Abstract

Why does the Marcellus not produce as much gas in the Allegheny Highland as it does in other areas due west? Areas like Doddridge and Harrison County West Virginia have proven to produce 1.8 - 2.2 BCFGGE per 1,000 feet of lateral consistently, whereas wells in the Allegheny Highland consistently range between 0.8 - 1.2 BCFGGE per 1,000 feet of lateral or worse. County scale 2D seismic, a microseismic survey, rock properties from well logs and well production are used to characterize the structural and stratigraphic framework for Marcellus Shale within the Allegheny Highland.

Three Marcellus Shale horizontal wells in Webster County West Virginia (within the Allegheny Highland) have produced 0 mcfg after stimulation. A microseismic survey on one of the non-producers indicated that fracture stimulation was primarily focused below the Marcellus. It is assumed that basal fracture barrier effectiveness potentially affected well performance in Webster County West Virginia. Therefore, rock properties from well logs of the Marcellus Shale and the underlying Onondaga Limestone were compared over a larger area to highlight the importance of basal fracture barrier effectiveness in relation to production performance. Also, county scale 2D seismic will be shown and interpreted to help determine possible completion hazards. It is proposed that the thickness and volume of shale in the underlying Onondaga Limestone, difference in minimum horizontal stress between the Marcellus and Onondaga, proximity to the structural front, and fault presence at Silurian to Ordovician level all play a role in fracture barrier effectiveness.
CHALLENGES WITH MARCELLUS SHALE HORIZONTAL EXPLORATION WITHIN OR NEAR THE ALLEGHENY HIGHLAND.

Cole Bowers
• Introduction
• Methods and Data
• Results
• Conclusion/Discussion
• Why does the Marcellus not produce as much gas in the Allegheny Highland as it does in other areas due west?
LOCALIZED DATA

- Core
- 2D Seismic
  - 2009 Vintage
- Microseismic

REGIONAL DATA

- Geomechanical Logs
- Production
Thicknness: 60ft

Avg φ: 6.2%

Avg Sw: 39%

TOC : 6.5%

Total GIP: 30.2 Bcf/section
LOCALIZED RESULTS
2D Seismic

Big Lime
Onondaga
Trenton
Wells creek
Copper Ridge
Basement

5 miles
LOCALIZED RESULTS
2D Seismic

- Big Lime
- Onondaga
- Trenton
- Wells Creek
- Copper Ridge
- Basement

5 miles
LOCALIZED RESULTS
2D Seismic

Fault-Bend Fold Model
LOCALIZED RESULTS
2D Seismic

Big Lime
Onondaga
Trenton
Wells creek
Copper Ridge
Basement

5 miles
Faulted Detachment Fold  Shankar Mitra (2002)
LOCALIZED RESULTS
2D Seismic
Figure 3 – Sun Lumber 2 MH – Stage 1 width contour geometry using mechanical properties log with data shift causing downward fracture growth below the Marcellus shale.
Figure 7 – Stress, width contours and length for Sun Lumber 2MH Stage 1, average fracture width in pay section is 0.052 inches for the created fracture.
RESULTS
Microseismic

Microseismic

Marcellus
Onondaga
Huntersville Chert
Oriskany
Helderburg
Salina
RESULTS
Microseismic
RESULTS
Microseismic
REGIONAL RESULTS
Geomechanical Properties

~1.7 Bcf/1000ft Area
0 Bcf/1000ft Area
REGIONAL RESULTS
Geomechanical Properties

~1.7 Bcf/1000ft Area

~1.0 Bcf/1000ft Area
REGIONAL RESULTS
Geomechanical Properties

~2.2 Bcf/1000ft Area
~1.8 Bcf/1000ft Area
~1.0 Bcf/1000ft Area
REGIONAL RESULTS
Geomechanical Properties

Skeletal limestone interbedded with **sparse** amounts of calcareous mudstone.

Skeletal limestone interbedded with **abundant** amounts of calcareous mudstone.
**REGIONAL RESULTS**

Geomechanical Properties

**Differential Stress Marcellus/Onondaga vs Regional Average Marcellus EUR per 1000ft**

- **Regional Avg. Bcfe/1000ft**
- **Differential Stress Marcellus/Onondaga**

The scatter plot shows a positive linear correlation between differential stress and regional average Marcellus EUR per 1000ft. The linear equation is given by:

\[ y = 15.35x + 0.9035 \]

with an R² value of 0.4837.
REGIONAL RESULTS
Geomechanical Properties

Differential Stress Map

[Map showing regional results with various geomechanical properties indicated by color-coding.]
REGIONAL RESULTS
Geomechanical Properties

Differential Stress Marcellus/Onondaga vs Regional Average
Marcellus EUR per 1000ft

- Distance from Structural Front vs Regional Average Marcellus EUR per 1000ft
- Linear (Distance from Structural Front vs Regional Average Marcellus EUR per 1000ft)

Regression equation:

\[ y = 0.0182x + 0.3137 \]

\[ R^2 = 0.3888 \]

Poor
• Basal frac barrier differential stress seems to have a large impact on hydraulic fracturing, and potentially gas production in the Allegheny Highland.
• Has any other operators seen similar results from a microseismic survey in the Allegheny Highland?

• Any other interpretations on why the Allegany Highland doesn’t produce as well?
  – Rock Quality? Structure?

• Has anyone else seen stand-out geologic parameters correlating to gas production.
  – Ex. OGIP