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Terra Slicing

Technology Overview

Contents

- What is Terra Slicing?
- How does a reservoir become damaged?
- How does Terra Slicing Repair Wellbore Damage?
- What is Directed Slice Fracturing?
- What Equipment is used in Terra Slicing?
- Benefits of Terra Slicing

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What is Terra Slicing?

- Patented, advanced excavation technology
- Terra Slicing cuts two perpendicular slices, through casing and cement, 3-10 ft. deep into formation, using high-pressure abrasive slurry (5000 psi)
- Optionally, Terra Slicing can orient the downhole machine, inject chemical reagents, and create fractures
- Terra Slicing eliminates near-wellbore compaction, cleans formation and increases permeability
- Creates pressure drop in near-wellbore zone
- Creates vertical permeability that does not exist naturally

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Terra Slicing in Action

After one minute of above surface pressure test, a 15-foot hole has been pierced into the ground.

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How

does a reservoir become damaged?

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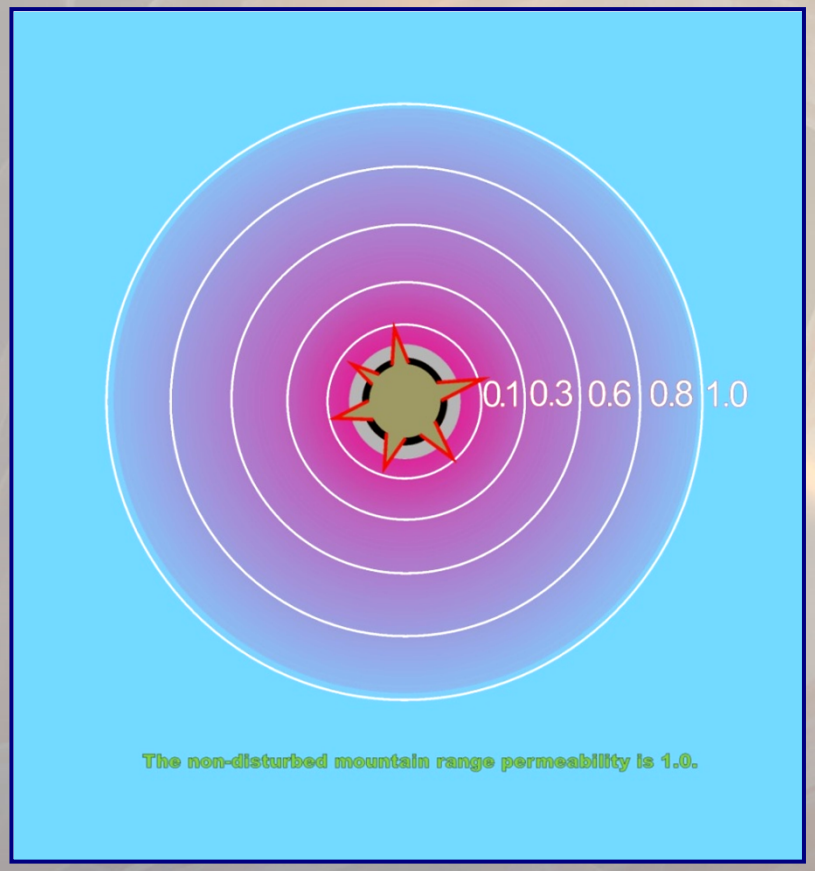
Poor Pressure Regime Around the Wellbore



Conventional drilling & completion technologies cause high pressure, low permeable area to form around the wellbore.

Often conventional drilling & completion technologies also damage the near-wellbore zone.

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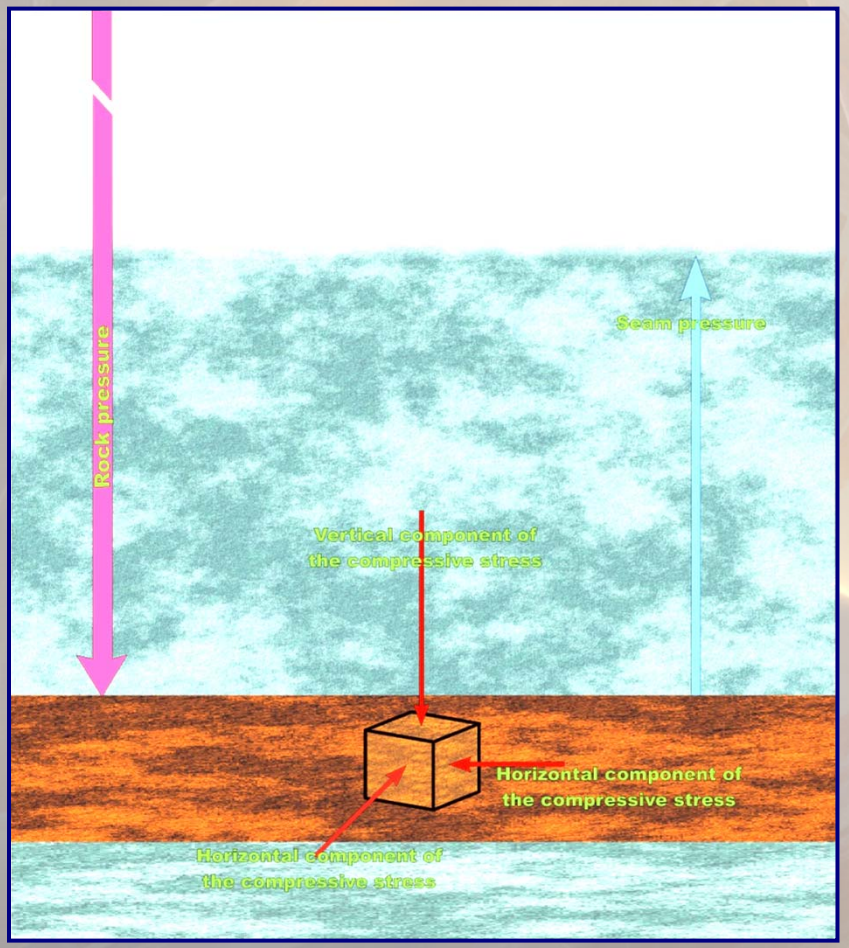
Normal Stress Regime



Formations sustain two types of mechanical stress:

- vertical stress
- horizontal stress

These stresses act on the formation in the vectors as indicated.

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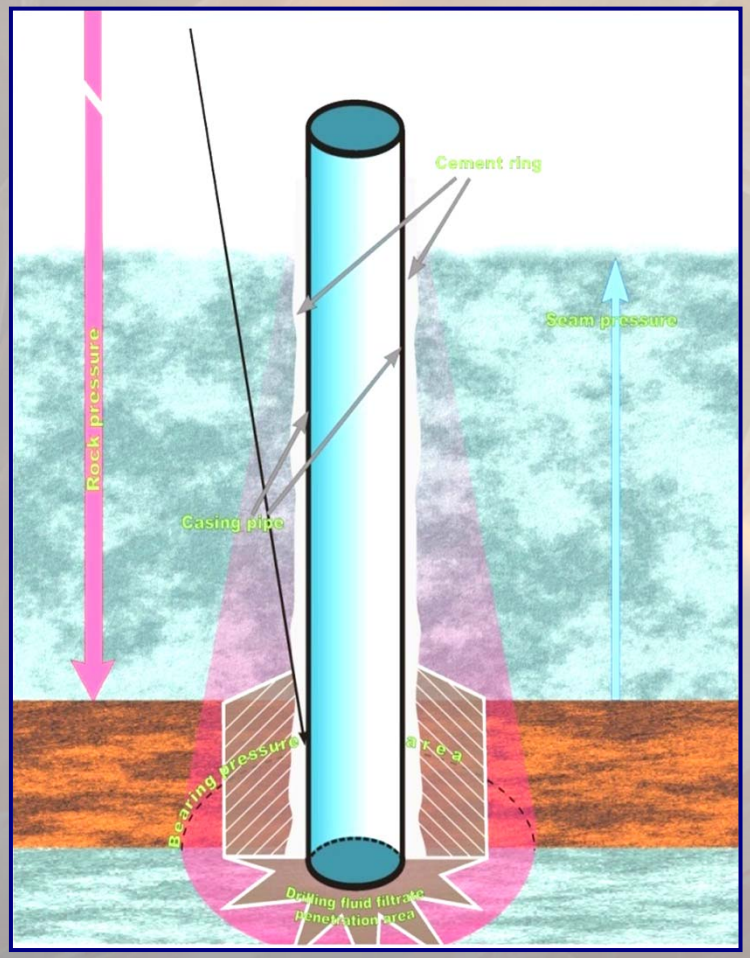
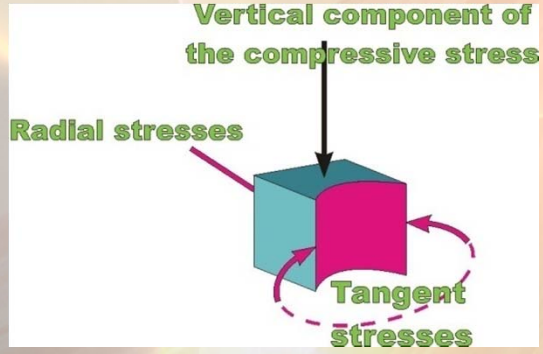
Damage Caused By Drilling



The act of drilling a bore-hole re-distributes mechanical stress.

Radial and tangent stresses arise.

Pay zone permeability can decrease by 5 to 10 times due to the effect of these stresses alone.



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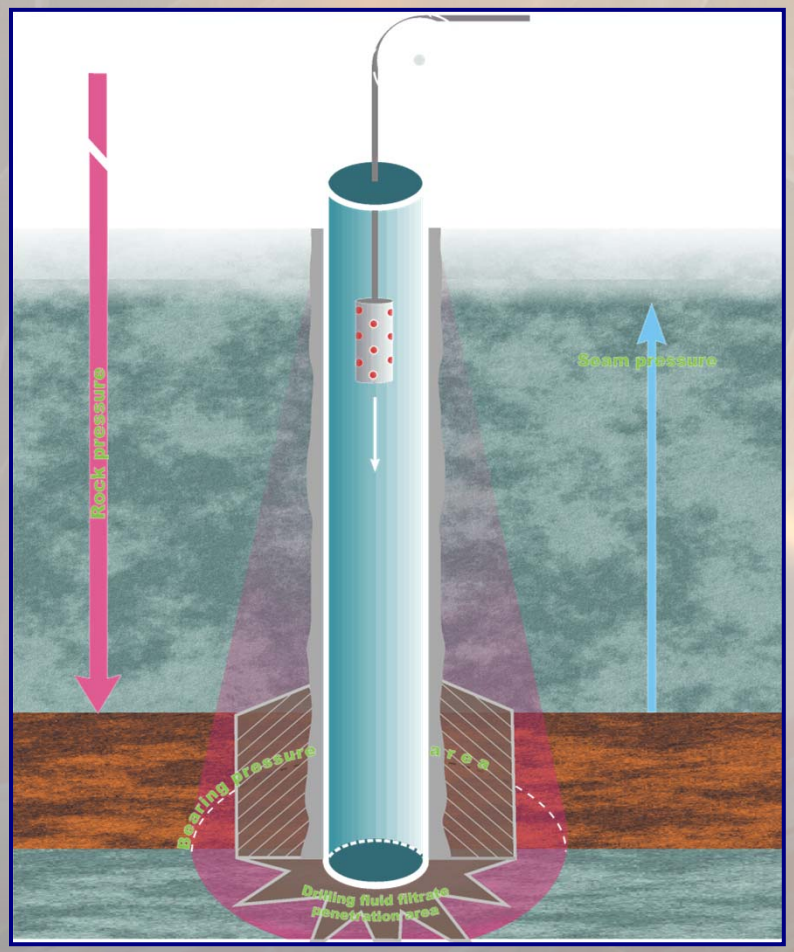
Damage from Completion (1)



The standard gun perforator is lowered into the hole.

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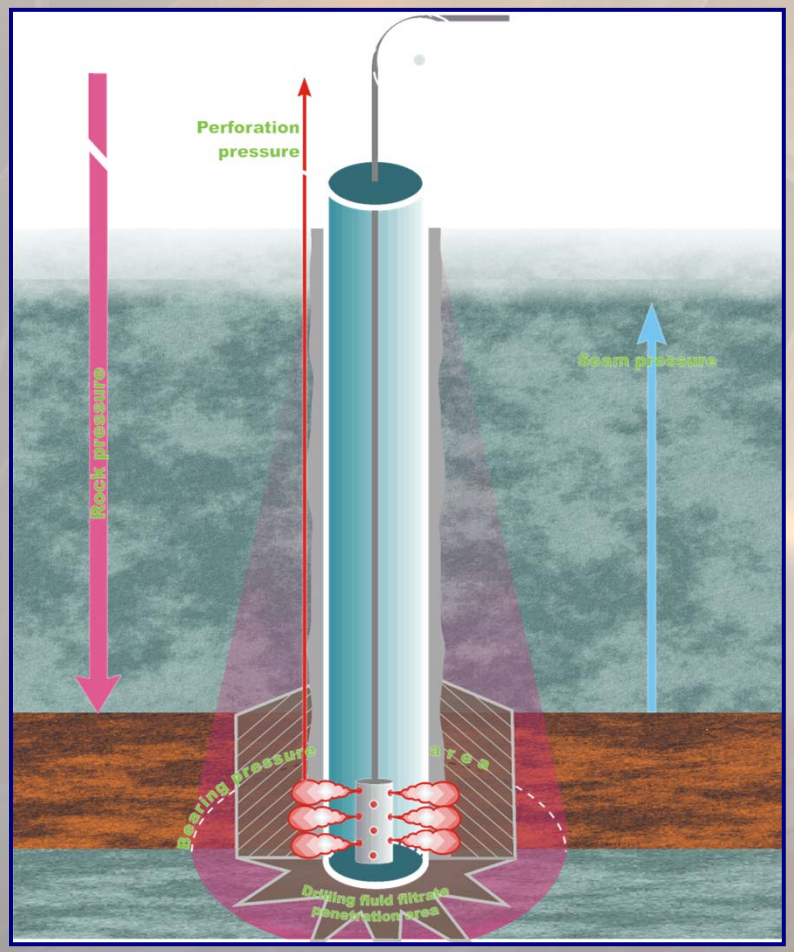
Damage from Completion (2)



During a conventional perforation, pay zone is subjected to high temperature and pressure shock.

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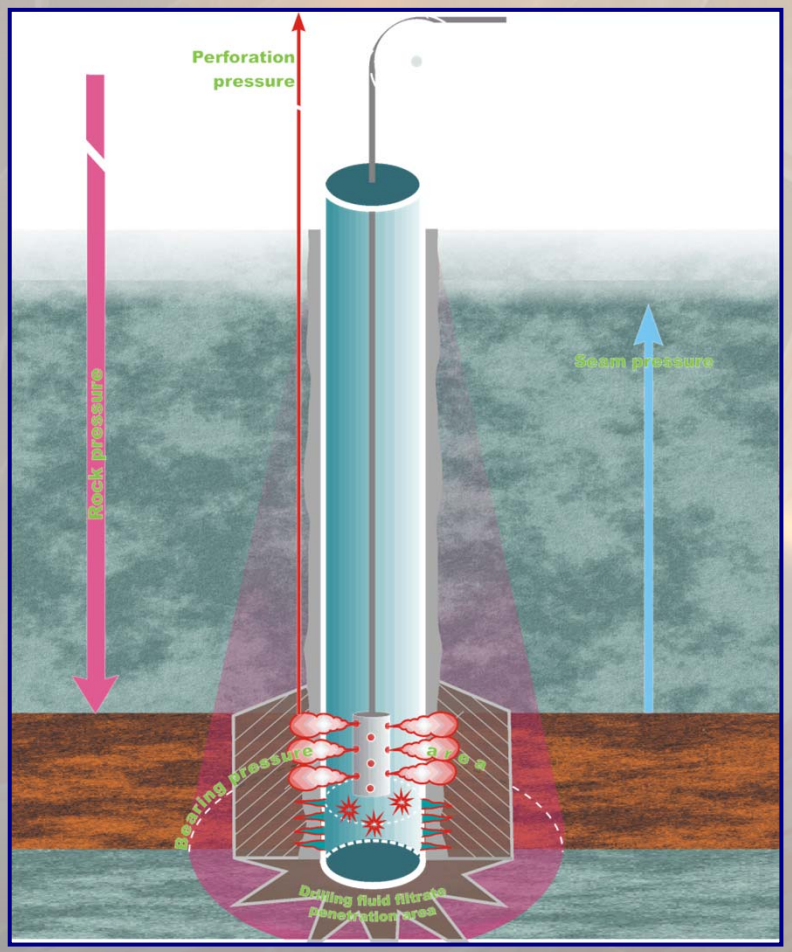
Damage from Completion (3)



Gun debris is deposited on the inner surface of the entry “carrot” and can further damage the formation.

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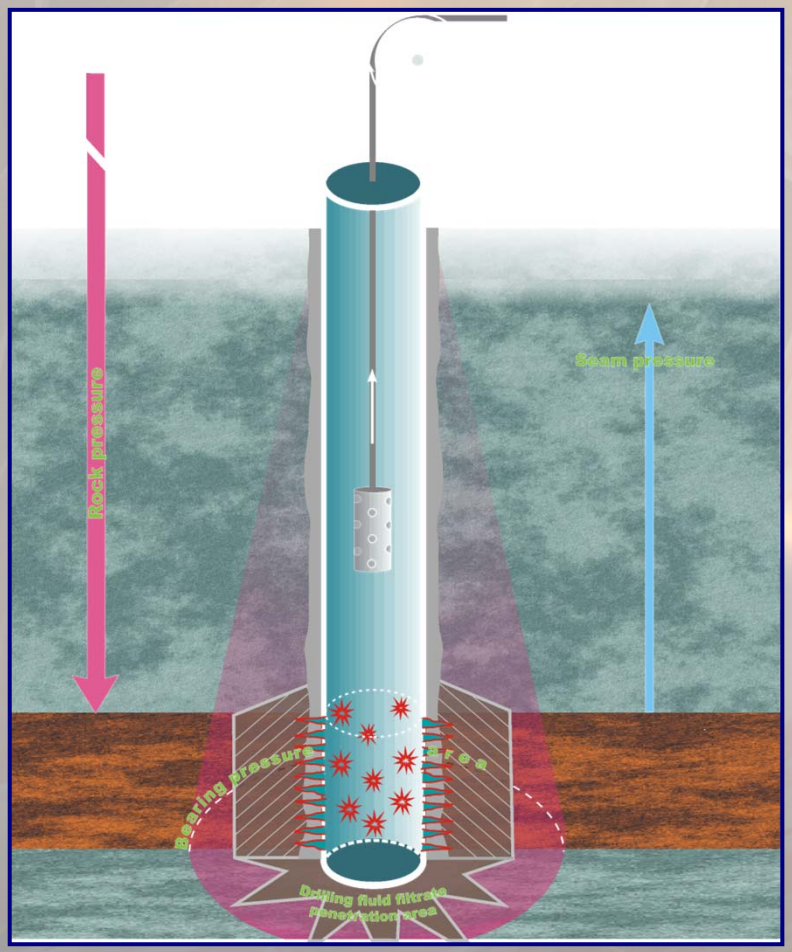
Damage from Completion (4)



Following conventional perforation, the zone of pressure re-distribution is expanded.

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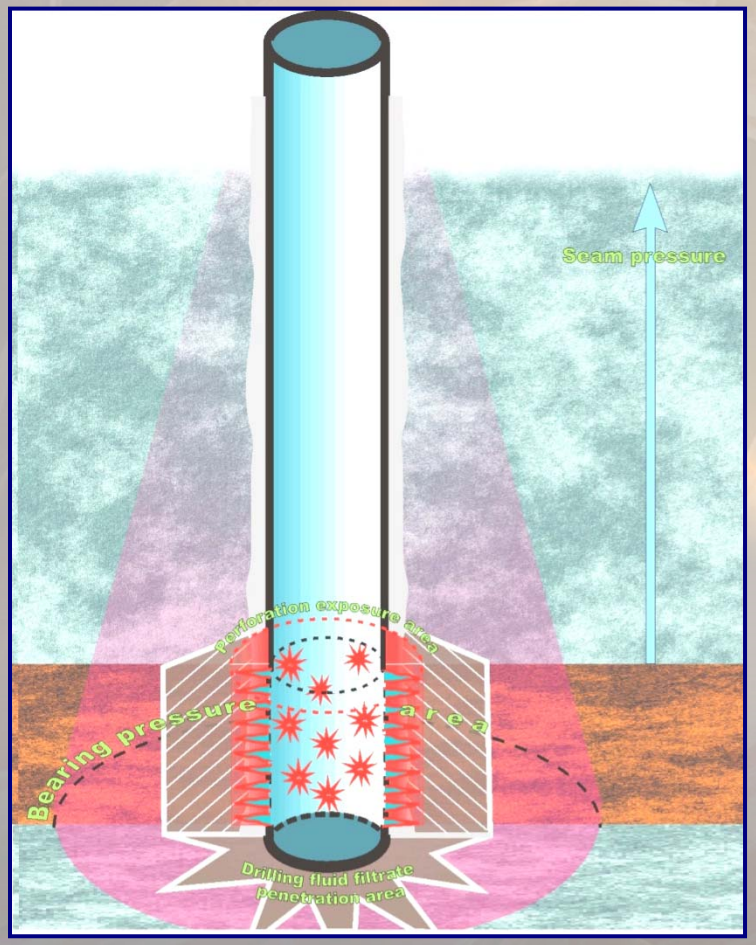
Summary of Wellbore Damage



- mechanical stress disrupted
- invasion of drilling fluid
- accumulated formation fines
- invasion of cement, and
- gun debris.

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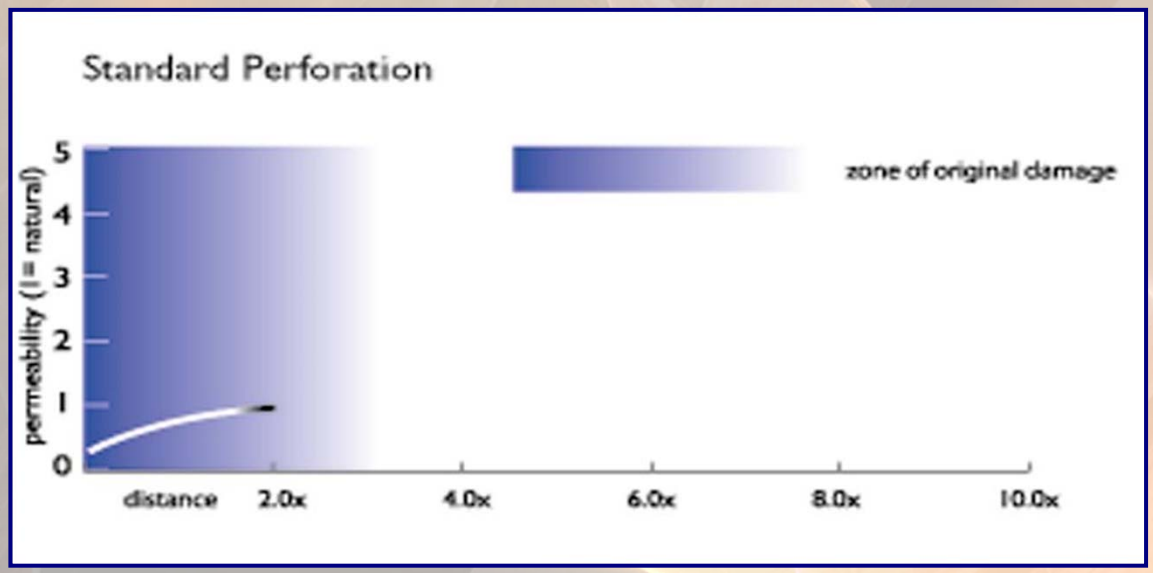
Result of Perforation



Within the pressurized area around the wellbore (in *blue*), formation permeability is reduced by 500 to 1000 percent.

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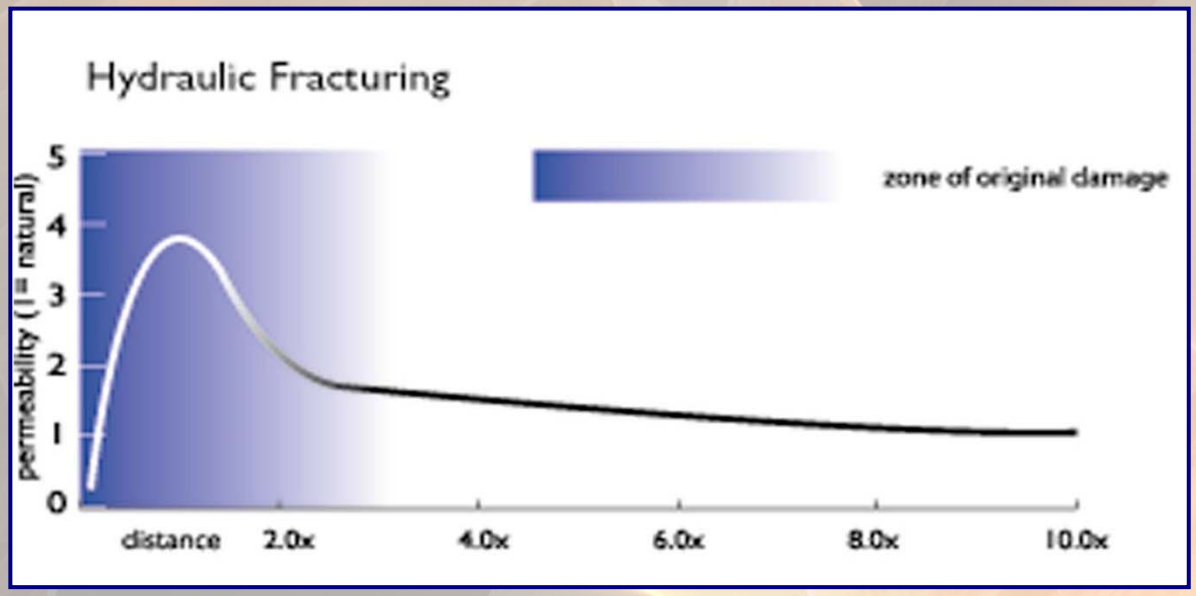
Result of Fracturing



Fracturing technologies impact deeper into the formation, but cannot repair the damaged near-wellbore zone (*blue*).

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Wellbore

Damage

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How does Terra Slicing Repair Wellbore Damage?

- Terra Slicing cuts through the compacted and low permeable near-wellbore zone
- Does not burn, scar, or “cook” the formation
- In carbonates, dislodges clay particles and fines
- In sandstones, reduces sand mobility problems
- In deep gas sands, relieves overpressure damage from mud weight systems

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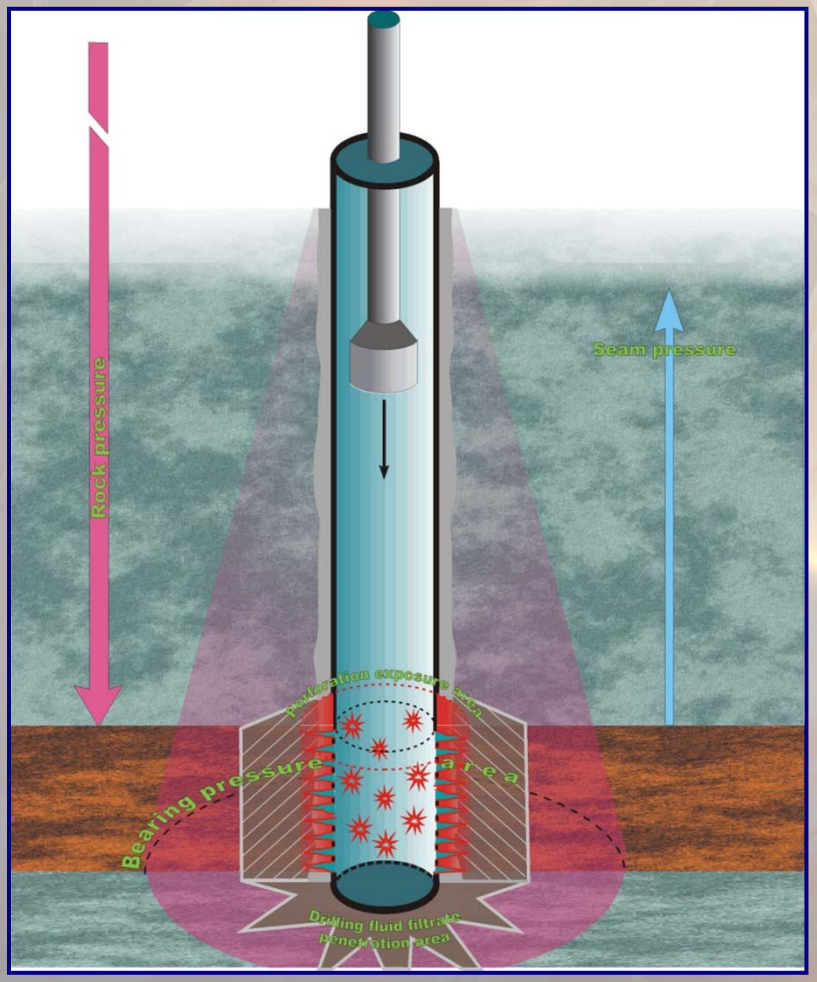
The Terra Slicing Process (1)



The Terra Slicing tool is lowered down to the target formation.

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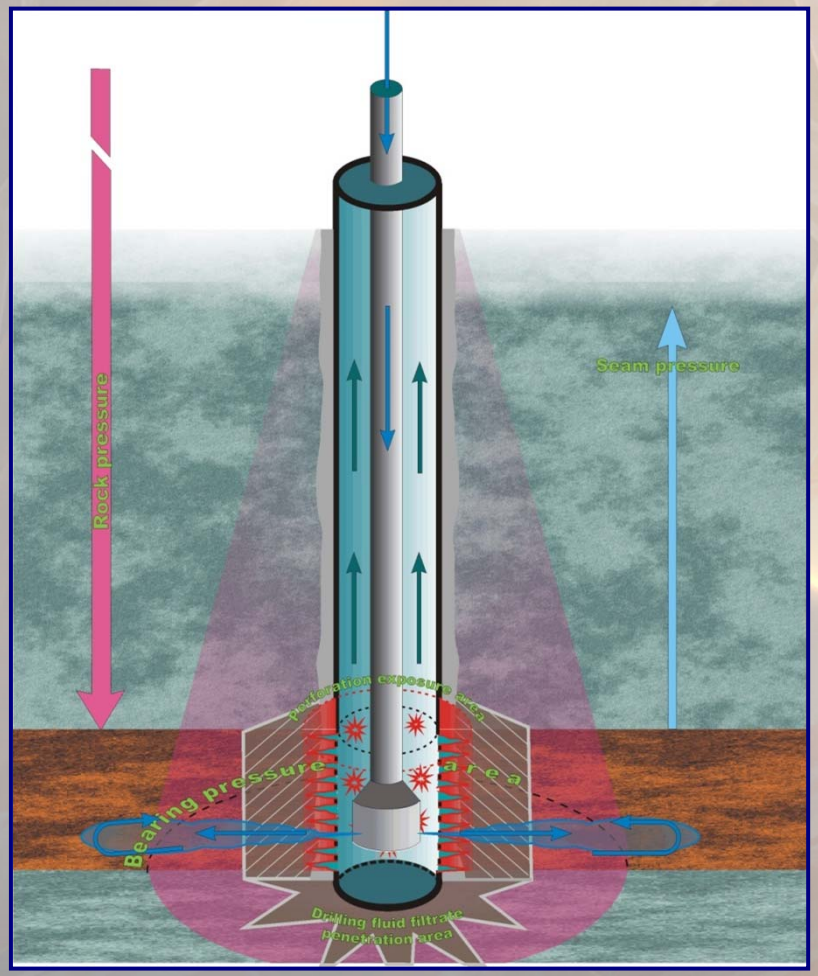
The Terra Slicing Process (2)



The abrasive slurry is aimed into the target formation at the correct pre-calculated vector.

Slicing treatment pressure is < or = to formation pressure

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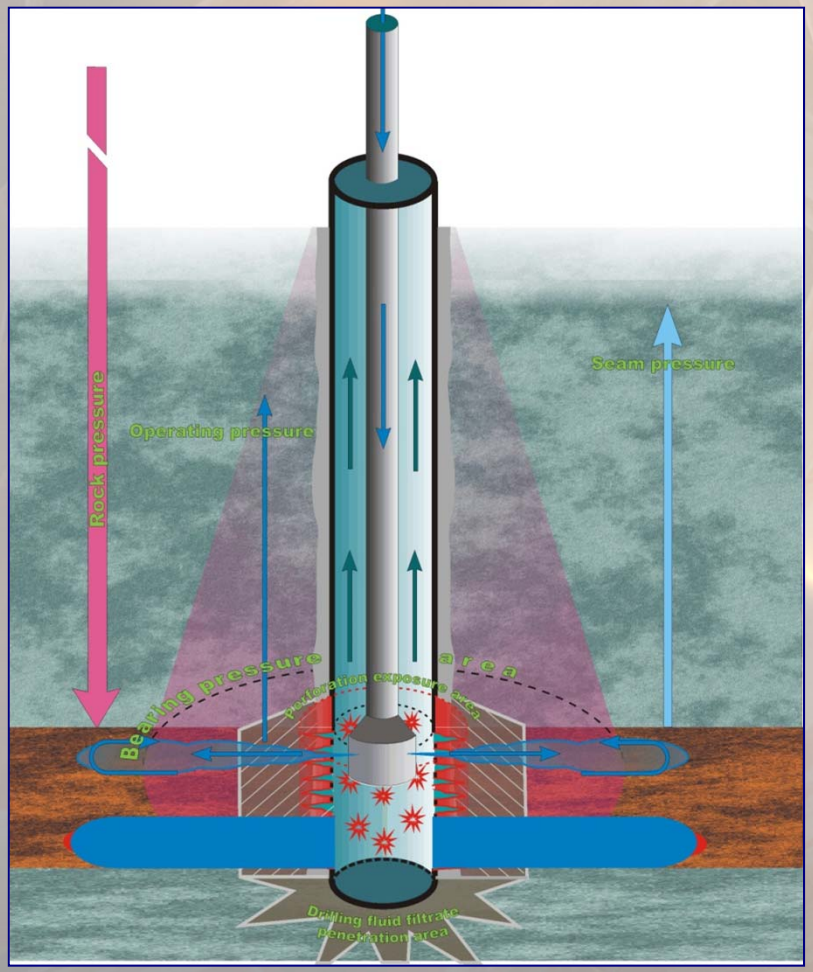
The Terra Slicing Process (3)



The tool is raised when the slice is complete to begin a new slice procedure.

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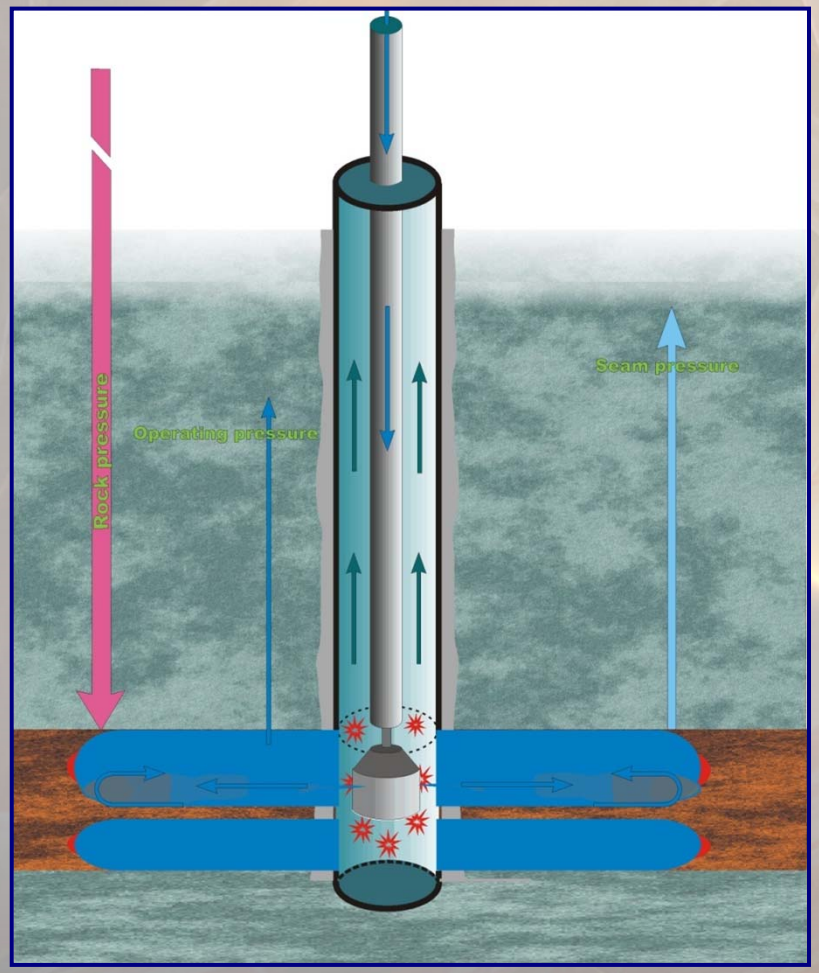
The Terra Slicing Process (4)



Powdered chemical reagents are circulated into the new slices. This disintegrates the intact formation area between each vertical slice, cleans each slice, and removes the pressure in all areas of the near-wellbore zone.

In this manner, the entire target interval is treated.

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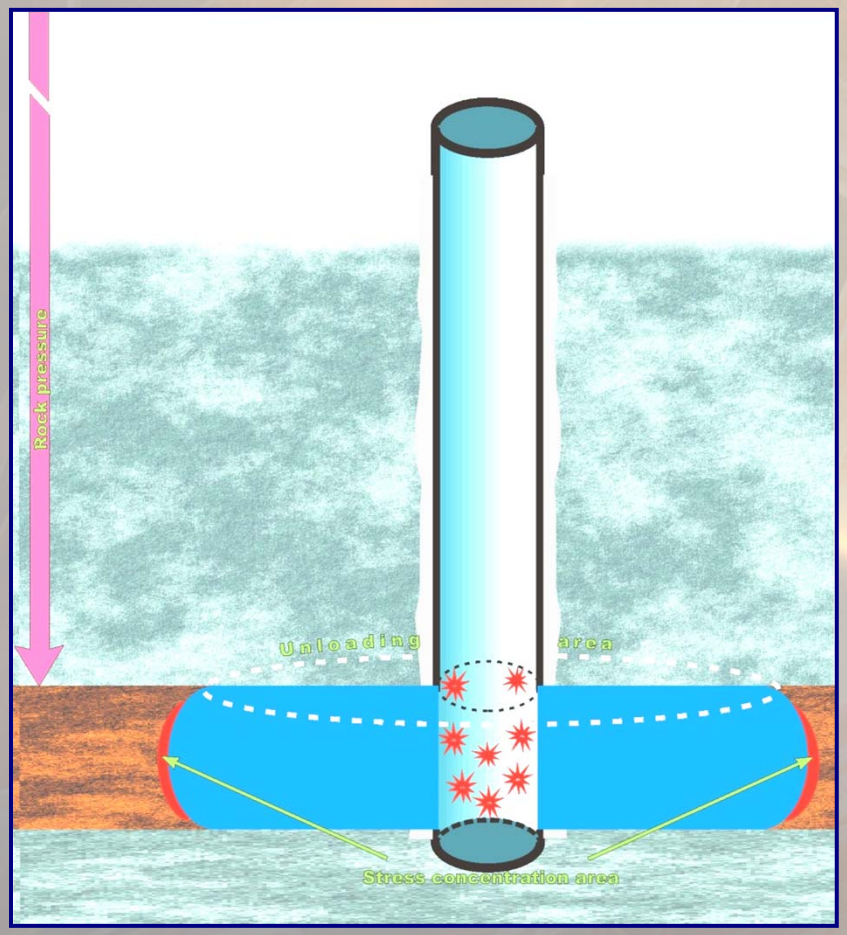
The Terra Slicing Process (5)



- Slicing transfers the zone of stress to the tips of the slices
- Chemistry repairs near-wellbore damage, enhancing productivity
- Porosity & permeability are increased in the sliced area of the near well-bore zone
- Slicing equalizes pressure differential between pay zone and well-bore (pressure drop is reduced within interval)

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Why Consider

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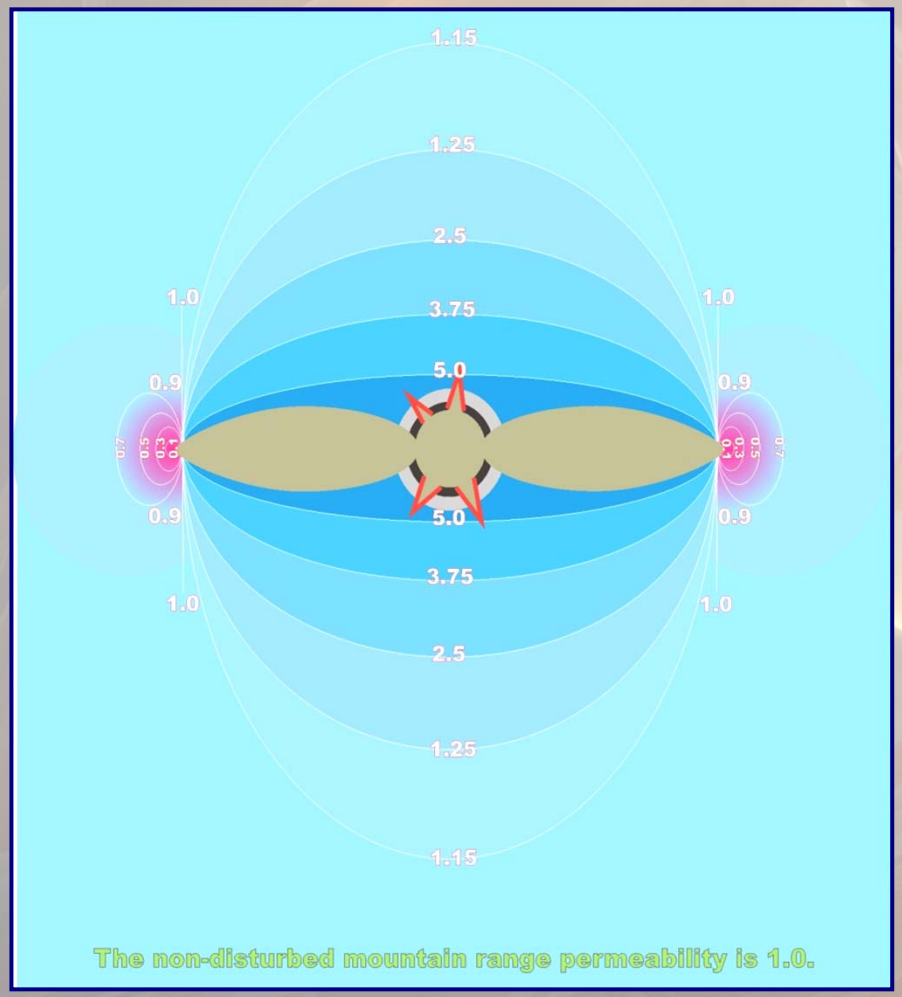
Terra Slicing Re-Distributes Stress



Vertical “door-frame” sliced design redistributes mechanical stress to the outside tips of the slices.

Removing near-wellbore stress creates a pressure drop that increases permeability.

Excavation expands the drainage surface area.

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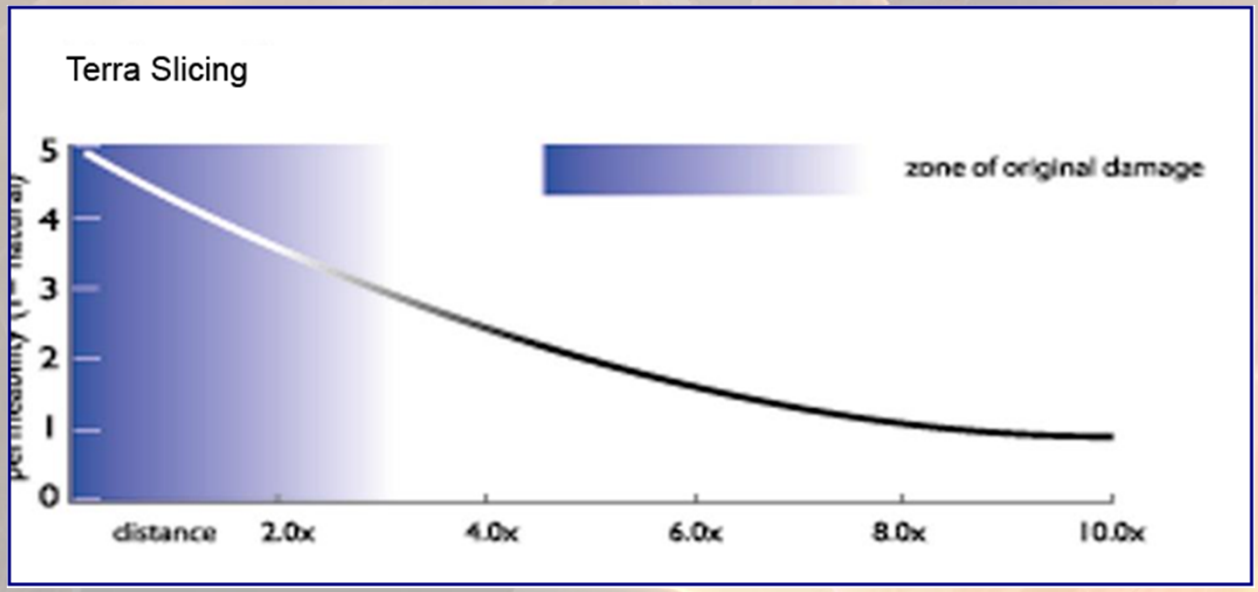
Result of Terra Slicing



Formation permeability within the area of enhanced permeability is increased by several orders of magnitude.

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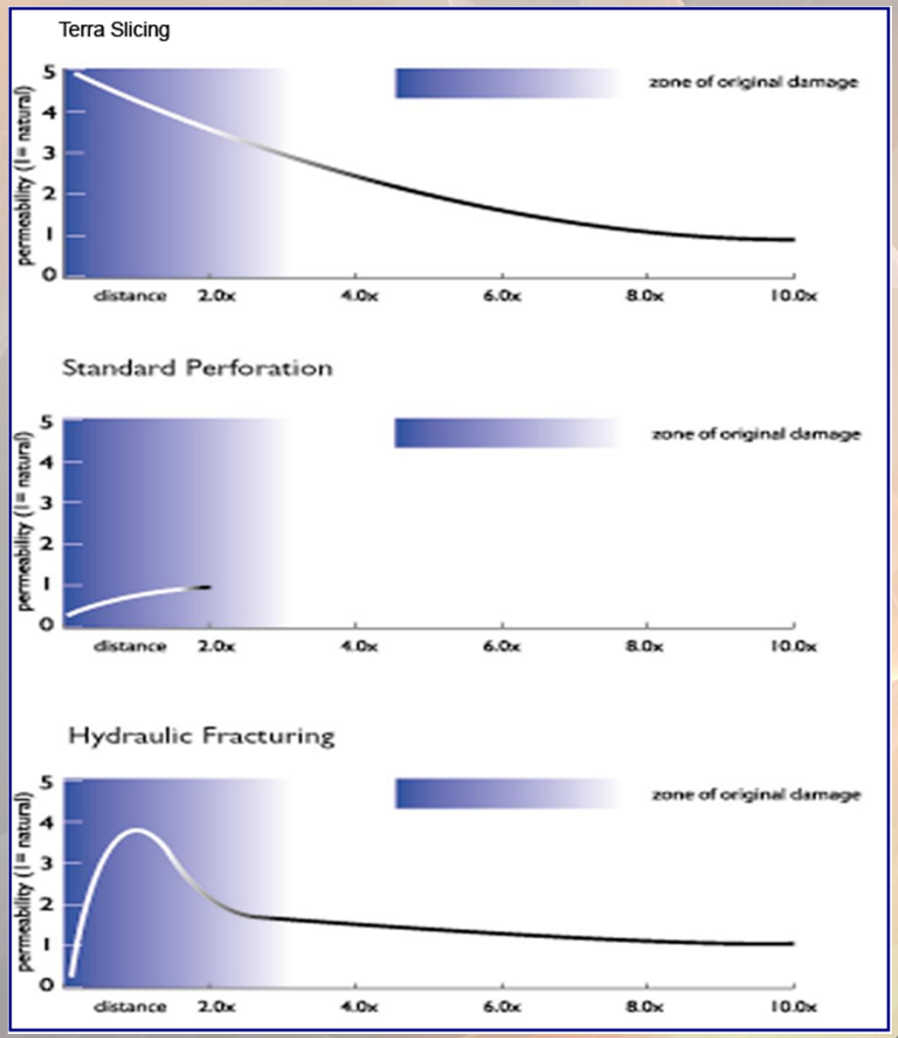

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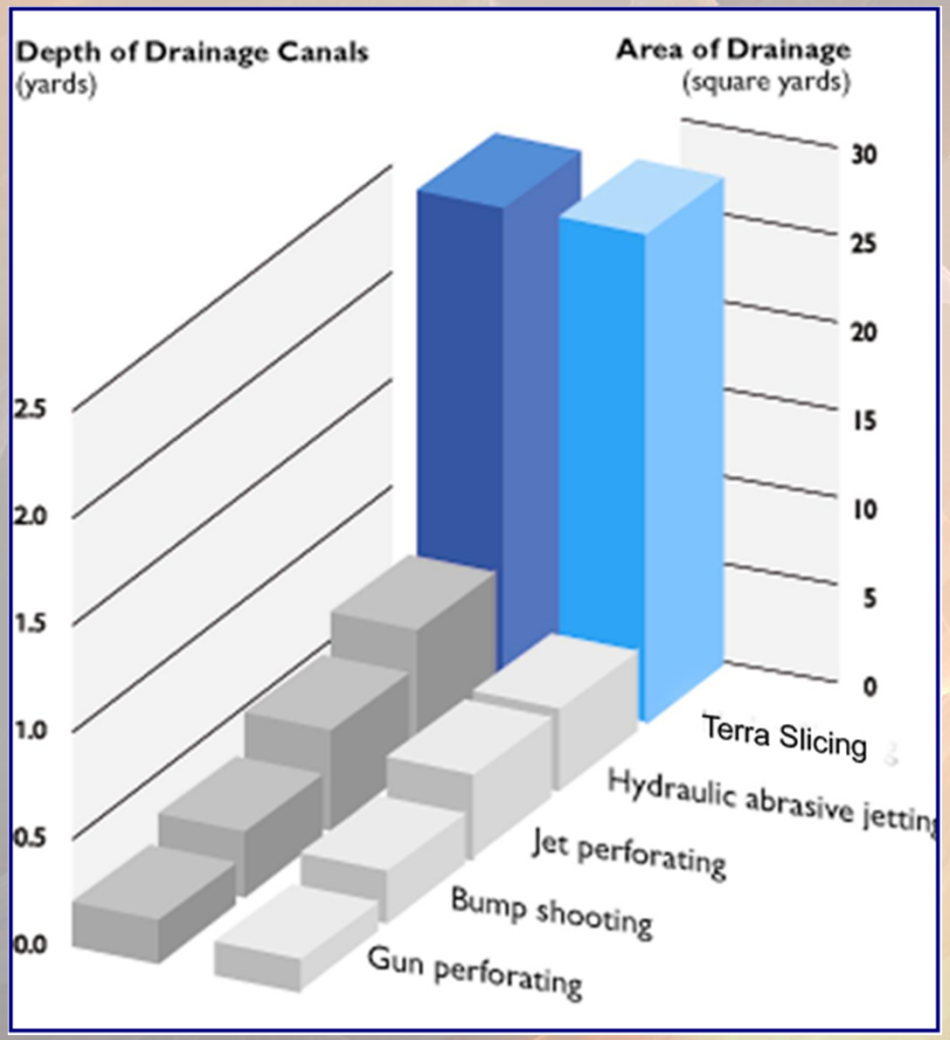
Terra Slicing vs. Perforation



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What is Directed

Slice Fracturing?

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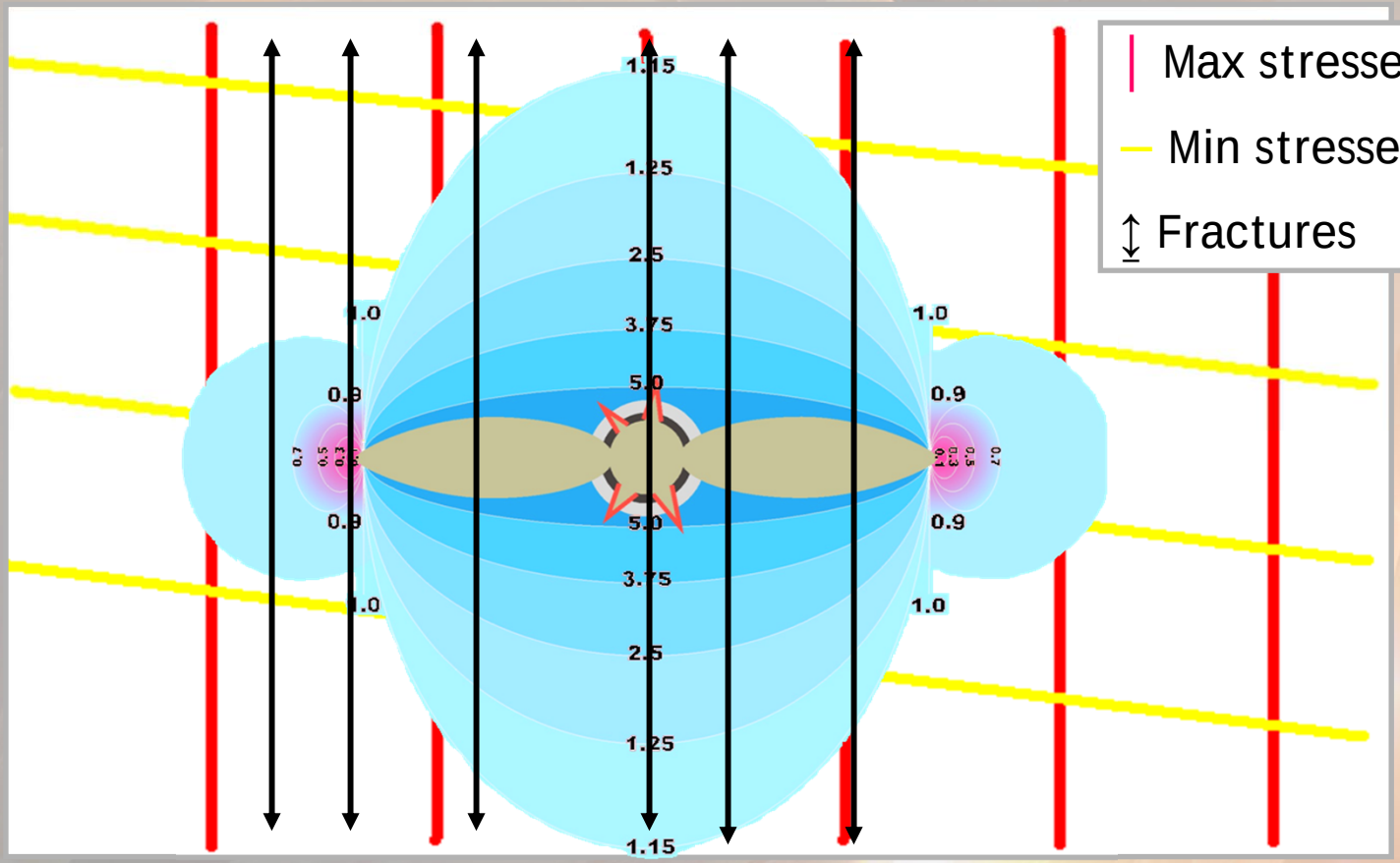
Directed Slice Fracturing



Permeability around the wellbore increases 15-20X Fracture size is minimum 6.2 X bigger

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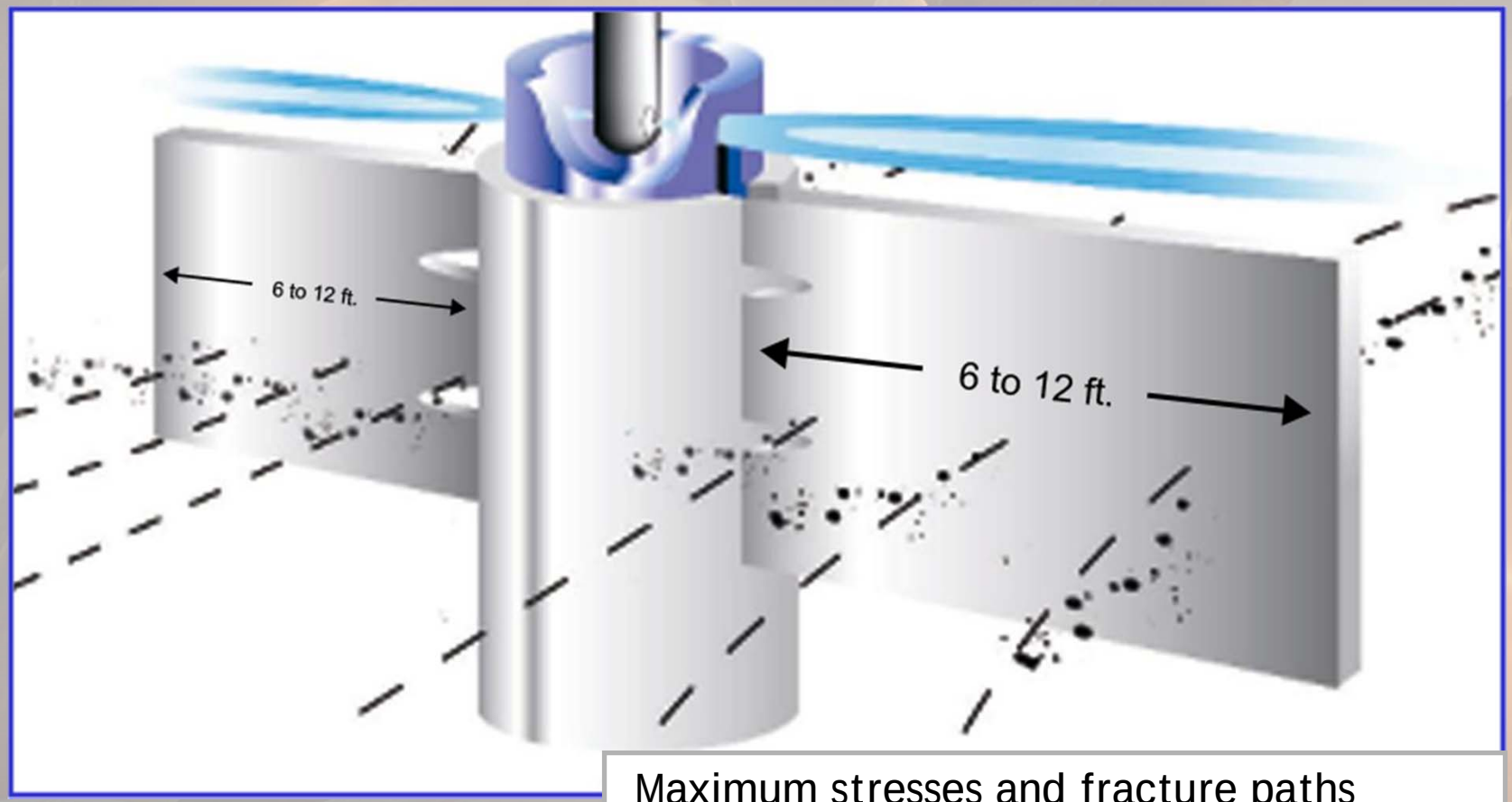
Hydraulic Wedge



Maximum stresses and fracture paths

Slices become hydraulic wedge.
Fracture propagates perpendicular to slices, parallel to maximum stresses.

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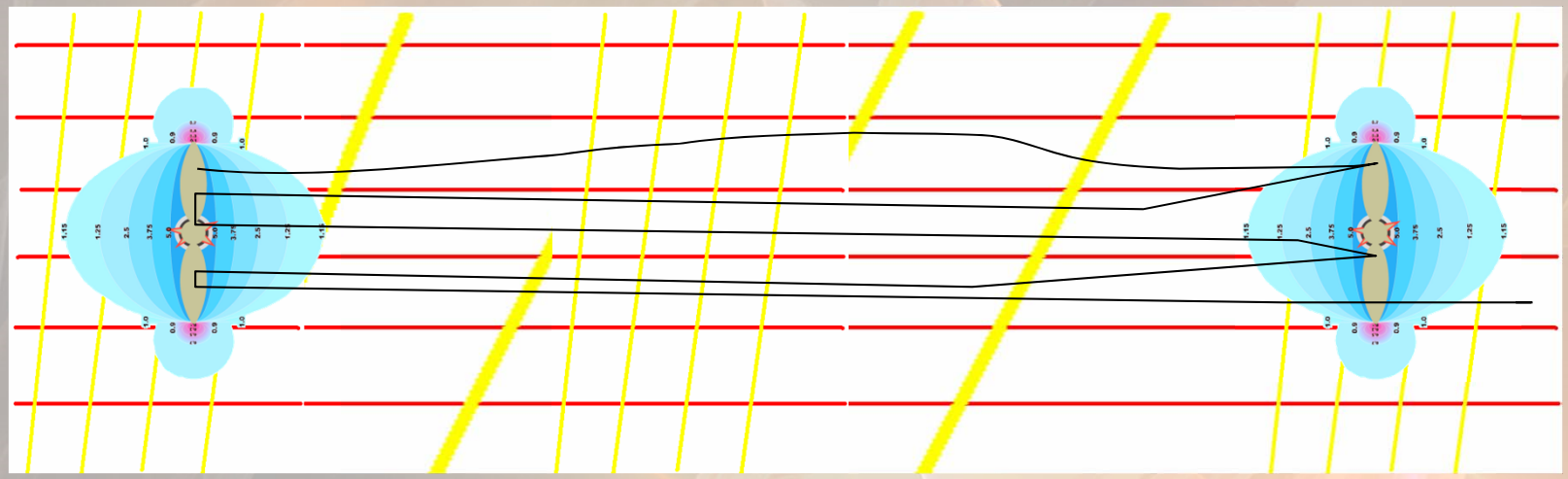
Fracture Propagation



Fracture extends up to 1500 feet.
Noticeable improvement in nearby wells.
Captures gas from whole thickness.

Fracture propagates along pre-determined course

Max stresses
Min stresses
Fractures

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Slice Orientation

Slices oriented perpendicular to geo-physical maximum stress lines

1) Centrator device orients Terra Slicer
2) Excavation by Terra Slicing
   - 2 slots, 180º apart, 6-12 ft. deep each way
   - Terra Slicing like a MAN-MADE WEDGE
   - Cleans formation & increases permeability
3) Fracture in pre-determined direction
   - Multi-staged Fracture if advised

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What Equipment is used

in Terra Slicing?

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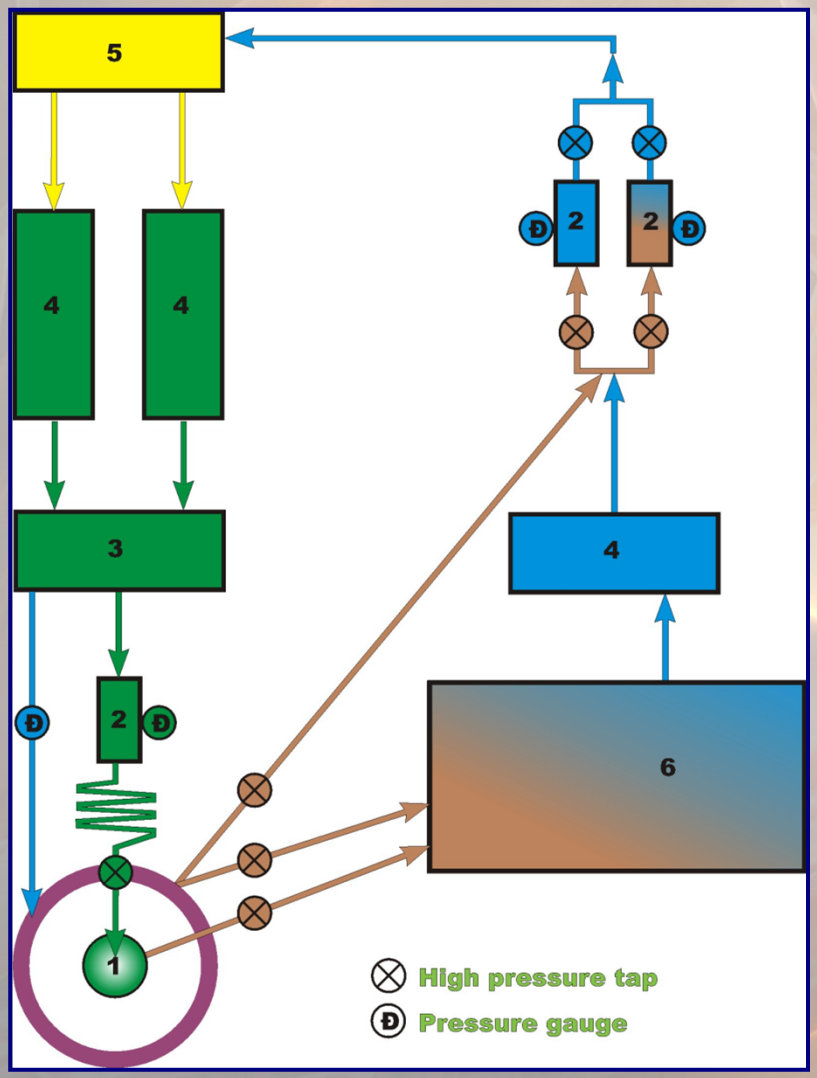
Surface Equipment



1. Wellhead
2. Pulp-cleaning filter
3. Manifold unit
4. Pump set
5. Sand-mixing set
6. Tank.

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Benefits

of Terra Slicing

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Benefits of Terra Slicing (1)

1. Re-distributes stresses away from near-wellbore zone
2. Porosity increases >> 4-5x; Permeability >> 15x
3. Drainage volume increases 6.2x greater than borehole
4. Very deep penetration (compared to perforation)
5. Eliminates screenouts, lamination, skin effects (all barriers)
6. Creates vertical permeability that does not normally exist in nature (reaches full thickness through interbedding / layers)
7. Has a longer lasting effect than any other technology

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Benefits of Terra Slicing (2)

8. “Managed balanced” drilling - not overbalanced
9. So powerful it can cut multiple casings & deep rock
10. Does not crack casing cement / keeps hydraulic integrity
11. The only technology that actually excavates rock
12. Accurate & controllable connection / communication
13. Helps direct a hydraulic fracture (even near water)
14. Ecologically safe / environmentally friendly
15. Follow-up intensification methods also show increased results due to huge drainage surface (i.e. acidization, hydro-fracturing, acoustics, etc.)

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