

---

# The Science & Technology of Oil and Gas

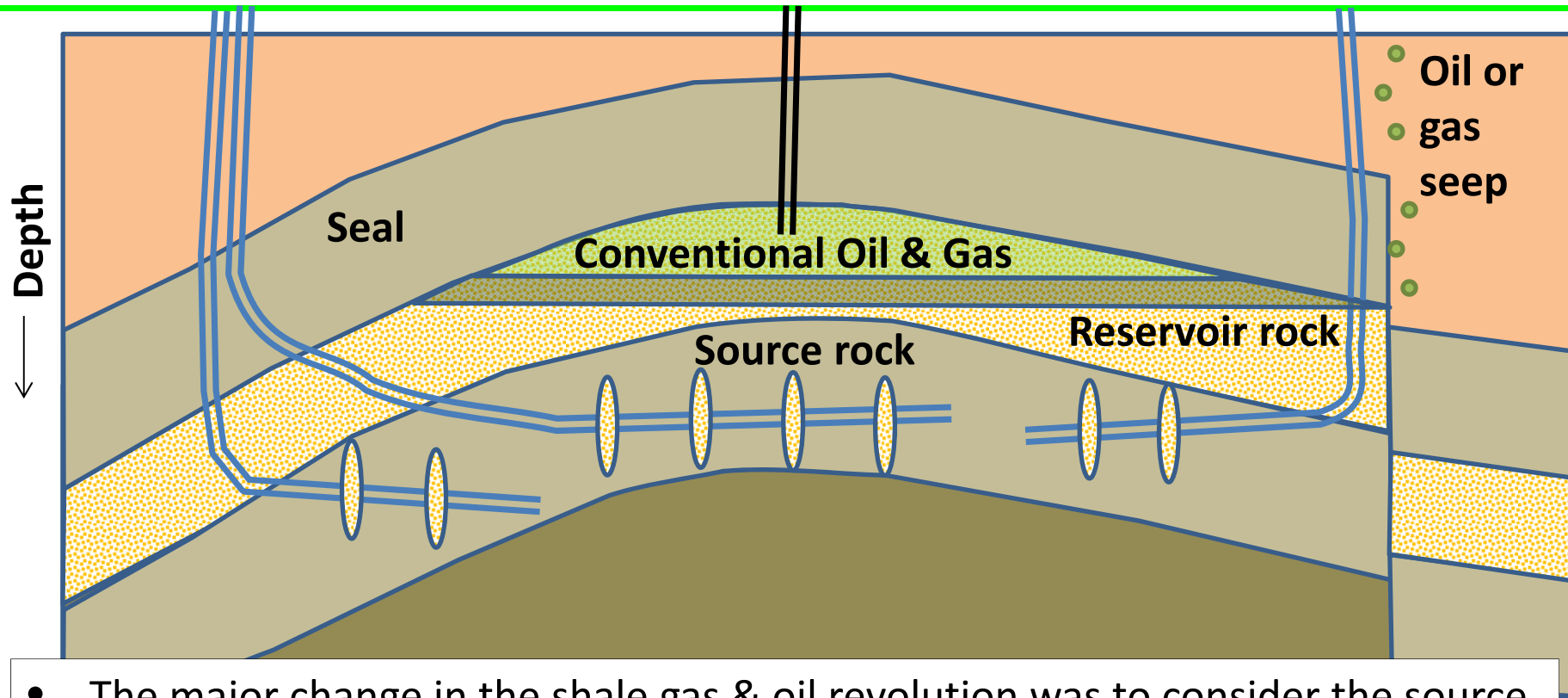
Dr John Pucknell

# Introduction

---

- Petroleum Geology
- Exploring for shale oil & gas
- Drilling, casing and cementing wells
- Propped Hydraulic Fracturing
- George Mitchell & the Barnett Shale
- Rush to shale gas...then to shale oil
- Risks

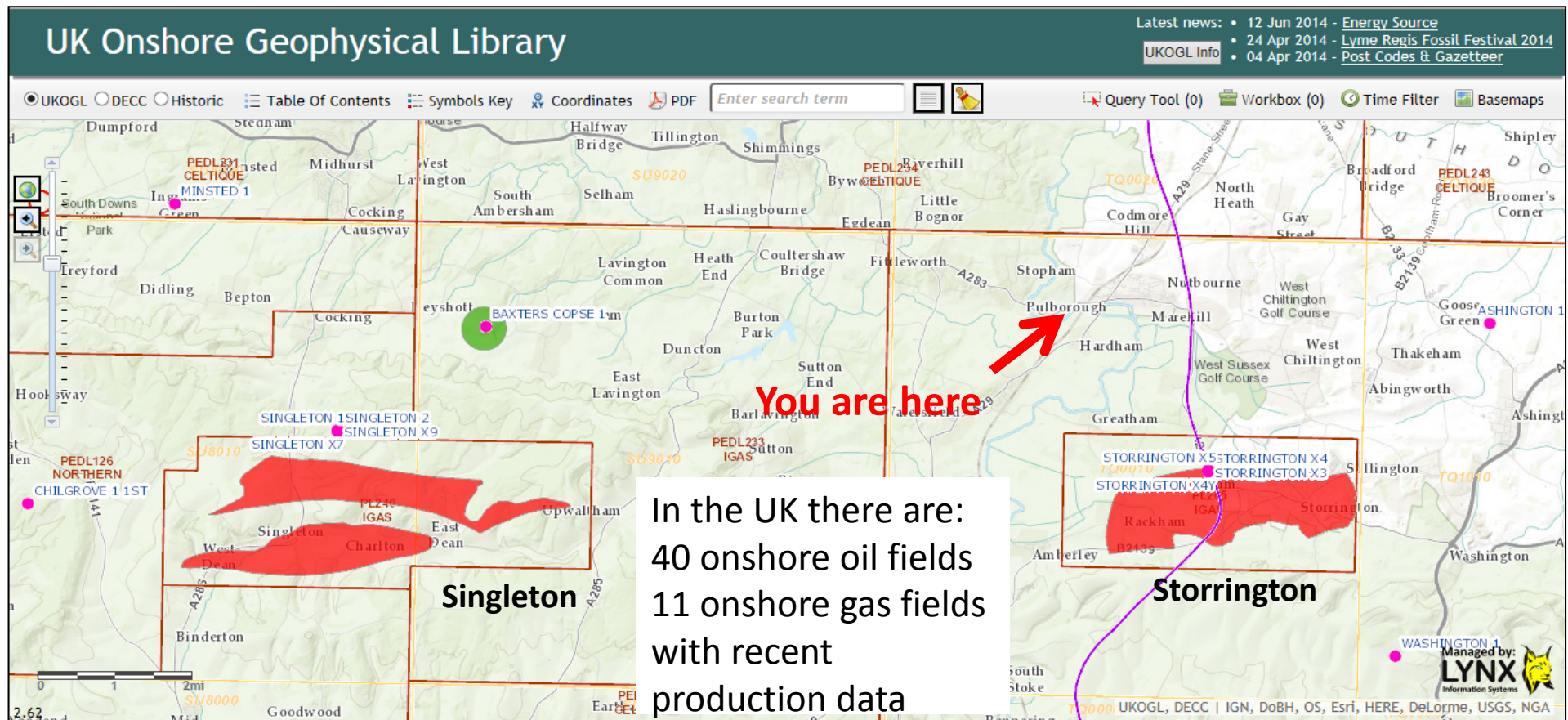
# Petroleum Geology



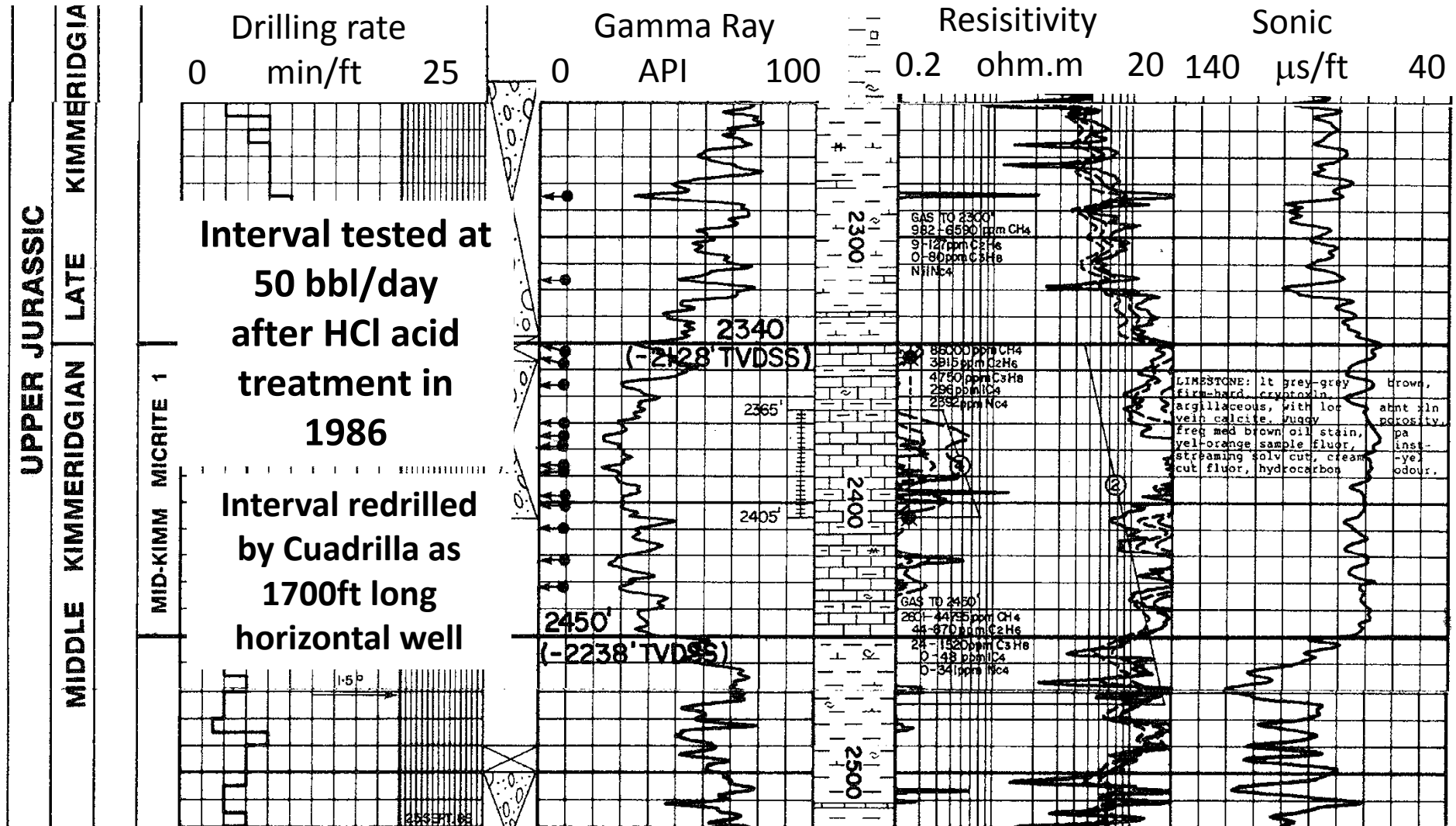
- The major change in the shale gas & oil revolution was to consider the source rock as a potential reservoir despite its very low permeability
- To find a shale gas or shale oil field only the source rock is needed. However it needs enough organic carbon, must be mature enough and hydraulic fracturing must be effective

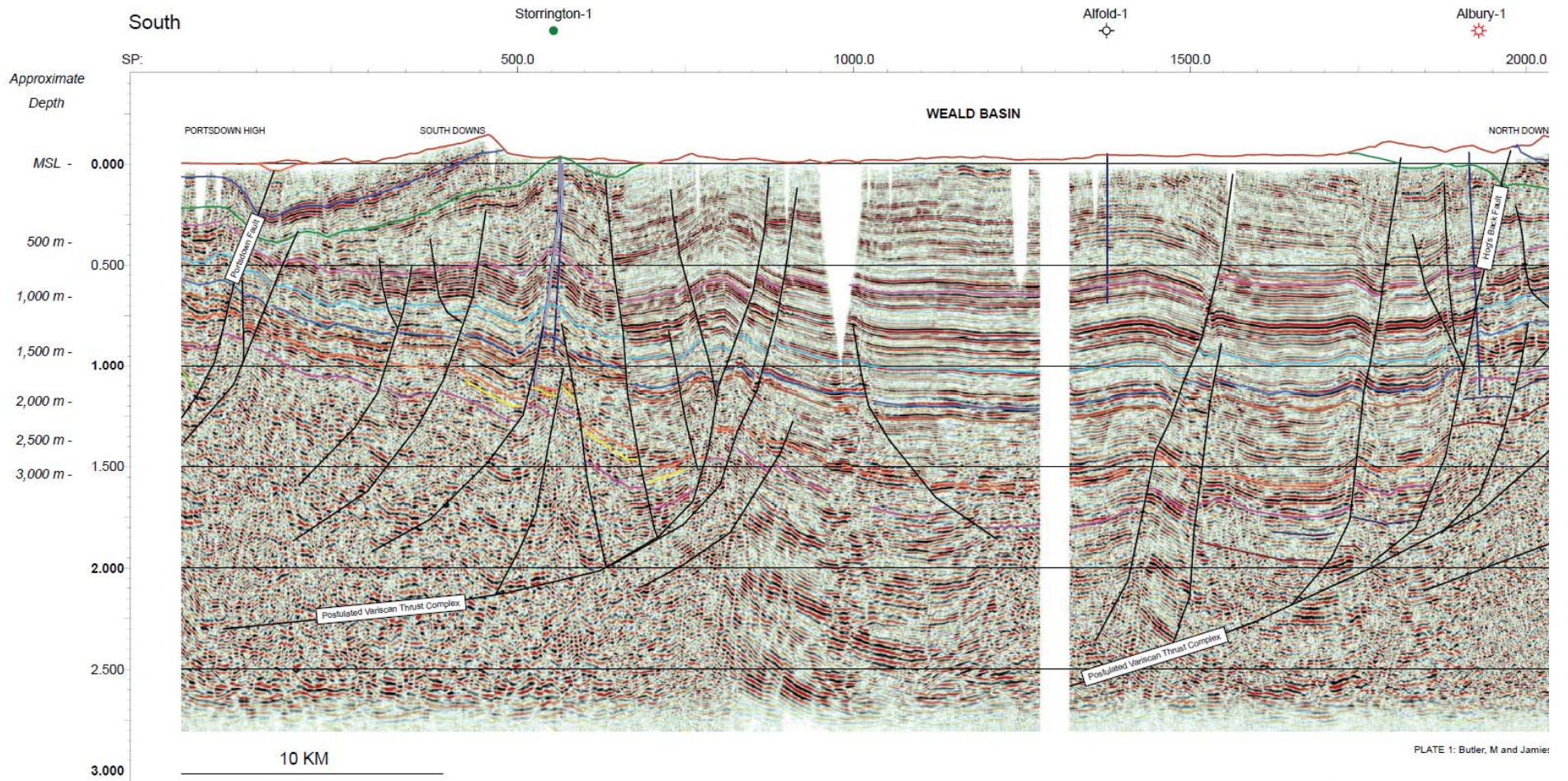
# Wells and Fields in area

There are already many oil & gas wells in the UK



# Balcombe 1





Copyright UKOGL

Seismic

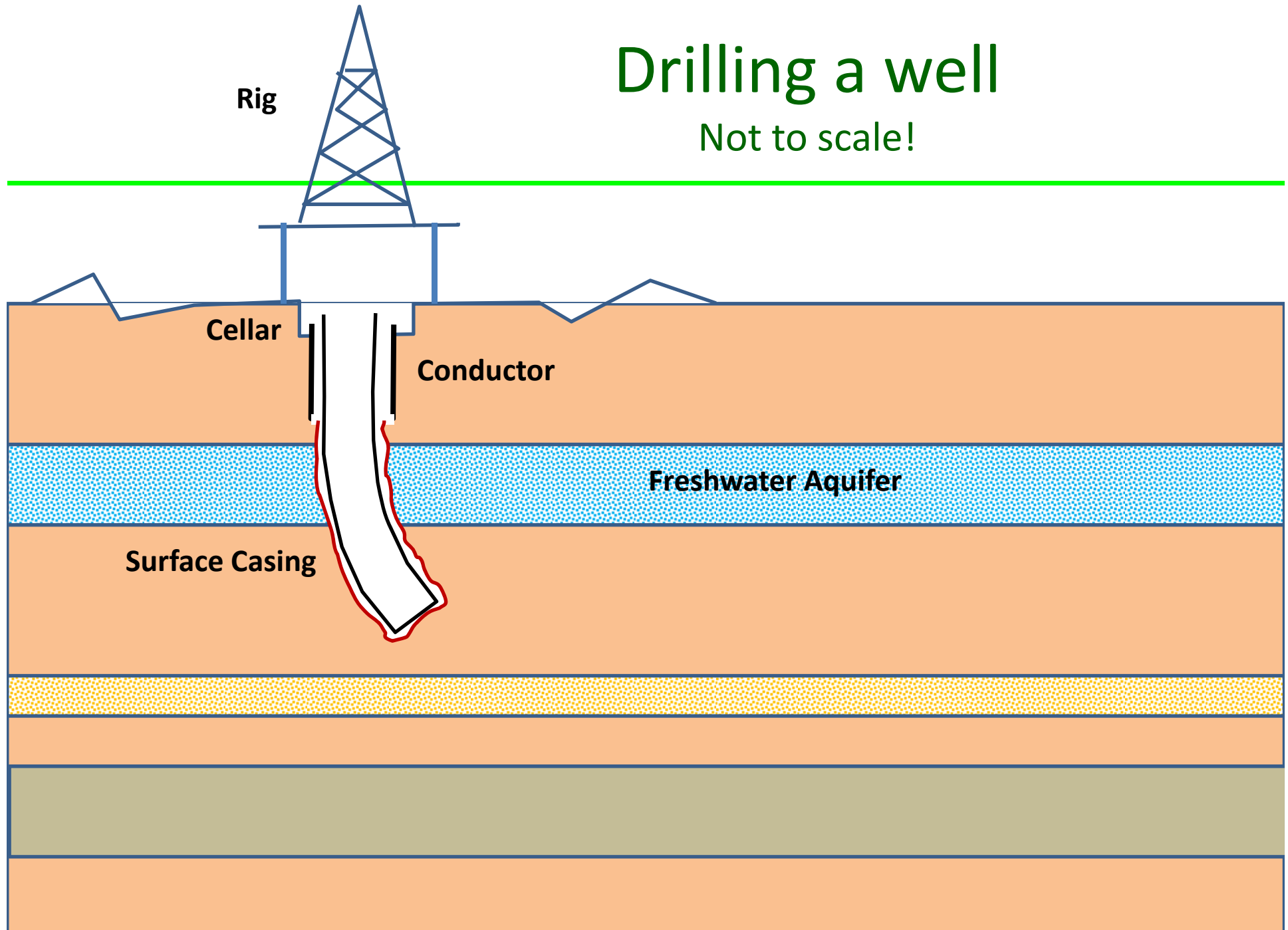
# Singleton Well & Processing site

Discovered 1988  
12 wells drilled  
4 wells producing  
since 1995



# Drilling a well

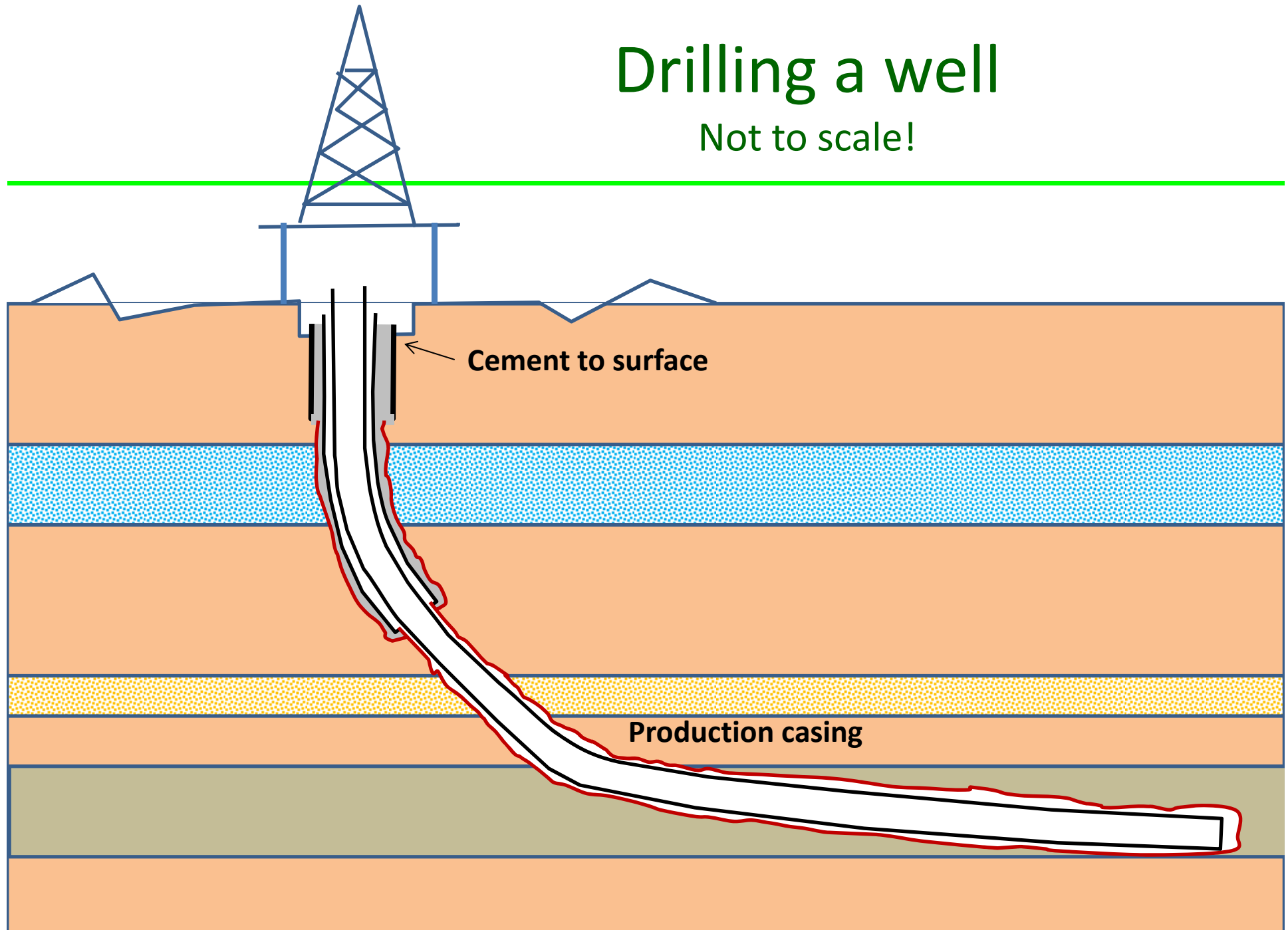
Not to scale!





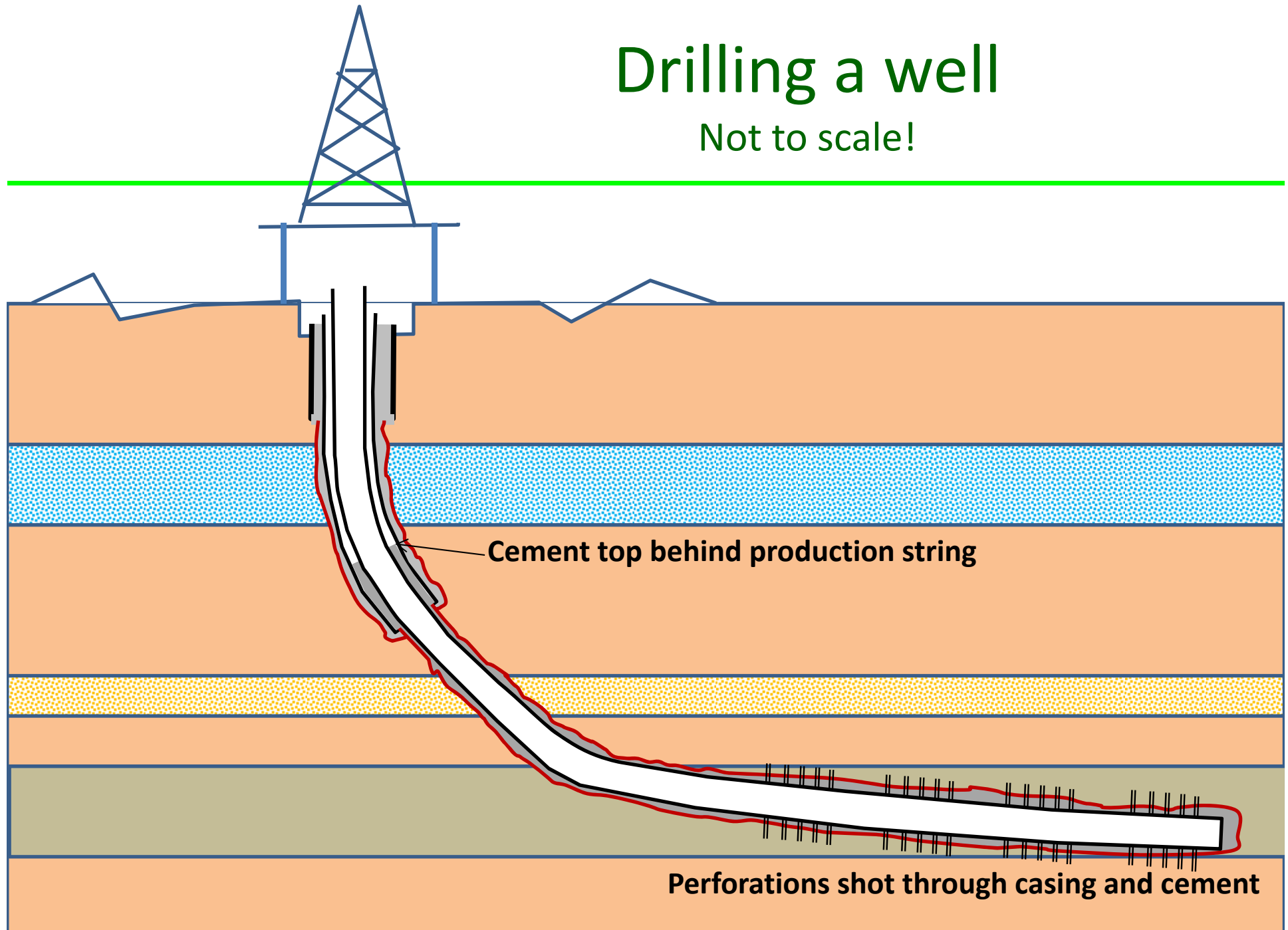
# Drilling a well

Not to scale!



# Drilling a well

Not to scale!

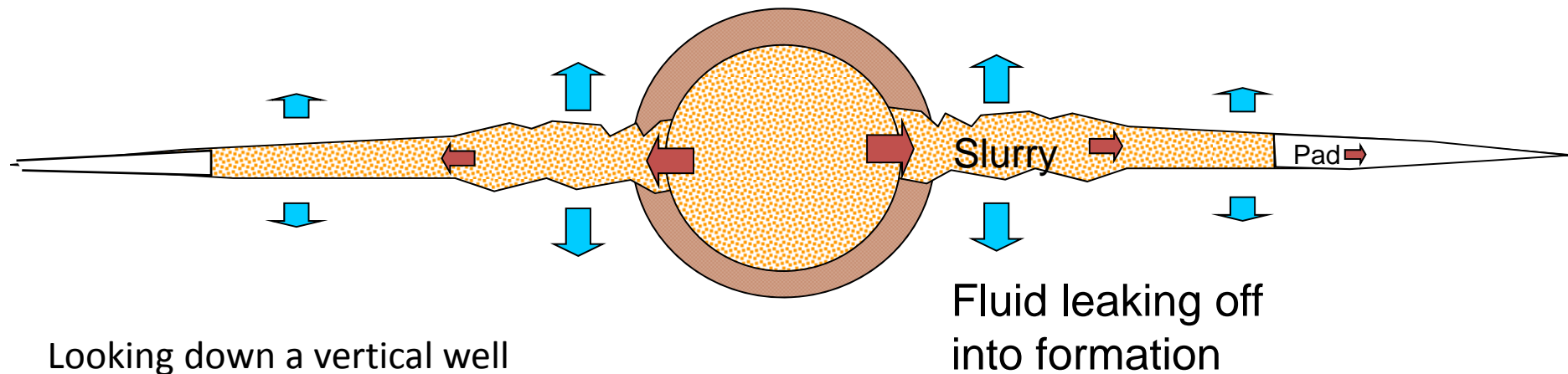


Cement top behind production string

Perforations shot through casing and cement

# Propped Hydraulic Fracture Treatments

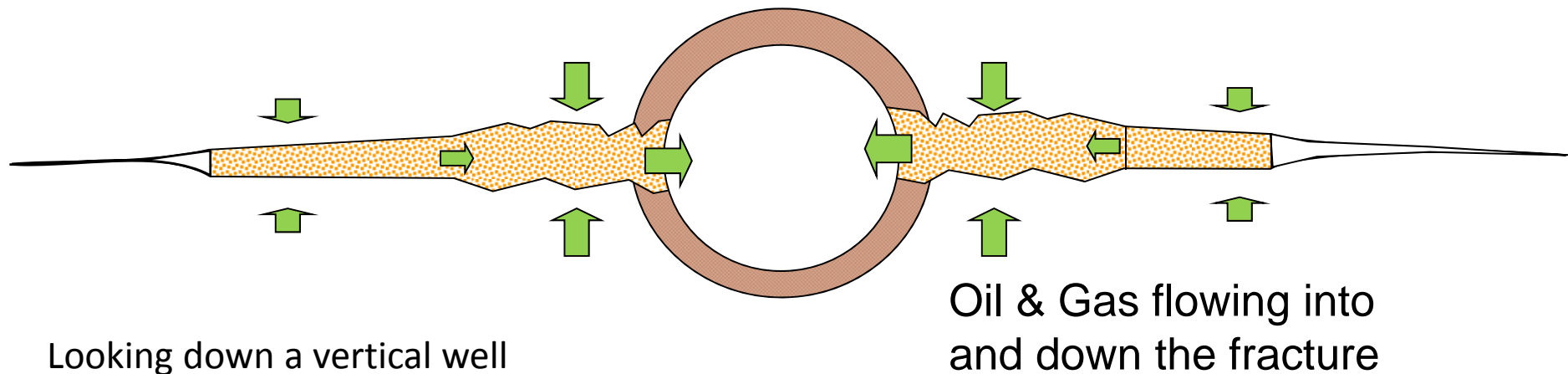
- Hydraulic Fracturing is designed to create a high permeability pathway through the rock
- This is achieved by the injection of fluid at sufficiently high pressure to split (i.e. fracture) the oil or gas bearing rock formation
- Sand is then pumped in as a slurry to prop the fracture open when injection stops
- The sand propped fracture acts as a highway for the egress of oil or gas when the pressure in the well is reduced



# Propped Hydraulic Fracture Treatments

---

- The fluid used in fracturing is mainly water, chemicals may be added to increase viscosity to keep sand in suspension, or reduce friction so that the fluid can be pumped at a higher rate
- Ceramic proppant may be used instead of sand
- The first Propped Hydraulic Fracture treatment was in 1947. It has been a standard treatment for low permeability reservoirs ever since. To date about 2.5 million treatments having been performed



# George Mitchell – Father of Shale Gas

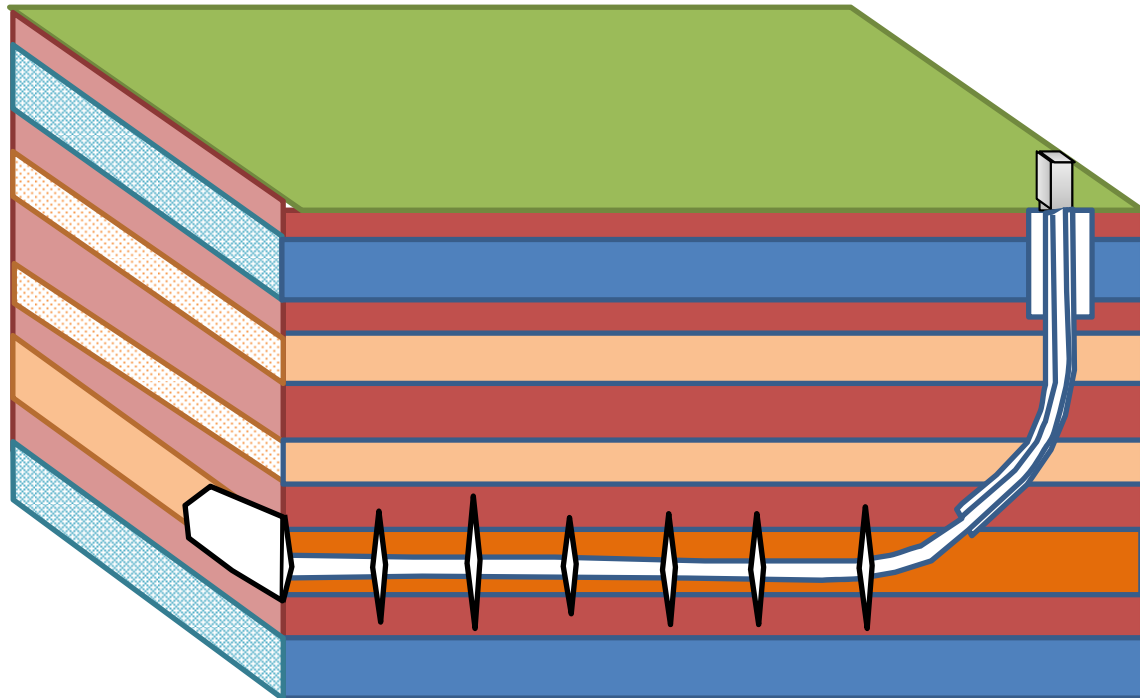
---

- Mitchell ran and largely owned a successful North Texas gas production company
- Running out of prospects to support his gas contract he tested the Barnett Shale in 1981
- After fracturing the initial well produced at a disappointing rate
- He persevered with larger frac jobs gaining moderate success
- However, the breakthrough came when combining horizontal wells with multiple hydraulic fracture treatments

# Horizontal wells and multiple fractures

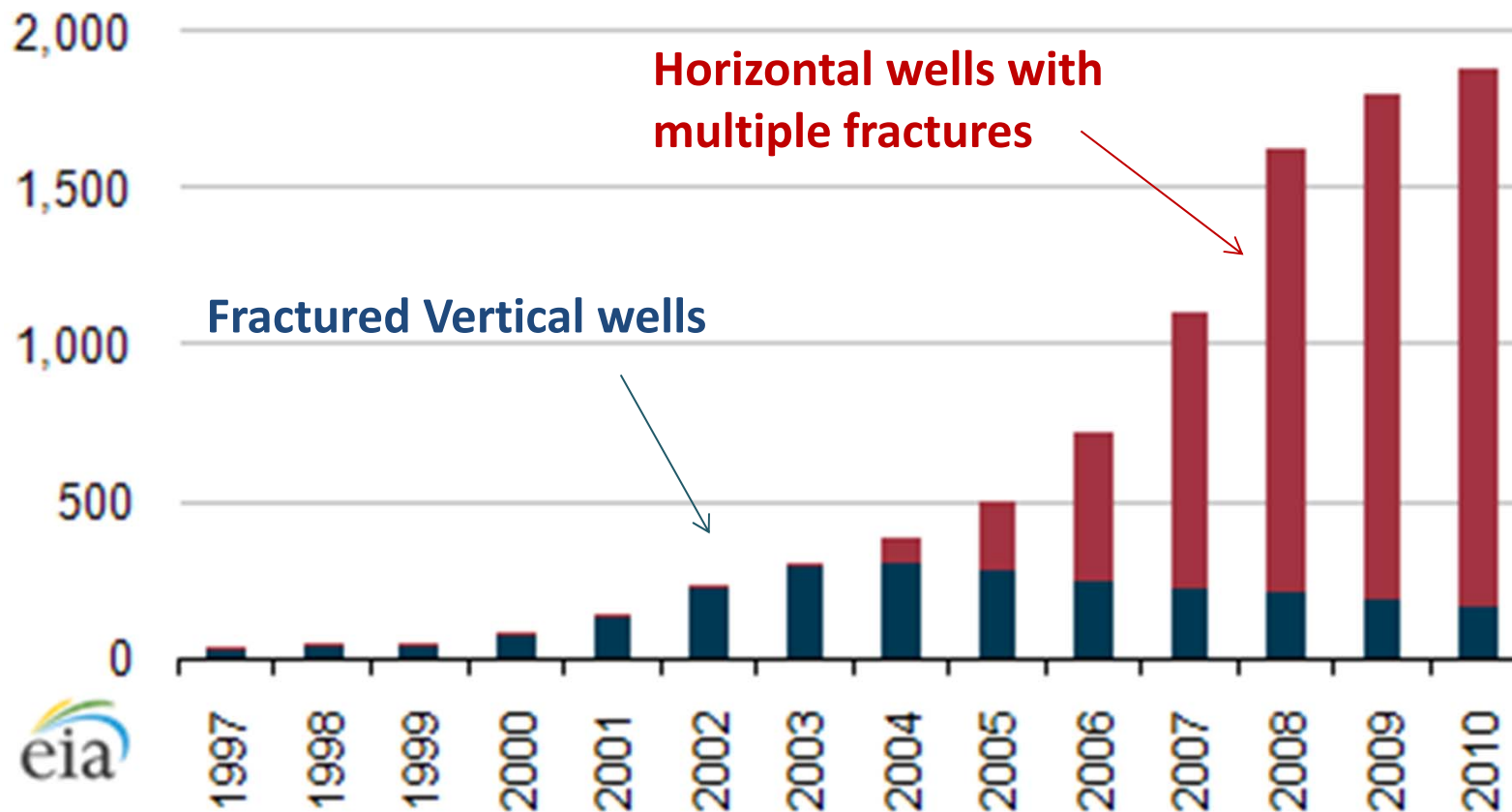
---

Horizontal section 2500-5000 ft long  
8-20 hydraulic fractures  
Each using 30-140 tons of sand  
and up to 2 Ml of water



# Overnight conversion to horizontal wells

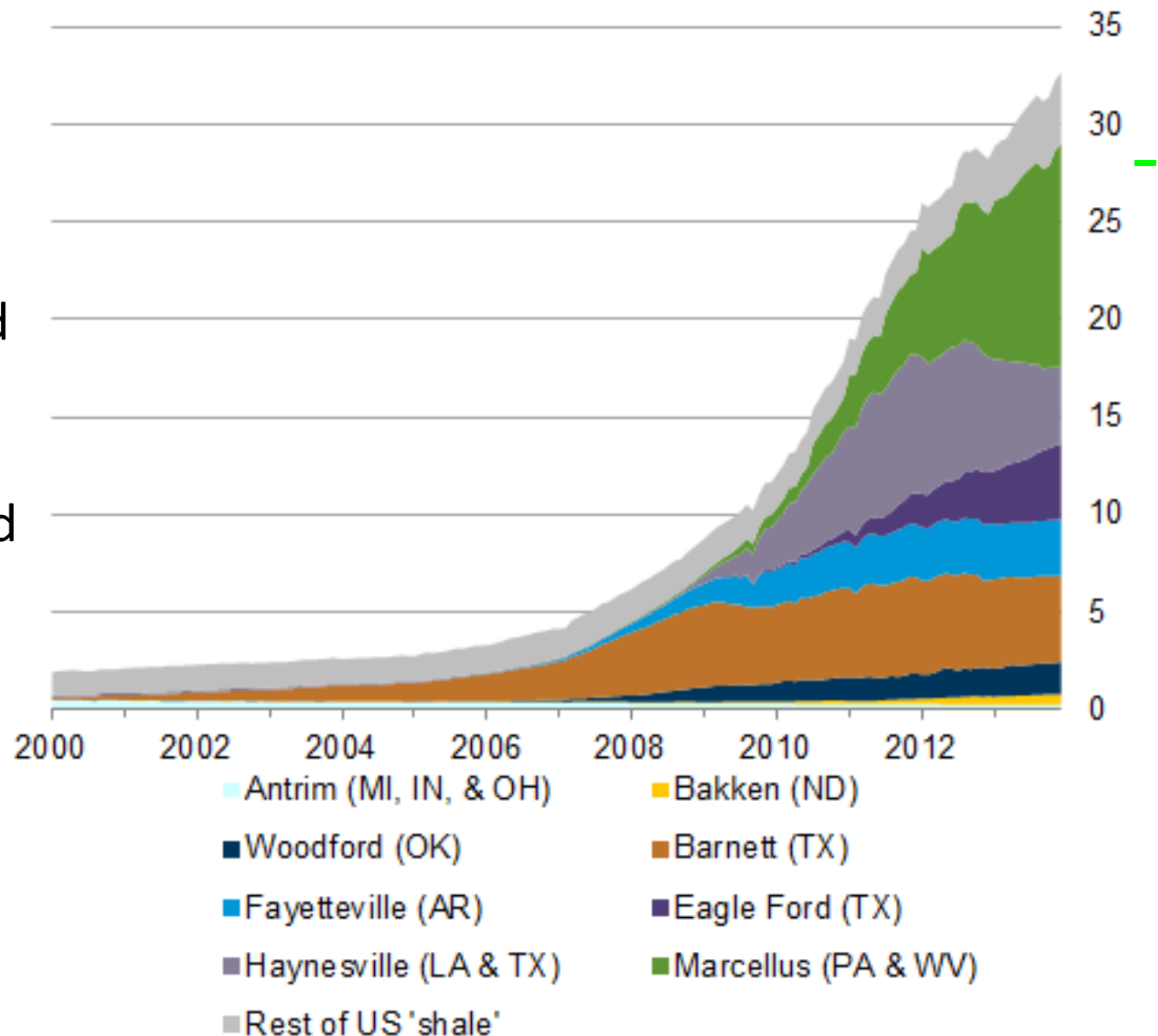
Annual Barnett shale natural gas production by well type  
billion cubic feet (Bcf)



# Shale Gas growth

- Success in the Barnett resulted in other shale formations being developed in the USA..
- ..at some speed

Monthly dry shale gas production  
billion cubic feet per day



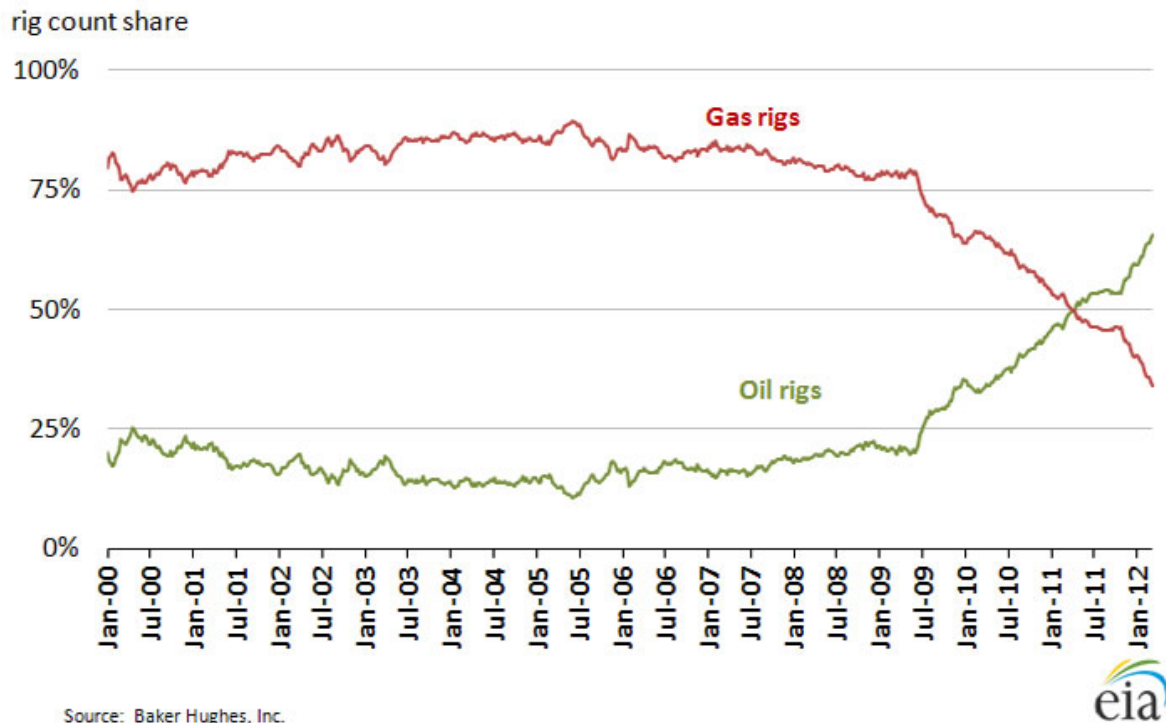
Source: EIA derived from state administrative data collected by DrillingInfo Inc. Data are through January 2014 and represent EIA's official shale gas estimates, but are not survey data. State abbreviations indicate primary state(s).



# Change in focus in USA

- Due to drop in gas price associated with shale gas development, drilling has moved to oil
- Drilling in the Bakken shale and Eagleford have been particularly successful
- The use of multiple hydraulic fractures from a horizontal well has provide as effective in shale oil as it is shale gas

Figure 3. Share of weekly active rig counts by orientation



# Arguments against Hydraulic fracturing

---

- “Earthquakes”
  - Seismic events associated with fracturing have never caused any damage
- **Contaminates groundwater with gas & chemicals**
  - Difficult to see how hydraulic fracture could reach groundwater; spills, leaks or poor cement jobs the main risks
- **Disposal of produced water**
  - Must be done responsibly, ideally back where it came from
- **Should be using renewable energy**
  - A choice for society, but if you use oil and gas, buy British!