Preliminary Report: Biogenic Controls on Reservoir Properties in the Lower Triassic Montney Formation, Dawson Creek Area, Northeastern British Columbia and Northwestern Alberta

D.T. Prenoslo, University of Alberta, Edmonton, AB, dprenosl@ualberta.ca

A.E. Gegolick, University of Alberta, Edmonton, AB

M.K. Gingras, University of Alberta, Edmonton, AB

J.-P. Zonneveld, University of Alberta, Edmonton, AB

Prenoslo, D.T., Gegolick, A.E., Gingras, M.K. and Zonneveld, J.-P. (2016): Preliminary report: biogenic controls on reservoir properties in the Lower Triassic Montney Formation, Dawson Creek area, northeastern British Columbia and northwestern Alberta; *in* Geoscience BC Summary of Activities 2015, Geoscience BC, Report 2016-1, p. 163–166.

Introduction

Over the past decade, the Montney Formation has evolved into western Canada's premier unconventional exploration play, containing an estimated 449 trillion cubic feet of marketable natural gas in addition to natural gas liquids and condensate (Faraj et al., 2002; National Energy Board et al., 2013). Historically, Montney Formation exploration has focused on conventional reservoir intervals, such as the turbidite interval and clastic and bioclastic shoreface intervals (Davies et al., 1997; Zonneveld et al., 2010). Although low porosity and low permeability siltstone intervals make up the largest portion of the Montney Formation, they have until recently been overlooked. With the advent of horizontal drilling and multistage hydraulic fracturing, these intervals have become highly prospective (National Energy Board et al., 2013).

Considering the economic importance of the Montney Formation, detailed geological analyses focusing on the sedimentology of the unconventional reservoir portions of the Montney Formation remain limited. Interpretations of depositional environments within the Montney Formation are constrained to petroleum fields along the eastern subcrop edge as well as those along the turbidite trend (Davies et al., 1997; Moslow, 2000; Zonneveld et al., 2010). Montney Formation successions in the western part of the Western Canada Sedimentary Basin have been referred to as distal, offshore or basin-centred due primarily to the restricted grain sizes observed in core and outcrop (Gibson and Edwards, 1990; Dixon, 2000). Preliminary core analysis suggests that this is not the case and a more complicated depositional scenario exists.

Keywords: *Montney Formation, ichnology, sedimentology, stratigraphy, unconventional resources*

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Despite minimal variation in grain size between facies, it has become apparent that primary depositional characteristics play a seminal role in preserved reservoir attributes. In particular, the presence and nature of bioturbation is increasingly recognized as a key element in resource distribution. Bioturbation has long been recognized as a potentially significant control on porosity and permeability in both conventional and unconventional reservoir units (Pemberton and Gingras, 2005; Baniak et al., 2015). The subtle nature of Montney Formation bioturbation makes trace fossils difficult to observe in hand sample. As a result, in published literature there has been minimal focus on the potential effects of bioturbation on reservoir properties of the Montney Formation. Recent studies have focused on the relationship between bioturbation and water saturation in Montney Formation siltstone (Wood, 2012). However, bioturbation and its relationship to porosity and permeability in the Montney Formation remains to be investigated.

Research Objectives

The goal of this research is to 1) investigate the influence of bioturbation on reservoir quality in the Montney Formation; 2) characterize the depositional setting and develop a stratigraphic framework for the Montney Formation in the Pouce Coupe–Dawson Creek area; 3) refine stratigraphic and sedimentological models used for defining reservoir units, reservoir correlations and properties important to reservoir quality; and 4) develop predictive models to help decrease exploration risk.

Study Area

The study area is located on either side of the Alberta–British Columbia border near the town of Dawson Creek, approximately 75 km south-southeast of Fort St. John (Figure 1). This area overlaps the Montney Formation turbidite trend, which was a prolific oil play during the 1990s. With advances in technology allowing the exploitation of the

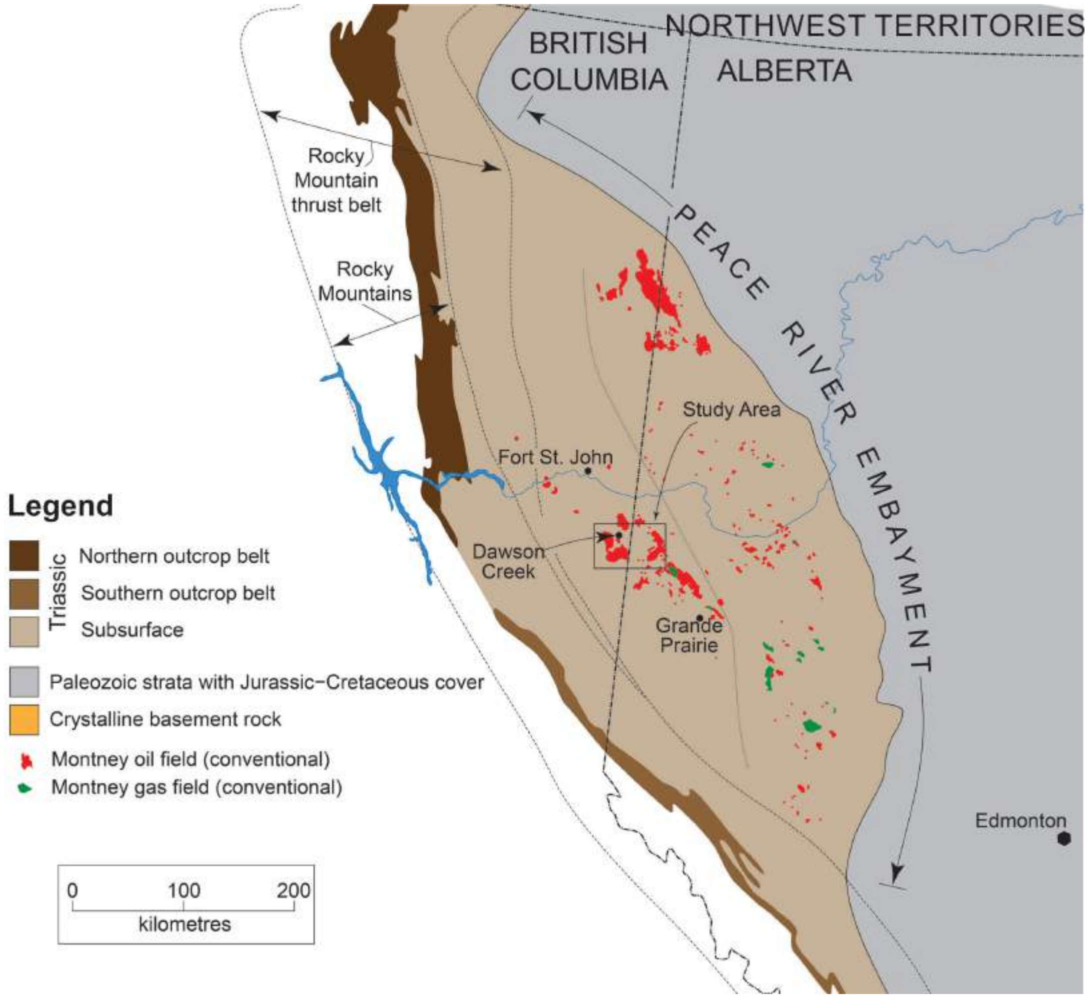

Figure 1. Distribution of Triassic strata in the Western Canada Sedimentary Basin (after Zonneveld et al., 2011). Location of study area outlined in black.

tight siltstone intervals, this area is once again an active exploration target. The studied interval directly overlies the Montney Formation turbidite and although stratigraphically equivalent successions are dry in surrounding areas, this area is characterized by liquid-rich natural gas. In the study area there are 2753 wells that penetrate the Montney Formation, of which 247 are cored.

Geological Framework

The Montney Formation is a complex accumulation dominated by siltstone and sandstone with shale and bioclastic packstone/grainstone occurring in some areas (Zonneveld et al., 2011). Deposition took place along the northwestern coast of Pangaea with the thickest accumulations occurring near the collapsed Peace River arch (Davies et al., 1997). An extensional tectonic regime combined with underlying Devonian reef complexes exerted a strong influence on the regional and local structure during the early Triassic (Moslow, 2000). During this time, the northwestern coast of Pangaea was situated in a midlatitudinal setting and was characterized by arid conditions with dominant northeast trade winds (Davies et al., 1997). The aridity of the region combined with exceptionally long sediment transport distances resulted in dominantly fine-grained clastic deposition throughout all environments; consequently, Montney Formation depositional environments are not easily segregated on the basis of grain size alone (Zonneveld et al., 2011).

In the study area, cores from 50 wells (Figure 2) were logged to assess the ichnological and sedimentological character of constituent lithofacies. Sedimentological analysis focused on bedding thickness, bedding contacts, grain size, penecontemporaneous deformation structures, primary physical sedimentary structures and sorting. Ichnological observations included ichnogenera identification, relative ichnogenera abundance, assemblage diversity and intensity of bioturbation. Thin section analyses were used to determine framework grain and cement compositions, as well as to observe subtle bioturbated fabrics. Permeability measurements were obtained using a Core Labo-

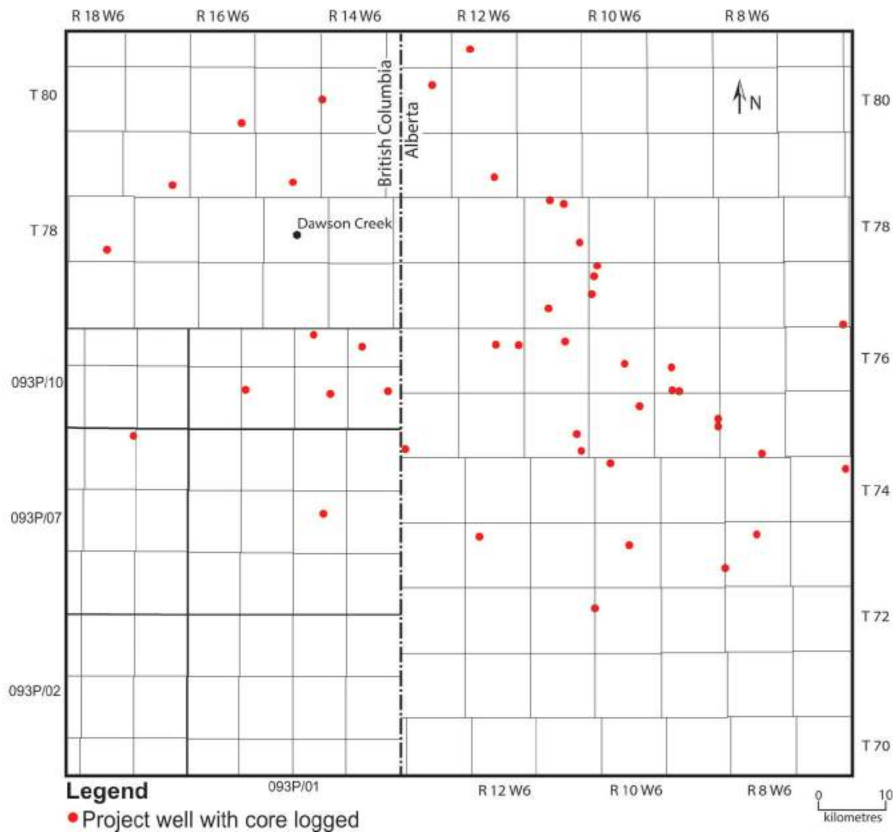

Figure 2. Location of 50 wells from which cores were analyzed in the study area, northeastern British Columbia and northwestern Alberta.

ratories pressure-decay profile permeameter located at the University of Alberta.

Preliminary Results and Future Work

In the studied core, the most common ichnofabric observed is cryptic bioturbation, which has been recognized throughout the interval and has altered much of the rock fabric. Bioturbation modifies the relationship between vertical permeability and horizontal permeability (i.e., it decreases permeability anisotropy), and preliminary porosimetry work indicates that the bioturbation has had an affect on resource storativity and deliverability. The trace fossils are also useful for subdividing the interval into facies. These facies will be mapped and together with observed facies-associated permeability trends will enable the development of a predictive framework for the delineation of areas with superior reservoir quality.

Acknowledgments

This research was funded in part by the Natural Sciences and Engineering Research Council (NSERC) along with contributions from Birchcliff Energy Ltd., Progress Energy Canada Ltd., TAQA North Limited, Sasol Canada and Shell Canada Limited. This report benefited from a meaningful review by E. Timmer.

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