

Identification of Natural Fractures from Conventional Wireline Logs*

Cody Knepper¹

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¹NuTech Energy Alliance, Oklahoma City, OK (cknepper@nutechenergy.com)

Abstract

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.

Identification of Natural Fractures from Conventional Wireline Logs

Cody Knepper

Area Account Manager

NuTech Energy Alliance

Fracture Identification Using Non-Imaging Open Hole Logs

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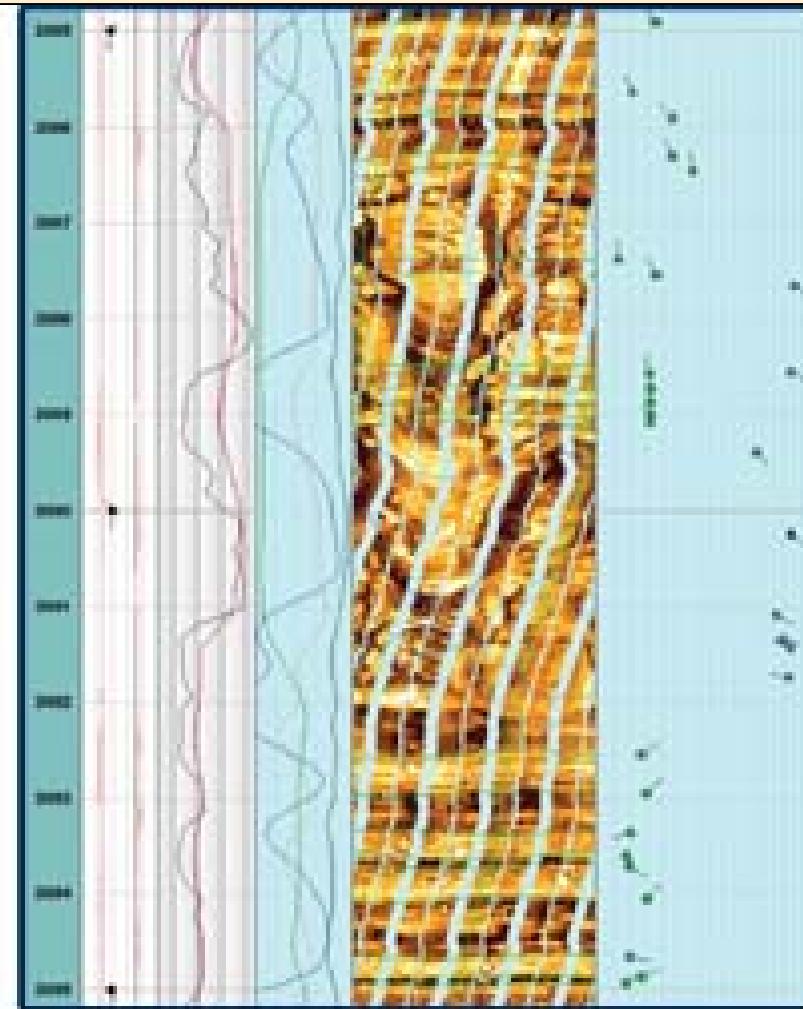
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**Traditional Imaging Logs - Lots of good data
but,**

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

Traditional Image Log



NuLook FIV – Fracture Intensity Vision

Fracture Intensity Vision (FIV) is the NuTech methodology of identifying fracture response from available conventional open hole log data sets.

Fracture pick data is used to help qualitatively identify secondary porosity & permeability enhancement from a fracture system in formation of interest.

Readily comparable between wells

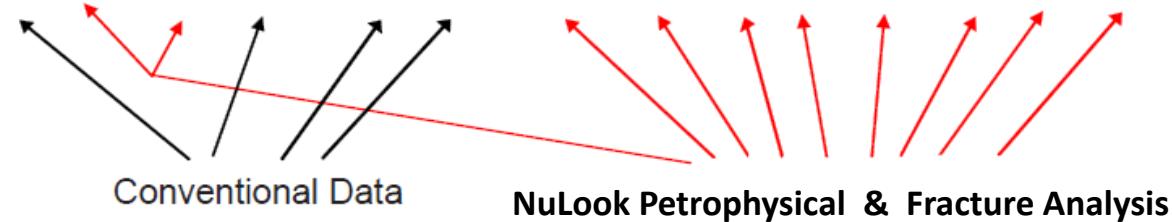
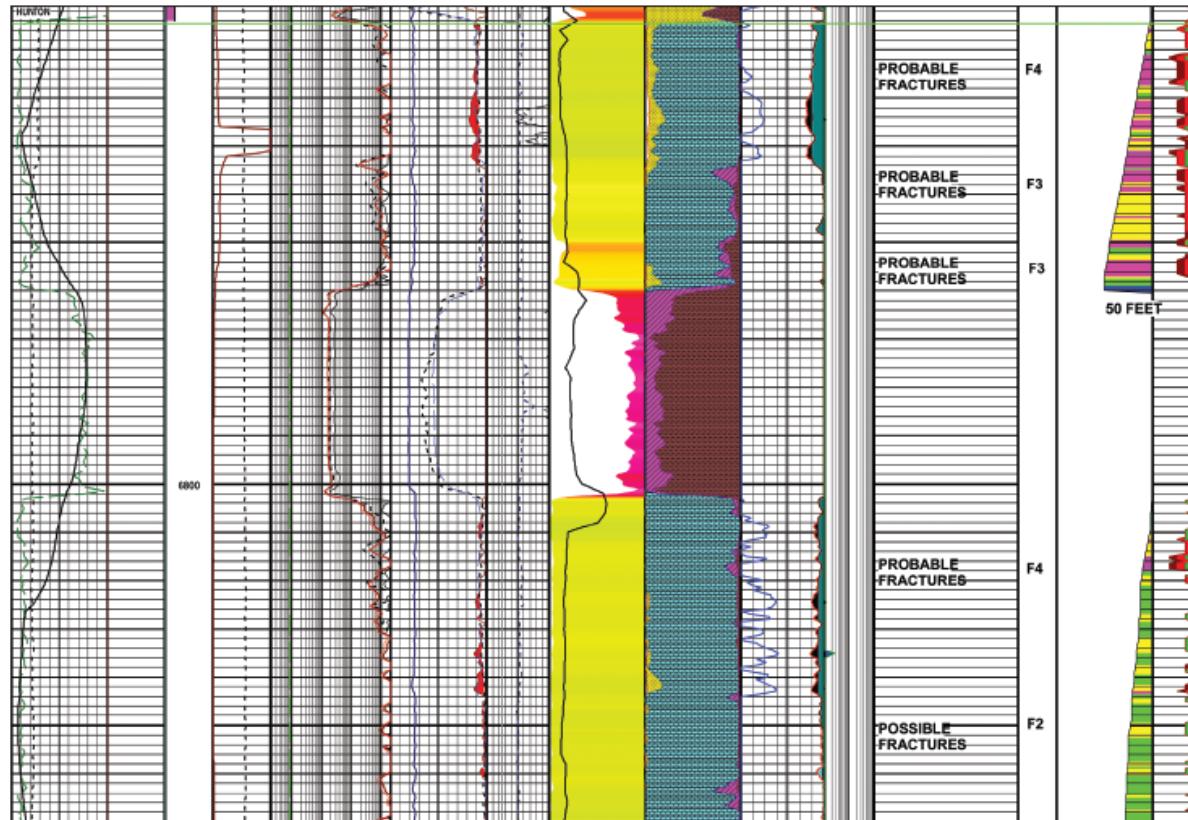
Additional reservoir parameter available for mapping

Several historical fracture identifiers: Resistivity, Density, Neutron, Sonic, SP, Caliper, GR, Microlog, etc

- Know what is applicable for area/formation of interest
- Know depth of investigation of possible indicators
- Know limits of indicators – fundamental understanding of tool theory
- Incorporate a grading system
- Consistency

Track Descriptions

1 2 Depth 3 4 5 6 7 8 9 10 11 12 13 14



FIV "Flags" and Grading System

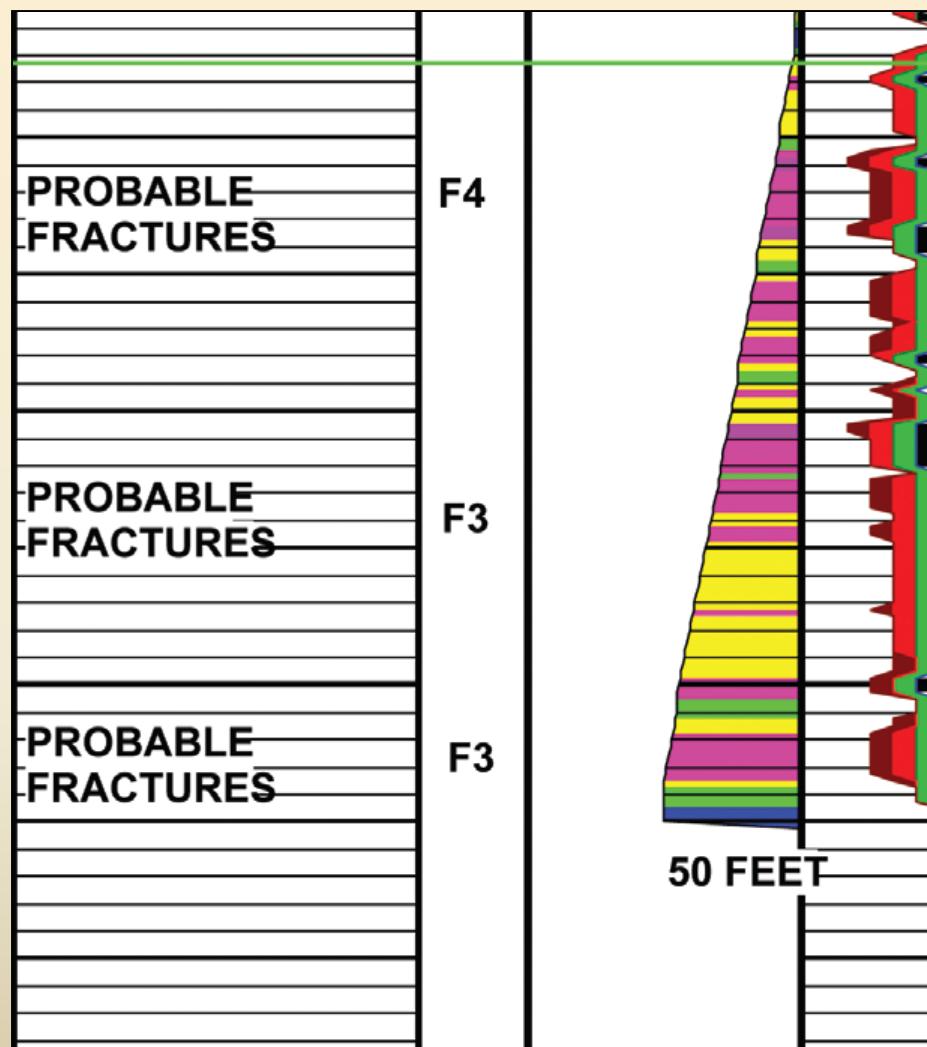
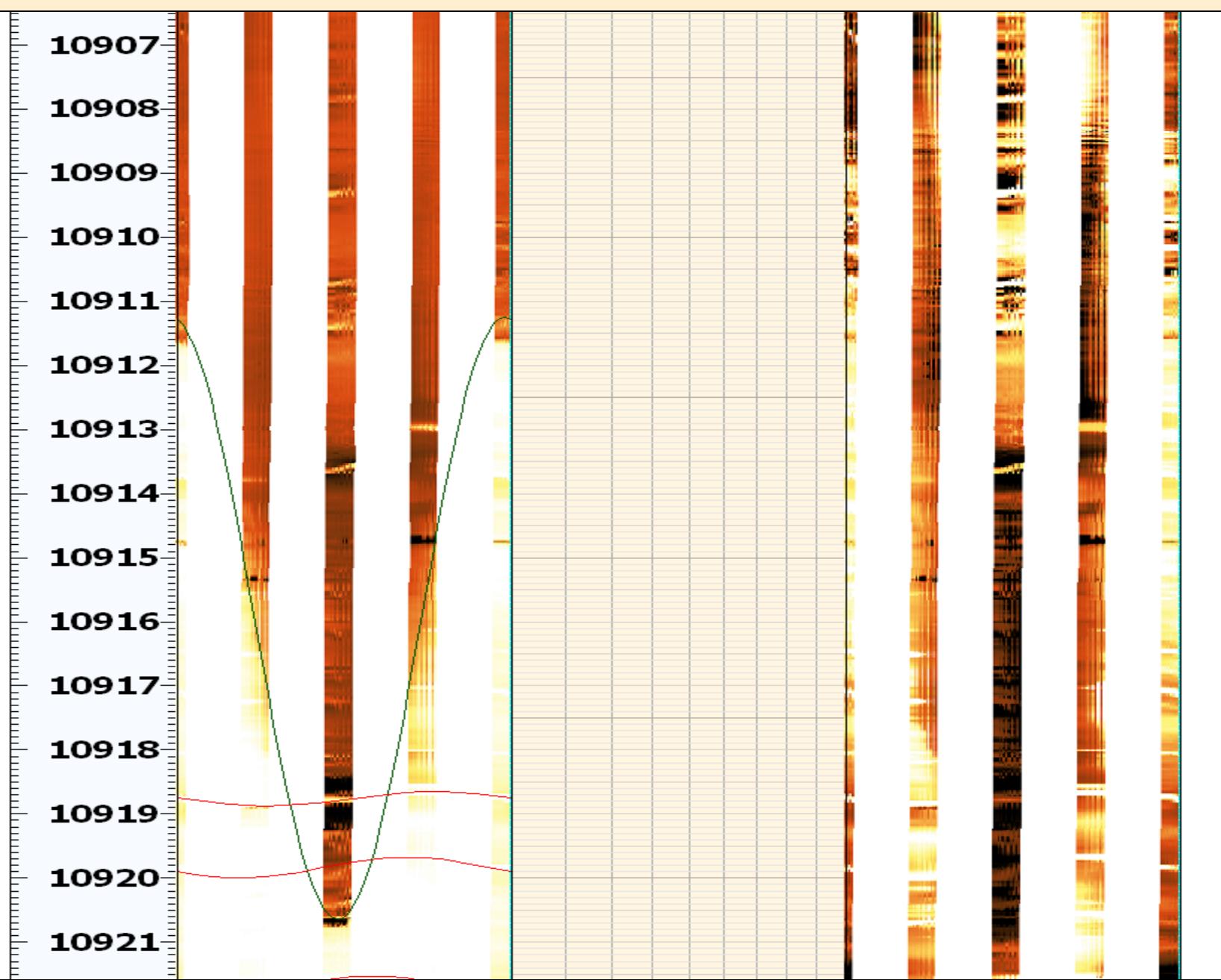


Image & Core Comparison

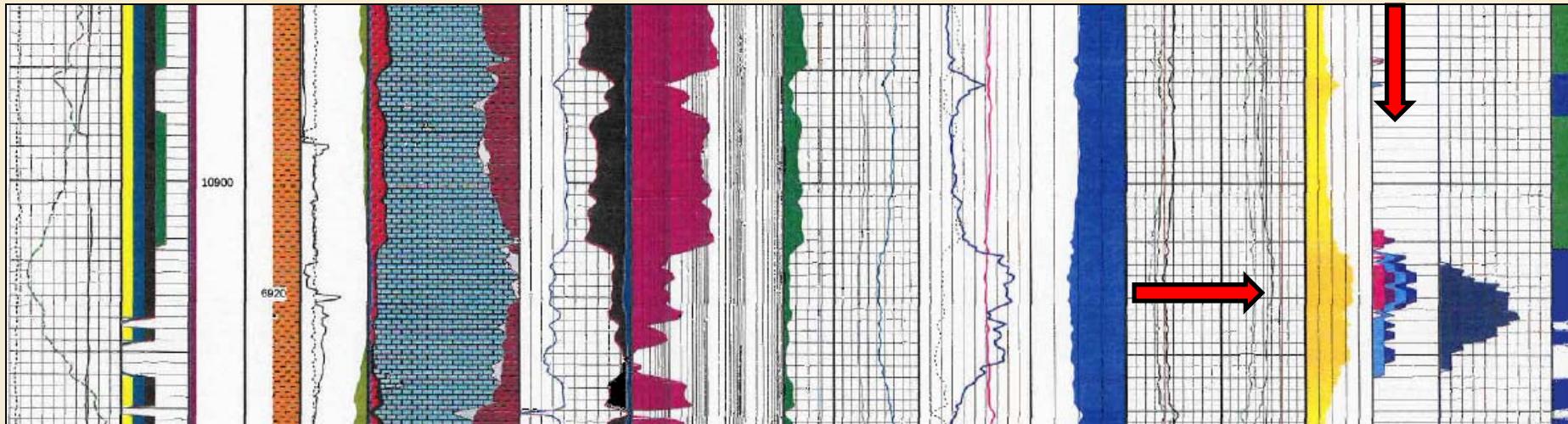
Eagle Ford Example

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



FIV vs. Image Tool – Fracture ID possible without Imaging logs

**FIV
Results**



*Good match of Fracture Intensity from Image Log data
and FIV analysis from open hole triple combo data*

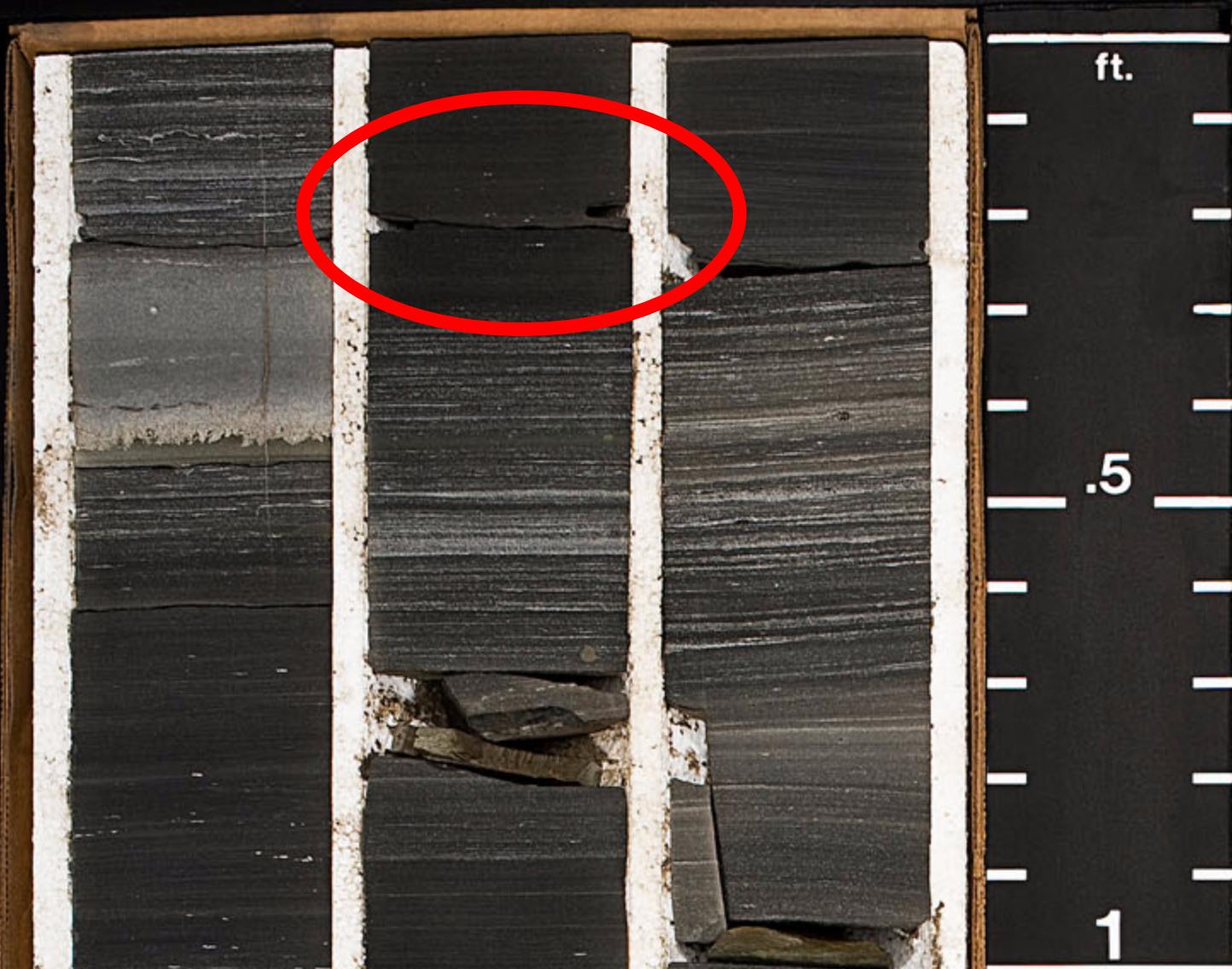
**Image Analyst
Frac density**

7586

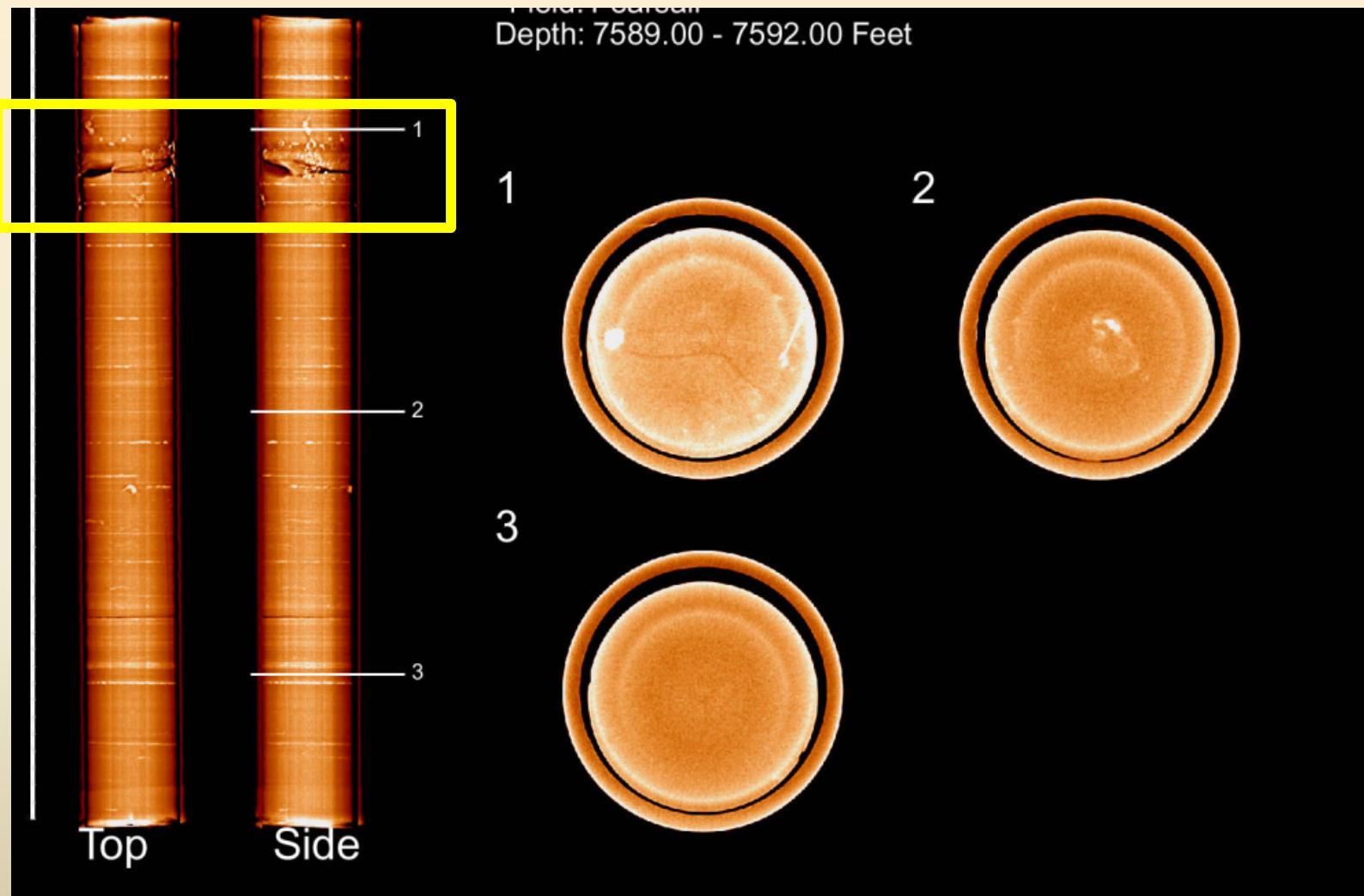
7589

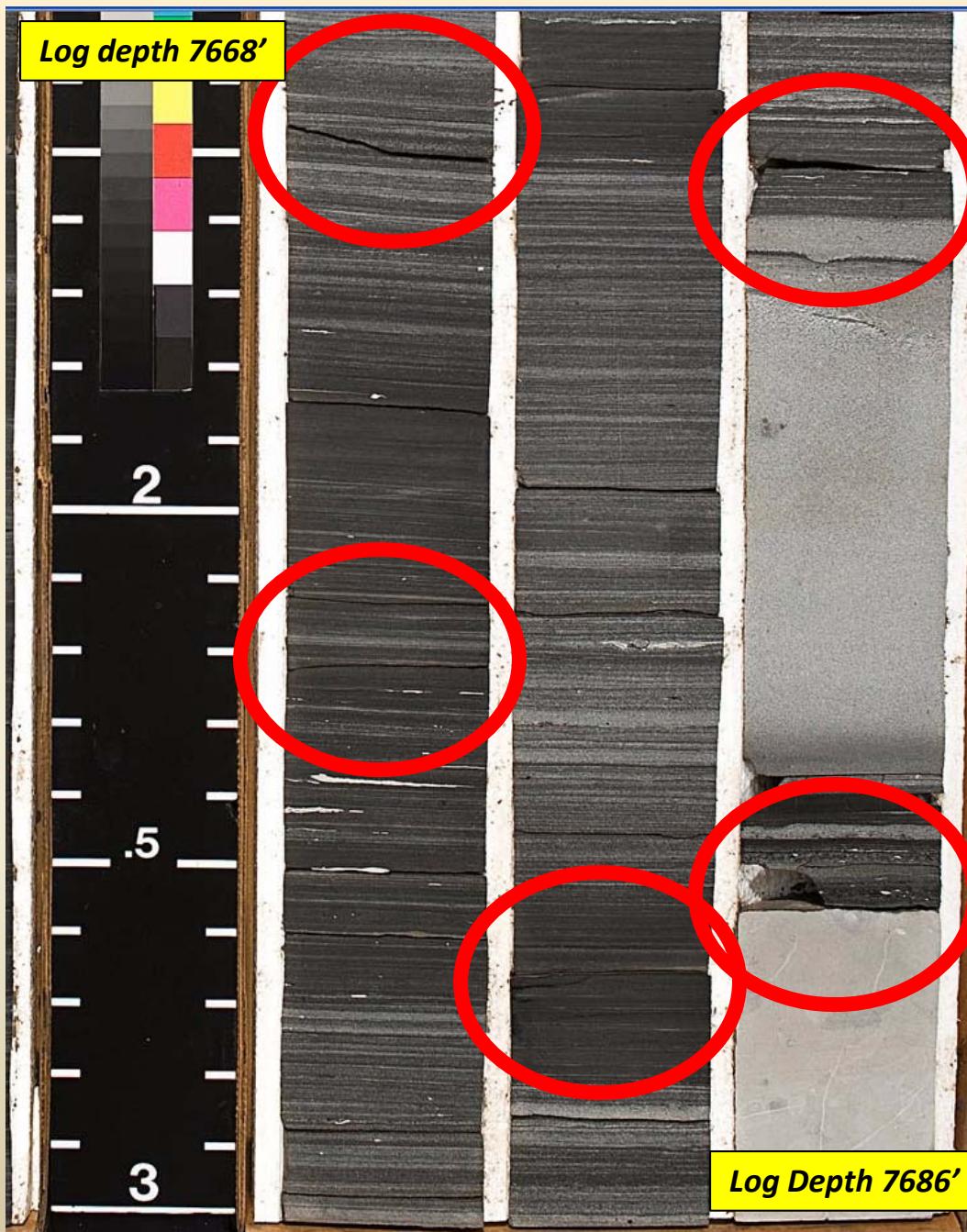
7592

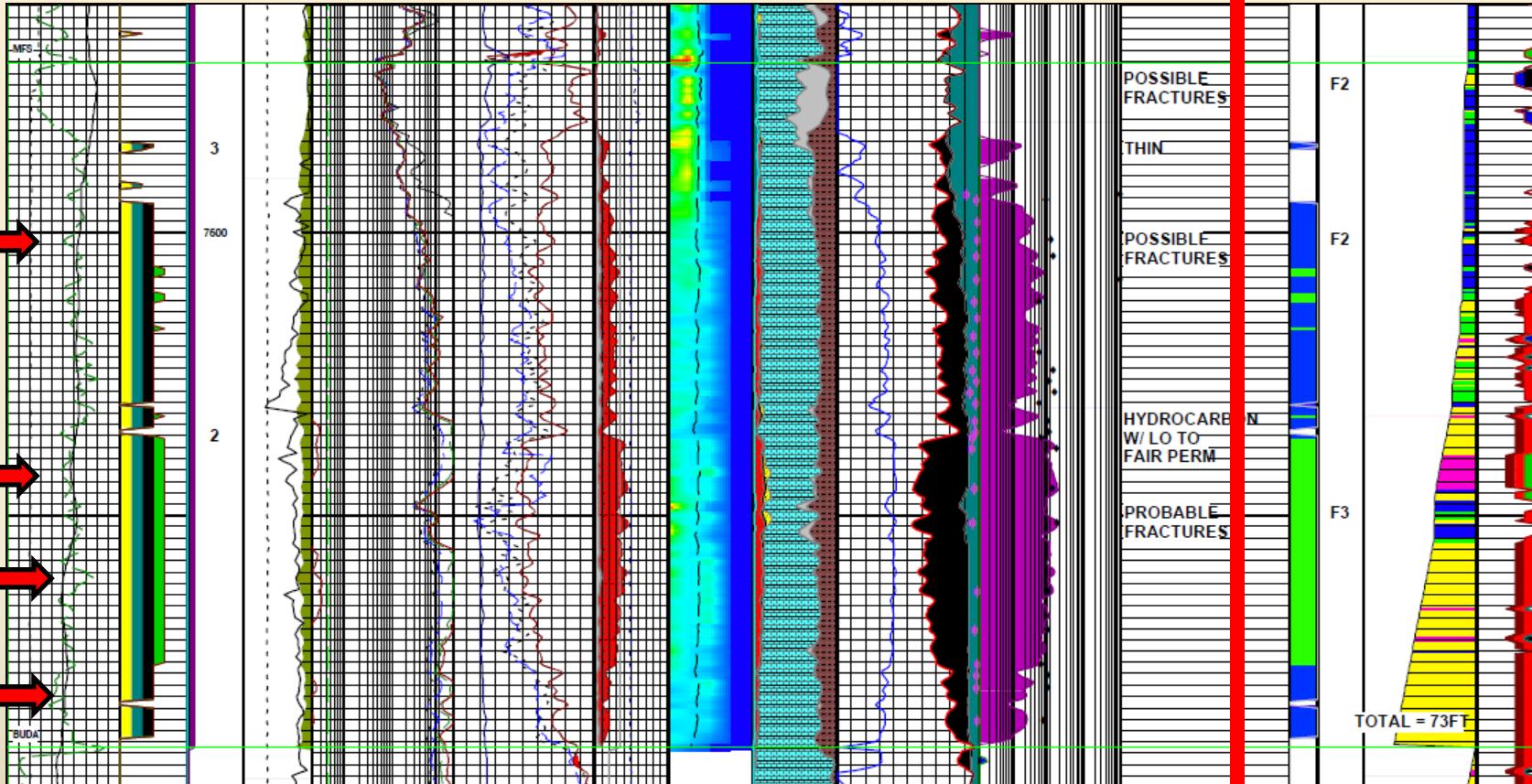
CORE 4



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







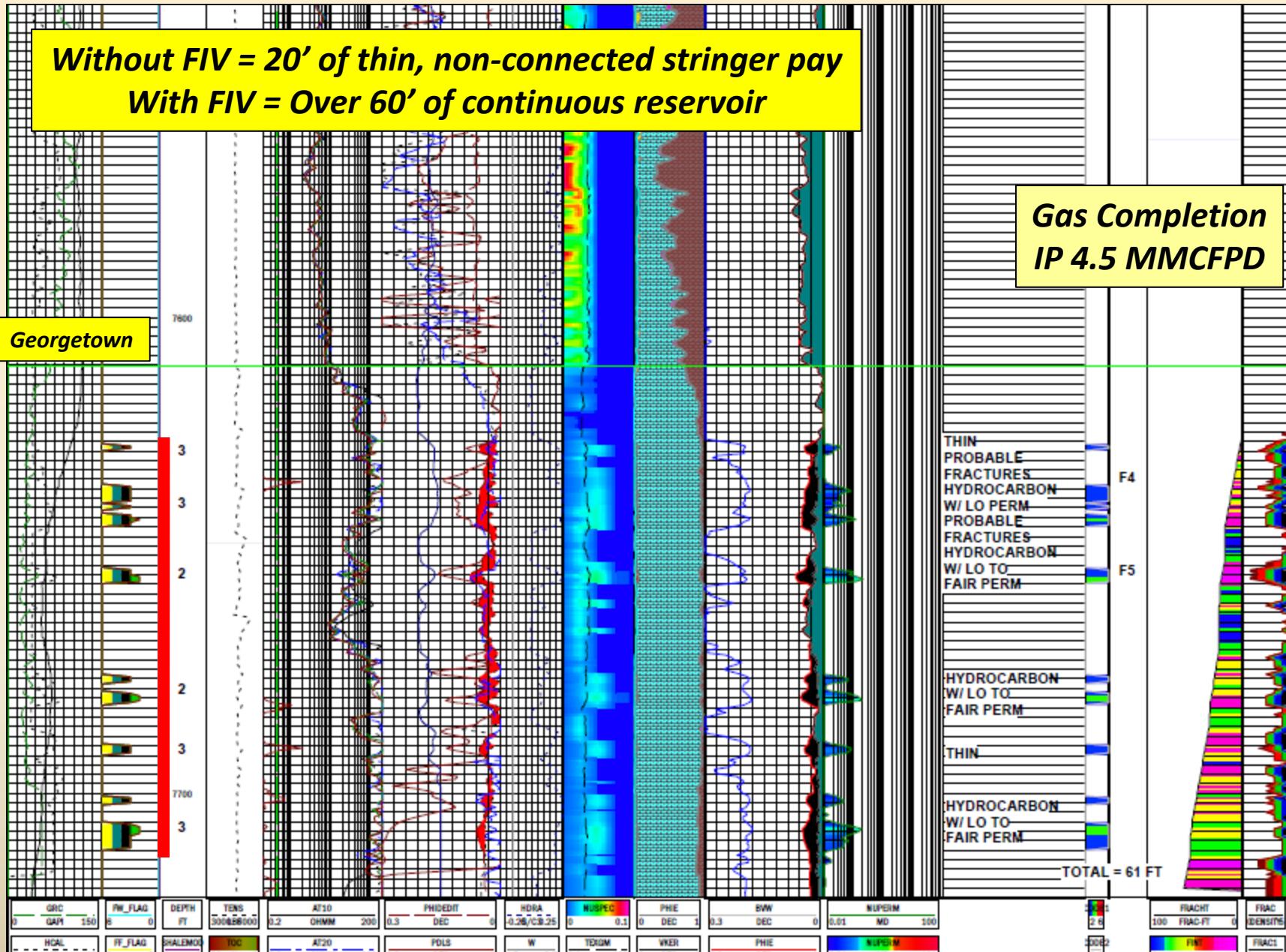
Fractured Carbonate Production

FIV “Enhancement”

*Without FIV = 20' of thin, non-connected stringer pay
With FIV = Over 60' of continuous reservoir*

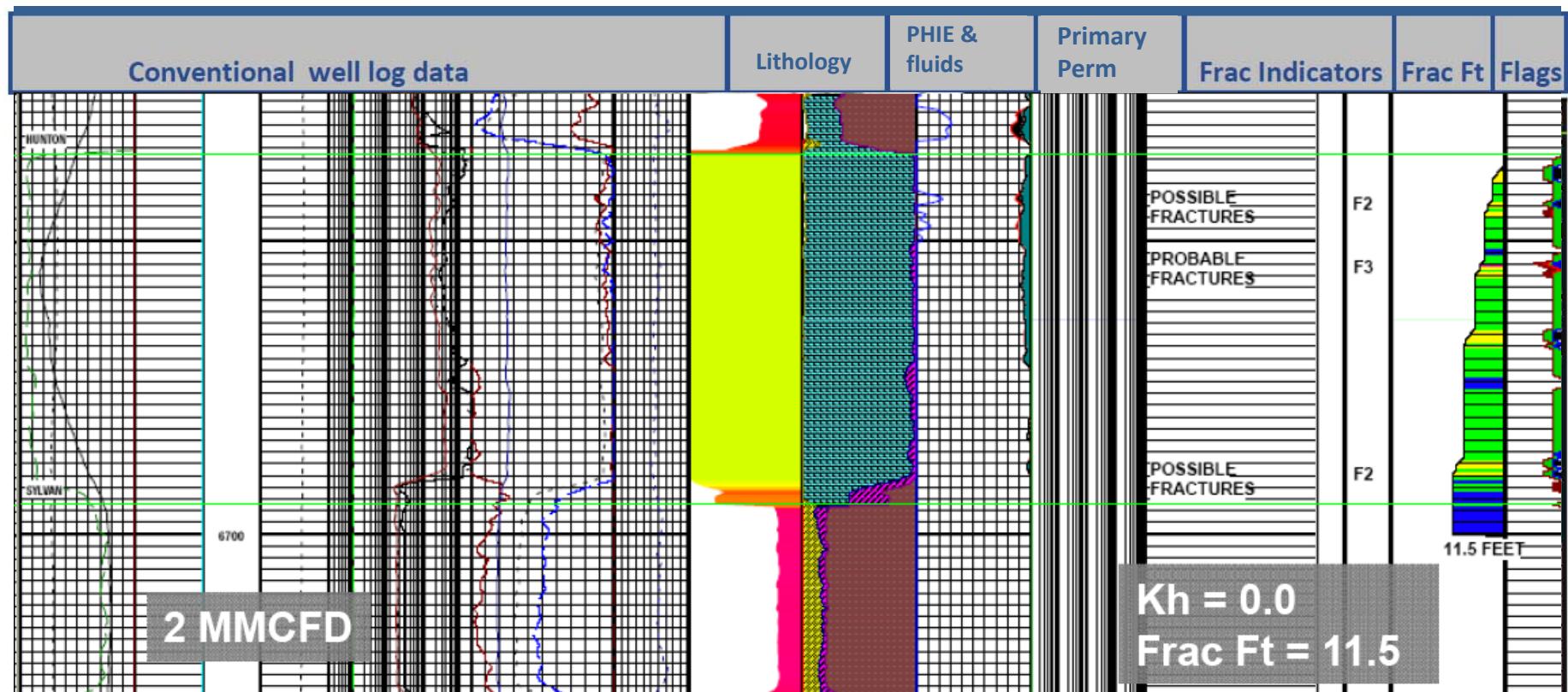
Georgetown

Gas Completion IP 4.5 MMCFPD

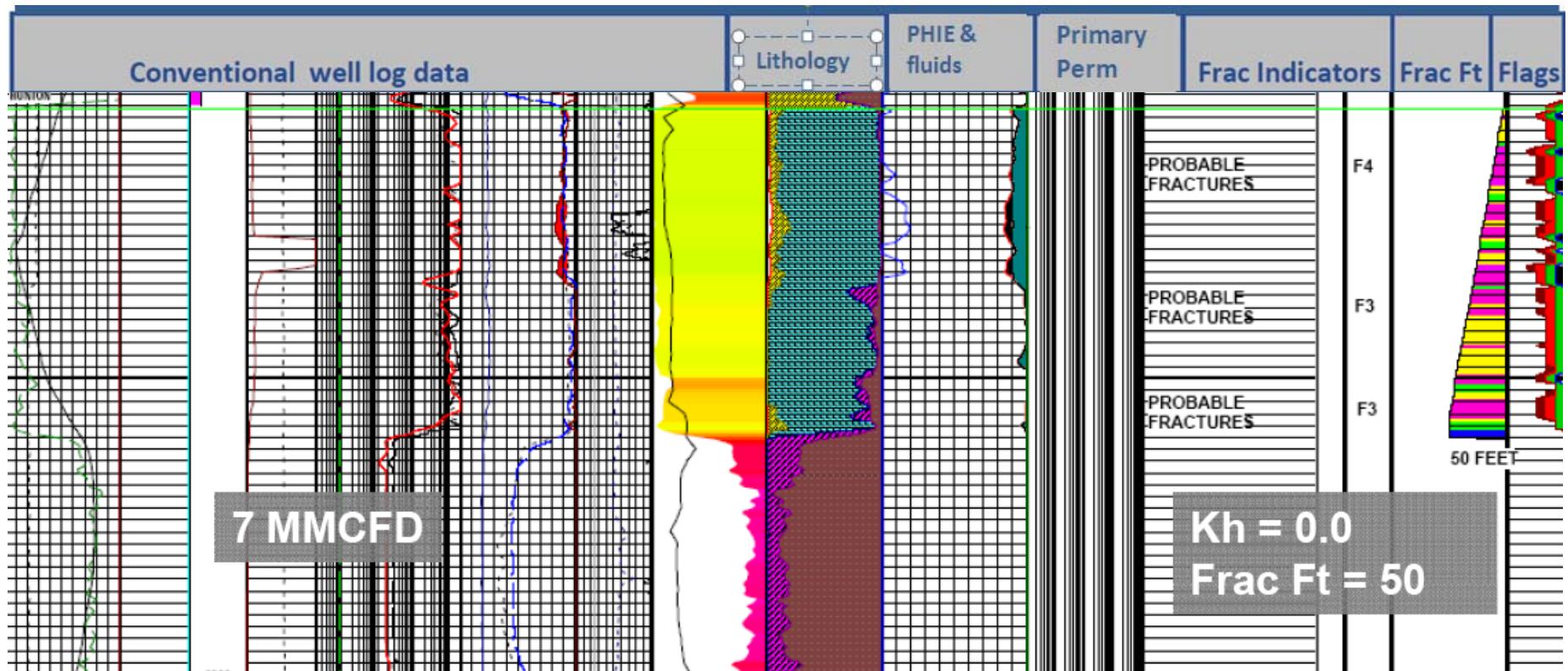


South Texas

Hunton Example well #1

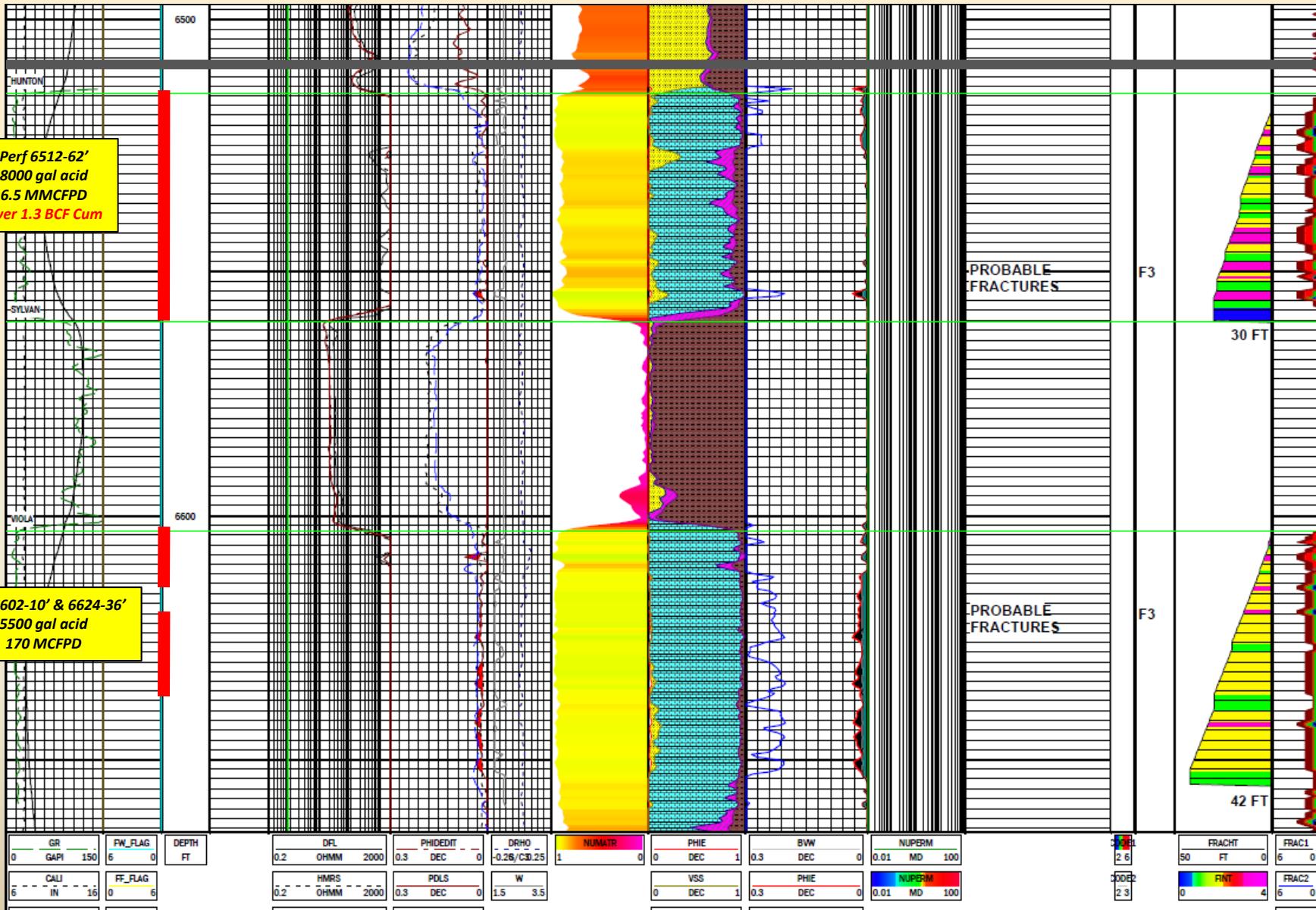


Hunton Example well #2



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

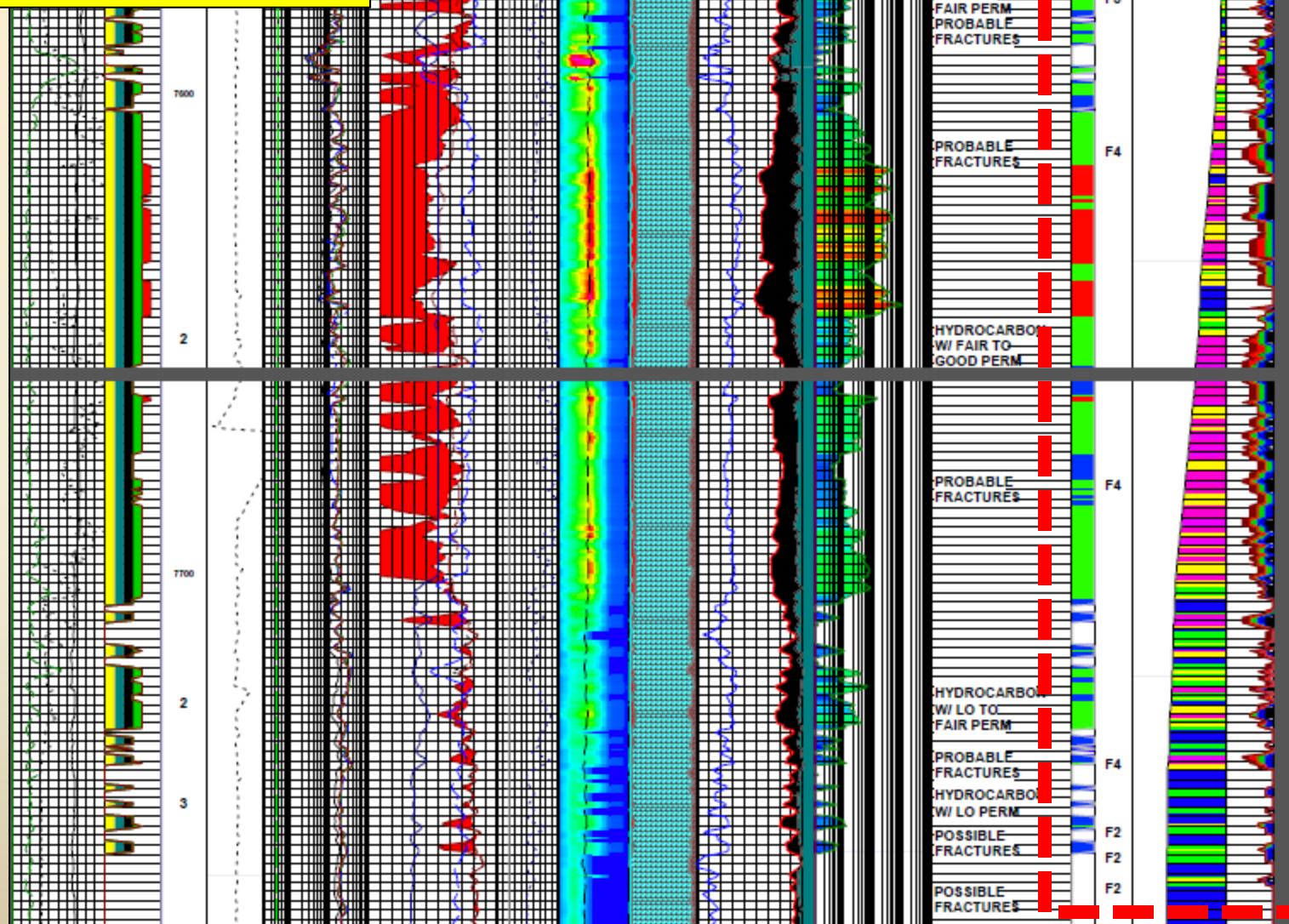
Haskell County, Ok (Kinta Field)



Both Hunton & Viola < 3% porosity & similar fracture response.
Hunton directly below source rock making it by far the better reservoir

Austin Chalk Fracture Interval

Backed by
Historical Drilling Results and
Production



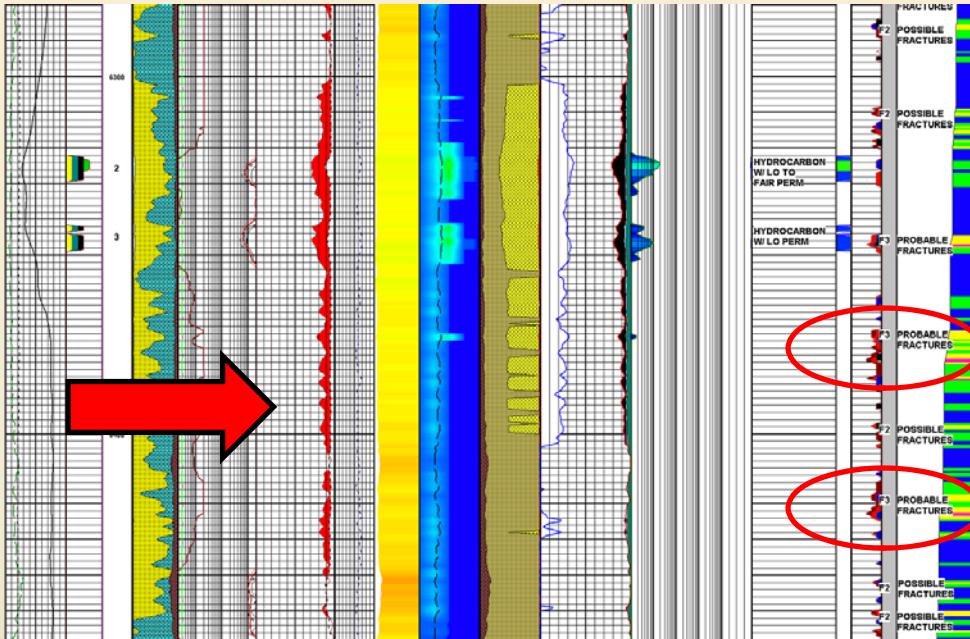
Mississippian Examples

Garfield County

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

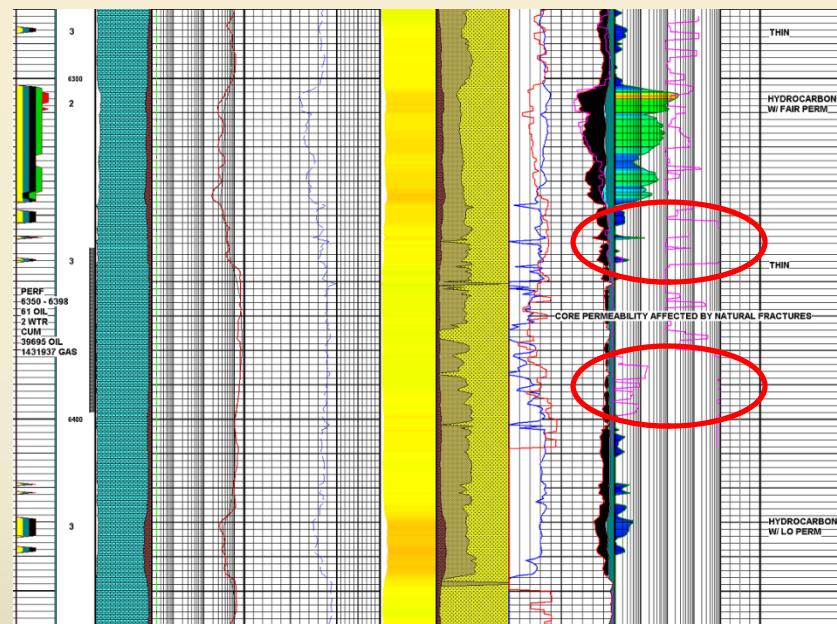
Logged 1982

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

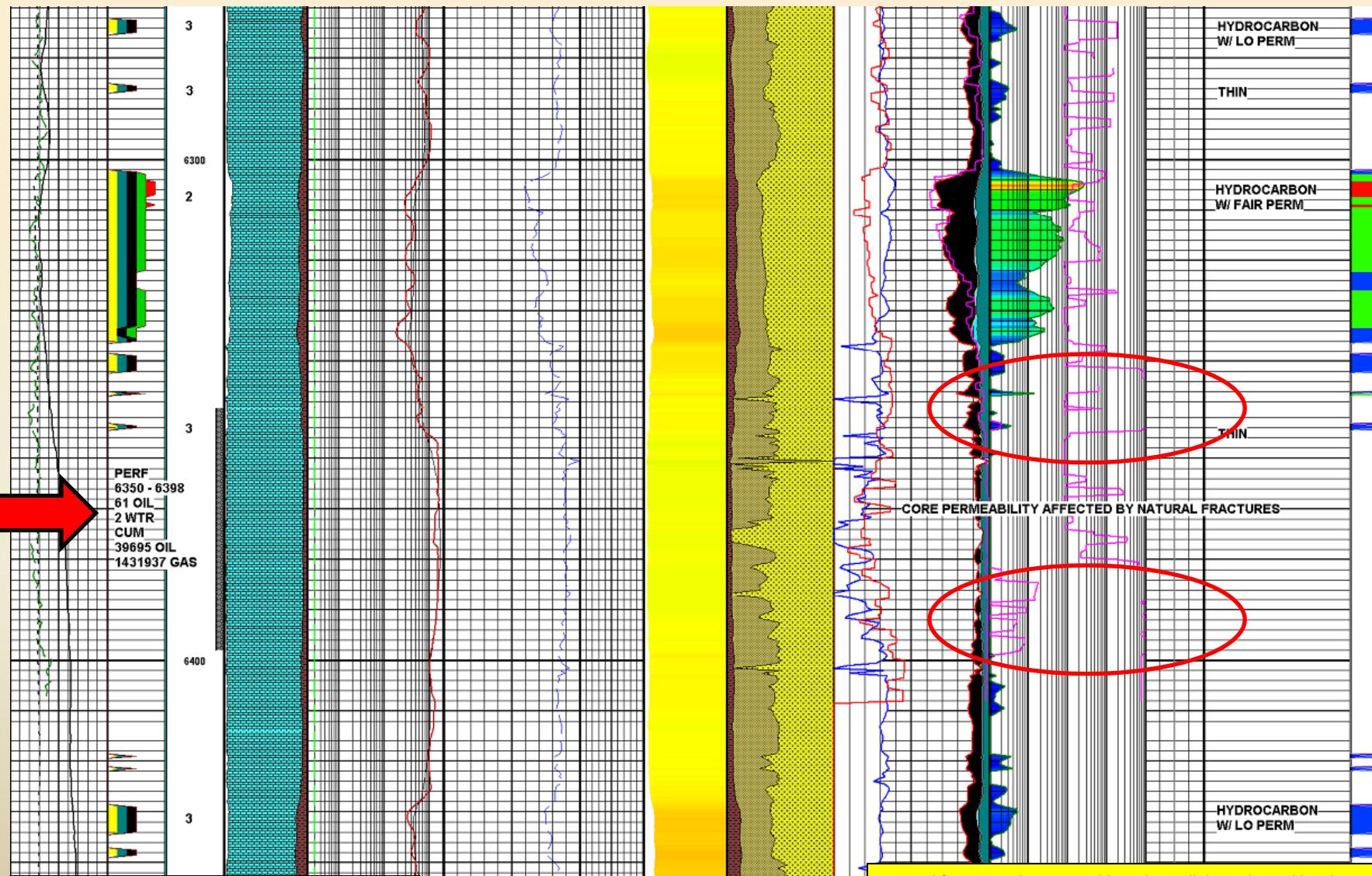


Note: these wells are located 3000' apart

1963

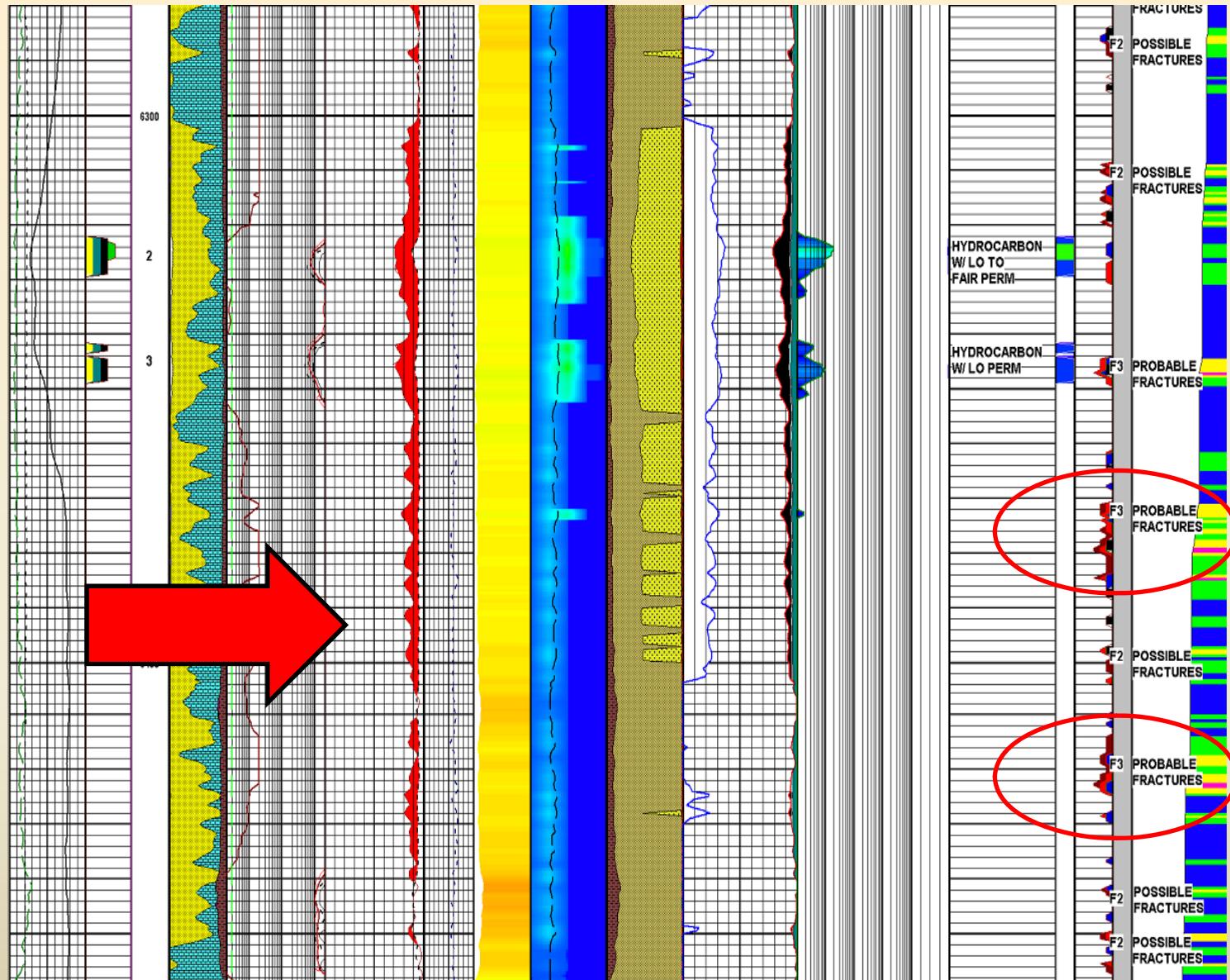
Perf. 6350-98'
IP 61 BO & 2 BW
Cum 1.4BCF & 40,000 BO

Perm Scale
0.01 mD – 100 mD



Natural fracture picks not possible in this well due to limited log data

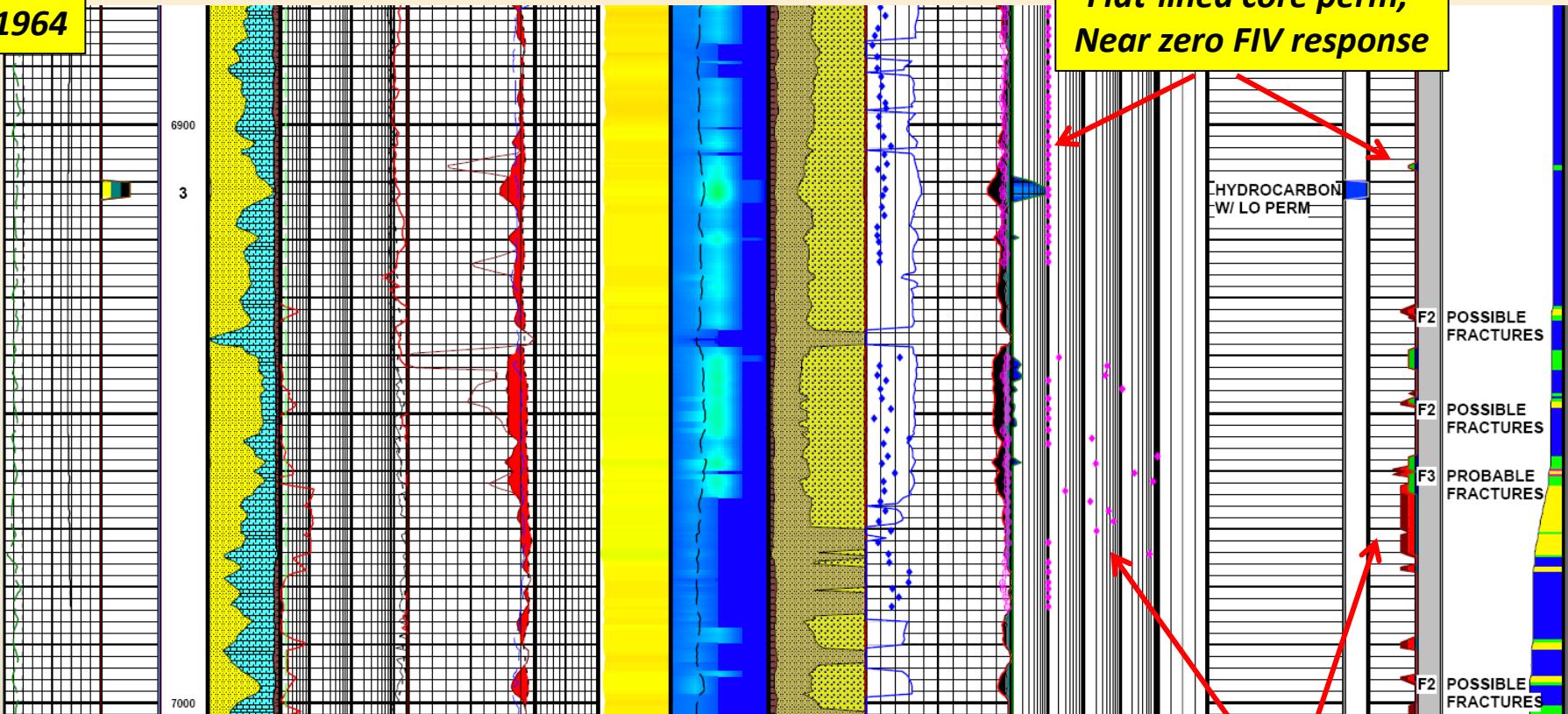
1982



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

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

1964



Flat-lined core perm,
Near zero FIV response

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

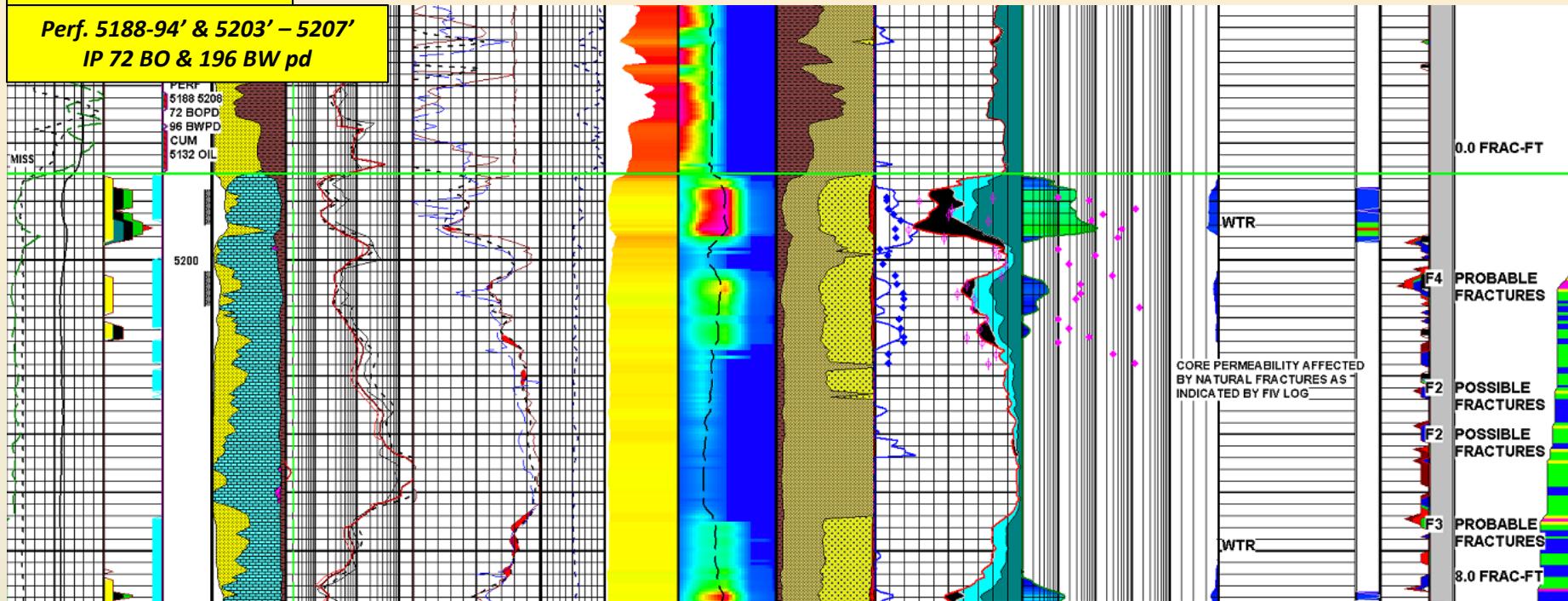
Core perm higher than Matrix perm,
Highly active FIV response

Grant County

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

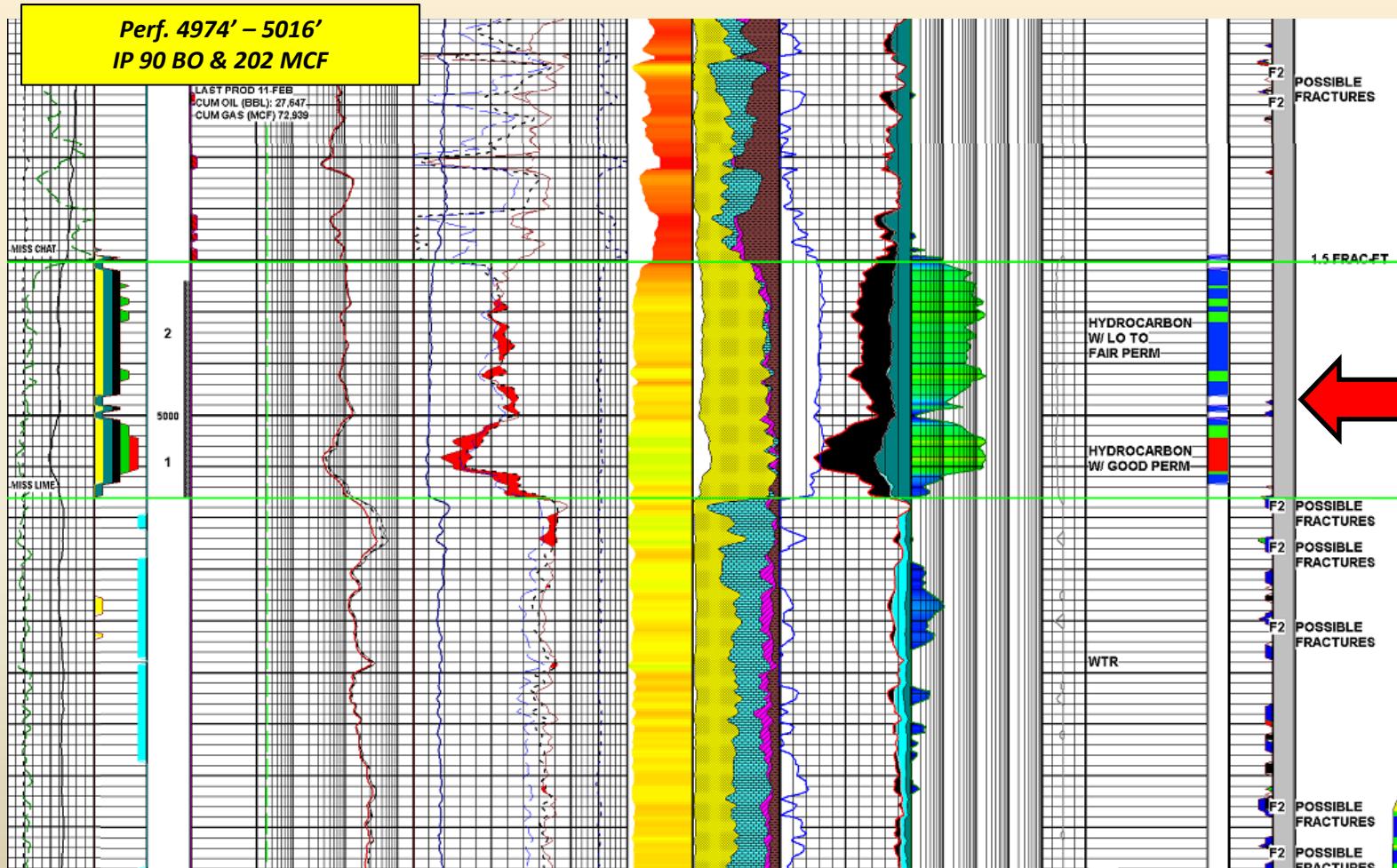
1967

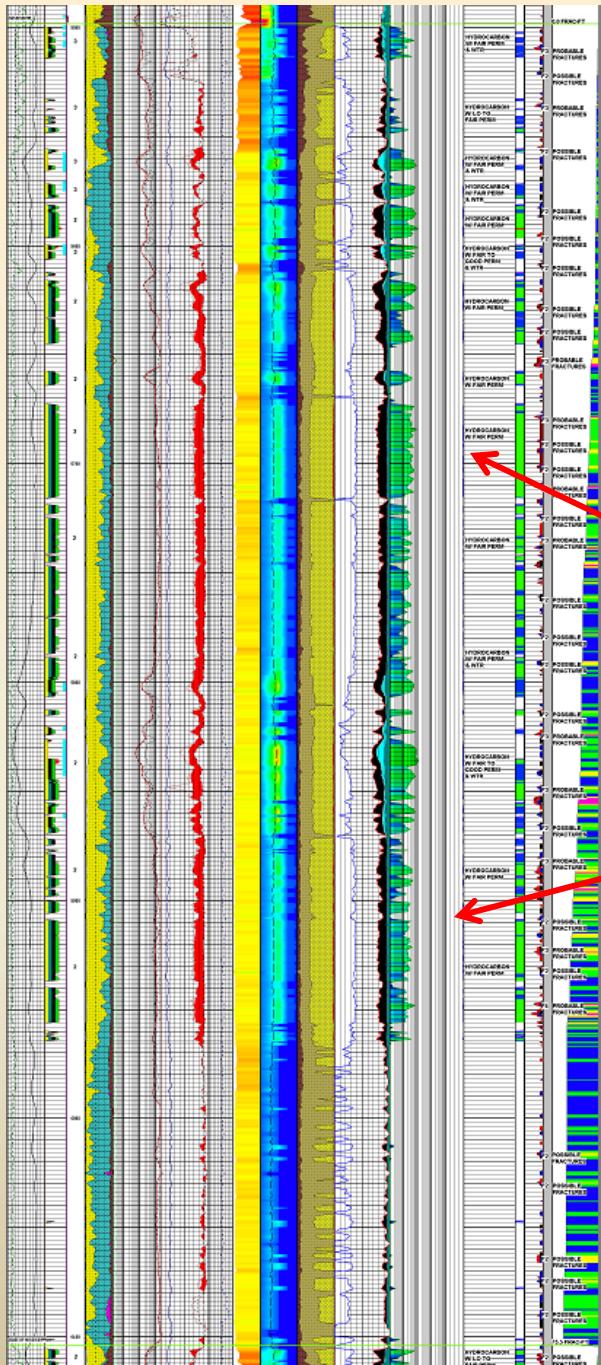
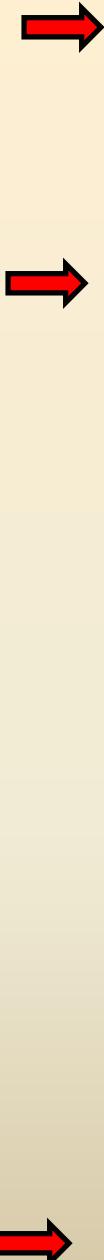
Perf. 5188-94' & 5203' - 5207'
IP 72 BO & 196 BW pd



GRC	GAPI	PW_FLAG	DEPTH	PHIE	LL8	PHIDEDIT	DRHO	NUMATR	NUSPEC	CLAY	SW	NUPERM	NUSPEC	FRAC	FIV	FRACHT		
0	150	6	0 FT	DEC 1	0.2 OHMM	200	0.3 DEC	0	0.1	0	1	0.01 MD	100	0.05 0	26	6	0 25	
CALD	IN	FF_FLAG	PERF	VSS	ILM	PDLS				TEXGM	0.1	SMALL	BW	NUPERM	W	0D1	FRAC	FRACHT
6	16	0	8 0	0 DEC 1	0.2 OHMM	200	0.3 DEC	0	100	0	0	0.3 DEC	0	0.01 MD	100	23	6 0	0 25
SPBL	MV	LW_FLAG	CALIFLG	VLS	ILD	PDLS				TEXGM	0.1	MEDIUM	PHIE	CORPERM	%	0D2	FRAC1	FINT
-120	30	0	10	0 DEC 1	0.2 OHMM	200	0	0	100	0	0	0.3 DEC	0	0.01 MD	100		6 0	0 4
FHC_FLAG		VOL		RT	PCNLS					SMALL	BW	NUPERM	W			FRAC2		
KF_FLAG										MEDIUM	PHIE	CORPERM	%			FRAC3		
KG_FLAG										LARGE	0.3 DEC	0				FRAC4		
										CORPOR	30 %					FRAC5		
										CORSW	100 %	-100						

Woods County
NWOK Miss play not fracture driven (so far)





Garfield County – Left Behind Pay?

606 ft of Miss

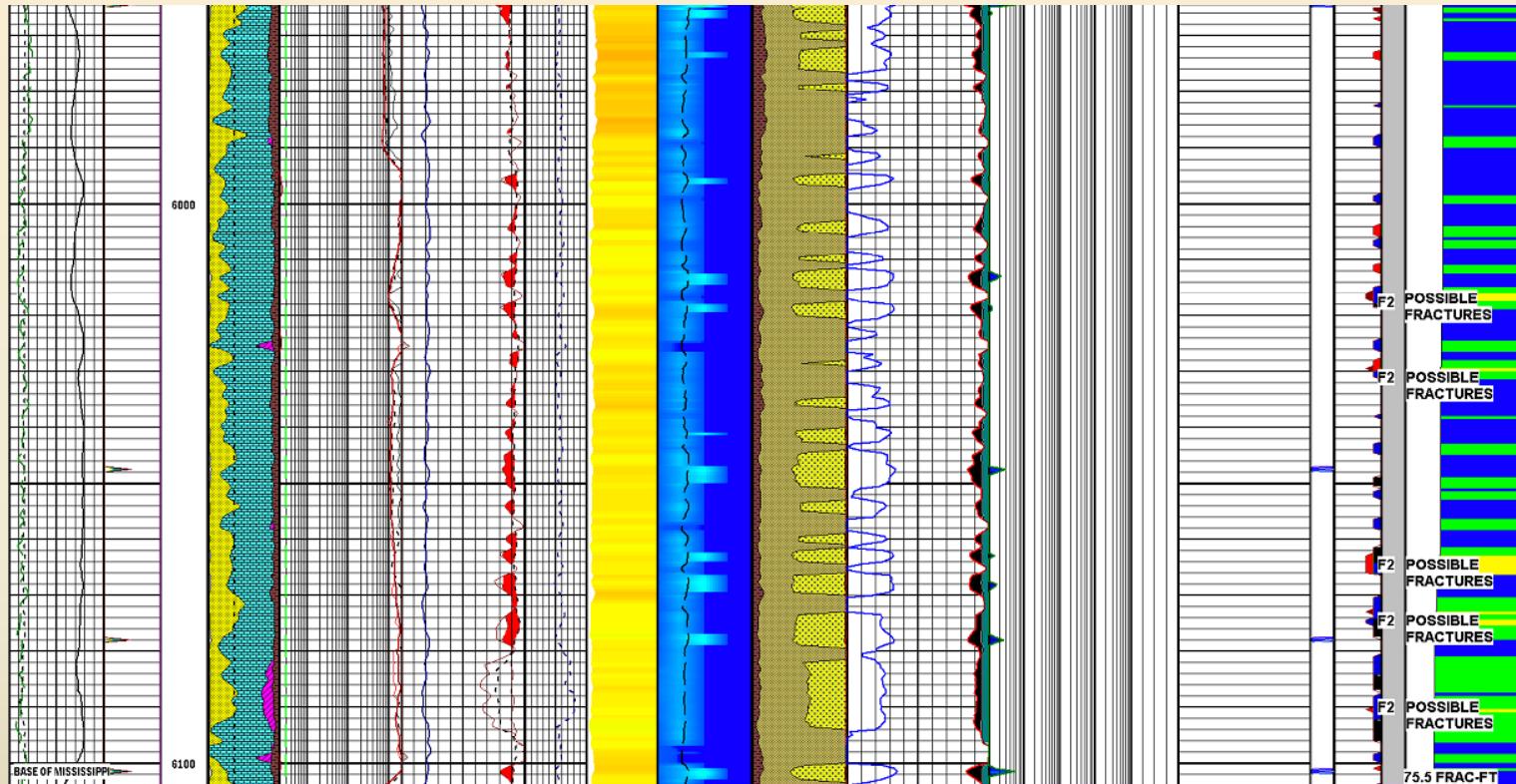
Perf. 5500', 5612-50' & 6074-110'
IP 3 BO, 48 MCF & 90 BW

*Significant Naturally
fractured section
Unperforated*

Garfield County – Left Behind Pay?

Perf. 5500', 5612-50' & 6074-110'
IP 3 BO, 48 MCF & 90 BW

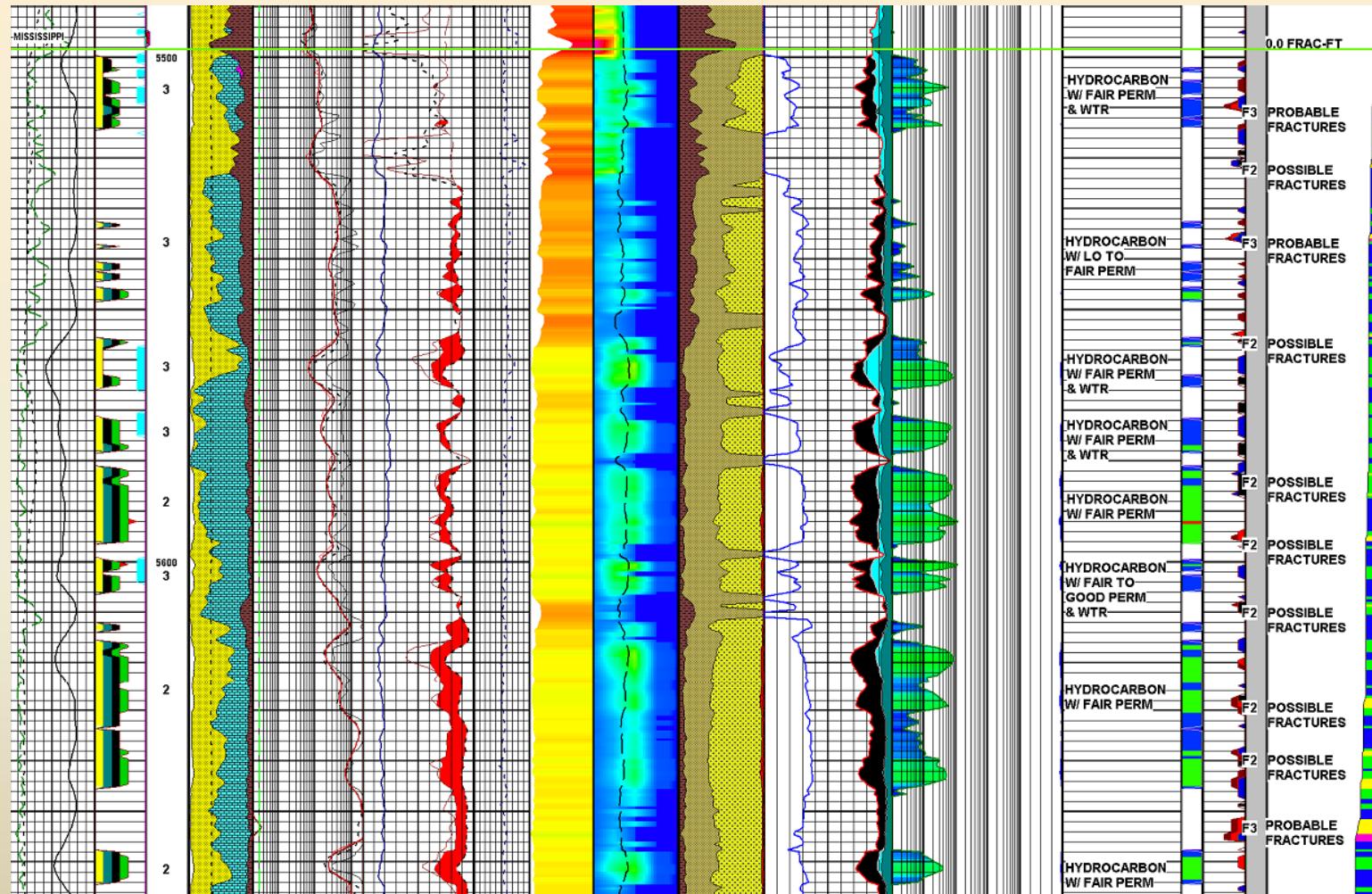
Lower Section – tested tight



Garfield County – Left Behind Pay?

Perf. 5500', 5612-50' & 6074-110'
IP 3 BO, 48 MCF & 90 BW

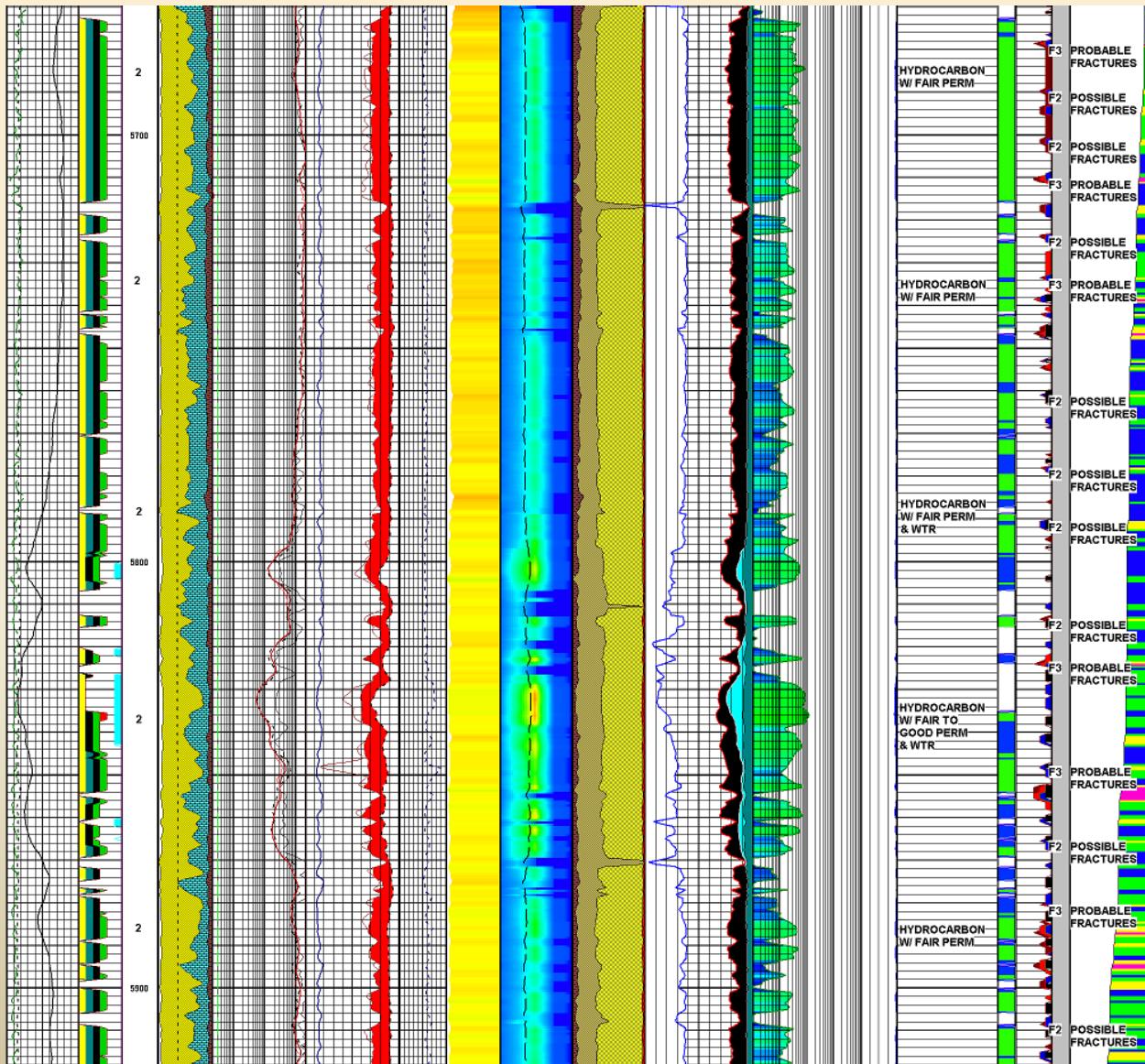
Upper Section – scared away by water production



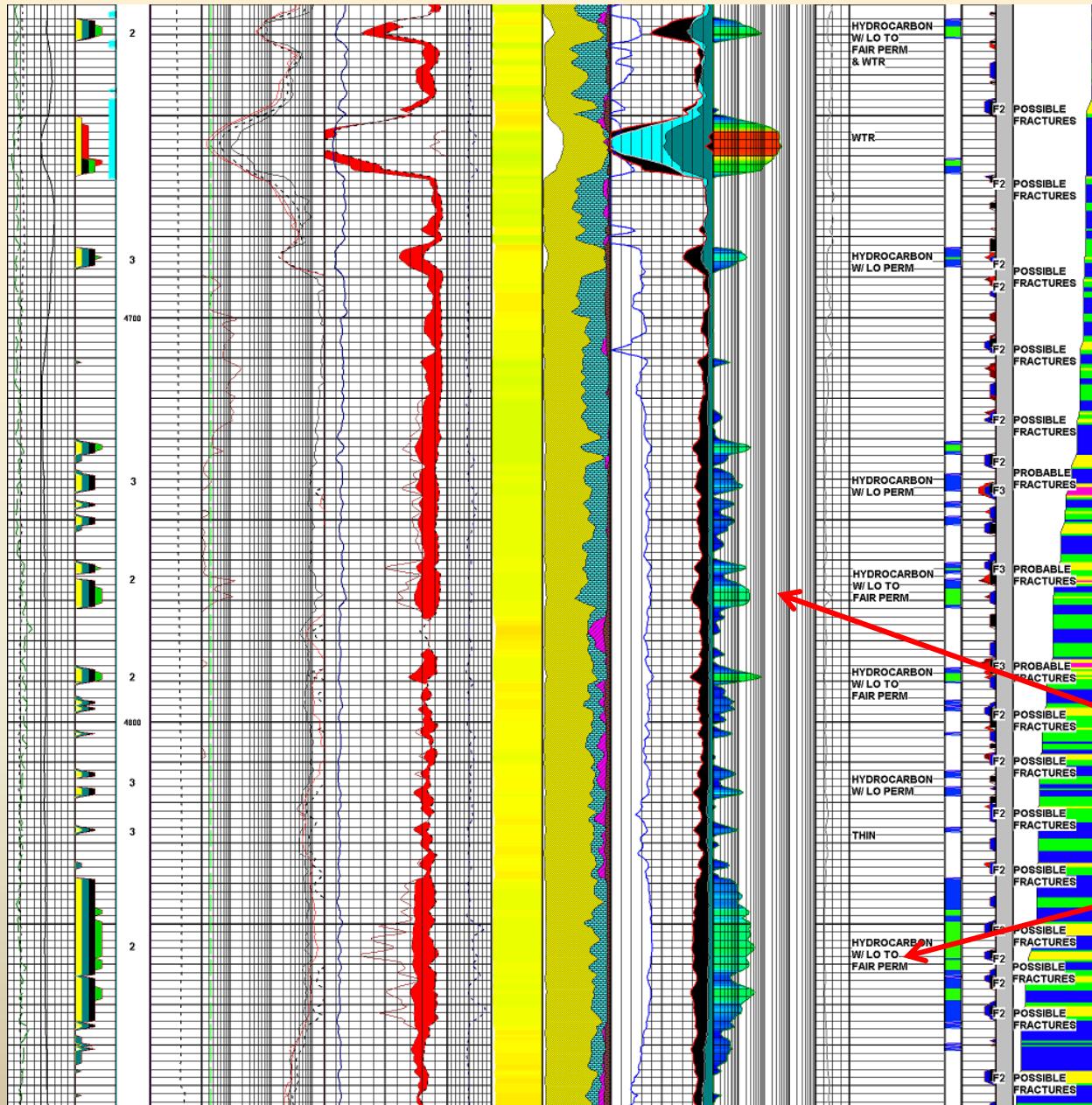
Garfield County – Left Behind Pay?

Perf. 5500', 5612-50' & 6074-110'
IP 3 BO, 48 MCF & 90 BW

Untested Middle Section

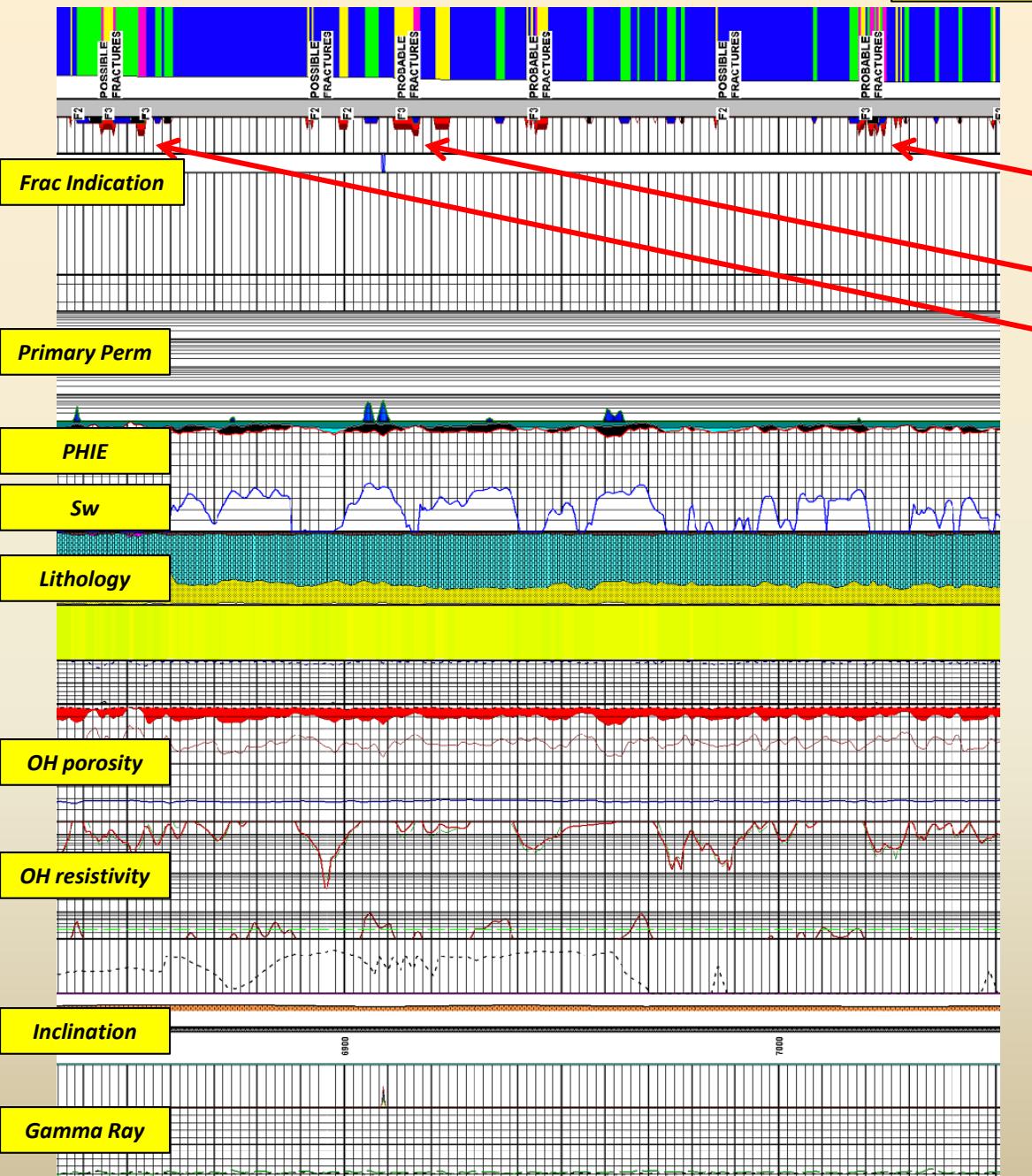


Sumner Co, KS



Primary reservoir development
Significant Natural fractured indication

Fracture ID in a Horizontal



*Lateral intersecting
fractures*

Thank you