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Stratigraphy, Basin Morphology and Hydrocarbon Potential of Middle to Upper Cretaceous Strata, Eagle Plain Basin, Northern Yukon

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Summary

The Eagle Plain Basin is a relatively unexplored intermontane basin located in northern Yukon with proven hydrocarbon potential (Figure 1). Previous studies of the middle Albian-Cenomanian Parkin Formation and the Turonian Fishing Branch Formation are based on broad lithostratigraphic correlations. The objective of this study is to refine the stratigraphic framework for the middle to upper Cretaceous succession of the Eagle Plain Basin by integrating seismic, outcrop, core, well log and petrographic data. Comparison of new data with research from adjacent basins is vital to understanding regional scale sedimentation patterns and paleogeography in northern Yukon and Northwest Territories. Hydrocarbon potential of the region is particularly significant in light of recent cabinet approval for the proposed Mackenzie Valley Pipeline.

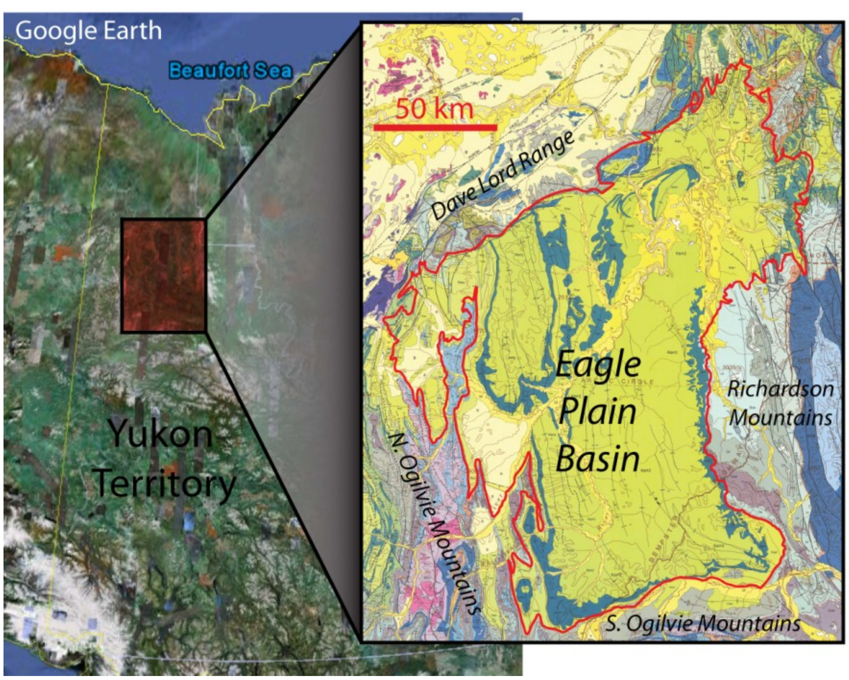

Figure 1. Geological map of northern Yukon Territory indicating location of the Eagle Plain Basin (outlined in red) and major geomorphological elements. Cretaceous bedrock (green and blue-green on map) underlies the majority of Eagle Plain at surface. (Modified from Norris, 1984)

Introduction

The middle Albian-Cenomanian Parkin Formation consists of a basal transgressive sandstone member and overlying shale member which sit unconformably on Lower Albian shales of the Whitestone River Formation. It is overlain gradationally by the regressive Turonian-aged Fishing Branch Formation. Observations from this study indicate greater stratigraphic complexity than previously recognized by Dixon (1992a) (Figure 2).

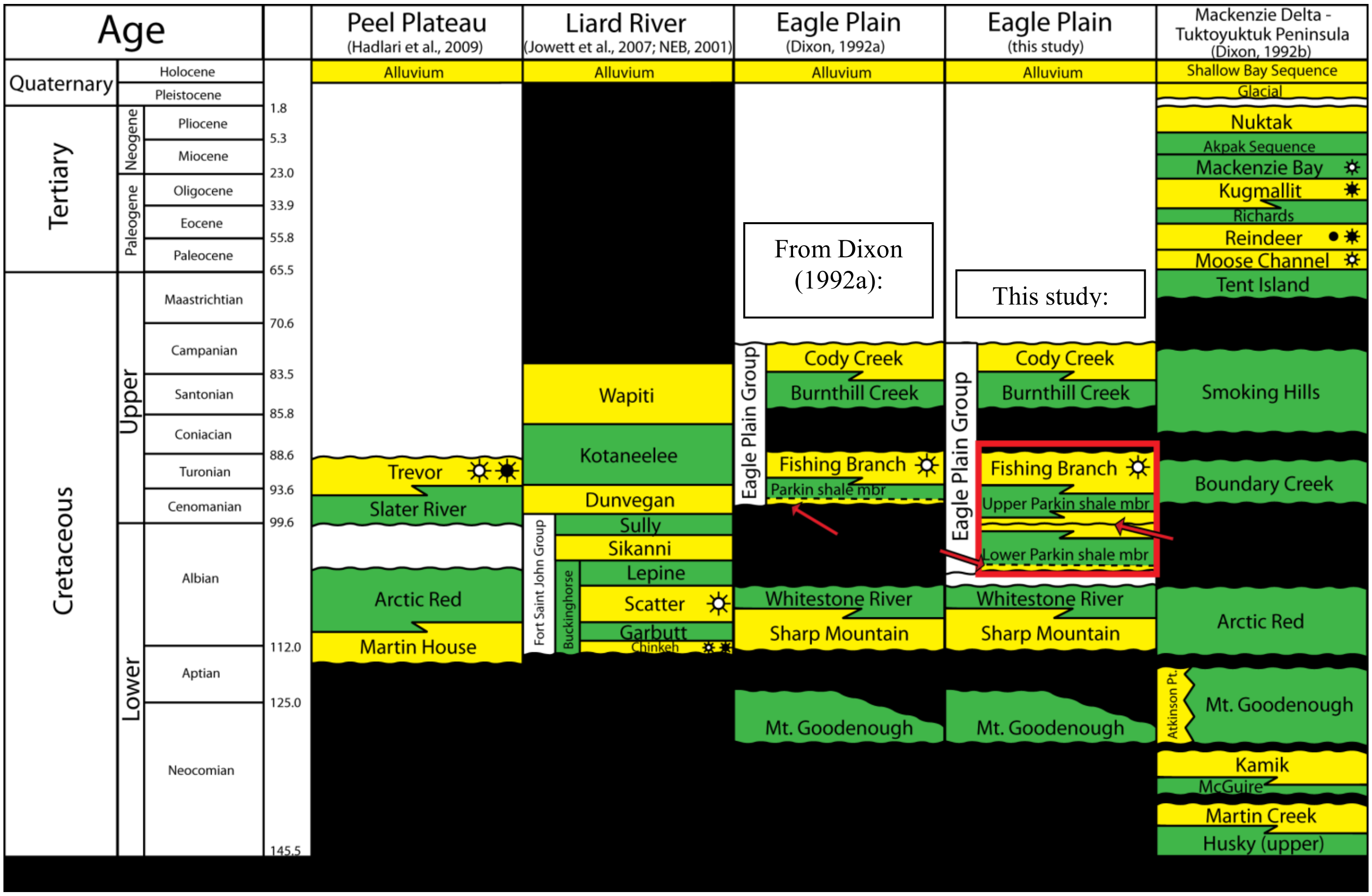

Figure 2: Cretaceous to recent stratigraphy of Eagle Plain area and other basins of northern Canada. Red box outlines the units investigated in this study.

Stratigraphy

The basal Parkin sandstone member is a transgressive unit consisting of coarse-grained fluvial and fine- to medium-grained shoreface sandstones. It is overlain abruptly at a major flooding surface by the newly defined lower Parkin shale member. Ammonites collected from the basal sandstone member have been dated as middle Albian (Haggart, 2010), indicating that the unit is older than the Cenomanian age suggested by Dixon (1992a).

The lower Parkin shale member is a siltstone and shale-dominated succession overlying the basal Parkin sandstone member at a major flooding surface. It is overlain by the newly defined middle Parkin sandstone member in southeastern Eagle Plain and stratigraphically equivalent sand-prone mass transport deposits identified from outcrop in the western part of the study area.

In southeastern Eagle Plain, the middle Parkin sandstone member consists of hummocky sandstones and a chert-rich pebble conglomerate layer overlain by an upward coarsening cycle with at least 15m of clean quartz-rich shoreface sandstones. The conglomerate lag marks a newly recognized intraformational sequence boundary.

The middle sandstone member is overlain by the newly defined upper Parkin shale member, which is gradationally overlain by the Fishing Branch Formation.

The Fishing Branch Formation consists of an overall upward-shallowing fine- to medium-grained marine sandstone unit consisting of stacked coarsening upward cycles, individually up to 30m thick. At the Eagle Plain Group type section in western Eagle Plain, two upward coarsening cycles capped by flooding surfaces represent the lowest parasequences of the Fishing Branch Formation. The sand-rich units consist of interbedded very fine to fine-grained sandstone and siltstone with unidirectional current ripples and tabular beds, interpreted as being deposited in the prodelta of a fluvial-dominated delta. Towards the east the Fishing Branch cycles are thicker, coarser-grained, sandier and show a *Teichichnus* and *Planolites* dominated ichnofabric; this outcrop is interpreted to represent a more a proximal deltaic setting i.e. the delta front. Petrographic analysis indicates significantly

In southern Eagle Plain, outcrops of the Fishing Branch Formation are considerably shalier, and sandstone beds are dominated by storm-generated bedforms including large hummocks. This change in facies indicates a more distal storm-dominated environment in the south, possibly in the windward side of a deltaic complex. Medium- to coarse-grained cross-bedded fluvial sandstones capping the Fishing Branch succession in the south overlie an unconformity which was not previously documented in outcrop.

Basin morphology and implications for hydrocarbon potential

Existing lithostratigraphic models of Cretaceous basin morphology based interpret deposition in a broad, low angle shelf setting in the Canadian Foreland Basin (Dixon, 1992). However, large scale sand-prone mass transport deposits in western Eagle Plain, equivalent to the middle Parkin sandstone member in southern Eagle Plain, indicate the presence of shelf-to-basin floor relief of at least 100m. Recognition of significant shelf-to-basin floor topography greatly increases the potential for large hydrocarbon reservoirs in stratigraphic traps associated with the shelf edge. Increased subsidence and accommodation at the shelf-edge allows potential space for the accumulation of thick sandstone bodies.

The mass transport deposits may represent the distal expression of a shelf-margin delta complex located farther landward at the shelf edge. Shelf-margin delta complexes are often associated with slope failures due to oversteepening of the delta front along the shelf edge. There is also potential for a turbidite fan complex basinward of the slope break by sandy gravity-driven flows. Very large oil and gas fields have been discovered within shelf-margin delta and turbidite fan sandstones around the world. Such high-yield reservoirs in stratigraphic traps could easily have been overlooked in northwest Eagle Plain where gaps in well control occur.

Conclusions

Refinement of the stratigraphic framework is required to reflect previously unrecognized intraformational unconformities. The following observations are highlighted thus far in the study: 1) Facies trends, paleoflow indicators, and isopachs suggest a broadly westward deepening basin; 2) southeastern Eagle Plain received periodic input of coarse-grained sediment during the middle to Upper Cretaceous; and 3) mass transport deposits in western Eagle Plain indicate the presence of significant shelf-to-basin floor relief (>100m), raising the potential for stratigraphically confined play types associated with the shelf edge.

Acknowledgements

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