

EMD Annual Leadership Meeting
April 19, 2008
Gas Shale Committee Report (Revised)
Brian Cardott, Chairman

1. Active Gas Shale Plays

Many black shale hydrocarbon source rocks across the U.S. and Canada are currently being evaluated as gas shales. 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. According to the Texas Railroad Commission web site (<http://www.rrc.state.tx.us/divisions/oq/statistics/fielddata/barnettshale.pdf>) as of January 23, 2008 there were a total of 7,170 Barnett Shale gas wells and 4,350 permitted locations in the Newark East Field (discovery date, October 15, 1981) of the Fort Worth Basin. During most of calendar year 2007 (January through November), 768 billion cubic feet (Bcf) gas was produced from the field, accounting for 15% of Texas gas production. Of a total of 191 operators in the Newark East Field, the top 10 operators are:

- (1) Devon Energy Production Co.
- (2) XTO Energy Inc.
- (3) EOG Resources Inc.
- (4) Chesapeake Operating Inc.
- (5) Encana Oil and Gas (USA) Inc.
- (6) Burlington Resources O&G Co. LP
- (7) Range Production Co.
- (8) Quicksilver Resources Inc.
- (9) Denbury Onshore, LLC
- (10) J-W Operating Co.

Technological discoveries made in the development of the Barnett Shale play (such as the application of microseismic mapping, slick-water fracs, and horizontal drilling) have contributed to the advancement of all gas shale plays. Recent reports indicate that simultaneously fractured wells (termed simo-frac) have higher gas production than wells fractured individually.

Reference: Schein, G.W., and S. Weiss, 2008, Simultaneous fracturing takes off: Hart Energy Publishing, E&P, v. 81, no. 3, p. 55-56.

(b) **Arkoma Basin, Arkansas: Fayetteville Shale (Mississippian).**

According to the Arkansas Oil and Gas Commission web site (<http://www.aogc.state.ar.us/Fayprodinfo.htm>), there are a total of 742 completed Fayetteville Shale wells (as of March 21, 2008). A map of Fayetteville Shale wells is available at

<http://www.geostor.arkansas.gov/apps/aogc/index.htm>. The top six operators of the Fayetteville gas shale play are:

- (1) Seeco Inc. (517 wells)
- (2) Chesapeake Operating Inc. (132 wells)
- (3) KCS Resources Inc. (30 wells)
- (4) One TEC Operating, LLC (16 wells)
- (5) Petrohawk Operating Co. (13 wells)
- (6) Hallwood Petroleum LLC (10 wells)

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 March 21, 2008 there were a total of 381 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 271 horizontal Woodford Shale gas wells from 2005-2007, initial potential gas rates ranged from 3 to 12,000 thousand cubic feet of gas per day (Mcf/d). Excluding 23 old well workover completions, cumulative production from 279 Woodford Shale-only wells drilled from 2004-2007 is 63,752,439 Mcf gas and 66,538 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/oilgas.php>). Of 28 operators active in calendar year 2007, the top five operators are:

- (1) Newfield Exploration Mid-Continent Inc.
- (2) Devon Energy Production Co. LP
- (3) Antero Resources Corporation
- (4) Chesapeake Operating Inc.
- (5) Pablo Energy II LLC

Caney Shale (Mississippian) gas-well completions dropped from 27 in 2004 to 2 in 2007 due to problems completing the clay-rich shale. A new Woodford gas-shale play is in the Ardmore Basin in southern Oklahoma.

Reference: Regener, W.E., J.M. Byl, and J.M. Hill, 2008, Shale in the Arkoma and Ardmore Basins: An Investor's Guide to Unconventional Gas: Shales and Coalbed Methane, Supplement to Oil & Gas Investor, January 2008, p. 24-25.

(d) **Michigan Basin, Michigan: Antrim Shale (Devonian):** by Dr. William B. Harrison, III (Western Michigan University)

The Michigan Basin Antrim Shale play is a little over 20 years old, having begun the modern phase of development in 1987. The total number of producing wells drilled in the play through 2007 is approximately 9,600 with about 9,400 still online.

Total cumulative gas production has exceeded 2.5 trillion cubic feet (Tcf) through 2007. 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 719 separate projects at the end of 2007. Cumulative production for 2007 was 136,104,267 Mcf of gas. That was a 3.2 % decline from 2006.

There were 32 operators with production at the end of 2007. There were 9,382 wells online at the end of 2007. There were 340 new wells drilled in 2007. That is a 3.8% increase in wells from 2006. Most of the production comes from a few operators. The top 10 operators produced 78.2% of the total Antrim gas in 2007. The top 10 operators in 2007 are as follows.

- (1) Atlas Gas & Oil Co. LLC/DTE Gas & Oil Co.
- (2) Highmount Midwest Energy LLC/Dominion Midwest
- (3) Terra Energy LTD
- (4) Breitburn Operating LP/Quicksilver resources Inc.
- (5) Ward Lake Energy
- (6) Muskogon Development
- (7) Trendwell Energy Corp.
- (8) Delta
- (9) Jordan Development Co. LLC
- (10) O.I.L. Energy Corp.

Although some wells can initially produce up to 500 Mcf/d, generally wells settle at less than 100 Mcf/d. Play wide average production at the end of 2007 was 39 Mcf/d 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; the 2007 ratio is 1.45 Mcf/BBL.

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 14% CO₂ in 2007.

Wells produce from depths as shallow as 350 ft to just over 3,000 ft, although the vast majority of wells are completed from 1,000 to 2,500 ft 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>

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

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

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

Current activity and interest in the Marcellus Shale in West Virginia and Pennsylvania has increased in the last year. Interest in leasing continues, with newspaper, billboard and television ads offering to lease oil and gas rights adding to the visibility of this rapidly evolving play. Leasing has been occurring in some areas in eastern West Virginia which have not traditionally had oil and gas operations occurring. Split estates are common and combined with multiple generations of heirs make title research challenging. Also, most county property records and maps are not available online in West Virginia, necessitating a large investment of time to go through deed books in county courthouses to obtain necessary legal information.

Another interesting legal issue in West Virginia has become very important recently. A legally “deep” well is defined as one which is drilled more than 20 ft below the top of the Onondaga Limestone or its equivalent. The Onondaga Limestone immediately underlies the Marcellus. Drilling only 20 ft into the Onondaga is not a sufficient amount of rat hole to allow modern logging strings access to the entire Marcellus and the contact with the Onondaga. As an interim measure, two companies proposed special field rules to the West Virginia Oil and Gas Conservation Commission which regulates deep wells. The special field rules were approved for areas in northern and southern West Virginia and permit drilling 75 ft into the Onondaga under a shallow well permit. Deep wells also have spacing and set back requirements (spacing is currently 3,000 ft between wells permitted to the same or a deeper unit and a 400 ft set back from a lease or unit boundary). Under the Special Field Rules, spacing of a 1,000 ft and a set back of 50 ft were established.

There were various efforts to effect a comparable State-wide change of the code defining deep wells during a special session of the legislature in August, 2007 and again during the regular session in January through March, 2008. None of these proposals was approved. Opposition to the spacing was voiced by the coal industry; underground mines must leave a

pillar of un-mined coal around every oil or gas well, so coal operators prefer wells to be spaced as far from one another as possible.

Another important difference between deep and shallow wells in West Virginia is that geophysical logs are required to be submitted to the West Virginia Oil and Gas Conservation Commission for deep wells. These logs are archived at the West Virginia Geological and Economic Survey (WVGES). The WVGES has scanned most of the logs currently in its log library and makes the scanned images available for free download via the WVGES website. Download traffic has been so great that a second T1 line was recently added to accommodate demand. Also, to facilitate Marcellus exploration, a list of all wells which should penetrate the Marcellus for which the WVGES has scanned logs available was placed on the WVGES website.

Most new West Virginia Marcellus wells were drilled beginning in late 2006. Annual and monthly production data for individual wells are required to be submitted to the West Virginia Department of Environmental Protection Office of Oil and Gas by March 31 for the preceding calendar year. Many new Marcellus wells went online during 2007, so the first production data for these wells should be available sometime in the summer of 2008. In Pennsylvania, individual well production data are required to be held confidential for 5 years.

Sec. 601.212. Well reporting requirements (a) Every well operator shall file with the department, on a form provided by the department, an annual report specifying the amount of production on the most well specific basis available. Annual reports shall also specify the status of each well; however, in subsequent years, only changes in the status need be reported. The department shall keep all such reports confidential for five years: Provided, however, that the Commonwealth shall have the right to utilize such information in enforcement proceedings, in making designations or determinations under section 1927 A of the act of April 9, 1929 (P.L. 177, No. 175), known as The Administrative Code of 1929, or in aggregate form for statistical purposes.

This makes it challenging to obtain data in a timely manner to evaluate the recoveries from newly drilled wells.

Many inquiries from companies interested in learning about the Marcellus and other Devonian shales in the Appalachian Basin have prompted the WVGES to add a section to the WVGES website which provides links to reference materials useful for obtaining a basic understanding of the geologic framework for the Marcellus. See:

<http://www.wvgs.wvnet.edu/www/datastat/devshales.htm>

Many landowners have been approached by companies wishing to lease their property. The current leasing activity has extended further east than historic production so often property owners are unfamiliar with leasing and drilling operations. Some landowners have had multiple lease offers and leasing has become quite competitive in some areas. Some offers involve paying the delay rental in a lump sum at signing as opposed to annually. Other offers are being made to purchase oil and gas rights as opposed to leasing. Some royalties of more than 1/8 (minimum required by WV state law to obtain a permit) are being offered.

Vertical as well as horizontal wells are being drilled throughout West Virginia. Drilling depths to the Marcellus typically range from a few hundred feet below the surface in eastern West Virginia to more than 9,000 ft on the Allegheny Front. Average depth to the top of the Marcellus is 5,162 ft based on wells in the WVGES oil and gas database. Availability of rigs for horizontal drilling can be a limiting factor as this play evolves.

On January 8-9, 2008, a PTTC workshop entitled "Fracture in Devonian Black Shale of the Appalachian Basin" taught by Terry Engelder and Gary Lash was filled to the meeting room capacity of 170 registrants. See the article in the March 2008 AAPG *Explorer*:

<http://www.aapg.org/explorer/2008/03mar/marcellus.cfm>

Other recent meetings with a focus on shales sponsored by SPE and other organizations also have been well-attended. See:

<http://www.spe.org/spe-app/spe/meetings/07APIT/2008/index.htm>

The last week in May 2008 will bring three back-to-back events focusing on shales. A PTTC workshop co-hosted by the Ohio Geological Society "Drilling and Completion in the Shales of Appalachia" will be held May 29.

<http://karl.nrcce.wvu.edu/workshops.html>

The Pittsburgh Association of Petroleum Geologists is hosting Dan Steward of Republic Energy to talk about the history and play concepts of the Barnett Shale on the evening of May 29. This will be followed by a two day field trip led by Gary Lash entitled "Stratigraphy and Fracture History of the Middle and Upper Devonian Succession, western New York – Significance to Basin Evolution and Hydrocarbon Exploration". For more information, see:

<http://www.papgrocks.org/>

The Eastern Section AAPG/Eastern Region SPE meeting October 11-15, 2008 will have a strong technical program with an emphasis on Devonian shales. Workshops, field trip and oral and poster presentations will all deliver the latest knowledge useful to understanding the shales. The

theme of the meeting, “Appalachia: Unconventional since 1859” underscores the importance of many areas of interest to EMD including gas shales and coalbed methane. See:

<http://www.aapgspe2008.org/index.htm>

(f) **Black Warrior Basin, Alabama and Mississippi: Neal/Floyd (Mississippian):** by Kent Bowker (Bowker Petroleum, LLC)

Again over the past year there has been continued activity in the Floyd/Neal Shale (hereafter referred to as the Floyd) play in the Black Warrior Basin of Alabama and Mississippi; but, as of yet, no commercial production has been established in the play. During the past year, two additional horizontal wells (there were five drilled previously) were drilled in the Floyd. Carrizo drilled a horizontal well in Clay County, Mississippi, and Jim Walter Resources drilled a horizontal in Tuscaloosa County, Alabama. Both of these wells were fracture stimulated, but with poor results.

Many companies have either sold their acreage positions (e.g., Murphy sold 200,000 acres to Vantage Energy, LLC) or have placed their positions on the market (e.g., David H. Arrington Oil & Gas). However, Cabot and others have announced that they will drill additional wells in the play in 2008.

In November, 2007, the Geological Survey of Alabama published an overview of Floyd Shale drilling activity in the state (http://www.ogb.state.al.us/documents/misc_ogb/Floyd%20Shale.pdf). Various companies active in the play, including Cabot (www.cabotog.com), have presented material to their investors regarding their activities in the play.

- (g) **Devonian Shale: Kentucky.** According to the Kentucky Geological Survey web site (<http://www.uky.edu/KGS/emsweb/oginfo/resource.html>, http://www.uky.edu/KGS/emsweb/oginfo/devsh_reserves.pdf), the estimated proven reserves in the Ohio/New Albany/Chattanooga black shale of Kentucky (Illinois and Appalachian basins) is 12 Tcf gas. “Gas reservoir character of Devonian shales of Kentucky” (<http://www.uky.edu/KGS/emsweb/devsh/dvnsh.html>) “Predicting cumulative production of Devonian shale gas wells from early well performance data, Appalachian Basin of eastern Kentucky” (<http://www.uky.edu/KGS/emsweb/devsh/production/>) Well activity and production data are not available.

(h) **Illinois Basin, Indiana: New Albany Shale (Devonian)**

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://igs.indiana.edu/pdms/>), there are a total

of 553 New Albany Shale gas wells completed since 1885 (as of March 21, 2008). Most of the wells, drilled since the mid 1990s, are in Harrison Co. at depths of 500-1,100 ft and production rates of 20-450 Mcfg/d. Recent exploration is in Daviess Co. Gas production is thermogenic and mixed thermogenic/biogenic primarily from the organic-rich Clegg Creek Member.

Source: Comer, J.B., N.R. Hasenmueller, M.D. Mastalerz, J.A. Rupp, N.R. Shaffer, and C.W. Zuppann, 2006, The New Albany Shale gas play in southern Indiana (abstract): 2006 AAPG Eastern Section meeting, Program with Abstracts, p. 17.

<https://scholarworks.iu.edu/dspace/handle/2022/712>

- (i) **Palo Duro Basin, Texas: Bend Shale (Lower Pennsylvanian).**
[Unconventional Natural Gas Report feature for May 2007]
- (j) **Utah Shale Gas Activity Update 2007-2008:** by Dave Tabet, Tom Chidsey and Craig Morgan (Utah Geological Survey)
[Gothic Shale/Paradox Shale, Paradox Basin, Colorado and Utah;
Unconventional Natural Gas Report feature for December 2007]

UINTA BASIN MANCOS SHALE PLAY (numerous operators testing and producing gas from the Mancos Shale in 2007-2008)

Bill Barrett Corporation - In 2008 at the West Tavaputs field of the southwestern Uinta Basin, Barrett will complete one deep Upper Cretaceous Mancos Shale gas test well.

GASCO Energy and Newfield Resources - In 2007 at River Bend field in the southwestern Uinta Basin, GASCO completed three wells at depths from 12,000 to 16,000 ft testing Mancos Shale gas potential. The Mancos is reported to be an over-pressured, silty shale section up to 3,500 ft thick, with 2 to 5% porosity, and 1.4%+ TOC. Estimated in-place gas is reported between 280 to 350 Bcf per square mile, with a projected EUR of 5 to 15% of in-place gas; initial flow rates are from 1,000 to 2,000 Mcf/d. Five new GASCO wells are planned for 2008. In 2008 at Monument Butte field of the Uinta Basin, Newfield, in partnership with GASCO, plan to drill two Mancos Shale reservoir tests below the currently productive Green River Formation.

Petro-Canada – In 2007 and 2008, Petro-Canada received permits to drill more than a dozen deep wells on the West Tavaputs Plateau in the southwestern Uinta Basin designed to test the Mancos Shale and shallower formations.

Questar Gas and XTO Energy - At the Natural Buttes field in the eastern Uinta Basin, Questar is evaluating deep, tight gas sand/shale gas play

potential, and completed 17 Mancos Shale/Dakota Formation wells in 2007 on their acreage; over 30 similar wells are planned for 2008. XTO is separately planning to test the Mancos Shale potential of their Natural Buttes acreage in 2008. Separately, Questar is also targeting Mancos Shale targets at the Flat Rock field in the southern Uinta Basin.

Royale Energy and Retamco - In 2007, Royale Energy and Retamco staked deep tests targeting the Mancos and other formations in the southeastern part of the Uinta Basin along the Uncompahgre uplift.

CENTRAL UTAH PALEOZOIC SHALE GAS PLAY (two companies testing Paleozoic shale gas reservoirs in central Utah)

Bill Barrett Corporation - In late 2007, Barrett sold a 50% working interest in 29,531 net acres of the Hook shale gas prospect in the southwestern Uinta Basin to ConocoPhillips. In 2008, the partners plan to continue to acquire leasehold acreage and drill one or two Mississippian Manning Canyon exploration tests in this prospect. At the nearby Woodside prospect, Barrett has completed the Woodside #1 well and is reportedly conducting a Pennsylvanian shale gas test.

Shell Western Exploration & Production, Inc. - In central Utah, Shell has drilled one well and staked a second rumored test of Paleozoic shale gas reservoirs in Emery and Carbon Counties, respectively.

PARADOX BASIN PENNSYLVANIAN SHALE GAS PLAY (several companies testing or trying to expand shale gas production from the Pennsylvanian Paradox Formation)

CrownQuest Operating, LLC - CrownQuest has recently conducted workovers on the Gothic and Chimney Rock shale zones of the Pennsylvanian Paradox Formation. In 2008, they plan an ambitious exploration program with at least nine wells staked.

Baytex Energy, Fidelity E&P, and Babcock & Brown – these three companies have also staked new wells planned to test Paradox Formation shale reservoirs.

Delta Petroleum and Petro-Canada – in the northwestern part of the basin near Delta's Greentown discovery, both companies have staked additional wells to evaluating clastic Paradox Formation zones, which likely include shales. In late 2007, Delta's Greentown discovery got approval from the BLM to connect up to pipeline for production.

WASATCH PLATEAU TUNUNK SHALE MEMBER OF MANCOS SHALE (CRETACEOUS)

XTO Energy – On the Wasatch Plateau in central Utah, XTO is drilling, completing or has staked three wells targeting the Tununk Shale Member of the Mancos. XTO took over the prospects from Dominion E&D.

OTHER NEWS

AAPG RMS meeting, Snowbird, UT – This meeting in October 2007 had over 690 attendees and over 100 technical presentations, of which more than 20 were related to shale gas reservoirs. In addition, a short course/core workshop on Rocky Mountain shale gas reservoirs was presented a second day due to overwhelming popular demand.

Research - In March 2008, RPSEA awarded funding for a 3-year project to the Utah Geological Survey (UGS) to characterize Carboniferous shale gas reservoirs in central Utah, and Permian shale gas reservoirs in the Paradox Basin of southeast Utah. Halliburton, the UGS's industry partner, will assist with the project by designing best completion practices based on the reservoir characteristics determined by the UGS.

(k) **Baxter & Hilliard Shales** (Green River Basin, Wyoming & Colorado)
[Unconventional Natural Gas Report feature for January 2008]

(l) **Canada:** by Jock McCracken (Petro-Canada)

The shale-gas potential for Canada has been recognized and summarized for the Western Canada Sedimentary Basin (WCSB) by Faraj and others (2002; 2004) and for the rest of the country by Hamblin (2006). The gas production from the increasingly important shale-gas plays in the continental USA have provided the inspiration and geological analogies to the Canadian counterparts.

The western Canada reports summarized the following formations: Upper Cretaceous Wilrich and equivalents, Jurassic Nordegg/Fernie, Triassic Doig/Doig Phosphate/Montney, Exshaw/Bakken and the Devonian Ireton/Duvernay. Their published cumulative resource volume for just the Wilrich, Duvernay, Montney, Doig and Doig Phosphate formations was in the order of 86 Tcf. This study concentrated on shales with a predominantly thermogenic-gas source.

Hamblin (2006) described 46 shale-gas plays from western Canada, Ontario, Quebec, Atlantic Canada, Northwest Territories and Nunavut. The report concluded that only seven regions had the best potential based on geological/geochemical properties and geographic locations with proximity to infrastructure and production. These plays are: Upper Ordovician of the Appalachian Basin, Upper Devonian of the

Appalachian/Michigan Basin, Upper Devonian of the northwestern WCSB, Jurassic of western WCSB, Middle to Upper Cretaceous of WCSB Plains and Middle Devonian of Mackenzie Corridor.

Since these reports came out and as a result of successful announcements of shale gas discoveries and production in the U.S., the Canadian industry has quietly had teams working on shale plays and building up land positions. Up until the end of 2007 there have been no announcements if these Canadian shales had economic potential. The following will summarize each area of importance.

NORTHEAST BRITISH COLUMBIA

Horn River Basin - Devonian Muskwa Shale (Ross and Bustin, 2008)

February 2008 – EOG announced that the Devonian Muskwa Shale in the northeast British Columbia Horn River Basin has substantial natural gas potential. Three horizontal wells tested at 5, 3.5 and 4.2 MMcf/d. This play is still in the early stages of delineation but based on the technical data gathered on their 14,000 acre position they may have the potential net reserves of approximately 6 Tcf. First production is expected to start in June 2008 with significant volumes coming on in 2010 and beyond.

<http://www.eog.press.release.2008-02-28>

The press has made positive comparisons to the Barnett Shale but this semi-remote northeast British Columbia location will reduce the project's rate of return.

<http://www.reuters.com/EOG.2008-03-20>

[http://www.vancouversun/Horn River Basin - 2008-03-06](http://www.vancouversun/Horn.River.Basin.-.2008-03-06)

[http://www.calgaryherald/eog- 2008-02-29](http://www.calgaryherald/eog-.2008-02-29)

Nexen has also made announcements of a land position in this important play.

[http://www.nexeninc.com/Canada/UnconventionalGas March 2008](http://www.nexeninc.com/Canada/UnconventionalGas.March.2008)

Apache, Encana and Devon also have been mentioned as land holders in this play.

Triassic Montney

Arc Energy Trust has had more success in the Montney with the best horizontals at 10 MMcf/d.

<http://www.arcenergytrust.com/operations>

<http://www.arcresources.com/DawsonAcquisition.pdf>

The British Columbia government has reported that total production went from 18 wells in June 2002 and 350 MMcf/month to 140 wells and 2,730 MMcf/month by May 2007. The Arc Dawson and Encana Swan fields are the biggest producers.

British Columbia Government Shale Information

The Government of British Columbia, Ministry of Mines, Minerals and Petroleum website is a good source for industry updates, activity maps and reports on the Devonian, Triassic and Cretaceous shales.

<http://www.BC Gov/oilandgas/shale.htm>

ALBERTA

Stealth Ventures announced their shale-gas project in the Wildmere region of eastern Alberta as commercial within the Colorado Group of shales. The Alberta Energy Resource Conservation Board (ERCB) recognizes their operations as shale gas exploitation. Thirty nine wells have been drilled into this play. A number of other players are targeting this formation.

<http://stealth shale gas>

SASKATCHEWAN

PanTerra Resource Corp. and other companies continue shale gas exploration in Saskatchewan. Thirty-six wells have been drilled to date.

<http://www.panterraresource.com/overview.html>

<http://PannTerra update March 5 2008>

QUEBEC – ST. LAWRENCE LOWLANDS

Forest Oil announced on April 1, 2008 a significant gas discovery in the Ordovician Utica Shale in Quebec. Two vertical wells were drilled and production rates of up to 1 MMcf/d were obtained. The play is still in its early stage but the players are encouraged because of shallowness, the rock properties, pipeline infrastructure and closeness to eastern markets. Junex and Questerre are partners.

<http://forest oil Utica Shale discovery>

<http://Junex>

<http://www.questerre.com>

NEW BRUNSWICK – MONCTON BASIN

Corridor Resources has reported that their most recent well encountered 1,160 m of a fractured Lower Mississippian Frederick Brook Shale with encouraging natural gas shows. This play is very much in its infancy with a horizontal well planned for latter 2008 targeting these shales.

<http://www.corridor/ 28 March 2008>

NOVA SCOTIA – KENNETCOOK BASIN

Triangle Petroleum announced that two wells drilled into the Upper Devonian/Lower Mississippian Horton Bluff formation have been fraced. One of the wells is beginning to recover small amounts of gas. The company is very encouraged and intends to drill 6 to 8 more wells including horizontals into this play. They have 516,000 gross acres in this block.

<http://www.trianglepetroleum.com/news 2 April 2008>
<http://www.trianglepetroleum.com/news 3 March 2008>

Canadian Society for Unconventional Gas

<http://www.csug.ca/faqs.html#Sa>

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- Ross, D.J.K., and R.M. Bustin, 2008, Characterizing the shale gas resource potential of Devonian–Mississippian strata in the Western Canada sedimentary basin: Application of an integrated formation evaluation: AAPG Bulletin, v.92, p. 87-125.

Figures

North East British Columbia Play

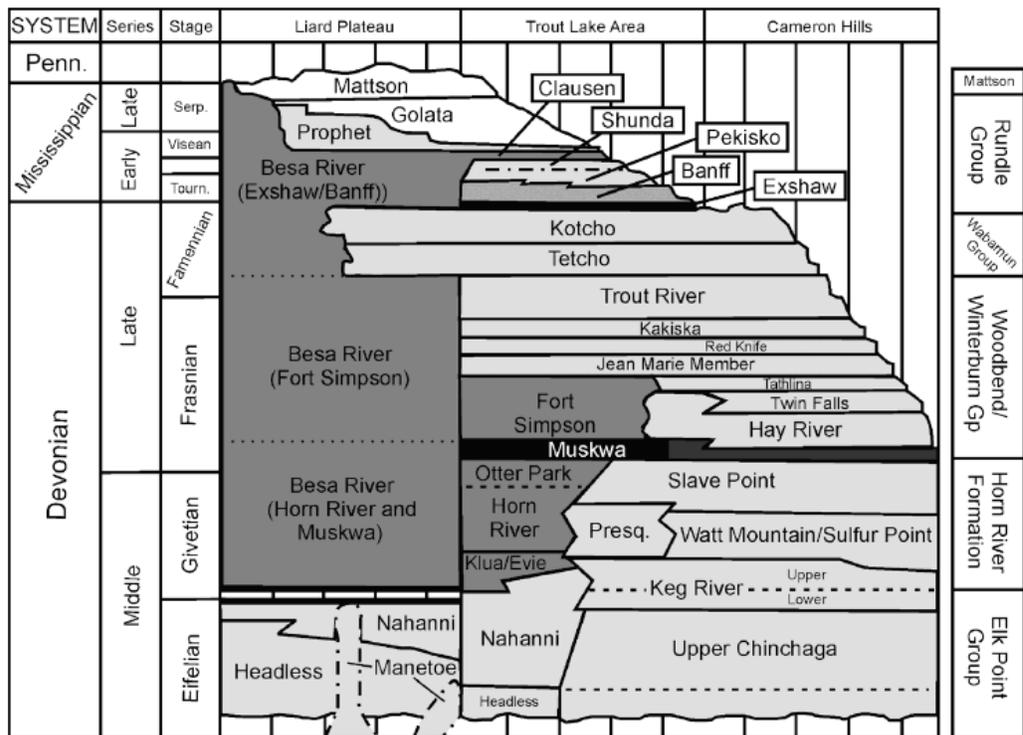


Figure 1. Stratigraphic section of Devonian–Mississippian in northern British Columbia, southeastern Yukon, and southwestern Northwest Territories (modified from Gal and Jones, 2003). Darker gray shadings represent shaly strata. Presq. = Presqu’île.

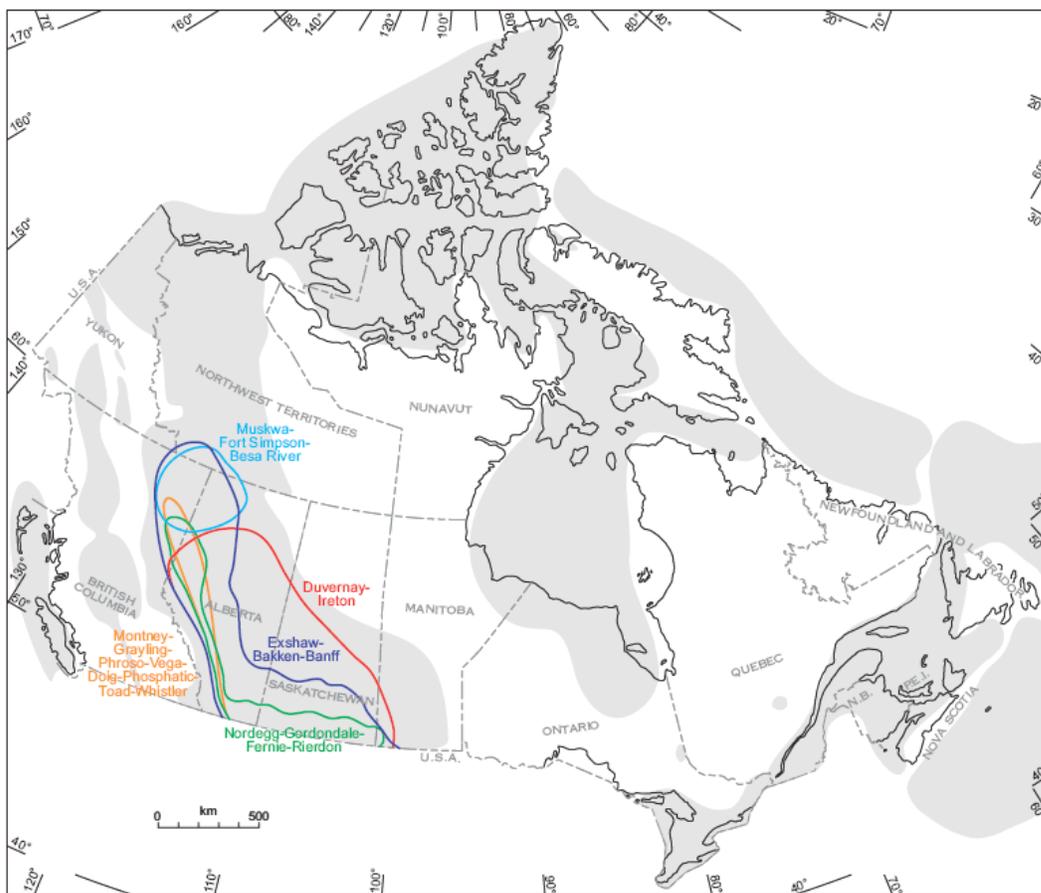


Figure 2: Western Canada (Paleozoic-Mesozoic passive margin platform) shale gas possibilities.

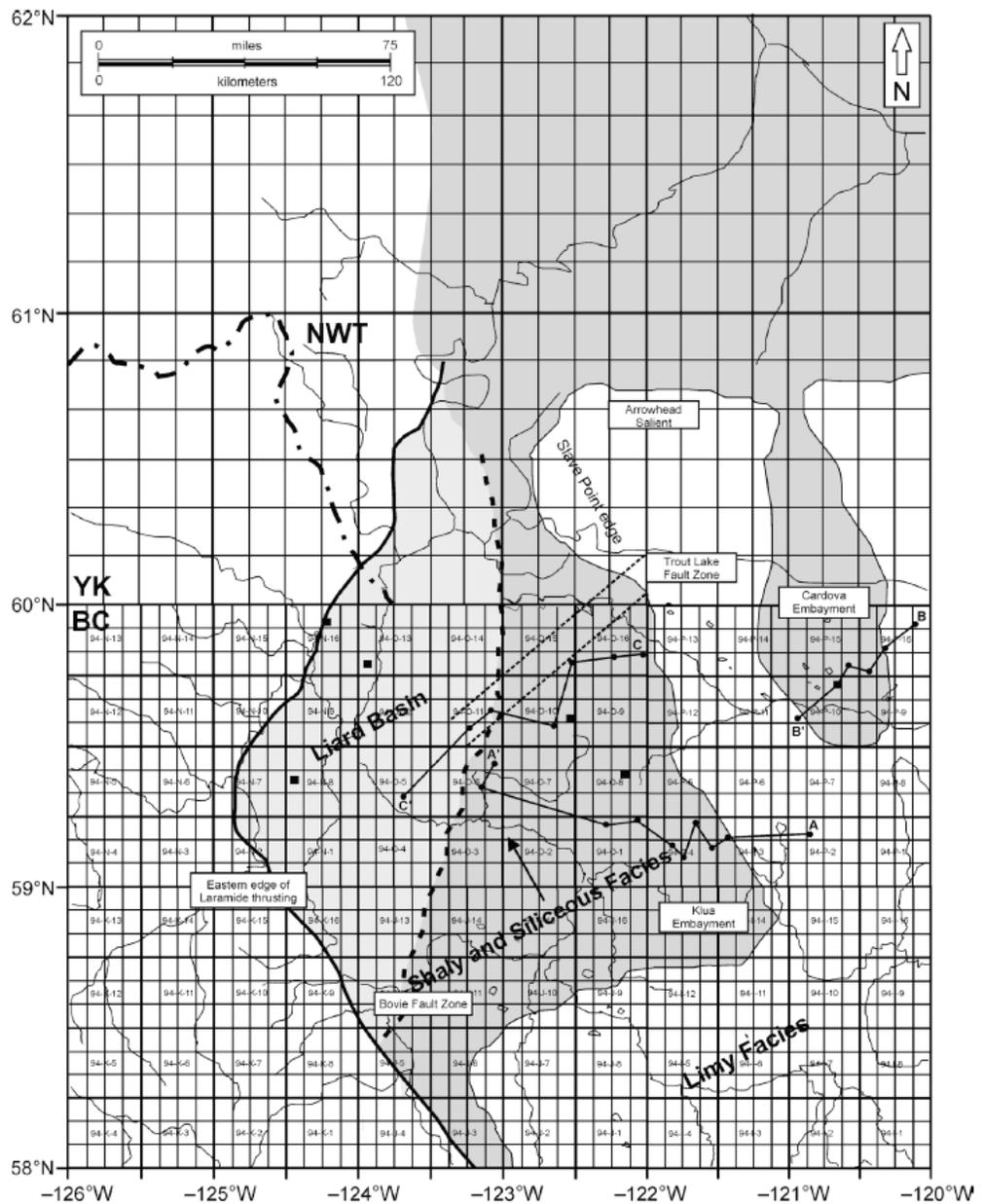


Figure 3. Major paleogeographic, depositional facies and structural features, which affected Devonian – Mississippian deposition, including the Cardova and Klua reefal embayments. Also shown is the Trout Lake fault zone (location from MacLean and Morrow, 2004); see section on structure for discussion. Cross section lines for Figures 5 and 8 are shown. Light-gray regions represent carbonate-dominated facies. Dark-gray regions represent basinal and argillaceous facies (Yukon and Northwest Territories use the grid-section-unit system of surveying, not NTS; hence, map grids are different to British Columbia). Black squares show well locations for Figures 4, 9, and 10.

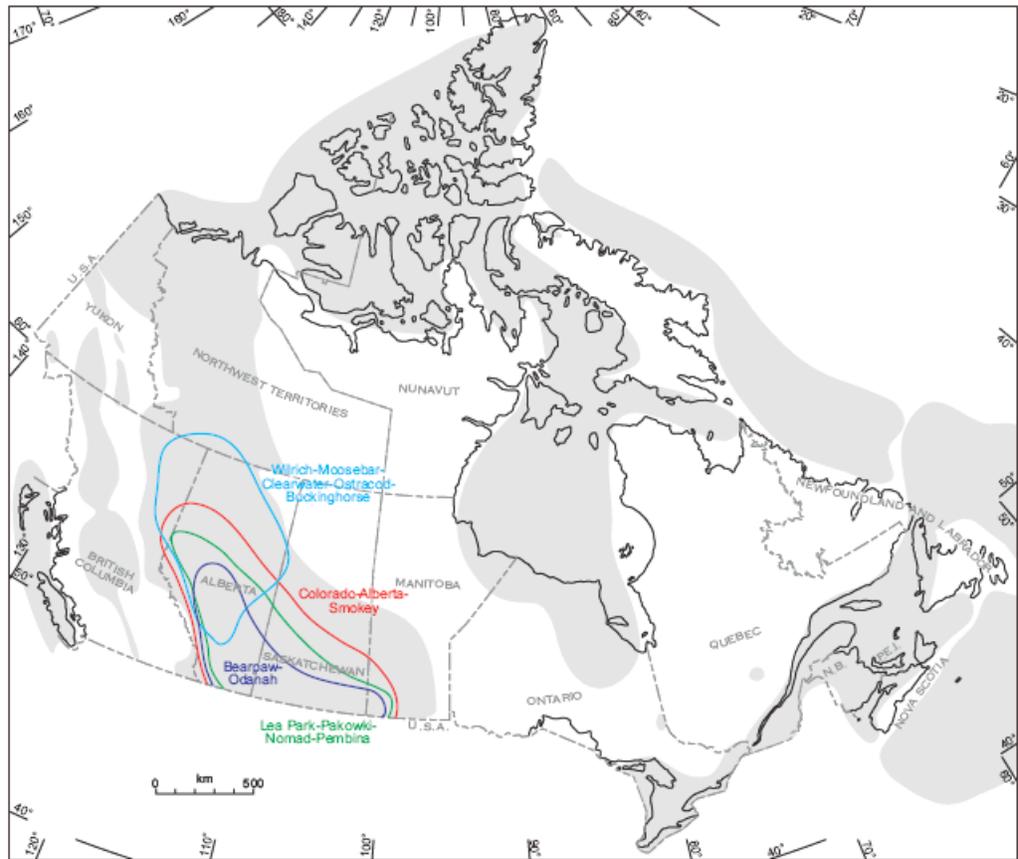
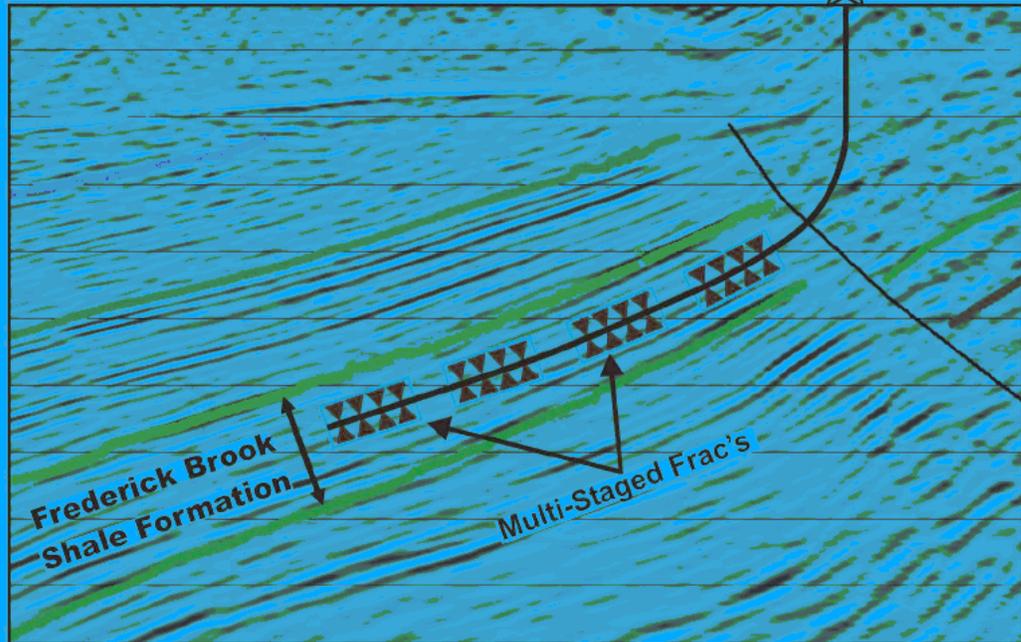


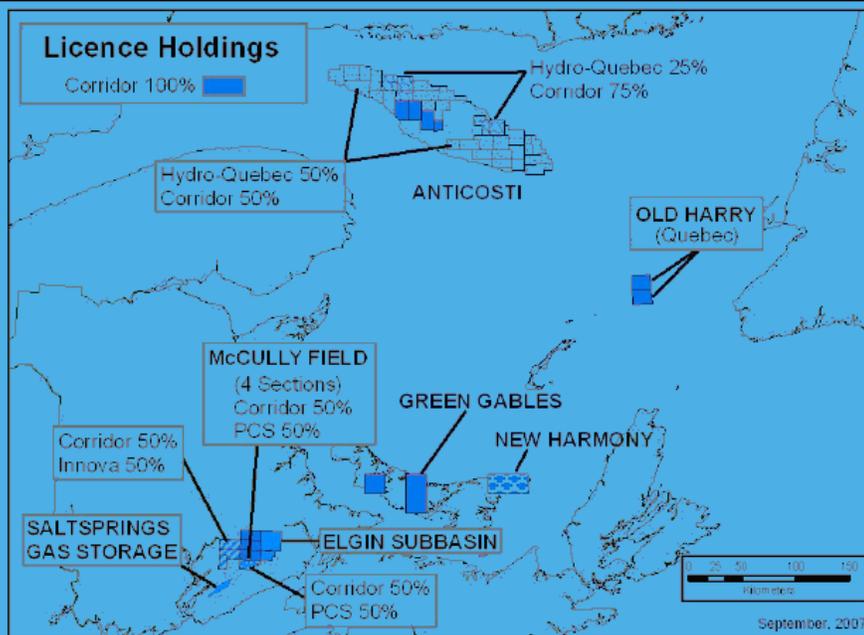
Figure 3: Western Canada (Mesozoic foreland basin) shale gas possibilities.

2008 Proposed Elgin Horizontal Shale Gas Well



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Property Portfolio



4



Figure 1: Atlantic Canada, Quebec, Ontario and Hudson Margin shale gas possibilities.

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** “Gas shales reservoir characterization and production properties” (<http://www.corelab.com/IRS/Studies/GasShaleFinal.asp>);
 - (b) **Colorado School of Mines FAST** (Fracturing, Acidizing, Stimulation Technology) Consortium Project 9: stimulation of “shale” reservoirs (<http://www.mines.edu/fast/>).
 - (c) **Humble Geochemical Services** (<http://www.humble-inc.com/>)
 Geochemical Data and Gas Shale Studies
 “Shale Gas: Source Rocks as Reservoirs” report
<http://www.humble-inc.com/shgas.html>
 “Rocky Mountain Shale Hydrocarbon Evaluation Project”
<http://www.humble-inc.com/Humble-LSSI%20Rocky%20Mountain%20Resource%20Study.pdf>
 “Extended Delaware and Permian Basin Shale Gas Studies”
<http://www.humble-inc.com/2005%20Shale%20Gas%20Study%20Culberson%20County%20and%20Permian%20Basin.pdf>
 - (d) **GeoMark Research**
 Appalachian Basin Shale Gas Study (2005)
http://www.geomarkresearch.com/studies_northamerica.cfm
 - (e) **Baseline Resolution**
 Black Warrior Basin Study
http://www.baselinedgsi.com/contents/black_warrior_basin.htm
- (3) **Government**
- (a) **RPSEA** (Research Partnership to Secure Energy for America)
<http://www.rpsea.org/>
List of Projects Selected for the Unconventional Resources Program
<http://www.rpsea.org/en/art/?68>
RPSEA Upcoming Forums <http://www.rpsea.org/en/cms/?1462>
 - (b) **USGS**. The U.S. Geological Survey is updating the National Assessment of Oil and Gas Resources, including shale gas in the Arkoma Basin, Oklahoma. <http://energy.cr.usgs.gov/oilgas/noga/>
<http://certmapper.cr.usgs.gov/data/noga95/natl/text/summary.pdf>
 Michigan Basin assessment <http://pubs.usgs.gov/fs/2005/3070/2005-3070.pdf>
 Bend Arch/Fort Worth Basin assessment
<http://pubs.usgs.gov/fs/2004/3022/fs-2004-3022.pdf>
 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.

3. What EMD technical session, publications, workshops, etc. exist or are planned that are relevant to this commodity?

2008 AAPG Annual Convention: gas shale sessions: (1) Overview of shale gas resources (EMD/AAPG); (2) Genesis of unconventional gases: coalbed methane, shale gas and gas hydrates (EMD/SEPM); (3) Geology of shale/mudrock reservoir systems (EMD/SEPM); (4) Improvements in shale gas drilling and completion (EMD/AAPG).

<http://emd.aapg.org/annualmeeting.cfm>

4. Sources of Information

(a) References (see gas shale bibliography on Gas Shale Committee web site (http://emd.aapg.org/members_only/gas_shales/index.cfm))

(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) Unconventional Natural Gas Report by Ann Priestman (720-261-4126)
- (2) IHS Energy (<http://energy.ihs.com/>)
- (3) Warlick International Report (<http://www.warlick.net/>)
(<http://www.warlick.net/id21.html>)

5. Calendar

May 6-7, 2008: 2008 Texas Gas Shales, Dallas, TX. Insight Information.
www.insightinfo.com

May 12-15, 2008: Unconventional II: Shale Gas. Canadian Society of Petroleum Geologists Convention, Calgary, AB, Canada.

<http://www.cspg.org/conventions/conventions-annual.cfm>

<http://www.geoconvention.org/sessions/unconventional-2.cfm>

May 5, 2008: Shale Gas Critical Fundamentals, Techniques and Tools for Exploration Analysis Short Course, Canadian Society of Petroleum Geologists <http://www.geoconvention.org/courses/scpre02.cfm>

May 29, 2008: Shale Plays and Completion Techniques, Columbus, OH. Ohio Geological Society. Contact 304-293-2867 x5443

June 23-24, 2008: Shale Gas Technical Master Class, The Carriage House Inn, Calgary, AB, Canada. Canadian Institute
<http://www.canadianinstitute.com/Home.htm>

July 9-11, 2008: Petrophysics of Shales and Tight Gas Sands: Converting Resource to Reserves; and Shale Gas—From Geochemistry to Completions, Denver, CO. AAPG Rocky Mountain Section. http://www.rms-aapg.org/2008_meeting/program.asp

October 3-4, 2008: U.S. Gulf Region Mudstones as Unconventional Shale Gas/Oil Reservoirs, Fractured and Non-Fractured, Houston, TX. Houston Geological Society.

October 11-15, 2008: Appalachia—Unconventional Since 1859, Pittsburgh, PA. AAPG Eastern Section. <http://www.aapgspe2008.org/>

October 21-23, 2008: Oklahoma Gas Shales Conference and Field Trip, Oklahoma City, OK. Oklahoma Geological Survey.
<http://www.ogs.ou.edu/calendar.php>

November 12-14, 2008: 10th Annual Unconventional Gas Conference, Calgary, AB, Canada. Canadian Society for Unconventional Gas.
<http://www.csug.ca/>

- 6. Committee Members** (in alphabetical order)
Bill Ambrose, Lee Avary, Kent Bowker, Charles Boyer, Dwight Brown, Marc Bustin, Brian Cardott, John Curtis, Bradley Dean, Wally Dow, Lisa Hunt, Dan Jarvie, Chris Johnson, Doug Kenaley, Jean Kulla, Charlie Landis, Jeff Levine, Peter Lufholm, Jock McCracken, Bob Milici, Mike Party, Doug Patchen, Jeremy Platt, Rick Richardson, Steve Ruhl, Steven Schamel, Loren Schmidt, John Sherborne, Dave Tabet, Bob Timmer, Frank Walles, Peter Warwick, Mark Whitney, Charles Wickstrom