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Fabric Selective Impacts on Reservoir Quality and Permeability Anisotropy in Sedimentary Facies of the Montney Formation, Northeast British Columbia

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A detailed multi-disciplinary study of the Montney formation in the greater Farrell Creek- Altares area of Northeastern British Columbia conducted by geoscientists from Talisman Energy and Sasol Petroleum International has provided significant insight to the origin, heterogeneity and predictability of reservoir quality enhancement in specific sedimentary facies. Detailed sedimentologic, petrographic and rock properties analysis of over 560m of full diameter core from 12 wells in the study area has led to the recognition of a fabric selective control on reservoir quality, pore throat size distribution and permeability anisotropy. Variability in sedimentary fabric (i.e. texture, sorting, net/gross, physical and biogenic sedimentary structures) is linked directly to sedimentary facies and corresponding depositional environments. As such, a predictive framework has been derived for the distribution of better/best reservoir quality facies that are mappable through calibration of facies to well log response and character. The mapping of reservoir facies- tracts provides a close match to well performance by Initial (IP) and first 12 month (F12mo) production.

On a sedimentologic level, the spectrum of siliciclastic lithofacies observed in the Montney is relatively restricted, ranging from bituminous sandy siltstone to fine-medium grained matrix-rich siltstone. Sedimentary facies observed in core were deposited in a ramp setting in Lower Shoreface through Offshore environments of deposition characterized by a low diversity but widely varying abundance of physical and/or biogenic sedimentary structures. Sandy coarser siltstone facies, deposited in a more proximal setting, are characterized by a higher net: gross ratio of coarse to fine silt, are planar to ripple laminated and have varying amounts of calcite, ferroan dolomite and silica overgrowth cement. This fabric yields a facies with larger maximum pore size, but lower total pore volume along with higher Kh but significantly lower Kv and thus greater permeability anisotropy and poorer overall reservoir quality. Conversely, finer grained siltstones deposited in a more distal ramp setting, specifically the Offshore Transition environment of deposition, and characterized by laterally discontinuous laminae and/or massive appearance, are cryptobioturbated. The cryptobioturbation has altered the original sedimentary fabric, homogenizing grain size and pore size distribution, and inhibiting cementation. This has resulted in higher pore volumes, enhanced Kv and reduced permeability anisotropy, thus yielding a better reservoir quality facies. These trends are empirically derived from sedimentologic and petrographic observations and have been established analytically

through calibration to porosimetry plots, pore throat size distributions and Swanson permeability calculations derived from mercury injection capillary pressure data. Mercury injection porosimetry plots display distinctive distributions of pore throat apertures which can be directly related to grain size distribution, physical and biogenic sedimentary structures (i.e. cyptobioturbation) and diagenesis characteristic of individual sedimentary facies.

The recognition of sedimentary fabric and facies relationships to reservoir quality provides a predictive and mappable framework, as observed in Geomodel reconstructions, for the trend and distribution of “sweet spots” in the Montney formation both spatially and stratigraphically within the study area.