

Why does Marcellus Shale Hold so much Natural Gas?

This column is presented weekly by the Public Education sub-committee of the Clinton County Natural Gas Task Force in an effort to provide accurate, up-to-date information on activities surrounding the Marcellus Shale formation and the natural gas exploration industry.

Marcellus Shale is currently estimated to contain 493 trillion cubic feet of natural gas. The United States consumes around 23 trillion cubic feet of gas annually, meaning the Marcellus Shale contains enough extractable natural gas for roughly a 20 year supply for the entire county. While a 20 year supply of natural gas may not sound like a lot, the fact is the Marcellus is currently the second largest unconventional shale reserve in the entire world. The Marcellus Shale ranks second only behind a shale formation in Iran.

As a super giant unconventional natural gas field, new Marcellus Shale wells usually produce millions of cubic feet of natural gas (mmcf) each day, while a new traditional shallow gas well might only produce thousands of cubic feet (mcf) of natural gas per day. The huge disparity in production is determined by a variety of factors including depth, thickness, how the formation developed as an ancient sea, and more.

In traditional Pennsylvania natural gas extraction a driller would look for a geologic formation called an anticline somewhere between 1,800 and 4,000 feet below the surface of the earth. An anticline formation might look something like the top of a hill or the crest of a wave, but made out of rock. In shallow gas development, generally the driller wants to drill through the top of the anticline formation to find natural gas or oil. The top of the anticline would be some sort of cap rock or barrier formation that traps gas and oil in the up-fold.

While shallow gas development generally looks for the presence of anticlines, the Marcellus Shale is what is called a continuous resource. As a continuous resource, the Marcellus can consistently be found at a specific depth and thickness in a geographic area. Compared to the peaks (anticlines) and valleys (synclines) that trap gas in certain locations and lead to a hit and miss strategy for natural gas development, the Marcellus is more like a rock table top that brings continuity to natural gas development through a layer of shale that can always be found. Essentially, once the precise depth and thickness of the Marcellus are known, a driller simply needs to drill into the formation to find commercial quantities of natural gas.

As a continuous formation, there is not pool or cavern of natural gas waiting to be sucked out of the ground. Marcellus natural gas is trapped in a continuous rock layer. Synclines and anticlines are still important in Marcellus development, but as a continuous formation we might expect a Marcellus well to “hit” or come in with commercial quantities of gas 95-99% of the time, while in traditional shallow gas development we might look at finding a well that produces commercial natural gas only 40-70% of the time.

Although we have already mentioned depth and thickness of the shale, it is important to note they also play a role in the amount of natural gas found in the Marcellus. Generally, the deeper the formation the more natural gas you would expect to find. We know from the more than 2,000 Marcellus wells already

completed in Pennsylvania that the depth of the Marcellus usually ranges from 5,000-9,000 feet below the surface of the earth. We also know the Marcellus actually outcrops or comes to the surface of the earth in some areas of Pennsylvania. The areas where we find Marcellus near the surface or actually coming completely to the surface will contain very little, if any, natural gas. The areas where the Shale is deepest are generally found along the southeast edge of the Marcellus formation, so Clinton, Lycoming and Susquehanna Counties are areas where the Shale may contain more natural gas.

Another key factor is the thickness of the Shale. The Shale ranges from about nine feet thick on the fringe of the Marcellus to over 300 feet thick in the northern tier of Pennsylvania and southern tier of New York. In Clinton County, we find the shale is about 75-150 feet thick. If we look at Marcellus production data across both West Virginia and Pennsylvania we see a general pattern emerge where the higher producing wells are found in the thicker parts of the shale. In fact, four of the five wells with the highest daily production average are in Susquehanna County where the shale is thought to be the thickest. In fact, one Susquehanna County well has produced an average of more than 10 million cubic feet (mmcf) of natural gas per day for 270 days.

As the second largest unconventional shale play in the world, the Marcellus Shale is truly a unique resource. The Marcellus is different in several ways from our previous Pennsylvania experience drilling for natural gas, perhaps most notably in the quantities of natural gas available in the Marcellus Shale. The Marcellus is a continuous resource spread under the surface of 95,000 square miles in the Appalachian Basin. Marcellus Shale tends to produce the most where the Shale is the deepest and thickest and is not dependent on the hit and miss strategies associated with shallow gas development.

For more information on Shale geology and other factors that influence the amount of natural gas in the Marcellus and other shale formations point your web browser to naturalgas.psu.edu and click on webinars.

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