

Business Cycles & Innovation Cycles:
Are They Related?
Case Studies from the Petroleum Industry

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Harvard Energy Journal Club
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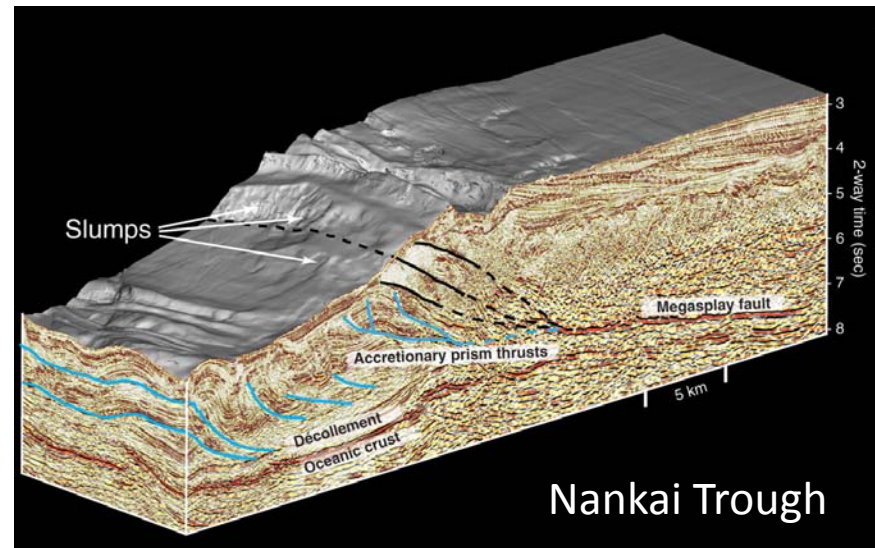
Petroleum Industry Business Cycles

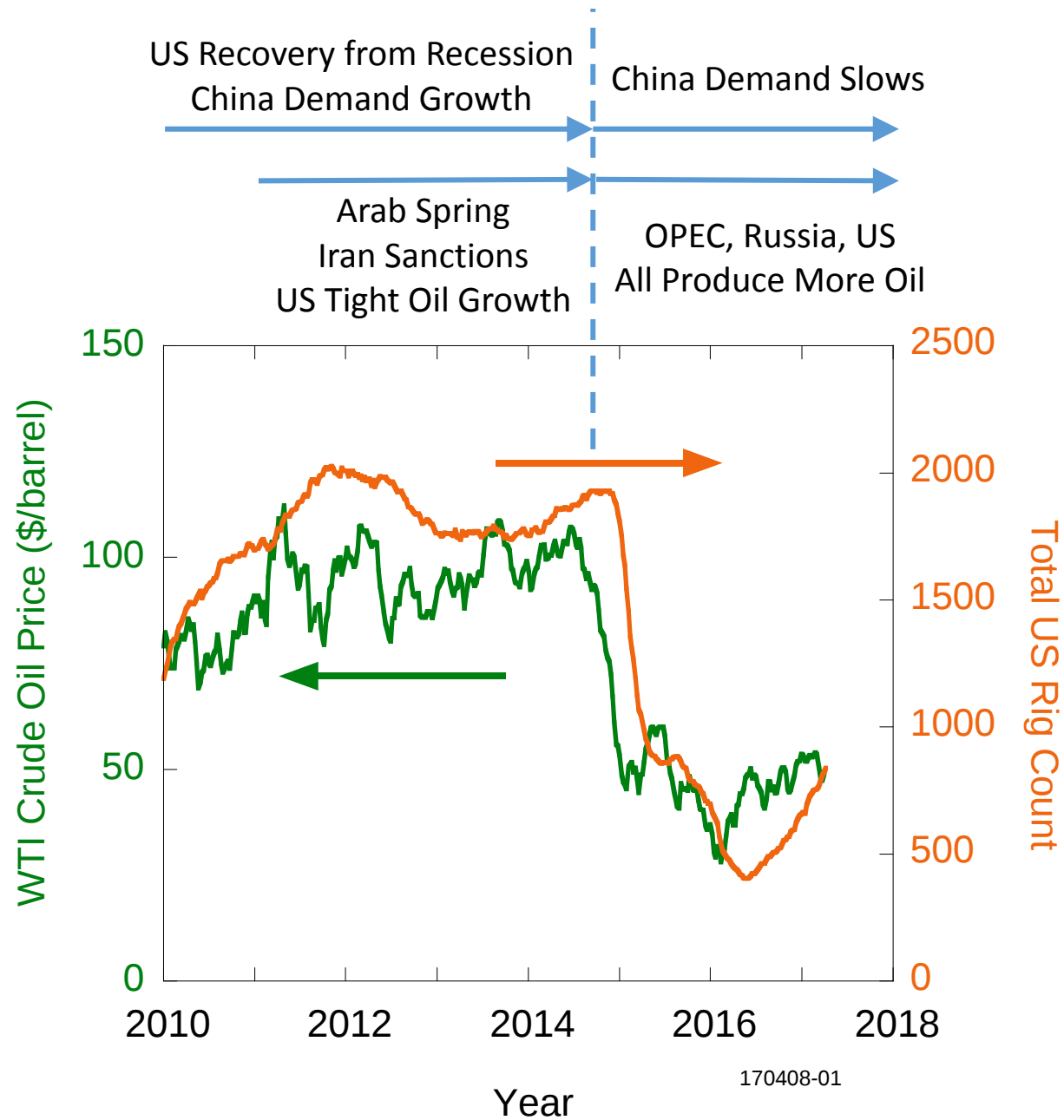
<https://www.youtube.com/watch?v=tLZxzgDL1V0>

Petroleum Industry Innovation



<http://www.iagc.org/geophysical-surveys.html>





US Energy Information Administration, Weekly Cushing, OK WTI Spot Price FOB
Baker Hughes North American Rotary Rig Count

“US shale resilience a product of innovation, CEOs say”

– Oil & Gas Journal, March 2016

Study Question:

Do declining and low oil prices encourage technical innovation?
or Do declining and low oil prices starve innovation?

Which Leads to Another Question:

What do you mean by “innovation”?

Types of Innovation

- ❑ Process & Efficiency Improvements
- ❑ Technical Innovations
- ❑ Industry-Changing Innovations

Process & Efficiency Improvements

Increasing Costs	Decreasing Costs
Play margin delineation	Derisked geology
Drilling/completion/ stimulation surprises	More efficient drilling/ completion/stimulation
Competition for leases	Consolidation of leases
Supply chain bottlenecks	Supply chain optimization
Infrastructure bottlenecks	Infrastructure buildout
Service cost increases - o Equipment shortages - o Personnel shortages	Service cost discounts - o Amortization of CAPEX - o Service efficiencies - o Increased competition

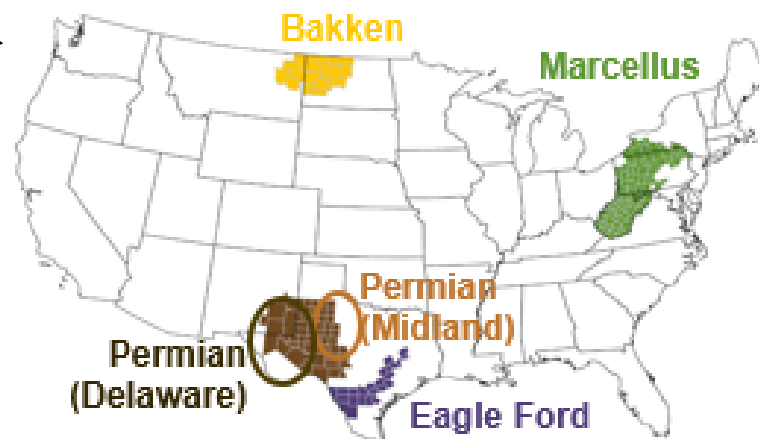
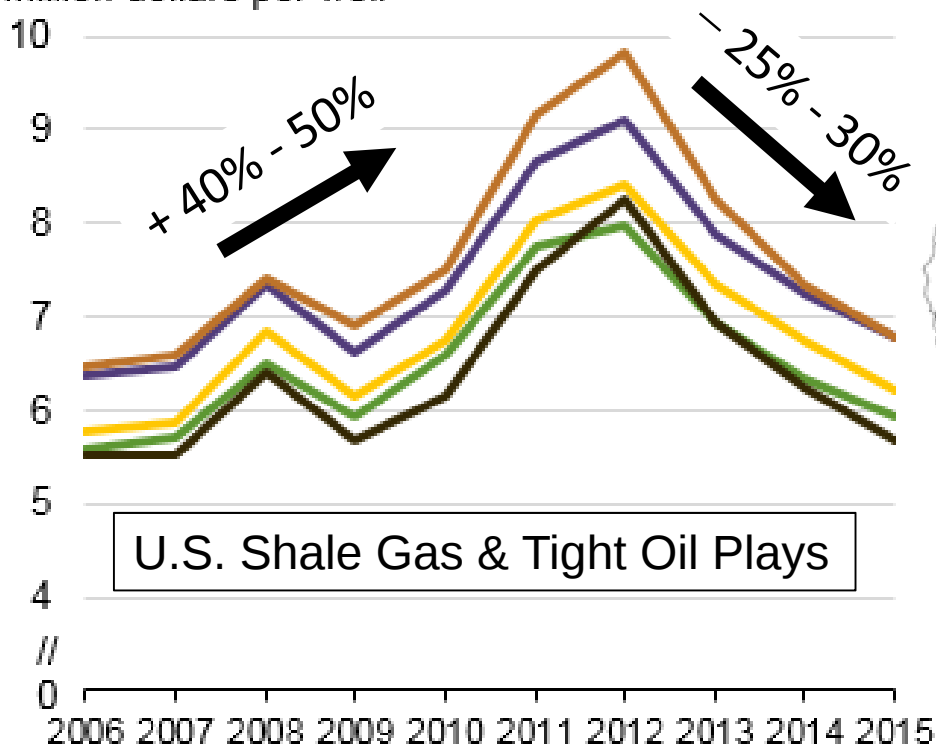
Early in development cycle

Late in development cycle

Process and Efficiency Improvements are “Every Day Innovations” that Continue Through Business Cycles

Average well drilling and completion costs indexed to 2014 well designs (2006-15)

million dollars per well



https://www.eia.gov/petroleum/weekly/archive/2016/160602/includes/analysis_print.cfm

Technical Innovation: Old-Style Drilling



Jonah Field, Wyoming
33 square miles
16-32 vertical wells per square mile

Technical Innovation

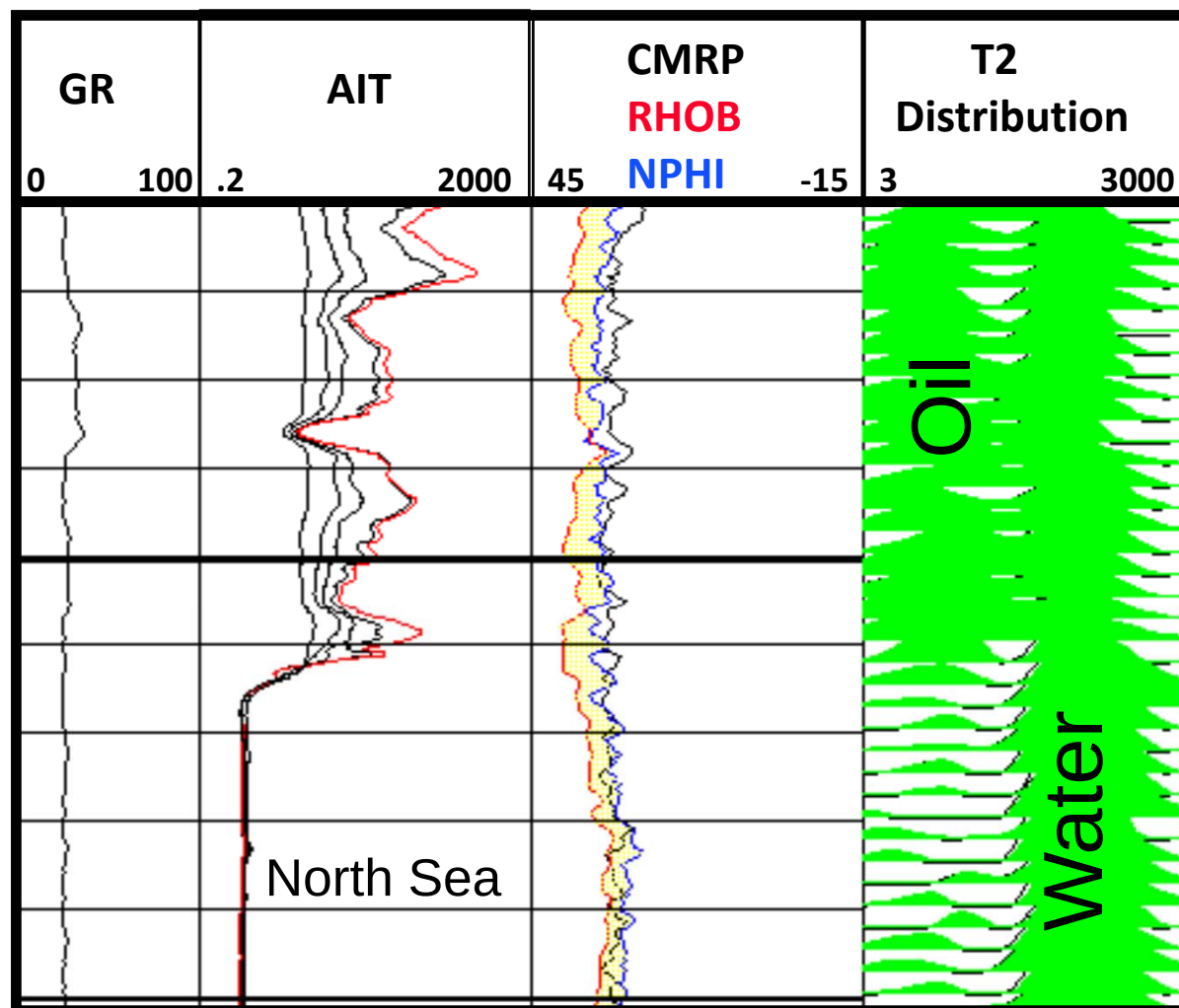
Pad Drilling	▪ Site construction efficiencies ▪ Well construction efficiencies ▪ Creeping rigs ▪ Supply chain simplification	Factory Mode
Super Fracks	▪ Longer horizontals ▪ Closer fracture initiation points ▪ More water ▪ More sand	Even More Brute Force
Asset High Grading	▪ No more exploratory drilling ▪ Only the best rigs and crews ▪ Only the best locations	Intelligent Downsizing

How Do **Industry-Changing** Innovations Develop Through Business Cycles?

Mini Case Studies:

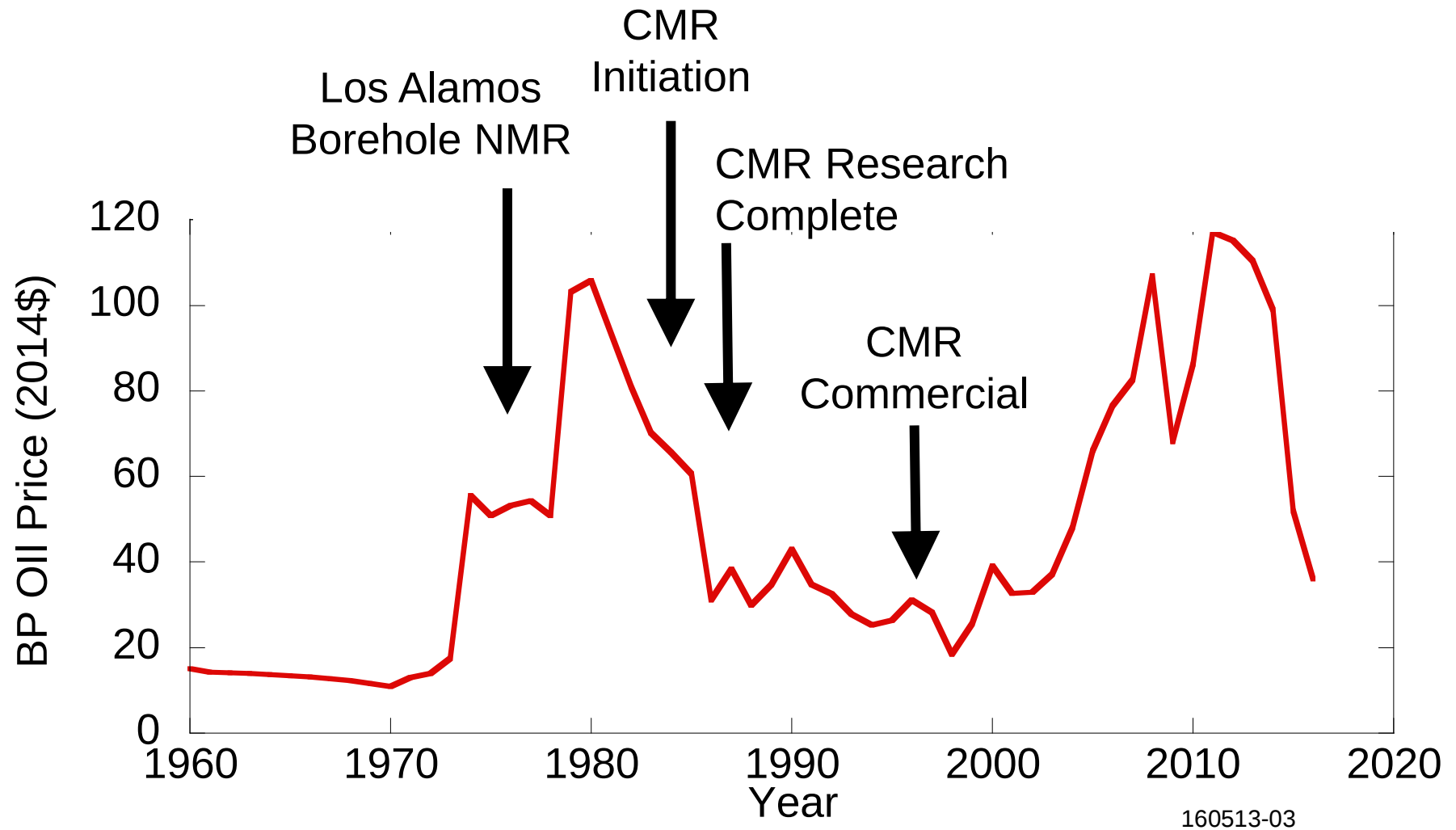
- 3-D Seismic
- ➡ ▪ Magnetic Resonance Logging
- ➡ ▪ Logging-While-Drilling & Geosteering
 - Rotary Steerable Drilling
- ➡ ▪ Horizontal Drilling + Massive Hydraulic Fracturing

Magnetic Resonance Logging

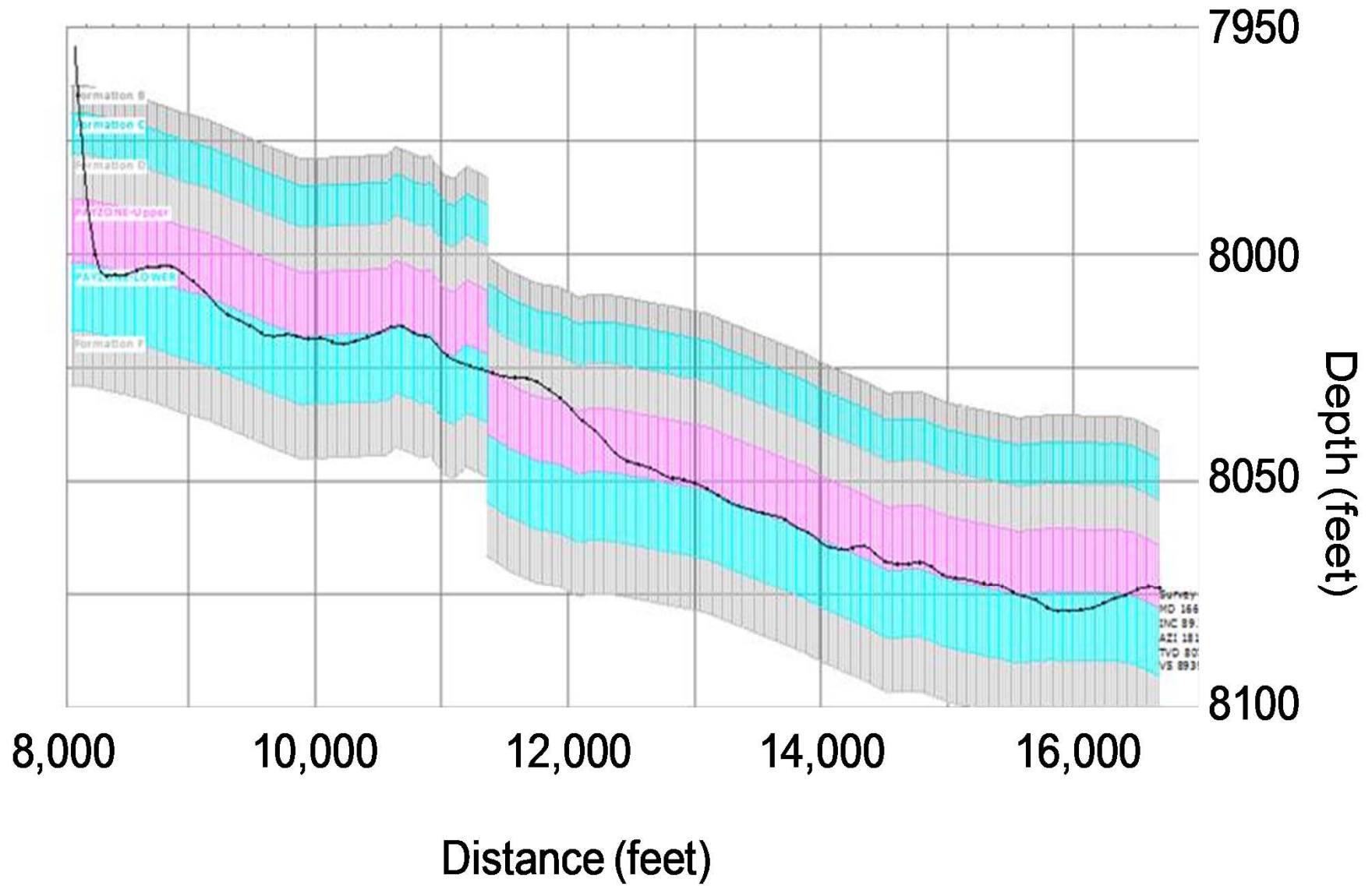


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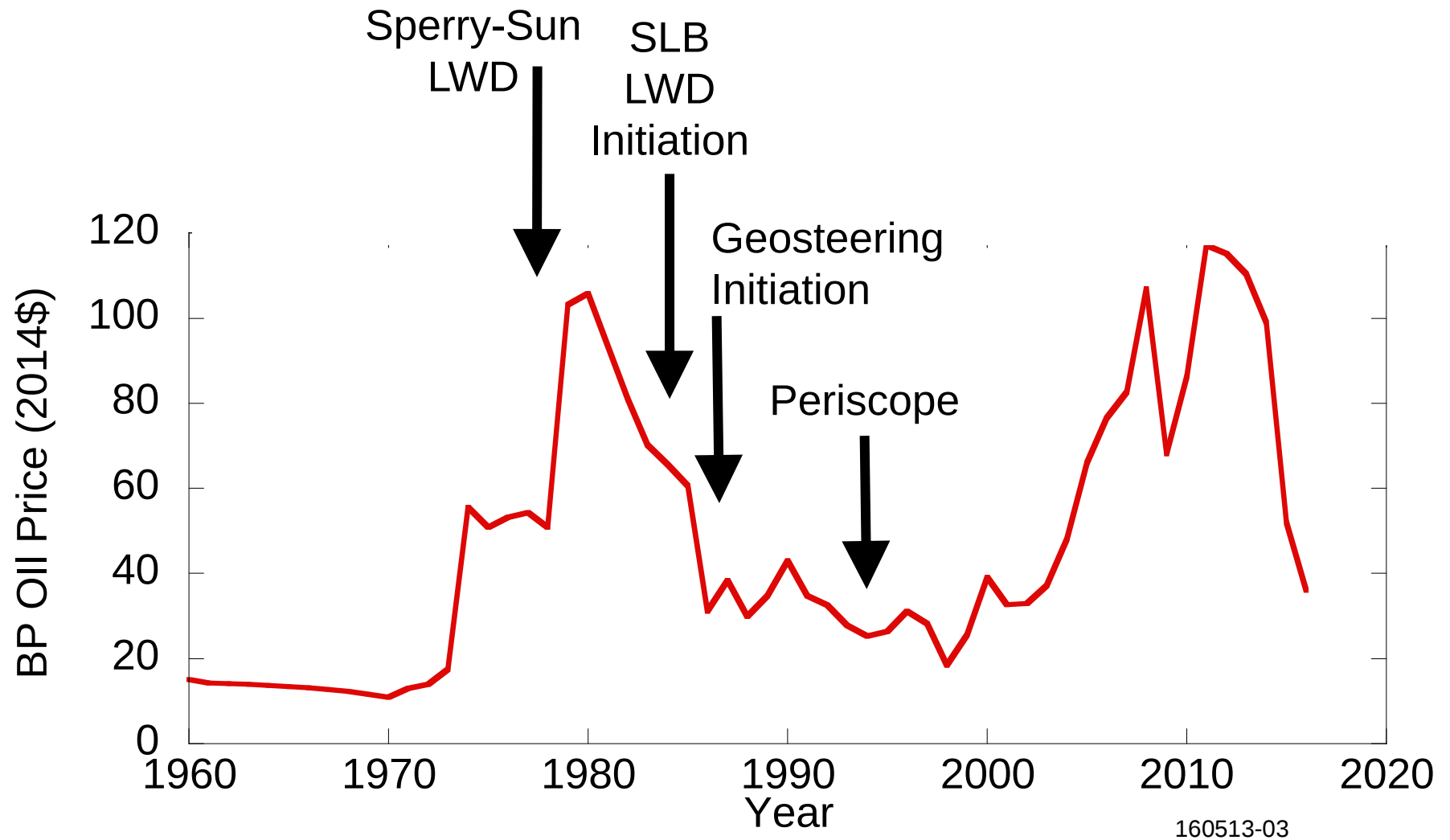
Magnetic Resonance Logging Initiated During Boom, Developed During Bust



Logging-While-Drilling & Geosteering



Logging-While-Drilling & Geosteering Initiated During Boom, Developed During Bust



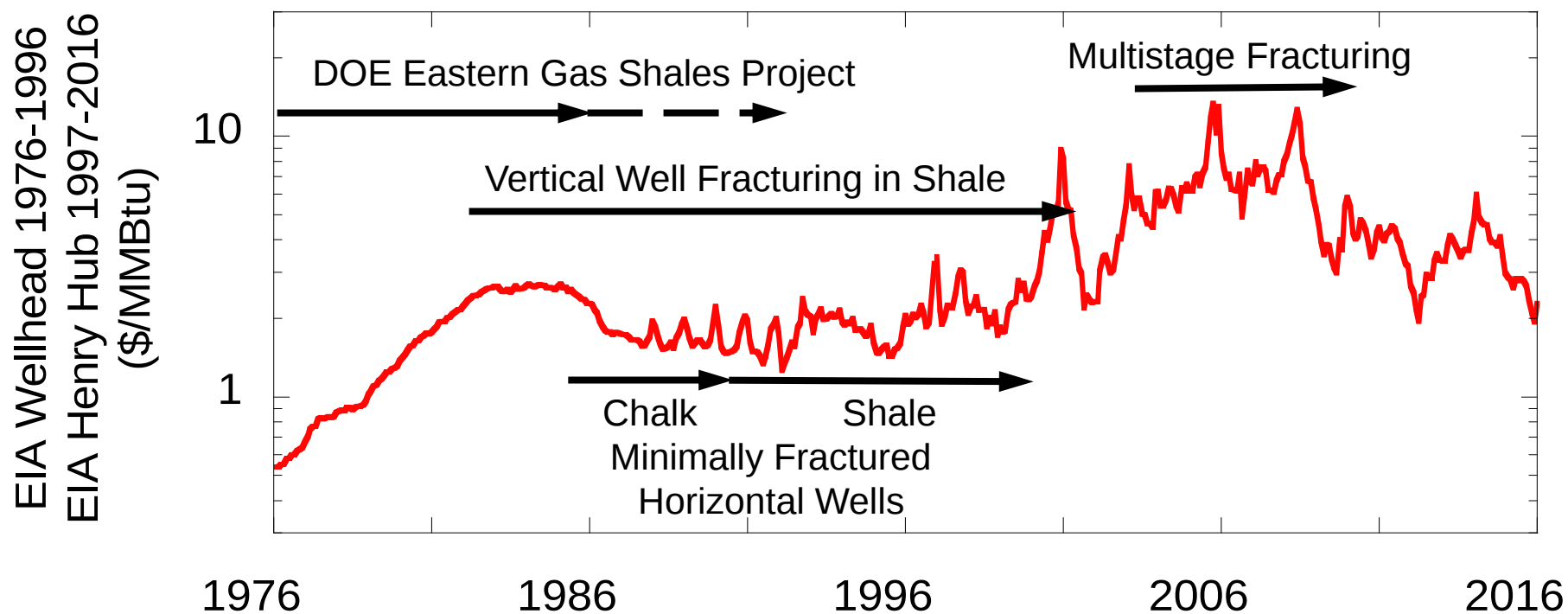
Gas Shale & Tight Oil



Greene County, Pennsylvania

Horizontal Wells and Hydraulic Fracturing Developed Separately

Multistage Fracturing Was the Key Enabler



160531-01b

EIA Wellhead Gas Price 1976-1996; Henry Hub Gas Price 1997-2016

Innovation & the Business Cycle

	Oil/Gas Prices	
	Rising & High	Falling & Low
Industry R&D	Grows	Shrinks
R&D Priorities	Novel Techniques	Efficiency Improvements
R&D Structure	Organic Growth	Downsizing of Risk IOCs → Service Cos → Start Ups
Academic & Govt Energy Research	Grows, emphasizing societal priorities	Shrinks
New Talent	Enters the field, generating new ideas	Exits the field, taking some new ideas with them
Survivors	Soldier On	

- Industry-changing innovations develop over 10 - 20 years
- There is no sure way to anticipate innovation. The key is to have the technical ability to quickly take advantage of surprises.
- Technology leaders of the next up-cycle shrink the least

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