

The Role of Stresses versus Rock Fabric on Hydraulic Fractures*

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Search and Discovery Article #41208 (2013)**
Posted October 8, 2013

*Adapted from oral presentation given at AAPG Geoscience Technology Workshop, Geomechanics and Reservoir Characterization of Shales and Carbonates, July 16-17, 2013, Baltimore, Maryland

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Abstract

The invention that has made possible recovery of gas and liquids from tight shales is horizontal wells and massive hydraulic fracturing. The fracturing must create enough lasting connected and conductive surface area to economically produce from the extremely low permeability rock formations. The surface area must be located in the region of high Reservoir Quality, in a fracture pattern that provides the highest recovery possible. This hydraulic fracturing process is a competition between the in situ stresses versus the rock properties—particularly the rock fabric for many shales. In some formations the stresses will dominate and in others the rock fabric will dominate. This paper reviews the process and speaks to role of the rock fabric.

AAPG Geoscience Technology Workshop
Geomechanics and Reservoir Characterization of Carbonates and Shales
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The Role of Rock Fabric on Hydraulic Fracturing

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July 16, 2013

Progression of Hydraulic Fracturing



1947

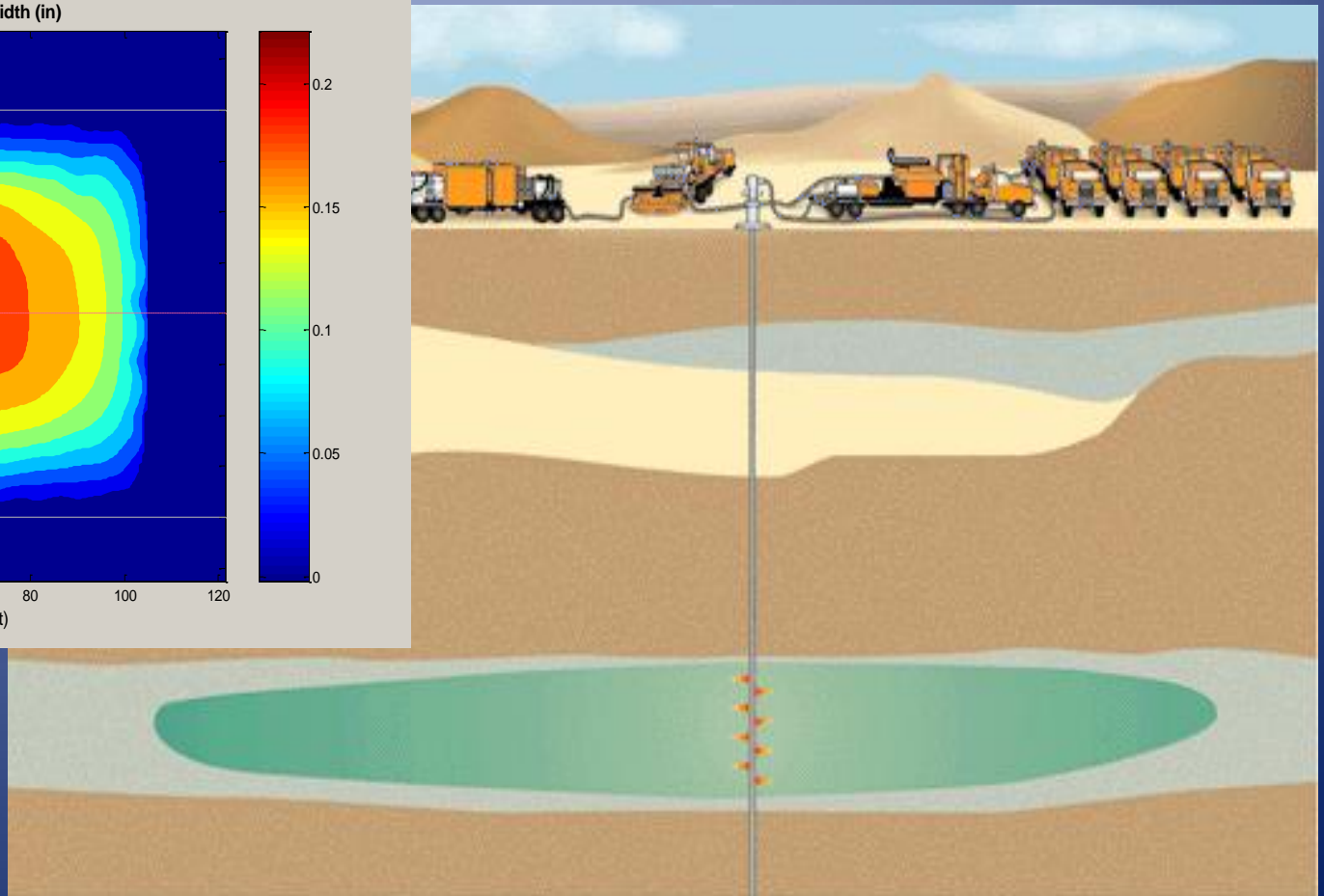
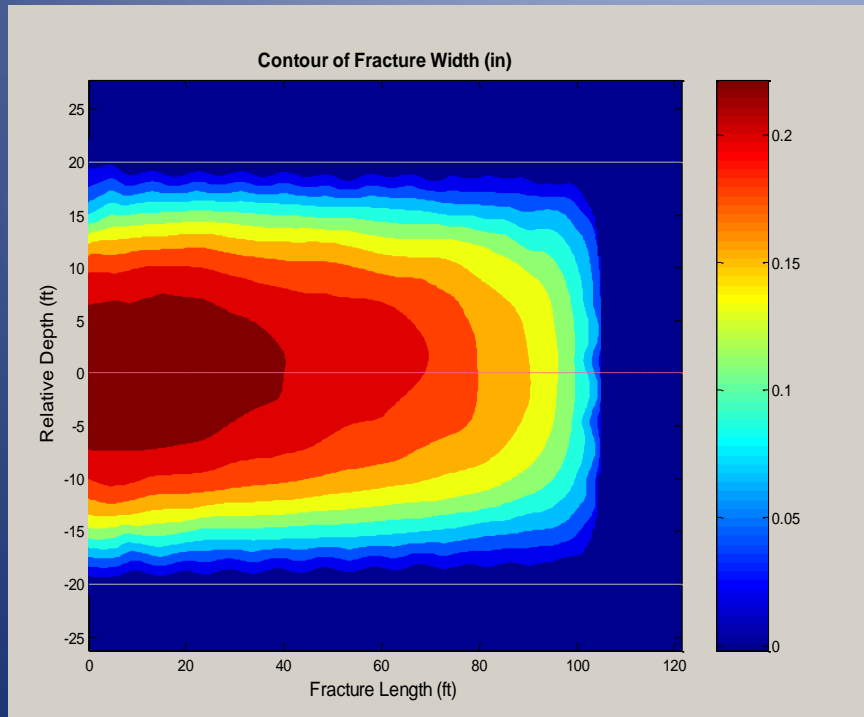


Today

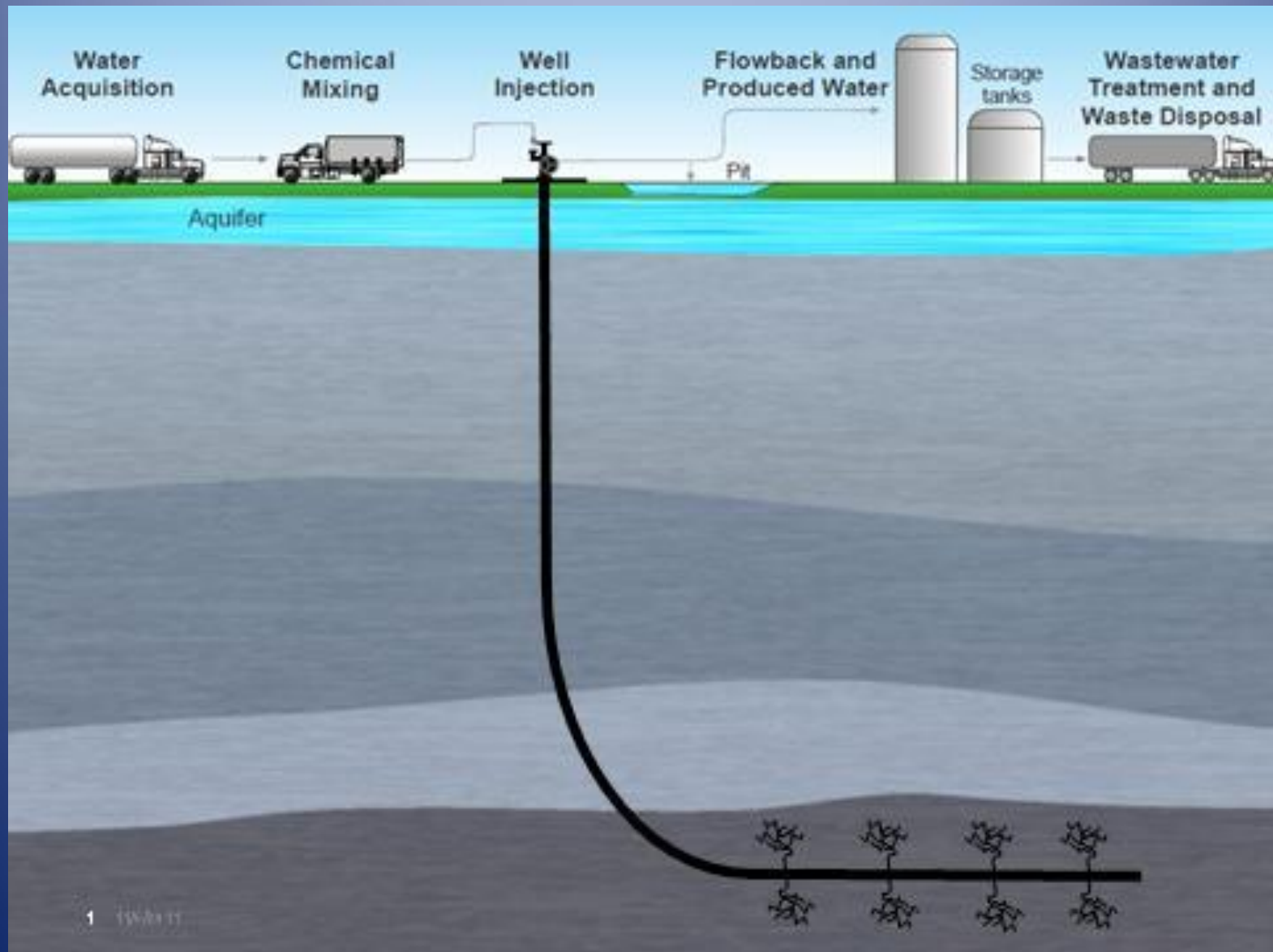


Common Wisdom—Vertical Wells

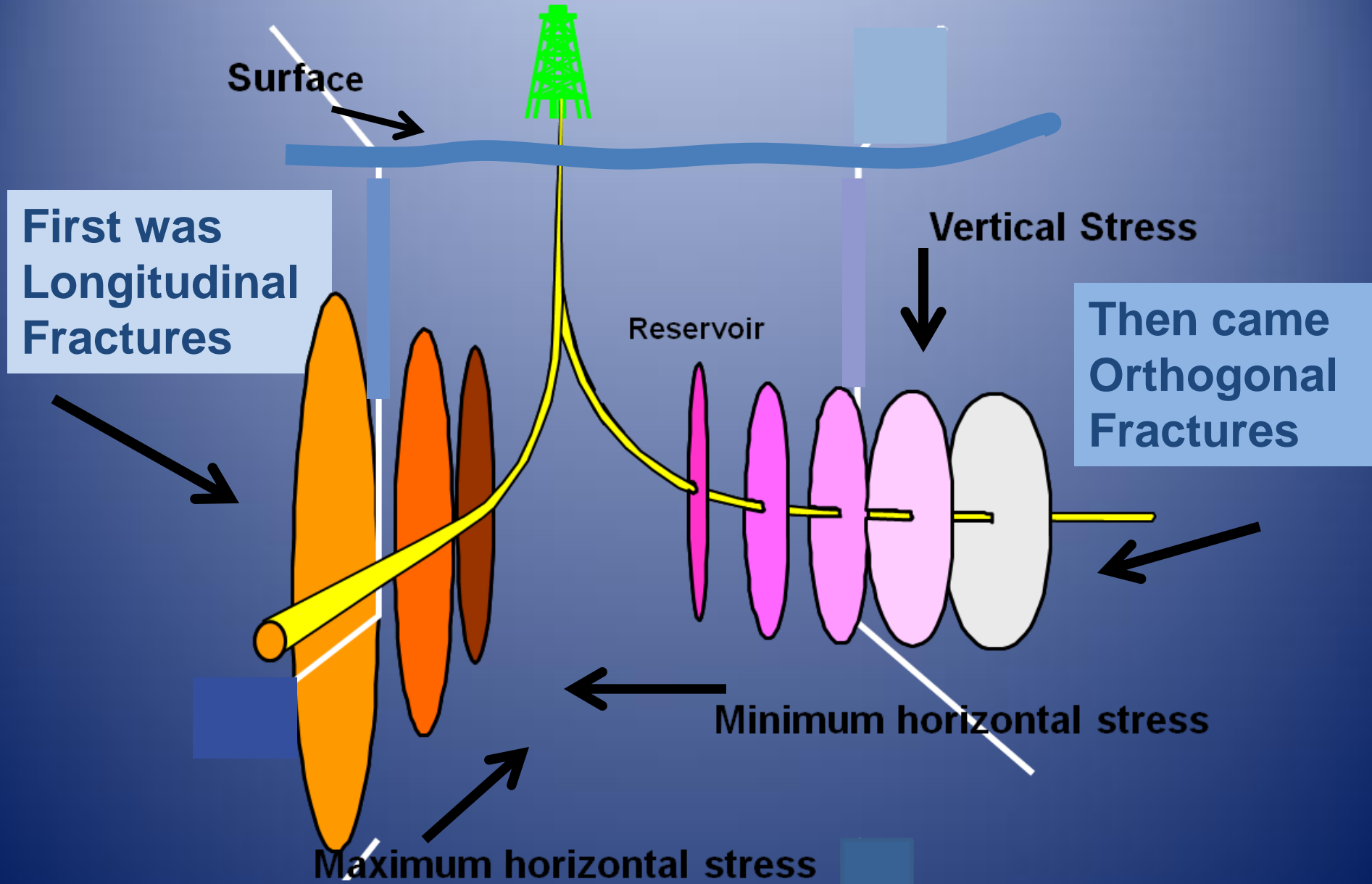
Stress variation from one formation to another contains the fracture and stress contrast sets the direction



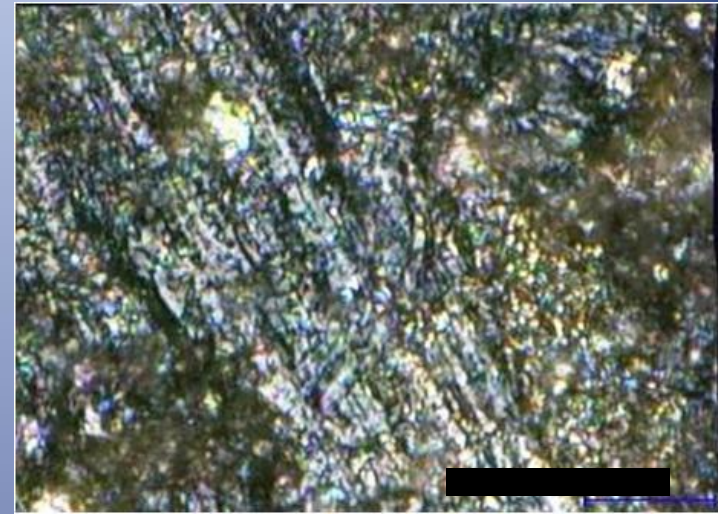
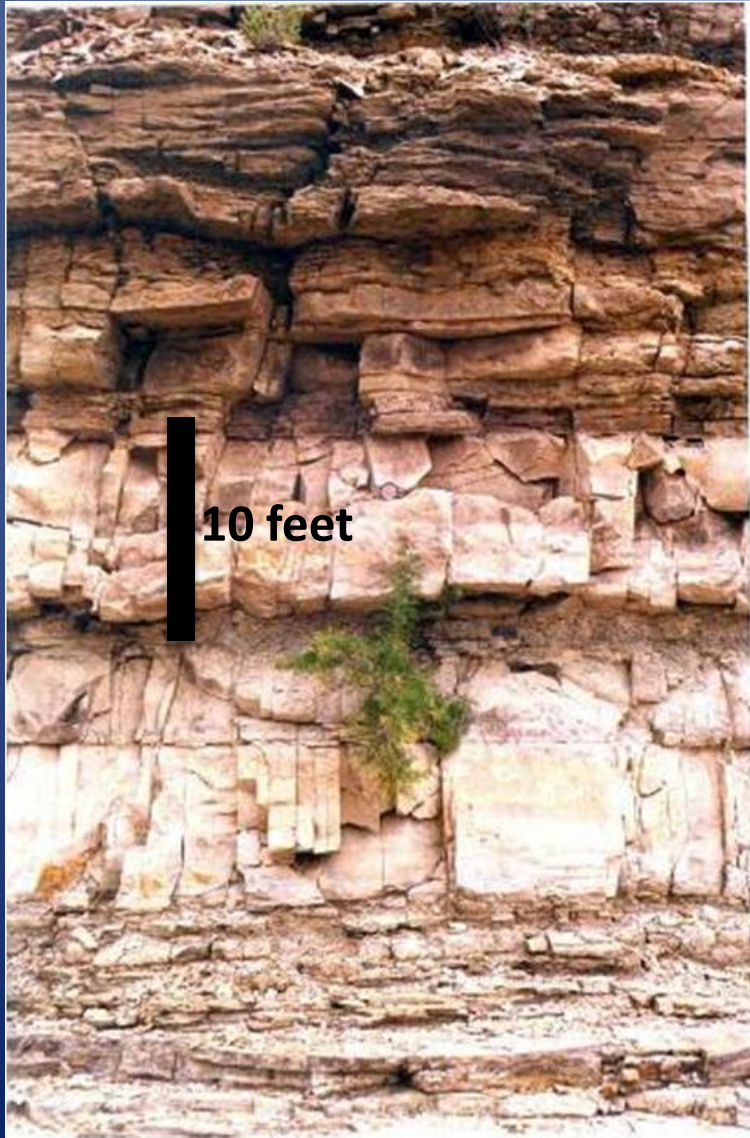
From Vertical Wells to Horizontal Wells



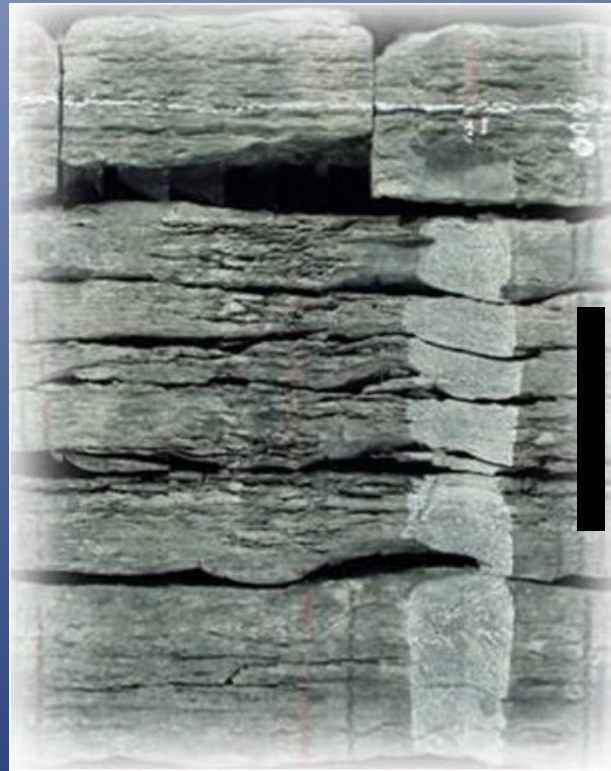
Horizontal Well Fracturing



Complex Formations



10 microns



10 inches

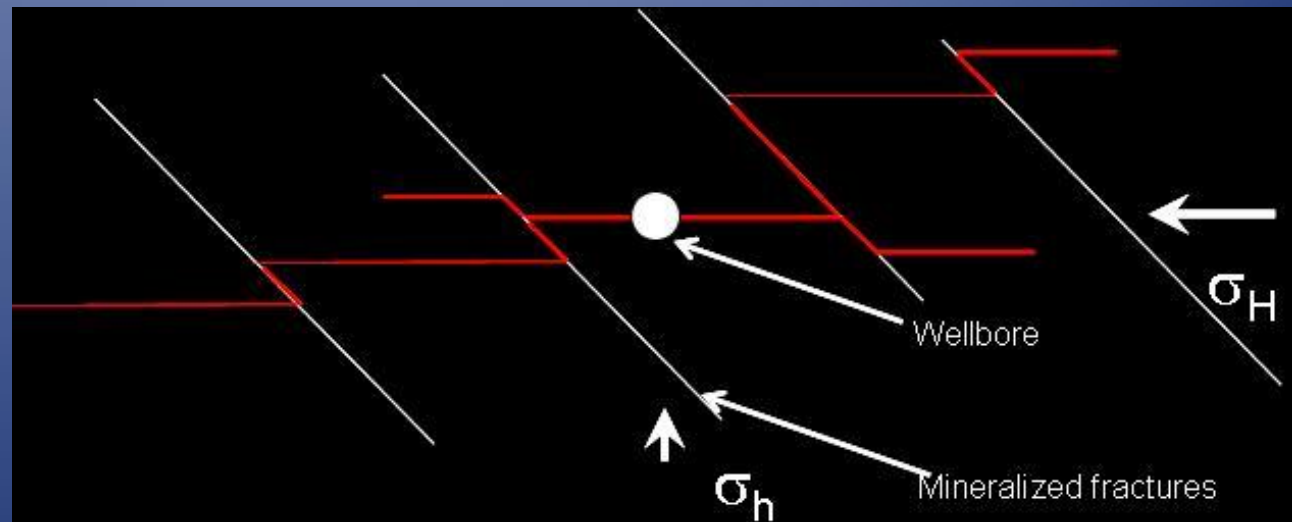
Horizontal Well Fracturing in Complex Formations



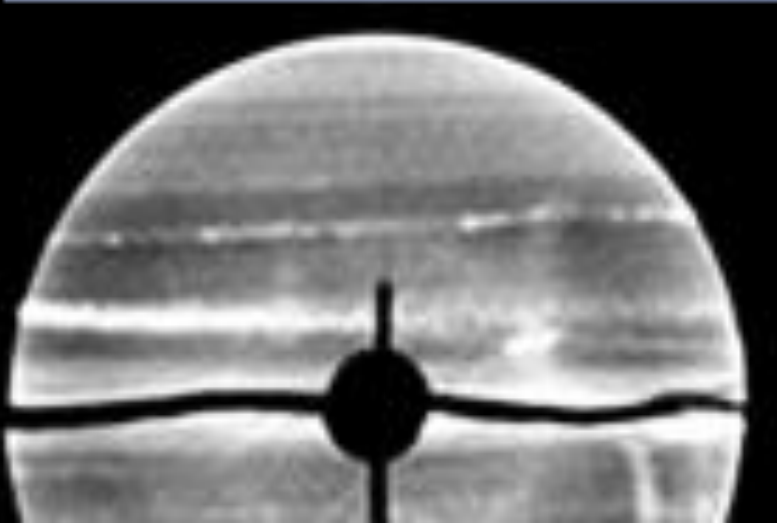
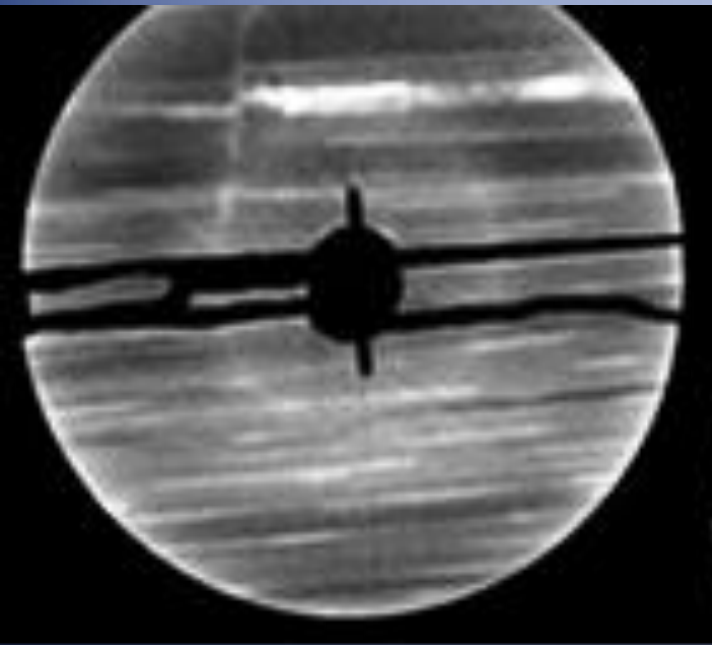
~5 Years Ago



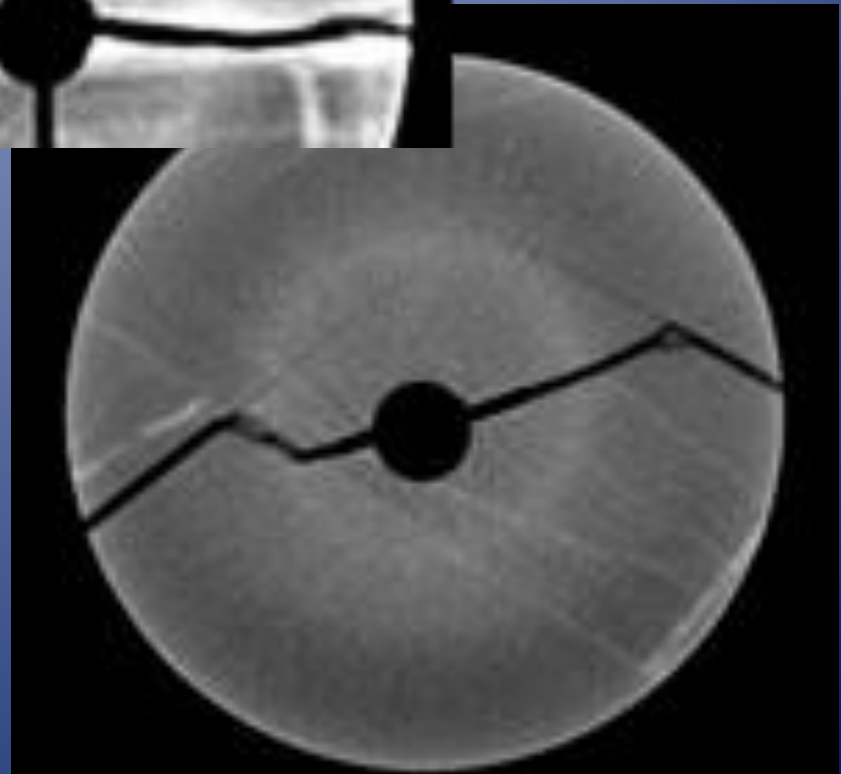
Today



The Role of Rock Fabric



**4-inch Diameter Core
X-Ray Images**



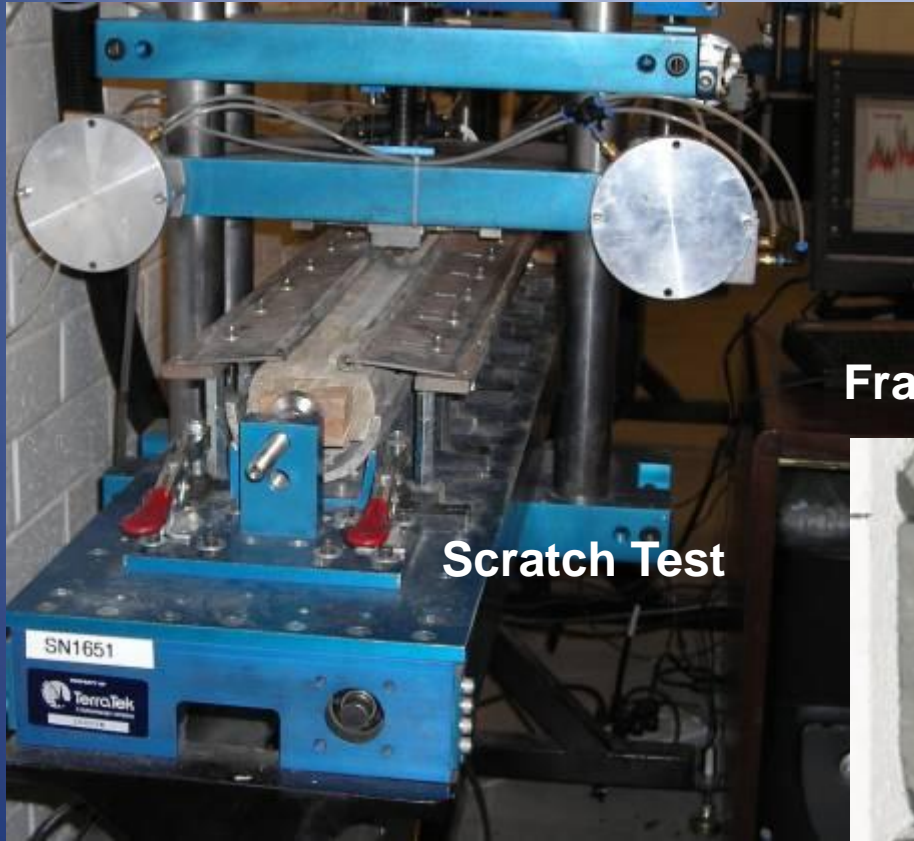
Laboratory Large-Block Tests



Large-Block Recovery



Test Sample Characterization



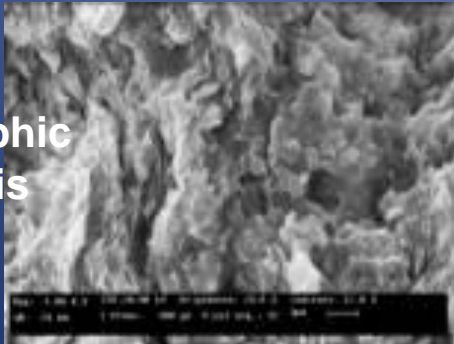
Scratch Test

Fracture Mapping

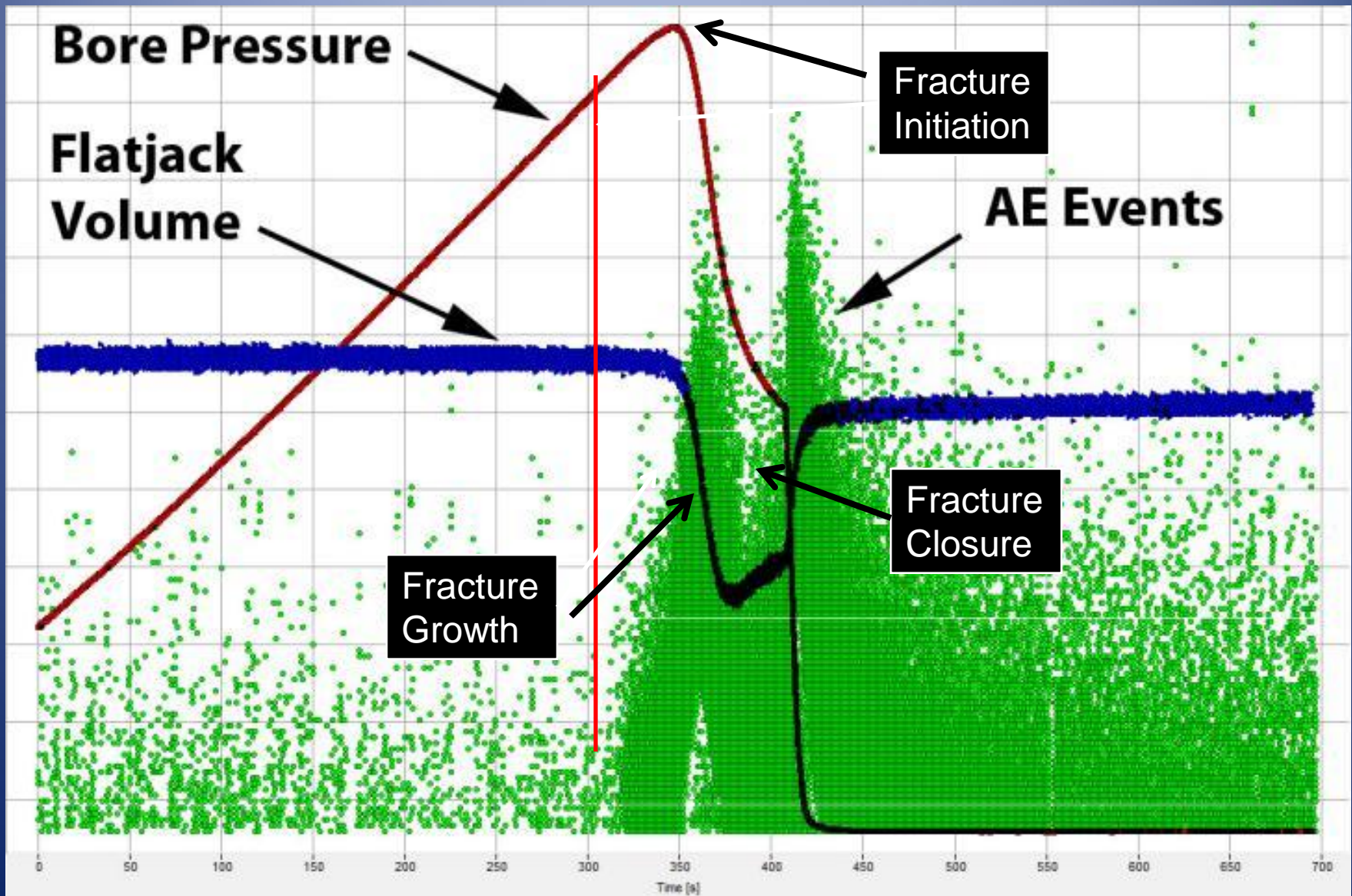


Mechanical Properties Measurements

Petrographic Analysis



Large-Block Test Measurements



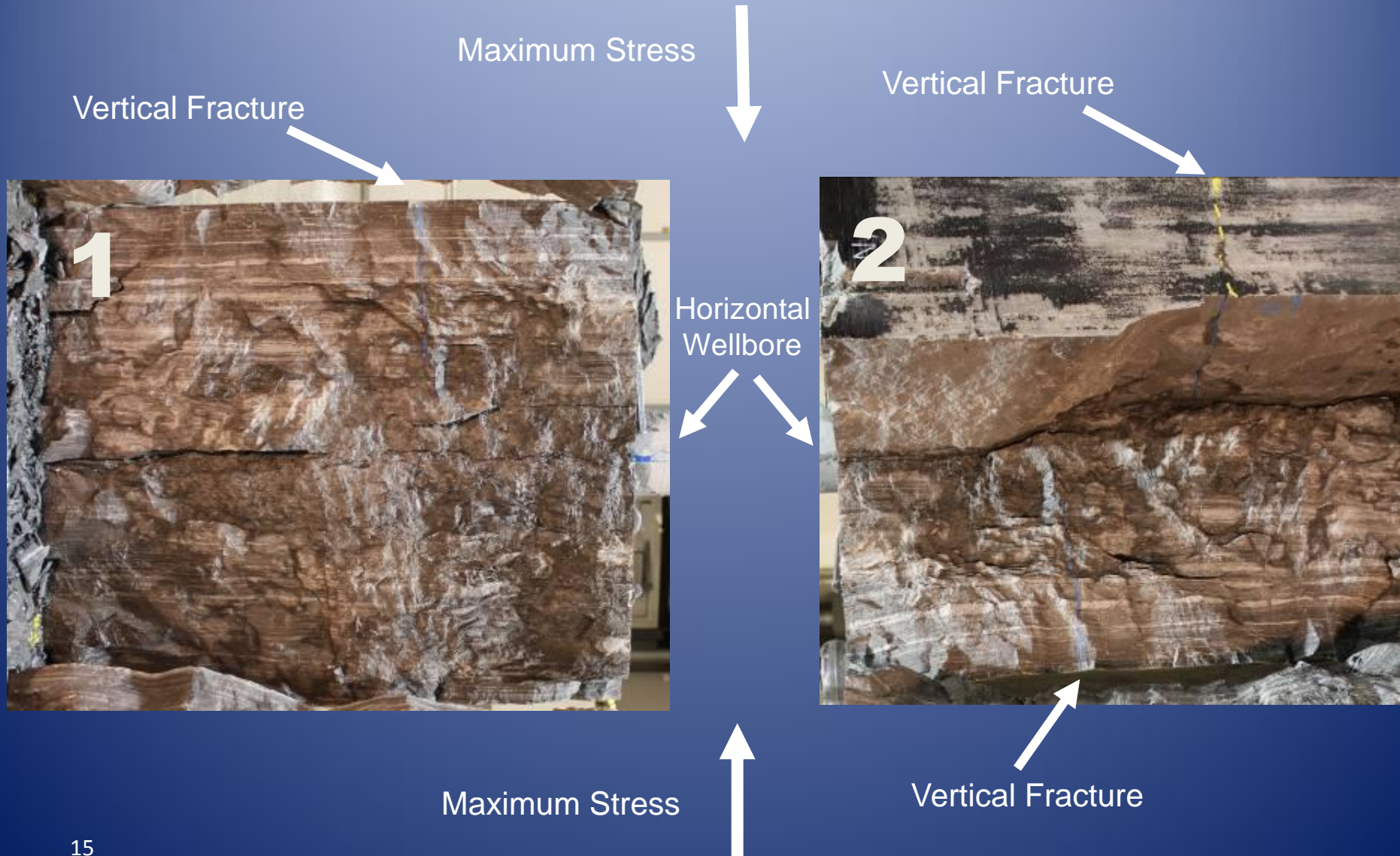
“Penny Shaped” Fracture



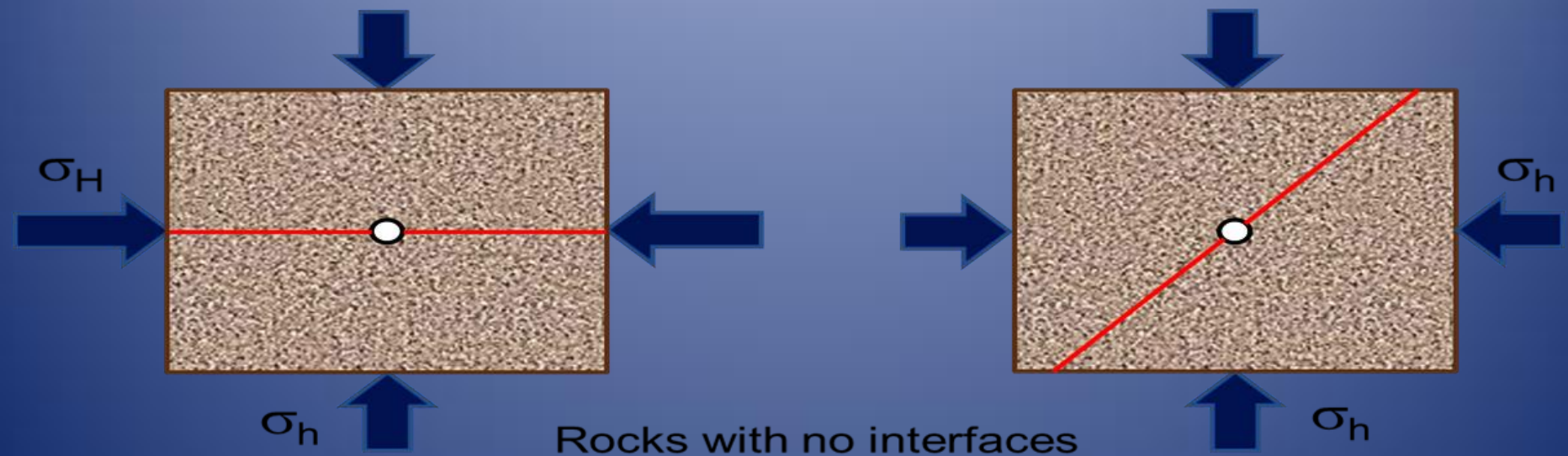
Single Discontinuity



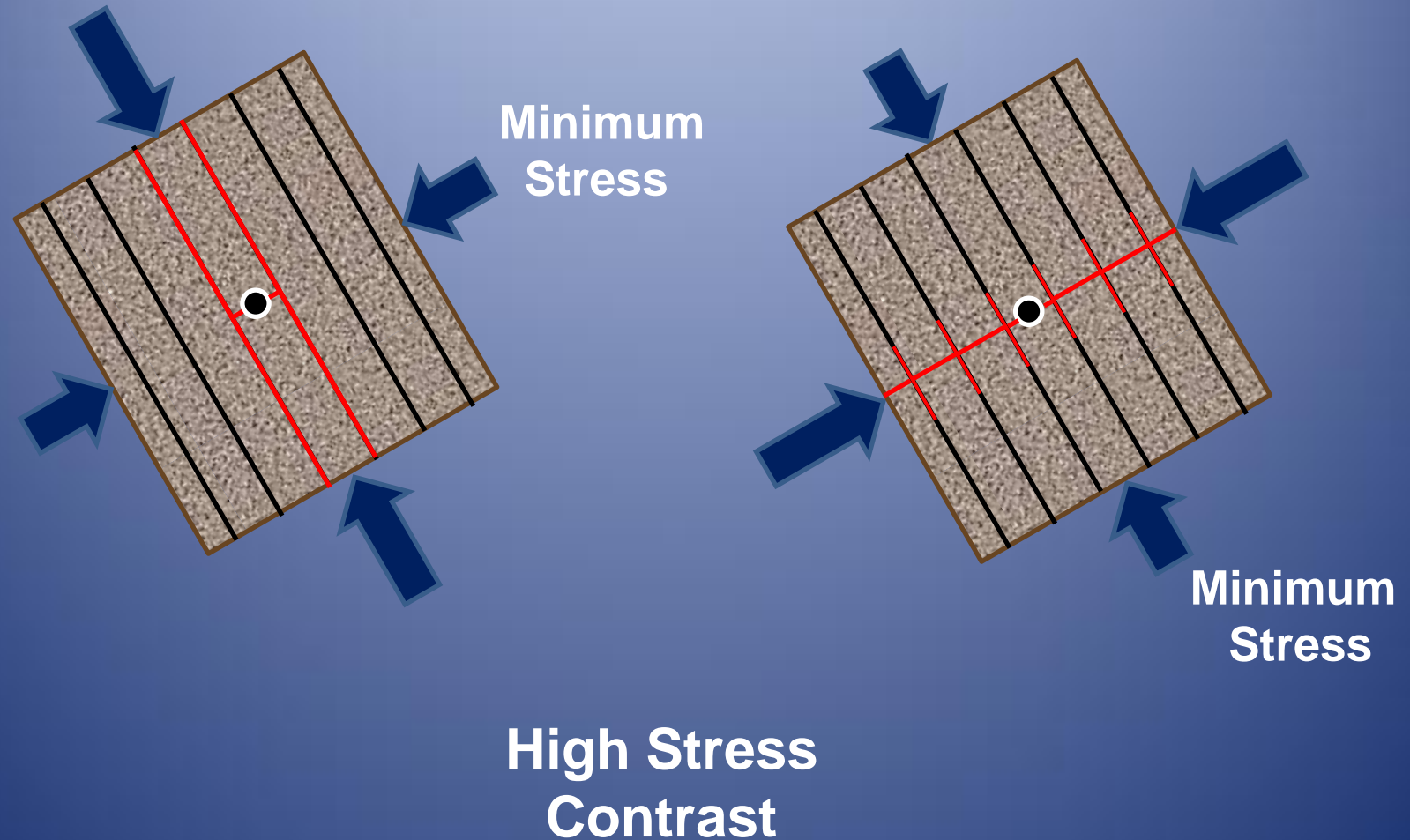
Highly Laminated Rock (Mancos Shale)



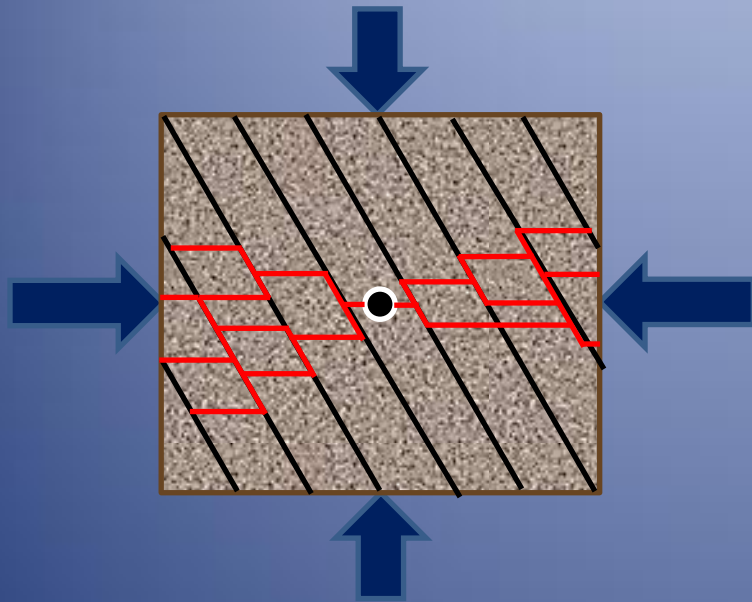
“No” Rock Fabric



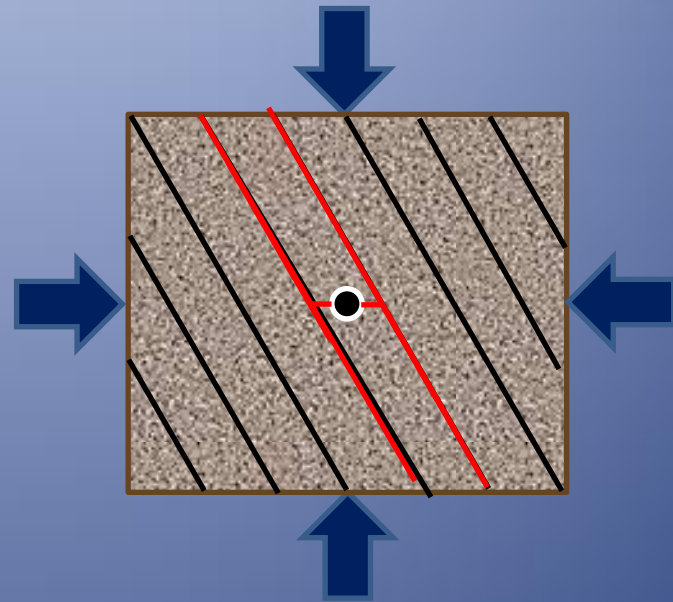
Rock Fabric Aligned with Stress Directions



Rock Fabric Not Aligned with Stress Directions



**High Stress
Contrast**



**No Stress
Contrast**

Factors Influencing Fracture Height Containment and Complexity

Rock Related:

- Rock fabric (planes of weakness and heterogeneity) including orientation relative to well and principal stress directions
- Stress magnitude (stress contrast and mean stress magnitude) and stress direction

Controllable:

- Fracture fluid viscosity and type
- Fracture fluid pumping rate (pumping schedule)
- Well orientation (relative to stresses and fabric principal directions)
- Near wellbore initiation (perforations, slotting, other)

Closing Words of Wisdom

**“Hydraulic Fracturing is a Competition
between Stresses and Rock Fabric”,
Roberto Suarez, 2012**

Questions

Current technology does not give a sustainable process, but it is quite logical to expect very large improvements in efficiency

We are just beginning -----

