

SHAP- A SHAPLEY Approach to Williston Rock Quality Category- Machine Learning and AI

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Summary

The purpose of this study is to identify areas of over- and under-performing assets given an operator's geological quality. We leveraged SHAP (Shapley Additive Explanation) values to characterize rock quality differences across the Williston Basin. Each SHAP value represents the marginal contribution to 36-month oil recoveries, the target variable, which can be summed to get the total contribution that geology plays in oil productivity. A resulting rock quality map compared against actual well results highlights areas where productivity is lower than anticipated and assists operators in understanding the upside potential.

Theory / Method / Workflow

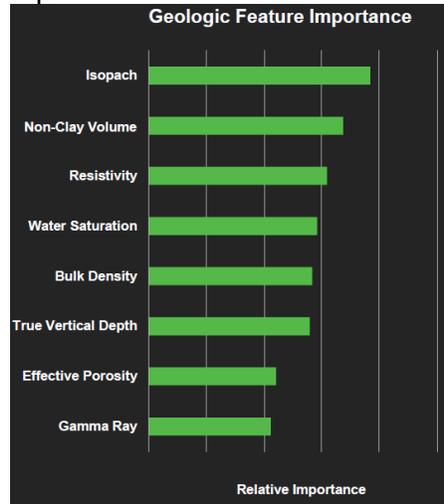
A database of more than 30 geological, timing, spacing and completions variables were provided as inputs to Enverus' Next Completion Sensitizer model to predict 36-month oil. The model outputs the most important geological features, including isopach, non-clay volume, resistivity and true vertical depth, and assigns a geological SHAP value for each well. Negative SHAP indicates where the rock quality was detrimental to a well's predicted performance relative to an average well, while positive values correlate to an expected uplift due to rock quality. After creating a correlation between productivity and the most important geologic features, a data-driven rock quality map was generated to create an unbiased view of the core of the play. These maps were compared to actual well results, to identify areas that over- and under-perform their geological acreage.

Results, Observations, Conclusions

The geologic feature with the highest relative importance was isopach, followed by non-clay volume and resistivity (**Figure 1**). Correlations between the important geological variables and oil productivity were identified, such as isopach's strong positive correlation between 20 and 45 feet (**Figure 2**). The geological SHAP map (**Figure 3**) highlights the geological core in the east end of McKenzie County, the north end of Dunn County and the south end of Mountrail County.

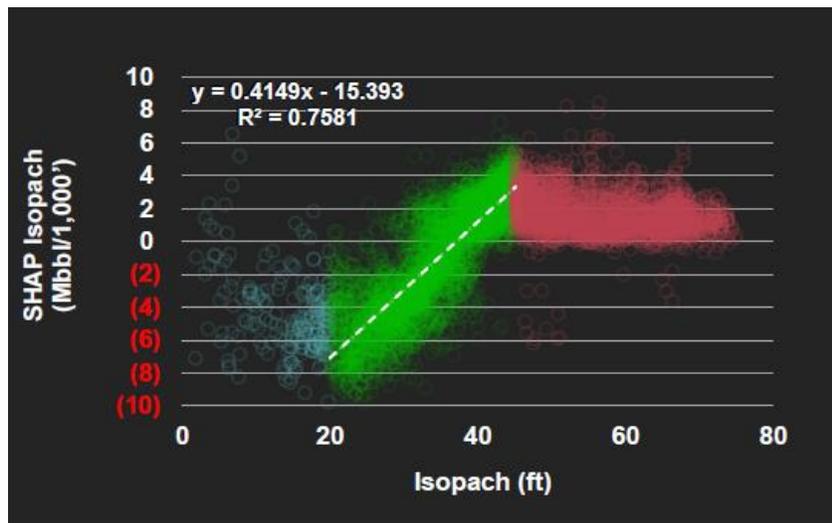
The productivity delta map shows that most of the oil outperformance lies in the "core" of the play, as well as parts of the legacy Elm Coulee play. These maps were intersected with operator acreage to identify the operators that are over- and under-performing their geologic quality.

FIGURE 1 | Geologic Feature Importance



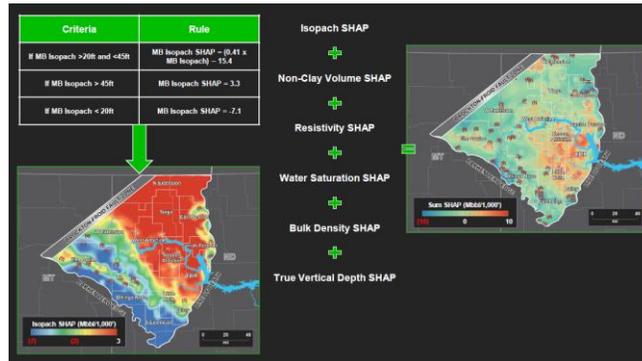
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FIGURE 2 | Characterizing Isopach's Impact on Oil Productivity



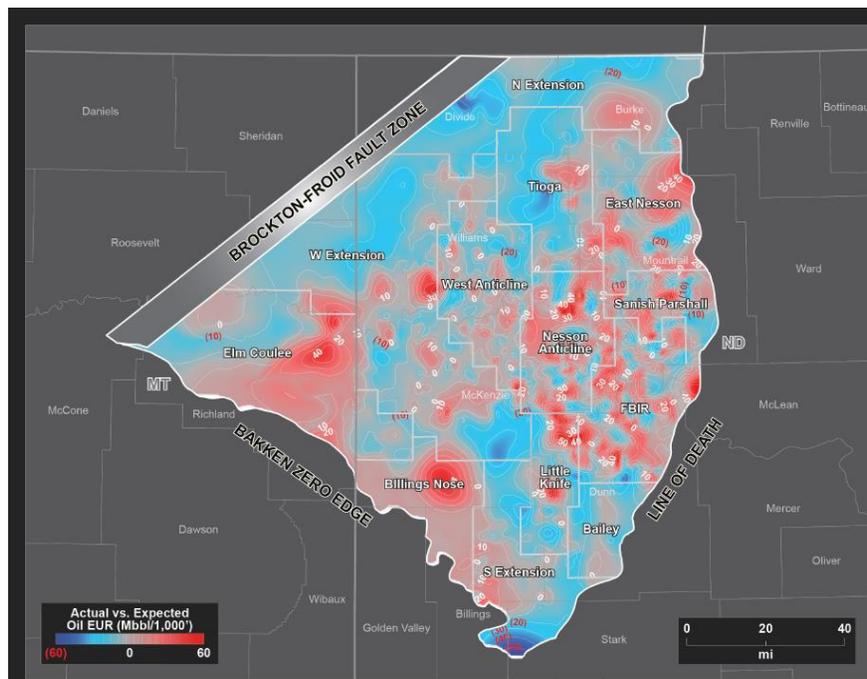
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FIGURE 3 | Geological SHAP Map Workflow



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FIGURE 4 | Actual Versus Expected Results



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