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ABSTRACT

There are many factors that are important for unconventional hydrocarbon prospectivity, this report shows a map of two based on the premise that Canol Formation contains natural fractures at relatively shallow levels, which has a negative impact on hydrocarbon production from stimulated fractures. Firstly, a depth map of Canol Formation was generated from interpretations of seismic data and well logs and is contained within a subsurface zero edge determined from both subsurface data and bedrock maps. Secondly, previously published thermal maturity data for the Canol Formation were plotted as Tmax values on the map, highlighting a 430-465 oil window. There is an area through most of Peel Plain and parts of Mackenzie Plain where the Canol Formation is within the oil window and resides at depths greater than 600 m.

INTRODUCTION

This report addresses two elements of the Canol Formation that are important indicators for the prospectivity of shale rocks as unconventional hydrocarbon plays. Thermal maturity is a fairly standard measure of source rock suitability and is typically used to define the oil window. With regard to unconventional shale oil plays, the presence of natural fractures can have a negative influence on oil production from stimulated hydraulic fractures (Gale et al., 2007). Pre-existing fractures will simply focus hydraulic fluids thereby decreasing the effectiveness of hydraulic fracture treatments. Compared to other Devonian mudstones in the region, the lithology of the Canol Formation is unique in that it is very siliceous (see Pyle et al., 2011) and could therefore behave in a more brittle manner than typical mudstone. Without experimental rheological analysis of the Canol Formation, we note the empirical observation that the Canol Formation at Norman Wells contains natural fractures at reservoir depths of 500-350 m (Yose et al., 2001; see discussion in Hadlari, 2015). It follows that the Canol Formation has better prospectivity for unconventional hydrocarbons at greater depths. Furthermore, with greater depth is it more likely that stimulated fractures will be oriented vertically (Hubbert and Willis, 1972), which is significant in a tectonically active setting such as the northern Mackenzie region.

METHODOLOGY

The source of thermal maturity data shown here for the Canol Formation is a compilation by Pyle et al. (2015). Where there are multiple samples for a given outcrop or well location, the results were averaged. Canol Formation depths derived from an interpretation of seismic data and exploration wells that was developed in the manner described in Maclean (2012). The area where Canol Formation is present in the subsurface is approximated by the distribution of the entire Horn River Group, for which Canol Formation is upper stratigraphic unit, and integrates both subsurface and bedrock maps (Aitken et al., 1969; Aitken and Cook, 1979a, b; Cook and Aitken, 1970, 1975a, 1975b, 1975c; Fallas, 2013; Fallas and MacLean, 2013; Fallas and MacNaughton 2013, 2014a, b; Fallas et al., 2013a,b,c; Norris, 1981a, b, c, d, 1982). In general, interpretations are not extrapolated over data gaps in the interest of accurate representation of data.

RESULTS

Figure 1 is a contoured depth map of the Canol Formation. In general, depths gradually increase from east to west toward the mountain front into the axis of a syncline running parallel to the mountain front. South and west of the syncline, the Canol Formation is typically exposed at

surface on one of a series of north- to northeast-dipping fold limbs along the Mackenzie Mountain front (Cook and MacLean, 1999), modified by hinterland-verging thrust faults in the Peel Plateau region (Lemieux et al., 2009). Thermal maturity trends increase in a westward direction. It is proposed that there lies an area under the Peel Plain and Mackenzie Plain regions where the Canol Formation lies within the oil window and remains at depths that may not significantly inhibit shale oil production from stimulated hydraulic fractures.

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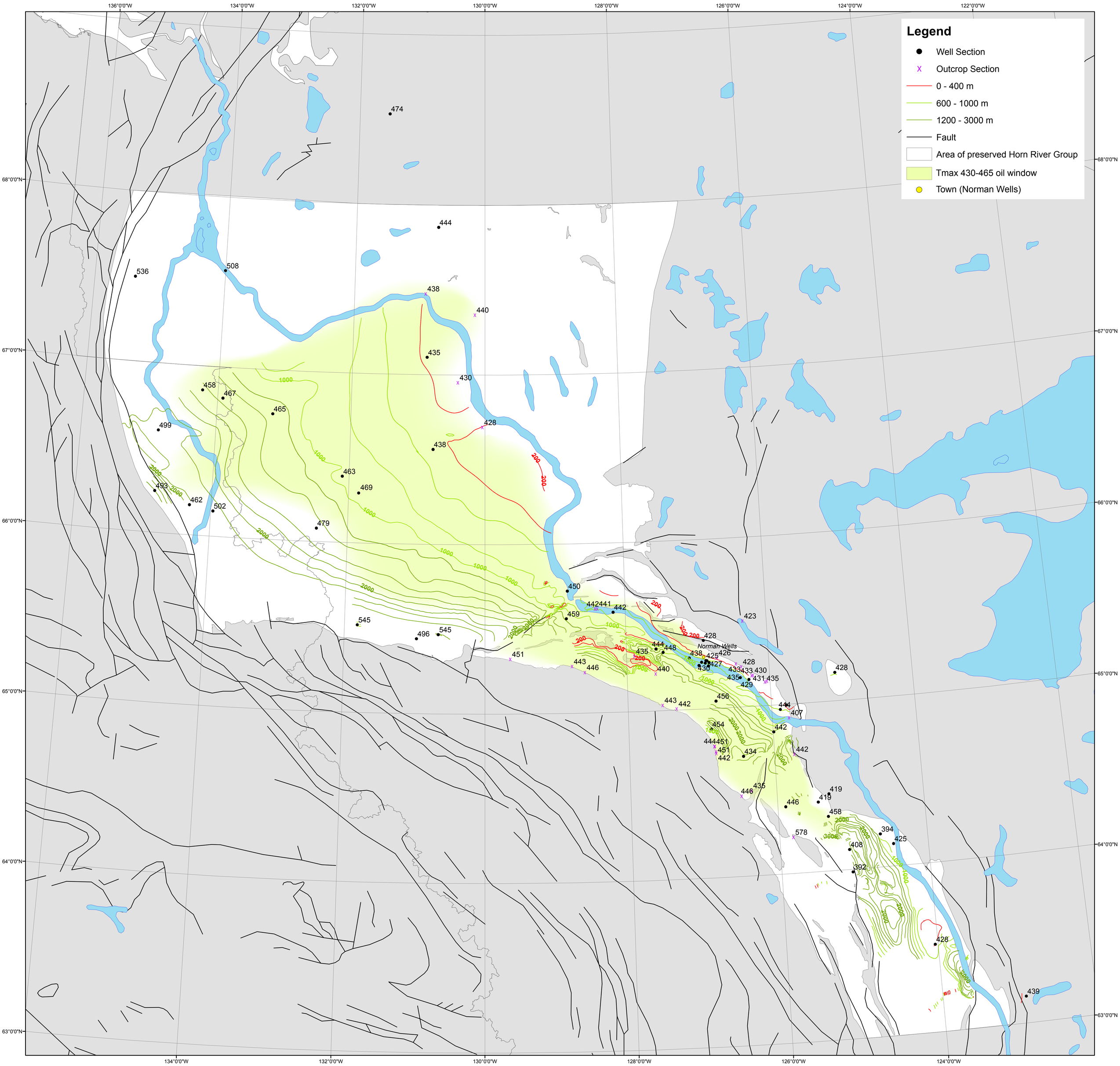

Combined depth and thermal maturity map of the Canol Formation, northern Mackenzie Valley, NWT

Figure 1. Map showing contoured depth of the Canol Formation and thermal maturity as Tmax values. Depths are interpreted from seismic data and well logs (MacLean, 2012). Average Tmax values were calculated by Pyle et al. (2015).

0 25 50 100 150 200 Kilometers