

# Geology of the Marcellus Shale and Gas Well Drilling

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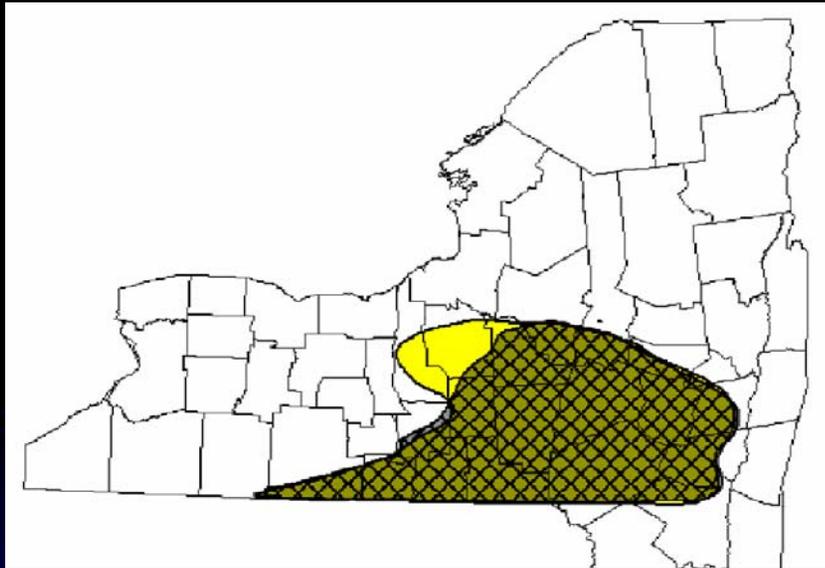


# It all began in New York!



34 years before the Drake well in Pennsylvania!

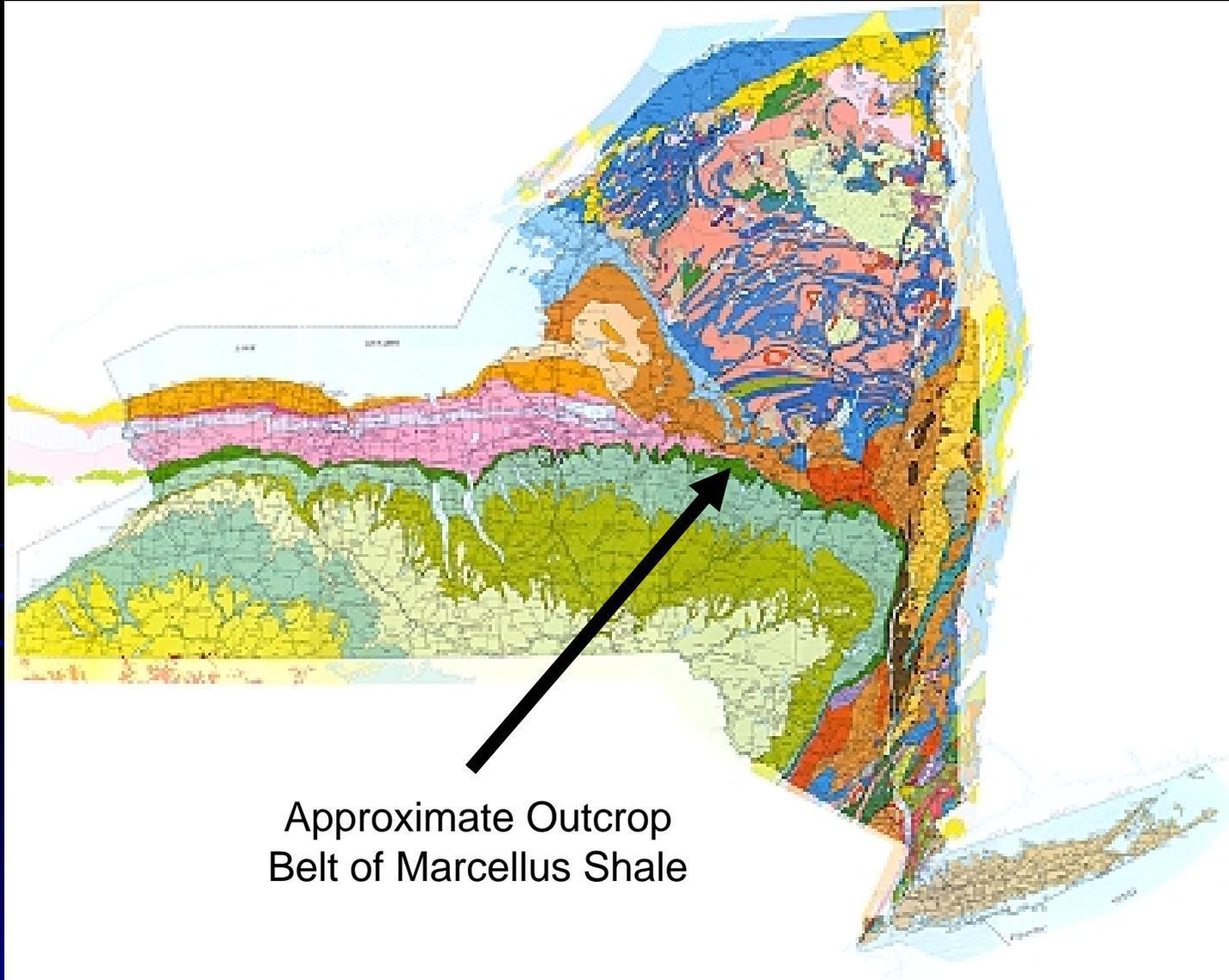
# Marcellus Gas Play



- Utica and Marcellus Fairways
- Unconventional shale gas targets
- Marcellus is considered a Rank Wildcat Field

Nyahay, et. al., 2007

# Simplified Geologic Map of NYS



Approximate Outcrop  
Belt of Marcellus Shale

# Marcellus Shale

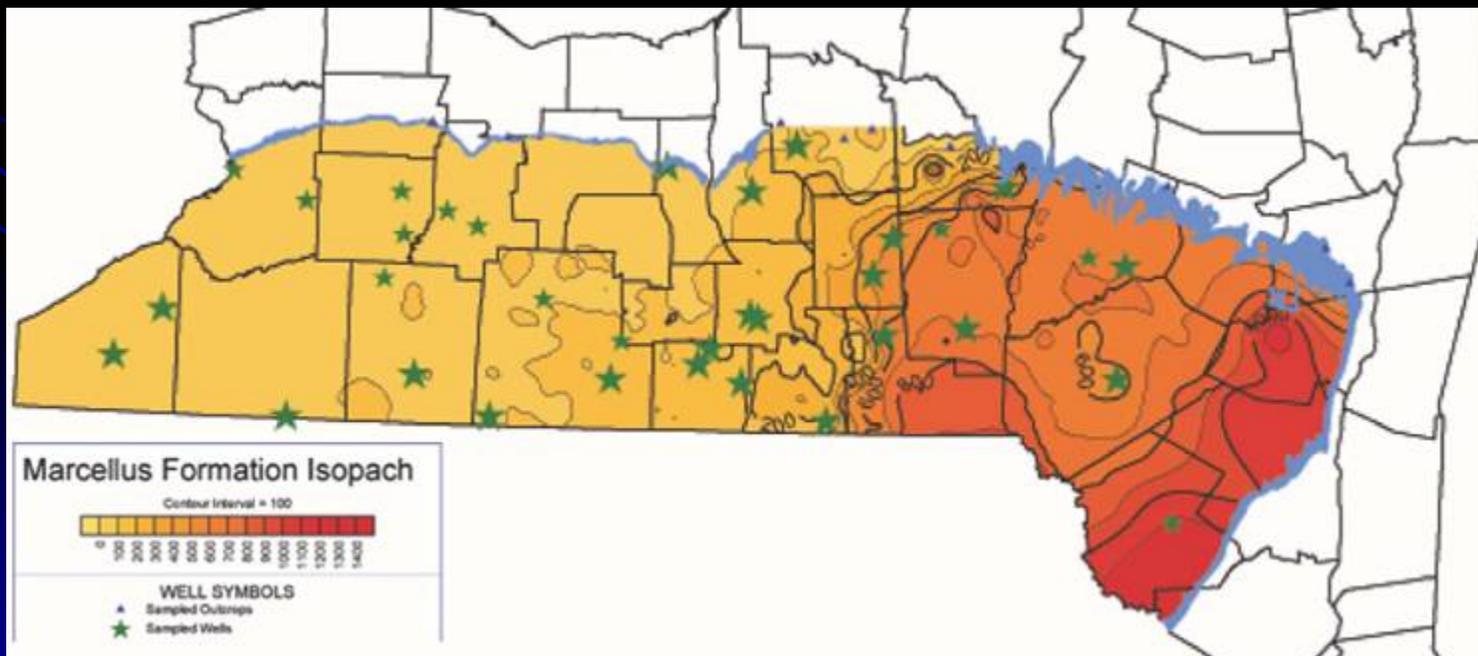


- Shale – rock made from mud (clay and silt)
- Black from high organic content
- Organic matter is source of gas

Terry Engelder photo

# Marcellus Shale

- Edge of layer exposed in northern Otsego County
- Layer dips gently south at 1-2°
- Marcellus is about 1200 to 1600 feet below Oneonta
- Well in Maryland shows top of Marcellus at 1570 ft.
- Layer thickens to the east, thins to the west
- Below Oneonta – approximately 680 ft thick



# Marcellus Shale



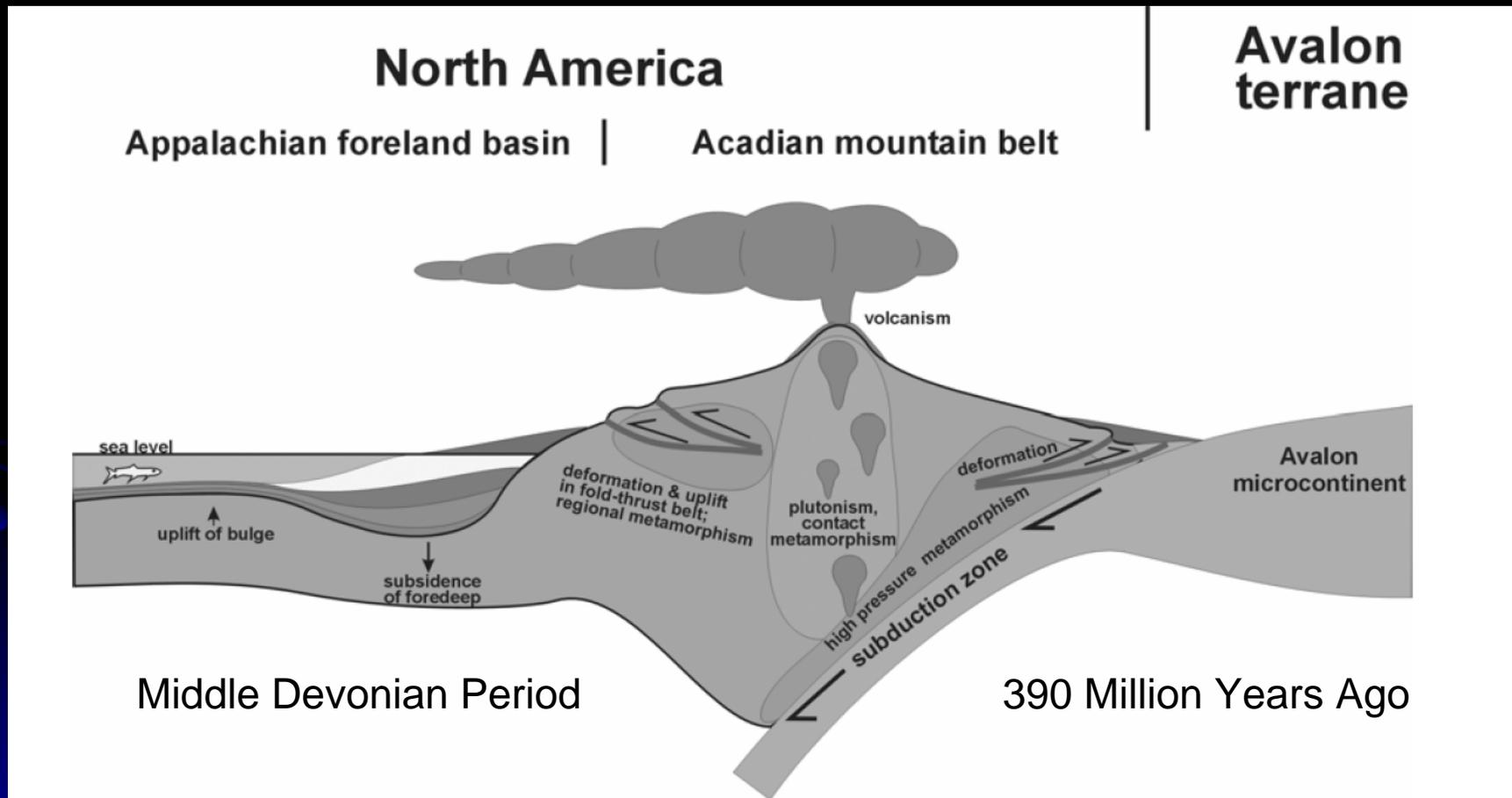
Terry Engelder photo

- High organic content means high gas potential
- Greater thickness means more gas potentially available
- Shale composition means very little connection between pore spaces that hold gas
- Fractures help gas flow within formation

# How did the Marcellus form and why is it so organic rich?

- Middle Devonian Period (390 million years ago)
- Formation of Acadian Mountains
- Collision of Avalon and North America causes Appalachian Basin to subside
- Sediment accumulates very slowly
- Deep water means poor circulation
- Oxygen is depleted at sea floor
- Low sediment accumulation rate and low oxygen allows organic matter from dead algae, plankton, etc. to be preserved in high concentrations

# How did the Marcellus form and why is it so organic rich?



Modified from Ver Straeten, Ebert,  
Bartholomew, Benedict, Matteson and Shaw (2005)

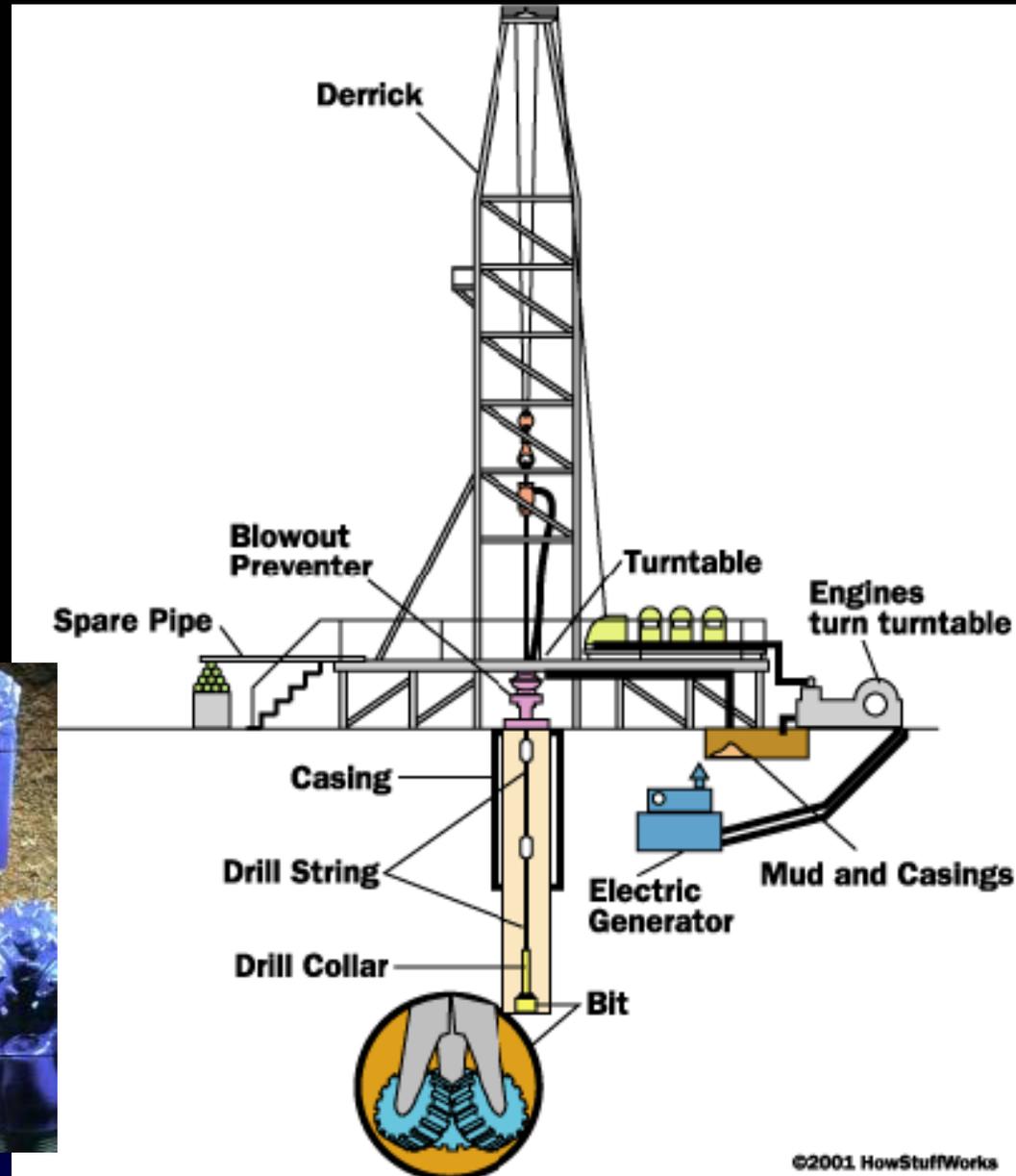
# Formation of Gas in the Marcellus

- Marcellus muds were buried under sand, silt and mud eroded from the Acadian Mountains in New England and eastern New York State.
- These thick deposits are the first sediments of the “Catskill Delta.”
- Marcellus muds buried under thousands of feet of sediment deposited over tens of millions of years.
- Heat from within Earth converts organics to oil, then gas

# Geology of Oil and Gas

- Source Rock – organic rich
- Thermal Cracking – hot, but not too hot!
- Migration – not a factor for the Marcellus
- Reservoir Rock – Marcellus is Source and Reservoir
- Trap – Not a factor for the Marcellus
- Leasing
- Exploration – geophysical and drilling
- Casing and perforation
- Production, including “frac-ing”

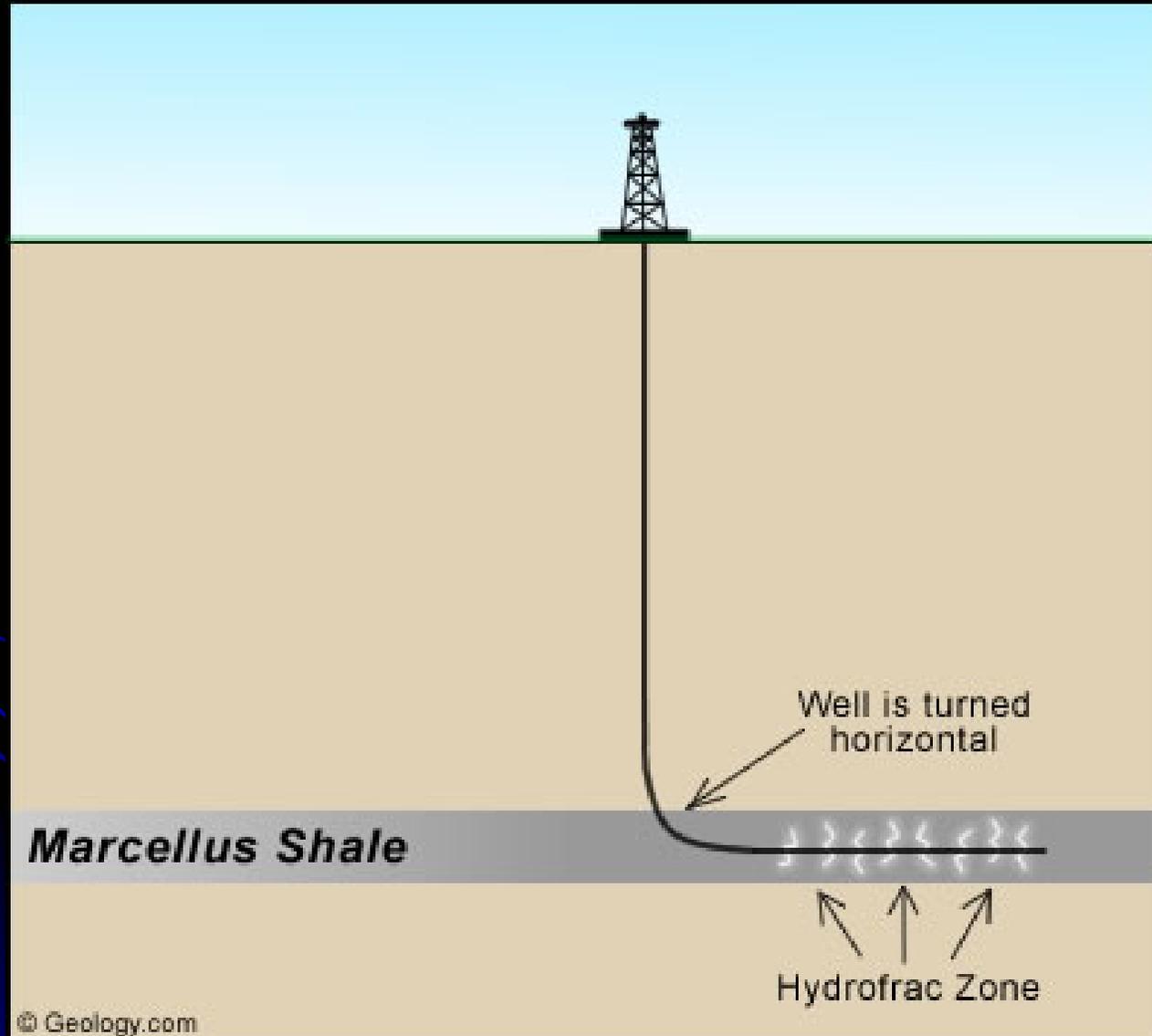
# Anatomy of a Drill Rig



# Gas Well Drilling



# Horizontal Drilling



# Frac-ing Operation



Halliburton photograph

# Completed Gas Well Chautauqua County, New York

