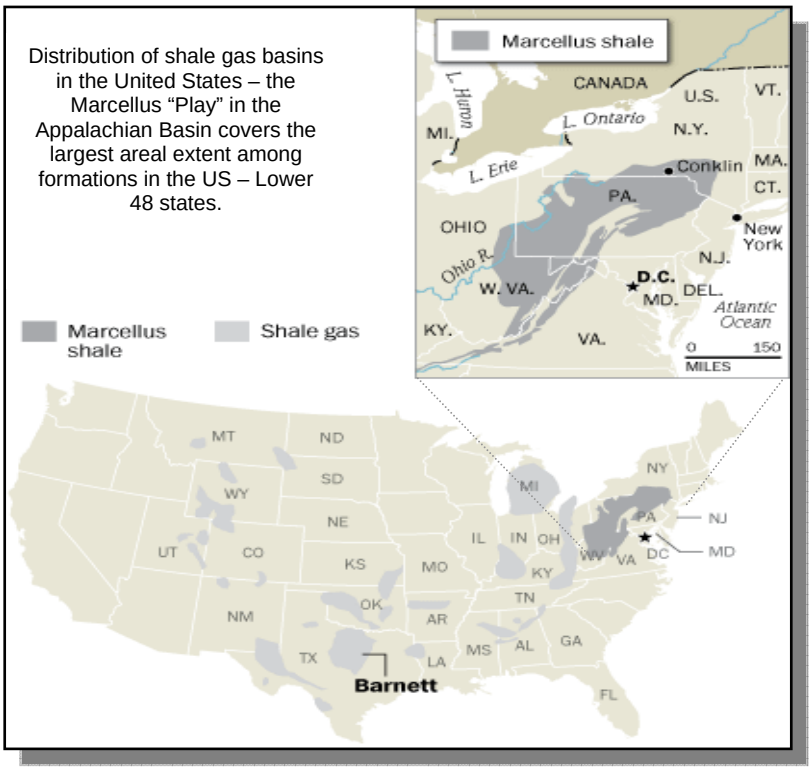
THE MARCELLUS SHALE: BALANCING ENERGY AND ENVIRONMENTAL RESOURCE INTERESTS

14 December 2009
Volume 1; No. 1



Experience, Expertise and Excellence for all your Water, Soil and Natural Resource needs.

FIGURE 1.

Map of Shale Gas plays in the United States Lower 48 with emphasis on the Marcellus Shale. The Marcellus Formation underlies approximately 95,000 square miles in the Appalachian Basin.

Contact Princeton Hydro, L.L.C.
www.princetonhydro.com

Ringoes, New Jersey
(T) 908.237.5660

Exton, Pennsylvania
(T) 610.524.4220

Sicklerville, New Jersey
(T) 856.629.8889

Glastonbury, Connecticut
(T) 860.652.8911

The Marcellus Shale: Balancing Energy and Environmental Resource Interests

The Marcellus Formation is a vast Devonian-period, black shale deposit that may contain enough natural gas to fulfill all United States demand for up to 25 years. Some believe that unconventional reserves, including shale deposits, represent the potential for domestic natural gas to become a "bridge fuel" – that is, allowing the US to reduce our dependency on foreign energy as well as offer a cleaner combustion fuel source when compared to oil or coal. While holding tremendous economic prospects, the production of gas from shale involves environmental risks.

Shale Gas Could Shift US Energy Structure

No matter from which angle it is viewed, natural gas production from the Marcellus Shale Formation can be expected to have an effect unlike anything on the landscape today.

Natural gas is seen as a panacea for a suite of ills and ailments ranging from global warming to national security to economic recession. The underlying rationale goes something like this: ***gas is an abundant, domestic fuel source that is cleaner-burning than coal or oil***. By shifting US fossil fuels of choice from coal and oil to greater reliance on natural gas in order to generate electricity, produce heat, and fuel transportation, the US will help avert climate disaster, reduce our energy dependence on unstable regions and nefarious international states, and re-kindle American jobs.

Based on Energy Information Administration (USDOE 2009) statistics, US energy consumption in 2008 was dominated by oil (37.7% of total), natural gas (24.5%), coal (22.4%), and nuclear (8.2%) sources. Moreover, since the late 1950s, US energy consumption has out-stripped production by growing margins.

In recent years, technical advances in production methods from unconventional sources have led to an explosion in projections of the United States' natural gas-in-place reserve estimates. Currently almost half of the estimated (NCI 2008) recoverable natural gas reserve in the United States – Lower 48 (US-L48) is associated with unconventional sources including tight gas sand deposits, coal bed methane (CBM), and shale. Shale accounts for nearly 30% of the overall estimate of US-L48 recoverable gas-in-place reserves. Between 1998 and 2008, US natural gas consumption (USDOE 2009) was fairly constant at about 20 trillion cubic feet (TCF) per year. The USDOE concluded that the recoverable natural gas reserve capacity from all US-L48 sources could supply US gas needs for at least 90 years (NCI 2008).

The Marcellus Shale "Play" is Enormous

The Appalachian Basin contains the largest extent of Devonian-period (i.e., 395 to 345 million years ago) shale in the US-L48 and the Marcellus Formation is the dominant gas-containing shale in the basin. The Marcellus Play's proportional upper-end gas-in-place reserve was estimated at more than 85% of the Appalachian Basin total (NCI 2008).

The Marcellus Formation is huge and underlies approximately 95,000 square miles principally situated in Pennsylvania, New York, West Virginia, and Ohio – refer to Figure 1.

Current estimates of recoverable natural gas reserves from the Marcellus Play indicate a 50% probability that up to 500 TCF of gas will be produced during its operational lifespan (Engelder 2009). At an annual consumption rate of 20 TCF, the 50% probability estimate of recoverable reserve potential for the Marcellus Play would fulfill the entire US natural gas demand for 25 years.

Marcellus Play Gas Production is an Infant Industry

For the past two years the Marcellus Play has been "red hot", but as recently as 2002, the United States Geological Survey (USGS) released an estimate of undiscovered natural gas reserves within the Marcellus Formation that amounted to a modest 1.9 TCF. Despite the lack-luster forecast by USGS, its proximity to the large energy markets of the Northeast and existing

network of gas transmission pipelines made the Marcellus Play a tantalizing mark for energy developers.

Credit for opening the Marcellus Play is generally granted to Range Resources – Appalachia, LLC (Range) which drilled a series of exploration wells in southwestern Pennsylvania's Washington County beginning in 2003 and experimented with well stimulation techniques used in the established Barnett Shale Play of Texas. Range began to produce gas in 2005 (Harper 2008). Favorable gas production reports began to emerge rapidly for the Marcellus Play and from 2005 through 2009; the Pennsylvania Department of Environmental Protection (PADEP) issued more than 2,100 Marcellus Shale well permits. More tellingly though, gas lease holdings increased dramatically; according to Oil and Natural Gas News (Oil and Shale Gas Discovery News 2009) at least 18 different energy companies had amassed 10,000 leased Marcellus acres or more as of early 2009 and at least six of those held half a million acres or more of Marcellus leases.

Pennsylvania is the epicenter of Marcellus gas drilling activity. To date, approximately 750 Marcellus gas wells have been completed in Pennsylvania; 195 such wells were finished in 2008 and 499 wells were added through November 2009 (PADEP 2009). Marcellus drilling activity is concentrated in two Pennsylvania regions; the southwest counties of Fayette, Greene, and Washington and the northeast counties of Susquehanna, Bradford, and Tioga.

Estimates for the average density of wells ultimately predicted for the

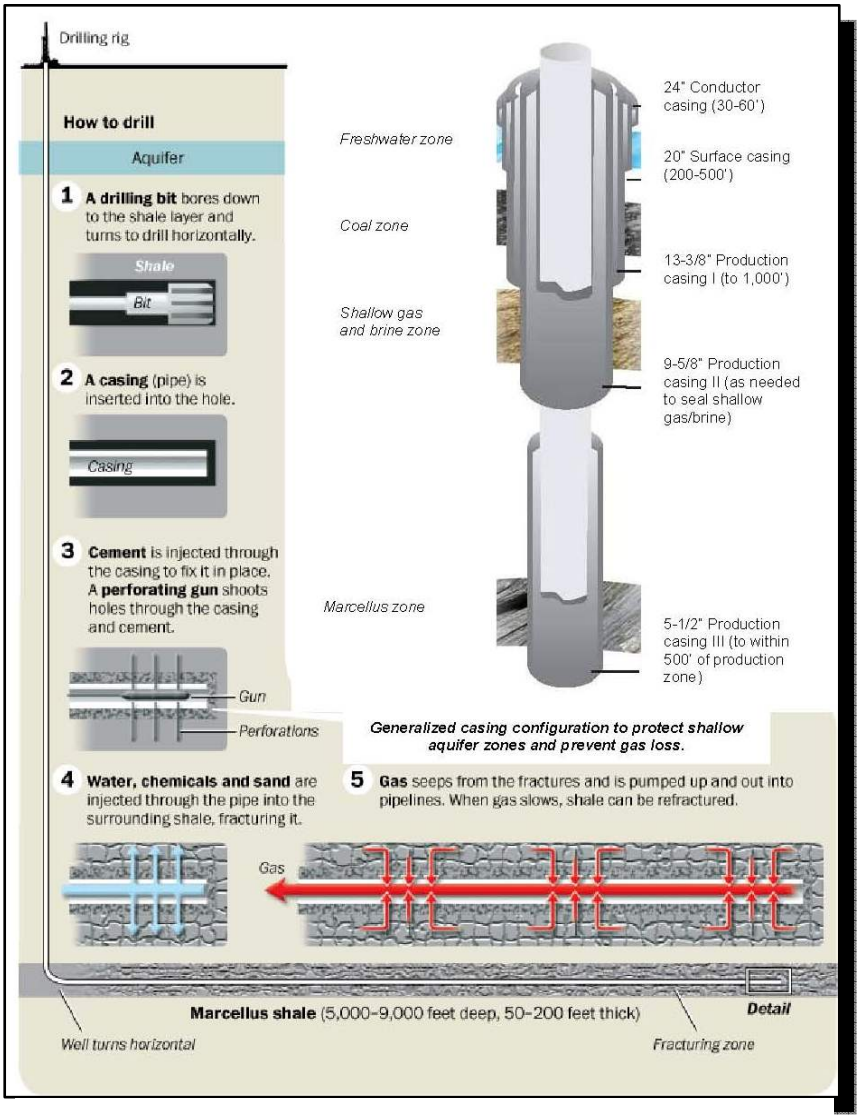


FIGURE 2. Conceptual layout of typical horizontal gas well in Pennsylvania portion of Marcellus Shale depicting well casing configuration and hydraulic fracturing process. Casing graphic credit: http://www.pamarcellus.com/process.php

Marcellus Formation range from one well per 160 acres (i.e., four wells per square mile or 2,600 feet on-center spacing) to as close as one well per 40 acres (i.e., 16 wells per square mile or 500 feet on-center spacing) (Arthur et al 2008). If even 25% of its areal extent ultimately is developed as a gas field, tens to hundreds of thousands of new wells will be needed to facilitate production from the Marcellus Formation.

Water Resource-Related Concerns

Among the major concerns for Marcellus gas drilling activities is the mixing of drilling fluids or natural briny waters that are brought up from deep below ground with shallow drinking water supplies and fresh surface water. Most energy-sector industry groups and several states associated with shale gas development have reported low rates of proven adverse impacts to potable wells that have been attributed to gas drilling activities; little information is available regarding impacts to surface water. The majority of confirmed adverse incidents involved temporary increases in well turbidity that tended to subside in time.

Although official reports of water quality impacts suggest rare occurrence, an inherent risk associated with Marcellus Shale gas drilling activity stems from extending well bores through potable aquifers and ecologically-sensitive groundwater flow-paths in order to exchange fluids/gases with the production zone. Figure 2 illustrates how multiple cemented casings are designed into the approach by which deep gas wells are installed in order to prevent mixing of shallow and deep zones, to isolate production areas, and to maintain pressure control. Cross-contamination by hydraulic fracturing ("hydro-frac") fluids used to expand cracks in rock to more easily extract gas and the natural briny water that occurs deep underground requires failure of more than one component of a well's casing system.

The management of fluids at the wellhead may present a greater risk to water resources than the well itself. Large quantities of hydraulic fracturing fluid are returned to the wellhead in addition to large quantities of salty water that are generated during drilling, installation, and gas production phases of a well's lifespan.

REFERENCES

Arthur, J.D., B. Bohm, and M. Layne. 2008. Hydraulic fracturing considerations for natural gas wells of the Marcellus Shale. Presentation at the The Ground Water Protection Council, Annual Forum in Cincinnati, Ohio 9/2008

Engelder, T. 2009. Marcellus 2008: Report card on the breakout year for gas production in the Appalachian Basin, In: Fort Worth Basin Oil and Gas magazine, August 2009 edition, Abilene, TX; pp. 18-22.

Harper, J.A. 2008. The Marcellus Shale – an old "new' gas reservoir in Pennsylvania. In Pennsylvania Bulletin, volume 38, number 1; a quarterly publication of the Bureau of Topographic and Geologic Survey, Pennsylvania Department of Conservation and Natural Resources, Middletown, PA; pp. 2-13

Navigant Consulting Inc (NCI). 2008. North American Natural Gas Supply Assessment; presentation prepared for the American Clean Skies Foundation; Navigant Consulting Inc Chicago, IL; 90 pp..

Oil and Shale Gas News. 2009 website with information and statistics about natural gas production http://www.oilshalegas.com/marcellusshale.html website accessed 12/2009.

Pennsylvania Department of Environmental Protection (PADEP). 2009. 2209 Permit and Rig Activity Reports, http://www.dep.state.pa.us/dep/deputate/minres/oilgas/PermitDrilledmaps.htm website accessed 12/2009.

United States Department of Energy (USDOE). 2009. Energy Information Administration; official energy statistics from the US government. http://www.eia.doe.gov/ website accessed 12/2009.

UPCOMING EMERGING ISSUES ABOUT THIS TOPIC:

Regulatory Framework for Gas Drilling
and
Methods to Safeguard Environmental Resources

Author Biography

James P. Shallenberger is a Pennsylvania-licensed Professional Geologist, has a B.S. in Geosciences (Pennsylvania State University, 1993) and an M.S. in Environmental and Forest Biology (State University of New York – College of Environmental Science and Forestry, 2001), and is a senior project manager at Princeton Hydro, LLC with nearly 15 years experience as a consulting geologist and ecologist with emphasis on water resource applications and ecological risk assessment.