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# The Use of Synthetic Logs For Geosteering

# Targeting

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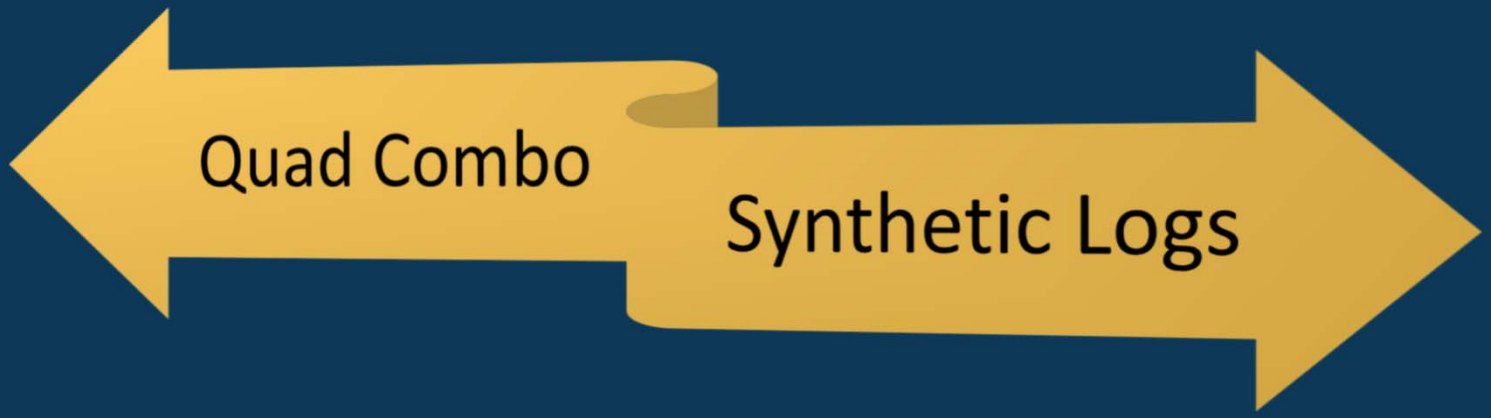
# Rock Properties

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# The Theory

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# Defining MSE

Energy required to destroy a unit volume of rock.

$$MSE = \frac{480 \times T \times RPM}{d_{bit}^{\,2} \times ROP} + \frac{4 \times WOB}{\pi d_{bit}^{\,2}}$$

| | |
|---|---|
| T | Torque, ft.lb |
| WOB | weight on bit, lbf |
| ROP | rate of penetration, ft/hr |
| RPM | revolutions per minute, min-1 |
| Dbit | Bit diameter, inches |
| MSE | mechanical specific energy, psi |



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# Using MSE to Calculate Rock Properties

MSE to UCS

$$UCS = \mathbf{MSE} \times D_{eff}$$

MSE to PorePressure

$$\frac{P_p}{D} = \frac{OB}{D} - \left[\frac{OB}{D} - \left(\frac{P_p}{D}_N\right)\right]\left(\frac{MSE_o}{MSE_N}\right)^n$$

UCS to CCS

$$CCS = \mathbf{UCS} + \Delta p\left(\frac{1+\sin\theta}{1-\sin\theta}\right)$$



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# Using MSE to Calculate Rock Properties

UCS to Porosity

$$\emptyset = k_1 \times UCS^{(-k_2)}$$

CCS to Young's Modulus

$$E = CCS \times a_E \times (1 + P_c)^{b_E}$$

Permeability & Porosity Correlation

$$K_p = k_3 + \emptyset^{k_4}$$

Cedola et al., 2017a

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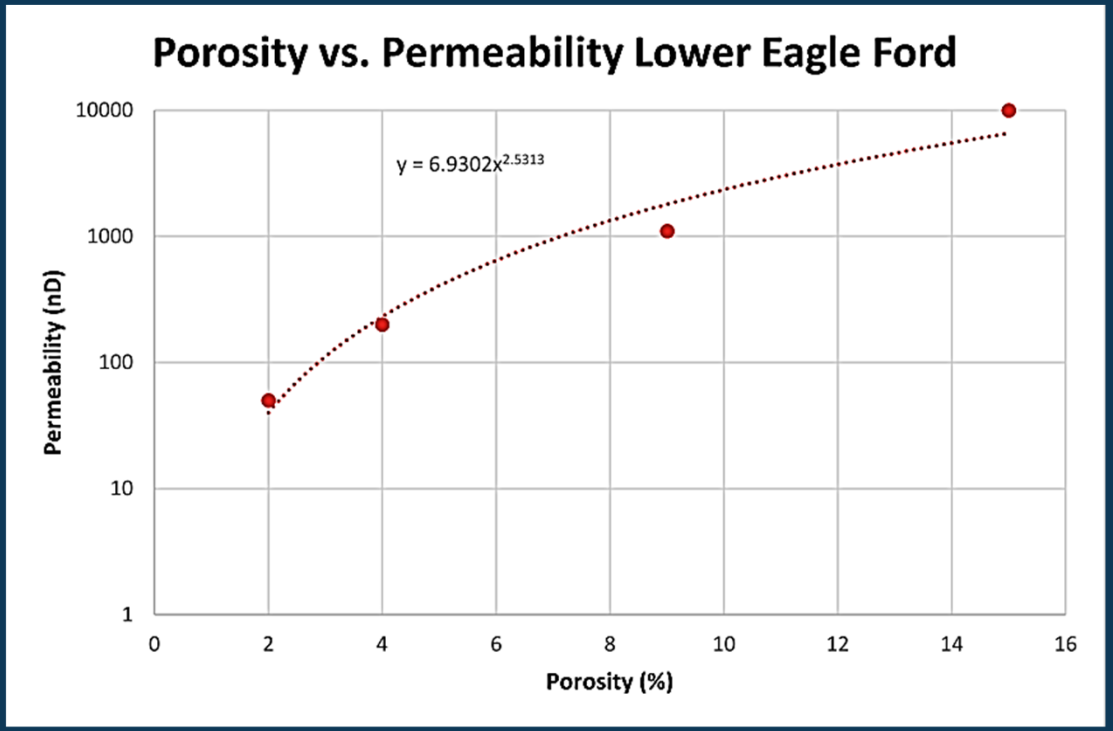
# Formation Constants




Walls, 2011

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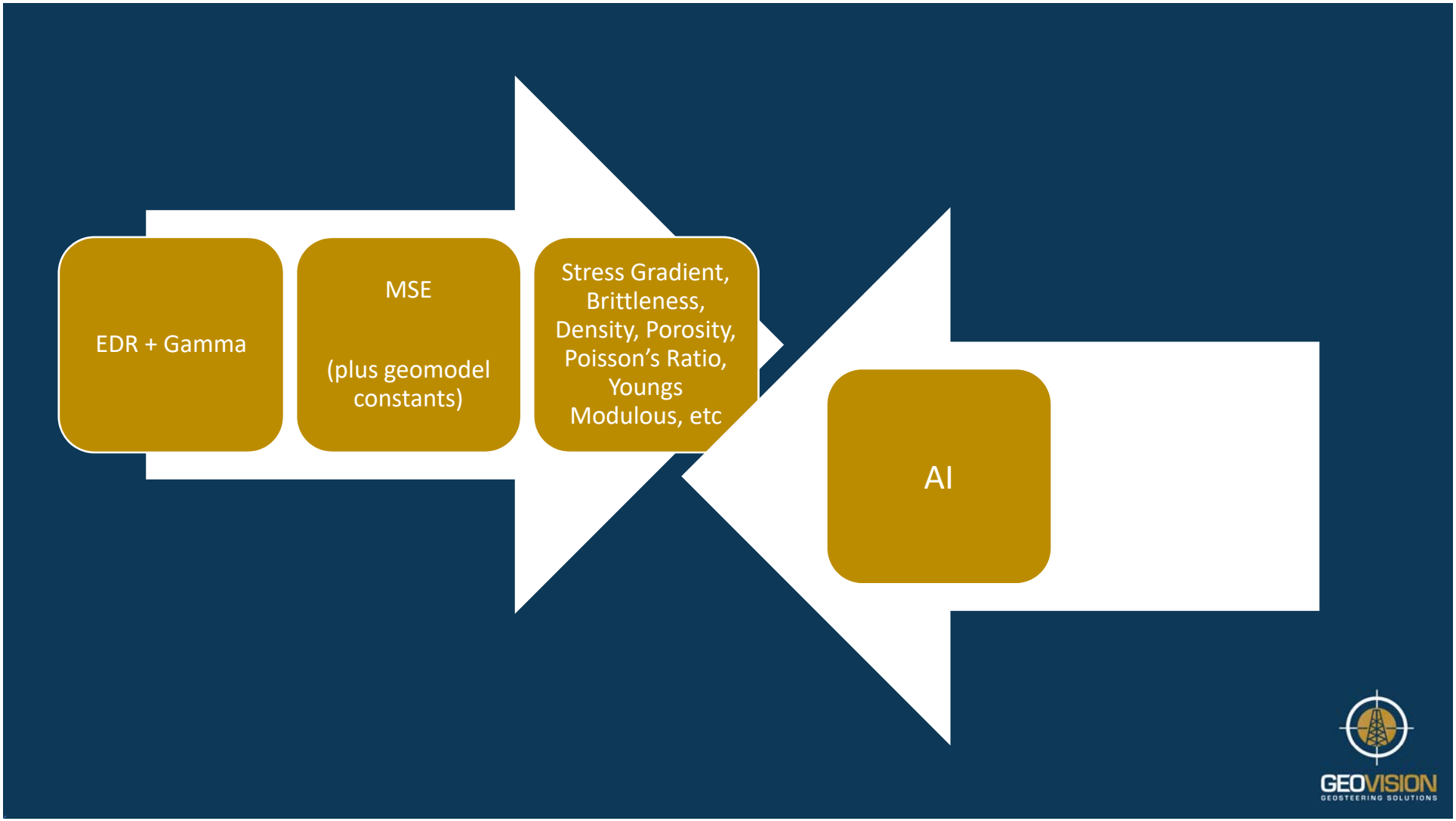
EDR + Gamma
MSE
(plus geomodel constants)
Stress Gradient, Brittleness, Density, Porosity, Poisson's Ratio, Youngs Modulous, etc
AI
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# The Application

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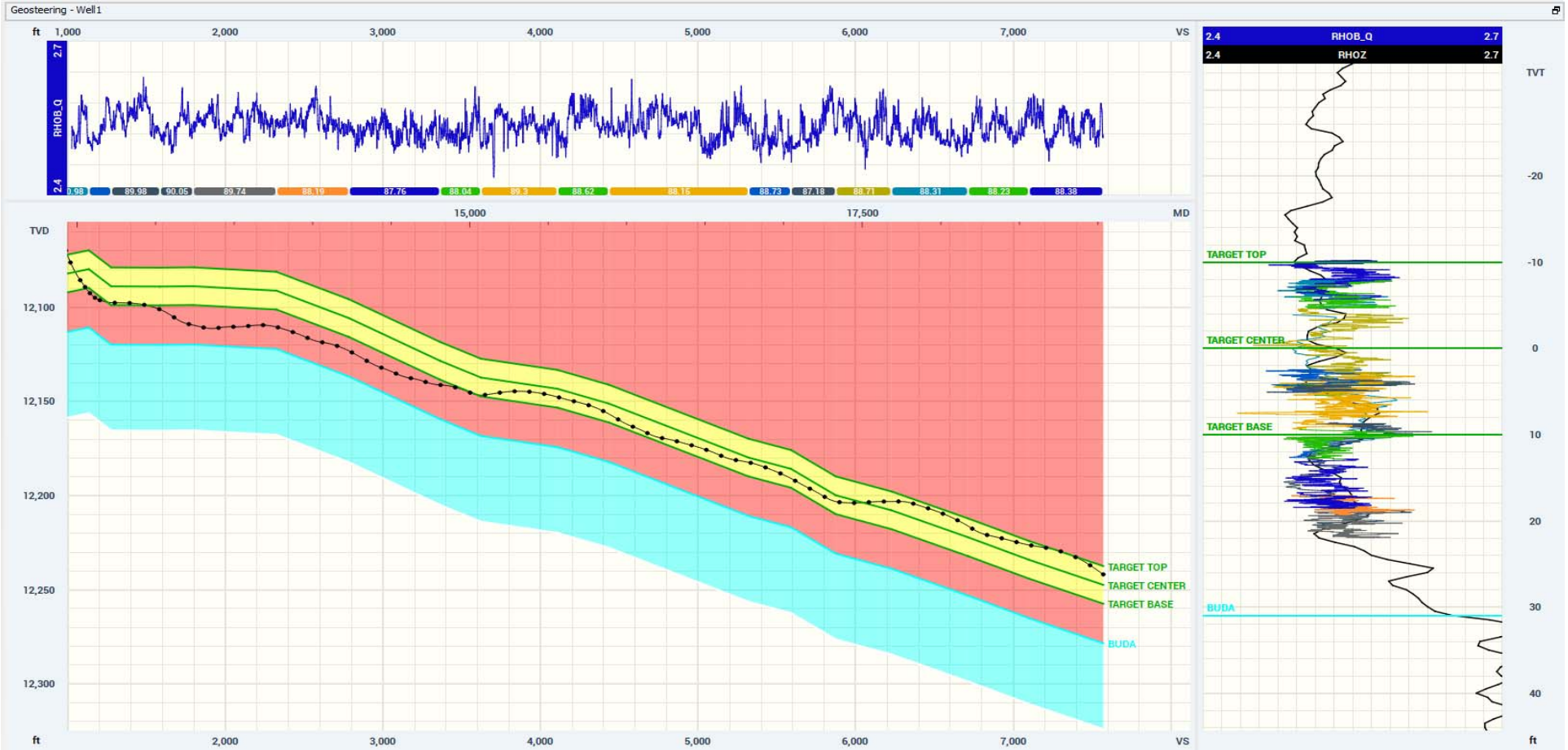
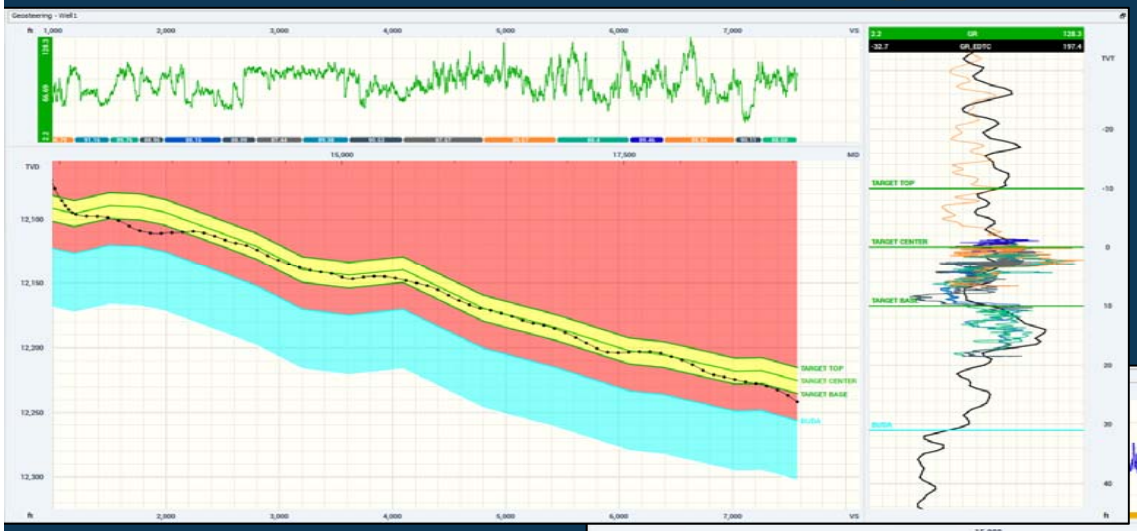
# Gamma Interpretation

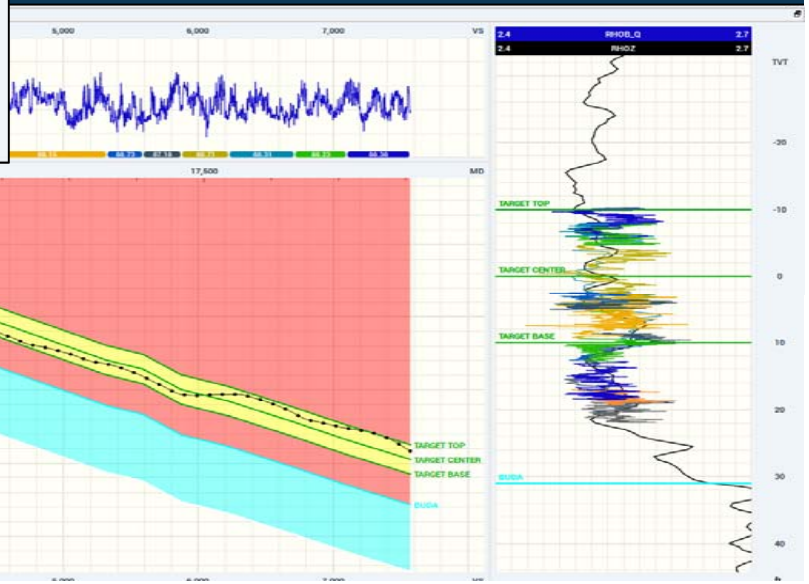
# Density Interpretation

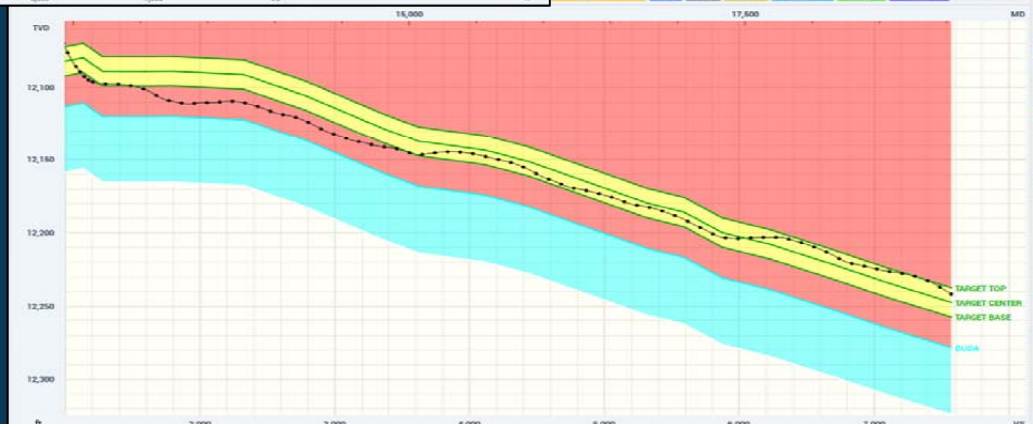


# Porosity Interpretation

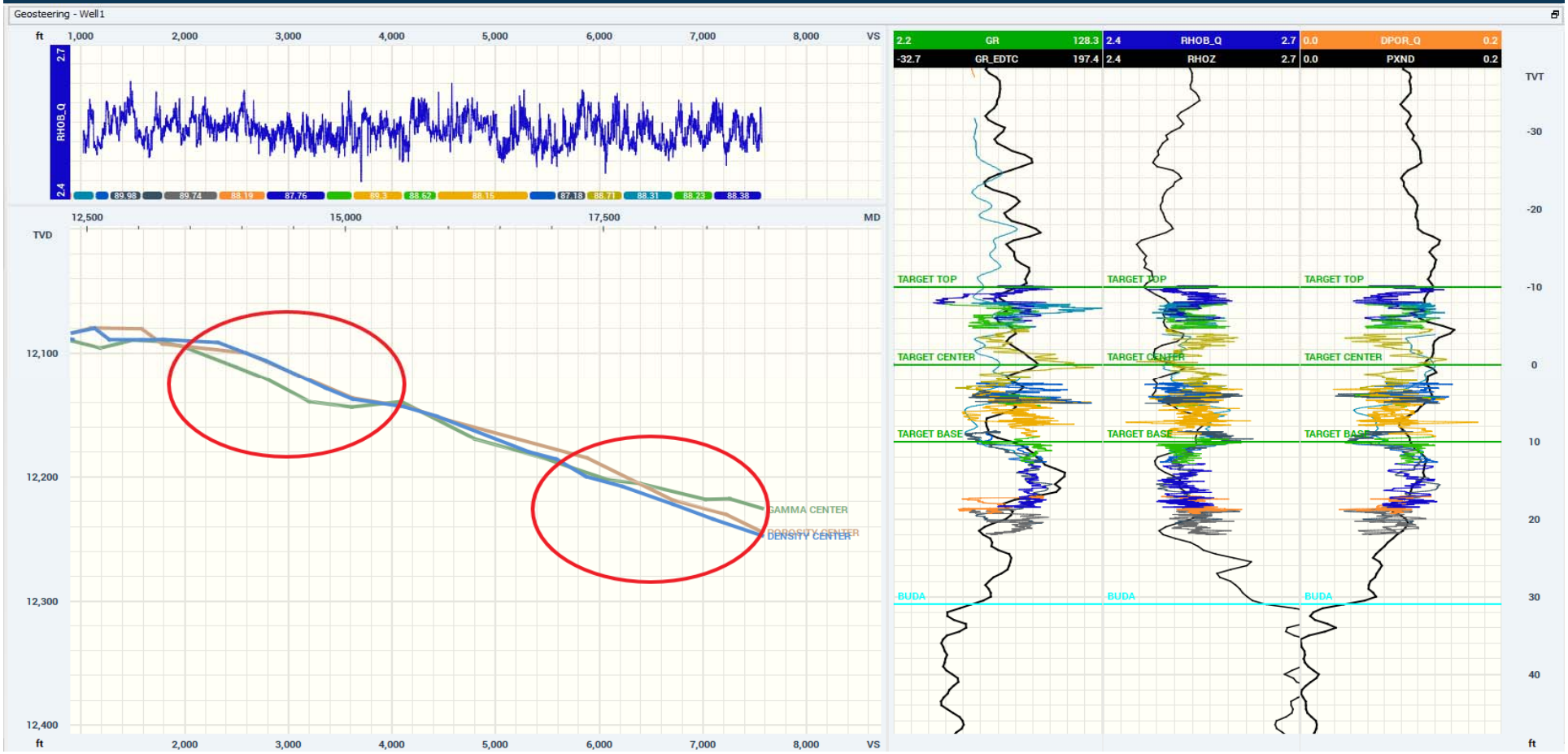
# Gamma and Density Interpretations



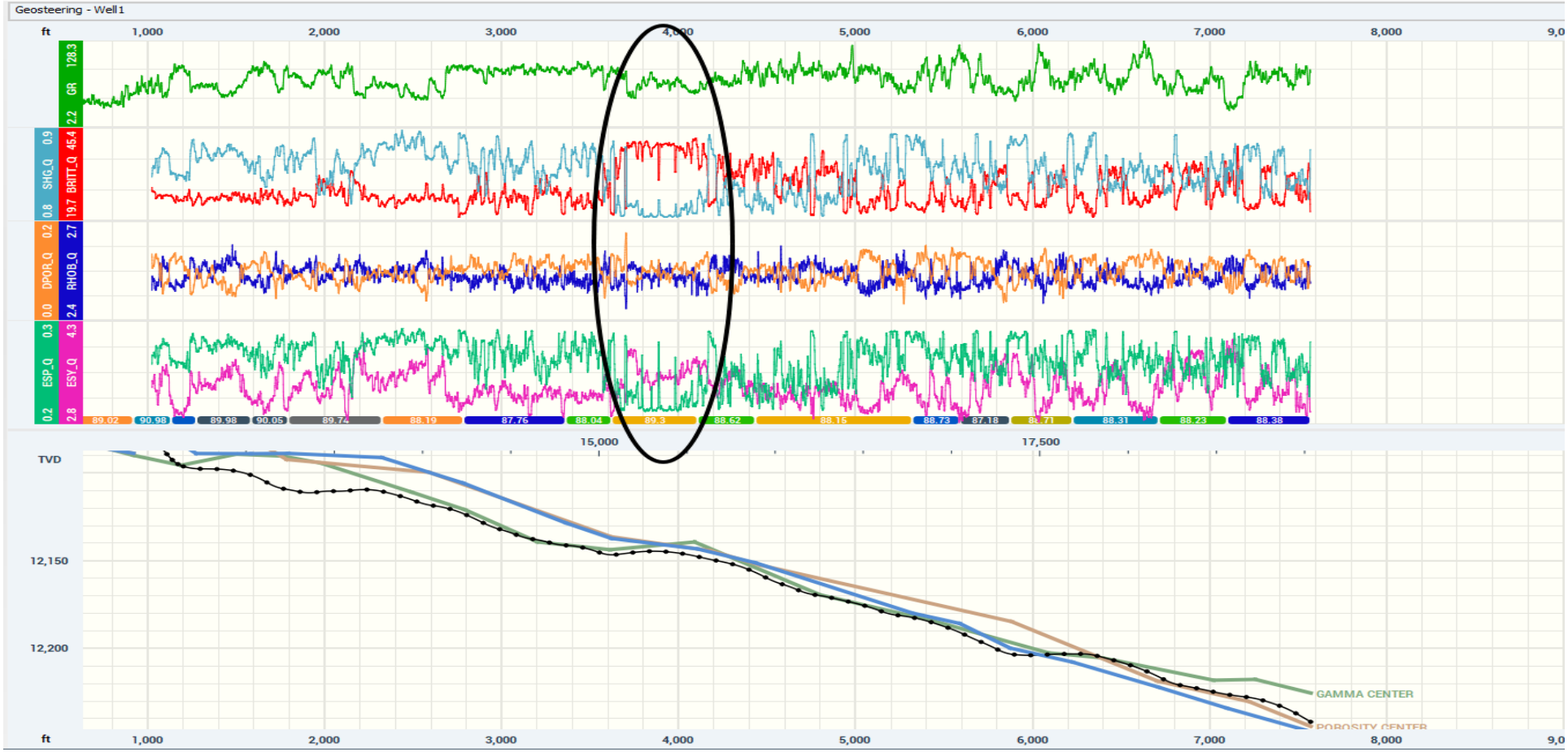



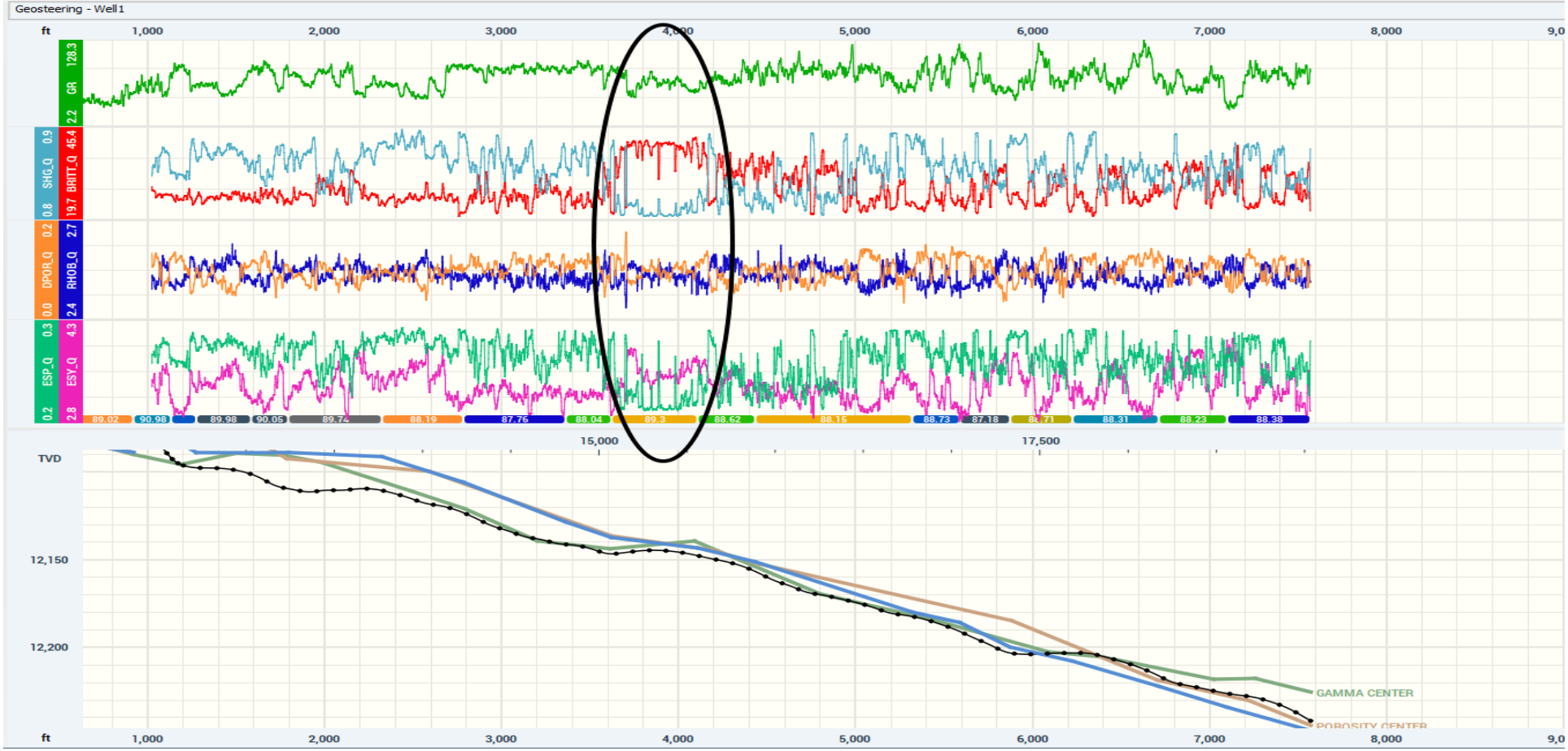
# Interpretations



# Steering by Rock Properties



# Completions



# Synthetic Logs Provided By:

QUANTICO

Energy Solutions

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