

Source Rock Geochemical Parameters Prediction-ML Approach

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Abstract

Objectives

Understanding variations in total organic content (TOC) is critical for identification of organic rich zones and source rock characterization and evaluation. Directly measured TOC are often time consuming and based on discrete data due to the testing destructive nature. Here, we showcase the implementation of machine learning algorithms using core images and TOC lab data to generate a continuous high-resolution TOC profiles in a timely manner.

Procedure

A total 182 ft of core photos were used for image attributes analysis. A moving average window of 0.5 ft was used to extract continuous visual attribute curves including entropy (i.e., color organization/texture), red, green, and blue color components. In addition, TOC measurements were measured in the lab using open system pyrolysis instrument.

Two machine learning workflows were used in this work. The first is unsupervised approach by using k mean clustering. Inputs included RGB curves, entropy, and number of clusters. The output is a continuous curve of cluster number, where sections of the core with the same visual characteristics were assigned the same cluster number. The number of clusters was chosen based on knowledge of the number of rock types. In this work, three clusters were found to be sufficient to differentiate between high, moderate, and low TOC rocks. The second workflow applies support vector regression (SVR) by tying color attributes to measured TOC. Only 80% of the data was used to train the model, whereas the remaining 20% were used to test and validate the model. Once the model is validated, it can be used to produce a continuous and high-resolution curve of TOC profile.

Results and Conclusions

The results show that the workflow is suitable for organic rich intervals, with 90% prediction accuracy within $\pm 1\%$ of measured data. The workflow generated results of a continuous high-resolution TOC profile as a final product. Similarly, this workflow has the potential to predict up to 92% accuracy for other key geochemical parameters analysis (e.g., PI, S1, S2 and S3), which can further assess organic rich rock evaluation.

After predicting a continuous TOC profile based on single well prediction, the model can be applied to calibrate other TOC measurements and generate TOC profiles for the offset wells with similar geology and geochemical attributes. Ultimately, this prediction can aid in enhancing source rock characterization in a timely and cost-effective manner.