Natural Resources Canada
Ressources naturelles Canada

The age, foraminifera, and palynology of the Upper Cretaceous Eagle Plain Group, northern Yukon

D.H. McNeil, J. Dixon, and K.M. Bell

Geological Survey of Canada
Current Research 2021-2

2021

Canada

Geological Survey of Canada
Current Research 2021-2

The age, foraminifera, and palynology of the Upper Cretaceous Eagle Plain Group, northern Yukon

D.H. McNeil, J. Dixon, and K.M. Bell

2021

ISSN 1701-4387
ISBN 978-0-660-38364-4
Catalogue No. M44-2021/2E-PDF
https://doi.org/10.4095/328237

A copy of this publication is also available for reference in depository libraries across Canada through access to the Depository Services Program's Web site at http://dsp-psd.pwgsc.gc.ca.

This publication is available for free download through GEOSCAN (https://geoscan.nrcan.gc.ca).

Recommended citation

McNeil, D.H., Dixon, J., and Bell, K.M., 2021. The age, foraminifera, and palynology of the Upper Cretaceous Eagle Plain Group, northern Yukon; Geological Survey of Canada, Current Research 2021-2, 13 p. https://doi.org/10.4095/328237

Critical review

R.A. Fensome and L.S. Lane

Authors

D.H. McNeil (dave.mcneil@nrcan-rncan.gc.ca)
J. Dixon (jdixon@halofire.net)
K.M. Bell (kimberley.bell@petrostrata.com)
Geological Survey of Canada
3303-33rd Street N.W.
Calgary, Alberta
T2L 2A7

Correction date:

The age, foraminifera, and palynology of the Upper Cretaceous Eagle Plain Group, northern Yukon

D.H. McNeil, J. Dixon, and K.M. Bell

McNeil, D.H., Dixon, J., and Bell, K.M., 2021. The age, foraminifera, and palynology of the Upper Cretaceous Eagle Plain Group, northern Yukon; Geological Survey of Canada, Current Research 2021-2, 13 p. https://doi.org/ 10.4095/328237

Abstract: A re-evaluation of the age of the formations comprising the Eagle Plain Group of northern Yukon was necessitated by widely disparate age determinations in recent years from various authors. Maximum age estimates for the base of the group have varied from middle Albian to Cenomanian, and age estimates for the uppermost strata varied by an even greater range, from Cenomanian to late Maastrichtian. A re-examination of new and archival foraminiferal and palynological data indicates an age range of Cenomanian to late Maastrichtian for the Eagle Plain Group. The late Maastrichtian age is derived from palynology from the northeasternmost area of Eagle Plain. However, the stratigraphic relationship of these youngest beds within Eagle Plain Group remains uncertain.

Marine strata of the Eagle Plain Group contain foraminiferal indices that correlate with long-established regional foraminiferal zones from the Mackenzie Delta area. The Cenomanian Zone of *Trochammina superstes* occurs in the Parkin and Boundary Creek formations of Eagle Plain and Mackenzie Delta, respectively. The *Haplophragmoides bilobatus* and overlying *Glaphyrammina spirocompressa* zones occur in the Burnthill Creek and Smoking Hills formations of Eagle Plain and Mackenzie Delta, respectively.

Reworked microfossils are a conspicuous feature of strata within the Eagle Plain Group. The basal sandstone of the Parkin Formation, for example, contains an assemblage of foraminifera that is entirely reworked. Palynomorph assemblages through the Eagle Plain Group have been estimated at as much as 99% reworked in some strata.

Résumé : Une réévaluation de l'âge des formations constituant le Groupe d'Eagle Plain, dans le nord du Yukon, s'avérait nécessaire en raison des âges très disparates déterminés par divers auteurs au cours des dernières années. L'âge maximal estimé pour la base du groupe varie de l'Albien moyen au Cénomanien, tandis que l'âge estimé pour les strates sommitales varie encore davantage, allant du Cénomanien au Maastrichtien tardif. Un réexamen de données sur les foraminifères et de données palynologiques nouvelles et d'archives indique un intervalle d'âges allant du Cénomanien au Maastrichtien tardif pour le Groupe d'Eagle Plain. L'âge du Maastrichtien tardif a été établi à partir de la palynologie de la région la plus au nord-est de la plaine Eagle. Toutefois, la relation stratigraphique de ces lits les plus jeunes au sein du Groupe d'Eagle Plain demeure incertaine.

Les strates marines du Groupe d'Eagle Plain contiennent des foraminifères stratigraphiques qui sont corrélés à des zones de foraminifères régionales établies de longue date dans la région du delta du Mackenzie. La Zone à *Trochammina superstes* du Cénomanien se situe à l'intérieur des formations de Parkin et de Boundary Creek de la plaine Eagle et du delta du Mackenzie, respectivement. La Zone à *Haplophragmoides bilobatus* ainsi que la Zone à *Glaphyrammina spirocompressa* sus-jacente sont présentes à l'intérieur des formations de Burnthill Creek et de Smoking Hills de la plaine Eagle et du delta du Mackenzie, respectivement.

Les microfossiles remaniés sont des constituants manifestes dans les strates du Groupe d'Eagle Plain. Le grès basal de la Formation de Parkin, par exemple, contient un assemblage de foraminifères remaniés en totalité. On estime que le contenu des assemblages de palynomorphes du Groupe d'Eagle Plain peut être jusqu'à 99 % remanié dans certaines strates.

Corresponding author: D.H. McNeil (email: dave.mcneil@nrcan-rncan.gc.ca)

INTRODUCTION

Mesozoic strata outcrop and underlie much of Eagle Plain in northern Yukon (Fig. 1), of which the Cretaceous Eagle Plain Group is the most widespread surface unit. Although the lithostratigraphy of Dixon (1992) has been generally accepted, the interpreted age of the Eagle Plain Group has varied widely, from Cenomanian–Campanian (Dixon, 1992), middle Albian–Cenomanian (Haggart et al., 2013), and late Albian–Maastrichtian (Lane et al., in press). Also, the age of the individual formations has varied between authors, leading to an interpretation of major diachroneity for the base of the youngest formation. A review of existing paleontological and stratigraphic data are thus necessary, keeping in mind some limiting factors that place constraints on the age of the formations within the Eagle Plain Group. Throughout this review there are several citations of Geological Survey of Canada paleontological reports that are available by contacting the Geological Survey of Canada (GSC), Calgary. Sample numbers ("C-numbers") refer to GSC Calgary cataloguing and the samples are accessible by interested specialists. Likewise, Dixon's field notebooks are archived at GSC Calgary, and can be accessed upon request.

Originally, the Eagle Plain Group was defined as a formation (Mountjoy, 1967). In 1992, Dixon raised it to group status, recognizing four component formations (Fig. 2). In

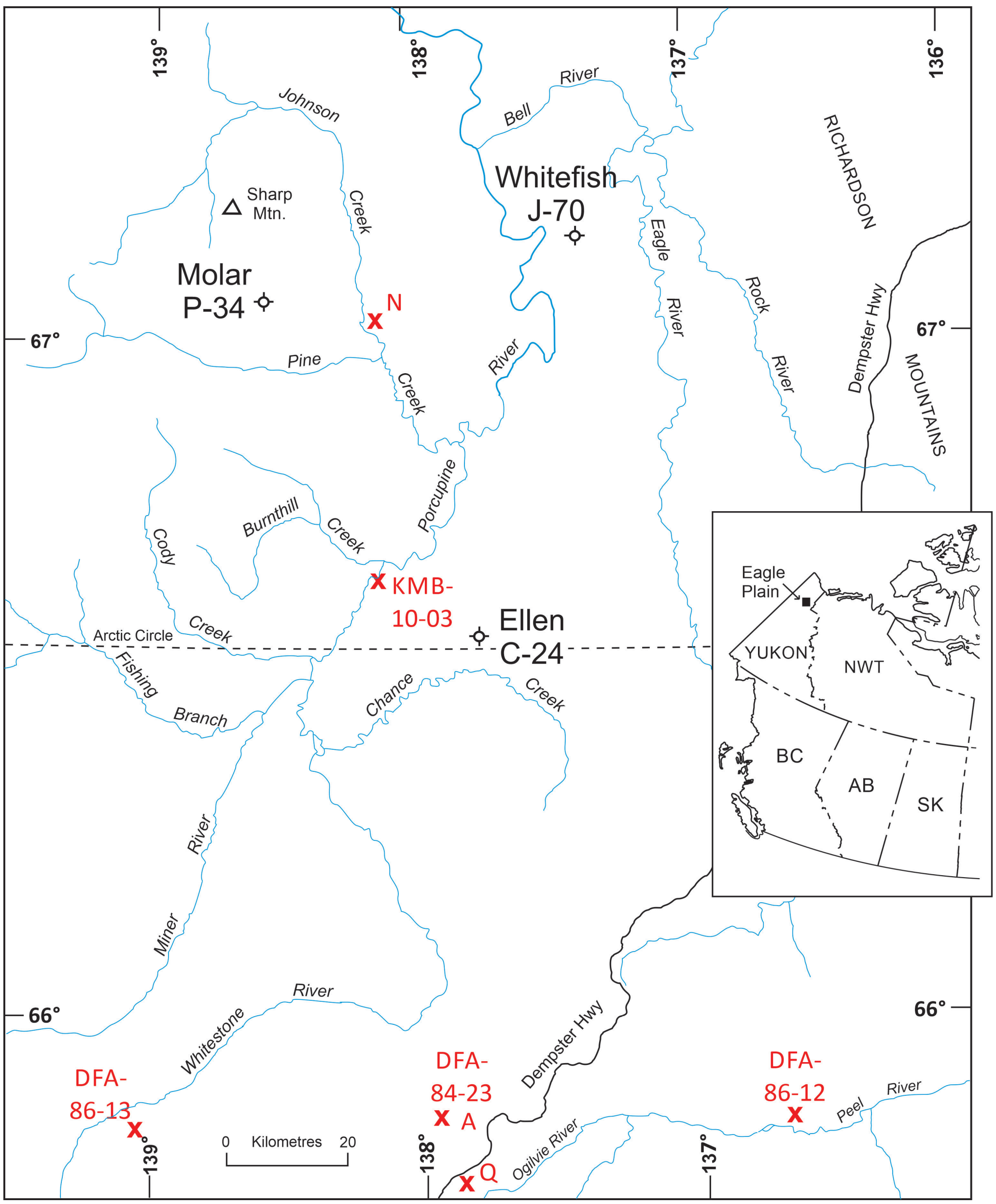

Figure 1. Location of Eagle Plain outcrop localities (in red) and exploration wells (in black) cited in the text.

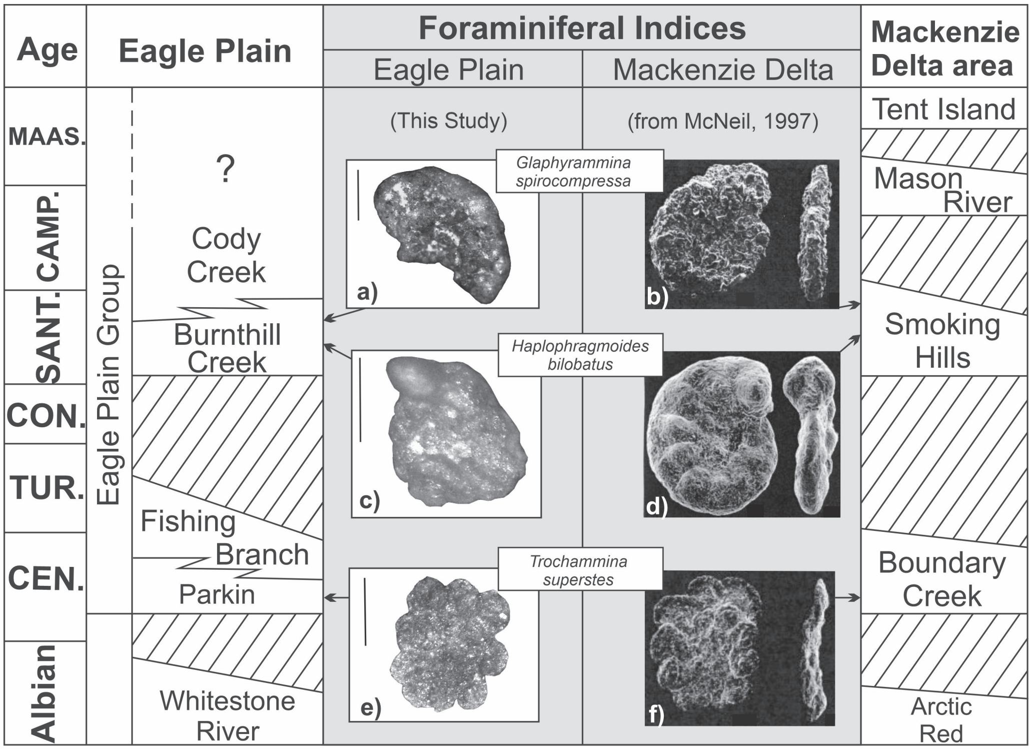

Figure 2. Comparison of stratigraphic units in Eagle Plain and the Mackenzie Delta area (Dixon et al., 1992; Plauchut and Jutard, 1976). The standard foraminiferal zones of the Mackenzie Delta area (McNeil, 1997) extend into Eagle Plain and demonstrate a general coeval stratigraphic relationship for the Upper Cretaceous units of the two areas. Curation and locality information for the illustrated foraminifera (a-f) are provided in the Appendix. Scale bar in a, c, and e equals 0.25 cm.

ascending order these are: Parkin, Fishing Branch, Burnthill Creek, and Cody Creek formations. Strata equivalent to the Parkin Formation were originally included in the upper part of an underlying, and then unnamed, Albian shale-dominated unit (later mapped as unit Kwr by Norris, 1981 a,b,c,d; and formally named the Whitestone River Formation by Dixon, 1992). The Parkin and Whitestone River formations are similar in that they are shale-dominated and can be difficult to separate in the field. However, Dixon (1992) demonstrated that the Parkin Formation is a separate unit unconformably overlying Whitestone River strata and has a distinct basal sandstone. This relationship has been confirmed or reiterated by subsequent workers (Jackson et al., 2011; Lane, 2012; Haggart et al., 2013; Quesnel et al., 2017).

Tectonically, the Eagle Plain Group was deposited in a foreland basin, in front of the rising Cordilleran Orogen and is part of a Late Cretaceous to Cenozoic series of generally northward-migrating depocentres, culminating in deposition in the Beaufort Sea (Dixon, 1992, 1986; Dixon et al., 1992; Dixon et al., 2019).

PROBLEMS OF REWORKING AND SCARCITY IN THE PARKIN FORMATION

Probably the most difficult aspect of dating the Eagle Plain Group is the scarcity of in situ age-diagnostic fossils, both micro and macro, and the predominance of reworked fossils from Devonian to Albian strata; this is true to some extent of foraminifera, but especially of palynomorphs. McIntyre (D.J. McIntyre, unpub. GSC Paleontological Report 4-DJM-1987, 1987, p.1, 5, 6) noted that less than 1% of the assemblages he examined for palynomorphs in the Cenomanian Parkin Formation could be considered in situ, with the bulk of the flora being reworked. Many of the field samples collected by Dixon (1992) and examined by D.J. McIntyre and D.H. McNeil were considered to be barren of in situ fossils. However, the Parkin Formation has yielded fossils that are considered to be in situ, and so this unit offers the best opportunity to date the base of the Eagle Plain Group.

In samples dominated by reworked fossils it is normal to expect the youngest-aged fossils to represent the in situ flora/fauna. But when the in situ fossils are less than 1% of the assemblage (D.J. McIntyre, unpub. GSC Paleontological Report 4-DJM-1987, 1987), they are easily overlooked. Also, the Eagle Plain samples contain an abundance of Albian fossils, which overshadow the youngest fossils present. In a suite of samples such as those examined by McIntyre (D.J. McIntyre, unpub. GSC Paleontological Report 4-DJM-1987, 1987), with minimal percentages of in situ material, it is highly likely that some, or even many, samples would be devoid of such material. Identifying reworked microfossils can also be difficult because thermal maturity of in situ and reworked material can be similar or identical. Also, microfossils could be transported within clasts and physical signs of abrasion may be absent.

Chamney (in Norford et al., 1971) dated strata equivalent to the Parkin Formation as Cenomanian and Campanian. Based on dinoflagellate assemblages identified by McIntyre (D.J. McIntyre, unpub. GSC Paleontological Report 2-DJM-1986, 1986; D.J. McIntyre, unpub. GSC Paleontological Report 4-DJM-1987, 1987) and a sparse, but unique, foraminiferal assemblage identified by McNeil (D.H. McNeil, unpub. GSC Paleontological Report 2-DHM-1987, 1987), Dixon (1992) restricted the age to the Cenomanian. Haggart et al. (2013) used macro- and microfossils to date the Parkin Formation as middle to late Albian. Later, Quesnel et al. (2017) used a foraminiferal assemblage from the Molar P-34 well to date the Parkin Formation as late Albian.

In the context of sparse recovery and reworked fossils, is the Parkin Formation middle to late Albian, late Albian, and/or Cenomanian, and what is the significance of it being Albian rather than Cenomanian? Dixon (1992, 1993) pointed out that a major regional unconformity exists between Cenomanian and Albian or older strata throughout northern Yukon and the Northwest Territories (*see* Thomson et al., 2011, for a record of this event on the Peel Plateau, and Ricketts, 1988, for its record in the west-central Yukon), and it is unlikely that such a major regional event would not be present on Eagle Plain. However, the latter would be the inference if an Albian age is accepted for the Parkin Formation, or that such an event occurs at a horizon higher in the Eagle Plain Group.

PARKIN FORMATION

Although Dixon (1992) assigned a Cenomanian age to the Parkin Formation, Haggart et al. (2013, p. 112–115) determined a middle to late Albian age, citing macrofossil and microfossil evidence. Macrofossils were primarily ammonites and bivalves and were recovered mostly from the basal sandstone member. Haggart et al. cited the age range of the macrofossils as early to middle Albian; their microfossil data are based on a few samples that yielded foraminifera with age ranges that span the early to late Albian and, in the case of four samples from their locality N, palynomorphs with an age range of Albian to Cenomanian. They also indicated that at their locality Q (Fig. 1) they recovered Albian foraminifera, whereas McIntyre (D.J. McIntyre, unpub. GSC Paleontological Report 4-DJM-1987, 1987) identified Cenomanian dinoflagellates from the same locality (samples C126301 to C126313; section 84–24 of Dixon,1992). We also found Albian fossils in the basal sandstone member, but considered them reworked in the transgressive basal sandstone associated with the Albian/Cenomanian unconformity.

Quesnel et al. (2017) studied foraminifera from the Whitestone River Formation and Eagle Plain Group in Ellen C-24 and Molar P-34 exploration wells (Fig. 1). The Parkin Formation in Ellen C-24 was barren and in Molar P-34 only a few foraminifera were recovered, the most significant identified as *Miliammina manitobensis,* which Quesnel et al. indicated to be a typical late Albian species. Their species range charts (Fig. 3, 6 in Quesnel et al., 2017) clearly show the abrupt change in species distribution between the Whitestone River and Parkin formations, especially in Ellen C-24, an occurrence that is consistent with the presence of a major unconformity at the base of the Parkin Formation. D.H. McNeil examined the same sample set from the Molar P-34 well but could not confirm the presence of *Miliammina manitobensis*. Washed residues from the Parkin Shale member in Molar P-34 consist of carbonaceous shale, suggesting a carbon-rich, low-oxygen substrate consistent with the general absence of benthic foraminifera.

In both Haggart et al. (2013) and Quesnel et al. (2017) a radiometric age of an exposed bentonite bed from the upper part of the Whitestone River Formation along Peel River is given as 105.5 Ma (see Quesnel et al., 2017, p. 457, for more details of the two methods used to obtain this age). This absolute age is within the early late Albian, and the foraminiferal data of Quesnel et al. (2017) also place the upper Whitestone River Formation within the early late Albian. The radiometric age and the ages assigned by McIntyre (D.J. McIntyre, unpub. GSC Paleontological Report 2-DJM-1986, 1986; D.J. McIntyre, unpub. GSC Paleontological Report 4-DJM-1987, 1987) and Quesnel et al. (2017) cast doubt on Haggart et al.'s (2013) middle Albian age for the lower part of the Parkin Formation. This discrepancy also was pointed out by Quesnel et al. (2017, p.461) and Lane et al. (in press).

Haggart et al. (2013) and Quesnel et al. (2017) appear to have placed little emphasis on the possibility that the fossils they use as Albian age indicators in the Parkin Formation could be reworked. This is especially true for Haggart et al.'s (2013) occurrences of Middle Albian ammonites and bivalves, the age of which conflicts with the early late Albian radiometric age (cited in both Haggart et al., 2013, and Quesnel et al., 2017) and the late Albian age determined by Quesnel et al. (2017) for the upper beds of the unconformably underlying Whitestone River Formation. Many of the macrofossils are described as fragmented or deformed, and the fact that most occur within the basal sandstone member that is interpreted as a transgressive deposit (Dixon, 1992; Jackson et al., 2011) is consistent with the possibility that they are reworked. Regarding the late Albian age, Haggart et al.'s (2013) conclusions appear to be based on the fact that some of the fossils range up into the late Albian, but with no specific fossil(s) that can be conclusively dated as late Albian. On the other hand, Quesnel et al. (2017) considered *Miliammina manitobensis,* present in Molar P-34, to be a late Albian indicator; however, its presence could not be verified by D.H. McNeil on examination of the same samples. Some of the other foraminifera that Quesnel et al. (2017) identified in the Parkin Formation also are present throughout the Whitestone River Formation and some extend into the overlying Burnthill Creek and Cody Creek formations (Fig. 3 in Quesnel et al., 2017). This suggests that they are reworked.

The Cenomanian age for the Parkin Formation relies principally on the dinoflagellates identified by McIntyre (D.J. McIntyre, unpub. GSC Paleontological Report 2-DJM-1986, 1986; D.J. McIntyre, unpub. GSC Paleontological Report 4-DJM-1987, 1987) from several outcrop locations on Eagle Plain (see appendix A and their comparison to similar assemblages in strata dated as Cenomanian to Turonian throughout northwestern mainland Canada. Such units include the Monster Formation (Ricketts, 1988), Boundary Creek Formation (Young, 1975) and Slater River Formation (Yorath and Cook, 1981; Thomson et al., 2011). McNeil (D.H. McNeil, unpub. GSC Paleontological Report 2-DHM-1987, 1987) noted that most samples collected from the Parkin Formation by Dixon were barren of foraminifera, or contained abundant reworked fossils, but he did identify a distinct in situ assemblage of thin-walled agglutinated foraminifera typical of low-oxygen substrates from the Parkin Formation at Dixon's (1992, Fig. 3) locality 86-13 (samples C149331, C149333 to C149336) in the southwestern part of the basin (Fig. 1). He considered these foraminifera to be equivalent to the *Trochammina superstes* Zone present in the Boundary Creek Formation in the Beaufort–Mackenzie area to the northeast of Eagle Plain. A comparison of Eagle Plain foraminifera with the Boundary Creek foraminifera in the Mackenzie Delta area confirms that the *Trochammina superstes* Zone is present in both areas (Fig. 2). The Boundary Creek Formation is generally accepted to be Cenomanian to Turonian in age (Young, 1975; Dixon et al., 1992). Haggart et al. (2013, p. 115) indicated that palynomorphs from their locality N (Fig. 1) have an age range of Albian to Cenomanian (citing identifications by A.R. Sweet, unpub. GSC Paleontological Report 10-ARS-2011, 2012). However, on the basis of analysis of four Parkin Formation samples from the HFB-10-13 section (locality N in Haggart et al., 2013), Sweet (A.R. Sweet, unpub. GSC Paleontological Report 10-ARS-2011, 2012) concluded that the combined evidence from pollen and dinoflagellates was "... strongly suggestive of a Cenomanian age"; consistent with the age cited by McIntyre (D.J. McIntyre, unpub. GSC Paleontological Report 2-DJM-1986, 1986; D.J. McIntyre, unpub. GSC Paleontological Report 4-DJM-1987, 1987).

Palynological data, with some support from limited foraminiferal evidence, suggests that a Cenomanian age for the Parkin Formation is more likely than an Albian age and better fits the known regional geology. The Campanian age assigned by Chamney (in Norford et al., 1971) is highly unlikely, based on the data and conclusions presented above and the probable Cenomanian age of the overlying Fishing Branch Formation, as discussed in the next section.

FISHING BRANCH FORMATION

The Fishing Branch Formation gradationally overlies the Parkin Formation and is dominated by thin to thick beds of very fine to fine-grained, nearshore marine sandstone intercalated with thin shale beds (Dixon, 1992), the latter becoming less common in the upper part of the succession. As for the Parkin Formation, age-diagnostic fossils are rare.

Haggart et al. (2013, p. 115–116) cited foraminiferal assemblages and bivalve evidence for their middle to late Albian age determination, but also noted that the recovered palynomorphs have an age range of Albian to Cenomanian; in comparison, Sweet (A.R. Sweet, unpub. GSC Paleontological Report 10-ARS-2011, 2012) indicated a Cenomanian age was more probable. Quesnel et al. (2017) recorded *Miliammina manitobensis* from the Molar P-34 well in Fishing Branch strata as indicative of a late Albian age. The same samples were examined by D.H. McNeil, who did not find evidence of a late Albian fauna. When present, the *Miliammina manitobensis* Zone typically contains a diverse and diagnostic assemblage with abundant specimens; but there is no evidence of this in Molar P-34. In Fishing Branch outcrops (samples C149307 to C149309 from Dixon's, 1992, locality 84-23, Fig. 1), McIntyre (D.J. McIntyre, unpub. GSC Paleontological Report 4-DJM-1987, 1987) reported dinoflagellates similar to those of the Parkin Formation (note that McIntyre misidentified this locality as section 86-23A and B). Some maps produced by Norris (e.g.,1981, map 1519A) indicate fossil locations in the Fishing Branch Formation (his map unit Kfb: Cretaceous Fishing Branch) identified as possibly Cenomanian.

The same arguments against a middle Albian age for the Parkin Formation apply equally to the Fishing Branch Formation. Once again this leaves the option of a late Albian and/or Cenomanian age for Fishing Branch strata. If the arguments for a Cenomanian age for the Parkin Formation are accepted, then the Fishing Branch Formation is probably also Cenomanian.

BURNTHILL CREEK FORMATION

The Burnthill Creek Formation rests abruptly on the underlying Fishing Branch Formation (Dixon, 1992) and consists of interbedded shale and sandstone intervals. Dixon

(1992) interpreted the contact to be a marine maximum flooding surface (MFS), indicating a major shift in the depositional regime. Sequence stratigraphic analysis implies that the MFS has to be preceded by a transgression, and in turn, preceded by a period of erosion and the development of an unconformity. Because Fishing Branch and Burnthill Creek strata across the formational boundary are marine sediments (Dixon, 1992), the unconformity would be a transgressively modified erosional surface. Therefore, although structurally conformable, an erosional event associated with the change from Fishing Branch to Burnthill Creek deposition is present. Lane et al. (in press, Fig. 4) described an exposure on the eastern outcrop edge where a thin sandstone (identified by Lane et al. (in press, Fig 4), as Fishing Branch Formation) rests unconformably on Carboniferous strata and is in turn overlain by Burnthill Creek Formation. Lane et al. (in press) also place an unconformity at the base of the Burnthill Creek Formation. They interpreted the Fishing Branch strata as a transgressive sandstone. Their interpretation confirms Dixon's (1992) contention that there was an erosional event associated with the change from Fishing Branch to Burnthill Creek deposition and that a thin interval in the uppermost beds of the Fishing Branch Formation is transgressive, although Dixon (1992) considered the contact with the Burnthill Creek Formation to be a maximum flooding surface, rather than an unconformity.

Samples collected from Dixon's (1992) localities yielded no information on the age of the Burnthill Creek Formation. Haggart et al. (2013) recovered palynomorphs from several of their sections from southern Eagle Plain that yielded an assemblage that they dated as late Albian to Cenomanian, although Sweet (A.R. Sweet, unpub. GSC Paleontological Report 10-ARS-2011, 2012) indicated a Cenomanian age was more likely. Quesnel et al. (2017) have no data from the Burnthill Creek Formation. McNeil (D.H. McNeil, unpub. GSC Paleontological Report 7-DHM-2018, 2018) however, reported the occurrence of two diagnostic foraminiferal species in Burnthill Creek strata in the Whitefish J-70 well located in northeast Eagle Plain (Fig. 1). These are the zonal indices *Haplophragmoides bilobatus* and *Glaphyrammina spirocompressa* illustrated in Figure 2. These species are regional markers that occur in the Smoking Hills Formation of the Mackenzie Delta (McNeil, 1997), which has been dated as Santonian to early Campanian (Dixon and McNeil, 2008) based on associated palynomorphs (D.J. McIntyre, 1974, pers. comm., 2006; Plauchut and Jutard, 1976; Yorath and Cook, 1981).

Although the ages cited above are disparate, a Santonian-Campanian age based on the zonal foraminifera from the Whitefish J-70 well is more probable. Burnthill Creek strata overlie Cenomanian beds of the Fishing Branch Formation also favouring the Santonian–Campanian age. The late Albian to Cenomanian assemblage identified by Haggart et al. (2013) and Sweet (A.R. Sweet, unpub. GSC Paleontological Report 10-ARS-2011, 2012) is probably reworked, with their samples lacking in situ Santonian–Campanian palynomorphs present in other parts of the basin.

CODY CREEK FORMATION

The Cody Creek Formation is dominated by thick sandstone intervals, separated by thinner shale-rich intervals and, in general, gradationally overlies strata of the Burnthill Creek Formation. Recovery of foraminifera is poor and age-diagnostic species are lacking. However, Quesnel et al. (2017, p. 457) recovered specimens of *Textularia gravenori* from upper beds in the Ellen C-24 well that suggest a possible Cenomanian age. Haggart et al. (2013) recovered palynomorph assemblages that have an age span of late Albian to Cenomanian. McIntyre (D.J. McIntyre, unpub. GSC Paleontological Report 2-DJM-1986, 1986) identified dinoflagellates from several of Dixon's (1992) sections that he thought were probably Cenomanian (Appendix A herein). Dixon (1992, p. 43) cited an unpublished report by G. E. Rouse (1965, in Mountjoy, 1967), who identified pollen and spores with a Cenomanian to Santonian age range. Bell (2018) identified seven palynofloral assemblages with specific age ranges from outcrop, well, and seismic shothole samples. These are: 1) Mesozoic, 2) late Albian–Cenomanian or younger, 3) Turonian, or younger, 4) middle Coniacian or younger, 5) Santonian–Campanian, 6) middle to late Campanian or younger, and 7) late Maastrichtian. Many of the samples Bell (2018) analyzed in wells from the southern part of Eagle Plain (Blackie M-59, Whitestone N-26, Porcupine F-18, Chance J-19 and Chance L-08) have palynofloral assemblages with ages of "late Albian to Cenomanian or possibly younger" which correspond with ages determined for outcrop samples in the south-central part of the basin (Haggart et al., 2013). Bell (2018, p. 200) considered the "late Albian–Cenomanian or younger" ages from the shotholes in northeast Eagle Plain to be suspect, stating: "There is a strong possibility these samples are in fact substantially younger than Cenomanian." In central and northeastern Eagle Plain, younger assemblages also were identified by Bell (2018), with ages of Turonian to late Maastrichtian being recorded. A significant aspect of Bell's work is that all seven palynofloral assemblages were identified in the seismic shothole samples from northeast Eagle Plain (Fig. 1; Bell, 2018, Fig. 5.4). Most of the 18.2 m (60 ft) deep shotholes were drilled into Cody Creek strata, with a few in Burnthill Creek and Fishing Branch beds. The seismic shotholes are located in a relatively low-relief area between the Porcupine and Bell rivers (Bell, 2018, Fig. 5.4). The relative stratigraphic position of each shothole remains uncertain. The broad age range of the identified fossil assemblages would suggest that only the younger ages identified, i.e. Santonian, Campanian and Maastrichtian, should be considered correct and that older assemblages are reworked. The Santonian to Maastrichtian ages would encompass the

Santonian–Campanian age noted in the underlying Burnthill Creek Formation from the Whitefish J-70 well (*see* previous section on the Burnthill Creek Formation).

Bell (2018) identified some samples with a Santonian–Campanian flora containing a suite of *Azonia* species (such as *Azonia* sp. cf. *A. recta*, *A. fabacea*, and *A. parva*) in strata mapped as Cody Creek Formation from northeastern Eagle Plain, which indicates Cody Creek strata are younger than Turonian. Also of note in Bell's (2018, her Fig. 5.4) recent work in northeastern Eagle Plain is the identification of some palynomorph assemblages that have a middle to late Campanian age (such as *Pulcheripollenites inrasus*, *Pulcheripollenites krempii*, *Cranwellia rumseyensis*, *Erdtmanipollis procumbentiformis*, *Azonia cribrata*, *Parviprojectus trialatus*, and *Triprojectus scabridus*) and late Maastrichtian palynomorphs (such as *Myrtipites scabratus* and *Wodehouseia spinata*) in strata that have been mapped as Eagle Plain Group. In north Eagle Plain, near the intersection of the Porcupine and Bell rivers (Fig. 1), White (J. White, unpub. GSC Paleontological Report 1-JMW-1994, 1994) reported a late Campanian to Maastrichtian age for samples from one of the shotholes (line 39A shothole 160), and McNeil (D.H. McNeil, unpub. GSC Paleontological Report 4-DHM-1994, 1994) reported a "probably Maastrichtian" age for foraminifera in a single sample from Bell Basin. The age determinations from the three authors are consistent and tend to confirm the youngest ages of what is identified as Cody Creek Formation. The middle Campanian to Maastrichtian ages would make such strata correlative with the Mason River Formation and the late Maastrichtian strata equivalent to the Cuesta Creek Member of the Tent Island Formation, with both units present in northern mainland Canada (Dixon, 1993). These age determinations are the youngest identified for strata thought to be Eagle Plain Group.

The ages identified by Haggart et al. (2013) and Bell (2018) could be interpreted to indicate diachroneity of the Cody Creek Formation from south to north (such as considered by Bell, 2018, and Lane et al., in press, their Fig. 4). However, diachroneity involving several stages, which is what their data would imply, over a relatively short distance seems highly unlikely. Alternatively, if we accept the Santonian-Campanian age of the underlying Burnthill Creek Formation, then the Coniacian and older fossils identified in the Cody Creek Formation are reworked.

DISCUSSION AND CONCLUSIONS

From the foregoing discussion it is apparent that determining specific ages for the component formations of the Eagle Plain Group has proven difficult; but given the evidence available the group could range from the late Albian to the late Maastrichtian. The middle Albian age suggested by Haggart et al. (2013) for the Parkin Formation is not tenable due to Quesnel et al.'s (2017) radiometric and foraminiferal evidence for a late Albian age in the underlying Whitestone River Formation and the unconformable contact between these two units.

This leaves the question of whether or not a late Albian age for the Parkin and Fishing Branch formations is a reasonable option. So far, only foraminifera from the Molar P-34 well have been identified as specifically late Albian, although this is not supported by D.H. McNeil's observations from the same well. Elsewhere, in both outcrop and wells, no specifically late Albian foraminifera have been identified. However, dinoflagellates and a unique foraminiferal assemblage (*Trochammina superstes* Zone) indicative of the Cenomanian–Turonian interval have been identified, the former from several localities and horizons within the Parkin and Fishing Branch formations. Palynomorphs give an age range of late Albian to Cenomanian but Sweet (A.R. Sweet, unpub. GSC Paleontological Report 10-ARS-2011, 2012) thought that a Cenomanian age was more likely. Based on available evidence, a Cenomanian age is most likely for these formations and the late Albian foraminifera probably are reworked or misinterpreted.

The remaining formations within the group are inconsistently dated, although some of the recently published interpretations (Haggart et al., 2013; Quesnel et al., 2017) favour a Cenomanian age based primarily on palynomorphs, and tentatively supported by foraminifera. However, given the number of reworked microfossils in the Eagle Plain Group it is possible that the Cenomanian fossils in the Burnthill Creek and Cody Creek formations may also be reworked. The presence of distinct Santonian–Campanian foraminiferal indices (Fig. 2) in strata assigned to the Burnthill Creek Formation (Dixon, 1993) from the Whitefish J-70 well indicates the formation is younger than Cenomanian. The age of the Cody Creek Formation remains contentious, but if the age of the foraminifera from Burnthill Creek Formation in Whitefish J-70 is accepted, then Cody Creek strata have to be at least Santonian and younger. Bell (2018) identified palynomorphs in the Cody Creek Formation indicating a long age span (late Albian to late Maastrichtian). However, she does have specific Santonian–Campanian ages for some of her samples and the palynomorphs diagnostic of older ages may not be in situ. The middle to late Campanian and late Maastrichtian palynomorphs identified by Bell (2018) are the youngest ages identified from strata mapped as Cody Creek Formation. If these younger strata are to be included in the Cody Creek Formation, then the age range of the Eagle Plain Group, as defined by Dixon (1992), must be extended. However, the geology of the northeastern part of Eagle Plain is difficult to unravel at present and additional work is required to understand the stratigraphic relationships of these youngest beds.

Dixon (1992, 1993) made a comparison of large-scale transgressive-regressive (TR) sequences known throughout northwestern Canada (a Cenomanian–Turonian and a Campanian–Santonian sequence) with the two large-scale TR sequences in the Eagle Plain Group (Parkin to Fishing

Branch formations, and Burnthill Creek to Cody Creek formations). However, because of the uncertainty of the age of the Burnthill Creek and Cody Creek formations, correlation with the upper TR sequence remains contentious. With new foraminiferal data from the Burnthill Creek Formation in the Whitefish J-70 well indicating a correlation with the Santonian–Campanian Smoking Hills Formation (Fig. 2), and Bell's (2018) identification of similar ages in parts of the Cody Creek Formation, Dixon's (1992) original suggestion that the two large-scale regionally distributed TR sequences are present in the Eagle Plain Group appears to still be a viable correlation. However, ages of middle to late Campanian and late Maastrichtian from northeastern Eagle Plain (Bell, 2018) in strata mapped mostly as Cody Creek Formation suggest that younger stratigraphic units correlative with the Mason River Formation and Cuesta Creek Member (Tent Island Formation) occur there. If correct, then TR sequences younger than previously thought (Dixon, 1992, 1993) are also present in the Eagle Plain Group. Also, work by Jackson et al. (2011) indicated that the Parkin-Fishing Branch TR sequence can be divided into two lesser TR sequences.

Figure 3 illustrates schematically our understanding of the stratigraphic relationships of the Whitestone River Formation and Eagle Plain Group, indicating where the relative positions of reliable biostratigraphic data are located. Although we realize that some formational boundaries are diachronous (the zig-zag lines on the diagram), we do not concur with the major diachroneity that Lane et al. (in press) present in their Figure 4, which, for example, indicates a diachroneity of Turonian to early Campanian for the base of the Cody Creek Formation from east to northeast Eagle Plain, a distance of approximately 80 km.

In palynological analysis, it is especially important to recognize the potentially misleading effect of recycled fossils. The Eagle Plain Group is a classic example of recycled fossils dominating the assemblages and the in situ material constituting a small portion, and in some instances, apparently, the whole of the assemblage. Long-term experience in Upper Cretaceous and Tertiary stratigraphy of northern Yukon and the adjacent Northwest Territories, recorded in the work of the late D.J. McIntyre (D.J. McIntyre, unpub. GSC Paleontological Report 2-DJM-1986, 1986; D.J. McIntyre, unpub. GSC Paleontological Report 4-DJM-1987, 1987) has helped to recognize and understand this problem.

ACKNOWLEDGMENTS

This publication is dedicated to the memory of Dave McIntyre, whose work in the northern Yukon and adjacent Northwest Territories helped establish the Late Cretaceous to Tertiary biostratigraphic history of this area and whose help in the field (with J. Dixon) was always much appreciated.

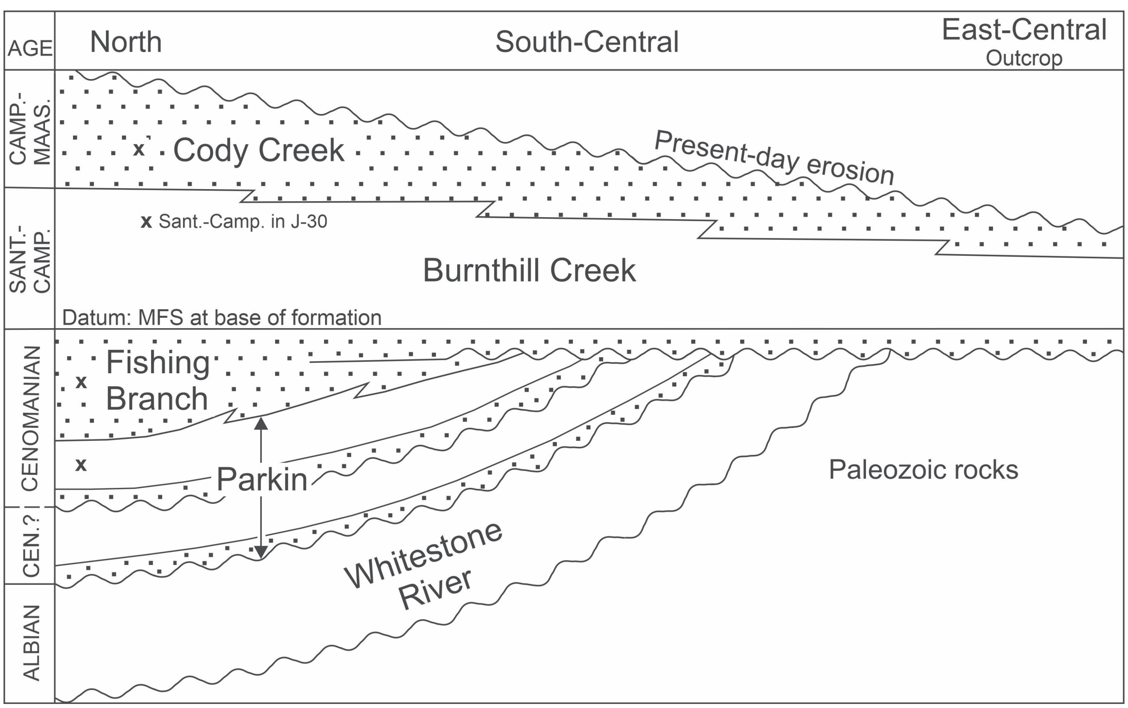

Figure 3. Schematic representation of stratigraphic relationships in the Eagle Plain Group based on this report and the work of Dixon (1992), Jackson et al. (2011), and Lane et al. (in press). Approximate stratigraphic positions (X) of what we consider to be reliable biostratigraphic age determinations are indicated. The Cody Creek Formation is left as a simple stratigraphic unit until further work is performed on the northeast occurrence of this unit. MFS = maximum flooding surface.

We are grateful to palynological consultant Graham Dolby (Dolby & Associates, Calgary) for reviewing Dave McIntyre's GSC palynological reports and generally concurring with Dave's interpretations. We thank Larry Lane (GSC Calgary) and Rob Fensome (GSC Atlantic) for their comments, and for Larry's discussions concerning Eagle Plain stratigraphy and tectonic setting.

Most of the data for this work was obtained when two of the authors (Dixon and McNeil) were employed by the Geological Survey of Canada and this organization and members of the staff at the Calgary office are thanked for their support. K.M. Bell thanks the University of Calgary, NSERC and Geological Survey of Canada for their support and funding of a PhD program under the supervision of Dr. L.V. Hills (deceased), Dr. A.R. Sweet (deceased) and Dr. C.M. Henderson. This work is a product of the Geological Survey of Canada's Geo-mapping for Energy and Minerals (GEM) project.

REFERENCES

Bell, K.M., 2018. Biostratigraphy of Cretaceous and Paleogene strata from northern Yukon Territory and District of Mackenzie, Northwest Territories; Ph.D. thesis, University of Calgary, Calgary, Alberta, 350 p.

Dixon, J., 1986. Cretaceous to Pleistocene stratigraphy and paleogeography, northern Yukon and District of Mackenzie; Bulletin of Canadian Petroleum Geology, v. 34, p. 49–70.

Dixon, J., 1992. Stratigraphy of Mesozoic strata, Eagle Plain Area, northern Yukon; Geological Survey of Canada, Bulletin 408, 58 p. https://doi.org/10.4095/133639

Dixon, J., 1993. Regional unconformities in the Cretaceous of northwest Canada; Cretaceous Research, v. 14, p. 17–38. https://doi.org/10.1006/cres.1993.1002

Dixon, J. and McNeil, D.H., 2008. Upper Cretaceous and Tertiary stratigraphy on the Tuktoyaktuk Peninsula, Northwest Territories. Geological Survey of Canada, Open File 5703, 24 p. https://doi.org/10.4095/224752

Dixon, J., Dietrich, J.R., and McNeil, D.H., 1992. Upper Cretaceous to Pleistocene sequence stratigraphy of the Beaufort-Mackenzie and Banks Island Areas, northwest Canada; Geological Survey of Canada, Bulletin 407, 90 p. https://doi.org/10.4095/133237

Dixon, J., Lane, L.S., Dietrich, J.R., McNeil, D.H., and Chen, Z., 2019. Geological history of the late Cretaceous to Cenozoic Beaufort-Mackenzie Basin, arctic Canada; *in* The Sedimentary Basins of the United States and Canada, (ed.) A. Miall; Elsevier B.V., p. 695–717. (second edition).

Haggart, J.W., Bell, K.M., Schröder-Adams, C.J., Campbell, J.A., Mahoney, J.B., and Jackson, K., 2013. New biostratigraphic data from Cretaceous strata of the Eagle Plain region, northern Yukon: reassessment of age, regional stratigraphic relationships, and depositional controls; Bulletin of Canadian Petroleum Geology, v. 61, p. 101–132. https://doi.org/10.2113/gscpgbull.61.2.101

Jackson, K., McQuilkin, M., Pedersen, P.K., and Lane, L.S., 2011. Preliminary observations on stratigraphy and hydrocarbon potential of middle to Upper Cretaceous strata, Eagle Plain basin, northern Yukon; *in* Yukon Exploration and Geology 2010, Yukon Geological Survey, p. 125–134.

Lane, L.S., 2012. Geology, Porcupine River (southeast), Yukon; Geological Survey of Canada, Canadian Geoscience Map 69 (preliminary edition), scale 1:100 000. https://doi.org/10.4095/290064

Lane, L.S., Bell, K.M., and Issler, D.R., in press. Overview of the age, evolution, and petroleum potential of the Eagle Plain Basin, Yukon; *in* Sedimentary basins of northern Canada: contributions to a 1000 Ma geological journey and insight on resource potential, (ed.) D. Lavoie and K. Dewing; Geological Survey of Canada, Bulletin 609.

McIntyre, D.J., 1974. Palynology of an Upper Cretaceous section, Horton River, District of Mackenzie, N.W.T.; Geological Survey of Canada, Paper 74–14, 57 p. https://doi.org/10.4095/103304

McNeil, D.H., 1987. Micropaleontology report on six outcrop samples from a locality near the Whitestone River in the Eagle Plains area, northern Yukon Territory (NTS 116F); Geological Survey of Canada, Internal Report 2-DHM-87.

Mountjoy, E.W., 1967. Upper Cretaceous and Tertiary stratigraphy, northern Yukon and northwestern District of Mackenzie; Geological Survey of Canada, Paper 66–16, 70 p. https://doi.org/10.4095/100967

Norford, B.S., Braun, W.K., Chamney, T.P., 1971. Biostratigraphic determinations of fossils from the subsurface of the Yukon Territory and the District of Mackenzie; Geological Survey of Canada, Paper 71-15, 25 p. https://doi.org/10.4095/100688

Norris, D.K., 1981a. Geology: Old Crow, Yukon; Geological Survey of Canada, Canadian Geoscience Map 1518A, scale 1:250,000. https://doi.org/10.4095/119399

Norris, D.K., 1981b. Geology: Bell River, Yukon–Northwest Territories; Geological Survey of Canada, Canadian Geoscience Map 1519A, scale 1:250,000. https://doi.org/10.4095/109696

Norris, D.K., 1981c. Geology: Porcupine River, Yukon; Geological Survey of Canada, Canadian Geoscience Map 1522A, scale 1:250,000. https://doi.org/10.4095/119401

Norris, D.K., 1981d. Geology: Eagle River, Yukon; Geological Survey of Canada, Canadian Geoscience Map 1523A, scale 1:250,000. https://doi.org/10.4095/109352

Plauchut, B.P. and Jutard, G.G., 1976. Cretaceous and Tertiary stratigraphy Banks and Eglinton islands and Anderson Plain (N.W.T.); Bulletin of Canadian Petroleum Geology, v. 24, p. 321–371.

Quesnel, A., Schröder-Adams, C.J., and Davis, W.J., 2017. Cretaceous (Albian to Cenomanian) biostratigraphic, paleogeographic and paleoenvironmental reconstruction of the northern Western Interior Sea. Yukon, Canada; Palaeogeography, Palaeoclimatology, Palaeoecology, v. 468, p. 453–472. https://doi.org/10.1016/j.palaeo.2016.12.009

Ricketts, B.D., 1988. The Monster Formation: a coastal fan-delta system of late Cretaceous age, Yukon Territory; Geological Survey of Canada, Paper 86–14, 32 p. https://doi.org/10.4095/126581

Thomson, D., Schröder-Adams, C.J., Hadlari, T., Dix, G., and Davis, W.J., 2011. Albian to Turonian stratigraphy and paleoenvironmental history of the northern Western Interior Seaway in the Peel Plateau region, Northwest Territories, Canada; Palaeogeography, Palaeoclimatology, Palaeoecology, v. 302, p. 270–300. https://doi.org/10.1016/j.palaeo.2011.01.017

Yorath, C.J. and Cook, D.G., 1981. Cretaceous and Tertiary stratigraphy and paleogeography, northern Interior Plains, District of Mackenzie; Geological Survey of Canada, Memoir 398, 76 p. https://doi.org/10.4095/109299

Young, F.G., 1975. Upper Cretaceous stratigraphy, Yukon coastal plain and northwestern Mackenzie Delta; Geological Survey of Canada, Bulletin 249, 83 p. https://doi.org/10.4095/103975

APPENDIX A

Dinoflagellate fossils cited by McIntyre (D.J. McIntyre, unpub. GSC Paleontological Report 2-DJM-1986, 1986) as indicative of a Cenomanian age, collected from Dixon’s (1992, Figure 3) localities

Sample C111894, locality 84-11, Cody Creek Formation

Endoscrinium campanulum (Gocht) Vozzhennikova

Microdinium opacum Brideaux

Ascondinium scabrosum Cookson and Hughes

Alterbidinium sp.

Spongodinium canadense Singh

Sample C111896, locality 84-15, Cody Creek Formation

Amphidiadema denticulata Cookson and Eisenack

Laciniadinium arcticum (Manum and Cookson) Lentin and Williams

Chlamydophorella nyei Cookson and Eisenack

Formea amphora Cookson and Eisenack

Sample C11187, locality 84-16, Cody Creek Formation

Amphidiadema denticulata Cookson and Eisenack

Sample C111899, locality 84-18, Cody Creek Formation

Alterbidinium sp.

Eurydinium sp.

Sample C111900, locality 84-19, Cody Creek Formation

Amphidiadema denticulata Cookson and Eisenack

Chlamydophorella trabeculosa (Gocht) Davey

Spinidinium echinoideum (Cookson and Eisenack) Lentin and Williams

Samples C127253, C127254, C127277, locality 84-21, Cody Creek Formation

Amphidiadema denticulata Cookson and Eisenack

Sample C127757, locality 84-24, Parkin Formation

Amphidiadema denticulata Cookson and Eisenack

Dinoflagellate fossils cited by McIntyre (D.J. McIntyre, unpub. GSC Paleontological Report 4-DJM-1987, 1987) as indicative of a Cenomanian age, collected from Dixon's (1992, Figure 3) and McIntyre's localities

Samples C149314 to C149318, locality 86-8, type section of the Parkin Formation

Alterbidinium sp.

Amphidiadema sp. cf. *A. denticulata* Cookson and Eisenack

Ascondinium scabrosum Cookson and Hughes

Chlamydophorella trabeculosa (Gocht) Davey

Chichaouadinium vestitum (Brideaux) Bujak and Davies

Eurydinium glomeratum (Davey) Stover and Evitt

Laciniadinium arcticum (Manum and Cookson) Lentin and Williams

Sample C149332, locality 86-12, probably Parkin Formation

This sample is dominated by reworked microfossils and has an abundance of Albian foraminifera.

Laciniadinium arcticum (Manum and Cookson) Lentin and Williams

Sample C149336, locality 86-13, probably Parkin Formation

Chichaouadinium vestitum (Brideaux) Bujak and Davies

Microflora dominated by reworked fossils.

Samples C149340 andC149341, locality 86-17, Parkin Formation

Amphidiadema sp. cf. *A. denticulata* Cookson and Eisenack

Chichaouadinium vestitum (Brideaux) Bujak and Davies

Eurydinium glomeratum (Davey) Stover and Evitt

Laciniadinium arcticum (Manum and Cookson) Lentin and Williams

Sample C149342, locality 86-18; sample C149340, locality 86-18, Parkin Formation

Alterbidinum sp.

Amphidiadema sp. cf. *A. denticulata* Cookson and Eisenack

Chichaouadinium vestitum (Brideaux) Bujak and Davies

Chlamydophorella trabeculosa (Gocht) Davey

Eurydinium glomeratum (Davey) Stover and Evitt

Eurydinium sp.

Laciniadinium arcticum (Manum and Cookson) Lentin and Williams

Trithyrodinium sp.

Samples C149307 to C149309, locality 84-23 (Note: McIntyre (D.J. McIntyre, unpub. GSC Paleontological Report 4-DJM-1987, 1987) incorrectly identified this as locality 86-23A and B). Parkin Formation

Amphidiadema sp. cf. *A. denticulata* Cookson and Eisenack

Eurydinium glomeratum (Davey) Stover and Evitt

Heterosphaeridium difficile (Manum and Cookson) Ioannides

Luxadinium propatulum (Manum and Cookson) Davey

Trithyrodinium suspectum (Manum and Cookson) Davey

Alterbidinium sp.

Samples C126301 to C126313, McIntyre's locality 86-1 which is the same as Dixon's 84–24. Parkin Formation

Amphidiadema sp. cf. *A. denticulata* Cookson and Eisenack

Ascondinium scabrosum Cookson and Hughes

Ascondinium verrucosum Cookson and Hughes

Chichaouadinium vestiitum (Brideaux) Bujak and Davies

Chlamydophorella trabeculosa (Gocht) Davey

Eurydinium glomeratum (Davey) Stover and Evitt

Florentinia cooksoniae (Singh) Duxbury

Ginginodium evitti Singh

Heterosphaeridium difficile (Manum and Cookson) Ioannides

Laciniadinium arcticum (Manum and Cookson) Lentin and Williams

Laberidocysta chlamydata (Cookson and Eisenach) Stover and Evitt

Luxadinium propatulum (Manum and Cookson) Davey

Trithyrodinium suspectum (Manum and Cookson) Davey

Foraminifera collected from Dixon's locality 86-13 (1992), identified by McNeil (1987) and compared to a similar assemblage in the Cenomanian-Turonian Boundary Creek Formation of the Beaufort-Mackenzie area

Samples C149331, C149333 to C149336, Parkin Formation

Bathysiphon brosgei Tappan

Ammodiscus sp.

Ammomarginulina (?) sp.

Trochammina sp.4913 and sp.4915 (= *Evolutinella boundaryensis* McNeil and Trochammina *superstes* McNeil)

Verneuilinoides (?) sp.

Trochamminoides sp.4950 (= *Evolutinella boundaryensis* McNeil) *Reophax* sp.4920

Saccammina (?) sp.

Molar YT P-34

Fishing Branch Formation

0–450 ft (0–137 m): barren.

450–500 ft (137–152 m): *Saccammina* spp., *Placentammina* sp., *P.* sp. (very large, sack-like form).

500–550 ft (152–168 m): *Placentammina* sp. – 1, *Bathysiphon vitta*? Nauss −1

550–600 ft (168–183 m): *Placentammina* sp. (elongate) – 1

600–1350 ft (183–411 m): *Placentammina* sp. (round to elongate) occurs in rare numbers, but consistently.

Parkin Formation, shale member (960? ft; 292.6? m)

1350–2050 ft (411–625 m): mostly barren, rare occurrences of Placentammina? sp. at 1650 ft (503 m), 1850 ft (564 m), and 2000 ft (610 m). Two specimens of Haplophragmoides sp. (small, thin-walled, compressed) at 1894–1994 ft (577–608 m).

1200 to 2050 ft (366–625 m): washed residue contains carbonaceous shale. Round otoliths (fish) occur commonly at 1989–1998 ft (606–609 m).

Parkin Formation, sandstone member (1900 ft; 579.1 m)

2050–2350 ft (625–716 m): rare occurrences of *Saccammina* sp.,

Haplophragmoides sp., *Ammodiscus rotalarius* Loeblich and Tappan, Trochammina sp., and *Gavelinella stictata*? (Tappan). Agglutinated foraminifera occur abundantly at 2250–2300 ft (686–701 m). These foraminifera are typical of the Early to Middle Albian and could be reworked.

2350–2600 ft (716–792 m): *G.* *stictata* in core at 2550 ft (777 m).

Whitestone River Formation (2570 ft; 783.3 m)

2600–7800 ft (792–2377 m): common occurrences of foraminifera diagnostic of the early to middle Albian Whitestone Formation.

Locality and curation information for foraminifera illustrated in Figure 2. All specimens are stored in the type collection of the Geological Survey of Canada (Calgary)

(a) *Glaphyrammina spirocompressa*, GSC no. 141599. Whitefish J-70, 488 m (1600 ft)

(b) *G.* *spirocompressa* McNeil, holotype GSC no. 109410 (McNeil, 1997, Pl. 4, Figures 3a, b).

(c) *Haplophragmoides bilobatus*, GSC no. 141600, Whitefish J-70, 701 m (2300 ft).

(d) *H.* *bilobatus* McNeil, holotype GSC no. 109390 (McNeil, 1997, Pl. 1, Figure 9a, b).

(e) *Trochammina superstes*, GSC no. 141601, GSC locality DFA-86–13, Whitestone River, Yukon.

(f) *T.* *superstes* McNeil, paratype GSC no. 109449 (McNeil, 1997, pl. 9, Figure 4a, b).