Probabilistic approach to reservoir quality modeling of the Montney Formation in the Pouce Coupe Field

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Summary

Reservoir quality of rocks in unconventional plays is typically determined using porosity (and permeability, if possible) and elastic properties (if possible) using well log analysis. If any core data exists, the credibility of the reservoir quality evaluation can be greatly enhanced by direct measurement of rock properties and composition. If core is available, lithological core description permits the development of a lithofacies classification which ideally could be directly associated both with the laboratory analysis data and the well logs. Our work indicates that this exemplar fails in using a core-description-based lithofacies classification as the basis for predicting reservoir quality in the Montney Formation for three reasons:

1. Lithofacies in the Montney Formation interchange frequently, and the average unit thickness is below or just above the vertical well-log resolution. Lithological changes cannot be typically detected via standard well logs;
2. Even when bed thicknesses are greater than the vertical log resolution, the differences in lithofacies properties are not sufficient for well logs to detect;
3. Porosity, permeability, and geomechanical properties are rarely lithofacies dependent. We suggest this is the composition of the detrital material delivered into the basin was fairly constant and not strongly influenced by the depositional environment. Major differences in rock composition are post depositional and are diagenetic in nature.

To overcome the above problems, reservoir quality models for the Montney Formation should be independent of lithofacies classification. In this study we present such a model for the Montney Formation in the Pouce Coupe Field created using the software GAMLS© (Geologic Analysis via Maximum Likelihood System).

Our dataset includes eight wells from the Pouce Coupe Field. Most wells were partially cored through the Montney Formation interval. Samples for analysis were taken from cores and cuttings. Analyses included mineralogy (QEMSCAN and/or XRD), elemental analysis (ICP-MS /XRF), routine core analysis (porosity, permeability, and grain density), capillary pressure (mercury injection), and total organic carbon.

GAMLS© discriminates rock types (electroclasses) using a probabilistic Multi-Variate Cluster Analysis of well-logs (typically gamma ray, bulk density, and neutron porosity). During clustering, each digitized sample is probabilistically assigned to one or more electroclasses. This permits a more refined calibration of the model to core analysis data than most other available clustering procedures. One cored well with QEMSCAN and RCA data was used for integrating and calibrating mineralogy and chemistry with well logs. The other wells were used to test and verify the model.

Results show a consistent, correlateable electroclass pattern across the field which could permit interpolation of data between wells. In addition, we were able to demonstrate a significant distinction in petrophysical and geomechanical properties between different electroclasses. This permits a more credible decision when targeting high reservoir quality zones. Finally, preliminary work indicates that extrapolation of the model to a nearby area is likely feasible.