Hydraulic Re-Fracturing*

Neil Stegent[1]

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Abstract

A discussion and review of re-fracturing of both vertical and horizontal wells. Discussion of basic fundamentals of hydraulic fracturing, reasons to re-frac, candidate selection, operational considerations, and case histories.

Hydraulic Re-Fracturing

Neil Stegent, P.E.
Technology Manager - Fracturing

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Re-Frac Case History Papers

(not all inclusive)

Vicksburg, S. Texas SPE 4118
Canyon Sand, Texas SPE 4800
Escondido Sandstone, Texas SPE 7912
J Sand, Wattenberg, CO SPE 7936
Undisclosed “low pressured field”, SPE 14376
Oak Hill, Cotton Valley E TX + LA SPE 14655
Morrow, Red Fork, Atoka, OK SPE 18861
Smackover, Mississippi SPE 19768
Mesaverde Group, CO & NM SPE 24307
McAllen Field, Vicksburg, S. Texas SPE 24872
Eastern Gas Shales-Antrim, MI and
Appalachian Shales SPE 26894
Mendota, Granite Wash, TX SPE 27933

Antrim Shale, MI SPE 29172
Gray Sand, Cotton Valley, LA SPE 29554
Almond/Wamsutter, WY SPE 30480
Green River Frontier, WY
+ Piceance Basin, CO SPE 55627
Piceance Basin, CO and GGRB, WY SPE 56482
Viking, Ferrier, Alberta Pet Society 99-60
Barnett Shale, TX SPE 63030
Cotton Valley TX SPE 63241
Codell, DJ Basin, CO SPE 67211, 71045, OGJ 2006
Medicine Hat, Milk River, Alberta SPE 81730
S. Texas undisclosed field E&P 2006

SPE 134330 by Mike Vincent

Refracs - Why do they work, and Why do they Fail in 100 Published Field Studies?

25 page Paper + 4 pages of paper references (120) + 15 pages of “findings” from re-fracs (130)

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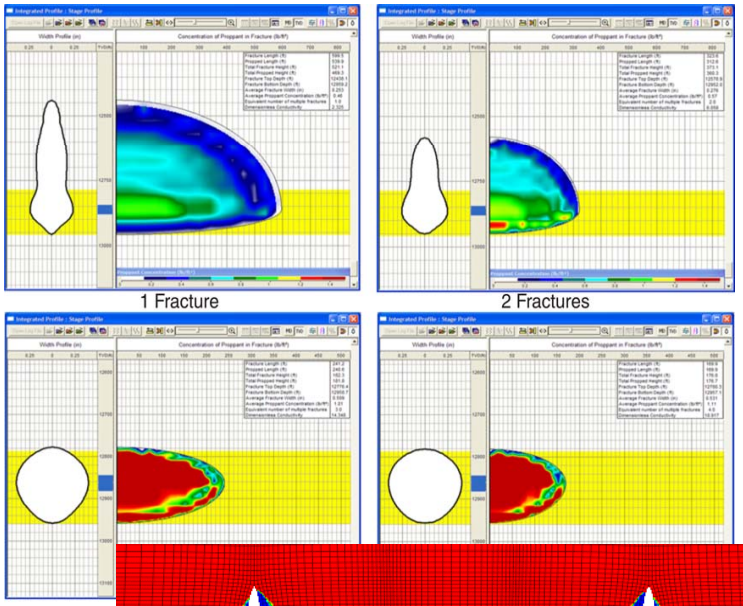
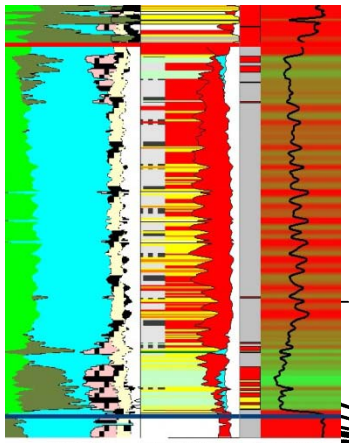
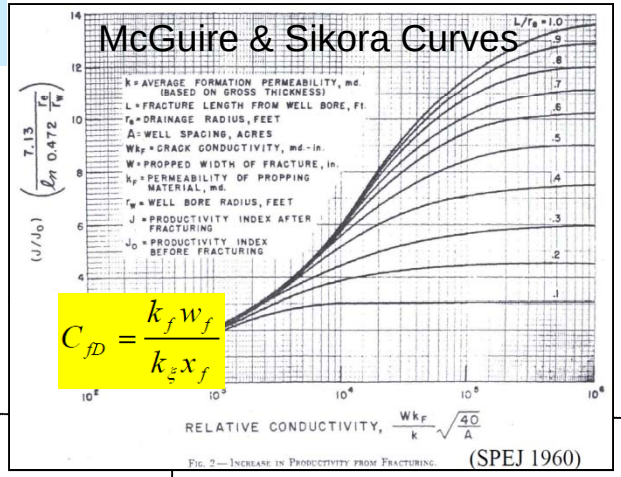
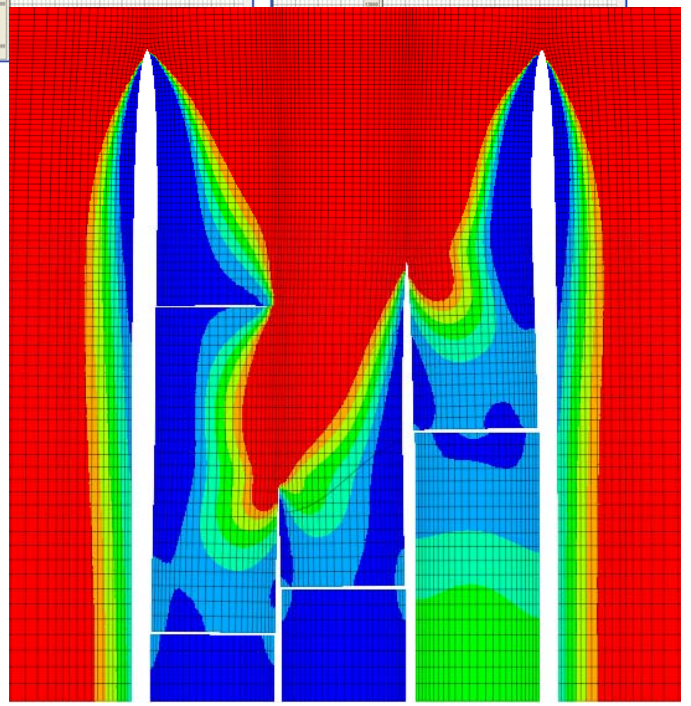
Hydraulic Fracture Design

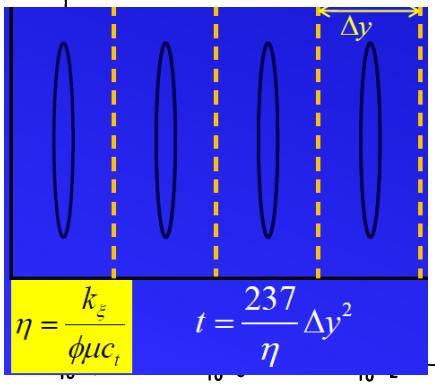
$$C_r = \frac{k_{frac} w_{frac}}{\pi k_{zone} X_{frac}}$$

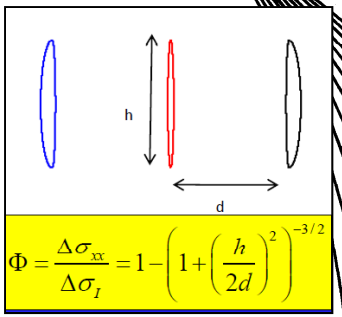












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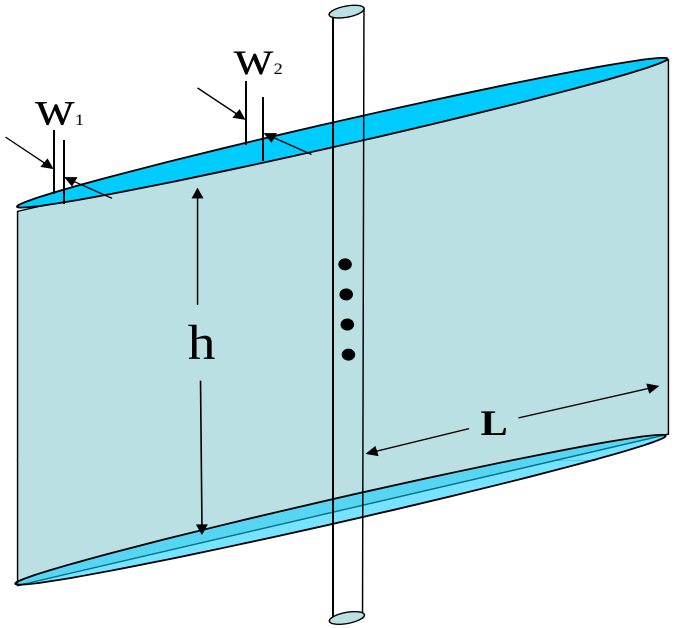
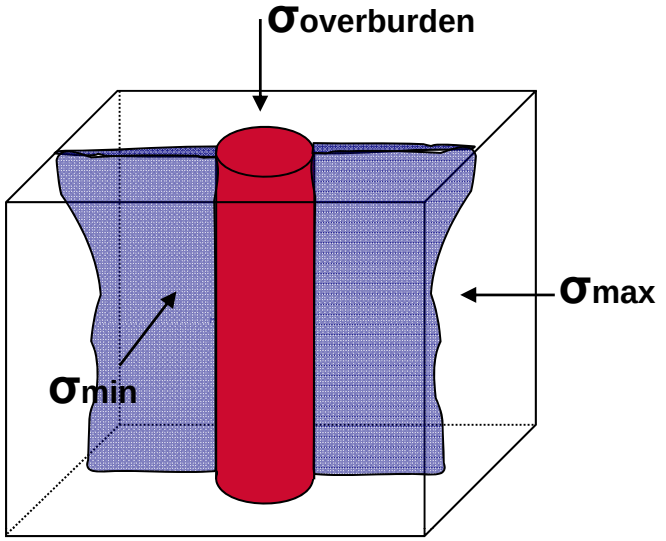
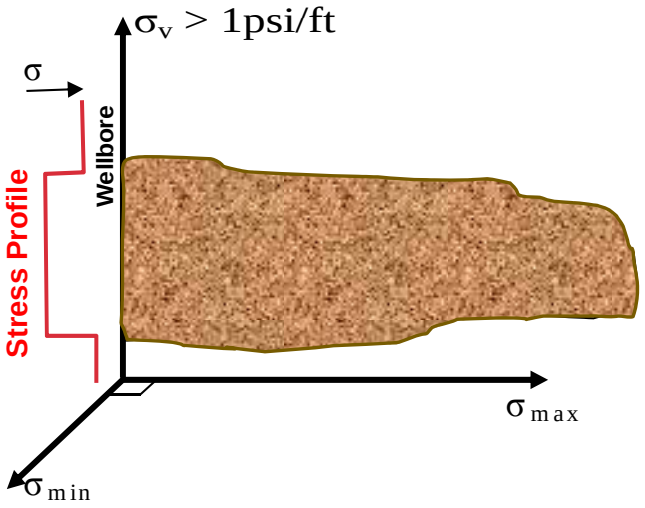
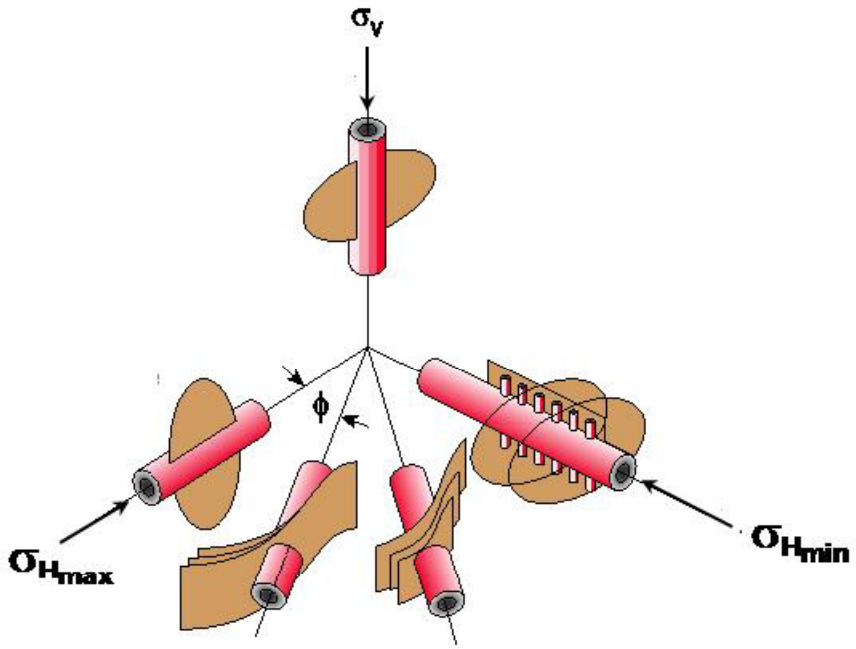
What is a Hydraulic Fracture?









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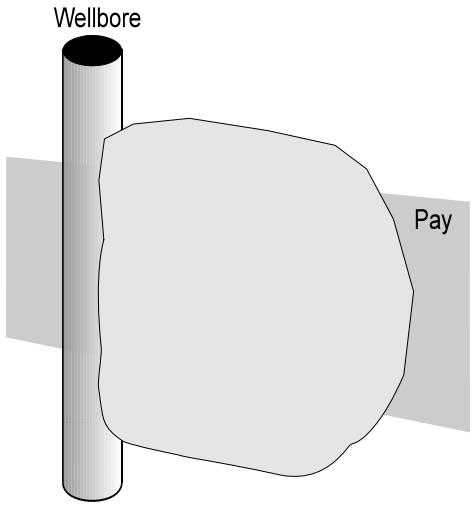
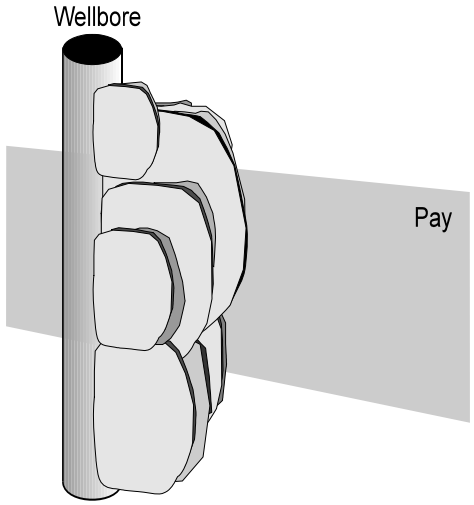
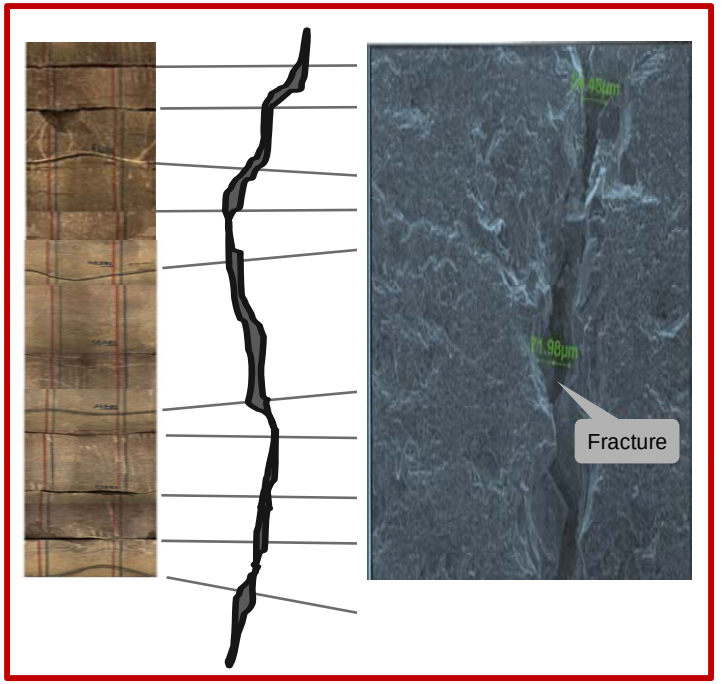
What's Fractures Really Look like.....

Ideal world



Real world





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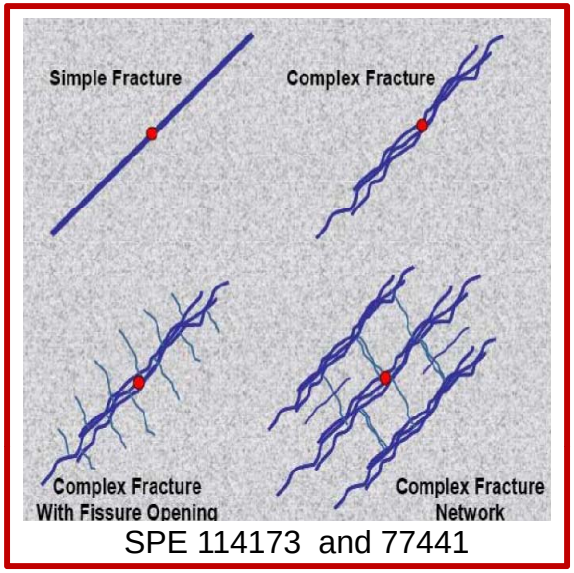
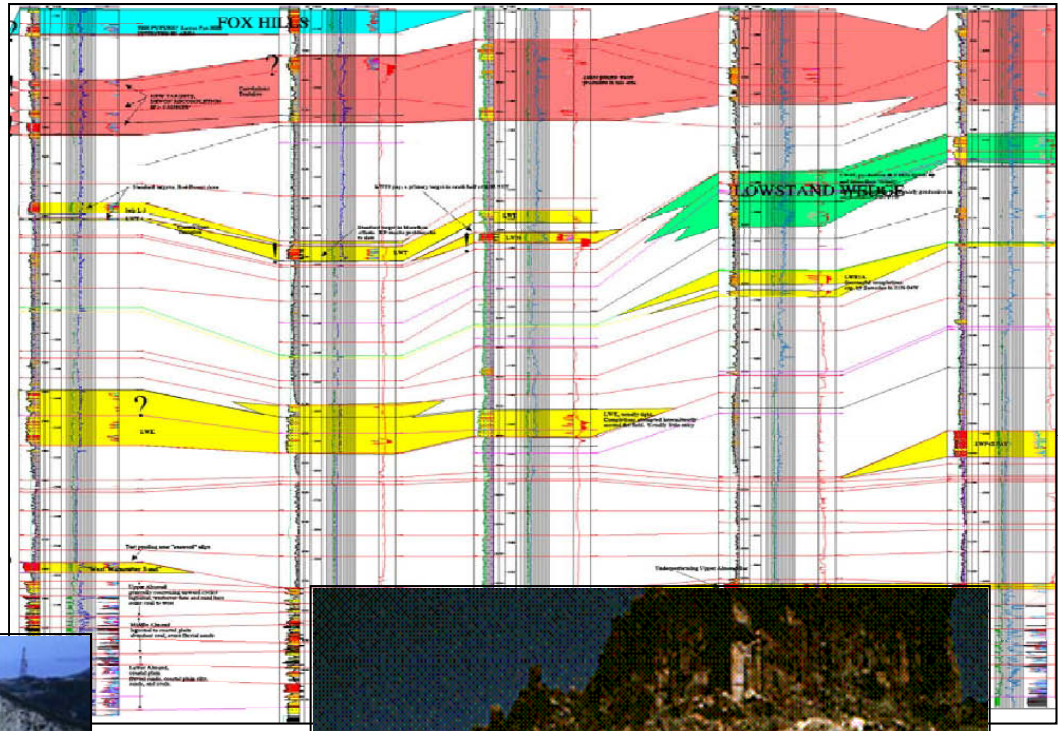


SPE 114173 and 77441



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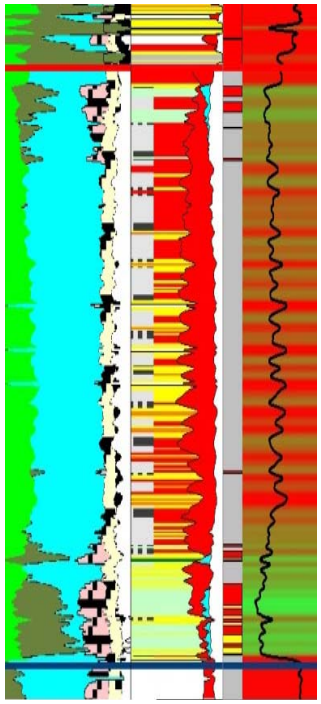
Initial Hydraulic Fracture Completion:



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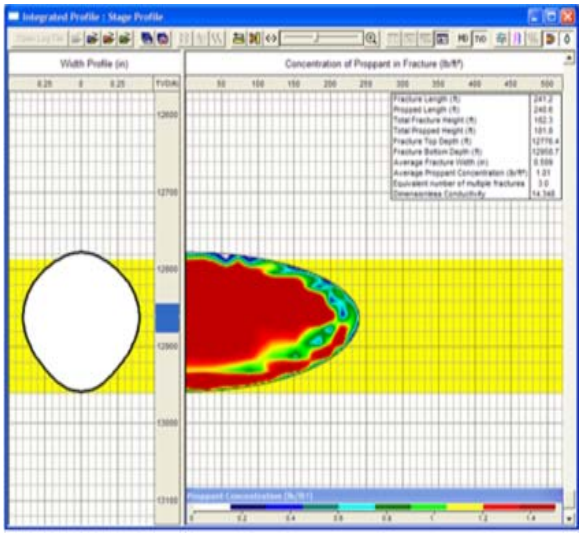
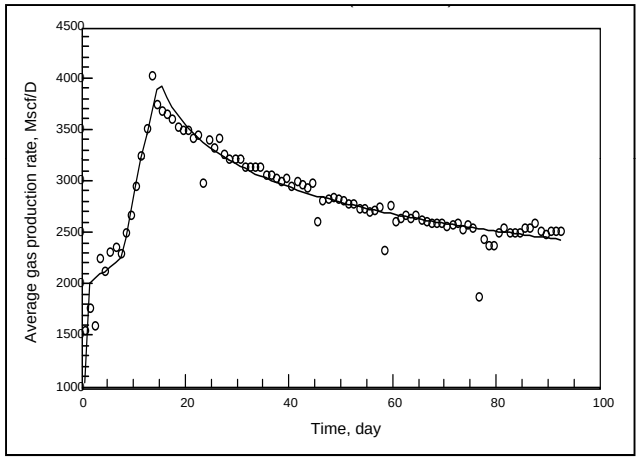


Frac Design



Production

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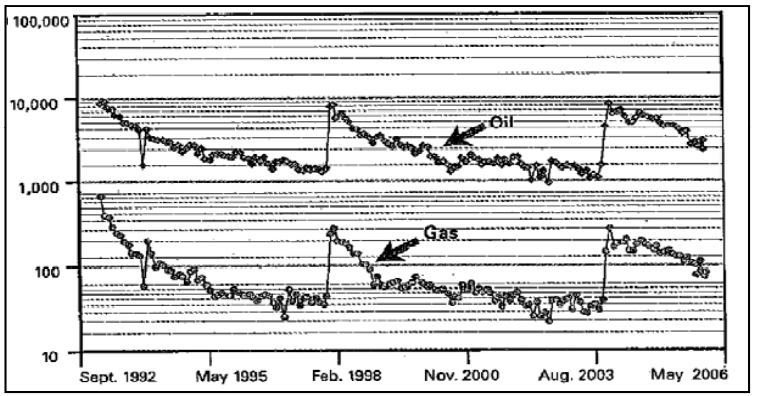
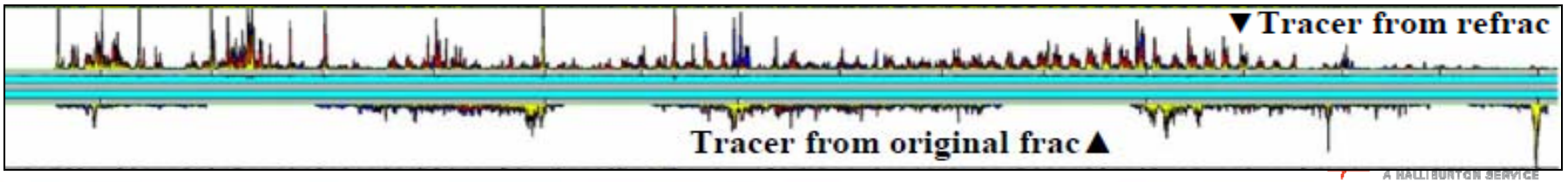
Reasons to Refrac:

Embedment – SPE 135502

- Improve original fracture conductivity
- Alter fracture geometry
- Restoration fracture conductivity of Proppant
  - Embedment
  - Stress cycling
  - Diagenesis
  - Scale/Fines
- Restore near-wellbore conductivity
- Stimulating “by-passed” pay intervals
- Utilize new Technology
- Re-energizing or re-inflating natural fissures
- Fracture reorientation due changes in the stress field
  - refrac often contacts “new” rock





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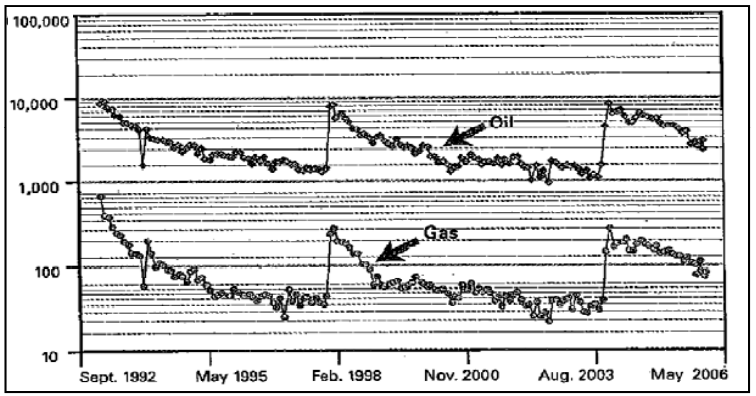

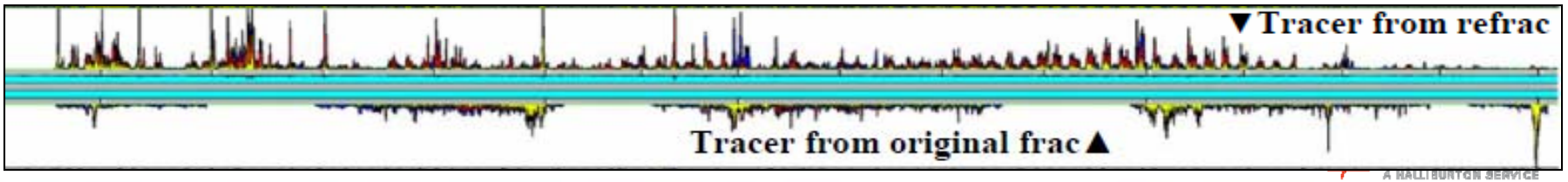

Increase Original Job Size

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Restimulation of Oil Wells

SPE 101821

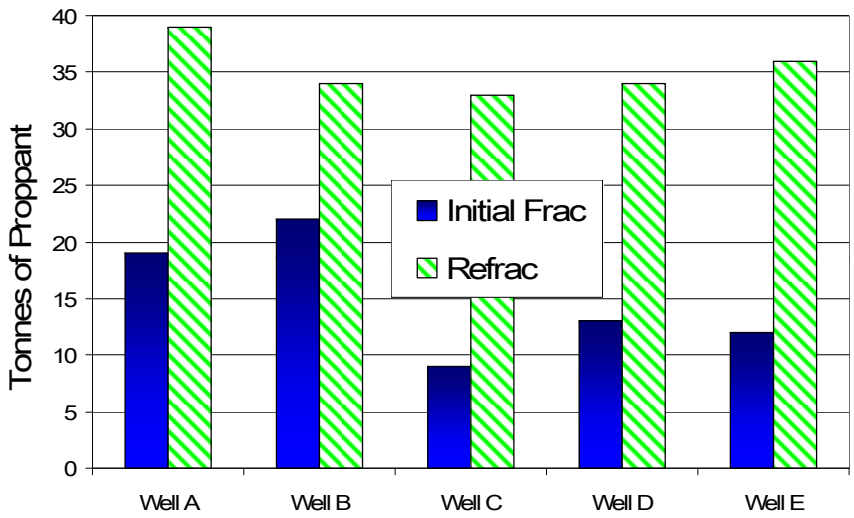

Fig. 14 – Restimulation Treatment Sizes were 135% Larger

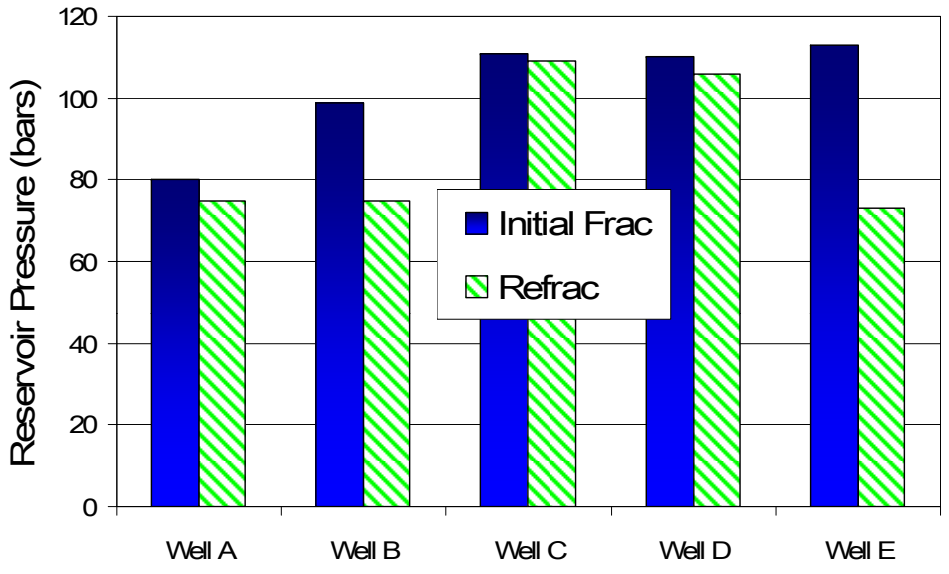

Fig. 15 – Reservoir Pressure declined approximately 15%

- Despite pressure depletion of ~15%, refracs provided large benefits
- Refracs were designed to improve conductivity, proppant mass increased by 135%.

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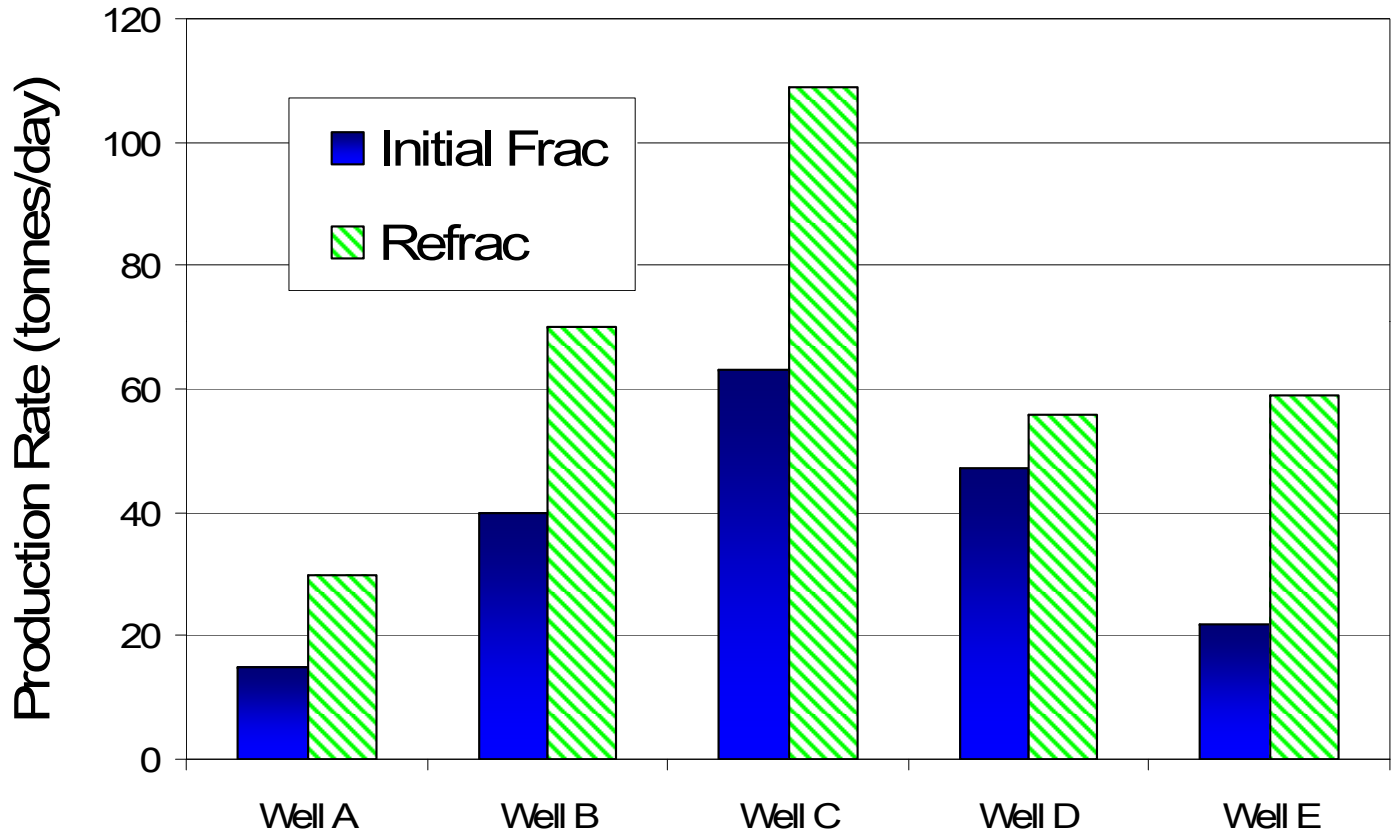
Restimulation of Oil Wells – Increased Job Size

SPE 101821



Production from restimulated wells increased by an average of 37 t/day
(~ 275 bbls/Day)

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Alter Original Geometry

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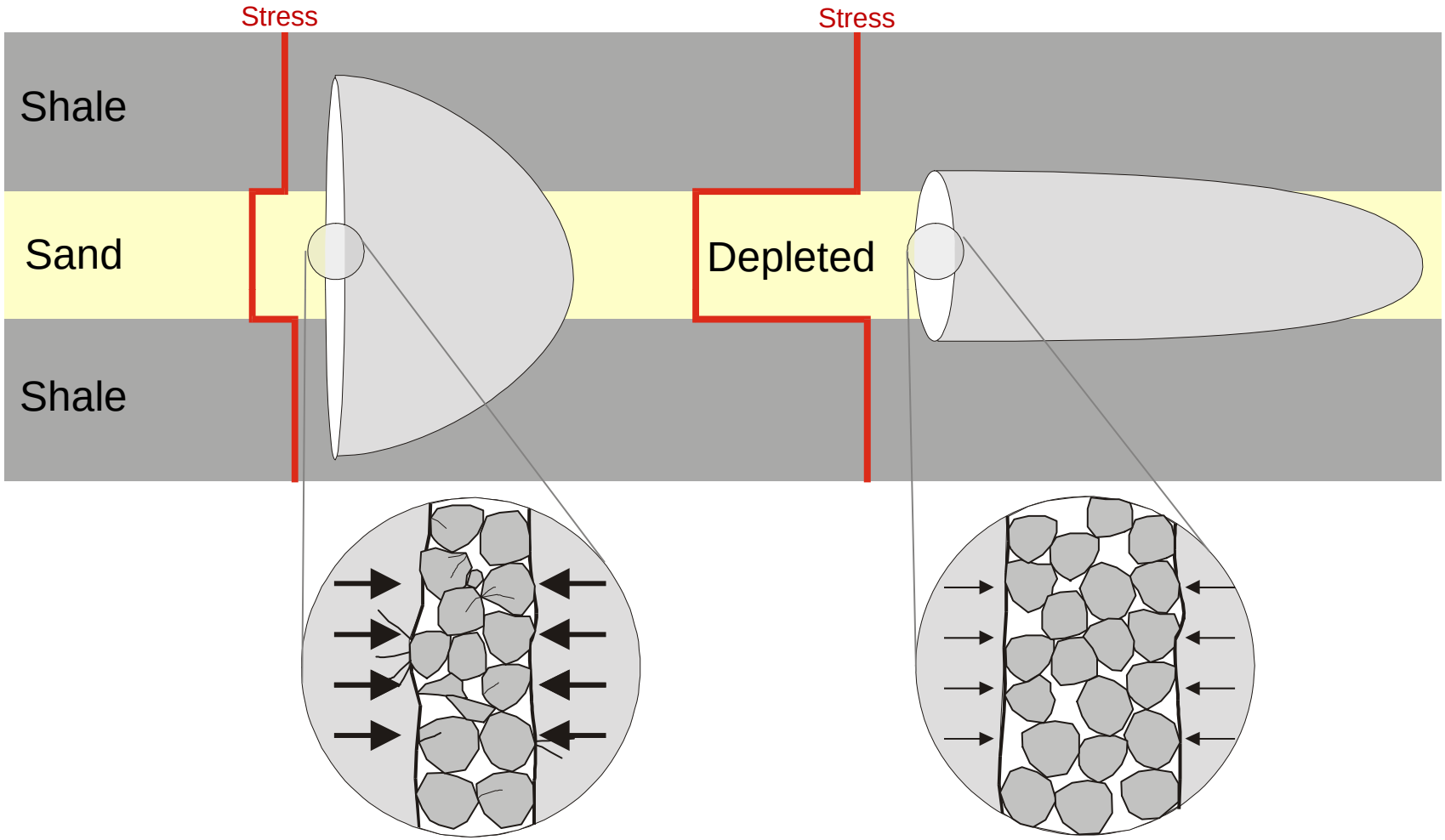
Re-fracture due to change in rock Stress



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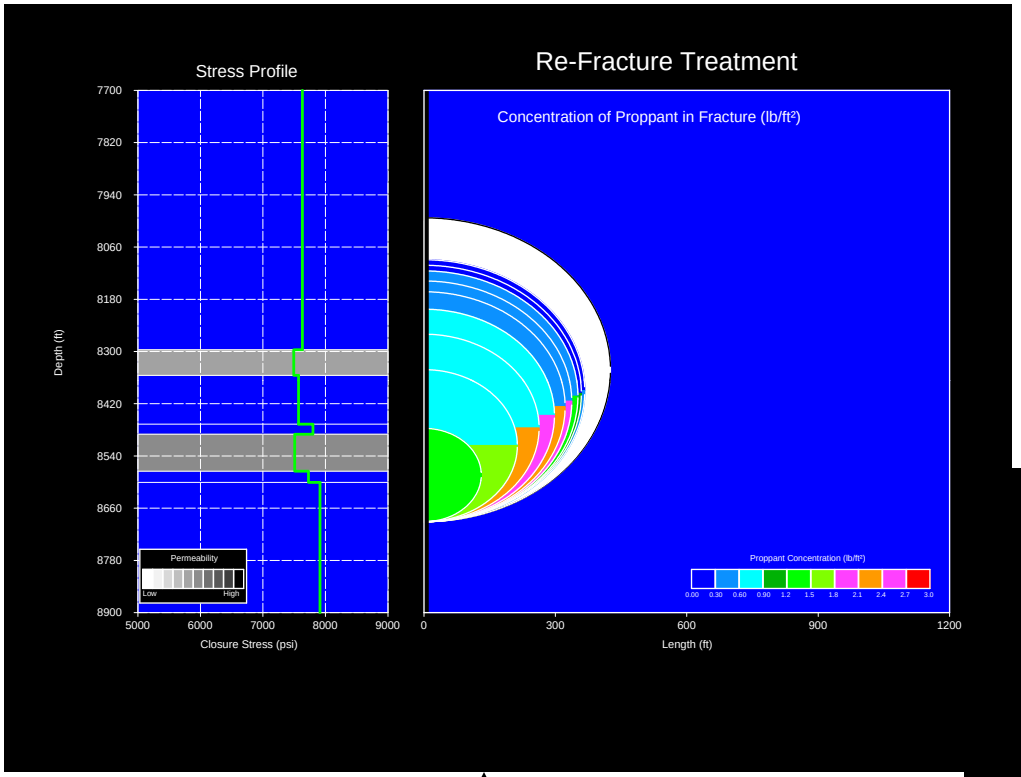
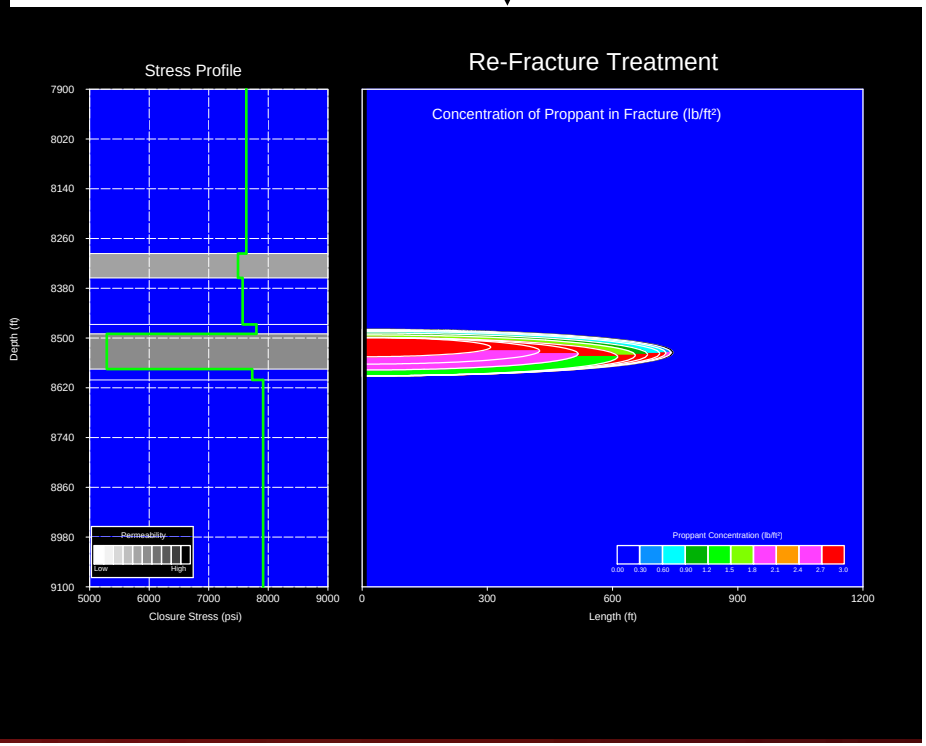
Re-fracture due to change in rock Stress

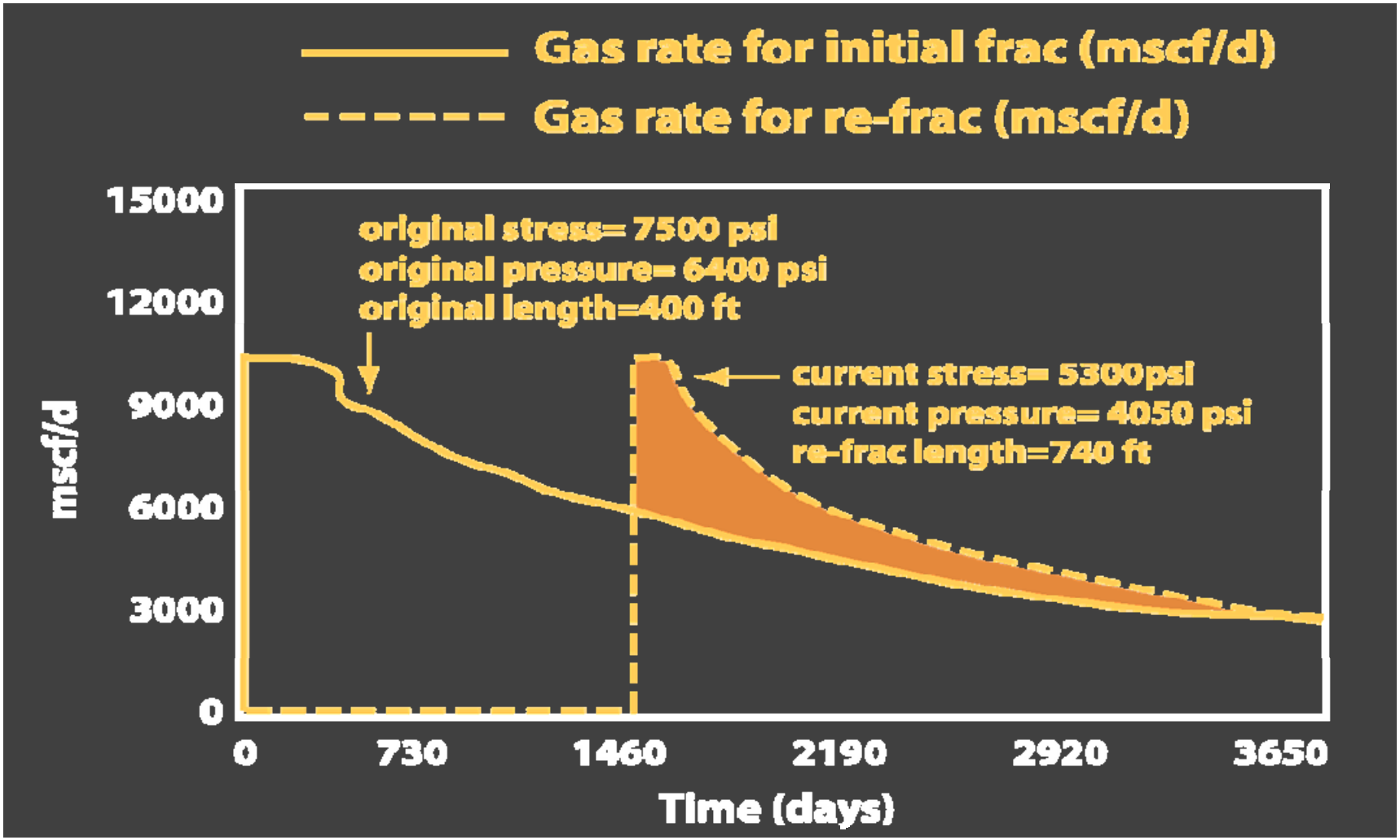


Re-Fracture Treatment Results in Longer Fracture



Original Fracture Grows Upward and is Short

Re-fracture due to change in rock Stress



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Restore Fracture Conductivity

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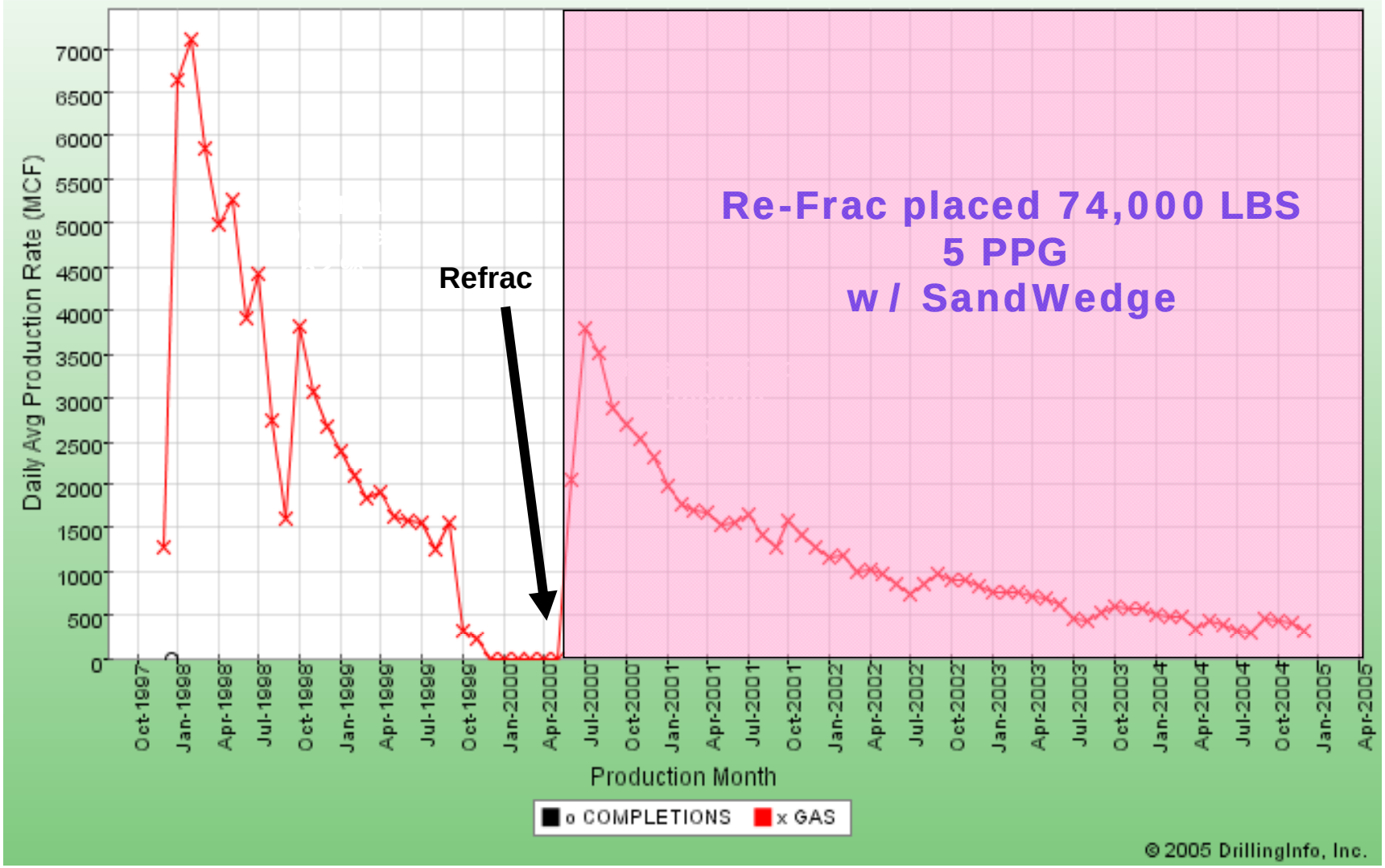
Re-fracture to remove near wellbore damage



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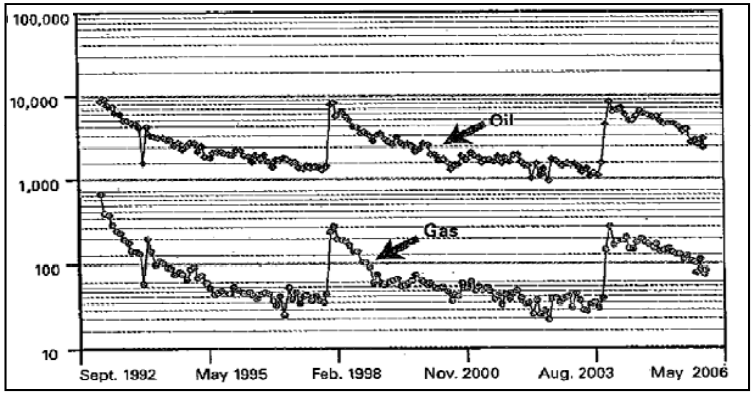
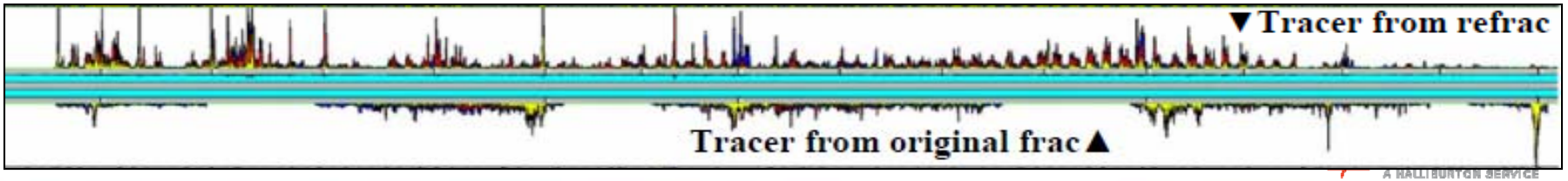
Reasons to Refrac: Candidate Selection

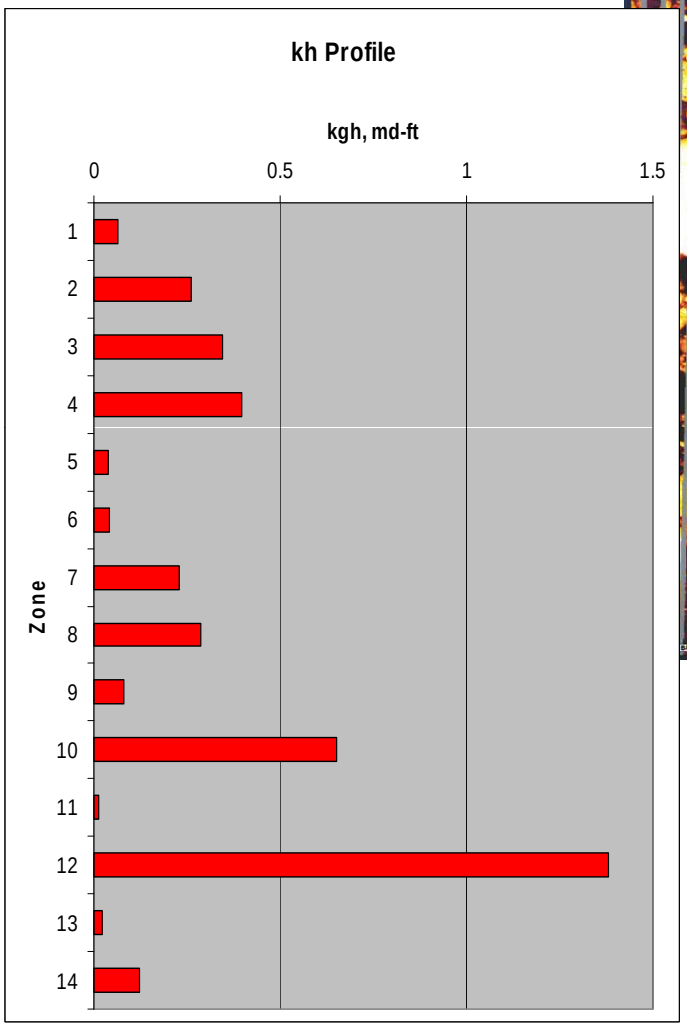
Embedment – SPE 135502

- Improve original fracture conductivity
- Alter fracture geometry
- Restoration fracture conductivity of Proppant
  - Embedment
  - Stress cycling
  - Diagenesis
  - Scale/Fines
- Restore near-wellbore conductivity
- Stimulating “by-passed” pay intervals
- Utilize new Technology
- Re-energizing or re-inflating natural fissures
- Fracture reorientation due changes in the stress field
  - refrac often contacts “new” rock

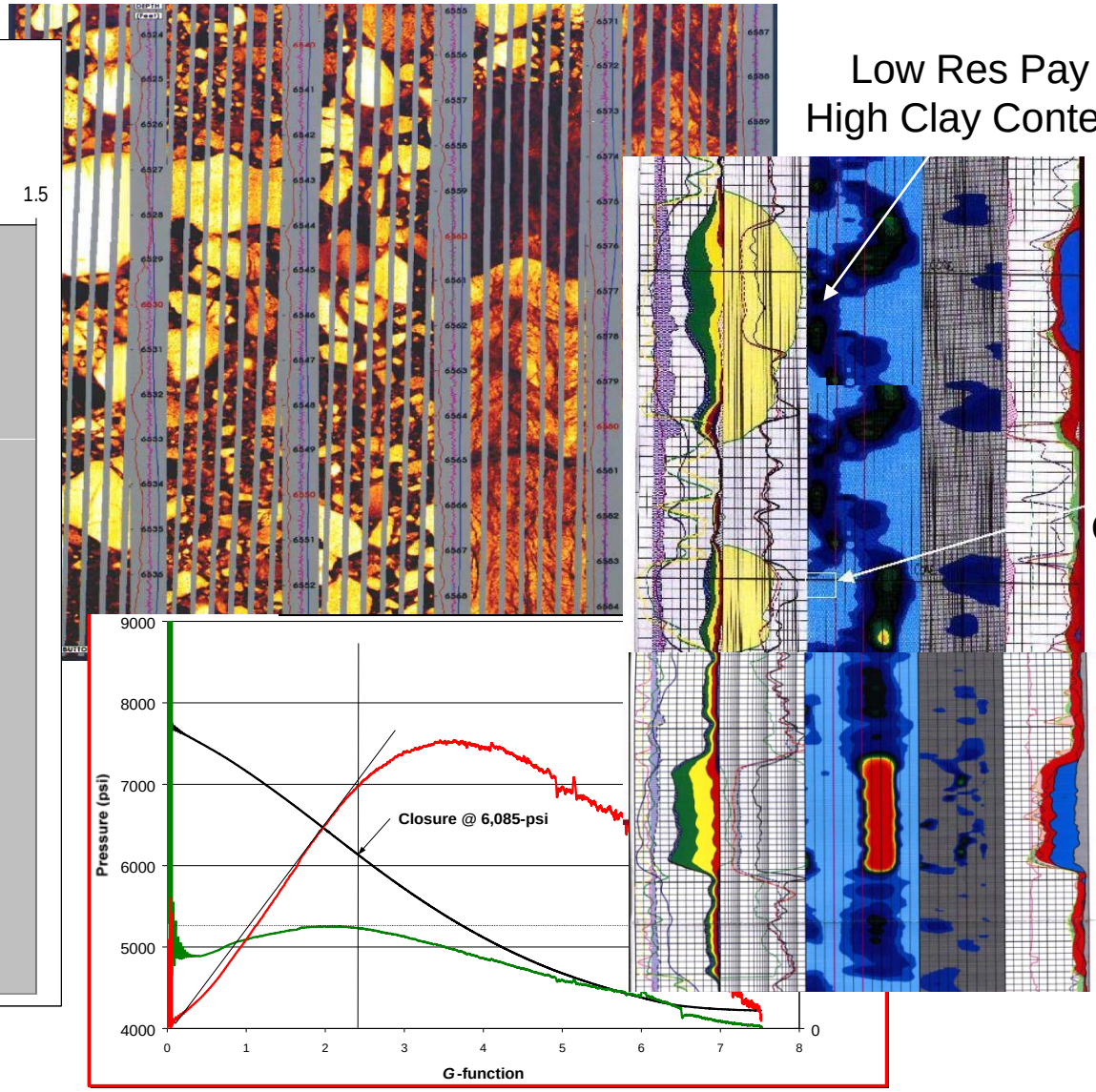




New Technology: By-Passed Pay



Quantify Pay Zones



Low Res Pay
High Clay Content

Low
Clay

DFIT – Diagnostic Fluid Injection Test

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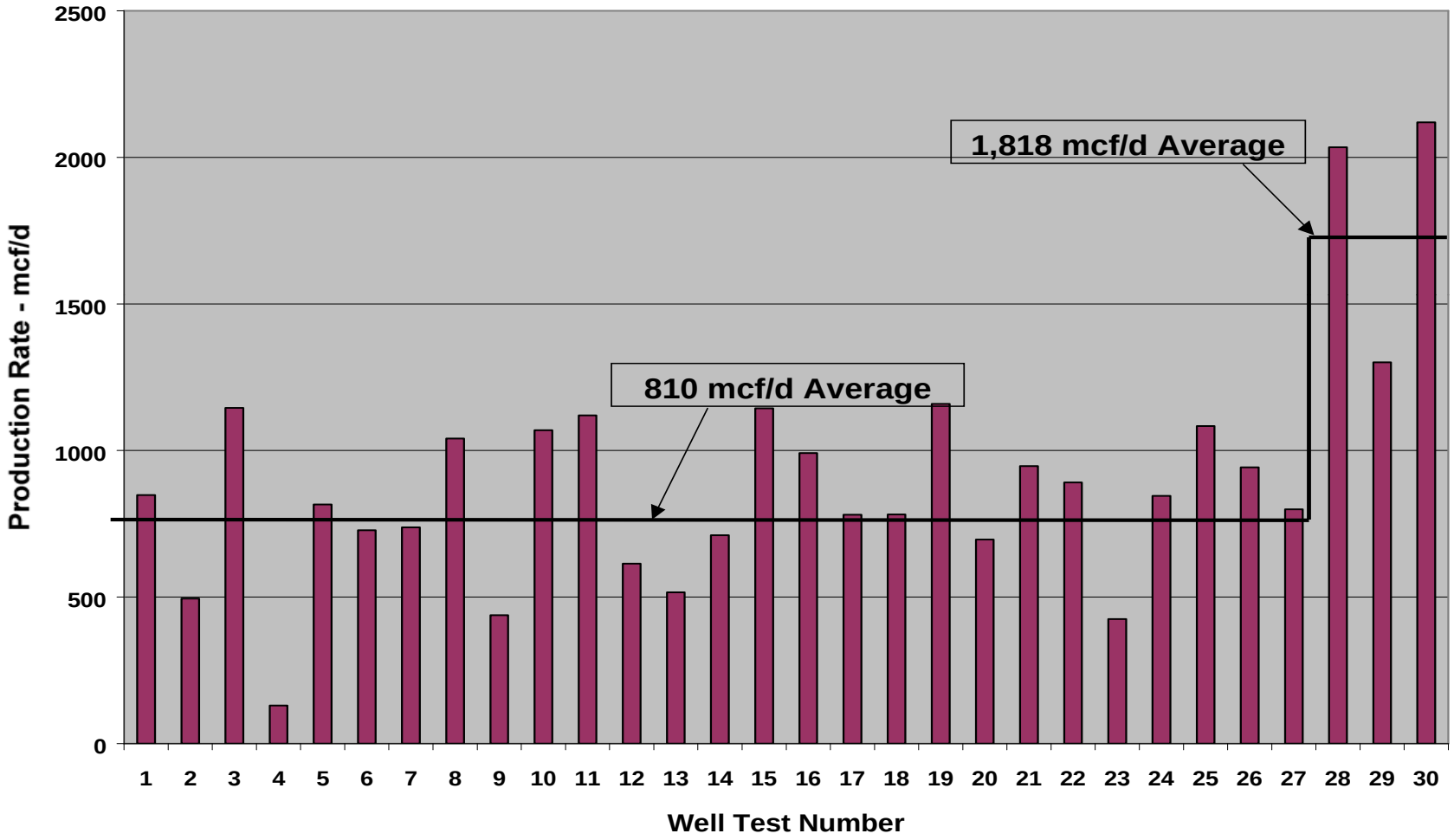
Increased Production: Re-frac by-passed Pay Zones



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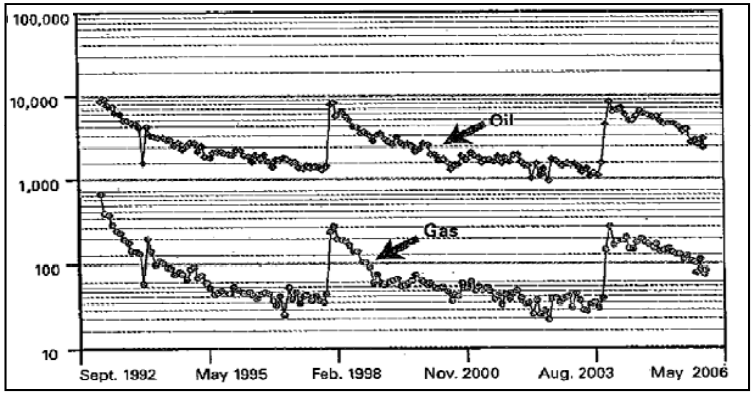

- Re-energizing or re-inflating natural fissures
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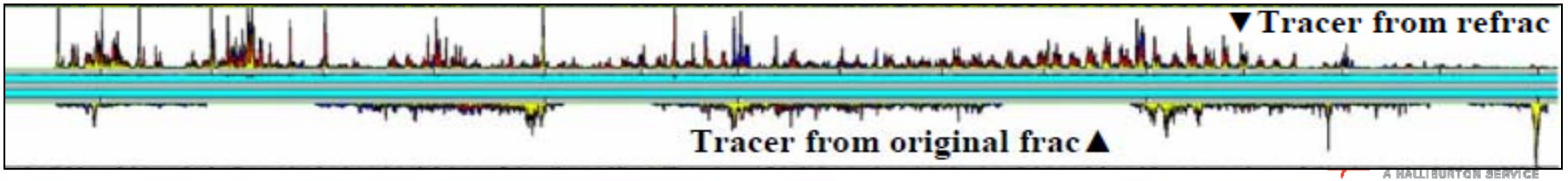
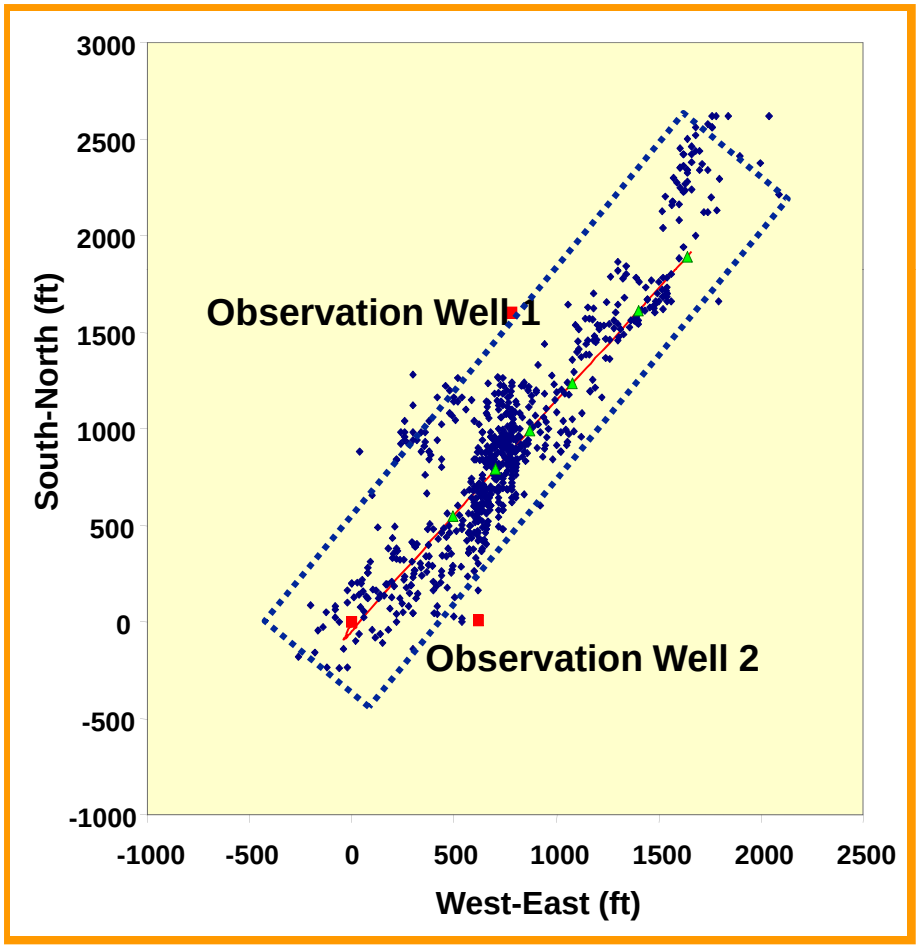
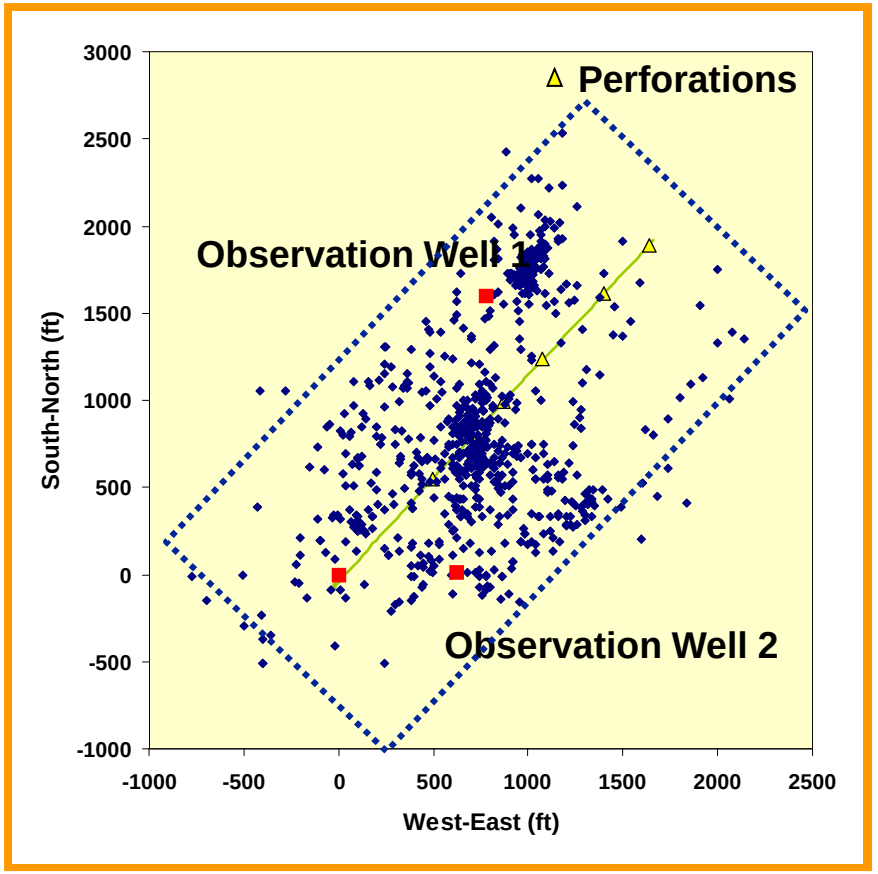


Re-Frac with Different Frac Design: SPE 95568

Original Frac: Viscous Polymer Gel Fluid





Re-Frac: Low Viscosity Water Frac Fluid

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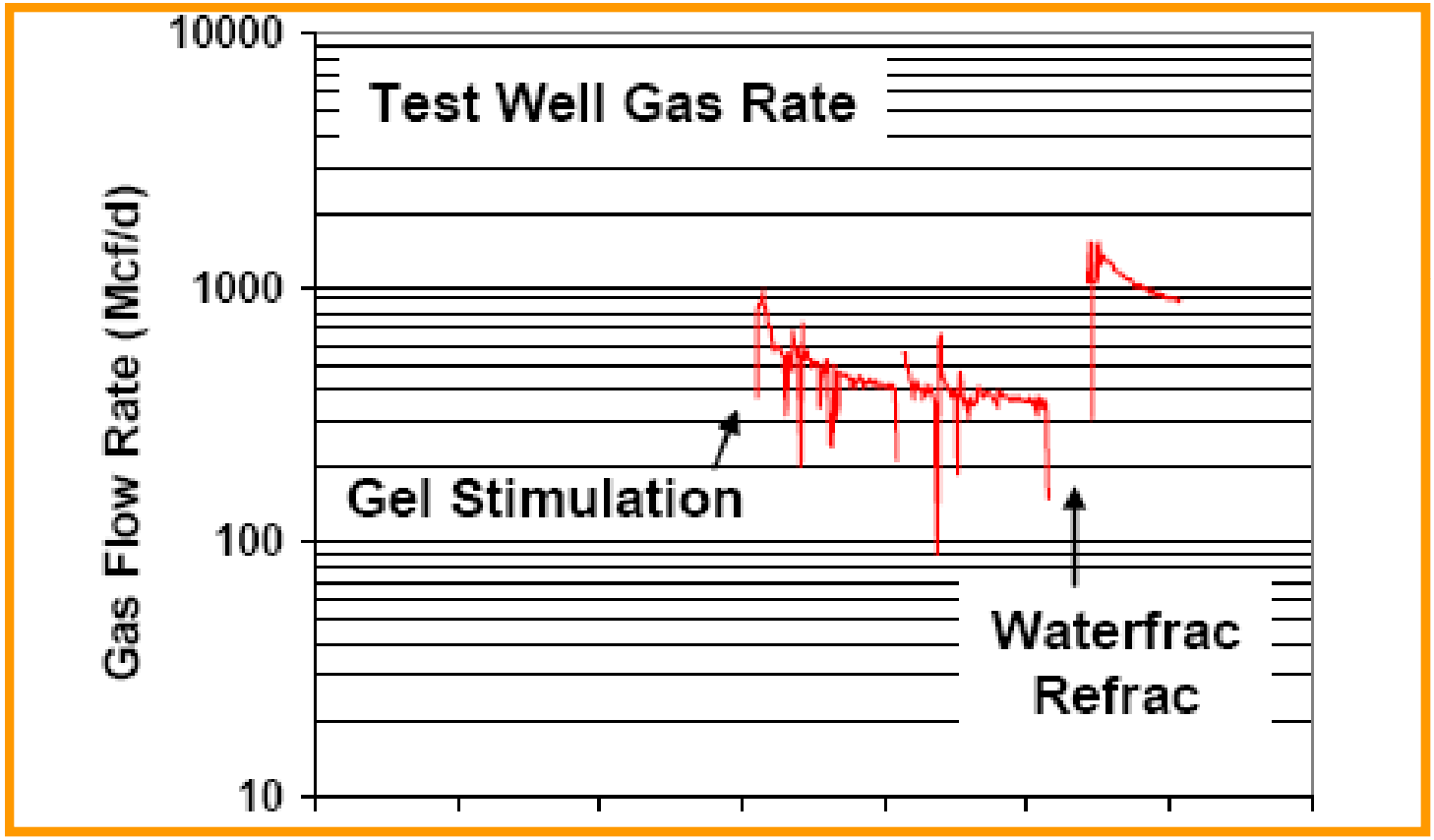
Re-Frac with Different Frac Design: SPE 95568



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Fracture Re-Orientation

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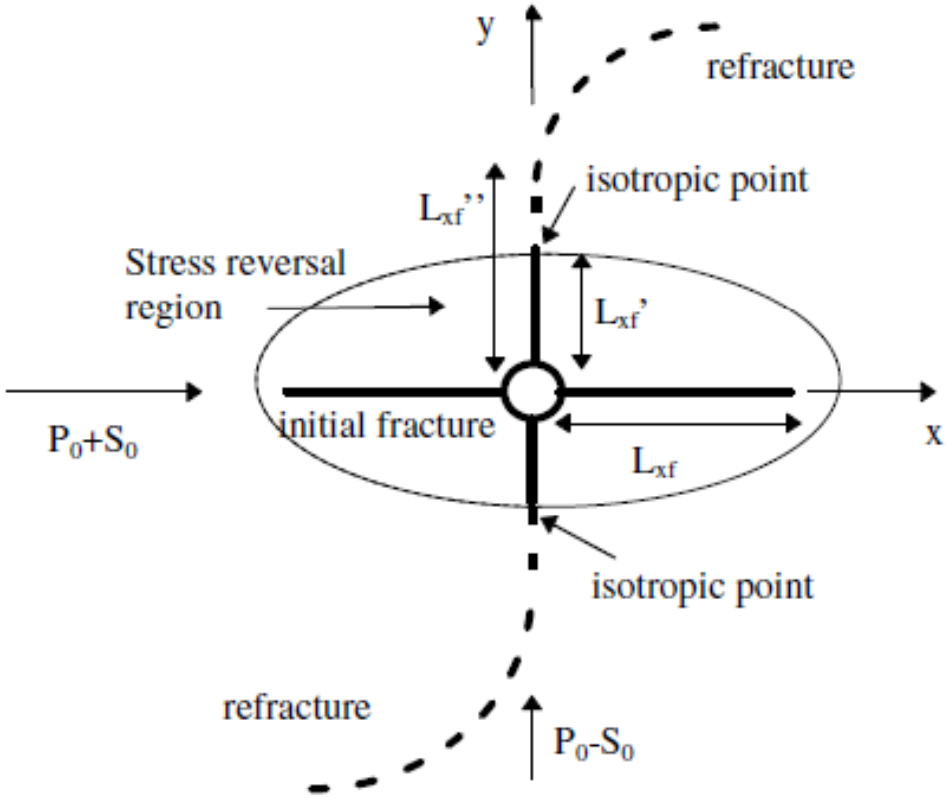
Re-fracture Reorientation - Barnett Shale

SPE 63030



Re-Frac Reorientation Concept

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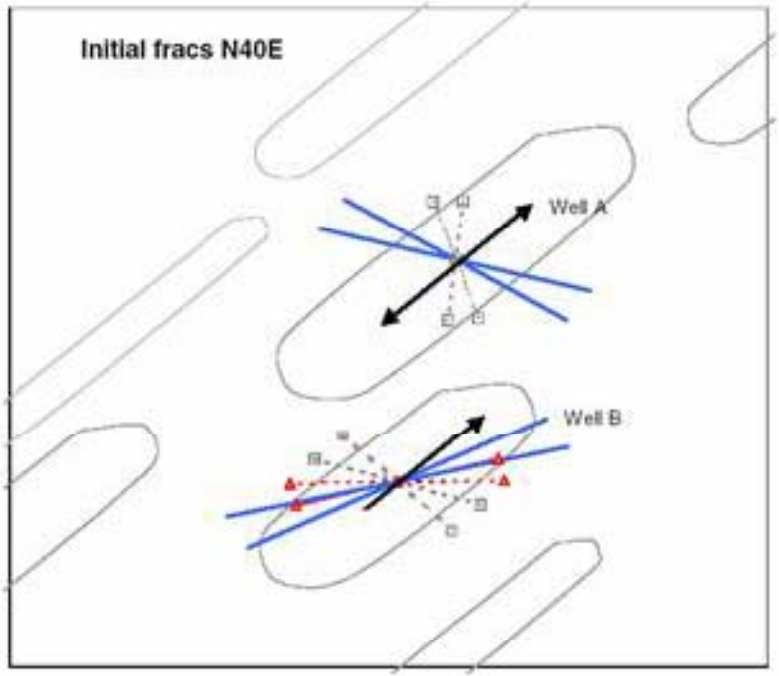
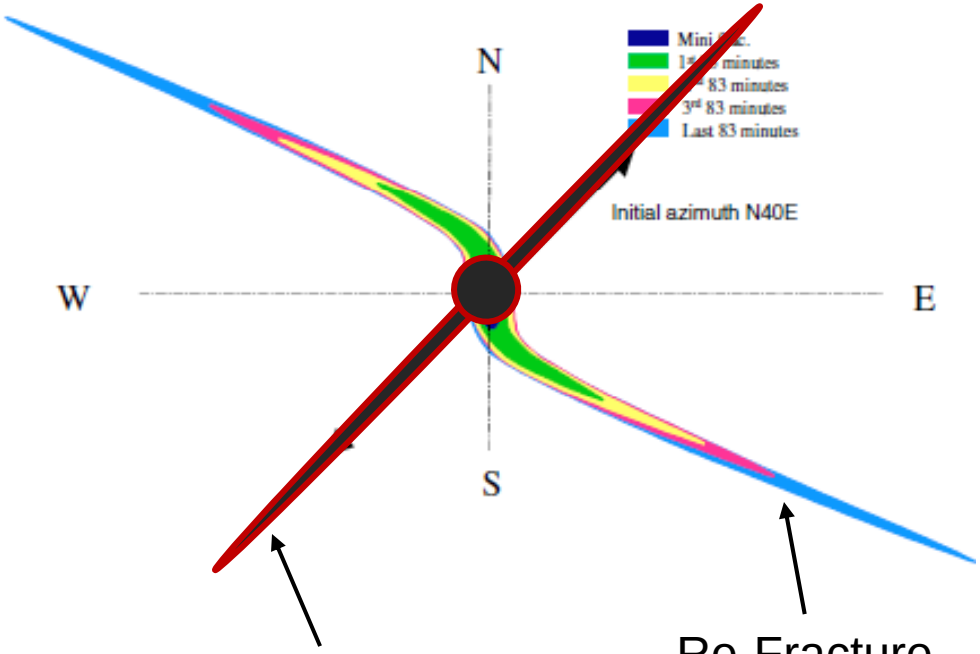
Re-fracture Reorientation - Barnett Shale

SPE 63030





Original Fracture Orientation

Re-Fracture Orientation

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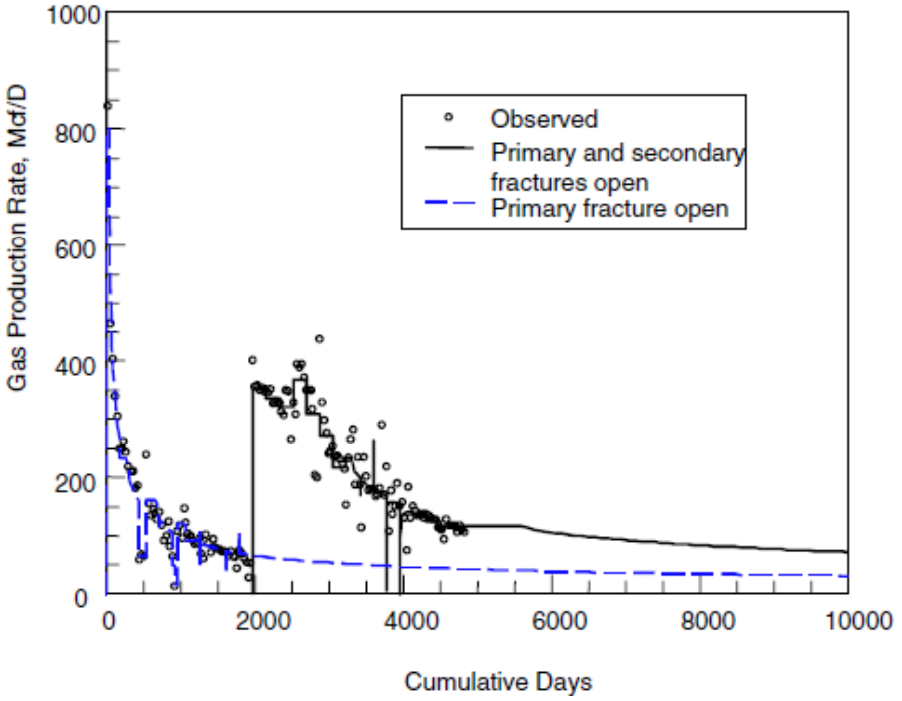
Re-fracture Reorientation - Barnett Shale

SPE 63030

Well		Volumes		Fluid Type
		Proppant lb	Fluid Gal	
Well C	Initial	360,000	225,000	75% N2 Foam
	Refrac	1,060,000	515,000	Crosslinked Gel
Well A	Initial	Unknown	Unknown	Crosslinked Gel
	Refrac	63,000	721,000	Light Sand Frac
Well B	Initial	1,291,000	437,000	Crosslinked Gel
	Refrac	92,000	715,000	Light Sand Frac



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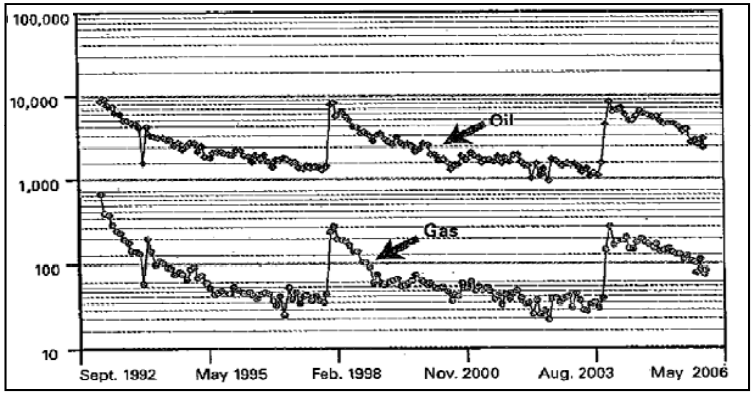

SPE 134330 by Mike Vincent
Refracs - Why do they work, and Why do they Fail
in 100 Published Field Studies?

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SIZE MATTERS!!
Thank You