CEE CENTER FOR ENERGY ECONOMICS

Bureau of Economic Geology, The University of Texas at Austin



Natural Gas Market, Technology Views

Congressional Seminar, 9/28/09

Overall Perspectives

- 1970s & 1990s “redux” with regard to perceptions about reliability, deliverability
  - Similar policy/regulatory disconnects are happening now
- Even without GHG policy, gas “push” is inevitable
  - With GHG caps, low carbon technologies are immature, timing of deployment and cost highly uncertain
  - Even without caps, strategic opposition to electric power transmission hinders both coal and renewables
- Oil and gas tax policies impact development
  - IDCs are particular challenge for continued drilling and exploitation

Conflicting Policy Views Persist

Even with storage at historic highs…

"Gas Short"

- Prevailing political sentiment (state regulators)
- Unconventional plays are unsustainable
- Global competition for LNG disadvantages US
- Persistent high and "volatile" prices

"Gas Long"

- Prevailing industry sentiment
- Unconventional plays are sustainable
- LNG will swing to US for storage, peak shaving
- Generally lower price deck but with price spikes

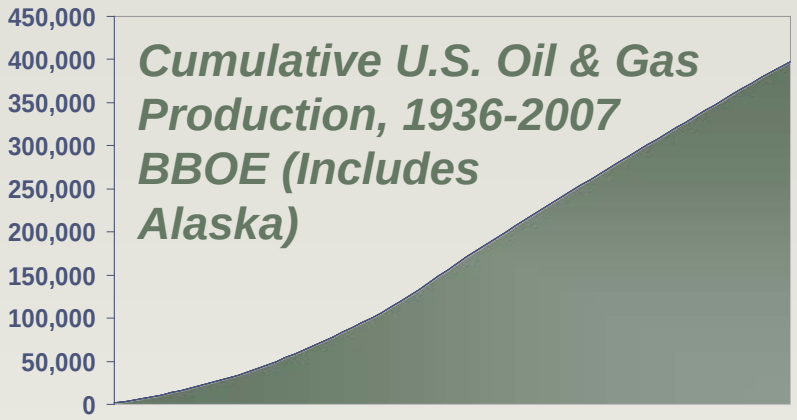
"Gas Short" Implications

- Undermines critical assumption that gas will be available for balancing
  - Renewables dispatch sensitivity
- Limits gas to incremental use
- Used to block progress on key upstream and midstream initiatives
  - OCS and other moratoria/restrictions
  - ROW for midstream

"Gas Long" Implications

- Gas can expand beyond "bridge fuel" assumptions
  - Persistent oil:gas price premium can support mixed end uses
  - Search for non-weather sensitive base load and cohesive commercial framework (policy/regulatory/market)
- Builds customer expectations regarding pricing and price risks
  - Search for strategies to dampen volatility, moderate prices, preserve margins for producers
- Adds to pressure on producers for value
- Discourages incremental LNG development near load centers

Impact of Technology – Deferring Declines



Oil & Gas Technology Pathway

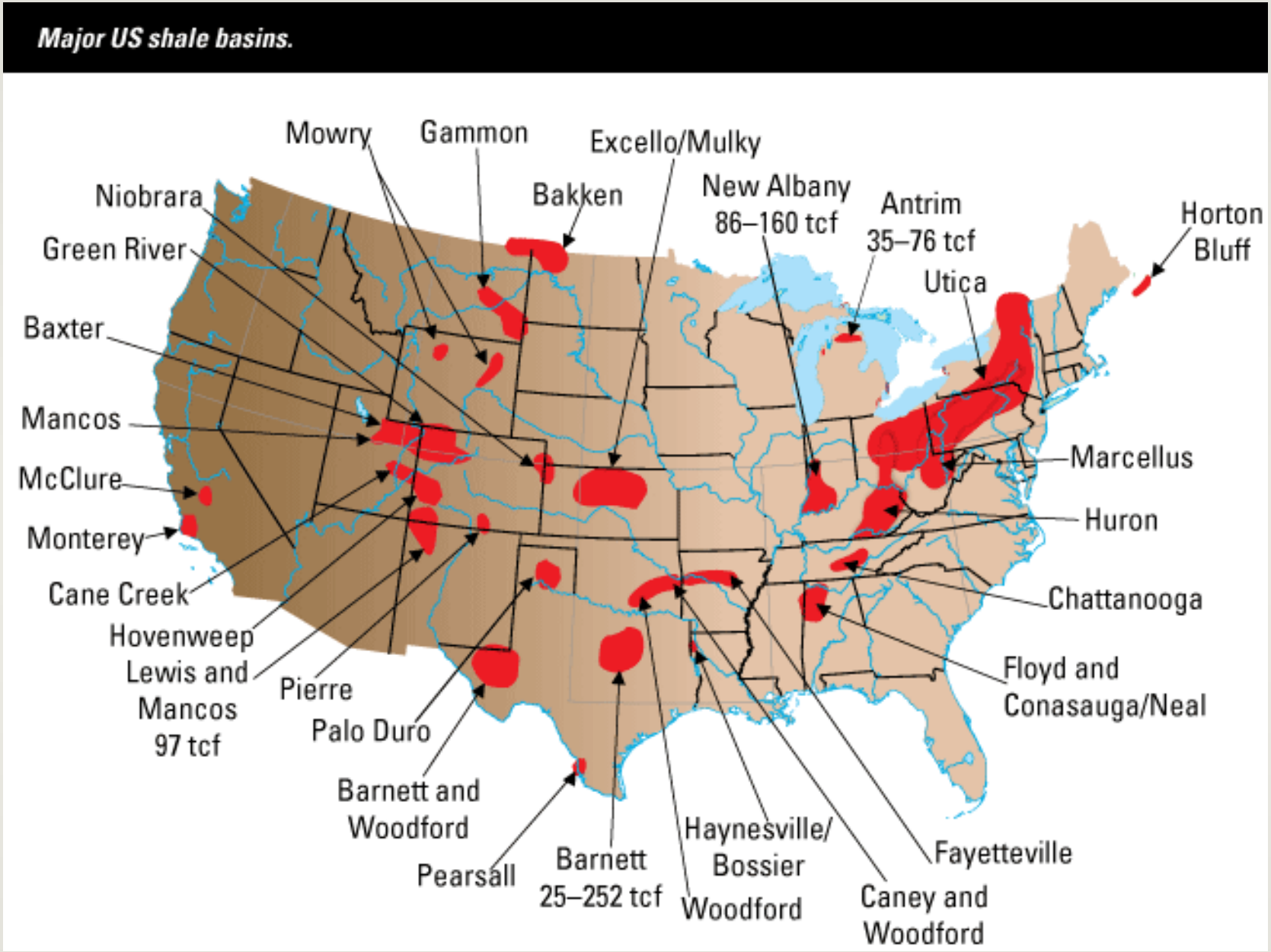
- *Arctic?*
- *Hydrates?*
- *Offshore below **10,000ft***
- *4-d seismic, offshore below **5,000ft***
- *3-d seismic, horizontal drilling, measurement while drilling, offshore below **1,000ft***
- *Pipeline trenching and welding, compression, pressure control, metering; national grid develops*
- *Directional drilling, offshore below **250ft** water depth*
- *Long-line pipeline transmission*
- *Advances in drilling, early seismic, shallow offshore E&P*
- *Oil discovered at Spindletop (Texas), 1901*
- *Oil discovered in Titusville, Pennsylvania, 1859; natural gas replaces town gas, 1870s*

Porosity, permeability: **Conventional** **Unconventional** **"Nano"**

IT Pathway: **Mainframes** **Minis** **Micros** **Work Stations**

1850 1900 1930 1940 1950 1960 1970 1980 1990 2000

Not to scale


Major US shale basins.
Mowry
Gammon
Excello/Mulky
Niobrara
Bakken
New Albany
86–160 tcf
Antrim
35–76 tcf
Horton
Bluff
Green River
Utica
Baxter
Mancos
Marcellus
McClure
Huron
Monterey
Cane Creek
Chattanooga
Hovenweep
Lewis and
Mancos
97 tcf
Pierre
Floyd and
Conasauga/Neal
Palo Duro
Barnett and
Woodford
Haynesville/
Bossier
Fayetteville
Pearsall
Barnett
25–252 tcf
Woodford
Caney and
Woodford

Barnett Shale

Estimated ultimate recoveries per well:

"Sweet Spot": 3.0 bcf plus

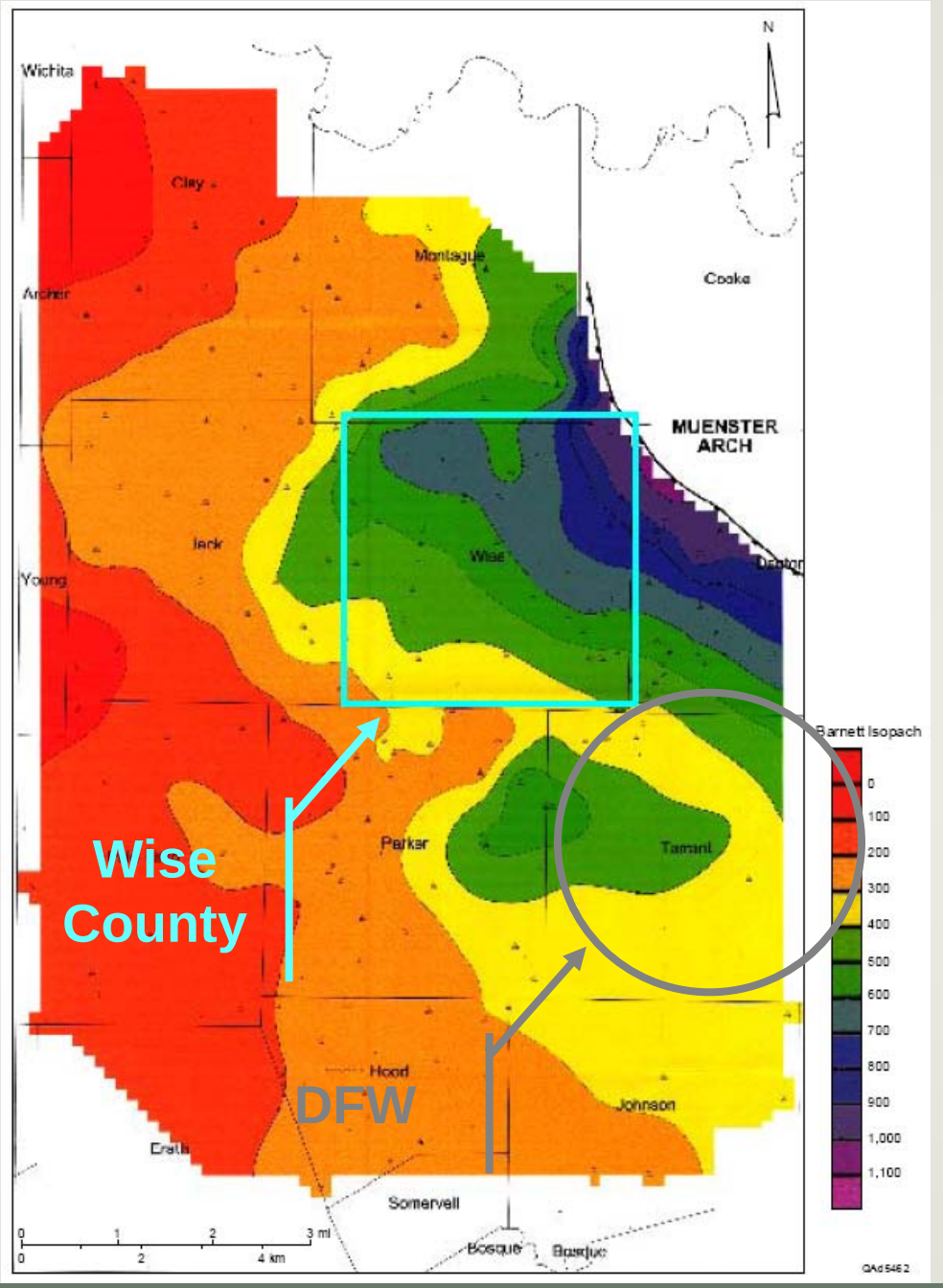
Second tier: 2.5 – 3.0 bcf

Third tier: 1.75 – 2.5 Bcf

Fourth tier: 1.25 – 1.5 bcf

Fifth tier: 0.5 – 1.25 bcf

Basin margin: 0.5 bcf

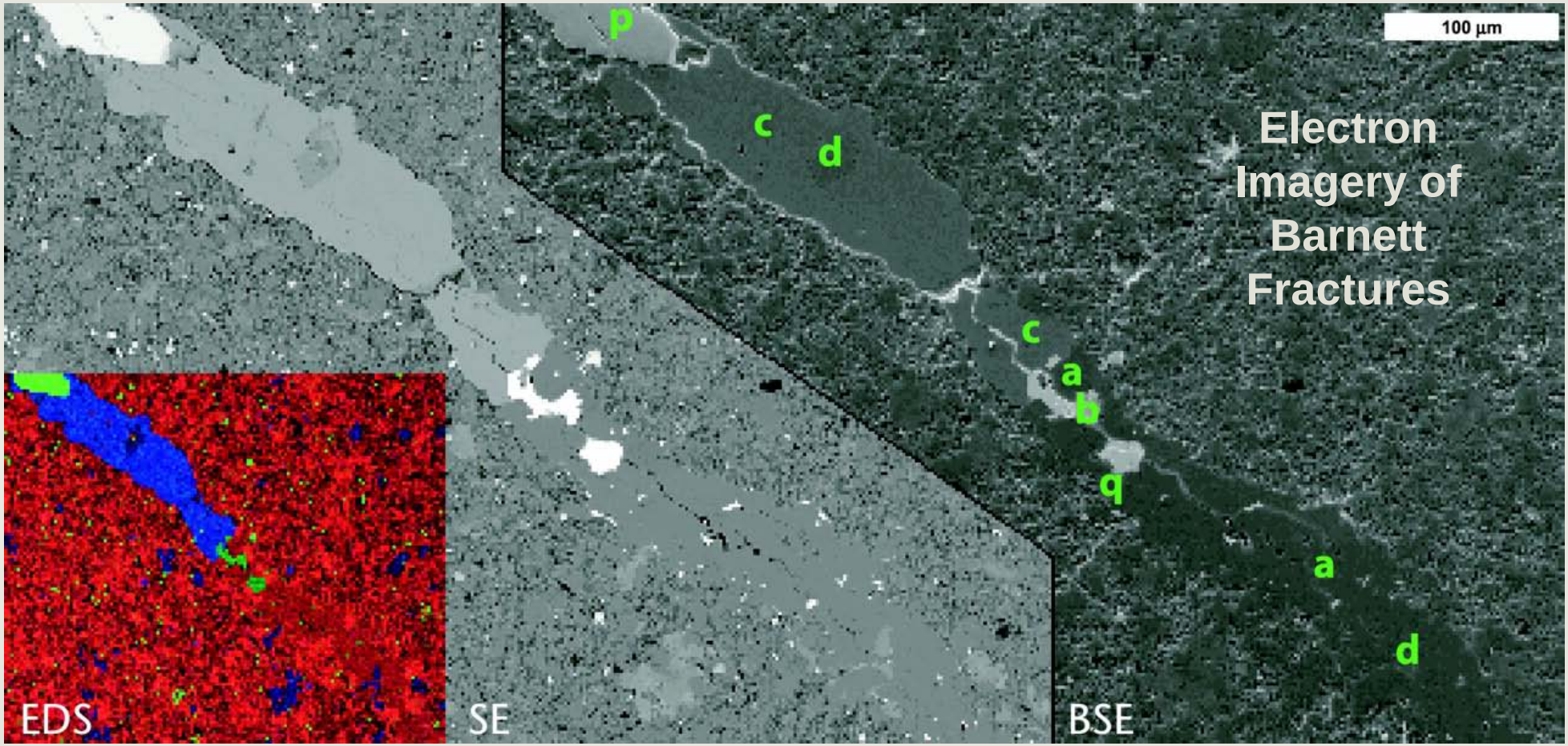


Barnett Shale Experience

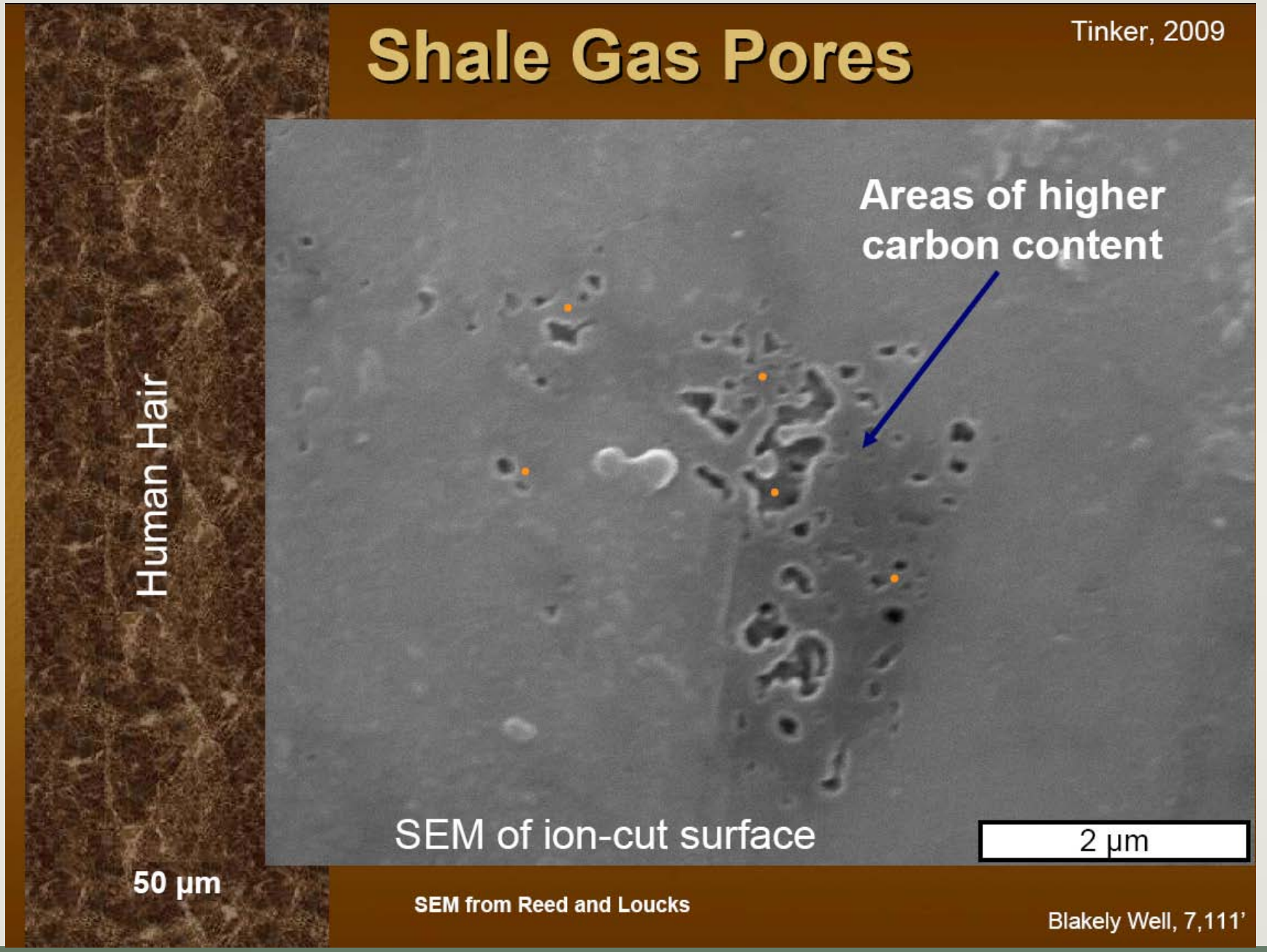
- Water use for “fracing” and other Barnett Shale development is less than 1% of total water use in affected counties
  - Water use has been growing, but rate of use in future may be lower with technology improvement and recycling
  - Operators are actively testing recycling to manage water demand and produced water
- NETL Produced Water MIS

http://www.netl.doe.gov/technologies/PWMIS/

The Frontier



Gale, J. F. W., Reed, R. M., and Holder, Jon, 2007, Natural fractures in the Barnett Shale and their importance for hydraulic fracture treatments: AAPG Bulletin, v. 91, no. 4, p. 603–622.


Shale Gas Pores
Tinker, 2009
Areas of higher carbon content
Human Hair
50 µm
SEM of ion-cut surface
2 µm
SEM from Reed and Loucks
Blakely Well, 7,111'

New "Nanodarcy" Universe of Technology

- Detection and advanced stimulation
- Slow decline curves
- Reduce drilling (fewer rigs, lower costs)
- Manage water disposal issues