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Petroleum source potential and depositional setting of Phanerozoic strata in northern Yukon and northwestern district of Mackenzie

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ABSTRACT

Rock-Eval/TOC analysis and organic petrography have been used to evaluate the petroleum source rock potential and depositional setting of the Phanerozoic succession in northern Yukon and northwestern District of Mackenzie. Average total organic carbon (TOC) values of stratigraphic units are generally low to moderate (0.1 to 2.0%) but organic-rich intervals occur throughout the studied succession. The kerogen is dominantly Type III except for minor amounts of Type I or II in Lower Paleozoic strata and locally a mixture of Type II and III in Middle Devonian, Carboniferous, Jurassic and Lower Cretaceous strata.

The quality of organic matter (QOM) varies significantly as a result of variability in the level of organic maturity, the type of organic matter and, in some cases, migration. For some strata, the variation in source rock quality closely reflects the depositional environment. Average QOM values of stratigraphic units are generally low to moderate (0.01 to 1.5 mg HC/g TOC) and, along with low to moderate hydrogen indices (HI <300 mg HC/g TOC), suggest poor to moderate petroleum source potential. Relatively few examples of potential oil-prone source rocks (Type I or Type II kerogen) occur. Gas prone (Type III kerogen) source rocks are present in the Blackie and Arctic Red River formations, in regressive shales of the Husky Formation and the Bug Creek Group and in low-energy shelf deposits of the Mount Goodenough Formation and map unit Kwr. Carbonaceous samples from deltaic sediments of the Porcupine River Formation and nearshore to inner shelf deposits of the Eagle Plain Group also have some gas potential.

RÉSUMÉ

L'analyse Rock-Eval/TOC (teneur en carbone organique total) et la pétrographie organique ont été employées afin d'évaluer le potentiel de roches formatrices de pétrole et le milieu de sédimentation de la succession Phanérozoïque dans le nord du Yukon et le nord-ouest du district de Mackenzie. La teneur moyenne en carbone organique total des unités stratigraphiques est généralement de basse à moyenne (0,1 à 2,0%) mais des intervalles riches en matière organique se trouvent partout dans la succession étudiée. Le kérogène de type III domine ici, à l'exception de quantités peu importantes de type I ou II dans des strates du Paléozoïque inférieur et un mélange local de types II et III dans des strates du Dévonien moyen, du Carbonifère, du Jurassique et du Crétacé inférieur.

La qualité de la matière organique (QOM) varie de façon significative à cause de la variabilité dans le niveau de maturité de la matière organique, du type de matière organique et, dans certains cas, de la migration. Pour certaines strates, la variation de la qualité de la roche formatrice de pétrole reflète de près le milieu sédimentaire. Les valeurs moyennes de la qualité de la matière organique des unités stratigraphiques sont généralement basses à moyenne (0,01 à 1,5 mg HC/g TOC) et, avec des indices d'hydrogène variant de bas à moyen (HI <300 mg HC/g TOC), suggère un potentiel de roches formatrices de pétrole bas à moyen. Il y a relativement peu d'examples de roches formatrices de pétrole potentielles (Kérogène de type I ou II). Les roches formatrices de gaz (Kérogène de type III) sont présentes dans les formations Blackie et Arctic Red River, dans les schistes argileux régressifs de la formation Husky et du groupe Bug Creek, et dans des dépôts de plateau à basse énergie de la formation Goodenough et de l'unité cartographique Kwr. Des échantillons charbonneux de sédiments deltaïques de la formation Porcupine River et les sediments littoraux à plateau interne du groupe Eagle Plain ont aussi le potentiel d'être producteurs de gaz.

Traduit par Marc Charest

INTRODUCTION

Organic geochemical evaluation of basins requires identifying potential petroleum source rocks, establishing the degree of organic maturation (DOM) and determining the regional extent of hydrocarbon source rocks and organic facies. The petroleum source rock potential of several organic-rich units in northern Yukon and northwestern District of

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$[(S_1 + S_2)/TOC]$ have herein been calculated across the thickness of each formation at different locations. In this way, each mapped unit can be regionally evaluated by considering individual parameters and their combined effects on source rock potential. A pitfall of TOC- and QOM-averaging over an entire formation or group is the potential dilution of the source potential of a good member of a formation or group. The source potential of the Road River Group, the Canol and Blackie formations and the Ford Lake shale is underestimated by the TOC-averaging technique due to lean samples (Link, 1988) and certain intervals within these units have better source potential than suggested by the TOC-averaging technique. Except for the Ford Lake shale and Blackie Formation, the QOM is not markedly different for units within formations.

RESULTS

Histograms of TOC content and modified van Krevelen diagrams (HI versus OI plots) are plotted in Figures 1 and 2 respectively. Rock-Eval logs and data for individual samples are on file in the Department of Geology at the University of British Columbia (Link, 1988). Tables I and II summarize the classification, depositional setting, maturation and petroleum source potential of specific stratigraphic units. In Figures 3 to 12 inclusive, the lateral variation in organic richness (TOC), type (QOM) and maturity (%Ro and conodont alteration index; CAI) for specific stratigraphic horizons are plotted.

DISCUSSION

It is difficult to interpret organic richness and maturation patterns laterally over any distance, especially where sample density is low, because the northern Cordilleran Orogen is characterized by a limited lateral continuity of stratigraphic units. Thus it must be emphasized that the interpretations presented here are based on limited data and the organic richness and isomaturation lines will change as more data become available.

PETROLEUM SOURCE ROCK POTENTIAL - ORGANIC MATURATION AND HYDROCARBON GENERATION

It is well documented that the petroleum source potential of a unit is controlled by the quantity, quality and maturity of the organic matter (Dow, 1977; Hunt, 1979; Durand, 1980; Waples, 1980; Powell and Snowdon, 1983; Barnes *et al.*, 1984; Tissot and Welte, 1984, and many others).

Interpretation of maturation levels and paleogeothermal gradients in the study area are discussed in detail in Link and Bustin (this volume) and are only briefly summarized here. In Figure 13, the regional variation in level of organic maturity with respect to hydrocarbon generation is plotted. Maturation increases with structural complexity, probably as a result of high paleoheat flow associated with tectonism (Link and Bustin, this volume), from the Peel Plateau and Eagle Plain toward the Richardson Mountains and from the Eagle Plain toward the Ogilvie Mountains. Mesozoic strata are immature to marginally mature in the Peel Plateau, the Eagle Plain and Ogilvie mountains, and mature to overmature in the Richardson Mountains. Paleozoic and Mesozoic strata are overmature on the Campbell Uplift, in the northwestern corner of the Peel Plateau. Upper Paleozoic strata are immature to marginally mature in central Eagle Plain, but are mature to overmature in all other areas of the study. Lower Paleozoic strata are overmature in all regions.

RELATIONSHIP OF TYPE AND ABUNDANCE OF ORGANIC MATTER TO DEPOSITIONAL ENVIRONMENT

In this reconnaissance study, too few data are available to rigorously interpret the distribution of organic matter, however, for at least some stratigraphic units there appears to be a good correlation between depositional environment and organic richness and type as summarized below and in Table 2.

EDM ASSEMBLAGE

Upper Cambrian to Lower Devonian – Road River Group (Cronin, Loucheux, Dempster, Vitreekwa Formations) (Figs. 1a, 2a, 3; Table 1, a)

Petroleum Source Potential. Road River strata have poor petroleum source potential, as evident from low QOM (<1.4 mg HC/g TOC). TOC values up to 9.6% and Type I or II kerogen indicate the Vitreekwa and Loucheux formations were excellent oil prone source rocks in the Richardson and Ogilvie mountains, which mark the former position of the Richardson and Blackstone troughs. However, hydrocarbons generated from Road River strata were available for migration in the Devonian to Carboniferous (see Figs. 10a, 13a, 14a and 19a of Link and Bustin, this volume). In southern Mackenzie Delta, mature strata have moderate QOM (1.4 mg HC/g TOC) but poor petroleum source potential (HC potential = 0.6 mg HC/g rock) as a result of low TOC content (0.5%).

The Hazen Trough is considered a northern extension of the Richardson Trough (Miall, 1976) and if the Hazen Trough had a deep-water depositional environment similar to that of the Richardson and Blackstone Troughs, then organic-rich shales equivalent to Road River strata may be found in the subsurface of the Mackenzie Delta where strata are mature to overmature (Link and Bustin, this volume).

Depositional Environment. Road River strata have the highest TOC content in the Richardson (2.9 to 9.6% TOC) and Ogilvie (2.5 to 5.0% TOC) mountains, which mark the former position of the Richardson and Blackstone troughs. These troughs were fault-bounded intracratonic depressions that dissected a regional shelf that extended across the Mackenzie Platform and Yukon Stable Block (Porcupine Platform) from Cambrian until Early to Middle Devonian time (A.W. Norris, 1985). The distribution of TOC in the Road River Group closely reflects a four-fold lithological division. The lower and upper graptolite-bearing and siliceous shale units of deep-water origin (Blackstone and Richardson troughs) have TOC values up to 9.6%. Low TOC values (<1% TOC) correspond to limestones that were deposited in shallow waters in the troughs and on neighbouring platforms (A.W. Norris, 1985).

from low QOM (<1.4 mg HC/g TOC) where strata are overmature. In southern Mackenzie Delta, mature strata have poor petroleum source potential (HC potential = 0.6 mg HC/g rock) due to low TOC (0.6%). The QOM is high (3.5 mg HC/g TOC) in overmature strata in eastern Eagle Plain (N-05 well), probably due to the presence of pyrobitumen (Tmax = 405° C, S_2 = 2.9 mg HC/g rock, HI = 277 mg HC/g TOC), which may be a result of migrated bitumen that has subsequently become

Figs. 3 to 12. Regional distribution of average TOC content, average HC potential, quality of organic matter (QOM), and the degree of organic maturity (DOM) for some formations and groups examined in the study area. Erosional edges modified from Geological Survey of Canada, Map 1505A, Tipper *et al.* (1981). **a.** Average organic carbon content of the formation(s) or group(s). Values plotted are average TOC content calculated across the thickness of the formation or group at each well or outcrop location. **b.** Average HC potential ($S_1 + S_2$) and average QOM [($S_1 + S_2$)/TOC] plotted with the DOM (measured by vitrinite reflectance and/or CAI) for the formation or group. The average HC potential and QOM (to the left and right of ',' respectively) are calculated across the thickness of the formation/group. HC-potential units = mg HC/g rock; QOM units = mg HC/g TOC. Legend: ◇ = calculated vitrinite reflectance (from regression line in Fig. 4 of Link and Bustin, this volume); ◆ = measured vitrinite reflectance (% Ro); ■ = Conodont Alteration Index (CAI). % Ro values are plotted near or at the base of the formation/group. DOM contours are dashed lines; QOM contours are solid lines. Paleogeography and scale are the same as in Figure 2 of Link and Bustin (this volume).

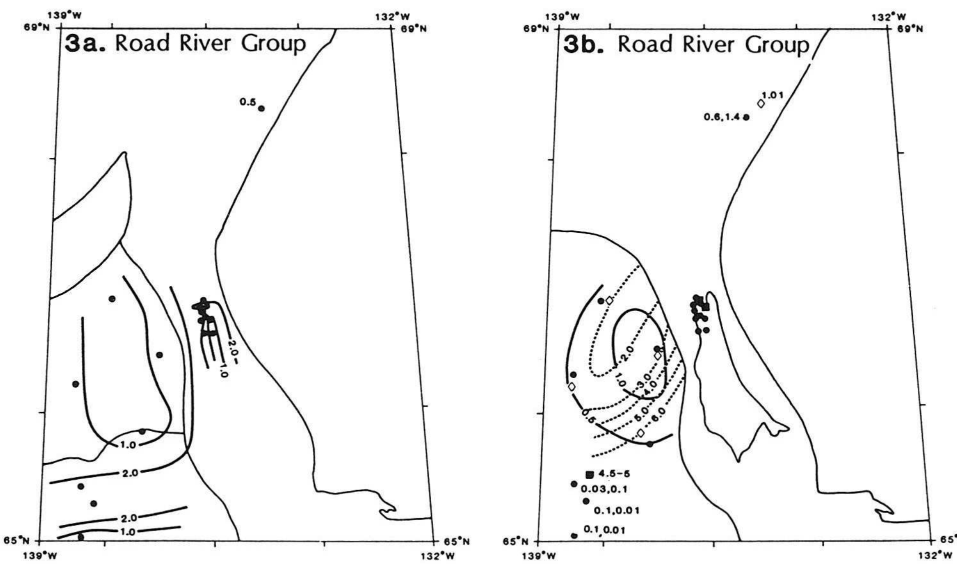

Fig. 3. Road River Group. Boundaries of paleogeographic divisions (after A.W. Norris, 1985) and the erosional edge of the EDM assemblage in the Richardson Mountains are shown. **a.** Regional distribution of TOC. Contour interval = 1.0% TOC. **b.** Regional distribution of DOM, HC potential and QOM. Contour interval for DOM = 1.0% Ro (dashed line); contour interval for QOM = 0.5 mg HC/g TOC (solid line).

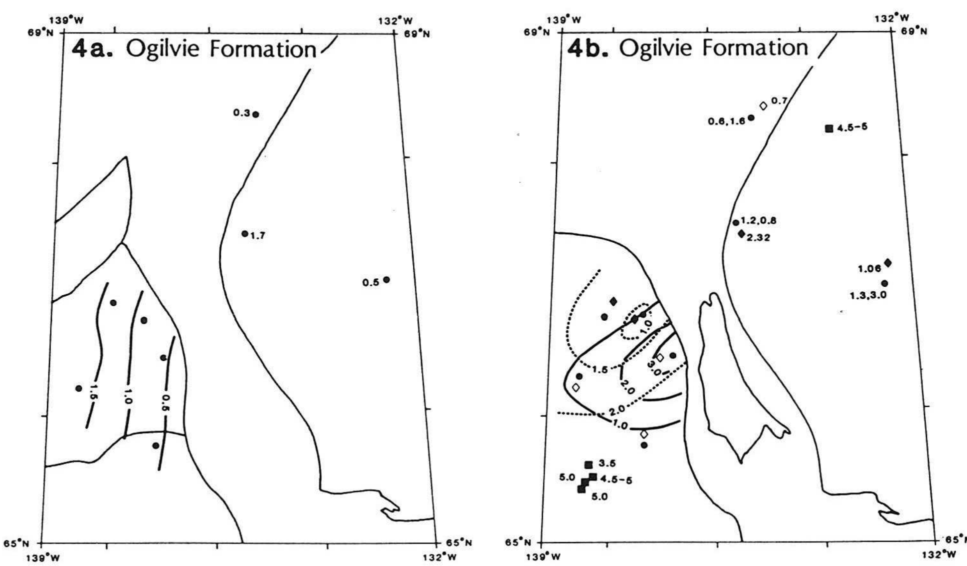

Fig. 4. Ogilvie Formation (Yukon Stable Block and Hazen Trough) and Hume Formation (Mackenzie Platform). Boundaries of paleogeographic divisions (after A.W. Norris, 1985) and the erosional edge of the EDM assemblage in the Richardson Mountains are shown. **a.** Regional distribution of TOC. Contour interval = 0.5% TOC. **b.** Regional distribution of DOM, HC potential and QOM. Contour interval for DOM = 0.5% Ro (dashed line); contour interval for QOM = 1.0 mg HC/g TOC (solid line).

gen (3.7 to 4.9% TOC) which suggests sufficient organic carbon was present to consider the strata potential source rocks. Free hydrocarbons are common throughout the section in southeastern (D-77, B-34 wells) and central (C-18, L-08 wells) Eagle Plain and may represent bitumen that migrated into the mature section. Alternatively, bitumen may have been generated from kerogen in Hart River strata (HC potential up to 7.8 mg HC/g rock). PI values, which increase from 0.1 in the Ford Lake shale to 0.6 in the Hart River Formation, indicate a hydrocarbon depleted zone (Ford Lake shale) and hydrocarbon accumulation zone in the immediately overlying Chance sandstone member of the Hart River Formation in the L-08 well (Snowdon, 1987a) and suggest the Ford Lake shale acted as the source of hydrocarbons in the Chance sandstone.

Depositional Environment. Clastic sediments of Carboniferous age consist of transitional marine facies and marine limestone and calcareous shale facies of the Hart River Formation and the basinal transgressive facies of the Ford Lake shale (Pugh, 1983). The variation in TOC of Carboniferous strata in Eagle Plain (Table 1, g and h) reflects increasing maturation to the southeast, but is independent of the level of organic maturity in all other areas of Eagle Plain. Moderate to high TOC values (1.2 to 7.9%) comprising a mixture of Type II and Type III kerogen in Ford Lake shale and in shales of the Hart River Formation, suggest a significant input of terrestrial organic matter into a marine basin in central Eagle Plain. Low TOC values (0.5 to 0.8%) in shoreline sandstone and siltstone near the northern erosional edge of Ford Lake shale may be a result of poor preservation of organic matter in a high energy shoreface (oxygenated waters) depositional environment or, alternatively, may be due to oxidation of organic matter where strata are exposed at the pre-Mesozoic unconformity. The increase in TOC of the Hart River Formation toward southeastern Eagle Plain does not reflect the depositional environment but is a result of migrated bitumen (PI = 0.6).

Unnamed Carboniferous unit (Table 1, i)

Petroleum Source Potential. Immature strata overlying the Hart River Formation in central (C-18 well) Eagle Plain have fair to good gas, and some oil, potential (Type II and Type III kerogen; QOM = 3.2 mg HC/g TOC; HC potential = 10.7 mg HC/g rock). Free hydrocarbons (S_1 values up to 1.7 mg HC/g rock) suggest migration of hydrocarbons into immature (0.44% Ro; Link and Bustin, 1989) strata.

Carboniferous – Blackie Formation (Figs. 1h, 2h; Table 1, i)

Petroleum Source Potential. Basinal shales contain sufficient amounts of organic carbon (0.9 to 1.2% TOC) for the strata to be considered possible source rocks. Free hydrocarbons occur in parts of the section (S_1 values > 0.5 mg HC/g rock) and may represent hydrocarbons generated from mature kerogen in the Blackie Formation (HC potential = 6.5 mg HC/g rock). Anomalously high HI (1050 mg HC/g TOC) and S_2/S_3 (>5) values in the uppermost 30 to 45 m at the B-34 well probably indicate the presence of drilling-mud contaminants. Significant amounts of Pluggit®, sawdust, Fibertex® and walnut shells were added to the drilling mud at about the depth of these anomalies.

JK_K ASSEMBLAGE

Jurassic – Bug Creek Group (Murray Ridge, Almstrom Creek, Manuel Creek, Richardson Mountain. Aklavik Formations) (Figs. 1i, 2i, 14; Table 1, j)

Petroleum Source Potential. Organic-rich intervals indicate some petroleum source potential in the southern Mackenzie Delta area. These include an 88 m section near the base of the Aklavik Formation and the top of the Richardson Mountain Formation, and a 28 m section at the base of the Almstrom Creek Formation and the top of the Murray Ridge Formation. Fair to good gas source potential is interpreted for the upper zone (QOM = 1.8 to 2.4 mg HC/g TOC; HC potential up to 16.2 mg HC/g rock), whereas the lower zone has fair gas potential (QOM = 1.7 mg HC/g TOC; HC potential ranging from 2 to 5 mg HC/g rock).

Jurassic – Porcupine River Formation (Figs. 1j, 2j; Table 1, k)

Petroleum Source Potential. Marginally mature to mature carbonaceous sandstones indicate fair gas source potential (QOM = 2.4 mg HC/g TOC; HC potential = 4.3 mg HC/g rock) in northern Eagle Plain (J-70 well). Free hydrocarbons, which occur throughout the section at the J-70 and F-48 wells, reflect the onset of hydrocarbon generation, or may represent hydrocarbons that migrated into sandstone. The QOM (1.1 mg HC/g TOC) indicates that there is little or no petroleum generation potential left in the overmature section at the P-34 well in northern Eagle Plain.

Jurassic and Lower Cretaceous – Husky Formation and Parsons Group (Martin Creek, McGuire, Kamik formations) (Figs. 1k, l, 2k, l, 14; Tables 1, l,m)

Petroleum Source Potential. The petroleum source potential of the Husky Formation and Parsons Group varies stratigraphically in southern Mackenzie Delta. The basal and upper 100 m of the Husky Formation have fair gas source potential (QOM = 2.8 mg HC/g TOC and HC potential ranges from 2.6 to 12.5 mg HC/g rock), whereas the middle 200 m section has moderate TOC (0.9%) but poor petroleum source potential due to low QOM (<1.5 mg HC/g TOC). TOC content decreases upward from the Husky Formation to the Martin Creek Formation and petroleum source potential of the latter is poor (HC potential = 1.8 mg HC/g rock; QOM = 1.7 mg HC/g TOC). Moderate TOC (1.5%) and hydrocarbon potential (2.1 mg HC/g rock) indicate the overlying McGuire Formation could be an effective gas source. The Husky Formation is marginally mature (0.53% Ro; Link and Bustin, this volume) in southern Mackenzie Delta and is considered to be the source for Parsons/Siku gas and condensate, but the restricted areal distribution (Langhus, 1980) of the source units limits the overall source potential of the Husky Formation.

Depositional Environment. The lateral variation in organic-richness and maturity could not be determined for Jurassic to mid-Hauterivian strata because they have been eroded from most of the study area (Jeletzky, 1974; 1980). However, where preserved, the vertical variation in Rock-Eval data appears to be closely related to the depositional environment of the strata (Fig. 14). Strata of the Bug Creek Group, Husky Formation and Parsons Group consist of marine shelf sediments oscillating between fine and coarse clastic deposits as a result of variable sediment supply, erosional episodes and transgressive and regressive phases (Dixon, 1982; Poulton *et al.*, 1982). At the base of the succession, in southern Mackenzie Delta, moderate TOC content (2.2%) and Type III kerogen with abundant spores and pollen (Poulton *et al.*, 1982) are consistent with shoreface to offshore open marine sediments of the Murray Ridge Formation and shallow marine shelf deposits of the Almstrom Creek Formation. Declining TOC content (1.6%) in younger strata of the Richardson Mountain Formation coincides with local sands deposited on an otherwise muddy, open shelf regime (Poulton *et al.*, 1982). TOC values, which increase upward from 2.2 to 3.7% in the overlying carbonaceous (Type III kerogen) sandstone of the Aklavik Formation, indicate proximity to a shoreline (Dixon, 1982) where there was a significant input of terrestrial organic matter. A shale sample with high TOC (5.6%), from the middle of the Aklavik Formation, may represent a shale tongue of the Richardson Mountain Formation that extends into sandstone of the Aklavik Formation (Dixon, 1982). Basin-margin expansion (Dixon, 1982) resulted in the deposition of the low energy marine shale of the Husky Formation and a corresponding increase in TOC (3.7 to 4 5%). This was followed by a basin-wide regression (Dixon, 1982), which correlates with TOC values that decrease upward from the base to the middle of the Husky Formation (4.5 to 0.8%). A short-lived transgression followed, which led to a reduction of sediment supply basinward (Dixon, 1982) and is reflected in TOC values that increase from 1.5% in the middle to 2.7% at the top of the Husky Formation. Progradation and basin-filling resulted in deposition of a thick, coarsening-upward cycle representing an offshore-barrier island succession (Dixon, 1982) in which TOC values decrease upward from the Husky to Martin Creek Formation (2.7 to 0.9%). TOC values that increase upward (0.9 to 1.5%) in carbonaceous sandstone and shale of the overlying McGuire Formation are consistent with a change to a low-energy nearshore to inner shelf depositional environment (lagoonal or upper coastal plain; Dixon, 1982) where there was significant terrestrial input and/or enhanced preservation of marine organic matter.

The Porcupine River Formation represents a minor phase of deltaic sedimentation (Jeletzky, 1980) in the Eagle Plain area. Total organic carbon content is lower (0.9 to 1.8%) in the carbonaceous sandstone of the Porcupine River Formation than in the laterally equivalent marine shale of the Husky Formation (2.0%), and kerogen is primarily Type III in both formations.

Jurassic and Lower Cretaceous – Mount Goodenough, Rat River and Arctic Red River formations (Figs. 1,m-o, 2m-o,9,10,11; Tables 1, n-p)

Petroleum Source Potential. Marine shale facies of the Mount Goodenough and Arctic Red River formations contain organic-rich intervals, which are potential gas source rocks. In northern Eagle Plain (J-70 well), the Mount Goodenough Formation has fair gas source potential (HC potential = 2.6 mg HC/g rock; QOM = 1.9 mg HC/g TOC). Immature strata from the upper 200 m of the Mount Goodenough Formation (HC potential = 4.7 to 50 mg HC/g rock) and from the overlying Arctic Red River Formation (HC potential = 3.8 mg HC/g rock; QOM = 8.1 mg HC/g TOC) in the southern Mackenzie Delta area have fair to excellent gas potential and minor oil source (HI up to 321 mg HC/g TOC) potential. Free hydrocarbons detected in immature strata in southern Mackenzie Delta are interpreted as hydrocarbons that have migrated into the section. In Peel Plateau and Richardson Mountains, the Mount Goodenough and Rat River formations have poor petroleum source potential (QOM <0.4 mg HC/g TOC) because of the low TOC content (0.3% to 0.7%). Anomalously high hydrocarbon potential (2.4 mg HC/g rock) and QOM (1.9 mg HC/g TOC) in the Rat River Formation in western Peel Plateau (I-50 well) reflects the presence of migrated hydrocarbons in the immature section (PI = 0.6; S1 = 0.7 to 2.0 mg HC/g rock).

Depositional Environment. The Mount Goodenough Formation consists of basal transgressive strata overlain by a generally regressive complex of marine shale and siltstone deposited on the slope to inner shelf (Dixon, 1986). Although the variation in TOC (Table 1, m), in part, reflects increasing maturation toward the Richardson Mountains, the regional TOC distribution appears to be mainly related to the depositional environment. In the southern Mackenzie Delta area, TOC content (1.0 to 5.5%) and HI values (120 to 321 mg HC/g TOC) increase upward in regressive deposits (nearshore to inner shelf; Dixon, 1982). An increase in HI (Type II kerogen) has been related to enhanced marine organic productivity and/or physical controls such as reduced circulation of oxygenated water or an oxygen-minimum zone controlled by water depth (Snowdon, 1980). By analogy, shallow waters in a nearshore to inner shelf setting would enhance marine productivity and create an oxygen-minimum zone favorable to the preservation of marine (Type II) organic matter in Mount Goodenough sediments. Alternatively, an increase in HI stratigraphically upward in the Mount Goodenough Formation may represent liptinite-rich terrestrial organic matter derived from deposition and preservation of allochthonous spores and pollen in a nearshore environment. Lipids associated with water-insoluble waxes and cutins from higher plants are less easily hydrolyzed by bacteria than proteins and carbohydrates (Barnes *et al.*, 1984).

Low to moderate TOC values (0.6 to 1.5%) and HI values (<150 mg HC/g TOC) in the Peel Plateau and Eagle Plain areas occur in sediments deposited on the continental shelf and slope. Low HI values may represent input of vitrinite or inertinite into oxygenated waters on the shelf and slope where marine Type II organic matter (primarily planktonic) would be chemically and/or biologically degraded.

Jurassic and Lower Cretaceous – map unit Kwr (Whitestone River Formation: Dixon, in press) (Figs. 1p, 2p, 11; Table 1, p)

Petroleum Source Potential. Hydrocarbon potential ranging from 2.3 to 5.3 mg HC/g rock and QOM, which varies from 1.3 to 2.2 mg HC/g TOC, indicate fair to good gas source potential in central (C-18 and J-19 wells), north-central (O-22 well), southeastern (B-34 well) and northern (J-70 well) Eagle Plain. Liptinite observed petrographically in some samples, along with the HI versus OI plot indicate that Type I and II oil-prone kerogen is present in certain samples from southeastern (B-34 well), central (C-24, J-19 wells) and northern (P-34, F-48 wells) Eagle Plain. Because there is no obvious indication for a depositional environment different from that indicated in previous geological studies (Dixon, 1986; Dixon, *in press*), the high HI values (590 to 1140 mg HC/g rock) are interpreted to represent drilling mud contaminants (walnut shells; well history reports).

Strata are immature at all locations where they were examined except in the Richardson Mountains and northwestern (N-53 well) Eagle Plain where strata are mature, but have poor petroleum source potential (QOM = 0.2 to 1.7 mg HC/g TOC; HC potential = 0.3 to 1.8 mg HC/g rock).

Depositional Environment. Albian strata of the Arctic Red River and Horton River formations and map unit Kwr are low-energy shelf deposits (Dixon, 1986), which generally contain 1 to 2% TOC of mainly terrestrial (Type III) kerogen. A mixture of Type II and Type III kerogen in some samples of the Arctic Red River Formation and map unit Kwr suggests input of terrestrial organic matter into anoxic marine waters on the continental shelf. The regional variation in TOC (Table 1,o) is independent of maturity levels and may reflect local bathymetric lows and highs on the shelf. TOC values up to 5.4% and HI values ranging from 590 to 1140 mg HC/g TOC in map unit Kwr suggest significant enrichment in marine-type (Type I or II) kerogen or, alternatively, contamination by drilling-mud additives (walnut shells and sawdust; well history reports). In southern Mackenzie Delta, TOC content values up to 2.5% reflect the presence of free hydrocarbons (PI = 0.7 and S_1 = 5.3 mg HC/g Corg; Link, 1988) rather than factors controlling organic richness in the depositional environment.

KA Assemblage

Upper Cretaceous – Eagle Plain Group (Cody Creek, Burnthill Creek, Fishing Branch and Parkin formations: Dixon, in press) (Figs. 1q, 2q, 12, Table 1, q)

Petroleum Source Potential. Carbonaceous strata of the Eagle Plain Group have fair to excellent gas source potential in parts (Table 1, p) of central Eagle Plain (QOM = 1.3 to 2.3 mg HC/g TOC; HC potential = 2.3 to 9.8 mg HC/g rock) but are immature except at the P-34 well. Petrographically, most of the kerogen comprises vitrinite and varying proportions of liptinite and inertinite in carbonaceous samples. Variations in the amount of hydrogen-rich kerogen (liptinite) is reflected in the wide range of QOM (0.1 to 2.3 mg HC/g TOC). The high hydrocarbon potential (3.6 mg HC/g rock) and TOC (2.7%) at the C-24 well may be a result of drilling-mud additives (e.g., Carbonox® and diesel fuel; Snowdon, 1987a) or, alternatively, may be correlative with carbonaceous samples (HC potential = 3.9 mg HC/g rock; TOC = 2.1%) at the C-18 well nearby.

Depositional Environment. In most of the Eagle Plain area, the Upper Cretaceous part of the Eagle Plain Group (map units Kfb, Kb and Kcc of Norris, 1981d) consists of marine sandstone, siltstone and shale interpreted as nearshore to inner shelf deposits (Dixon, 1986). TOC content exceeds 4% in several samples in map units Kb and Kfb, in which carbonaceous and coaly debris were observed petrographically. Local bathymetric lows and highs probably existed on the shelf (Dixon, 1986) and may have controlled variations in organic richness by influencing water circulation patterns and/or water depths. Alternatively, high TOC values in carbonaceous samples containing varying proportions of vitrinite, liptinite and inertinite suggest significant input of terrestrial organic matter in a nearshore to inner shelf depositional environment. Anomalously high TOC (13%) and HI values (600 to 1000 mg HC/g TOC) at the P-34 and C-24 wells are considered to be a product of the presence of drilling-mud additives (*e.g.*, Carbonox®, diesel fuel, walnut shells, sawdust, Fibertex®, Cellophane®; Snowdon, 1987a) rather than of processes operating in the depositional environment.

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Age + fauna of Michelle Fm, NYK

BULL CAN. PETROL GEOL

V. 18 # 3 p. 407 - 429

*** ✓ Norris 1997 ~~***~~ Description of Mesoz. Strata

Geol., Min + Hydoc. Pot. of N YT + NWT

✓ GSC Bull 422 p. 163 - 280

*** Norris, 1985 p. 21 - 61

Eastern Cord foldbelt of N Canada + hydrocarb

✓ AAPG Bull v. 69 p. 788 - 808