

“omne trium perfectum” – The Rule of Three: Using Microseismic, Geochemistry & Interference Testing to Optimize Spacing and Stacking.

T.Hobbs, M. de Groot & H. Du

Summary

The psychology of the Rule of Three is not particularly scientific, but can you really argue with triangles, Three Musketeers and Three Wise Men? Within Orintiv’s land base of Dawson and Pipestone efforts to understand spacing and stacking to support development are employing multiple technological methods, Figure 1.

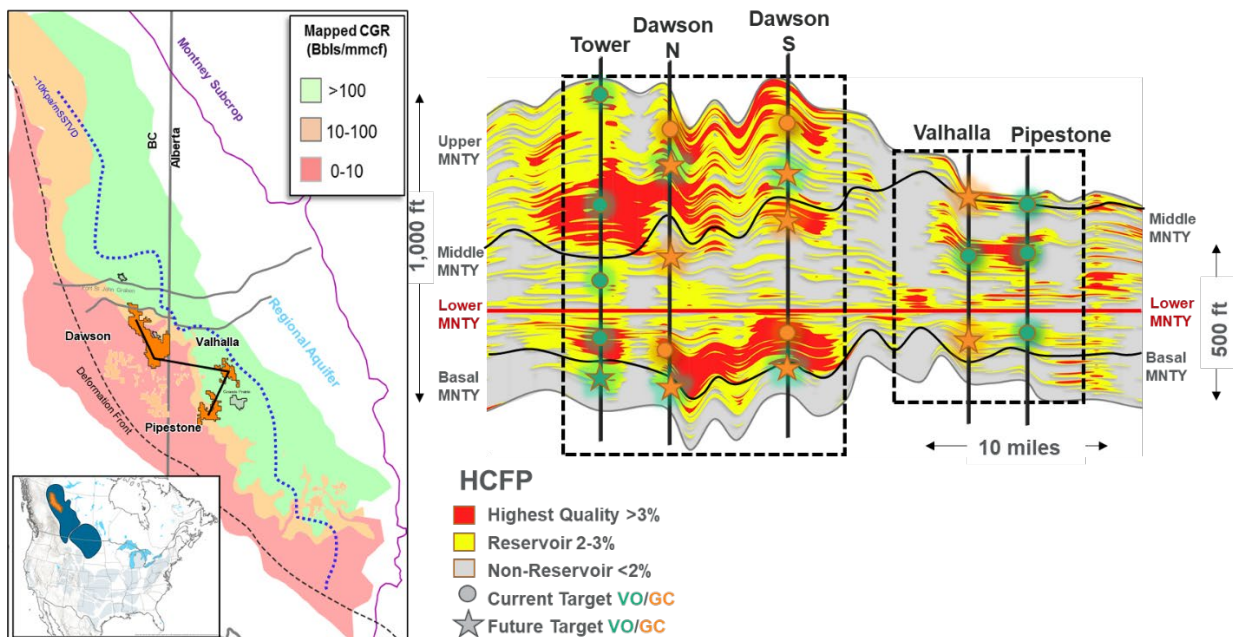


Figure 1. Orintiv’s historic Montney development by area and CGR bin. Cross-section illustrates resource potential of the various benches within the Montney areas of interest.

To efficiently allocate capital, data collection on Montney pad development has focused on understanding the communication between stacked benches. Ideally, horizontal development is deployed to effectively access resource while limiting communication between benches. To understand optimal well placement several studies and tools are employed to monitor potential interference and help with well spacing decisions. Several pads in the Pipestone area have collected microseismic during completion, produced fluid over several time increments for geochemical analysis and interference testing analysis during production. Microseismic collected during the completions indicate which Montney Benches are hydraulically stimulated during completions. Wells landed in the Montney F, G and H benches (Middle Montney) typically show microseismic events growing toward the lower stress G bench. Microseismic data within the Sexsmith bench (Lower Montney) shows more containment with some growth upwards, Figure 2. Additionally, microseismic data in Pipestone has relatively small aspect ratios compared to

other areas of the Montney, showing shorter half-length and larger heights. HRGC and Isotope changes observed through the first 5 months of production show initial contribution from several benches that appear to have unique chemical and isotopic signature. Analysis suggests that after stabilized production is reached, approximately 3 months, Montney Benches F and G show communication whereas the H and Sexsmith appear to be chemically separate, Figure 3. This implies that a two stack could be effective use of capital without sacrificing stranded reserves. Similarly, production interference testing suggests that there is competition between wells placed in the F and G, and to a lesser extent competition between H and Sexsmith. Vertical communication remains the dominate pathway between wells, with F to G bench connections typically stronger than G to SXSM.

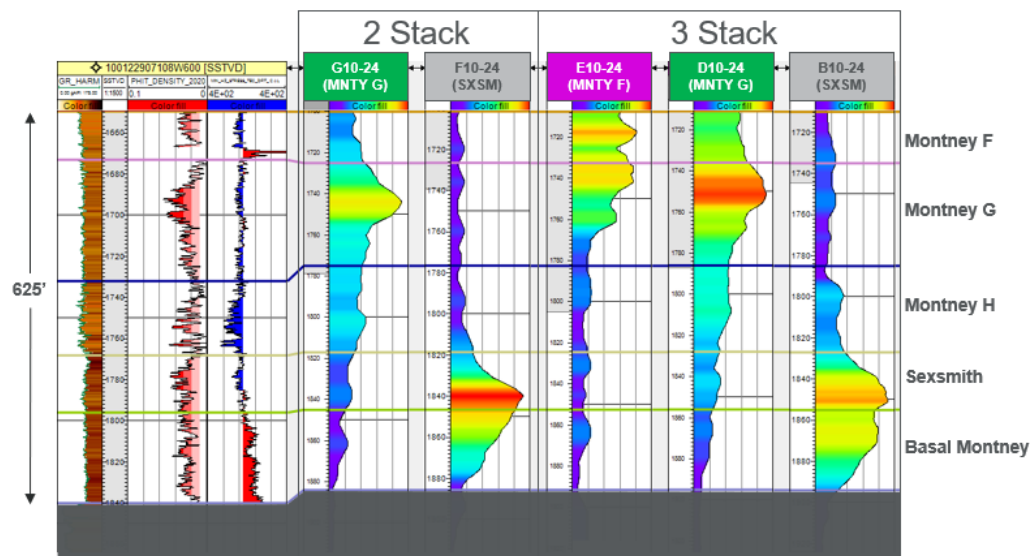


Figure 2. Microseismic distribution shows clear separation between the stimulation of wells in the Sexsmith (Lower Montney) vs wells landed in the F and G (Middle Montney). Significant overlap observed between Montney F and Montney G wells.

By using interference test results to guide spacing and stacking designs, we can balance vertical and lateral Connection Strength while effectively capturing resources and minimizing over-capitalization. These analyses suggest that a two stack could be the most effective allocation of capital in the Montney in this part of the Pipestone area. The three data sets reflect independent scientific measurements but

appear to be quite complimentary to help guide development decisions.

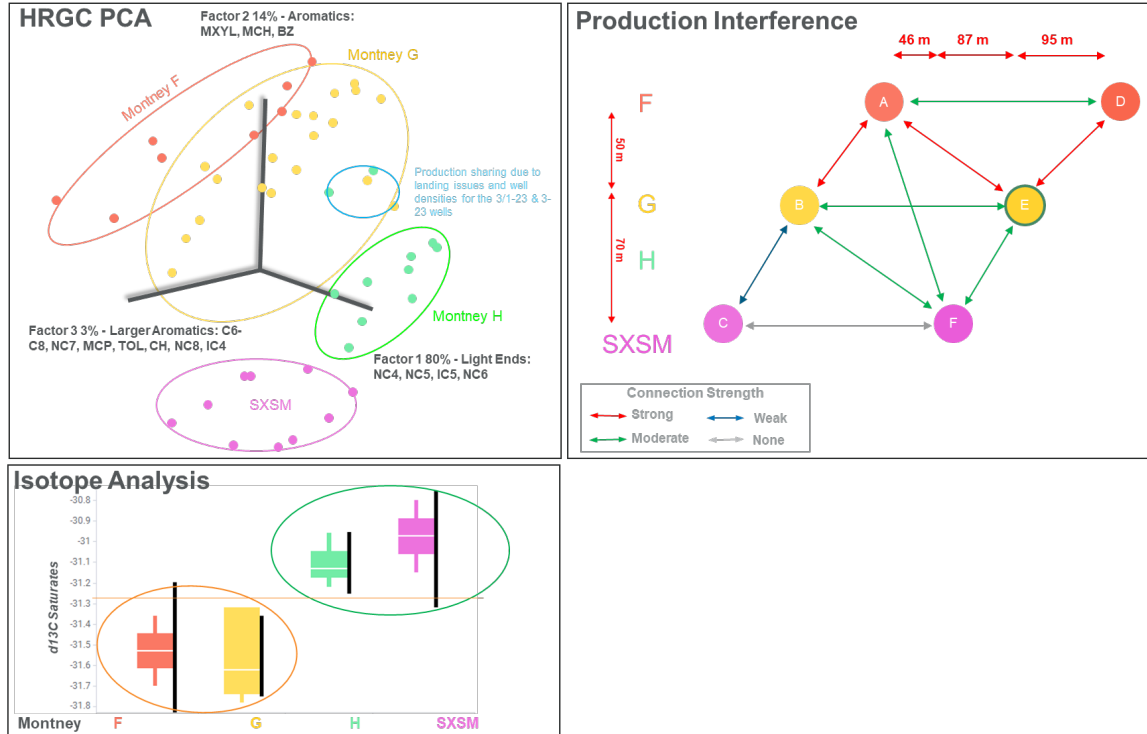


Figure 3. Geochemistry and production interference testing showing clear separation between the Middle F & G Montney and the Lower SXSM Montney.