

# Open Questions Regarding Well Construction and Hydraulic Fracturing

Courtney C. Hemenway, P.E.

President

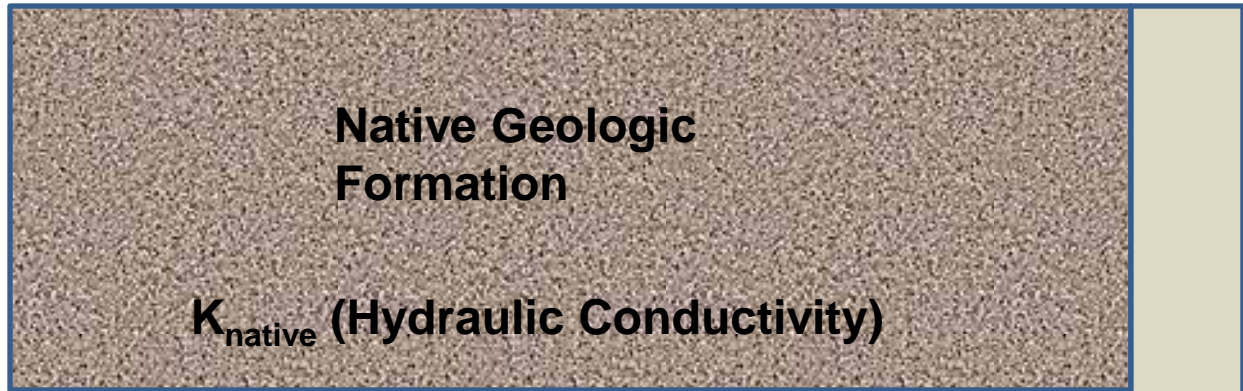
Hemenway Groundwater Engineering,  
Inc.



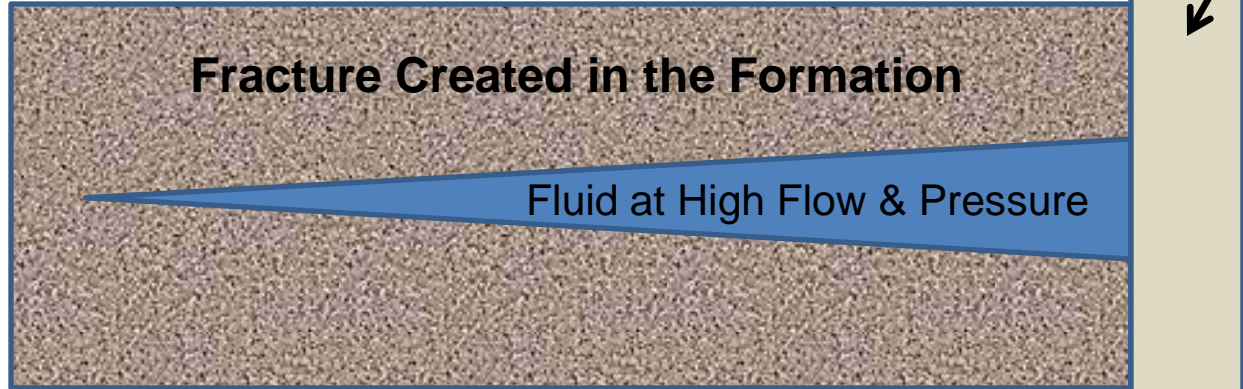
# What is Hydraulic Fracturing?

- Hydraulic fracturing began in 1947 by Stanolind Oil in KS
- Patented by Haliburton in 1949
- Hydraulic fracturing is the fracturing of a geologic formation through high pressure and the flow of fluids in a well bore. The fractures are then propped open through the use of proppants.

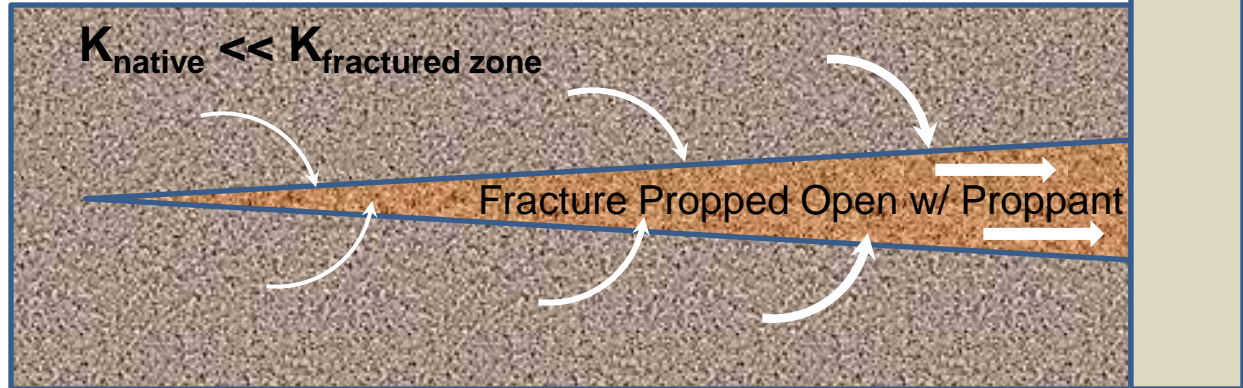
Conditions  
Prior to  
Hydraulic  
Fracturing



Conditions  
During  
Hydraulic  
Fracturing



Conditions  
Following  
Hydraulic  
Fracturing



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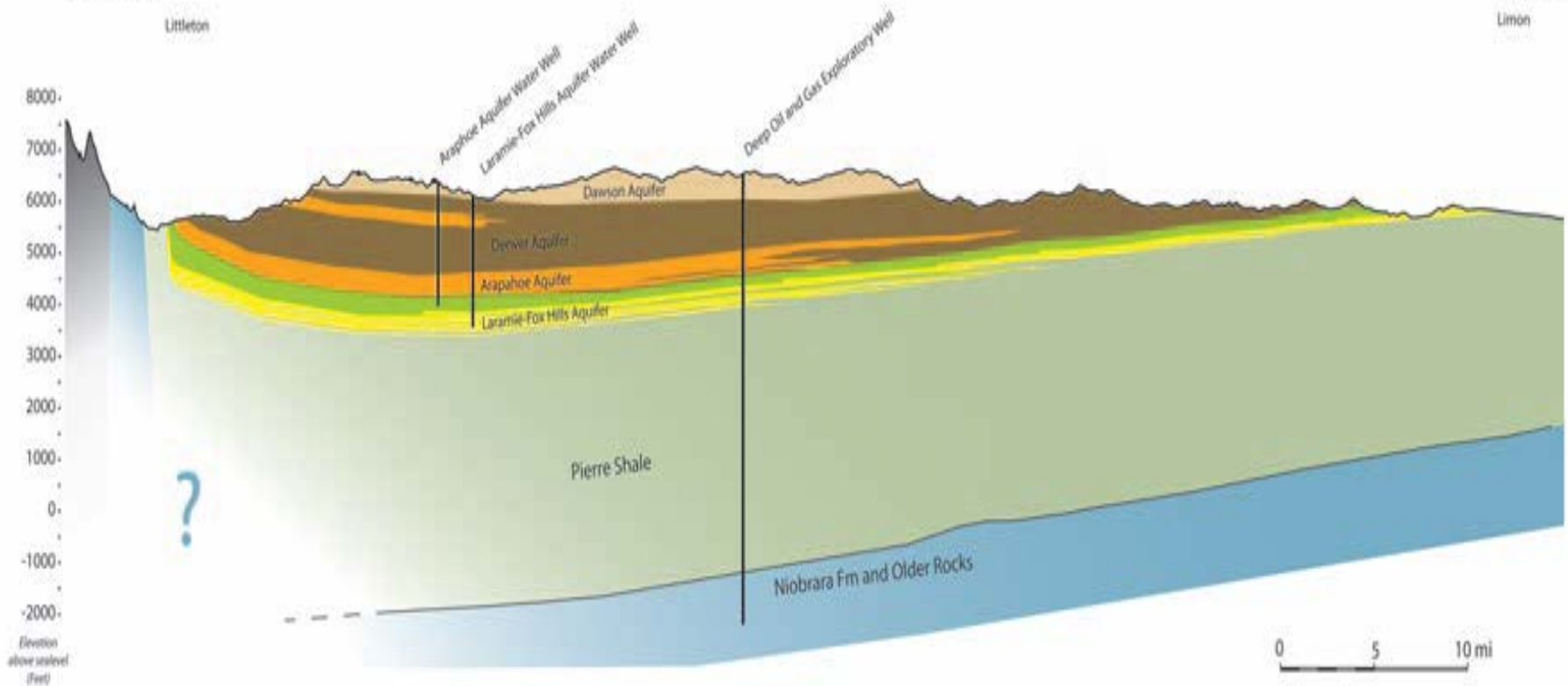
How do you define hydraulic fracturing with respect to well construction?

Typically hydraulic fracturing is equated with all aspects of well construction.

Impacts - Case Study: Colorado Geothermal & Water Well Projects

# Potable Drinking Water Aquifers with Respect to Oil and Gas Formations

Northwest (Denver Basin Water Supply Aquifers and Niobrara Oil and Gas Formations) Southeast



Denver Basin Cross-section Showing Bedrock Aquifers Above the Pierre Shale and the Distance above the Niobrara Formation

Colorado Geological Survey

2011

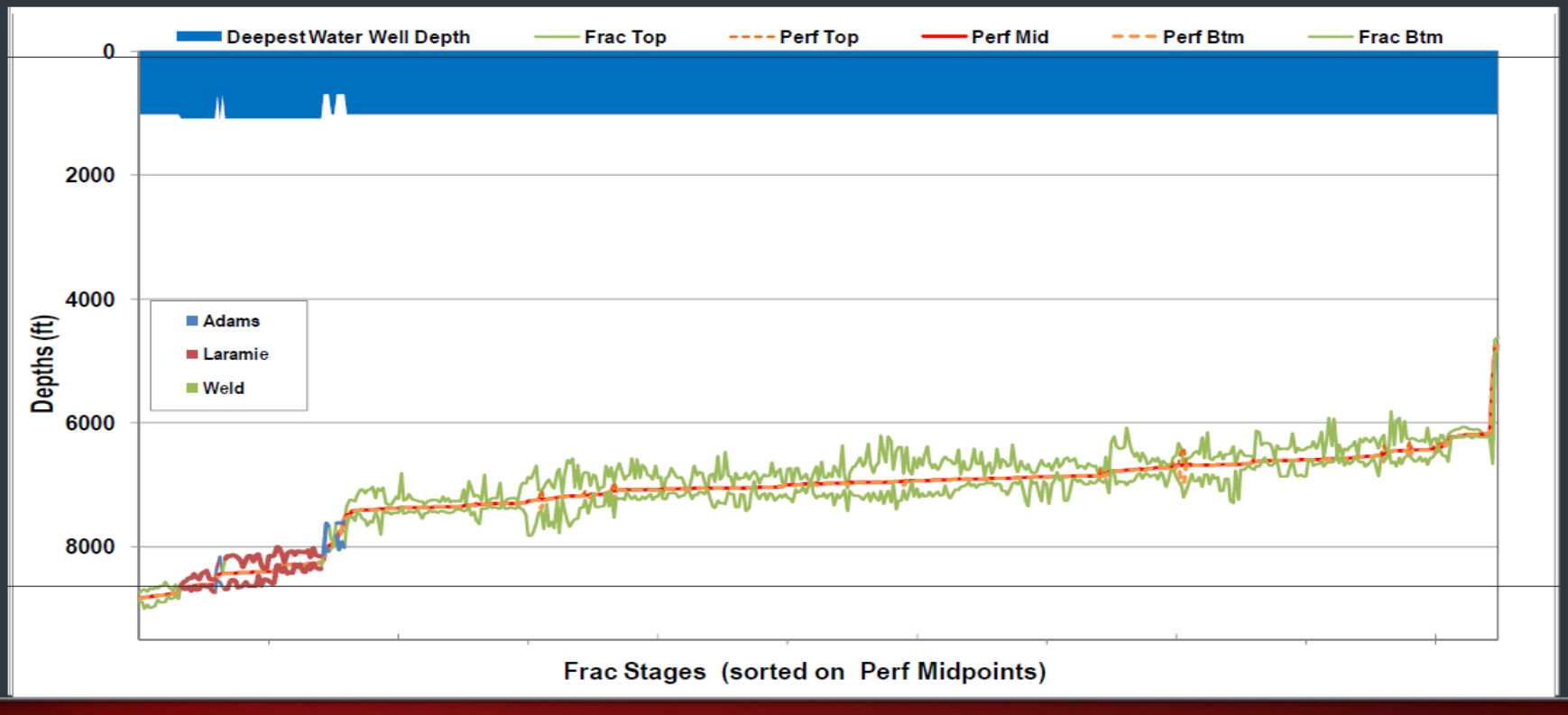
# Hydraulic Fracture Height Growth: Real Data

By Kevin Fisher & Norm Warpinski

(Society of Petroleum Engineers Paper 145949; 2012)

## Mapped microseismic height for Niobrara

- Top: shallowest microseism; Bottom: deepest microseism
- Aquifers: USGS deepest water well levels by county

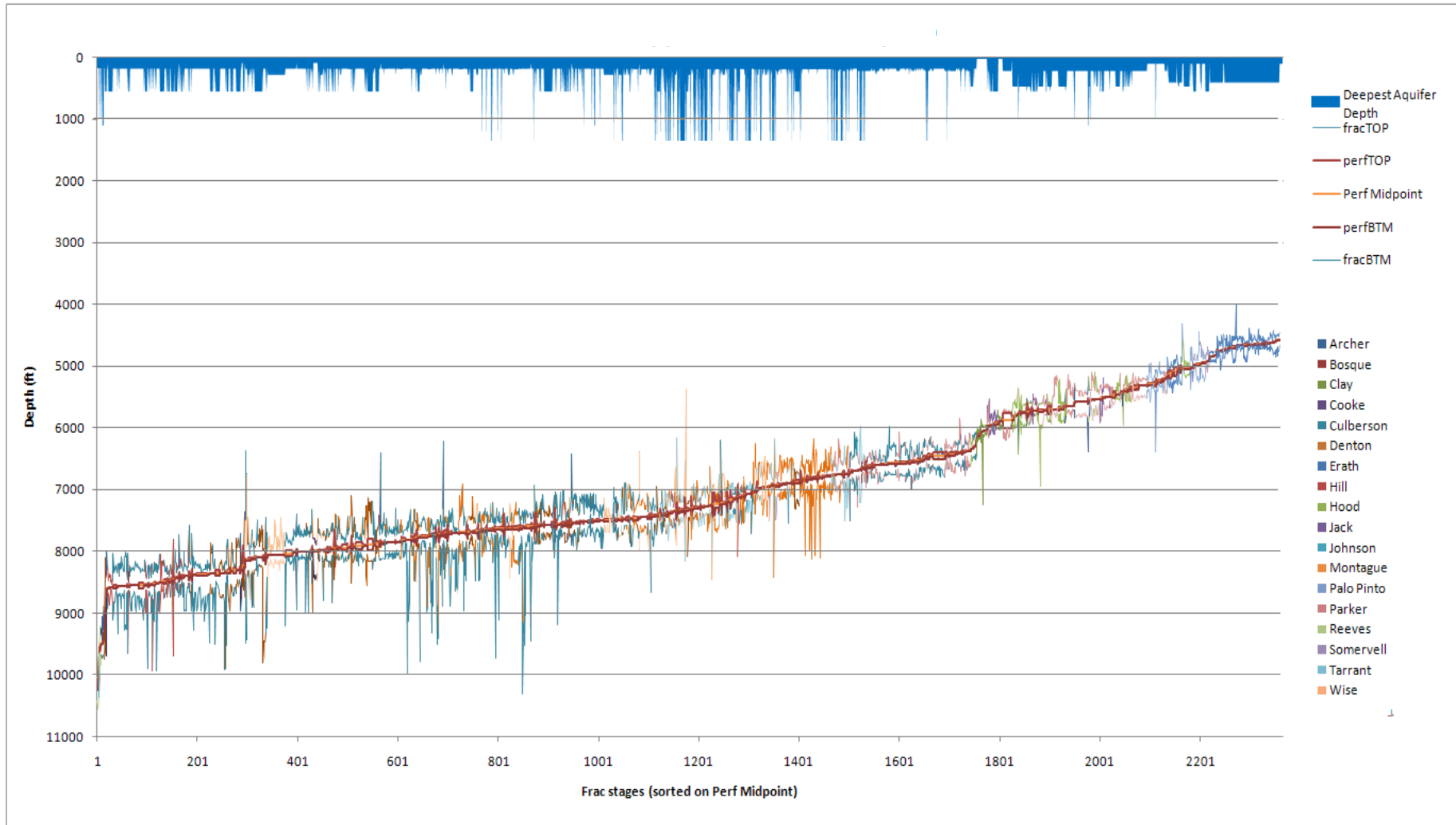


# Hydraulic Fracture Height Growth: Real Data

By Kevin Fisher & Norm Warpinski

(Society of Petroleum Engineers Paper 145949; 2012)

Mapped Microseismic Height for the **Barnett Formation**

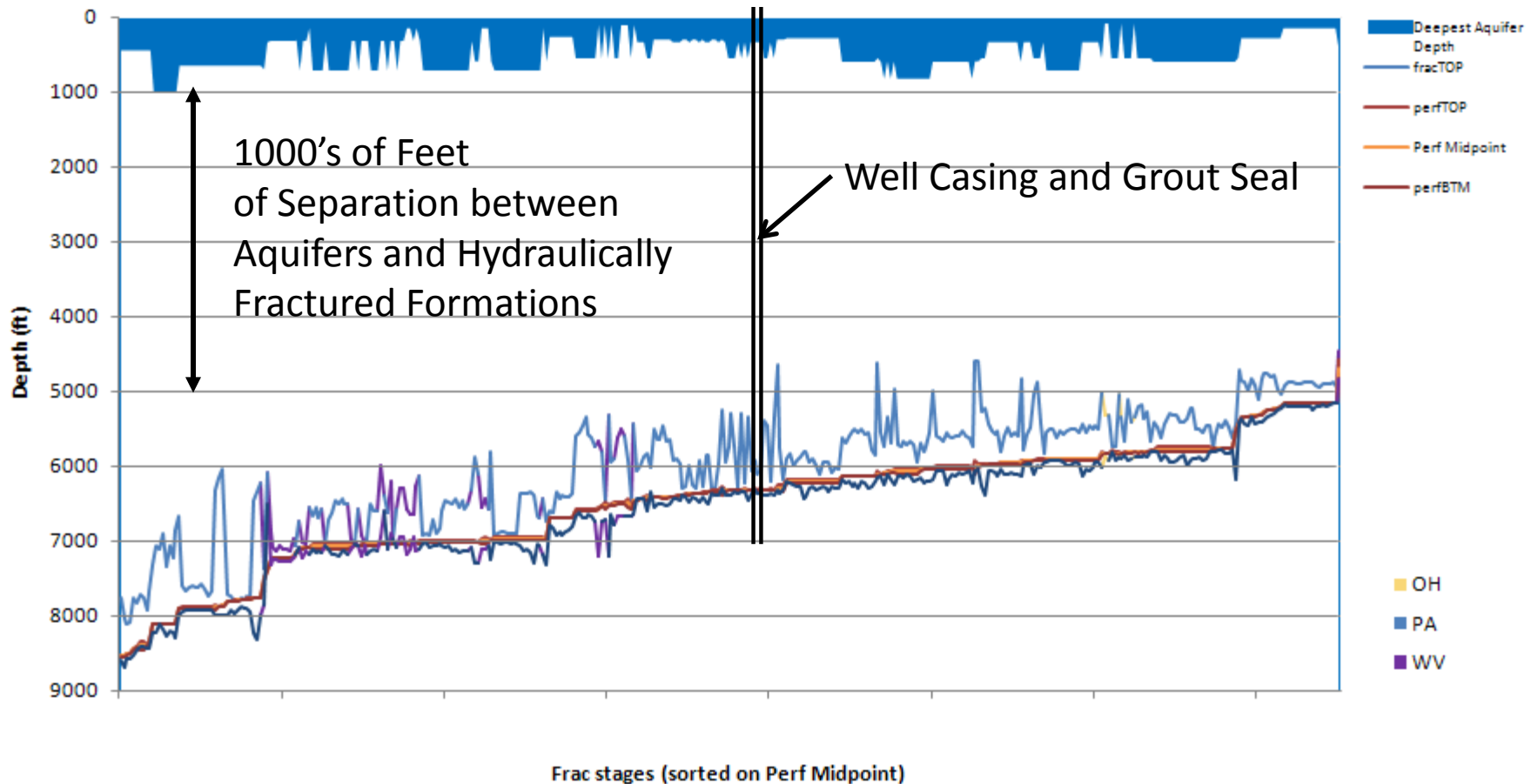


# Hydraulic Fracture Height Growth: Real Data

By Kevin Fisher & Norm Warpinski

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## Mapped Microseismic Height for the **Marcellus Formation**





# Open Questions Regarding Well Construction and Hydraulic Fracturing

- When should baseline ground and surface water quality samples be collected?  
1 month or 1 year before drilling?
- How and what ground and surface water quality data should be collected?  
Collected from existing wells or new monitoring wells?  
Which parameters: Hydraulic Fracturing fluids only, hydrocarbons (thermogenic/biogenic gas), Drinking Water Standards, target constituents, etc.)?
- What information (well construction, abandonment procedures, etc.) and testing is required for existing (offset) wells completed through oil/gas-producing intervals to be hydraulically fractured?

# Open Questions Regarding Well Construction and Hydraulic Fracturing

- What are the criteria for groundwater monitoring wells (existing wells or new wells with verifiable construction methods)?
- How should Underground Sources of Drinking Water (USDW) be identified (geophysical logging, physical testing, or other alternative methods)?
- Do all wells within an oil and gas development field need to test potential USDW's or a representative number?
- What is the required depth and type of surface casing, what types of cementing requirements should be considered for oil and gas wells to prevent possible contamination to USDW's, and does this change from field to field?

# Open Questions Regarding Well Construction and Hydraulic Fracturing

- How are cement grout seals verified during or after well construction (cement bond logs, cement evaluation tools, temperature logs, etc.) and should all wells be required to verify the cement seal?
- Should Mechanical Integrity Tests (MIT) be conducted on surface casing strings that are completed through USDW's?
- How does time factor into all aspects of well construction and monitoring (pre-development, construction, production, and abandonment)?

# Open Questions Regarding Well Construction and Hydraulic Fracturing

- Does the use of “green” fluids in hydraulic fracturing change the approach to well construction, inspection, and monitoring?
- What controls are effective to mitigate surface spills (close-looped systems, whole-site spill prevention measures, etc.)?
- What should be the focus areas for the “US EPA Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water”?

Hydraulic fracturing is a small piece of a much larger oil and gas well construction, operation, and abandonment process.