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The Lower Triassic Montney Formation: facies distribution and stratigraphic architecture, northeastern British Columbia

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Summary

The Lower Triassic Montney Formation in the Western Canada Sedimentary Basin has been a target for oil and gas exploration since the 1950's. It records sediment accumulation in a variety of coastal and marine depositional settings, including: siliciclastic shoreface, mixed clastic-carbonate ramp, turbidites, deltas and biostromes (Zonneveld and Moslow, 2018). As a result of its wide lateral extent, pervasive fine-grained nature and regional hydrocarbon charge, the Montney has become widely known as a world-class unconventional petroleum reservoir system.

In British Columbia, the Montney Formation is overall characterized by small-scale heterogeneities associated with subtle grain size variations, diminutive biogenic structures, lateral facies variability, and intraformational discontinuities, challenging the establishment of a strong stratigraphic framework across the area. For this reason, detailed geological analyses are necessary to improve efficiency in the identification and development of potential reservoirs in the area.

Study area and Methods

The study area focuses in northeastern British Columbia, between Townships 81 to 104 and Ranges 14W6 to 25W6, and includes NTS blocks 94-A, 94-B, 94-G and 94-H, comprising the area known as the Northern Montney Field (BC Oil and Gas Commission, 2017). According to recent stratigraphic nomenclature (Zonneveld and Moslow, 2018), the study interval includes the Lower Montney, Pocketknife, Middle Montney, Altares and Upper Montney members. Detailed analyses were conducted on 37 drill cores (~2500 metres of core), focusing on description of lithology, physical sedimentary structures, fossil content, and ichnological characteristics, including bioturbation intensity and size diversity index. Additionally, 56 thin sections from 4 cored wells were analyzed to characterize the texture, composition and diagenetic features of the different facies identified. Furthermore, using sedimentological and wireline log data, stratigraphic cross sections were established, along both depositional dip and depositional strike, aiding in the interpretation of the sequence stratigraphic framework of the Montney Formation in the study area.

Results and Discussion

Based on core examination, 12 lithofacies were identified, distributed within 3 facies associations: 1) facies association A: retrogradational siliciclastic distal offshore transition to distal offshore; 2) facies association B: progradational, mixed siliciclastic-carbonate offshore to offshore transition; and 3) facies association C: progradational, storm-dominated siliciclastic offshore transition to lower shoreface. Overall, the Montney Formation in the study area has been interpreted to represent sedimentation on a storm-influenced ramp, with alternating siliciclastic and carbonate deposition, temporarily influenced by hyperpycnal flow discharge (Fig. 1). Stratigraphic surfaces were interpreted from core examination, and their wireline-log expressions found from core to log correlations, essential for the interpretation of the sequence stratigraphic framework.

The Montney Formation consists of three 3rd-order sequences (Fig. 2). Sequence 1 (Changsingian-Dienerian to Griesbachian-Dienerian; Golding et al., 2014; Henderson and Schoepfer, 2017; Henderson et al., 2018), is bounded at its base by an erosional unconformity at the top of the Paleozoic Belloy Formation, interpreted as a coplanar lowstand surface of erosion and transgressive surface of erosion (Golding et al., 2014). Sequence 1 consists of two units; a lower unit containing retrogradational higher-frequency-sequence-sets, interpreted as a Transgressive Systems Tract (TST1), and an upper unit containing aggradational/progradational higher-frequency-sequence-sets, interpreted as a Highstand Systems Tract (HST1). At the top, the sequence is bounded by a maximum regressive surface (MRS1), overlying the Pocketknife Member.

Sequence 2 (Smithian; Golding et al., 2014; Henderson and Schoepfer, 2017; Henderson et al., 2018) consists of two units. The lower unit contains a series of higher-frequency-sequence-sets with a retrogradational stacking pattern, interpreted as a Transgressive Systems Tract (TST2). The upper unit contains a series of higher-frequency-sequence-sets with a progradational stacking pattern, interpreted as a Highstand Systems Tract (HST2). Sequence 2 is bounded at the bottom by a maximum regressive surface (MRS1). The upper boundary has a variable expression in core. In some core locations, the boundary is represented by a conformable contact at a maximum regressive surface (MRS2) overlying the Altares Member; in other locations, the boundary is represented by an unconformable contact at a wave ravinement surface (WRS).

Sequence 3 (Spathian; Golding et al., 2014; Henderson and Schoepfer, 2017; Henderson et al., 2018) is subdivided into two broad lithological units. The lower unit is characterized by phosphate-rich higher-frequency-sequence-sets with a retrogradational stacking pattern, interpreted as a Transgressive Systems Tract (TST3). The upper unit consists of strongly progradational higher-frequency-sequence-sets, of a Highstand Systems Tract (HST3). Sequence 3 is bounded at its base by a maximum regressive surface (MRS2) or a coplanar sequence boundary/wave ravinement surface (WRS1). At the top, the sequence is bounded by a coplanar sequence boundary/transgressive surface of erosion underlying the Sunset Prairie Formation (Furlong et al., 2018b).

Detailed lithofacies analysis, and its corresponding core to log correlations, are essential for interpreting the sequence stratigraphy of the formation, allowing to establish a strong stratigraphic framework that can provide the means for predicting the distribution and continuity of potential hydrocarbon reservoirs in the area.

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References

Furlong, C.M., Gingras, M.K., Moslow, T.F. and Zonneveld, J.-P. (2018b): The Sunset Prairie Formation: designation of a new Middle Triassic formation between the Lower Triassic Montney Formation and Middle Triassic Doig Formation in the Western Canada Sedimentary Basin, northeast British Columbia; *in* The Montney Play of Western Canada: Deposition to Development, T. Euzen, T.F. Moslow and M. Caplan (ed.), Bulletin of Canadian Petroleum Geology, v. 66, no. 1, p. 193–214.

Golding, M.L., Orchard, M.J., Zonneveld, J.-P., Henderson, C.M. and Dunn, L. (2014): An exceptional record of the sedimentology and biostratigraphy of the Montney and Doig formations in British Columbia; Bulletin of Canadian Petroleum Geology, v. 62, p. 157–176.

Henderson C.M., Golding, M.L., Orchard, M.J. (2018). Conodont sequence biostratigraphy of the Lower Triassic Montney Formation. Bulletin of Canadian Petroleum Geology, v. 66. No. 1, p. 7-22.

Henderson, C.M., and Schoepfer, S. (2017). High-resolution biostratigraphic and XRF-geochemical correlation of the Montney Formation, NEBC. GeoConvention 2017 Abstracts, Geological Association of Canada.

Plint. A.G. (2010): Chapter 8: Wave- and storm-dominated shoreline and shallow-marine systems; *in* Facies Models 4. N.P. James and R.W. Dalrymple (eds.), Geological Association of Canada, v. 4, p. 167-200.

Reading, H.G., and Collinson, J.D. (1996): Chapter 6: Clastic coasts; *in* Sedimentary Environments: Processes, Facies and Stratigraphy. H.G. Reading (ed.), Blackwell Publishing, third edition, p. 154-231.

Walker, R.G., and Plint, A.G. (1992): Chapter 12: Wave- and storm-dominated shallow marine systems; *in* Facies Models: Response to sea level change. R.G. Walker and N.P. James (eds.), Geological Association of Canada, p. 219-238.

Zonneveld, J-P., MacNaughton, R.B., Utting, J., Beatty, T.W., Pemberton., S.G., and Henderson, C.M. (2010): Sedimentology and ichnology of the Lower Triassic Montney Formation in the Pedigree-Ring/Border-Kahntah River area, northwestern Alberta and northeastern British Columbia. Bulletin of Canadian Petroleum Geology, v. 58, p. 115-140.

Zonneveld, J.-P., and Moslow, T.F. (2018): Palaeogeographic setting, lithostratigraphy, and sedimentary framework of the Lower Triassic Montney Formation of western Alberta and northeastern British Columbia; *in* The Montney Play of Western Canada: Deposition to Development, T. Euzen, T.F. Moslow and M. Caplan (ed.), Bulletin of Canadian Petroleum Geology, v. 66, no. 1, p. 93–127.

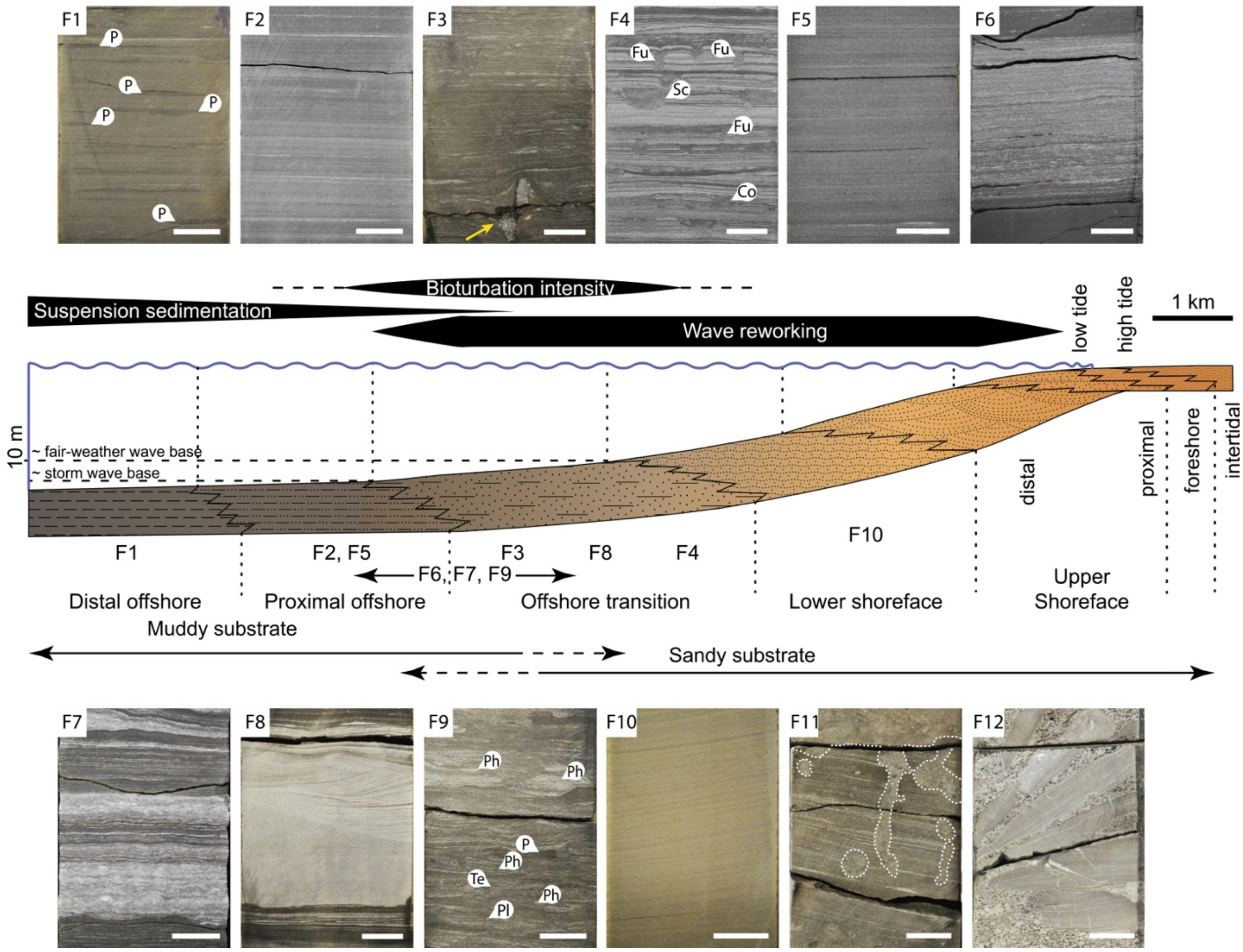

Figure 1: Summary of facies present within the Lower Triassic Montney Formation and their distribution along a schematic facies model. Facies model modified from Walker and Plint (1992), Reading and Collinson (1996), Plint (2010), and Zonneveld et al., (2010). Scale bar in facies photographs is 2cm. Abbreviations include: P: phosphate, Fu: fugichnia, Sc: *Scolicia*, Co: *Conichnus*, Ph: *Phycosiphon*, Te: *Teichichnus*, Pl: *Planolites*; F1-F12: indicate Facies numbers; yellow arrow in Facies 3 (F3) indicates Ichthyosaur vertebra.

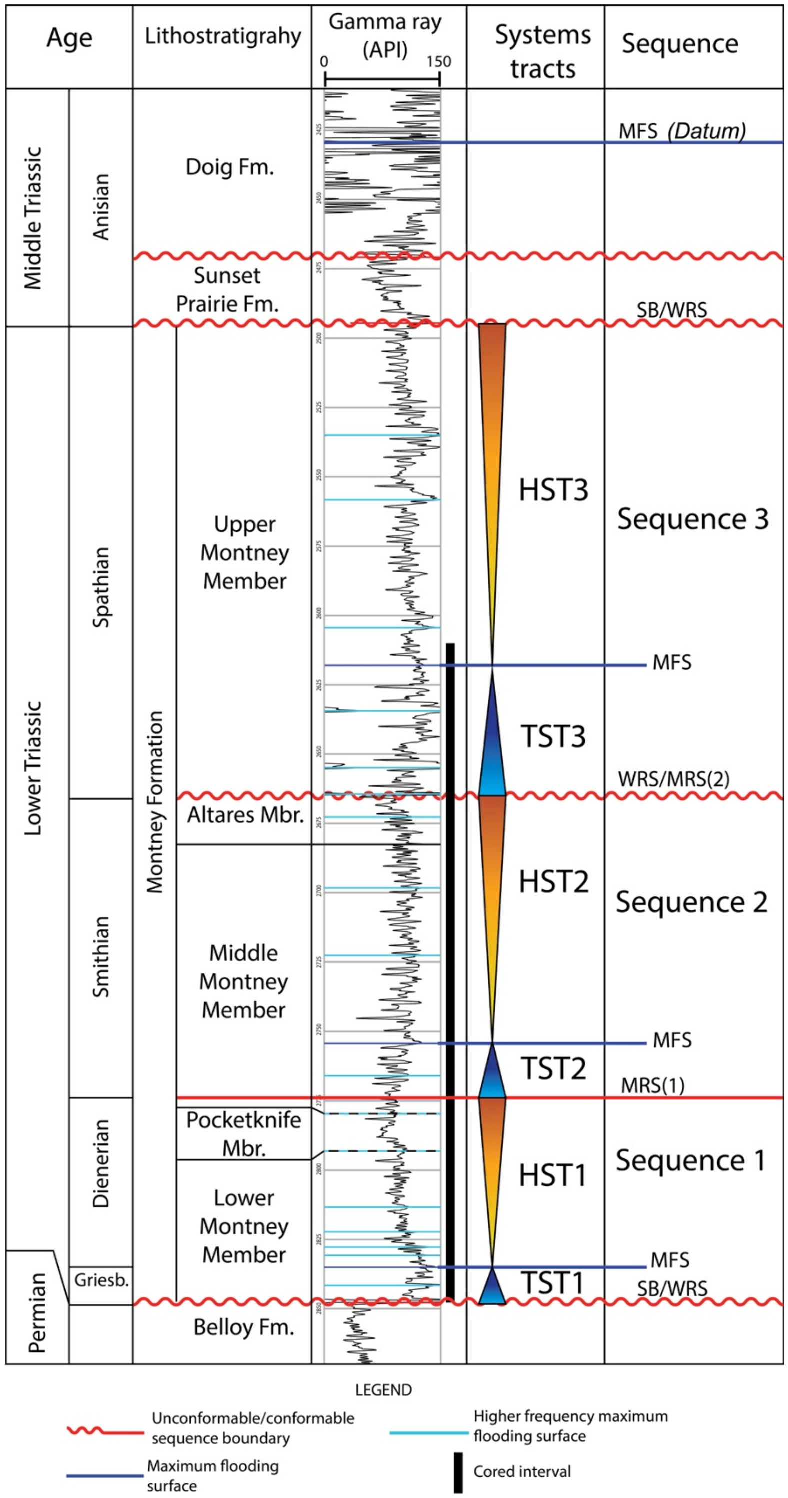

Figure 2: Schematic sequence stratigraphic framework of the Montney Formation in northeastern British Columbia in well Talisman Graham c-006-L 94-B-08. Ages from Golding et al., (2014), Henderson and Schoepfer, (2017); Henderson et al., (2018).