GeoConvention
Calgary • Canada • March 7-11 2016
OPTIMIZING RESOURCES

Petrophysical, geomechanical and geochemical characteristics of the Montney Formation: Implications for hydrocarbon storage and transport

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Summary

We present results from an ongoing laboratory study investigating petrophysical, geomechanical and geochemical characteristics of the Montney Formation. The primary objectives are to 1) characterize the pore network attributes (porosity, pore size distribution, specific surface area) and fluid transport (gas permeability) properties of selected intervals, 2) analyze the effects of different geological factors (total organic carbon (TOC) content, maturity and mineralogical composition) on porosity, pore size distribution and permeability, and 3) investigate possible interrelationships amongst various petrophysical, geomechanical and geochemical characteristics of the Montney Formation. The techniques used for characterization include: bitumen reflectance (BR_o), Rock-Eval pyrolysis; Extended Slow-Heating (ESH) Rock-Eval analysis (Sanei et al., 2015); helium pycnometry; low-pressure gas (N_2) adsorption; pressure-decay profile (N_2) permeability and pulse-decay (N_2) permeability.

Petrographic analysis indicates that most of the TOC is solid bitumen with major implications for reservoir quality, as previously shown by Wood et al. (2015) and Sanei et al. (2015). The results of Rock-Eval analysis indicate that TOC contents of the samples range from 0.25 to 5.5%. Rock-Eval T_{max} values range between 431 and 482 °C. The measured permeability values on core plugs increase with increasing porosity (2.2-7.5%), ranging from $3 \cdot 10^{-5}$ to $1.5 \cdot 10^{-2}$ mD. For the core plugs analyzed ("as-received"), profile (probe) permeability values ($6.5 \cdot 10^{-4}$–$1.5 \cdot 10^{-2}$ mD) are consistently higher than pulse-decay ($1.2 \cdot 10^{-4}$–$7.9 \cdot 10^{-4}$ mD) permeability values. Corrected profile (probe) permeability values for "in-situ" effective stress ($3 \cdot 10^{-5}$–$1 \cdot 10^{-3}$ mD) are, however, comparable with the pulse-decay ($1.2 \cdot 10^{-4}$–$7.9 \cdot 10^{-4}$ mD) permeability values. These observations are in agreement with those previously reported by Ghanizadeh et al. (2015a) for other Montney samples. The dominant pore throat diameter controlling fluid flow is estimated for all samples using newly-established Winland-style correlations (Di and Jensen, 2015). Permeability values measured parallel to bedding are up to 60% larger than those measured perpendicular to bedding.

The data obtained in the present study are compared to those previously collected for other sample suites from the Montney (Wood et al., 2015; Wood, 2015; Sanei et al., 2015; Ghanizadeh et al., 2015a,b,c). Applying multiple analysis techniques on a large number of samples, this study provides a comprehensive petrophysical, geomechanical and geochemical description of the Montney Formation in western Canada.

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