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Leading Energy Services, Supply, Manufacturing and Innovation

Presentation to FNCI

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Jan 16th 2020

All About Fracturing

Explanation of hydraulic fracturing

Concerns and response

- Water usage
- Groundwater contamination
- Earthquakes
- Chemistry & additives

What are PSAC's members doing to address areas of legitimate concern?

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Hydraulic Fracturing – A Short Phase in the Lifecycle of a Well

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What is Hydraulic Fracturing?

Fluid is pumped at pressures that create a crack in the rock

Sand (proppant) is placed into the cracks using thickened water or water pumped at high rates

Cracks stay “propped” by sand trapped in place when the water flows out of the well into tanks

This creates a “conductive” pathway for natural gas or oil to flow

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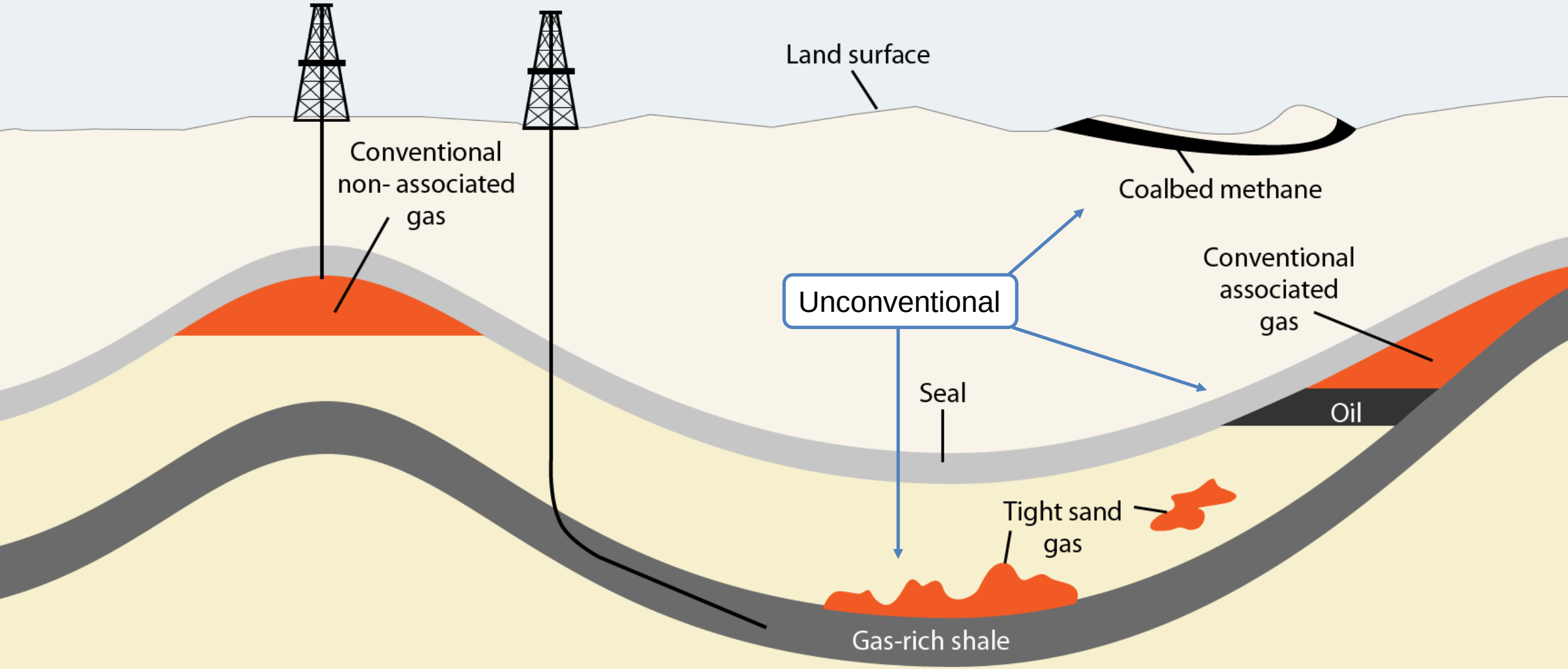
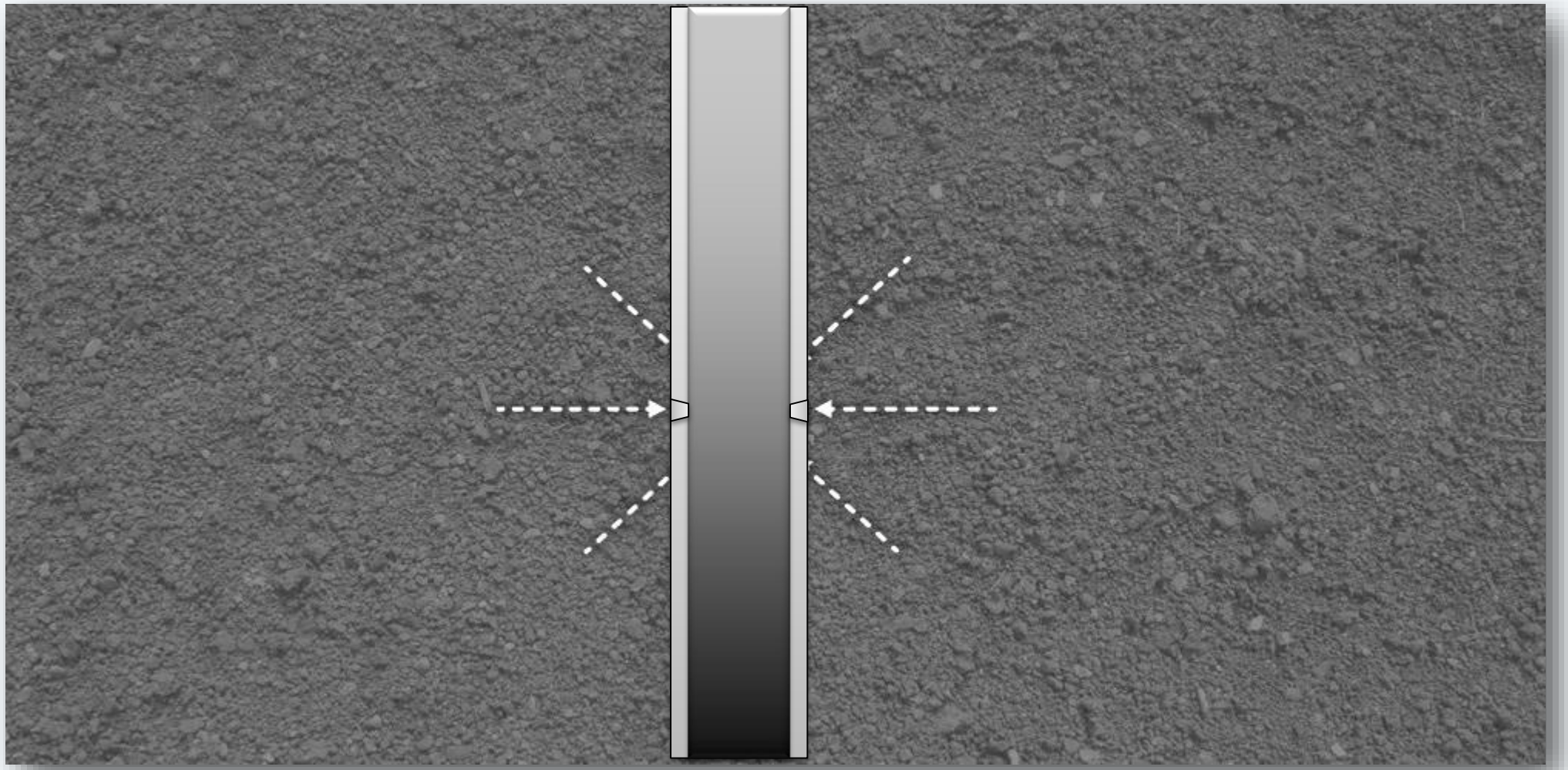
Why Frac? Conventional vs. Unconventional



U.S. Energy Information Administration and U.S. Geological Survey

Why Frac?



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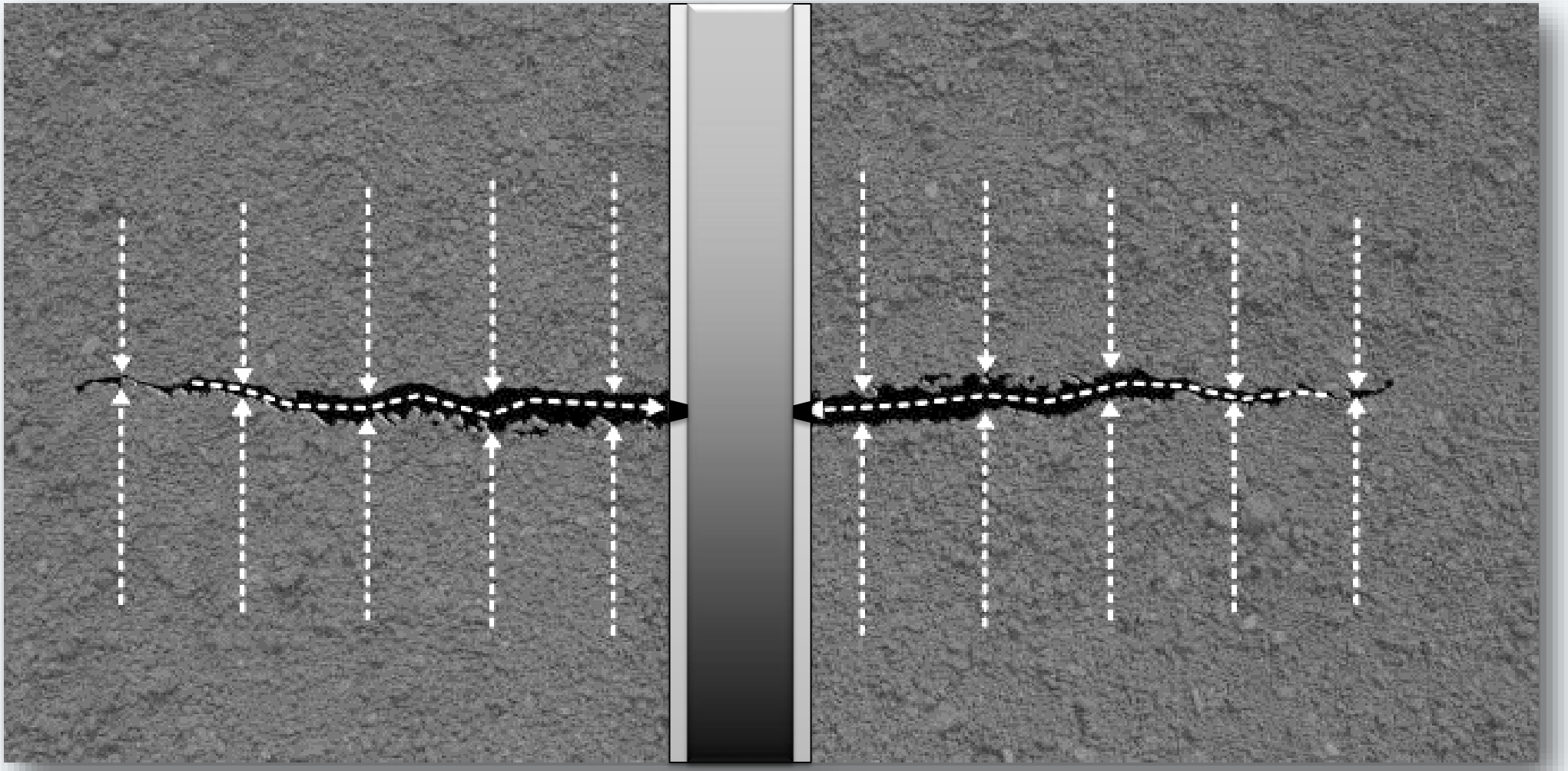

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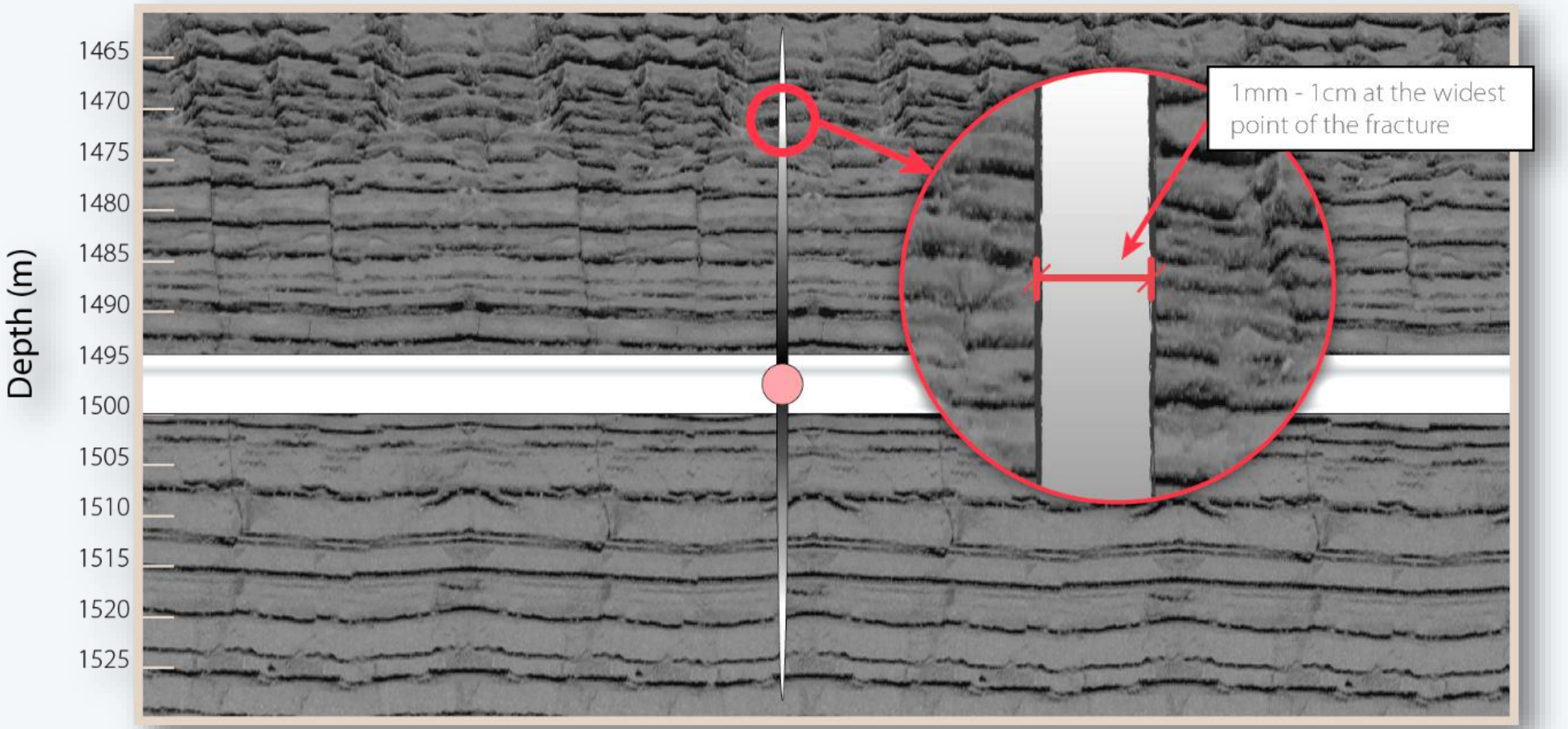
What does a Frac look like?



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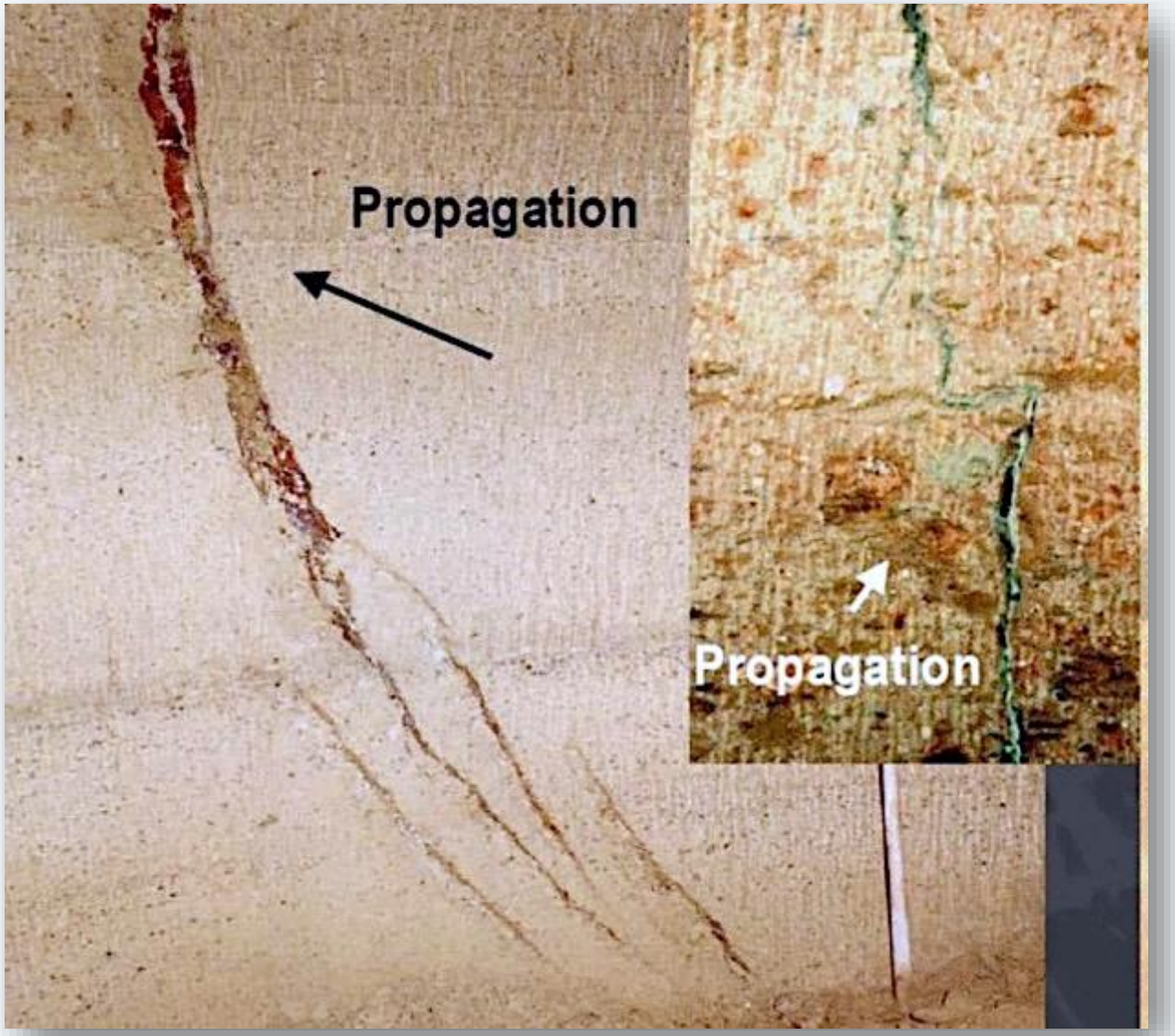
What does a Frac look like?



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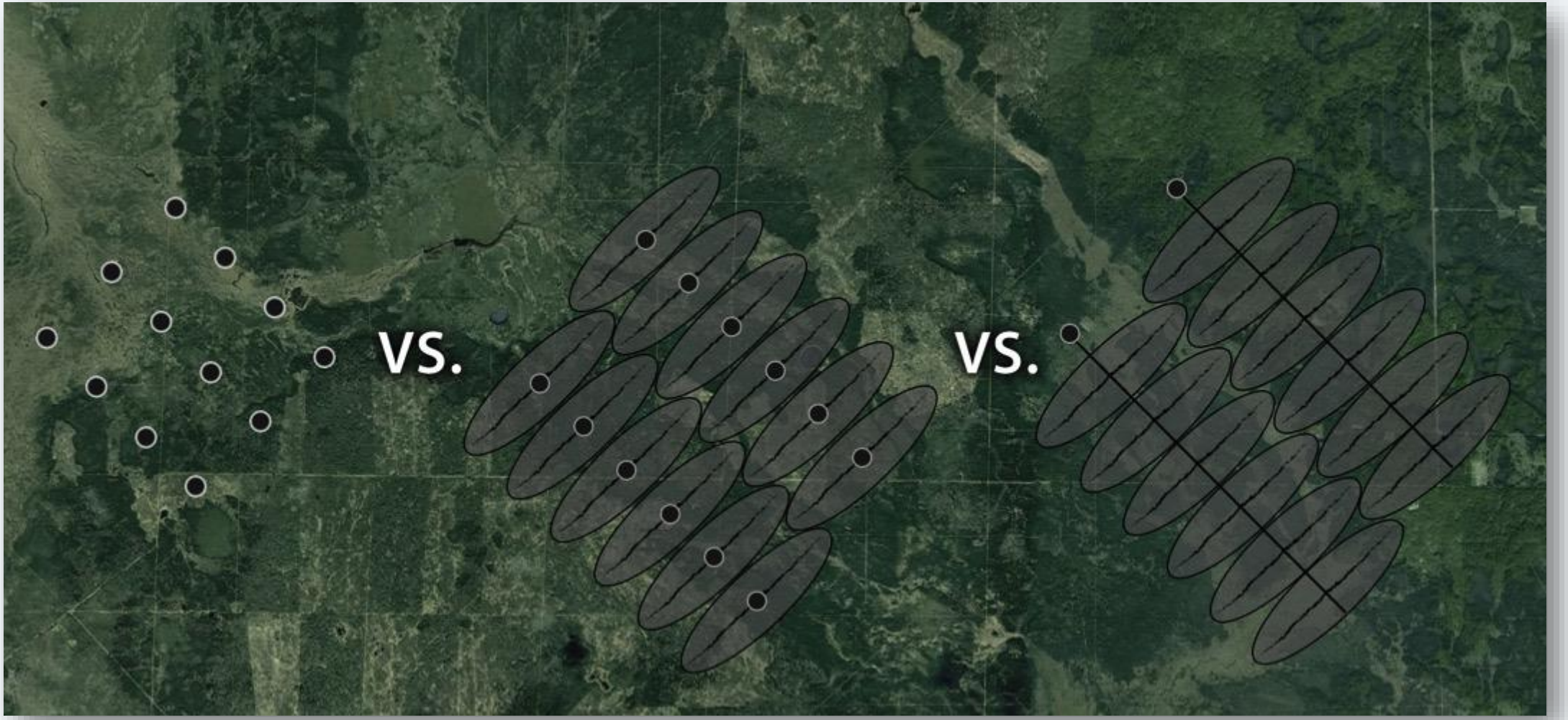
Better When Combined with Horizontal Drilling



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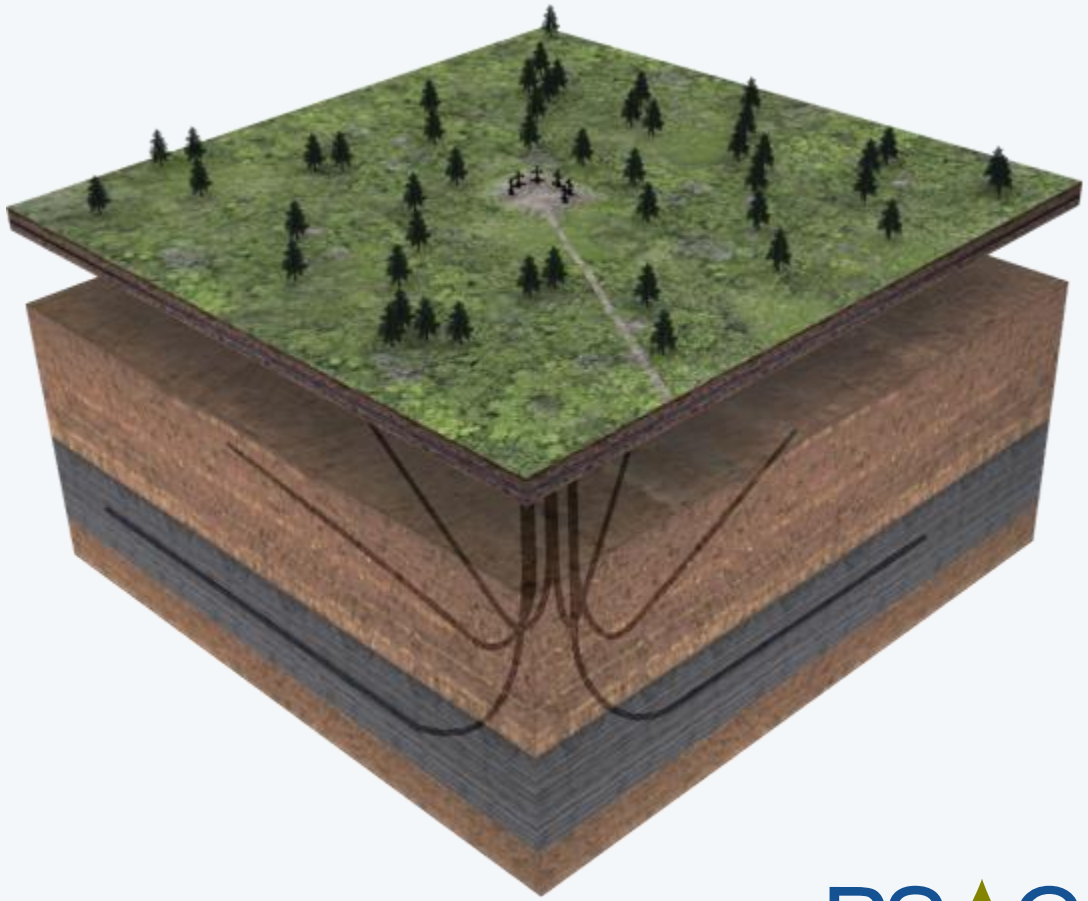
Less Surface Disturbance



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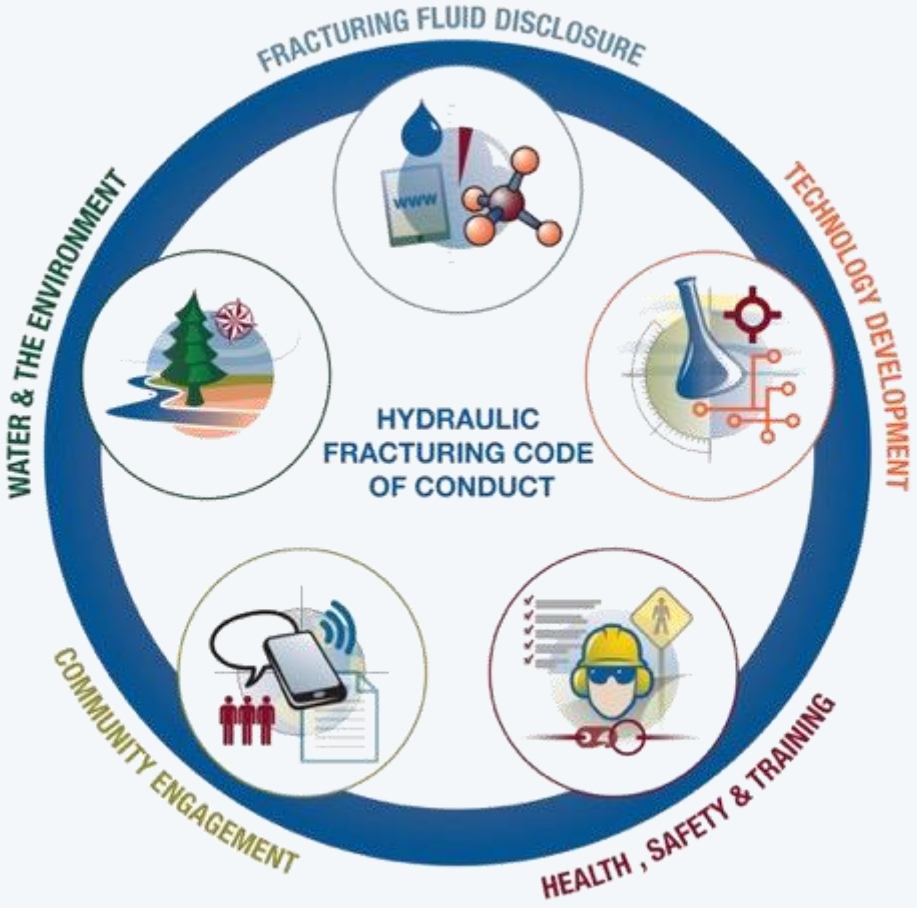
Hydraulic Fracturing Code of Conduct



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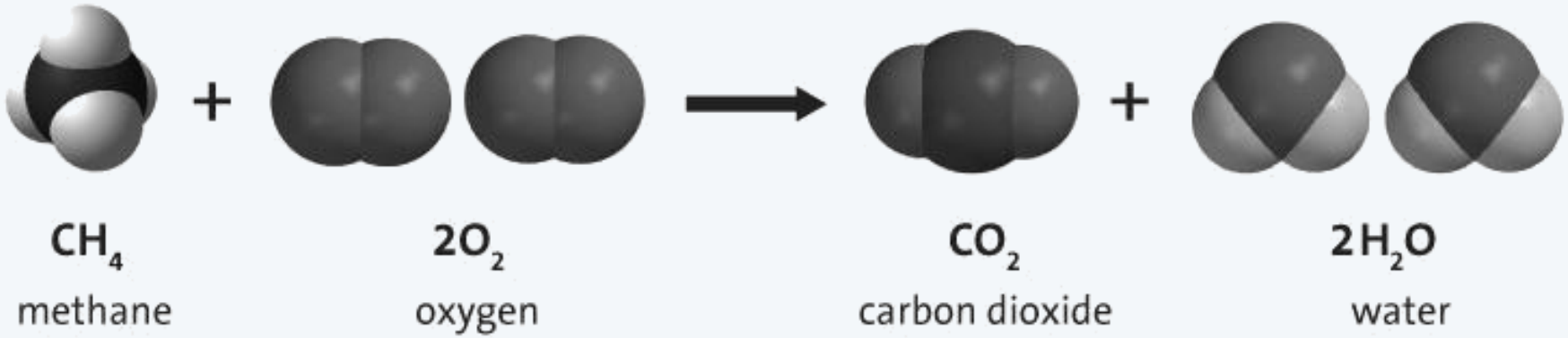
Water Usage

The fracturing process requires water

O&G water usage in 2016 BC was 0.001% of total availability

How much is 10,000 cubic meters? (Average water for one horizontal well in BC)

- **Metro Vancouver residential usage** in approximately **13 minutes**
- A **golf course** in **8 days**



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What is industry doing to reduce water usage?

Re-using and/or recycling frac fluid (stored in lined tanks on site)

Partnering with counties and farmers to collect stagnant water or gray water

Water is reused for subsequent jobs, treated or pumped into disposal wells

Using produced (undrinkable) and sources of salty (brine) water

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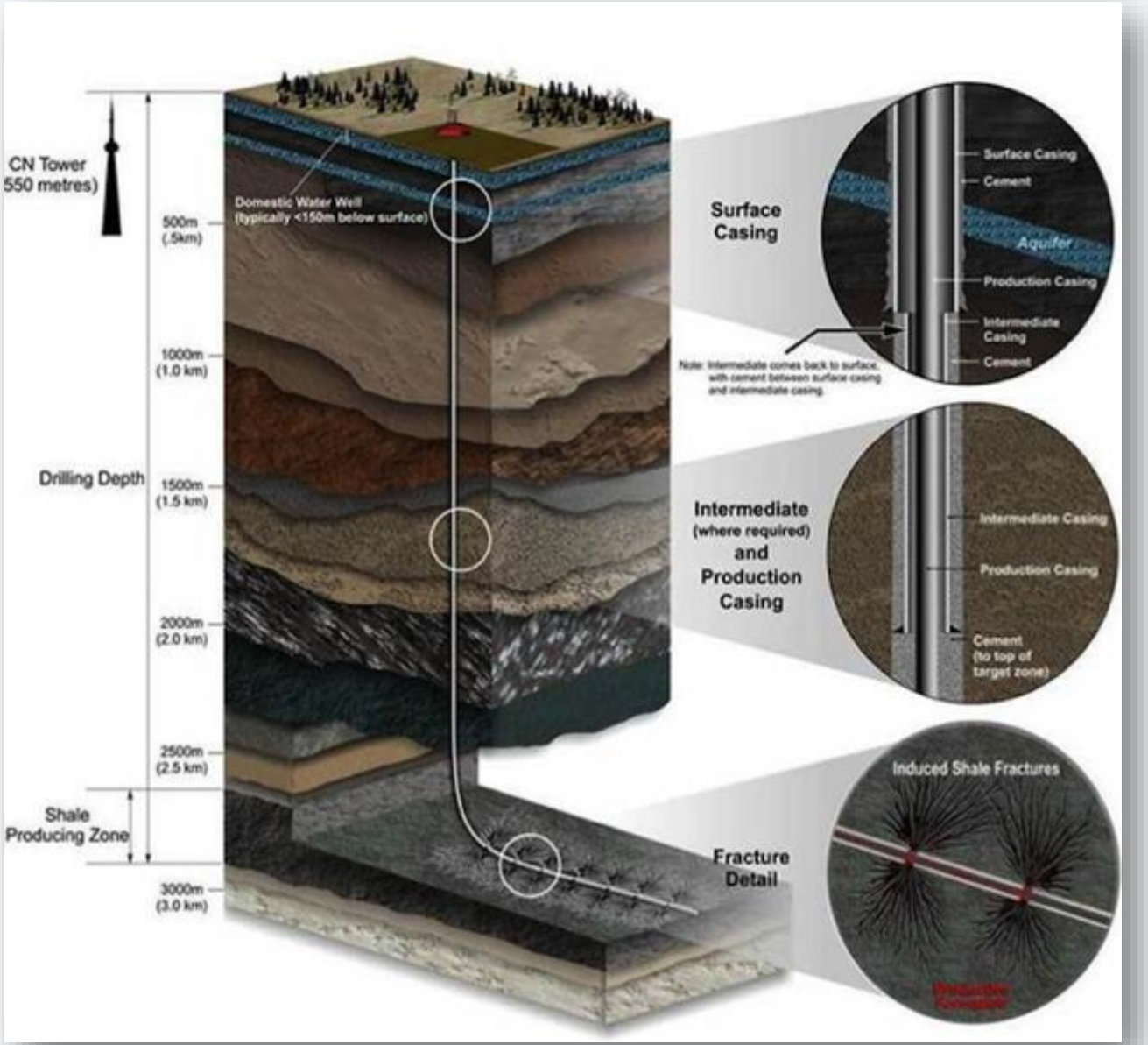

Do fractures contaminate groundwater?

Wellbores are cased and cemented (Steel pipe and cement layers)

This seals and isolates all fresh water areas from oil and gas areas, and isolates the oil and gas areas from one another

Fracturing occurs after the vertical part has been sealed with 2-3 layers of steel casing and cement

Fracturing occurs far below fresh water areas

Highly regulated in Canada

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Flaming Tapwater

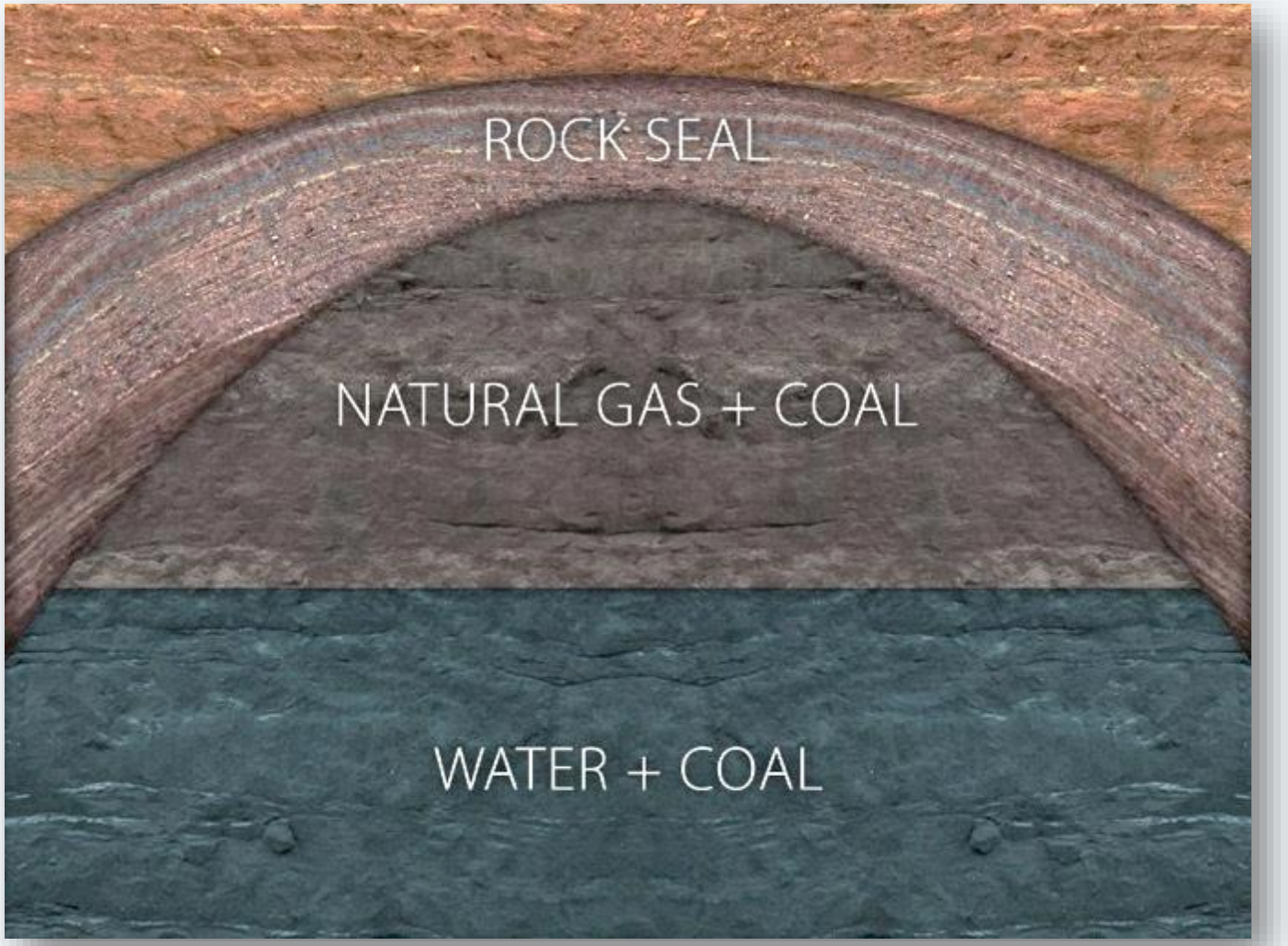
Natural degradation of coal produces methane gas

Gas on top of water

Coalbed methane (natural gas)

Occurs close to surface

Brita® filter



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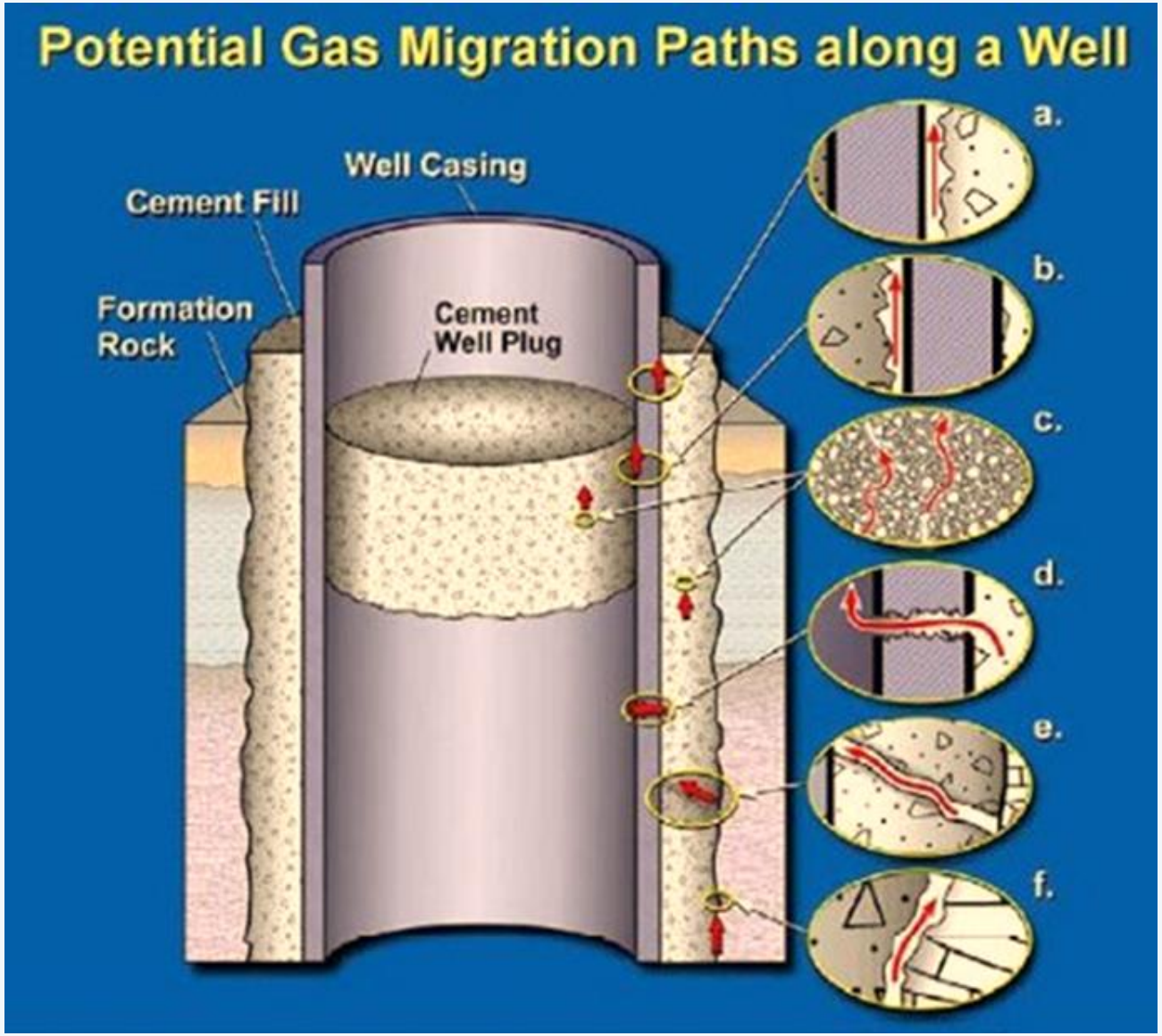
Why regulations and best practices matter:

All wells in Canada require **cement bond logging** to evaluate the quality or integrity of the well.

Uses acoustic sonic and ultrasonic tools to ensure cement has adhered solidly to the outside of the casing.

Prevents gas migration along the well.



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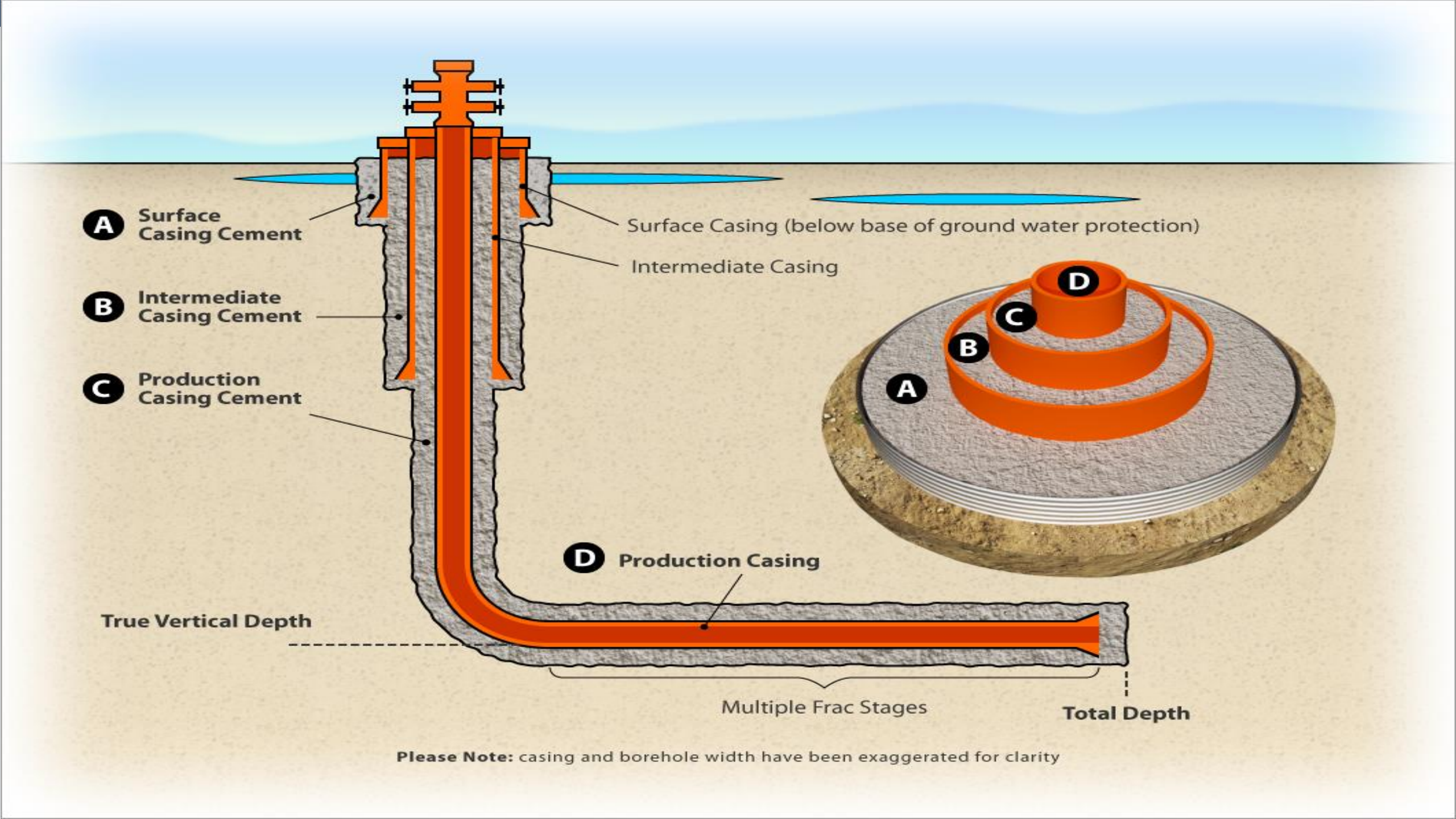


Please Note: casing and borehole width have been exaggerated for clarity

Can fractures grow up into fresh water aquifers?

The size of the fracture is the volume of the proppant and water injected

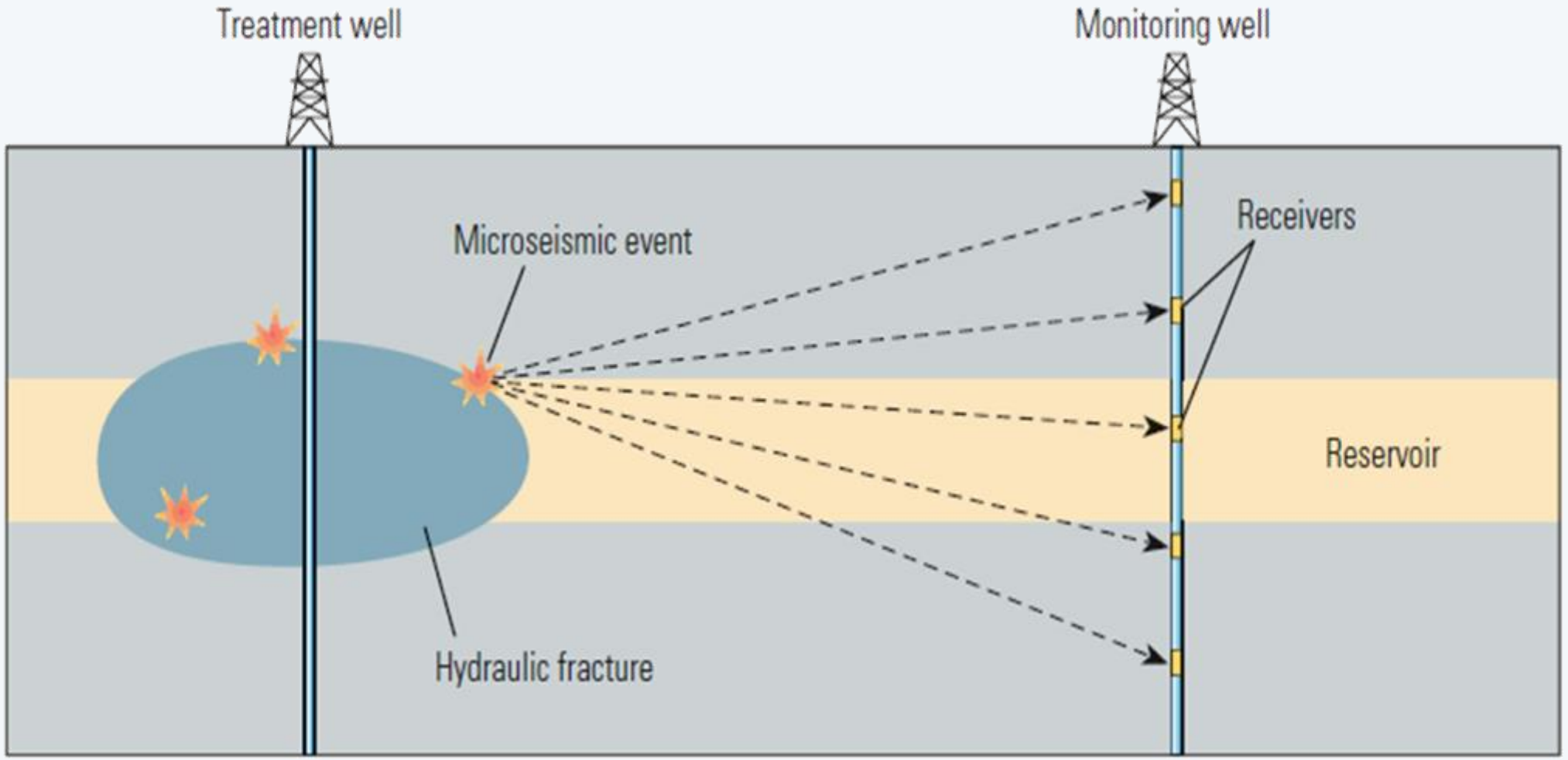
100 tonnes of sand + 1000 m^3 of water

= 1,037 m^3 of fracture

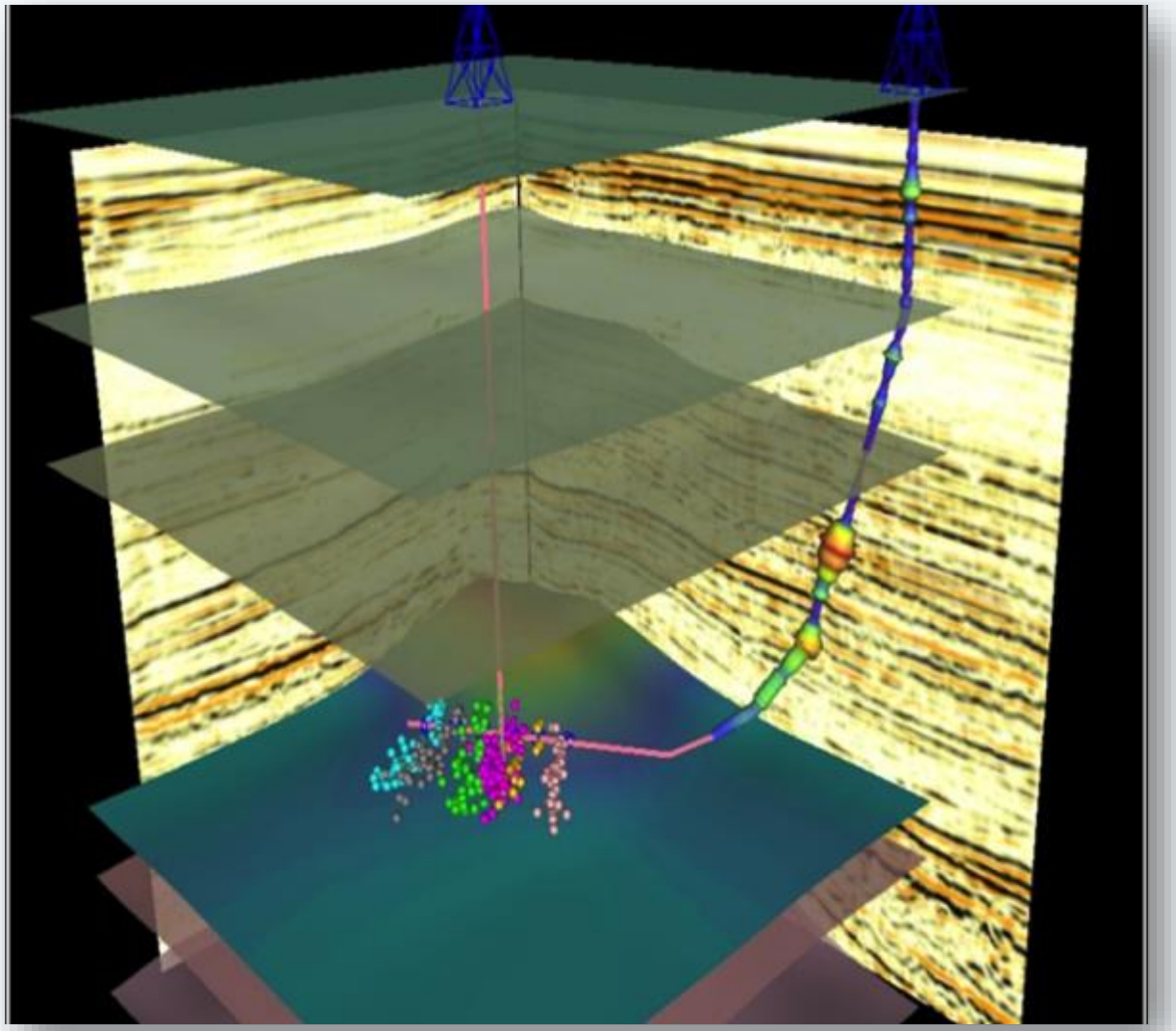
vs

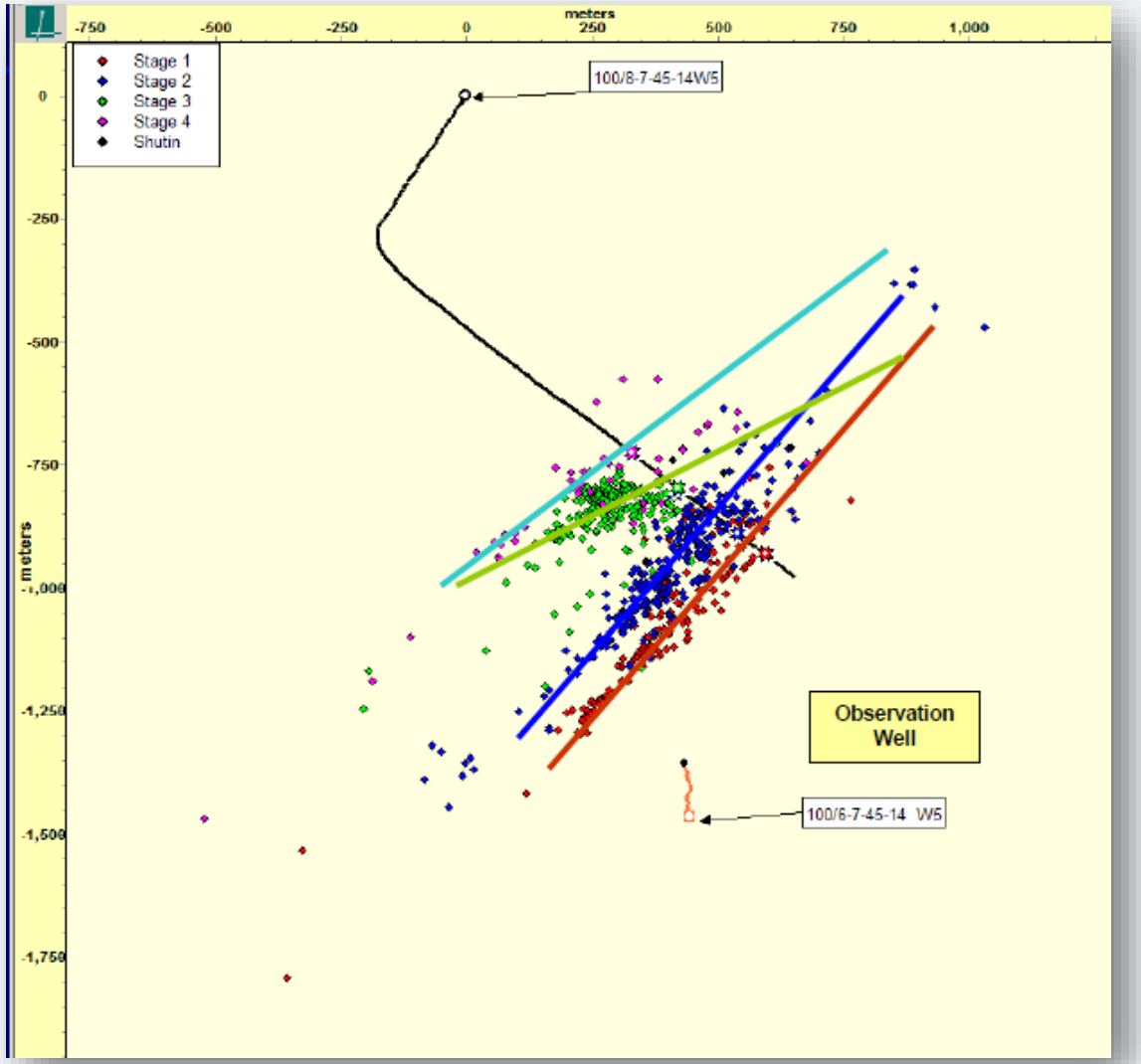
1,000,000,000 m^3 or large of rock above (if 1 km deep)

How can we measure dimensions of a fracture?



3D Modeling





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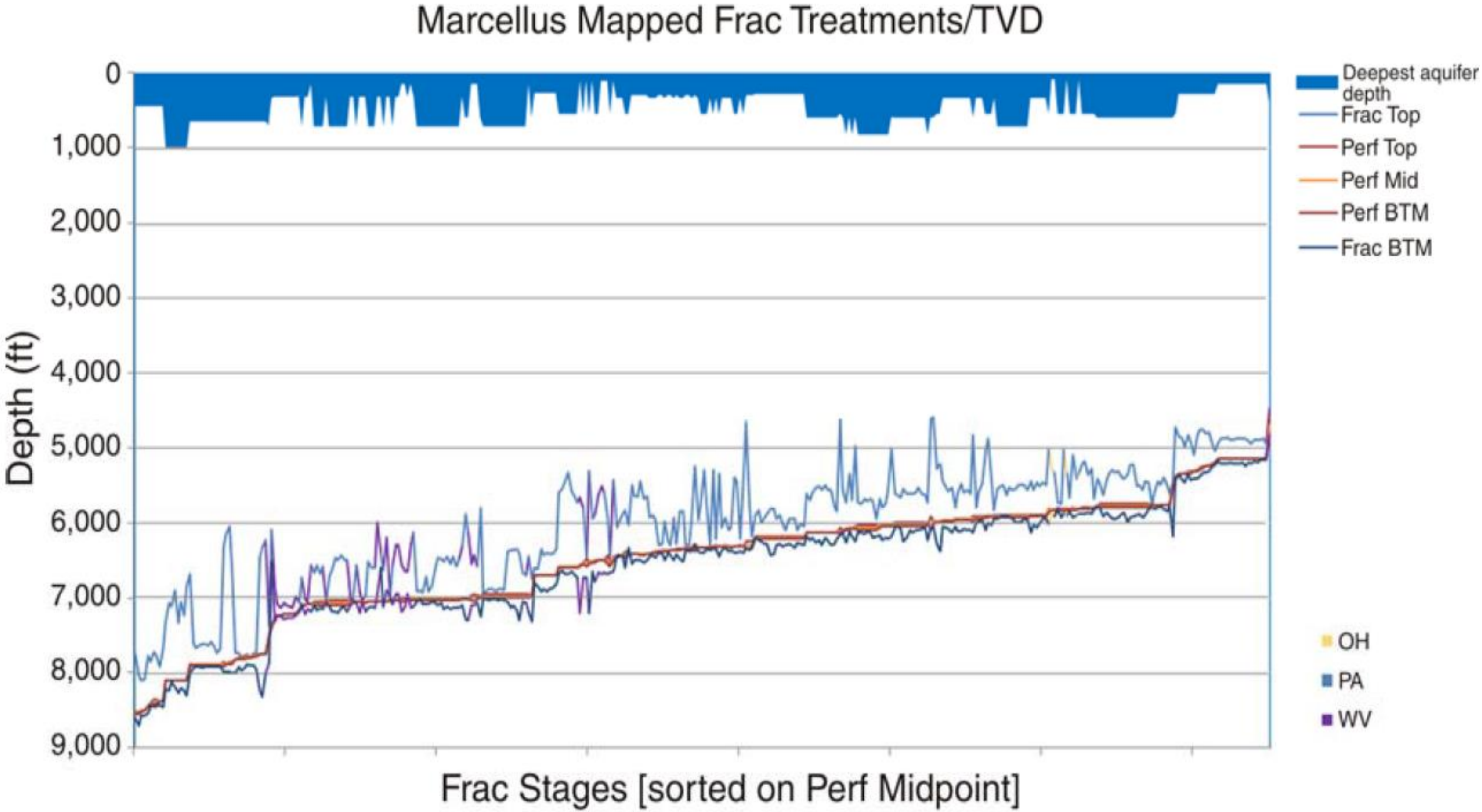
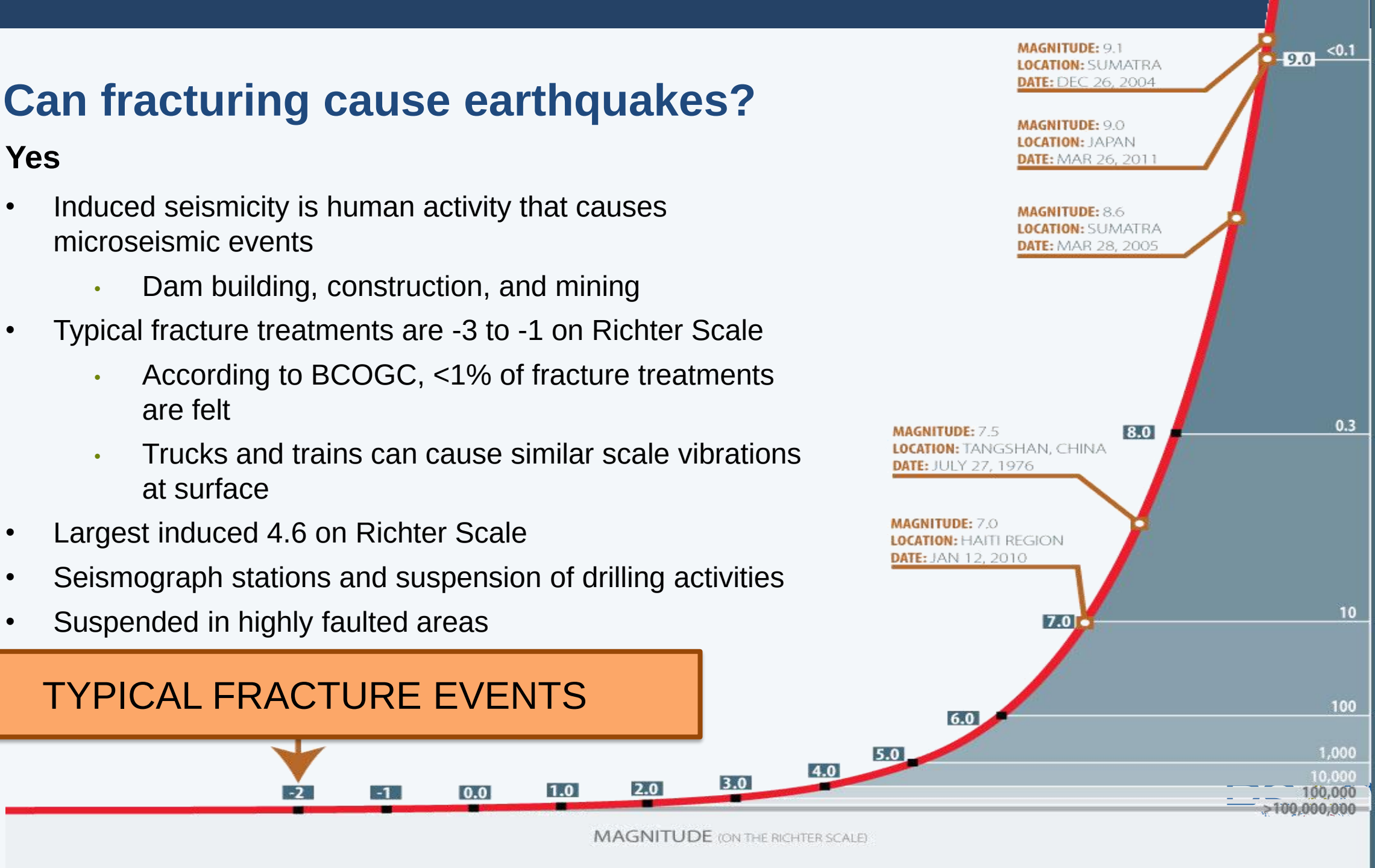

Marcellus Mapped Frac Treatments/TVD
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
Depth (ft)
Deepest aquifer depth
Frac Top
Perf Top
Perf Mid
Perf BTM
Frac BTM
OH
PA
WV
Frac Stages [sorted on Perf Midpoint]

Can fracturing cause earthquakes?

Yes

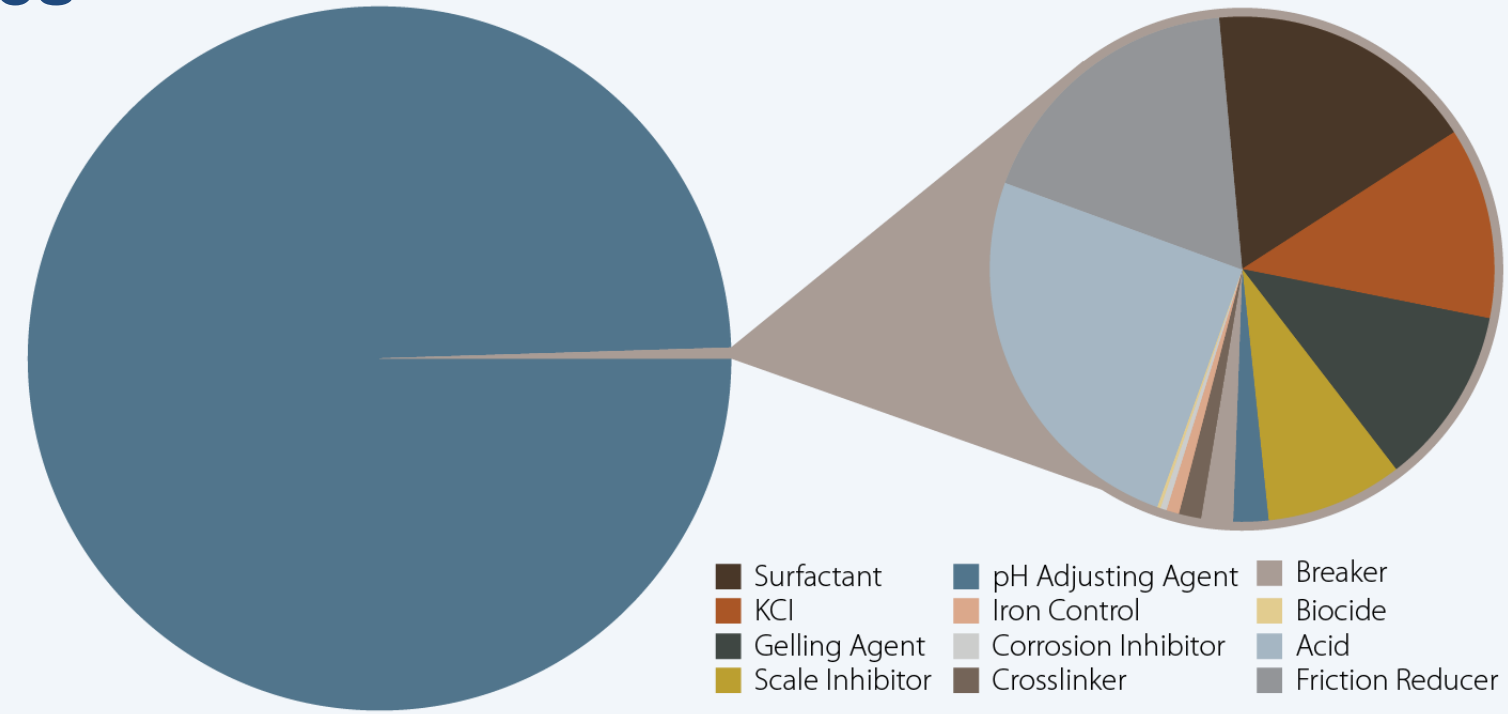
- Induced seismicity is human activity that causes microseismic events
  - Dam building, construction, and mining
- Typical fracture treatments are -3 to -1 on Richter Scale
  - According to BCOGC, <1% of fracture treatments are felt
  - Trucks and trains can cause similar scale vibrations at surface
- Largest induced 4.6 on Richter Scale
- Seismograph stations and suspension of drilling activities
- Suspended in highly faulted areas

TYPICAL FRACTURE EVENTS



Fracturing Fluid Additives

A typical frac fluid requires additives



- Friction reducer or viscosifier
- Breaker
- Clay Stabilizer (seawater substitute)
- Flowback enhancer
- Scale inhibitor
- Biocide (when water source has bacteria in it)
- Fracturing fluid is 99.5% water

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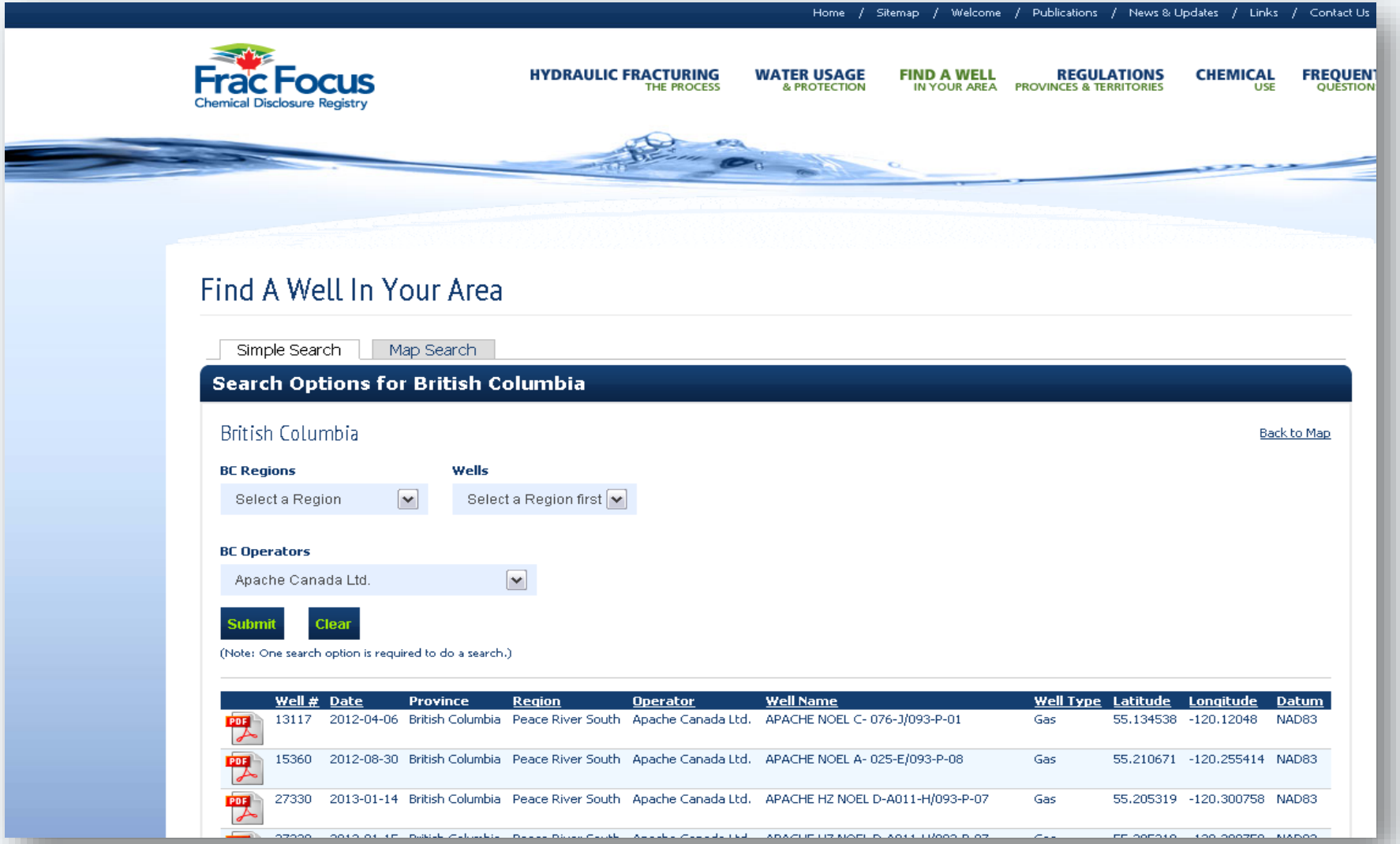
Ingredient	Common Name	Fluid Use	Common use
Gellant	Guar bean gum	Water viscosifier (thickener)	Cosmetics and food
Crosslinker	Borate salt	Water viscosifier (thickener)	Detergent, cosmetics
Breaker	Sodium borate salt	Gel breaker for flowback	Laundry detergent
Friction Reducer	Polyacrylamide	Minimizes friction between fluid and pipe	soil conditioner for farming
Clay Control	Salt compound	Prevent clay swelling	Additive for feed/farming
Flowback Enhancer	Surfactants	Flowback carrier fluid	Cosmetics, soaps
Scale Inhibitor	Polyamine	Prevents scale from forming on pipes	Water treatment, hot tubs
pH Control	Sodium carbonate	Maintains gel crosslinker	Soap, hot tubs
Bactericide	DBNPA (amide)	Kills bacteria in mix water	Hot tubs

Additive Disclosure



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Environmental Innovation

- Green lines of frac fluids and additives
- Challenging suppliers to provide green options
- Containment barriers and absorbent pads under equipment
- Dry add guar (powdered) instead of slurried with oil (mineral or diesel)
- Natural gas or e-fracturing equipment
- Reducing water requirements (3R’s)

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More Opportunity for NG and LNG to Reduce Global Emissions

Fuel	Time
Nuclear	Longest
Oil	
Coal	
Natural Gas	Shortest

CO2: Every 1,000 MW of coal-fired power generation converted to natural gas reduces CO2 equivalent emissions by 4.4 million tonnes annually (860,000 cars off the road)

Sulfur: Converting one large-container ship from bunker crude to LNG reduces sulphur oxide emissions equivalent to 50 million diesel cars (28 ships = all the cars on earth)

Heavy Metals: Zero vs 100 tonnes per year of mercury released from North America alone

Ally to Renewables: Natural gas plants are “fast reacting” - 1% Increase in Natural Gas energy capacity associated with 0.8% increase in renewables

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Key Takeaways

- Hydraulic fracturing is not a new technology
- Occurs over 3-4 days of a well's 20 – 30 year lifecycle
- Uses relatively little water; industry is working hard to reduce water usage
- Wells are steel cased and cemented before fracturing occurs to protect aquifers
- Well integrity and water usage is highly regulated in Canada
- Fracturing is performed far below the surface and cannot propagate to fresh water zones
- Causes small, localized, non-destructive earthquakes like many other industrial activities

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Key Takeaways Continued

- Fracturing additives are made from widely used chemicals; trying to improve these to improve handling safety (people and environment)
- Additive disclosure is mandatory
- Natural gas compliments renewables and results in an environmental benefit over other fuel sources
- BC, with it's abundant natural gas and access to Asian markets, has a unique opportunity to play a significant role in reducing global GHG emissions using fracturing
- Allows us to produce more natural gas – cleaner burning, important component of global energy mix and transition to lower carbon economy

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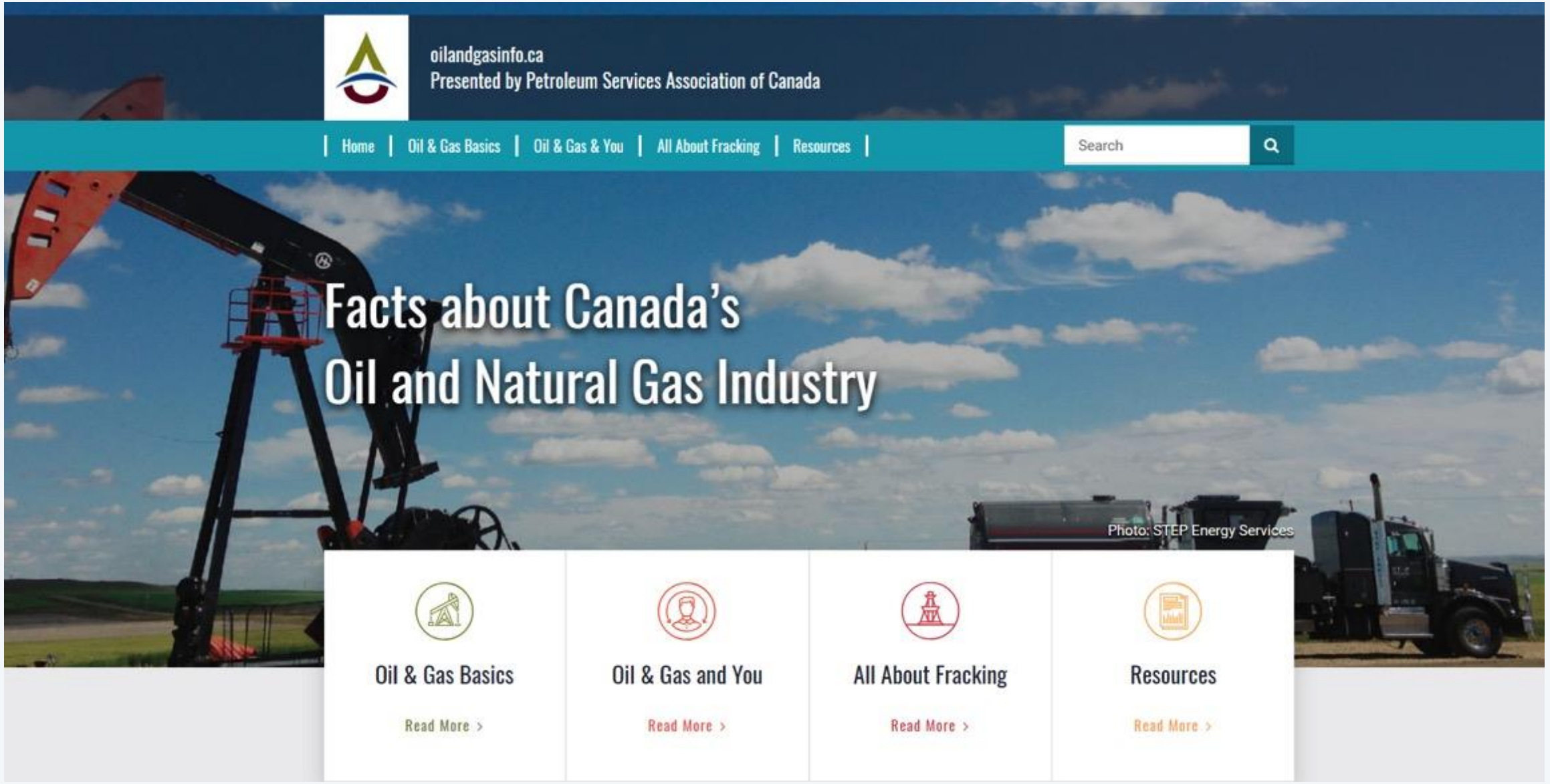
Resources

OilandGasInfo.ca



Canadian Oil & Natural Gas in the global energy mix

is a **win-win-win** ENVIRONMENT

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VALUE-ADD

INDIGENOUS PEOPLES ECONOMY RELIABLE

CLIMATE

EXPORTS TAXES

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