# [PS]Outcrop Lithostratigraphy of the Middle Devonian Marcellus Interval in West Virginia, Pennsylvania and Virginia*

**Margaret Walker-Milani[1], Kyle Littlefield[2], Richard Smosna[2], and Timothy Carr[2]**

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## Abstract

The Middle Devonian Marcellus Shale is part of a large emerging unconventional shale gas play in the Appalachian Basin. This unconventional gas reservoir is distributed widely across the basin and has significant economic potential. Although the Marcellus interval is presently being drilled throughout the basin, several uncertainties remain including the definition of stratigraphic units, distribution and controls on organic richness, depositional patterns, and petrophysical characteristics. Surface exposures of the Marcellus Shale were measured, described and logged with a spectral gamma-ray scintillometer at several localities in the outcrop belt including parts of Pennsylvania, West Virginia, and Virginia. The spectral scintillometer was used to correlate surface exposures to nearby subsurface data and to construct cross-sections from the outcrops to the subsurface. Detailed outcrop description tied to petrophysical data has allowed for a better understanding of the depositional history and economic potential of the Middle Devonian Marcellus Shale in West Virginia and throughout the Appalachian Basin.

## Reference

Milici, R.C., and C.S. Swezey, 2006, Assessment of Appalachian Basin oil and gas resources: Devonian Shale-Middle and Upper Paleozoic total petroleum system: U.S. Geological Survey Open-File Report 2006-1237.

# Outcrop Lithostratigraphy of the Middle Devonian Marcellus Interval in West Virginia and Pennsylvania

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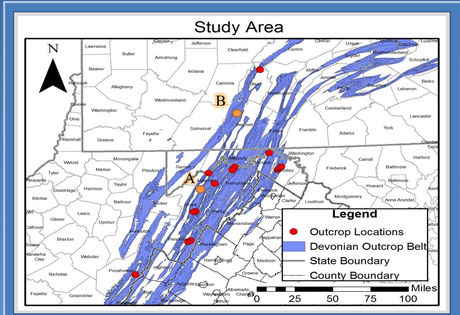
## ABSTRACT

The Middle Devonian Marcellus Shale is part a large emerging unconventional shale gas play in the Appalachian Basin. This unconventional gas reservoir is distributed widely across the basin and has significant economic potential. Although the Marcellus interval is presently being drilled throughout the basin, several uncertainties remain including the definition of stratigraphic units, distribution and controls on organic richness, depositional patterns, and petrophysical characteristics. Surface exposures of the Marcellus Shale were measured, described and logged with a spectral gamma-ray scintillometer at several localities in the outcrop belt including West Virginia and parts of Pennsylvania, The spectral scintillometer was used to correlate surface exposures to nearby subsurface data and to construct cross-sections from the outcrops to the subsurface. Detailed outcrop description tied to petrophysical data has allowed for a better understanding of the depositional history and economic potential of the Middle Devonian Marcellus Shale in West Virginia and throughout the Appalachian Basin.



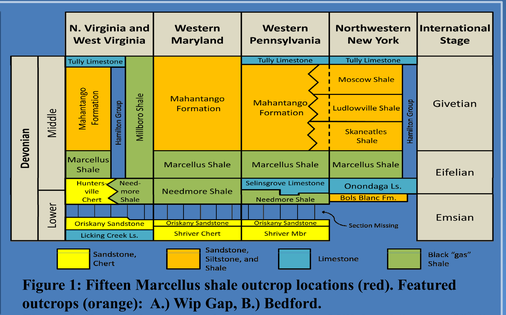




**Figure 1: Fifteen Marcellus shale outcrop locations (red). Featured outcrops (orange): A.) Wip Gap, B.) Bedford.**
**Figure 2: Regional stratigraphic column (*after* Milici and Swezey, 2006)**

## B). Bedford Outcrop, Bedford Co, PA

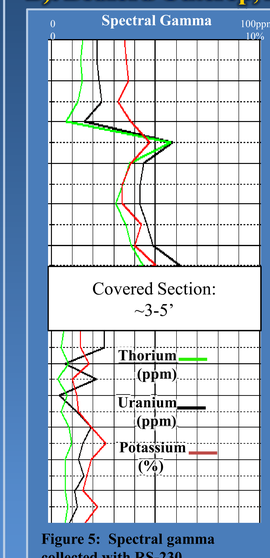



**Figure 5: Spectral gamma collected with RS-230.**

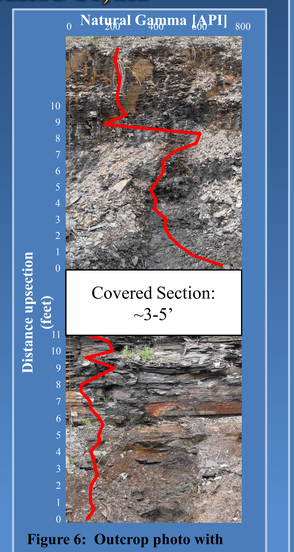



**Figure 6: Outcrop photo with total natural gamma overlay.**

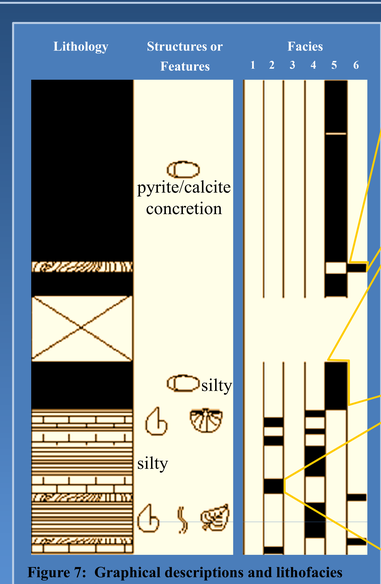
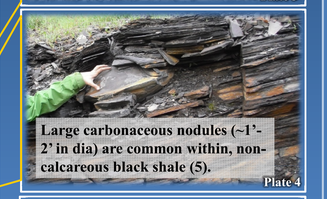
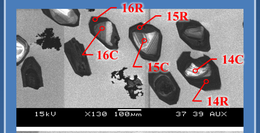



**Figure 7: Graphical descriptions and lithofacies identification.**



### Tioga Bentonite Geochronology



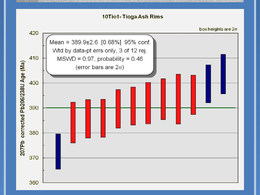
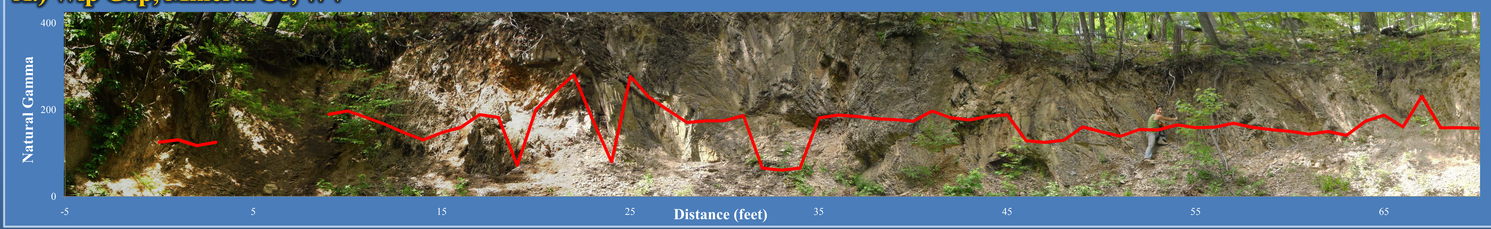
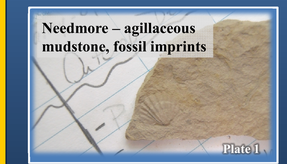




**Figure 8: SEM backscatter of Tioga zircons with shot locations (top). U/Pb ages of zircon rims (bottom). *Courtesy of Dr. Jaime Toro (WVU).***

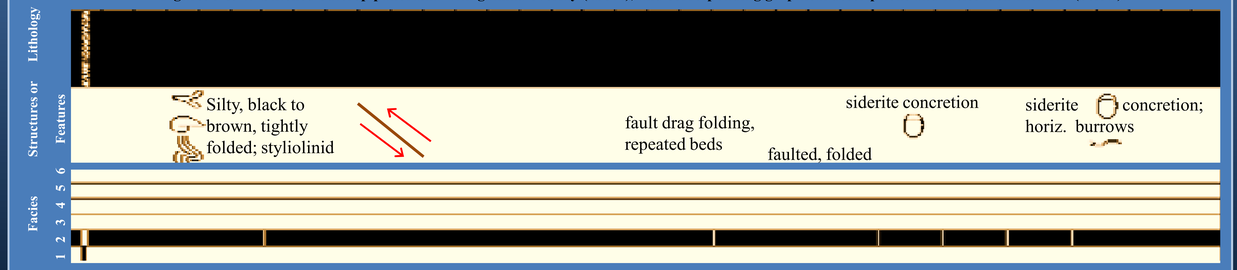
## A.) Wip Gap, Mineral Co, WV





**Figures 3 & 4: Stitched outcrop panorama with gamma overlay (above), and corresponding graphical descriptions and facies identification (below).**




## CONCLUSIONS

To date, a total of fifteen Middle Devonian Marcellus shale outcrops have been studied in West Virginia and Pennsylvania. Outcrops have been measured, described and logged with a handheld spectral gamma ray scintillometer. These detailed examinations have resulted in the recognition of six distinct lithofacies in the Marcellus shale formation, including: 1) Gray Calcareous Shale, 2) Limestone, 3) Gray Shale, 4) Black Calcareous Shale, 5) Non- Calcareous Black Shale (6) Metabentonite. Zircons from the Tioga Ash, the latter of these, have been dated using the Sensitive High-Resolution Microprobe at Stanford University. Average rim ages are 389.9 ± 2.6 Ma, consistent with Middle Devonian emplacement.

Future work includes detailed descriptions of additional outcrops in West Virginia, a compilation and consolidation of lithofacies descriptions, and an interpretation of the depositional environment for each. Additionally, applying these characteristics to a sequence stratigraphic framework will identify how the Marcellus depositional environment changed through time and aid in the construction of a generalized stratigraphic column for the complete Marcellus section within West Virginia. Division of the Marcellus into members with recognizable spectral gamma character will allow the correlation of outcrop lithostratigraphy to nearby subsurface spectral gamma ray logs.

## REFERENCES

Milici, R.C. and Swezey C.S., 2006, Assessment of Appalachian Basin Oil and Gas Resources: Devonian Shale-Middle and Upper Paleozoic Total Petroleum System: U.S. Geological Survey Open-File Report 2006-1237.

## ACKNOWLEDGEMENTS

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