c) Subscription Services
(1) Hart Unconventional Natural Gas Report
(http://www.ugcenter.com/; http://www.ugcenter.com/Newsletters/)
(2) IHS Energy (http://energy.ihs.com/)
(3) Warlick International Report (http://www.warlick.net/)

5. Calendar


April 11-14, 2010: AAPG Annual Convention, New Orleans, LA.  
http://www.aapg.org/neworleans/

October 5-7, 2010: Unconventional Gas International Conference & Exhibition, Fort Worth, TX.  http://www.unconventionalgas.net

6. Committee Members (in alphabetical order)