74-10

GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES, OTTAWA

PAPER 74-10

CONTRIBUTION TO THE JURASSIC AND CRETACEOUS GEOLOGY OF NORTHERN YUKON TERRITORY AND DISTRICT OF MACKENZIE, NORTHWEST TERRITORIES

J. A. JELETZKY

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Energy, Mines and Resources Canada
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Price: $3.00 Catalogue No. M44-74-10

Price subject to change without notice

Information Canada
Ottawa
1974

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ABSTRACT

Geological investigations during the field season of 1973 in northern Yukon Territory and District of Mackenzie, Northwest Territories, are summarized in this preliminary report. Stratigraphic sections of Jurassic and Cretaceous rocks were investigated in nine separate areas and a lithological description of each is presented.

Included also are the author's conclusions on the tectonics, facies changes and environments of deposition based on the lithology and paleontology of each stratigraphic section and the lithological and paleontological changes between each area.

RÉSUMÉ

Les résultats des recherches géologiques entreprises au Yukon et dans le district de Mackenzie, Territoires du Nord-Ouest, sont présentés dans ce rapport préliminaire.

Des coupes stratigraphiques furent levées dans le Jurassique et le Crétacé à neuf sites différents. Une description lithologique de chacune d'entre-elles est donnée.

Ce rapport présente aussi les conclusions de l'auteur concernant la tectonique, les changements de faciès, l'interprétation des milieux de dépôt en fonction d'une part, des critères lithologiques et paléontologiques relevés dans chaque coupe stratigraphique, et d'autre part, des changements lithologiques et paléontologiques intervenant entre chaque site étudié.

CONTRIBUTION TO THE JURASSIC AND CRETACEOUS GEOLOGY OF NORTHERN YUKON TERRITORY AND DISTRICT OF MACKENZIE, NORTHWEST TERRITORIES (NTS 116I, 116J, 116L, 116-O, 116P and 117A)

INTRODUCTION

This preliminary report summarizes the results of about five weeks of field work conducted in 1973. The work consisted of a stratigraphical and paleontological study of the Jurassic and Cretaceous (mainly Berriasian to Aptian) strata of the northern Yukon Territory and northwestern District of Mackenzie, Northwest Territories. It included, also, paleontological support for other Geological Survey field officers in these and adjacent areas. The writer was ably assisted in the field by A. Hedinger.

The approximate boundaries of the principal areas studied in 1973 are indicated on figure 1 where they are numbered consecutively from 1 to 9. These are discussed in the same order in the text.

ACKNOWLEDGMENTS

The writer is indebted to colleagues D. K. Norris and F. G. Young for helpful suggestions and discussion, and particularly to D. K. Norris for supplying accommodation and transportation during the course of the field investigations. The conclusions presented here are those of the writer; not all of these are shared by his colleagues.

DISCUSSION OF GEOLOGY

Area 1: Headwaters of Bluefish River and Lord Creek

D. K. Norris led the writer to the Jurassic part of Mountjoy's (*in* Frebold *et al.*, 1967, p. 7) main section 230MJ in the eastern Keele Range. The study of this section invalidates the writer's (Jeletzky, 1972b) previously expressed doubts about the correctness of Mountjoy's (ibid.) interpretation of this part of the section and particularly his suggestion concerning the provenance of the Late Jurassic *Buchia* collected there by Mountjoy (*in* Frebold *et al.*, 1967, p. 7).

The Jurassic to mid-Hauterivian sequence of the area as now known includes (in ascending order):

Kingak Formation (restricted)

This formation is represented by at least 500 feet (base cut off by a strong northeast-trending ?normal fault) of poorly exposed and extremely disturbed bluish grey, partly sandy, apparently unfossiliferous siltstone. The Kingak siltstone is overlain conformably and apparently gradationally by an unnamed Upper Jurassic sandstone unit.

Unnamed Upper Jurassic sandstone

This unit is represented exclusively by littoral to neritic rocks containing an abundant pelecypod fauna representing the *Buchia mosquensis* (sensu lato) Zone at several levels. The unit, about 400 feet thick, includes about 125 feet of siltstone and sandy siltstone, mostly unfossiliferous, in the middle. This strongly attenuated offshore facies of the Unnamed Upper Jurassic sandstone is overlain conformably and apparently gradationally by the Husky Formation.

Husky Formation

This formation is represented by some 1,400 feet (approx.) of dark grey siltstone (mostly pure) and shale which is mainly very poorly exposed, and so far appears to be unfossiliferous. The formation is gradational into the overlying sandstone division through 300 to 400 feet of dull to dark grey, sandy to very sandy, micaceous, hard to moderately hard, massive-looking, locally carbonaceous siltstone with some interbeds of superficially similar, very fine grained, silty sandstone.

Lower sandstone division

This unit consists of 500 to 550 feet of light to dark grey or dull yellow, mostly fine- to very fine grained, hard to very hard, in places quartzite-like sandstone. Intercalated beds of dark grey, moderately hard, sandy to very sandy siltstone occur in the basal and topmost parts. Most of these beds are thin but some are as much as 50 feet thick. This resistant, ridge-forming division is built largely of quartzose to orthoquartzitic sandstone but includes interbeds of polymictic

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Manuscript received: September 9, 1973

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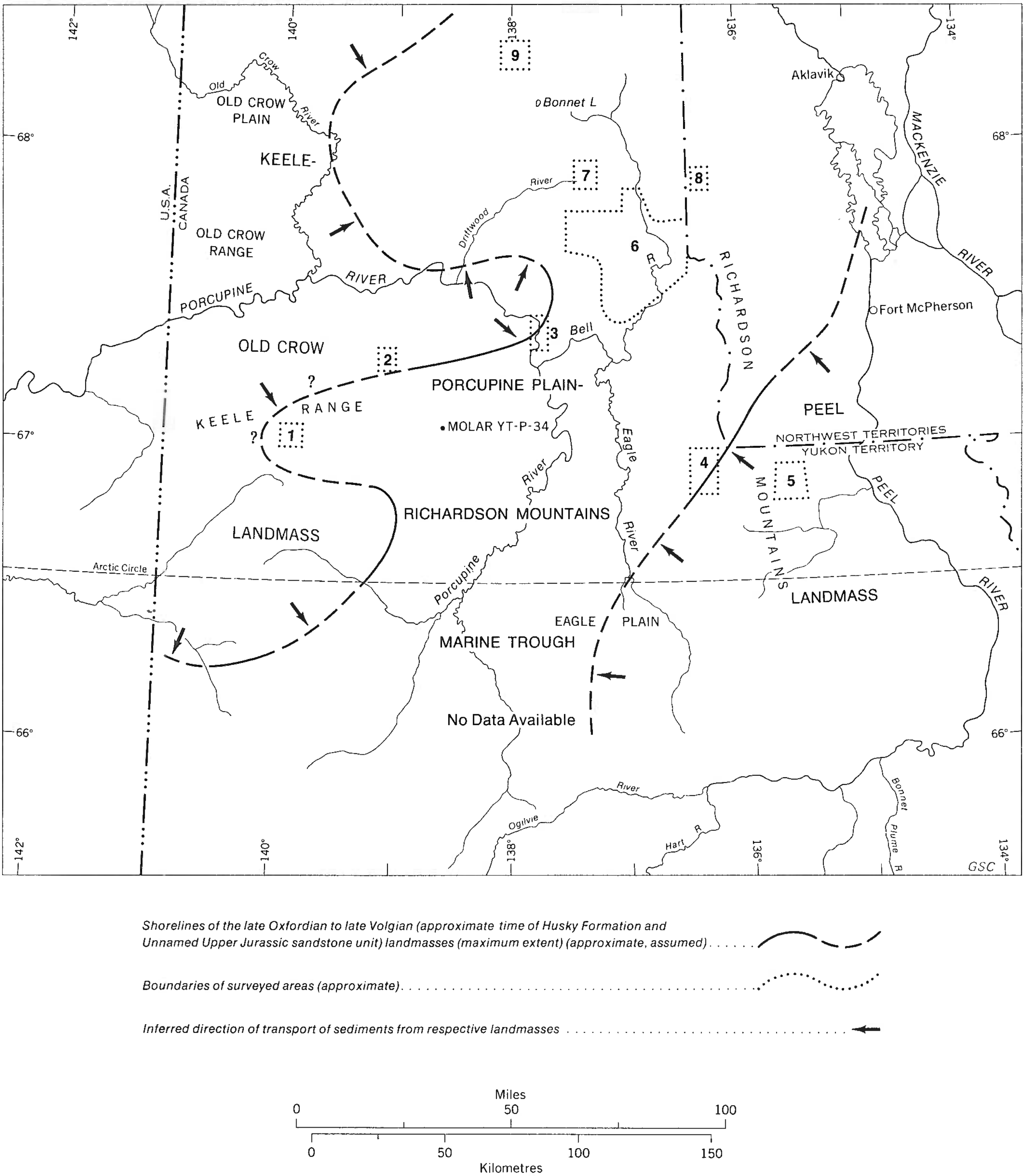

Figure 1. Index map showing location of areas studied

sandstone containing up to 15 per cent (est.) of grains of ?kaolinized feldspar (?or white chert) and the same amount (est.) of dark mineral (?chert) grains. The sandstone is non-carbonaceous to slightly carbonaceous, feebly to slightly glauconitic, and well to moderately rounded and sorted in the upper 300 to 350 feet. This predominantly massive to thickly and indistinctly bedded sandstone contains some non-diagnostic marine pelecypods and is believed to be a lagoonal to outer barrier deposit. The lower part, 200 to 250 feet thick, consists predominantly of thinly bedded to laminated, commonly crossbedded and ripple-marked, carbonaceous or coaly sandstones characterized by alternation of dark to light grey laminae (flaser bedding). Sorting and rounding of grains are poor for the most part. Glauconite grains are notably absent while sub-vertical coaly rootlets, specks and inclusions of coaly matter, laminae and one- to three-inch pods of impure coal are common. This locally wood- and plant-bearing sandstone did not yield any marine fossils and is believed to be of alluvial or deltaic origin. The division appears to be a western shoreline to nonmarine facies of the lower part of the Lower sandstone division of other areas of northern Yukon. It grades upward into the overlying siltstone unit.

Blue-grey shale division (western marginal facies)

This unit begins with the Flinty siltstone member, consisting of at least 300 feet (rough estimate only because of poor exposures and apparently tectonically disturbed state of rocks) of siltstone that is light grey to whitish grey, and weathers light grey or dirty white with orange to rust-coloured specks. The siltstone is mostly sandy to very sandy and grades locally into superficially similar, very silty and very fine grained, hard and dense, more or less strongly silicified and apparently non-porous, micaceous and rarely to moderately glauconitic sandstone that is thinly and evenly bedded. It includes numerous interbeds of similarly hard and silicified, mottled dark to light grey, strongly bioturbated, pure to variably sandy siltstone rich in worm burrows; *Buchia volgensis* Jeletzky, 1964 (non Lahusen, 1888) *Arctotis* aff. *anabarensis* Petrova, 1953, variegated long-ranging pelecypods, *Cylindroteuthis (Communicobelus)* sp. indet. and *Pentacrinus* sp. indet. occur in the uppermost 100 to 150 feet exposed.

All pelecypods are preserved as single, commonly fragmentary and abraded valves oriented along bedding planes. Combined with the presence of belemnites and *Pentacrinus*, this indicates deposition in an open marine (normal salinity), relatively high energy (inner neritic to lower littoral) environment. The top of the unit is faulted in all sections studied. Because of its late Berriasian age (*Buchia volgensis* Zone), this unit must underlie the basal sandstone unit of the Mid- to upper Valanginian (*Buchia* n. sp. aff. *inflata* Zone) siltstone-sandstone division and younger Lower Cretaceous units previously described by Jeletzky (1972b) from several faulted sections situated just east and north of the section described here. The lithology and thickness of the lower Valanginian rocks (*Buchia keyserlingi* Zone), missing due to faulting and separating the present unit from the Mid- to upper Valanginian rocks, are unknown. The lithology of this unit and that of the Mid- to upper Valanginian siltstone-sandstone division matches closely that of the western marginal facies of the Blue-grey shale division observed at the headwaters of Berry Creek (Jeletzky, 1972b). However, the known, incomplete thickness (at least 2,500 feet) of these two component units of the Blue-grey shale division greatly exceeds that of any known section of its marginal or offshore facies in the more northerly areas of the Porcupine Plateau-Richardson Mountain Trough (Jeletzky, 1961b, p. 12, 13; 1972b).

Paleogeographical remarks

The presence of the open marine Kingak and Husky Formations and of the attenuated open marine facies of the Unnamed Upper Jurassic sandstone in the eastern Keele Range necessitates a re-interpretation of the Jurassic paleogeography of the area. The earlier idea (Jeletzky, 1972a, p. 212, Fig. 1; 1972b, Fig. 1) that the Valanginian to mid-Lower Cretaceous marine rocks outcropping at the headwaters of Bluefish River and Lord Creek apparently resulted from an eastward onlap of a shallow sea originating in the marine basin of central Alaska appears to be improbable since no Upper Jurassic to lower Valanginian marine rocks are known to be present in the latter area. It is suggested instead that the Jurassic to mid-Lower Cretaceous rocks outcropping at the headwaters of Bluefish River and Lord Creek were deposited in a narrow but deep embayment of the Porcupine Plain-Richardson Mountain Trough which separated two eastward protruding deltaic lobes of the Keele-Old Crow Landmass. This embayment apparently ended blindly within the western part of Keele Range somewhere east of the Yukon-Alaska boundary as exemplified by the paleogeographic map of Late Jurassic time included in figure 1.

Area 2: Middle course of Lord Creek

Mid- to upper Valanginian siltstone-sandstone division

This unit, originally described at the headwaters of Bluefish River and Lord Creek (*see* Jeletzky, 1972b, p. 63-65; and Area 1 of this report), outcrops on the hillsides immediately west of the upper forks of Lord Creek (at approx. 67° 10'30"N, 139°36'30"W). As much as 150 feet of dull grey to light brownish grey, buff to dull brown weathering, mostly fine-grained sandstone is estimated to outcrop in these folded and faulted, invariably frost-heaved and debris-covered exposures. The covered intervals probably are underlain by friable siltstone. The sandstone, mainly polymictic (subgreywacke-like) and non-carbonaceous, is estimated to comprise 70 to 80 per cent of quartz grains; 10 to 15 per cent of white kaolinized feldspar (?and/or white chert) grains, and a comparable percentage of dark mineral (mainly black chert) grains. Most of the grains are moderately to poorly rounded (subrounded to subangular) and moderately well sorted as to size. This moderately hard to fairly friable, medium to thick and indistinctly bedded, moderately porous sandstone is fossiliferous at a number of levels and includes some intercalated beds of coquinoid sandstone (1/2 inch to 4 inches thick). The diversified, exclusively marine fauna (GSC loc. 88693) includes: *Acroteuthis?* (a new genus?) n. sp. A of Jeletzky (1964, p. 48, Pl. X, figs. 1A-1B), *Arctotis* cf. *anabarensis* Petrova, 1953, *Pecten (Entolium) orbicularis* d'Orbigny, *?Buchia sublaevis* (Keyserling, 1845) (a poorly preserved, single left valve), *Oxytoma* sp. indet., *Arctica* sp. indet., various long-ranging pelecypods and *Ditrupa cornu* Imlay, 1960. The sandstone apparently was deposited in a stenohaline, fairly high energy, outer littoral environment (an open shelf sea). The latest Valanginian age is assigned tentatively to this undoubtedly early to mid-Early Cretaceous (Berriasian to Hauterivian) fauna. The sandstone unit concerned appears to be correlative with the *Buchia sublaevis*-bearing topmost sandstone unit of the Mid- to upper Valanginian siltstone-sandstone division at the headwaters of Bluefish River and Lord Creek; the topmost part of the Blue-grey shale division of the northwestern Richardson Mountains (Jeletzky, 1961b, p. 13, 14; 1972b, p. 43); and the uppermost part of the offshore facies of the White sandstone member of eastern Richardson Mountains (Jeletzky, 1972b, p. 22, 23). This sandstone unit appears to be widespread in the part of northeastern Keele Range confined between the headwaters of Bluefish River and the Lone Mountain, judging by distant observations and an airphoto analysis. However, there was no opportunity to land on any of its assumed exposures.

?Mid-Lower Cretaceous siltstone-sandstone division

There was no opportunity to study on the ground the exposures of rocks apparently stratigraphically intermediate between the Mid- to upper Valanginian siltstone-sandstone division and the Eagle Plain Formation, and presumably corresponding to the Mid-Lower Cretaceous siltstone-sandstone division exposed at the headwaters of the Bluefish River and Lord Creek (Jeletzky, 1972b, p. 63-66).

Eagle Plain Formation

The Cretaceous rocks exposed in the right (east) bank of an unnamed right confluent of Lord Creek at about 67°13'10"N Latitude and 139°01'30"W Longitude (approx. 1 1/3 miles above the confluent's mouth) consist of some 250 feet of dull greenish grey weathering, dark grey to dull brown lithic sandstone (greywacke) containing abundant black chert grains and few of quartz. This fine- to very fine grained, moderately to poorly rounded and sorted greywacke is indistinctly but thinly to medium bedded, hard and dense but not quartzite-like. Three-dimensional or flattened clay balls (1/8" to 1"), variously shaped worm burrows and subvertical, rounded burrows of a ghost-shrimp (*?Calianassa*) are common at a number of levels; no distinct crossbedding or ripple-marks were noted and most fossils are preserved in a life-like position with valves closed or only slightly open. This suggests deposition in a generally low energy lagoonal or estuarine environment. An abundant marine pelecypod fauna collected in the basal 20 feet exposed (base covered) is non-diagnostic. However, that collected 60 to 70 feet stratigraphically higher (GSC loc. 88702) is rich in small *Inoceramus* ex aff. *cordiformis* Sowerby and includes some *Inoceramus* ex gr. *deformis* Meek. This fauna is assigned a latest Turonian to Coniacian age and suggests correlation of the greywacke unit concerned with the uppermost beds of the open marine (flyschoid) Turonian shale unit outcropping in the banks of Porcupine River between Driftwood and Old Crow Rivers (Jeletzky, 1972b, p. 46-48).

The Lord Creek greywacke section forms part of the almost unfossiliferous Eagle Plain Formation (Mountjoy, 1967, p. 5-7) and indicates its being a predominantly nonmarine facies of the unnamed Lower to mid-Upper Cretaceous marine sequence outcropping farther north between Driftwood and Old Crow Rivers (Jeletzky, 1972b, p. 46-53).

Area 3: Porcupine River Canyon

Additional study of and collecting from the well-exposed, unusually fossiliferous sandy siltstone-silty sandstone section situated in the western bank of Porcupine River at the point ten and one-half miles downstream from the mouth of Bell River (Jeletzky *in* Frebold, 1961, p. 2, footnote) confirmed its shallow water (inner neritic) facies and confirmed the previously suggested existence of a sequence of several largely endemic belemnite faunas in the ?late Bajocian to lower Callovian rocks of Arctic Canada. This sequence begins with the *Pachyteuthis* (?new subgenus) n. sp. A fauna ranging from ?late Bajocian (*Cranocephalites borealis* Zone) to ?basal Bathonian, continues with the *Pachyteuthis (?Pachyteuthis)* n. sp. B and *?Cylindroteuthis* (new subgenus) n. sp. A fauna ranging from lower to middle Bathonian and ends with the fauna consisting of *?Cylindroteuthis* (new subgenus) n. sp. B, *Cylindroteuthis (Communicobelus)* aff. *subextensa* (Nikitin), *Hastites* n. sp. A, and a new genus of ?megateuthidine belemnites apparently allied to *Paramegateuthis* Gustomessov, 1960. The latter fauna ranges through the upper Bathonian (beginning with the *Arcticoceras kochi* Zone) and the ?lower Callovian. The overlying Jurassic beds yielded only rare, poorly preserved *Cylindroteuthis (Cylindroteuthis)* sp. and *Cylindroteuthis (Communicobelus)* sp. of ?north Siberian affinities.

Area 4: Southern Richardson Mountains

West and southwest of the area surveyed in 1971 (Jeletzky, 1972b, p. 2-9, Fig. 1), the pre-Albian Mesozoic rocks were found to be widespread along a north-south trending line situated two to four miles east of Rock River. No outcrops of the pre-Albian Mesozoic strata were seen either farther west or south of Latitude 66°52'N (approx.).

The most extensive section comprising Bug Creek and Husky (arenaceous facies) Formations was studied about 10 to 12 miles west-southwest of the 3,956-foot summit of the ridge across which the principal Mesozoic section was measured in 1971 (Jeletzky, 1972b, p. 3-9, Fig. 1). The former section was measured from east to west on the plateau between approximate Longitudes 136°29'30"N and 136°32'30"W and 2 to 3 miles south of the bed of the nameless eastern confluent of Rock River emptying into the latter at about 66°51'15"N and 136° 40'W. This synclinal outlier is surrounded by Upper Devonian to ?Lower Mississippian flyschoid turbidites on all sides and exposes the following upward sequence on the eastern flank.

Bug Creek Formation

This formation consists of the same two members as in the 1971 sections (Jeletzky, 1972b, p. 3). However, the Lower member, at least 140 to 150 feet thick (base covered), consists predominantly of fine-grained, orthoquartzitic, non-carbonaceous to slightly carbonaceous sandstone that is moderately well sorted and rounded. Interbeds of lithologically similar, but extremely carbonaceous sandstone and dark grey, friable coaly siltstone containing poor plant remains and fossil wood are rare, and do not exceed 3 feet in thickness. Interbeds of medium- to coarse-grained, locally gritty and fine pebbly sandstone are rare also and thin (from 2 inches to very rarely 3 feet). Only a few lenticular interbeds (1" to 4" thick) of fine to medium pebble conglomerate were seen. This sandstone, in places abundantly crossbedded and ripple-marked, appears to be an alluvial to deltaic facies deposited seaward of the predominantly piedmont facies of the lower member that characterizes the principal section studied in 1971 (*see* Jeletzky, 1972b, p. 3).

The sandstone of the Upper member, about 160 feet thick, differs from that of the principal 1971 section in being slightly to moderately (5 to ?15%, est.) glauconitic. It contains numerous 2- to 6-inch bands of orange- to wine-red coloured, extremely ferruginous, very fine grained sandstone and sandy siltstone ("clay ironstone"), and appears to grade (contact covered) into the overlying Husky Formation shale through a 50- to 60-foot (est.) zone where the sandstone is interbedded with several beds of dark grey, non-carbonaceous siltstone from 2 to 5 feet thick. Some long-ranging marine pelecypods (no *Buchia* seen) occur locally. The member appears to be of beach to upper littoral origin in contrast to its nonmarine facies in the principal section studied in 1971.

Husky Formation

The lower 300 feet (est.) of the Husky Formation are composed of a poorly exposed Shale member consisting of dull to dark grey, friable, flaky to powdery-weathering, apparently unfossiliferous shale with some 3- to 6-inch thick clay ironstone concretions. This unit is overlain (contact covered) by a Sandstone member, about 750 to 800 feet (est.) thick, consisting of orthoquartzitic, slightly to moderately glauconitic sandstone, lithologically similar to that of the Upper member of the Bug Creek Formation but containing thick pods and interbeds, 3 to 6 inches thick, of medium- to coarse-grained sandstone and fine to coarse, pebbly grit consisting mainly of quartz clasts in the basal 100 feet. The sandstone is laminated to thinly, but in places indistinctly, bedded, and is commonly crossbedded to ripple-marked; it contains an abundant fauna of littoral marine pelecypods of *Buchia mosquensis* (sensu lato) Zone at many levels, including the basal and topmost beds exposed, and apparently was deposited in a fairly high energy, intertidal stenohaline environment. The Sandstone member is overlain by a very poorly exposed, apparently synclinally folded Shale-siltstone member with an estimated visible thickness of some 250 to 300 feet (top not reached). This Shale-siltstone member did not yield any fauna. Like the underlying Bug Creek Formation, the Husky Formation of the section described here is a basinward facies of the arenaceous facies of the formation exposed in the section 10 to 12 miles to the east-northeast studied in 1971 (*see* Jeletzky, 1972b, p. 4). Several Mesozoic outliers occur 3 to 6 miles north of the bed of the previously mentioned major eastern confluent of Rock River. There, the basinward facies of the Bug and Husky Formations described above is overlain by the Lower sandstone, the Coal-bearing, the Upper shale-siltstone and the Upper sandstone divisions striking north-south and dipping moderately westward. All these units are lithologically similar to those of the principal section (*see* Jeletzky, 1972b, p. 5-8), measured in 1971, 10 to 13 miles east-southeastward on the eastern limb of a major anticline.

Paleogeographical and structural setting of pre-Albian Mesozoic rocks

The pre-Albian Mesozoic rocks of the outliers mentioned above are gently to moderately folded along north-south trending axes. The underlying Upper Devonian to Lower Mississippian flyschoid turbidites of the "Imperial Formation" are, in contrast, folded (somewhat more steeply) along west-trending axes. Both groups of rocks are moderately to strongly disturbed by north- to north-east-trending normal and ?strike-slip faults. The pre-Albian Mesozoic rocks are preserved, therefore, only as erosional outliers underlying the topographically higher parts of the divide-areas and isolated mesa-like hills separated from each other by larger areas of lower ground underlain by the "Imperial Formation". The erosional remnants of the pre-Albian Mesozoic clastic rocks rapidly become thin and then wedge out southward within the report-area; the oldest formation extends farthest southward. None were observed south of the Bug Creek-Husky outlier described in this report and another Bug Creek-Husky outlier situated 1.5 miles east of it (centred around a high mesa-like hill situated at 66°53'N and 136°28'W). The complete absence of any shoreward facies changes toward the south combined with the presence of pronounced basinward facies changes of all pre-Albian Mesozoic formations towards the west (Jeletzky, 1972b, p. 9a and in the previous paragraph in this section), indicates that their southern zero edge is an erosional feature only. The southern Richardson Mountains and Eagle Plain apparently experienced much stronger uplift during and immediately after the late Aptian orogeny than the more northerly areas of northern Yukon (Jeletzky, 1972a, p. 539, 540). This resulted in the apparently complete destruction of their pre-Albian Mesozoic cover south of Latitude 66°50'N (except for the upper Peel River outlier; *see* Jeletzky, 1972b, p. 1, 2, Fig. 1).

Area 5: Upper Vittrekwa River

Age of the North Branch Formation

A well-preserved fauna of *Buchia okensis* (Pavlow) (sensu stricto), including the giant forms of *B. okensis* var. *canadiana* (Crickmay, 1930), was found in place in a lenticular clay ironstone band, 8 to 9 inches thick, and 17 to 17.5 feet below the top (a disconformity with the Glauconitic sandstone member) of the rusty-weathering shale bed 37 of the type section of the North Branch Formation (*see* Jeletzky, 1967, p. 133). Thus, this bed is equivalent to the Red-weathering shale member of the Husky Formation of more northerly and westerly areas of northern Yukon (compare Jeletzky, 1961b, p. 30; 1967, p. 30, 31) and denotes the same earliest Cretaceous peak of the Husky time transgression (Jeletzky, 1963, p. 81, 82; 1967, p. 44).

The discovery of *Buchia okensis* fauna in the topmost part of the Sandstone-conglomerate member indicates that the Glauconitic sandstone member of the North Branch Formation is younger than any part of the Husky Formation, and probably corresponds to the Buff sandstone member of the Lower sandstone division. However, only a few, long-ranging marine pelecypods were found in the Glauconitic sandstone member in 1973.

Discordance between Paleozoic and Mesozoic rocks

Contrary to the previous ideas of the writer (Jeletzky, 1961a, p. 539, 540), the "angular discordance of from 5 to 10 degrees between the Conglomeratic and the Grey Sandy Siltstone members of the Upper Sandstone division....", observed in several sections on upper Vittrekwa River below its confluence with the North Branch Creek, actually occurs between the Upper Devonian to Lower Mississippian rocks and those of Aptian age. The basal 300 feet (est.) of the outcrop in the 450-foot high, triangular-shaped bluff of the right (southeast) bank of Vittrekwa River opposite the mouth of the North Branch Creek, was found to consist of rhythmically alternating, medium- to thick-bedded (6 inches to 2 feet) argillite, greywacke and pebble conglomerate. All rock varieties including the conglomerate are graded. The basal contacts of greywacke beds are sharp, uneven and exhibit numerous load casts, flute casts and scratch marks diagnostic of their deposition by turbidity currents. Some *Sigillaria-* or *Lepidodendron*-like plant remains (field identifications of the writer) of Early Mississippian age have been found in the fresh, locally derived float at the base of the bluff. The Grey sandy siltstone member and the Albian Shale-siltstone division overlie these turbidites unconformably in this section and for several miles farther downstream in the banks of Vittrekwa River until the latter plunge beneath the water's level. The true Conglomeratic member of the Upper sandstone division exposed south and west of the section discussed here in the banks of North Branch Creek and the upper Vittrekwa River proper is absent in these downstream sections either by non-deposition or by erosion in late late Aptian time. The juxtaposition of this Conglomeratic member with the lithologically similar Lower Mississippian turbidites is caused by a previously unrecognized, principal (in the sense of Jeletzky, 1961a, p. 545) north-northwest trending ?normal or ?strike-slip fault with the western side relatively downthrown. This fault underlies the bed of the straight, north-northwest trending part of Vittrekwa River immediately upstream from its confluence with the North Branch Creek.

Area 6: Northern part of Bell Basin

The previously little known Jurassic to mid-Cretaceous (Aptian) rocks of that part of Bell Basin confined between the Waters River to the west, Latitude 67°35'N to the south, Longitude 136°30'N to the east, and Latitude 67°50'N to the north, were studied in considerable detail to elucidate their stratigraphy, facies pattern and depositional tectonics within this key area.

Kingak Formation (restricted)

This shale was observed only in a few discontinuous, poorly exposed sections at the headwaters of Waters River and its left confluents west of Longitude 137°05'W. As far as it is possible to judge, the lithology and thickness of Kingak shale in this part of the area are similar to those of the sections situated farther west in the headwaters of Berry Creek (Jeletzky, 1972b, p. 37, 38). No Kingak shale sections transitional to those of the silty mid-basin facies of the Bug Creek Formation observed between Summit Lake and the confluence of Bell and Little Bell Rivers (*see* below) were found in the intervening part of the area and the detailed facies and age relationships of the two require additional study.

Bug Creek Formation

These strata in the area confined between Summit Lake and the mouth of Little Bell River are represented by a mid-basin facies which differs from that characteristic of the Horn Lake-McDougall Pass and eastern White Mountains areas (Jeletzky, 1967, p. 24, 25) in having a greater thickness (at least 2,000 feet) and prevalance of argillaceous rocks and the restriction of arenaceous rocks to the relatively thin basal and topmost beds. The most complete, typical section studied is situated 2.5 to 3 miles south of the western end of Summit Lake (at approx. 67°30'N, and 136°30'W) and consists of the following downward sequence:

The Upper sandstone member consists of 300 to 350 feet (approx.) of light grey to light brownish grey, very fine grained to fine-grained, moderately well rounded (subrounded to subangular grains prevail) and sorted, quartzose to orthoquartzitic, mostly non-carbonaceous to slightly carbonaceous sandstone with few or no interbeds and pods of ferruginous sandstone. This hard, ridge-forming sandstone ranges to true quartzite and is massive to thick bedded and forms sheer bluffs 150 to 180 feet high. It includes several intercalated beds of sandstone, 5 to 15 feet thick. These are thinly to indistinctly bedded, partly ferruginous, carbonaceous to coaly, very fine grained and contain abundant coaly inclusions, 1 inch to 3 inches long and up to 0.5 inch thick, some of which are subvertical and resemble rootlets of plants. These interbeds occur at irregular intervals including the basal 5 to 6 feet exposed. Crossbedding and ripple-marks were rarely seen. Very rare generically indeterminate ?cadoceratid ammonites and *Inoceramus* fragments (field identifications of the writer) occur in the scree of the lower 60 to 70 feet of the unit and these suggest its Bathonian or Callovian age. The member grades upwards into the basal tongue of the Husky Formation. The lower contact is covered or very poorly exposed but is believed to be abrupt and uneven (?erosional) because of the presence of fine, scattered chert pebbles in the uppermost exposed beds of the Intermediate siltstone member.

The Upper sandstone member appears to correspond to the Upper sandstone member of the eastern Richardson Mountains (Jeletzky, 1967, p. 14) and to represent the "moment" of the maximum regression of Bug Creek time; a time when the littoral to lagoonal regime briefly extended into the mid-basin zone including the Summit Lake-Little Bell area and that of the eastern flank of the White Mountains.

The Intermediate siltstone member consists of about 1,400 feet of dark grey and dull to ash-grey, fine rubbly to flaky and recessive, friable siltstone; the siltstone is micaceous and varies from fairly sandy (mostly in the basal 100 and uppermost 700 feet) to almost pure. The member contains some rows of rounded to angular concretions, 3 to 10 inches across, of very hard, blue-grey, bright orange to wine-red weathering, ferruginous siltstone ("clay ironstone"). Sandy varieties of siltstone are commonly bioturbated, with rare to common worm burrows and may be crossbedded locally on a small scale. The lower contact is covered but believed to be gradational. No fossils were seen.

The Lower sandstone member consists of quartzose sandstone similar to that of the Upper sandstone member. It differs, however, in containing up to 10 per cent of limonite grains and the same amount of dark mineral (?chert) grains, as well as numerous 4- to 10-inch bands and rows of pods and lenses, up to 15 feet long and 6 inches to 4 feet thick, of hard to very hard, dull grey, intensively orange to wine-red weathering, ferruginous sandstone and sandy siltstone ("clay ironstone"). No carbonaceous to coaly interbeds were seen in the member. *Inoceramus (Retroceramus)* cf. *menneri* Koshelkina, very rare and poorly preserved fragments of *?Cranocephalites*-like cadoceratid ammonites and various long-ranging pelecypods (field identifications of the writer) occur in the lowermost 60 feet exposed. The base is covered and the unit appears to be faulted against the upper tongue of the Husky Formation. Some 270 feet are exposed in the principal section but other thin and poorly exposed sections suggest that the complete thickness of the unit is about 300 feet and that it overlies paraconformably the lithologically similar Permian sandstones. The Lower sandstone unit of the report-area appears to be equivalent to the Intermediate sandstone member of the eastern Richardson Mountains (Jeletzky, 1967, p. 15, 25, Figs. 1, 2) and to be a deposit of an early Middle Jurassic (?late Bajocian) transgression on the crest of the Aklavik Arch following a late Early to earliest Middle Jurassic phase of its flexing, uplift and erosion.

Unnamed Upper Jurassic sandstone

This unit becomes notably more shaly and thinner eastward which is consistent with its inferred derivation from a western source area (Jeletzky, 1971, p. 205, 211-213, Fig. 2; 1972b, p. 9a-9c).

The westernmost section studied is situated on the crest and southwestern shoulder of the 4,409-foot summit shown on the 1:250,000 scale topographic map (approx. 137°06'W to 137°07'W and 67°38'30"N to 67°30'45"N). There, the unit is about 1,635 feet thick and restricted to rocks of ?mid- or ?late Callovian to late Kimmeridgian or early Portlandian [*Buchia mosquensis* (sensu lato) Zone] age. Westward and southwestward of this section, however, the Unnamed Upper Jurassic sandstone ranges in thickness from about 2,000 to ?4,000 feet (top not reached) and includes beds of ?early Callovian to at least early late Tithonian (*Buchia fischeriana* Zone) age (*see* Jeletzky, 1971, p. 211, 213, Figs. 2, 3; 1972b, p. 39-41). The post-lower Portlandian beds of these Porcupine River and Berry Creek sections are replaced laterally by the predominantly argillaceous rocks of the Husky Formation in the northern part of Bell Basin (*see* below).

The section measured on the 4,409-foot summit is divisible into a ?mid- or ?upper Callovian to upper Oxfordian Lower member, about 650 feet thick, consisting mostly of hard and ridge-forming, light to dark grey, predominantly carbonaceous to coaly, fine- to very fine grained, quartzose to polymictic sandstones with minor interbeds of black carbonaceous to coaly, sandy to very sandy siltstone. These predominantly lagoonal to deltaic sandstones are estimated to include 25 to 30 per cent of upper littoral (including supratidal) deposits characterized by an abundant fauna of marine pelecypods. These littoral interbeds increase upwards until they become prevalent. This defines the base of the exclusively marine Upper member that is about 985 feet thick. The sandstones of this member are mainly buff, light orange, or rust coloured, ferruginous, fine to very fine grained, quartzose to orthoquartzitic, non-carbonaceous and thinly bedded to laminated. They contain numerous interbeds, 3 to 18 inches thick, of pelecypod coquina and are commonly intensively crossbedded and ripple-marked with the foreset beds usually inclined eastward at 5 to 15 degrees. The variegated invertebrate fauna consists mostly of marine (no brackish water types were seen) pelecypods diagnostic of the upper (?lower Kimmeridgian) part of *Buchia (Anaucella) concentrica* Zone and most or ?all of *Buchia mosquensis* (sensu lato) Zone. This fauna includes some poorly preserved ammonites, belemnites, starfish and brittle starfish indicating its littoral to ?inner neritic, stenohaline (i.e. open shelf) depositional environment. The Upper member includes some interbeds, 5 to 60 feet thick, of dark grey, non-carbonaceous, sandy to pure siltstone with clay ironstone concretions comprising about 12 per cent of its thickness. The member grades upwards into the Husky Formation.

Farther east, another section of the Unnamed Upper Jurassic sandstone was measured east of the second eastern confluent of Waters River (approx. at 137°01'W Longitude and 67°39'30" to 67°40'N Latitude). It differs from the section described above (i.e. 4,409-foot summit) in that the Upper member includes only rocks of the *Buchia (Anaucella) concentrica* (sensu lato) Zone [with a possible addition of the basal beds (mid-Kimmeridgian) of *Buchia mosquensis* (sensu lato) Zone] and in being composed of at least 20 per cent of intercalated beds of dark grey, non-carbonaceous siltstone with clay ironstone concretions from 5 to 70 feet thick. The upper part of the member containing the bulk of the *Buchia mosquensis* (sensu lato) Zone evidently is replaced laterally by the basal siltstones of the upper tongue of the Husky Formation between the two sections concerned. Still farther east, the Unnamed Upper Jurassic sandstone changes almost entirely to a shale facies between Longitude 137° 00'W and the confluence of Bell and Little Bell Rivers. This is indicated by the following section that was measured (mostly paced) across the northern shoulder of a butte-like mountain, about 2,500 feet high, overlooking Little Bell River from the south at a point 3.25 miles southwest of the western end of Summit Lake (downward sequence):

Husky Formation (upper tongue)

1. Siltstone, jet-black, mostly pure, micaceous, friable, recessive, weathers flaky to fine rubbly; some rounded, 1- to 2-foot concretions of hard, bright orange weathering clay ironstone; top not reached in the syncline's axis on top of the butte; no fossils seen in this section but *Buchia mosquensis* (sensu lato) fauna was found in the basal 20 feet of the unit in an adjacent section; lower contact gradational; 150 feet exposed (est.).
2. Siltstone, jet-black to dark brownish grey, slightly to markedly sandy for the most part, otherwise as in unit 1; contains a considerable number of dull grey to brown-grey, sandy to very sandy, moderately hard siltstone beds increasing downward in the section; regular attitude 330°/17°E; locally strongly bioturbated with abundant worm burrows; no fossils seen; lower contact gradational; thickness 135 feet (approx.).
3. Siltstone similar to the more sandy varieties of unit 2 except for being hard and resistant; forms a 40-foot high precipitous bluff; no fossils seen; thickness 50 feet (est.).
4. Siltstone much as in unit 1 but with some shale interbeds and poor in clay ironstone concretions; no fossils seen; attitude as in unit 2 except near the base where the dips steepen rapidly to 50° to 60°N; lower contact gradational; thickness 700 feet (est.).

Unnamed Upper Jurassic sandstone (tongue)

5. Sandstone, brownish grey to dull grey, weathers dull brown to light brown or light grey, very fine grained, silty but fairly quartzose, hard and dense but not quartzite-like and with some visible porosity; thin bedded to laminated and commonly crossbedded on a small scale; locally ripple-marked; no fossils seen; attitude as in basal beds of unit 4; lower contact gradational; thickness 40 feet (est.).
6. Siltstone, as in unit 2; no fossils seen; attitude as above; thickness 90 feet (approx.).
7. Sandstone, as in unit 5 but with some interbeds (6" to 18" thick) of coquinoid, intensively ripple-marked sandstone containing an abundant shallow water pelecypod fauna of the lower part (?upper Oxfordian) of *Buchia concentrica* Zone; general attitude 210° to 220°/± 90° and mostly intensely disturbed; lower contact gradational; thickness 12 feet (approx.).
8. Siltstone, as in units 2 and 6; attitude as above and equally strongly disturbed; no fossils seen; lower contact gradational; thickness 100 feet (approx.).
9. Sandstone, as in units 5 and 7; attitudes as above; abundant shallow water pelecypod fauna, including early forms of *Buchia concentrica* (Sowerby), occurs in the topmost 2 to 3 feet represented by a coquinoid sandstone; some similar coquinoid interbeds occur farther down; lower contact gradational; thickness 60 feet (approx.).

Husky Formation (basal tongue)

10. Siltstone as in unit 1; no fossils seen; attitude as above; grades downward into the upper sandstone member of Bug Creek Formation; thickness 300 feet (approx.).

This section duplicates that previously described on the eastern flank of the White Mountains (Jeletzky, 1972b, p. 18 - 20) and indicates that the bulk of the Unnamed Upper Jurassic sandstone as developed in the Keele Range-Berry Creek-Waters River area is replaced laterally eastward by argillaceous rocks of the Husky Formation across the Bell Basin.

Husky Formation

This shale exhibits pronounced facies changes which are the reverse of those exhibited by the Unnamed Upper Jurassic sandstone. It becomes thinner and progressively more sandy westward as the latter sandstone thickens in the same direction. This is exemplified by the following data.

In the previously mentioned section (*see* under Unnamed Upper Jurassic sandstone) measured east of the second confluent of Waters River, the Husky Formation is as least 1,200 feet thick (contact with the underlying Unnamed Upper Jurassic sandstone, at least 800 feet thick, is faulted), comprises rocks ranging from the ?middle part (?upper Kimmeridgian) of the *Buchia mosquensis* (sensu lato) Zone to the early Berriasian, and includes only one member, approximately 100 feet thick, of marine fine- to very fine grained, quartzose, intensively ripple-marked and crossbedded sandstone. Moreover, the black siltstone, about 700 feet thick, comprising the upper part of the Husky Formation in this section and believed to represent *Buchia fischeriana* to *Buchia okensis* (sensu stricto) Zones is predominantly pure.

Farther west in the previously mentioned section measured across the southwestern shoulder of the 4,409-foot summit, the Husky Formation is even more reduced. There, it is only 760 feet thick, and is restricted to mid-Portlandian (*Buchia piochii* Zone) to latest Jurassic (*Buchia terebratuloides-Buchia* aff. *okensis* Zone) or ?lowermost Cretaceous [*?Buchia okensis* (sensu stricto) Zone] time and does not include any shale. However, it includes a number of interbeds, 3 to 10 feet thick, and two sandstone units, 25 and 45 feet thick respectively, in the upper 435 feet approximately corresponding to the 710-foot interval of mostly pure siltstone of the previously described section measured east of the second eastern confluent of Waters River. These non-carbonaceous to carbonaceous sandstones are lithologically identical to those of the underlying Unnamed Upper Jurassic sandstone. They comprise at least 25 per cent of the thickness of the upper part of the formation on the 4,409-foot summit exposure and evidently represent only the eastwardly thinning wedges of the correlative uppermost part of the Unnamed Upper Jurassic sandstone of the Keele Range-Berry Creek area (*see* in the previous section). It is believed that the argillaceous rocks of the Husky Formation were completely replaced laterally by the arenites of the Unnamed Upper Jurassic sandstone unit in the Keele Range-Berry Creek sections even though this cannot yet be verified because of the incompleteness of all sections known (*see* Jeletzky, 1971, p. 205, 211-213, Fig. 2; 1972b, p. 38-41). It is postulated that in this area, which was situated at the eastern shoreline of the Upper Jurassic Keele-Old Crow Land (Jeletzky, 1971, Fig. 1; 1972b, Fig. 1; this report, Fig. 1), the Unnamed Upper Jurassic sandstone unit merged imperceptibly into the littoral to nonmarine facies of the western equivalent of the Lower sandstone division.

The above data indicate that the Husky Formation of the Bell Basin is almost entirely to entirely an argillaceous, eastern mid-basin facies of the Unnamed Upper Jurassic sandstone.

Lower sandstone division

This division is widespread in the area where its thickness and lithology vary greatly from one section to another because of the lateral facies changes and the effects of the subsequent mid- to late Hauterivian uplift.

In most of the sections studied, between the middle course of Waters River in the west and that of Bell River in the east, the division is subdivisible into two lithological members.

This is shown by the two best exposed sections measured on the eastern side of the second eastern confluent of Waters River at approximately 137°01'W Longitude and 67°40'N Latitude and on the western side of Bell River at approximately 136°52'W Longitude and 67°48'N Latitude (3 miles west of the adjacent part of the river's bed). There the Lower member is between 400 and 425 feet thick and is lithologically similar to the restricted Lower sandstone division of the western headwaters of Bell River (Jeletzky, 1961b, p. 28, 29) and the eastern headwaters of Berry Creek (Jeletzky, 1972b, p. 41, 42) with which it is correlative [all three units contain the *Buchia volgensis* Jeletzky, 1964 (non Lahusen, 1888) fauna throughout most or all of their thickness] and are presumably contiguous. The Lower member of this part of northern Bell Basin represents, however, an offshore (presumably mid-basin) facies of the late Berriasian sea as compared with that of the other two areas mentioned. The Lower member consists predominantly of a cyclical alternation of very fine grained, quartzose, commonly carbonaceous, quartzite-like, hard to very hard, ridge-forming sandstone, in beds 1 to 5 feet thick, and black to dark grey, sandy to pure, friable siltstone, in beds 2 to 10 feet thick. The upper part of the member is a unit of such siltstone, 35 to 70 feet thick. This facies of the Lower member contains only a few thicker sandstone units (50 to 70 feet thick) and the sandstone comprises considerably less than 50 per cent of the member's thickness.

Buchia volgensis Jeletzky, 1964 (non Lahusen, 1888) occurs throughout the Lower member. In the sandstone interbeds and members this fossil forms layers of single shells and beds of coquinoid sandstone, 1 inch to 4 inches thick, at irregular intervals. Other pelecypods are rare or absent. The fossils occur invariably as single, often fragmentary valves oriented along the bedding planes with the convex side upward. This indicates deposition of the sandstones in a fairly high energy inner neritic to lower littoral environment. The intervening almost unfossiliferous siltstones presumably were deposited in a deeper and quieter, ?outer neritic environment.

The Upper member is from 85 to 100 feet thick in the two previously mentioned sections and appears to be comparably thick elsewhere. The sandstone comprising the basal 20 to 40 feet of the member is usually cream to dirty white when fresh but weathers white with rusty specks and spots. It is mainly fine grained but with some interbeds of medium-grained sandstone, predominantly quartzose to orthoquartzitic but with 5 to 10 per cent (est.) of orange limonite grains (probably deeply weathered glauconite) and some chert and feldspar grains. The sandstone is mostly non-carbonaceous with grains predominantly subrounded to well rounded. This hard and moderately dense sandstone is generally thick bedded (1 foot to 3 feet) to massive and indistinctly bedded. It is resistant, forms sharp-crested ridges, is locally crossbedded and contains large-scale (1 foot to 3 feet across) ripple-marks. No fossils were seen. The lower contact is poorly exposed but appears to be abrupt. This unit, apparently of beach or lagoonal origin, grades upward into a sandstone unit between 65 and 80 feet thick that is light grey to mottled dull grey and cream, and that weathers dirty white or rust coloured. This upper sandstone is mainly fine to medium grained in the lower part, but includes numerous laterally variable layers, interbeds, lenses and pods of medium- to coarse-grained, fine to coarse gritty and pebbly sandstone, grit, and fine to medium (1/8- to 2-inch pebbles predominate but larger pebbles occur) pebble conglomerate. The sandstone is predominantly quartzose but includes 10 to 15 per cent (est.) of dark mineral (?coaly and/or ?black chert) grains; 2 to 5 per cent (est.) of kaolinized feldspar or (?)white chert grains and some (up to 10%) lithic fragments. The sandstone appears to lack glauconite or limonite grains, is characteristically poorly to moderately rounded (subrounded to subangular grains predominate), and poorly sorted according to grain size. The contained pebbles and grit particles are predominantly poorly rounded to angular and consist largely of black to white chert with less abundant pebbles of black to light brown shale and grey, fine-grained, quartzose to polymictic sandstone probably derived from the underlying Unnamed Upper Jurassic sandstone or Husky Formation. Some flattened clay balls of orange- to rust-coloured, ferruginous clay occur also. Intercalated beds, up to 5 feet thick, of bluish grey, carbonaceous to coaly siltstone containing pods and stringers (up to 4 feet in length and 1 inch in thickness) of shiny coal and plant remains occur locally in the upper 20 to 25 feet of the unit (especially in the section situated at 136°52'W Long. and 67°48'N Lat.). The unit also includes beds of fine-grained sandstone, usually laminated with black carbonaceous to coaly lamellae alternating with those that are light grey and slightly carbonaceous. The sandstone is cross-bedded locally and ripple-marked with foreset beds inclined mainly toward the southwest and south. The topmost 5 to 15 feet of the unit contain an abnormally large number of grit and pebble conglomerate beds and this upper part locally may be represented largely or entirely by these coarse clastics. The contact with the overlying Upper shale-siltstone division is abrupt and uneven.

Because of the gradational superposition on the reliably dated Lower member and the lithological similarity with the mid- to upper Valanginian White sandstone member of the eastern Richardson Mountains (Jeletzky, 1958, p. 7, 8; 1960, p. 5, 6), the Upper member described above is correlative with the latter unit. Like the White sandstone member, the Upper member appears to represent a largely to entirely nonmarine eastern facies of the Blue-grey shale division of northwestern Richardson Mountains (Jeletzky, 1961b, p. 13, 14, Fig. 1) and of its siltstone equivalents in the eastern Keele Range (Sec. 1 of this report). Because of the abrupt and uneven, apparently erosional contact with the overlying Upper shale-siltstone division, the predominantly coarse clastic (piedmont) lithology of the uppermost beds and other data presented in the next section, it is extremely unlikely that the Upper member includes any equivalents of the Coal-bearing division of the eastern Richardson Mountains (*see* Jeletzky, 1960, p. 7-9; 1972b, p. 6, 7, 12-15) or the White and Coaly quartzite divisions of the western Richardson Mountains (Jeletzky, 1961b, p. 14-18) and Porcupine Plateau (Jeletzky, 1972b, p. 63-66; Sec. 1 of this report).

The westernmost section studied, situated on the southwestern spur of the 4,409-foot summit (see Bell River topographic map, scale 1:250,000) located at approximately 137°07'W Longitude and 67°30' 45" N Latitude, is exceptional in exposing about 135 feet of apparently nonfossiliferous sandstone. This sandstone is dark to dull grey or mottled grey when fresh, but weathers mottled brown, dull orange or rusty. It is normally fine grained, quartzose to orthoquartzitic and contains only 2 to 5 per cent (est.) of dark minerals (?chert) and is carbonaceous to coaly particularly in the lower 55 to 60 feet. Higher in the unit, the beds are mainly non-carbonaceous to slightly carbonaceous; grains are mostly subrounded to subangular and fairly well sorted as to size. It is ridge-forming, thickly and indistinctly bedded (beds 1 to 5 feet thick), weathers large blocky to thick slabby and is medium hard and dense but with a fair interstitial porosity. This sandstone is referable to the Lower sandstone division because of its stratigraphic position between the arenaceous facies of the Husky Formation carrying *Buchia* ex gr. *terebratuloides* (Lahusen) in its upper (but not the uppermost) part and the lithologically typical lower part of the Upper shale-siltstone division. It could be interpreted as the relatively thin western shoreline facies of the entirely marine, largely argillaceous facies of the Lower member of the division outcropping farther east. However, the relatively attenuated nature of the sandstone unit of the section discussed here suggests that it may represent the basal part of the Lower member (consisting of 55 to 70 feet of similar sandstone in adjacent sections) truncated by early to late Hauterivian erosion (*see* in next section). The apparent absence of marine fossils may well be only an accident of collecting.

The easternmost section of the Lower sandstone division studied, situated about 6.5 miles south-southeast of the confluence of Bell and Little Bell Rivers (at approx. 136°33'45"W Long. and 67°39'30"N Lat.; *see* Fig. 5), is exceptional also. This section is rather thin (about 125 feet) and is represented almost exclusively by unfossiliferous, apparently alluvial to ?deltaic sandstones, grits and fine pebble conglomerates similar lithologically to the nonmarine facies of the Lower sandstone division exposed on upper Treeless Creek and in the adjacent parts of the eastern slope of Richardson Mountains (Jeletzky, 1960, p. 6). These arenaceous to rudaceous clastics overlie gradationally the sandy siltstone of the upper Husky Formation and are overlain, apparently disconformably, by the open marine siltstone of the Upper shale-siltstone division. Therefore, they appear to be correlative with the basal beds of the Lower member of the previously described, more westerly section of the division. Its younger beds are believed to be absent by non-deposition for reasons presented in the next section.

The White and Coaly quartzite divisions were not found within the investigated part of northern Bell Basin (Figs. 1, 2) in spite of their widespread occurrence to the north (Jeletzky, 1972a, p.207, 208), and northwest (Jeletzky, 1961b, p. 14-18; 1972b, p. 43) of the area. The same is true of the approximately equivalent Coal-bearing division of northeastern and southern Richardson Mountains (Jeletzky, 1960, p. 7-10; 1972b, p. 7-9, 23-25) and the equivalent lower part of the mid-Lower Cretaceous Siltstone-sandstone division of the eastern Keele Range (Jeletzky, 1972b, p. 63-66). For reasons explained in the preceding and following sections, these units appear to be absent by nondeposition rather than by subsequent erosion.

Paleogeographical and structural setting in mid-Valanginian to mid-Hauterivian time

The upward replacement of the mainly open marine sandstones and siltstones of the Lower member of the Lower sandstone division by the carbonaceous to coaly, commonly gritty to conglomeratic, nonmarine clastics preceded the mid-Valanginian orogenic phase previously recorded by Jeletzky (1961a, p. 537-539) on the eastern flank of Richardson Mountains. The uplift apparently was spreading gradually westward, judging by the previously mentioned lateral westward replacement of the alluvial to deltaic facies of the Lower member by open marine sandstones and siltstones. The gritty to conglomeratic lithology of the Lower member in the easternmost part of the area (see easternmost section, p. 10) and the apparent absence of the Upper member there support this conclusion.

The upward and westward facies changes of the Lower sandstone division indicate that the northern Bell Basin was situated on the southwestern continuation of the crestal zone of the mid-Valanginian to mid-Hauterivian Aklavik Arch originally defined by Jeletzky (1961a, p. 537-539, Figs. 1, 22) on the eastern flank of the Richardson Mountains. The uplifted crestal zone of the arch now is known to extend through the central and western Richardson Mountains at least to the middle course of the Waters River. It is believed to have extended still farther west into the northeastern Keele Range, even though this cannot be demonstrated because of the apparent absence of low to mid-Lower Cretaceous rocks in the deeply eroded area between Waters River and Lord Creek.

The localization of the southwestern extension of the crestal part of the mid-Valanginian to mid-Hauterivian Aklavik Arch in the northern part of Bell Basin well to the north of its previously suggested position (*see* Jeletzky, 1961a, p. 539, Fig. 22) suggests that its Rat Uplift was contiguous with the contemporary Dave Lord Uplift of the arch.

The previously described, gradual upward coarsening of the nonmarine clastics of the Lower sandstone division culminates in the prevalence of poorly rounded to angular grit and pebble conglomerate (a piedmont facies) in its uppermost beds followed by an early to mid-Hauterivian hiatus (time of the Coal-bearing, White quartzite, and Coaly quartzite divisions). This trend for the sediments to become coarser upward and the unconformable overlap of the Lower sandstone division (*see* above in this section and under Area 8) by the upper Hauterivian siltstone of the Upper shale-siltstone division suggest that neither marine nor nonmarine equivalents of the Coal-bearing division of the northeastern and southern Richardson Mountains or of the White and Coaly quartzite divisions of northwestern Richardson Mountains ever were deposited within the northern Bell Basin. This area, extending at least from the Summit Lake area in the east to the valley of Waters River in the west, must have been an elevated source area in early to mid-Hauterivian time providing sediment for the above-mentioned clastic units situated to the north and south of it (Fig. 2).

Unlike the northeastern Richardson Mountains (Jeletzky, 1961a, p. 538), where the effects of the mid-Valanginian orogenic phase ceased to be apparent by the end of the Valanginian (i.e. end of the time of White sandstone member), this phase, in the northern Bell Basin, must have continued through the early to mid-Hauterivian (and probably into the early late Hauterivian) and culminated during that time. These structural conditions apparently prevailed also on the eastern slope of White Mountains (*see* Fig. 2 and under Area 8), where the partly arenaceous facies of the Upper shale-siltstone division overlaps disconformably (and probably unconformably) the deeply eroded surface of the Husky Formation. The same structural relationships possibly prevailed still farther north in the headwaters of Cache Creek and Fish Rivers. This appears to be yet another example of the well-known phenomenon of a "temporal migration" of orogenic phases along and across the structural grain of tectonically active belts.

The presence of marine equivalents of the White and Coaly quartzite divisions to the west of their typical nonmarine facies in northwestern Richardson Mountains and eastern Keele Range (Jeletzky, 1972b, p. 30-33, 63-66) and the previously discussed general east-west changes of the Valanginian facies across the northern Bell Basin seem to favour the presence of a narrow-marine, early to mid-Hauterivian strait separating the Bell Basin Peninsula of Peel Landmass from the adjacent parts of the Keele-Old Crow Landmass as indicated in figure 2. It is possible also, however, that the crestal zone of the Aklavik Arch was elevated above sea level throughout this interval and that only nonmarine clastics of the White and Coaly quartzite divisions were deposited in the area around the confluence of Driftwood and Porcupine Rivers (Fig. 2). If so, the Jurassic to mid-Early Cretaceous Porcupine Plain-Richardson Mountain Trough was split briefly into a northern and a southern embayment by an isthmus in early to mid-Hauterivian time.

Upper shale-siltstone division

This unit was found to be widespread in the northern Bell Basin where a generally west-east trending belt of its outcrops extends at least from the point situated west of Waters River Valley at about 67°30'N Latitude and 137°15'W Longitude to that on the western side of Bell River at about 67°34'N Latitude. West of the former point, the division apparently is cut out by a major northeast-trending fault which brings Albian shales against the Unnamed Upper Jurassic sandstone. East of Bell River, extensive outcrops of the division are centred around the point situated at Latitude 67°35'N and Longitude 136°32'W. These outcrops appear to be contiguous with those on the western side of Bell

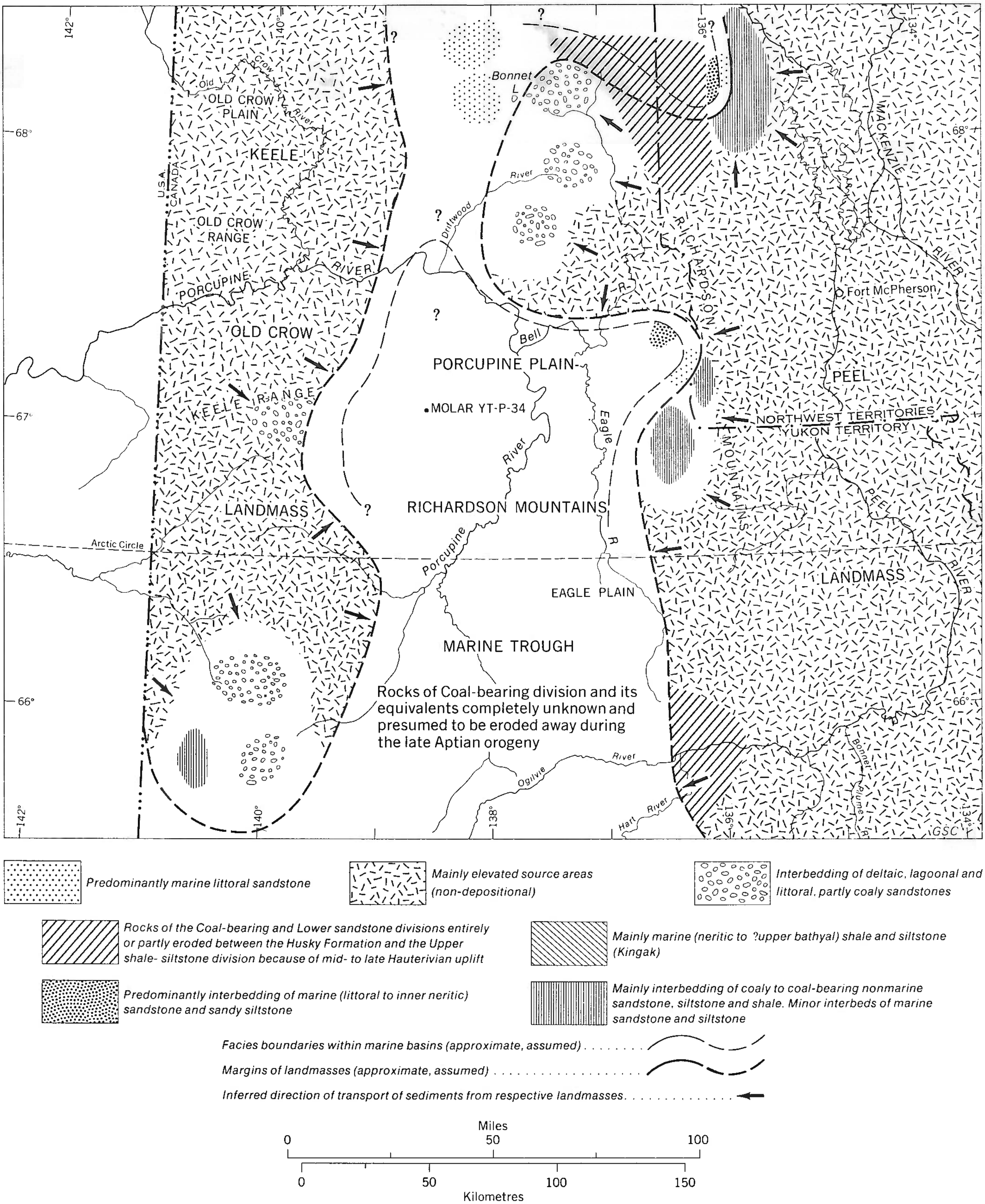

Figure 2. Early to mid-Hauterivian paleogeography (time of the Coal-bearing division and its nonmarine to marine equivalents; e.g. White quartzite and Coal-bearing quartzite divisions, "White sandstone member" of northwestern Ogilvie Mountains, unnamed marine sandstones and siltstones of Bonnet Lake and Keele Range area)

River. South of the section at Latitude 67°35'N and Longitude 136°32'W (*see* Fig. 5), the division appears to outcrop more or less uninterruptedly in a north-south trending belt all the way to the "Pacific Rat River" sections described by Jeletzky (1972b, p. 15).

About 4,200 feet of argillaceous rocks of the Upper shale-siltstone division have been measured in the best known (principal), completely exposed, but locally faulted section situated on the divide just east of the second eastern confluent of Waters River (at approx. 137°00'W Long. and between 67°39'10" and 67°38'15"N Lat.). This thickness is believed to approximate closely the true thickness of the division which appears to range between 3,500 and 4,200 feet between the westernmost known exposures west of Waters River and those on the western side of Bell River. This unusually thick western facies of the Upper shale-siltstone division appears to be subdivisible into two lithological members. The Lower member, which is about 1,750 feet thick in the above-mentioned principal section, consists of a monotonous sequence of black to dark grey, dull to dark bluish grey weathering siltstone. The siltstone is massive to indistinctly bedded, friable to moderately hard, fine rubbly to flaky, recessive, slightly sandy to pure, and mostly micromicaceous. This siltstone is devoid of large concretions and bands of rusty weathering clay ironstone which are so abundant in the ferruginous shale and siltstone of the equivalent Lower member of the division on the eastern flank of the Richardson Mountains (Jeletzky, 1958, p. 10, 56-65; 1960, p. 11, 12). It contains instead some distinctive spindle- to sausage-like concretions (1/2 inch to 4 inches long and up to 1 inch thick) of hard black siltstone and rare, flat (discus-like to angular) concretions (3 to 12 inches) of bright orange weathering ferruginous siltstone ("clay ironstone"). Except for the scarcity or a complete lack of arenaceous fraction and predominantly dark grey to bluish grey colour, the siltstone of the Lower member resembles closely that of the correlative Dark grey siltstone division of the divide area between the headwaters of Bell and Driftwood Rivers (Jeletzky, 1961b, p. 19, 33). The latter division is now considered to represent the more arenaceous, presumably shoreward phase of the facies discussed here of the Lower member of the Upper shale-siltstone division. The Lower member contains very few fossils. Only a few *Lima (Limatula)* ex gr. *consobrina* d'Orbigny, generically indeterminate nuculid pelecypods and *Dentalium*-like shells have been found in it. The extreme rarity of pelecypods and the total absence of belemnites indicate that the member was deposited in an outer neritic (150 feet or deeper) or ?upper bathyal environment.

Although the lower contact of the division is uneven, sharp and obviously erosional in all appropriately exposed sections, no basal conglomerate or accumulation of arenaceous to gritty particles were observed immediately above it. This probably indicates a rapid, regional subsidence of the previously strongly elevated (*see* preceding two sections) area of northern Bell Basin.

The Upper member, which is about 2,365 feet thick in the above-mentioned principal section, is represented by a generally cyclical alternation of variegated siltstone units, 50 to 60 feet thick, including:

1. Siltstone, lithologically identical with that of the Lower member.
2. Siltstone, dull to dark grey, light grey and mottled weathering, moderately sandy, moderately hard and resistant, forms precipitous bluffs and sharp ridges; massive to indistinctly bedded and mostly replete with ramifying to straight worm burrows 1/16 to 1/2 inch in diameter, and sometimes segmented burrows (*Nereites*-like). This extremely bioturbated siltstone contains some calcareous *Dentalium*-like tubes at several levels.
3. Siltstone, black to dark grey, weathering dark brown to rusty, mostly pure; contains common to abundant clay ironstone concretions and bands, friable, weathers flaky and is recessive.
4. Siltstone, dark brownish grey to dark grey, weathers same but in alternating sharply delimited brown and grey lamellae and thin beds; pure to very sandy, ferruginous, micromicaceous; distinctly graded and crossbedded on a small scale within thin to very thin (1/4 inch to 4 inches) recurrent beds some of which exhibit fairly typical Bouma sequence. The very sandy basal parts of the beds are commonly sharply and apparently erosionally delimited from the uppermost parts of preceding beds consisting of pure to slightly sandy siltstone. This distinctly flyschoid siltstone appears to be a deep water (?upper bathyal) turbidite deposited by weak to ?moderate turbidity currents. It is prevalent in the upper part of the member comprising the bulk of its uppermost 700 to 750 feet (*see* Fig. 3).

Rare interbeds, up to 15 feet thick, of poorly sorted and rounded, lithic (greywacke-like), fine- to medium-grained, gritty and fine pebbly, unfossiliferous sandstone and rare units, 50 to 150 feet thick, of black, pure, friable shale with or without clay ironstone concretions and bands occur in the Upper member. Contact with the overlying Upper sandstone division is gradational.

No diagnostic fossils were found in the western, presumably deep water (mid-basin) facies discussed here of the Upper shale-siltstone division. However, its equivalence with the reliably dated, more shallow water (inner to ?outer neritic) facies of the division exposed on the eastern flank of the Richardson Mountains (Jeletzky, 1958, p. 11-15; 1960, p. 13) is indicated by its stratigraphic position between the reliably dated rocks of the Lower sandstone and Upper sandstone divisions.

The section of the Upper shale-siltstone division studied east of Bell River at the point 6.5 miles south-southeast of the confluence of Bell and Little Bell Rivers (Fig. 5) represents a different facies. These beds are lithologically similar to, and of comparable thickness (800 to 1,000 feet, est.) to that encountered in sections previously measured on the "Pacific Rat River" and at the

Figure 3. View of the uppermost 1,460 feet (approx.) of the Upper member of Upper shale-siltstone division (U. sh.) and the lower 800 feet (approx.) of the Lower member of Upper sandstone division (U. ss.) exposed in the principal section of their western facies on the northern face of an unnamed mountain (approximate location 67°37'15"N Lat. and 136°59'15"W Long.). The approximate position of the contact between the divisions is marked by a stippled line. Sharp rocky ridge closest to the camera is composed of fine to medium grained greywacke, about 15 feet thick, situated 1,371 to 1,356 feet stratigraphically below the top of the Upper shale-siltstone division. View approximately due south with rocks dipping away from the camera at moderate (in the foreground) to low (in far background) angles.

Figure 4. Close up of uppermost beds of the Upper shale-siltstone and basal beds of the Upper sandstone divisions in sheer bluffs situated 400 to 500 feet (est.) east of the left margin of figure 3. Lettering as in figure 3. The paler, banded intervals of the Upper sandstone division are the sandstone beds and units. The four sandstone units of the Upper sandstone division exposed are, respectively, 27, 22, 31, and 60 feet thick in the principal section (ascending order). The intervening, uniformly and darker grey coloured intervals are composed of siltstone. View generally due east (along the strike) from a station situated about one-third up in the section of the Upper sandstone division shown in figure 3 on top of the chimney-like ravine near the left margin of the photograph.

Figure 5. View of the eastern facies of the Upper shale-siltstone and Upper sandstone divisions exposed in the eastern slope of a nameless high ridge situated about 6.5 miles south-southeast of the confluence of Bell and Little Bell rivers (at approx. 67°39'30"N Lat. and 136°33'45"W Long.). View north-northeast (i.e. toward the point of confluence) from a station on top of the Lower sandstone division (L. ss.). Other lettering as in figure 3. All rocks dip obliquely to the left (i.e. westward) at low angles. Upper shale-siltstone division is between 800 and 1,000 feet thick (est.) in contrast to the much greater thickness of the western facies shown in figure 3.

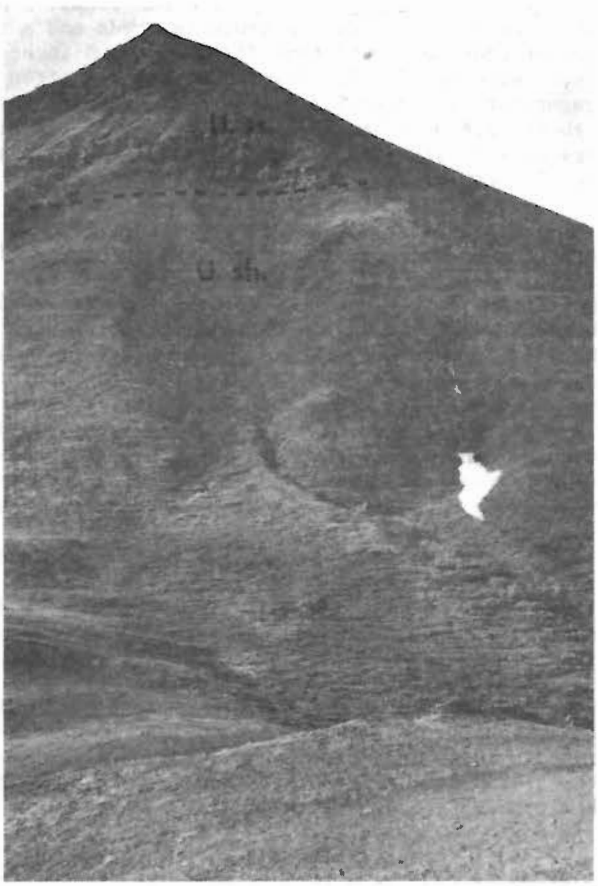

Figure 3

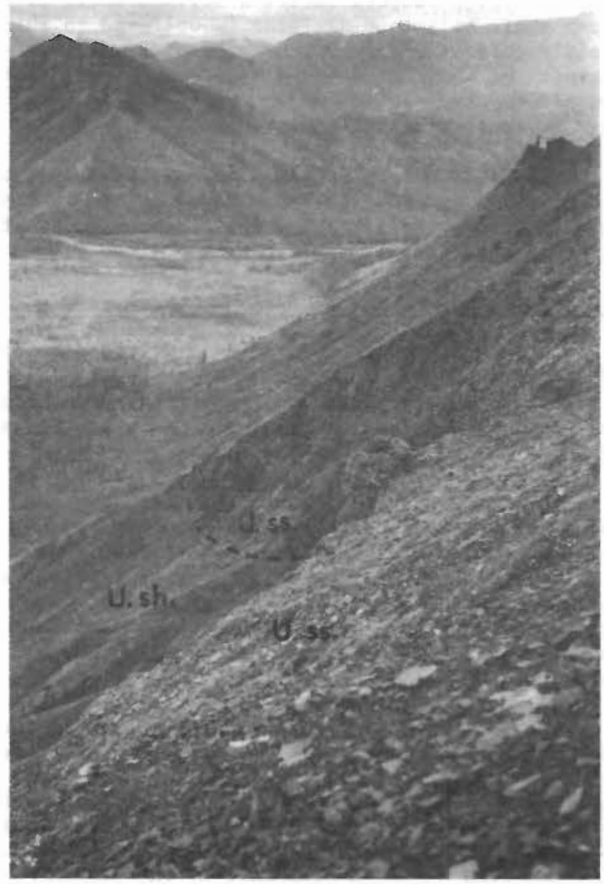

Figure 4

Figure 5

eastern headwaters of Rock River (Jeletzky, 1972b, p. 7, 8, 15).

The thick western facies described above of the Upper shale-siltstone division is believed to thin rapidly east of Bell River because of a relative scarcity of sediment derived from western and eastern source areas in the mid-basin to the deeper eastern shelf zones of the trough.

Like the western facies, the eastern facies of the division did not yield any diagnostic fossils in the northern Bell Basin and is identified by its lithology and stratigraphic position alone.

Upper sandstone division

This sequence outcrops in exactly the same parts of the northern Bell Basin as does the Upper shale-siltstone division. It forms sharp to rounded ridges flanking broad valleys and depressions underlain by the Upper shale-siltstone division.

The lateral facies changes of the Upper sandstone division are similar to those of the Upper shale-siltstone division; it is thick (at least 2,367 feet in the above-mentioned principal section) and predominantly argillaceous west of Bell River, but becomes relatively thin (400 to 500 feet, est.) and predominantly arenaceous east and southeast therefrom.

The thick and silty (containing more siltstone than sandstone) western facies of the division can be subdivided into two lithological members. The Lower member is estimated to be between 850 and 900 feet thick in all sections studied. It is about 865 feet thick in the best exposed section of this facies measured on the divide east of the second eastern confluent of Waters River approximately between 137°00' and 136°58'W Longitude and between 67°38'15" and 67°37'30"N Latitude (Fig. 3). This section represents a continuation of the previously mentioned principal section of the western facies of the Upper shale-siltstone division and is designated herewith the principal section of the western facies of the Upper sandstone division.

The Lower member consists of a cyclical interbedding of sandstone units (10 to 240 feet thick) with siltstone units (18 to 170 feet thick). The siltstone is more common than the sandstone in all sections studied, their approximate ratios (mostly estimated) fluctuating from 10:7 to 10:8. In the above-mentioned principal section, the Lower member includes about 505 feet of siltstone and 360 feet of sandstone. The sandstone is predominantly light grey to buff, weathers buff, orange, or rust-coloured, very fine (commonly grading into very sandy siltstone) to (rarely) fine grained, quartzose but with a variable (10 to 20% est.) admixture of glauconite grains, limonite grains and dark minerals (?chert). It is noncarbonaceous to slightly carbonaceous, hard and dense, fairly porous to non-porous; mostly thinly and well bedded, crossbedded and ripple-marked but with a considerable ratio of massive to thickly and indistinctly bedded sandstone. The thinly bedded varieties commonly contain numerous partings, laminae and interbeds (1/2 inch to 6 inches thick) of hard to friable, sandy to pure siltstone. The sandstone is resistant and forms a series of precipitous to vertical bluffs (Fig. 4).

Few to very few marine pelecypods occur in a number of thinly bedded to laminated beds and a few beds of coquinoid sandstone (1/2 inch to 3 inches thick) were noted. The disarticulated and often fragmentary preservation of most pelecypods combined with the presence of starfish (and brittle starfish) suggest a fairly high energy, stenohaline, open marine (?inner neritic) depositional environment.

The siltstone varies from mottled light and dark grey or dull brown to dark grey or black. The lighter coloured varieties are for the most part moderately to very sandy, moderately to very hard, thinly and well bedded to laminated, crossbedded and/or ripple-marked. They commonly grade into and may be difficult to differentiate from the very fine grained sandstone. The dark grey to black varieties are normally friable to very friable, feebly sandy to pure, indistinctly bedded to massive (mudstone), more or less bioturbated and locally rich in worm burrows and hieroglyphic markings. This fact, combined with the rare to very rare presence of articulated marine pelecypods, starfish, and brittle starfish, suggests a moderately high to low energy, stenohaline open màrine (inner to ?outer neritic) depositional environment.

The hard, sandy, commonly flinty siltstone varieties are resistant and tend to form precipitous to vertical bluffs, while the moderately hard to friable, slightly sandy to pure varieties are recessive and form moderately steep slopes and/or benches between the bluffs (Fig. 4).

A unit, about 400 to 450 feet thick of the above-described, hard to very hard, mostly flinty sandstone and sandy siltstone forms the topmost part of the Lower member and is largely responsible for its forming prominent, sharp-crested ridges and summits (Fig. 3).

The Upper member consists predominantly of siltstone but with the moderately hard to friable, mudstone-like varieties being more common than the hard to very hard, thinly bedded to laminated, crossbedded and ripple-marked sandy varieties. Only a few 1- to 10-foot thick beds and one 150- to 180-foot thick unit of very fine grained sandstone, lithologically similar to that of the Lower member, have been observed in the middle part of the Upper member. This results in the latter forming moderately steep to gentle slopes where the rock is poorly exposed.

The Upper member contains a rare to moderately common fauna of marine pelecypods at many levels. Some poorly preserved starfish and brittle starfish also were found. The lithology and fauna suggest the same depositional environment as for the corresponding rock types of the Lower member.

The Upper member gradationally overlies the uppermost resistant and bluffy part of the Lower member. The top is faulted in the longest and best exposed (principal) section where the member measured about 1,500 feet thick. The contact with the overlying ?early (?or earliest late) Albian argillaceous rocks of the *Sonneratia* (sensu lato) n. sp. A Zone (discovered and studied by F.G. Young; unpublished fossil identifications of the writer) was not seen in any of the sections studied.

Only the Lower member of the western facies of the Upper sandstone division resembles lithologically the typical Upper sandstone division of the eastern slope of Richardson Mountains (Jeletzky, 1958, p. 10, 11, 75-78; 1960, p. 13-17), "Pacific Rat River", and eastern headwaters of Rock River (Jeletzky, 1972b, p. 8, 15, 16). However, the diagnostic Aptian *Aucellina* ex gr. *aptiensis-caucasica* (Jeletzky, 1964, Pls. XVIII, XX) ranges through the Lower member and to the level 615 feet stratigraphically below the faulted top of the Upper member in the principal section. This fact and the absence of index fossils of the oldest known Albian zone [i.e. *Sonneratia* (sensu lato) n. sp. A Zone which was found elsewhere in the area by F.G. Young] in the uppermost 615 feet of the Upper member suggest a late Aptian age for these beds and their equivalence with the upper part of the lithologically typical (i.e. arenaceous) Upper sandstone division of the eastern Richardson Mountains. The lithology of the western facies of the division is, furthermore, similar to that of the Blow Pass-Bonnet Lake sections where similarly thick rocks known to be equivalent with the Upper sandstone division of the eastern Richardsons according to their fossil content (Jeletzky, 1972a, p. 208, 209; 1972b, p. 33, 34) include more siltstone than sandstone. The thick, silty facies of Blow Pass-Bonnet Lake and northern Bell Basin appears to represent two segments of the same (presumably contiguous) belt of mid-basin facies of the Upper sandstone division.

The following conclusions about the thickness and lithology of the eastern facies of the Upper sandstone division are rather tentative, being based on a somewhat hurried study of a single section (*see* Fig. 5) situated 6.5 miles south-southeast of the confluence of Bell and Little Bell River (at approx. 136°33'45"W Long. and 67°39'30"N Lat.) supplemented by an analysis of aerial photographs of the adjacent area. In this section, the Upper sandstone division (Fig. 5) was estimated to be only from 400 to 450 feet thick. It consists predominantly of a uniform sequence of very fine grained, silty sandstone lithologically similar to that of the previously measured sections on the "Pacific Rat River" and in the eastern headwaters of Rock River (Jeletzky, 1972b, p. 8, 9, 15, 16). The division appears to be overlain (distant observations only) by several hundred feet of shale and siltstone lithologically similar to the Albian shale-siltstone division of the other two areas mentioned above. No fossils were found in the Upper sandstone division of the section at 136°33' 45"W Longitude and 67°39'30"N Latitude so that the identification and correlation of the division and the overlying argillaceous rocks proposed here is based on their lithology and stratigraphical position only. If the above conclusions are correct, the Upper sandstone division of the area east of the confluence of Bell and Little Bell Rivers is similar to that of the more southerly areas of the western Richardson Mountains and rather unlike that of the eastern slope of the White Mountains (*see* below in Area 8).

Area 7: Western headwaters of Bell River

Husky Formation (lower tongue)

An additional study of the basal part of section 5 discussed previously (*see* Jeletzky, 1961b, p. 31, 32) revealed the presence of a thick siltstone unit, about 580 feet thick (measurement approximate only), stratigraphically below (contact covered) bed 1 of the section. The siltstone is dark grey to dark brownish grey, weathers dark brown-grey with rust-coloured specks and spots, pure to slightly sandy, micromicaceous, fairly friable to moderately hard; weathers fine to very fine rubbly and is recessive with massive to thin but indistinct and corrugated beds. Darker coloured, friable interbeds are commonly strongly bioturbated and replete in fucoid markings and various worm burrows including segmented, *Nereites*-like types. Early forms of *Buchia mosquensis* (von Buch) or ?late forms of *Buchia concentrica* (Sowerby) (sensu lato) occur at several levels locally forming thin pods or beds (1/4 to 1 inch) of coquinoid siltstone. A unit of sandstone, about 60 feet thick, lithologically similar to that of unit 1 of section 5 (*see* Jeletzky, loc. cit.) as redescribed below, forms the visible base of the formation. The base of the sandstone unit is covered and appears to be cut off by a major 360°-trending subvertical (?normal) fault.

Unnamed Upper Jurassic sandstone (?tongue)

The basal 180 feet of unit 1 of section 5 (*see* Jeletzky, 1961b, p. 31) appear to be composed predominantly of dull brown to grey, commonly extremely rusty weathering, very fine grained, quartzose but silty, partly ferruginous, hard to very hard and dense, quartzite-like (little or no visible porosity) sandstone. The rock is thinly to medium and well bedded to laminated, abundantly crossbedded and ripple-marked and is interbedded with considerable siltstone as described by Jeletzky (1961b, p. 31). *Buchia mosquensis* (von Buch) (?advanced forms) were collected on fresh, apparently locally derived float 80 feet above the visible base of the unit. Unit 1 as a whole probably is more appropriately assigned to the attenuated offshore (inner neritic) facies of the Unnamed Upper Jurassic sandstone than to the Husky Formation, particularly since the 40-foot wide covered interval (i.e. unit 2; *see* Jeletzky, 1961b, p. 31) possibly may harbour a strike fault of major displacement causing the disappearance from the outcrop of an unknown upper part of the Unnamed Upper Jurassic sandstone.

Area 8: East flank of White Mountains

Arenaceous facies of the Upper shale-siltstone division

An additional investigation of the poorly understood upper part of the previously studied (Jeletzky, 1972b, p. 20, 21) section across a small, strongly faulted syncline on the eastern flank of White Mountains (at approx. 67°55'N Lat. and 136° 27'W Long.) necessitates the above reassignment of beds described tentatively as shale equivalents of the Lower sandstone and Coal-bearing divisions (Jeletzky, 1972b, p. 20, 21). The division consists of (in ascending order):

1. Sandstone, silty, light brownish grey, weathers brown to rust, very fine grained, fairly well rounded and sorted according to grain size, quartzose, non-carbonaceous to feebly carbonaceous, some bright orange limonite grains and those of a dark mineral (?chert), hard to very hard and quartzite-like to true quartzite. This sandstone forms a 10- to 20-foot high escarpment across the slope. It is massive to indistinctly and medium bedded, apparently devoid of ripple-marks and crossbedding except in one coarse-grained bed. The unit contains numerous lenticular to persistent 4- to 12-inch thick bands and 5- to 10-foot long pods of strongly ferruginous, rust- to orange-weathering, hard, very sandy siltstone to very fine grained sandstone ("clay ironstone"). At least one 1.5- to 2-foot persistent interbed of coarse-grained, gritty sandstone with small pods of fine grit was noted. The contact with the underlying *Buchia volgensis* Jeletzky, 1964 (non Lahusen, 1888)-bearing, upper part of the Husky Formation (Jeletzky, 1972b, p. 19) is sharp, uneven and evidently erosionally disconformable. No basal conglomerate or accumulation of coarse sand or grit particles were seen, however, at this contact. The upper contact is gradational. Rare marine fauna occurring scattered throughout the unit's thickness includes:

    Simbirskites (Simbirskites) ex gr. *kleini* (Neumayr and Uhlig)

    Acroteuthis (Boreioteuthis) ex gr. *impressa* (Gabb)

    Dicraniodonta ex gr. *dowlingi* McLearn

    Astarte n. sp. aff. *A. cantabrigiensis* Woods

    other nondiagnostic pelecypods

   The unit is 27 feet thick.
2. Shale, black to dark grey and bluish tinged, fissile, fairly friable, weathers flaky to earthy and is recessive. Contains some scattered, rounded concretions, 2 to 8 inches across, of orange-weathering, hard clay ironstone. Also present are some 1- to 5-foot interbeds of dark grey, sandy siltstone near the base and the top. Rare *Lima (Limatula)* cf. *consobrina* (d'Orbigny) occurs at several levels. Thickness of the unit is 165 feet.
3. Sandstone, lithologically similar to that of unit 1 but less quartzose and containing 15 to 20 per cent (est.) of orange limonite grains and 10 to 15 per cent (est.) of dark mineral (?coaly and/or ?chert) grains. The sandstone is hard and dense though not quartzite-like and forms an escarpment, 25 to 35 feet high, across the slope. The lower contact appears to be abrupt but is poorly exposed whereas the upper contact is covered. Scattered mid-Early Cretaceous (?Hauterivian or Barremian) fossils include:

    Pleuromya n. sp.

    fragmentary *Inoceramus* sp. indet.

    Dicraniodonta sp. indet.

   No *Buchia* was found and the previously made tentative identification of *Buchia* cf. *volgensis* Jeletzky, 1964 (non Lahusen, 1888) (Jeletzky, 1972b, p. 20) is withdrawn herewith. Thickness of the unit is 55 feet (approx.).
4. Siltstone, friable, dark grey to black when fresh, weathers same or dull grey, fine rubbly to flaky, recessive; more or less sandy throughout and contains some concretions of hard clay ironstone as in unit 2. The unit appears to grade into overlying and underlying units through zones, 35 to 40 feet thick, of harder, paler, very sandy siltstone. No fossils were seen. The thickness is 730 feet.

The presence of a late Hauterivian *Simbirskites (Simbirskites)* ex gr. *kleini* fauna in unit 1 indicates the assignment of units 1 to 4 to the Upper shale-siltstone division. A major hiatus corresponding to all of the Coal-bearing and Lower sandstone divisions and to the uppermost beds (i.e. the sandy siltstone beds of the Upper member; Jeletzky, 1958, p. 4) of the Husky Formation must occur between the lower contact of unit 1 and the underlying upper part of the Husky Formation. This fact, together with the occurrence of an arenaceous facies of the Upper shale-siltstone division indicate that the eastern slope of White Mountains formed part (presumably the northern flank) of the same crestal zone of the mid-Valanginian to mid-Hauterivian Aklavik Arch as the previously discussed northern Bell Basin (*see* Area 6 and Fig. 2). Because of the erosion of the Husky Formation, it is not known whether or not the eastern slope of the White Mountains was lifted above sea level in the mid-Valanginian to mid-Hauterivian time and formed part of the same source area as the northern Bell Basin. This uncertainty is indicated in figure 2. However, the predominantly inner to outer neritic, arenaceous facies of the overlying Upper shale-siltstone division suggests that it may have been so. This facies of the division indicates a much shallower water environment than its northern Bell Basin counterpart and the sediment must have been derived from an adjacent southern and/or southeastern source area (?a residual island within the submerged crestal zone of the arch). This lesser subsidence of the eastern slope of White Mountains in the Hauterivian-Barremian time in comparison with the northern Bell Basin suggests that it was at least as strongly (or more strongly) elevated in the mid-Valanginian to mid-Hauterivian time as the latter area. These relationships indicate that the Rat Uplift of the mid-Valanginian to mid-Hauterivian Aklavik Arch extended considerably farther north and northwest than previously believed. Its extension into the northeastern White Mountains is consistent with the erosional truncation or the shallow water, nearshore facies of the Lower sandstone, White quartzite and Coaly quartzite divisions in adjacent parts of the Fish River-Cache Creek area noted by Young (1972, p. 230; 1973, p. 31). This area must have formed part of a broad shelf-like, eastern zone of the Porcupine Plain-Richardson Mountain Trough in mid-Valanginian to mid-Hauterivian (and in part in the late Hauterivian to Barremian) time. Throughout this time, the deeper, mid-basin zone of the trough must have been situated farther west within the present headwaters of Rapid Creek-Blow Pass area (*see* Jeletzky, 1971, p. 208, 209; 1972a, Figs. 2, 3; 1972b, p. 30-34, Figs. 2,3; this report, Fig. 2) and south therefrom in the areas now occupied by Porcupine Plateau and eastern Keele Range.

Upper sandstone division

The following conclusions concerning the thickness and lithology of the Upper sandstone division of northeastern White Mountains are tentative, being based on the study of a single, considerably faulted section which did not yield any diagnostic Aptian fossils. The conclusions are based, therefore, only on the lithology and stratigraphic position of the rocks concerned. The upward sequence of these rocks is as follows.

The Lower sandstone member is about 435 feet thick and gradationally overlies unit 4 of the Upper shale-siltstone division. It consists of grey, buff or dirty white sandstone commonly weathering light brown, dull yellow or orange. The sandstone is almost exclusively fine to very fine grained, quartzose to orthoquartzitic, with or without an appreciable (up to 20%, est.) admixture of limonite and dark mineral grains. Non-carbonaceous to slightly carbonaceous sandstone alternates irregularly with a somewhat lesser amount of strongly carbonaceous to coaly sandstone locally containing coaly fragments (1/4" to 1") and specks. The sandstone is mainly well sorted as to grain size with subrounded to rounded grains predominating. The structure varies from moderately porous to true quartzitic and very hard and dense varieties alternate with moderately hard ones. However, all varieties are resistant and ridge-forming; massive to indistinctly and thickly bedded varieties alternate irregularly with the fine to medium and well bedded to laminated varieties. The latter varieties are, in places, extremely crossbedded and ripple-marked on a medium to large scale; these exhibit an alternation of dark and light grey laminae due to alternating layers of coaly and less coaly layers. The member contains only a few, indeterminate, ?marine pelecypods. The topmost 5 to 6 feet of the member are composed of a mottled dull to greenish grey, dark brown to wine red, speckled sandstone that weathers mottled brown, rust and orange. This extremely ferruginous (common limonitic weathering) sandstone is fine to medium grained, with an admixture of coarse grains and gritty particles; the grains are mostly subangular to angular. This moderately quartzose sandstone is distinctly enriched with lithic fragments and contains a considerable admixture of limonite and dark mineral (?chert) grains. It is extremely carbonaceous to coaly throughout and contains an abundance of irregularly shaped to rounded inclusions (from 1/4" to 5") of hard, orange-weathering clay ironstone or very ferruginous siltstone or sandstone. The sandstone is hard and dense but not quartzite-like. The upper contact is extremely sharp and uneven and has an excessively but irregularly pitted (?burrowed) appearance.

The lithological and sedimentological characteristics of the member as described above suggest a lagoonal to outer bar depositional environment with a supratidal climax ended by an abrupt subsidence of the area.

The Lower siltstone member is 405 feet thick and lithologically similar to unit 4 of the underlying Upper shale-siltstone division. Only a few nuculid pelecypods were found in this apparently outer neritic deposit which grades upward into the Middle sandstone member.

The Middle sandstone member is about 300 feet thick (approx.) and consists almost exclusively of thinly bedded to laminated, extremely crossbedded and ripple-marked sandstone lithologically similar to the corresponding varieties of the Lower sandstone member. The bedding surfaces of this sandstone are commonly covered with silt grains or mica flakes. The sandstone is interbedded and interlaminated with varying, locally major (up to 40% in uppermost 100'), quantities of 2-inch to 2-foot beds, layers, laminae and partings of sandy siltstone as in the uppermost beds of the underlying Lower siltstone member. Bedding surfaces of sandstone and siltstone commonly are covered by various hieroglyphic markings and worm burrows. Variegated, long-ranging (generally Aptian-Albian), shallow water, marine pelecypods occur at several levels either scattered or forming coquinoid siltstone layers and pods up to 4 inches thick. This fauna is rare or absent in the intervening beds of intensively crossbedded and ripple-marked sandstones probably because of their high energy, intertidal to supratidal depositional environment being inimical as a habitat. The lithology of the siltstones, the shallow water nature of their fauna and the single-valved often fragmented preservation of most shells suggest their somewhat quieter (?lagoonal) but nevertheless upper littoral depositional environment.

The Upper siltstone member appears to overlie the middle sandstone member conformably and is estimated to be some 2,000 feet thick in spite of generally poor exposures and considerable faulting. The siltstones of the member are dark grey to black both on fresh and weathered surfaces, normally pure and micromicaceous, fairly friable to moderately hard and weather fine rubbly to flaky and are recessive. A considerable number of rounded concretions (4" to 12") of hard, orange-weathering clay ironstone and very hard, dark grey siltstone (including cannonball concretions) and 3- to 8-inch bands of the same clay ironstone occur at variable intervals throughout the member's thickness. Between 250 and 450 feet, the member contains several 5- to 25-foot thick beds of fairly hard, slightly to moderately sandy siltstone intercalated with dull brown-grey, very fine grained, quartzose sandstone that is extremely crosssbedded on a small scale (current type). Very rare, scattered chert pebbles (1/8" to 1/2" across) occur in these interbeds. No fossils were seen, except at the 200-foot level where a clay ironstone band has yielded *Pecten (Entolium)* cf. *irenense* McLearn, *Tancredia* cf. *stecki* McLearn, *Nucula* sp. indet. and other long-ranging pelecypods of general Aptian-Albian affinities. A general neritic, possibly outer neritic depositional environment is suggested for the member.

The Upper sandstone member forms the visible top of the sequence. It has an estimated exposed thickness of 400 feet but the top is covered everywhere. This member is lithologically and presumably environmentally identical with the Middle sandstone member and contains the same variegated fauna of long-ranging, shallow water, marine pelecypods.

The rocks described above and assigned to the Upper sandstone division appear to be considerably thicker (about 3,500 feet) than those at any other known section of the division in the Porcupine Plain-Richardson Mountain Trough. An additional few hundred feet of the division may be concealed stratigraphically above the covered top of the Upper sandstone member in the badly faulted axial part of the syncline centred at approximately 136°23'W Longitude and 67°55'N Latitude in the valley of the north-south trending branch of Fish Creek (*see* Bell River map-sheet; scale 1:250,000).

The Upper sandstone division of northeastern White Mountains closely resembles lithologically the considerably thinner sections of the division exposed at the headwaters of Rapid Creek (Jeletzky, 1971, p. 208, 209; 1972b, p. 33, 34) which also consist of three sandstone members separated by two siltstone members. The Upper sandstone division of northeastern White Mountains is similar also lithologically to the thick, argillaceous western facies of the division outcropping in the northern Bell Basin (*see* under Area 6). The three sections resemble each other in containing considerable sandstone in the lower parts and in being predominantly argillaceous in the upper parts.

However, in spite of these similarities with the sections of the division exposed in the Blow Pass-Bonnet Lake and northern Bell Basin areas, the Upper sandstone division of northeastern White Mountains does not seem to form part of the mid-basin belt of the Aptian trough but appears to lie east of it in the proximity of some local southern or southeastern source area (?a residual island on the crestal zone of Aklavik Arch rather than a northwest-trending promontory of the Peel Landmass). This is suggested in particular by the apparently restricted inner littoral, outer bar and lagoonal origin of all sandstone members of the division in the northeastern White Mountains, in contrast to the deeper water, open marine origin of the equivalent sandstone members in the Blow Pass-Bonnet Lake (including the headwaters of Rapid Creek) and northern Bell Basin areas. Large ?tectonically caused fluctuations in the depth of the Upper sandstone division sea of northeastern White Mountains are indicated by the intercalation of very shallow water to supratidal (i.e. beach) sandstones with neritic siltstones. The area must have remained just as anomalous paleogeographically and structurally in the Upper sandstone division (Aptian) time as it was in the Upper shale-siltstone (late Hauterivian and Barremian) time probably because of its position on the northern slope of Aklavik Arch. More work must be done to elucidate the reasons for this anomalous behaviour.

Area 9: Blow Pass-Bonnet (=Bonny) Lake

Kingak Formation and Unnamed Upper Jurassic sandstone

An extremely important section of the Kingak Formation (restricted) and the Unnamed Upper Jurassic sandstone was measured across the valley (i.e. in the west-east direction at approximately 68°17'45"N Lat. and between 138°06'30" and 138°05'30"W Long.) of a north-flowing confluent of the southwestern branch of Blow River. The upward sequence is as follows:

Kingak Formation (restricted)

1. Irregularly interbedded, superficially similar, pure siltstone and silty shale. Both rock types are dark grey and friable; they weather dull to ash-grey, fine flaky to earthy and are recessive. A few interbeds (1/2" to 3' thick) and some rows of irregularly rounded, lenticular (discus-like) concretions (4" to 18" thick and 1' to 4' long) of siltstone occur at intervals. These are dull grey, weathering light grey to buff, pure to very sandy (locally grading into very fine grained, silty sandstone) and hard to very hard. One 32-foot thick member of moderately hard, dark to blackish grey, brown-grey weathering sandstone occurs between 297 and 329 feet above the visible base. This sandstone is very fine grained, silty (sublithic to ?lithic), and thinly to medium but indistinctly bedded.

   The basal 300 feet exposed are of an early Bajocian (=Aalenian) and ?Toarcian age because a juvenile ammonite closely resembling *Pseudolioceras m'clintocki* (Haughton) was found at the 258-foot level and *Pseudodicoelites* sp. was found in the sandstone member at the 298- to 303-foot level. Higher beds are of a later Bajocian to Bathonian age as *Pachyteuthis* (?new subgenus) n. sp. A (*see* under Area 3 of this report) and *Inoceramus (Retroceramus)* aff. *menneri* Koshelkina were found between 350 and 370 feet and another fauna including *Inoceramus (Retroceramus)* ex aff. *retrorsus* Keyserling and an *?Arctocephalites*-like cadoceratid ammonite was found at about the 495-foot level. All of the above age determinations are based on the tentative field identifications of the writer. In spite of being predominantly argillaceous, the unit apparently was deposited largely or ?entirely in an inner neritic (above 150 feet) environment. The base is covered and faulted about 250 yards west of the above-mentioned confluent and the top is covered on its western bank. The thickness visible is 585 feet (approx.).

The unit appears to be largely or completely missing due to faulting in the middle part of the previously measured (Jeletzky, 1972b, p. 26) section of the Kingak Formation situated just southeast of Barn Mountains. The suggested thickness of this section accordingly should be increased to at least 1,350 feet.

2. A completely covered interval on the eastern bank of the confluent apparently corresponding to about 550 feet of the section and concealing the Callovian and early Oxfordian part of the Kingak Formation exposed in the upper part of the section situated just southeast of Barn Mountains (Jeletzky, 1972b, p. 26).

3. Siltstone, dull to dark grey, weathers dull to brownish grey or buff, flaky to chippy, recessive, pure to sandy, micromicaceous. The unit includes some (?minor) interbeds, 0.5 to 4 inches thick, of dull grey to buff, very fine grained, quartzose but more or less silty, apparently non-carbonaceous, thinly bedded to laminated sandstone. A few *Buchia (Anaucella)* cf. *concentrica* (Sowerby) were found in fresh, locally derived float between 120 and 130 feet. Both contacts are covered but the visible thickness is 200 feet (approx.).

Unnamed Upper Jurassic sandstone

4. Siltstone, as in unit 3 but interbedded with a considerable (?almost equal) amount of hard, very sandy siltstone and very fine grained, quartzose, quartzite-like, thinly and well bedded to laminated sandstone. These two rock types form laminae, layers, and thin (1" to 6") to very thick (up to 10') beds. Outcrops are patchy and poorly exposed, no fossils were seen, the upper contact is covered and the visible thickness is 180 feet (est.).

5. Sandstone, light grey, dull grey, or brown-grey; weathering buff, or dull brown to rust-coloured. Rock is fine to very fine grained, fairly quartzose but with 5 to 15 per cent of orange limonite grains and the same ratio of a black mineral (?chert). It is mainly non-carbonaceous to feebly carbonaceous but contains some very carbonaceous to coaly laminae, layers and interbeds up to 10 feet thick. Subrounded to rounded grains predominate and sorting as to grain size is mostly good. Rock is hard and dense but not quartzite-like or true quartzite for the most part; it is resistant and underlies the crestal part of the more than 2,000-foot high, sharp, almost straight, north-south trending ridge situated about 0.5 mile east of the above-mentioned confluent (*see* Blow River map-sheet; scale 1:250,000). The unit is predominantly thinly and well bedded to laminated and intensively crossbedded to ripple-marked on a large scale; the carbonaceous to coaly interbeds tend to be medium to thinly but indistinctly bedded; they may contain numerous worm burrows and some subvertical coaly tubes (?plant rootlets). Very few indeterminate marine pelecypods were found except at about the 100-foot level where *Pecten (Entolium) nummulare* Eichwald, *Lima (Limea)* aff. *blackei* Cox, and poorly preserved, generically indeterminate belemnites occur. No *Buchia* were seen.

The bulk of the unit was probably deposited in a fairly high energy, upper littoral (including supratidal) environment but the carbonaceous to coaly, indistinctly bedded sandstones with ?plant rootlets may be outer bar or lagoonal deposits. The upper contact is covered and the visible thickness is 345 feet.

Husky Formation

6. Shale or siltstone, dark brown to dark grey (only weathered rock seen), friable and flaky to earthy. No fossils were seen. The upper contact is covered on the eastern side of the above-mentioned ridge and the formation appears to be faulted against the upper Aptian to Lower Albian flysch (Jeletzky, 1971, p. 209, 210) which outcrops extensively farther to the east.

Another section of the uppermost Kingak Formation (restricted) and Unnamed Upper Jurassic sandstone was measured from west to east across the sharp ridge (more than 2,500 feet high), situated 0.5 to 1.5 miles west of the traversed part of the above-mentioned confluent of the southwestern branch of Blow River (centred at 138°09'W Long. and 68°17'30"N Lat.). The much thicker Unnamed Upper Jurassic sandstone of this section is subdivisible into two lithological members.

The Lower member is approximately 840 feet thick and consists of a cyclical alternation of four 40- to 80-foot thick members (totalling 235') of resistant, ridge-forming sandstone with four 35- to 450-foot thick members (totalling 605') of friable to moderately hard, recessive siltstone.

The sandstone is mainly dark grey or mottled light and dark grey, weathers to dull grey with orange specks or to orange and brown, is invariably fine to very fine grained, hard and dense to only moderately hard, in places quartzite-like to true quartzite, mostly poorly sorted and rounded, most grains being subangular to (more rarely) angular. The lithology varies from quartzose to lithic (greywacke-like). The latter varieties may contain up to 30 per cent (est.) of orange limonite grains, black mineral (?chert) grains, and lithic fragments combined. Some lithic varieties contain 5 to 20 per cent (est.) of white ?kaolinized feldspar (?or white chert). Carbonaceous to coaly sandstones are common. They are characteristically indistinctly and irregularly bedded, moderately to strongly bioturbated, locally contain many worm burrows and subvertical coaly tubes (?plant rootlets), and contain few or are devoid of crossbeds and ripple-marks. Crossbedding and ripple-marks are scarce also in the non-carbonaceous to slightly carbonaceous, thinly bedded and well bedded sandstones except locally in the upper parts of the members. Contacts with the underlying and overlying siltstone members are mostly covered or poorly exposed but, where visible, appear to be gradational. The member overlies the Kingak Formation conformably and apparently gradationally. The shale of the latter includes at least one 25-foot thick interbed of the ridge-forming sandstone lithologically similar to those of the Lower member some 300 feet below the assigned top.

Fossils generally are absent. However, rare *Buchia (Anaucella)* ex gr. *concentrica* (Sowerby) occur in the basal sandstone unit of the member and a few shells including the early forms of *Buchia (?Anaucella)* ex gr. *mosquensis* (von Buch) of late to mid-Kimmeridgian age occur in the fourth sandstone unit, 525 to 450 feet below the top.

The siltstone is black to dark grey, pure to sandy, commonly micromicaceous and contains some carbonaceous to coaly interbeds. It is friable to moderately hard, weathers fine chunky to flaky and is recessive. Outcrops are mostly patchy and poorly exposed and no fossils were seen.

The rocks of the Lower member are believed to have been deposited mainly in a lagoonal to deltaic environment with only a few minor interbeds of stenohaline, upper littoral facies.

The Upper member is about 620 feet thick and consists of resistant sandstone underlying most of the above-mentioned ridge. The sandstone includes the same varieties as the equivalent unit 5 of the preceding section. However, the carbonaceous to coaly, medium to thinly but indistinctly bedded varieties poor in or completely lacking in crossbedding and ripple-marks are prevalent. In contrast to the preceding section, the relatively rare, thinly and pronouncedly bedded to laminated, crossbedded and ripple-marked varieties tend to be carbonaceous to coaly and to feature an alternation of sharply delimited dark and light grey (correspondingly more and less carbonaceous or coaly) lamellae, layers and thin beds with the bedding planes covered with silt particles or mica flakes. The indistinctly bedded varieties may contain abundant worm burrows and subvertical coaly tubes (?plant rootlets), some limonite-filled mud cracks were noted also. Marine fossils are rare and have been found only at two or three levels in the lower 270 feet of the member where the non-carbonaceous, intensively crossbedded and ripple-marked, presumably upper littoral sandstones are more common. No fossils were seen higher in the unit. The member appears to be largely a lagoonal, outer bar or deltaic deposit with the ratio of nonmarine rocks sharply increasing upward in the section. The contact with the overlying Husky Formation is covered but is believed to be normal.

The two sections described above document the previously suggested (Jeletzky, 1972b, p. 28) eastward and southeastward attenuation and shaling out of the Unnamed Upper Jurassic sandstone accompanied by a far-reaching lateral replacement of the deltaic, lagoonal and outer bar facies by that of a shallow but open sea facies. These facies changes are well illustrated by the disappearance of all partly carbonaceous to coaly, ridge-forming sandstone units of the Lower member of the western section in the equivalent, predominantly argillaceous units 3 and 4 of the eastern section. These latter units are largely or entirely shallow water, open sea deposits, in contrast to their predominantly lagoonal to deltaic western equivalents.

The Upper member of the western section becomes strongly attenuated in the eastern section where the equivalent unit 5 is only 345 feet thick. Its lagoonal, outer bar and deltaic component becomes strongly reduced in the eastern section and is replaced by the upper littoral (including supratidal) stenohaline deposits, as documented by the presence of belemnites.

The eastward attenuation and shaling out of the Unnamed Upper Jurassic sandstone results in a marked diachronism of the upper boundary of the Kingak Formation (shale) in this direction. In the western section, the Kingak shale does not include any upper Oxfordian rocks as the first *Buchia (Anaucella)* ex gr. *concentrica* appear in the basal arenaceous beds of the Unnamed Upper Jurassic sandstone. However, in the eastern section, *B.* (*A.*) ex gr. *concentrica* appears at least 80 feet stratigraphically below the top of the marine siltstone of unit 3 forming the topmost part of the Kingak shale. It was not possible to document paleontologically the probable eastward lowering of the upper boundary of the Unnamed Upper Jurassic sandstone.

The data discussed above support the previously made suggestion (Jeletzky, 1972b, p. 28) that the Unnamed Upper Jurassic sandstone of the Blow Pass-Bonnet Lake area was derived from "a nearby source area (situated; writer's addition) to the northwest or ?north of the area (?within Barn or Buckland Mountains)." This inferred source area is assumed to be a large eastward prograding deltaic lobe of the Keele-Old Crow Landmass and is indicated accordingly in figure 1. However, it could have been an island within the western part of the Porcupine Plain-Richardson Mountain Trough.

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