[AV]The Contribution of Shale Gas to Future U.S. Production: A View of the Resource Base*

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Abstract

Projections published in 2008 by the United States government indicated that annual U.S. gas demand could increase from the current 22 Tcf (trillion cubic feet) to 24 Tcf by the year 2016 and then decline to 23 Tcf by 2030. This would occur during a period of declining Canadian gas imports and increasing U.S. reliance on LNG imports, a commodity only available in a highly competitive market. To put these numbers into perspective, a 1 Tcf/year increase is a challenge: domestic gas production was flat for nine years prior to 2006. Gas production then increased 9% from 1Q 2007 to 1Q 2008, with Texas (i.e., the Barnett Shale) providing most of this growth.

Shale gas production, which dates from 1821 in the United States, is now rapidly increasing, accounting for approximately 7% of annual production. The U. S. Energy Information Administration estimates that shale gas production will overtake coalbed methane production by 2025, and will grow from the current 1+ Tcf to 2.3 Tcf annually by 2030. Some industry analysts, apparently using Delphi-type studies, dispute these numbers and claim that shale gas alone will account for 50% of our production within the next 10 years. The developing Haynesville and Marcellus plays are key to their predictions.

Shale gas is also an increasingly large component of future, technically recoverable resources. Both of these trends are due to improvements in exploration, completion, and production technologies, aided by wellhead price increases.

The robustness of the North American gas resource base, particularly shale gas, coalbed methane, and tight sands gas, needs to be quantified.

The latest Potential Gas Committee (PGC) biennial assessment, (September, 2007), showed an overall increase of 18% (200 Tcf) for total U.S. gas resources. The bulk of this increase was for shale gas resources assessed in the Appalachian, Anadarko, Arkoma, Ft. Worth, and Permian basins. This presentation analyzes shale gas future potential in light of past production, current proved reserves, geological, and economic realities of current and emerging Lower-48 U.S. plays and the Spring 2009 PGC natural gas resource assessment.

References

Hill, D.G., and C.R. Nelson, 2000, Gas productive fractured shales; An overview and update: GasTips, v. 6/2, p. 4-13.

Potential Gas Committee, 2007, Potential supply of natural gas in the United States: Report of the Potential Gas Committee (December 31, 2006), Colorado School of Mines, Golden, Colorado, Web accessed 28 July 2009 www.aga.org/NR/rdonlyres/6CC4915E.../0709PGCSLIDES.PPT

Potential Gas Committee, 2003, Potential supply of natural gas in the United States: Report of the Potential Gas Agency (December 31, 2002), Colorado School of Mines, Golden, Colorado, 316 p.

Walter, L.M., J.C. McIntosh, A.M. Martini and J.M. Budai, 2001, Hydrogeochemistry of the New Albany Shale, Illinois Basin; *in* Final Report to Gas Technology Institute, v. 1, phase III, GTI-00/0153, 66 p.

The Contribution of Shale Gas to Future U.S. Production:

A View from the Resource Base

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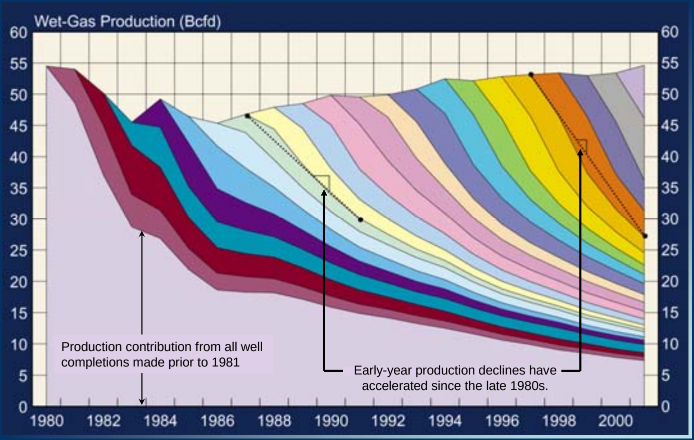
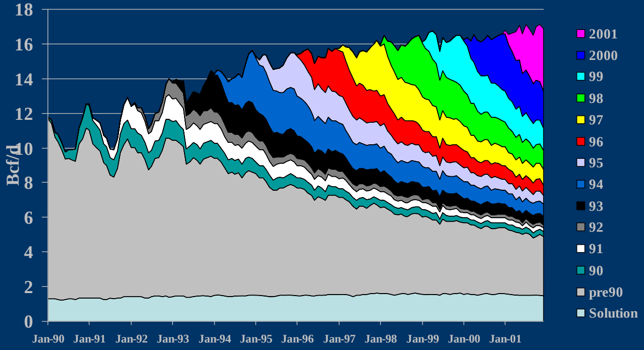
Gas Production Replacement, L48 US



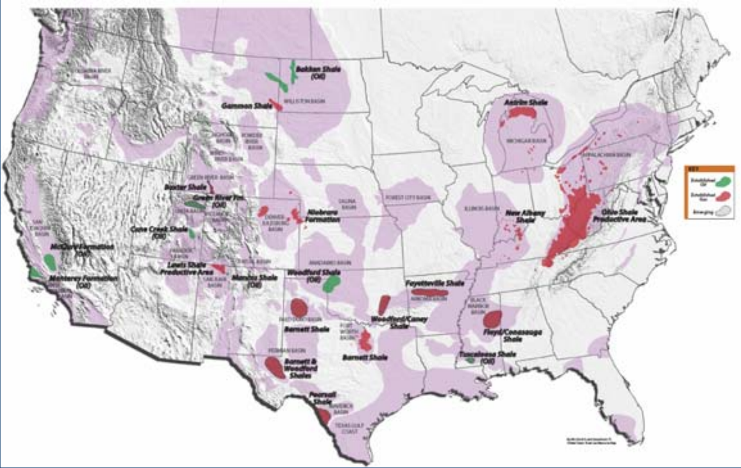
Source: Potential Gas Committee (2003). Data from EIA and Petroleum Information/Dwights LLC (©2002).

WCSB Marketable Gas Production Grouped by Connection Year

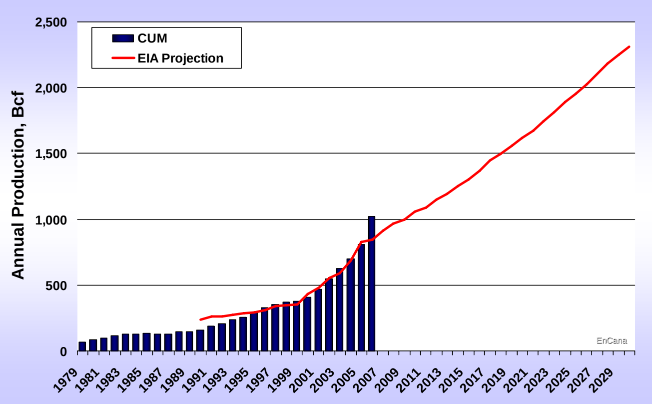


NEB - Short Term Natural Gas Deliverability - Dec 2002

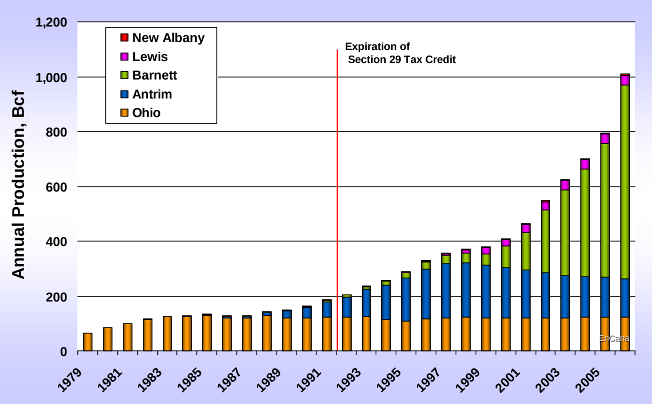
Major U.S. Basins and Shale Plays c. 2007
(Where are the Haynesville and Marcellus???)



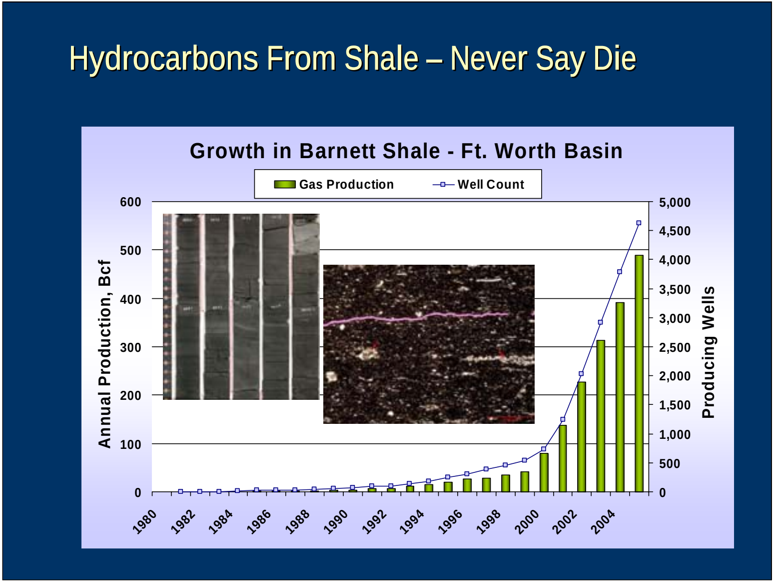
Shale Gas Annual Production and Energy Information Administration (EIA) Forecast



U.S. Shale Gas Annual Production from Five Classic Plays to 2007

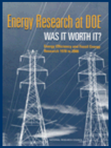


Modified and updated from Hill and Nelson, 2000



Presenter's Notes: Low-magnification view exhibits darker, more carbonaceous mudstone texture. Thinly laminated siliceous/argillaceous matrix hosts a mix of organic material, microcrystalline clay, silica, angular to subrounded silt, micromicas, phosphatic debris, and microfossil fragments. White, patchy chert is primarily recrystallized biotic components, especially forams and radiolarians (arrows). Magenta epoxy highlights an induced, layer-parallel microfracture. (Plane-polarized light. Scale bar = 0.5 mm)

Targeted Research – $150 Million



Acquisitions – >$8 Billion

Source: Trollart.com – Ray Troll

Resource Development – >$15 Billion


Source:AAPG


Source:devonenergy.com

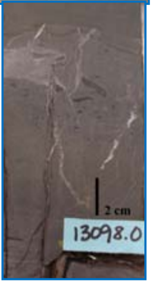

Source:chiefoiland gas.com

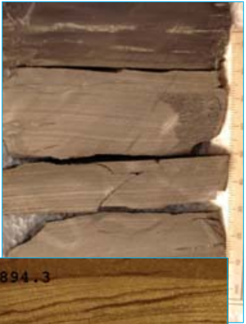

Source:AAPG


Source:devonenergy.com

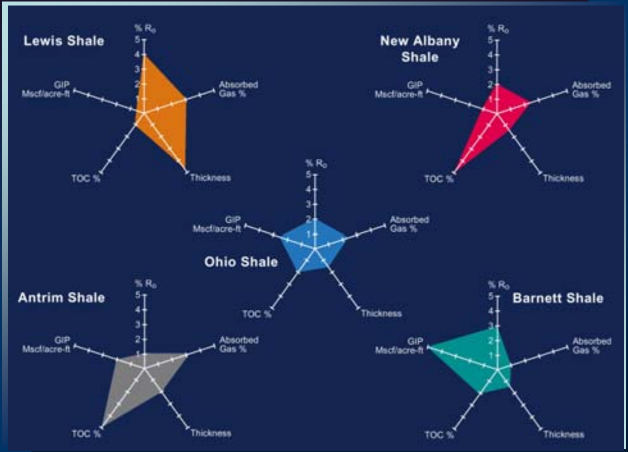
It’s not all black shale

Woodford Shale Consortium





Geochemical Properties of Gas Shales

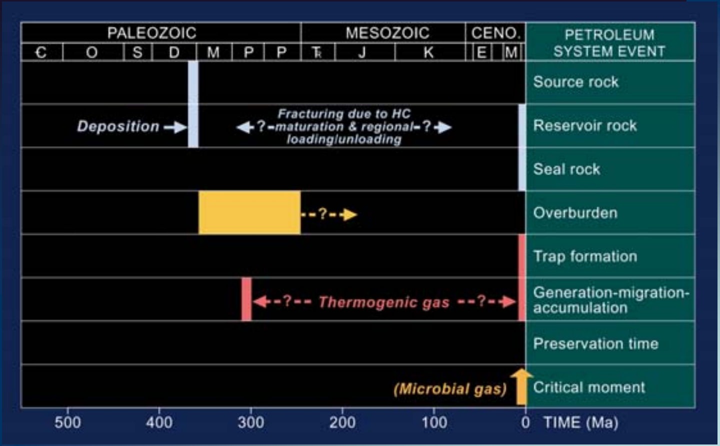


Modified from Hill and Nelson, 2000

Exploration Considerations

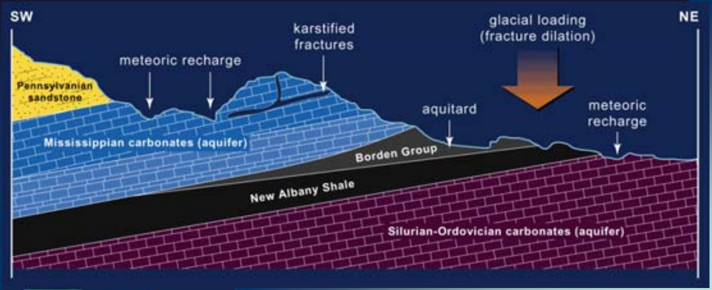
- Natural fractures - Friend or Foe?
- Facies changes - greater k
- Kerogen type
- Biogenic or thermogenic gas?
- Thermal maturity
- MWD - especially w/ gas isotopes

Evolution of Antrim Shale Gas

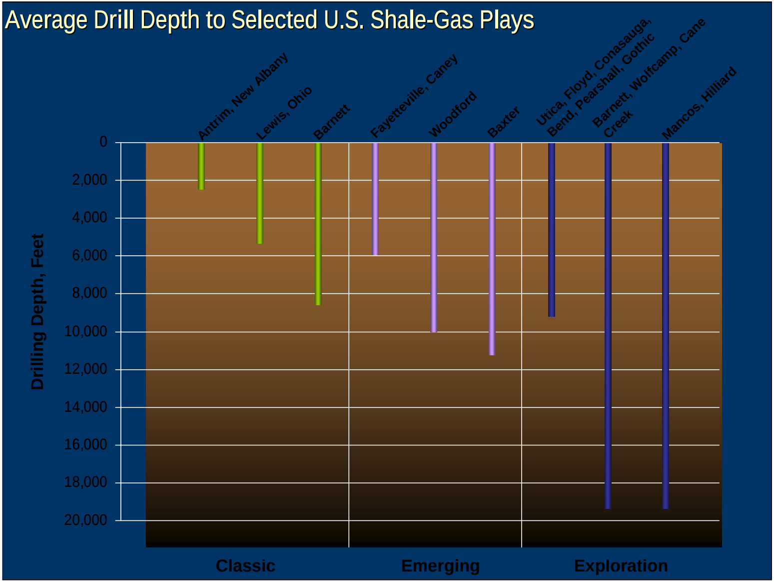


Modified from original work by Ira Pasternack

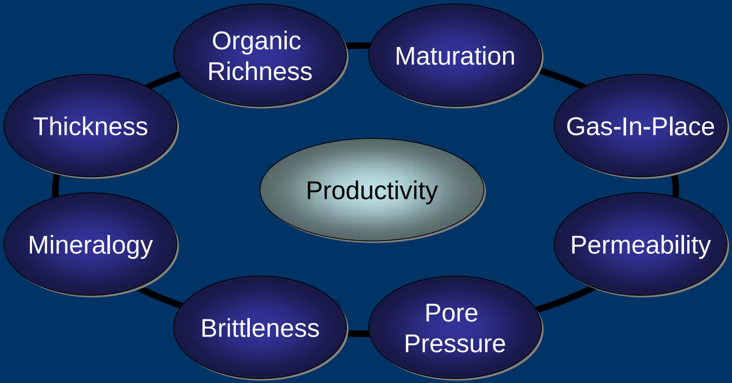
Hydrogeology of New Albany Shale



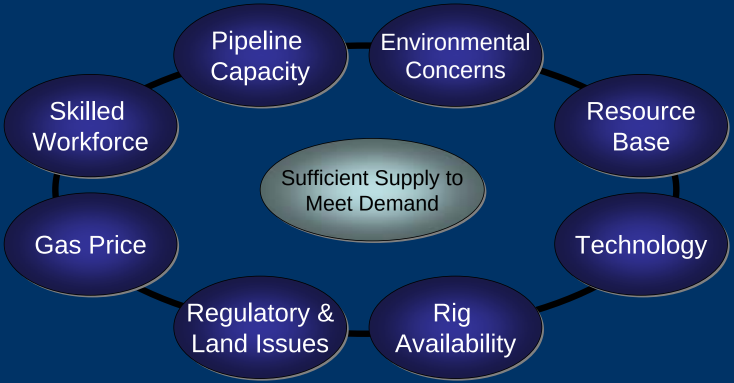
Modified from Walter and others, 2000


Average Drill Depth to Selected U.S. Shale-Gas Plays
Drilling Depth, Feet
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
20,000
Antrim, New Albany
Lewis, Ohio
Barnett
Fayetteville, Caney
Woodford
Baxter
Utica, Floyd, Conasauga, Bend, Pearshall, Gothic
Barnett, Wolfcamp, Cane Creek
Mancos, Hilliard
Classic
Emerging
Exploration

Some Elements of a Successful Shale Gas Play

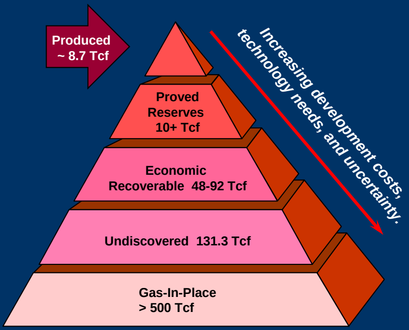


Possible Constraints on Future Gas Supply



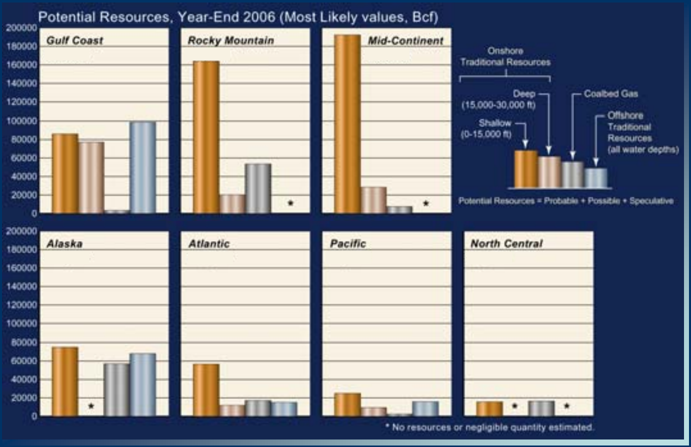
U. S. Shale-Gas Resource Base (Prior to 2007)

241 Tcf Producible



Modified and Updated from Hill and Nelson, 2000

Regional Resource Comparison (PGC 2007)

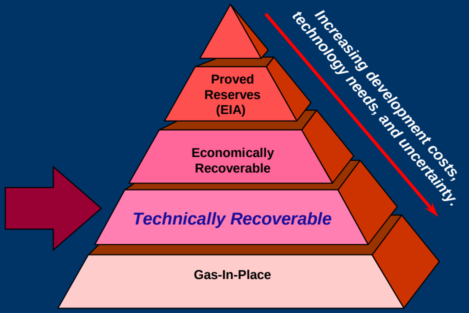


Data source: Potential Gas Committee (2007)

Shale Gas Assessments (PGC 2009)

- ***Appalachian*** (Ohio, Rhinestreet, Utica Chattanooga, Dunkirk, Conasauga, Marcellus)
- ***Michigan*** (Antrim, Bedford, Sunbury)
- ***Illinois*** (New Albany)
- ***LA, MS, AL Salt*** (Haynesville, Bossier)
- ***East Texas*** (Haynesville, Bossier)
- ***Texas Gulf Coast*** (Eagle Ford, Pearsall)
- ***Arkoma*** (Fayetteville, Caney, Woodford, Moorefield)
- ***Ft. Worth*** (Barnett)
- ***Permian*** (Barnett, Woodford)
- ***Uinta*** (Mancos, Manning Canyon)
- ***San Juan*** (Lewis, Mancos)

U. S. Shale-Gas Technically Recoverable Resource Update: 10 Days to Go…



Potential Supply of Natural Gas in the United States

Report of the Potential Gas Committee (as of December 31, 2008)

Press Release
6/18/2009
Washington, D.C.

Contact Linda D'Epagnier for Press Release: ldepagni@mines.edu