

Timeline of the shale revolution: a history of horizontal drilling and hydraulic fracturing in the United States

John Kemp
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1859: First commercially successful U.S. oil well drilled near Titusville in Pennsylvania by “Colonel” Edwin Drake.

1860s: Stimulation of oil wells (“shooting”) using explosives in shallow hard rock formations of Pennsylvania, New York, Kentucky and West Virginia.

1865/66: Colonel Edward A L Roberts receives first of many patents for “Improvement in Exploding Torpedoes in Artesian Wells” culminating in U.S. Patent No 59,936 for what would become known as the Roberts Torpedo. Founder of the Roberts Petroleum Torpedo Company. Initial stimulations done with “black powder” but later switched to nitro-glycerin.

1919: Patent application filed for equipment designed to drill horizontal wellbores.

1929: First horizontal laterals successfully drilled from a vertical oil well.

1930s: Stimulation of oil and gas wells using powerful acids to create pathways through the formation by etching.

1947: First experimental “hydrafrac” stimulation performed on the Kelpper No 1 well in the Hugoton gas field in Grant County, Kansas using 1,000 gallons of napalm-thickened gasoline by Stanolind Oil and Gas Corporation (forerunner of Amoco and BP). Five other hydraulic fracturing treatments were performed at Rangley in Colorado, all considered to be failures.

1948/9: Stanolind’s JB Clark presented hydraulic fracturing process to a wider audience with publication of a paper on “A Hydraulic Process for Increasing the Productivity of Wells”. Paper presented the results of 32 treatments at 23 wells in seven fields of which 11 wells showed an increase in production.

1949: Patent issued for hydrafrac treatment with exclusive license to Halliburton Oil Well Cementing Company (Howco). First two wells hydrafracked in March 1949 in Stephens County, Oklahoma, and Archer County, Texas, using lease crude oil or blend of crude and gasoline. In the first year, 332 wells were treated, with an average production increase of 75 percent.

1949-54: Nearly 6,000 fracture treatments performed in the eastern United States: gel fracs (the original hydrafrac process), sand fracs (also known as sandoil fracs) and acid fracs. Hydrafrac treatments reach more than 3,000 per month for stretches in the mid-1950s.

1954: “Lateral Drain Hole Drilling” published by John Eastman in *The Petroleum Engineer* describing the process for horizontal drilling from vertical wells. Steady pace of lateral drilling through the 1970s.

Mid-1950s: Dowell (later Schlumberger) begins offering water-based fracturing fluids with its “waterfrac” and “riverfrac” treatments.

1956: Dowell completes “biggest frac job in history”: 250,000 gallons of fresh water, 200,000 pounds of sand and 4,500 horsepower.

1957: First 500,000 gallon waterfrac completed with expectations “the first million-gallon treatment may soon be performed”.

1980s: Horizontal drilling becomes more widespread as a result of high oil prices and the shift in emphasis from oil exploration to development of existing fields

1981: Mitchell Energy and Development drills first C W Clay No 1 well into Barnett shale

1981-83: Elf Aquitaine drills four horizontal wells in three European fields: Lacq Superieur oil field (2 wells) (France), Castera Lou oil field (France), and Rospero Mare oil field (offshore Italy).

Early 1980s: BP drills horizontal wells in Prudhoe Bay, Alaska.

1986: Petroleum Development Oman drills three short-radius horizontal wells in the chalky Shuaiba limestone oil reservoir.

1990: More than 1,000 horizontal wells drilled worldwide, of which 850 targeted the Austen Chalk formation in Texas.

Late 1980s/early 1990s: First horizontal wells drilled into North Dakota's Bakken Shale formation. Meridian Oil drills first horizontal Bakken well in 1987. First Bakken boom 1989-95. Commercial failure because oil prices were not high enough to cover the expensive cost of drilling horizontal wells.

1994: Petroleum Development Oman has drilled more than 200 horizontal wells in more than 20 fields and seven different producing horizons.

1990-96: Abu Dhabi drills more than 50 horizontal wells in offshore reservoirs Zakuk, Umm Shaif, Um Al Dalkh and Satah.

1995: Operators in the East Texas Cotton Valley experiment with "waterfracs" using treated water with very low concentrations of proppant. Subsequent papers presented at Society of Petroleum Engineers include "Proppants? We don't need no proppants" (1997), "Waterfracs: results from 50 Cotton Valley wells" (1998) and "Proppants? We still don't need no proppants" (1998).

1997: Mitchell Energy tries first "slickwater" slickwater hydraulic fracturing treatment in Barnett shale with roughly twice the fluid but less than 10 percent of the proppant compared with previous experiments

1998: More than half of new wells drilled in the North Dakota are horizontal.

2001-02: Devon Energy acquires Mitchell Energy and Development. Mitchell Energy had already drilled 400 wells in the Barnett shale and announced plans for 1200 more.

2002: Devon combines Mitchell's expertise in hydraulic fracturing with its own expertise at horizontal drilling to start the Barnett shale boom. Seven horizontal wells completed in 2002 and another 55 in 2003.

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