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# Geomechanical Characterization of the Farrell Creek Montney Reservoir, Northeast British Columbia

*Pat McLellan, Irene Anderson, Jennie Wong, Vahid Mostafavi**

*Talisman Energy Inc.*

** Now with ConocoPhillips Canada*

## Summary

*A detailed geomechanical characterization of the Farrell Creek Montney gas field in northeast British Columbia was undertaken to help understand the primary factors controlling well productivity in this unconventional, primarily siltstone reservoir. An unparalleled dataset of in-situ stresses, pore pressures, rock mechanical properties and discontinuity data has been collected and analyzed for this purpose. A comprehensive set of mini-fracs or diagnostic fracture injection tests (DFITs), obtained in the toe stages of 33 horizontal wells, has provided valuable data on the spatial and depth distribution of pore pressure, instantaneous shut-in pressure (ISIP), fracture closure pressure (or minimum horizontal stress, $S_{Hmin}$) and kh (permeability-fracture height product). In parts of the field, even at true vertical depths in excess of ~2500 m, there is evidence of horizontal hydraulic fractures being propagated where the vertical to horizontal in-situ stress ratio is near unity. High DFIT net pressures (ISIP-$S_{Hmin}$) suggest evidence of a complex involvement of natural and induced fractures, and near-wellbore fracture tortuosity in these horizontal wells.*

*Horizontal stress orientations ($S_{Hmin}$ and $S_{Hmax}$) have been constrained using borehole breakouts and drilling-induced fractures (DIFs) observed on image logs. $S_{Hmax}$ is typically 040° with local variations near faults. In a few cases, evidence of principal in-situ stress rotations up to 45° has been interpreted from rotated DIFs. $S_{Hmax}/S_{Hmin}$ ratios in the field range from 1.1 to 1.7 and average 1.4.*

*Laboratory test programs have been conducted to characterize rock strength, and elastic, acoustic, and stress-dependent permeability properties for selected Montney strata. Vertical, horizontal and sidewall core plugs have been tested under representative in-situ conditions to determine static and dynamic Young's moduli, Poisson's ratio, unconfined compressive strength (UCS), triaxial compressive strength and other properties. Peak and residual Mohr-Coulomb envelopes for the four principal stratigraphic divisions in the Montney have been prepared. Correlations between laboratory and log-derived elastic properties were also developed for each stratigraphic unit. "Brittleness" measures have been calculated by several techniques using static and dynamic lab and log data, and mineralogical data. Comparisons between these different techniques are highlighted.*

*A high quality dataset of rock matrix pulse decay permeability (PDP) data has been obtained on vertical and horizontal core plugs. The relationship between effective confining stress and permeability for cores from three wells is shown. A novel set of tests on a few samples has also permitted an estimation of the poro-elastic Biot parameter.*

*Natural fracture and fault characteristics have been analyzed using core, log and seismic data. A unique dataset of bedding plane peak and residual strength, and shear and normal stiffnesses was obtained from direct shear tests to help better understand casing deformations localizing on weak interfaces. Bedding plane and fracture strength are considerably weaker than peak matrix rock strength data. The importance of natural fractures, faults and bedding planes during high pressure stimulation treatments and subsequent production is analyzed using Mohr Coulomb theory.*