EIA Marcellus Shale Play Map*

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Abstract

The U.S. Energy Information Administration is updating maps of major tight oil and shale gas plays of the lower 48 states including the Marcellus Shale of the Appalachian Basin. The revised Marcellus play map summarizes geologic play elements, the growth of production, and distribution of sweet spots within the play based on publicly available data and a commercial well information database. The Middle Devonian Marcellus Shale was deposited during the early stages of mountain building events in a foreland basin. The Marcellus Shale disconformably overlies the Onondaga Limestone and is composed of a basal black shale, a widespread limestone unit, and an upper black shale. Key geologic drivers defining the most prospective areas within the Marcellus Shale footprint are comparable to other shale-gas plays and consist of an optimal combination of structural, geochemical, petrophysical, and thermodynamic characteristics. From 2004 through July 2014 more than 7000 wells targeting the Marcellus Shale were drilled in the Appalachian Basin (Drilling Info, Inc). Reported natural gas production from the Marcellus play is more than 15 billion cubic feet per day (Bcf/d), accounting for almost 40% of U.S. shale gas production as of July 2014 (EIA, 2014). For the Marcellus play, the geologic elements presented include contoured elevation of the top and base of formation, isopach, major structures and tectonic features, play boundaries, well locations, and gas-to-oil ratios of producing wells. Additional map layers will be added as additional geologic data becomes available.

References Cited


Websites Cited


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May 31-June 3, 2015, Denver, Colorado
• Overview

• Dataset

• Marcellus maps for model development

• Next steps
Shale gas and tight oil plays in the lower 48 states

Source: U.S. Energy Information Administration, based on data from various published studies
Shale gas and tight oil plays in the lower 48 states by geologic age

Source: U.S. Energy Information Administration, based on data from various published studies
http://www.eia.gov/todayinenergy/detail.cfm?id=20852 | Updated April 13, 2015
Datasets for the Marcellus shale

• DI (DrillingInfo) well data

• State well data (PA, OH, NY, and WV)

• Published articles and information provided by State agencies on stratigraphy, lithology, tectonics, and petrophysical properties

We integrated EIA research with DI and State well data and prepared a combined dataset for Marcellus
Datasets and Applications

- Well data
- Stratigraphy
- Structural features
- USGS topography
- Formation boundary

- SAS
- jmp
- Excel
- ArcGIS
- Surfer
- QGIS

Marcellus shale model
Geologic cross section through the Appalachian Basin, NY
Devonian interval

Source: Taury Smith and Jim Leone, New York State Geological Survey
Geologic cross section through the Appalachian Basin, PA
Devonian interval

Geologic cross section through the Appalachian Basin, WV

Devonian interval

Marcellus formation (wells with stratigraphic picks)


Note: EIA used stratigraphic picks from 2,416 wells for the top and bottom of the Marcellus provided directly by state geological survey agencies. These wells may not be producing from the Marcellus formation; however, these are the wells the state agencies used for their stratigraphic picks.
Interpolation and contouring: Surfer, QGIS, & ArcGIS

2 by 2 km grid produced by QGIS algorithm, to acquire ArcGis kriging raster outcome
Structure map of the Marcellus formation (subsea depth)


Note: Map includes production wells (7,894) from January 2003 through December 2014.
Thickness map of the Marcellus formation

Note: Map includes production wells (7,894) from January 2003 through December 2014.
Marcellus shale 3D surface produced by Surfer based on the structure contour map of the formation top.


Note: Map includes production wells from January 2003 through December 2014.
Marcellus formation
Monthly Natural Gas Production

billion cubic feet per day

15.2 Bcf/D
April 2015

> 37% of shale gas production
> 18% of total dry natural gas production in the US
Initial Wellhead Yields (liquid-to-gas ratios, bbl/MMcf) of Marcellus wells

Jan 2003-Dec 2014

Different Thermal maturity characteristics
Vitrinite reflectance ($R_o$) range:
- Southwestern area: 1.0-2.8 $R_o$ (dry gas window and a combination gas-gas condensate play)
- Northeastern area: 2.0-3.1% $R_o$ (dry gas window)

Legend
Wellhead Yields (liquid-to-gas ratios, bbl/MMcf)
- 0
- 0-0.5
- 0.5-1.0
- 1.0-2.0
- 2.0-5.0
- 5.0-10.0
- 10.0-100.0
- >100.0

Source: U.S. Energy Information Administration, http://www.eia.gov/todayinenergy/detail.cfm?id=20612, based on DrillingInfo Inc. Note: EIA calculates the initial Yield for each well (7,894) using the second through fourth contiguous months of liquid and/or gas production. Yields are expressed as per barrel per million cubic feet (bbl/MMcf). The first month of production may not represent full production and thus is not included in the initial Yield calculation.
Cumulative Production (Mcf) of Marcellus wells

Jan 2003-Dec 2014

Future steps: Multivariate analysis: inputs to resource assessment and production forecast

- Well logs (IHS, States)
  - Depth
  - Thickness
  - Porosity
  - Total organic carbon

- Operator reports (DI, IHS)
  - Shut in Pressure
  - Bottom Hole Temperature
  - Production data
  - Well completion

- Previous research and Core data where available
  - Thermal maturity
  - Kerogen content
  - Permeability

1. Build play model
2. Address uncertainty in reservoir property estimates and resource assessment
3. Identify how formation properties affect Decline curves and recovery factors (geological dependencies)
EIA Online Maps


NATURAL GAS

Maps: Exploration, Resources, Reserves, and Production

Summary Maps: Natural gas in the Lower 48 States and North America

- Gas production in conventional fields, Lower 48 States
- Gas production in offshore fields, Lower 48 States
- Shale gas and oil plays, Lower 48 States (4/13/2015)
- Shale gas and oil plays, North America (5/9/2011)
- Major tight gas plays, Lower 48 States
- Coalbed methane fields, Lower 48 States

Oil- and gas-related maps, geospatial data, and geospatial software

- Oil and gas field maps in Portable Document Format
- Oil and gas field data in Shapefile Format
- EIA's oil and gas field Boundary Generation Scripts

Maps in Portable Document Format (.pdf)

The following maps were developed using GIS software and then converted to pdf format. You must therefore have the Adobe Reader® browser plugin installed to view them (free download available at Adobe Acrobat Reader®). Most of the maps are large format (60 inches X 36 inches, for example) because they were intended for printing on a wide-bed printer. To clearly view them on your monitor you will have to zoom in and then scroll through the map. They will also take more than just a couple of seconds to load owing to their complexity.
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References


