Lateral and Vertical Variations in the Montney Formation, Northeast British Columbia

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The Montney Formation has been successfully exploited as an unconventional gas play by many companies across a fairway extending through Alberta and Northeast British Columbia. The Montney throughout the fairway has many consistent geological properties including: thick clinoforms, fine-grained clastic deposits, low porosity and permeability, elevated pressure, and high gas saturation. However, important properties such as hydrostatic pressure, gas composition, and hydraulic fracture stimulation patterns show dramatic lateral changes over small geographic areas. Significant vertical lithological changes can occur on a scale of meters to submillimeters, impacting porosity estimation. Here we present observations, potential causes, and estimations of spatial variations in the Montney, focusing on examples from Groundbirch, Monias, and Farrell Creek.

Major tectonic events influenced the study area before, during, and after Montney deposition. The Ft. St. John Graben in the Monias area is characterized by large normal faults and rebound folds. In contrast, the Farrell Creek area is dominated by compressional thrust faults associated with the Laramide Orogeny. The significant influence of these large-scale tectonic features on Montney deposition is recognized by clinoform thickness changes. Correlations of individual clinoforms and their reservoir properties are useful in determining well locations and planning horizontal well trajectories. Microseismically inferred hydraulic fracture patterns observed at Farrell Creek are probably influenced by natural fractures generated during thrust faulting. The hydraulic fracture distribution is highly variable and can change along individual horizontal well profiles. The Montney has large lateral variations of hydrostatic pressure over short distances. The position and timing of the structural elements in the study area helps predict lateral pressure change. Gas composition also shows a strong relationship to tectonic features, with higher liquid yields to the northeast.

Lithological variations in the Montney can be observed in core, cuttings, and log data. Abrupt lithology changes imply abrupt rock-matrix density changes, which throws standard calculation of porosity from conventional density logs into doubt. Correlation with grain density from core helps, but other methods of porosity determination may prove more useful. Nuclear Magnetic Resonance (NMR) logs can be used to estimate porosity in lithology with vertically changing grain density because it calculates porosity from fluid, not rock-matrix. Comparisons of conventional density logs, NMR logs, and core porosity show the benefits of this approach in the Monias area.

Many common features hold throughout the Montney fairway; however, properties that do vary have a significant impact on exploration, exploitation, and economics. Tectonic and lithologic understanding provides improved estimates of these properties.