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**PALEONTOLOGIC DATA: TINGMERKPUK SANDSTONE AND RELATED UNITS,
NORTHWESTERN DE LONG MOUNTAINS, BROOKS RANGE, ALASKA**

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by M.B. Mickey⁽¹⁾, Hideyo Haga⁽¹⁾, and C.G. Mull⁽²⁾

INTRODUCTION

The Alaska Division of Geological and Geophysical Surveys, in collaboration with the Alaska Division of Oil and Gas, University of Alaska, Fairbanks, U.S. Geological Survey, and Bureau of Land Management are engaged in an ongoing study of the hydrocarbon potential of Neocomian sandstones in northwestern Alaska. Surface geological studies involve mile to inch geological mapping of the northern part of the DeLong Mountains and western Misheguk Mountain quadrangles in the western Brooks Range and studies of depositional environments. The results of a study of the depositional environment of the Tingmerkpuk Sandstone (Neocomian) have been summarized by Crowder and others (1994).

As an aid to the geologic mapping and in order to evaluate the hydrocarbon potential of the Neocomian rocks of the western Arctic Slope, samples have been collected for micropaleontologic dating, apatite fission-track uplift history, and organic geochemical analysis for hydrocarbon source rock potential and thermal maturity. Megafossil collections have also been made. Following are the results of the micropaleontologic analysis of 58 shale samples from the northern DeLong Mountains and western Misheguk Mountains quadrangle. Samples were collected from six formal and informal stratigraphic units used in the field mapping (fig. 1). The results are reported by stratigraphic unit and field station number. Samples from measured sections or samples collected in sequence are indicated in the sample descriptions. Additional comments on some samples are given in italics. Preliminary field identifications (by Mull) of the megafossil collections are also included; formal reports with identifications and dating have not yet been received. The location of each sample is shown on figure 2. Collectors of sample material reported here are by field station numbers which include the year of the collection, the initials of the collector, and a field station number (example--93Mu 88). Samples were collected by C.G. Mull (93 Mu ___) R.R. Reifstuhel (93RR ___), R.K. Crowder (93RKC___), and E.H. Harris (93Ha___).

The microfossil samples were processed and analyzed by Michael Mickey and Hideyo Haga of Micropaleo Consultants, Inc. ⁽¹⁾ Analyses were performed initially on 22 samples to determine the most definitive analyses to be used for samples from each of the stratigraphic units. Inasmuch as some stratigraphic units yielded no useful data from foraminifera analyses and other units yielded no data from the palynomorphs, subsequent analyses were performed for foraminifera and/or palynomorphs based upon the results of the preliminary analyses.

The rock material was crushed prior to processing for microfossil extraction. The foraminiferal preparation was made with standard procedures which involve boiling the material in Quaternary-O and washing over 20 and 200 mesh screens. A representative fauna and washed lithology were then picked into slides for examination. The palynology preparation was made using hydrochloric and hydrofluoric acid treatments. The resultant organic residues were further concentrated by a heavy liquid separation, sonification and a sieving/panning technique. Permanent slide mounts were made for each sample.

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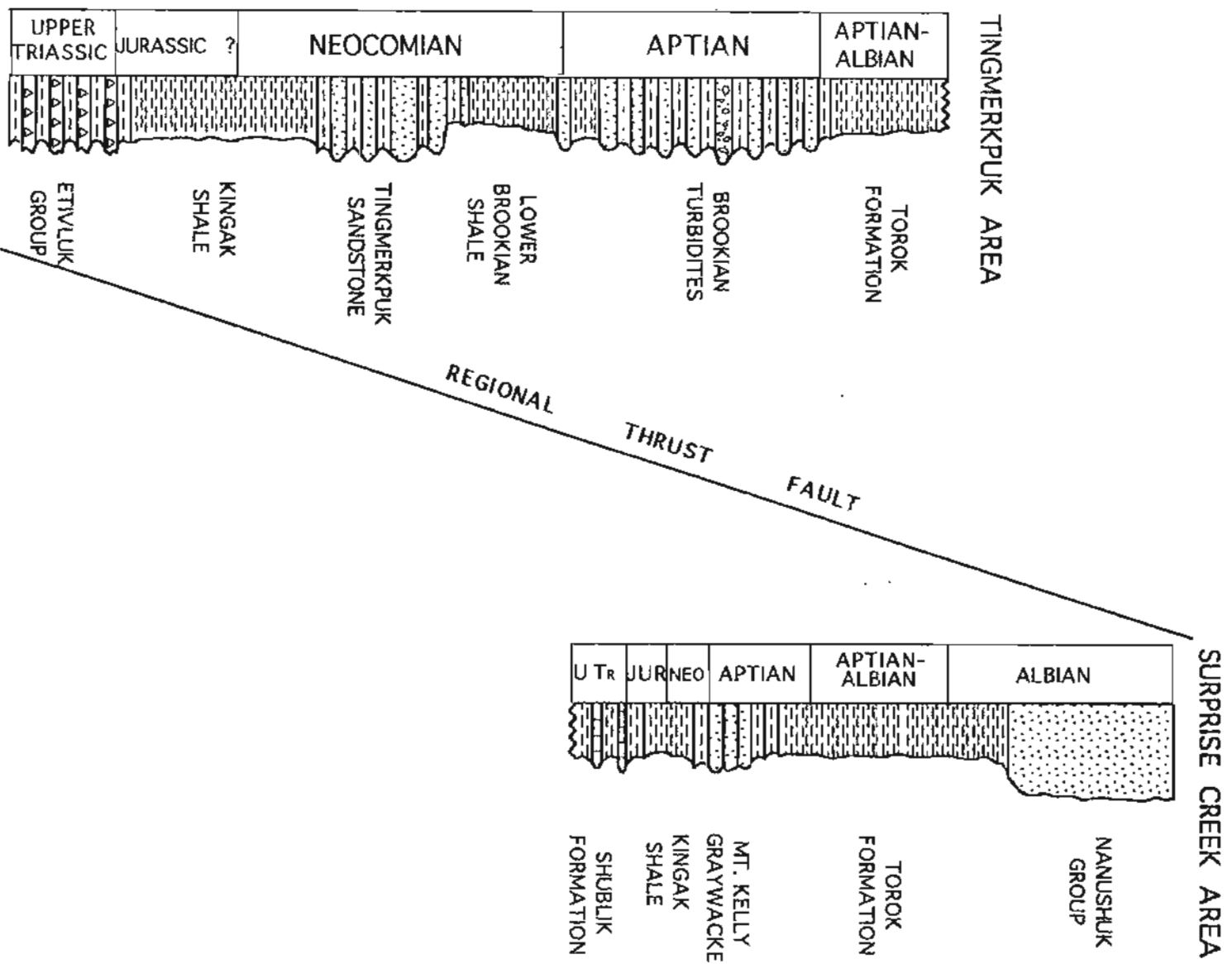


Fig. 1. Generalized composite stratigraphic columns, Tingmerkpuk Mountain and Surprise Creek areas, northwestern DeLong Mountains.

RESULTS

The interpretations for the age, zone, and environment of deposition by Micropaleo Consultants, Inc. are given for each discipline. A list of the recovered microfossils is provided for each sample. The foraminiferal analysis also includes the washed lithology description. The palynological analysis also includes the thermal alteration index (T.A.I.). DGGs editorial comments and discussions of the results reported by Micropaleo Consultants are given in italics.

The foraminiferal abundances represent the following quantities: X = very rare (single specimen), R = rare (2 - 5 specimens), F = few (6 - 25 specimens), C = common (26 - 100 specimens), A = abundant (101 - 999 specimens) and P = prolific (1000+ specimens).

The reported palynomorph abundances represent the following quantities: V = very rare (single specimen), R = rare (2 - 5 specimens), F = frequent (6 - 15 specimens), C = common (16 - 30 specimens) and A = abundant (greater than 30 specimens). An asterisk (*) denotes reworked forms.

TOROK FORMATION

The Torok Formation (fig.1) underlies thick deltaic sediments of the Albian to Cenomanian Nanushuk Group (Chapman and Sable, 1960), and contains a thick section of silty mudstone and silty shale deposited in a pro-delta setting.

93-Mu-101 Eagle Creek

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Forams.	Barren of Foraminifera.
Washed lith.	Dark gray to black slightly silty shale.

Palynology

Age.	Possible Early Cretaceous, possible Neocomian (Undiff.)
Environment.	Marine?
Palynomorphs.	Undifferentiated gymnosperm pollen (R) <i>Oligosphaeridium</i> complex (thick-wall) (V)
Remarks.	TAI = 3.0

Note: The possible Neocomian age seems anomalous and may represent reworked material.

93-Mu-101-1 Eagle Creek

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Forams.	Barren of Foraminifera. Paper shale (F)
Washed lith.	Dark gray to black shale.

Palynology

Age.	Indeterminate
Environment.	Indeterminate
Palynomorphs.	? <i>Densosporites</i> spp. (R)
Remarks.	TAI = 3.5?

93Mu-95 Eagle Creek

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of Foraminifera.
Washed lith.	Dark gray shale.

93Mu-96 Tributary of Tingmerkpuk River

Foraminifera

Age.	Early Cretaceous, probable Barremian to Aptian
Zone.	F-11
Environment.	Probable Bathyal (Slope)
Fauna.	arenaceous spp. (R) <i>Bathysiphon granulocoelia</i> (R) <i>Bathysiphon vitta</i> (F)
Washed lith.	Dark brownish-gray shale.

93Mu-97 Tributary of Tingmerkpuk River

Foraminifera

Age.	Early Cretaceous, probable Barremian to Aptian
Zone.	F-11
Environment.	Probable Bathyal (Slope)
Fauna.	arenaceous spp. (R) <i>Haplophragmoides excavata</i> (X)
Washed lith.	Dark brownish-gray shale.

93Mu-89 Tingmerkpuk River

Foraminifera

Age.	Early Cretaceous, probable Barremian to Aptian
Zone.	F-11
Environment.	Probable Bathyal (Slope)
Fauna.	<i>Ammobaculites fragmentarius</i> (F) arenaceous spp. (F) <i>Bathysiphon granulocoelia</i> (R) <i>Haplophragmoides topagorukensis</i> (F)
Washed lith.	Dark brownish-gray slightly silty shale.

93Mu-88-1 Tingmerkpuk River

Foraminifera

Age.	Early Cretaceous, probable Barremian to Aptian
Zone.	F-11
Environment.	Probable Bathyal (Slope)
Fauna.	<i>Ammobaculites fragmentarius</i> (R) arenaceous spp. (F) <i>Bathysiphon vitta</i> (R)
Washed lith.	Dark brownish-gray slightly silty shale.

93-Mu-100 Northeast fork of Eagle Creek

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Forams.	Barren of Foraminifera.
Washed lith.	Dark gray to black slightly silty shale.

Palynology

Age.	Indeterminate
Environment.	Indeterminate
Palynomorphs.	Essentially barren of palynomorphs.
Remarks.	Relatively sparse organics. TAI = 3.0?

93Mu-100-1 Northeast fork of Eagle Creek

Foraminifera

Age.	Early Cretaceous, probable Barremian to Aptian
Zone.	F-11
Environment.	Probable Bathyal (Slope)
Fauna.	arenaceous spp. (F) <i>Bathysiphon granulocoelia</i> (R) <i>Haplophragmoides gigas</i> (X) <i>Hippocrepina barksdalei</i> (X)
Washed lith.	Dark gray shale.

93Mu-99-1 Northeast fork of Eagle Creek, interbedded with Mt. Kelly Graywacke

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of Foraminifera.
Washed lith.	Dark brownish-gray shale.

93-Mu-99 Northeast fork of Eagle Creek, interbedded with Mt. Kelly Graywacke

Foraminifera

Age.	Early Cretaceous, probable Hauterivian to Barremian
Zone.	F-12 to F-13
Environment.	Marine (Undiff.)
Forams.	<i>Bathysiphon granulocoelia</i> (X) <i>Haplophragmoides coronis</i> (R) <i>Haplophragmoides duoflatis</i> (R) Fecal pellets? (F)
Washed lith.	Dark gray to black slightly silty shale.

NOTE: The probable Hauterivian to Barremian age seems anomalous, and may represent reworked material.

Palynology

Age.	Indeterminate
Environment.	Indeterminate
Palynomorpha.	Undifferentiated gymnosperm pollen (F)
Remarks.	TAI = 3.0 - 3.5

DISCUSSION

Most of the samples reported here are probably from the lower part of the Torok Formation. The best faunal recoveries, reported in samples 93Mu 89 and 93Mu 96, contained abundant foraminifera thought to range from the Barremian (upper Neocomian) to the Aptian. Based upon the apparent stratigraphic position of the Torok Formation gradationally below the Nanushuk Group (Albian) (Chapman and Sable, 1960) and above a very thick section of Neocomian turbidites (data reported below), the lower part of the Torok Formation in the northern DeLong and Misheguk Mountains is probably Albian.

BROOKIAN TURBIDITES

A long section of turbidites characterized by lithic-rich graywackes containing abundant muscovite, detrital carbonate, and carbonate cement underlies the Torok Formation in the northern DeLong Mountains (fig. 1). The upper part of this section, which contains the thickest and coarsest grained graywackes, has been defined as the Mt. Kelly Graywacke Tongue of the Fortress Mountain Formation of Aptian-Albian age (Mull, 1985). Field relationships observed in the present mapping suggest that the Mt. Kelly Graywacke becomes finer grained downward into a dominantly shale section. For the purpose of this report, these rocks are referred to as undifferentiated Brookian turbidites, pending further stratigraphic study and more detailed mapping.

94 Mu 48 West of Kokolik River

Palynology

Age,	Probable Early Cretaceous, possible Aptian - Albian
Environment,	Marine
Palynomorphs,	Undifferentiated gymnosperm pollen (C) <i>Calamospora</i> sp. (V) * <i>Densosporites</i> spp. (F) * <i>Endosporites</i> spp. (R) * <i>Hymenozonotriletes lepidophytus</i> (R) * <i>Lycospora</i> sp. (V) * <i>Vitreisporites pallidus</i> (R) <i>Cyclonephellum distinctum</i> (R) <i>Gonyaulacysta</i> sp. G (V) * <i>Odontochitina operculata</i> (R) <i>Oligosphaeridium complex</i> (F) <i>Oligosphaeridium complex</i> (thick-wall) (C) *? <i>Sverdrupiella usitata</i> (V) *
Remarks,	T.A.I. = 2.5

The palynomorph assemblage represents a mixture of ages, and most of the forms appear to be reworked. By selecting particular dinocyst forms as being indigenous, a possible Hauterivian - Barremian age may be assigned. However, this assemblage would differ from the typically diverse assemblages that are recovered from Hauterivian - Barremian strata. The mixture seen here is more commonly recovered from the Torok Formation.

93-Ha-153 Eagle Creek

Foraminifera

Age.	Early Cretaceous, possible Neocomian (Undiff.)
Environment.	Distal (Starved Basin)
Forams.	Barren of Foraminifera. Paper shale (C)
Washed lith.	Dark brownish-gray to black paper shale.
Discussion.	Based on lithology only.

Palynology

Age.	Early Cretaceous, Hauterivian - Barremian
Zone.	P-M19
Environment.	Marine
Palynomorphs.	Undifferentiated gymnosperm pollen (F) Classopollis classoides (R) Taxodiaceae (R) Gardodinium trabeculosum (R) Oligosphaeridium complex (F)
Remarks.	TAI = 3.0

Note: : Reported age seems anomalous, see discussion of 94Mu 48 (above).

94 Mu 50 Iligluruk Creek

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of Foraminifera.
Washed lith.	Dark brownish-gray to black slightly micaceous shale.

Palynology

Age.	Indeterminate
Environment.	Indeterminate
Palynomorphs.	Barren of palynomorphs.
Remarks.	Mostly thick, coaly organics. T.A.I. = 2.5?

94 Mu 51 Spike Creek

Palynology

Age.	Indeterminate
Environment.	Indeterminate
Palynomorphs.	Essentially barren of palynomorphs.
Remarks.	Mostly thick, coaly organic fragments.
	T.A.I. = 2.5?

94 Mu 55 Iligluruk Creek

Palynology

Age.	Indeterminate
Environment.	Indeterminate
Palynomorphs.	Undifferentiated gymnosperm pollen (V)
Remarks.	Mostly thick, coaly organics.
	T.A.I. = 2.5?

94 Mu 56 Spike Creek

Palynology

Age.	Indeterminate
Environment.	Indeterminate
Palynomorphs.	Barren of palynomorphs.
Remarks.	Mostly thick, coaly organics.
	T.A.I. = ?

DISCUSSION

Based upon the limited faunal data and their stratigraphic position gradationally underlying Albian and Aptian rocks, the Brookian turbidites are probably Aptian age.

LOWER BROOKIAN SHALES

Reconnaissance mapping in the northern DeLong Mountains has delineated a thick section that is dominantly shale. The shale is generally poorly exposed and structurally complicated, but appears to gradationally underlie the Brookian turbidites and overlies the Tingmerkpuk Sandstone (figs. 1 & 3)). Pending more detailed mapping and further stratigraphic studies, these shales are here informally referred to as lower Brookian shales. The lower part of the shale section consists of black fissile clay shale that contains a few thinbeds of micaceous quartzose sandstone. The samples reported here were collected from the lower 100 -150 m of the lower Brookian shales

94 RR 67A Tributary of Kukpowruk River

Palynology

Age. Early Cretaceous, possible Hauterivian - Barremian

Environment. Marine

Palynomorphs. Undifferentiated gymnosperm pollen (A)
Classopollis classoides (R)
Densosporites spp. (R) *
Hymenozonotriletes lepidophytus (V) *
Cyclonephelium distinctum (R)
Gardodinium trabeculosum (R)
Herendeenia alaskaensis (V)
Sentusidinium cuculliformis (R)
Sverdrupiella usitata (V) *

Remarks. The organic recovery consists mainly of palynomorphs. The relatively sparse dinocyst assemblage is comprised of species that suggest a Hauterivian-Barremian age, but these species do not represent a complete assemblage. It is possible that most of this assemblage consists of reworked species. T.A.I. = 2.4

94 RR 68A Tributary of Kukpowruk River

Palynology

Age. Early Cretaceous, probable Hauterivian - Barremian

Environment. Marine

Palynomorphs. Undifferentiated gymnosperm pollen (A)
Densosporites spp. (R) *
Osmundacidites spp. (F)
Gardodinium trabeculosum (A)
Herendeenia alaskaensis (R)
Oligosphaeridium complex (R)

Remarks. The palynomorph recovery in this sample is similar to the above sample. The species diversity is low, however, the abundance of *Gardodinium trabeculosum* and the presence of *Herendeenia alaskaensis* are consistent with a Hauterivian -Barremian age. The abundance seems to make the possibility of reworking less likely. The organic recovery consists mainly of palynomorphs. TAI 2.4.

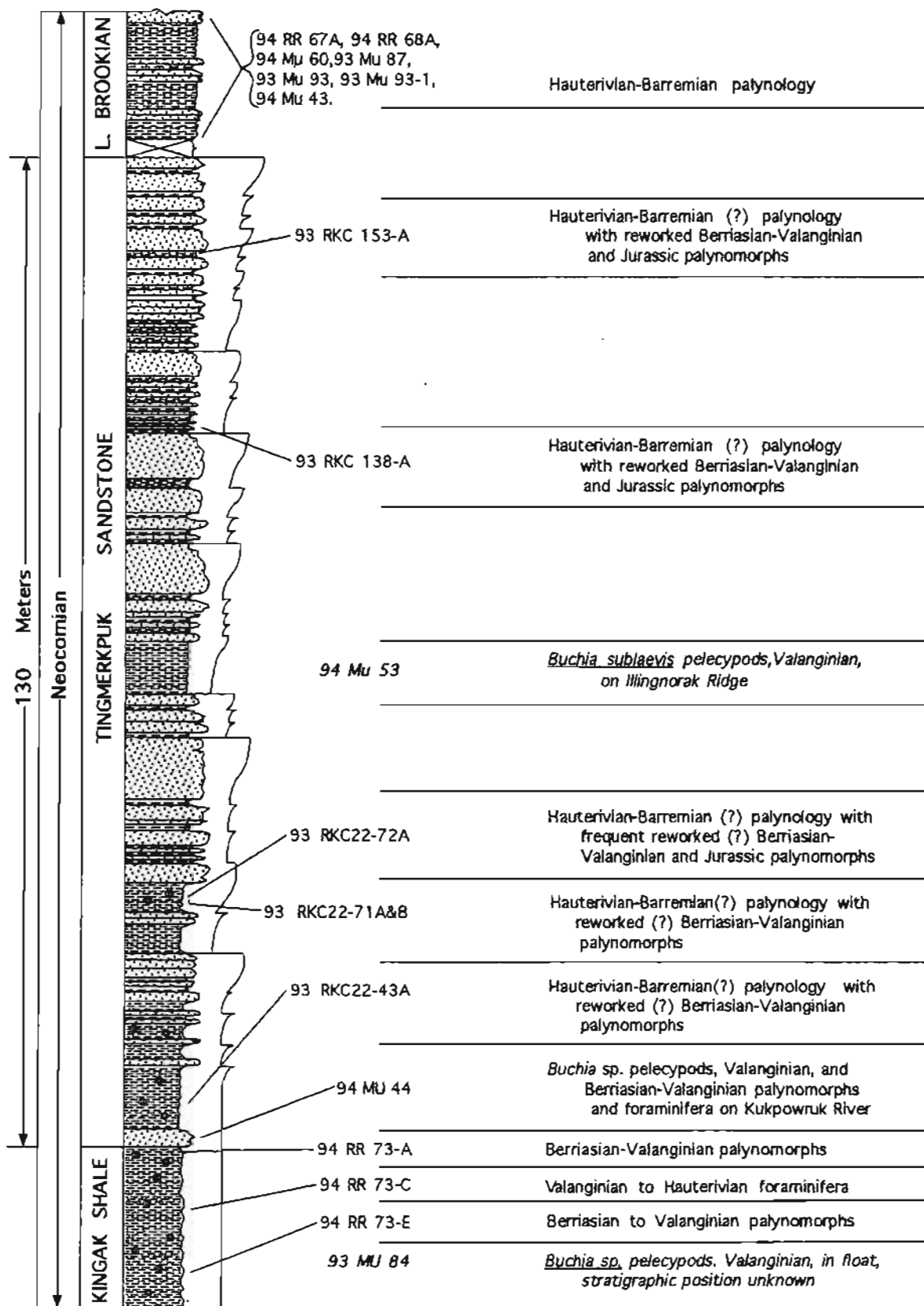


Figure 3. Generalized stratigraphic column of the Tingmerkpuk Sandstone and adjacent units, showing stratigraphic position of paleontologic data on Tingmerkpuk Mountain and nearby areas. Numbers in italics are for fossils of uncertain stratigraphic position. Column generalized from Crowder and others, 1994.

94 Mu 60 Tributary of Kukpowruk River

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of foraminifera. Slickensides (F)
Washed lith.	Dark brownish-gray to black slightly micaceous slickensided shale.

Palynology

Age.	Early Cretaceous, possible Hauterivian - Barremian
Environment.	Marginal marine
Palynomorphs.	Undifferentiated gymnosperm pollen (A) <i>Densosporites</i> spp. (F) * <i>Lycopodiumsporites</i> sp. (V) <i>Rogalskisporites cicatricosus</i> (V) <i>Tubotuberella apatela</i> (V) *? <i>Tubotuberella uncinatum</i> (R) *?

Remarks. Organics consist mainly of gymnosperm pollen. If the recorded dinocysts are reworked, then an Aptian - Albian age would be probable. The very sparse assemblage may be an indication that these dinocysts are reworked.

T.A.I. = 2.7

Note: Same stratigraphic section and general area as 94RR 67A and 94RR 68A.

93-Mu-87 Upper Eagle Creek

Foraminifera

Age.	Early Cretaceous, possible Neocomian (Undiff.)
Environment.	Distal (Starved Basin)
Forams.	Barren of Foraminifera. Paper shale (F) Pyrite (F)
Washed lith.	Dark brownish-gray to black paper shale.
Discussion.	Based on lithology only.

93-Mu-87 (continued)

Palynology

Age.	Indeterminate
Environment.	No evidence of marine.
Palynomorphs.	<i>Classopollis classoides</i> (V) <i>Stereisporites</i> sp. (V)
Remarks.	Relatively sparse organics. TAI = 3.0?

93-Mu-93 Tributary of upper Tingmerkpuk River

Foraminifera

Age.	Early Cretaceous, possible Neocomian (Undiff.)
Environment.	Distal (Starved Basin)
Forams.	Barren of Foraminifera. Paper shale (A) Mica (F)
Washed lith.	Dark brownish-gray to black slightly silty paper shale.
Discussion.	Based on lithology only.

Palynology

Age.	Early Cretaceous, probable Berriasian - Valanginian
Zone.	Probable P-M20
Environment.	Marine
Palynomorphs.	Undifferentiated gymnosperm pollen (F) <i>Cyclonephelium distinctum</i> (R) <i>Gonyaulacysta</i> sp. G (granular) (R) <i>Sverdrupiella usitata</i> (V) reworked <i>Tanyosphaeridium</i> cf. <i>T. variecalamum</i> (V)
Remarks.	TAI = 2.3 - 2.5

Note: Anomalously old age in view of the stratigraphic position, may represent contamination or an inadequate palynomorph assemblage.

93-Mu-93-1 Tributary of upper Tingmerkpuk River

Foraminifera

Age.	Early Cretaceous, possible Neocomian (Undiff.)
Environment.	Distal (Starved Basin)
Forams.	Barren of Foraminifera. Paper shale (A) Mica (F) Tar (R)
Washed lith.	Dark brownish-gray to black paper shale.
Discussion.	Based on lithology only.

Palynology

Age.	Early Cretaceous undifferentiated
Environment.	Marine
Palynomorphs.	<i>Densosporites</i> spp. (R) reworked <i>Cyclonephelium distinctum</i> (V) <i>Oligosphaeridium</i> complex (R)
Remarks.	TAI = 2.3 - 2.5

94 Mu 42 Tributary of upper Tingmerkpuk River

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of Foraminifera.
Washed lith.	Dark brownish-gray to black micaceous shale.

Palynology

Age.	Indeterminate
Environment.	Indeterminate
Palynomorphs.	Indeterminate spore fragment (V)
Remarks.	Mostly thick, coaly organics. T.A.I. = 3.0?

Note Resample of same locality as 93Mu 93.

94 Mu 53-1 Ilingnorak Ridge

Foraminifera

Age.	Probable Early Cretaceous, possible Neocomian
Zone.	F-12? to F-14?
Environment.	Indeterminate
Fauna.	Barren of Foraminifera. Rounded frosted quartz floating sand grains (R)
Washed lith.	Dark gray to black slightly silty shale.

Palynology

Age.	Indeterminate
Environment.	Nonmarine?
Palynomorphs.	Undifferentiated gymnosperm pollen (V)
Remarks.	Mostly thick, coaly organics. T.A.I. = 2.5?

Sample from very near base of Brookian section. Note presence of frosted quartz grains, which may suggest possible correlation with pebble shale unit of the northern Arctic Slope..

94 Mu 43 Upper Tingmerkpuk River

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of Foraminifera.
Washed lith.	Dark brownish-gray slightly micaceous shale.

Palynology

Age.	Jurassic - Cretaceous undifferentiated
Environment.	Nonmarine?
Palynomorphs.	Undifferentiated gymnosperm pollen (V) <i>Classopollis classoides</i> (F) <i>Gleichenioidites senonicus</i> (R) Indeterminate psilate spore (R)
Remarks.	Mostly thick, coaly organics.

T.A.I. = 2.5

Note: This sample and 94Mu 43-1 collected from beds that probably interfinger with top of Tingmerkpuk Sandstone.

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of Foraminifera. Slickensides (F)
Washed lith.	Dark brownish-gray slightly micaceous slickensided shale.

Palynology

Age.	Indeterminate
Environment.	Indeterminate
Palynomorphs.	Barren of palynomorphs.
Remarks.	Mostly thick, coaly organics. T.A.I. = 3.0?

DISCUSSION

The abundance of late Neocomian (Hauterivian-Barremian) fossils in 94RR 68A, and their presence in other samples suggests that at least the base of the lower Brookian shale section in the western DeLong Mountains is Neocomian. In addition, the fissile clay shales in the lower Brookian section are lithologically similar to the shales interbedded with the underlying Tingmerkpuk Sandstone (Neocomian). The stratigraphic relationships and the paleontologic data suggest that the inception of Brookian deposition of this part of the Colville basin began in the late Neocomian.

TINGMERKPUK SANDSTONE

The Tingmerkpuk Sandstone has been studied in detail at Tingmerkpuk Mountain in the northern DeLong Mountains, where a well exposed section has been measured, sampled, and described in detail (Crowder and others, 1994). Study of the stratigraphic sequence and depositional features of the section, indicates that the Tingmerkpuk sands were deposited as turbidites in a deep sea environment. Black, fissile clay shale interbedded with the sandstone is similar to the shale in the lower part of the overlying Brookian section and in the underlying Kingak Shale (fig. 3) and represents the background sedimentation in the Colville basin during the Early Cretaceous.

93-RKC-22-153-A Tingmerkpuk Mountain measured section, upper part

Foraminifera

Age.	Early Cretaceous, possible Neocomian (Undiff.)
Environment.	Distal (Starved Basin)
Forams.	Barren of Foraminifera. Paper shale (F)
Washed lith.	Dark brownish-gray to black paper shale.
Discussion.	Based on lithology only.

Palynology

Age.	Early Cretaceous, probable Hauterivian - Barremian
Zone.	Probable P-M19
Environment.	Marine
Palynomorphs.	Undifferentiated gymnosperm pollen (A) <i>Classopollis classoides</i> (F) <i>Contignisporites cooksonii</i> (R) <i>Densosporites</i> spp. (R) reworked <i>Lycopodiumsporites</i> spp. (R) <i>Trilobosporites</i> cf. <i>T. apiverrucatus</i> (V) <i>Boreocysta butticula</i> (C) <i>Chytroesphaeridia pericompso</i> (F) reworked <i>Cleistosphaeridium</i> spp. (R) <i>Cyclonephelium distinctum</i> (C) <i>Discorsia nanna</i> (V) <i>Gardodinium trabeculosum</i> (R) <i>Hystriodinium voigtii</i> (F) <i>Microhystridium</i> spp. (F) <i>Muderongia tetracantha</i> (R) <i>Nannoceratopsis gracilis</i> (V) reworked <i>Nelchinosporites kostromiensis</i> (F) probably reworked <i>Oligosphaeridium</i> complex (A) <i>Sentusidinium rioultii</i> (V)

93-RKC-22-153-A (Continued)

Remarks.	Frequent reworked Berriasian - Valanginian (P-M20) and Jurassic (P-M23 and P-M22) dinocysts. TAI = 3.0 - 3.5
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93-RKC-22-138-A Tingmerkpuk Mountain measured section, upper part

Foraminifera

Age.	Early Cretaceous, possible Neocomian (Undiff.)
Environment.	Distal (Starved Basin)
Forams.	Barren of Foraminifera. Paper shale (F)
Washed lith.	Dark brownish-gray to black paper shale.
Discussion.	Based on lithology only.

Palynology

Age.	Early Cretaceous, probable Hauterivian - Barremian
Zone.	Probable P-M19
Environment.	Marine
Palynomorphs.	Undifferentiated gymnosperm pollen (A) <i>Aequitriradites spinulosus</i> (V) <i>Cicatricosisporites australiensis</i> (R) <i>Cicatricosisporites</i> spp. (R) <i>Classopollis classoides</i> (F) <i>Densosporites</i> sp. (V) reworked <i>Exesipollenites tumulus</i> (R) <i>Gleicheniidites senonicus</i> (R) <i>Lycopodiumsporites</i> spp. (R) <i>Osmundacidites</i> spp. (R) <i>Gardodinium trabeculosum</i> (F) <i>Hystriodinium voigtii</i> (V) <i>Nannoceratopsis gracilis</i> (V) reworked <i>Nannoceratopsis pellucida</i> (R) reworked <i>Nelchinospis kostromiensis</i> (R) probably reworked <i>Oligosphaeridium</i> complex (A)
Remarks.	Some reworked Berriasian - Valanginian (P-M20) and Jurassic (P-M23 and P-M22) dinocysts. TAI = 3.0 - 3.5

93RKC-22-129.5

Tingmerkpuk Mountain measured section, upper part

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of foraminifera.
Washed lith.	Dark brownish-gray quartzitic siltstone or siliceous shale.

Palynology

Age.	Early Cretaceous, probable Neocomian (Undiff.)
Zone.	Probable P-M19 or P-M20
Environment.	Marine
Palynomorphs.	<i>Oligosphaeridium</i> complex (R) <i>Sentusidinium rioultii</i> (R)
Remarks.	Poor preservation of organics. TAI = 2.5

93-RKC-22-72A

Tingmerkpuk Mountain measured section, middle part

Foraminifera

Age.	Early Cretaceous, possible Neocomian (Undiff.)
Environment.	Distal (Starved Basin)
Forams.	Barren of Foraminifera. Paper shale (A)
Washed lith.	Dark brownish-gray to black paper shale.
Discussion.	Based on lithology only.

Palynology

Age.	Early Cretaceous, probable Hauterivian - Barremian
Zone.	Probable P-M19
Environment.	Marine
Palynomorphs.	Undifferentiated gymnosperm pollen (A) <i>Classopollis classoides</i> (F) <i>Exesipollenites tumulus</i> (R) <i>Lycopodiumsporites</i> spp. (R)

93-RKC-22-72A (continued)

Taxodiaceae (R)
Boreocysta butticula (R)
Cleistosphaeridium spp. (F)
Discorsia nanna (V)
Gochteodinia judilentiniae (V) probably reworked
Nannoceratopsis gracilis (V) reworked
Nannoceratopsis pellucida (R) reworked
Nelchinopsis kostromiensis (F) probably reworked
Oligosphaeridium complex (A)
Sirmiodinium grossi (R) probably reworked
Tubotuberella apatela (R)

Remarks. Frequent reworked Berriasian - Valanginian (P-M20)
and some Jurassic (P-M23 and P-M22) dinocysts.

TAI = 3.0 - 3.5

93-RKC-22-71B

Tingmerkpuk Mountain measured section, middle part

Foraminifera

Age. Indeterminate

Environment. Indeterminate

Forams. Barren of Foraminifera.
Pyrite (R)

Washed lith. Dark brownish-gray to gray well indurated
sandstone.

Palynology

Age. Early Cretaceous, probable Hauterivian - Barremian

Zone. Probable P-M19

Environment. Marine

Palynomorphs. Undifferentiated gymnosperm pollen (A)
Classopollis classoides (F)
Gleicheniidites senonicus (R)
Hymenozonotriletes lepidophytus (R) reworked
Lycopodiumsporites spp. (R)
Boreocysta butticula (V)
Gochteodinia villosa (V) probably reworked
Oligosphaeridium complex (F)
Oligosphaeridium complex (thick-wall) (R)
Sentusidinium rioultii (R)

Remarks. Minor amount of reworked Berriasian -
Valanginian (P-M20) dinocysts.

TAI = 3.0 - 3.5

93RKC-22-71A

Tingmerkpuk Mountain measured section, middle part

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of foraminifera.
Washed lith.	Dark brownish-gray very fine grained quartzitic sandstone or siltstone.

Palynology

Age.	Early Cretaceous, Hauterivian - Barremian
Zone.	P-M19
Environment.	Marine
Palynomorphs.	Undifferentiated gymnosperm pollen (A) <i>Cicatricosisporites</i> sp. (V) <i>Classopollis classoides</i> (R) <i>Densosporites</i> sp. (V) reworked <i>Hymenozonotriletes lepidophytus</i> (V) reworked <i>Trilobosporites</i> sp. (V) <i>Clathroctenocystis elegans</i> (V) <i>Gonyaulacysta</i> sp. G. (granular) (R) reworked <i>Muderongia</i> cf. <i>M. simplex</i> (R) reworked <i>Nelchinopsis kostromiensis</i> (R) reworked <i>Oligosphaeridium</i> complex (C) <i>Oligosphaeridium</i> complex (thick-wall) (R) <i>Sentusidinium rioultii</i> (F)
Remarks.	Frequent reworked Berriasian - Valanginian (P-M20) dinocysts. TAI = 2.7

93-RKC-22-43A

Tingmerkpuk Mountain measured section, lower part

Foraminifera

Age.	Early Cretaceous, possible Neocomian (Undiff.)
Environment.	Distal (Starved Basin)
Forams.	Barren of Foraminifera. Paper shale (F)
Washed lith.	Dark brownish-gray to black paper shale.
Discussion.	Based on lithology only.

93-RKC-22-43A (continued)

Palynology

Age.	Early Cretaceous, probable Hauterivian - Barremian
Zone.	Probable P-M19
Environment.	Marine
Palynomorphs.	Undifferentiated gymnosperm pollen (A) <i>Cicatricosisporites</i> sp. (R) <i>Classopollis classoides</i> (F) <i>Deltoidospora</i> spp. (R) <i>Exesipollenites tumulus</i> (R) <i>Gleicheniidites senonicus</i> (F) <i>Hymenozonotriletes lepidophytus</i> (V) reworked <i>Osmundacidites</i> sp. (R) <i>Taxodiaceae</i> (V) <i>Trilobosporites</i> cf. <i>T. apiverrucatus</i> (R) <i>Gardodinium trabeculosum</i> (V) <i>Gochteodinia villosa</i> (V) probably reworked <i>Nelchinopsis kostromiensis</i> (V) probably reworked <i>Oligosphaeridium</i> complex (F) <i>Sirmiodinium grossi</i> (V)
Remarks.	Some reworked Berriasian - Valanginian (P-M20) dinocysts. TAI = 3.0 - 3.5

94Mu 44 Kukpowruk River, shale at base of Tingmerkpuk Sandstone

Foraminifera

Age.	Early Cretaceous, probable Berriasian to Valanginian
Zone.	Probable F-13 to F-14
Environment.	Outer Neritic To Bathyal
Fauna.	<i>Bathysiphon granulocoelia</i> (X) <i>Gaudryina milleri</i> (X) <i>Haplophragmoides coronis</i> (X) <i>Haplophragmoides duoflatis</i> (X)
Washed lith.	Dark brownish-gray to black shale.

Palynology

Age.	Early Cretaceous---Berriasian - Valanginian
Environment.	Marine

94Mu 44 (continued)

Palynomorphs.	Undifferentiated gymnosperm pollen (A) <i>Classopollis classoides</i> (F) <i>Densosporites</i> spp. (R) * <i>Gleicheniidites senonicus</i> (F) <i>Kraeuselisporites</i> sp. (V) * <i>Pilosporites trichopapillosus</i> (R) <i>Trilobosporites</i> spp. (R) <i>Gochteodinia villosa</i> (R) <i>Gonyaulacysta</i> sp. G (F) <i>Micrhystridium</i> spp. (F) <i>Oligosphaeridium</i> complex (F) <i>Sirmiodinium grossi</i> (R)
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Remarks.	T.A.I. = 2.3 - 2.5
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Note: Thin interbedded sandstone at this locality contains *Buchia* sp. of probable Valanginian age. See data below.

TINGMERKPUK SANDSTONE MEGAFOSSIL DATA

Megafossils are uncommon in the Tingmerkpuk Sandstone, but have been collected in a few localities. Preliminary field identifications of these collections are given below.

94Mu44 Kukpowruk River.

Scattered pelecypod molds, probably *Buchia* sp., collected from basal sandstone bed in Tingmerkpuk Sandstone. See micropaleontologic report 94Mu 44 for the interbedded shale.

Age	Valanginian
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94 Mu 64 Tingmerkpuk Mountain, west side.

Scattered pelecypod molds, probably *Buchia sublaevis*, in float slab of gray, very fine grained sandstone, clearly from overlying Tingmerkpuk Sandstone. Exact stratigraphic position unknown, however sandstone is similar to sandstone at base of Tingmerkpuk Sandstone.

Age	Probably Valanginian
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94Mu 53 Ilingnorak Ridge, eastern end.

Coquina bed (2 cm. thick) of *Buchia sublaevis* interbedded with Tingmerkpuk Sandstone, stratigraphic position within section unknown.

Age	Valanginian
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DISCUSSION

All of the shales interbedded with the Tingmerkpuk Sandstone analyzed in this study contain a mixture of foraminifera and/or palynomorphs of Neocomian age. Hauterivian-Barremian (upper Neocomian) and Berriasian-Valanginian (lower Neocomian) faunas are represented in many of the samples, and recycling of older faunas is probable. Megafossil data shows that at least the base of the Tingmerkpuk is of Valanginian age. However, palynomorphs thought to be of Hauterivian-Berriasian age are abundant in the samples from the upper part of the Tingmerkpuk Mountain measured section. This suggests that the Valanginian-Hauterivian boundary, which marks the position of the Lower Cretaceous unconformity (LCU) in the subsurface of the northern Arctic Slope, may be somewhere within the Tingmerkpuk Sandstone (fig. 3).

KINGAK SHALE

The Kingak Shale in the northern DeLong Mountains quadrangle consists of black fissile clay shale with scattered zones of maroon to greenish gray clay shale. The upper part is well exposed underlying the Tingmerkpuk Sandstone at the base of the Tingmerkpuk Mountain measured section (fig. 3); scattered discontinuous exposures are found elsewhere in the northern foothills of the western DeLong Mountains.

93-RKC-22-36-A Tingmerkpuk Mountain measured section, sample from top 1 m of Kingak Shale

Foraminifera

Age.	Early Cretaceous, possible Neocomian (Undiff.)
Environment.	Distal (Starved Basin)
Forams.	Barren of foraminifera. Paper shale (F)
Washed lith.	Dark brownish-gray to black paper shale.
Discussion.	Based on lithology only.

Palynology

Age.	Early Cretaceous, probable Hauterivian - Barremian
Zone.	Probable P-M19
Environment.	Marine
Palynomorphs.	Undifferentiated gymnosperm pollen (A) <i>Cicatricosisporites australiensis</i> (R) <i>Classopollis classoides</i> (C) <i>Gleicheniidites senonicus</i> (F) <i>Hymenozonotriletes lepidophytus</i> (R) reworked <i>Lycopodiumsporites</i> sp. (R) <i>Trilobosporites</i> cf. <i>T. apiverrucatus</i> (R)

93-RKC-22-36-A (continued)

Gardodinium trabeculosum (V)
Gochteodinia villosa (F) probably reworked
Microdinium opacum (V)
Nelchinopsis kostromiensis (R) probably reworked
Oligosphaeridium complex (F)
Oligosphaeridium complex (thick-wall) (V)
Sentusidinium rioultii (V)
Tubotuberella apatela (V)

Remarks. Frequent reworked Berriasian - Valanginian
(P-M20) dinocysts.

TAI = 3.0 - 3.5

Note: The reported probable Hauterivian-Barremian age for the top of the Kingak Shale at this locality is probably the result of surface contamination of the sample, inasmuch as megafossils of probable Valanginian age are present in the overlying Tingmerkpuk Sandstone. See resample 94RR 73A reported below.

93-RKC-22-12-A Tingmerkpuk Mountain measured section, 24 m. below top of Kingak Shale

Foraminifera

Age. Early Cretaceous, probable Hauterivian to Barremian
Zone. F-12 to F-13
Environment. Distal (Starved Basin)
Forams. *Ammobaculites erectus* (X)
Arenaceous spp. (R)
Trochamminoides sp. (R)
Paper shale (A)
Rounded frosted quartz floaters (R)
Washed lith. Dark reddish-gray hematitic? paper shale.

Palynology

Age. Indeterminate
Environment. Indeterminate
Palynomorphs. Essentially barren of palynomorphs.
Remarks. Essentially barren of organics.
TAI = ?

Note: The reported probable Hauterivian-Barremian age for this sample of the Kingak Shale is probably the result of surface contamination of the sample, inasmuch as megafossils of probable Valanginian age are present in the overlying Tingmerkpuk Sandstone. See resample 94RR 73C reported below.

93RKC-22-10 Tingmerkpuk Mountain measured section, 26 m below top of Kingak Shale

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of Foraminifera. Pyrite (R)
Washed lith.	Dark maroon siliceous shale.

Palynology

Age.	Indeterminate
Environment.	Indeterminate
Palynomorphs.	Barren of identifiable palynomorphs.
Remarks.	Organic material is very poorly preserved. TAI = 3.0

94RR 73-A Tingmerkpuk Mountain measured section, resample of top 1 m. of Kingak Shale (93 RKC 36-A).

Foraminifera

Age.	Probable Early Cretaceous, probable Neocomian (Undiff.)
Zone.	Probable F-12 to F-14
Environment.	Marine (Undiff.)
Fauna.	<i>Ammobaculites erectus</i> (R) <i>Inoceramus</i> prisms (R) Rounded frosted quartz floating sand grains (R)
Washed lith	Dark brownish-gray to black slightly silty shale.

Palynology

Age.	Early Cretaceous, Berriasian - Valanginian
Environment.	Marginal Marine
Palynomorphs.	Undifferentiated gymnosperm pollen (F) <i>Nelchinopsis kostromiensis</i> (R) <i>?Dingodinium cerviculum</i> (R)
Remarks.	T.A.I. = 2.8

94RR 73-C Tingmerkpuk Mountain measured section, resample about 20 m. below top of Kingak Shale (93RKC 12-A).

Foraminifera

Age.	Early Cretaceous, Valanginian to Hauterivian
Zone.	P-13
Environment.	Middle Neritic to Bathyal
Fauna.	<i>Ammobaculites erectus</i> (F) <i>Gaudryina cf. milleri</i> (F) <i>Gaudryina tailleuri</i> (R) <i>Glomospirella arctica</i> (R) <i>Haplophragmoides coronis</i> (F) <i>Haplophragmoides duoflatis</i> (R) Fish debris (R) Rounded frosted floating quartz sand grains (R)
Washed lith.	Medium to dark gray shale.

Palynology

Age.	Indeterminate
Environment.	Indeterminate
Palynomorphs.	<i>Stereisporites</i> sp. (V)
Remarks.	Sparse organics. T.A.I. = 2.8 - 3.0?

94RR 73-E Tingmerkpuk Mountain measured section, resample about 45 m. below top of Kingak Shale

Foraminifera

Age.	Early Cretaceous, Valanginian to Hauterivian
Zone.	P-13
Environment.	Outer Neritic to Bathyal
Fauna.	<i>Ammobaculites fragmentarius</i> (R) <i>Bathysiphon scintillata</i> (C) <i>Bathysiphon granulocoelia</i> (F) <i>Haplophragmoides coronis</i> (R) <i>Haplophragmoides inflatigrandis</i> (R)
Washed lith.	Medium to dark gray shale.

94RR 73-E (Continued)

Palynology

Age.	Indeterminate
Environment.	Probable Marine
Palynomorphs.	Undifferentiated gymnosperm pollen (R) Gleicheniidites senonicus (V) ?Gonyaulacysta sp. fragment (V)
Remarks.	Sparse organics. T.A.I. = 3.0?

94RR 73-G Tingmerkpuk Mountain measured section, resample about 55m below top of Kingak Shale

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of Foraminifera. Shell fragments (F)
Washed lith.	Dark gray shale.

Palynology

Age.	Early Cretaceous, probable Hauterivian - Barremian
Environment.	Marine
Palynomorphs.	Undifferentiated gymnosperm pollen (A) Densosporites spp. (C) * Gleicheniidites senonicus (R) Lycopodiumsporites spp. (R) Osmundacidites spp. (R) Cleistosphaeridium sp. (V) Cyclonephelium distinctum (R) Gardodinium trabeculosum (R) Odontochitina operculata (F) Oligosphaeridium complex (R) ?Prionodinium alaskense (V)
Remarks.	T.A.I. = 2.4

Note: The reported probable Hauterivian-Barremian age for this sample of the Kingak Shale is probably the result of surface contamination of the sample, inasmuch as megafossils of probable Valanginian age are present in the overlying Tingmerkpuk Sandstone..

93-Mu-84 Tingmerkpuk Mountain, southwest side, below Tingmerkpuk Sandstone.

Foraminifera

Age.	Early Cretaceous, probable Berriasian to Valanginian
Zone.	F-13 to F-14
Environment.	Outer Neritic to Bathyal
Forams.	<i>Gaudryina milleri</i> (R) <i>Haplophragmoides coronis</i> (R) <i>Trochamminoides</i> sp. (X)
Washed lith.	Dark gray shale and dark red hematitic? shale.

Palynology

Age.	Early Cretaceous, Berriasian - Valanginian
Zone.	P-M20
Environment.	Marine
Palynomorphs.	<i>Gleichenioidites senonicus</i> (R) <i>Bourkidinium</i> sp. (V) <i>Cyclonephelium distinctum</i> (A) <i>Gonyaulacysta</i> sp. G (granular) (A) <i>Nelchinospis kostromiensis</i> (F) <i>Oligosphaeridium</i> complex (thick-wall) (F) <i>Sverdrupiella usitata</i> (V) reworked
Remarks.	TAI = 2.5 - 3.0

93-Mu-86-1 Tingmerkpuk Mountain, south side.

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Forams.	Barren of Foraminifera. Megaspores (R)
Washed lith.	Dark red hematitic? shale.

Palynology

Age.	Early Cretaceous, Neocomian (Undiff.)
Environment.	Marine
Palynomorphs.	<i>Cyclonephelium distinctum</i> (A) <i>Oligosphaeridium</i> complex (thick-wall) (A) <i>Tanyosphaeridium</i> cf. <i>T. variecalamum</i> (F)
Remarks.	TAI = 3.0

94 Mu 64 Tingmerkpuk Mountain, west side, below Tingmerkpuk Sandstone,
upper part of Kingak Shale

Foraminifera

Age.	Early Cretaceous, probable Hauterivian to Barremian
Zone.	F-12 to F-13
Environment.	Outer Neritic to Bathyal
Fauna.	<i>Gaudryina tailleuri</i> (R) <i>Haplophragmoides duoflatis</i> (R)
Washed lith.	Medium to dark gray shale.

Palynology

Age.	Early CretaceousNeocomian (undifferentiated)
Environment.	Marine
Palynomorphs.	<i>Oligosphaeridium complex</i> (thick-wall) (R)
Remarks.	Mostly thick, coaly organics.
	T.A.I. = 3.0

Note: The probable Hauterivian-Barremian age reported for this sample of the Kingak Shale is probably the result of surface contamination of the sample, inasmuch as megafossils of probable Valanginian age are present in the overlying Tingmerkpuk Sandstone.

94Mu 64-1 Tingmerkpuk Mountain, west side, greenish gray clay shale

Foraminifera

Age.	Early Cretaceous, Neocomian (Undiff.)
Zone.	F-12 to F-14
Environment.	Marine (Undiff.)
Fauna.	<i>Bathysiphon scintillata</i> (R) <i>Haplophragmoides coronis</i> (R) <i>Haplophragmoides duoflatis</i> (R)
Washed lith.	Medium to dark gray shale.

Palynology

Age.	Indeterminate
Environment.	Indeterminate

94Mu 64-1 (Continued).

Palynomorphs Barren of palynomorphs

Remarks. Sparse organics.

T.A.I. = 2.5?

93-Mu-104 Kukpowruk River, structurally contorted section.

Foraminifera

Age. Early Cretaceous, probable Neocomian (Undiff.)

Environment. Marine (Undiff.)

Forams. *Glomospirella arctica* (R)
Paper shale (F)
Slickensides (C)

Washed lith. Dark gray to black slickensided shale.

Palynology

Age. Possible Early Cretaceous, possible Neocomian (Undiff.)

Environment. Marine

Palynomorphs. *Oligosphaeridium* complex (thick-wall) (V)

Remarks. Very sparse organics.
TAI = 3.5?

Gray to maroon clay shale underlying Tingmerkpuk Sandstone in structurally contorted section.

93-Mu-104-5 Kukpowruk River

Foraminifera

Age. Early Cretaceous
Probable Hauterivian to Barremian

Zone. F-12 to F-13

Environment. Probable Outer Neritic to Bathyal

Forams. *Ammobaculites reophacoides* (R)
Ammodiscus sp. (small, thin) (R)
Bathysiphon granulocoelia (F)
Gravellina sp. (small) (X)
Haplophragmoides coronis (R)
Haplophragmoides duoflatis (X)
Trochammina conicominuta (X)
Fish debris (R)
Paper shale (F)
Rounded frosted quartz floaters (A)

93-Mu-104-5 (Continued)

Washed lith. Dark red sandy hematitic? shale.

Palynology

Age. Indeterminate

Environment. Marine?

Palynomorphs. *Micrhystridium* spp. (R)

Remarks. Very sparse organics.
TAI = 3.0?

94Mu 59-2 Tributary of Pitmegea River, black clay shale with abundant marcasite-pyrite nodules.

Foraminifera

Age. Early Cretaceous, probable Berriasian to Valanginian

Zone. Probable F-13 to F-14

Environment. Middle Neritic to Bathyal

Fauna. *Ammodiscus* cf. *asperus* (X)
Gaudryina milleri (X)
Glomospira subarctica (R)
Haplophragmoides coronis (F)
Haplophragmoides duoflatis (R)
Inoceramus prisms (R)
Shell fragments (R)

Washed lith. Dark gray shale.

Palynology

Age. Indeterminate

Environment. Indeterminate

Palynomorphs. Barren of palynomorphs.

Remarks. Very sparse organics.

T.A.I. = 2.5?

94Mu 59-1 Tributary of Pitmegea River, thin clay shale interbedded with coquina of *Buchia sublaevis*.

Foraminifera

Age.	Early Cretaceous, probable Valanginian
Zone.	Probable F-13
Environment.	Middle to Outer Neritic
Fauna.	<i>Ammodiscus cf. asperus</i> (R) <i>Bathysiphon scintillata</i> (R) <i>Conorboides umiatensis</i> (X) <i>Dentalina praecommunis</i> (X) <i>Fronicularia anpulla</i> (X) <i>Gaudryinella irregularis</i> (X) <i>Gravellina</i> 1 (X) <i>Globulina canadensis</i> (X) <i>Glomospira subarctica</i> (F) <i>Glomospira arctica</i> (R) <i>Haplophragmoides coronis</i> (R) <i>Haplophragmoides duoflatis</i> (R) <i>Lenticulina muensteri</i> (F) <i>Lingulina loryi</i> (X) <i>Nodosaria cf. concinna</i> (X) <i>Oolina apiculata</i> (R) <i>Vaginulinopsis grata</i> (R) <i>Inoceramus prisms</i> (F) Shell fragments (C)
Washed lith.	Dark brownish-gray shelly shale.

Palynology

Age.	Early Cretaceous, Neocomian (undifferentiated)
Environment.	Marginal Marine(?)
Palynomorphs.	<i>Oligosphaeridium</i> complex (thick-wall) (F)
Remarks.	Mostly thick, coaly organics.
	T.A.I. = 2.4 - 2.7

Note: Sample interbedded with coquina of *Buchia sublaevis* of Valanginian age. The foraminifera reported contains the only calcareous forams found in any of the samples submitted from the western DeLong Mountains.

94Mu 59 Tributary of Pitmegea River, black clay shale overlying *Buchia sublaevis* coquina.

Foraminifera

Age.	Early Cretaceous–Neocomian (Undiff.)
Zone.	F-12 to F-14
Environment.	Outer Neritic To Bathyal
Fauna.	<i>Glomospira subarctica</i> (X) <i>Haplophragmoides coronis</i> (R) <i>Haplophragmoides duoflatis</i> (R) <i>Haplophragmoides inflatigrandis</i> (X) Fish debris (F)
Washed lith.	Dark gray shale.

Palynology

Age.	Indeterminate
Environment.	Indeterminate
Palynomorphs.	<i>Gleicheniidites senonicus</i> (V)
Remarks.	Mostly thick, coaly organic fragments. T.A.I. = 2.4?

94Mu 72-1 Ipewik River, hard, organic-rich shale, 5 m. below base of Brookian turbidites

Foraminifera

Age.	Probable Early Cretaceous, probable Neocomian (Undiff.)
Zone.	Probable F-12 to F-14
Environment.	Indeterminate
Fauna.	Barren of foraminifera. Tar (F) Rounded frosted quartz floating sand grains (F)
Washed lith.	Black oil? stained shale.

Palynology

Age.	Cretaceous, probable Hauterivian - Campanian
Environment.	Marine

94Mu 72-1 (Continued)

Palynomorphs.	Undifferentiated gymnosperm pollen (F) <i>?Cyclonephelium distinctum</i> (V) <i>Odontochitina operculata</i> (V) <i>Oligosphaeridium</i> complex (R)
Remarks.	Abundant amorphous and coaly organics.
	T.A.I. = 2.3

Note presence of frequent frosted quartz sand grains, which suggest correlation with the pebble shale unit of the northern Arctic Slope.

94Mu 72 Ipewik River, black organic-rich shale, 15 m below 94Mu 72-1

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of Foraminifera.
Washed lith.	Dark gray to black shale.

Palynology

Environment.	Marine
Palynomorphs.	<i>Odontochitina operculata</i> (F)
Remarks.	Abundant, mostly amorphous, organics.
	T.A.I. = 2.3

The limited assemblage provides evidence for only a broad age assignment.

93-Mu-80 Surprise Creek, black clay shale 2 m. below Mt. Kelly Graywacke

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Forams.	Barren of Foraminifera. Megaspores (R) Paper shale (F)
Washed lith.	Dark brownish-gray to black shale.

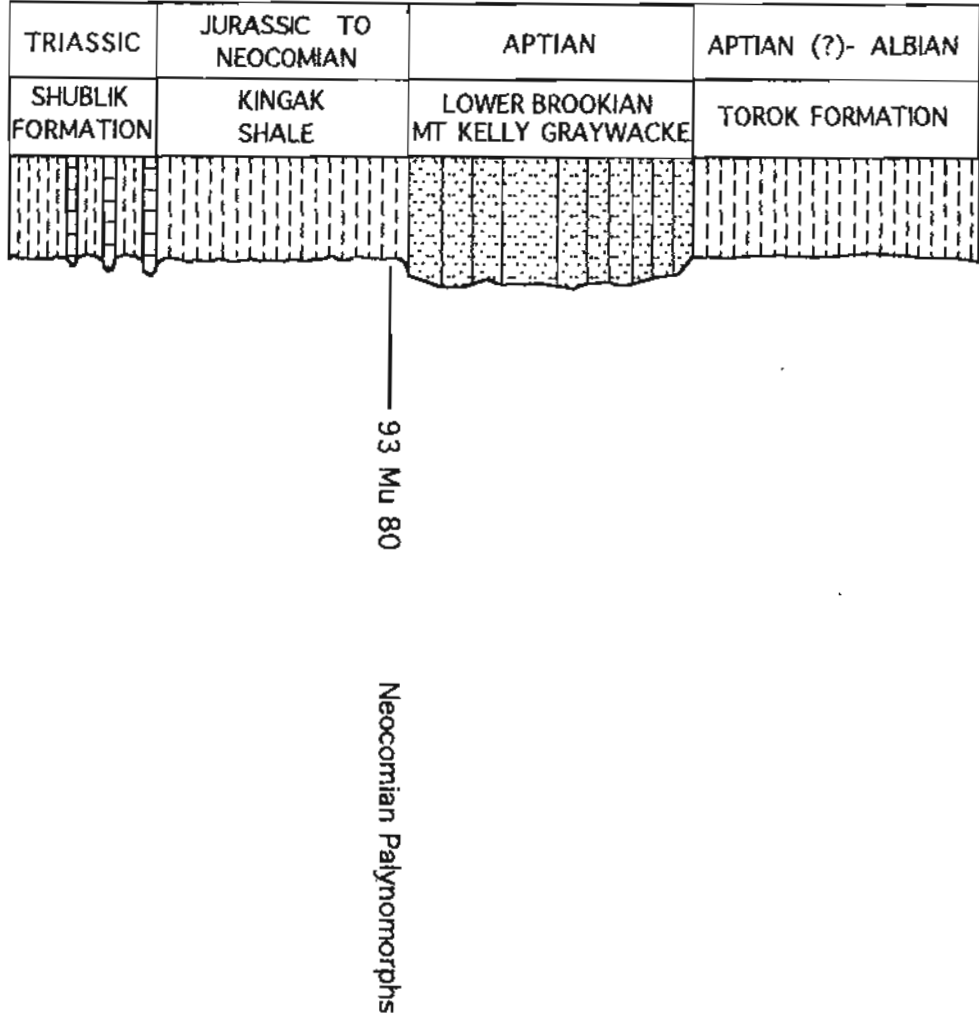


Figure 4. Generalized stratigraphic column of the Surprise Creek area, showing stratigraphic position of paleontologic data.

93-Mu-80 (Continued)

Palynology

Age.	Early Cretaceous, possible Neocomian (Undiff.)
Environment.	Marine
Palynomorphs.	Undifferentiated gymnosperm pollen (A) Classopollis classoides (V) Lycopodiumsporites sp. (V) Cyclonephelium distinctum (V) Oligosphaeridium complex (R) Oligosphaeridium complex (thick-wall) (V)
Remarks.	TAI = 2.3 - 2.5

Note: Interesting section of poorly exposed Kingak Shale about 30 m. thick, overlies Shublik Formation typical of the subsurface of the Arctic Slope, and is overlain by northern facies of Mt. Kelly Graywacke (figs. 1 & 4).

94 Mu 47 Kokolik River tributary between Tingmerkpuk River and Surprise Creek, lower part of Kingak Shale.

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of Foraminifera. Pyrite (R) Gypsum (F)
Washed lith.	Dark brownish-gray to black shale.

Palynology

Age.	Jurassic - Cretaceous Undifferentiated
Environment.	Marginal Marine
Palynomorphs.	Undifferentiated gymnosperm pollen (V) Indeterminate spore(?) fragments (A) Classopollis classoides (R) Densosporites spp. (V) * Micrhystridium spp. (F)
Remarks.	Poorly preserved palynomorphs. Abundant thick, coaly organics. T.A.I. = 3.5

Overtured section of hard black, iron-stained shale of the lower Kingak, overlying chert and silicified mudstone of Etivoluk Group.

94 Mu 47-1 Kokolik River tributary

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of Foraminifera. Gypsum (F)
Washed lith.	Dark brownish-gray iron-stained shale.

Palynology

Age.	Possible Jurassic - Cretaceous Undifferentiated
Environment.	Marginal Marine
Palynomorphs.	Indeterminate spore(?) fragments (A) ?Classopollis classoides (R) Micrhystridium spp. (F)
Remarks.	Poorly preserved palynomorphs. Abundant thick, coaly organics. T.A.I. = 3.0+

94 Mu 47-2 Kokolik River tributary

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Fauna.	Barren of Foraminifera.
Washed lith.	Dark brownish-gray iron-stained shale.

Palynology

Age.	Indeterminate
Environment.	Marginal Marine
Palynomorphs.	Indeterminate spore(?) fragments (A) Lycospora sp. (V) * ?Micrhystridium spp. (R)
Remarks.	Poorly preserved palynomorphs. Mostly woody-fusinitic organics. T.A.I. = 3.0+

ETTIVLUK GROUP

93-Mu-104-3 Kukpowruk River, structurally contorted section

Foraminifera

Age.	Indeterminate
Environment.	Indeterminate
Forams.	Barren of Foraminifera. Paper shale (C)
Washed lith.	Dark gray shale.

Palynology

Age.	Indeterminate
Environment.	Marine
Palynomorphs.	Classopollis classoides (R) Taeniaesporites spp. (C) probably reworked Micrhystridium spp. (A)
Remarks.	TAI = 3.0 - 3.5. The apparently reworked grains are Triassic-age striated bisaccate forms.

Structurally contorted section contains organic-rich shale and chert, probably of Otuk Formation.

SUMMARY

The data in this report are from Upper Triassic through Lower Cretaceous strata of the northwestern DeLong Mountains; the majority of the data are from Neocomian to Aptian or Aptian-Albian strata. The strata record the progressive filling of the Colville Basin during the Early Cretaceous transition from deposition of Ellesmerian (or Beaufortian) strata derived from a northern source to deposition of Brookian sediments derived from the Brooks Range orogenic belt to the south. Paleontologic data show that the onset of Brookian deposition occurred in the late Neocomian in this part of the Colville Basin.

Interpretations of depositional environments from the faunal data suggest that the Kingak Shale may record progressive deepening of the Colville Basin before the onset of Brookian deposition; poorly dated samples from the lower Kingak, which are probably Jurassic age, are interpreted as marginal marine. The Neocomian clay shales of the upper Kingak are interpreted to represent deposition in distal starved basin and bathyal to neritic conditions.

Shales associated with Buchia coquina beds are interpreted to have been deposited in neritic conditions, but the calcareous foraminifera in these shales are greatly affected by dissolution, which suggests deposition at depths below carbonate compensation depth (CCD). This suggests the possibility that the Buchia sublaevis pelecypods, which make up the coquinas, lived in a shallow marine shelf (neritic) environment but were transported off the shelf (possibly in density current flows) into deeper marine settings. At least one thin Buchia coquina bed (94Mu 53), which is interbedded with the Tingmerkuk Sandstone turbidites, was also deposited as a turbidite. Other Buchia coquina beds in the northwest

DeLong Mountains have similar sedimentologic characteristics but are not associated with obvious turbidite sandstones. The depositional environment and regional significance of the Buchia coquinas will be investigated in future field studies.

Shales interbedded with the Tingmerkpuk Sandstone are interpreted to have been deposited in a distal starved basin setting; this is compatible with the interpretation of a turbidite depositional environment for the the Tingmerkpuk sandstones (Crowder and others, 1994). The overlying lower Brookian shales and turbidites are also interpreted to have been deposited in a distal starved basin setting on the basis of micropaleontology and field observations, and probably represent the deepest stage of the Colville Basin. The prodelta mudstones of the overlying Torok Formation record slope deposition at bathyal depths, and represent the progressive shallowing of the Colville Basin as the Nanushuk depositional wedge prograded into the basin from the west and south.

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