ENVIRONMENTAL REGULATION OF HUDRAULIC FRACTURING IN SHALE FORMATIONS

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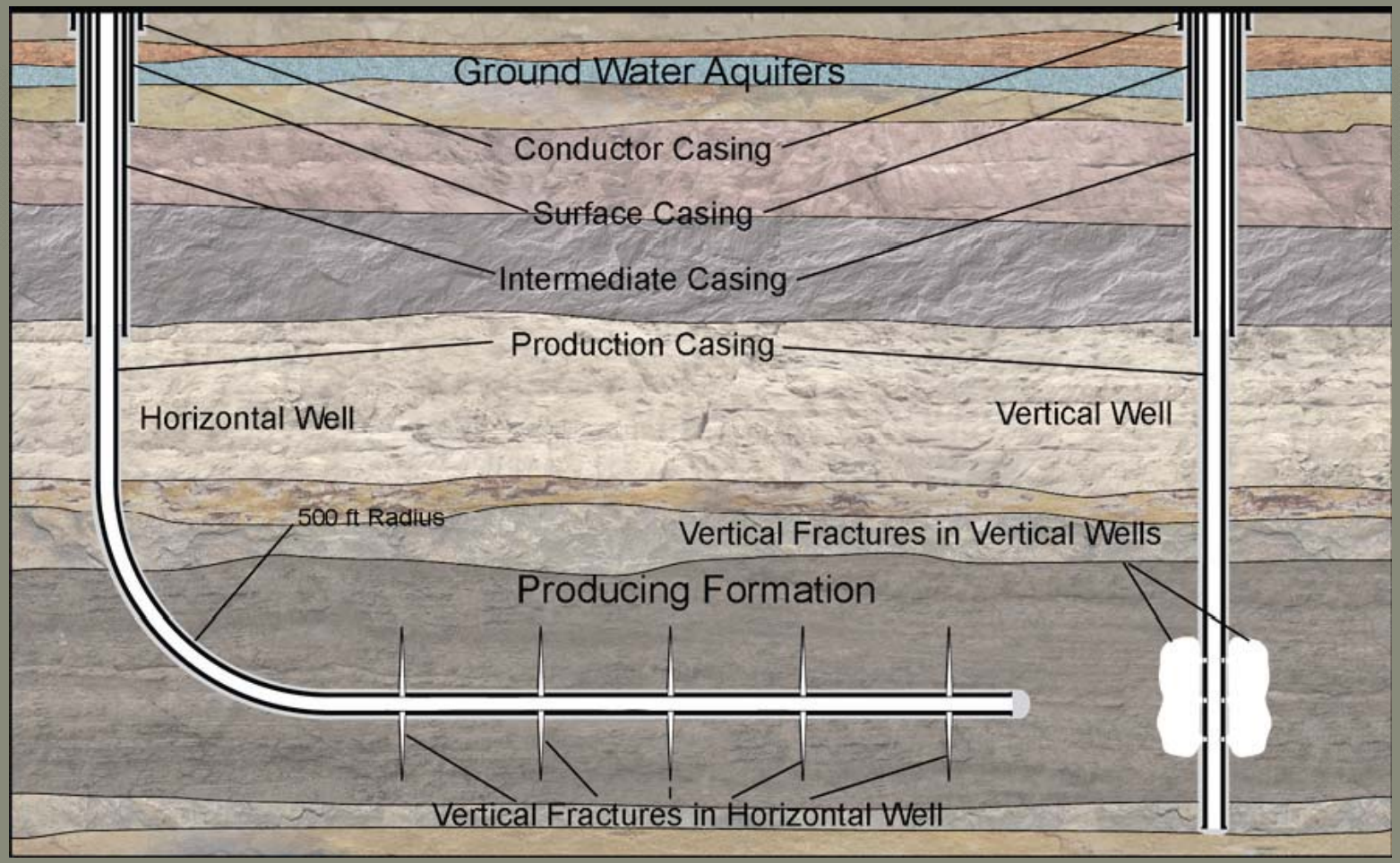
What is Hydraulic Fracturing?



History of Hydraulic Fracturing

- **1903: first tested in Mt. Airy Quarry, NC to mine granite**
- **1948: first used commercially**
- **1974: Safe Drinking Water Act (SDWA) enacted. Amended 1986 and 1996 (Fracing not targeted)**
- **1981: Texas Oilman George Mitchell starts gas fracing of shale (Barnett Shale)**
- **1990s: Better know-how and high gas prices pushe Shale fracing to other regions**

History of Hydraulic Fracturing

- **1997: *Legal Environmental Assistance Foundation (LEAF) v EPA (118 F.3d 1467 (11th Cir. 1997)*(hydraulic fracturing should be regulated under SDWA)**
- **2004: EPA report on the use of hydraulic fracturing in coal bed methane operations finds no effect on groundwater (raised concerns on diesel).**
- **2005: Energy Policy Act of 2005 Exempts Hydraulic Fracturing under SDWA (except diesel)**

History of Hydraulic Fracturing

- **2007: Gas well in Bainbridge, Ohio causes explosion; incident blamed on hydraulic fracturing. Similar events reported in other gas producing states – Penn, Colorado.**
- **2008: Outside interest groups expand efforts to attack hydraulic fracturing in mid-Atlantic region (Marcellus Shale).**
- **2010: Movie (Gasland) released to rave reviews (Oscar nominated)**
- **2010: Congress commissions EPA study (prelim. result expected in 2012)**

If Hydraulic Fracturing Has Been Around For 100 Years, Why The New Concerns?

?

"CONVENTIONAL" VS. "UNCONVENTIONAL"

Conventional Reservoirs

- high quality rock properties (porosity and permeability),
- No need for artificial stimulation (fracturing)
- Wells typically drain hundreds/thousands of acres, typically geologically driven plays with higher risk.

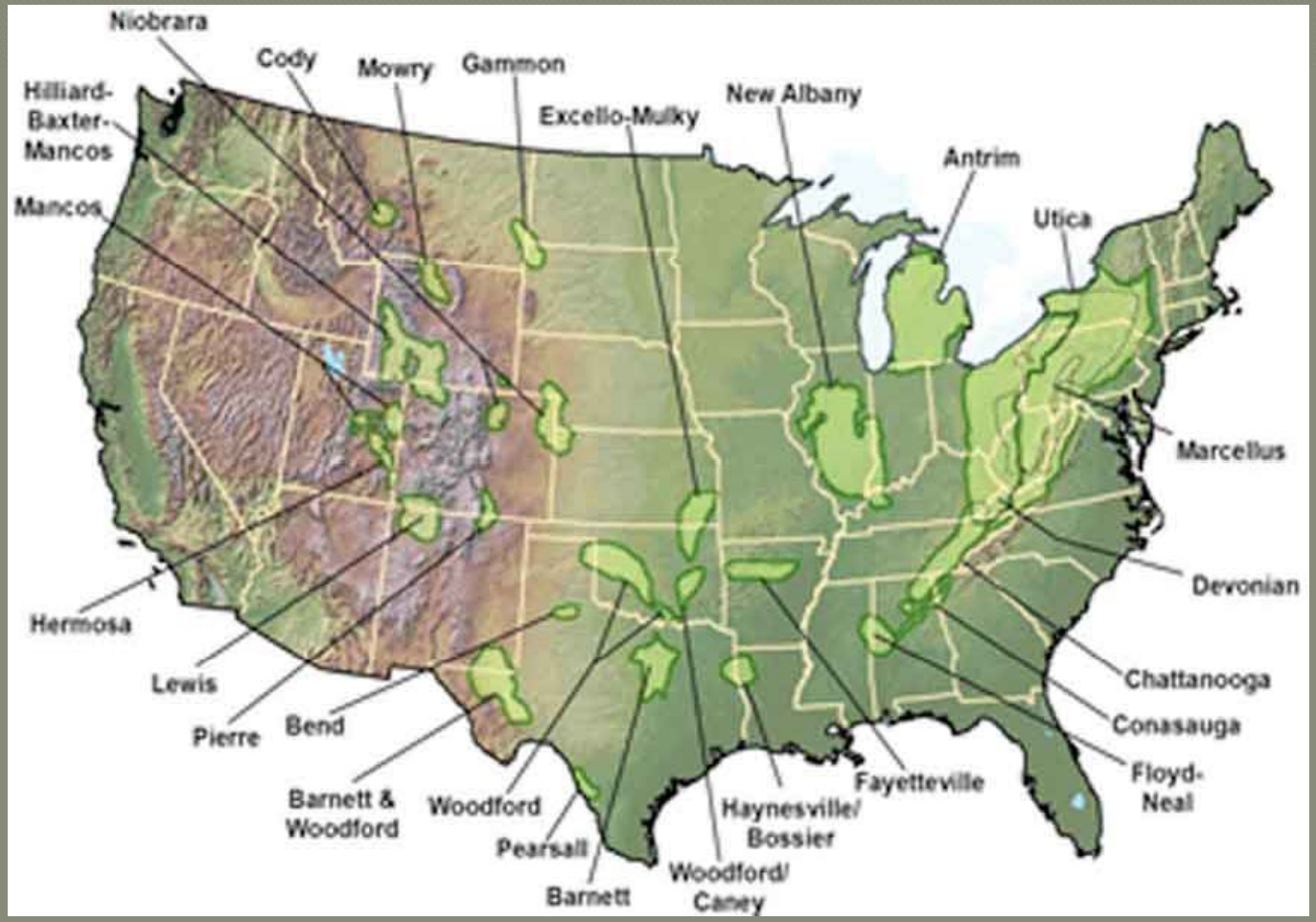
Unconventional Reservoirs

- Poor Rock Properties (low porosity and permeability)
- Need fracturing
- Drain poorly (10-40 acres typical)
- Horizontal wells generally improve drainage (but high production decline 70% – 80% in year 1

CONVENTIONAL" VS. "UNCONVENTIONAL"

Porosity and Permeability

Shale is Everywhere -- Almost



Environmental Concerns

- **Fracing Fluid Composition**
- **Surface Concerns**
- **Underground Water Safety**
- **Nuisance Issues**
- **Water Withdrawal**

Fracing Fluid Composition

- **Issues**
  - **Nondisclosure**
  - **Hazardous content (Acids, Biocides, Surfactants)**
- **Regulation**
  - **State Mandatory Disclosure Laws (Penn lists online)**
  - **Reflexive Disclosure by Industry (FracFocus website)**
  - **Federal (MSDS—limited)**

Surface Concerns

- Noise
  - About a month (drill + frack)
- Road Use
  - Wear and tear
  - Dust and auto damage
- Pad size
  - Trucks need space
  - Erosion/landslides
  - Scarring (aesthetic damage)
- Transient Workers
- Multiple Time, Place, Manner Regulations at the Municipal Level

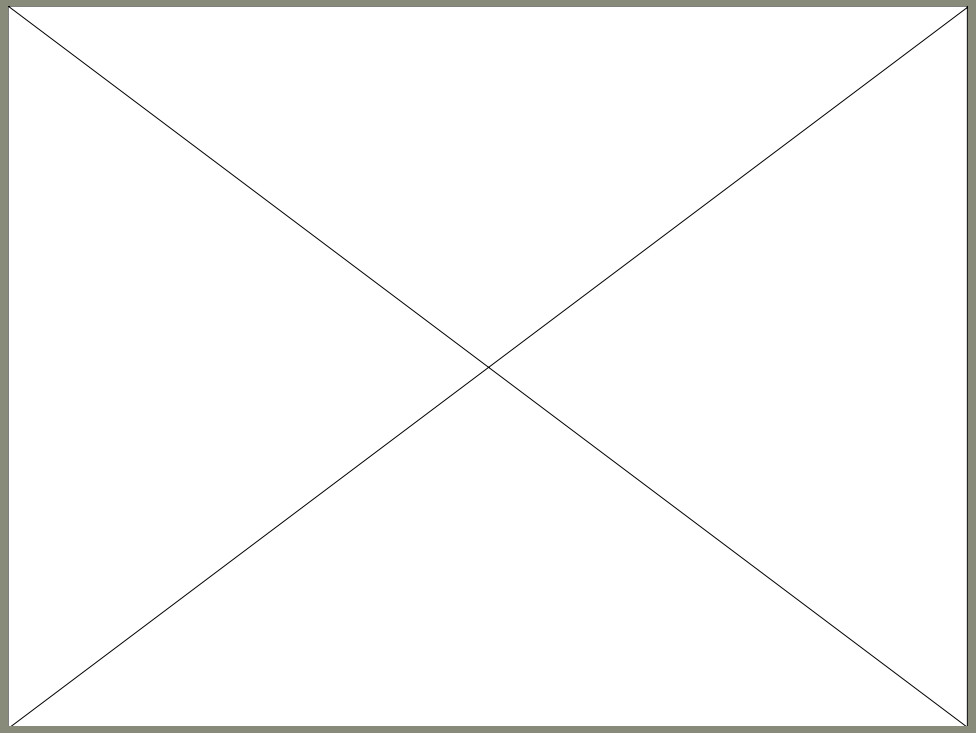
Surface Concerns

- **Run Off Water**
- **Frac Fluid Spills**
  - **Blowouts**
- **Regulations**
  - **Multiple local level regulation**
  - **Private action civil suits**
  - **Organized citizen groups providing visibility**

Underground Water Safety

- Issues
  - Gas migration into aquifers (Gasland)
    - U.S. v. Range Resources (N.D. Tex 2011)
  - Diesel?
- Regulations
  - State Level Controls on well casing integrity (zonal isolation)
  - SDWA (UIC—not applicable, attempted legislative amendments failed)
  - DOI considering regulation on national parks

Underground Water Safety



Water Withdrawal

- **Issues: Fracing is very water intensive**

Shale Gas Play	Volume of Drilling Water per Well (gal)	Volume of Fracturing Water per Well (gal)	Total Volumes of Water per Well (gal)
Barnett	400,000	2,300,000	2,700,000
Fayetteville	60,000*	2,900,000	3,060,000
Haynesville	1,000,000	2,700,000	3,700,000
Marcellus	80,000*	3,800,000	3,880,000

- **Regulations**
  - **Water withdrawal permits (e.g. Penn)**
  - **Reflexive solution through increased recycling**

Conclusions

- **Increasing pressure to regulate at Federal level (initial result of EPA study in 2012 will be instructive)**
- **Push back by some States (Texas)**
- **Industry becoming more accountable and self-regulating**
- **Active citizen groups won't leave fracing alone and will be forcing a lot of change**