Unconventional Oil & Gas in Colombia

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Outline of Presentation

- Context: Global out look for unconventional O&G
- Balancing Economic Benefits and Environmental Impacts
- Significant Environmental issues
- Managing Environmental Impacts – U.S. experience
- Lessons for Colombia
- Preliminary observations

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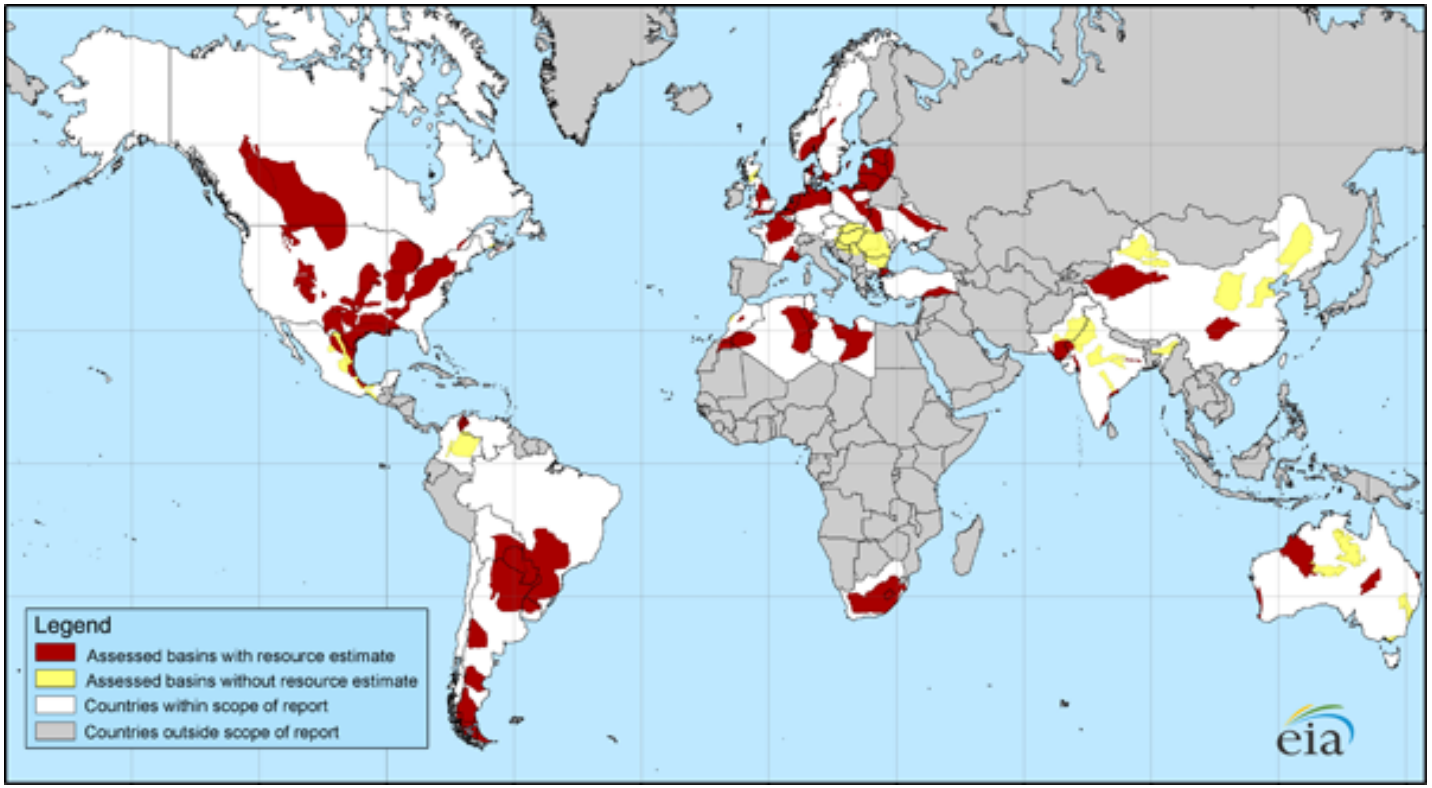
Explosion of Shale gas resource is world-wide



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- ***Global Resource Base Potential Huge***
- **Potential Economic Benefit Enormous (jobs, domestic supply, export earnings)**
- **Uncertainties Large**
  - **High variability within resource play – Oil/Gas/Water**
  - **Environmental impacts and production costs**
  - **Oil/Gas price uncertain both in local economy and globally**
  - **Economic of global LNG trade uncertain**
- **Points to uncertainty of pace of commercial development**
  - **No need to rush - Take long-term view**
  - **Hard to predict relative economic value of oil/gas for domestic use compared to export.**

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Balance Economic and Environmental Impacts

- **While hydraulic fracturing is widely used in conventional O&G production and has been for many decades, its use in unconventional production from shale and tight sands is on much larger scale in terms of production activity, use of fracturing fluids and requirements for recovery.**

First Decision – Separate conventional from unconventional O&G regulation?

- **Pro: difference in scale of operation, number of participants, permitting burden**
- **Con: How to draw a line that does not result in gaming of the regulatory system?**

Second Decision – Seek to Define fixed set of regulation or Establish process for continuous improvement based on field experience?

- **Rapid pace of technology change argues for continuous improvement.**

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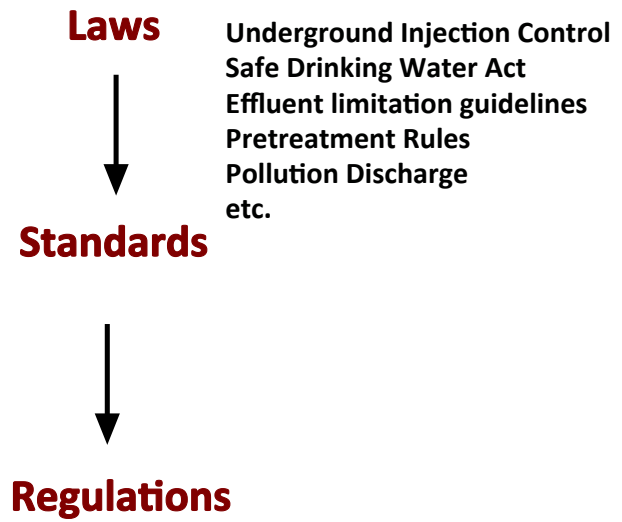
US approach to Unconventional O&G regulation is good, but not perfect:

Weaknesses:

- Not integrated approach to water management that follows water quantity/composition
- Mixed federal and state authority

Strengthens:

- Generally strong technical competence
- Honest
- Generally experienced personal for inspection and enforcement.



Third Decision **– Mix of Federal and Provincial or all Federal regulation?**

Also consult Canada Energy Resources Conservation Board - "Regulating Unconventional O&G" discussion paper 12/17/2012

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- My present to environmental management based on technical, government, and industry experience
- Especially DOE SEAB 2011 reports

Secretary of Energy Advisory Board

Shale Gas Production Subcommittee
Second Ninety Day Report

November 18, 2011

U.S. DEPARTMENT OF ENERGY

Secretary of Energy Advisory Board

Shale Gas Production Subcommittee
90-Day Report

August 18, 2011

U.S. DEPARTMENT OF ENERGY

Obama's March 31, 2011 Energy Speech: (important)

"Recent innovations have given us the opportunity to tap large reserves – perhaps a century's worth" of shale gas.

- **Obama's *Blueprint for a secure energy future* instructs DOE Sec. Chu to establish SEAB Subcommittee and charge it to:**

  "Within 90 days of its first meeting, the Subcommittee will report to SEAB on the immediate steps that can be taken to improve the safety and environmental performance of fracturing."

  Not a net assessment of economic benefits vs. environmental costs

- **Subcommittee members :**

Susan Tierney	**Kathleen McGinty**	**Daniel Yergin**
Fred Krup	**Steven Holditch**	**Mark Zoback**

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Principal Environmental impacts:

① Water quality

② Air quality

③ Seismicity

④ Community impacts

⑤ Land-use impacts

Key points:

- Not just hydraulic fracturing
- All environmental impacts of production should be included
- Different than conventional production
- Expect great diversity

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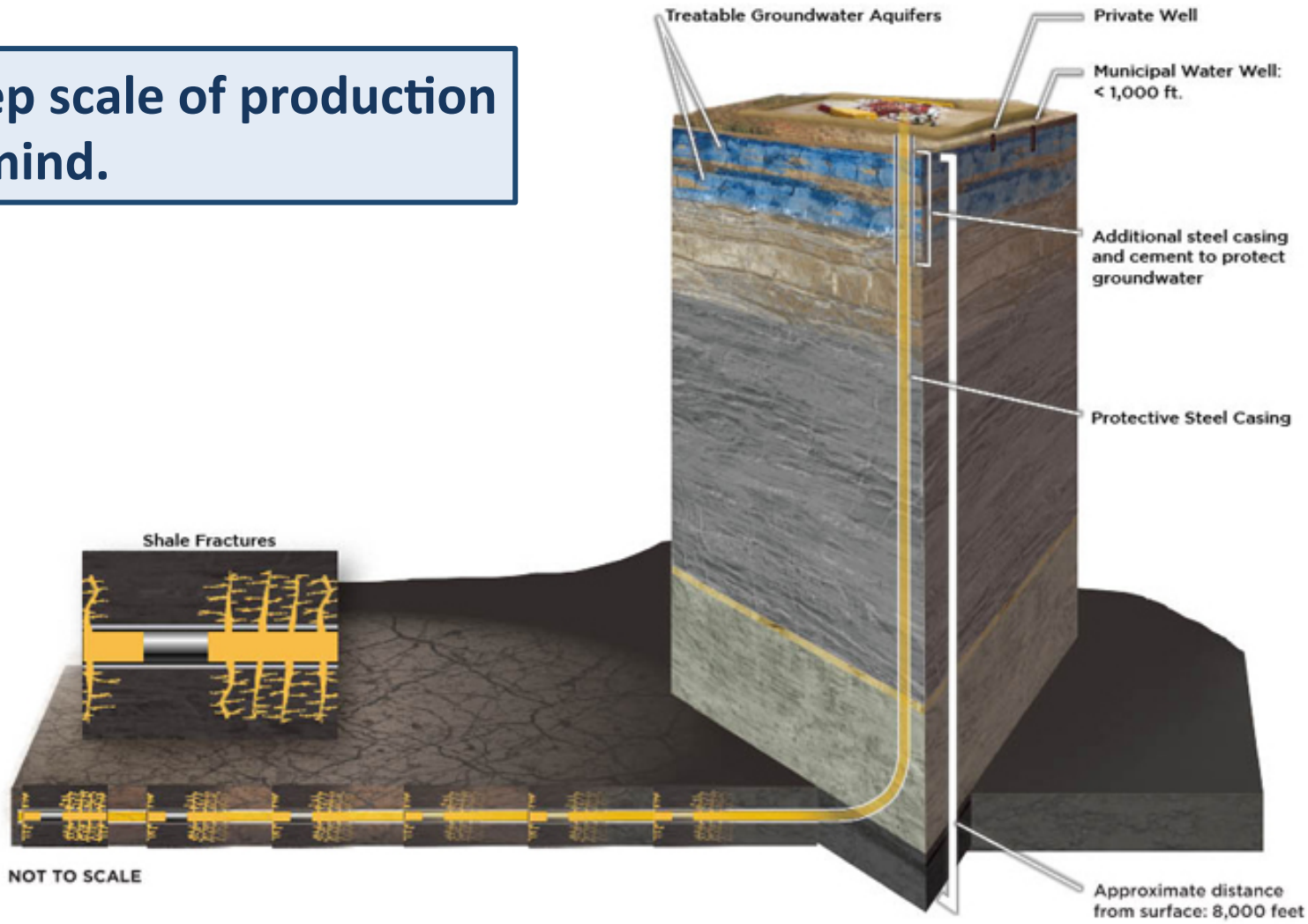
Keep scale of production in mind.



Much of the environmental challenge comes from surface operations

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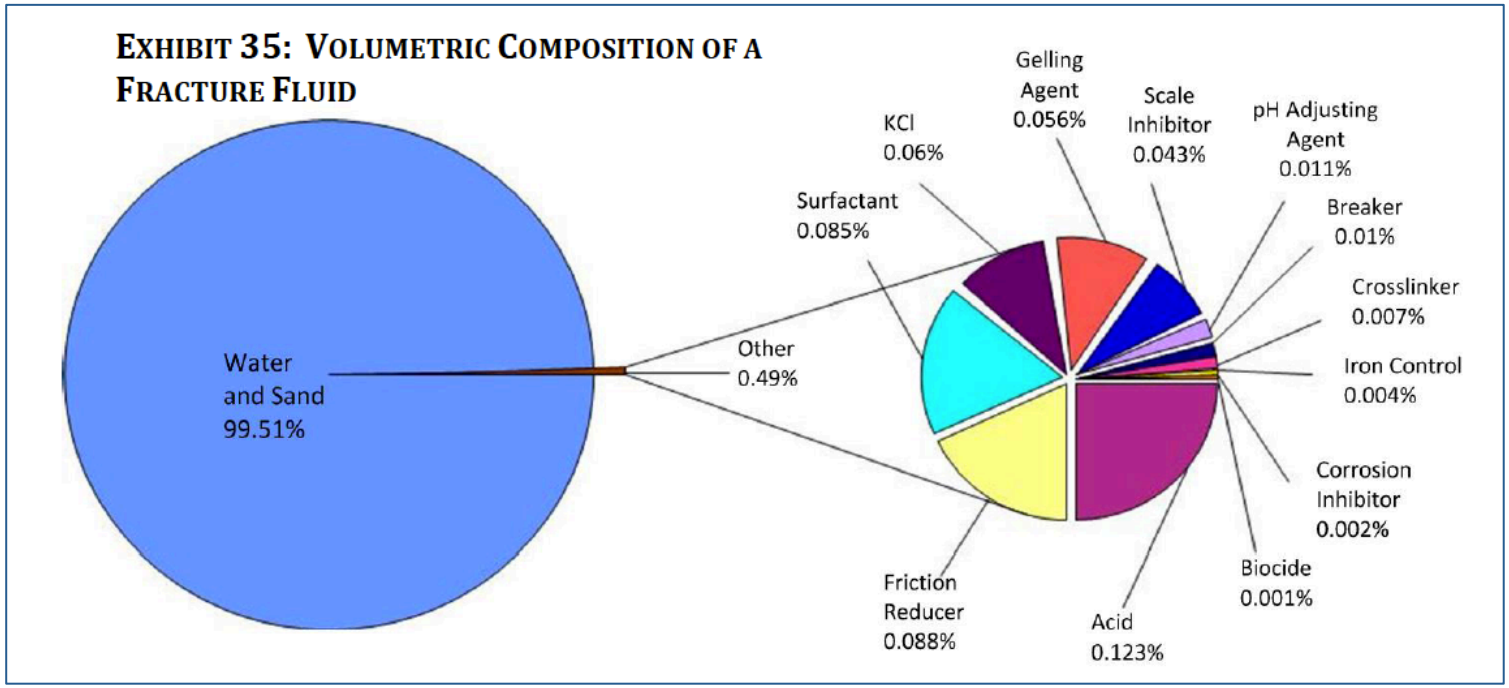
Initial Environmental Concern - Hydraulic fracturing fluid contaminating drinking water – no longer issue



Full disclosure of <u>all</u> additives – type and quantity

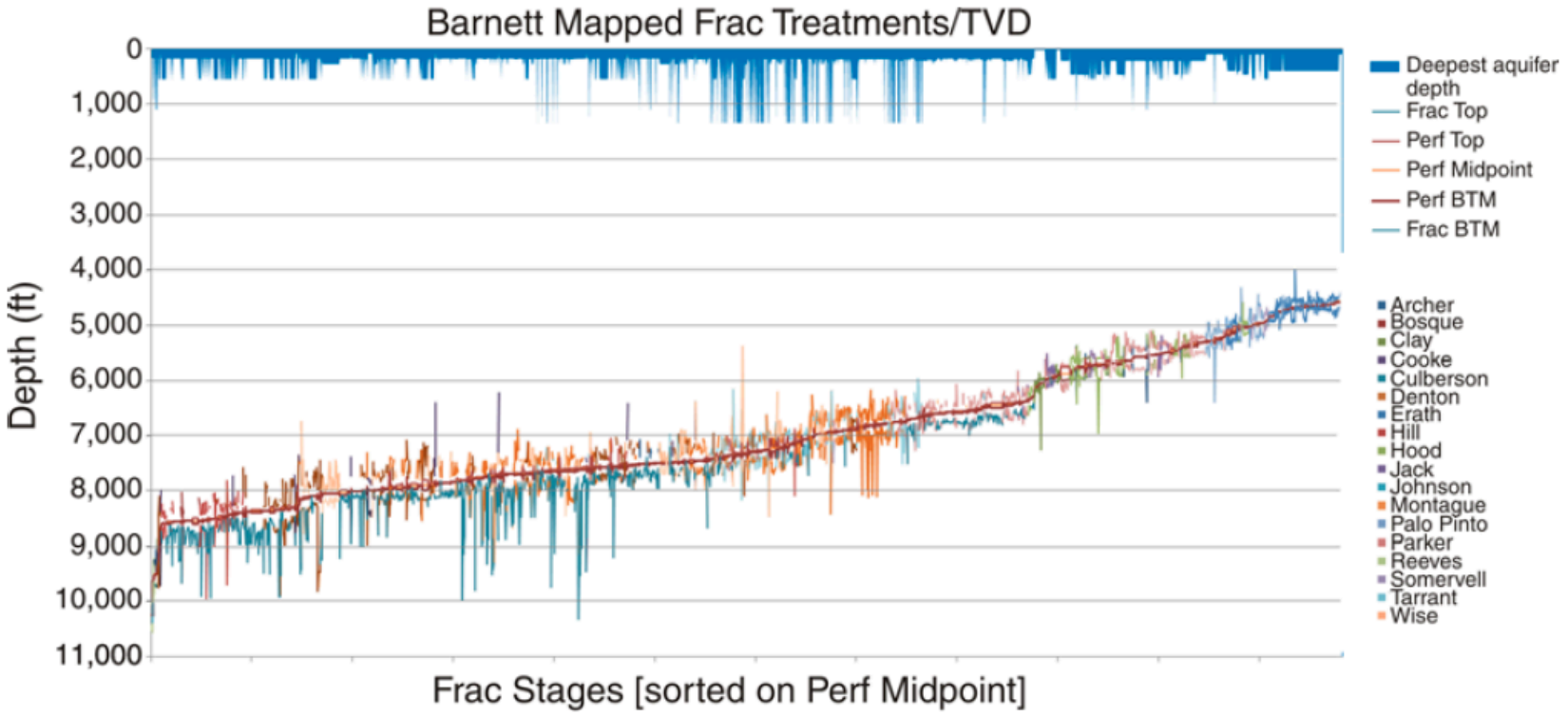


Fig. 2—Barnett shale measured fracture heights sorted by depth and compared to aquifers.

SPE 145949

Hydraulic Fracture-Height Growth: Real Data

Kevin Fisher and Norm Warpinski, SPE, Pinnacle—A Halliburton Service

Spread of well productivity in different plays (2010)

		Well Peak Production Data: $1x10^3$ m^3 per day[1]			
Shale Play	*# of H. Wells*	*Mean*	*P80*	*P50*	*P20*
Barnett	**1,785**	**60.6**	85.5	52.1	30.6
Fayetteville	**870**	**65.7**	90.8	63.4	37.1
Haynesville	**509**	**261.5**	339.6	246.2	167.5
Woodford	**208**	**108.1**	152.3	91.7	51.2
Marcellus	**576**	**90.0**	127.4	76.1	43.3

1 Data from HPDI database as reported in Francis O'Sullivan1 and Sergey Paltsev1, Environ. Res. Lett. 7 (2012); Shale gas production: potential versus actual greenhouse gas emissions

Framework for regulatory design (SEAB Sub-comm.)

- No single point definition of environmental adequacy
- Shale gas concerns do not extend to all NG operations
- Shale gas plays are quite different (regional differences)
- Environmental impact involves the entire production process not just hydraulic fracturing
- Take systems approach
- Design of regulatory system is background issue

Ninety Day Report: One basic principle:

Measure, disclose and continuously improve hydraulic fracturing production process

(Expanding "standards," "best practice" to include measurements)

Twenty Recommendations:

- **Establish public website with all publically available shale gas information**
- **Assistance for STRONGER & Ground Water Protection Council**
- **No use of 'diesel' in fracturing fluid (use mineral oil or crude)**

(Overtime replace natural gas for diesel in surface operations)

Too many recommendations without specifying priority, responsible entity, or implementing steps.

Ninety Day Report -- Recommendations Continued:

- Air quality – Surface & production
  - Selected air emission measurement projects
  - Comprehensive study of GHG footprint of NG activity
- Water quality (EPA SAB water study results only in 2014)
  - Manage water system all flows and composition
  - Flow back and produced water
  - Methane leakage into surrounding water wells (Duke study)
- Measure water quality in wells surrounding prospective hydraulic fracturing sites.
- Industry should establish organization for "best practice" in the field based on measurement (national vs. regional).
- Federal government has role in unconventional gas R&D (USGS, EPA and DOE).

Lessons for Colombia and ANH – Regulation modules

- Air quality – Surface & production
- Water quality– Address entire water system
- Community impacts
  - Truck traffic
  - Accidents – Safety, emergency response and recovery
  - Local impact assistance
- Land use
  - wildlife,
  - visibility,
  - gathering systems

Lessons for Colombia and ANH – Regulatory Response

- Adequate and capable staff – cost paid by operators
- Assure inspection and enforcement of rules
- Encourage joint stakeholder engagement (officials, industry, public)
- Focus on safety and best field practice, supported by data
- Orderly development, by accomplishment not schedule
- Cover entire life cycle of production
- Base regulation on risks

5 principles for responsible E&P of unconventional oil and gas

- Common understanding about environmental impacts between producers, regulators and the public. (requires outreach)
- Field operators trained in good practices and held to this standard
- Regulators trained and capable to act promptly and fairly on permitting, inspection, and enforcement.
- Companies committed to measurement, reporting, and continuous improvement.
- Activity level does not exceed capacity for good oversight