Determination of Elastic Anisotropy of Intact and Artificially-Fractured Montney Tight Siltstone Samples Using Ultrasonic Measurements

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Summary

Acoustic wave propagation measurements performed in the lab may be used to estimate sonic velocities, elastic anisotropy and dynamic rock mechanical properties. These data may in turn be used for calibration of sonic logs and to inform 3D/4D seismic and microseismic interpretations. However, elastic properties, and particularly anisotropy, depend strongly on the fabric of the rock, including natural and induced fractures.

In this study[1], ultrasonic experiments were performed on Montney tight siltstone core plug samples using a sonic coreholder simultaneously with permeability measurements under the same triaxial pressure conditions. Both intact and artificially-fractured samples, with and without proppant, were analyzed.

The objectives of this study were to:

1) quantify the impact of the effective pressure changes on P- and S-wave velocities, and derived elastic and mechanical properties, for the intact samples;
2) compare lab- and log-based estimates of sonic velocities and mechanical properties;
3) quantify the impact of propped/unpropped fractures and effective pressure on derived elastic properties and elastic anisotropy.

For both intact and fractured samples, P- and S-wave velocities increased with increasing effective pressure. These velocities, and derived mechanical properties (such as Young's modulus), for intact core plug samples are in excellent agreement with log-derived values. Because of the difference in scales for core- and log-based measurements, this agreement suggests that reservoir heterogeneities affecting acoustic wave propagation (and derived rock mechanical properties) occur at the sub-core plug scale for the reservoir interval studied.

Measures of elastic anisotropy, such as shear-wave splitting, were also determined to be a strong function of effective pressure. In one case, an intact sample was artificially fractured during the experiment with increasing effective pressure – the shear wave velocity difference (S1-S2) reversed at

[1] At the time of writing, a full-length paper on this topic was in review with the journal *Fuel*

the estimated point of fracturing. This finding has important implications for interpretation of hydraulic and induced fractures in the reservoir using seismic data.

Finally, a core containing 1) an unpropped fracture and 2) a propped fracture was analyzed to determine the impact of these fracture types on anisotropy changes with effective pressure. Shear wave splitting changes were found to be much larger for the propped fracture sample than for the unpropped fracture sample, suggesting that time-lapse seismic may be used to distinguish fracture types.