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STRATIGRAPHY, FACIES AND PALAEOGEOGRAPHY OF MESOZOIC AND TERTIARY ROCKS OF NORTHERN YUKON AND NORTHWEST MACKENZIE DISTRICT, N.W.T. (NTS-107B, 106M, 117A, 116O (N½), 116I, 116H, 116J, 116K (E½).

Project 550004

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From June to August 1971 about nine weeks were spent in a stratigraphical-palaeontological study of Mesozoic and Tertiary rocks of the northwestern part of Mackenzie District, N.W.T. and North Yukon and in the supporting of field work of F.G. Young in the adjacent areas of these territories.

Camp facilities, air support, and field assistants have been made available at the invitation of Shell Oil, Canada Ltd., Calgary. This assistance and co-operation are deeply appreciated.

The approximate boundaries of the principal areas surveyed in 1971 are indicated in Figure 1 where they are numbered from 1 to 10 inclusive. These areas are numbered and discussed in the same order in the text for the convenience of the reader.

1. Upper Peel River

Only late Hauterivian rocks were found in the core of a medium-sized syncline situated at appr. Lat. 65°52'N; Long. 136°10'W. (see GSC Map 1048A). These rocks overlap unconformably (5°-10° angular discordance) the fossiliferous marine Permian siltstones. A ½ to 2 feet basal conglomerate consists predominantly of fine to very fine (1/8" to 1/4") to medium (1/2" to 4"), rounded to subrounded chert pebbles with variable admixtures of various sedimentary and metamorphic pebbles. This predominantly coaly conglomerate is overlain gradationally by 5-8 feet of predominantly fine to very fine grained, predominantly quartzose (contains about 5% chert, about the same ratio of carbonaceous particles and some

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glauconitic grains), poorly sorted and rounded, partly gritty and fine pebbly, moderately porous sandstone rich in worm and ghost shrimp burrows. This commonly crossbedded and ripple marked sandstone appears to be an intertidal deposit. It grades upward into 20 to 35' thick siltstone dull brownish grey, more or less sandy, locally glauconitic, moderately hard to friable. This siltstone grades, in turn, into dark brownish grey, very friable, recessively weathering pure siltstone wth some 2-6 feet large, rounded septarian concretions of hard siltstone. Only the basal 35 to 45 feet of this high marine siltstone are exposed but it may be several hundred feet thick in the almost completely covered axial part of the syncline.

Late Hauterivian Cylindroteuthis (Communicobelus) cf. subporrecta Bodylevsky (GSC loc. 87835, 87836, 87838, 87839 and 87840), and Pleuromya ex aff. P. vancouverensis Whiteaves range throughout the exposed part of the Cretaceous sequence indicating its equivalence either to the upper part of the Coalbearing division (Jeletzky, Ref. 1, p. 9), or to the lower member of the Upper shale-siltstone division (Jeletzky, Ref. 2, p. 11-12). An eastward or northeastward onlap of the southern flank of Late Jurassic - early Lower Cretaceous eastern landmass which occupied the present southern Richardson Mountains and the headwaters of Peel River (Fig. 1) by the late Hauterivian sea seems to be indicated.

An isolated collection of long-ranging pelecypods (GSC loc. 85021) made in the almost entirely covered axial part of the syncline suggest, but does not prove, the presence of Aptian or Albian marine siltstones there.

2. Southern Richardson Mountains

Pre-Albian Mesozoic rocks are much more widespread in the core of Richardson Mountains in headwaters of Vittrekwa and Rock Rivers than it is indicated on GSC Map 10-1963.

?Upper Triassic. The oldest rocks studied in the Mesozoic section exposed across an unnamed north-south trending 3956' high ridge at appr. 66°58'30"N and 136°09'W are about 30 feet of dull grey, impure (?calcarenitic) massive limestone the base of which was not seen (Fig. 2). The limestones are overlain, apparently conformably (contact covered) by 80'+ of rust- to brown-coloured, highly ferruginous, extremely poorly sorted and rounded, fine to coarse grained, gritty and pebbly sandstone weathering siderolitically. Both units contain some ~~indeterminate~~ marine pelecypods of possible Triassic affinities (Mountjoy, Ref. 14, p. 14) ~~general Mesozoic affinities~~ and are tentatively placed in the Upper Tri ~~Jur~~assic because of their distinctive lithology and stratigraphic position.

Unnamed ?Jurassic coaly siltstone. Some ?50 to 60 feet of dark grey, carbonaceous to coaly, sandy siltstone and similar silty, very fine grained sandstone with wood and plant fragments overlies the ?Upper Triassic rocks. Exposures are poor and both contacts are covered.

Bug Creek Fm. (non-marine facies) begins with an about 100 feet thick Lower member represented mostly by very fine to medium, carbonaceous to coaly pebble-conglomerates and grits interbedded with variable amounts of coarse to fine grained feldspar-rich, extremely poorly rounded and sorted sandstone. The basal 30-40 feet include several 6 inch to 3 feet thick interbeds of sandstone and siltstone similar to those of the underlying ?Jurassic coaly siltstone unit. These fine grained clastics contain specks and laminae of impure coal and plant fragments.

The Lower member evidently represents alluvial deposits derived from the east and/or southeast. It grades upward into an Upper member consisting of predominantly quartzose sandstone whitish grey to white, mostly fine grained, moderately well to poorly sorted and fairly to poorly rounded. Some admixture of white kaolinized feldspar and limonite grains occurs commonly in this essentially non-carbonaceous, moderately hard and rather porous sandstone. No fossils of any kind were found in the about 150' thick Upper member which appears to be largely

or entirely a beach deposit. Contact with the overlying arenaceous facies of Husky Fm. appears to be gradational.

Husky Formation (arenaceous facies) largely consists of dull brown to light brownish grey, whitish grey to light grey weathering, predominantly quartzose (75-85% of quartz grains) sandstones with 5-15% of orange-weathering limonite grains (presumably derived from weathering of glauconite), 3-15% of glauconite grains and 0 to 5% of coaly grains; these mostly fine to very fine grained sandstones may contain considerable interbeds of medium grained sandstones and a variable ratio (from 5 to 30% of the total thickness) of interbeds of dark grey, mostly sandy and glauconitic, friable and recessively weathering siltstone and shale (Fig. 2). The sandstones are mostly moderately hard, more or less porous and moderately to well rounded and sorted. Ripple marks and large scale crossbedding are common in these neritic to littoral sandstones. Various Buchia and other marine pelecypods are common and locally form thin (1"-4") lenticular coquina interbeds.

The thickness varies from about 500 feet (possibly reduced by faulting) to at least 830 feet.

An about 100 feet thick shale-siltstone member forms the top of Husky Fm. in all better known sections. Upper contact was only observed in one section (at 66°56'15"N; 136°20'W) where it is abrupt, uneven and suggestive of an erosional disconformity.

The formation has yielded Buchia mosquensis f. typ., B. cf. piochii s. lato, B. cf. fischeriana, and ?B. terebratuloides faunas. Buchia concentrica fauna may be present in the basal beds. The apparently unfossiliferous uppermost shale-siltstone member is believed to represent the basal Cretaceous Buchia okensis zone because of its stratigraphic position and lithology.

The clastics of Husky Formation were apparently derived from a south-eastern or southern source, in part at least, as the sandstone units appear to thicken toward the south while the siltstone-shale interbeds appear to thin out or disappear in the same direction. No east-west facies changes are apparent within the area. However, this arenaceous facies of Husky Fm. evidently represents the basinward, predominantly neritic facies of the predominantly littoral and beach deposited North Branch Formation which outcrops extensively 12 to 14 miles to the east in western confluents of Vittrekwa River (Jeletzky, Ref. 3, p. 41-44, 132-137).

Lower sandstone division (non-marine facies). A 120 to 225 (Fig. 2) feet thick unit of fine to coarse grained sandstones, grits and conglomerates overlies the arenaceous facies of Husky Fm. In the principal section studied (Fig. 2) the unit consists of a Lower about 200 feet thick member consisting of dark to dull grey, buff to light grey weathering, carbonaceous to coaly sandstones. Fine to very fine grained, subquartzose to sublithic sandstones predominate. They commonly contain 5-15% of white kaolinized feldspar grains and a similarly large admixture of coaly grains. Only a trace of orange limonitic grains and no glauconitic grains were seen. The subordinated interbeds of medium to coarse grained sandstones contain 20 to 40% of white, often fresh feldspar and the same amount of coaly grains as the fine grained varieties. Flattened clayballs and pieces of fossil wood are common locally.

The uppermost 25 feet of the division comprise the Upper member which consists of an almost non-carbonaceous, quartzose to subquartzose, fine to medium grained light grey sandstone weathering white to cream-coloured.

The lithology and thickness of the division change drastically within short distances across and along the strike. In the section situated at 66°56' 15"N; 136°20'W the Lower member is only 70-85 feet thick but consists of an

irregular and thin interbedding of: 1) Mostly medium to coarse grained, gritty and fine to very fine pebbly, strongly feldspathic (20-30%) , feebly to moderately carbonaceous, extremely poorly rounded and sorted sandstone with; 2) Lithologically similar fine to coarse grit and very fine to fine pebble conglomerate. Grit particles and pebbles are poorly rounded to angular and consist mostly of chert, quartz and white kaolinized to fresh feldspar. All rock varieties are moderately hard to friable and fairly porous.

The Upper member is lithologically similar to that of the former section (Fig. 2) and only differs in being predominantly fine to very fine grained. It is at least 50 feet thick (top not reached).

No marine fossils have been found in this apparently alluvial to deltaic facies of the division, except once in a thin interbed occurring about 100' above the base of its Lower member.

The Lower member is lithologically similar to and appears to be correlative with the non-marine facies of the Buff sandstone member in Treeless Creek-Barrier River Highlands area (Jeletzky, Ref. 1, p. 6). The Upper member is lithologically similar to and apparently correlative with the White sandstone member and White quartzite division (Jeletzky, Ref. 4, p. 14-16) of northern Richardson Mountains.

Coal-bearing division begins with an about 205 feet thick Lower member consisting of a cyclical alternation of: 1) Sandstones, predominantly quartzose and lithologically similar to those of the underlying White sandstone member except for being moderately to strongly carbonaceous or coaly. These presumably alluvial sandstones are ridge-forming and occur in discrete 5 to 100 feet thick units. The topmost 20 feet of the uppermost 100' thick unit are moderately to strongly coaly and rich in specks and spots of coaly matter and in up to ½ inch thick and 4 inch long lenses of shiny black coal. This interval contains, furthermore, considerable interbeds of medium to coarse grained, very poorly sorted and rounded feldspathic sandstones similar to those of the Lower member of Lower sandstone division. Contacts are mostly sharp but even; and 2) Irregular but mostly thin

interbedding of dark to bluish grey siltstone, shale and fine to very fine grained silty sandstone. These paludal rocks are invariably carbonaceous to coaly and often rich in carbonized fragments of wood and bark. Microlamellae and small pods of impure coal occur locally. The rocks are moderately hard to friable and weather recessively, they form 2 to 10 feet thick interbeds between the sandstone ridges.

The Upper member of Coal-bearing division consists of an about 45' thick unit of black, pure to silty, flaky micaceous and apparently non-carbonaceous marine shale containing some Lingula sp. This friable, recessively weathering shale contains some orange-weathering concretions of hard clay ironstone and grades upward into an about 230 feet thick unit of dull brown-grey, brown to rust speckled fine to very fine grained, partly silty,mostly carbonaceous to coaly sandstone. This moderately hard, fairly porous, thinly but extremely irregularly (knotty to corrugated) bedded sandstone is extremely strongly bioturbated and commonly rich in various burrows and tracks filled up by dull to dark grey coaly sandstone. In spite of a total lack of marine fossils this sandstone is believed to be a shallow marine to outer marine bar deposit. It appears to grade into the overlying argillaceous rocks of Upper shale-siltstone division.

Upper shale-siltstone division consists of an irregular alternation of dull to dark grey, massive-looking to thinly bedded or laminated shale and siltstone with some 2-6" rounded to irregularly shaped concretions of hard clay ironstone. The rocks are invariably friable and weather recessively, except in the topmost 50 feet which consist of thinly to very thinly bedded to laminated, predominantly dull to light grey, dull brown-to orange-weathering, mostly sandy to very sandy, fairly hard and weathering-resistant siltstone. These siltstones often grade into very fine grained, silty sandstone, are commonly crossbedded on a small scale and ripple marked. The division grades into the overlying Upper sandstone division.

No fossils have been found except for some long-ranging marine pelecypods in the uppermost 50 feet of the division. However, it is believed to be entirely high marine (?lower shelf). The division is about 430 feet thick in the only complete section studied.

Upper sandstone division consists predominantly of dark grey to brown-grey quartzose to sublithic, very fine to fine grained sandstones with considerable interbeds of similarly coloured sandy to pure siltstone lithologically similar to that of the uppermost 50 feet of the Upper shale-siltstone division; some interbeds of dark grey pure shale occur also. The sandstones and sandy siltstones mostly contain 2 to 10% of glauconite grains or a similar percentage of orange-weathering limonite grains evidently derived through weathering of glauconite and are commonly slightly to fairly carbonaceous. The rocks are mostly hard and dense, with but little interstital porosity, thinly bedded (½"-3") to laminated, frequently crossbedded on a small scale with foreset beds mostly dipping toward N at 10-20°; large scale ripple marks are common; long-ranging pelecypods of the general Aptian-Albian affinities are common at many levels (e.g. GSC loc. 87842) and form a number of thin (½"-4") coquinod interbeds. The division is about 575 feet thick in the only complete section studied; it grades upward into the Albian shale-siltstone division.

The Upper sandstone division of the area is an offshore marine facies (middle to lower neritic zone) of the littoral fine to coarse grained quartzose sandstones and rudites, which characterize the division in the adjacent parts of the eastern slope of Richardson Mountains (Jeletzky, Ref. 1, p. 13-14), and so must have been derived largely from an eastern source. The presence of an additional southern (?or southeastern) source area is, however, suggested by the prevalent northern dips of the foreset beds.

Albian shale-siltstone division was only seen in a couple of short, partial sections. These sections appear to be closely similar to the better exposed sections of the division observed farther north on "Pacific Rat River" (see there).

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3. Headwaters of Stony Creek and those of "Pacific Rat River".

Bug Creek Formation. In the headwaters of Stony Creek east of the watershed with "Pacific Rat River"[1] the facies of Bug Creek Fm. does not differ materially from that of Southern Richardson Mountains. Several complete sections measured between Teeweechee Mountain (contrary to Jeletzky's Ref. 3, p. 140 indication, this 4,500'+ mountain~~s~~ has nothing to do with the unnamed 5165' summit and is situated east of Stony Creek at 67°14'N; 135°59'W) and the unnamed 5165' summit consist of carbonaceous to coaly arenites and rudites discordantly overlying the Imperial Formation. The northermost sections (e.g. Sections 120 and 122a of Jeletzky, Ref. 3., p. 141, 146) are predominantly fine to very fine grained. Interbeds of coarse grained sandstone, grit, pebble conglomerate and coaly argillaceous rocks with plant remains appear to increase southward and to be most prominent in the section measured on southeastern side of the unnamed 5165' summit (Lat. 67°10'30"N; Long. 136°14'30"W).

West of the divide in northern headwaters of "Pacific Rat River", Bug Creek Formation is represented by brownish grey, brown and dirty white, mostly to exclusively fine to very fine grained, quartzose to sublithic sandstones containing traces to 5% of white kaolinized feldspar grains, some orange-coloured limonite (?decomposed glauconite) grains and a trace to 5% of black coaly grains. These mostly well sorted and rounded sandstones are predominantly hard and dense (quartzite-like) with little or no interstital porosity. They are heavily to medium (3 feet to 6 inches) and indistincly bedded for the most ~~time~~ part but contain several interbeds of laminated sandstones featuring alternation of light coloured

[1] This unofficial name is introduced herein to distinguish the "Rat River" falling into Bell River from true Rat River falling into Mackenzie River; see Topo Map 116P.

Palaeogreography of Southern Eagle Plains. The above description of Jurassic and Lower Cretaceous rocks of Southern Richardson Mountains is critical for the understanding of the Jurassic and Lower Cretaceous (pre-Albian) palaeogeography of adjacent Eagle Plains.

The foregoing discussion indicates that all Jurassic and Lower Cretaceous (pre-Albian) units of Southern Richardson Mountains have been derived from nearby eastern and southeastern source areas. They must have been deposited on the northeastern flank of a large landmass designated as Eastern Landmass in this paper (Fig. 1). It is generally believed (e.g. by Frebold et al., Ref. 13, p. 24) that this landmass: "extended from Southern Richardson Mountains across the Eagle Plains to Monster syncline in northwest Ogilvie Mountains (Fig. 1) as indicated by the present distribution of Mesozoic formations in this area (Mountjoy, in press a, b; Norris, Price and Mountjoy 1963)." However, this concept was discredited by a more recent observation (Jeletzky, Ref. 5, p. 213-219, Figs. 1, 3) of regular shaling and thinning out of all arenaceous, littoral to non-marine units of northwest Ogilvie Mountains and southeastern Keele Range toward the south, southeast and east. As shown in Fig. 2, it is most difficult to interpret the east- to southeast- dervied, predominantly arenaceous, non-marine to littoral Jurassic and Lower Cretaceous (pre-Albian) rocks of Southern Richardson Mountains as a direct continuation of their northwest-derived, mostly arenaceous, littoral to non-marine equivalents exposed in Kandik area and headwaters of Bern Creek. These two arenaceous facies must have been separated from each other by a broad zone of high marine, predominantly or entirely argillaceous facies as shown in Fig. 2 The apparent absence of these argillaceous rocks in the Eagle Plains wells must be caused by their total or almost total ~~removal by the~~ erosion during and after the strong Aptian tectonic movements (Jeletzky, Ref.5, p. 209).

The Eastern Landmass of Southern Richardson Mountains and Upper Peel area evidently did not extend across the Eagle Plains but formed a blunt peninsula

surrounded on three sides by waters of the southern part of the pre-Albian Porcupine Plain-Richardson Mountain trough (Fig. 1). It must be pointed out that this interpretation was mentioned as a possibility by Frebold et al (Ref. 14, p. 24-25) who state: "The region (i.e. Eagle Plains; writer's remark), however, may also have been thinly covered by Jurassic sediments which were later eroded in the late Lower Cretaceous time."

The quartzose of orthoquartzitic development of many (but not all!) Jurassic and Lower Cretaceous (pre-Albian) arenaceous units of Keele Range and northwestern Ogilvie Mountains does not necessarily indicate their derivation from an eastern source area. The granitoid intrusions of Old Crow Range (e.g. GSC Map 10, 1963) provide one suitable northwestern source of quartz ~~grains~~ detritus. The smallish present day size of these mid-Palaeozoic plutons is not an obstacle either. These plutons may well be but the roots of originally much more extensive laccolith-like intrusions which were largely destroyed by the Jurassic and Lower Cretaceous (pre-Albian) erosion. This hypothesis has also the advantage of explaining the previously reported (Jeletzky, Ref. 5, p. 209) drastic change in the sedimentological regime of Northern and Central Yukon which occurred in the Aptian time.

Dr. R.L. Detterman (USGS, Menlo Park; personal communication of March 5, 1971) suggested the Permotriassic Sadlerochit Formation of eastern Brooks Range as another likely source for the Jurassic and Lower Cretaceous quartzose arenites of Keele Range and northwestern Ogilvie Mountains. The Brooks Range was strongly uplifted at about the early Upper Jurassic time. This erosion of quartzose arenites of Sadlerochit Formation could provide the needed quartz material.

The predominantly quartzose (but also argillaceous), 2000 to 3000 feet thick conglomerates, etc. of Sadlerochit Formation (=Jungle Creek Fm.) also have been found by D.K. Norris in several Keel Range sections in 1970 (personal communication of September 28, 1971). The far-reaching Upper Jurassic and Lower Cretaceous

erosion of central Keele Range outcrop-areas of Sadlerochit Formation could provide an even closer northwestern source area for the quartzose Upper Jurassic and Lower Cretaceous arenites of southeastern Keele Range and northwestern Ogilvie Mountains.

non- to feebly carbonaceous lamellae with dark coloured coaly lamellae and microlamellae of black shiny coal. Crossbedding and ripple marks are rare or absent in most beds. Several 10-20 feet interbeds of dark grey, very thinly bedded to laminated, sandy to very sandy siltstone containing fragments of carbonized plants occur in this 400 feet+ thick (base was not seen) facies of Bug Creek Fm. No marine fossils have been found in this apparently lagoonal to estuarine facies. Contact with the overlying Husky Fm. appears to be abrupt but even and devoid of accumulations of pebbles or grit particles.

Husky Formation. All sections measured in the headwaters of Stony Creek east of the watershed with "Pacific Rat River" are closely similar to those of the arenaceous facies measured by Jeletzky (Ref. 3., p. 127, 140, 144) on Mount Toughenough and between Teeweechee Mountain (Lat. 67°14'N; Long. 135°59'W) and the unnamed 5165' summit. This facies of Husky Formation differs from that of southern Richardson Mountains in a slightly to fairly greater ratio of argillaceous marine rocks.

In headwaters of "Pacific Rat River" Husky Formation is represented by a considerably more argillaceous facies transitional between the arenaceous facies and the typical shale-siltstone facies. The best and most nearly complete section studied on S side of the river (Lat. 67°20'25"; ~~and~~ Long. 136°21'30") is about 528 feet ~~long~~ thick and consists largely of dark grey to brown-grey, mostly sandy to very sandy, commonly glauconitic siltstone with numerous small pods, laminae and ¼" to 2" interbeds of dull to dark grey, very fine grained, sublithic sandstone. Several 9' to 53' thick units of buff to yellow, very fine to fine grained, quartzose to sublithic sandstone hard and dense, often quartzite-like, commonly with a considerable (10-15%) admixture of orange limonite (?weathered glauconite) and glauconite grains occurring in the section total less than one-quarter of its total thickness. This sandstone is commonly crossbedded and ripple

marked. Dark grey, pure to silty shale with clay ironstone comprises about 10% of the total thickness. Coarser clastics are completely absent. All rocks are marine and marine pelecypods occur at many levels commonly forming ½-3" thick lenticular coquina interbeds. Buchia fischeriana fauna occurs in the topmost beds of this section (GSC loc. 87644). The middle part contains Buchia n. sp. aff. piochii (GSC loc. 87647, 87648) and Buchia mosquensis f. typ. (GSC loc. 87649) faunas. The lower 120 feet did not yield diagnostic fossils but are believed to represent Buchia concentrica zone. Contacts with the overlying rocks are invariably covered or faulted. This transitional facies of Husky Fm. was evidently deposited basinwards of its arenaceous facies occupying the headwaters of Stony Creek. The assumed presence of typical shale-siltstone facies of Husky Formation west of the transitional facies (Fig. 1) ~~remains~~ without confirmation because of its disappearance from outcrops.

Lower sandstone division. East of the divide between Stony Creek and "Pacific Rat River" the facies of Lower sandstone division is generally speaking similar to that of Southern Richardson Mountains and the lithology of its non-marine rocks varies just as strongly within shortest distances. No marine fossils of any kind were ~~have been~~ found in the about 180 to 200' thick carbonaceous to coaly clastics of Buff sandstone member. The overlying up to 140' thick (at Lat. 67° 14'35"N; 136°06'W) White sandstone member contains considerable slightly carbonaceous to non-carbonaceous interbeds of littoral to beach deposits. Several specimens of ?Hauterivian Lytoceras (?Eulytoceras) cf. saturnale Anderson (GSC loc. 87831) were ~~have been~~ collected in one of these interbeds on the left (west) side of Stony Creek at Lat. 67°14'35"N; Long. 136°06'W. White sandstone member seems ~~appears~~ to be lithologically indistinguishable from coaly, non-marine facies of Buff sandstone member in the poorly exposed and faulted southernmost section measured in southeastern shoulder of the unnamed 5165' summit probably because

of lateral facies changes. The lower boundary of the division is placed at the top of a persistent unfossiliferous shale unit believed to represent Buchia okensis zone of adjacent areas. Its top is drawn at the base of another 15 to 30 feet thick persistent shale unit overlying White sandstone member.

Lower sandstone division is not recognizable as a lithological unit in any section studied west of the divide. However, an about 150 feet thick unit of black, dark grey weathering, fine chippy to flaky and recessively weathering, soft, apparently carbonaceous to coaly, shale with some thin interbeds of similarly coloured sandy siltstone and very fine grained silty sandstone appears to be equivalent to this division in part at least. In the best section situated on the southern side of "Pacific Rat River" at Lat. 67°20'25"N. and Long. 136°21'30"W this shale unit occurs between the topmost Buchia fischeriana-bearing (GSC loc. 87644) sandstone of Husky Formation and a thick succession of mostly coaly, marine to non-marine deposits equivalent to the Coal-bearing division of the adjacent areas. Well preserved Buchia n. sp. aff. inflata Toula (GSC loc. 87643) was collected in angular, evidently locally derived carbonaceous sandstone slabs on the middle part of the unit. These relationships suggest a westward shaling out of predominantly non-marine arenites of the division.

Coal bearing division (lagoonal to marine facies). In the headwaters of Stony Creek the facies of Lower member appears to be closely similar to that of the Southern Richardson Mountains (see there). However, this 200 to 250 feet thick member contains a considerably greater ratio of black to dark grey, evidently paludal, coaly siltstone and shale and at least one 15' interval of ?non-carbonaceous, ?marine shale with clay ironstone at the base. The cyclical alternation of weathering-resistant sandstone units with the recessive siltstone-shale units is less regular than in Southern Richardson Mountains.

The Upper member is at least 850 feet thick and represented by cyclical alternation of shale and sandstone units. The basal unit of marine black shale is rich in clay ironstone, 215'+ thick and contains Lima (Limatula) ex gr. consobrina d'Orb. (GSC loc. 87834). This shale is overlain by an about 270' lower unit of cream to pale yellow, whitish grey weathering, bright to orange spotted, predominantly fine grained, mostly non-carbonaceous, quartzose to subquartzose, poorly rounded and sorted sandstone. Minor to considerable interbeds of similar, fine to medium grained sandstone occur at several levels. Subquartzose varieties contain 5-10% each of rust-coloured limonite grains (?decomposed glauconite) and of white kaolinized feldspar grains. Dull to dark grey coaly sandstones with plant remains are rare to almost absent and carbonaceous varieties (2-3% of coaly grains and matter) are relatively rare and thin. This apparently unfossiliferous, medium hard, porous to dense sandstone is mostly heavily to indistinctly bedded and devoid of ripple-marks and crossbedding. It appears to be a lagoonal to beach deposit. This sandstone is overlain by a second 90'+ thick unit of black, marine shale with clay ironstone concretions followed by a 250 to ?300 feet thick Upper sandstone unit. This unit consists of light grey, buff or brown-grey, predominantly fine to very fine grained, quartzose to sublithic (5-15% of feldspar grains; 3-5% of glauconite and derivative limonite grains; and 3-15% of black coaly grains), weathering-resistant sandstone commonly rich in to replete with vertical to oblique, coaly tubes (?plant rootlets), partings, laminae and pods of coaly matter.

The basal 70 to 100 feet contain 5 to 10% of thin (1"-6") lenticular beds, pods and laminae of gritty to fine pebbly sandstone and very fine (1/8"-1/4") pebble conglomerate consisting largely of chert (35%-65%) and white kaolinized feldspar (20-25%) clasts. Other sedimentary clasts including those of shale, coal and flattened clay pebbles are common to abundant. These presumably deltaic

to ?alluvial basal beds are commonly crossbedded on a small and large scale and are locally ripple marked. They grade upward into 25-30 feet of fine to very fine grained, silty, presumably deltaic to lagoonal sandstone extremely rich in coaly pods, laminae and partings and containing rare Cylindroteuthis (Communicobelus) cf. subporrecta Bodylevsky (GSC loc. 87849). This late Hauterivian 135+ thick sandstone grades upward into commonly ferruginous sandstone which is very fine grained at the base but becomes fine to medium grained and cherty (≃ 10%) in the uppermost 40-50 feet. This sandstone is rich in coaly plant rootlets, partings, laminae and small ($\frac{1}{4}$-2") pods of coaly matter in the uppermost 40-45 feet but is almost pure quartzose farther down. Rare Cylindroteuthis- or Oxyteuthis-like belemnites of late Hauterivian to (?) early Barremian affinities occur in this quartzose phase of the ferruginous unit. The ferruginous sandstone probably was deposited in an offshore marine bar environment and reflects an eastward onlap of the late Hauterivian sea onto the Eastern Landmass (Fig. 1). The contact of the Upper member with the overlying Upper shale-siltstone division was not seen.

The moderately hard to hard, mostly more or less porous but weathering-resistant sandstones of the Upper member represent the principal erosional level in the headwaters of Stony Creek. They form the upper steep slopes and the flat tops of all 4,000' to 5,000'+ high mesa-like mountains in the area between Teeweechee Mountain and the nameless 5165' high summit.

The only complete section of Coal-bearing division measured west of the divide occurs on the southern side of "Pacific Rat River" at appr. Lat. 67° 20'25"N. and Long. 136°21'30"W.

The Lower member is represented by the same presumably paludal to lagoonal facies as in the previously mentioned sections in the headwaters of Stony Creek. However, the member is only about 135' thick, and confined between

considerably thicker units of marine shale and siltstone, and apparently represent~~ing~~s the western pinch-out zone of its non-marine facies.

The Upper member is about 875 feet thick. Its facies is closely similar to that of the Stony Creek sections, except for the reduction of the upper shale unit to a 10'-15' thick siltstone interbed. The Upper sandstone unit is about 325 feet thick and consists largely of thinly but irregularly (knotty to corrugated) bedded, coaly sandstone lithologically similar to that forming the top part of the division in Southern Richardson Mountains (see there). The lower 55 feet of this apparently marine unit contain a considerable number of few inches to 12 feet long and up to 4 feet thick lenses of strongly ferruginous sandstone and siltstone ("clay ironstone") locally rich in non-diagnostic marine pelecypods including Pecten (Entolium) sp., Oxytoma sp., Dicraniodonta sp., Lima (?Limea) sp., and Astarte sp. (GSC loc. 87651).

The lower sandstone unit is about 400 feet thick and represented by the same paludal to lagoonal facies as its equivalent in the headwaters of Stony Creek. An about 165' thick Lower shale unit separates this sandstone unit from the Lower member of the division.

Upper shale-siltstone division. All visited sections of the Upper shale-siltstone division are either poorly exposed or completely covered by debris and/or vegetation. So far as possible to judge, they only differ from those of the Southern Richardson Mountains (see there) in a somewhat greater thickness which comprises 870 feet (appr.) in the only complete section measured. No diagnostic fossils have been found in these presumably high marine (lower shelf zone) rocks.

Upper sandstone division. No exposures of Upper sandstone division have been found in the investigated part of headwaters of Stony Creek. Its exposures are common, however, farther west in the headwaters of "Pacific Rat River" where the

about 600 feet thick sandstones of the division represent the principal erosional level and crown most of the 4,000"± mesa-like summits. In this part of the area the facies of Upper sandstone division only differs from that of the Southern Richardson Mountains in the prevalence of extremely uniform quartzose, micaceous and slightly to feebly glauconitic sandstones in its middle part. These very fine grained sandstones are mostly well sorted but only moderately well rounded, rich in round-crested, symmetrical ripple marks 4-8 inches wide between the crests, and locally crossbedded on a small to large scale. Various tracks and burrows are common on many bedding planes.

Marine pelecypods are common at many levels and form a number of ½-18" thick coquina interbeds and pods. However, the diagnostic Aucellina aptiensis fauna (Jeletzky, Ref. 1, p. 16) was ~~only~~ found but once at the level about 240 feet above the base of the division (GSC loc. 87865, at top of 3990' mesa-like mountain; Lat. 67°19'30"N; Long. 136°19'30"W.). The upper half of the division could, therefore, be already of an earliest Albian age.

The ~~sandstones of~~ Upper sandstone division grades into the overlying Albian shale-siltstone division through a 50 to 100 feet thick zone of dull to bluish grey, very fine grained, silty to very silty (lithic) sandstone grading into and interbedded with superficially similar sandy to very sandy siltstone. These transitional beds are excellently exposed in the 200' high bluff on the undercut northern (right) bank of "Pacific Rat River" at Lat. 67°21'50"N; Long. 136°33'45"W. Like its equivalent in Southern Richardson Mountains (see there), the Upper sandstone division of the area represents an offshore marine facies (lower neritic zone) derived from an eastern source.

Albian shale-siltstone division. The outcrops of the Albian shale-siltstone division (see Jeletzky, Ref. 1, p. 18-19) are mostly restricted to that part

of the area west of the longitude 136°33'W. The best section studied is exposed in the already mentioned 200 feet high bluff (Lat. 67°21'50"N; Long. 136°33'45"W.) on the northern bank of "Pacific Rat River".

The division consists of an about 220 feet thick Basal member consisting of siltstone, dark to brown-grey, weathering medium to ash-grey and chippy to flaky, friable, pure to sandy, micaceous. This siltstone is mostly massive to indistinctly bedded. It includes, however, laminae, thin interbeds and considerable units (up to 63 feet thick) of thinly bedded to laminated, pure siltstone and of hard, weathering-resistant, light brown-weathering, sandy to very sandy siltstone often grading into superficially similar, very fine grained, silty to very silty sandstone. Several rows of 4 to 12" "cannonball" concretions of dark grey, very hard, often sandy siltstone and up to 6 feet long and 4 feet high, spherical concretions of orange-weathering calcareous shale or impure limestone occur at irregular intervals. Upper contact is somewhat abrupt but conformable and devoid of accumulation of any coarser particles.

The Basal siltstone member is sparingly fossiliferous throughout. Its marine pelecypods do not include, however, any diagnostic forms.

An at least 400 feet thick Shale member overlies the Basal siltstone member. It consists of dark grey, medium blue-grey, flaky and recessively weathering, soft, fissile, micaceous, mostly more or less silty shale of an extremely uniform lithology; rows of rounded, 1-2 feet concretions of bright orange-weathering hard shale and those of discus-like, 2-4 feet long concretions of layered, weathering dull rust-coloured, medium hard to very hard shale occur at irregular intervals. The row of latter concretions occurring about 8 feet above unit's base has yielded one specimen of late lower to early Middle Albian (Jeletzky, Ref. 1, p. 18) <u>Beudanticeras</u> (<u>Grantziceras</u>) <u>affine</u> (Whiteaves) (GSC loc. 87803). Higher beds have only yielded long-ranging pelecypods of

general Aptian-Albian affinities. The top of Shale member was not reached in any of the sections studied.

The Albian shale-siltstone division of the area is closely similar lithologically to its equivalent on the eastern slope of Richardson Mountain. It was evidently deposited in the central part of the same several hundred feet deep, wide epicontinental sea basin unaffected by the Aptian orogenic movements which have taken place along its western margin (Jeletzky, Ref. 5, p. 209).

4. East Flank of White Mountains

An important exposure-area of Jurassic and early to mid-Lower Cretaceous rocks occurs closely east of the Paleozoic-Mesozoic contact at appr. Lat. 67°55'N; Long. 136°27'W. The following upward sequence was observed in this area:

Bug Creek Formation. The thickness, subdivision and lithology of the Bug Creek Formation match closely those of the adjacent section 165 and the Goat and Eagle section 65-G.E.S.-1-56 (Jeletzky, Ref. 3, p. 161-163, 166-171).

Husky Formation begins with an at least 200 feet thick (rocks disturbed by faulting) Basal shale tongue consisting of black, dark grey and flaky to earthy and recessively weathering, soft to moderately hard, fissile to papery shale grading into the underlying Bug Creek quartzite. The basal sandy beds have yielded a fairly rich marine fauna including: Pachyteuthis (Pachyteuthis) ex aff. P. (P.) panderiana (d'Orb.), Camptonectes (Boreionectes) ex gr. praecinctus Spath and Meleagrinella ex gr. echinata (Smith). This late Callovian or ?early Oxfordian fauna (GSC loc. 87436) lacks any Buchia.

Unnamed Upper Jurassic sandstone (tongue of). The Lower shale tongue grades upwards into a 140 to 150 feet thick (est.) sandstone-siltstone unit evidently representing the eastern pinch-out zone of much thicker, largely non-marine Upper Jurassic sandstone widespread in Keele Range and Porcupine-Water River area (Jeletzky, Ref. 5, pp. 211, 213, Figs. 1-3).

The marine sandstone-siltstone unit consists of three weathering-resistant, ridge-forming sandstones ranging from 30 to 35 feet in thickness and separated by two 20 to 30 feet thick siltstone units.

The sandstones are dull grey to brown-grey, often dull brown to rust-weathering, very fine to fine grained, invariably sublithic to lithic with 15% to ?50% of orange coloured limonitic grains (?decomposed glauconite) and some dark mineral grains. The sandstones are mostly hard, dense and locally quartzite-like to true quartzite. Interbeds and pods of fairly friable, moderately dense, ferruginous, partly fossiliferous to coquinoid sandstone occur at irregular intervals. Medium to thick (6" to 18") and indistinctly bedded sandstones alternate with thinly bedded to laminated, more or less crossbedded and ripple-marked varieties. The intervening siltstones are dark grey to black, recessively weathering, mostly sandy and with considerable laminae, thin (1-6") interbeds and pods of very sandy siltstone grading into very fine grained, very silty sandstone. Both contacts appear to be gradational.

Buchia concentrica (Sowerby) s. lato first appears 5 feet above the base of the unit (GSC loc. 87574) and ranges throughout its thickness (GSC loc. 87571, 87572 and 87573).

The overlying upper part of Husky Formation is at least 435 feet thick (thickness probably reduced by normal faults) and is closely similar lithologically to the corresponding parts of its sections measured between the Fault Creek and Donna River in Aklavik Range (Jeletzky, Ref. 2, p. 39-47; Ref. 3, p. 29-32, 70-79, 108-113). Like these sections, this part of Husky Formation is subdivisible in readily recognizable: Upper part of the Lower, Arenaceous, Red-Weathering Shale and Upper members. Each of these members contains its diagnostic Buchia faunas ranging from Buchia concentrica (Sowerby) s. lato to Buchia volgensis Jeletzky 1964 non Lahusen 1888.

Shale equivalent of Lower sandstone division. The lithologically and palaeontologically typical Upper member of Husky Formation is overlain by an at least 400 feet thick (top not reached) sequence of almost unfossiliferous black to dark grey, bluish tinged, fissile, fairly friable, flaky to earthy and recessively weathering shale with some scattered, rounded, 2-8" concretions of the orange-weathering hard clay ironstone. This division contains some 1-5' interbeds of dark grey, sandy siltstone similar to that of the underlying Upper member of Husky Formation and two well delimited, apparently persistent 15 to 25 feet thick beds of weathering resistant, quartzite-like sandstone forming 10-20 feet high walls across the slopes. One of these beds was selected as the base of the division while the other occurs 165-185 feet stratigraphically above its base. These light-brownish grey, very fine grained, quartzose to sublithic sandstones contain variable admixtures of bright orange limonite grains and those of dark mineral. They were apparently deposited in a fairly deep, quiet marine environment (lower neritic zone) as they are mostly strongly bioturbated and do not exhibit well developed ripple marks and crossbedding.

Some poorly preserved Buchia cf. volgensis Jeletzky 1964 non Lahusen 1888 (GSC loc. 87867) found in the upper sandstone bed about 190 feet above division's base suggest the equivalence of its lower part with the Buff sandstone member of the eastern slope of Richardson Mountains (see in Section 5 below). The two sandstone beds are therefore interpreted as the westward pinching out tongues of this member in its mid-basin shale facies. The overlying 210 feet+ thick (top not reached) upper part of the division appears to correspond to the White sandstone member of the eastern slope and to the Bluish-grey shale division of Western Richardson Mountains (Jeletzky, Ref. 4, p. 12-14). The above described shale facies of the Lower sandstone division is also equivalent and closely similar lithologically to black shales forming the upper part of

Husky Formation on the eastern side of Blow Pass (Jeletzky, Ref. 5, p. 207). These two areas apparently formed part of the central zone of Porcupine Plain-Richardson Mountains Trough (Fig. 1) equally far removed from the western and eastern source areas.

Equivalents of Coalbearing division. There was no opportunity to study closely the upper 600 feet (est.) of the Lower Cretaceous rocks overlying the second sandstone bed of the above described shale division ~~second sandstone unit~~. It must be noted, however, that only one more ?30-40 feet thick (est.) ridge-forming sandstone unit was seen in the ~~at least 600 feet thick~~ recessive (apparently argillaceous) interval separating the top of the measured section from the typically developed shales of the Upper shale-siltstone division. It seems likely therefore that on the eastern slope of White Mountains the equivalents of the Coalbearing division are largely or entirely represented by marine argillaceous rocks.

5. Martin Creek - Canoe Lake area.

Lower sandstone division partly shales out between the eastern slope of Aklavik Range (Jeletzky, Ref. 2, p. 7, 31-53; Ref. 4, p. 14, corr. chart) and the eastern shore of Canoe Lake at appr. Lat. 68°13'45"N; Long. 135°52'30"W. This shaling out is least pronounced in the lower and middle parts of Buff sandstone member which retain their characteristic 95 to 100% sandstone lithology throughout this interval. The thickness of this part of Buff sandstone member remains about the same between the eastern slope of Aklavik Range and the Lower Canyon of Martin Creek (Lat. 68°12'30"N; Long. 135°35'W.). Farther west the thickness decreases gradually (from its maximum of about 300 feet in Martin Creek sections) as the sandstone becomes interfingered with 10 to 20% of sandy siltstone (especially in the basal 100 to 150 feet). The thickness drops finally to some 150 feet (est.) in the ridge immediately east of Canoe Lake (Lat. 68°13'45"N; Long. 135°52'30"W.). It is not known whether this gradual decrease of thickness

is caused by the decrease of sediment in the offshore parts of the trough or by the lateral replacement of the lower part of Buff sandstone member by the sandy siltstones of the Upper member of Husky Formation as these two units contain the same Buchia volgensis Jeletzky 1964 non Lahusen 1888 fauna.

The shaling out of the upper part of Buff sandstone member is much more pronounced. The 16 to 18-foot-thick bed of blackish-grey, silty and sandy shale with numerous clay ironstone concretions and pods characteristically present in the northern part of Aklavik Range (Jeletzky, Ref. 2, p. 51-52; see bed 7 of Section 11a) thickens into a 55 to 60 feet member of black, dull to bluish grey weathering, pure to silty shale with clay ironstone concretions and bands in the Lower Canyon of Martin Creek (Lat. 68°12'30"N; Long.135°35'W.). Furthermore, two respectively 45 and 29 feet thick interbeds of dark grey, sandy siltstone with clay ironstone concretions and bands appear beneath this shale member in the upper 160 feet of these Martin Creek sections. Still farther west in the area adjoining Canoe Lake from the northeast (appr. Lat. 68°16'40'N; Long. 135°44'05"W.) the equivalent upper part of Buff sandstone member consists of a complex interfingering of varicoloured, fine to very fine grained, silty to very silty, ferruginous and feebly to fairly glauconitic marine sandstones with an about equal ratio of black to dark grey shale and siltstone with clay ironstone concretions. The equivalence of the beds concerned is proven by the presence of the same mixed Buchia keyserlingi-Buchia inflata (= B. crassa) fauna in all three groups of sections. These data confirm an earlier suggestion (Jeletzky, Ref. 4, p. 14, Fig. 1), that the persistent 16-18 foot shale bed of northeastern Aklavik Range is the extreme thin wedge of the Bluish grey shale division of Western Richardson Mountains.

The lateral facies changes of White sandstone member are even more far-reaching than those of the upper part of Buff sandstone member. In the

Lower Canyon of Martin Creek (appr. Lat. 68°11'55"N; Long. 135°34'45"W.) it is 105 to 110 feet thick and consists of an extremely complex interfingering of paludal, deltaic, lagoonal and littoral sediments. The typical fine to coarse grained, gritty and pebbly, often feldspatic alluvial sandstones characteristic of the White sandstone member of eastern Aklavik Range (Jeletzky, Ref. 2, p. 7; 48-50) are either absent or reduced to minor interbeds in most Martin Creek sections. They are replaced either by the paludal to lagoonal coaly sandstones and shales with plants and several 1 to 2½ feet thick lenticular coal seams lithologically indistinguishable from the lower part of the Coalbearing division (Jeletzky, Ref. 1, p. 8); or by deltaic to littoral (outer marine bars), cream to light lavender coloured, mostly fine grained, quartzose, ferruginous, intensively crossbedded sandstones with superabundance of huge (2-4 feet high) steeply north to northwest-dipping foreset beds. Some sections consist of a complex, often deeply channeled interfingering of these two facies. The deltaic to littorial sandstones commonly carry mid- to late Valanginian <u>Buchia</u> n. sp. <u>inflata</u> fauna (e.g. GSC loc. 87431, 87529) indicating their equivalence with the White sandstone member of eastern Aklavik Range. The paludal to lagoonal facies of White sandstone member was not seen westward of the Lower Canyon of Martin Creek.

New P

No P

Toward the west and northwest it is replaced by the gradually thinning out littoral to deltaic sandstone facies containing the same <u>Buchia</u> n. sp. aff. <u>inflata</u> fauna. This sandstone facies appears to shale out in the part of the area adjoining Canoe Lake from northeast and east much as the upper part of Buff sandstone member does.

<u>Equivalents of Coalbearing division.</u> Only the lower 100 feet of Coalbearing division were studied closely in Martin Creek sections (appr. Lat. 68°11'45"N; Long. 135°34'30"W.). These beds consist of presumably paludal to lagoonal

(presence of vertical rootlets of plants), mostly ferruginous, knotty-to corrugated-bedded, commonly carbonaceous to coaly sandstones lithologically similar to those prevalent in the Upper member of Coalbearing division in Southern Richardson Mountains and in headwaters of "Pacific Rat River". Minor interbeds of dark grey, apparently non-carbonaceous, ?marine shale occur locally but no coaly siltstones and shales and no coal seams were seen in contrast with the Lower Donna River facies of the Lower member farther to the east (Jeletzky, Ref. 1, p. 8).

Westward and northwestward of the lower Martin Creek the equivalents of the Coalbearing division are represented by a 90 to 100 feet thick, predominantly littoral to ?deltaic (or ?lagoonal) sandstone unit. The sandstones of this unit are bright rust-, light orange-, dull brown- or yellow coloured, mostly fine to very fine grained, quartzose to more or less strongly feldspathic (up to 25%), often more or less glauconitic, strongly ferruginous to limonite cemented, poorly sorted and rounded and extremely strongly crossbedded on a large scale. The steeply inclined (30-40°), huge (2-4 feet high) foreset beds are predominantly dipping northward to north-westward. Stringers, small pods and ½"-4" interbeds of medium to coarse grained, gritty and pebbly sandstones, fine to coarse grit and very fine pebble conglomerate consisting predominantly of chert, quartz and weathered white feldspar clasts are common locally. Numerous rounded to discus-like 6" to 2½' concretions and up to 30 feet long and 7 feet thick lenses of orange-, rust-, or wine-red-weathering, pure to sandy, gritty and fine pebbly, hard, ferruginous sandstone or siltstone ("clay ironstone") occur at irregular intervals. The sandstones are friable to medium hard and porous but fairly weathering-resistant. Variable amounts (10 to 30%) of partings, laminae and thin (1-3") to thick (up to 10 feet), apparently lenticular interbeds of dark grey to dull brown, friable, more or less sandy siltstone or shale are intercalated with the above sandstones in most sections.

Most of the above described sandstones yield a scarce marine fauna (e.g. GSC loc. 87580, 87582, 87585) including: Simbirskites (?Simbirskites) sp., indeterminate (?)simbirskitid ammonites, Cylindroteuthis (Communicobelus) cf. subporrecta Bodylevsky, Acroteuthis (Acroteuthis) sp., Pecten (Entolium) cf. orbicularis (d'Orb.), Astarte sp., Modious sp., and Dicraniodonta sp.. No Buchia or Aucellina were found in this mid- or (?)late Hauterivian fauna which makes its first appearance only 20 to 30 feet stratigraphically above the highest occurrences of Buchia n. sp. inflata fauna (e.g. GSC loc. 87583) in the basal few feet of this unit. Other subordinate sandstone beds contain a mixture of above marine forms with Viviparus-like ?fresh- to brackish-water gastropods and plant remains. Yet other presumably deltaic to lagoonal beds only yielded wood fragments, carbonized, vertical plant rootlets, and fossil wood.

The best sections of this sandstone unit were measured in a deep nameless canyon of the southern confluent of Beaver House Creek at approx. Lat. 68°16' 06"N; and between approx. Long. 135°38'20"W and 135°41'30"W. Throughout this interval the unit is sharply delimited from much more somber coloured mostly white to cream ~~mostly~~ weathering rocks of White sandstone member below and the dark grey, fissile, clay ironstone-rich shales of the Upper shale-siltstone division above. Farther west to southwest between the upper end of this canyon and the eastern shore of Canoe Lake this sandstone equivalent of the Coalbearing division thins out to 75-80' and overlies gradationally black to dark-grey shales and siltstones (with some sandstone interbeds) equivalent to the White sandstone member and the upper part of Buff sandstone member according to their Buchia and belemnite fauna.

No exposures of Cretaceous rocks were found within a broad Palaeozoic belt (GSC Map 10-1963) separating the Martin Creek-Canoe Lake area from the previously discussed area on the eastern flank of White Mountains (see in Section 4). There

seems to be little doubt, however, that the residual sandstone tongues of the Lower sandstone and Coalbearing divisions continued to shale out in this interval until reduced to the previously described (see in Section 4) three 15 to 30 feet thick interbeds still present in the shale-siltstone equivalents of these divisions on the eastern flank of White Mountains.

Upper shale-siltstone division. The investigated basal 300 feet of the Upper shale-siltstone division appear to be lithologically identical to its equivalent beds exposed on the eastern slope of Aklavik Range (Jeletzky, Ref. 2, p. 10, 61-65), except that no basal pebble conglomerate was observed anywhere within Martin Creek-Canoe Lake area. The abrupt but even contact with the underlying sandstone equivalent of the Coalbearing division remains, however, time-parallel, biochronologically speaking, from eastern Aklavik Range to Canoe Lake as the basal beds of the division contain everywhere the same Simbirskites (Simbirskites) cf. kleini fauna (see Jeletzky, Ref. 1, p. 13 and GSC loc. 87599).

6. Bonnet (=Bonny) Lake - Blow Pass area.

Kingak equivalent (restricted). An apparently complete but poorly exposed and somewhat disturbed section in northern headwaters of southwestern branch of Blow River, just southeast of Barn Mountains (appr. Lat. 68°20'30"N; Long. 138° 05'30"W.) suggests that the restricted (i.e. the shale unit underlying the Unnamed Upper Jurassic sandstone unit; see Jeletzky, Ref. 5, p. 205, 207, Figs. 2, 3) is represented exclusively by shale and is not more than 800 feet thick in this part of the area. This Kingak equivalent does not seem to extend into the Upper Oxfordian either as the first Buchia sp. (GSC loc. 87637) were found immediately above it in a series of 8 feet thick sandstone lenses assigned to the basal part of the Unnamed Upper Jurassic sandstone. The contact between these two units is gradational.

The Kingak shale appears to be considerably thicker in the headwaters of Johnson Creek where it includes at least 400 feet of Buchia concentrica s. lato zone (e.g. GSC loc. 87628, 87629, 87630) underlying the apparently considerably reduced Unnamed Upper Jurassic sandstone unit (at approx. Lat. 68° 05'45"N; Long. 138°14'W. and for the next 1½ miles downstream.

Unnamed Upper Jurassic sandstone unit. Judging by a somewhat arbitrary combination of several partial, mostly poorly exposed and partly disturbed sections situated in the headwaters of southwestern branch of Blow River (e.g. at approx. Lat. 68°20'30"N; Long. 138°05'30"W. and at approx. Lat. 68° 19'30"N; Long. 138°06'45"W.), the Unnamed Upper Jurassic sandstone unit is at least 350 feet thick in this part of the area. It consists of several 8 to 120 feet thick, partly lenticular, weathering-resistant sandstone units separated from each other by 40-50 feet thick, recessively weathering sandy siltstone and superficially similar, very fine grained, very silty sandstone units. The complete thickness of the unit may be considerably greater (?900 feet+) provided that it is not repeated by thrust faults.

The ridge-forming sandstones are mostly dark grey or mottled light and dark grey, weathering dull grey with orange specks or orange to brown, mostly very fine to fine grained, hard and dense, often quartzite-like to true quartzite, poorly sorted and rounded ~~grains~~ with most grains being angular to subangular. The sandstones are mostly thinly bedded and weather slabby to rubbly. Crossbedding and ripple marks are rare to absent in the lower part but may be common in the upper part. The lithologic composition of the sandstones varies from almost quartzose to sublithic (subgreywacke); they may contain from 2 to 10% limonite grains; about the same ratios of dark mineral grains which is mostly mica but also includes some chert, and 5 to 20% of white, kaolinized feldspar.

The siltstones are dull to dark grey coloured and weather brown-grey to dark brown and fine rubbly, soft to moderately hard and sandy to very sandy.

At least one 1 foot-thick bed of coarse, fine to very fine pebbly grit with small pods and stringers of fine to medium (1/8-2") pebble conglomerate occurs in the lower part of the unit. Grit particles and pebbles are invariably angular. They are built mostly of quartz with lesser amounts of pebbles built of chert, sandstone, shale and various metamorphic rocks. The lithology and poor rounding of these sandstones and especially coarser grained clasts suggest a nearby source area to the northwest or ?north of the area (?within Barn or Buckland Mountains).

Poor specimens of Buchia sp. resembling early forms of Buchia concentrica (Sowerby) occur in the basal 80 feet of the unit (GSC locs. 87637, 87639). No fossils were found in the higher beds.

The Unnamed Upper Jurassic sandstone unit probably is not more than 250 feet thick in its only known poor exposure on the southern bank of Johnson Creek (approx. Lat. 68°06'45"N; Long. 138°16'40"W.) and consists exclusively of very fine grained, argillaceous sandstones closely similar to the previously described sandstones ~~in outcrop~~ outcropping in the headwaters of southwestern branch of Blow River.

Husky Formation. At least 1,000 feet of dark grey shale and siltstone of Husky Formation overlie the Unnamed Upper Jurassic sandstone unit in the banks of southwestern branch of Blow River between the point at (appr.) Lat. 68°19'30"N; Long. 138°06'45"W. and the faulted base of Section 161 (Jeletzky, Ref. 4, p. 41, corr. chart) about 1½ miles farther downstream. No fossils have been found in this poorly exposed and possibly faulted section.

Poorly exposed, supplementary folded and strongly faulted section of Husky Formation occurs in the southern bank of Johnson Creek at approx. Lat. 68° 07'[redacted]N; Long. 138°16'15"W. Late Portlandian Buchia cf. blanfordiana Stoliczka (GSC loc. 87627) were found in this section.

Lower sandstone division (restricted). The restricted (see Jeletzky, Ref. 4, p. 9-10, Fig. 1) Lower sandstone division (=Buff sandstone member of eastern Richardson Mountains) thickens markedly westward within the area. In contrast to the lens-like character and less than 200' thickness of the unit on the eastern side of Blow Pass (Jeletzky, Ref. 5, p. 207) it is a laterally persistent, about 450 feet thick unit in the area between the head of southwestern branch of Blow River and Sam Lake. In the thick western sections (e.g. at approx. Lat. 68°20'N; Long. 138°15'W; Lat. 68°19'N; Long. 138°23'W., and Lat. 68°21' 15"N; Long. 138°20'50"W.) the division consists almost exclusively of ridge-forming, hard and dense but mostly not quartzite-like, fine to very fine grained, quartzose, feebly to fairly glauconitic, commonly crossbedded and ripple marked sandstones. It grades downward into the Husky Formation through a 100 to 150 feet thick unit consisting of a thin bedded (1/4-4") to laminated interbedding of above described sandstones with dark grey, mostly sandy siltstones.

Buchia volgensis Jeletzky, 1964 non Lahusen 1888 and B. keyserlingi var. visiginensis (Sokolov, 1908) fauna was found in all sections studied (GSC 11c Locs. 87631, 87634, 87635).

The above described facies changes of Lower sandstone division and the previously noted (Jeletzky, Ref. 5, p. 207) northward and ?eastward shaling out of the division between Bonnet Lake and the eastern side of Blow Pass indicate that its sands have been derived from a southwestern source area (see Fig. 1).

Bluish grey shale division. In all sections studied between the head of southwestern 11c Branch of Blow River and Sam Lake the ~~The~~ restricted Lower sandstone division is conformably and probably gradationally overlain by a 450 to 500 feet thick (est.) succession of dark grey, dark blue-grey to dull blue and recessively weathering, fissile, pure to silty shale containing bands and rows of concretions of rust to orange-

weathering ferruginous shale and siltstone ~~in all sections studied between the head of southwestern branch of Blow River and Sam Lake.~~ The division contains considerable interbeds of moderately hard, sandy siltstone and very fine grained very silty sandstone in its basal 50 feet and again in the uppermost 100 to 150 feet. The diagnostic early Valanginian Buchia keyserlingi (Lahusen) fauna occurs locally in the middle part of the division (GSC loc. 87866).

The Blue-grey shale division of the western part of Bonnet Lake-Blow River area is only equivalent to the upper part of the 900 to ?1,100 feet thick interval of Bluish grey shale separating the reduced and lens-like facies of Lower sandstone division (restricted) from the White quartzite division on the eastern side of Blow Pass (Jeletzky, Ref. 5, p. 207). The lower part of this shale interval is evidently replaced laterally by the underlying 450 feet thick sandstones of the Lower sandstone division.

White quartzite division. In the western part of the area white-weathering, quartzite-like sandstones lithologically and stratigraphically similar to the White quartzite division (Jeletzky, Ref. 4, p. 14-19) were only studied in one section situated on the southern side of a 2,000 feet+ high, isolated mountain (approx. Lat. 68°18'50"N; Long. 138°15'W.). These at least 200 feet thick (top not reached) sandstones overlie the Blue grey shale division conformably and apparently gradationally, and are lithologically similar to the facies of White quartzite division outcropping on the eastern side of Blow Pass (Jeletzky, Ref. 5, p. 207). Only poor discontinuous exposures of similar sandstones were seen elsewhere in the western part of the area in the mostly covered interval separating Blue-grey shale division from the lk equivalents of Coaly quartzite division. The thickness of White quartzite division probably does not exceed 250 to 300 feet anywhere on the western side of Blow Pass. This attenuated unit is believed to represent only the basal part of the about 1,000 feet thick White quartzite division exposed on the eastern side of Blow Pass, the rest being replaced laterally by the equivalents of Coaly quartzite division (see below).

Equivalents of Coaly Quartzite Division. In contrast to the eastern side of Blow Pass (Jeletzky, Ref. 5, p. 207-208) no lithologically recognizable equivalents of the Coaly quartzite division (Jeletzky, Ref. 4, p. 14-19) were observed in the western part of the area. Instead, the attenuated White quartzite division appears to be overlain (contact was not seen) by an at least several hundred feet (possibly up to 1,500 feet) thick unit of non-carbonaceous, very fine grained, fairly quartzose to sublithic sandstones interbedded with somewhat lesser non-carbonaceous sandy siltstones and some dark grey, clay ironstone-bearing shales. Definitely recognizable exposures of this unit appear to be restricted to the northwestern part of the area confined between the southeastern tip of Barn Mountains (approx. Lat. 68°21'45"N.; Long. 138°21'W.) and a nameless flask-shaped lake situated at approx. Lat. 68°17'N.; and Long. 138°16'30"W.

The ridge-forming sandstones comprising the greater part of the division form several 50 to 150 feet thick units. They are mottled light brownish grey to light brown when fresh, weather buff with brown to rust-coloured specks and spots, very fine grained, mostly fairly quartzose to sublithic and moderately well sorted and rounded. Considerable admixture of mica flakes and slight to appreciable admixture of glauconite, limonite, kaolinized feldspar, and dark mineral (?chert) grains occur in these sandstones, which grade often into superficially similar, very sandy siltstone. The sandstones are medium hard and dense, mostly thinly to very thinly and regularly bedded, weather thin slabby to papery. No ripple marks or crossbedding were noted. Some 2-10 inch bands of highly ferruginous, orange to rust-weathering, very fine grained, clay-ironstone-like sandstone occur at irregular intervals. Worm burrows, including segmented ones, occur locally.

A sparse non-diagnostic marine fauna including Pleuromya ex aff. sikanni McLearn, Pinna sp., ?Tancredia sp., ?Solecurtus sp., ?Goniomya sp., and numerous Ditrupa cf. cornu Imlay (e.g. GSC loc. 87633) occurs at several levels. It suggests a low energy marine environment.

The predominatly 20 to 100 feet thick recessive stilstones interbedded with sandstones are mottled light and dark grey, weather mottled light to dull blue-grey or medium brown and fine rubbly to chippy, moderately hard to friable,mostly sandy to very sandy and strongly micaceous, very indistinctly and conchoidally to knotty beded. The siltstones mostly grade into overlying and underlying sandstones. They contain the same sparse non-diagnostic marine fauna as the latter.

The subordinate dark grey shales interbedded with sandstones and siltstones are invariably poorly exposed to almost completely covered. They appear to be lithologically similar to the shales occurring in the overlying and underlying units.

An at least 800 feet thick unit of sandstones interbedded with considerable siltstones and shales outcrops in the banks of Johnson Creek for about 1/3 of a mile each way from the approx. Lat. 68°06'40"N. and Long. 138°17'30"W. On the eastern side this unit is faulted against the Husky Formation while on the western side it is flanked by several hundred feet of unfossiliferous, strongly disturbed dark grey shales and siltstones tentatively assigned to the Upper shale-siltstone division. The sandstones of this unit only differ from those of the previously discussed lic equivalents of Coaly quartzite division in being quartzose to subquartzose, in containing more glauconite and limonite grains, and in being more or less to strongly ferruginous for the most part. These sandstones weather, therefore, reddish brown, bright orange or intensively rust-coloured. Another distinction of the unit consists in the prevalence of pure siltstones and silty shales with clay ironstone bands and concretions over sandy to very sandy siltstone. The rare and non-diagnostic marine fauna (GSC locs. 87626; 87624 and 87629) includes the same pelecypod genera as that of the definitely known sections of the division and an indetermined true belemnite. Because of the above similarities this unit is

tentatively correlated with the ~~E~~equivalents of the Coaly quartzite division outcropping in the northwestern part of the area.

The above described equivalents of the Coaly quartzite division appear to be a largely or (?)entirely marine facies of this division. More work is needed to evaluate the palaeogeographical significance of this facies.

Equivalent of Upper sandstone division. The previously reported (Jeletzky, Ref. 5, p. 208) equivalent of the Upper sandstone division was found to consist of three sandstone members separated from each other by considerably thicker units of dark-grey to black shale or siltstone. The best available section in the western headwaters of Rapid Creek (approx. Lat. 68°17'N; Long. 137°19'W.) consists of an at least 45 foot thick (top covered and probably faulted) of dull grey, weathering dull brown, predominantly fine to very fine grained greywacke rich in chert grains and mica flakes. The uppermost 8-10 feet are often gritty and fine pebbly (mainly chert pebbles) and contain a rich Aptian (Jeletzky, Ref. 1, p. 16) fauna of marine pelecypods (GSC loc. 87422) including Aucellina aptiensis (Pompeckj), A. caucasica (Abich), Astarte n. sp. ex aff. A. cantabrigiensis Woods and Pecten (Entolium) n. sp. A. The member is conformably and apparently gradationally ~~over~~ underlain by about 400 feet (est.) of dark grey, mostly thinly bedded to laminated friable shale with numerous laminae and 1/4"-4" interbeds of medium hard to hard, dull to light grey coloured, more or less sandy siltstone and a few 6" to 3' interbeds of fine grained greywacke. The shale is locally consedimentary slumped and contains rarely scattered fine to coarse (1/4"-3") pebbles and cobbles (6'-9"). It is underlain with an abrupt, uneven and possibly erosional contact by an about 135 foot thick (est.) middle (equals "upper member" of Jeletzky, Ref. 5, p. 208) greywacke member. The underlying beds represent the "Siltstone unit" and the "Lower sandstone member" of the earlier report (Jeletzky, Ref. 5, p. 208). The only difference noted consists in the reduced thickness (40 to 45 feet) of the Lower sandstone member.

The apparently younger dark blue-grey, micaceous, pure to silty, indistinctly but thinly bedded, fairly friable shales occuring downstream from and apparently faulted against the Upper greywacke member in the above described section seem to be still Aptian and older than the Upper Aptian to Lower Albian flysch (Jeletzky, Ref. 5, p. 209-211) as they seem to grade upward into flysch-like argillaceous rocks similar to those of the Lower shale-siltstone unit of this flysch in the axial part of Rapid Creek syncline. All these rocks are, however, too badly faulted and contorted to be certain of their stratigraphical relationships.

Upper Aptian and Albian rocks. The previously reported (Jeletzky, Ref. 5, p. 209-211) Upper Aptian to lower Albian flysch appears to grade upward into fairly thick shelf type deposits. In the principal section (centered at Lat. 68° 17'N; Long. 137°42'30"W.) situated on the southeastern side of a small nameless creek starting on the southeastern side of 2969 foot summit (Topo Map 117A) the flysch appears to be overlain by an at least several hundred feet thick unit of moderately hard, dark grey to jet black, fissile, pure to silty, micromicaceous shale commonly containing numerous, closely spaced rows of rounded to irregularly shaped (2" to 3' in diameter) often septarian concretions.

This so far unfossiliferous shale unit is lithologically similar to and is tentatively correlated with the fossiliferous, late lower to early middle Albian shales widespread in Bell River Basin (see in Section 3 and Jeletzky, unpublished). It is conformably and apparently gradationally overlain by at least 600 (section is poorly exposed and disturbed) feet of dark grey, massive-looking, generally non-concretionary silty shale and more or less sandy siltstone often rich in lamellae and 1"-3" interbeds of light-grey, crossbedded, sandy to very sandy siltstone. These rocks grade upwards, in turn, into an at least several hundred feet thick unit consisting of a cyclical alternation of 15 to 100 feet thick members of: 1. Shale, dark-grey, friable, flaky to earthy and recessively

weathering, micaceous, with rows of 2"-3' flat to rounded, orange-weathering clay ironstone concretions; 2. Siltstone, mottled dark-grey to light-grey, sandy to very sandy and grading locally into very fine grained, silty sandstone, indistinctly and knotty-to corrugated-bedded, rich in various trails and worm burrows, including segmented burrows, moderately hard; and 3. Sandstone brown-grey to buff coloured, hard and dense, indistinctly bedded and weathering chunky to blocky, commonly quartzite-like, fine to very fine grained, moderately well sorted and rounded, quartzose to sublithic. The contacts of these sandstones with adjacent argillaceous members are abrupt but even. The top of these shelf-type Albian clastics is nowhere exposed and appears to be cut off by a major north-south-trending fault, the western side of which exposes Kingak shale and Mississippian coal-bearing clastics.

Dislocated late Tertiary rocks. An at least 650 feet thick sequence of mostly poorly exposed to completely slumped lavender grey, dull blue, or dark brown almost unconsolidated siltstone and silty to pure clay with considerable interbeds of dark brown, friable lignite and minor interbeds of arkose outcrop in the southern bank of Johnson Creek for more than 2/3 of a mile downstream from the approx. Lat. 68°06'50"N.; Long. 138°19'W. The siltstones and clays vary from pure to lignitic containing fragments of lignitized fossil wood and twigs. Numerous thin (1 inch to 1 foot) interbeds and several 10 to more than 40 feet thick beds and members of friable, dark brown, pure to argillaceous lignite occur throughout the unit. All exposed major lignite beds and members are concentrated in the interval 100 to 220 feet (est.) above visible base where they comprise more than 50% of the thickness. Numerous 1 inch to 3 foot-thick interbeds of white to cream-coloured, fine to very fine grained, medium hard and dense to friable or almost unconsolidated, fairly poorly sorted and

rounded strongly feldspathic (estimated to contain 30-40% of feldspar grains) sandstone apparently devoid of dark minerals. These sandstones may be either thinly and evenly bedded to laminated or indistinctly and heavily bedded. An about 25 feet thick (top covered and probably faulted) member of lithologically similar, ripple marked sandstone containing problematical markings and ? worm burrows on some bedding planes forms the visible top of the sequence. This sandstone member contains irregularly rounded 3 to 10-inch-long and 1 to 3-inch-thick inclusions and several-foot-long lenses of strongly ferruginous, dark brown to rust-weathering, very fine grained sandstone or very sandy siltstone.

Clay interbeds adjacent to the principal more than 40-foot-thick lignite member have yielded spores and pollen. These were kindly identified and dated by Mr. A.P. Audretsch of Shell Oil, Canada, Calgary whose written communication of September 24, 1971 follows: "Some blue-grey clays were examined for spores and pollen, above and below the brown coal. The following genera could be identified: Spruce, Alder (Alnus), Birch (Betula), Castanea, Heather family (Ericaceae), Osmunda, Carya, Swamp Cypress (Taxodium), Momipites tennipollis, Pterocarya stellatus, Holly (Ilex), Elm (Ulmus), Metasequoia/Sequoia, and Juglans."

"The assemblage indicates without doubt a Tertiary age, probably Miocene to possible Pliocene? Carya, Castanea, Yuglans, Pterocarya, Ilex are living nowadays along the west coast and in eastern Canada in a temperate climate."

All above described, probably Miocene rocks, including lignite beds and members, strike 310° to 330° and dip southwest at 35 to 45 degrees. They were obviously affected by the major post-mid-Upper Cretaceous (? Tertiary) faults (Jeletzky, Ref. 6, pp. 542-543, 574-576) crisscrossing the adjacent Mesozoic and Palaeozoic rocks. The better exposed interbeds of harder rocks exhibit, indeed, slickensided fault planes with calcitic fillings and are locally contorted The western contact of the sequence appears to be a major northeast-trending fault with at least some strike-slip component. This fault

brings the uppermost sandstone member ofthe sequence against lignitic clays and siltstones similar to and probably correlative with the basal part of the same sequence. The eastern contact of the sequence appears to be another major, north-northeast-trending possibly strike-slip fault which brings it against the Cretaceous shales and siltstones, tentatively assigned to the Upper shale-siltstone division (see above under the Equivalents of Coaly quartzite division). Generally speaking, the style and degree of dislocation of above discussed late Tertiary rocks is comparable to that of adjacent Lower Cretaceous and Jurassic rocks. The above data are important in confirming the previously published conclusions (Jeletzky, Ref. 6, pp. 542-543) that the post-Mid-Upper Cretaceous (? Tertiary) orogeny of Northern Yukon continued well into the late Tertiary (? post-Miocene and even possibly (!) post-Pliocene) time.

7. Headwaters of Berry Creek

Equivalent of Kingak shale

The following complete, apparently unfaulted but indifferently exposed section of Early to Middle Jurassic rocks was measured in the eastern headwaters of Berry Creek between appr. Lat. 67°36'30" N; Long. 137°26'15" W and Lat. 67°36'45" N; Long. 137°30' W (downward sequence):

1. Siltstone, dark brownish-grey to dark grey, weathers dull to light bluish grey and chunky, mostly sandy to very sandy, micaceous, carbonaceous to coaly in part and contains some subvertical coaly plant rootlets, weathers recessively and outcrops mostly poor; contact with the overlying Unnamed Upper Jurassic sandstone covered ... 180 (est.).

2. Irregular and medium to heavy interbedding of 1. Sandstone brown grey to buff coloured, fine to very fine grained, lithic and estimated to be fairly rich in chert (15%), limonite (15-20%) and weathered feldspar (10-15%), medium hard to hard and fairly porous to quartzite-like, mostly very thinly to thinly and regularly bedded (1/8 inch to 2 inch), pronouncedly crossbedded to ripple marked; with 2. Sandy to very sandy, ferriginous ~~to very sandy~~ siltstone with

numerous concretions of clay ironstone. Early Callovian Cadoceras aff. C. barnstoni (Meek) and C. crassum (Madsen) (GSC loc 87819) identified and dated by Dr. Hans Frebold were collected 36 feet below top. Both contacts covered ... 100' (approx.).

3. Almost completely covered interval apparently underlain by dark grey shale and siltstone ... 890' (est.).

4. Sandstone dull to light brown, very fine grained and often grading into very sandy siltstone, apparently quartzose with only a trace of orange limonite, dark mineral and white feldspar grains, fairly well sorted and rounded, moderately hard and dense, thinly to very thinly bedded, commonly intensively ripple marked, only a few ? Inoceramus sp. fragments seen, both contacts covered ... 160' (est.).

5. Almost completely covered interval probably underlain by dark grey siltstone or shale ..... 1650' (est.).

6. Siltstone dark-brown to dark grey, weathers wine-red, dark-rust or chocolate-coloured with limonitic spots and specks, sandy to very sandy, ferruginous, indictinctly bedded to massive, fairly friable and weathers conchoidally to spheroidally. Interbedded with 40 to 45% of 3 to 8 feet beds of superficially similar extremely fine grained sandstone otherwise similar to that of unit 4. A rich marine fauna collected in place 18 to 20 feet stratigraphically below visible top (GSC loc. 87820) includes an early Bajocian Pseudolioceras sp. indet. identified and dated by Dr. Hans Frebold and the belemnites Brachybelus sp. and Pseudodicoelites sp. identified by the writer. Both contacts covered. Visible 45' (approx.).

7. Mostly covered interval apparently underlain by dull brown grey, friable silty shale with interbeds of similarly coloured medium hard, sandy siltstone ... 60' (appr.).

8. Sandstone superficially similar to that of unit 4 but ferruginous and containing numerous inclusions and 4-10-inch bands of bright orange and conchoidally to spheroidally weathering, very ferruginous hard siltstone ("clay ironstone"). Only a few long-ranging marine pelecypods of Mesozoic affinities and Lingula sp. were found in this unit. Both contacts covered. Visible 130' (approx.).

9. An almost completely covered interval apparently underlain by interbedding of dark grey silty shale and rust to chocolate coloured, moderately hard, ferruginous, more-or-less sandy siltstone. No fossils seen. Both contacts covered. Visible 750' (est.). Total thickness 3965 feet.

Unit 9 of the section is tentatively assigned an Early Jurassic age as it is underlain by a more than 250 feet thick Permocarboniferous siltstone unit containing productid brachiopods.

The above results confirm the previously reported (Jeletzky, Ref. 5, p. 211-213) tentative conclusions concerning the lithology and unusually great thickness of Early to Middle Jurassic rocks of the Waters River-Berry Creek area. The arenaceous interbeds of this relatively shallow water facies of Kingak shale must have been derived from a western source area (budding Keele ~~Range~~-Old Crow Landmass). They wedge out, apparently completely, northward, northeastward and eastward and are replaced laterally by the contemporary supratidal sandstones to the west at the confluence of Porcupine and Driftwood rivers (see in Section 8).

Unnamed Upper Jurassic sandstone. The upper part of above described Berry Creek section includes the total of 1,155 feet of Unnamed Upper Jurassic sandstone, the top of which is not reached at the top of a 3,500-foot high mesa-like mountain (approx. Lat. 67°36'30"N; Long. 137°25'15" W). The facies of this sandstone is transitional between the predominantly or wholly marine facies of its other sections situated farther to northeast (Jeletzky, Ref. 5, p. 211, Fig. 2) and north (see below in this section) and the predominantly non-marine facies of the sections situated on Porcupine River and in southeastern Keele Range (Jeletzky, Ref. 5, pp. 211, 213, Figs. 2, 3). Marine fossils are rare and restricted to a few beds and the unit includes considerable intervals of moderately to strongly carbonaceous sandstones devoid of marine fossils and locally rich in carbonized subvertical plant rootlets. The about 1,000 feet thick siltstone-shale interval of Waters River section is, furthermore, reduced to some 165 feet in Berry Creek section presumably because of its shoreward pinching out.

Like the previously reported, much thicker Waters River section (Jeletzky, Ref. 5, p. 211, Fig. 2), the Berry Creek section of Unnamed Upper Jurassic sandstone extends from *Buchia concentrica* zone (GSC loc. 87818) to *Buchia fischeriana* zone (GSC loc. 87815) inclusive. The topmost 260 feet and the basal 288 feet of the section did not yield any diagnostic fossils. The latter, predominantly carbonaceous to coaly, presumably non-marine interval may be early Oxfordian to mid-Callovian in age judging by its stratigraphic position.

The only complete section of Unnamed Upper Jurassic sandstone measured in the extreme northeastern headwaters of Berry Creek is situated at approx. Lat. 67°45' N; Long. 137°31'30" W. There the unit consists of a lower about 850' thick (est.) unit of fine to very fine grained, quartzose, entirely marine sandstone moderately to fairly moderately well rounded glauconitic (est. 5-15%), and sorted, medium to thin but indistinctly bedded. Neither coarser grained sandstone interbeds nor any interbeds of carbonaceous to coaly sandstone were noted in this unit which overlies the Kingak shale conformably and apparently gradationally. The unit contains *Buchia concentrica* (Sowerby) s. lato (GSC loc. 87661) in the lower part and *Buchia mosquensis* (v. Buch) s. lato (GSC loc. 87660, 87662, and 87663) in the upper part.

An about 75 feet thick (est.) unit of very poorly exposed, possibly faulted dark grey shale separates this lower sandstone unit from an about 700 feet thick (est.) unit of mottled white grey to dull grey, dark speckled, predominantly fine grained, subquartzose to sublithic sandstone somewhat arbitrarily assigned to the Unnamed Upper Jurassic unit. This mostly poorly sorted (admixture of medium sized grains and larger angular fragments) and rounded sandstone is either poor in or completely lacks glauconite grains and contains instead an appreciable to strong admixture of coaly grains and fragments and of those of white kaolinized feldspar. The unit grades upward into poorly exposed dark grey shale corresponding to the upper part of Husky Formation.

The upper sandstone unit contains the latest Jurassic Buchia cf. terebratuloides-Buchia n. sp. aff. okensis fauna (GSC loc. 87664) in the basal part, presumably basal Cretaceous Buchia cf. okensis fauna in the lower third (GSC loc. 87665) and the late Berriasian Buchia uncitoides s. lato fauna (GSC 87666) in the uppermost 100 feet. This upper sandstone unit evidently replaces laterally most of the middle and upper parts of Husky shale of Bonnet Lake-Blow Pass (Jeletzky, Ref. 5, p. 207, Fig. 1) and Upper Bell River (Jeletzky, Ref. 4, p. 6-9) areas and represents their western, neritic to littoral facies.

Husky Formation. A possible 750 feet thick (est.) unit of extremely poorly exposed shale, apparently faulted and contorted in part, overlies the Upper sandstone unit of Unnamed Upper Jurassic sandstone in the northeasternmost headwaters of Berry Creek. This so far unfossiliferous dark grey, friable, micaceous and silty shale appears to be a westward thinning wedge of Husky shale confined between the shallow marine facies of Unnamed Upper Jurassic sandstone and the littoral to beach facies of restricted Lower sandstone division (see below). This unit or its sandstone equivalent appears to be completely destroyed by the erosion in the more southerly and westerly parts of the area where the older beds of the unnamed Upper Jurassic sandstone represent the principal erosional level.

Lower sandstone division (restricted) was only found in the extreme northeastern headwaters of Berry Creek on the ~~W~~western slope of a 4,000' + high range delimiting Berry Creek and Waters River basins (approx. Lat. 67°44'40" N; Long. 137°30'30" W). This division (= Buff sandstone member; see in Section 6) is represented by at least 140 feet (base covered and possibly faulted and the top part disturbed by faulting) of sublithic to lithic sandstone, dull brown to dull brown grey with dark grey stripes, specks and spots, mostly fine to very fine grained, moderately hard to hard and dense but mostly not quartzite-like, poorly to extremely poorly sorted (small to large admixture of medium to coarse grains and larger lithic fragments) and rounded (angular to subangular grains strongly predominate), carbonaceous to coaly and locally contain~~s~~ing specks, partings and up to ½ inch lamellae of pure shiny

coal. The sandstone is rich in fresh and Kaolinized feldspathic grains (up to 40%) and also contains up to 15% of dark mineral (? mostly chert) grains and lithic fragments. Limonite and glauconite grains are mostly rare but may increase locally to 5-15%. The sandstone ranges from medium bedded to (more commonly) thinly bedded (1"-6") or laminated characterized by a regular alternation of darker coloured, more carbonaceous to coaly and lighter coloured, non-carbonaceous to feebly carbonaceous laminae, very intensively crossbedded and ripple marked throughout. Several 1-inch- to 3-foot thick, mostly medium to coarse grained and gritty, apparently lenticular sandstone interbeds are replete with 1/8" to 3", red, brown and dull grey, flattened clay balls commonly associated with marine pelecypods.

This peculiar facies of Lower sandstone division (restricted) appears to represent an alternation of littoral to beach deposits with subordinate deltaic (e.g. the coarser, clay ball-bearing sandstones) and outer marine bar deposits. Because of the presence of deeper water marine facies (upper shelf to high marine) of the division to the east, northeast, and north of Berry Creek area (Jeletzky, Ref. 4, pp. 9-12; Ref. 5, p. 207 and in Section 6 of this report) this shoreline facies must have been deposited at the eastern or northeastern margin of Keele Range-Old Crow Landmass (Fig. 1) and derive entirely from this western source area.

The Lower sandstone division grades upward into the marginal facies of Blue grey shale division through a 45-50 feet thick unit consisting of a thin interbedding or interlamination of sandstones and siltstones.

Well preserved Buchia volgensis Jeletzky, 1964 non Lahusen 1888 and more rare representatives of B. uncitoides (Pavlow 1907) and B. keyserlingi var. visiginensis (Sokolov, 1908) (GSC loc. 87667 and 87668) occur at intervals throughout the exposed thickness of the division. B. aff. unschensis (Pavlow, 1907) (Jeletzky, Ref. 7, pl. I, fig. 5) was found in the basal 5 feet of the transitional unit (GSC loc. 87669).

Blue grey shale division (marginal facies of) occurs in the same sections as the restricted Lower sandstone division. It is 300 to 350 feet thick and is represented predominantly by a medium (2"-6") to thin, mostly irregular interbedding of prevalent friable siltstone dark to dull grey, recessively and fine rubbly- to chippy-weathering, pure to sandy with subordinate fairly to medium hard siltstone, dull to light grey, sandy to very sandy, locally crossbedded on a small scale. Thin to heavy interbeds (? up to 30 feet) of dark grey, bluish-grey-weathering shale, which dominates the division in the Upper Bell River area (Jeletzky, Ref. 4, pp. 12-14) and in the western part of Bonnet Lake-Blow Pass area (see in Section 6), are rare and restricted to the middle part of the division.

The decreased thickness and the predominantly silty development of Bluish grey shale division in the northern part of Berry Creek area (Fig. 1) indicates its being a more shallow water, westward sanding out facies of this division. Like the sandstones of underlying units, the sediments of blue grey shale division of Berry Creek area must have been derived entirely from the Keele ~~Range~~-Old Crow Landmass (Fig. 1).

Buchia keyserlingi (Lahusen) and poor polyptychitid ammonites occur rarely in the middle part of Blue grey shale division.

White quartzite division forms the crest of previously mentioned 4,000' + high ridge delimiting Berry Creek and Waters River basins. This division is at least 400 feet thick (top not reached) and its facies appears to be similar to that of the Upper Bell River area (Jeletzky, Ref. 4, pp. 14-16). This division was not studied closely.

center heading

8. Porcupine River between Driftwood and Old Crow Rivers. That part of Porcupine River surveyed in 1971 is characterized by an almost complete absence of Jurassic and Lower Cretaceous rocks and by the widespread occurrence of predominantly marine early to mid-Upper Cretaceous rocks.

Unnamed Lower or (?) Middle Jurassic sandstone. The presence of possibly Lower Cretaceous or Jurassic light grey sandstones on the west bank of Porcupine River, 2½ miles below the mouth of Driftwood River was mentioned by Mountjoy (Ref. 8, p. 7).

These sandstones are dull to brownish grey, weather light brown to dull reddish brown, medium hard and fairly porous, mostly very fine to fine grained, subfeldspathic and sublithic. They always contain an admixture of dark mineral (? chert) grains. The sandstones are ferruginous and rich in oreoles of ferruginous oxidation and in small limonitic vugs, apparently non-carbonaceous, fairly poorly rounded (subangular to subrounded grains predominate) and sorted, moderately hard and fairly porous.

Mud cracks, ferruginous ¼" to 1½" in diameter flattened clay balls, and subvertical rootlets of plants abound locally in the upper 40 feet of the unit. This generally unfossiliferous, supratidal part of the unit includes at least one 1-foot thick marine interbed of limonite-permeated and-crusted, fossiliferous sandstone containing scattered grit particles and fine quartz and chert pebbles up to ½-inch in diameter. The fauna (GSC loc. 87657) includes the apparently mid-lower (Pliensbachian) to early Middle (Bajocian) Jurassic Hastites ex gr. clavatus (Schlotheim)* and non-diagnostic Oxytoma sp., and ? Astarte sp. A 2-foot thick bed of fine to very fine (1/8"-1") pebble conglomerate with considerable sandy pods and interbeds gradationally underlies these upper sandstones. This fossiliferous marine conglomerate consists almost exclusively of poorly rounded to angular quartz and chert pebbles with an admixture of flattened clay balls. The fauna (GSC loc 87659) includes Hastites ex gr. clavatus (Schlotheim), Pecten (Camptonectes) sp., Oxytoma sp., ? Astarte sp., and ? Lima (s. lato) sp. and is of the same age as that of GSC loc. 87657.

Some 35 to 40 feet of anticlinally bent sandstones are exposed stratigraphically beneath the conglomerate bed (contact covered). These sandstones are closely similar lithologically to the upper sandstones but are medium to heavily (6"-2½') and indistinctly bedded and apparently devoid of mud cracks, clay balls and gritty to pebbly intervals. Rare marine pelecypods similar to those found in the upper sandstones occur in these lower sandstones (GSC loc. 87658).

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* Closely similar Hastites ex gr.clavatus (Schlotheim) occur,however, in the ammonite-bearing Callovian rocks of southeastern Alaska(unpublished observations in the USGS collections preserved in the Smithonian Institution,Washington,D.C.,USA).

The top of the unit is covered and it is probably faulted against the Upper Cretaceous marine shales outcropping farther upstream. The base of the unit is also covered and its stratigraphical and structural relationship with adjacent Paleozoic rocks downstream (Mountjoy, Ref. 8, p. 7) are unknown.

The above discussed Unnamed Lower or(?) Middle Jurassic sandstone is the

The above discussed Unnamed Lower Jurassic sandstone is the

supratidal to beach facies of restricted Kingak shale and its more shallow water marine equivalents (e.g. in Berry Creek area; see Section 7). The presence of these shoreline deposits on the northeastern side of Keele Range and the apparent absence of Jurassic and pre-Albian Lower Cretaceous marine rocks in the eastern part of Keele Range and adjacent parts of Porcupine River (i.e. between Porcupine River Canyon; see Jeletzky in Frebold, Ref. 9, p. 2, Footnote, and Driftwood River) indicate the presence of Early to Middle Jurassic source area (? an island) there. The widespread occurrence of high marine facies of the restricted Kingak shale in northwestern Ogilvie Mountains and the headwaters of Kandik River (Jeletzky, Ref. 5, pp. 213, 218, Fig. 3) indicates that this ancestral land was much smaller than its Late Jurassic to Lower Cretaceous successor (i.e. Keele -Old Crow Landmass; see Fig. 1). ~~Too little is known about the~~ The inferred extent of this Early to Middle Jurassic western land (nucleus of Keele - Old Crow Landmass) is shown ~~to attempt its graphic presentation~~ in Fig. 3.

Unnamed Middle Jurassic siltstone. An at least 200 feet thick, mostly poorly exposed siltstone unit outcrops intermittently in both banks of Old Crow River for about 4 miles (straight line) above its mouth. The siltstones are dark blue-grey to mottled dark and blue grey, moderately hard to fairly friable, sandy to very sandy, strongly micaceous and commonly carbonaceous to coaly. Rows of 6" to 12" rounded, highly fossiliferous concretions of hard, ferruginous siltstone weathering dark brown to rust-coloured occur at several levels.

Bathonian Arctocephalites or Cranocephalites, belemnitids, and Inoceramus spp. have been identified by Dr. Hans Frebold (GSC loc. 87622) from a concretionary bed situated near the visible top of the unit at approx. Lat. 67°36'15" N; Long. 139°46'15" W in the west bank of Old Crow River.

The base of the unit was not seen and its deeply eroded upper surface is highly discordantly

overlapped by the almost horizontal ?non-marine ?Tertiary sandstones.

The still insufficiently understood Bathonian siltstone unit is a neritic deposit. It appears to be a relatively shallow water western facies of the restricted Kingak shale deposited in the proximity of and derived from the Keele ~~Mountain~~-Old Crow Landmass (Fig. 1). This facies appears to be roughly equivalent palaeogeographically to the equivalents of Kingak shale exposed in the southern part of Berry Creek area (see Section 7) and in the Porcupine River canyon (Jeletzky in Frebold, Ref. 9, p. 2, Footnote). The exact palaeogeographical significance of the is Bathonian unit is uncertain as its sediments could have been derived either from the south (Keele Range area) or from the west (Old Crow Range area) (see Fig. 3)

Early to mid-Upper Cretaceous marine sequence. The Upper Cretaceous marine rocks outcropping at intervals in the banks of Porcupine River between the mouth of Driftwood River and the Old Crow village were discovered by McConnell (Ref. 10, p. 127D, map sheet No. 8). Some Turonian or Coniacian and Santonian inocerami have been subsequently identified from these rocks (see Mountjoy, Ref. 8, p. 7 and Jeletzky, Ref. 11, p. 54, 59). However, these rocks are not shown on GSC Map 10-1963 and were not previously studied in any detail.

Turonian shale unit. The oldest known unit of the Upper Cretaceous sequence is the at least 180 feet thick (neither the base nor the top were seen) unit of shale, dark grey, weathering olive grey, first conchoidally to spheroidally and then fine rubbly, mostly pure, apparently non-carbonaceous and non-calcareous. In the principal section studied, which is situated on the right (northeast) bank of Porcupine River about 7¼ miles below the mouth of Driftwood River (appr. Lat. 67°37'35"N; Long. 138°36'25"W.), the upper 130 feet of the unit contain only very rare and thin (up to 3") interbeds of fine to very fine sandstone (as in underlying part of the unit; see below) and are unfossiliferous.

The lithology of the lower 50 feet+ (est.) of the unit exhibits strong lateral facies changes. In northwestern part of the exposures these beds consist of an irregular interbedding of 6" to 3' thick shale beds with similarly thick beds of greywacke-like sandstone, greenish grey to brownish grey and "salt and pepper" coloured, mostly fine to medium grained, sublithic to lithic (estimated to contain at least 40% of chert and other dark minerals, kaolinized to fresh feldspar, limonite and coal grains combined), poorly sorted (contains an appreciable to considerable admixture of coarse grains and larger lithic fragments) and rounded (subangular to low spherical grains predominate), moderately hard and dense and somewhat to fairly porous. Numerous small pods and 2"-6" thick lenses of lithologically similar, medium to coarse grained, gritty and fine pebbly sandstone, locally rich in ferruginous, dull orange- to rust-coloured, often flattened 1/8"-2" clay balls and 1/8" to 1" angular fragments of similarly coloured shale and lithic, fine grained sandstone occur in these sandstone interbeds. The sandstone is carbonaceous to coaly and often contains coaly partings, laminae, and up to 1/2-inch thick pods and layers of black, shiny coal. The bedding surfaces of carbonaceous to coaly laminae are commonly replete in poorly to well preserved, carbonized dicotyledonous leaves.

Small scale crossbeds and pinched to round-crested, low and broad ?current marks abound locally. Their troughs are filled out by shale.

The rocks are commonly penecontemporaneously slumped and the lower surfaces of sandstone interbeds are often covered by well developed flute casts, scratch marks and pinch marks. The variegated lower part of the unit at least appears therefore to consist of proximal turbidites and ?fluxoturbidites deposited on a steep submarine slope. An adjacent northwestern or ?western source area (Fig.3) is indicated by the regular southeastward (i.e. upstream) thinning out of all sandstone interbeds within an about 250 to 300-yard long interval of good exposures. At the end of this interval the interbeds either completely pinch out or are reduced to 1"-3" thick layers such as occur in upper 130 feet of the unit.

Farther southeast within the remaining 180 to 200-yard long stretch of good outcrops all exposed thickness of the unit is represented by shale with thin and rare interbeds of fine grained sandstone.

Several sections of the Turonian shale unit are exposed around the mouth of Driftwood River (e.g. McConnell, Ref. 10, p. 127D and map-sheet No. 8; Mountjoy, Ref. 8, p. 7). These only briefly visited sections appear to be represented by dark grey shale with minor interbeds of siltstone and fine-grained, lithic sandstone. The lower contact of the unit is not exposed in any of these sections. It seems likely, however, that the unit overlies directly the adjacent Palaeozoic rocks.

No exposures of the Turonian shale unit were seen on either bank of Porcupine River downstream of the above described principal section. The unit apparently plunges beneath the younger Upper Cretaceous rocks in this direction and does not reappear at the western margin of the Upper Cretaceous outcrop-area near Old Crow village because of the westward overstep of the Santonian sandstone unit (see Fig. 3).

The sandstone interbeds in the basal 50 feet of the principal section have yielded numerous and well preserved latest Turonian (Jeletzky, Ref. 11, p. 31-32) Inoceramus deformis Meek s. lato including of its giant, up to 1½-foot long variant and some I. cf. sturmi Andert (GSC locs. 87607, 87610, 87611 and 87612). Poorly preserved inocerami of the same general type have been collected from other exposures of the unit (Mountjoy, Ref. 8, p. 7). No Cenomanian fossils have been seen in any of the sections. However, the presence of Cenomanian beds in the lowermost parts of the only briefly visited sections in the proximity of Driftwood River seems likely because of the presence of Inoceramus ex gr. dunveganensis McLearn in the Eagle Formation exposures on Bell River (Mountjoy, Ref. 8, p. 6).

Dark grey siltstone unit. An about 200 feet thick (rough estimate only) unit outcropping in the undercut northern (right) bank of Porcupine River at the point about 2 3/4 miles upstream of the upper end of Cadzow Lake (appr. Lat. 67°35'30"N; Long. 138°52'45"W.) consists of dark grey to dull blue-grey (siltstone which weathers mottled light blue grey and) ~~and~~ dull brown to dark rust-coloured and conchoidally to spheroidally. This siltstone is friable, sandy to very sandy, massive-looking to indistinctly, corrugated- to knotty-bedded. Rows of ellipsoidal 1-5 foot long and 6-12 inches thick concretions of dull grey, hard to very hard siltstone or shale mostly extensively burrowed by mud eaters and rows of concretions of dark-brown weathering, hard clay ironstone occur at irregular intervals. Some laminae, thin interbeds and several up to 5 feet thick beds of sandstone superficially similar to the above siltstone, very fine grained and silty to very silty occur in this unit which has only yielded poor fragments of carbonized plants. Both contacts are covered in the above section situated on the southwestern flank of an open, northwest-trending anticline near its core. However in another section tentatively referred to this unit and situated about 3/4 mile upstream on the north-eastern flank of the same anticline about 25 feet of lithologically identical siltstone grade upward into about 60 feet of bluish grey, ash grey and earth weathering, very friable shale devoid of any concretions. This unfossiliferous shale is lithologically identical with and is tentatively placed into the basal part of the Santonian shale unit. This conclusion agrees well with the stratigraphical relationships (contacts are covered) of the above siltstone and shale units with the adjacent fossiliferous sections of Santonian shale unit which occupy the outer flanks of the same anticline.

No outcrops of Dark-grey siltstone unit were seen in the proximity of the Turonian shale unit and the stratigraphic relationships of these two units remain obscure except that the former unit is the younger of the two.

Santonian shale unit. The next younger unit consists of at least 160 feet of dark blue-grey to bluish grey and earthy-weathering, mostly friable to almost unconsolidated, pure to silty shale. The previously mentioned lower 60 feet+(rough estimate only) appear to lack any concretions and are partly silty. The upper 100 feet contain several rows of large to huge (up to 12 feet in diameter), elongated to rounded, mostly septarian concretions of mottled dull to light grey, buff-weathering, impure, hard to very hard limestone. Several 2-4 inch thick, bright-orange-weathering benthonite layers occur in these beds. The concretions and benthonitic layers are largely concentrated in the basal 15 feet of these beds. The top of the unit was not observed in any of the sections studied.

Large(up to 4 feet long) inocerami including well preserved Inoceramus steenstrupi de Loriol 1883 (GSC loc. 87619) and I. lundbreckensis McLearn 1929 (= ?I.patootensisformis Seitz 1965) occur commonly in the concretionary and benthonic interval 85 to 100 feet below visible top of the unit.This fauna (especially the presence of I.steenstrupi) suggests a mid- to late Santonian age for this interval. However, its early Campanian age cannot be ruled out. No fossils were found in older and younger beds and the unit is only tentatively assigned a mid- to late Santonian age.

Outcrops of the Santonian shale unit appear to be confined to the stretch between the eastern end of Cadzow Lake (appr. Lat. 67°33'30"N; Long. 138°56'30"W.) and a point about 4½ miles farther upstream (appr. Lat. 67°35'40"N; Long. 138°48'45"W.). The unit appears to be eroded away east of the latter point but its disappearance from the outcrops downstream (i.e. westward) of Cadzow Lake appears to be caused by lateral facies changes (see below).

Santonian sandstone unit. Extensive but scattered outcrops of variegated, mostly feldspathic marine sandstones with subordinate interbeds of sandy siltstones occur in the banks of Porcupine River in the interval 10 to 19 miles downstream of Cadzow Lake (i.e. from appr. Lat. 67°31'N; Long. ~~139°37'30"W~~ 139°20'W to appr. Lat. 67°35'20"N; Long. 139°37'30"W).

The apparently oldest known about 50 foot thick unit is exposed in a 4/5 of a mile long bluff of the undercut southern (left) bank of Porcupine River (appr. Lat. 67°31'30"N; Long. 139°20'15"W.) It consists of sandstone mottled greenish brown to brown-grey ("salt and pepper-coloured"), weathering mottled brick red, dull brown or various shades of rust and fine blocky to chunky, fine to very fine grained, feldspathic to sublithic, fairly rich in dark mineral grains (?mainly black chert) and with some limonitic grains. Partings, laminae, thin layers and 2 to 4 foot-thick beds of dull grey to dark grey, strongly arenaceous siltstone or very fine grained, very silty sandstone occur in this sandstone unit. Large inocerami collected 30 to 35 feet above the visible base include a mid- to late Santonian (possibly mid-Santonian) fine ribbed variant of Inoceramus pinniformis Willett closely resembling I. pinniformis subsp. martinii Seitz, 1965 (GSC loc. 87618).

The apparently slightly younger beds of the unit outcrop in the bluffy, northern bank of Porcupine River at appr. Lat. 67°35'25"N; Long. 139°31'15"W. The section begins with at least 70-foot thick (base was not seen) siltstone dull brownish grey, locally bluish tinged, massive-looking to indistinctly and irregularly bedded, fairly friable and weathering fine rubbly, locally carbonaceous, sandy to very sandy and locally grading into superficially similar very fine grained very silty sandstone. Several rows of ellipsoidal 1 to 5-foot long and 6-12 inches thick unfossiliferous concretions of dull grey, hard to very hard siltstone and 3-inch to 8-inche fossiliferous concretions of moderately hard, very sandy siltstone occur in the unit. The latter contain a diversified pelecypod fauna (GSC loc. 87621) including Inoceramus lundbreckensis McLearn, 1929, Anomia cf. subquadrata Stanton, Pholadomya sp., ?Pinna sp. and Pecten (Entolium) sp. On the western side these beds are faulted against an at least 250 feet unit of sandstone white to cream-coloured with rust coloured specks, weathering

spheroidally and bright orange to bright yellow with numerous brick-red limonitic fillings of joint planes, mostly fine grained, strongly feldspathic (50% or more) and very poor in dark mineral grains (less than 5%). Sorting and rounding is poor to fairly poor, most grains being subangular. The sandstone is ferruginous to strongly ferruginous, mostly fairly friable but rarely moderately hard, fairly porous, mostly heavily and indistinctly bedded, apparently devoid of crossbedding and ripple marks. Numerous but fragmentary Inoceramus steenstrupi de Loriol 1883 (GSC loc. 87620) occur in the middle part of the unit. The top of the unit is not exposed (?faulted) but lithologically similar , folded and faulted sandstones outcrop at intervals in the north bank for the next 2 1/3 miles downstream. At the end of this interval (appr. Lat. 67°35'20"N; Long. 139°37'30"W) they appear to rest directly on the mid-Palaeozoic (?Silurian) dolomites. The outcrops are poor, small and discontinuous. However, an orange-weathering, fine to medium (¼"-2") basal pebble conglomerate seems to underlie the above sandstones and to overlie a deeply weathered surface of the dolomite. The Santonian sandstone unit is largely geologically contemporary to the Santonian shale unit and may include some slightly older (mid-Santonian) beds. Therefore it appears to be the littoral facies of the latter unit deposited in the proximity of the western shoreline of mid-Upper Cretaceous basin. These facies changes and the apparent absence of pre-mid to late Santonian rocks in the westernmost section of the Santonian sandstone unit suggest a gradual westward onlap of the early to mid-Upper Cretaceous sea (Fig. 3). As elsewhere (Jeletzky, Ref. 11, p. 50, 56) this regional transgression apparently reached its peak in the mid- to late Santonian time when the sea overstepped the mid-Palaeozoic dolomites closely east of Old Crow village (Fig. 3).

New P

Non-marine ?Cretaceous sandstone unit. The poorly exposed, about 10 miles wide interval immediately downstream of Cadzow Lake appears to be underlain by sandstones

lithologically different from and possibly geologically younger than those of the Santonian sandstone member. The best section seen is situated on the northern bank of Porcupine River at appr. Lat. 67°34'N; Long. 139°10'W. There the sandstones are dull bright orange, mostly medium to coarse grained, highly feldspathic (at least 50%) but with a considerable ratio of dark mineral (?black chert) grains. These poorly sorted and rounded sandstones are locally carbonaceous to coaly and contain grains and pebbles of black coal. They are interbedded with some dark grey, blocky-weathering, often silty and carbonaceous shales. Neither the top nor the base of this at least 150 feet thick unit was seen. The rocks are strongly folded on a small scale and locally faulted. It is suggested tentatively that these apparently non-marine sandstones are younger than the Santonian sandstone unit and of a late Upper Cretaceous ~~A~~age. They could be equivalent to Monster Formation of Mountjoy (Ref. 8, p. 4).

9. Sharp Mountain area

Lower Albian conglomerates and their palaeogeographical significance. The slopes of 3395-foot high Sharp Mountain in the eastern part of Keele Range (appr. Lat. 67° 11'45"N; Long. 138.41'25"W; see Fig. 1) and those of adjacent ridges to the west and to the east expose a thick succession of pebble conglomerates previously assigned either Permian (GSC Map 10-1963) or Late Devonian (Bassett and Stout, Ref. 12, p. 750, Fig. 11) age but found to be Lower Albian by the writer.

In the principal section measured on northwestern slope of Sharp Mountain the pebble conglomerate sequence consists of three ~~principal~~ ridge-forming units respectively 490-,690- and 40-foot thick (downward sequence) and separated by entirely covered, respectively 865- and 155-foot thick intervals. The covered intervals are believed to be underlain either by friable conglomerates or (?) by argillaceous rocks. Each ridge-forming conglomerate unit is lithologically different (see below) and the section appears to be structurally conformable and basically continuous throughout in spite of the local faulting and steepening of its persistently southerly dipping rocks. The conglomeratic sequence is accordingly interpreted as being at least 2,930 feet thick.

The conglomeratic sequence appears to underlie disconformably and probably unconformably the poorly exposed clastics of Eagle Plains Formation (Mountjoy, Ref. 8, p. 5). Its base is concealed and probably faulted in the principal section. However, it appears to overlie unconformably Permian and ?older Palaeozoic rocks in some shorter, adjacent sections.

The upper ridge-forming conglomerate unit of the principal section consists of mottled light-brown-grey and green or less commonly bright orange, mostly fine to very fine (1/8" to 1/2") pebble conglomerate which commonly grades into coarse grit but includes sizable pods and 1 to 6-inch thick interbeds of somewhat coarser (1/4" to 1") pebble conglomerate. Pebbles are predominantly fairly rounded to subangular but the conglomerate includes a fair ratio of subangular to angular finer pebbles and grit particles. The conglomerate is estimated to include 55 to 60% of chert pebbles, 20-25% of white, mostly feebly weathered feldspar pebbles, 10-15% of quartz pebbles and 5-15% of pebbles consisting of various metamorphic and clastic rocks. The abundant gritty to very coarse grained sandy matrix consists almost exclusively of chert and feldspar grains. The conglomerate is moderately hard to fairly friable, fairly tightly to tightly packed but is not silicified. It is mostly poor in cement (mostly ferruginous), has a fair to good porosity and is thinly to medium (2" to 18"), fairly regularly bedded. Some 1/4 to 1-inch thick, lenticular interbeds and pods of bright orange-weathering, strongly ferruginous, hard, fine grained lithic sandstone or sandy siltstone ("clay ironstone") with scattered grit particles and fine pebbles occur at irregular intervals. One of these interbeds occurring 352 feet below the unit's top (GSC loc. 87670) has yielded fragments of a specifically indeterminate Inoceramus sp. and a pectenid. Only some fragments of lithified fossil wood were found elsewhere in this unit.

The middle conglomerate unit differs from the upper one in the presence of considerable interbeds and up to 100 feet thick members of friable, recessively weathering conglomerate and rare 1 to 4-inch thick beds of light brownish grey,

weathering buff, fine to medium grained, locally carbonaceous greywacke-type sandstone containing poor marine pelecypods (GSC loc. 87671). Some bedding surfaces of these sandstones carry asymmetrical ripple marks. Lower bedding surfaces are locally covered by flute cast-like markings.

The basal conglomeratic member consists of an irregular, often lenticular, thin to medium (1 to 12 inch thick) interbedding of strongly ferruginous, light brown to rust-weathering, fine to very fine pebble conglomerate with light to whitish grey or cream-coloured, light to dark brown or light-rust-weathering sandstone. The conglomerate is mostly very rich in sandy to silty matrix and contains pebbles of characteristic Devonian pebble conglomerate rich in fine to very fine clasts of semitransparent blue-grey chert but is similar otherwise to that of the overlying units. The sandstone is estimated to contain 30 to 40% of feldspar grains, some 25-30% (of dark mineral (mostly chert) and 10 to 15%) of orange-coloured limonite grains. It is predominantly fine grained but contains variable admixture of medium to coarse grains, grit particles, fine to very fine pebbles, angular fragments of dull grey carbonaceous to coaly shale and 1/8" to 1½ inch flattened clay balls. Sorting and rounding of grains is invariably poor, most grains being subangular to angular. The sandstone contains some grains, pebble size clasts, and rare specks, laminae and 1/4 to 1/2-inch thick interbeds of black shiny coal, is moderately hard to hard and dense but not quartzite-like, and has some interstital porosity. No crossbedding or ripple marks noted. Fragments of fossil wood and poor fragments of carbonized plants, including some ferns and ?dicotyledonous leaves, occur locally. Rich and variegated marine fauna found at several levels (GSC locs. 87672, 87673, 87675 and 87676) includes late Lower Albian Sonneratia Bayle 1878 s. lato (including Tetrahoplites Casey 1952 and Hemisonneratia Casey, 1952), Lima (Limatula) sp., Pecten (Entolium) sp., ?Inoceramus sp., ?Arctica sp., Modiolus sp. and a rhynchonellid brachiopod. This fauna is geologically contemporary to that occurring

in the Upper shale-siltstone division of the Upper Aptian to Lower Albian flysch in Bonnet Lake-Blow Pass area (Jeletzky, Ref. 5, p. 210). About 1/3 of a mile northeast of the principal section outcrop about 175 feet of dull brown-grey, fine to very fine (1/8" to 1/4") pebble conglomerate consisting almost exclusively of fairly rounded to angular chert pebbles enclosed in dark brown, fine sandy to silty matrix. Sparsely pebbly conglomerate grading upward into pebbly siltstone alternates somewhat cyclically with tightly packed conglomerate in a manner suggestive of the deposition by turbidity currents. Both contacts are covered and probably faulted. This conglomerate is tentatively interpreted as a deeper water facies (possibly a distal turbidite deposit) of the beach to ?piedmont conglomerate of the principal section.

The Lower Albian conglomerates have been traced from the air and on air-photographs for 9 to 10 miles WSW of the top of Sharp Mountain. Northeastward these conglomerate ridges appear to be traceable for 5 to 6 miles only. They apparently extended all the way to Porcupine River, however, as outcrops of lithologically similar and probably correlative chert pebble conglomerates occur on its right bank at appr. Lat. 67°25'N; Long. 138°05'W.

The above described early Albian conglomerates reflect the previously reported (Jeletzky, Ref. 5, p. 209) drastic change of sedimentological regime in southern and western parts of the Richardson Mountain-Porcupine Plain basin caused by strong Aptian tectonic movements. The above described outcrop-belt of these largely or entirely beach to alluvial conglomerates evidently marks the approximate position of a short segment of the shoreline of this marine trough. Because of the presence of deeper water (partly flysch) late Aptian to early Albian marine facies to the east (on Water and Bell rivers), northeast (Bonnet Lake-Blow Pass area) and southeast (headwaters of Cody Creek and Fishing Branch), these conglomerates are believed to outline the southeastern margin of an extensive late Aptian to early Albian orogenic highland (Fig. 3), which was a successor to the Late Jurassic and early Lower Cretaceous Keele-Old Crow landmasses depicted in Fig. 1.

The orientation of above discussed outcrop-belt of early Albian conglomerates, the presence of thick flyschoid ?late Aptian to early Albian rocks on Bell River and Waters River and in headwaters of Cody Creek and Fishing Branch suggest a strong eastward bulging of this successor landmass in Keele Range- middle Porcupine River area. In this area the shape and extent of the late Aptian to early Albian orogenic highland (Fig. 3) may have been similar to those of its Late Jurassic and early Lower Cretaceous predecessors (see Fig. 1). Judging by the known distribution of Upper Aptian to lower Albian flysch in Bonnet Lake-Blow Pass area (Jeletzky, Ref. 5, p. 209) this late Aptian to early Albian successor landmass extended northward well beyond the present Old Crow Range, including at least the western parts of Old Crow Flats and Barn Mountains (Fig. 3). The Chert conglomerate unit of this flysch must have been derived from this part of the tectonic highland.

Thick to very thick, flyschoid ?late Aptian to early Albian rocks appear to be restricted to the relatively narrow western zone of the Porcupine Plain-Richardson Mountain trough (e.g. Bonnet Lake-Blow Pass area, Waters River-Bell River area, headwaters of Cody Creek and Fishing Branch) adjacent to the above discussed late Aptian to early Albian tectonic highland. They are flanked in the east by relatively thin, shelf-like Aptian to early Albian rocks (see in Sections 2 and 3; Jeletzky, Ref. 1, and unpublished). This suggests a strongly asymmetrical, foredeep-like appearance of the late Aptian to early Albian trough which subsided most strongly in its westernmost zone which received the bulk of the sediments.

The flysch-like, thick late Aptian to early Albian sediments outcropping in headwaters of Kandik River

(Jeletzky, Ref. 5, p. 219-220) apparently were deposited within a sublatitudinal strait connecting the late Aptian to early Albian depositional trough of the Porcupine Plain with that of the Charley River (= Kandik River) basin in Central Alaska (Fig. 3). The presumably early Albian, flyschoid rocks occurring in the headwaters of Lord Creek (see in Section 10) are believed to be deposited within a presumably narrow western embayment of the Porcupine Plain-Richardson Mountain trough (Fig. 3). The trough probably ended blindly east of the headwaters of Kandik River within the present northern Ogilvie and Wernecke Mountains (Fig. 3).

10. Headwaters of Bluefish River and Lord Creek

The flat top and slopes of the 4,580 feet high, unnamed mountain massif straddling the divide between Bluefish River and Lord Creek (Fig. 1) are underlain by a thick, basically synclinally bent but locally strongly faulted and contorted sequence of Lower Cretaceous rocks. This outcrop-area has been discovered and briefly described by Mountjoy (Ref. 13, p. 7-8). However, contrary to Mountjoy's (Ref. 13, p. 7-8) conclusions and Jeletzky's (Ref. 5, p. 213) expectations, no Jurassic rocks were found in the investigated part of the area.

The following upward sequence of Lower Cretaceous rocks was obtained by palaeontological and partly stratigraphical-lithological correlation of several adjacent partial sections separated from each other by strong normal and ?reverse faults.

Basal non-marine unit was studied only in one indifferently exposed and disturbed section situated on the southern flank of the massif in headwaters of Bluefish River (appr. Lat. 66°58'40"N; 139°49'35"W). There the unit is estimated to be 155 to 165 feet thick and consists of (downward succession):

1. Sandstone, dull grey, weathers light grey to whitish grey with rust-coloured specks and spots, very fine grained and grades locally into superficially similar

very sandy siltstone, sublithic with estimated 10-15% of the black coaly grains, 5-10% of rust- to orange-coloured limonite grains and a trace to ?5% of white feldspar grains, moderately well sorted according to the grain size but fairly to very poorly rounded, most grains being subangular to angular, mostly massive and weathers large blocky to slabby. The sandstone varies from very hard and dense true quartzite to more rarely hard and dense but porous, and is carbonaceous to coaly throughout. Coaly lamellae, specks, small pods and coaly subvertical tubes (plant rootlets) occur commonly to rarely at several levels. Lower contact covered. Appears to grade upward into Mid- to late Valanginian siltstone-sandstone unit. Lower contact covered ....90-95' (est.).

2. Pebble conglomerate, fine to very fine (1/8" to 1"), dull to brownish grey or brown with rusty spots and specks, pebbles poorly rounded to angular and predominantly consist of chert with admixture of some metamorphic and sandstone pebbles, very rich in matrix consisting of lithic, fine to coarse grained, gritty and pebbly sandstone. The conglomerate contains pods and lenticular interbeds of fine to coarse grit, is carbonaceous to coaly, ~~and~~ contains some wood and plant fragments, and is hard and dense ..... 20' (est.)

3. Shale, olive green to black, weathers dark or bluish grey, recessively and medium to fine flaky, friable, mostly pure but with interbeds of silty shale, micromicaceous, fissile. The shale is non-carbonaceous to ?slightly carbonaceous, except in the uppermost 5 to 7 feet where it is sandy, locally pebbly and strongly carbonaceous to coaly with microlaminae and small pods of shiny coal. The shale grades upward into unit 2. Lower contact covered ..... 40' (est.).

4. Pebble conglomerate, dull grey, fine to medium (1/4"-2") tightly packed, hard to very hard, matrix fine gritty to fine grained sandy and strongly calcareous; otherwise lithologically similar to the conglomerate of unit 2. Outcrops are poor, discontinuous and partly disturbed by strike faults. However, this basal conglomerate appears to be 5 to 10 feet thick (est.) and to overlie discordantly a thick sequence

of mid- to ?early Palaeozoic carbonates (mostly dolomites).

No fossils of any kind were found in the Basal non-marine unit and it is tentatively assigned a mid- to (?) early Valanginian age because of its gradational contact with the overlying Mid- to late Valanginian siltstone-sandstone division.

Mid- to late Valanginian siltstone-sandstone division consists of a 550 to 600 feet thick (estimate based on a somewhat arbitrary combination of several incomplete sections) unit of marine sandstone overlain conformably and apparently gradationally by an about 1,750 feet thick (appr.) unit of marine siltstone.

The sandstone is light brownish grey, weathers light grey to dirty white with medium brown to rust coloured specks and spots, very fine grained and locally grades into superficially similar very sandy siltstone, subquartzose with an appreciable admixture of grains of orange limonite, kaolinized feldspar and black carbonaceous to coaly matter, includes some interbeds of mottled dark to medium grey, coaly sandstone, moderately well sorted but fairly poorly rounded, most grains being subangular to subrounded, hard and dense, strongly silicified but neither quartzite-like nor true quartzite for the most part, massive-looking to indistinctly but medium to thinly bedded, crossbedding and ripple marks mostly absent, weathering-resistant and ridge-forming.

The basal 250 feet of the sandstone unit exposed in the above described section (appr. Lat. 66°58'40"N; Long. 130°49'35"W.) of Basal non-marine unit only yielded a few indeterminate marine pelecypods (GSC loc. 87853). However, in an adjacent section across Bluefish River (appr. Lat. 66°59'15"N; Long. 139°50'25"W.) the sandstone unit yielded well preserved mid- to late Valanginian Buchia n. sp. aff. inflata [Toula] fauna at the levels 430 to 465 feet (GSC loc. 87829) and 20 to 40 feet (GSC loc. 87828) below the top.

The siltstone is dark grey to black, weathers same or dull bluish grey with rusty specks and spots, fine rubbly to chippy, and recessively, friable to

moderately hard, commonly rich in small (1/4"-1/2") worm burrows, mostly sandy to very sandy and contains considerable interbeds of similarly coloured, very fine grained, lithic to subquartzose partly crossbedded and ripple marked sandstone which is mostly limited to the uppermost 500 to 600 feet. In the middle and lower part of the unit sandy siltstone is interbedded with and is sometimes largely replaced by dark grey, pure soft siltstone and similar pure to silty shale weathering flaky to earthy. The unit grades upward into about 535' thick basal part of the Mid-Lower Cretaceous-sandstone-siltstone (faulted at the top) unit in the principal section (appr. Lat. 66°59'40"N; Long. 139°50'25"W.) situated on the southern slope of an about 4,000 feet high ridge overlooking the headwaters of Bluefish River from the north.

In the principal section a depauperated offshore [(?)lower shelf zone] marine mid- to late Valanginian fauna including numerous Buchia n. sp. aff. inflata (Toula), Buchia bulloides Lahusen, Lima (Limatula) ex gr. consobrina (d'Orbigny) and Cylindroteuthis-like belemnites persists through the generally sandy upper 600 feet of siltstone unit (GSC locs. 87825, 87826, and 87827) with the exception of the uppermost 140 feet. The latter beds are represented by thinly bedded to laminated intensively crossbedded and ripple marked, partly ferruginous presumably neritic siltstones containing a rich presumably latest Valanginian fauna (GSC loc. 87824). This fauna includes: relatively rare Buchia sublaevis (Keyserling) s. str., B. cf. crassicollis (Keyserling sensu Lahusen 1888), B. cf. keyserlingi (Lahusen), Arctotis n. sp., Oxytoma sp., numerous long-ranging pelecypods, several species of gastropods, Ditrupa-like worm tubes, and a brittle star fish.

Farther north the several fault slices of Mid- to late Valanginian siltstone-sandstone division were found within the principal outcrop area of Mid-Lower Cretaceous-sandstone-siltstone unit (at appr. Lat. 67°00'; Lat. 139°52').

Judging by the geographic location and the lithology, the Mid- to late Valanginian siltstone-sandstone division of this report corresponds to the "Jurassic shale formation" of Mountjoy (Ref. 13, p. 5, 7). However, this division is definitely early Lower Cretaceous in its entirety. No Jurassic argillaceous rocks were found anywhere in the vicinity and their presence appears to be highly unlikely because of the above described structural relationships between the early Lower Cretaceous rocks and the underlying Palaeozoic carbonates.

The writer has restudied the originals of Mountjoy's (Ref.13, p. 7) Jurassic Buchias reported to be found in his main section 230MJ and confirms the mid-Upper Jurassic age of these fossils. However, the matrix of all these fossil collections is not right for the area. Neither the coquinoid dull-brown-weathering, strongly ferruginous (clay ironstone-like) sandy siltstone (GSC loc. 52718) nor the coquinoid dull-brown-weathering, strongly ferruginous, very fine grained, lithic, very thinly bedded to laminated and crossbedded sandstone (GSC locs. 52636, 52738, 52739 and 52641) was seen in the Mid- to late Valanginian division of our area, except for its firmly dated uppermost 140 feet (see above). At the same time these two rock types are characteristic of the more sandy parts of and sandstone interbeds in the 4,000 feet thick late Oxfordian to early Kimmeridgian dark grey shale-siltstone unit outcropping in Mountjoy's (Ref. 13, p. 5, 7) section 235MJ and restudied more recently by Jeletzky (Ref. 5, p. 213, Figs. 2, 3). Conversely, the matrix of the ~~incomplete~~ previously mentioned (Jeletzky, Ref. 5, p. 213) incompatible collection containing Buchia cf. inflata (Toula) (GSC loc. 52669) allegedly collected in the section 235MJ (Mountjoy, Ref. 13, p. 8) is a hard dull grey, sandy siltstone

lithologically similar to the harder interbeds in the Siltstone unit of Mid- to late Valanginian siltstone-sandstone division. The above discussed fossil collections apparently have been mislabelled prior to their submission for the identification. Only the collection GSC loc. 52669 seems to be actually from the section 230MJ.

In the southeast (i.e. in northwestern Ogilvie Mountains; see Jeletzky, Ref. 5, pp. 213-219, Fig. 3 and this report Figs. 1, 2) the neritic to littoral Mid- to late Valanginian siltstone-sandstone division is flanked by the contemporary but northwest-derived, largely to entirely non-marine equivalents of White and Coaly quartzite divisions. In the east (i.e. in headwaters of Berry Creek; see in section 7) these neritic to littoral rocks are flanked by the littoral to non-marine early to late Valanginian rocks derived from a western source. Therefore, the Mid- to late Valanginian siltstone-sandstone division is believed to result from an eastward onlap of the early Lower Cretaceous sea centered farther west in the marine basin of Central Alaska (Fig. 1) onto the western flank of the Keele-Old Crow Landmass. This embayment was apparently isolated from the adjacent part of Porcupine Plain-Richardson Mountain marine trough.

Mid-Lower Cretaceous siltstone-sandstone division overlies the Mid- to late Valanginian marine rocks conformably and apparently gradationally. The upper and middle parts of the division are approximately 5,000 feet thick in the incomplete principal section which was roughly (mainly by pacing) measured in the north-south direction across the top part of 4,580' high, nameless massif (between approximate latitudes 67°02'N and 67°00'N). In this section the division consists of a cyclical alternation of ten 125 to 275 feet thick, recessively weathering siltstone units with ten 50 to 250 feet thick [except for one some 950 feet (est.) thick unit occurring ≃870 to ≃1,820 feet

stratigraphically below section's top] units of ridge-forming sandstone.

The sandstones are dull to light grey, weather light grey to dirty white with rust-coloured spots and specks or light brown to dull orange, very fine grained, quartzose to subquartzose with a minor to appreciable admixture (estimated to range up to 20-25%) of grains of orange-coloured limonite (? glauconite-derived), unweathered glauconite, white kaolinized feldspar, and dark mineral (?black chert). With one exception (see below) the sandstones are non-carbonaceous to slightly carbonaceous and do not seem to include any coaly lamellae, pods and interbeds. Sorting and rounding of grains ranges from fair to poor. The sandstones are mostly hard and dense, quartzite-like to true quartzites but locally contain minor to considerable interbeds of moderately hard to fairly friable, porous sandstone. They are, for the most part, indistinctly and medium to heavily bedded and weather blocky to slabby. Crossbedding and ripple marks appear to be rare or absent. Contacts with the adjacent siltstone units are invariably covered.

The siltstones are lithologically similar to the sandy to very sandy phase of the Siltstone unit of Mid- to late Valanginian siltstone-sandstone division (see there). They contain minor to sizable interbeds of sandstones lithologically similar to those of the intervening sandstone units. However, the interbeds of friable pure siltstone and shale appear to be extremely rare or absent in these invariably poorly exposed siltstone units.

The above mentioned, exceptionally thick sandstone unit differs from the rest in being carbonaceous to coaly throughout. Also it is rich in 1/4 to 2-inch flattened rounded clayballs and grit to pebble size, angular fragments of dark grey, carbonaceous shale in the uppermost 60 feet. This sandstone unit is believed to be an alluvial to deltaic interbed in the otherwise shallow marine division.

In the principal section the division appears to be overlain conformably by the basal siltstone-shale unit of the ?Upper Aptian to Lower Albian flysch division. However, the actual contact is covered.

The strongly faulted lower part of Mid-Lower Cretaceous siltstone-sandstone division is best exposed in the principal section of Mid- to late Valanginian siltstone-sandstone division (see there) and immediately north from the latter. It differs from the above described middle and upper parts of the division in the prevalence of light to whitish grey weathering, sandy to very sandy, very hard and dense, strongly silicified, carbonaceous to non-carbonaceous siltstone. These rubbly to slabby-weathering, ridge-forming siltstones are interbedded with laminae, thin to heavy beds, and several up to 300 feet thick units of ridge-forming sandstones mostly lithologically similar to those of the middle and upper parts of the division. However, these sandstones are partly carbonaceous to coaly and contain interbeds of pronouncedly and thinly bedded to laminated (flaser-type bedding), intensively crossbedded and ripple marked sandstones of alluvial to ?deltaic origin.

The lower part of the division may be considerably more than 1,000 feet thick. However, only its basal 535 feet were measured in an unfaulted, well exposed section.

The Mid-Lower Cretaceous siltstone-sandstone division only yielded a few non-diagnostic Arctica-like marine fossils observed in the strongly faulted exposures of its lower part. The division is tentatively assigned a general Hauterivian to Aptian age because of its gradational superposition on the Mid- to late Valanginian siltstone-sandstone division and of its being apparently conformably overlain by flysch-like clastics tentatively correlated with the Upper Aptian to lower Albian flysch of Bonnet Lake-Blow Pass area (Jeletzky, Ref. 5, p. 209).

Like the underlying Mid- to late Valanginian marine rocks, the Mid-Lower Cretaceous siltstone-sandstone division apparently resulted from an eastward

onlap of the shallow Hauterivian to Aptian sea originating in the marine basin of Central Alaska (Fig. 1). This suggestion may be subject to a revision, however, when the facies pattern of the Hauterivian-Aptian marine rocks along the western flank of the Porcupine Plain-Richardson Mountain trough will become better known.

?Upper Aptian to lower Albian flysch. An at least 1,500 feet thick (top not reached) sequence of flysch-like clastics overlies the Mid-Lower Cretaceous siltstone-sandstone division in the western headwaters of Lord Creek (appr. Lat. 67°02'30"; Long. 139°50'W). These clastics consist of a thinly bedded (1/4" to 2") to laminated, rhythmical interbedding of dull grey to medium brown, weathering rust-coloured, very fine grained, hard, dense greywacke with similarly coloured, sandy to very sandy, hard to very hard and dense siltstone, and massive black mudstone. The more sandy, hard to very hard rock varieties are crossbedded on a small scale (?current marks). Some graded bedding was seen and various hieroglyphic markings occur on the bedding plane~~s~~. However, no definite load casts or other ~~bottom marks~~ sole markings suggestive of deposition by turbidity currents were seen. These fine grained clastics form units several hundred feet thick separated from each other by 15 to 100 feet thick units of ridge-forming sublithic to ?lithic, very fine to fine grained, hard and dense, often quartzite-like to true quartzite sandstones.

No fossils were found in these flysch-like clastics. However, these rocks are correlated tentatively with the Upper Aptian to lower Albian flysch of the Bonnet Lake-Blow Pass area (Jeletzky, Ref. 5, p. 209) and that of the headwaters of Kandik River (Jeletzky, Ref. 5, p. 219-220) because of the close lithological similarity and the superposition on the apparently Mid-Lower Cretaceous rocks.

As pointed out in Section 9, the above discussed flysch-like clastics were apparently deposited within a western embayment of the Porcupine Plain-Richardson Mountain trough (Fig. 3). This is suggested mainly because of their close proximity to west-southwestern end of the belt of Lower Albian conglomerate which makes it difficult to assume the existence of a land barrier in the intervening area apparently underlain by Palaeozoic rocks.

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