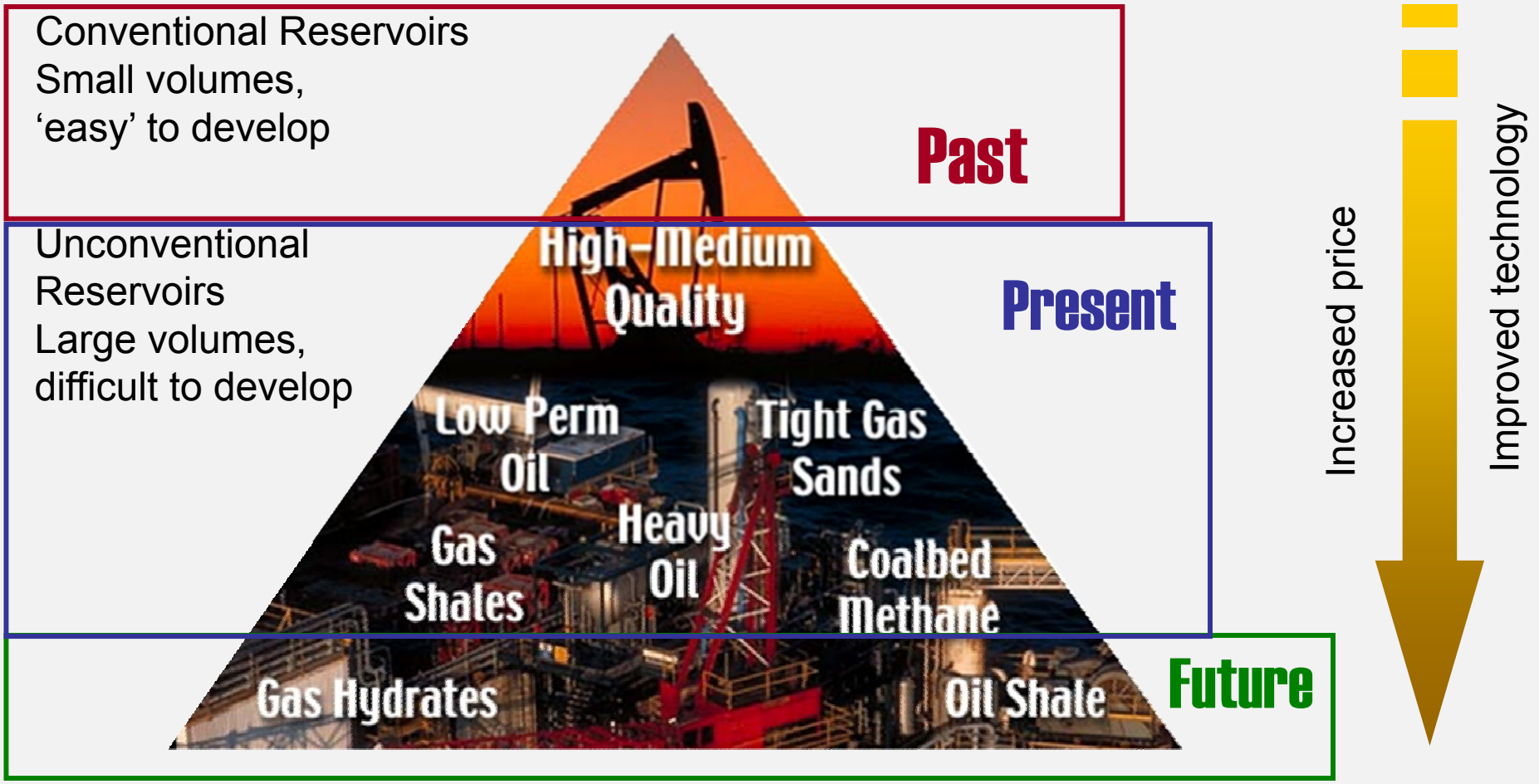
Has Unconventional Become Conventional?

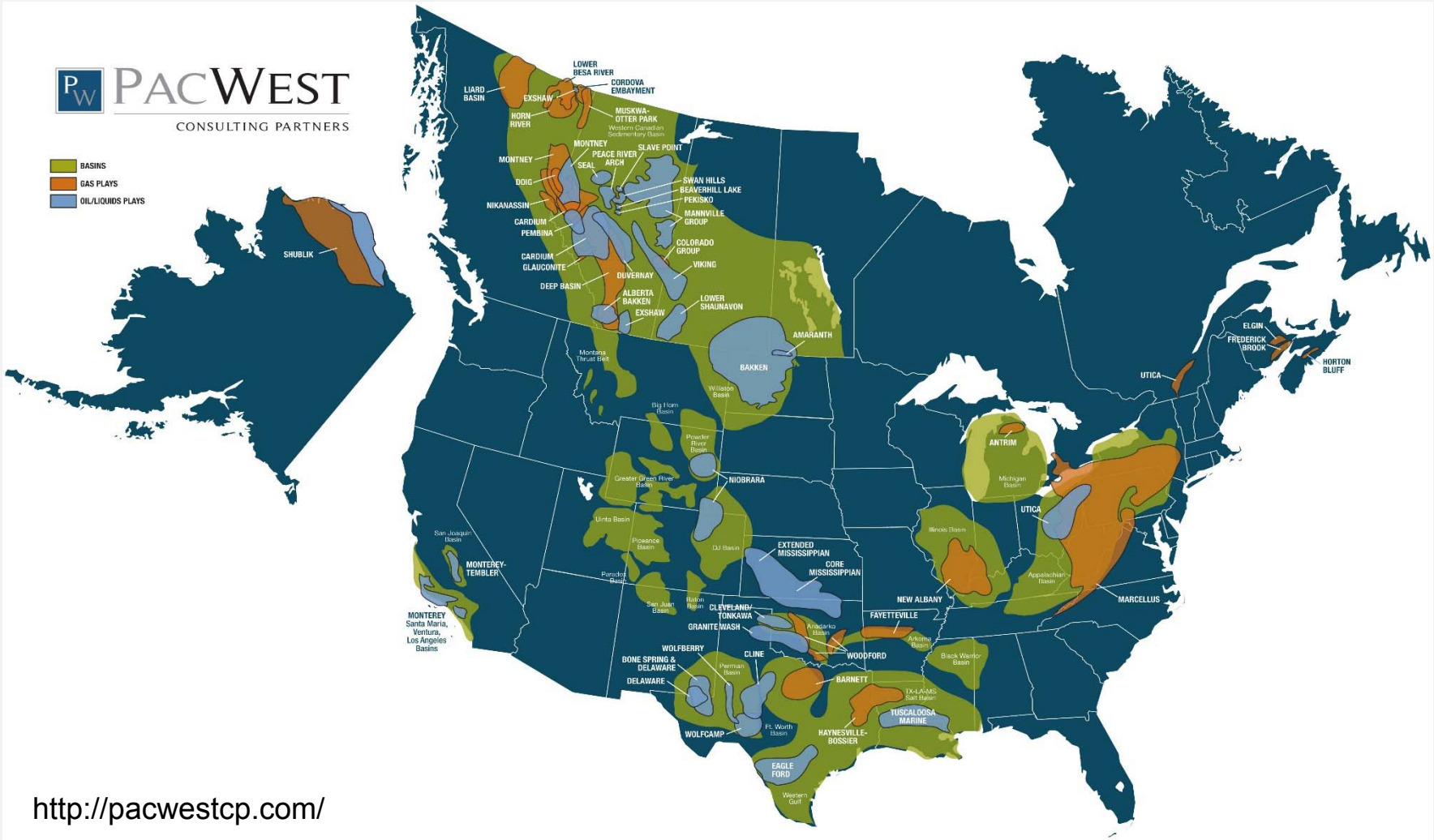
SPEE Luncheon Presentation
February 4, 2015

Dr. Christine Ehlig-Economides
University of Houston

Hydrocarbon Resource Triangle

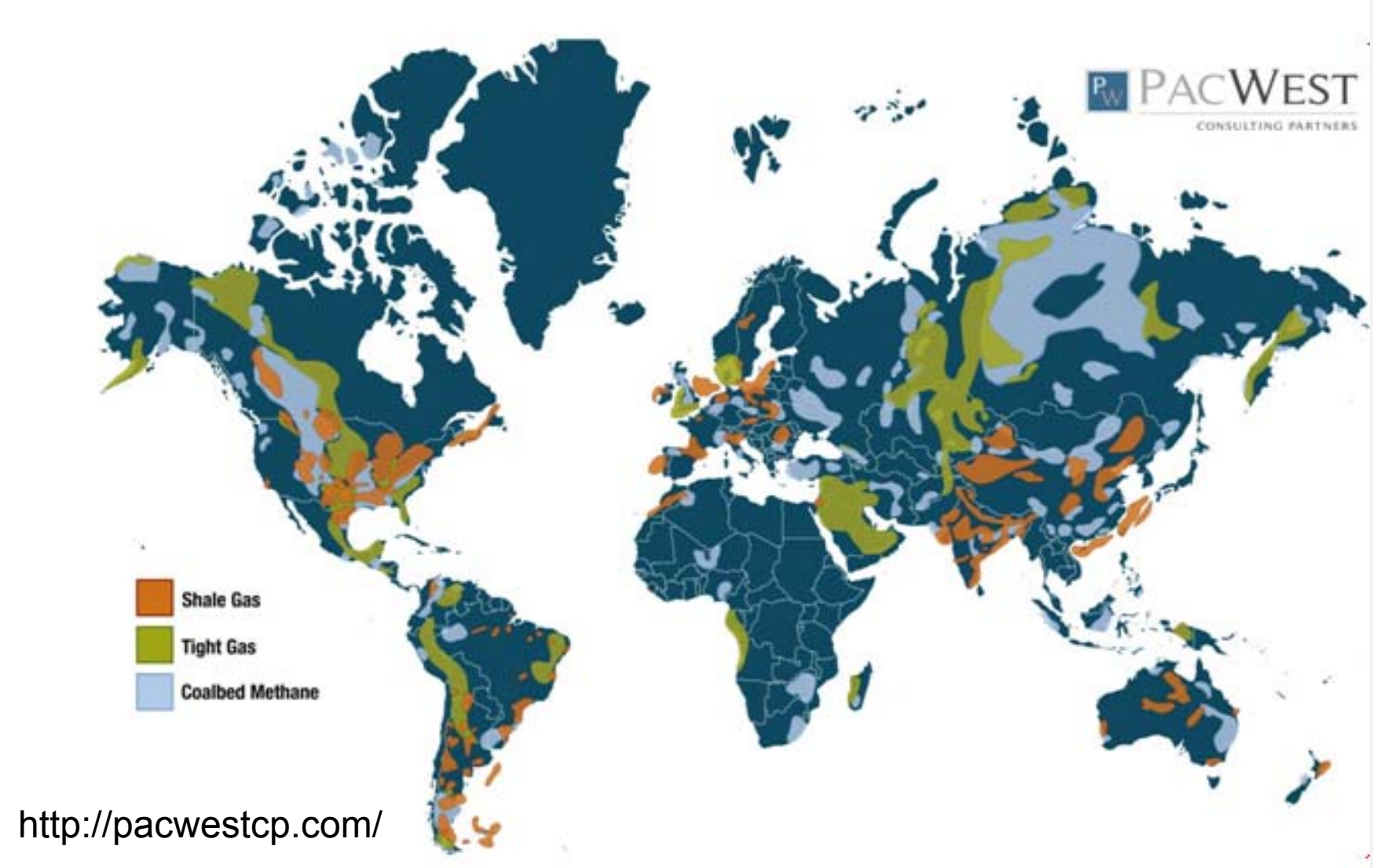


North America Shale Plays



http://pacwestcp.com/

World Unconventional Gas

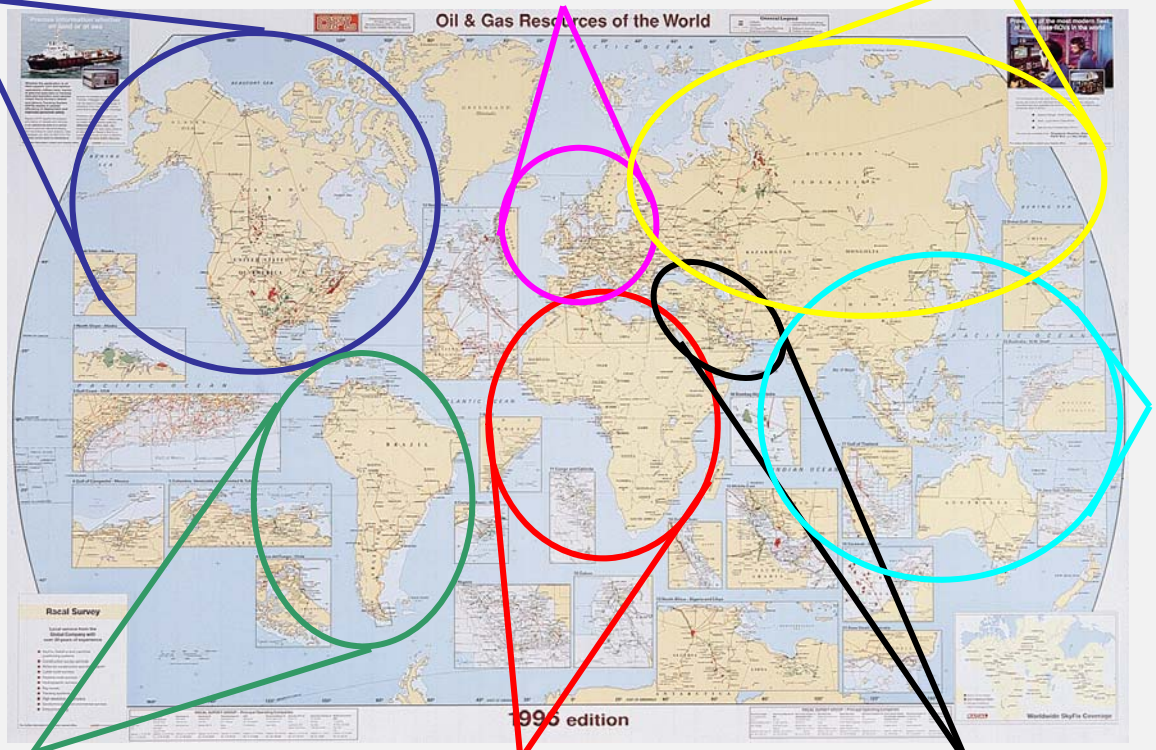


A World of Oil

North America:
15.4 MMbbls/day
50 Billion bbls
2805 billion bbls

Europe:
7 MMbbls/day
18.3 Billion bbls
52 Billion bbls

Former Soviet Union:
9.0 MMbbls/day
79 Billion bbls
2254 Billion bbls



Asia:
8 MMbbls/day
38.7 Billion bbls

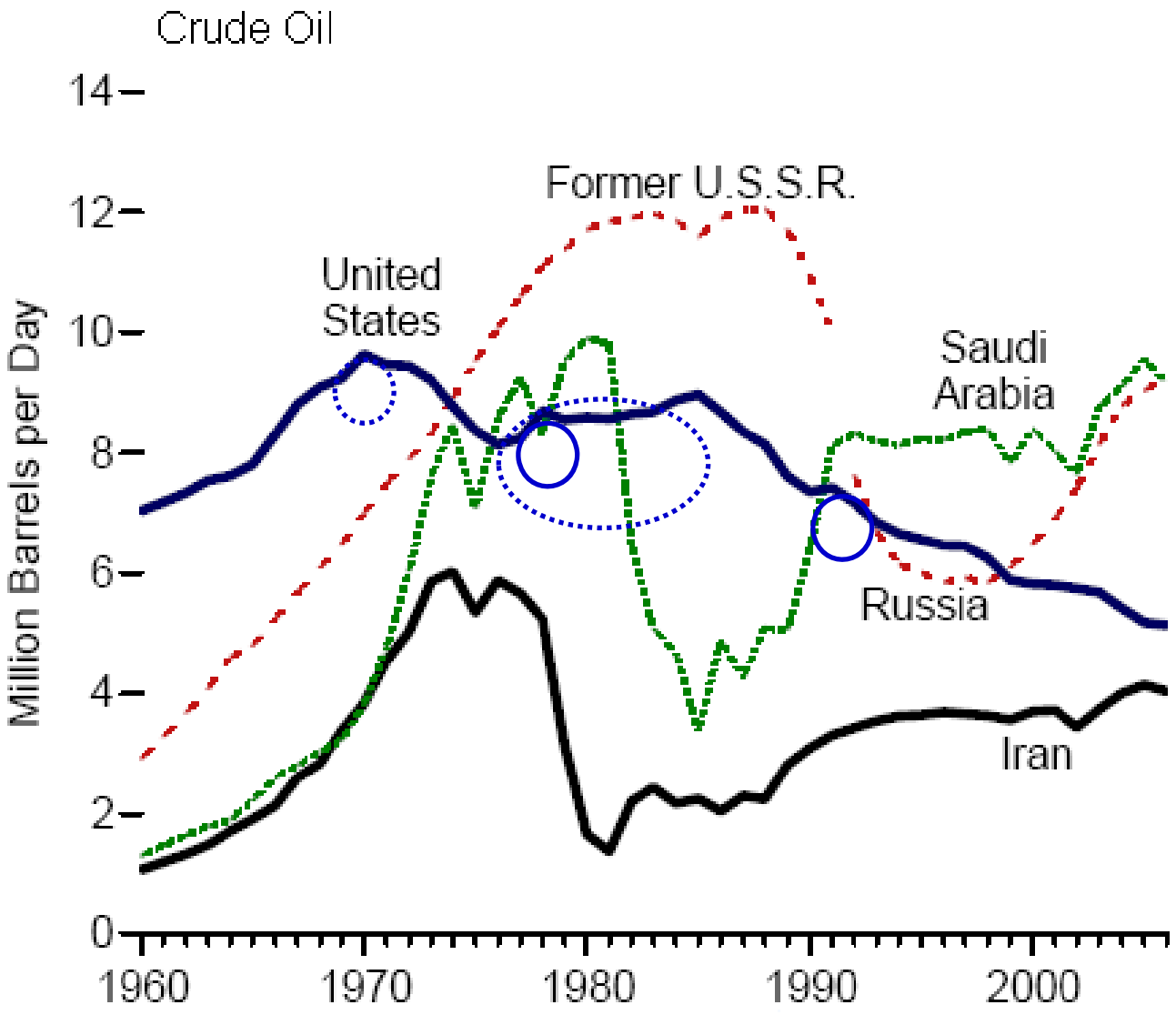
South America:
6.9 MMbbls/day
98.5 Billion bbls
2174Billion bbls

Africa:
8.1 MMbbls/day
77.4 Billion bbls
184Billion bbls

Middle East:
22.5 MMbbls/day
685 Billion bbls
470 Billion bbls

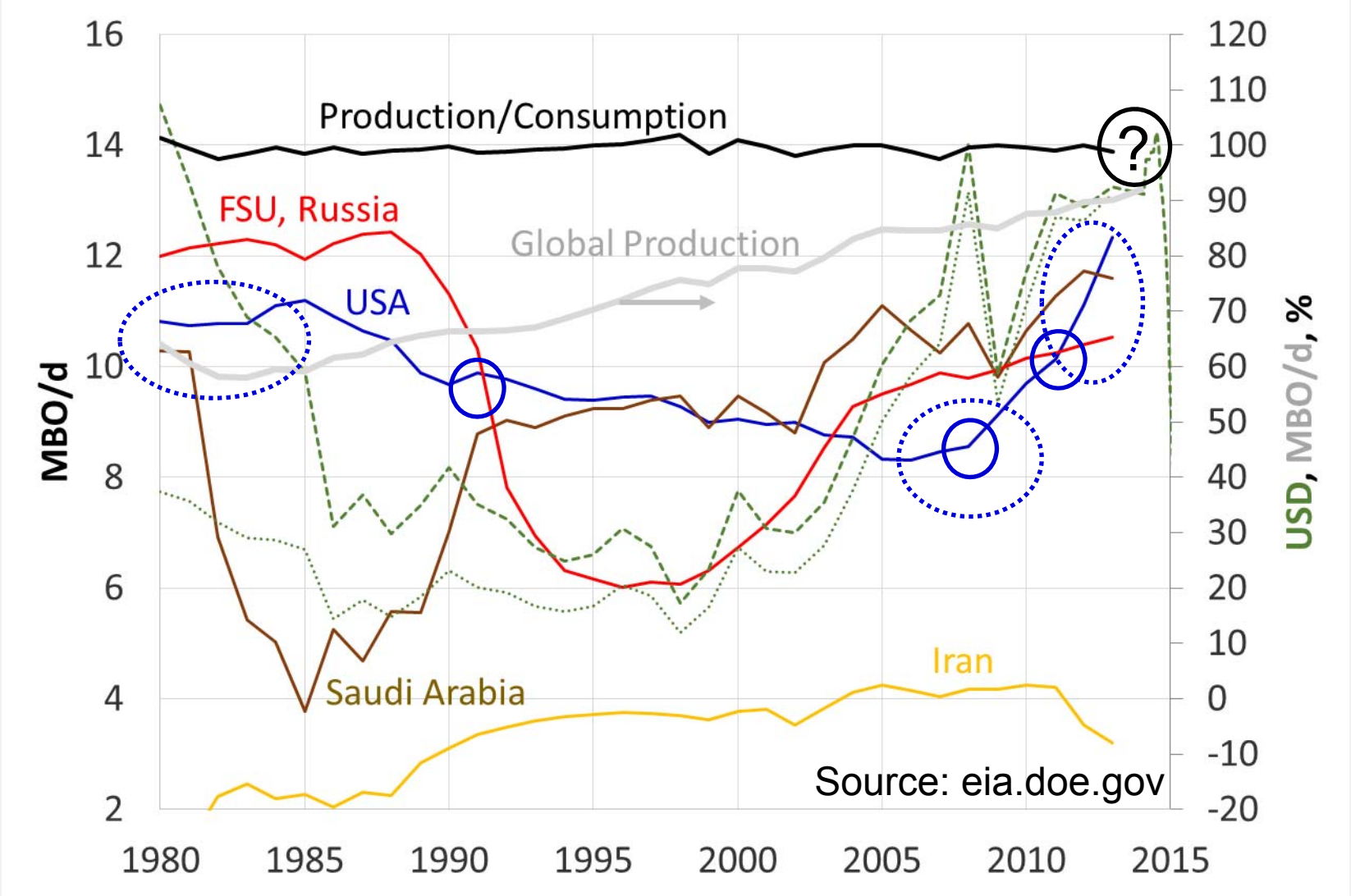
Production and Price

Top Producing Countries, 1960-2006

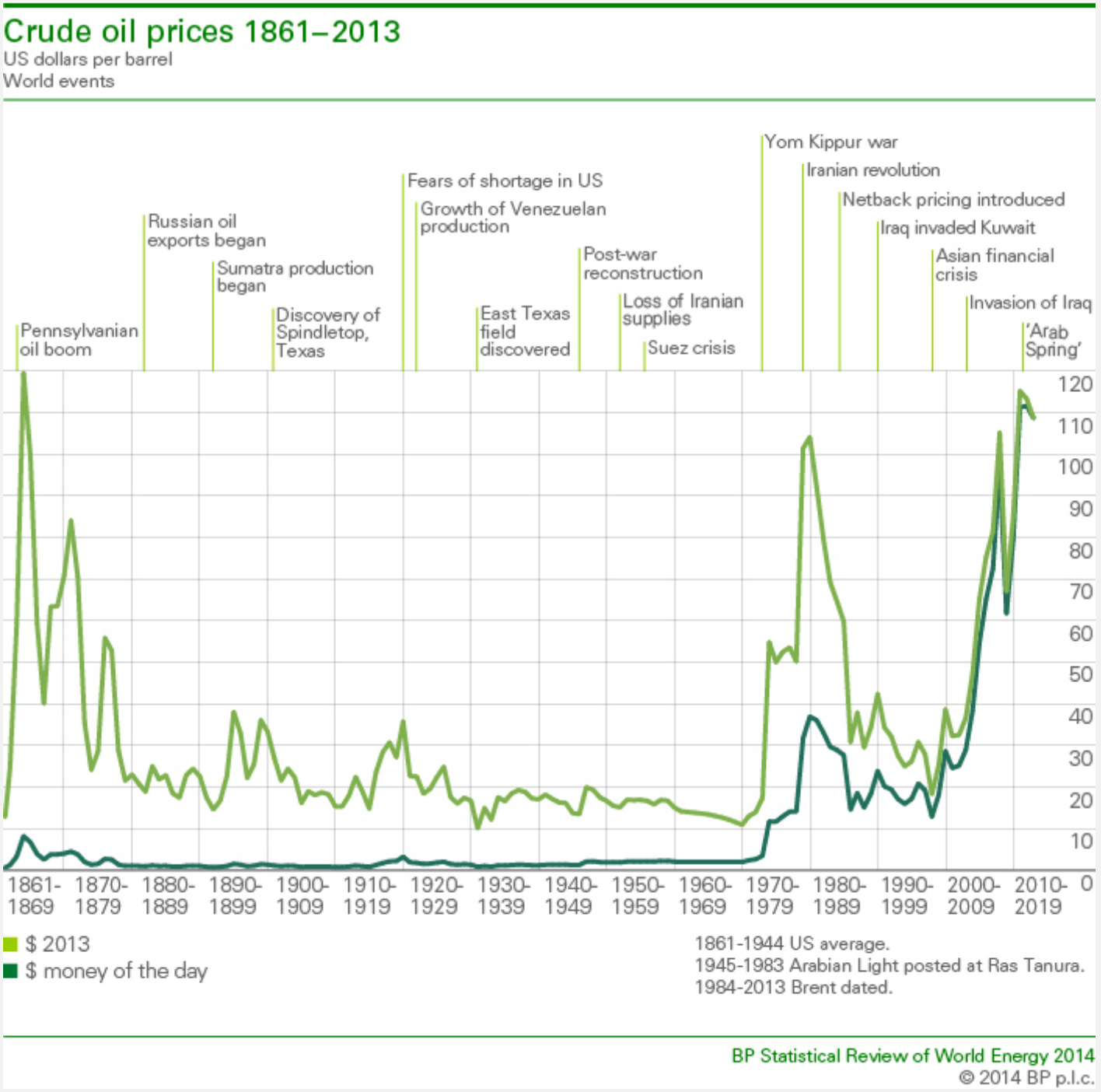


Source: US DOE, Energy Information Administration
Annual Energy Review 2006

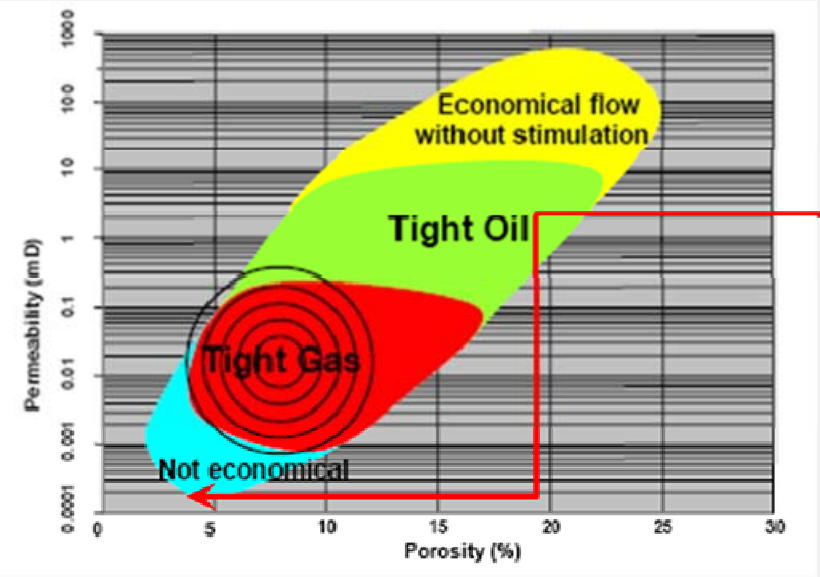
Production and Price



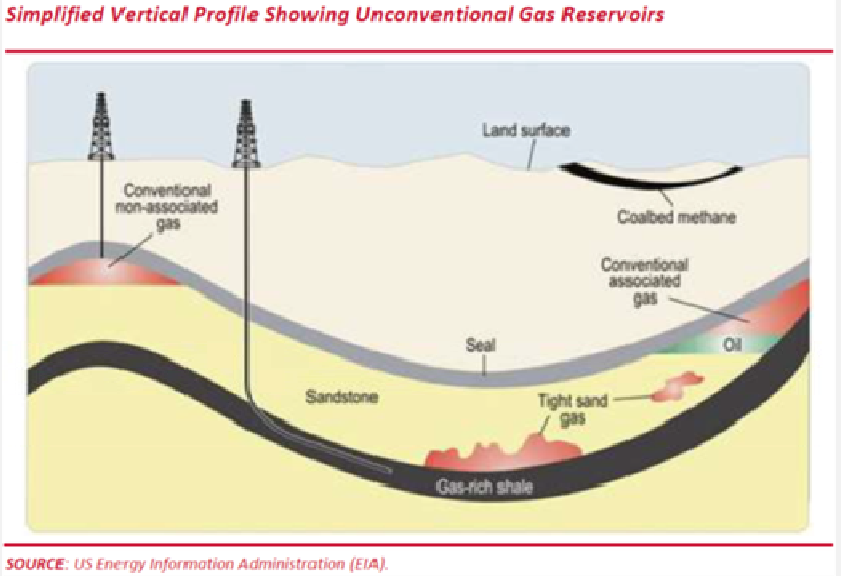
Geopolitics and Oil Price



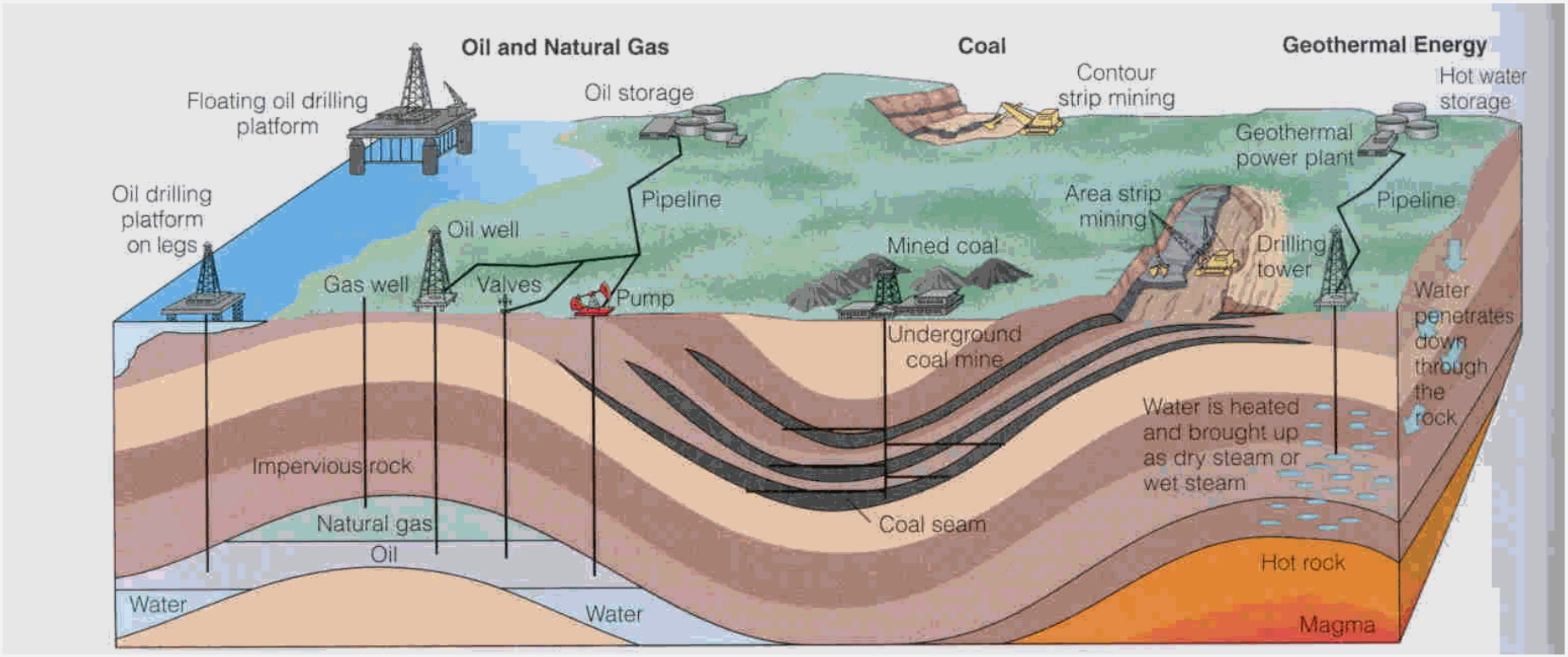
Permeability and Volume



Post 2006: Shale Matrix Permeability range

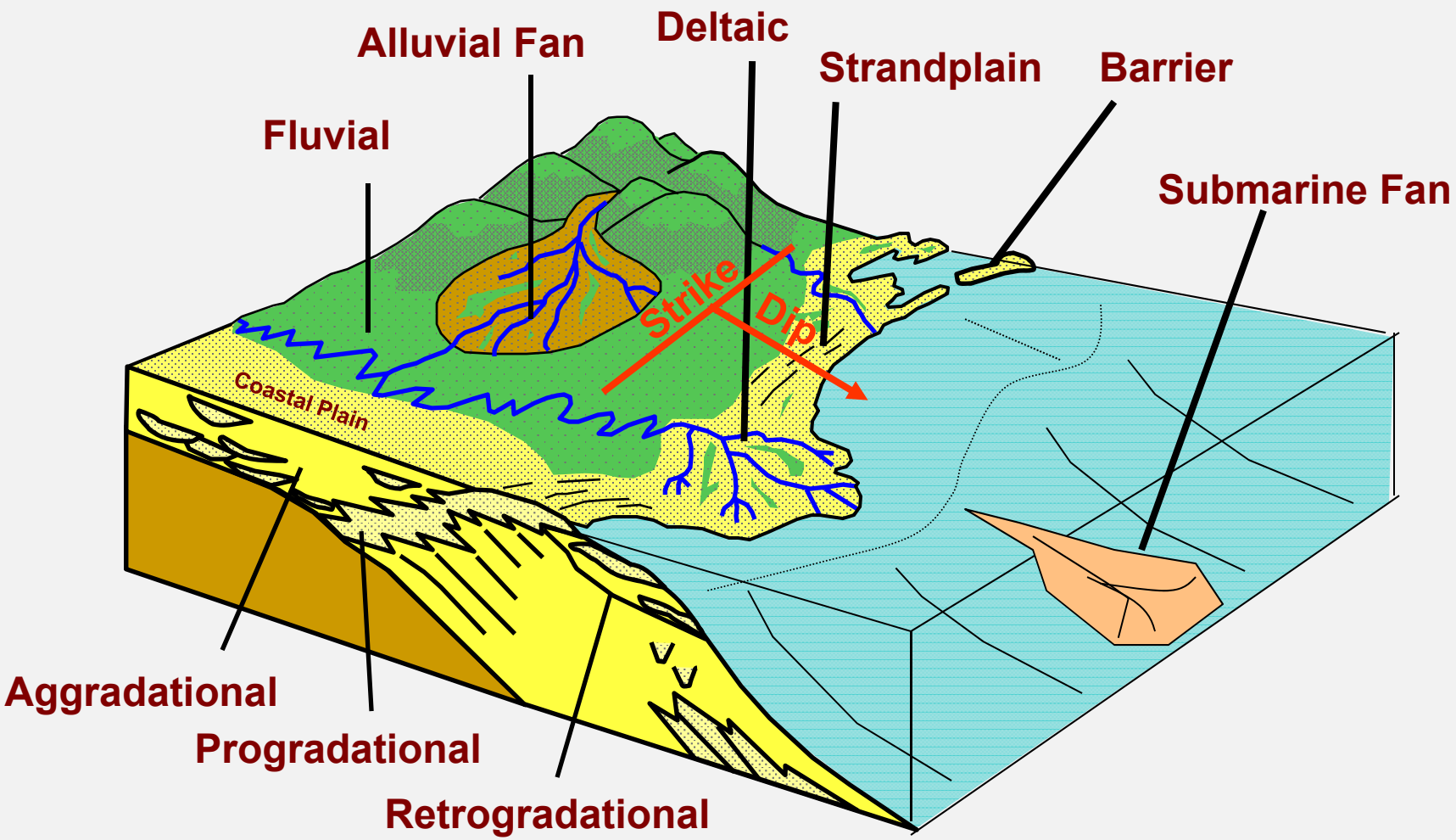


Fossil and Geothermal Energy Sources



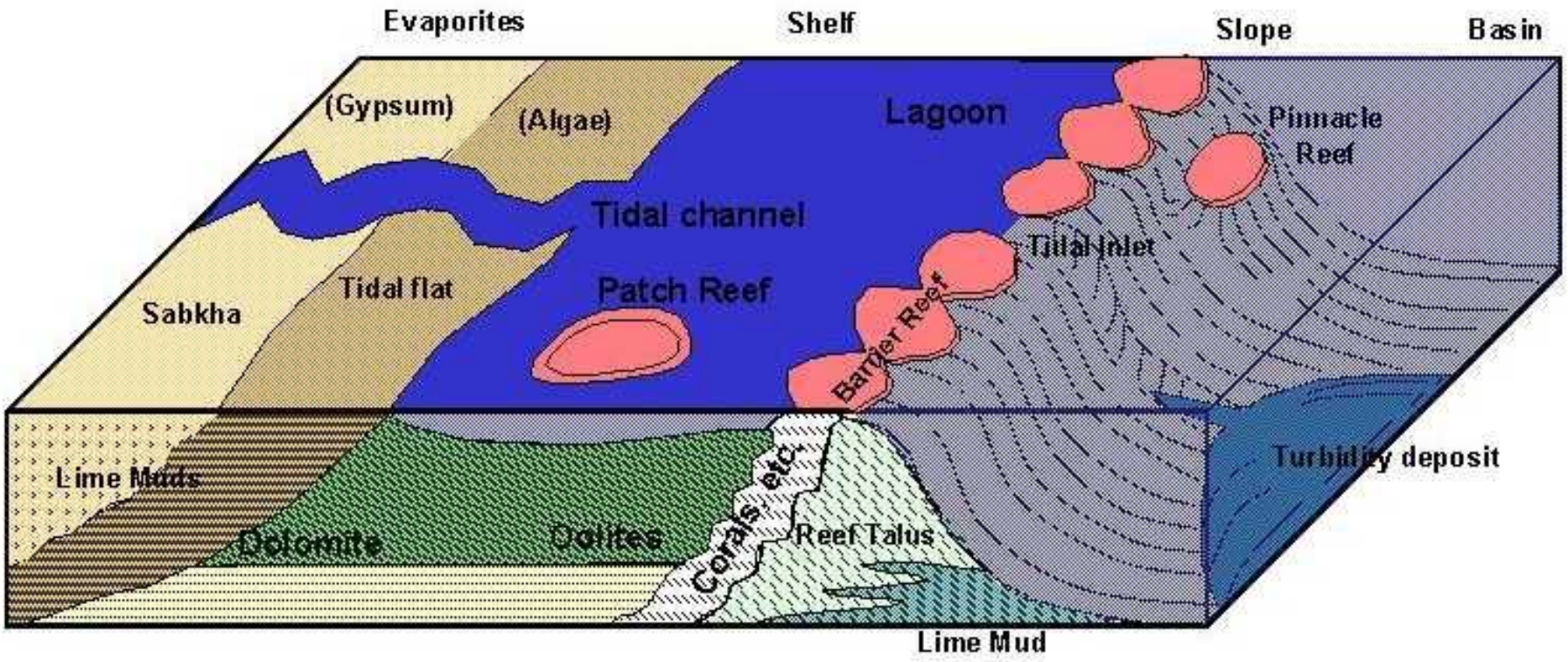
http://geosurvey.state.co.us/energy/Coal/Pages/CoalHowdoesitform.aspx

Clastic Depositional Systems

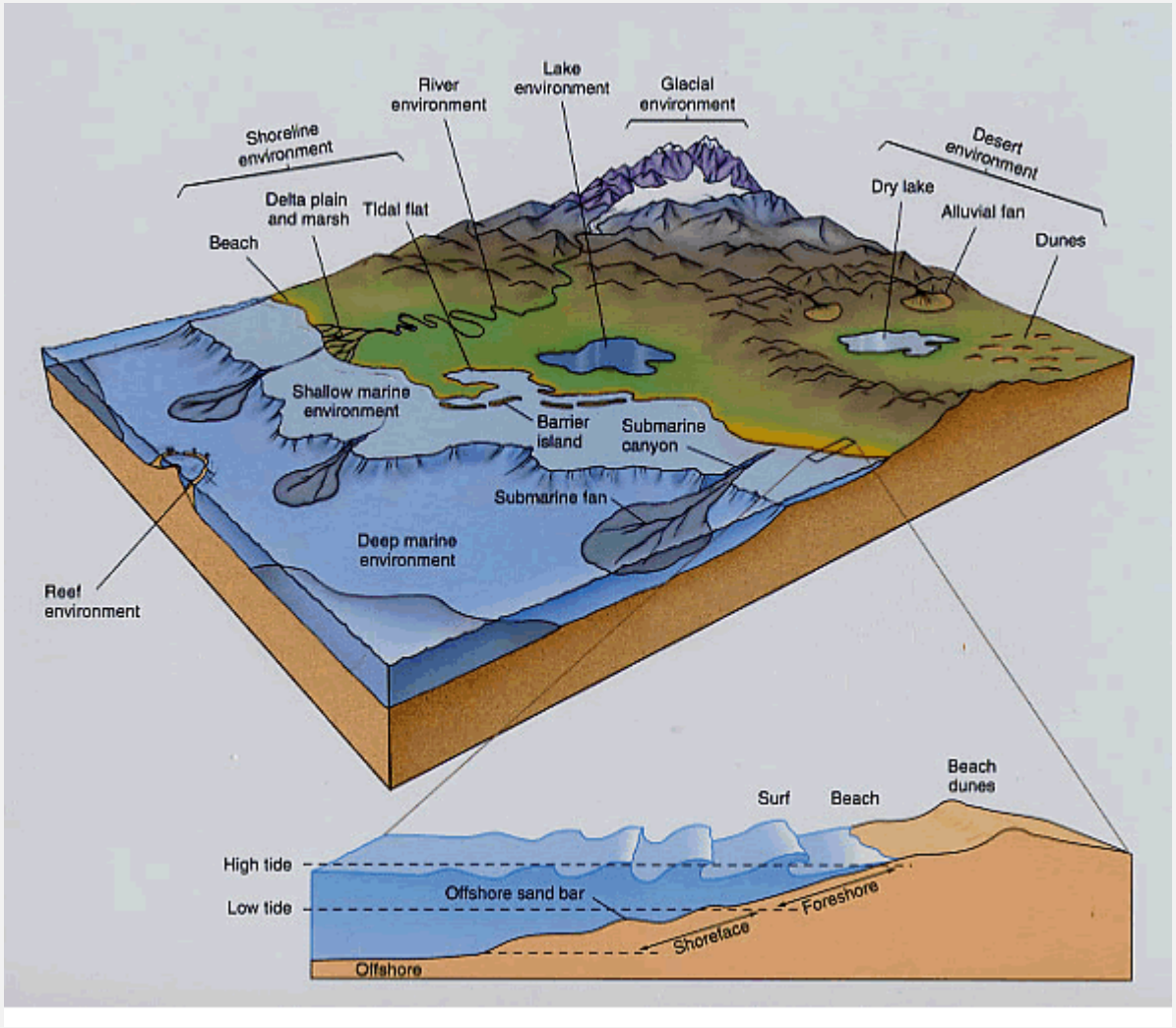


Modified from Hentz and others, 1997

Carbonate Deposition

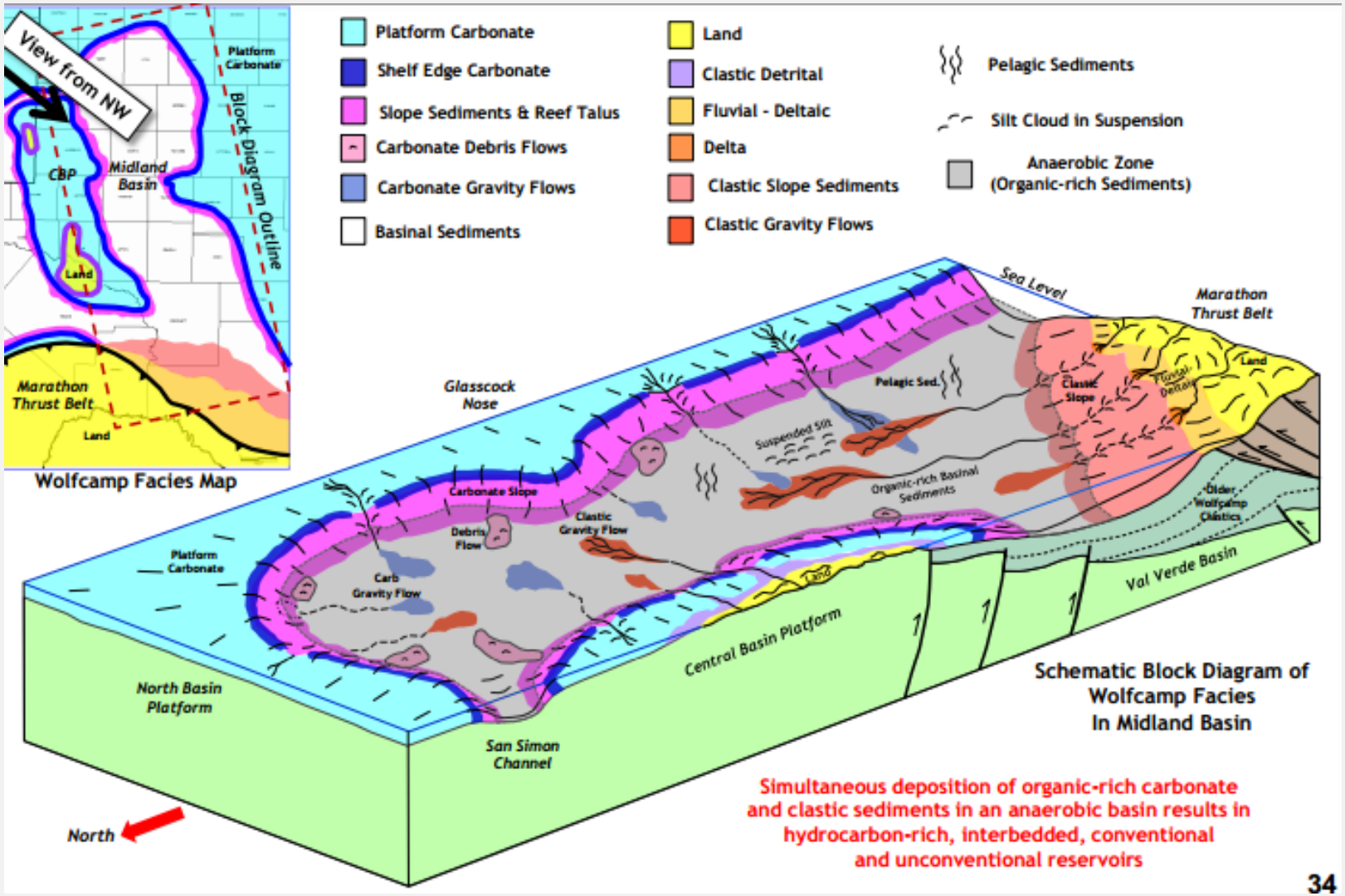


Shale Deposition



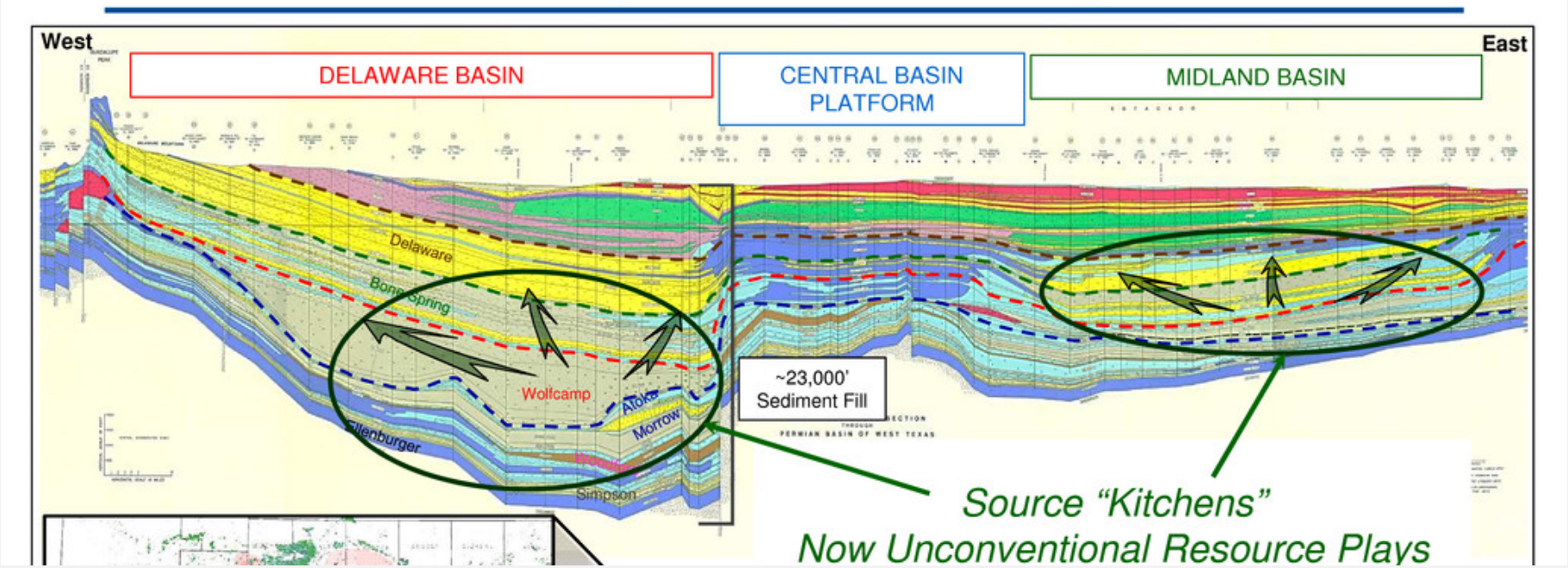
Guillermo Rocha, P. G. / Brooklyn College Geology Department http://academic.brooklyn.cuny.edu/geology/grocha/monument/shale.html

Wolfcamp Depositional Model



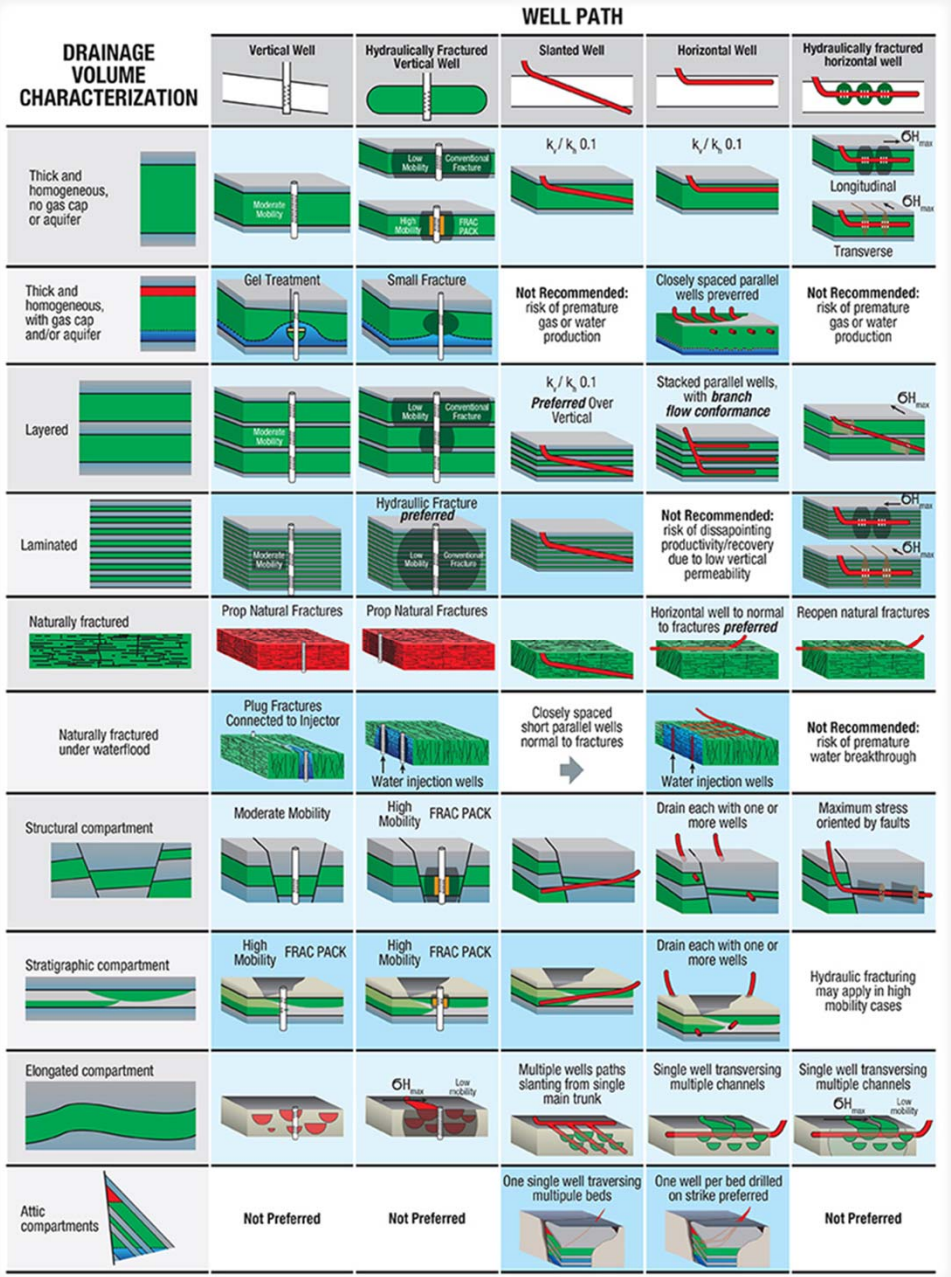
Pioneer Natural Resources Investor Presentation

Wolfcamp as a Source Rock

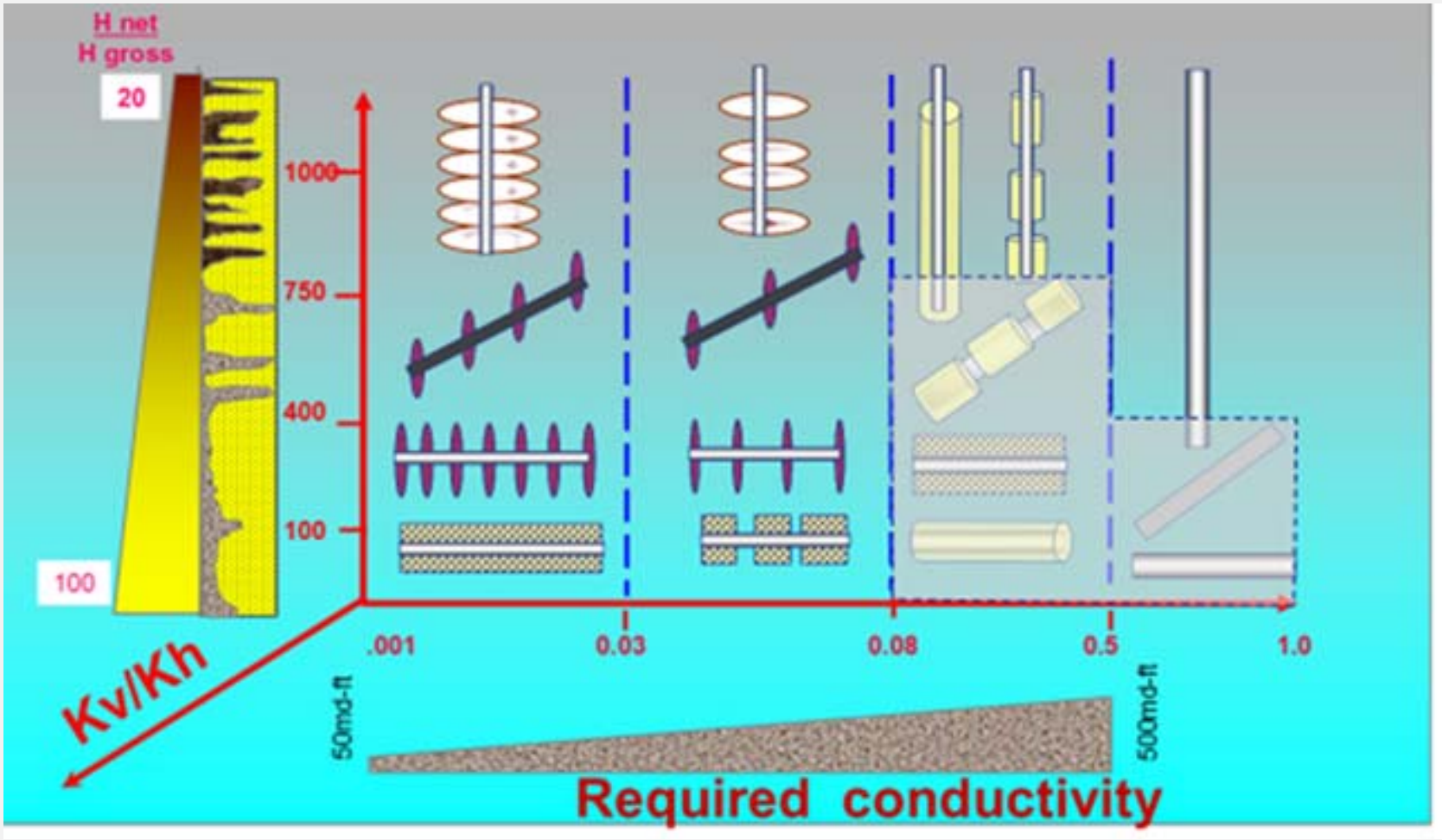


Source: http://www.sec.gov/Archives/edgar/data/1405073/000119312513141665/d516183dex991.htm

Qualitative Well Concepts



Quantitative Well Design Criteria



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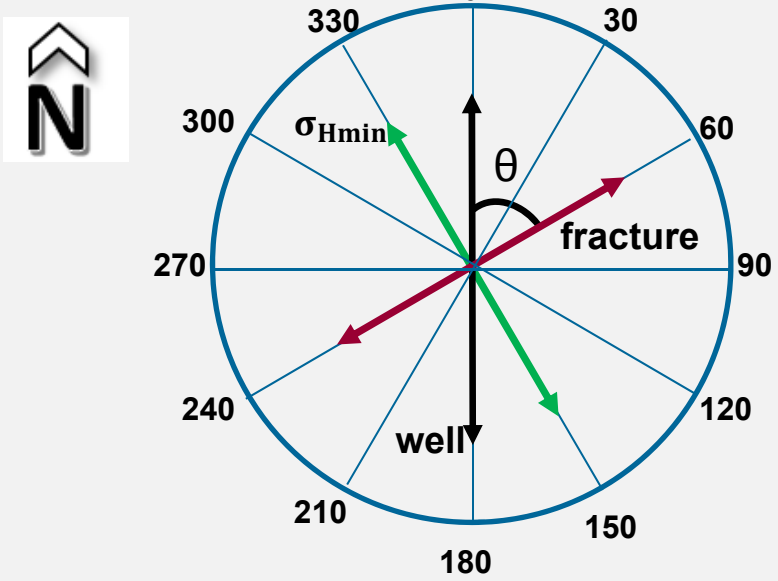
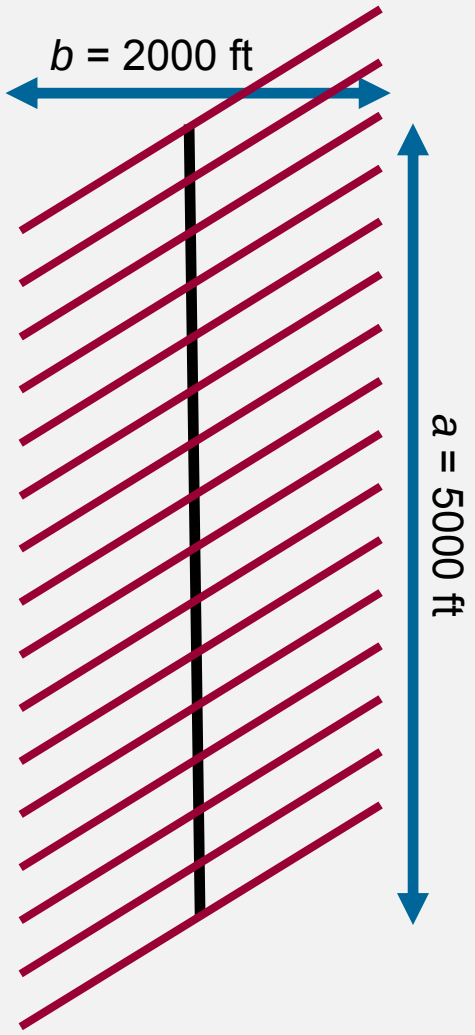
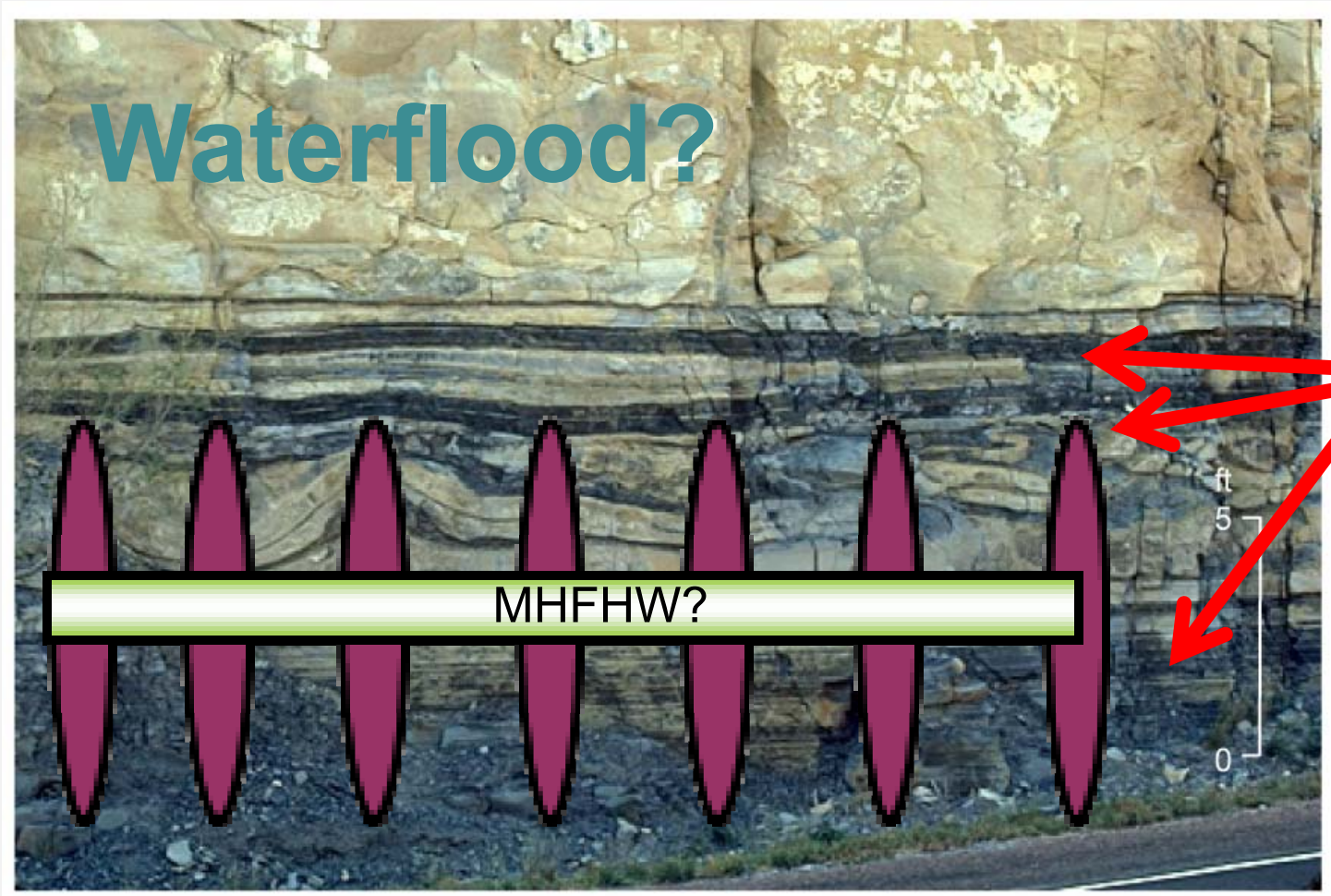
Operational Challenge





- Hydraulic fracture planes propagate perpendicular to minimum stress independent of the horizontal well direction.
- Operators frequently drill horizontal wells in other directions.

DMG Outcrop



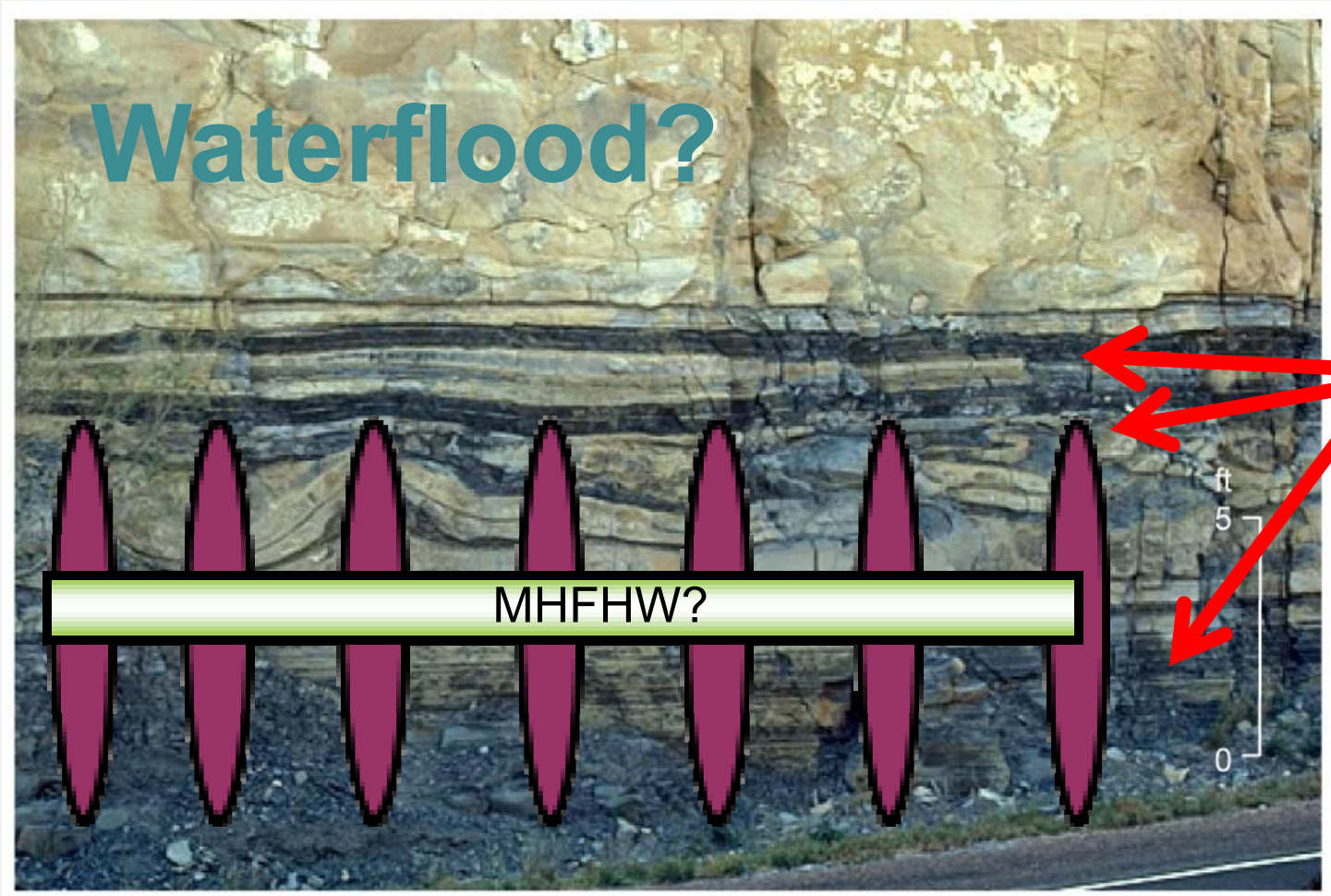
ϕ ~ 15%
S_o ~ 20%
S_w ~ 50%
k ~ 10 md

Organic-rich siltstones

ϕ ~ 5%
S_o ~ 20%
S_w ~ 60%
k ~ 0.01 md
TOC up to 46%

Middle Permian Basinal Siliciclastic Deposition in the Delaware Basin: The Delaware Mountain Group (Guadalupian)

DMG Outcrop



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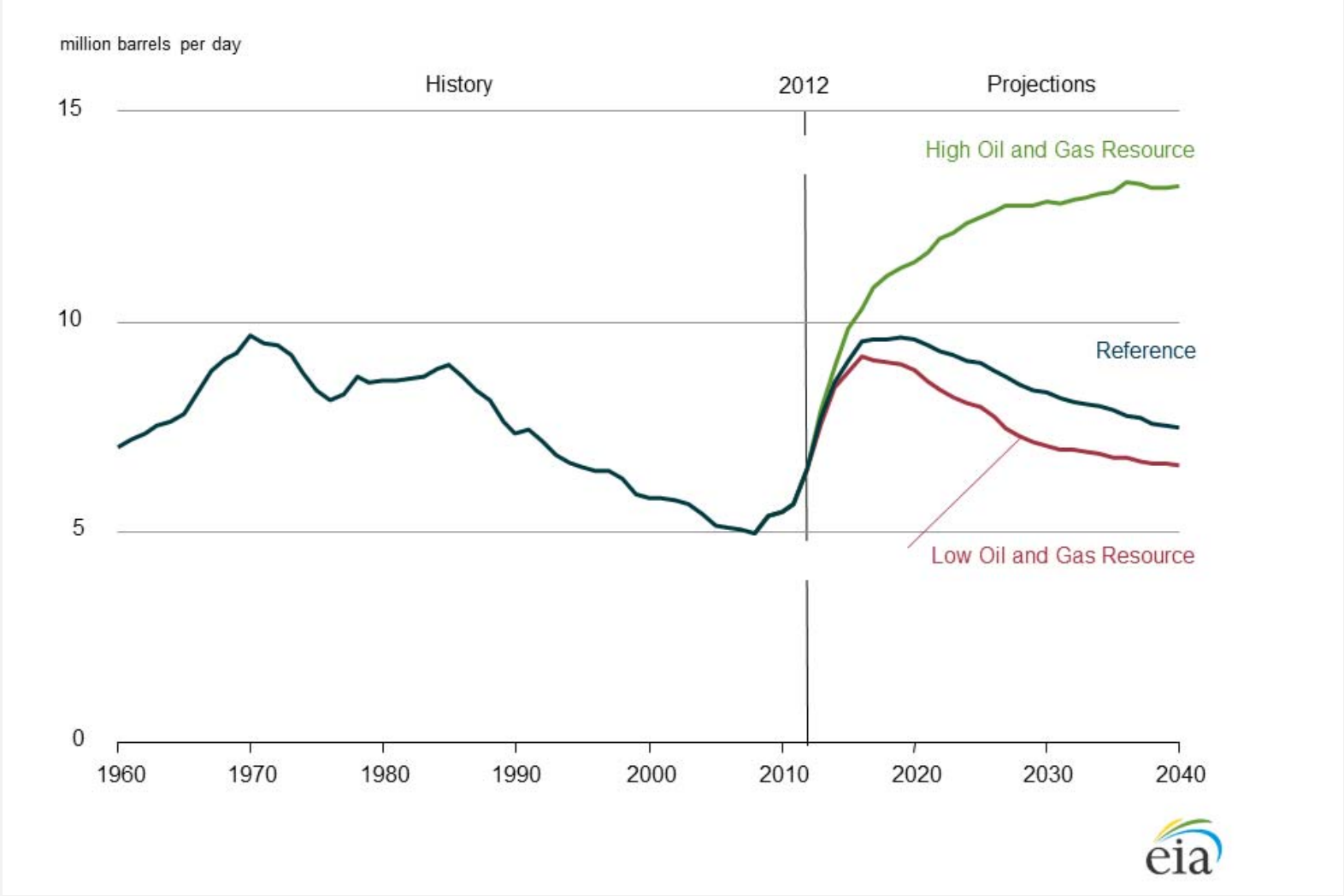
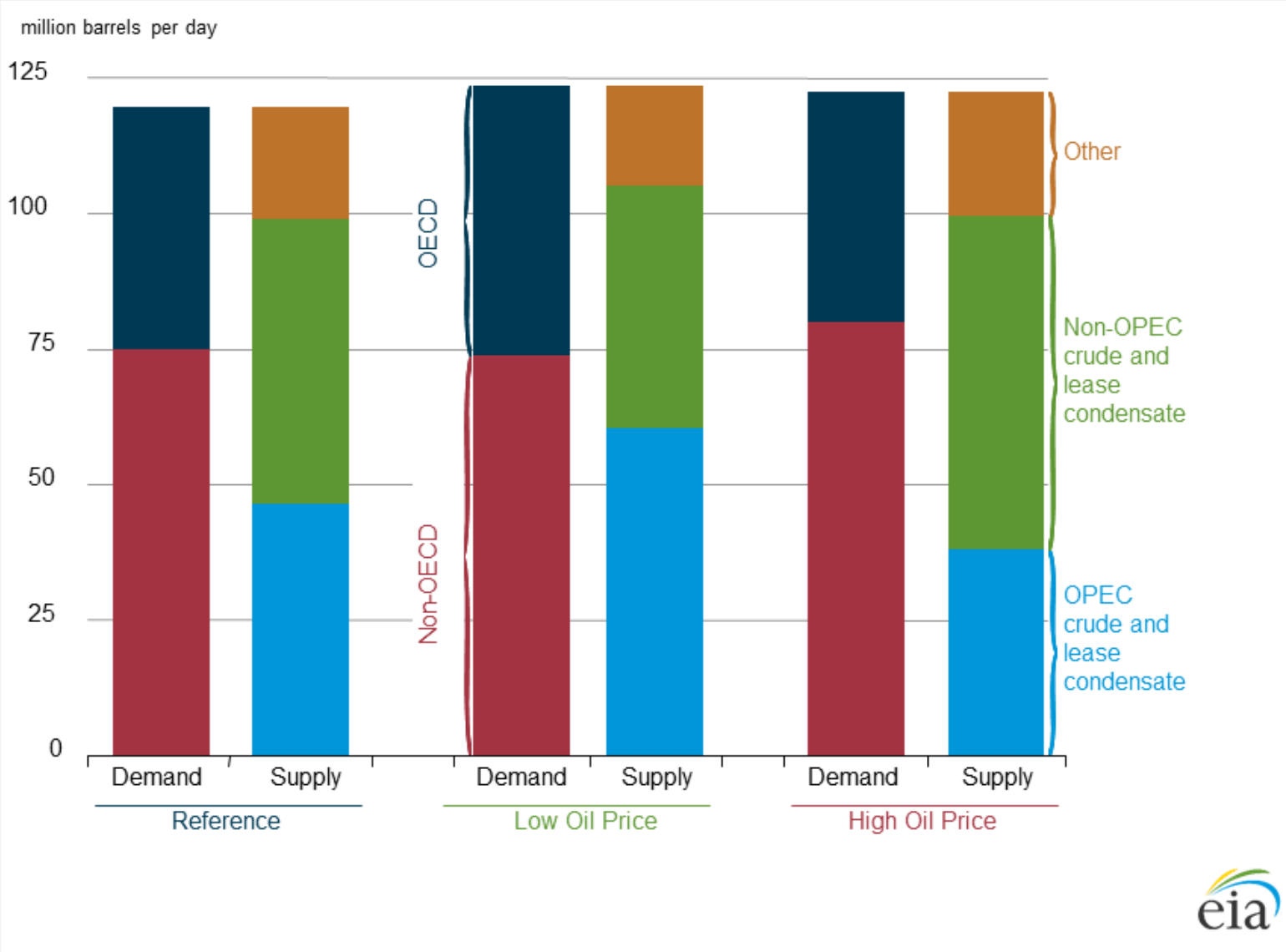
EIA US Production Forecasts

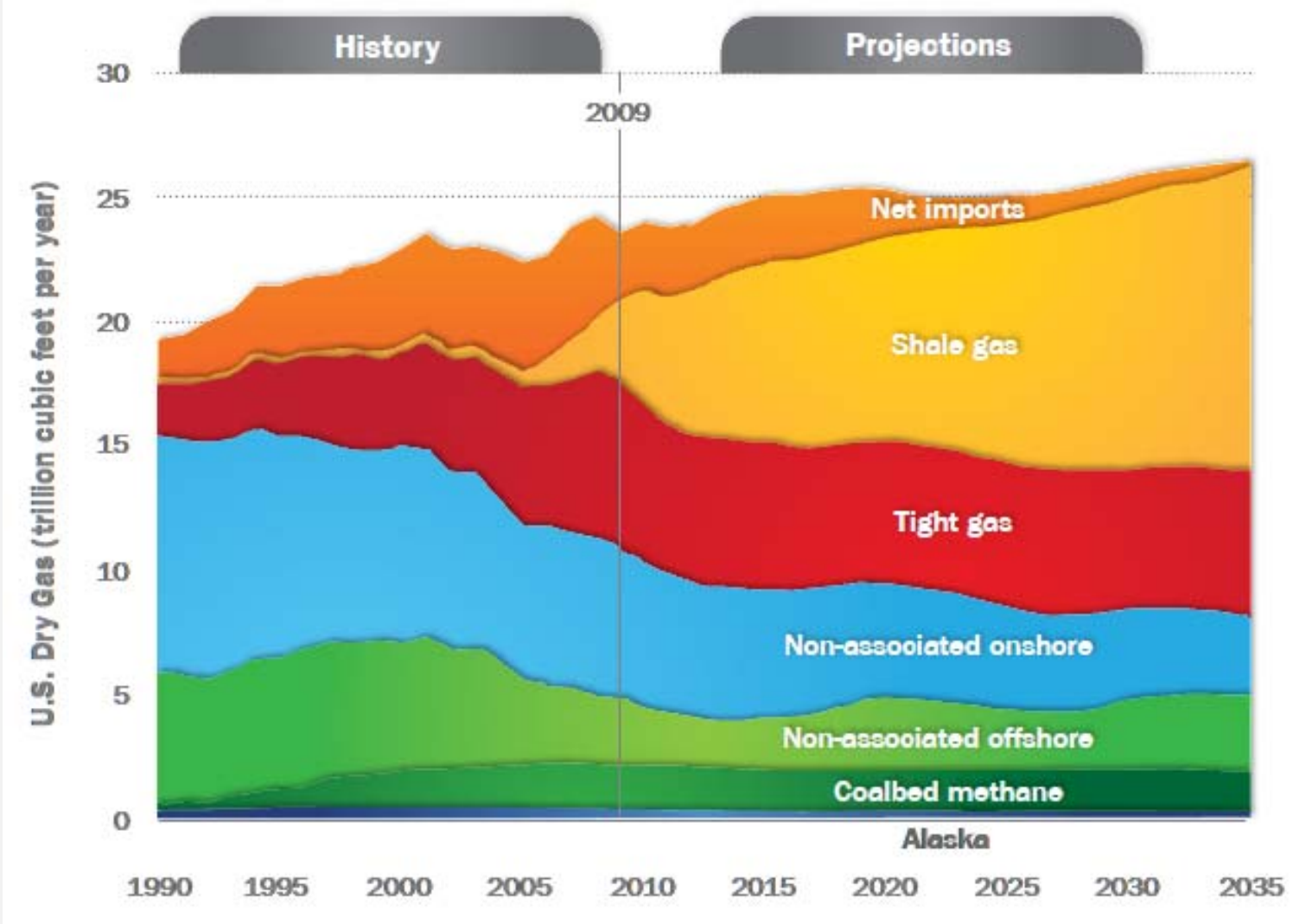


Reality Check: Oil price > $110/STB and rising

EIA on Oil Price Impact



Natural Gas Supply

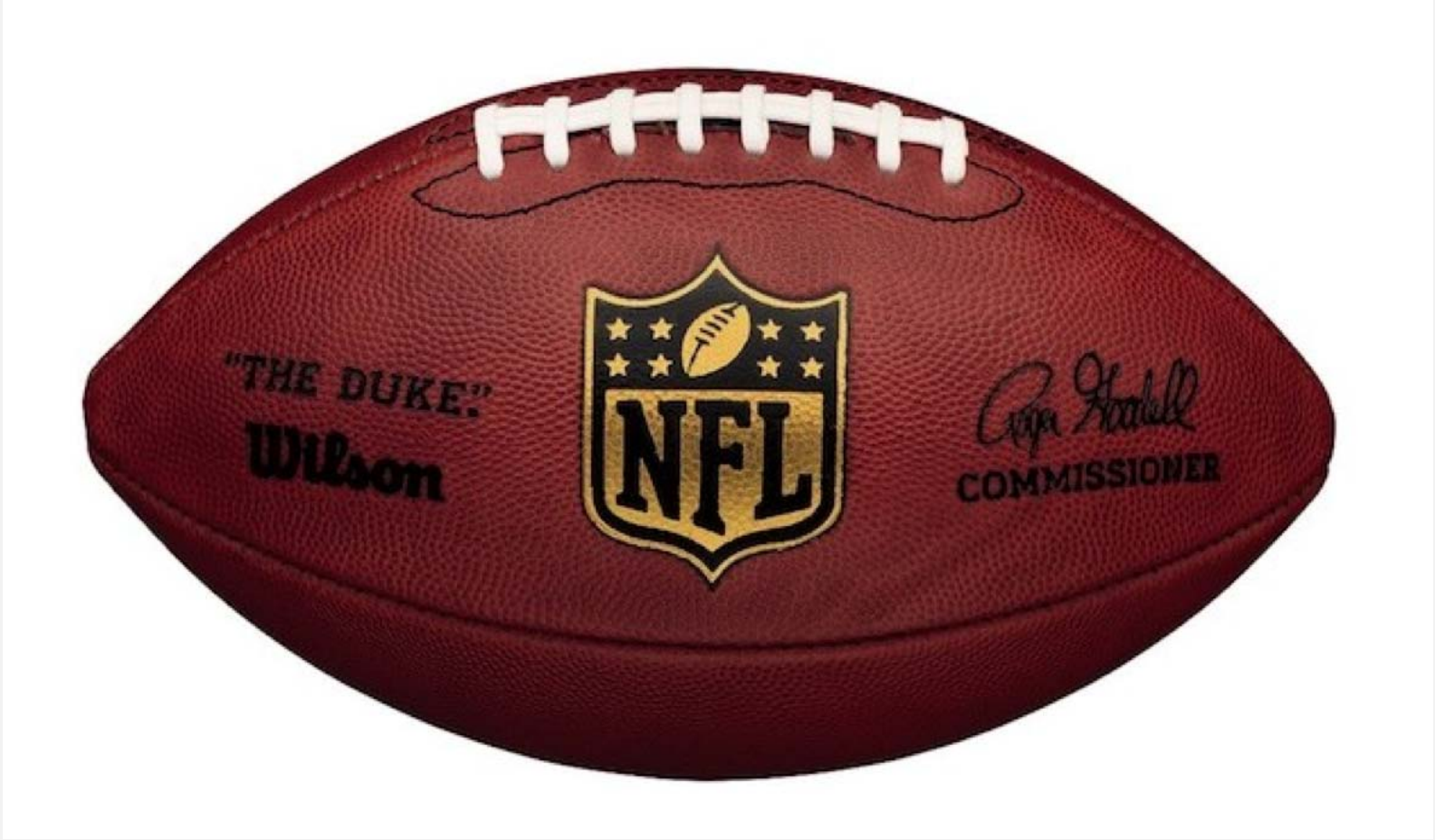


Source: DOE QTR Report 2011

Natural Gas Emerging Markets

- Electricity Generation
- Petrochemical feedstock
- Transportation
- LNG export
- Condensate export

Football Question



How much pressure will the football lose when inflated at 70 ^{o}F and in play at 35 ^{o}F?