FRACKING THE MARCELLUS IN PENNSYLVANIA

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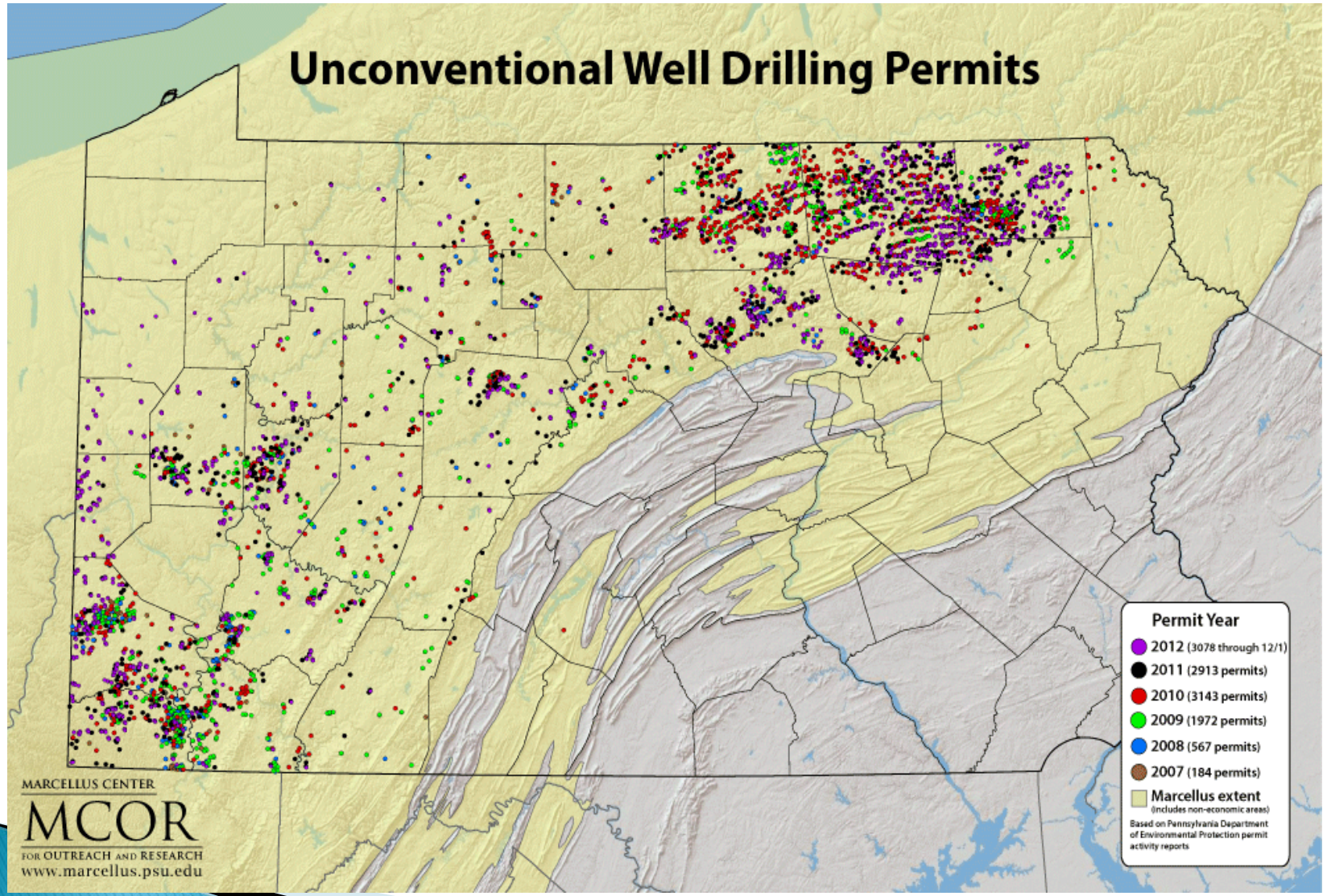
Topics

- Economic significance
- Geology of Marcellus
- Construction and fracking
- Environmental Problems

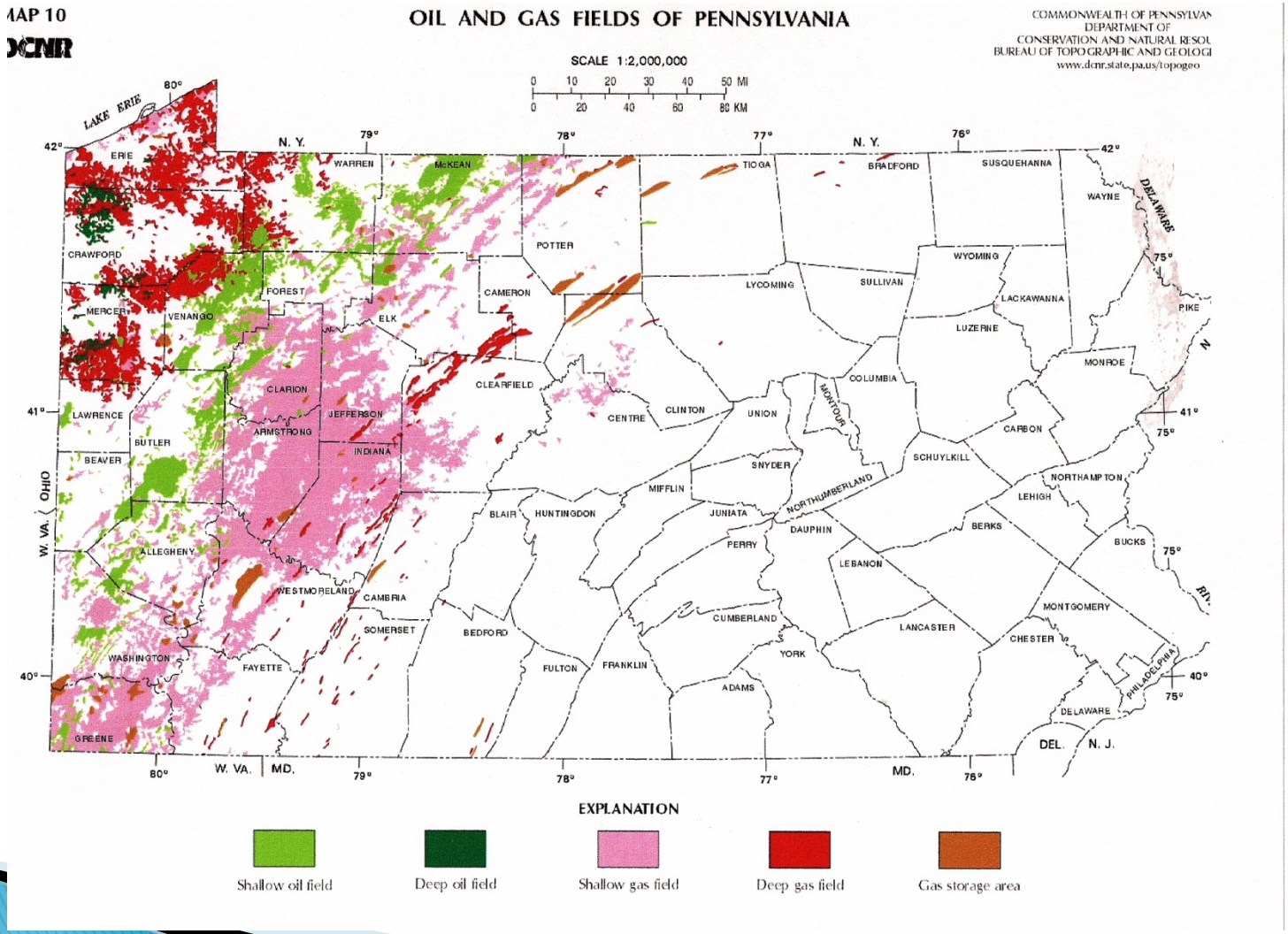
Marcellus wells in PA, 2007–12



Oil and Gas in PA

- First gas production in PA – late 1800's
- More than 300,000 wells drilled since.
- Many have unknown locations
- Many were not plugged properly, leak into near surface.
- Most are relatively shallow, tapping horizons in the upper Paleozoic; a few deeper fields.
- Deeper fields are structurally controlled, shallow fields largely stratigraphic traps.
- Old very shallow wells near Erie tap shale, but supply only 1-3 homes.

Oil and Gas in PA – Conventional



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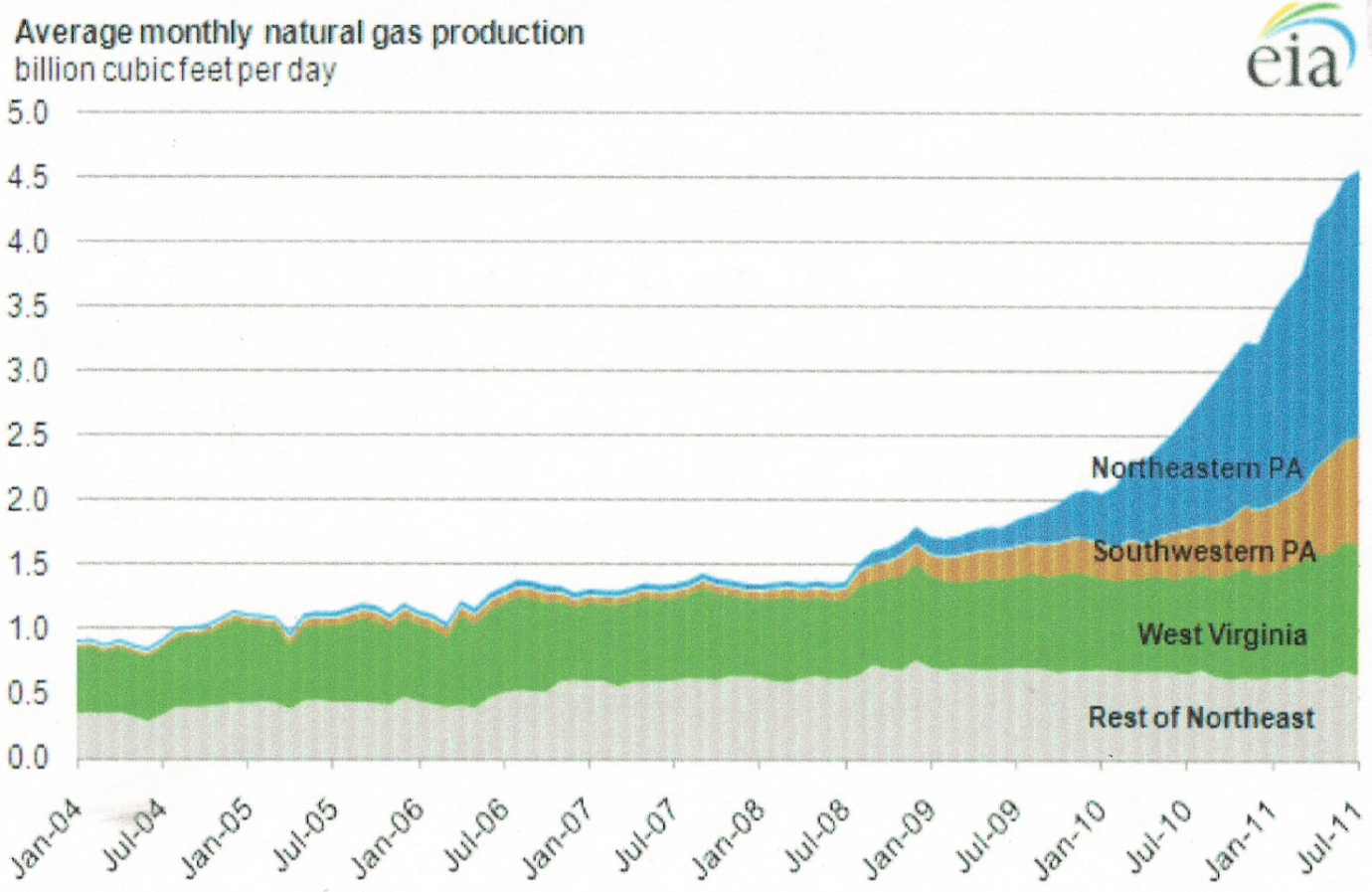
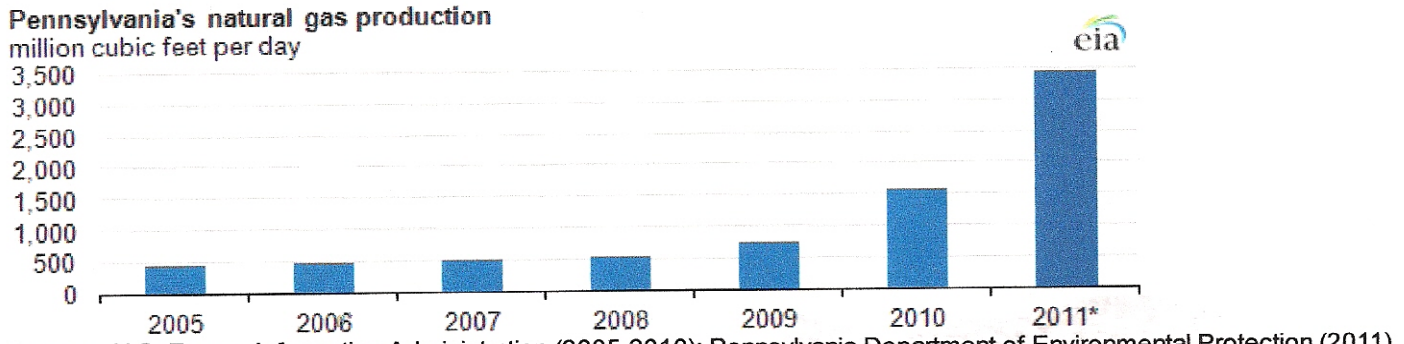
PA Production



Source: U.S. Energy Information Administration based on Bentek Energy, LLC.
Note: Rest of Northeast includes KY, MD, NY, OH, TN, VA.

PA Gas Production 2005-11

MMcf/day



Source: U.S. Energy Information Administration (2005-2010); Pennsylvania Department of Environmental Protection (2011).

Pennsylvania Gas Production Data

Production 1990's ~0.2 Tcf/yr Value ~$0.4 billion/yr
Production 2011 ~1.3 Tcf/yr Value ~$6.3 billion/yr

Marcellus Production 2012: 2 Tcf ~$10 billion/yr
Marcellus wells drilled 2007-12: 6200

In 2007, about 1% of US production
In 2011, about 5% of US production

Marcellus Gas "Reserves" (Tcf)

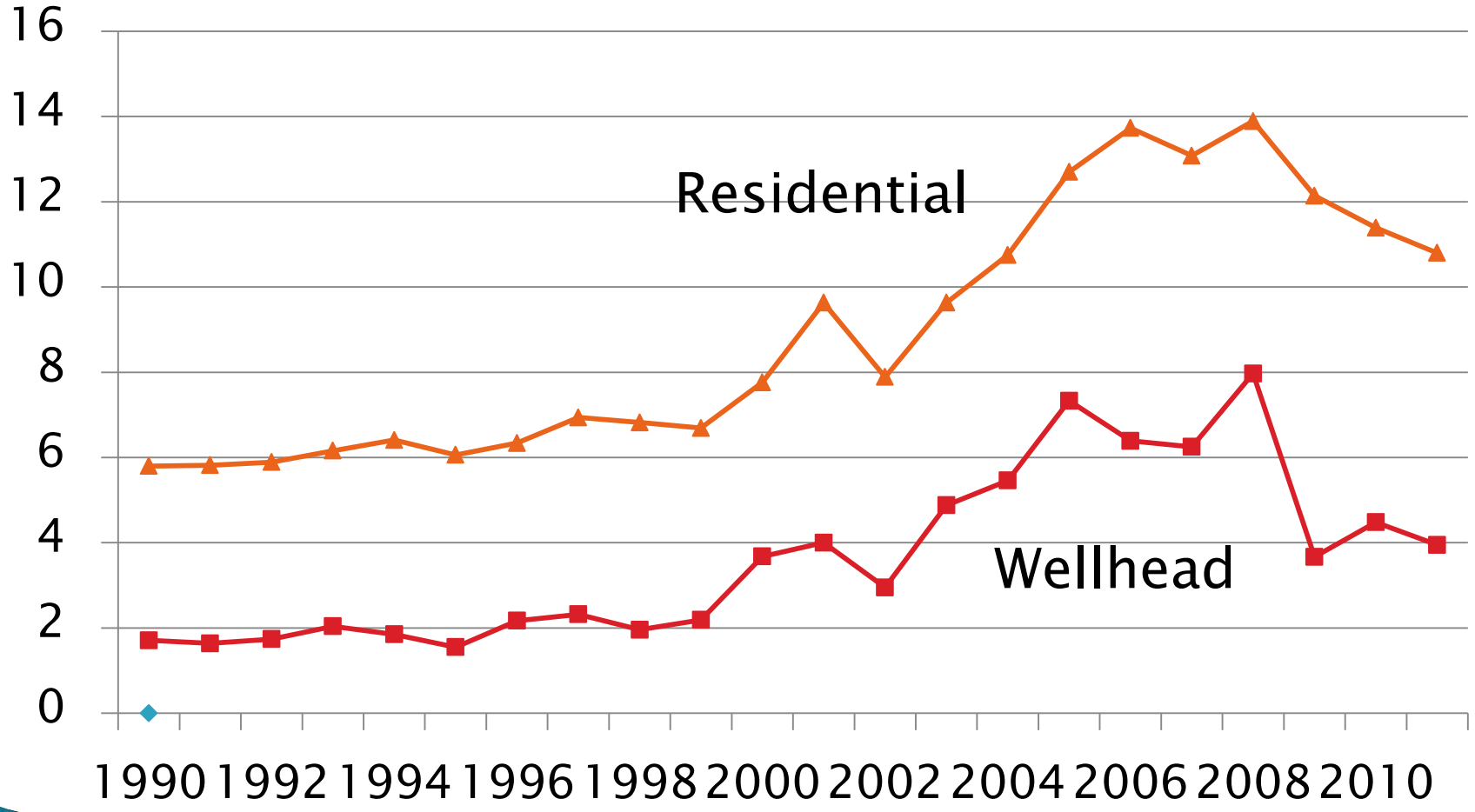
- Energy Information Admin.: 410 earlier
  141 later
- "Reserves in Place" 1500
- Engelder (2009) 489

- 70 to 700 years of production at present rate

- Reserves depend on economics, price, technology, geologic interpretation.

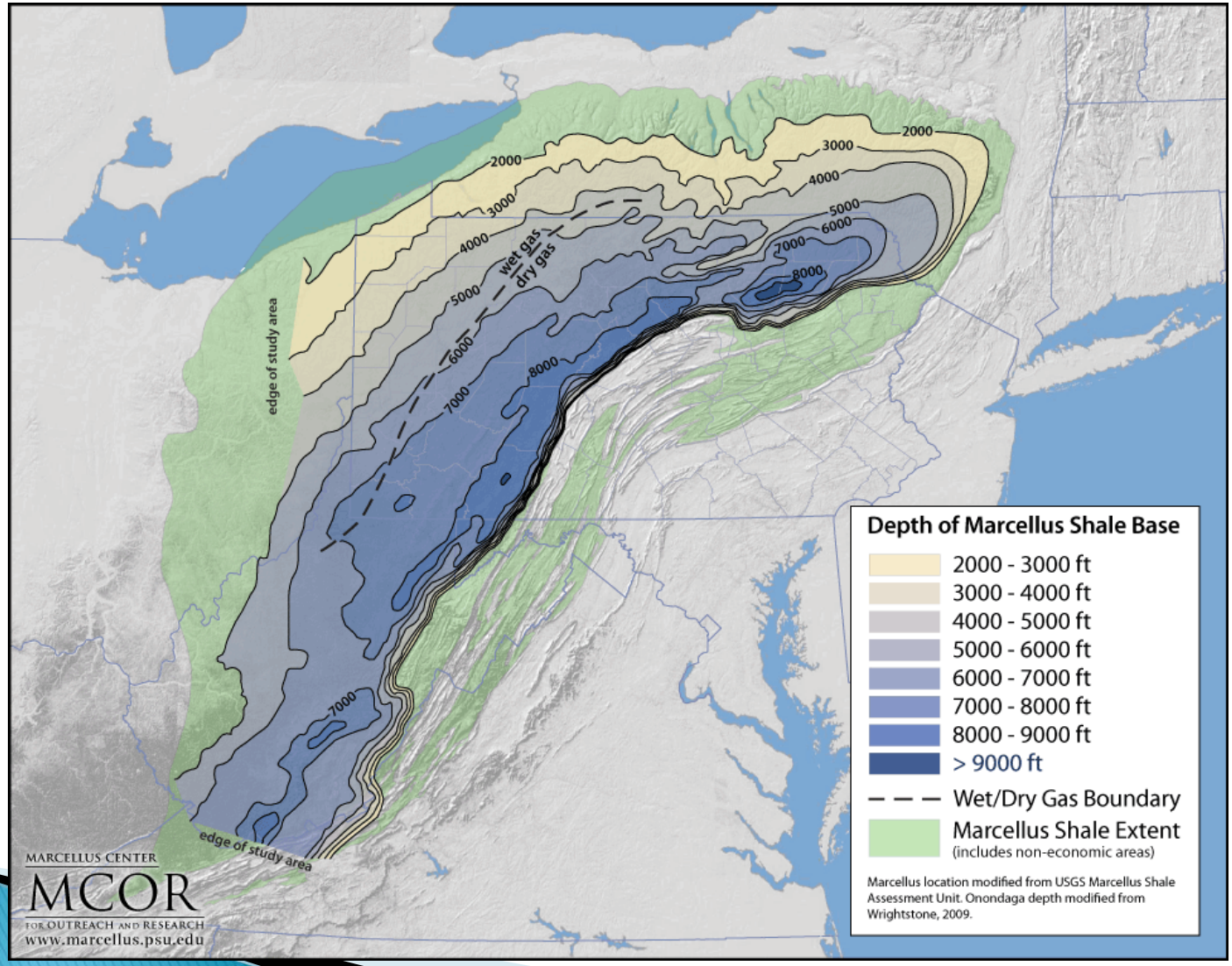
Natural gas prices 1990–2011

$/Mcf

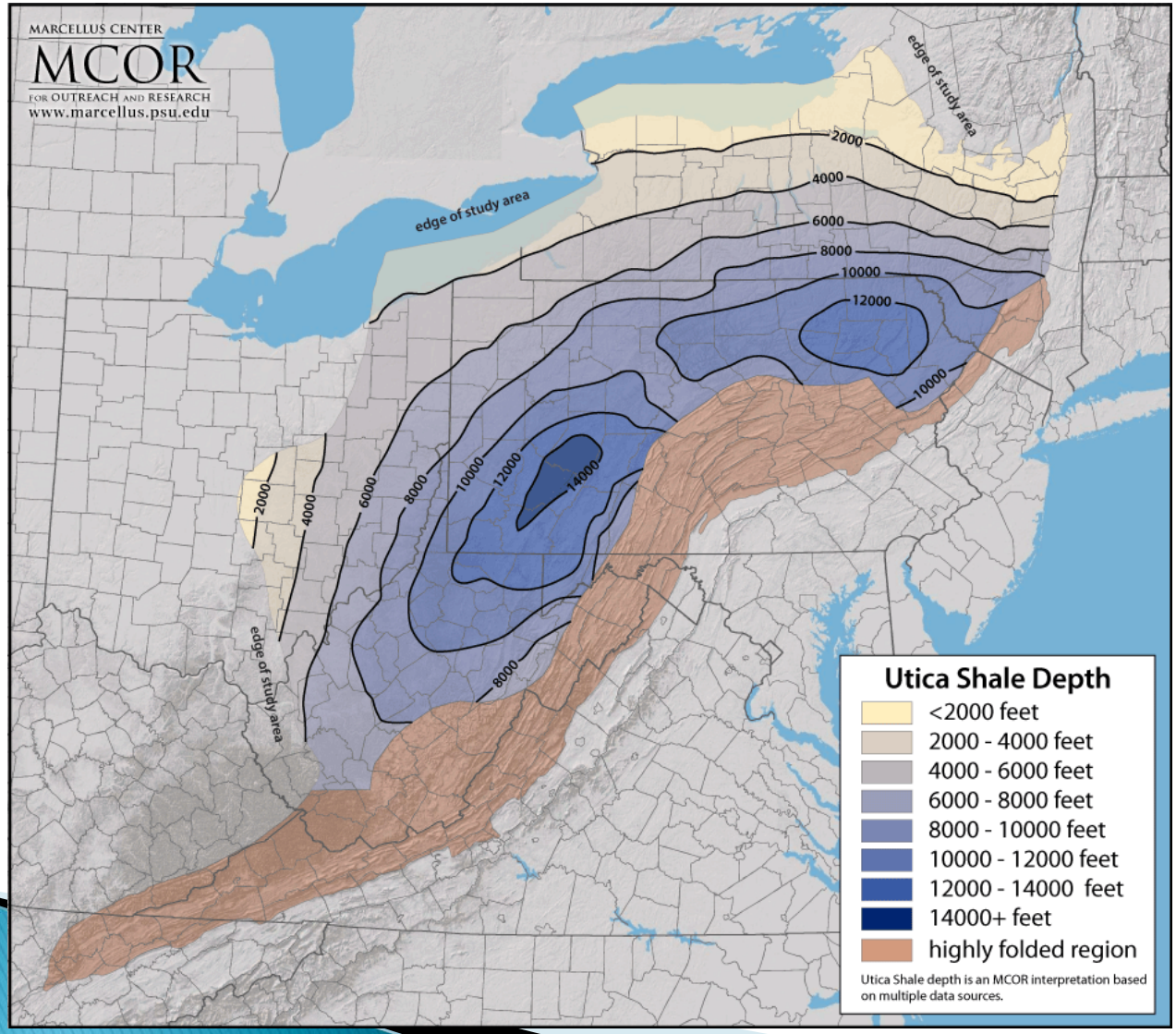


Wet gas vs. Dry gas

Ethane, butane, propane,.....



Utica Shale – Another gas source



Stratigraphy in PA

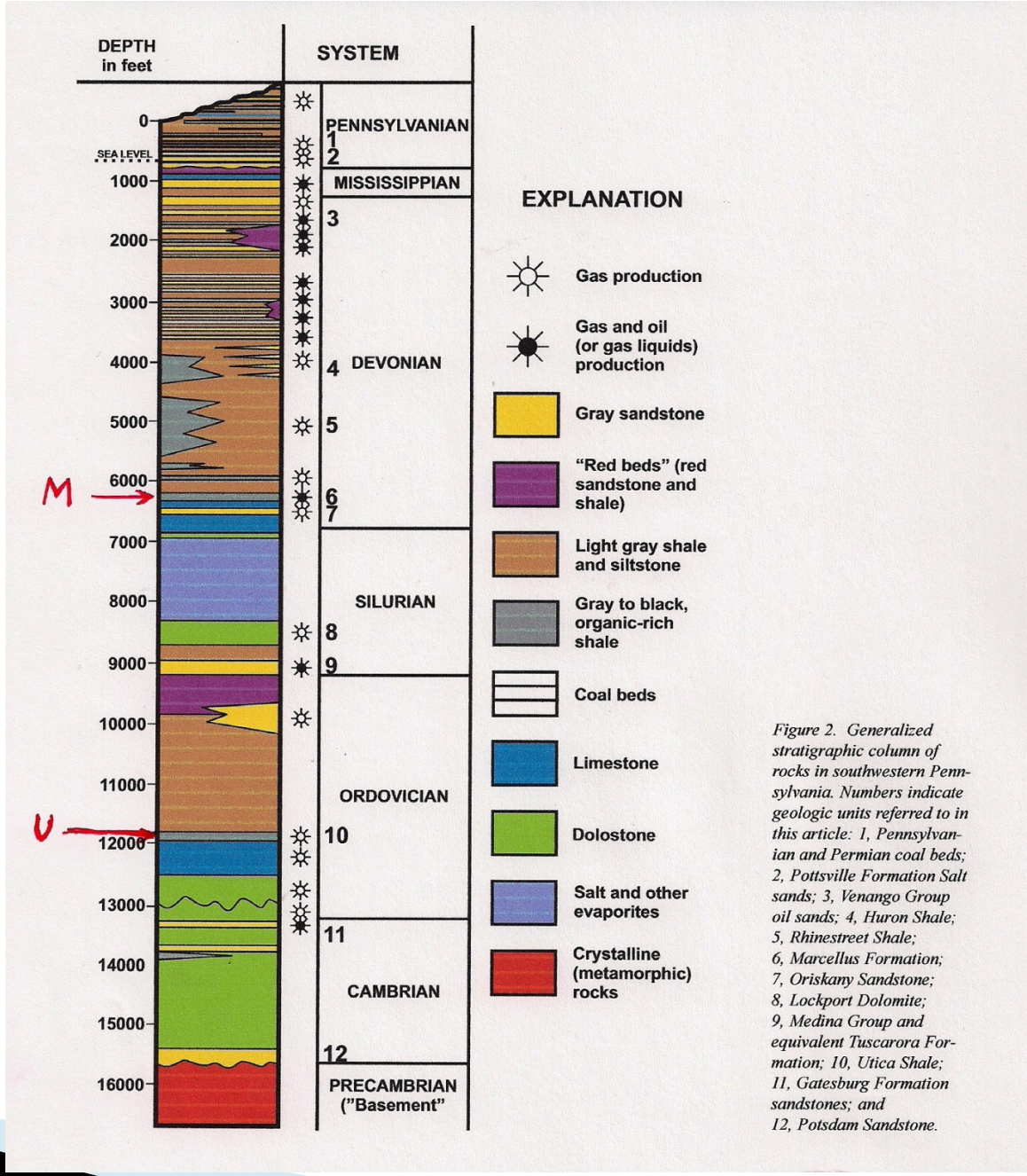
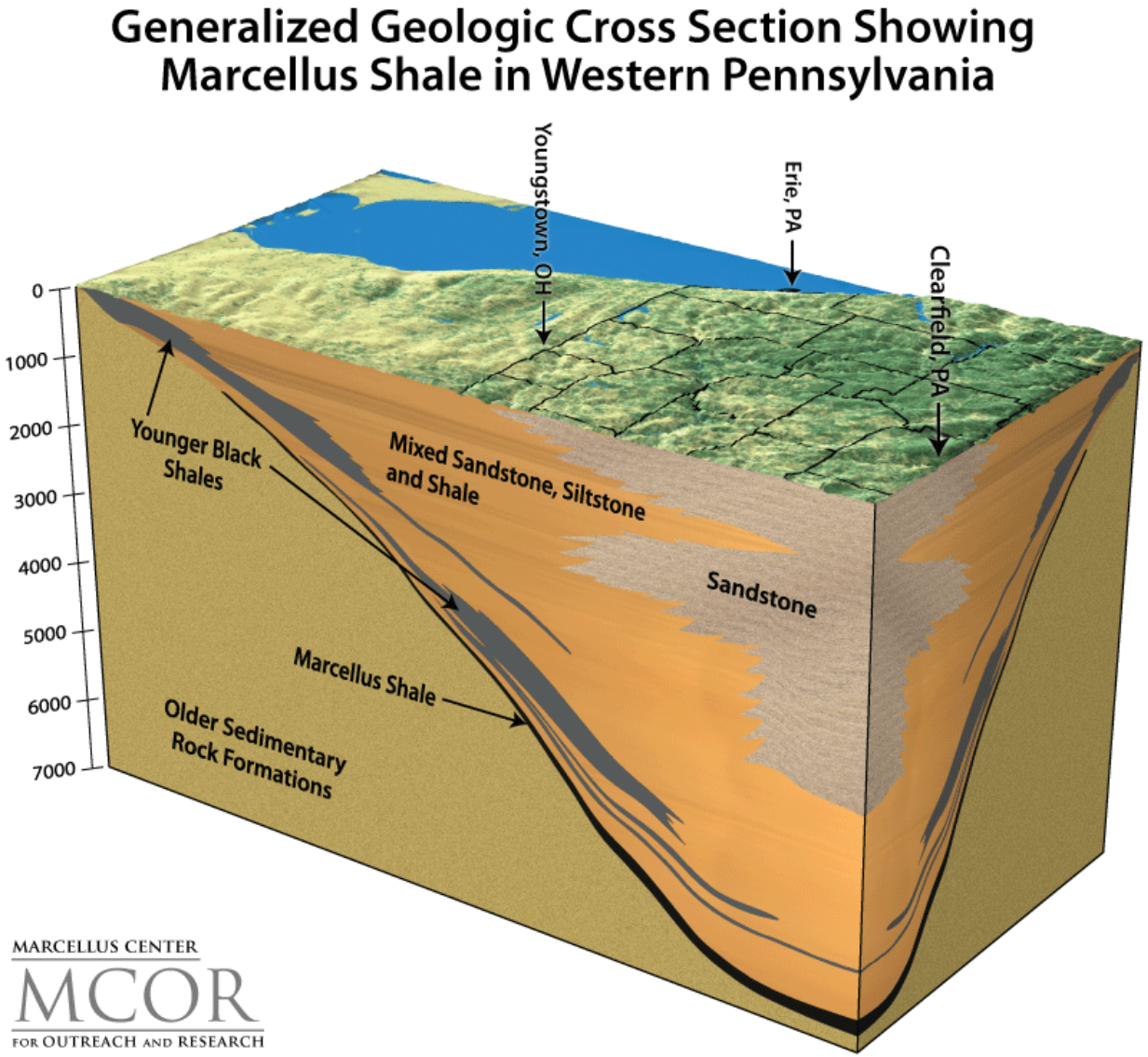
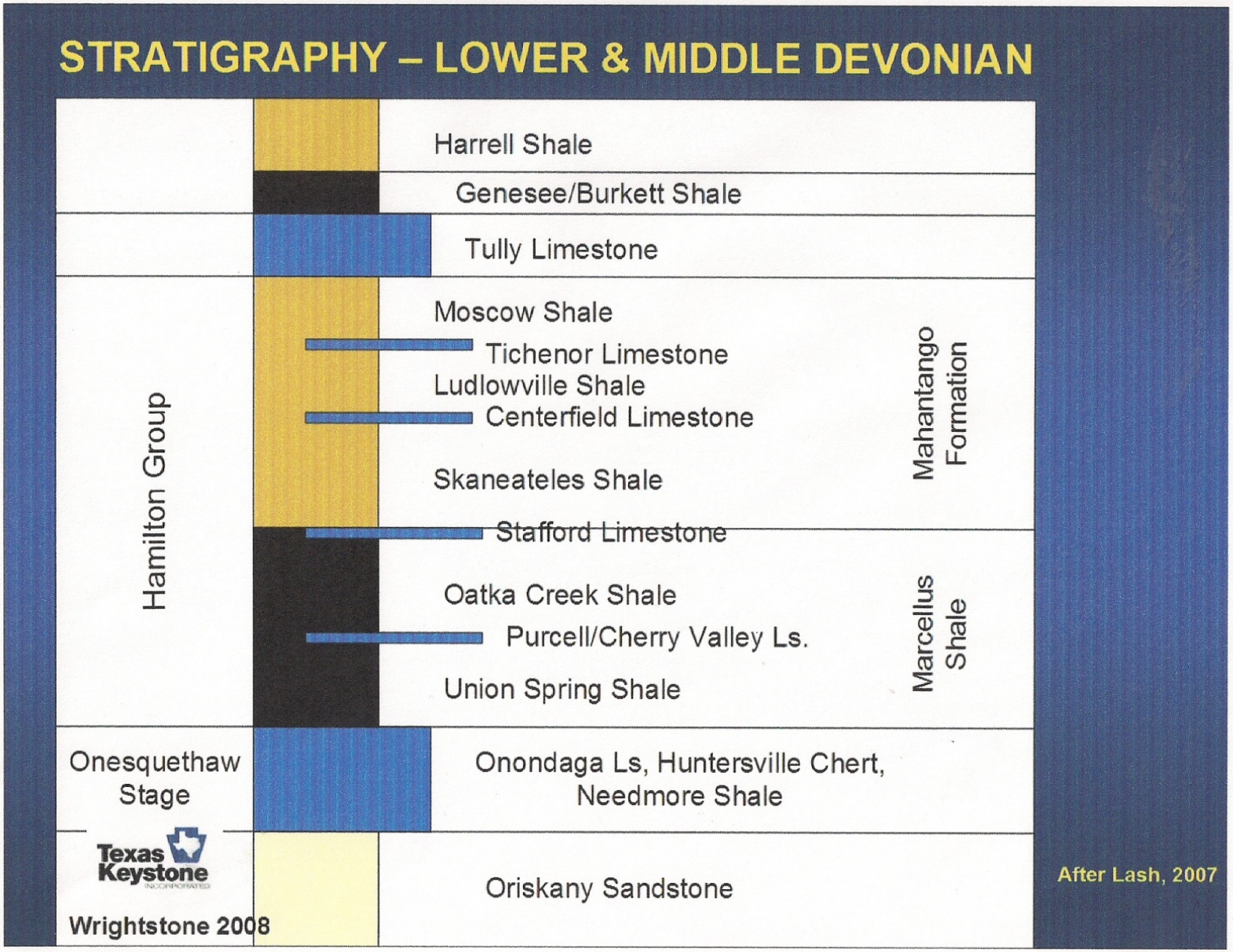


Figure 2. Generalized stratigraphic column of rocks in southwestern Pennsylvania. Numbers indicate geologic units referred to in this article: 1, Pennsylvanian and Permian coal beds; 2, Pottsville Formation Salt sands; 3, Venango Group oil sands; 4, Huron Shale; 5, Rhinestreet Shale; 6, Marcellus Formation; 7, Oriskany Sandstone; 8, Lockport Dolomite; 9, Medina Group and equivalent Tuscarora Formation; 10, Utica Shale; 11, Gatesburg Formation sandstones; and 12, Potsdam Sandstone.

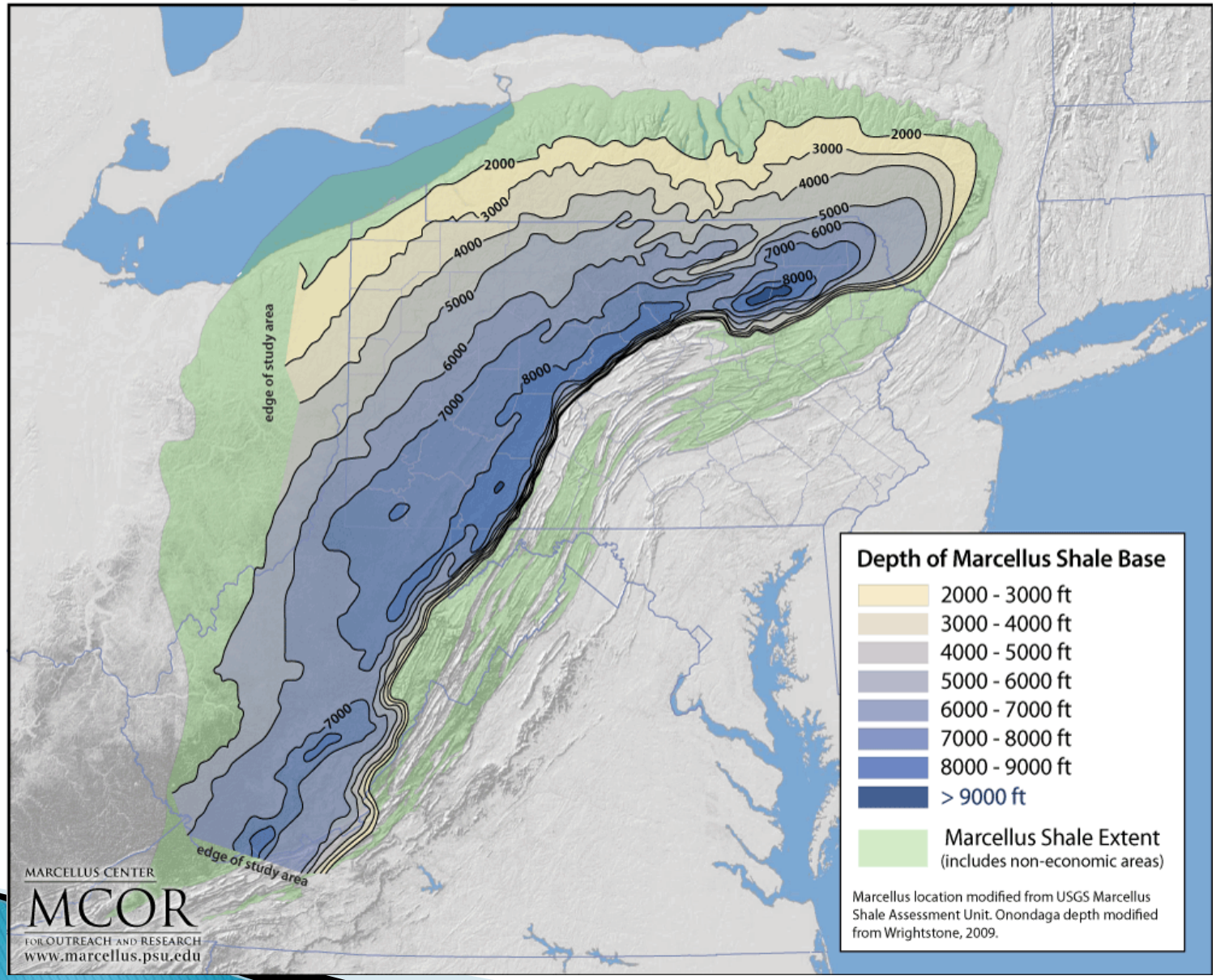
W–E cross section of Marcellus



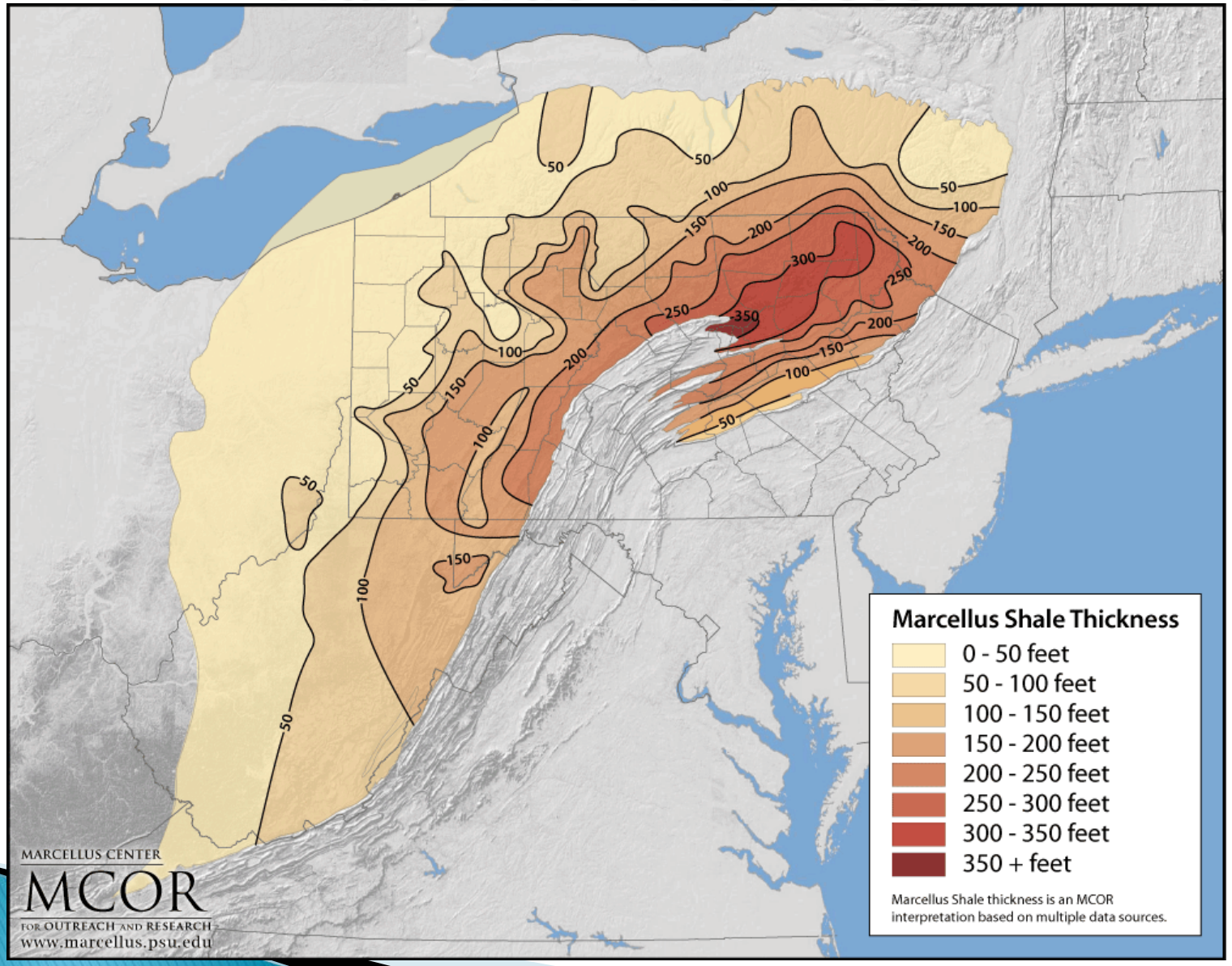
MARCELLUS CENTER
MCOR
FOR OUTREACH AND RESEARCH


STRATIGRAPHY – LOWER & MIDDLE DEVONIAN
Harrell Shale
Genesee/Burkett Shale
Tully Limestone
Moscow Shale
Tichenor Limestone
Ludlowville Shale
Centerfield Limestone
Skaneateles Shale
Mahantango Formation
Hamilton Group
Stafford Limestone
Oatka Creek Shale
Purcell/Cherry Valley Ls.
Union Spring Shale
Marcellus Shale
Onesquethaw Stage
Onondaga Ls, Huntersville Chert, Needmore Shale
Texas Keystone
Wrightstone 2008
Oriskany Sandstone
After Lash, 2007

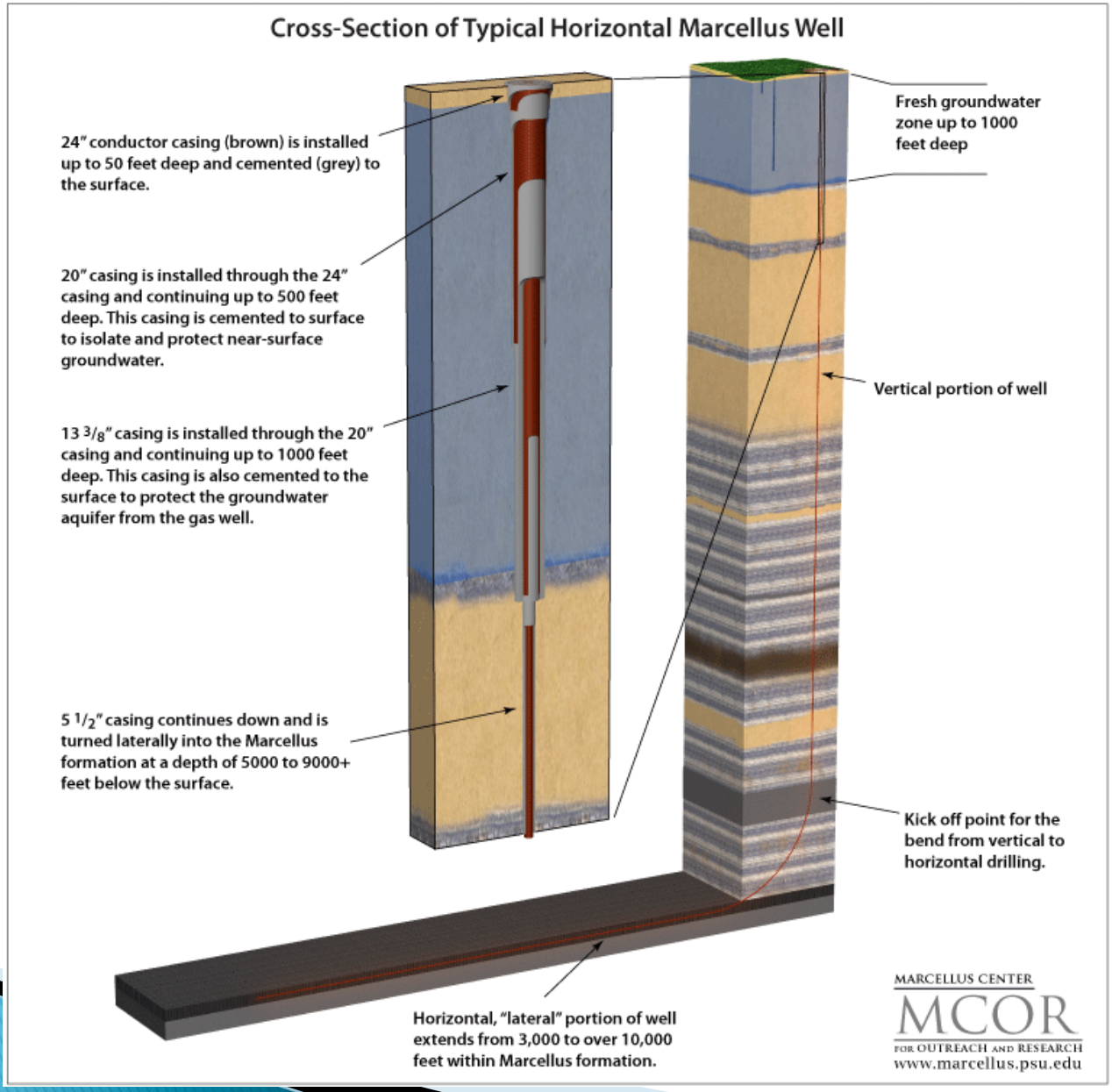
Depth to Marcellus



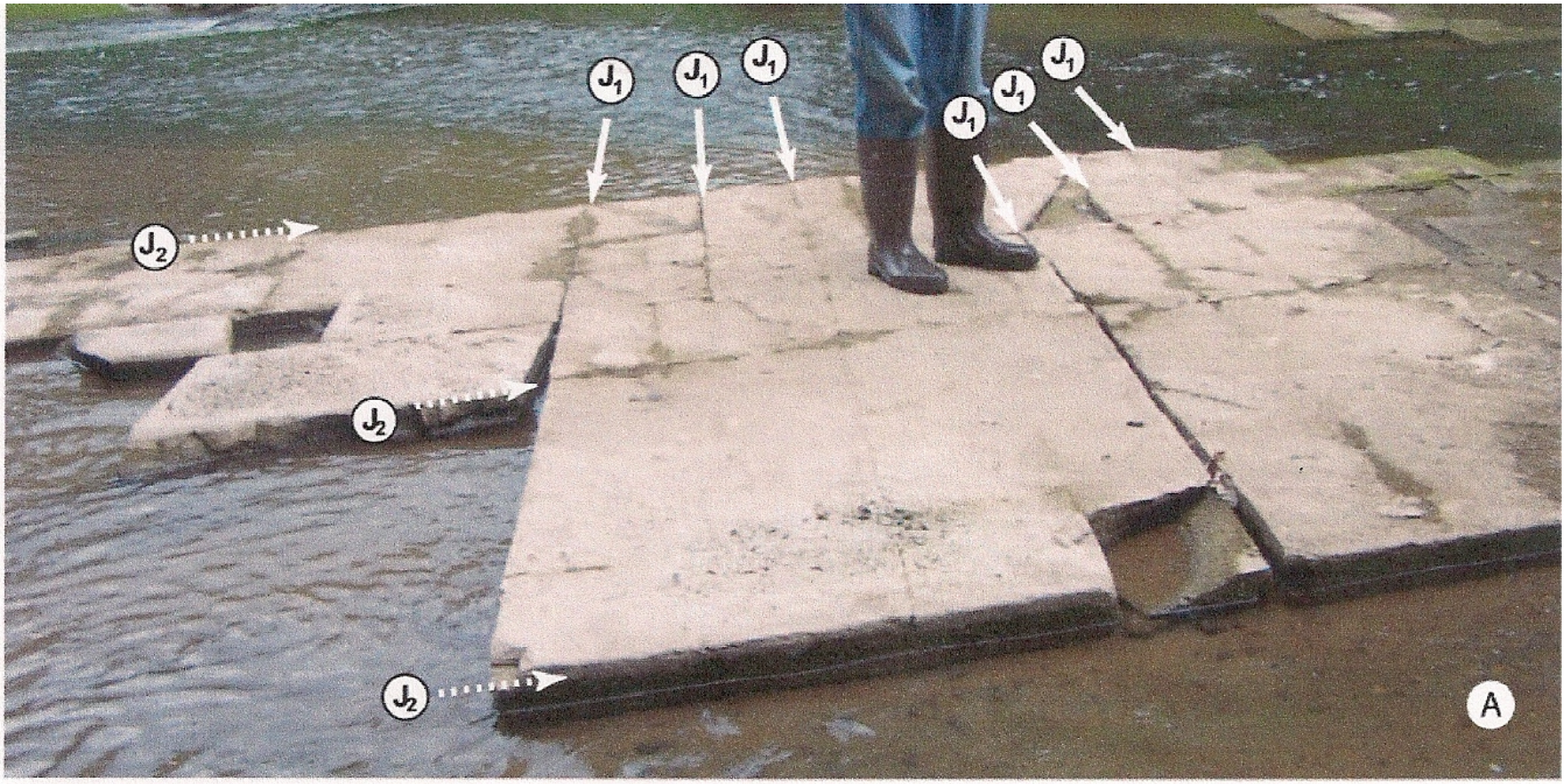
Marcellus thickness



Horizontal Well – Note casing



Importance of joints



Regional Joint Direction

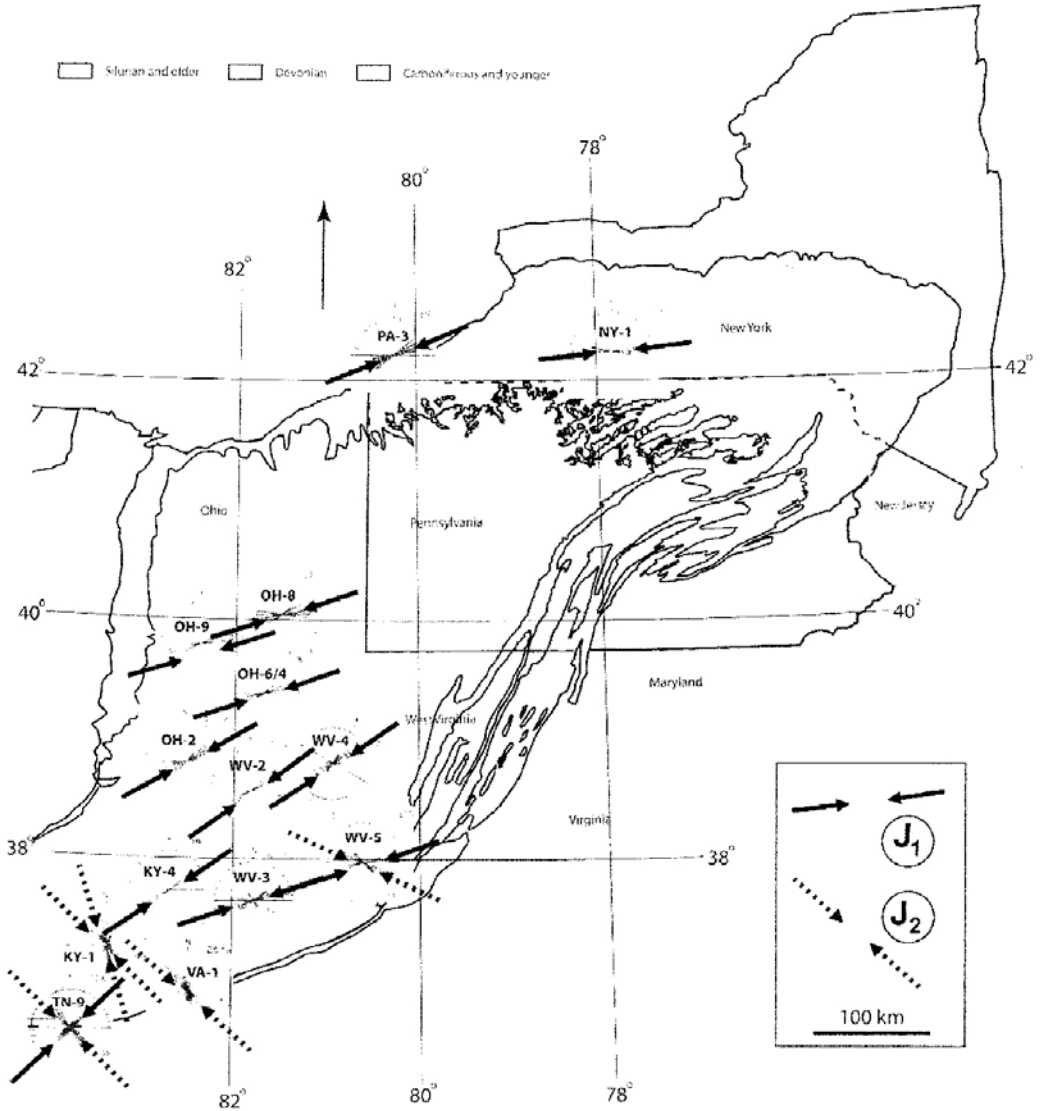
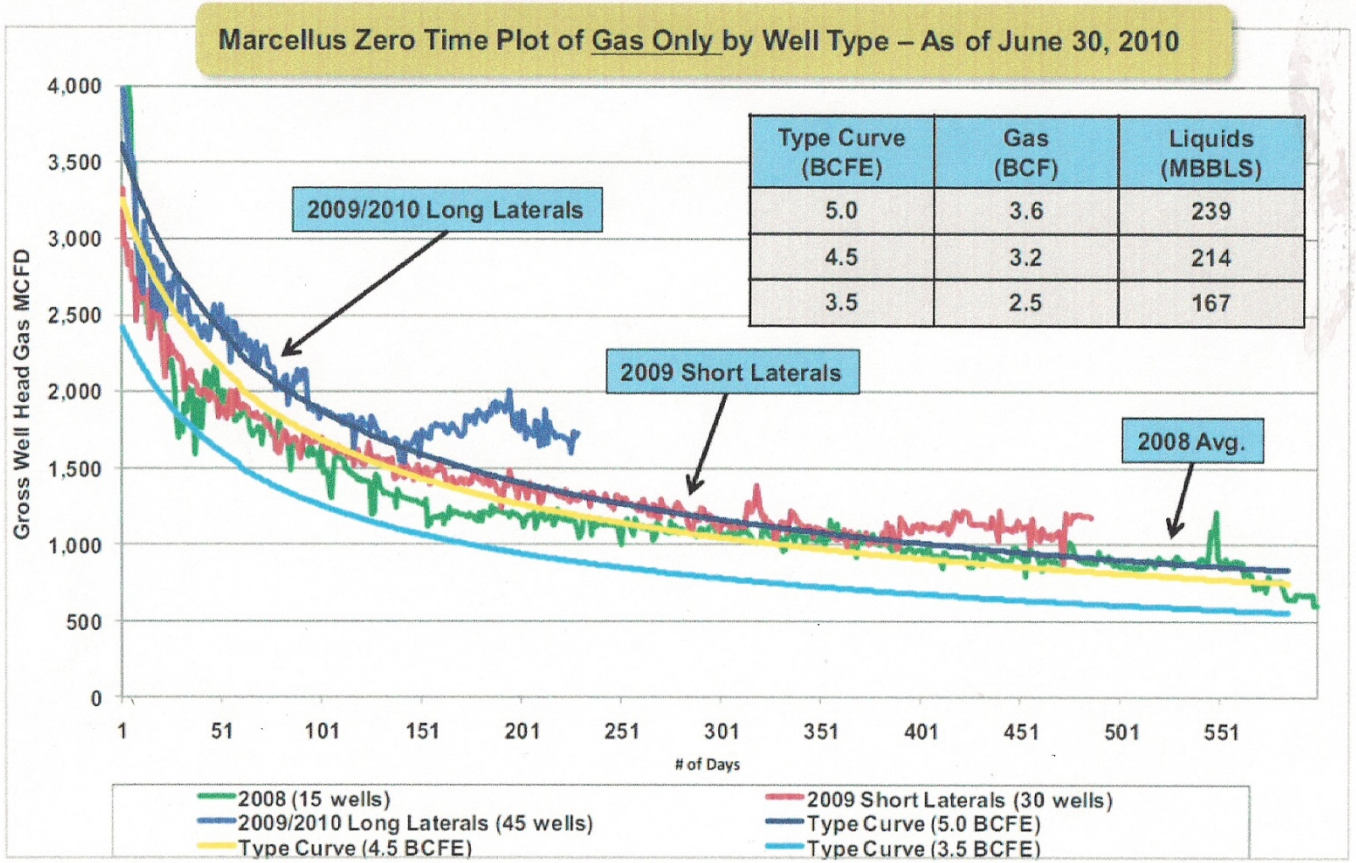


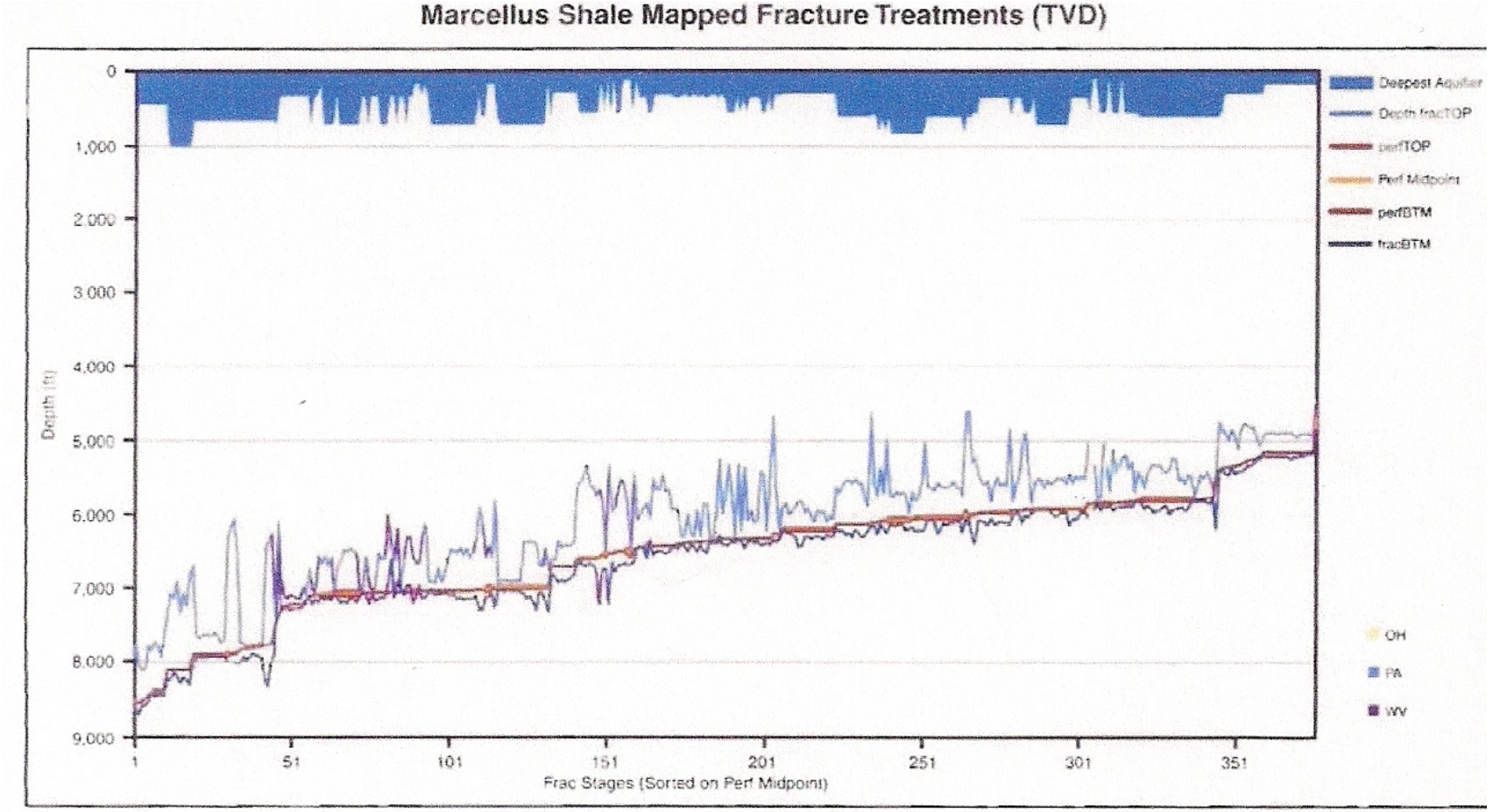
Figure 4. Rose plots showing the orientation of joints in the Dunkirk middle Huron interval of cores recovered during the EGSP (modified from Cliffs Minerals, 1982). Well designations are those of the ESGP. Wells with less than three joints are omitted. Well WV-4 is corrected for misalignment as indicated by induced fractures.

Production decrease after fracking

Well Performance Continues to Improve



Depth of fractures below surface during Fracking



Fisher, 2010

Chemicals added during fracking

fracfocus.org

- Sand or ceramic pellets
- Hydrochloric acid
- Biocides
- Gelling agents
- Gel stabilizers
- Clay stabilizers
- Corrosion Inhibitors
- Cross Linkers
- Friction reducers
- Iron control
- pH adjuster
- Scale Inhibitor
- Surfactant

Environmental Problems

- Wellpad
- Traffic, roads
- Site contamination
- Additives
- Flowback
- Methane in shallow ground water
- Pipelines
- Global warming – Methane effects

Summary

- Marcellus gas is a major energy and economic benefit to the region and nation.
- Gas and liquids from the Utica and other horizons will also be important
- The geology of the gas is complicated.
- Many environmental effects must be handled skillfully.