UR06

Organic Richness Evaluation through Empirical Methods and Neural Networks

F. Juarez* (IPN)

Summary

From a petrophysical point of view, organic shales are unique and complex formations since play both source and reservoir roles in the petroleum system. Because of this, it is important to compute the total organic carbon content of these formations and convert it to kerogen volume. In order to achieve it, there are many empirical methods developed for different US shale plays. In the current case of study, some of the well-known methods were applied to an Eagle Ford well and the outputs were calibrated to Rock-Eval 6 core data. Thermal maturity was inferred too by means of the pyrolysis results. Furthermore, a neural network for TOC computation was built and the results were statistically compared each other, and the best output was converted to kerogen volume, one of the most important inputs in the subsequent steps in the petrophysical evaluation of organic shales

Introduction

From a petrophysical point of view, gas shales are unique and complex formations since play both source and reservoir roles in the petroleum system. Because of this, it is important to compute the total organic carbon content of these formations. In order to achieve it, there are many empirical methods developed for different US shale plays.

Method and/or Theory

TOC computation is critical in the petrophysical evaluation of organic shales. These formations are typically defined by its TOC quantity, which usually ranges from 1.5 to 2 wt%. Thus, TOC quantification is a valuable step in identifying potential shale oil/gas reservoirs, and can be related to the reservoir quality (Ramirez *et al*., 2011).

Kerogen is the organic constituent of sedimentary rocks that is neither soluble in aqueous alkaline solvents nor in the common organic solvents (Tissot & Welte, 1984). Total organic carbon is the amount of carbon bound to organic compounds of the rock.

Multiple models for TOC computation from well logs have been developed. The majority of them is empirically derived, e.g. ΔlogR, Schmoker. They rely on the assumption that matrix properties are invariant through organic shale intervals (Ramirez *et al*., 2011). Kerogen volume can be computed from TOC content by using the formula showed below (Glorioso & Rattia, 2012).

$$V_k = \frac{(TOC \cdot K_{vr} \cdot \rho_b)}{\rho_k} \quad (1)$$

Where:
TOC = total organic carbon content (wt%)
Kvr = conversion factor
ρb = bulk density (g/cc)
ρk = kerogen density (g/cc)

First, TOC content was computed in the pilot hole from well log data and it was calibrated to Rock-Eval 6 core data by varying the parameters of each equation. The equation that best worked was the Schmoker one, which is a function of the density log. A neural network then was built and trained with a 5-5-5-1 architecture. Once it was validated in the pilot hole, it was used to extrapolate the TOC to the horizontal section, reducing the uncertainty (Figure 1). Finally, TOC content was converted to kerogen volume by means of equation 1. Pyrolysis analysis indicated that the source rock has reached a high level of maturity (VRo > 2 %), so a kerogen type-II at the end of catagenesis was considered (Kvr = 1.19).

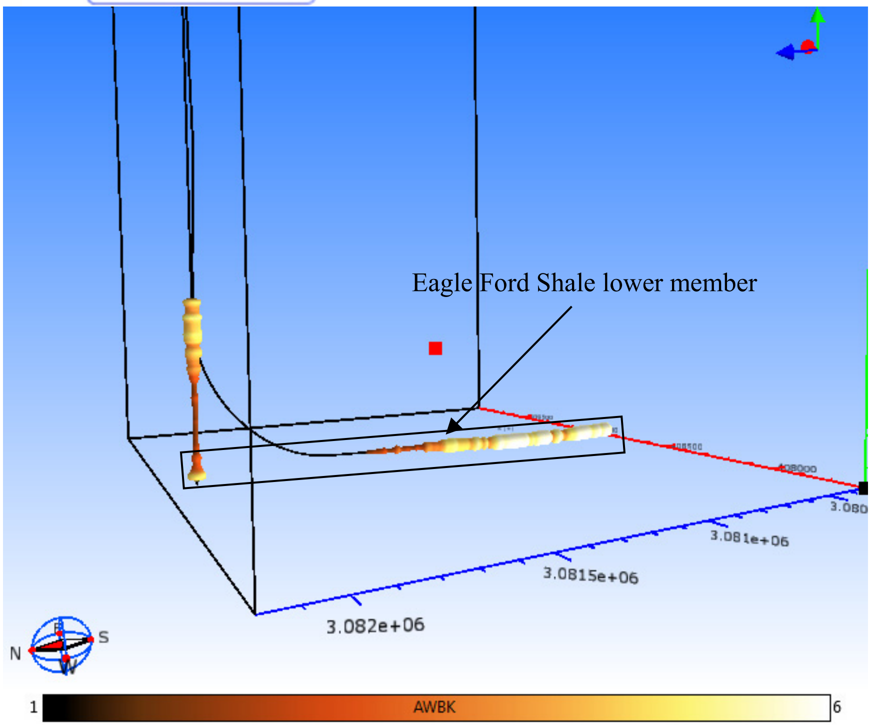

Figure 1 *TOC through both vertical and horizontal sections of the well A-1; variation range: 1-6 wt%.*

Conclusions

Based on the TOC content and kerogen volume curves through both vertical and horizontal sections, it is concluded that in the current well the lower member of the Eagle Ford Shale is the most prospective interval due to its TOC content that reaches 6 wt%, what makes this formation a very good source rock.

References

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