



Leading Energy Services,
Supply, Manufacturing
and Innovation

Presentation to FNCI

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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?



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



What is Hydraulic Fracturing?

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

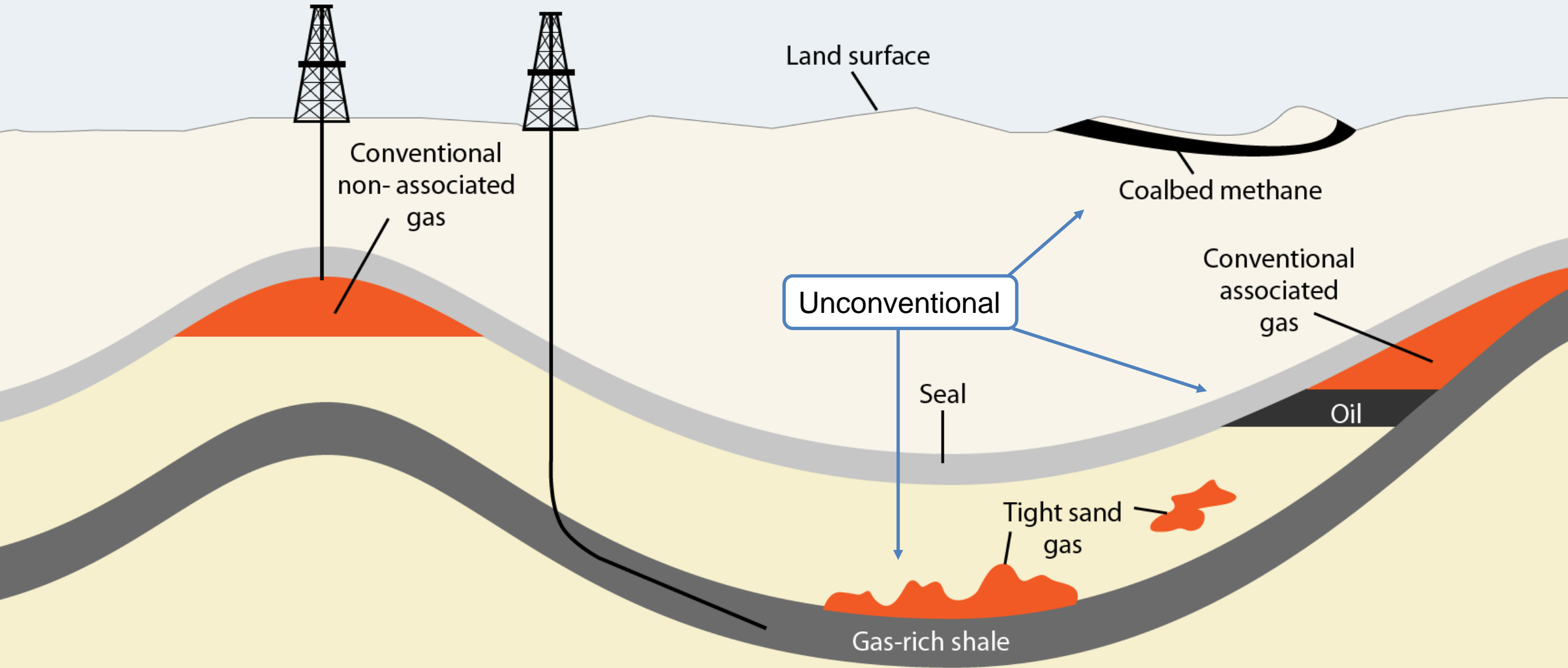
Sand (proppant) is placed into the cracks using thickened water or water pumped at high rates

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

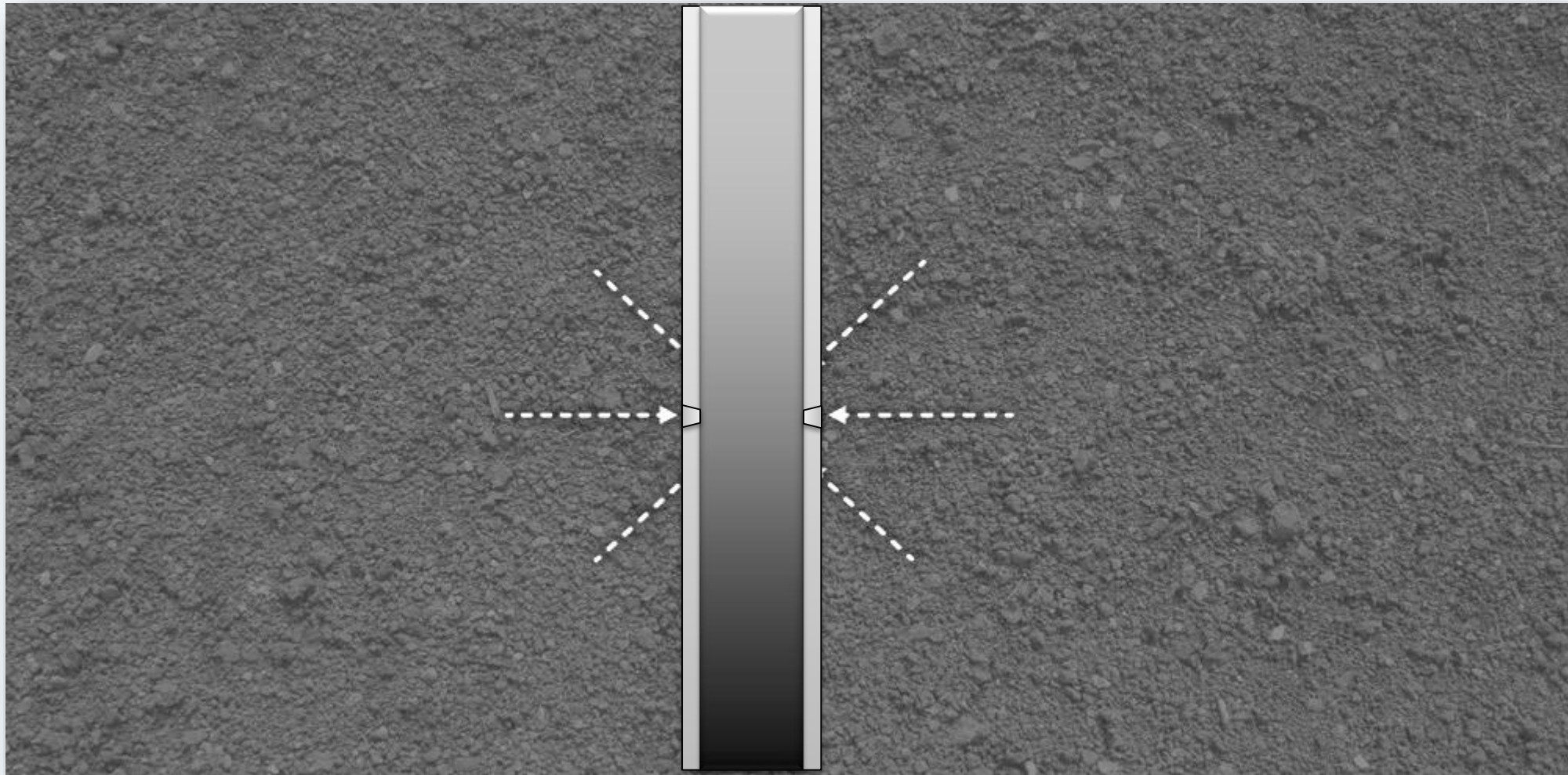


Why Frac? Conventional vs. Unconventional

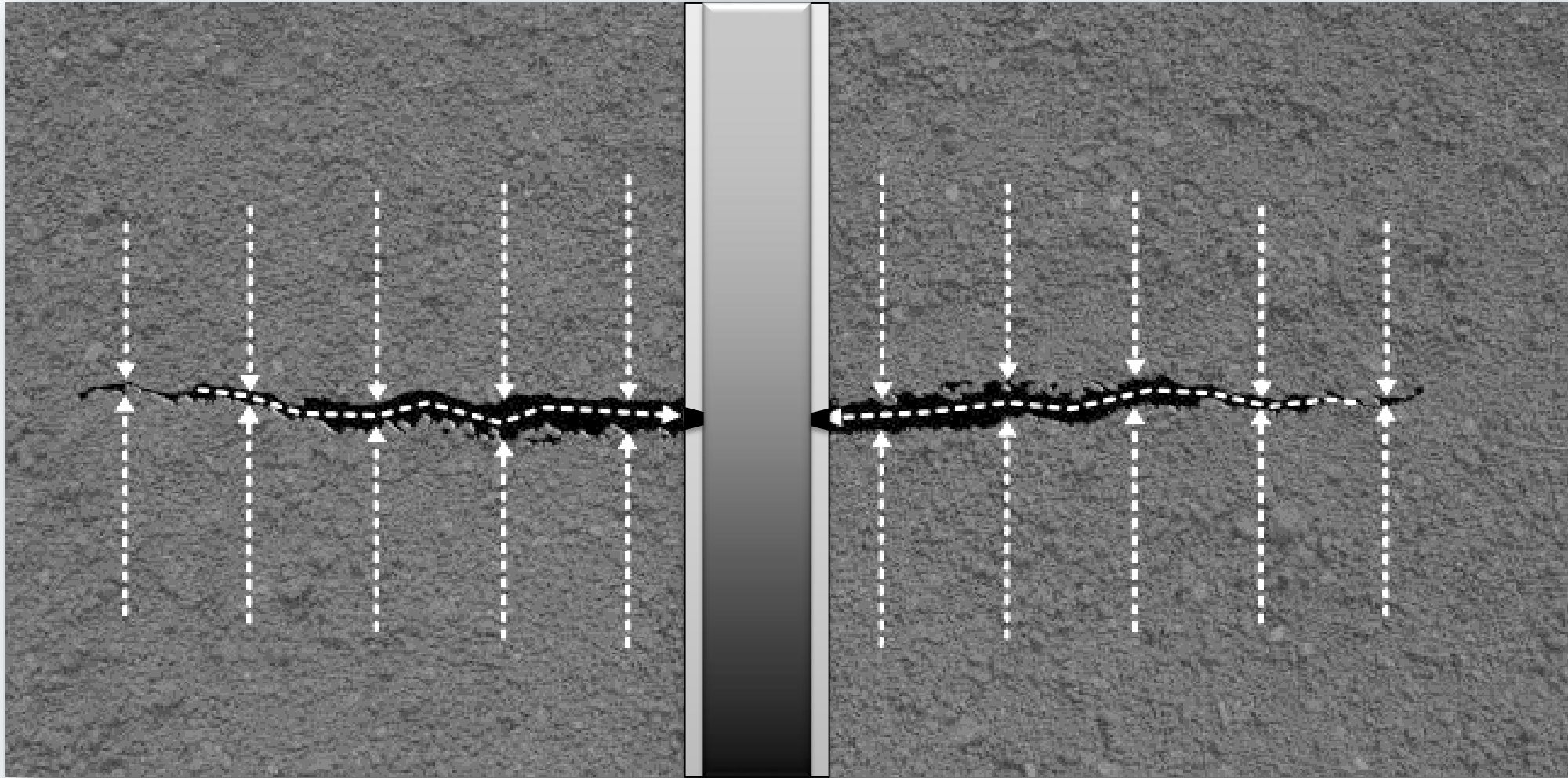


U.S. Energy Information Administration and U.S. Geological Survey

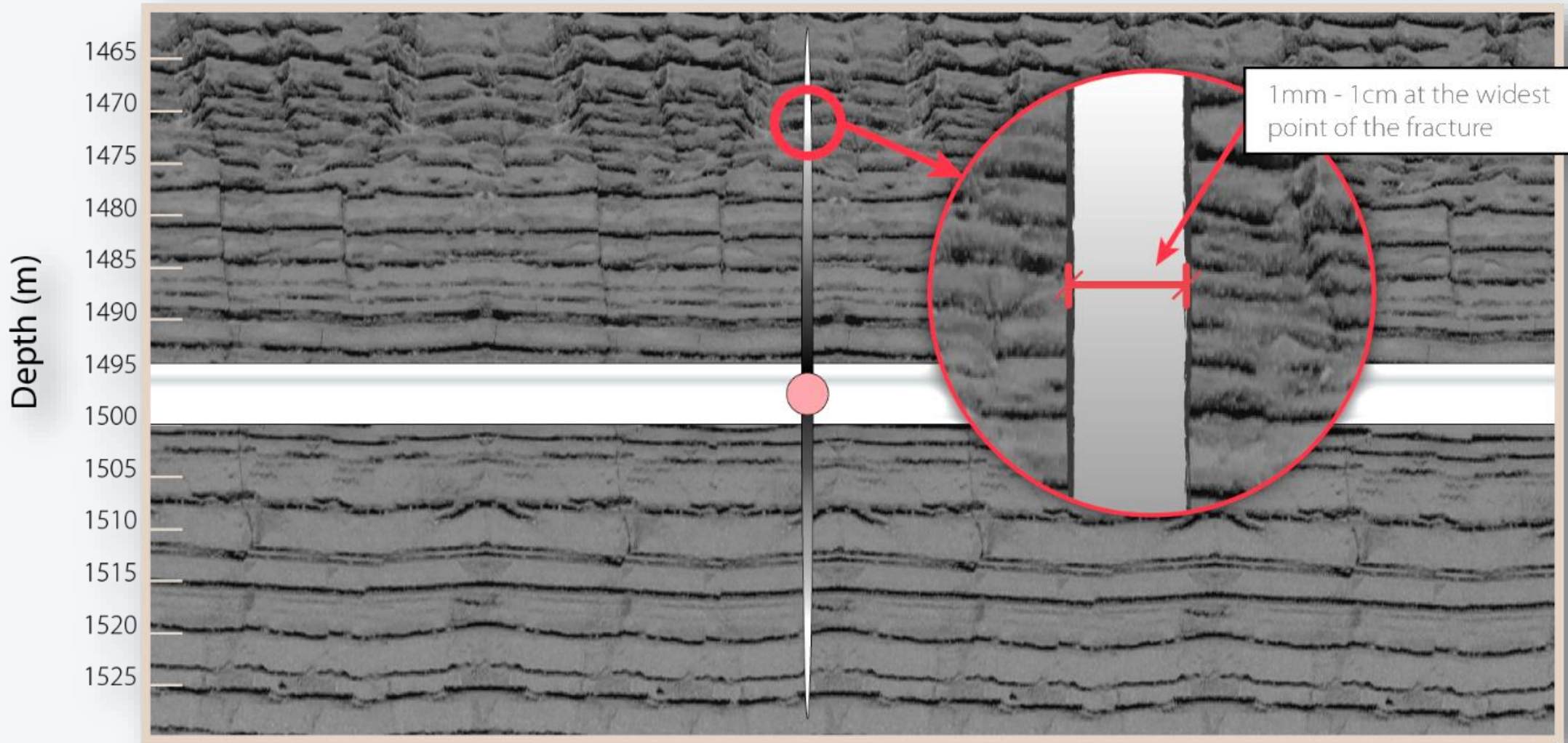
Why Frac?



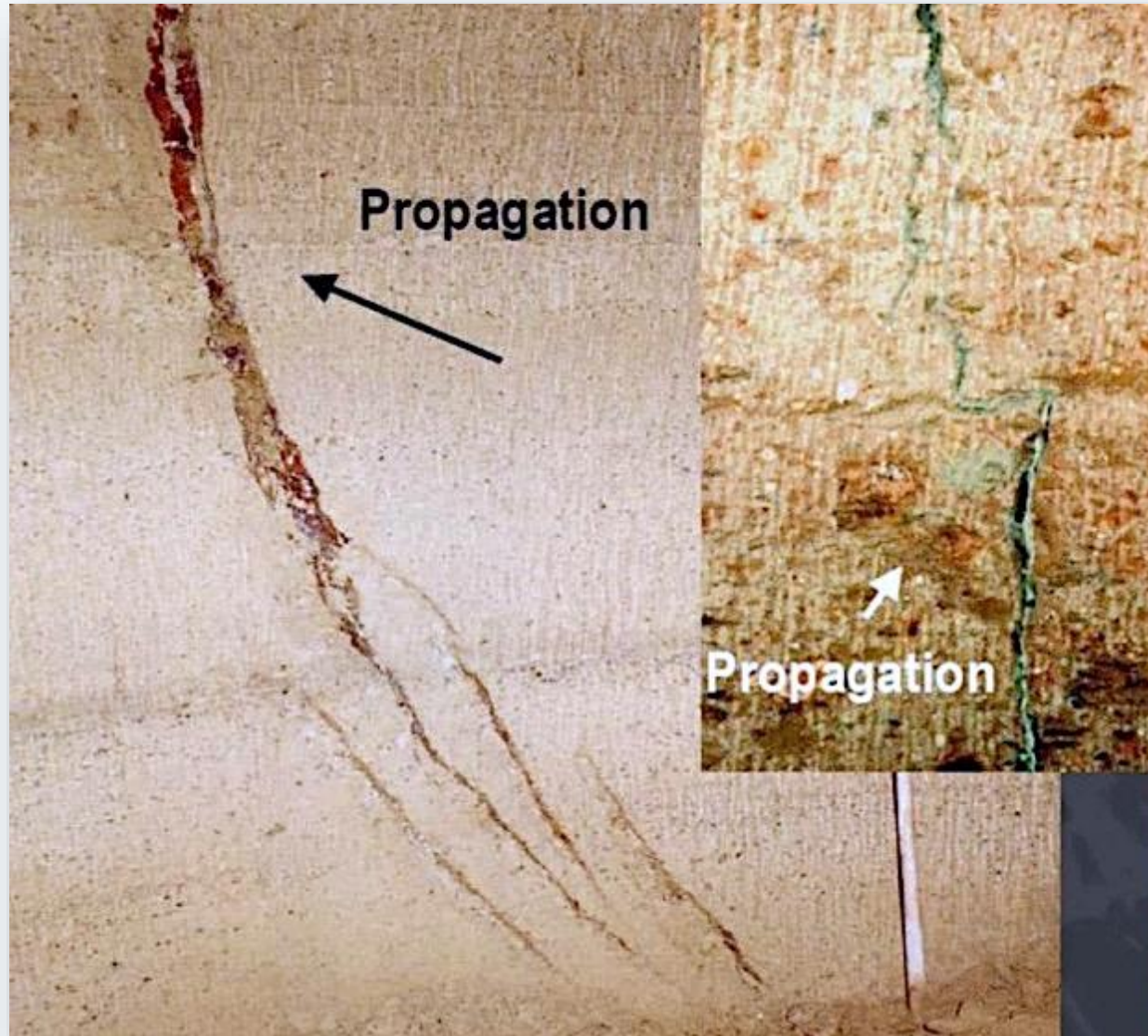
Why Frac?



What does a Frac look like?



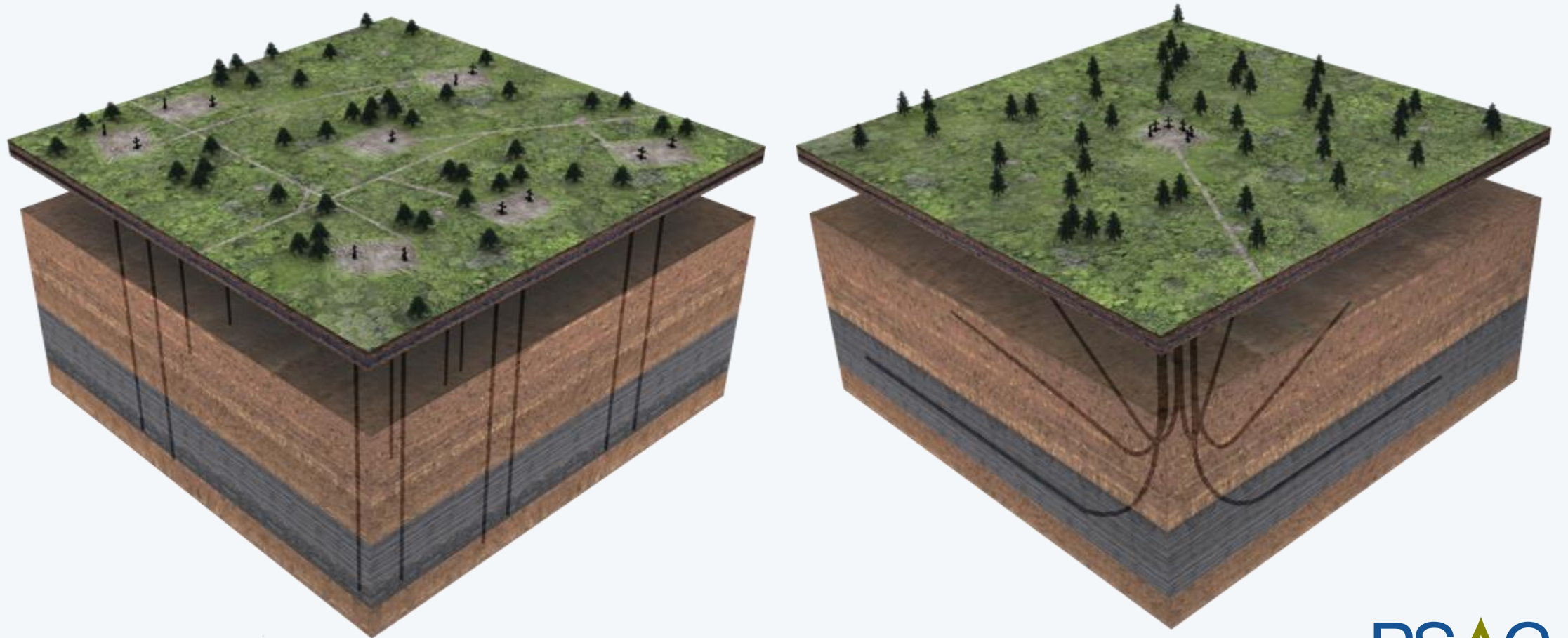
What does a Frac look like?



Better When Combined with Horizontal Drilling



Less Surface Disturbance









Hydraulic Fracturing Code of Conduct



WORKING ENERGY COMMITMENT Hydraulic Fracturing Code of Conduct

This Hydraulic Fracturing Code of Conduct is a set of commitments being made by cooperative participating members of the Working Energy Consortium, describing how data sector of our industry operates as key players in the responsible and sustainable development of Canada's oil and natural gas resources.

Participating companies strive to deliver the best value to our stakeholders, including the resource owner, direct customers, our shareholders and employees, and the residents and local communities in which we work. Our collective goal is to ensure operational excellence, focusing on reducing our environmental impact and maximizing the development of Canada's vast resources, while delivering long-term social benefits in a manner that supports the interests of all stakeholders.

As endorsers to this Code of Conduct, we will focus our efforts in five key areas:

- WATER AND THE ENVIRONMENT**

We will...

 - Develop technologies for reduced water consumption in our operations that make viable alternate fresh water, with a continued focus on reducing, recycling and the recovery of water.
 - Maximize the protection of all water sources by supporting our customers in their commitment to the Canadian Association of Petroleum Producers' (CAPP) *Hydraulic Fracturing, Quality, Integrity, Stewardship Practices*, including those related to water sourcing, hauling and disposal, as well as integrity for the protection of groundwater.
 - Continue to develop a culture of environmental stewardship amongst our workers.
- FRACTURING FLUID DISCLOSURE**

We will...

 - Provide our customers with a list of additives used in fracturing fluids that meets all regulatory requirements and encourage the use of public disclosure mechanisms such as *DiscOps*. In the event that the scale of work and formation type are important determinants to ensuring the fracturing of a well.
- TECHNOLOGY DEVELOPMENT**

We will...

 - Develop new technologies and processes, informed by scientific study and applied operational and environmental performance by maximizing resources used in our operations.
 - Apply scientific research and computer modelling of our operations to optimize the environmental impact of our operations.
 - Invest in research and development and continue to develop environmental technologies which enhance the products and services provided to our customers.
- HEALTH, SAFETY & TRAINING**

We will...

 - Continue to make safety for our workers and the public a cornerstone of all our operations, and strive to achieve a zero-incident performance record through proactive and structured approaches.
 - Meet or exceed safety requirements, and maintain credentials through regular and vigorous internal and third-party audits of our safety practices.
 - Commit to continuous improvement and development of best practices in health and safety.
 - Provide ongoing and specialized training to our workforce in both operations and health and safety safety culture that permeates our entire organization top-down and bottom-up.
 - Implement Emergency Response Procedures (ERPs) that support every aspect of hydraulic fracturing, internal policy and procedures are understood and followed and on an ongoing basis to ensure that all required by regulations and best practices.
 - Report all incidents, worker injury or spills in an immediate way to our customers and to the regulator, as well as our subcontractors to the same operating standards as we hold ourselves.
- COMMUNITY ENGAGEMENT**

We will...

 - Engage with local communities to understand and respond to specific local concerns, and communicate openly about our operations where we work and live.
 - Work through our industry association to develop tools that will facilitate ongoing and meaningful dialogue, and make sources of fact-based information easily accessible to our stakeholders.
 - Participate in the *Community Partners* program, a program dedicated to reminding workers about respectful behaviors, and include the program's guiding principles as a part of our internal safety policies and procedures.
 - Champion the *Community Partners* program as the industry-wide program to our customers and our subcontractors.
 - Commit to using local suppliers and service providers when appropriate and available.

Endorsed by:

BAKER HUGHES, CALFRAC, CANYON, ELEMENT, GARDVAC, HALLIBURTON, MILLERBURN, Sanyel, Schlumberger, VERTECAN

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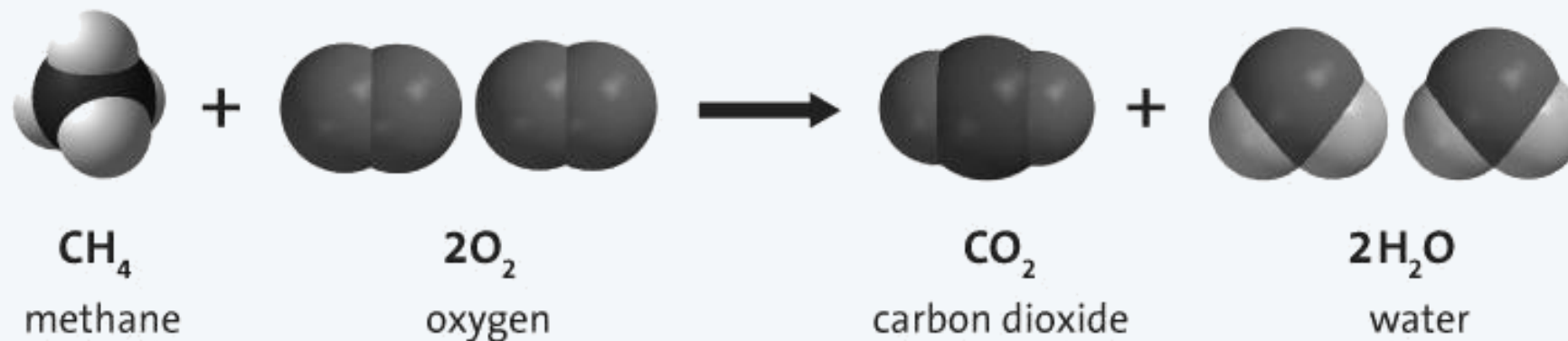
Water Usage

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**



What is industry doing to reduce water usage?

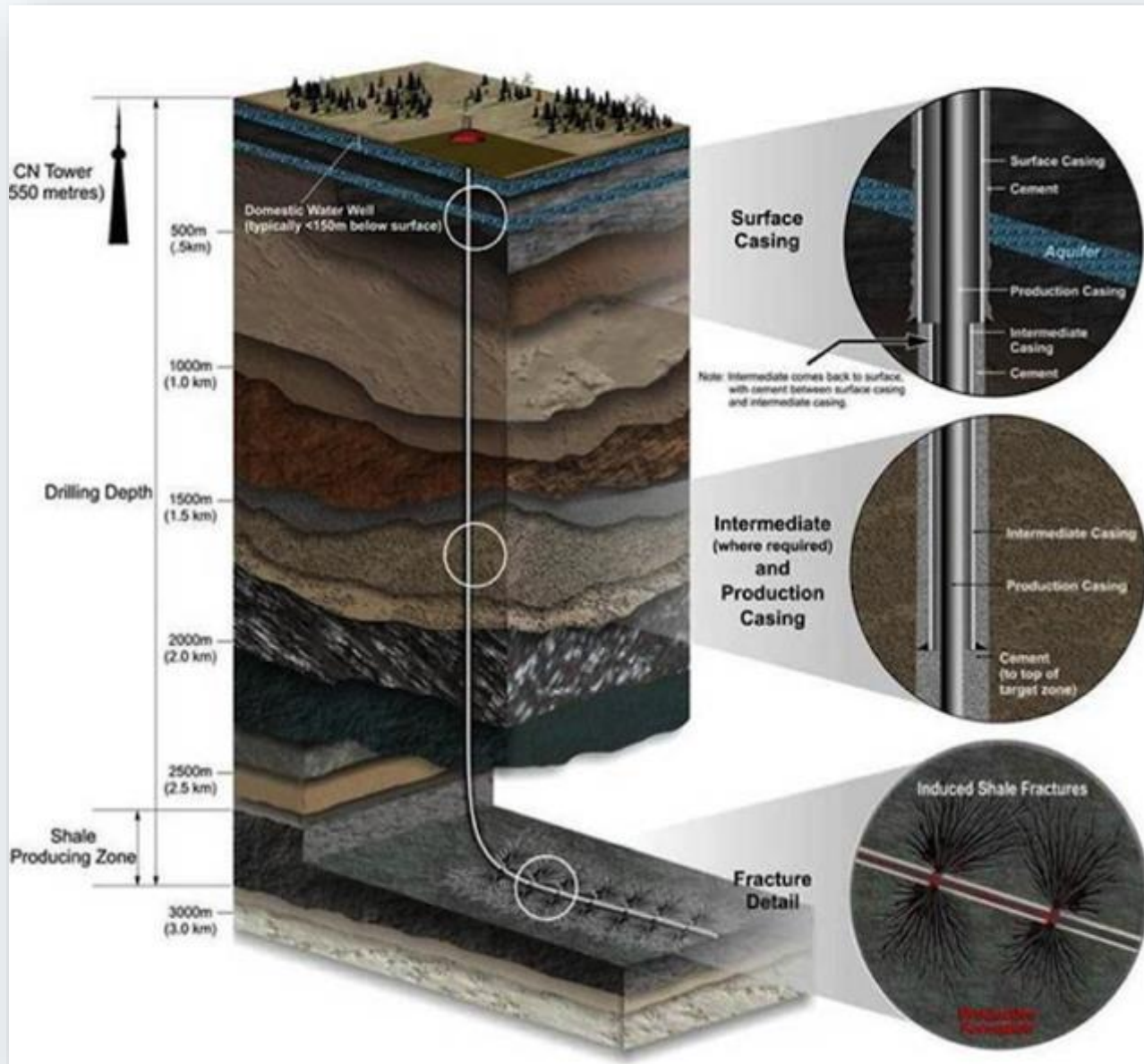
Re-using and/or recycling frac fluid
(stored in lined tanks on site)

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





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



Flaming Tapwater

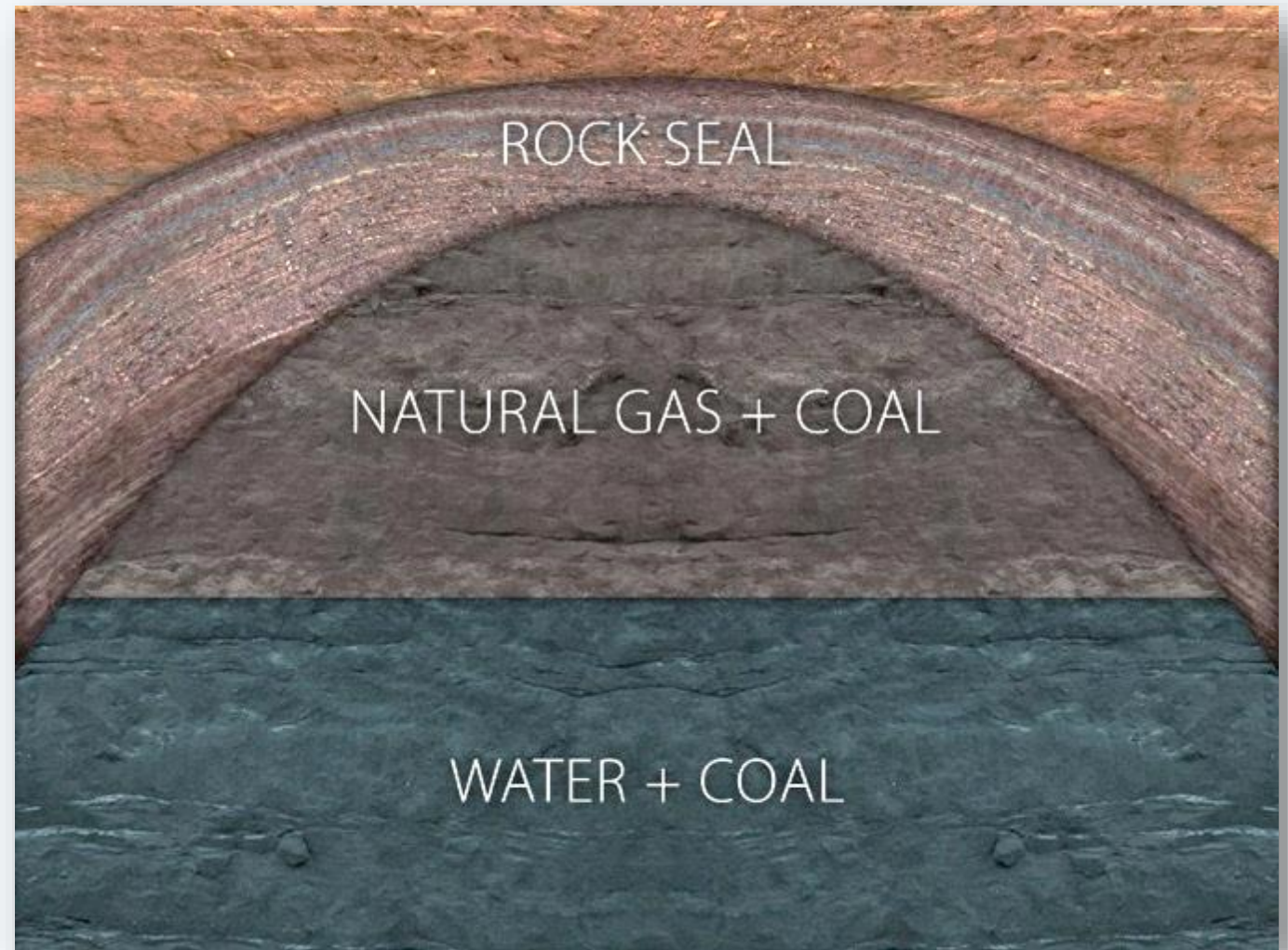
Natural degradation of coal produces methane gas

Gas on top of water

Coalbed methane (natural gas)

Occurs close to surface

Brita® filter

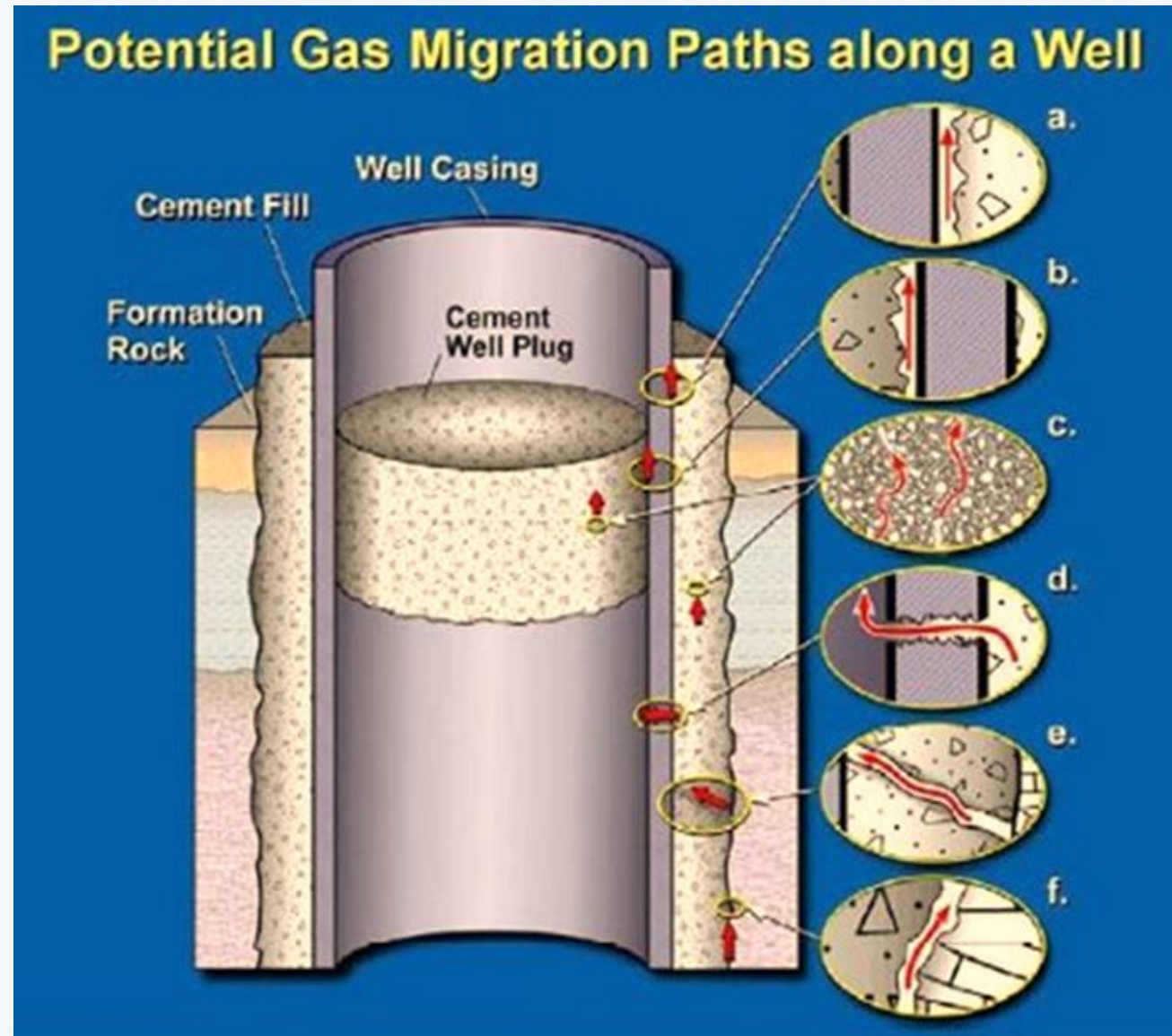


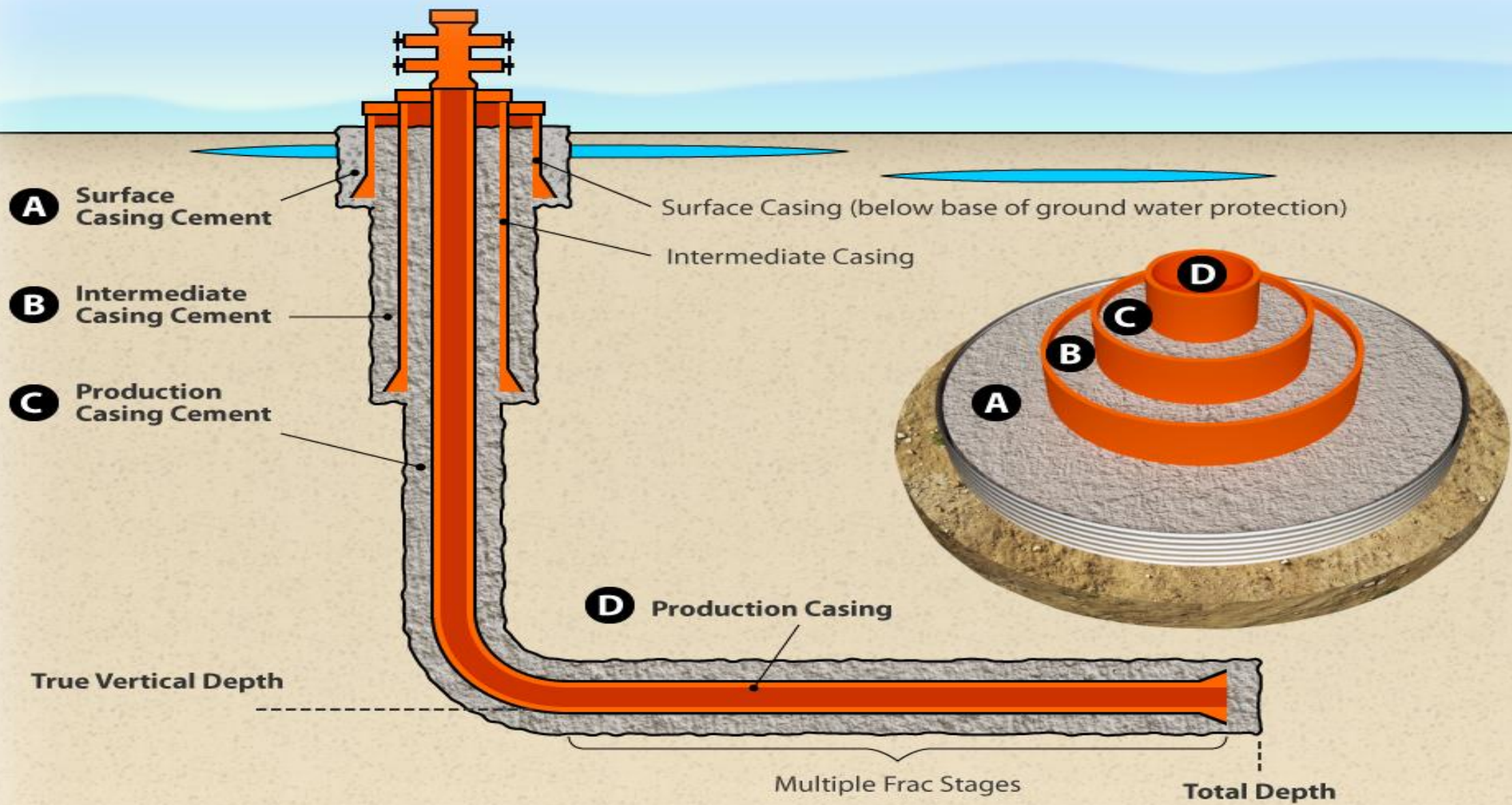
Why regulations and best practices matter:

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.





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

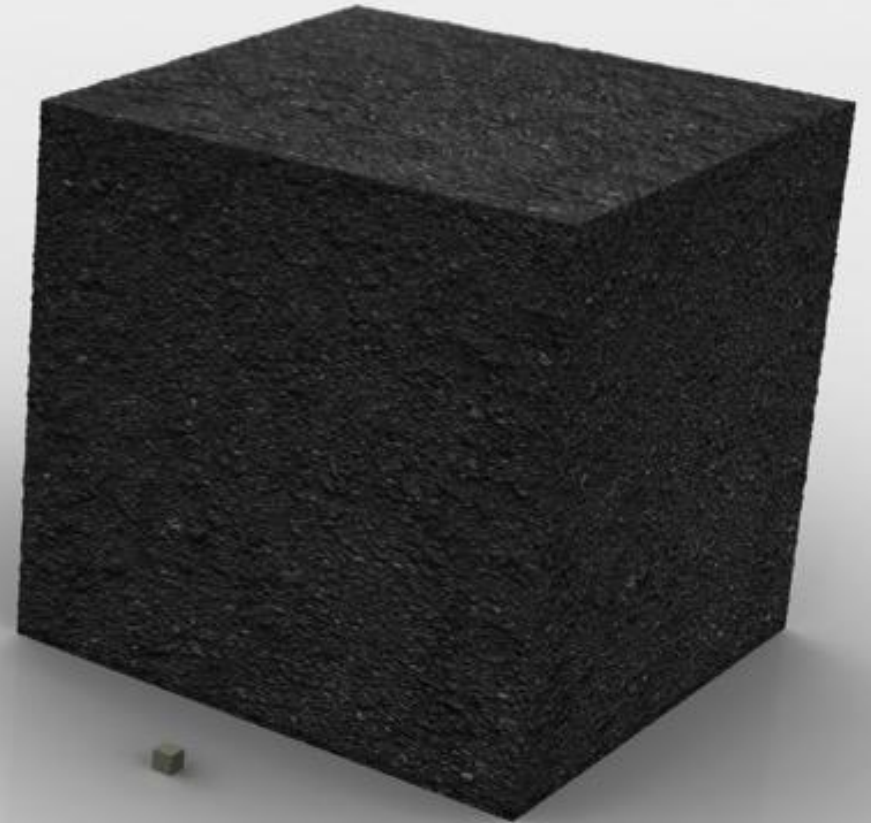
Can fractures grow up into fresh water aquifers?

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

100 tonnes of sand + 1000 m³ of water
= 1,037 m³ of fracture

VS

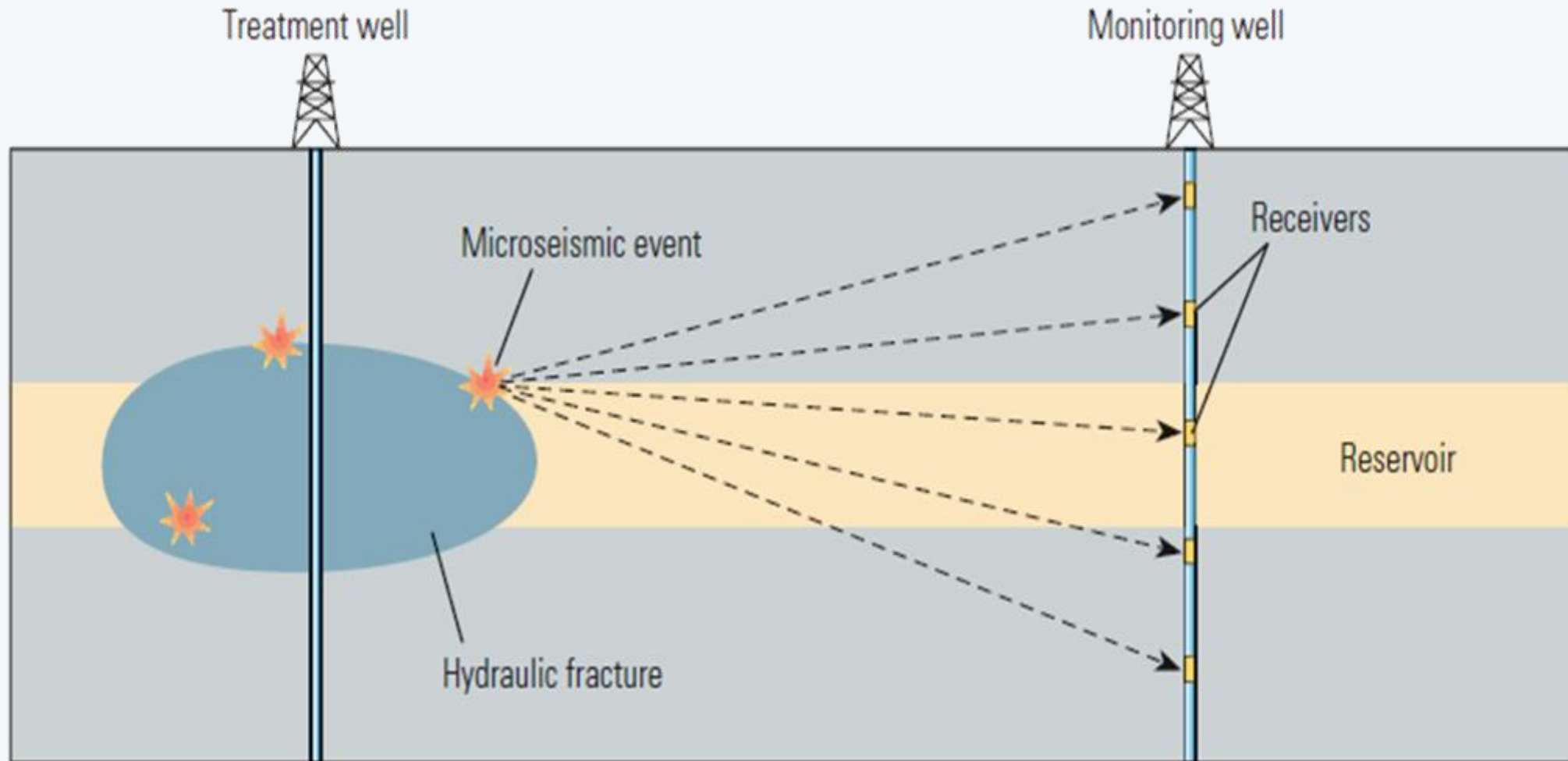
1,000,000,000 m³ or large of rock above (if 1 km deep)



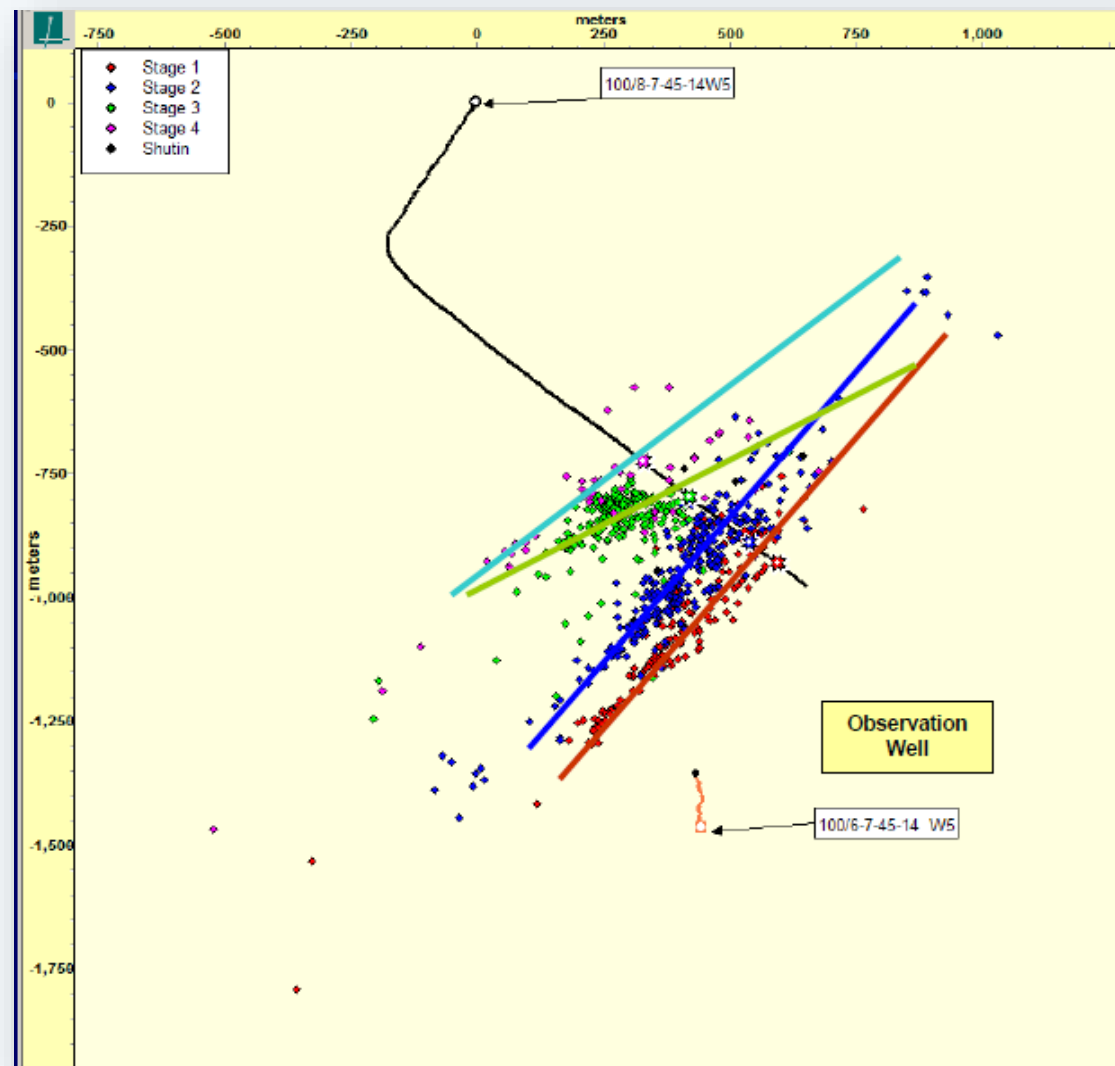
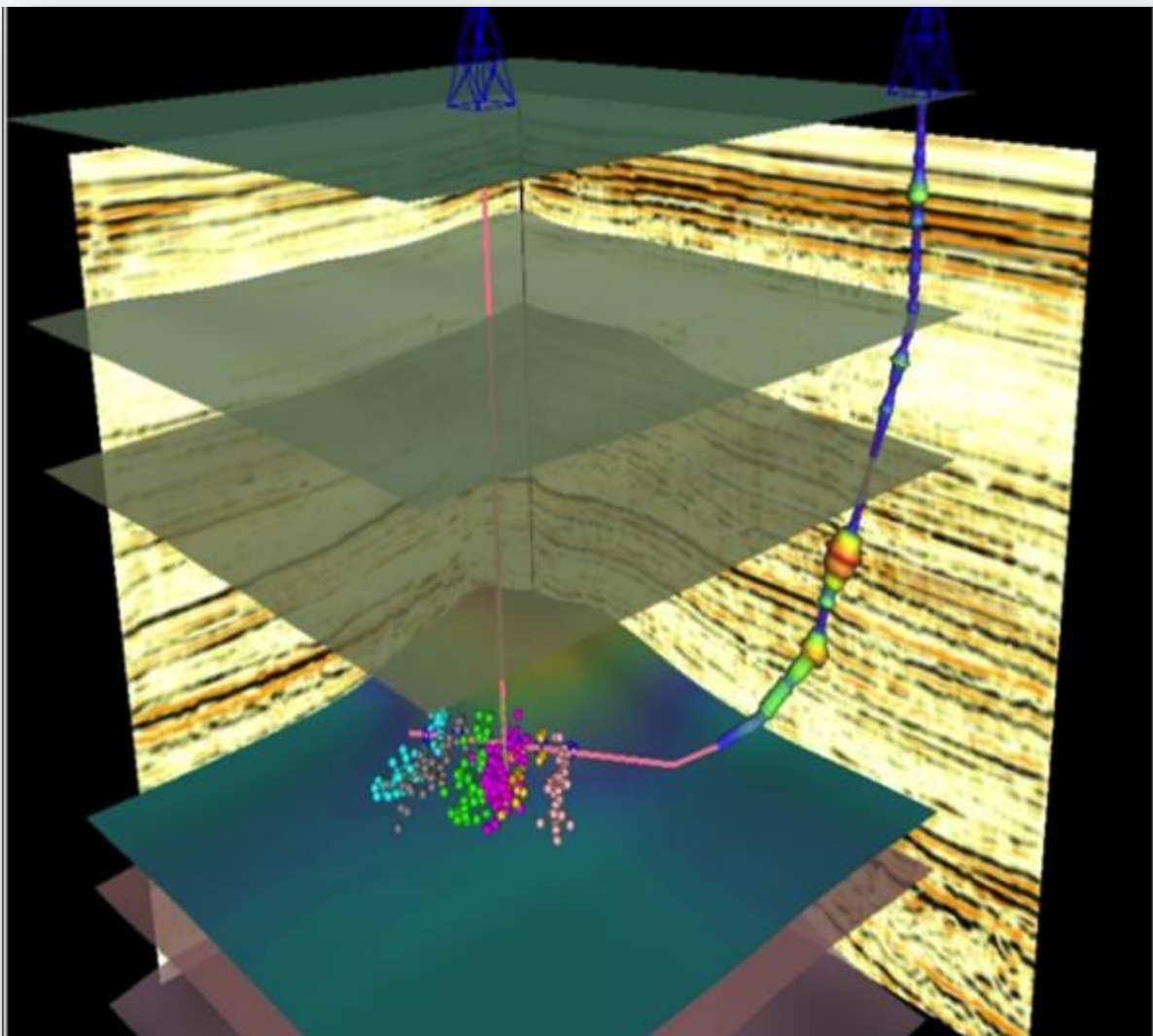




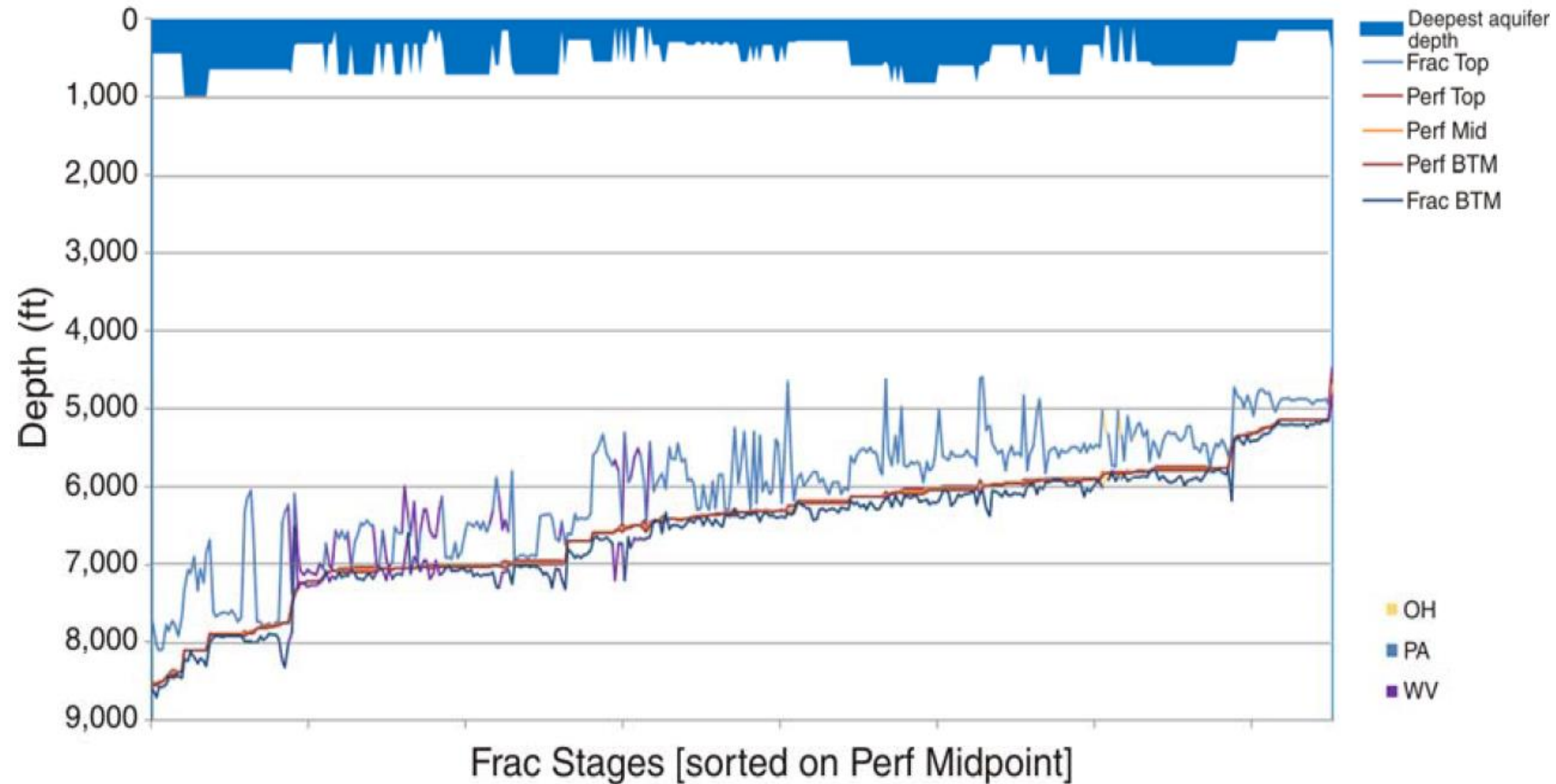
How can we measure dimensions of a fracture?



3D Modeling



Marcellus Mapped Frac Treatments/TVD

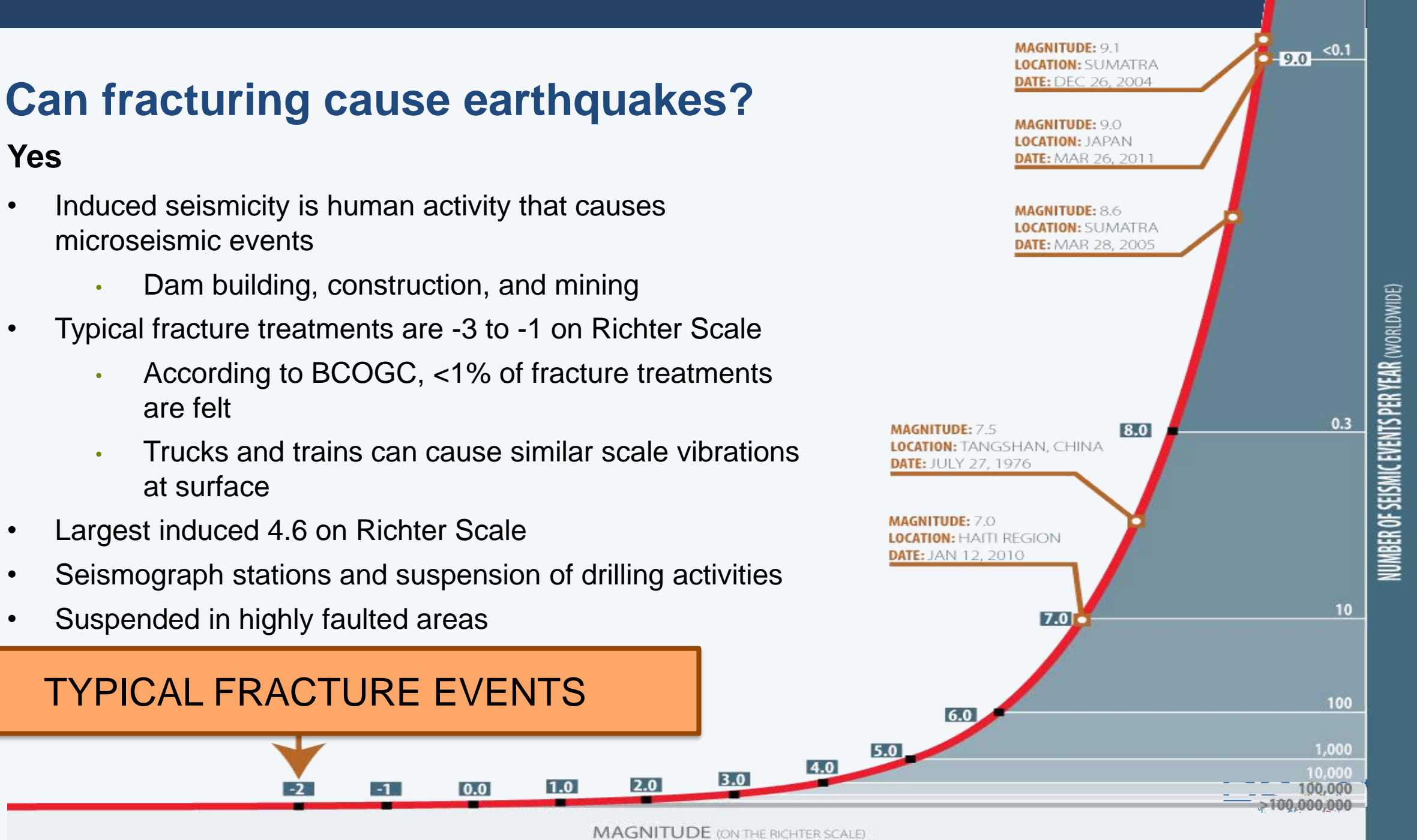


Can fracturing cause earthquakes?

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

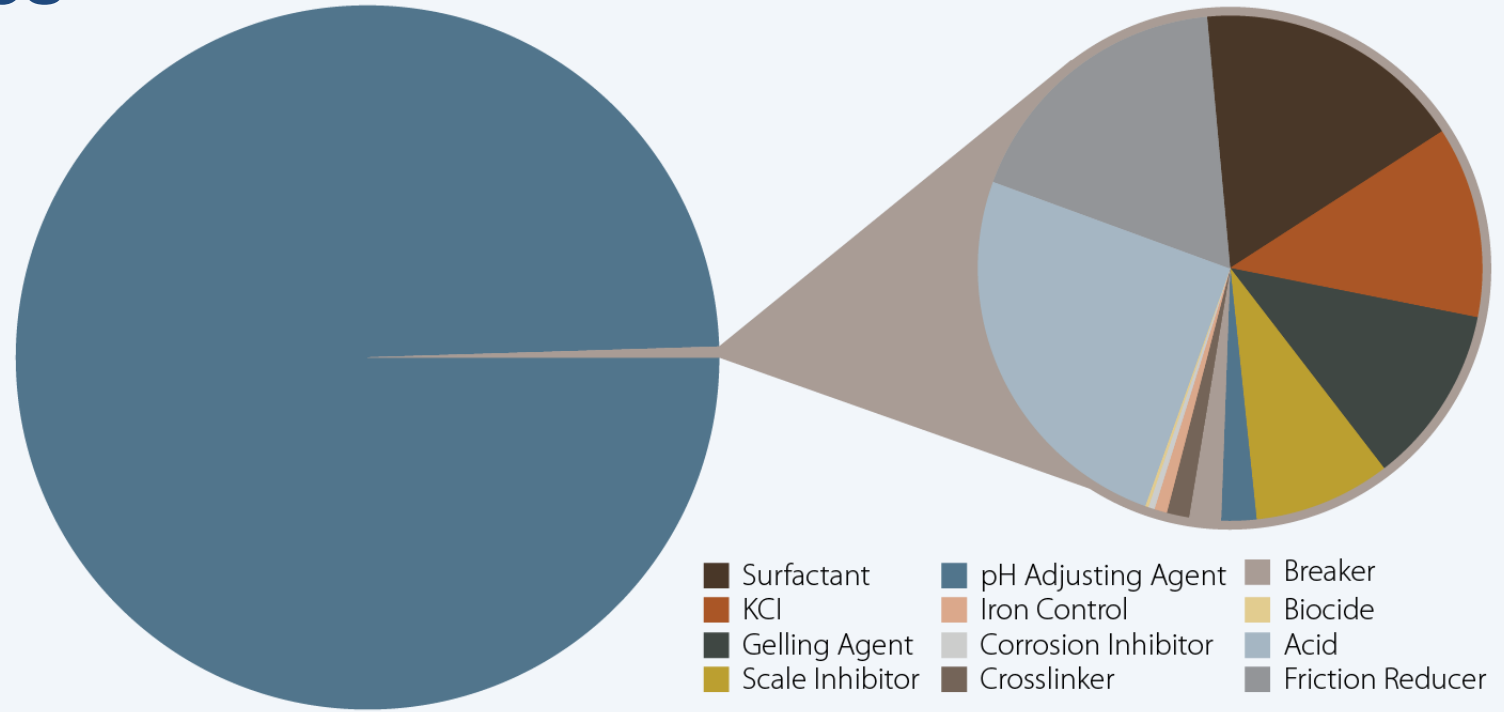
TYPICAL FRACTURE EVENTS



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



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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Frac Focus
Chemical Disclosure Registry

HYDRAULIC FRACTURING THE PROCESS **WATER USAGE** & PROTECTION **FIND A WELL** IN YOUR AREA **REGULATIONS** PROVINCES & TERRITORIES **CHEMICAL** USE **FREQUENT** QUESTION

Find A Well In Your Area

Simple Search Map Search

Search Options for British Columbia

British Columbia [Back to Map](#)

BC Regions **Wells**





Select a Region Select a Region first

BC Operators

Apache Canada Ltd.

Submit **Clear**

(Note: One search option is required to do a search.)

Well #	Date	Province	Region	Operator	Well Name	Well Type	Latitude	Longitude	Datum
 13117	2012-04-06	British Columbia	Peace River South	Apache Canada Ltd.	APACHE NOEL C- 076-J/093-P-01	Gas	55.134538	-120.12048	NAD83
 15360	2012-08-30	British Columbia	Peace River South	Apache Canada Ltd.	APACHE NOEL A- 025-E/093-P-08	Gas	55.210671	-120.255414	NAD83
 27330	2013-01-14	British Columbia	Peace River South	Apache Canada Ltd.	APACHE HZ NOEL D-A011-H/093-P-07	Gas	55.205319	-120.300758	NAD83
 27330	2013-01-15	British Columbia	Peace River South	Apache Canada Ltd.	APACHE HZ NOEL D-A011-H/093-P-07	Gas	55.205319	-120.300758	NAD83

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)



More Opportunity for NG and LNG to Reduce Global Emissions



Fuel	Time
Nuclear	Longest ↓ Shortest
Oil	
Coal	
Natural Gas	

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

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

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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 VALUE-ADD ECONOMY RELIABLE
 INDIGENOUS PEOPLES EXPORTS TAXES CLIMATE



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