

Geological controls on permeability of gas shales: Examples from the Triassic Montney/Doig Formations and Devonian Strata of the Horn River Basin, northeastern British Columbia, Canada

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GeoConvention 2012: Vision

Geological controls on permeability of the Triassic Montney/Doig and Devonian Horn River formations in northeastern British Columbia were investigated. Permeabilities from pulse-decay analyses at an effective pressure of 23 MPa range between $6.50E-7$ and 1.11 mD. Porosities vary between 1.9 and 6.7% and TOC contents range between 0.73 and 6.8 wt%. Microporous surface area ranges between 1.4 and 25 m²/g. Quartz contents are greater on average for the Horn River shales compared to the Doig/Montney with ranges between 1.5 and 80% for the former and between 17.2 and 65% for the latter. Dolomite and/or calcite dominate low quartz content samples and feldspar is significant in some Doig/Montney samples (< 24%).

The lithological/mineralogical variations with shale formations result in differences in the fabric, texture, surface area and pore size distribution within the gas shale reservoir. These differences control the permeability and the proportions of free and sorbed gas. Coarser, TOC-lean, quartz-rich intervals within the Montney/Doig formations have lower surface area, greater porosities and higher volume of macropores to coarse mesopores compared to the finer, TOC-rich, carbonate/clay-rich intervals resulting in the former having a higher free to sorbed gas ratio and greater permeabilities. The finer-grained intervals contain more sorbed gas because of higher TOC, surface area and volumes of finer mesopores and micropores than the coarser-grained units. Although sorbed gas contents are high, permeability is low and fracture stimulation of carbonate-rich intervals would be necessary to achieve economic flow rates. Mineralogical controls on permeability are more complex within the Devonian strata due to diagenetic alteration. Clay-rich strata are characterised by higher porosities (higher free gas component) and permeabilities than recrystallised biogenic silica, dolomite or calcite-rich strata which contain low porosities and permeabilities but are more fracable than clay-rich intervals.

When considering exploration targets, a balance is needed between TOC richness, porosity, permeability and fracability for both the Montney/Doig formations and Devonian strata of the Horn River basin.