Seismic Interpretation of Rich Hill 3D Salt Creek and Rich Hill Townships Muskingum County Ohio

2019 AAPG Eastern Section Columbus Ohio

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ARTEX OIL COMPANY

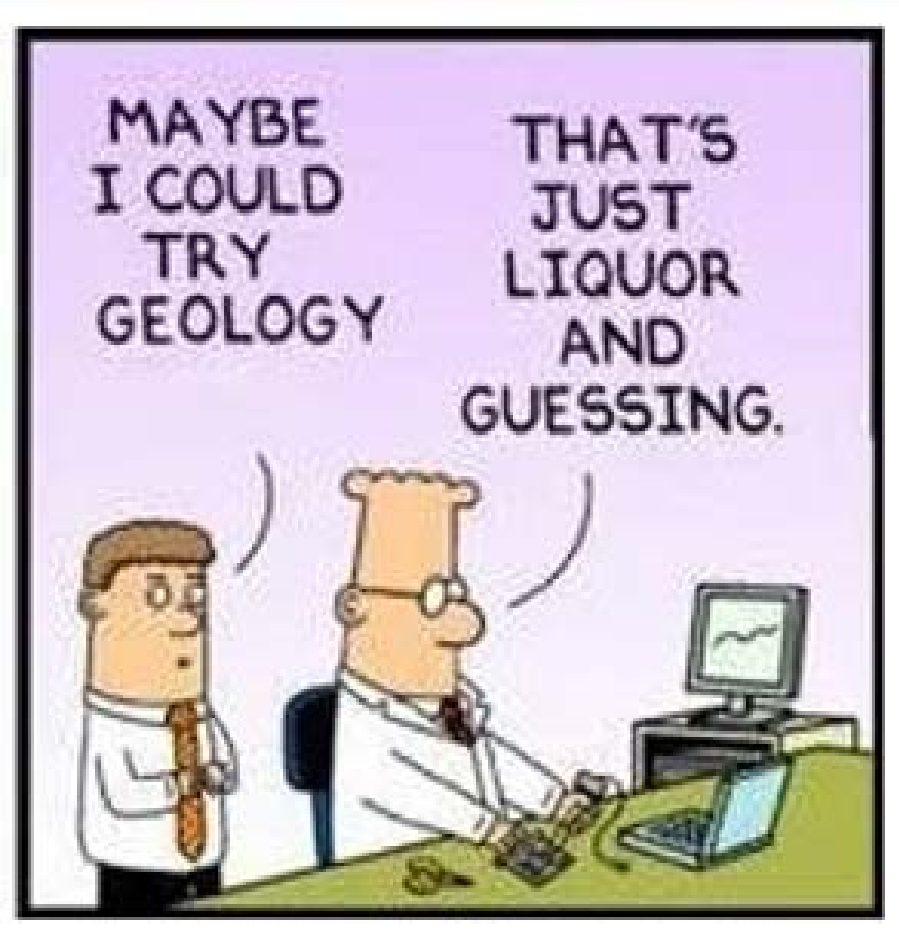
EMF GEOSCIENCE, INC.

CASTO PETROLEUM ENGINEERING

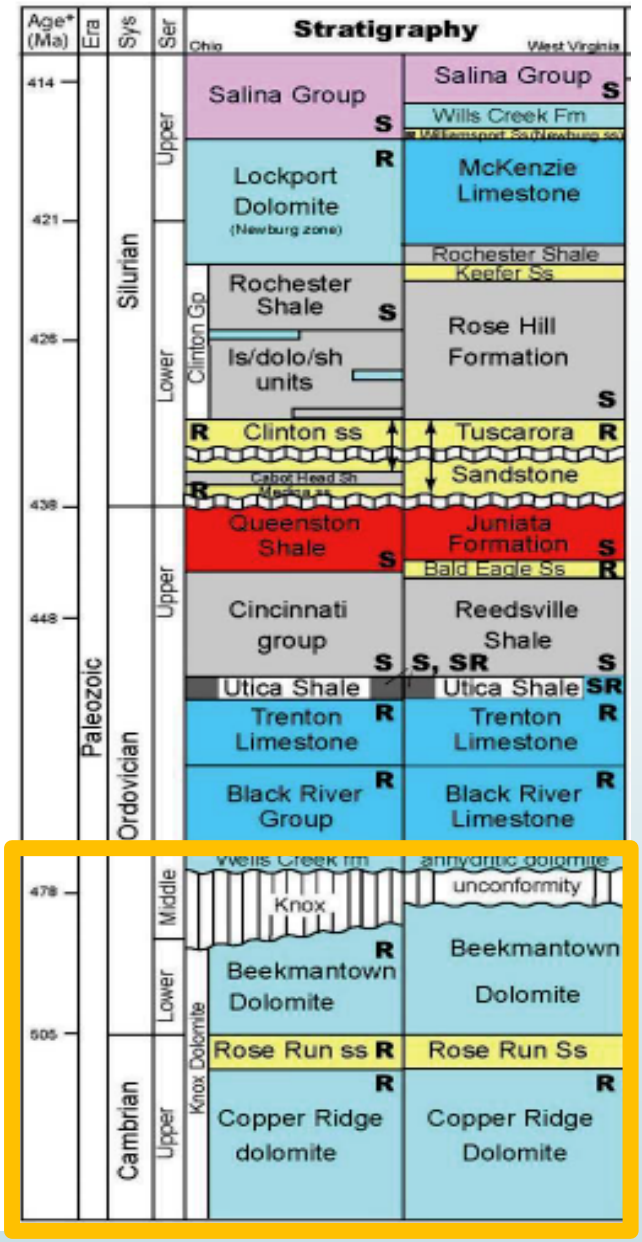
Outline

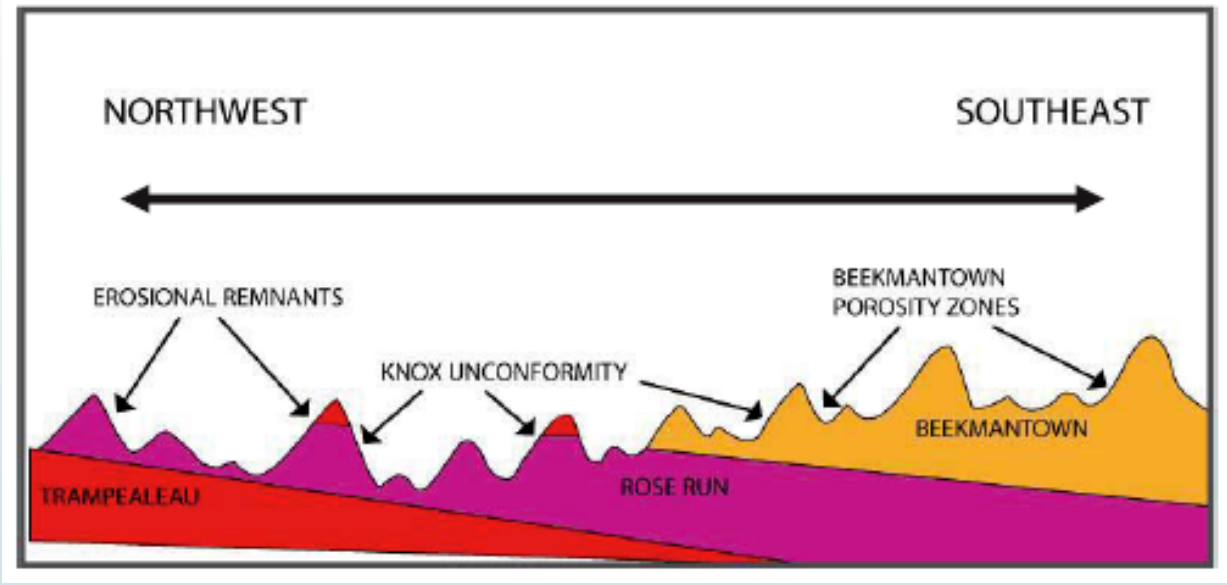
- Beekmantown Dolomite Stratigraphy
- Rich Hill 3D Seismic
- Differential Compaction in the Knox Group
- Increasing Frequency in the 3D Data

Problem: Thin paleokarst reservoirs within the Beekmantown Dolomite can make seismic interpretation difficult.

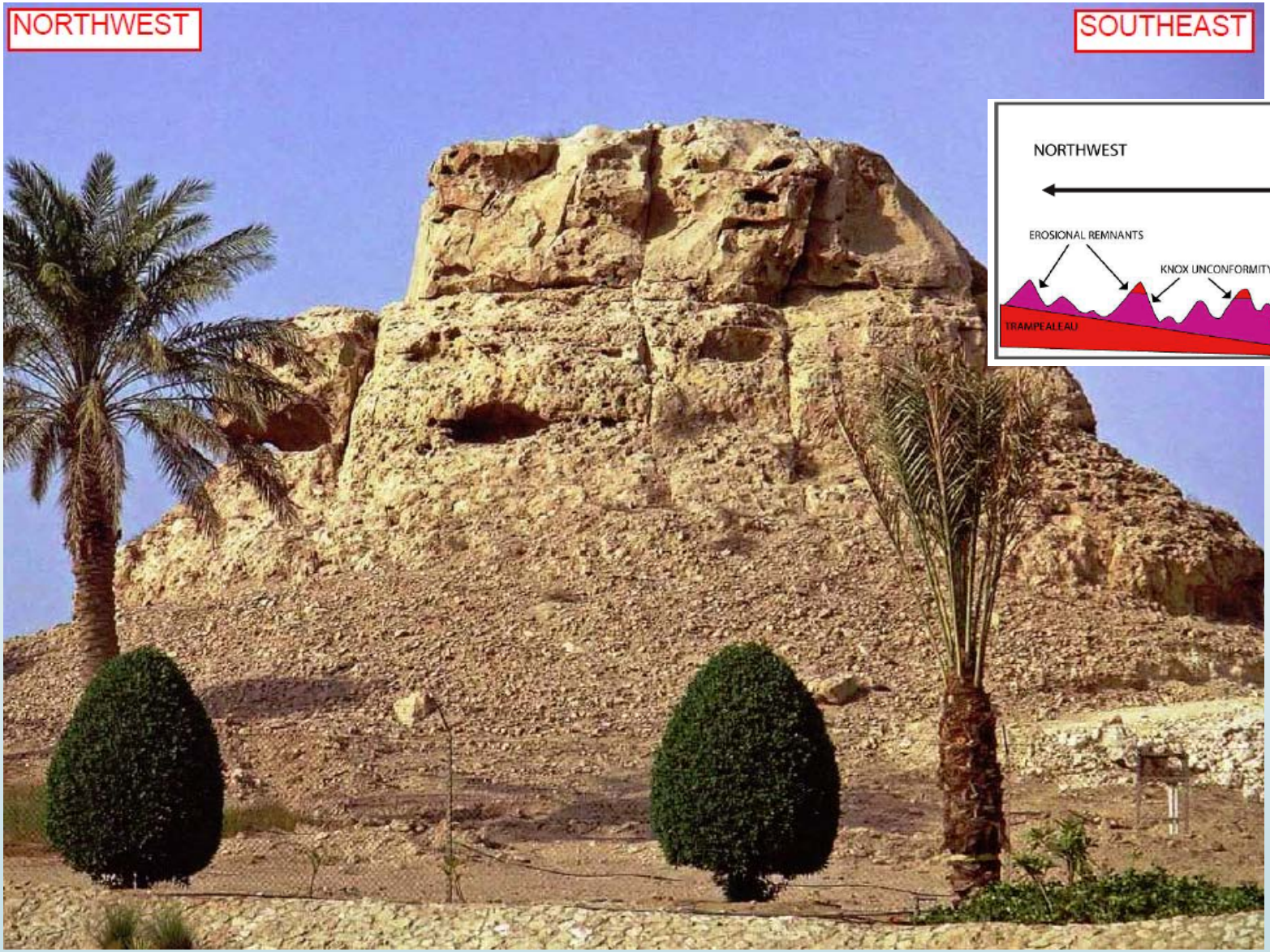


Stratigraphy





Source: Ohio Geological Survey

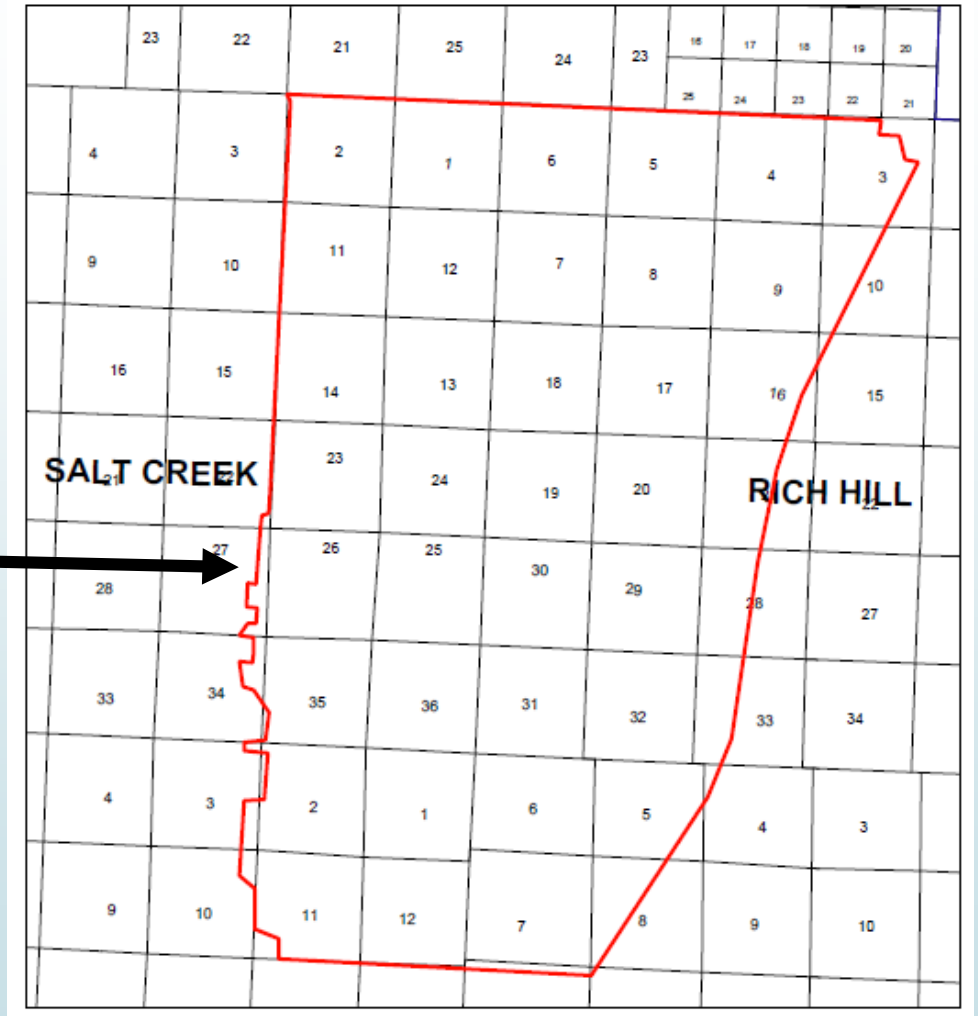


Post-Knox Unconformity (PKUNC)

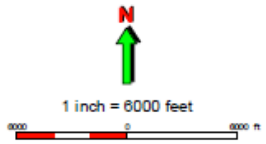
Source: Middle East, AAPG Bulletin

Rich Hill 3D

32 Square Mile 3D Shoot



All interpretation done with post stack data



ARTEX/ EMF

RICH HILL 3D OUTLINE
MUSKINGUM CO., OHIO

PREPARED BY EMF GEOSCIENCE

Scale: 1 INCH = 6000 FT

Date: 30 April, 2019

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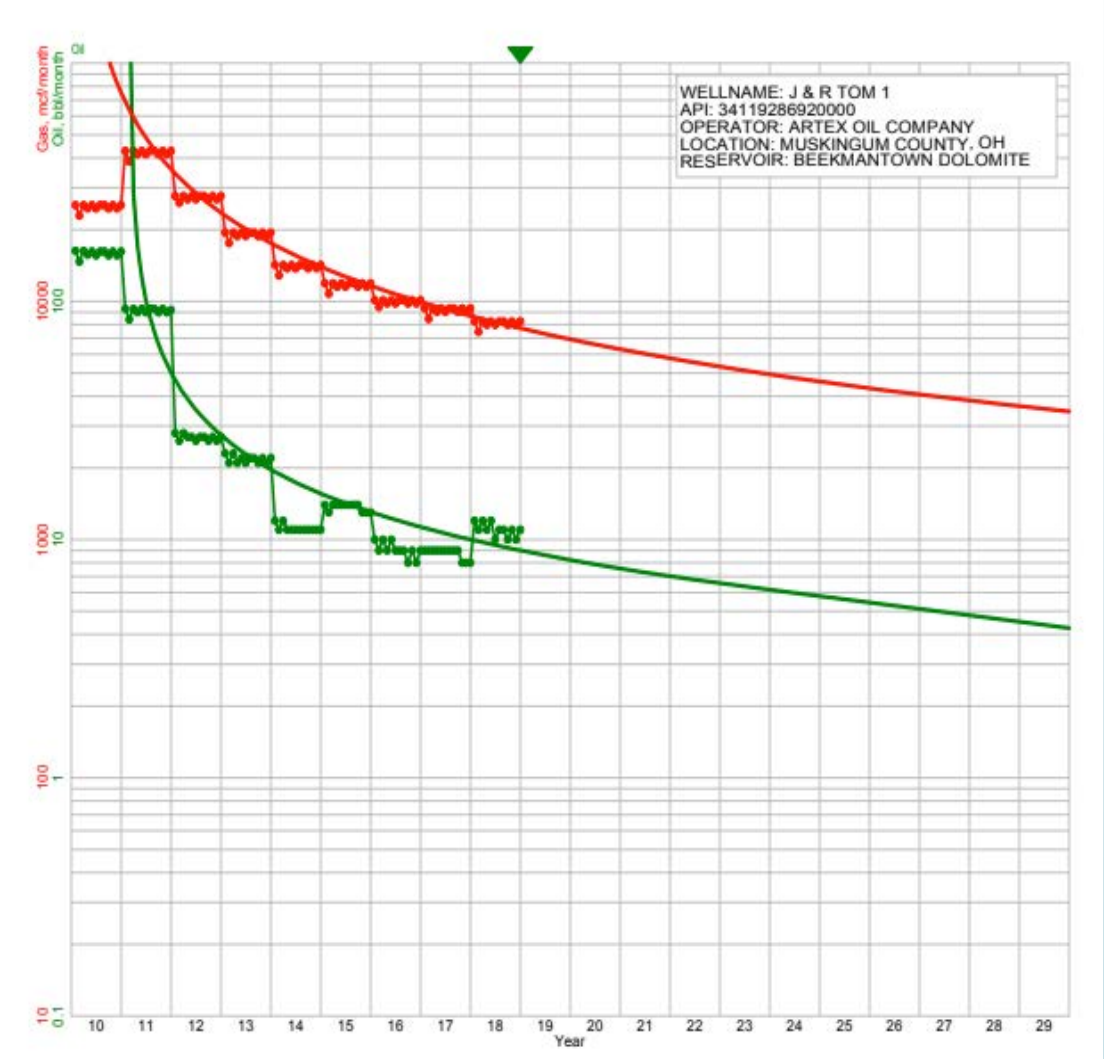


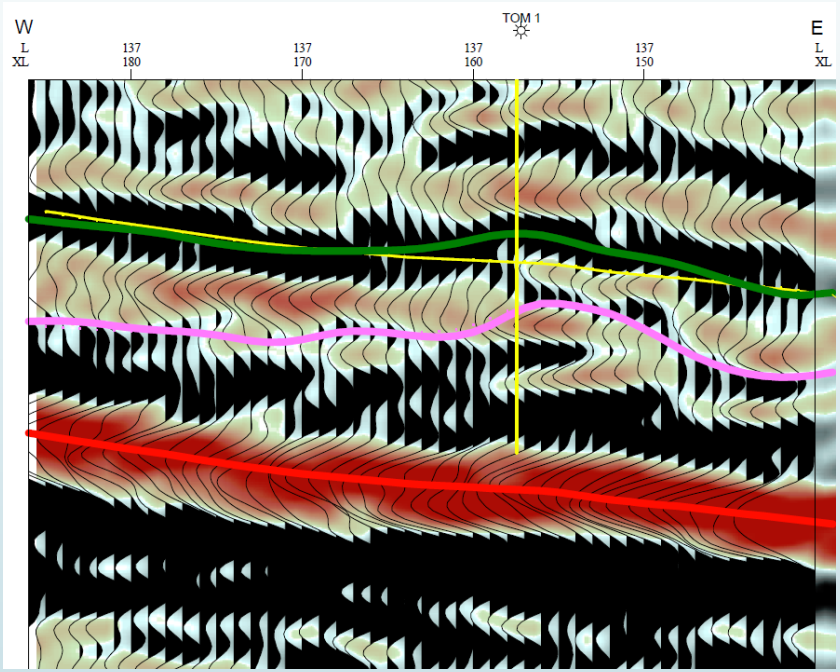
Who Cares?

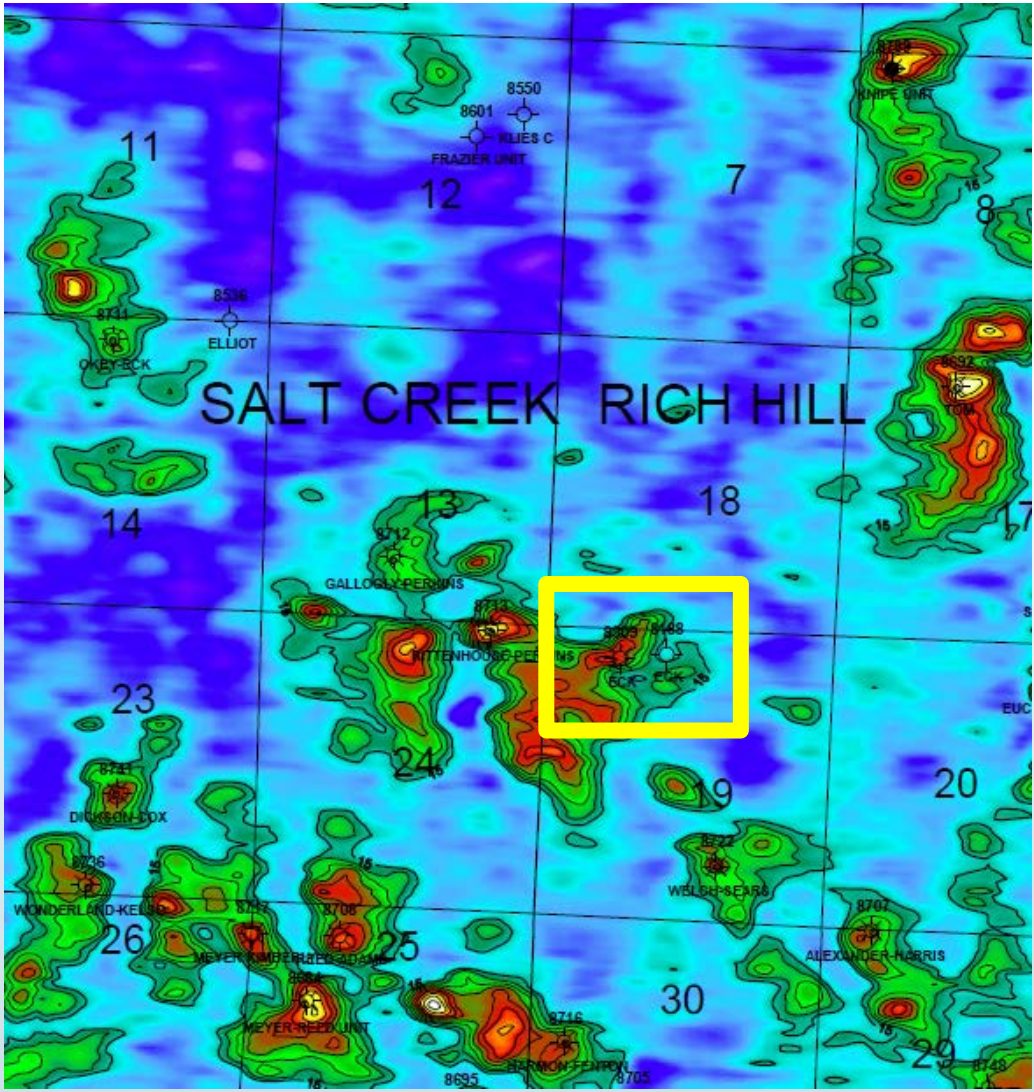
EUR: ~17.5 BCF of gas within 29 producers

Finding Costs: ~$1.00 per MCF at time of full development

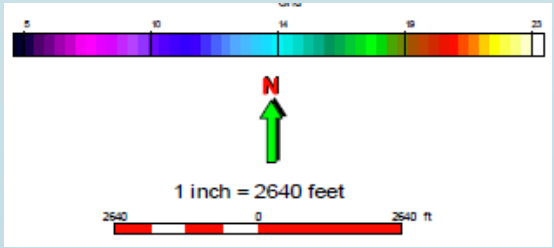
Beekmantown Isochron

PKUNC to the Rose Run horizon (ms)





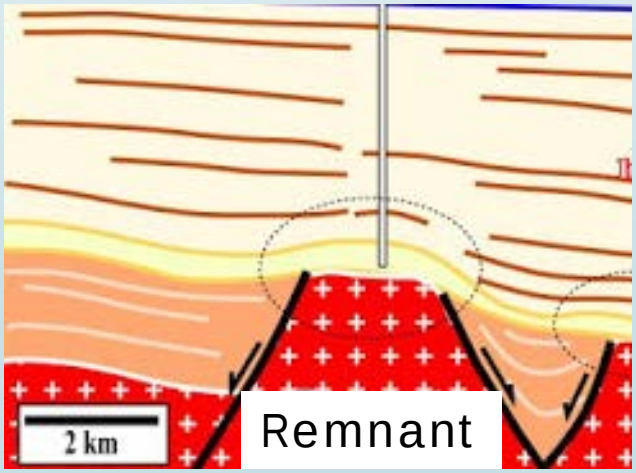
EMF GEOSCIENCE		
ARTEX OIL - RICH HILL 3D BEEKMANTOWN ISOCHRON (MS) 1 MS ~ 10 FT		
PREPARE BY EMF		Date: 18 April, 2019
	Scale: 1 IN = ½ MILE	

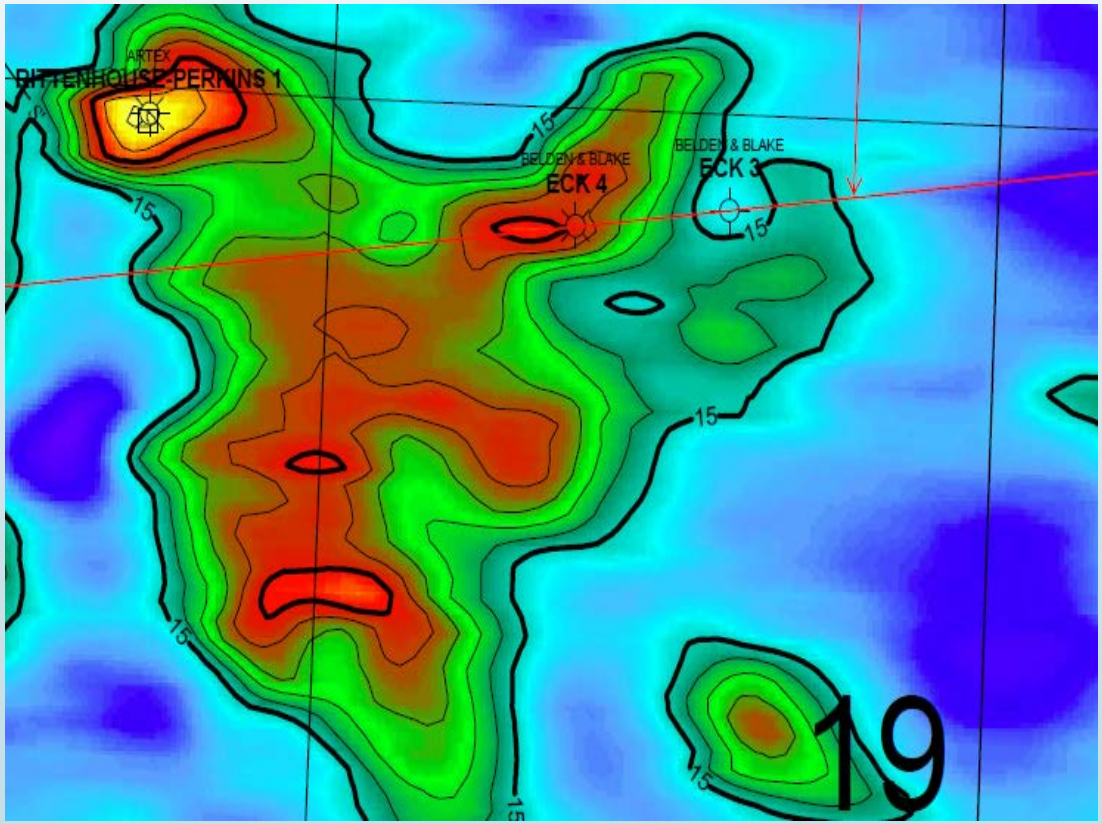


Differential Compaction:

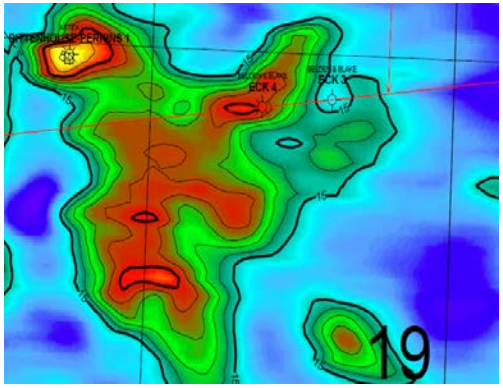
Due to water expulsion from the mud and alignment of the clay minerals due to overburden pressure, shale compacts and will take up far less vertical section in the sub-surface.

Example: Eck 4 and Eck 3





W



E

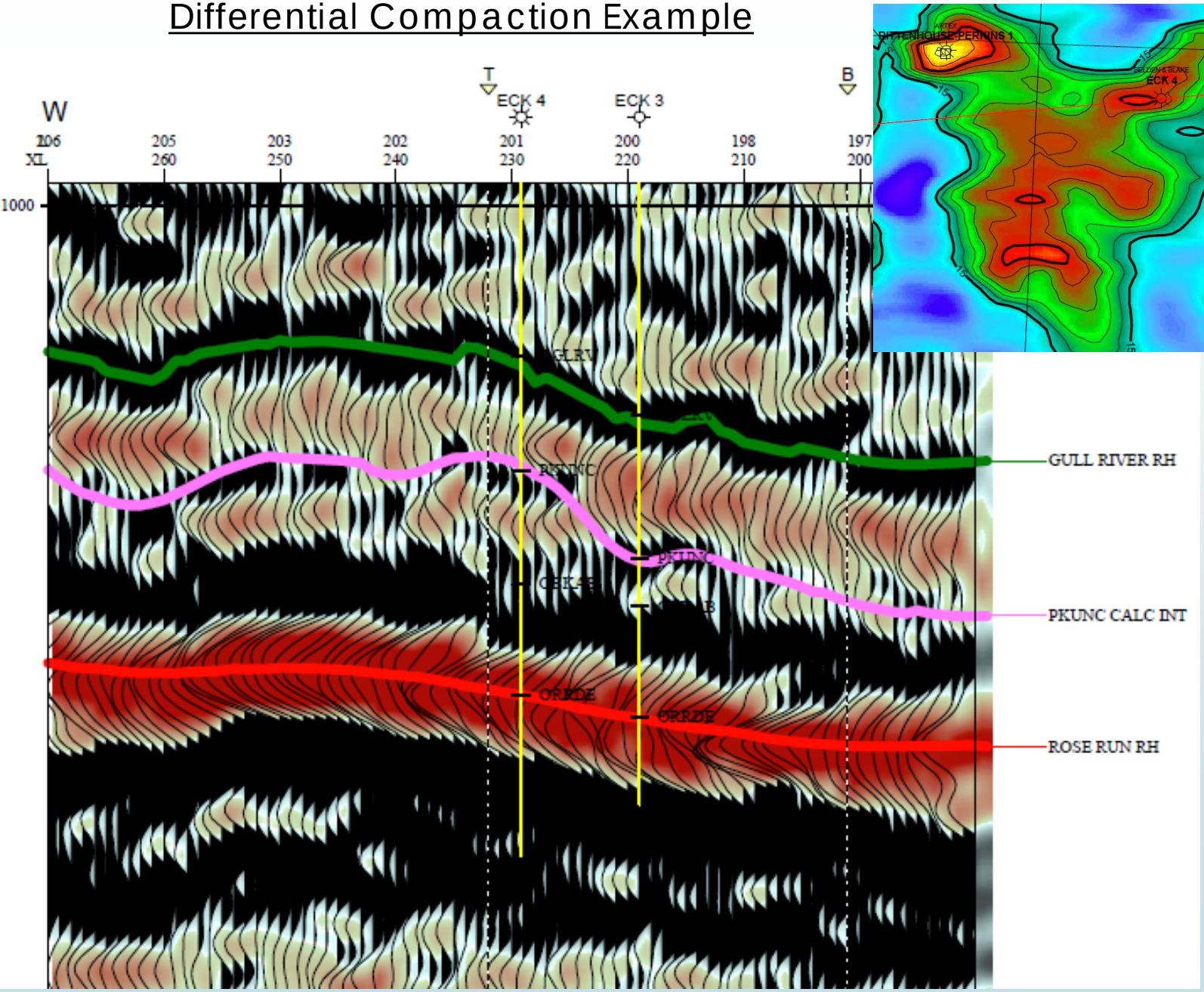
Eck cross-section shows that Lower Chazy plus Glenwood Shale compacts to about 62% of its original thickness.

Well-site rule of thumb: For every foot of Lower Chazy + Glenwood you drill, you lose 1.5 foot of Beekmantown.

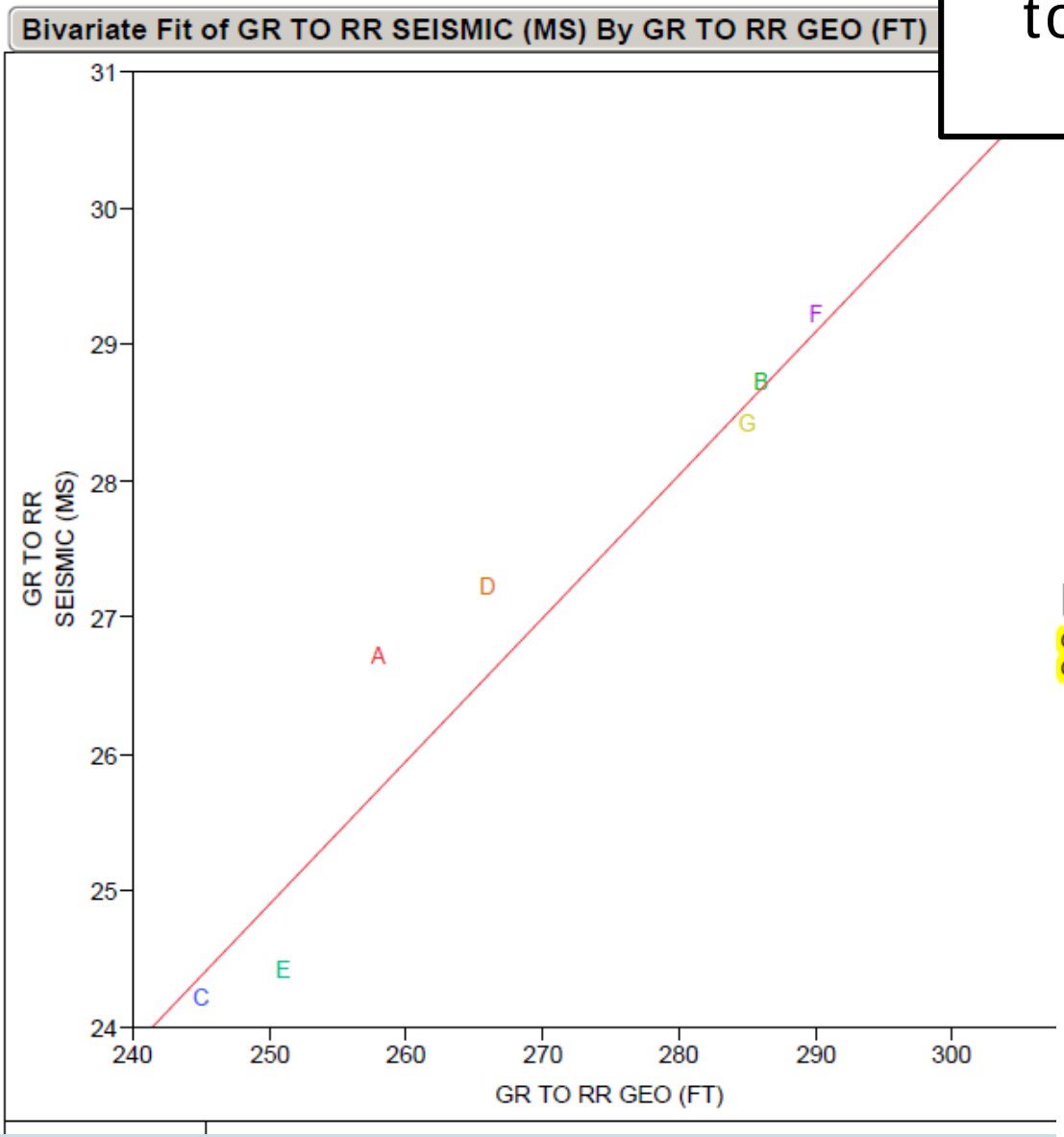
Eck #4: 350,000 MCF

Eck #3: Dry Hole

Differential Compaction Example



Ability to convert Gull River to Rose Run footage into milliseconds



A - ECK #3 (3411928188)

B - ECK #4 (3411928309)

C - ELLIOT #1 (3411928536)

D - KIRSCH #1 (3411928338)

E - KLIES #1 (3411928550)

F - OHIO POWER #47K (3411927886)

G - TROY- TOM #1 (3411928069)

H - WORSTALL #1 (3411928157)

Linear Fit

GR TO RR SEISMIC (MS) = -1.29125 + 0.1047647*GR TO RR GEO (FT)

Summary of Fit

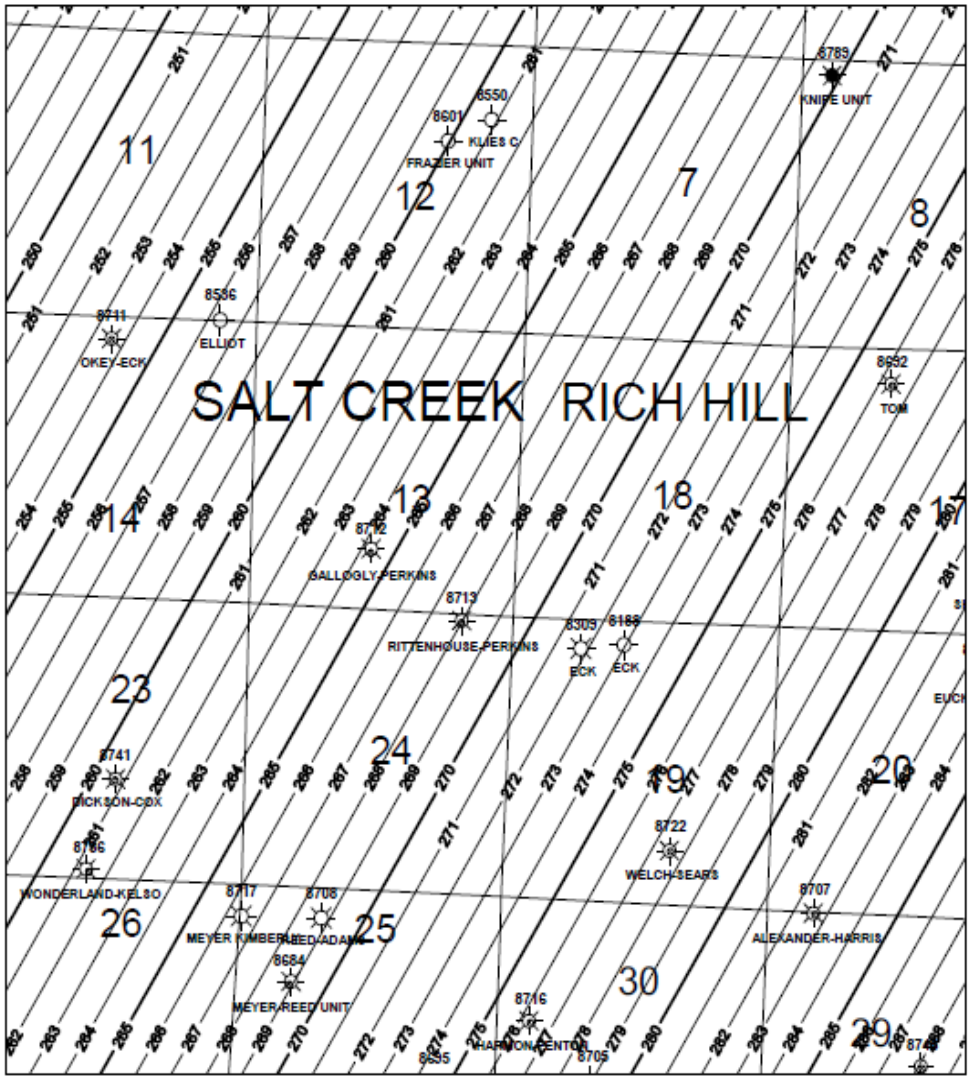
RSquare	0.956692
RSquare Adj	0.949474
Root Mean Square Error	0.527942
Mean of Response	27.375
Observations (or Sum Wgts)	8

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	36.942664	36.9427	132.5428
Error	6	1.672336	0.2787	Prob > F
C. Total	7	38.615000		<.0001*

Parameter Estimates

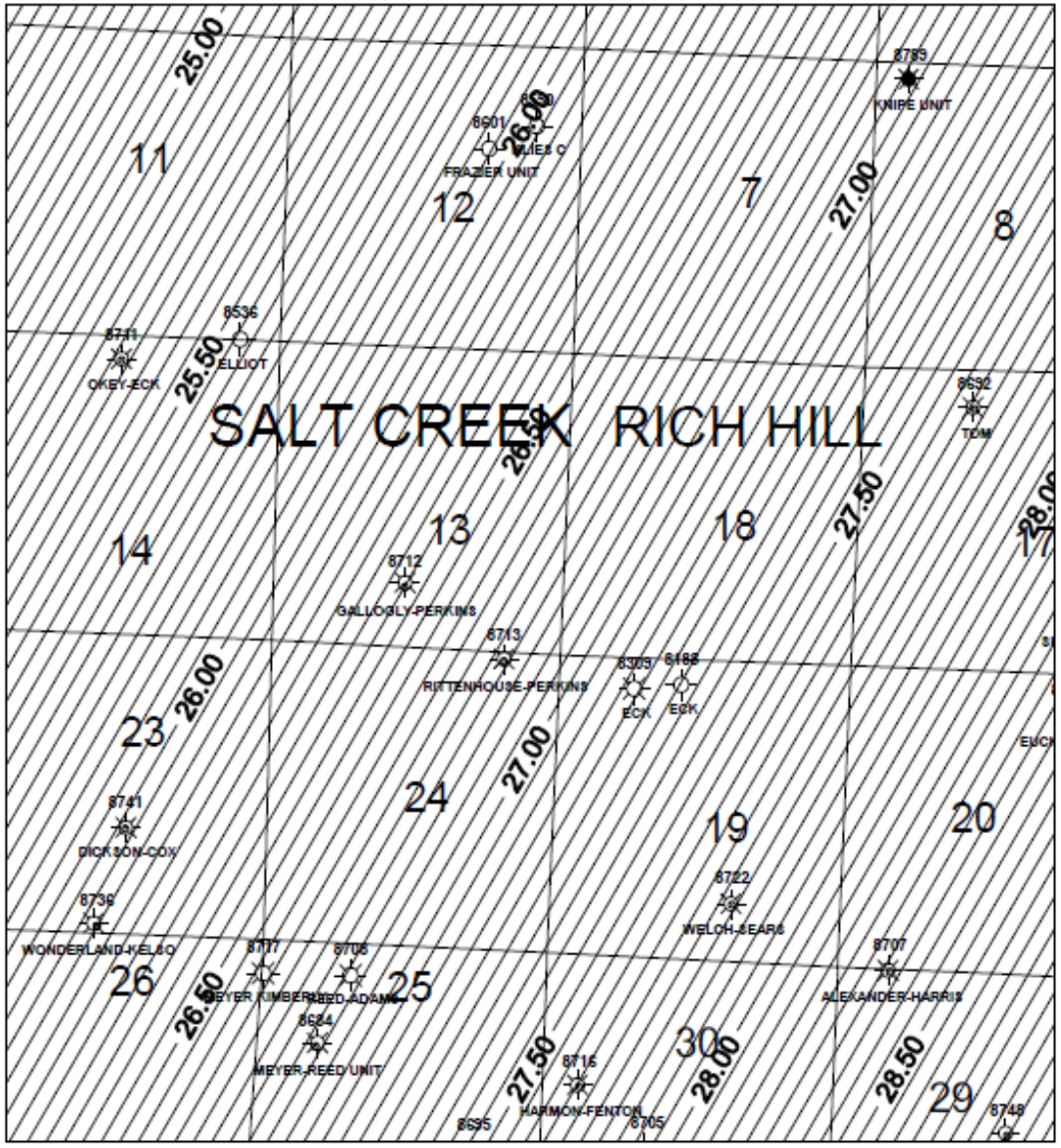
Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-1.29125	2.496949	-0.52	0.6236
GR TO RR GEO (FT)	0.1047647	0.0091	11.51	<.0001*



Gull River to Rose Run Isopach first order trend (ft).

This surface is placed from the formula on the previous slide and the resulting layer is the Gull River to Rose Run Isochron (ms) first order trend shown on the next slide.

ARTEX OIL / EMF GEOSCIENCE		
RICH HILL 3D ROSE RUN TO GULL RIVER 1ST ORDER TREND SURFACE (FT)		
PREPARE BY EMF		Date: 23 April, 2019
	Scale: 1 IN = ½ MILE	



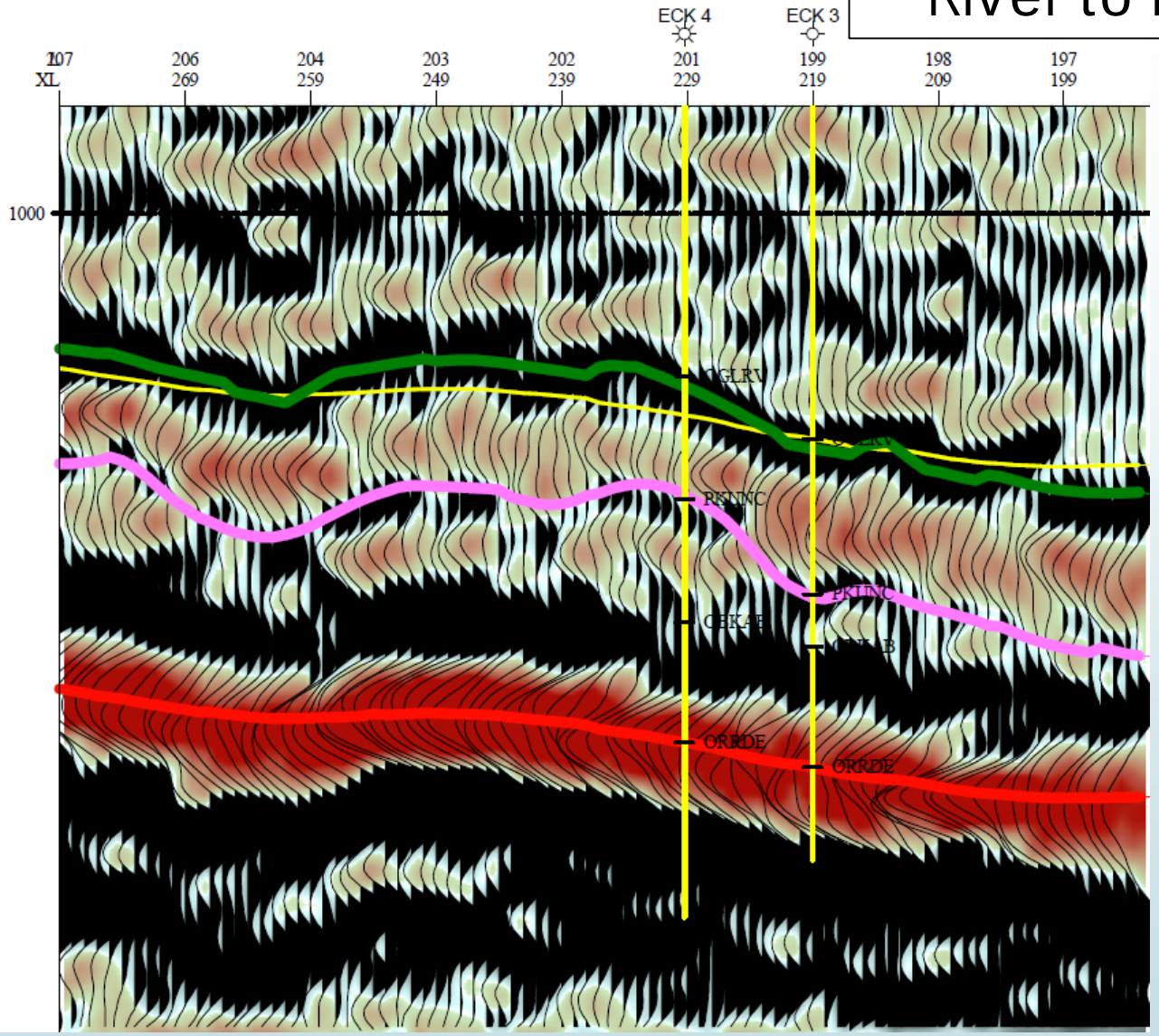
Gull River to Rose Run Isochron first order trend map (ms).

This surface is the first order trend calculated from the Gull River to Rose Run Isopach (ft) using the equation shown previously.

Import surface into seismic software as (xyz file) and subtract from the Rose Run horizon that was manually picked (ms).

Summary Thus Far

Yellow line is projected Gull River to Rose Run Isochron



\+

Gull River

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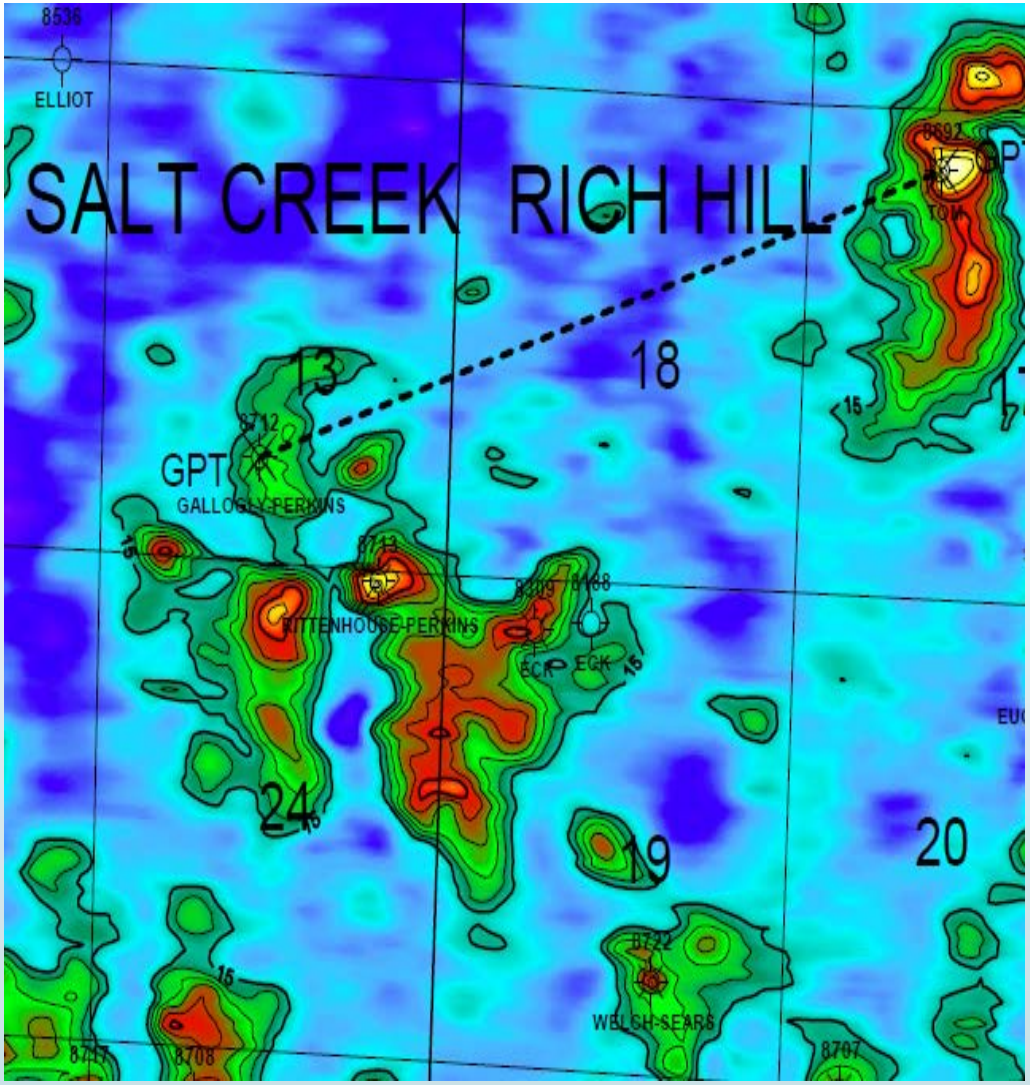
Post Knox Unconformity

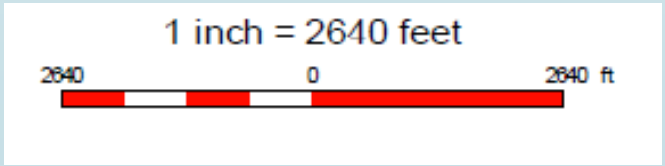
Rose Run Sandstone

1.) Rose Run 2.) Gull River 3.) Project the Gull River 4.) Interpret PKUNC



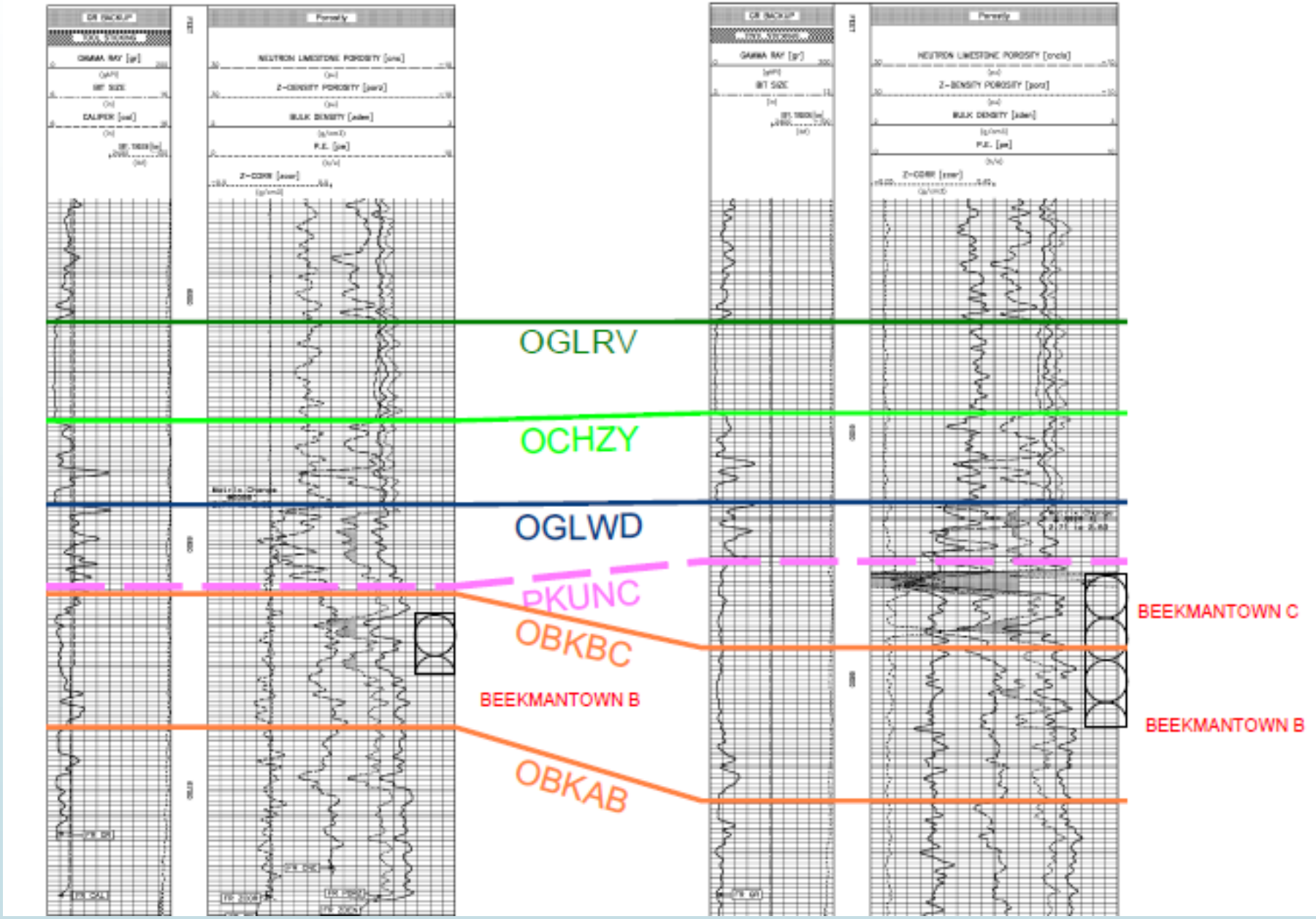
Example of low relief vs high relief success.

If remnants in the Beekmantown get too tall they become tight and less productive.

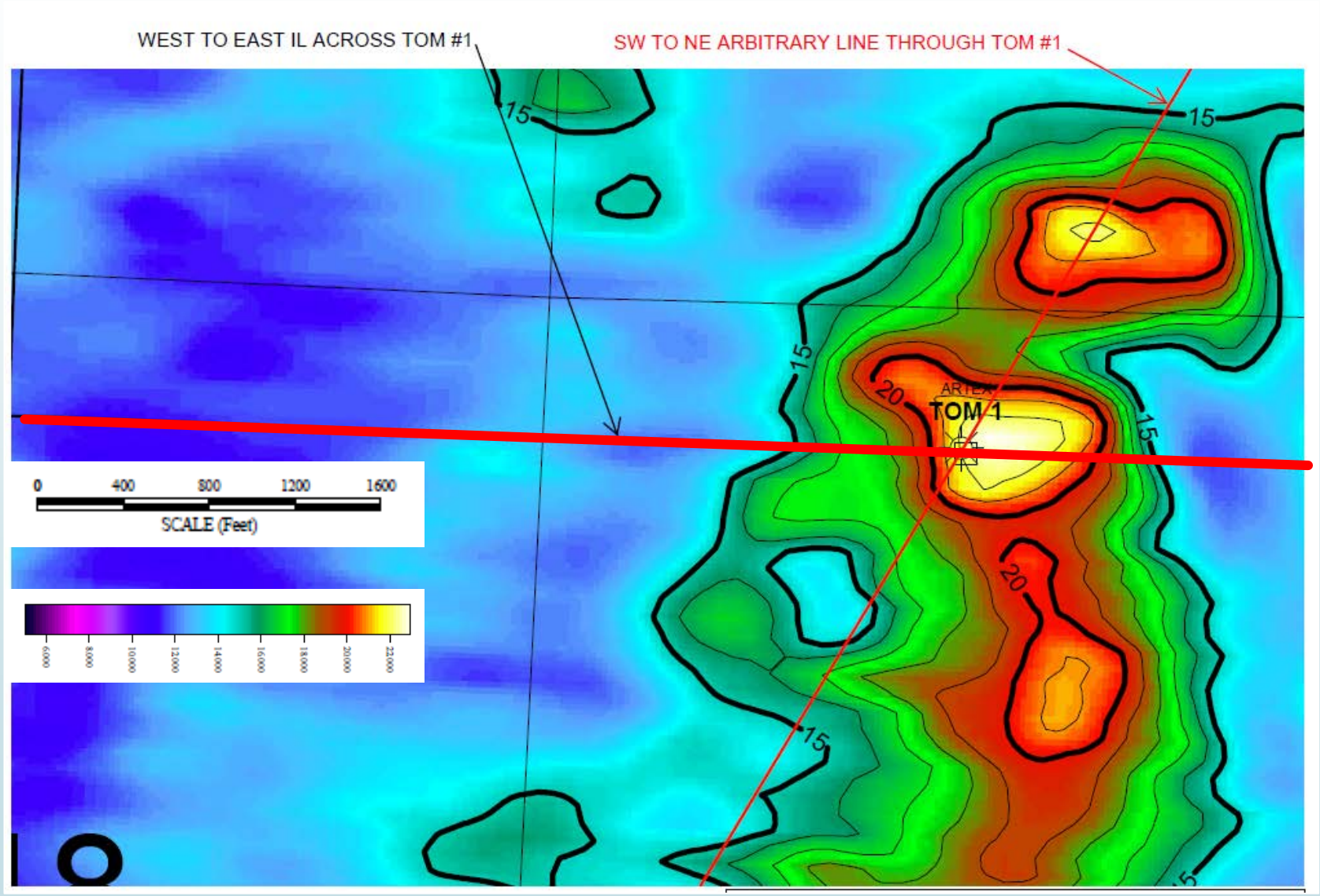


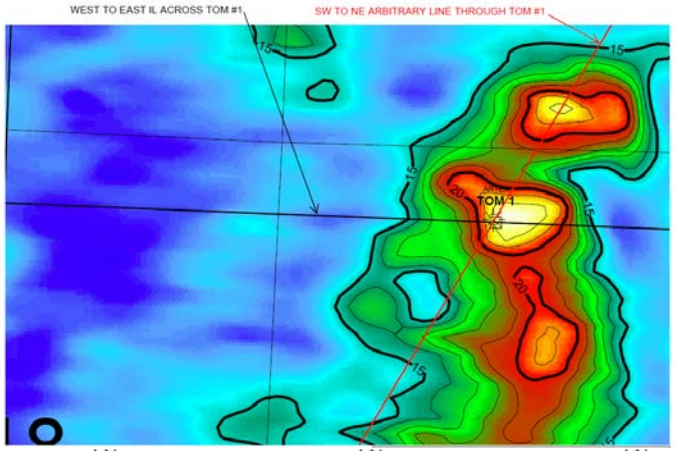
Gallogly-Perkins Well: 1.1 BCF Gas

Tom Well: 3.4 BCF Gas

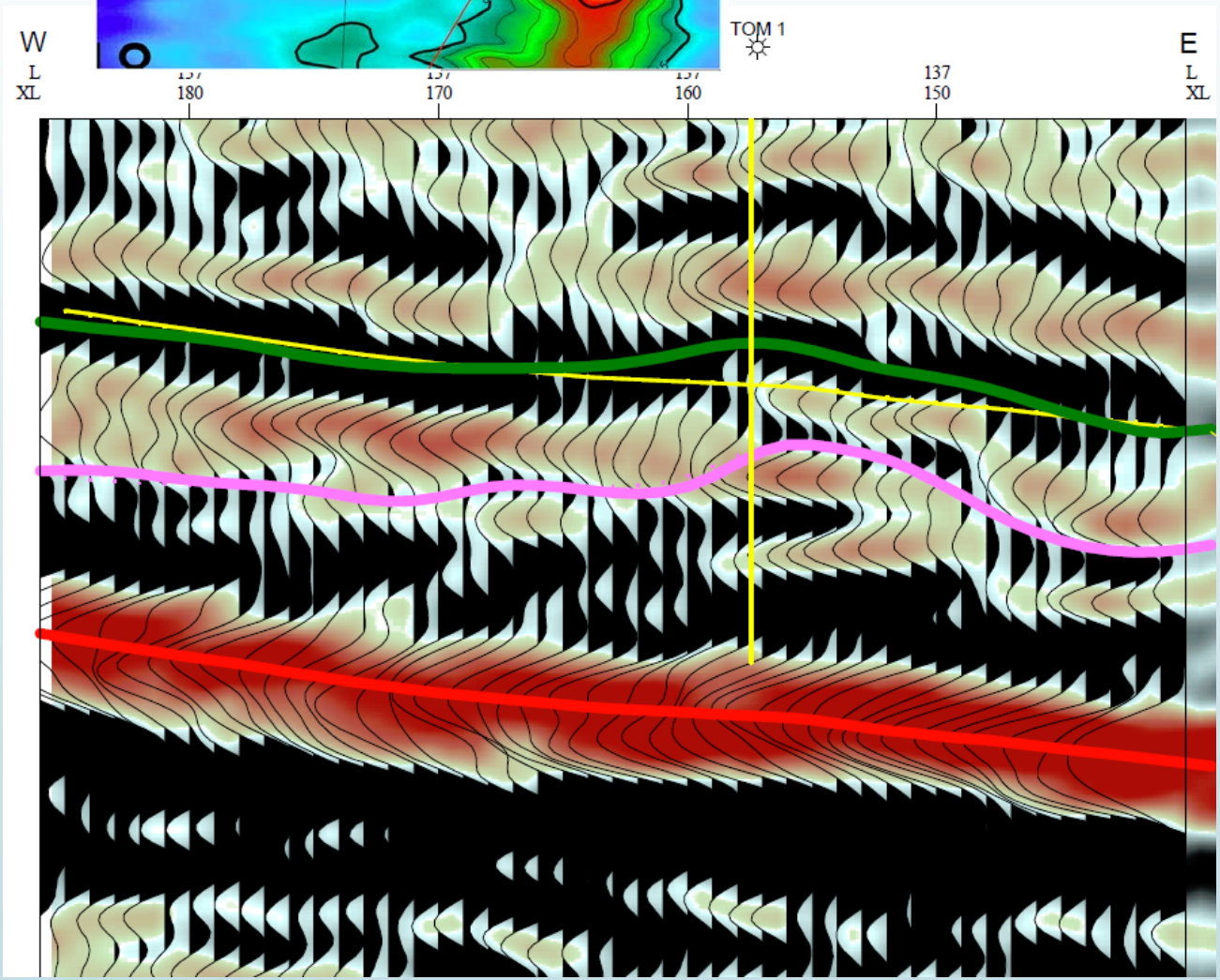


Arbitrary Lines 1 and 2 through Tom #1 remnant





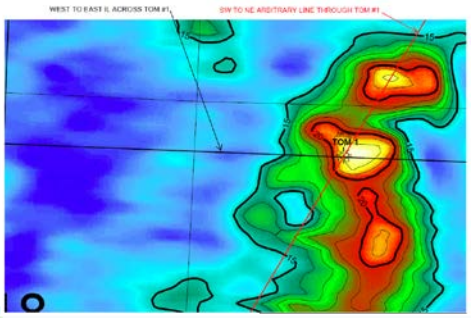
Good separation between the Gull River and the Gull River trend.
Troughs indicating possible Beekmantown “B” and “C” porosity.

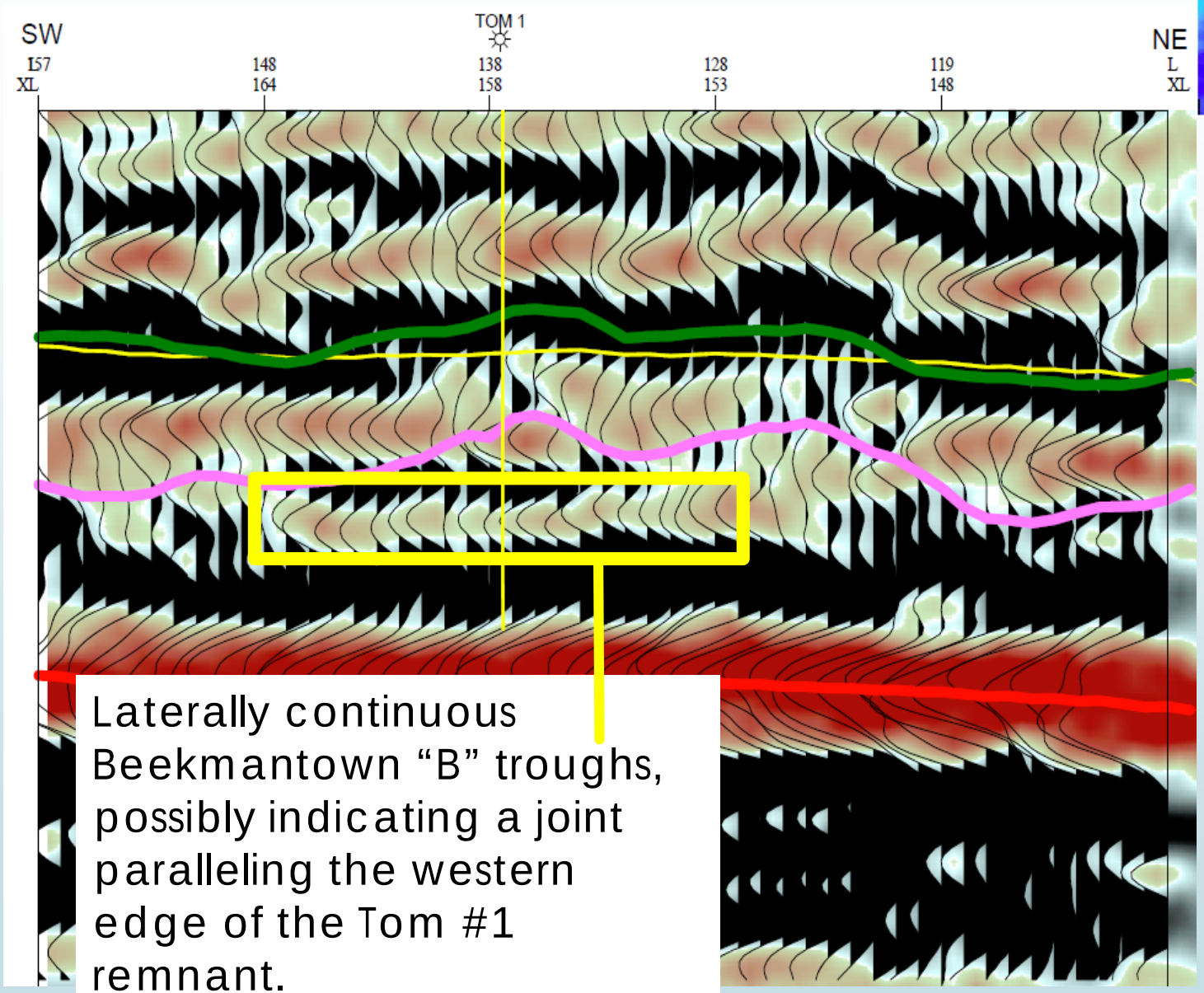


Gull River

PKUNC

Rose Run





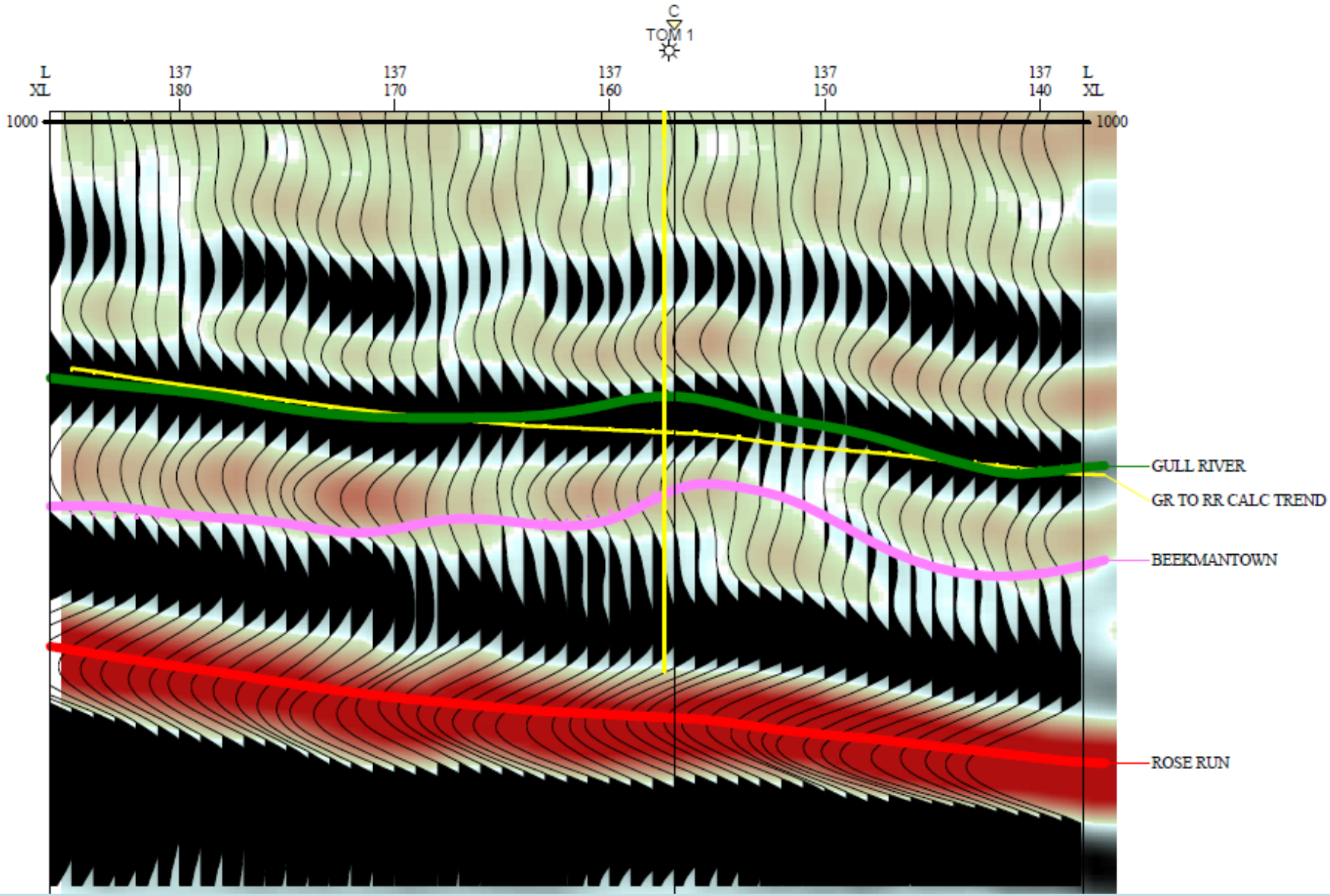
Gull River

PKUNC

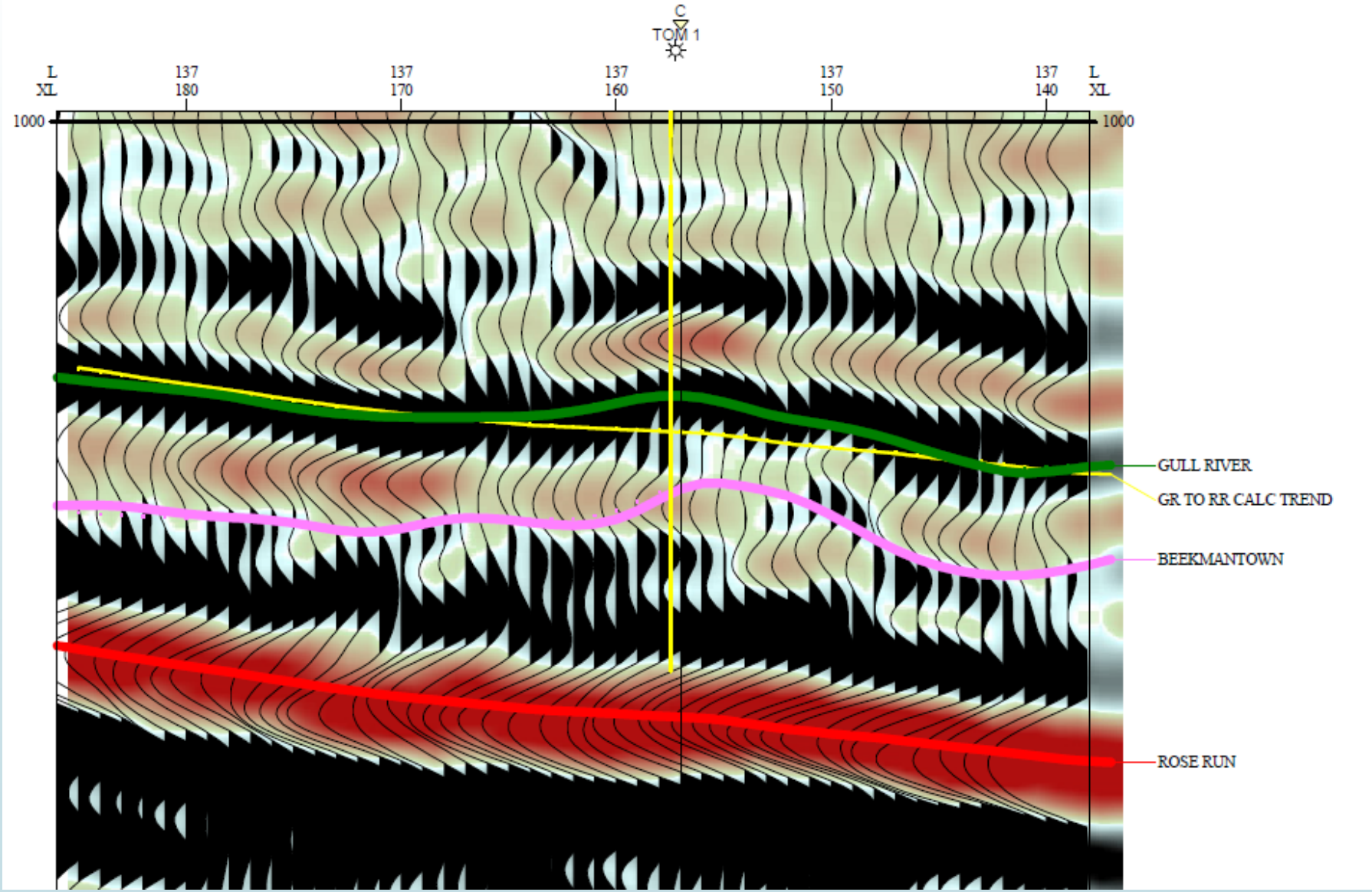
Rose Run

Laterally continuous Beekmantown “B” troughs, possibly indicating a joint paralleling the western edge of the Tom #1 remnant.

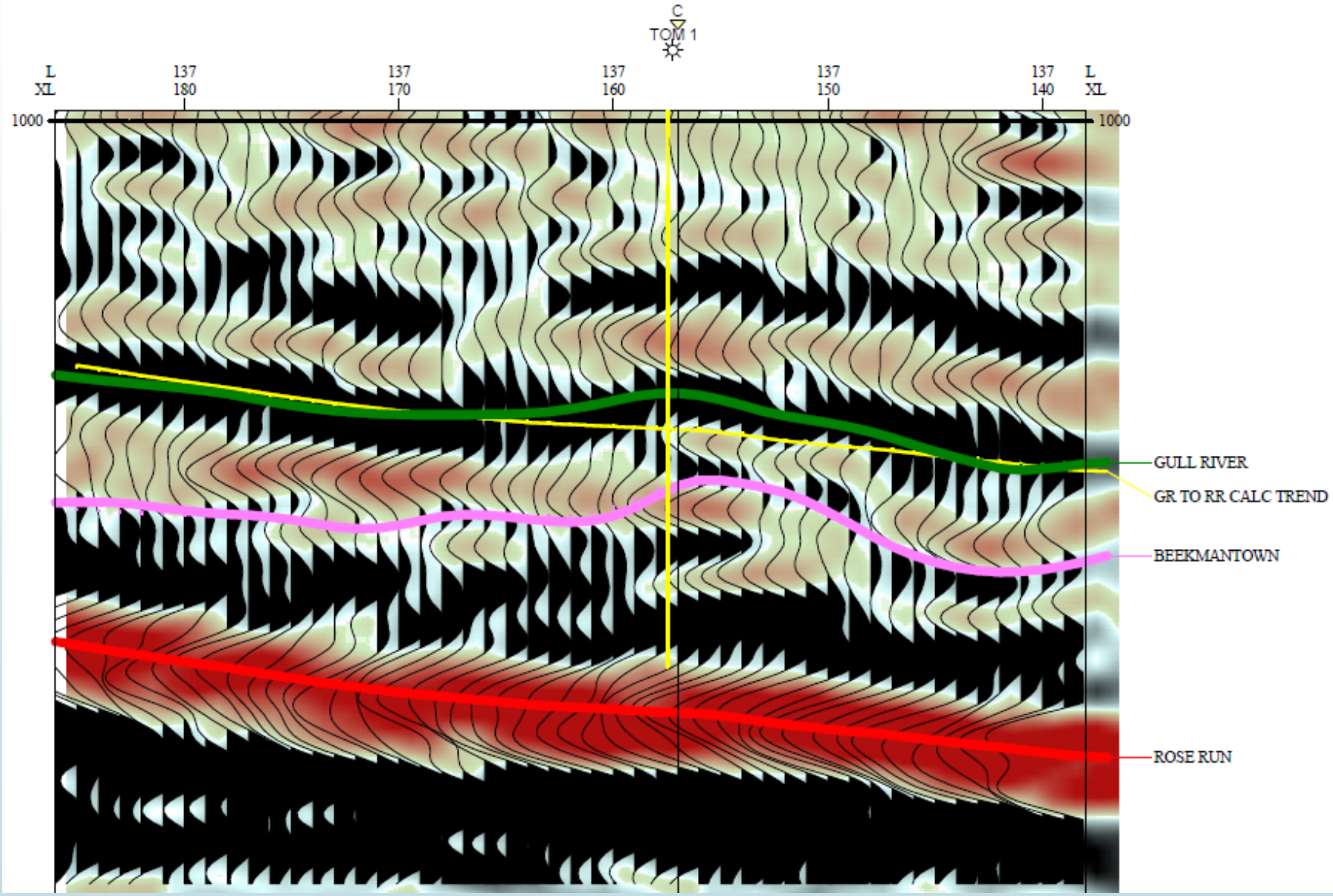
Freqency-90 HZ



Frequency-130 HZ



Frequency-180 HZ



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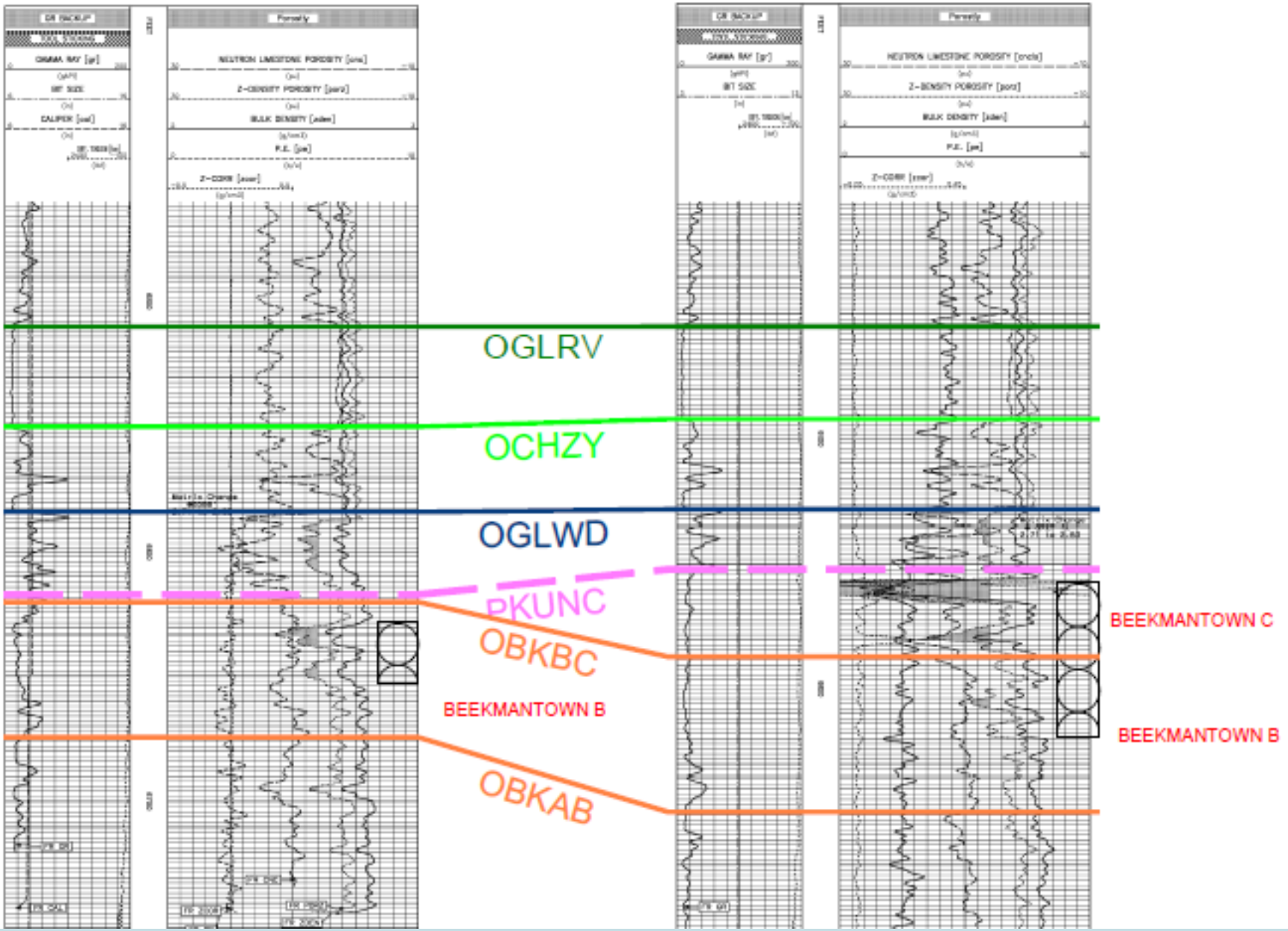
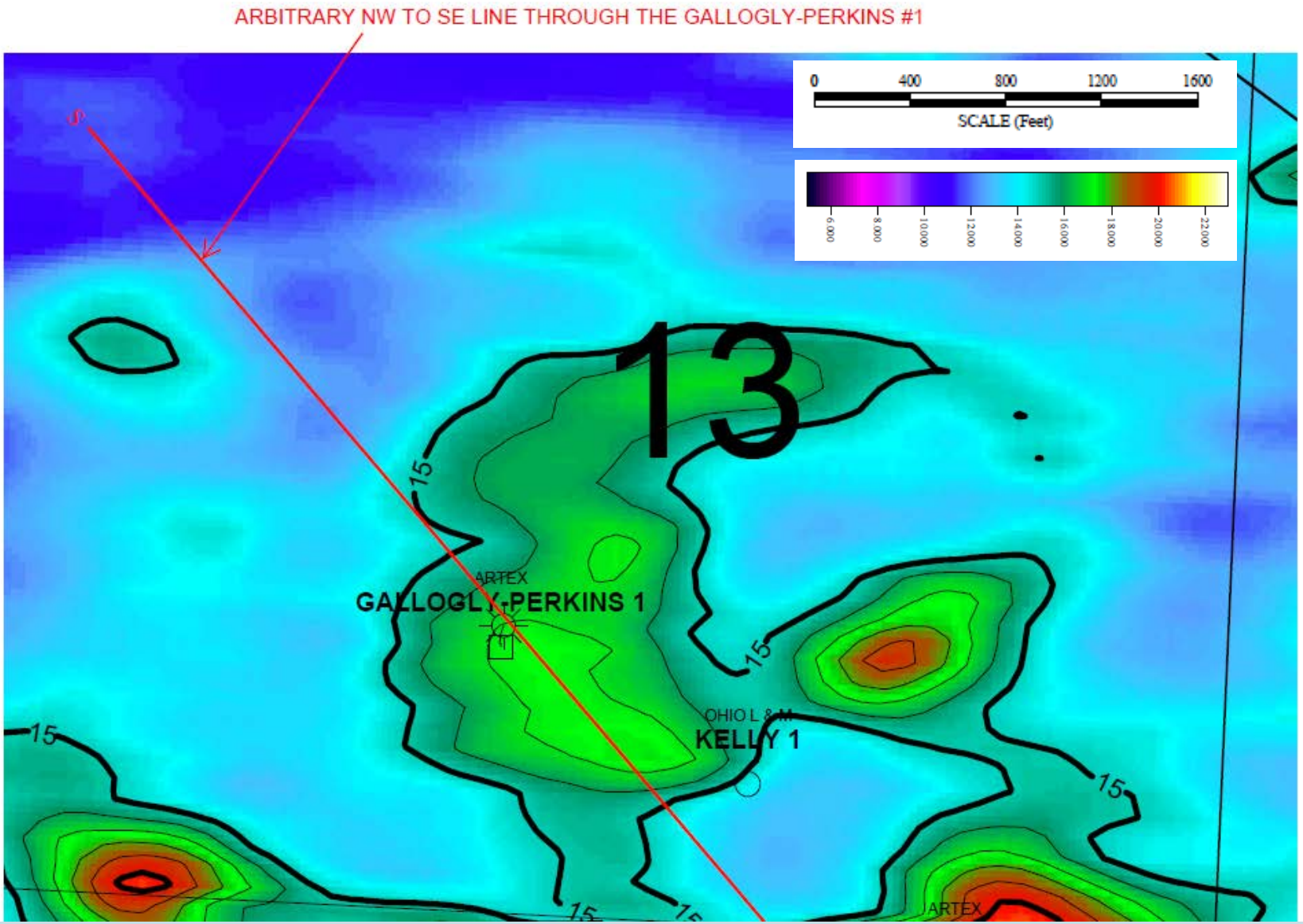
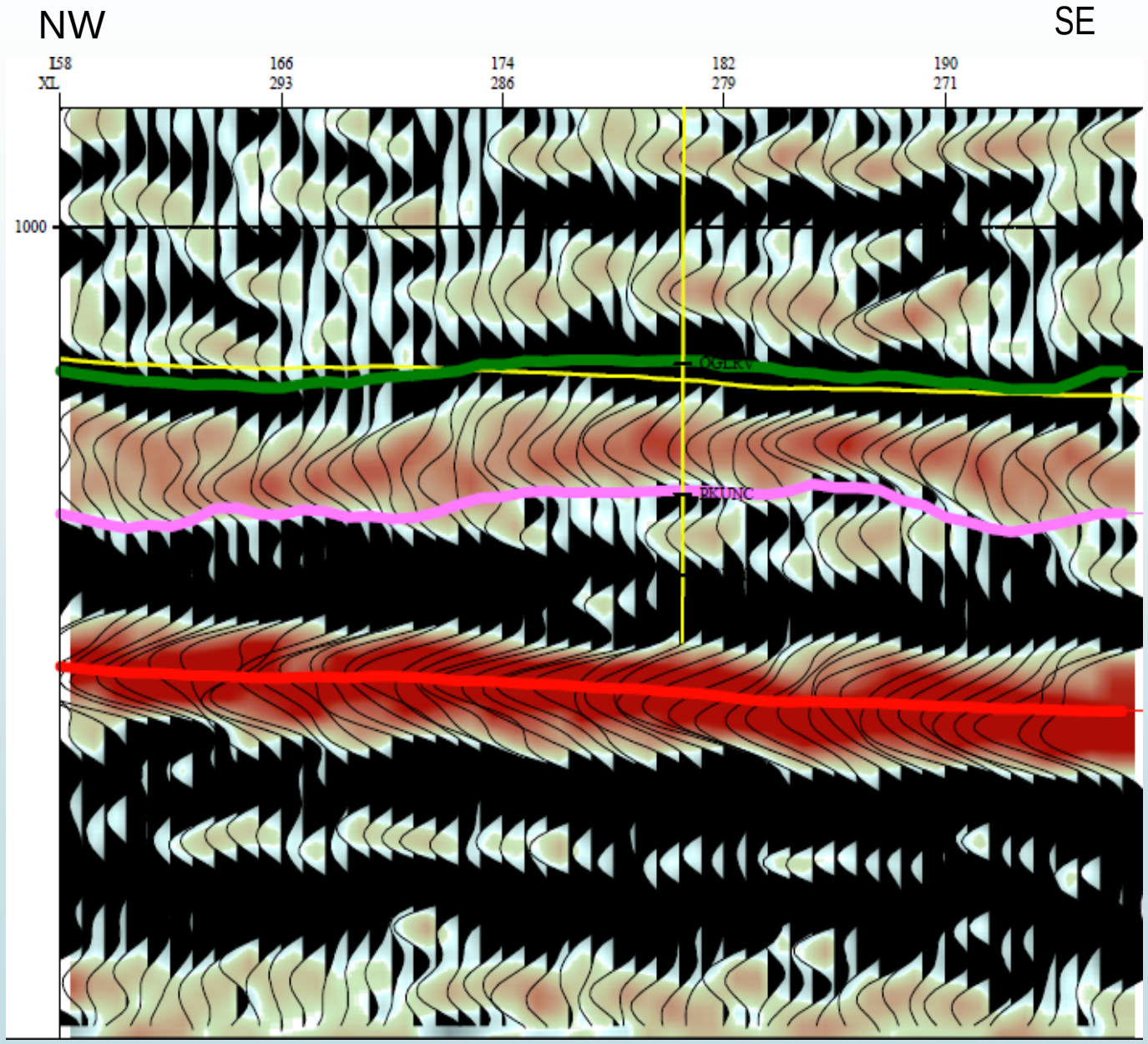


Arbitrary Line through Gallogly-Perkins remnant



Gallogly-Perkins



Subtle Separation between the Gull River and the Gull River trend. Troughs indicating possible “B” porosity zone.

Gull River

PKUNC

Rose Run

Conclusions

- Calculating the Gull River trend allows for an interpreter to more confidentially pick the Post-Knox Unconformity (PKUNC).
- Low relief, difficult to interpret remnants can yield large reserves.
- Higher frequency 3D can assist in visualization of the “B” and the “C” porosity zones.
- There is much more to be done within the Knox Group across the Appalachian Basin.