Identification of Natural Fractures from Conventional Wireline Logs

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Fracture Identification Using Non-Imaging Open Hole Logs

The accurate identification of natural fractures is a critical part of many reservoir evaluations. The ability to properly identify such features is critical in better evaluating the economic viability of many reservoirs by adding a second "porosity and permeability" system to a matrix based reservoir. Apparently tight, non porous reservoirs can be shown to be productive due to the presence of natural fractures.

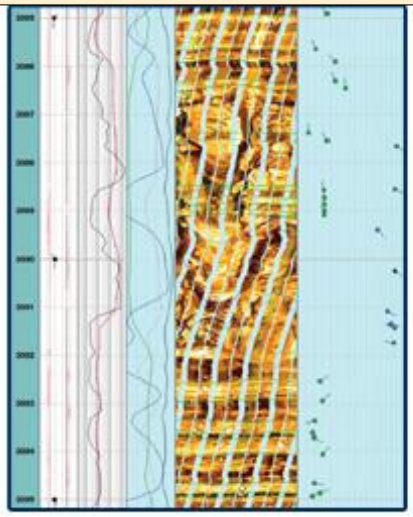
Although some techniques exist to utilize conventional logging data to identify natural fractures, the tendency today is normally focused on the acquisition and processing of wellbore imaging logs. This process can be very expensive and time consuming when you consider all the costs associated with this data acquisition (including rig time and associated costs). In addition, wellbore stability oftentimes precludes the ability to run these tools.

Fracture Intensity Vision (FIV) is an analysis that takes conventional log data and subsequently extracts information as to the presence and density of natural fractures in a wellbore. Examples of this application in both vertical and horizontal wells will be shown in addition to cases where apparent dry holes were turned into producing wells based on the identification of fractures using this technology.

Traditional Imaging Logs - Lots of good data but,

- **Additional open hole logging runs**
- **Additional costs and rig time**
- **Additional mechanical risks**
- **NOT POSSIBLE IN CASED WELLS**

Traditional Image Log



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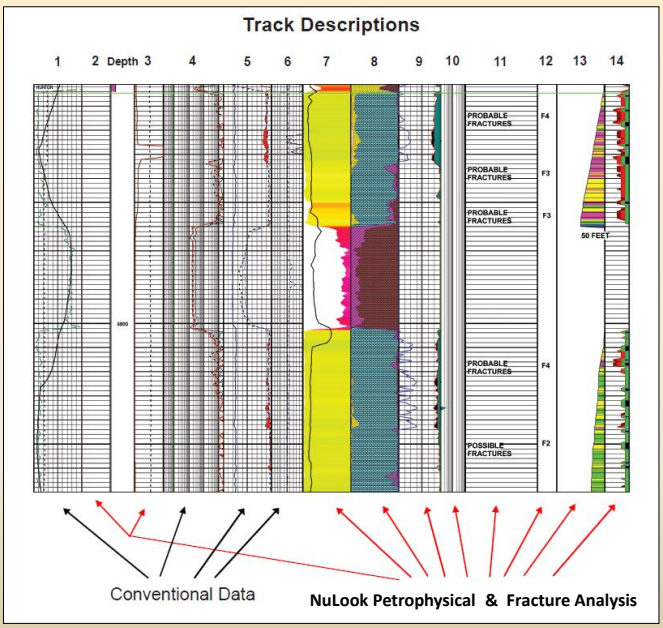

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FIV "Flags" and Grading System

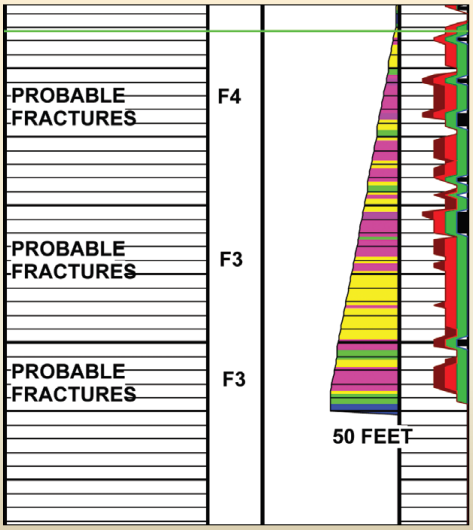

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Image & Core Comparison

Eagle Ford Example

Fracture Identification using whole core or Interpreted Image Log and FIV analysis

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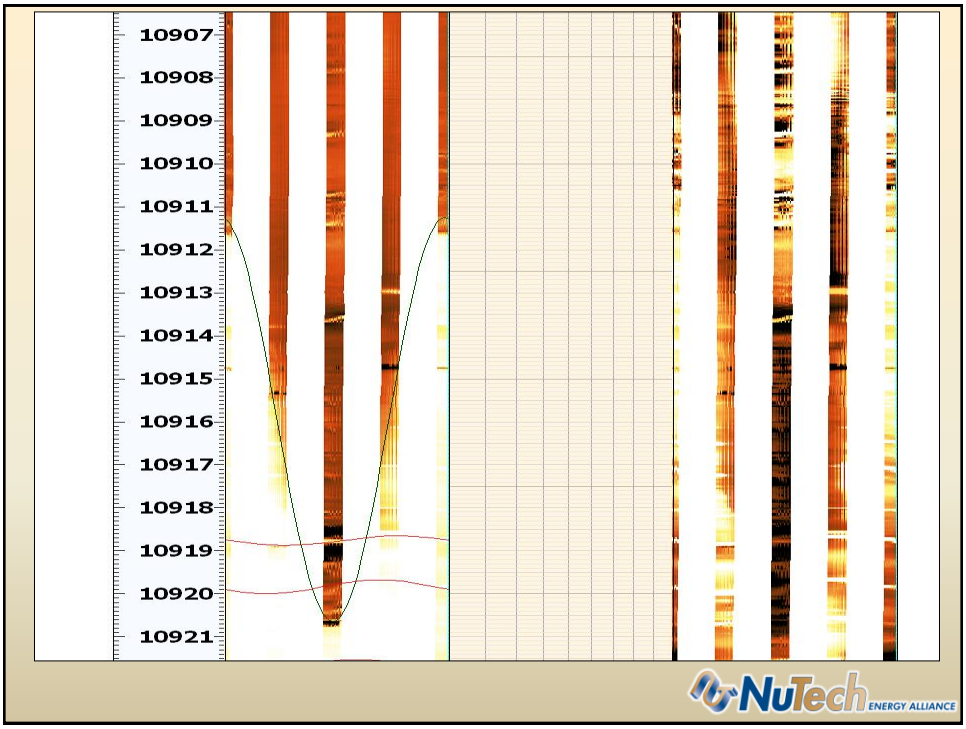
10907
10908
10909
10910
10911
10912
10913
10914
10915
10916
10917
10918
10919
10920
10921
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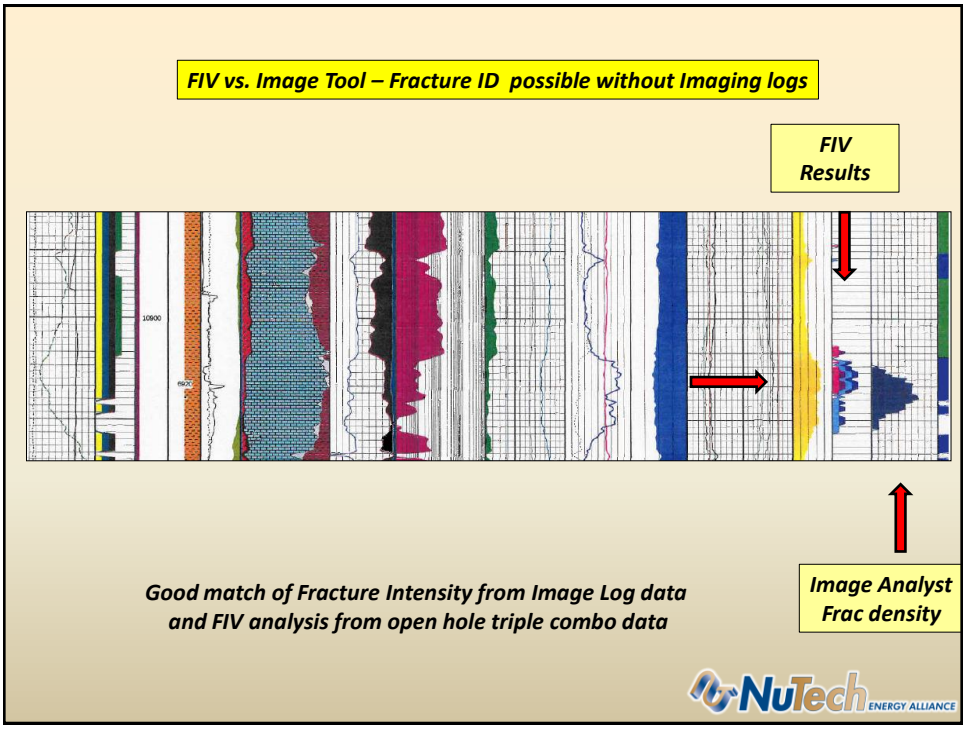
FIV vs. Image Tool – Fracture ID possible without Imaging logs
FIV Results
10900
Image Analyst Frac density
Good match of Fracture Intensity from Image Log data and FIV analysis from open hole triple combo data
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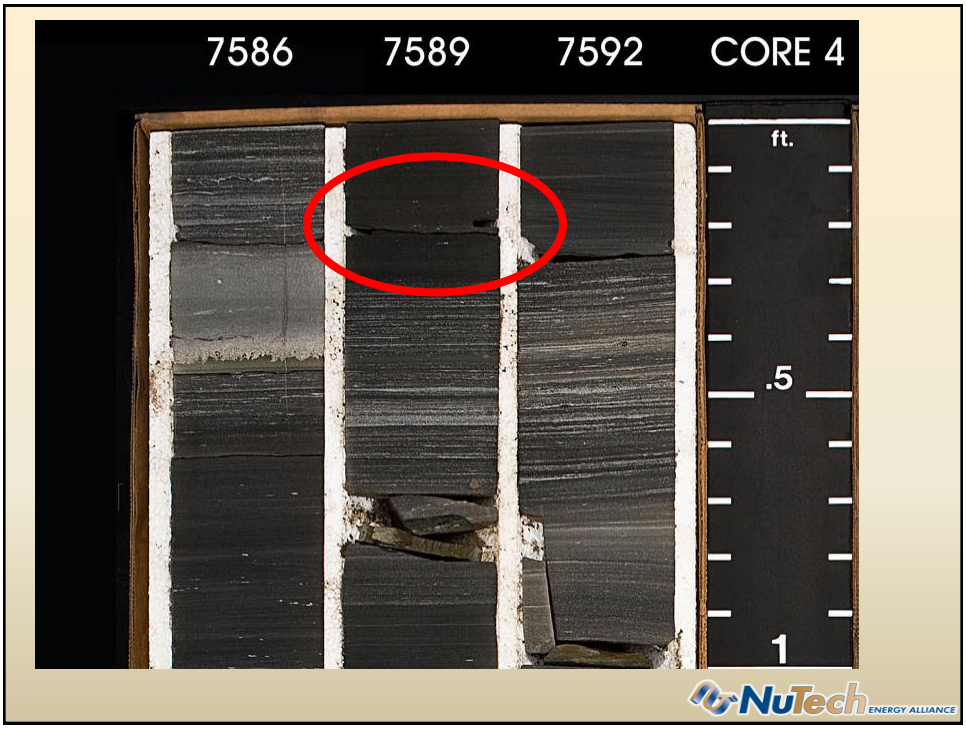
7586
7589
7592
CORE 4
ft.
.5
1
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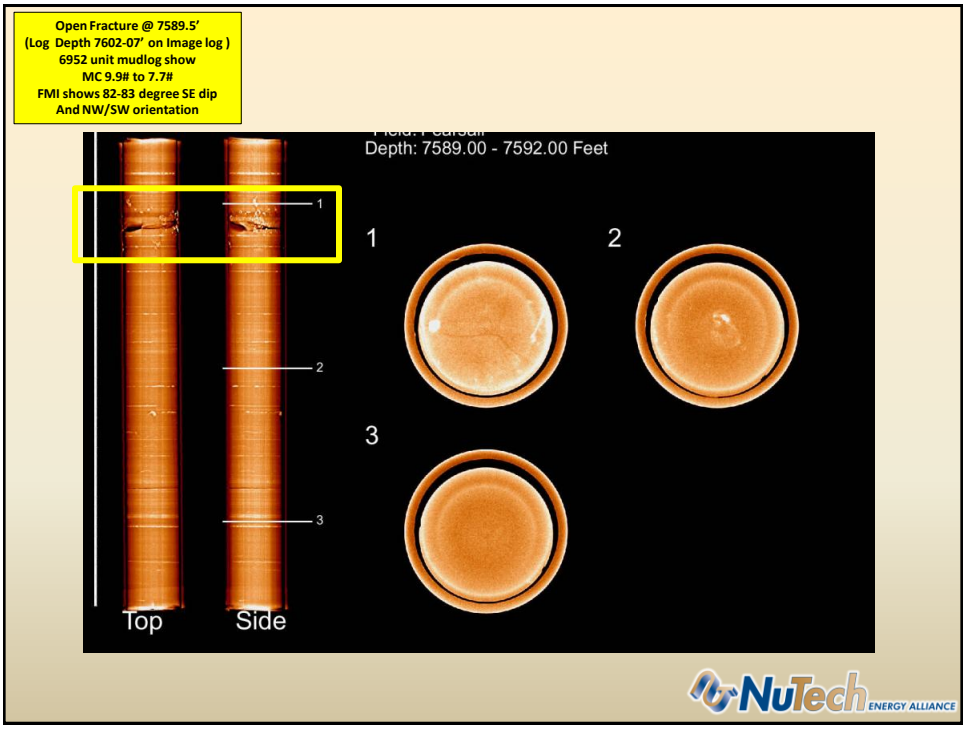
Open Fracture @ 7589.5'
(Log Depth 7602-07' on Image log)
6952 unit mudlog show
MC 9.9# to 7.7#
FMI shows 82-83 degree SE dip
And NW/SW orientation
Depth: 7589.00 - 7592.00 Feet
1
2
3
Top
Side
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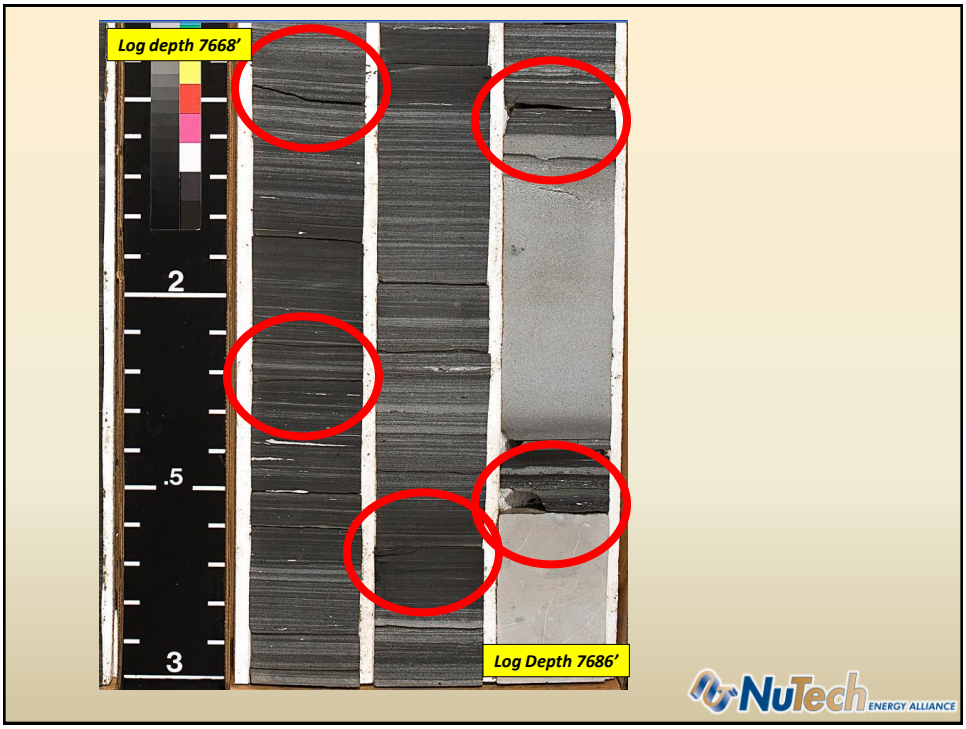
Log depth 7668'
2
.5
3
Log Depth 7686'
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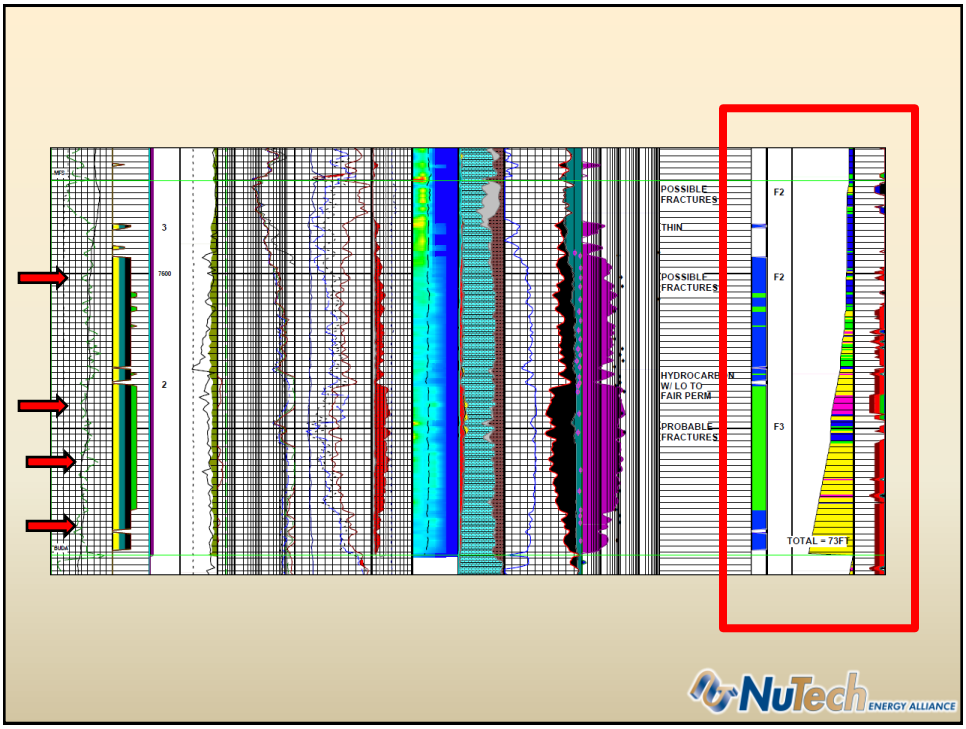
POSSIBLE FRACTURES
THIN
POSSIBLE FRACTURES
HYDROCARBON W/ LO TO FAIR PERM
PROBABLE FRACTURES
F2
F2
F3
TOTAL = 73FT
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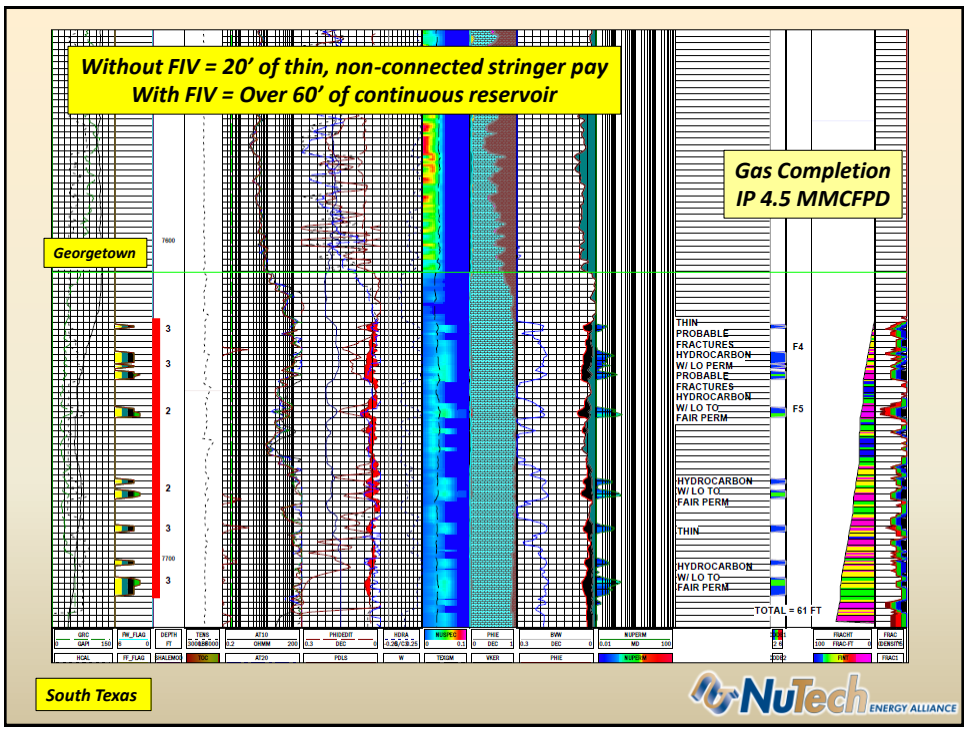
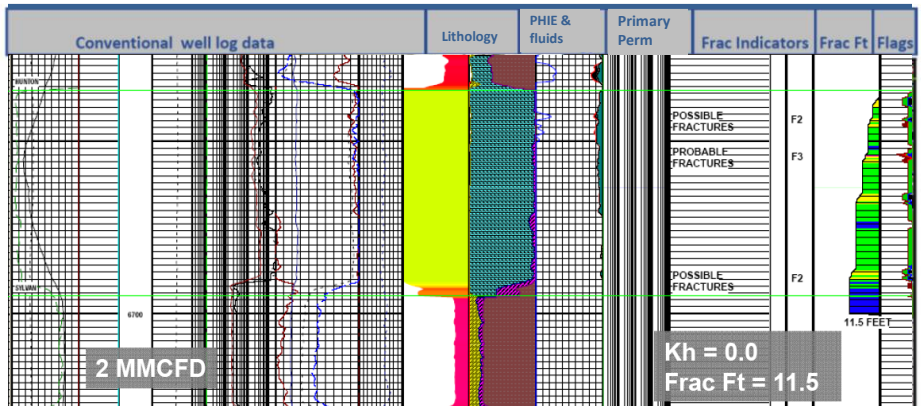
Fractured Carbonate Production
FIV "Enhancement"

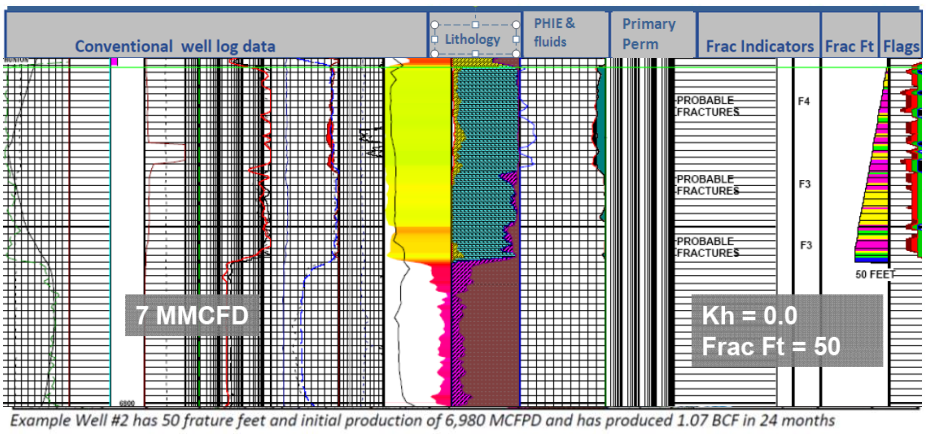


Hunton Example well #1

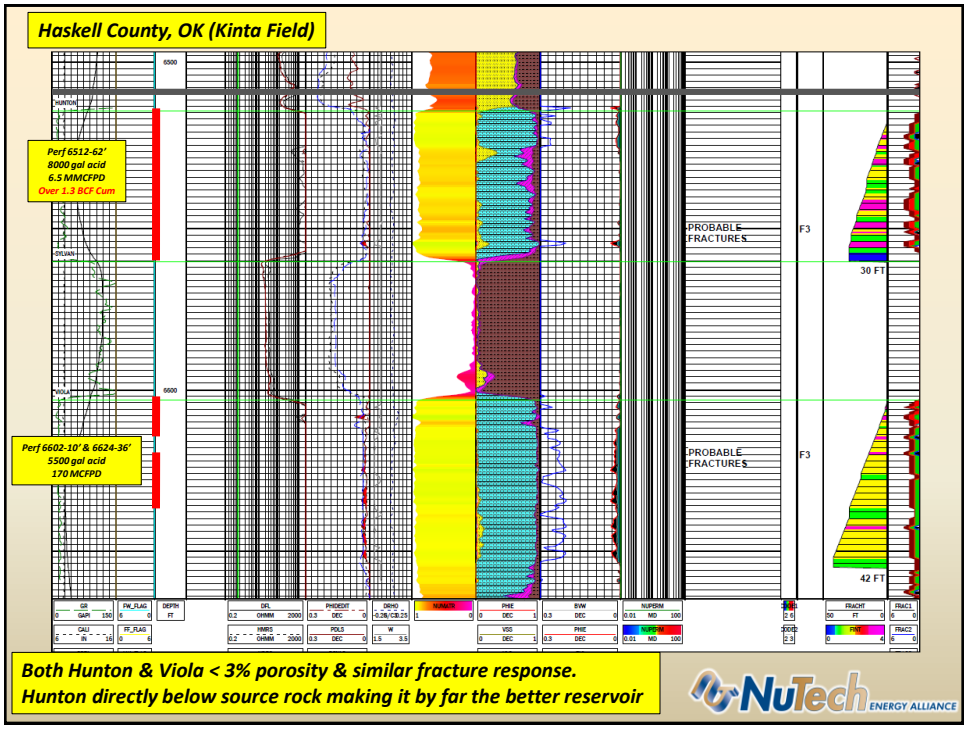


Example well #1 has 11.5 fracture feet and initial production of ~2MCFPD

Hunton Example well #2



Example Well #2 has 50 frature feet and initial production of 6,980 MCFPD and has produced 1.07 BCF in 24 months


Haskell County, OK (Kinta Field)
Perf 6512-62'
8000 gal acid
6.5 MMCFPD
Over 1.3 BCF Cum
Perf 6602-10' & 6624-36'
5500 gal acid
170 MCFPD
PROBABLE FRACTURES
F3
30 FT
PROBABLE FRACTURES
F3
42 FT
Both Hunton & Viola < 3% porosity & similar fracture response.
Hunton directly below source rock making it by far the better reservoir
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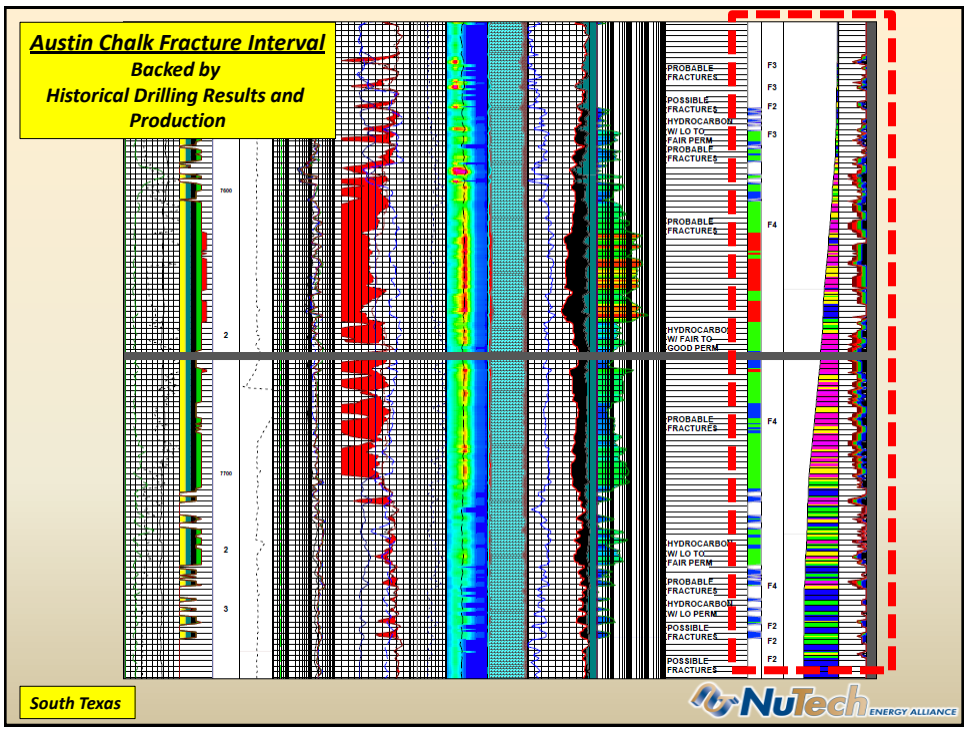
Austin Chalk Fracture Interval
Backed by
Historical Drilling Results and
Production
PROBABLE FRACTURES
F3
POSSIBLE FRACTURES
F2
HYDROCARBON W/ LO TO FAIR PERM
F3
PROBABLE FRACTURES
PROBABLE FRACTURES
F4
HYDROCARBON W/ FAIR TO GOOD PERM
PROBABLE FRACTURES
F4
HYDROCARBON W/ LO TO FAIR PERM
PROBABLE FRACTURES
F4
HYDROCARBON W/ LO PERM
F2
POSSIBLE FRACTURES
F2
POSSIBLE FRACTURES
F2
South Texas
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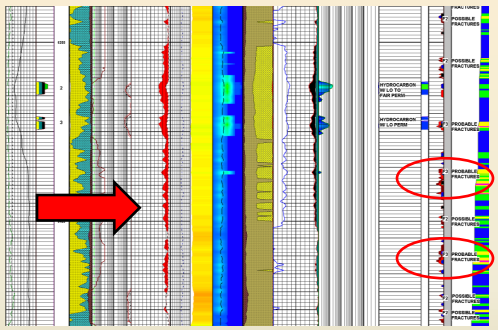
Mississippian Examples

Garfield County
Comparison of natural fracture response from open logs to offset well with core data.

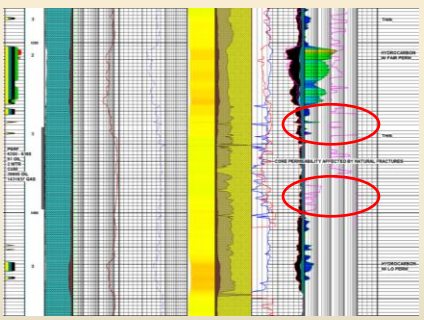
Logged 1982

Perf. 6003-6449'
IP 30 BO, 10 MCF & 107 BW
Cum 200 MMCF & 2284 BO



Logged 1963

Perf. 6350-98'
IP 61 BO & 2 BW
Cum 542 MCF & 1807 BO



Note: These wells are located 3000' apart

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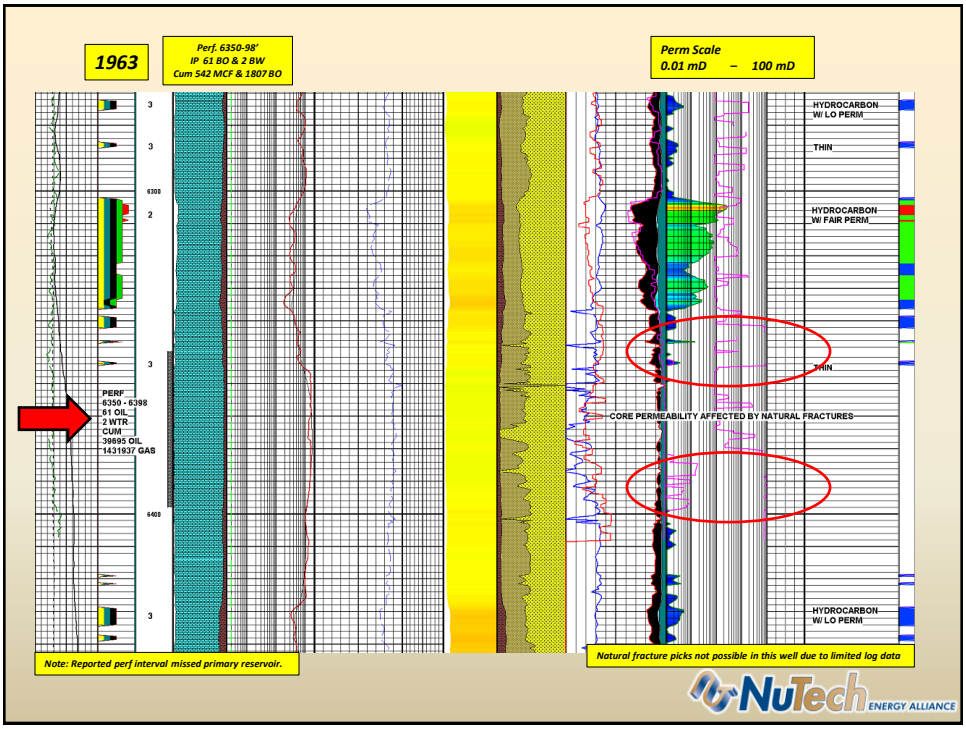
1963
Perf. 6350-98'
IP 61 BO & 2 BW
Cum 542 MCF & 1807 BO
Perm Scale
0.01 mD – 100 mD
HYDROCARBON W/ LO PERM
THIN
HYDROCARBON W/ FAIR PERM
THIN
CORE PERMEABILITY AFFECTED BY NATURAL FRACTURES
HYDROCARBON W/ LO PERM
PERF
6350 - 6398
61 OIL
2 WTR
CUM
39695 OIL
1431937 GAS
Note: Reported perf interval missed primary reservoir.
Natural fracture picks not possible in this well due to limited log data
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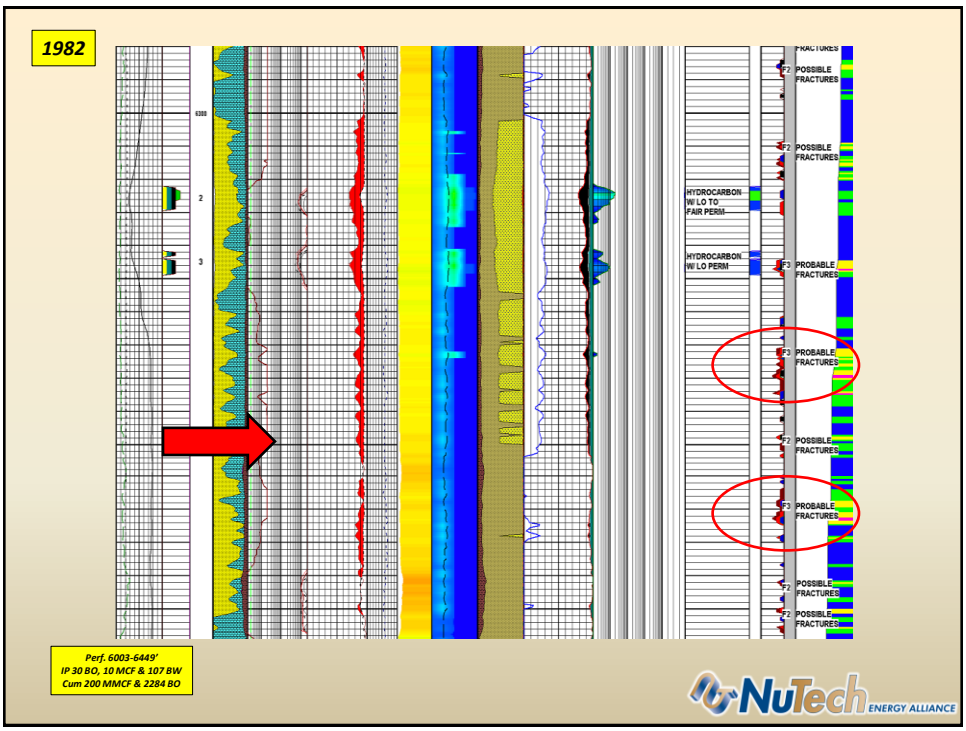
1982
F2 POSSIBLE FRACTURES
F2 POSSIBLE FRACTURES
HYDROCARBON W/ LO TO FAIR PERM
HYDROCARBON W/ LO PERM
F3 PROBABLE FRACTURES
F3 PROBABLE FRACTURES
F2 POSSIBLE FRACTURES
F3 PROBABLE FRACTURES
F2 POSSIBLE FRACTURES
F2 POSSIBLE FRACTURES
Perf. 6003-6449'
IP 30 BO, 10 MCF & 107 BW
Cum 200 MMCF & 2284 BO
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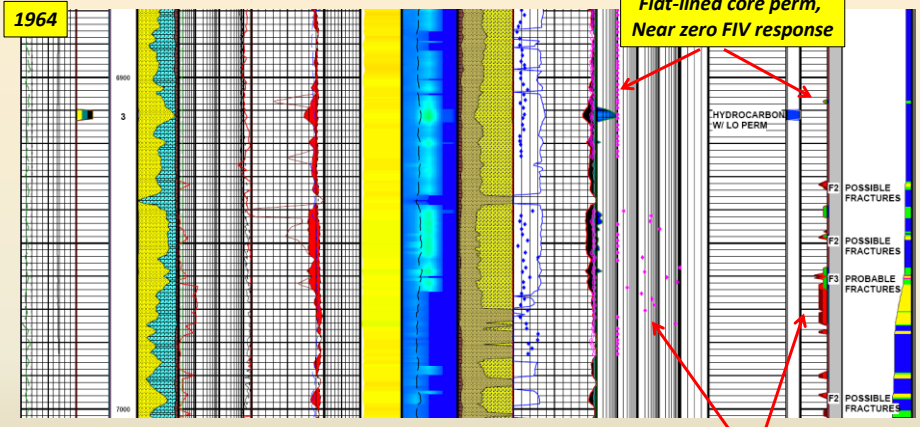
Alfalfa County
Comparison of natural fracture response from open logs to core data.

1964



Natural fracture picks were possible in this. Better dataset than previous 1963 example

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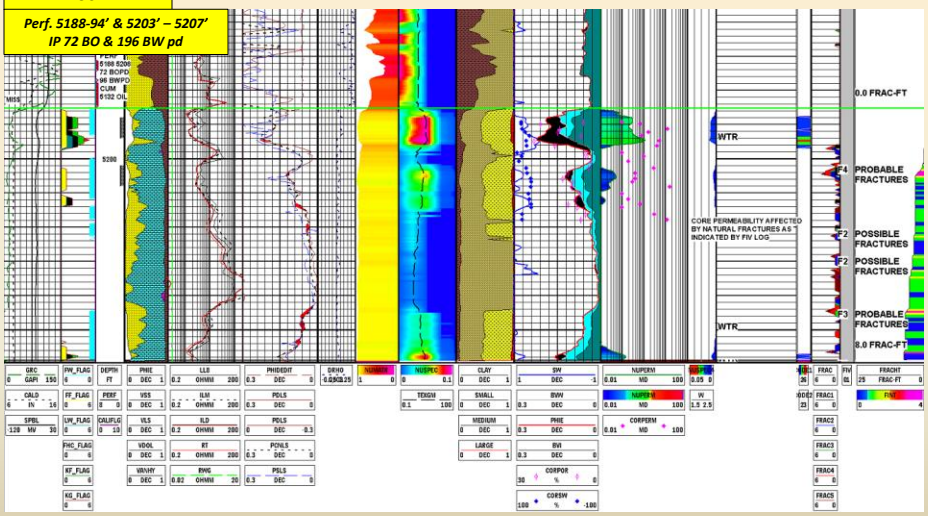
Grant County
Comparison of natural fracture response from open logs to core data.

1967

Perf. 5188-94' & 5203' – 5207'
IP 72 BO & 196 BW pd



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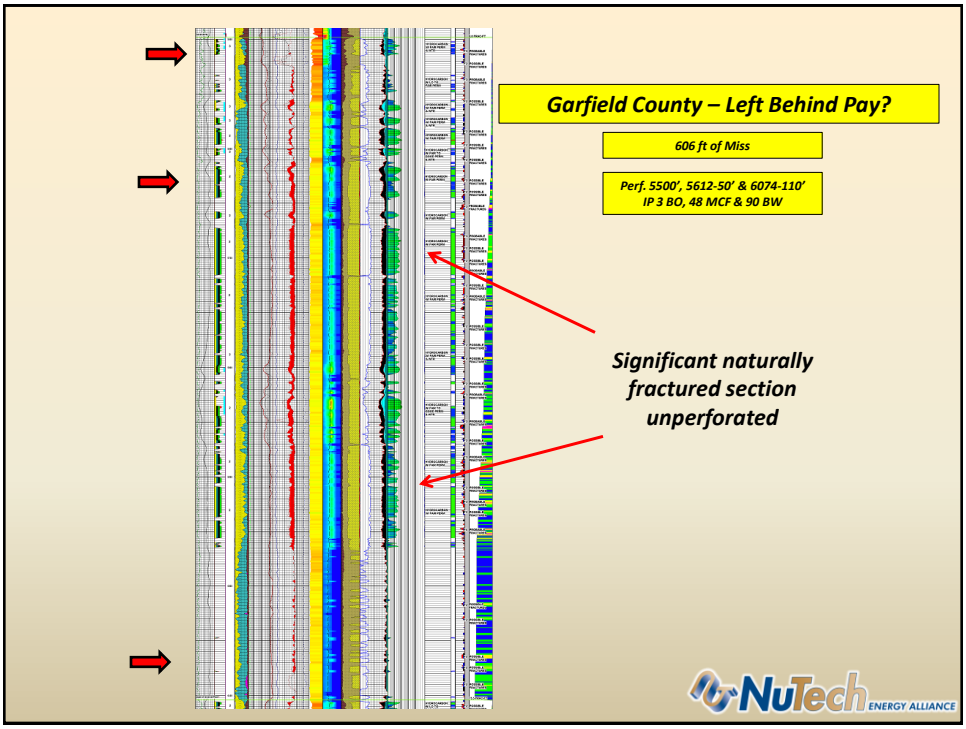
Garfield County – Left Behind Pay?
606 ft of Miss
Perf. 5500', 5612-50' & 6074-110'
IP 3 BO, 48 MCF & 90 BW
Significant naturally fractured section unperforated
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