A Quick Method to Evaluate Potential "SHALE" Reservoirs

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In 2009 Rick Lewis with SCHLUMBERGER suggested cut-offs for Pe (< 4.0 barnes/electron) and Bulk Density (RHOb < 2.53g/cc) that can be used to define potential organic-rich "Shale" reservoirs. Walls and others (2012) used RHOb and Pe data obtained from core data [CT Scanner] to determine shale "sweet spots" in the Eagle Ford Shale.

A recent paper by Wang and Carr (2013) presented an opportunity to test these cut-offs with core derived shale lithofacies. Wang and Carr (2013) subdivided the Marcellus into the following seven lithofacies.

OSS – Organic Siliceous Shale
OMS – Organic Mixed Shale
OMD – Organic Mudstone [ductile]
GSS – Grey Siliceous Shale
GMS – Grey Mixed Shale
GMD – Grey Mudstone [ductile]
CARB – Carbonate

Along with the mineralogical analysis Wang and Carr (2013) included Pe and RHOb data for each of the seven lithofacies. A plot of their log data on a Pe versus RHOb cross plot revealed that only the best lithofacies [OSS] plotted with Pe < 4 [3.5] and RHOb < 2.53 [2.39].

Next Pe and RHOb data from a Permian Wolfcamp well in the Midland Basin was plotted on a Pe versus RHOb cross plot. Most of Pe and RHOb data from the Wolfcamp A and B clustered in the area of the cross plot defined by Pe<4 and RHOb<2.53, which indicated that Wolfcamp A and B contained the better potential organic-rich reservoirs. The Wolfcamp C contained very few zones where Pe<4 and RHOb<2.53.

Data was obtained from two additional Wolfcamp wells [upper 900 feet] that in addi-

tion to Pe and RHOb data had GEOCHEM plus compressional (ITTc) and shear (ITTs) wave data. Using the ITTc and ITTs data Poisson's Ratio and Young's Modulus were calculated, and compared to the vertical distribution of zones where Pe<4 and RHOb<2.53. In one of the Wolfcamp wells the lower section exhibited sharp increase in Poisson's Ratio [0.20 to 0.26], and decrease in Young's Modulus [3.6*10^6psi to 3.0*10^6psi] indicating poorer reservoir potential. In addition, the lower section in this well contained only a few zones with Pe<4 and RHOb <2.53. The second well exhibited more uniform values for Poisson's Ratio [0.2] and Young's Modulus [4.0*10^6psi] indicating more continuous good reservoir potential. The vertical distribution of zones with Pe<4 and RHOb<2.53 in this well were more evenly distributed. Therefore, the distribution of zones with Pe<4 and RHOb<2.53 are related to the distribution of geomechanical properties [Poisson's Ratio and Young's Modulus].

In wells with no ITTc and ITTs data the Pe versus RHOb cross plot can be used to delineate the vertical distribution of potential reservoir quality "shale". These delineated zones have the potential to fracture under stress [low Poisson's Ratio], and for the fractures to remain open [high Young's Modulus].