geoconvention
Calgary • Canada • June 17-19 2024

Towards Optimized Completion: A Data-Driven Proxy for WCSB Wells

Tamer Moussa and Hassan Dehghanpour, University of Alberta

Summary

In the past decade, over 40,000 multi-fractured horizontal wells have been completed in the Western Canadian Sedimentary Basin (WCSB). Despite completion intensity surging by nearly 100%, hydrocarbon productivity only rose by 20%. Why doesn't hydrocarbon production growth align with the increase in completion intensity? Another observation from our data insights highlights the differences between the designed and executed completions in WCSB. Is the efficiency gap attributed to formation characteristics, injection fluid properties, or the fracturing strategy? Our objective is to develop a data-driven proxy model to predict the recovery performance of MFHWs as a function of reservoir characteristics and completion design.

Theory / Method / Workflow

We analyze data from 40,000 wells in WCSB. Using core analysis and well log data, we develop a support vector machine (SVM) to predict formation permeability. Through hierarchical clustering, we categorize each formation's lithology. Applying 3D kriging interpolation, we fill missing data points, subsequently developing high-resolution petrophysical maps for WCSB. From these, we derive a reservoir quality index (RQI) map, which we combine with production data to identify optimal sweet spots. We introduce a stage placement efficiency (SPE) metric. Incorporating this with the RQI and historical production data, we create a neural network-based proxy to predict well performance based on reservoir quality and completion design.

Results, Observations, Conclusions

Here are the initial findings we have so far:

1. We have generated 3D maps detailing key petrophysical properties across WCSB. Each map point reveals formation elevation, thickness, and properties such as porosity, permeability, gamma ray, hydrocarbon saturation, initial reservoir pressure and the net-pay thickness as shown in **Fig. 1**.
2. Two main patterns stand out: Over 75% of Montney wells are located in areas with higher initial reservoir pressure and hydrocarbon saturation. In contrast, 20% of wells are in areas with higher porosity and permeability, and lower gamma ray. This suggests a preference by operators for initial reservoir conditions.
3. Our permeability model achieves over 90% prediction accuracy on the testing dataset. The SVM's empirical correlations have been extracted for wider applicability.
4. Montney MFHWs have an average SPE of 70%. Our findings suggest potential optimization up to 90% if stages are placed as function of RQI profile along wellbore, number of stages, stage length and spacing.

We're preparing a comprehensive completion design dataset that includes the completed length, number of stages, number of clusters in each stage, perforation density, injected fluid per stage, proppant concentration, fracturing technology and the injected fluid type as well as the well location, wellbore direction and well profile to understand how the completion practice could either limit or enhance reservoir recovery performance as demonstrated in **Fig. 2**.

Novel/Additive Information

We've consolidated the data-driven proxy and various analytical tools into an online dashboard. This aims to 1) assist WCSB oil and gas operators to efficiently optimize fracturing-design as a function of reservoir quality to improve fracturing operations and project profitability in tight reservoirs; and 2) minimize freshwater consumption and mitigate the environmental impacts of fracturing operations.

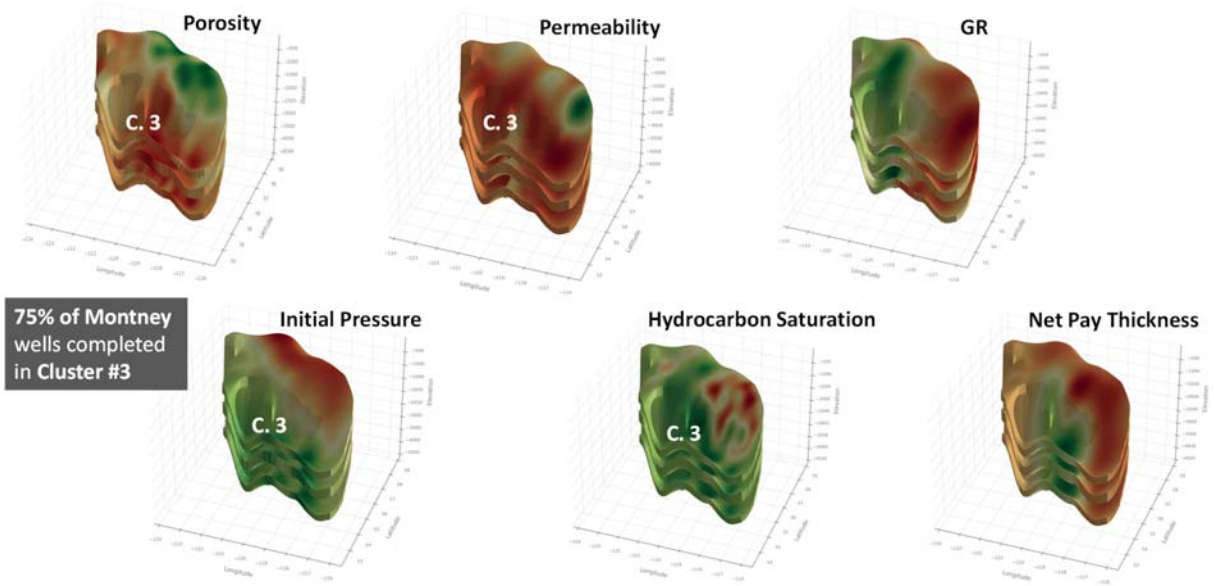

Fig. 1 - 3D Modelling of Montney Petrophysical Properties

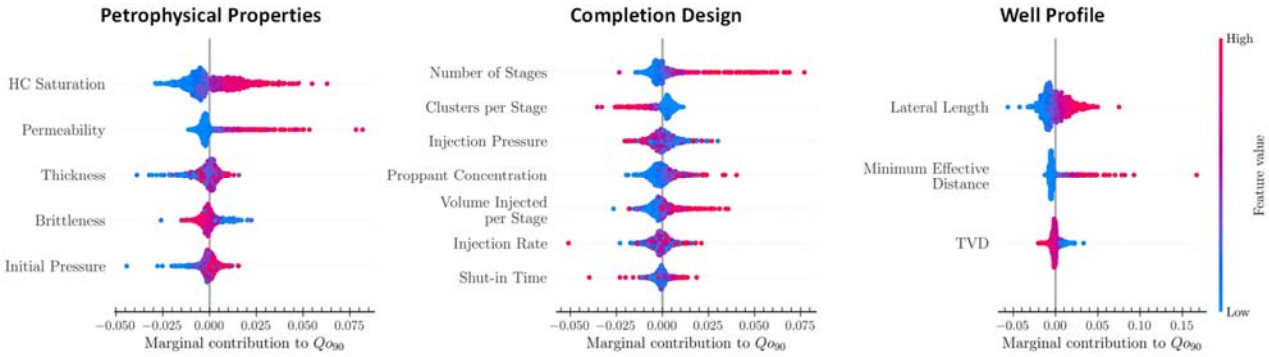

Fig. 2 – Relative impact of the petrophysical, completion and well profile on MFHWs' productivity