

DRBC's Regulatory Implications of Natural Gas Exploration/Production in the Marcellus Shale Formation in the Delaware River Basin

William J. Muszynski P.E.

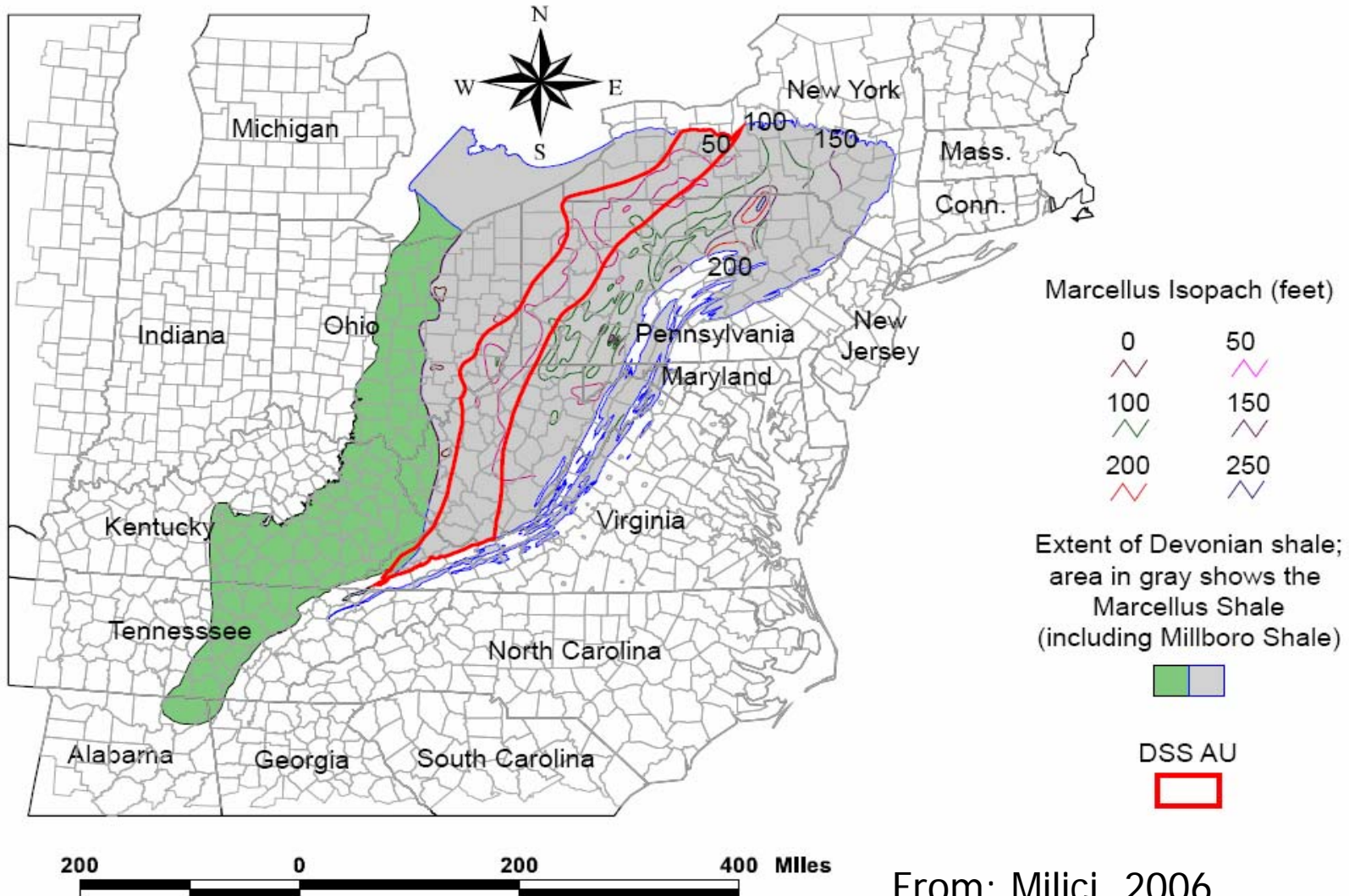
Gregory J. Cavallo P.G.

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Marcellus Shale---A Potential Natural Gas Play

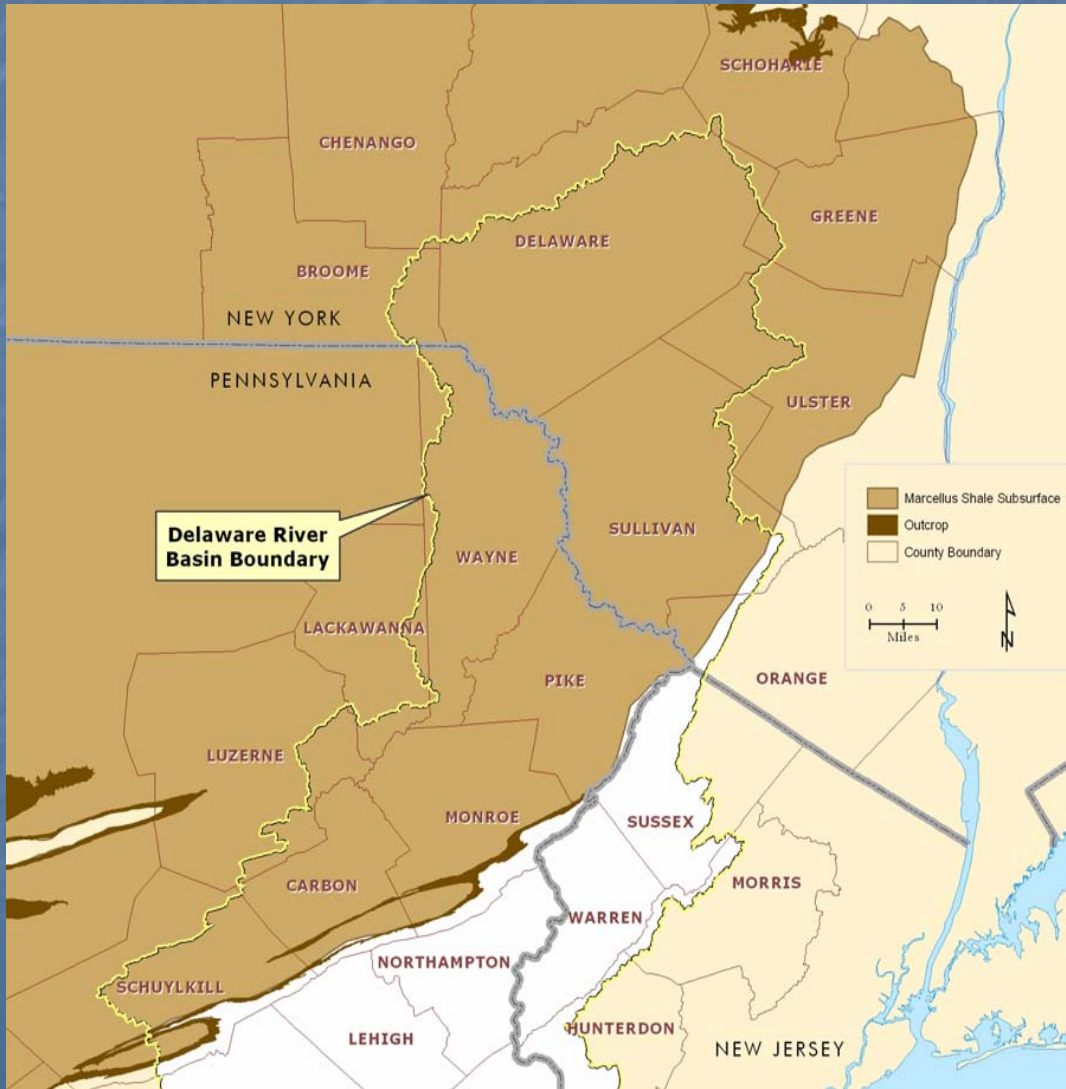
- The Marcellus Shale contains natural gas deposits.
 - Investigators including the U.S. Department of Energy and the U.S. Geological Survey have described occurrences of natural gas in the Marcellus Shale
- Advances in horizontal drilling techniques, hydraulic fracturing and higher natural gas prices have made natural gas from some shale formations economically viable.
- Successful exploration and production of natural gas in the Barnett Shale in the Fort Worth area of Texas has spurred gas exploration in similar types of terrain.

Extent and Thickness of Marcellus Shale Formation



From: Milici, 2006

Extent of Marcellus Shale Formation within the Delaware River Basin



36% (4,937 mi²) of the Delaware Basin is underlain by the Marcellus Shale

Marcellus Shale

- Devonian Black Shale ~400 my
- Deep water deposition—reduces bioturbation
 - Which preserves silt laminae and increases lateral permeability.
- Elevated organic content—provides the source material for future gas deposits
- Anoxic conditions--preserves organic material
- Greater burial thickness--increases formation temperature
 - Which enhances hydrocarbon maturity by converting organic material to natural gas

Potential Natural Gas Exploration Areas in the Marcellus Shale in the Delaware River Basin

- Formation thickness, organic content and burial depth increases toward the Delaware River Basin
- These are advantageous geologic conditions for the development of natural gas deposits due to:
 - Elevated organic content
 - Preservation of organic material
 - Conversion of organic material to natural gas
- These conditions are found primarily in the Marcellus Shale formation underlying Wayne Co. Pa. and in Delaware Co. NY.

Marcellus Shale Gas Well Drilling Techniques

Drilling in the Marcellus Shale

In Northeastern Pennsylvania, the shale is 7,000 feet deep. Horizontal drilling reaches the layer of interest and then follows the layer of interest a couple thousand feet. It can give a greater return than vertical drilling.

Mud pond

Plastic-lined excavation used to contain debris from drilling.

Access road

Has to be cut through land so equipment and workers can get to drilling site.

Drilling rig

Set up and drilling take several weeks. Rig is removed and replaced with equipment to control gas extraction. Well can produce for decades.

Site prep
Area has to be cleared and prepped for drilling operations.

Gas pipelines

Needed to move gas off site once well is producing.

Concrete

Water table

Water table

The steel drill shaft is encased in concrete to prevent possible contamination of groundwater.

Steel casing

Shale

2,500 - 3,500 feet horizontally

6,500 - 7,500 feet deep (not to scale)

Extraction — The drill shaft is perforated with explosives. A slurry of water and sand is then pumped down into the shale. The pressurized mix fractures the shale, and forces the gas out and up the shaft.

Secondary Enhancement Techniques

“Fracing” or “Hydraulic Fracturing”

- Increases permeability of producing formation
 - Which increases recovery rates and extends production life
- Horizontal wells generally increase productivity to at least 2-3 times that of vertical wells.
- For wells which would have otherwise been considered marginal or uneconomic, horizontal drilling often enables successful reservoir development.

Hydraulic Fracturing

- Force a fracturing fluid, either oil or water based, and is likely to contain additives into a sealed off portion of the borehole under high pressure
- The applied pressure causes the formation to fracture, allowing the fracturing fluid to enter further into the formation and extending the cracks
- Solid propping agent (typically sand) is added to the fracture fluid to keep fractures open after the injection stops

DRBC Regulatory Requirements/Concerns

- Section 3.8 of the DRBC Compact
 - “No project having a substantial effect on the water resources Unless it shall have been first submitted to and approved by the Commission...”
- Section 2.3.5 B Rules of Practice and Procedure (RPP)
 - All projects not excluded by Section 2.3.5 A that may have a substantial effect on the water resources of the Basin shall be submitted to the Commission

Natural Gas Development Project in the Marcellus Shale Formation

- May have a substantial impact on the water resources of the Basin due to:
 - Water withdrawals
 - Chemical addition to drilling “mud” and “frac” water
 - Storage, reuse and disposal activities
 - Interbasin transfer of water or waste

DRBC Actions to Date

- Coordination with states of PA/NY
 - Familiarization with state oil and gas permitting requirements
 - Coordinating reviews/meetings
 - Streamline permitting requirements
- Sent letter to Stone Energy (6/6/08)
 - Required to file an application
 - Project sponsor may not:
 - Commence any withdrawal
 - Drill any well
 - Construct any impoundments
 - Discharge to ground/surface water

DRBC Actions to Date (cont)

- Recommending pre-application meeting
- Attended PA Summit
- Met with drill company representatives
- Advice to applicants:
 - Requirements for applications
 - Commission procedures
 - Timing of review and docket decision
 - Potential docket conditions
 - Coordination with state permitting agencies

Next Steps

- Expect applications to be filed, especially for exploratory wells.
- Evaluate multiple well docket
- Increased docketing activity