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

Native Geologic Formation K_{native} (Hydraulic Conductivity)

Well Bore

Conditions

During

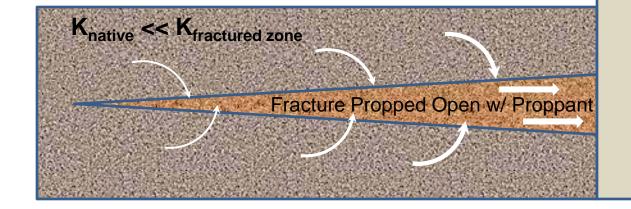
Hydraulic

Fracturing

Fracture Created in the Formation

Fluid at High Flow & Pressure

Conditions
Following
Hydraulic
Fracturing



What is Hydraulic Fracturing?

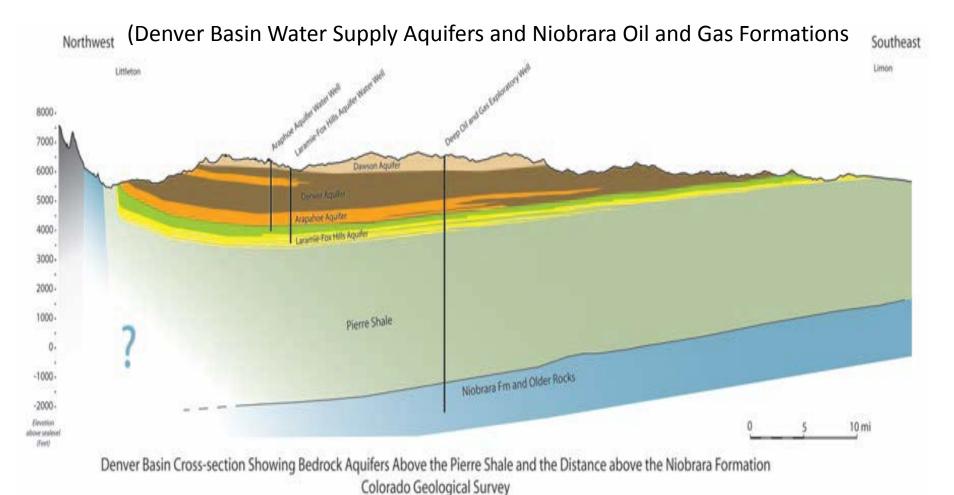
- Hydraulic fracturing began in 1947 by Stanolind Oil in KS
- Patented by Haliburton in 1949
- Hydraulic fracturing is the fracturing of a geologic formation through high pressure and the flow of fluids in a well bore. The fractures are then propped open through the use of proppants.

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

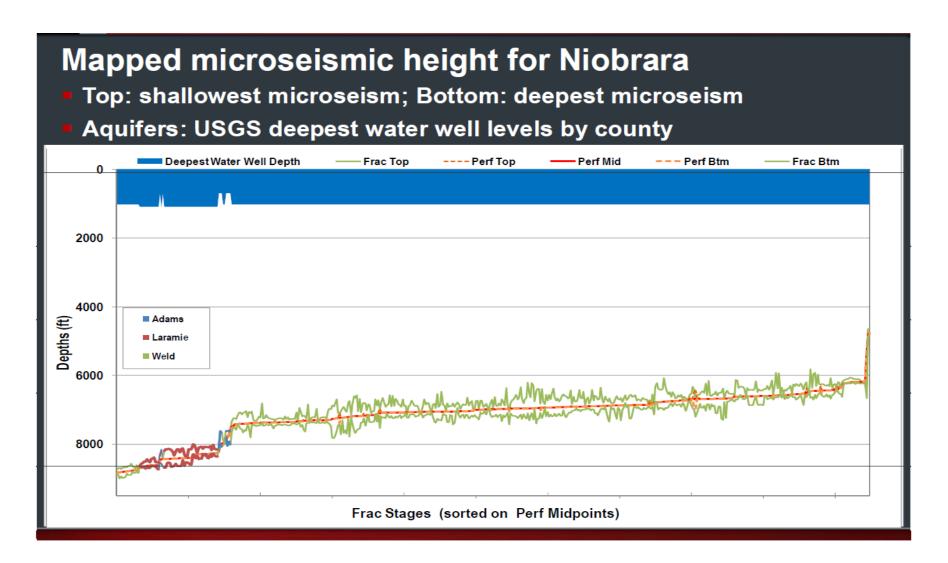
Potable Drinking Water Aquifers with Respect to Oil and Gas Formations



2011

Hydraulic Fracture Height Growth: Real Data

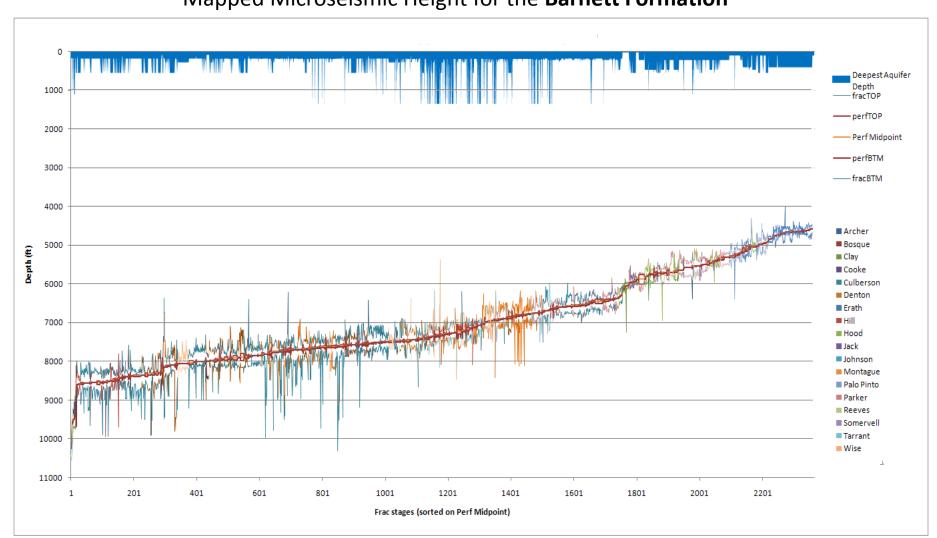
By Kevin Fisher & Norm Warpinski (Society of Petroleum Engineers Paper 145949; 2012)



Hydraulic Fracture Height Growth: Real Data

By Kevin Fisher & Norm Warpinski (Society of Petroleum Engineers Paper 145949; 2012)

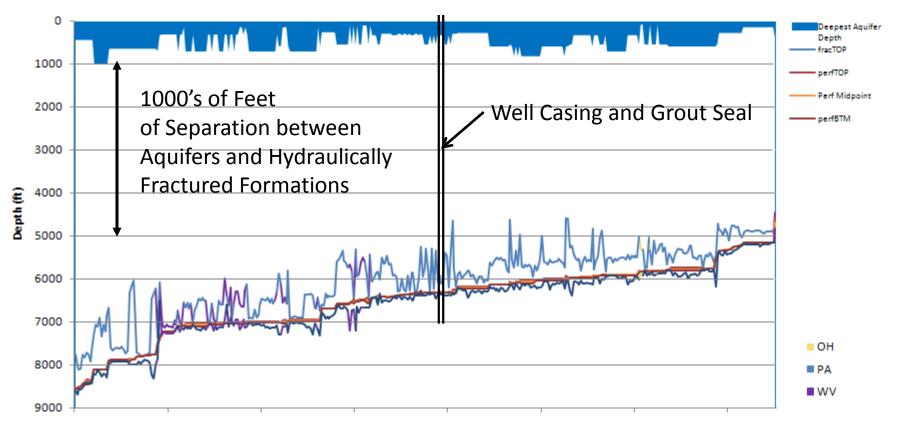
Mapped Microseismic Height for the Barnett Formation



Hydraulic Fracture Height Growth: Real Data

By Kevin Fisher & Norm Warpinski (Society of Petroleum Engineers Paper 145949; 2012)

Mapped Microseismic Height for the Marcellus Formation



Frac stages (sorted on Perf Midpoint)

 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?

- 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?

- 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)?

- 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.