GEOLOGICAL SURVEY OF CANADA
COMMISSION GÉOLOGIQUE DU CANADA

PAPER 78-22

LOWER CRETACEOUS AND JURASSIC ROCKS OF McDOUGALL PASS AREA AND SOME ADJACENT AREAS OF NORTH-CENTRAL RICHARDSON MOUNTAINS, NORTHERN YUKON TERRITORY AND NORTHWESTERN DISTRICT OF MACKENZIE, N.W.T. (NTS-116P/9 AND 116 P/10): A REAPPRAISAL

J.A. JELETZKY

Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

1980

GEOLOGICAL SURVEY
PAPER 78-22

LOWER CRETACEOUS AND JURASSIC ROCKS OF McDOUGALL PASS AREA AND SOME ADJACENT AREAS OF NORTH-CENTRAL RICHARDSON MOUNTAINS, NORTHERN YUKON TERRITORY AND NORTHWESTERN DISTRICT OF MACKENZIE, N.W.T. (NTS-116P/9 AND 116 P/10): A REAPPRAISAL

J.A. JELETZKY

Available in Canada through

authorized bookstore agents
and other bookstores

or by mail from

Canadian Government Publishing Centre
Supply and Services Canada
Hull, Québec, Canada K1A 0S9

and from

Geological Survey of Canada
601 Booth Street
Ottawa, Canada K1A 0E8

A deposit copy of this publication is also available
for reference in public libraries across Canada

Cat. No.	0-660-10280-3	Canada:	$5.00
ISBN –	M44-78/22E	Other countries:	$6.00

Price subject to change without notice

Critical readers

D.G.F. Long
J.R. McLean

Original Manuscript Received: 1977 - 09 - 06
Approved for Publication: 1978 - 05 - 03

CONTENTS

Figures

Plates

LOWER CRETACEOUS AND JURASSIC ROCKS OF MCDOUGALL PASS AREA AND SOME ADJACENT AREAS OF NORTH-CENTRAL RICHARDSON MOUNTAINS, NORTHERN YUKON TERRITORY AND NORTHWESTERN DISTRICT OF MACKENZIE, N.W.T. (NTS-116 P9 and 116 P10): A REAPPRAISAL

Abstract

Jurassic and Lower Cretaceous rocks of the McDougall Pass area of north-central Richardson Mountains include (ascending order):

a. *The 70 to 100 m thick, shallow marine Bug Creek Sandstone of mid-Bajocian to ?early Callovian age.*

b. *?Mid-Callovian to Berriasian Husky Formation which is completely developed, open marine but thin (98-137 m) and largely argillaceous in the northeastern part of the area. In the southwest the Husky is, in contrast, largely arenaceous and 335 to 900 m thick in spite of the absence of its upper part. This Arenaceous facies consists of (ascending order):*

b1. *Prodeltaic, shallow marine Lower marine member; b2. Deltaic to alluvial Mount Millen Member (new); and b3. Postdeltaic, open marine Upper marine member which is only preserved in the extreme southwestern corner of the area.*

The presence of 25 to 60 km wide belts of contemporary marine facies east, west, and south of the high constructive Little Bell deltaic lobe (new) of Mount Millen Member indicates its derivation from a northern source area. This presumably cordillera-like White Island (new) apparently was confined between McDougall Pass in the south, headwaters of Cache Creek in the north, upper Bell River in the west and the eastern flank of White Mountains in the east. White Island appears to be the previously unrecognized Late Jurassic generation of the Cache Creek Uplift which is re-interpreted as a westward-tilted, north-trending horst. The above described facies pattern of the Husky Formation was controlled by the Late Jurassic movements of this horst and the flanking grabens.

c. *The Late Hauterivian to Late Barremian Upper shale-siltstone division overlaps the Husky Formation disconformably and probably regionally discordantly. The normally intervening Lower sandstone and Coal-bearing divisions are absent by nondeposition. The area evidently formed part of strongly uplifted crestal zone of the Rat Uplift of Aklavik Arch from the early Valanginian to mid-Hauterivian.*

The Lower member of Upper shale-silstone division is represented by about 610 m thick Arenaceous facies (= southern facies) in the northeastern part of the area. This facies extends southeastward into the Stony Creek – Vittrekwa River area and northward into the White Mountain area. It appears to be a northwest-trending belt of shoals and barrier islands derived from the Barrier River – Stony Creek deltaic lobe (new) by a northward-flowing current which was reworking its western flank.

The Arenaceous facies grades laterally into entirely argillaceous, open marine Shelf facies (formerly eastern facies). The latter outcrops in the southwestern corner of the area (and farther west in Bell Basin) and to the east in the Canoe Depression.

The Arenaceous facies of Upper shale-siltstone division was deposited on top of the previously unrecongized late Hauterivian to ?earliest Barremian generation of the Cache Creek Horst. This horst continued to separate the main trough of the Richardson Mountains – Porcupine Plain Aulacogene situated immediately to the west from the structurally negative fault block of the Canoe Depression situated to the east.

The 195 to 260 m thick Upper member of Upper shale-siltstone division is represented largely by argillaceous, commonly flysch-like, predominantly neritic rocks. This member does not exhibit any major facies changes in north-central Richardson Mountains evidently because of a far reaching bevelling and subsidence of the whole area in the Barremian.

d. *Only small, 15.5 to 100 m thick erosional remnants of the Upper sandstone division occur in the McDougall Pass area. These shallow marine rocks do not exhibit major facies changes anywhere in north-central Richardson Mountains. Therefore the whole area must have remained tectonically inactive in the early Aptian.*

Résumé

Les roches du Jurassique et du Crétacé inférieur de la région du col McDougall, au nord et au centre des chaînons Richardson, comprennent (de bas en haut):

a. *Les grès de Bug Creek, de 70 à 100 m d'épaisseur, qui sont le produit d'une sédimentation marine peu profonde d'âge bajocien moyen à (?) callovien inférieur.*

b. *La formation de Husky, d'âge callovien moyen (?) à berriasien, entièrement représentée, qui s'est formée en milieu marin ouvert; elle a une faible puissance (98-137 m), et un caractère nettement argileux dans le nord-ouest de la région. Par contre, au sud-est, la formation de Husky est surtout arénacée; sa puissance varie de 335 à 900 m, malgré la disparition de sa partie supérieure. Ce faciès arénacé est constitué (de bas en haut:*

b1. *D'un membre marin inférieur, formé en milieu marin peu profond, prodeltaïque, b2. Du membre de Mount Millen (récemment désigné), d'origine deltaïque à alluviale; et b3. D'un membre marin supérieur, formé en milieu marin ouvert, post-deltaïque, qui ne subsiste que dans l'extrémité sud-ouest de la région.*

La présence de bandes d'une largeur de 25 à 60 km de faciès marins contemporains à l'est, à l'ouest et au sud du lobe deltaïque de Little Bell (récemment désigné), fortement "constructif" et faisant partie du membre de Mount Millen indique que ces faciès dérivent d'une région-source septentrionale. Cette zone, appelée zone de White Island (récemment désignée), probablement du type cordillère, était apparemment limitée par le col McDougall au sud, le cours supérieur du ruisseau Cache au nord, la portion supérieure de la rivière Bell à l'ouest, et le flanc est des monts White à l'est. La zone de White Island correspond sans doute à la portion d'âge jurassique supérieur (récemment identifiée) du soulèvement de Cache Creek, que l'on considère maintenant comme horst d'orientation nord, incliné vers l'ouest. Les faciès de la formation de Husky, décrits plus haut, doivent leur caractère au mouvement de ce horst et des grabens avoisinants pendant le Jurassique supérieur.

c. *La division supérieure à schistes argileux et siltstones, dont l'âge se situe entre le Hauterivien supérieur et le Barrémien supérieur, recouvre la formation de Husky en disconformité, et probablement en discordance à l'échelle régionale. Du fait d'une interruption de la sédimentation, on ne trouve pas les formations intermédiaires habituelles, à savoir la division du grès inférieur, et de la division carbonifère. Il est évident que cette région a fait partie de la zone sommitale fortement rehaussée du soulèvement de Rat qui a affecté l'arche d'Aklavik entre le Valanginien inférieur et le Hauterivien moyen.*

Le membre inférieur de la division supérieure à schistes argileux et siltstones est représenté par un faciès arénacé (= faciès sud) d'environ 610 m d'épaisseur, dans la portion nord-est de la région. Ce faciès se prolonge vers le sud-est jusqu'à la région du ruisseau Stony et de la rivière Vittrekwa, et au nord jusqu'à la région des monts White. Il s'agit sans doute d'une zone de hauts-fonds et cordons littoraux, d'orientation nord-ouest et formée à partir du lobe deltaïque de Barrier River et Stony Creek (récemment désigné) par un courant dirigé vers le nord, qui remaniait le flanc ouest de ce lobe.

Le faciès arénacé passe latéralement à un faciès ouvert de plate-forme marine entièrement schistes argileux de caractère (anciennement faciès est). Ce dernier affleure dans le coin sud-ouest de la région (et plus loin à l'ouest dans le bassin Bell), et à l'est dans la dépression de Canoe.

Le faciès arénacé de la division supérieure à schistes argileux et siltstones s'est déposé au sommet des strates formées entre le Hauterivien supérieur et (?) la base du Barrémien, qui n'avaient jusqu'à présent pas été identifiées. Ce horst a continué à séparer le principal sillon de l'aulacogène Richardson Mountains-Porcupine Plain, qui se trouve immédiatement à l'ouest, du bloc faillé et déprimé de la dépression de Canoe, situé à l'est.

Le membre supérieur de la division supérieure à schistes argileux et siltstones, qui a de 195 à 260 m d'épaisseur, est largement représenté par des roches néritiques argileuses, généralement de type flysch. La raison pour laquelle ce membre ne manifeste aucune importante variation de faciès, au nord et au centre des chaînons Richardson, est sans doute le considérable nivellement et la subsidence de toute la région au Barrémien.

d. *Dans la région de McDougall, on rencontre quelques lambeaux épargnés par l'érosion, de 15.5 à 100 m d'épaisseur, de la division des grès supérieurs. Ces roches marines peu profondes ne manifestent nulle part d'importantes variations de faciès au nord et au centre des chaînons Richardson. Par conséquent, toute la région a dû rester pratiquement inactive pendant l'Aptien.*

LOWER CRETACEOUS AND JURASSIC ROCKS OF MCDOUGALL PASS AREA AND SOME ADJACENT AREAS OF NORTH-CENTRAL RICHARDSON MOUNTAINS, NORTHERN YUKON TERRITORY AND NORTHWESTERN DISTRICT OF MACKENZIE, N.W.T. (NTS-116 P9 and 116 P10): A REAPPRAISAL

INTRODUCTION AND ACKNOWLEDGMENTS

Part of 1975 field season was spent in a paleontological-stratigraphical and depositional-tectonic study of an outcrop area of Jurassic and Lower Cretaceous rocks situated in the McDougall Pass area (NTS 116 P/9, 116 P/10) within the largely Paleozoic core of northern Richardson Mountains. As pointed out by Jeletzky (1975a, p. 9-14), the knowledge of the geology of this area is critical for understanding the facies changes, paleogeography and depositional tectonics of the Northern Bell Basin segment of the Richardson Mountains – Porcupine Plain Trough. Parts of this outcrop area were briefly and somewhat hurriedly surveyed during the 1973 field season. However, the results of the more detailed study carried out in 1975 necessitate a somewhat drastic reappraisal of some of the previously published (Jeletzky, 1974, p. 6-9; 1975a, p. 9-14) ideas about the age, stratigraphy, and facies of its Jurassic and Lower Cretaceous rocks. The purpose of this preliminary report is to summarize the most important results obtained during the 1975 field season, to integrate these results with those obtained in 1973, and to outline the bearing of the resulting synthesis upon the biochronology, stratigraphy, paleogeography, and depositional tectonics of some adjacent areas surveyed in the period from 1958 to 1973 inclusive.

This report is the latest item in a long series of preliminary reports dealing with various aspects of the same general topic – Cretaceous and Jurassic geology and paleontology of the Richardson Mountains – Porcupine Plain Trough and adjacent areas. Therefore, it must be used in conjunction with these earlier reports. References to appropriate sections and illustrations of these reports have been provided throughout the text.

The approximate boundaries of the McDougall Pass area are indicated in Figure 1 which also elucidates its geographical position within the Richardson Mountains – Porcupine Plain Trough and that of most of the geographical terms mentioned in the text but not indicated in other illustrations.

During the 1975 field season camp facilities and air support were provided by F.G. Young. The writer was ably assisted in the field and in the office by M.F. McLaughlin, PC 1, Ottawa Paleontology Section, I.S.P.G. J. Callomon, Chemistry Department of University College, London, England and T.P. Poulton, Western Paleontology Section, I.S.P.G., Calgary, Alberta, kindly made available the results of their study of a previously unvisited section of the Bug Creek and Husky formations which revealed the need for additional field work and so led to the reappraisal presented in this paper. These results are discussed in greater detail in the following sections of this paper. The assistance and co-operation of all above mentioned persons are deeply appreciated.

GEOLOGY

Geographical and Structural Setting

The principal body of Jurassic and Lower Cretaceous rocks dealt with in the paper underlies a 2.4 to at least 5 km wide (in northwest-southeast direction) zone of up to 760 m high, sharp-crested to flat-topped rocky ridges on both sides of McDougall Pass. These ridges flank the flat-bottomed, lake-dotted, broad valleys of the Rat River and Little Bell River from the southeast (Fig. 2; Pl. II, fig. 1). The Jurassic and Cretaceous rocks of this body comprise a northeast-striking, considerably distorted, synclinal structure confined between structurally positive, apparently anticlinal, northeast- to sublatitudinally oriented belts of predominantly Paleozoic rocks underlying high mountains to the south and to the north of McDougall Pass. A detailed study of these strongly faulted Jurassic and Lower Cretaceous rocks was restricted to that part of the syncline confined between Sheep and Fish creeks in the east and the confluence of Bell and Little Bell rivers in the west. This area is designated, somewhat arbitrarily, as the McDougall Pass area in this paper (Fig. 2).

Jurassic and Basal Cretaceous Rocks

The Husky Formation of the McDougall Pass area exhibits exceptionally pronounced lateral facies changes in the northeast-southwest direction (Fig. 5). Therefore, the stratigraphy of the Jurassic and basal Cretaceous rocks outcropping in the northeastern part of the area confined between Sheep Creek and Summit Lake is here described separately from that of equivalent but lithologically dissimilar rocks outcropping in its southwesternmost part situated south of the confluence of Bell and Little Bell rivers.

Bug Creek and Husky Formations Between Sheep Creek and Summit Lake

Stratigraphy and delimitation from adjacent units

The detailed survey of Bug Creek and Husky formations of the northeastern part of the area carried out in 1975 was triggered by J. Callomon and T.P. Poulton's study of a previously unvisited, little disturbed, and unusually well exposed section situated on the southern side of McDougall Pass on the ridge next west of Sheep Creek. This section is designated as the Section No. 1 (see Fig. 2; Pl. I, fig. 1).

According to J. Callomon and T.P. Poulton (pers. comm., July 24, 1975), in this section the 6 m thick (est.) pinchout tongue of the Porcupine River sandstone (former Unnamed Upper Jurassic sandstone, see Jeletzky, 1977) with **Buchia (Anaucella) concentrica** (Sow) s. lato (GSC loc. 92593) occurs about 30.5 m stratigraphically above the top of Bug Creek sandstone. The Bug Creek Formation is somewhat less than 100 m thick and entirely similar lithologically and biochronologically to the thin and entirely arenaceous Bug Creek sandstone of Rat River Gorge – Horn Lake area (Jeletzky, 1967, p. 21-24, 150, 155).

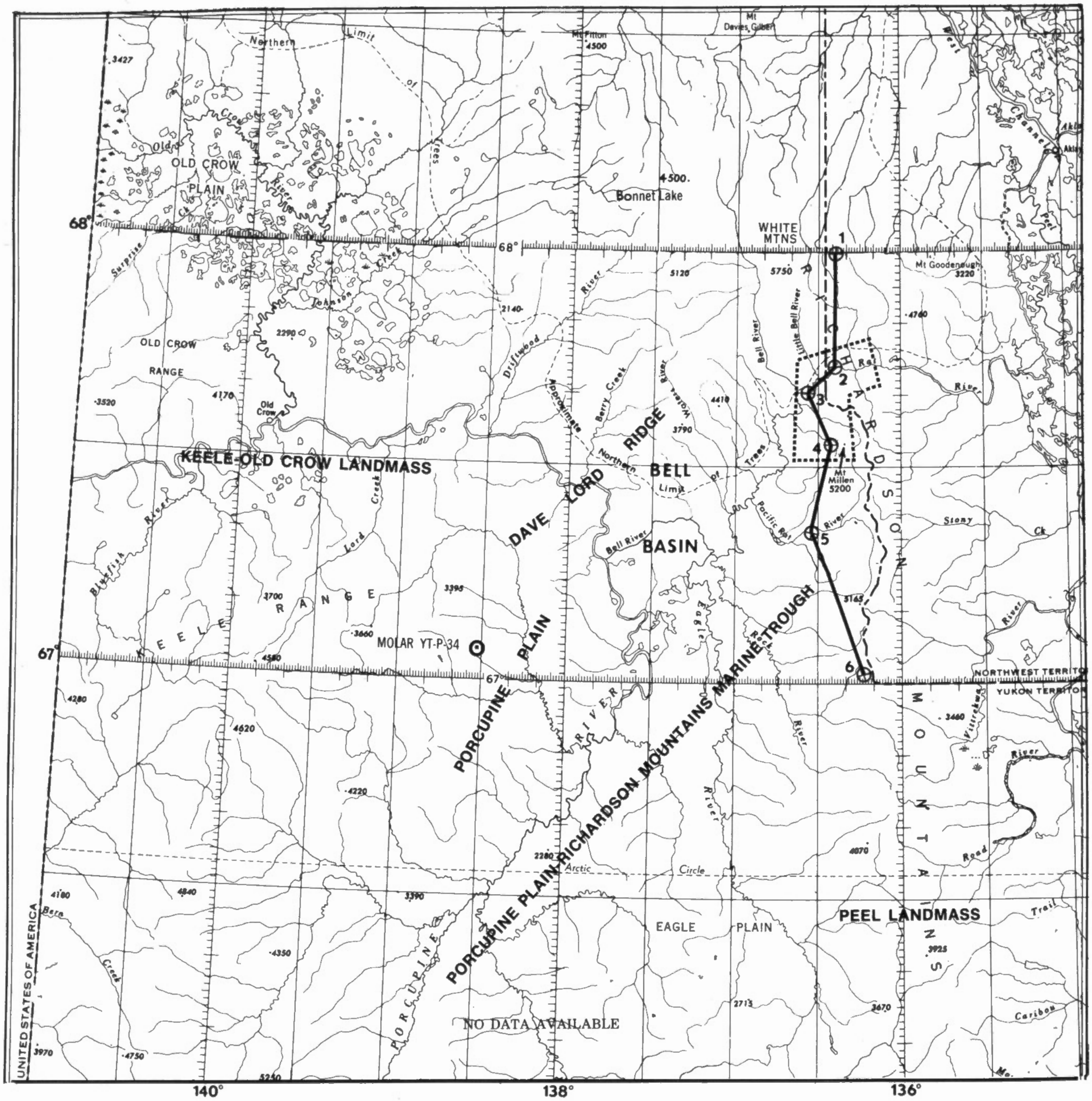
The recessive, about 30.5 m wide interval between the **Buchia (Anaucella) concentrica**-bearing tongue of the Porcupine River sandstone and the Bug Creek Formation is occupied by deeply weathered, black, argillaceous rocks. Another, better exposed, black argillaceous unit about 60 m thick (est.) overlies the **Buchia (Anaucella) concentrica**-bearing sandstone apparently conformably. This argillaceous unit contains a well preserved **Buchia okensis** (Pavlow) s. str. fauna (GSC loc. 92594) at about 30.5 m (est.) above the base. The unit is overlain, in turn, by more than 15 m (top not reached) of sandstone, representing the eastward extension of the "Lower sandstone member of the Bug Creek Formation" of Jeletzky (1974, p. 7). The contact of these units is abrupt and uneven.

Table of Formations of McDougall Pass area
(including northwestern corner of Mount Millen area)

Time-rock units: System and Series	Time-rock units: Stage	Time-rock units: Regional Zone (Jeletzky, 1964)	Formation and/or Member		Lithology and Thickness: Northeast part	Lithology and Thickness: Southwest part
Lower Cretaceous	Aptian	**Aucellina ex gr. aptiensis-caucasica**	Upper sandstone division (lower part only)		Most of the division eroded Siltstone, dull grey, weathers brown, sandy to very sandy, pronouncedly silicified and very hard, thinly bedded, crossbedded and ripple marked on a large scale. Thickness 15.5 m Lower contact abrupt and uneven but apparently conformable.	Upper part of division eroded Sandstone, dull brown, weathers rust- to orange-coloured, very fine grained, quartzose, dense and hard but not silicified, thick to thin and pronouncedly bedded, commonly crossbedded and ripple marked on a large scale; considerable interbeds of sandy siltstone as in northeast part of area and of rust-weathering, ferruginous and calcareous siltstone. Thickness up to 100 m. Lower contact abrupt but conformable.
	? Barremian	**Aucellina ex gr. aptiensis-caucasica** / **Hoplocrioceras** cf. **remondi**	Upper shale-siltstone division	Upper member	Cyclical interbedding of: 1. Siltstone, light-grey to orange-coloured, sandy to very sandy, hard to very hard and strongly to very strongly silicified; thinly bedded to laminated; intensively crossbedded and ripple marked; with 2. Siltstone, dark grey to black; slightly sandy to pure, moderately hard to friable, indistinctly and irregularly bedded or massive; commonly strongly bioturbated. Thickness 195 m. Lower contact conformable and probably gradational.	Cyclical interbedding of siltstones lithologically similar to those of the Upper member of northeast part of the area. However, the lower contacts of interbeds of variety 1 are mostly abrupt and the siltstones themselves are commonly graded. Siltstones are commonly interbedded with sandstone similarly coloured, very fine grained, silty, hard and dense; intensively crossbedded and ripple marked; ratio of sandstone interbeds increases upward; lower contact gradational. Thickness 260 m.
	Barremian ? Hauterivian	Unnamed Zone B ? **Simbirskites (Simbirskites)** cf. **kleini**	Upper shale-siltstone division	Lower member	Arenaceous (=Southern) facies (descending order): 3. Upper sandstone unit. Thickness 106 m to 0; 2. Intermediate siltstone unit. Thickness 213.5 m to 430 m. 1. Lower sandstone unit. Thickness 12 m to 80 m. See text for further lithologic details.	Argillaceous facies (Shelf phase) Siltstone, dull to bluish grey and mottled coloured; feebly to very sandy, commonly micaceous, mostly thinly bedded to laminated but with considerable units and interbeds of uniformly coloured, indistinctly bedded to massive-looking siltstone; fairly rare 3 - 6 cm, angular to disc-shaped clay ironstone concretions; thickness 155.5 m.
	Hauterivian	Not zoned	Lower sandstone and Coal-bearing divisions (or the Blue-grey shale division) absent by non-deposition		Disconformity and ? regional discordance accompanied by hiatus of varying magnitude.	

Table of Formations (cont.)

Time-rock units			Formation and/or Member	Lithology and Thickness		
System and Series	Stage	Regional Zone (Jeletzky, 1967)				
Lower Cretaceous	Berriasian	**Buchia** n. sp. aff. **volgensis**	Husky Formation	?	Absent by subsequent erosion ?or/and nondeposition	
		Buchia okensis s. str.				
Jurassic	Upper Tithonian	**Buchia terebratuloides** s. lato		Upper argillaceous member. Dark grey to black, pure to slightly sandy shale and siltstone. Thickness 61 m to 91.5 m		
		Buchia fischeriana s. lato			Upper marine member. Mainly dark grey to black, pure to sandy siltstone and pure shale. Considerable units and interbeds of buff to grey, fine to very fine grained, crossbedded to ripple marked sandstone. Thickness up to 166.5 m.	
	Portlandian s. str.	**Buchia piochii** s. lato				
		Buchia mosquensis s. lato			Mount Millen Member (new). Mainly fine grained, silty, carbonaceous to coaly sandstone. Considerable interbeds of grit and pebble conglomerate (mainly in the north) and dark grey, coaly and sandy siltstone (mainly in the south). Thickness 38 m to 156 m.	
	Kimmeridgian			Porcupine River Tongue. Sandstone, buff- to orange-coloured quartzose, fine to very fine grained. Thickness from 6 m to 29 m.	Lower marine member thickness 210 m to 516 m	Upper tongue of Lower marine member. Cyclical interbedding of shallow marine, fine to very fine grained sandstone and sandy siltstone. Thickness up to 381.0 m.
	Upper Oxfordian	**Buchia (Anaucella) concentrica** s. lato				Porcupine River Tongue. Same lithology as in the northeastern part of the area (see opposite) but the thickness increases to about 122 m.
	Mid Callovian to Lower Oxfordian	Not zoned		Lower argillaceous member. Dark-grey to black, pure to slightly sandy shale and siltstone. Thickness 30.5 m to 91.5 m.		Lower tongue of Lower marine member. Siltstone, brownish-grey, sandy. Thickness 13.5 m
	Middle Bajocian to ?lower Callovian	Not zoned	Bug Creek Formation	Sandstone, light grey- to buff-coloured, predominantly fine grained, rarely medium grained, quartzose to orthoquartzitic, mostly thick and indistinctly bedded to massive-looking, more rarely medium- to thinly bedded, crossbedded and ripple marked on a large scale; lithologically uniform throughout the area; thickness 70 to 100 m; upper contact abrupt but conformable.		
				Regional to angular discordance accompanied by a hiatus embracing all of the Lower Jurassic and lower Bajocian, all Triassic, and some Upper Permian.		
Triassic and Upper Permian			Underlying rocks	Permian	Permian	



.... Approximate boundaries of McDougall Pass area and northwestern corner of Mount Millen area

⊕——⊕ Approximate direction of geological profile of Text-fig. 4 and geographical positions of all its individual sections (numbered as in Text-fig. 4).

0 MILES 20 40

0 Km 25 50

Figure 1. Index map of northern Richardson Mountains and adjacent areas showing the approximate boundaries of McDougall Pass area and approximate locations of the geological sections of Figure 4.

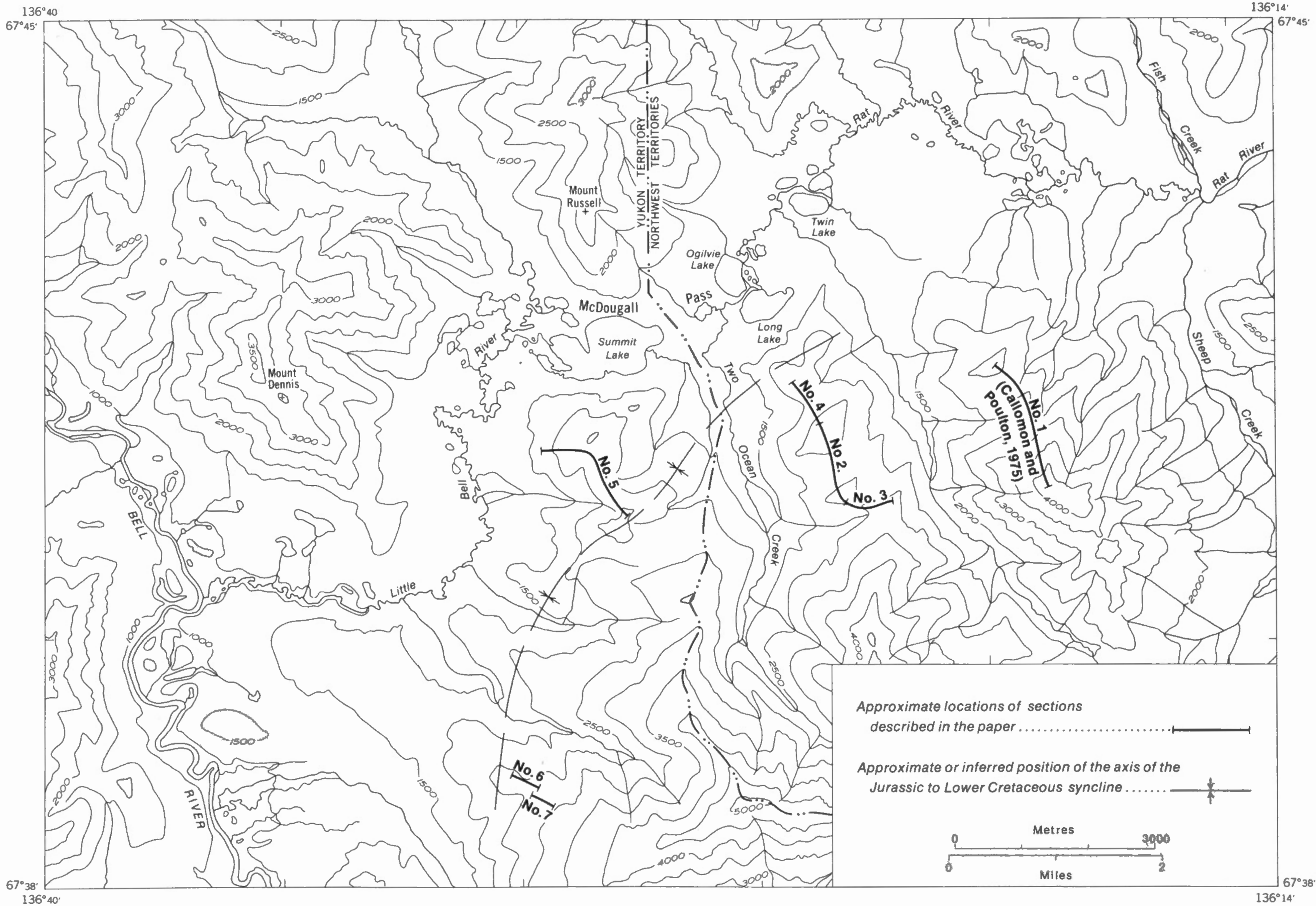
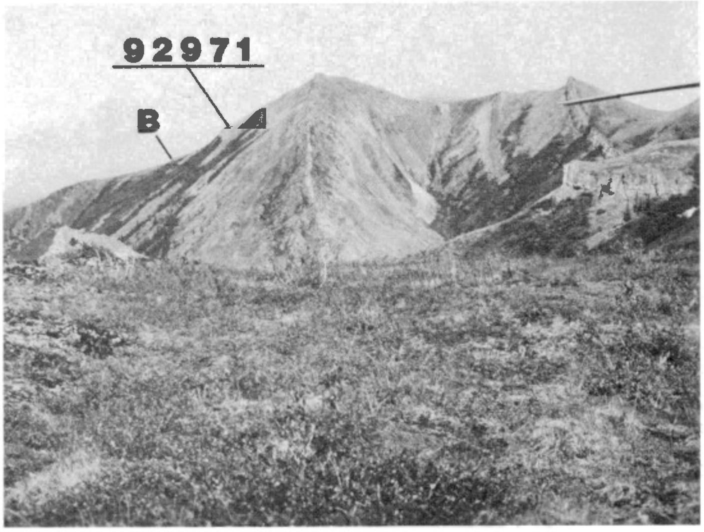


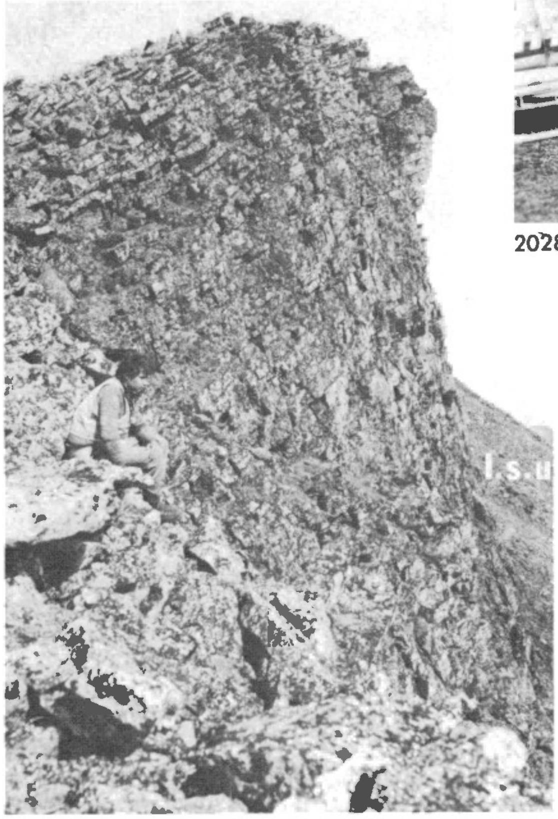
Figure 2. Index map showing approximate position of the investigated part of Jurassic-Lower Cretaceous syncline in the McDougall Pass area and extent of stratigraphic sections described in the paper.

PLATE I

202819-N 1



202819-S 2



164415 3

164409 4

PLATE I

Figure 1. View of the Upper argillaceous member of Husky Formation (marked U.a.m.) and the Lower sandstone unit of the Arenaceous facies of the Lower member of Upper shale-siltstone division (marked L.ss.u) in Section 1 (see p. 1 and Fig. 2 for further details). View approximately due north (i.e. updip) with the rocks dipping obliquely away (toward the left lower corner of the photograph) from the camera. The sun-lighted ridges in the far background are on the northwestern side of McDougall Pass. So far as known, they expose principally Permian and Bug Creek rocks. GSC Photo 202819-N.

Plate I (cont'd)

Figure 2. Close up of a segment in the left (i.e. northwest) half of the panoramic view of the Section 5 shown in Fig. 3. Introduced to elucidate stratigraphical and structural details of the Jurassic and Permian parts of the section which are somewhat indistinctly reproduced in Fig. 3. View from station on the middle (i.e. that marked by numbers 10, 9, 8) of three rocky ridges visible in the foreground and middle background of Fig. 3. The bluff of unit 13 of Section No. 5 (see Appendix) is marked 13. The position of fossil locality (GSC loc. 92971) in the basal beds of Bug Creek Formation is indicated. The rest of geological features are marked in the explanation of Fig. 3 which see for further details. GSC Photo 202819-S.

Figure 3. View of thinly bedded, nonmarine phase of the Upper sandstone unit of the Arenaceous facies of the Lower member of Upper shale-siltstone division in the Section 2 (see unit 3, Section 2, in Appendix for further details). View due northeast (i.e. approximately into the strike of the unit). The almost entirely covered contact with the Intermediate siltstone unit (the exposure of which is marked I.s.u.) is hidden behind the bluff of the Upper sandstone unit. The photographed bluff is visible as a small mound on the extreme left side of the exposure of Upper sandstone unit in Pl. II, fig. 3. GSC Photo 164415.

Figure 4. General view of section 3 (see in Appendix and Fig. 2 for further details). View due west from station on northern part of unit 2 covered by the scree of Bug Creek Formation. View obliquely upsection with the rocks dipping obliquely away from the camera (i.e. toward the right lower corner of the photograph). The gentle slope in the foreground is underlain by the Lower argillaceous member of Husky Formation marked L.a.m.). This slope is crowned by the ridge-forming exposure of the Porcupine River sandstone (tongue of) marked P.R.s. Another gentle slope visible in the background of this sandstone ridge is underlain by the upper part of the Upper argillaceous member of Husky Formation (marked U.a.m.). The high, precipitous ridge in the far background is built of the Lower sandstone unit of the Arenaceous facies of the Upper shale-siltstone division (marked L.ss.u.). This 25 to 28 m sandstone bluff represents the unit 1 of Section 2 (see Appendix). GSC photo 164409.

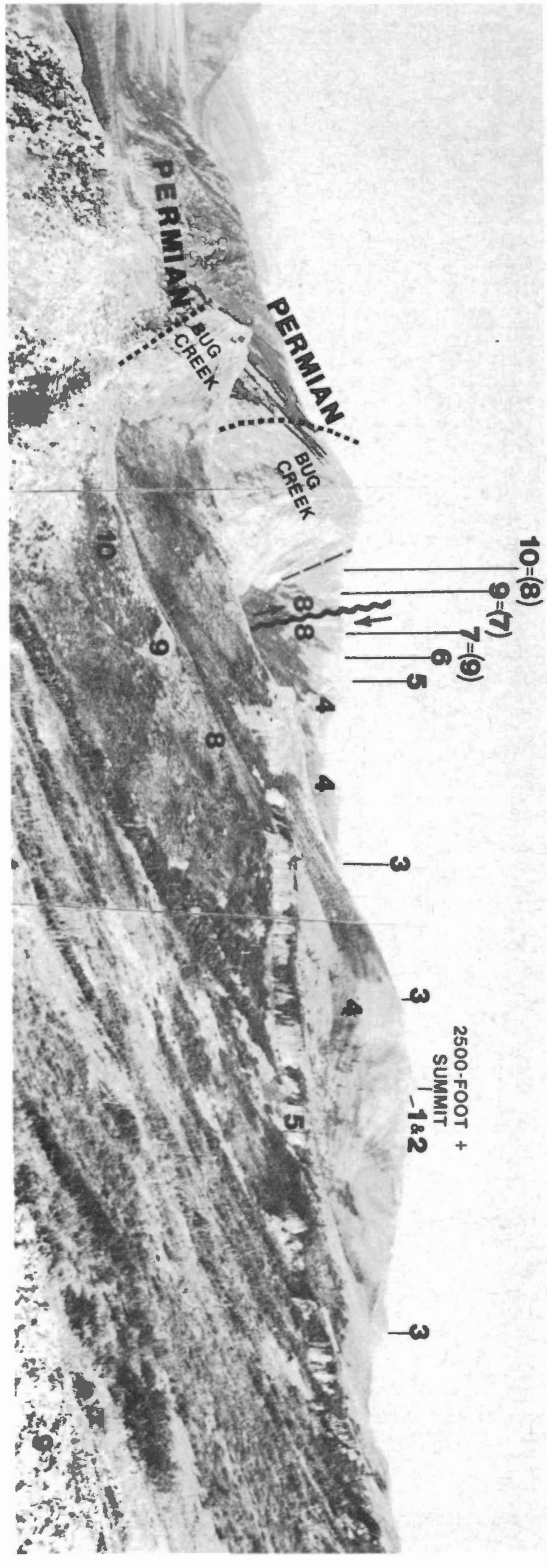


Figure 3

A panoramic view of the succession of northeast-striking and southeast dipping (i.e. toward the right) Lower Cretaceous, Jurassic, and Permian rocks exposed in Section 5 measured on northeastern shoulder of a nameless 760 m + high, mesa-like mountain overlooking Summit Lake from the south (this section described by Jeletzky, 1974, p. 8 and indicated in Fig. 2 is in central background) and in the slopes adjoining this mountain from southwest (in the foreground). View due northeast to east-southeast from a station on the slope at the point about 3.2 km (2 miles) southwest of the section previously described by Jeletzky (1974, p. 8). The photo station is on the ***Buchia (Anaucella) concentrica****-bearing tongue of the Porcupine River sandstone.*

The flat-bottomed, lake dotted McDougall Pass is visible on the extreme left (middle distance) of the photograph. The eastern defile of the pass is in the extreme left background (confluence point of Rat River, Sheep Creek and Fish Creek is hidden behind this defile). Summit Lake is just outside of the left margin of the photograph.

Lower Cretaceous and Upper Jurassic units of the section described by Jeletzky (1974, p. 8) and their equivalents on the slope in foreground are indicated by their respective previously used numbers. The designations 10 (=8), 9 (=7), 7 (=9) refer to the duplication of these beds by the high angle normal fault indicated in the photograph. Units 1 to 3 inclusive exposed on the 760 m + summit are bent synclinally. Other designations and symbols are self-explanatory. See text for further details, including the reappraisal of the age and correlation of units described by Jeletzky (1974, p. 8).

All above-mentioned units strike approximately southeast-northwest and dip to northeast at moderate angles. They are all but undisturbed otherwise and the presence of any major faults is ruled out in the opinion of Callomon and Poulton (pers. comm). The writer concurs with this conclusion after having visited the section concerned.

The validity of Callomon and Poulton's observations was subsequently confirmed by the discovery of the mid-Portlandian (s. str.) **Buchia** n. sp. aff. **piochii** fauna in the lower third of the Upper argillaceous member, (i.e. of unit 5), of the Husky Formation in the adjacent, somewhat less attenuated Section 3 (see Appendix and Fig. 2) measured by the writer about 3.2 km farther southwest on the rocky ridge overlooking Two Ocean Creek from the east. This section adjoins from the south the previously described (Jeletzky, 1974, p. 6-7) about 610 m thick section of arenaceous and argillaceous rocks previously assigned to the mid-basin facies of Bug Creek Formation but here reinterpreted as equivalent of the Lower member of the Upper shale-siltstone division (see below). The latter section, here designated Section 2 (see Appendix and Fig. 2) adjoins, in turn, from the south Section 4 measured in 1975. Sections 3, 2 and 4 combined expose the most complete sequence of Jurassic and Lower Cretaceous rocks presently known in the northeastern part of the McDougall Pass area. The paleontological-stratigraphical data mentioned above indicates that all faults cutting these three sections are of minor consequence. Contrary to the previously held opinion (Jeletzky, 1974, p. 7; in the description of the Lower sandstone member), none of these faults causes a repetition of the section's units. Nor do these faults bring the Porcupine River tongue against Permian rocks.

Sections No. 2 and 3 are critical for the correct interpretation of yet another section measured in 1973, published next year (Jeletzky, 1974, p. 8), and designated Section 5 in this paper (see Appendix and Fig. 2). As recognized in 1975, Section 5 is situated approximately 1.6 to 3.2 km southeast of Long Lake (it is centred at lat. 67°41'40"N.; long. 136°23'30"W.) instead of 4 to 4.8 km south of the western end of Summit Lake as it was erroneously stated previously (Jeletzky, 1974, p. 6).

Comparison of Sections 1, 2 and 3 with Section 5 measured about 4.8 km west of the Sections 2 and 3 on the northern shoulder of a nameless, about 765 m high, butte-like mountain overlooking Summit Lake from the south (see Jeletzky, 1974, p. 8; this paper, Appendix and Figs. 2 and 3) indicates that in Section 5 the Husky Formation is only represented by units 6 to 10 inclusive. However, the combined thickness of 176.5 m of these units (now assigned to Husky Formation) in this section is not the true thickness of the formation. The very strongly jointed and sheared, almost vertical, unit 7 and the adjacent part of unit 8 appear to be a fault slice of units 9 and 10 repeated by a high angle, south-dipping normal fault (see Fig. 3). This conclusion is supported by the presence of only one tongue of **Buchia (Anaucella) concentrica**-bearing sandstone in the otherwise entirely similar sections occurring 1.6 to 3.2 km farther southwest on the same hillside and representing a direct continuation of the above mentioned section (Fig. 3). The visually estimated thickness of Husky Formation in these only hurriedly visited sections appears to be only 122 to 137 m, including the 30 m thick tongue of Porcupine River Formation.

Contrary to Jeletzky (1974, p. 8), the contact between unit 6 representing the upper tongue of the Husky Formation and unit 5 representing the "Lower sandstone member" of the Upper shale-siltstone division, in Section 5 (see Appendix) was found to be abrupt, uneven and apparently erosionally disconformable.

The Bug Creek sandstone directly and apparently gradationally underlying the lower tongue of Husky Formation (i.e. unit 10 of the Section 5; Fig. 2, 3; and Jeletzky, 1974, p. 8) was found to overlie directly and presumably unconformably a several hundred metres thick (base not reached) succession of **Spirophyton**-bearing Permian clastics occupying the northern part of the ridge adjoining the western end of Summit Lake (see units 11 to 15 of Section 5 in Appendix and Fig. 3). The previously suggested (Jeletzky, 1974, p. 8) correlation of this approximately 100 m thick, arenaceous, marine unit of the Bug Creek Formation with the "Upper sandstone member" of adjacent sections is withdrawn herewith.

The above stratigraphical and paleontological data indicate that the Bug and Husky formations are unusually thin throughout the northeastern part of the McDougall Pass area and that the about 610 m thick, almost to totally unfossiliferous argillaceous and arenaceous units previously assigned to these formations by Jeletzky (1974, p. 6-7) are considerably younger.

The results obtained in the northeastern part of the McDougall Pass area in 1975 may be summarized as follows:

1. At the base of the Jurassic sequence lies a thin, entirely arenaceous, shallow water facies of the Bug Creek Formation, which does not exceed 100 m in thickness and is essentially similar in the lithology and facies to the Bug Creek Formation of Rat River Gorge – Horn Lake area (Jeletzky, 1967, p. 21-24, 150, 155).
2. An exceptionally to strongly attenuated, almost entirely argillaceous facies of the Husky Formation overlies the Bug Creek Formation. The thickness of Husky Formation decreases from 122 to 137 m (est.) in the westernmost sections of the northeastern part of the area to about 98 m (est.) in the easternmost measured sections. The tongue of the **Buchia (Anaucella) concentrica**-bearing Porcupine River Formation is only 7 m thick in the easternmost measured sections in constrast to 18 to 29 m (est.) in the southwesternmost measured sections. The minor (not mappable) eastward thinning wedge of the Porcupine River Formation is treated here as a tongue of the Husky Formation separating its Lower and Upper argillaceous members (Figs. 4, 5).

Age and correlation

The Lower argillaceous member of the Husky Formation of the northeastern part of McDougall Pass area did not yield any fossils. However, it can be dated indirectly by reference to the equivalent argillaceous member on the eastern flank of White Mountains (Section 1, Fig. 1; Jeletzky, 1972, p. 18). There the basal sandy beds of the member have yielded a fairly rich marine fauna including: **Pachyteuthis (Pachyteuthis)** aff. **P. (P.) subextensa** (Nikitin), **Camptonectes (Boreionectes)** ex gr. **praecinctus** Spath and coarsely ribbed, large **Meleagrinella** ex gr. **echinata** (Smith). This fauna (GSC loc. 87436) lacks any **Buchia** and was accordingly assigned a (?)mid- or (?)late Callovian to early Oxfordian age (Jeletzky, 1977, p. 11,12). The same age is, therefore, accepted for the basal beds of the Lower argillaceous member in the northeastern part of McDougall Pass area. The uppermost beds of this member are assumed to be lower Oxfordian in age because of the presence of a rich fauna of early forms of **Buchia (Anaucella) concentrica** (Sowerby) in the gradationally superimposed tongue of the Porcupine River sandstone (Jeletzky, 1974, p. 8).

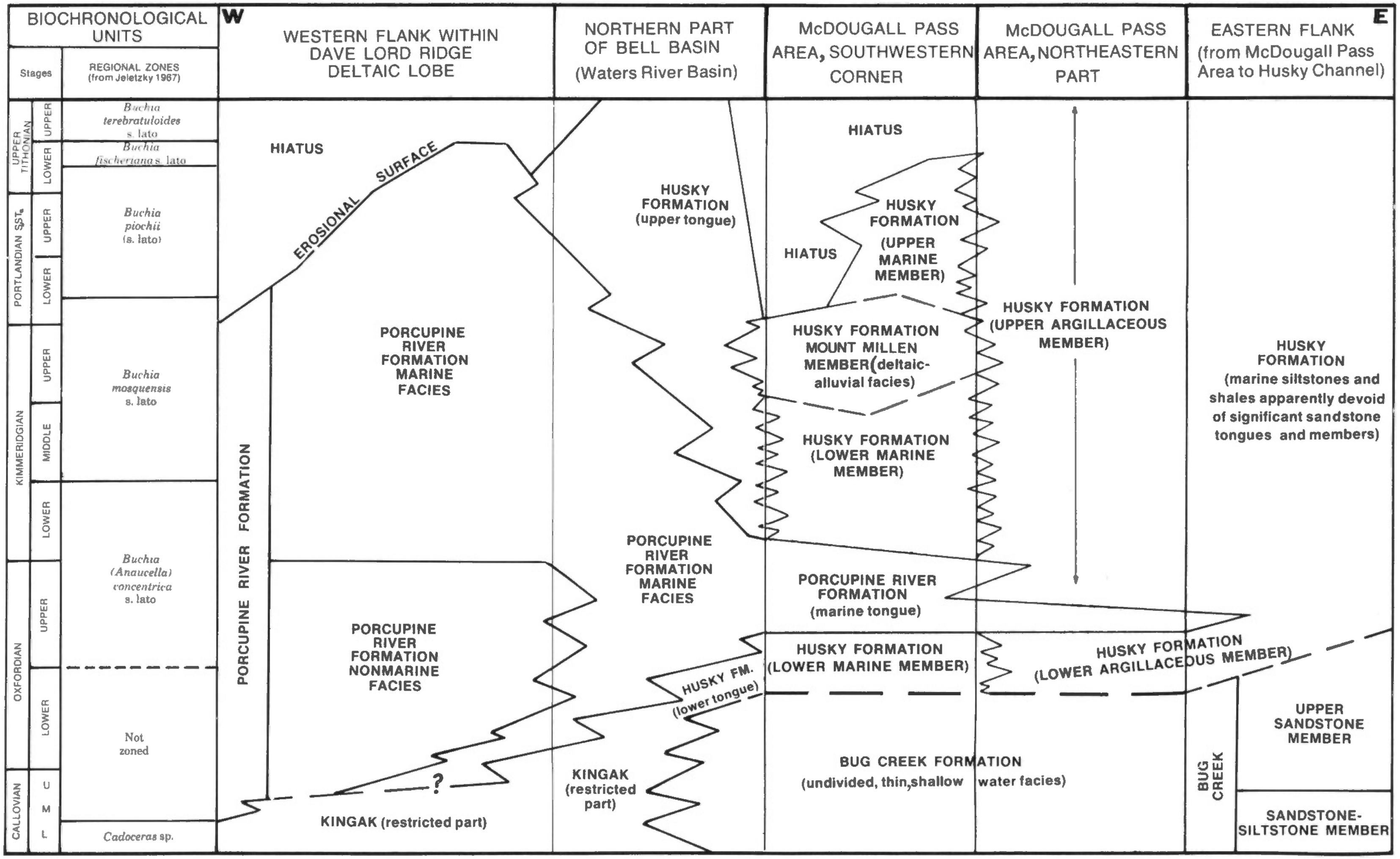


Figure 5. Age limits and facies changes of Porcupine River and Husky formations across the Richardson Mountains-Porcupine Plain Trough at the latitude of McDougall Pass area.

The tongue of the Porcupine River sandstone is upper Oxfordian in its entirety, as the early forms of **Buchia (Anaucella) concentrica** (Sowerby) were found to range up into its topmost beds (Jeletzky, 1974, p. 8; unit 9 of Section 5 in the Appendix). Therefore, this tongue is correlative with unit 2 of Section 8 (see Appendix and Section 4 of Fig. 4) and some part of the covered interval 2 of Section 7 (see Appendix and Section 3 of Fig. 4) but not with the Mount Millen Member of these sections (see below). The paleogeographical and depositional tectonic implications of this correlation are discussed below (see p. 16-20).

The Upper argillaceous member of the Husky Formation has yielded **Buchia mosquensis** (v. Buch) s. lato, **Buchia** n. sp. aff. **piochii** (Gabb), and **Buchia okensis** (Pavlow) faunas. Therefore, it includes beds ranging at least from the early Kimmeridgian (i.e. the upper part of **Buchia (Anaucella) concentrica** s. lato Zone; see above) to the basal Berriasian. This member corresponds, accordingly, to the bulk of the Lower member (excluding its basal 15 m or so), the whole of the Arenaceous member, and part or (?)all of the Red-weathering member of northeastern and northwestern Richardson Mountains (Jeletzky, 1961b, p. 8; 1967, p. 33-35). According to these paleontological data only the uppermost part of the type Husky Formation (i.e. its Upper member) containing **Buchia** n. sp. aff. **volgensis** (Lahusen) fauna may be absent (i.e. eroded away) between the uppermost preserved beds of the member and the directly overlying Lower sandstone unit of the Lower member of the Upper shale-siltstone division. However, there is room for the **Buchia** n. sp. aff. **volgensis** Zone in the so far unfossiliferous uppermost 30.5 m of the Husky Formation (i.e. in the section studied by J. Callomon and T.P. Poulton) overlying the **Buchia okensis**-bearing beds. Hence the Husky Formation is either completely or almost completely developed in the northeastern part of the McDougall Pass area.

Jurassic Rocks in the Southwestern Corner of McDougall Pass Area

Only a small outcrop area of Jurassic and Lower Cretaceous rocks was studied in 1973 and 1975 in the southwesternmost part of McDougall Pass area near the eastern boundary of Northern Bell Basin. This area is situated 9.6 to 10.4 km south-southeast of the confluence of Bell and Little Bell rivers and centred at approximately 136°33'45"W long. and 67°39'30"N lat. (Jeletzky, 1974, p. 6, 10, 13 and 17; Fig. 5; this paper, Figs. 1 and 2). The area is important in terms of stratigraphic, depositional, structural, and paleogeographical setting of the Husky Formation in the adjacent northeastern part of the McDougall Pass area. The results of a re-evaluation of Jurassic rocks in this area, in the light of the 1975 field work are presented below.

Bug Creek Formation

No attempt was made to study the Bug Creek Formation in any detail. However, the lithology of the formation, as exemplified by unit 1 of Section 7 (see Appendix), in combination with distant observation of adjacent sections of the formation and its easily discernible contacts with the underlying Permian rocks suggest that its thickness, lithology, and depositional environment are similar to those observed in the northeastern part of the area (see p. 1). Paleogeographical and depositional-tectonic implications of these findings are discussed below.

Husky Formation

Stratigraphy and indirect paleontological correlation. The presence of marine sandy siltstones of the Husky Formation in the southwestern corner of the McDougall Pass area was only briefly mentioned in an earlier report (Jeletzky, 1974, p. 10). Though these siltstones did not yield any diagnostic fossils, they had been correlated with the upper part of the Husky Formation of adjacent areas. This correlation was proposed because of the sandy character of the siltstones and their gradational contact with overlying nonmarine arenites and rudites then referred tentatively to the lithologically and environmentally similar (Jeletzky, 1960, p. 6) nonmarine facies of the Lower sandstone division. The lower part of the Husky Formation, including the pinchout tongue of the Porcupine River sandstone discussed earlier (p. 1, 8), was assumed to be concealed in a covered interval separating the sandy siltstones from the underlying sandstones of the Bug Creek Formation (see units 1 and 2 of Section 7 in the Appendix). These tentative conclusions had to be revised, in part, following a detailed study in 1975 of several much more complete sections of fairly fossiliferous Jurassic rocks in the area immediately south of the southwestern corner of the McDougall Pass area. All of these sections are situated outside of the report area proper. However, the best exposed and the most complete of these measured on the western slope of Mount Millen and situated about 21.8 km south of Section 7 is included in the Appendix (see Section 8) and summarized graphically in Fig. 4 (see its Section 4) to document the revised dating and correlation of the Jurassic rocks of Section 7 proposed in this paper.

It must be pointed out in this connection that the Husky Formation of the northwestern part of Mount Millen area was found to be subdivisible into: a (Lower) marine member, a (middle) nonmarine member and an (upper) marine member. The middle, nonmarine member is herein named the Mount Millen member, after the 2575 m high Mount Millen (see second edition of 116P sheet of 1:250 000 topo map and Fig. 1). This subdivision is indicated in description of Section 8 (see Appendix and Section 4 of Fig. 4). It is also applied to the Husky Formation of the southwestern corner of the McDougall Pass area (see text below and Section 7 of the Appendix) which is designated herewith the southwestern facies of the formation.

The lithology and stratigraphic position of the reliably paleontologically dated units 1 to 25 of Section 8 matches closely those of units 3 to 24 of Section 7. This indicates that the, ca. 200 m thick, lower division of the latter section (i.e. units 3 to 15 inclusive), which consists of a cyclical alternation of thin to thick (15 cm to 5 m) beds and 20 to 65 m thick units of very fine to fine grained, silty, predominantly quartzose sandstone (i.e. units 4, 6, 8, 10, 12 and 14 of Section 7: see Appendix) with prevalent sandy to very sandy siltstones (i.e. units 3, 5, 7, 9, 11, 13 and 15), does not represent an attenuated facies of the whole Husky Formation as previously suggested (Jeletzky, 1974, p. 10). It corresponds, instead, only to the upper part of the Lower marine member (named informally herein) of the Husky Formation in Section 8 as indicated by its similar lithology and its entirely similar stratigraphic position between the Bug Creek Formation and the Mount Millen Member (see text below and Fig. 4 for further details). The Lower marine member of the southwesternmost corner of the McDougall Pass area was presumably deposited in the same shallow marine environment as that of the adjacent southern area centred around Mount Millen.

There are no indications of major faulting within the completely covered interval 2 of Section 7. Therefore, this interval is inferred to conceal some 107 m of beds of the basal Husky Formation corresponding approximately to units 1 and 2 and the lower part of unit 3 inclusive of the Lower marine member of Section 8 (see Appendix and Section 4 of Fig. 4). This covered interval apparently conceals the southwestern extension of the **Buchia (Anaucella) concentrica**-bearing tongue of the Porcupine River sandstone outcropping throughout the northeastern part of the McDougall Pass area (see Sections 1, 3 and 5 discussed in the preceding sections and the Appendix). The thickness and facies of this tongue in Section 7 are expected to be similar to those of the equivalent unit 2 of Section 8 (see Appendix) on the basis of paleogeographical, depositional and stratigraphical considerations presented below (see p. 17). On this basis, the complete thickness of the Lower marine member in the westernmost corner of the McDougall Pass area is likely to be in the order of 300 m. This tentative estimate of the thickness, which is only about 55 per cent of the thickness (516 m; see Section 8 in the Appendix) of the member in the adjacent part of Mount Millen area, is based on the reasonable assumption that covered interval 2 is underlain entirely or almost entirely by the predominantly argillaceous rocks of this member. Furthermore, it depends on the probable but still unproven validity of the idea favoured in this paper that the so far unfossiliferous unit 1 of Section 7 represents the upper part of the Bug Creek Formation rather than the lithologically similar but unrelated sandstone unit 2 of Section 8 (see Appendix).

Like the fine arenaceous to argillaceous rocks of the Lower marine member of Section 8, those of the Lower marine member of the southwesternmost corner of the McDougall Pass area are interpreted herein as prodeltaic deposits (see p. 18 for further details).

The overlying 38 m thick member of nonmarine rocks comprising units 16 to 24 of Section 7 (see Appendix) is lithologically and environmentally similar to and occupies the same stratigraphic position in relation to the Lower marine member as does the reliably paleontologically dated (see below) Mount Millen Member of the Husky Formation of Section 8 (see Appendix and Fig. 4). Therefore, it is correlative with the latter member of the southwestern facies of the Husky Formation rather than with the nonmarine facies of the Lower sandstone division and is so reinterpreted in this paper.

The facies of the lithologically indivisible Mount Millen Member of the southwesternmost corner of the McDougall Pass area resembles closely that of the Upper nonmarine unit of its equivalent in the northwestern part of Mount Millen area. However, the Mount Millen Member of McDougall Pass area differs from this unit in having a considerably greater ratio of grit and fine pebble conglomerate interbeds and pods in some of its beds and of units of poorly sorted and rounded, medium to coarse grained sandstone (e.g. in unit 16 of Section 7; see Appendix); in the presence of a few medium to thick beds of grit and fine pebble conglomerate (e.g. unit 20 of Section 7; see Appendix); and in the presence of abrupt and uneven, obviously erosionally disconformable lower contacts at the base (see description of unit 15 of Section 7, in the Appendix) and within the member (see in description of units 16 and 18 of Section 7, in the Appendix). Other lithologically distinctive features include the presence of "upward coarsening" (e.g. in unit 18 of Section 7; see Appendix) as well as "upward fining" sequences, presence of lamellae and pods of impure coal (e.g. in unit 18 of Section 7; see Appendix), and local presence of ripped up fragments and pebbles of coal (e.g. in units 16 to 18 of Section 7; see Appendix).

The relatively insignificant thickness of the Mount Millen Member in Section 7 combined with the direct superposition on the Lower marine member and its erosionally disconformable (presumably regionally unconformable; see p. 32) upper contact suggests that only the lower part of the member escaped the Valanginian and/or Hauterivian erosion in the southwestern corner of the McDougall Pass area. It is concluded accordingly that units 16 to 24 of Section 7 (see Appendix) correspond not to the lithologically similar Upper nonmarine unit of the Mount Millen Member of the Mount Millen area but to part or ?all of the delta front to lagoonal Lower nonmarine unit of that area (i.e. to units 15-18 of Section 8; see Appendix). This correlation suggests, in turn, that the deposition of alluvial facies of the Mount Millen Member began considerably earlier in the southwestern corner of the McDougall Pass area than it did in the adjacent part of the Mount Millen area situated immediately south of it.

The above considerations suggest that the indubitably alluvial Mount Millen Member in the southwesternmost corner of McDougall Pass area was deposited by faster streams than the stratigraphically equivalent delta front- to lagoon-deposited Lower nonmarine unit of the adjacent northwestern part of the Mount Millen area (i.e. units 15-18 of Section 8; see Appendix). Therefore, the member appears to be an alluvial plain deposit laid down by the more steeply inclined, upstream part of the same south-flowing river(s) which deposited the equivalent unit of the Mount Millen Member of the Mount Millen area.

Stratigraphical nomenclature. The lithologically distinctive, predominantly nonmarine sandstone unit separating the largely argillaceous rocks of the Lower and Upper marine members of Husky Formation in Section 8 and, apparently, in Section 7 (see Fig. 4) is designated herewith formally as the Mount Millen Member of the formation. The name is derived from Mount Millen (see p. 10) on the western flank of which the best known and most typical section of the member was measured (Fig. 1). Units 19 to 25 of Section 8 (see Appendix and Section 4 of Fig. 4) measured on the ridges adjoining the principal peak of Mount Millen from the west, are herewith designated as the type section of Mount Millen Member. The member differs from the nonmarine facies of the Dave Lord Ridge and southeastern Keele Range deltaic lobes of the Porcupine River Formation (Jeletzky, 1977, p. 5, 13, 14) in the presence of interbeds of medium to coarse grained, commonly gritty and pebbly sandstones, and grit and fine pebble conglomerate. From the nonmarine facies of the Porcupine River Formation in the Barn Mountain deltaic lobe (Jeletzky, 1977, p. 16, 17) the Mount Millen Member differs in a considerably more quartzose lithology and a, generally speaking, lighter coloured appearance of its sandstones. The North Branch Formation (Jeletzky, 1967, p. 41-43, 134-137) differs in the much greater ratio of grit and pebble conglomerate in relation to sandstone, almost exclusively noncarbonaceous character of all rock types, and in the presence of minor to major admixture of glauconite in many beds.

As demonstrated in the section on the environmental interpretation and paleogeography of Husky Formation below (see p. 15-18, and Fig. 5-7) the Mount Millen Member is an independent, strongly lenticular body of deltaic to alluvial sandstones, confined to the southern part of the Late Jurassic Cache Creek Horst (p. 20, Fig. 8) and surrounded by belts of marine argillaceous to arenaceous facies of Husky Formation on all sides.

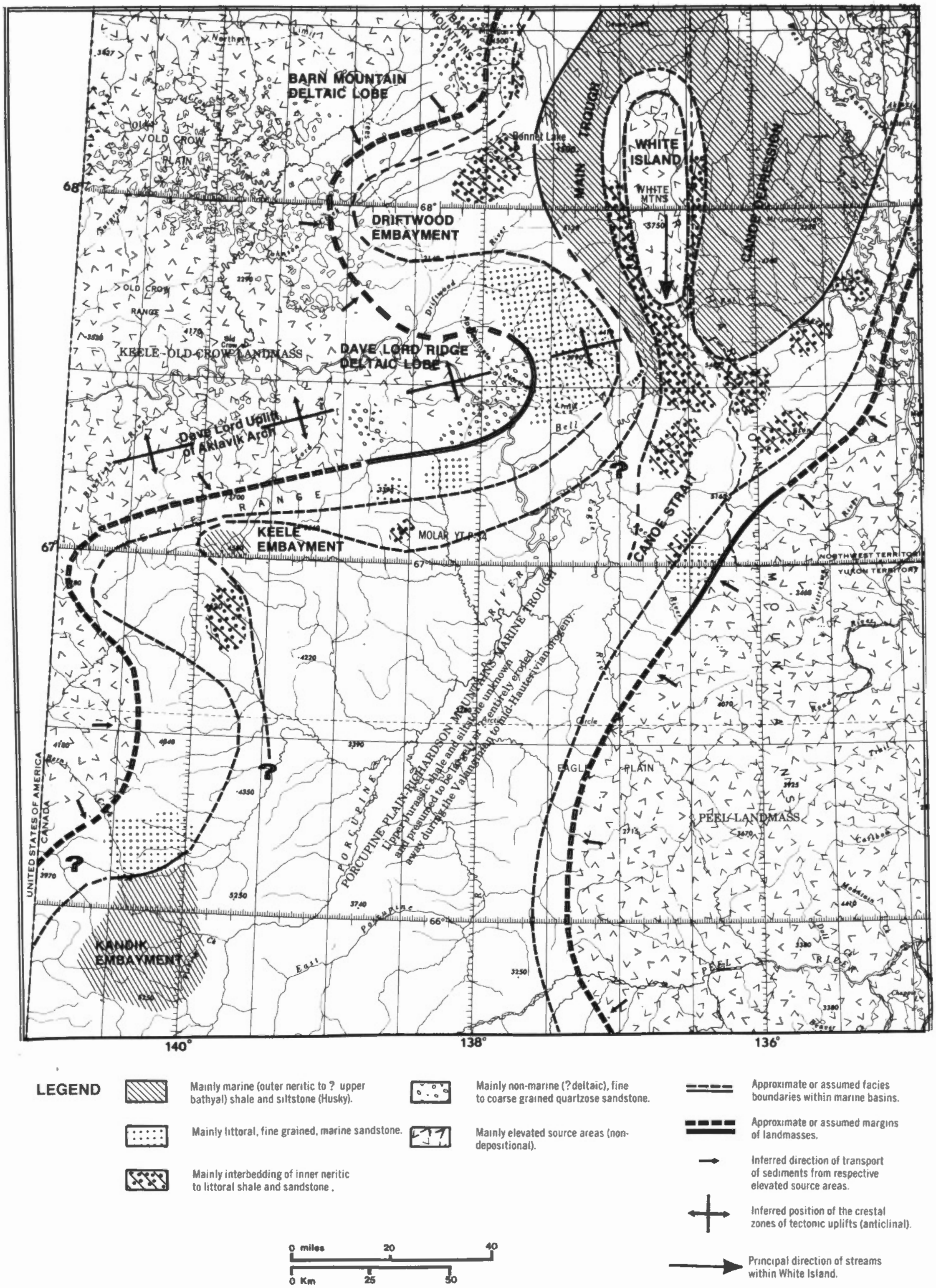


Figure 6. Geographic extent, paleogeography, facies and depositional tectonics of Porcupine River Formation and its predominantly argillaceous equivalents (Husky Formation) in Late Oxfordian to Early Kimmeridgian. Only the arenaceous *and interbedded* arenaceous *and argillaceous rocks on the west side of the Richardson Mountains–Porcupine Plain Trough form part of Porcupine River Formation. Those on the eastern side of the trough belong to Arenaceous facies of Husky Formation.*

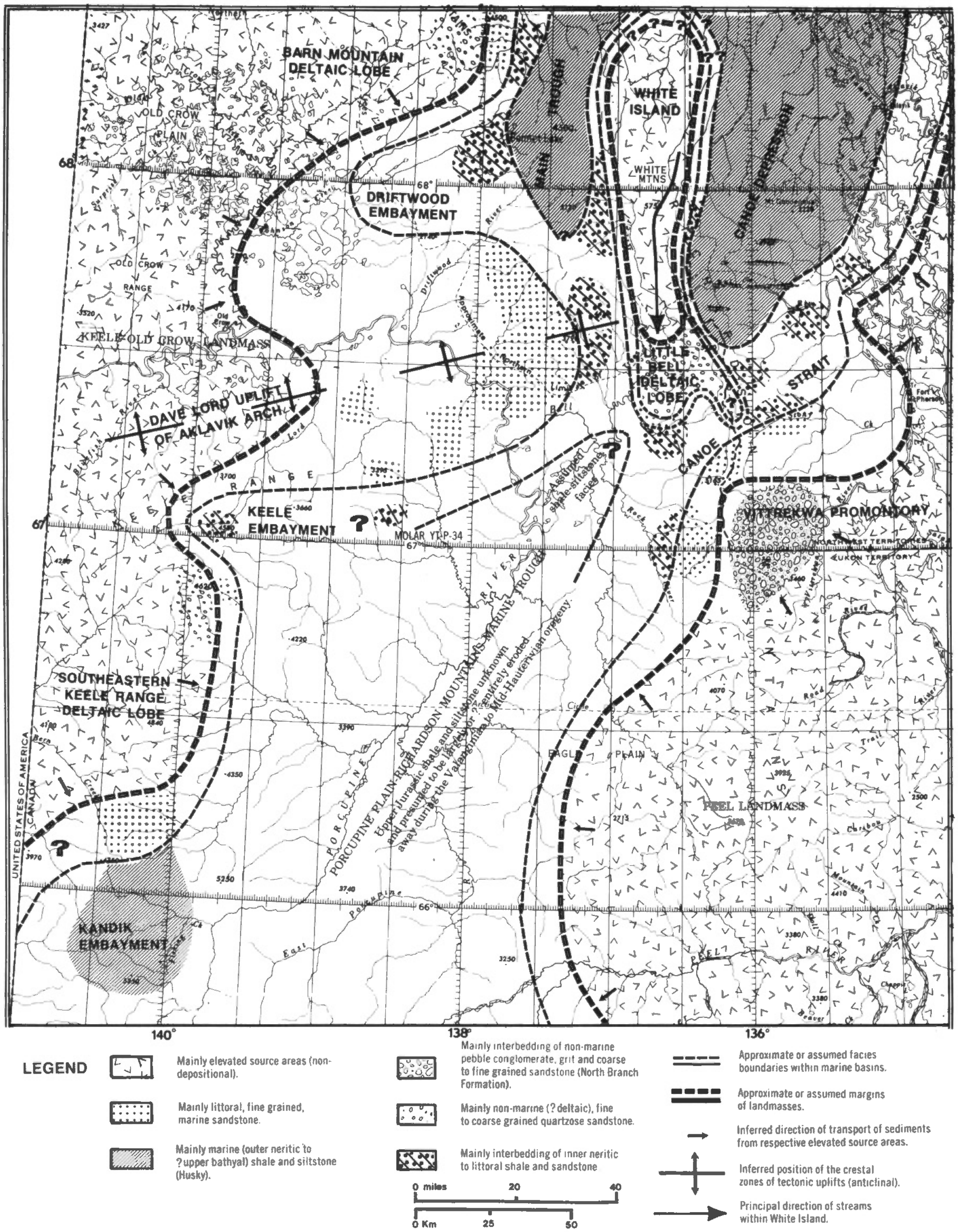
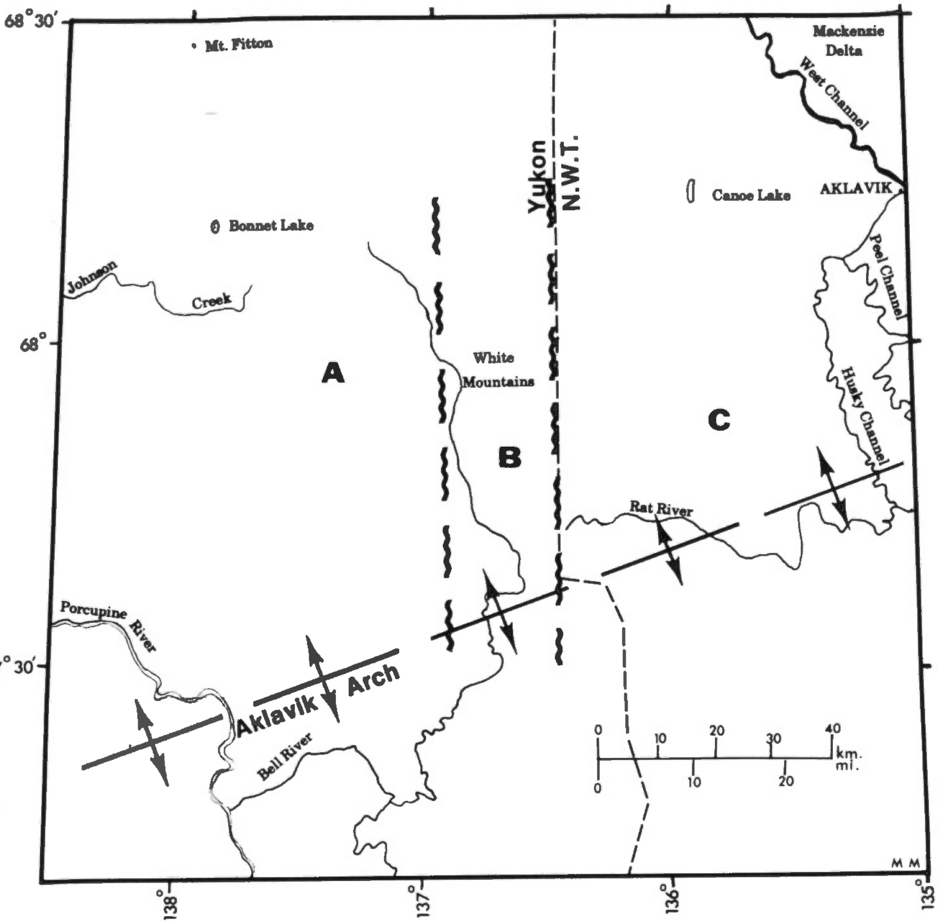


Figure 7. Geographic extent, paleogeography, facies, and depositional tectonics of Porcupine River Formation and its predominantly argillaceous equivalents (Husky Formation). Early Portlandian s. str. and ?latest Kimmeridgian time. Only the arenaceous and interbedded arenaceous and argillaceous rocks on the west side of the Richardson Mountains-Porcupine Plain Trough form part of Porcupine River Formation. Those on the eastern side of the trough belong to Arenaceous facies of Husky Formation.



A. Western structurally negative fault block (a graben or ?halfgraben);

B. Cache Creek Horst;

C. Eastern structurally negative fault block (a graben or ?halfgraben).

Figure 8. Suggested principal Late Jurassic tectonic elements of east-central Richardson Mountains. The Late Jurassic generation of the Proterozoic or (?)Early Paleozoic Aklavik Arch is assumed to be dismembered by the Early (?earliest) Jurassic, north-south trending, normal faults delimiting the Cache Creek Horst. The approximate locations of these faults are indicated by a wavy pattern.

The Mount Millen Member is sufficiently thick and widespread, and lithologically distinctive enough to be treated as a formation. However, it is more practical to treat this sandstone body as a member of the Husky Formation, for the time being at least. Otherwise one would have to treat the so far lithologically indistinguishable Upper and Lower marine members of the Husky Formation as separate formations. This would necessitate, in turn, discontinuation of the accustomed use of the Husky Formation (e.g. Jeletzky, 1974, p. 8; 1975a, Fig. 6, Col. E3; Fig. 7, Col. F4; Fig. 8, Col. G3) as a comprehensive unit of formational rank which includes all three members wherever the Upper Jurassic column is dominated by a complex intertonguing of argillaceous and arenaceous units and beds.

Age and correlation. As already mentioned (see p. 10), the Husky Formation of the southwestern corner of the McDougall Pass area did not yield any diagnostic fossils. Therefore its dating and correlation depend entirely on the above discussed lithological comparison with the fossiliferous, reliably dated rocks of the Husky Formation outcropping in the adjacent part of the Mount Millen area (i.e. on an indirect paleontological dating; see Jeletzky, 1967, p. 9, 10 for further details). As indicated in Section 8 (see Appendix and Section 4 of Fig. 4), the larger lower part of the Lower marine member of that area contains **Buchia (Anaucella) concentrica** s. lato fauna. The topmost known occurrence of this fauna in unit 12 of Section 8 (see Appendix) features its late, lower Kimmeridgian phase. This suggests that the rather thick, unfossiliferous argillaceous rocks of the overlying units 13 and 14 are younger and form the lower (i.e. mid- to late Kimmeridgian) part of the next following **Buchia mosquensis** Zone. This provides an approximate lower age limit for the Mount Millen Member of that section, and, inferentially, for the correlative Mount Miller Member of the southwestern part of the McDougall Pass area. The latter is therefore considered, to be entirely younger than the **Buchia (Anaucella) concentrica** s. lato Zone and probably younger than the lower part of **Buchia mosquensis** s. lato Zone.

The Upper marine member of Section 8 contains the upper but not the uppermost Tithonian (= upper Volgian) **Buchia fischeriana** s. lato fauna which is restricted to its uppermost about 23 m thick units 31 and 32. In the basal part of this sequence **Buchia** forms transitional between **Buchia piochii** s. lato and **Buchia fischeriana** are accompanied by **B.** cf. **piochii** s. lato. This suggests that the underlying, unfossiliferous units 26 to 30 of the Upper marine member represent the underlying **Buchia piochii** s. lato Zone. Therefore, Mount Millen Member of Section 8, and consequently its equivalent in Section 7, is judged to be either entirely or at least largely older than **Buchia piochii** s. lato Zone.

The above paleontological evidence suffices to assign the bulk of the Mount Millen Member to the upper, lower Portlandian s. str., part of the **Buchia mosquensis** s. lato Zone (see Jeletzky, 1967, p. 35 for further details concerning age and intercontinental correlation of this zone). The member may possibly include beds corresponding to the lower part of this zone and/or those corresponding to the lower part of the **Buchia piochii** s. lato Zone. However, it is definitely younger than any part of upper Oxfordian to lower Kimmeridgian **Buchia (Anaucella) concentrica** s. lato Zone and older than any part of the upper Portlandian to basal upper Tithonian **Buchia fischeriana** zone.

Facies, Paleogeography and Depositional Tectonics of Jurassic and Basal Cretaceous Rocks

Bug Creek Formation. Throughout the investigated part of the McDougall Pass area the insignificant thickness and exclusively arenaceous lithology of the Bug Creek Formation is combined with an apparently complete absence of its lower (i.e. Sinemurian) part. This indicates that the eastern, shallow water facies of the formation extended much farther west than believed by Jeletzky, (1975a, p. 10, Fig. 6, 9). So far as it is possible to judge from distant observations, a study of air photographs, and examination of the scattered collections of belemnites collected by the Shell Oil Co. Ltd. (e.g. GSC loc. 88184, 88185 and 88187) and others, this shallow water facies of the Bug Creek Formation extends at least as far northwestward as the Mount Dennis area (Fig. 2). Southwestward, this facies extends at least to the point about 10.4 km south-southeast of the confluence of Bell and Little Bell rivers (approx. 67°39'30"N; 136°33'45"W). There it was apparently encountered at the base of Section 7 (see Appendix) which features an abnormally sandy, partly nonmarine facies of the Husky Formation (Jeletzky, 1974, p. 10; this paper, Fig. 4, column 3). Therefore, the westward fining and shaling out of the littoral to inner neritic arenaceous wedges of Bug Creek Formation, and the filling in of the Sinemurian to ?middle Bajocian part of the prolonged hiatus separating the formation from the underlying Permian rocks (Jeletzky, 1975a, p. 10, Fig. 6, 9), must have occurred still farther west, somewhere within the interval between the confluence of Bell and Little Bell rivers on the one hand, and the lower course of Waters River (Fig. 1) on the other. It is not possible to localize this facies change any closer until the Lower and Middle Jurassic rocks of the area would be studied in detail.

The above discussed results indicate that the tectonically active, strongly positive Early to Mid-Jurassic generation of the Rat Uplift of Aklavik Arch extended southwestward to at least near the northeasternmost tip of Dave Lord Uplift (compare with the earlier interpretation of Jeletzky, 1975a, p. 10, Fig. 9). Therefore it is likely that these two uplifts did not exist at that time as separate entities.

More general aspects of previously attempted interpretation of paleogeographical and depositional history of Northern Bell Basin segment of the Richardson Mountains – Porcupine Plain Trough in Early to Mid-Jurassic time (Jeletzky, 1975a, p. 10, Fig. 6, 9) do not seem to be affected by the above results as the writer does not agree with any of the more recent paleogeographical conclusions of Young (1975, p. 309, 310, 316, Fig. 1-3) and Young et al. (1976). In his opinion, the evidence now available continues to favour the idea that the mid-basinal Lower to Middle Jurassic deposits of the Richardson Mountains – Porcupine Plain Trough have been destroyed throughout the Whitefish Lake area during uplifts following mid-Valanginian and Aptian orogenic phases (Jeletzky, 1972, p. 99; 1974, p. 11; 1975a, p. 4-8; 1977, p. 13; and the following sections of this paper).

Husky Formation. Unlike the facies of the Bug Creek Formation, that of the Husky Formation changes drastically within the about 4.8 km wide interval separating Section 5 of the northeastern part of the report area from Section 7 (Fig. 2, 4) situated in its southwestern corner. These exceptionally rapid facies changes were evidently caused by pronounced differences of paleogeographical and depositional-structural regimes which existed in these parts of McDougall Pass area and adjacent areas of the Richardson Mountains – Porcupine Plain Trough.

Facies and depositional environment in the northeastern part of McDougall Pass area. The strongly attenuated, almost entirely argillaceous facies of the Husky Formation that characterizes the northeastern part of the McDougall Pass area is a deposit of an open, fairly deep sea. The pure to sandy siltstones and shales of this facies are almost unfossiliferous and their scarce fauna is represented almost exclusively by depth-tolerant Buchias. Such littoral to inner neritic forms as belemnites and thick shelled pelecypods appear to be completely absent. The Husky Formation of this part of the McDougall Pass area is, therefore, believed to be represented exclusively by outer neritic to ?upper bathyal deposits. This attenuated but exclusively open marine and relatively deep sea facies of the Husky Formation persists for at least 16 km south-southeastward from the McDougall Pass area. This is indicated by the facies of Husky Formation in the Snafu Mountain section being almost identical to that of Sections 1 to 5 of the report area (see Jeletzky, 1967, p. 164, 165 and the re-interpretation of the Snafu Mountain section proposed below p. 23). However, this facies of the Husky Formation is replaced by an entirely dissimilar, much thicker facies within a few kilometres to the southwest and south-southwest.

Depositional tectonics in the northeastern part of McDougall Pass area. Like all other areas situated astride of the crest of Aklavik Arch (e.g. Jeletzky, 1974, p. 11; 1975a, p. 12, Fig. 12, 13), the northeastern part of the McDougall Pass area was affected by the mid-Valanginian orogenic phase and the subsequent late Valanginian to mid-Hauterivian uplift. However, the above described, strong reduction of the thickness of the Husky Formation in the northeastern part of the McDougall Pass area in comparison with that in the adjacent areas of northern Richardson Mountains (i.e. 137 to 98 m as compared to 241 to 366 m or more in the northeastern Richardson Mountains; see Jeletzky, 1967, p. 26; 1974, p. 8, 9) and to more than 930 m in the adjacent part of Mount Millen area (see the incomplete Section 8 in the Appendix) is not appreciably influenced by its erosion during the mid-Valanginian orogenic phase and following uplift. This is clearly indicated by the already mentioned (p. 1, 8) presence of the Late Jurassic and earliest Cretaceous (early Berriasian) **Buchia** faunas in the Upper argillaceous member of the Husky Formation.

The almost complete or (?)complete development of the formation in the northeastern part of the area is combined with an apparent absence of any signs of the shallowing of Late Jurassic sea either during the time of deposition of Husky Formation or in the topmost preserved beds of its Upper argillaceous member. This indicates that in the northeastern part of McDougall Pass area the Husky transgression progressed uninterruptedly at least until the end of the early Berriasian and possibly until the end of the late Berriasian (i.e. until the end of **Buchia** n. sp. aff. **volgensis** time). So far as known, this part of the report area subsided uninterruptedly throughout Husky time except for a feeble episode of uplift in the late Oxfordian attested by the presence of the tongue of Porcupine River sandstone.

The northeastern part of McDougall Pass area was obviously characterized by an unusually quiet tectonic regime throughout Husky time. Except for the late Oxfordian uplift, the northeastern part of the area was evidently not affected to any extent by the strong Late Jurassic tectonic movements (mostly epeirogenic in character) which were responsible for the emergence of the Little Bell deltaic lobe only a few kilometres to the southwest and the further depositional-tectonic evolution of its source area (see Figs. 5-7).

Furthermore, the facies of the exceptionally attenuated Husky Formation attests that this generally sediment starved depositional area did not receive any appreciable amount of arenaceous or coarser clastic sediment from the contemporary Little Bell deltaic-alluvial depocentre that adjoined it from the southwest and presumably the west.

The above described extremely uneventful depositional-tectonic regime of Husky time is totally unlike that characteristic of the adjacent southwestern corner of the McDougall Pass area. The reasons are discussed below in the section dealing with the paleogeography and depositional tectonics of that corner and adjacent areas of the Richardson Mountains – Porcupine Plain Trough.

Environmental interpretation of the southwestern facies and some paleogeographical implications. The extremely rapid, southwestward thickening of the Husky Formation within the report area is accompanied by drastic change of its lithology and facies. The entire formation thickens several times within this only 4.8 km wide interval, becomes strongly arenaceous in Sections 7 and 8, and does not include any outer neritic or ?upper bathyal rocks, except in the Upper marine member. Furthermore, the thickness of the late Oxfordian sandstone tongue of the Porcupine River Formation is presumably doubled in comparison with its thickness near Sheep Creek, judging by the relationships observed in Sections 1 and 5 (Fig. 2). Finally, an entirely new, thick, predominantly nonmarine Mount Millen Member appears stratigraphically above this tongue in the southwestern corner of the McDougall Pass area and the adjacent part of Mount Millen area. These facies changes indicate that the outer neritic to ?upper bathyal facies of the Husky Formation that occupied the northeastern part of the area was juxtaposed to its shallow marine to nonmarine facies that occupied the adjacent southwestern corner.

The predominantly deltaic to alluvial Mount Millen Member of the southwestern facies of the Husky Formation evidently represents the eastern flank of its previously unknown deltaic-alluvial lobe that was present in the central zone of northern Richardson Mountains in the mid-Late Jurassic. The geographic position of this lobe (named herein the Little Bell deltaic lobe) indicates that it straddled the western part of the Rat River Uplift of Aklavik Arch (Fig. 7). The geographical extent of the lobe and its relationships with other Late Jurassic deltaic-alluvial lobes known to exist within the Richardson Mountains – Porcupine Plain Trough (see Jeletzky, 1977 for further details) will be explored below.

Lateral facies changes observed within the Husky Formation in the McDougall Pass area rule out the derivation of any part of its southwestern facies (exemplified by Sections 7 and 8) from an eastern source. This conclusion is equally valid for the prodeltaic rocks of the Lower marine member, deltaic-alluvial rocks of the Mount Millen Member, and the postdeltaic rocks of the Upper marine member. Instead of an eastern source area all data available indicate the existence of a fairly wide expanse of normally saline, fairly deep (outer neritic to ?upper bathyal) open sea to the east and southeast of the McDougall Pass area (Jeletzky, 1975a, p. 29, 31, Fig. 10; this paper Fig. 6, 7). The almost entirely argillaceous, totally open marine character of the redefined Husky Formation in the Snafu Mountain section situated about 16 km southwest of Horn Lake (i.e. units 3 to 5 inclusive of that section; see Jeletzky, 1967, p. 164, 165 and p. 23 of this paper for further details) provides the most important evidence concerning the extension of this open marine facies southeastward of the report area.

The expanse of the open and deep Husky Sea that existed to the east and southeast of the McDougall Pass area and included its northeastern part, evidently was confined to the previously unrecognized Late Jurassic generation of the negative tectonic structure named the Canoe Depression by Norris (1972, p. 91, 93, Fig. 1) and discussed in a greater detail by Jeletzky (1975a, p. 31, Fig. 12, 13). However, this Late Jurassic generation of the Canoe Depression extended southward well beyond the southern end of its early Cretaceous successors. Furthermore, for reasons presented below (see p. 18 and Fig. 6, 7) it was directly connected in the southwest with the mid-basin zone of the Husky Sea of the Richardson Mountains – Porcupine Plain Trough that occupied the sites of the Eagle Plain and Porcupine Plain (Fig. 1). Therefore, this Late Jurassic depression was a marine strait rather than an embayment. It is designated the Canoe Strait in this paper (see Fig. 6 and 7). The name Kugmallit Trough introduced by Young et al. (1976, p. 6, Fig. 2, 5, 8) is a junior synonym of the Canoe Depression. Therefore it is not used in this paper.

The unavailability of the eastern source area for the prodeltaic to deltaic-alluvial rocks of the southwestern facies of the Husky Formation of the report area seems to indicate that this facies was derived from the west. At the first sight, the Mount Millen Member of the southwestern facies of Husky Formation seems to be but the eastern extension of the adjacent Dave Lord Ridge deltaic lobe of the Porcupine Formation as defined by Jeletzky (1977, p. 3, 4, Fig. 1). Furthermore, because of its almost entirely nonmarine, partly alluvial facies, the Mount Millen Member of McDougall Pass area might seem to, but does not provide the long sought (e.g. by Frebold et al., 1967, p. 24; Tempelman-Kluit, 1970, p. 31, Fig. 10; Young, 1973, pers. comm.; see Jeletzky 1975a, p. 3 for further details) suitable eastern source area for the Dave Lord Ridge deltaic lobe. However, any such assumption is contradicted by the well established biochronological ages of the deltaic lobes concerned. As pointed out by Jeletzky (1977, p. 11, 12, Fig. 4, 5, 6), the prograding deltaic phase of Dave Lord Ridge lobe, as reflected in the deposition of the Nonmarine facies of the typical development of the Porcupine Formation, lasted only from ?mid- or late Callovian to late Oxfordian inclusive. Thereafter (i.e. at the end of the late Oxfordian) the lobe became inactive and was flooded by the shallow, earliest Kimmeridgian sea. This episode of subsidence and marine transgression lasted at least well into **Buchia fischeriana** time and the sea extended for a considerable distance westward into Keele Range and adjacent parts of western Porcupine Plateau. Furthermore, the time span (as determined by paleontological zones contained therein) of the nonmarine facies of Porcupine River Formation of the Dave Lord Ridge lobe is known to decrease rapidly eastward within the western part of the northern Bell Basin. Yet farther east this facies wedges out completely in the attenuated, entirely marine sections of the Porcupine River Formation described by Jeletzky (1974, p. 7, 8; 1977, p. 15, Fig. 2, 6) in the eastern part of northern Bell Basin (i.e. on eastern confluents of Waters River). Furthermore, the marine sandstones of this attenuated Porcupine River Formation are exclusively of late Oxfordian to early Kimmeridgian age and so entirely older than the Mount Millen Member of the McDougall Pass area. The overlying mid- to late Kimmeridgian and Portlandian s. str. (i.e. **Buchia mosquensis** s. lato and **Buchia piochii** zones) parts of these sections, which alone are correlative with the Mount Millen Member of the report area, are built almost exclusively of the high marine argillaceous rocks of the upper tongue of Husky Formation (Jeletzky, 1974, p. 8; this paper, Fig. 5).

The above biochronological data attest that the deposition of the Little Bell deltaic lobe in the southwestern corner of McDougall Pass area and the adjoining part of Mount Millen area began long after (presumably at the onset of the early Portlandian s. str. moment of **Buchia mosquensis** s. lato time; see p. 14 for further details) the ?mid- or late Callovian to late Oxfordian nonmarine phase of existence of the Dave Lord Ridge deltaic lobe was concluded. Only shallow marine arenites of the Marine facies of the typical development of the Porcupine River Formation were being deposited within the deposition area of Dave Lord Ridge deltaic lobe when the Little Bell deltaic lobe was deposited farther east. Even these arenites are separated from those of the Little Bell deltaic lobe by a fairly wide belt of the open marine argillaceous rocks of the upper tongue of Husky Formation. Therefore, the deltaic-alluvial facies of the Little Bell deltaic lobe (i.e. its Mount Millen Member) did completely widge out westward and was replaced laterally by marine argillaceous rocks of **Buchia mosquensis** s. lato Zone within the about 32 km wide interval separating Sections 7 and 8 from the entirely marine sections of the Porcupine River Formation occurring in the eastern part of northern Bell Basin (see Fig. 5). These data confirm, furthermore, Jeletzky's (1977) conclusion that the deltaic lobe of Dave Lord Ridge prograded eastward instead of westward.

Only the marine sandstones of the older, Upper Oxfordian tongue of the Porcupine River Formation occurring low in the Lower marine member (e.g. units 2 and 4 of Section 8; see Appendix and Fig. 4) are correlative with the upper part of the nonmarine facies of the Dave Lord Ridge deltaic lobe. This tongue probably represents the direct eastward continuation of this facies as the intervening attenuated marine facies of the Porcupine River Formation outcropping in the basin of Waters River is also of the Late Oxfordian age (Jeletzky, 1974, p. 8; 1975a, p. 10, 11, Fig. 6, Col. E2). The Upper Oxfordian tongue of the Porcupine River Formation is, therefore, interpreted as a widespread sheet-like sand deposit. The early Portlandian s. str. Mount Millen Member of the southwestern corner of the report area (and the adjacent parts of Mount Millen area) appears to be, in contrast, a pronouncedly lenticular sand deposit which had a rather restricted areal extent in the east-west direction. These inferred relationships are indicated diagrammatically in Figure 5 which represent an updating of the oversimplified facies diagram recently published by the author (Jeletzky, 1977, Fig. 5).

The biochronologic evidence leaves no doubt that the Little Bell and Dave Lord Ridge deltaic lobes owed their existence to two independent, localized pulses of uplift. For reasons presented below (see p. 19), these epeirogenic pulses were presumably restricted to the individual fault blocks which must have existed within the Late Jurassic generation of Richardson Mountains – Porcupine Plain Trough.

Because of the above discussed difference in age, the Little Bell and Dave Lord Ridge deltaic lobes cannot even be shown on the same paleogeographic map. The early Portlandian s. str. time interval reproduced in Figure 7 shows the Mount Millen Member of the Husky Formation within Mount Millen and the southwesternmost part of McDougall Pass areas flanked by vast expanses of contemporary late Porcupine Sea (i.e. time of the Marine facies of its typical development) in the west and the equivalent, late, but not the latest, Husky Sea in the east. The preceding late Oxfordian to early Kimmeridgian time interval reproduced in Figure 6 shows, in contrast, only the Dave Lord Ridge deltaic lobe of Porcupine River Formation flanked by vast expanses of contemporary early Husky Sea in the east. These two paleogeographic maps replace the overgeneralized and partly outdated paleogeographic map of the Porcupine River time recently published by the writer (Jeletzky, 1977, Fig. 1).

The ?mid- or late Callovian to late Oxfordian nonmarine facies of the Dave Lord Ridge lobe of the Porcupine River Formation is known to wedge out completely southwestward, southward and southeastward within the Keele Embayment of the Porcupine Sea (Jeletzky, 1977, p. 11-18, Fig. 1, 4, 6). This fact and the presence of a thick, entirely marine mid-basinal facies of the Jurassic rocks in Molar YT-P 34 well (Jeletzky, 1975a, p. 8, Fig. 4, Col. C2) rule out the derivation of the deltaic-alluvial rocks of the Mount Millen Member of the report area from a southwestern source, even though the nonmarine facies of the Southeastern Keele Range deltaic lobe (Fig. 7) of the Porcupine River Formation includes rocks of about the same age as the Mount Millen Member of the report area. Because of these considerations, the writer continues to reject Young's (1975a, p. 309, 310, 316, Fig. 1-3) hypothesis of the presence of a Late Jurassic landmass beneath the Eagle Plain and insists on the former presence of thick, entirely marine, basinal Upper Jurassic deposits throughout the area.

The derivation of the deltaic-alluvial lobe of the Mount Millen Member from a southern or southeastern source area situated within the Vittrekwa River promontory of the Peel landmass (see Fig. 7) is even less probable than its derivation from a hypothetical source area situated beneath the Eagle Plain. Furthermore, the same is true of the strongly thickened arenaceous siltstones and fine grained sandstones of the Lower and Upper marine members of this facies of Husky Formation. The reasons are as already mentioned (see p. 11), the deposition of the nonmarine, alluvial-deltaic rocks of the Mount Millen Member began appreciably earlier in the northern (e.g. in Section 7) than in the southern (e.g. in Section 8) area of the investigated part of Little Bell deltaic lobe. Furthermore, the basal beds of the member are dominated by distinctly coarser grained, gritty and pebbly sandstones, grit, and fine pebble conglomerate in the northern Section 7. The equivalent basal beds of the member outcropping in the southern sections (e.g. in Section 8; see Appendix and Fig. 4) are dominated, in contrast, by fine to very fine grained, carbonaceous to coaly sandstones interbedded with sandy, carbonaceous to coaly siltstones. These predominantly lower deltaic to delta front rocks include considerable interbeds of marine (?lagoonal) sandstones and siltstones. This southward change of facies and gradual fining of nonmarine clastics of the Lower nonmarine unit of the Mount Millen Member is combined with an appreciable thickening of its Intermediate marine unit in the same direction (unpublished observations of the writer in southwestern part of Mount Millen area). The southward thickening of the Intermediate marine unit is accompanied by a corresponding facies change of the Upper nonmarine unit of the member. The upper deltaic to alluvial sandstones, grits and fine pebble conglomerates of the Upper nonmarine unit in the northwestern part of Mount Millen area (see units 22 to 26 inclusive of Section 8 in the Appendix) are replaced laterally by fine to very fine grained, carbonaceous to coaly, locally plant-bearing sandstones and plant-bearing, sandy to very sandy siltstones in the southern part of the area. These presumably lagoonal to delta front rocks were previously mistaken for the nonmarine facies of the Bug Creek Formation (Jeletzky, 1972, p. 9, 10). However, their occurrence in an undisturbed section closely below the characteristically developed **Buchia fischeriana**-bearing rocks of the Upper marine member of Husky Formation indicates the correlation with the Upper nonmarine unit of Section 8 (see Appendix).

Still farther south on the southern side of the "Pacific Rat River" (Jeletzky, 1972, p. 10, 11; 1975a, Fig. 4, Col. C3) the interval of Husky Formation corresponding to the Mount Millen Member of more northerly sections (i.e. **Buchia mosquensis** s. lato and **Buchia piochii** s. lato zones) is represented exclusively by richly fossiliferous, shallow marine sandstones and siltstones of the arenaceous facies of the formation. Therefore, the fine grained facies of the Upper nonmarine unit of the Mount Millen Member is entirely replaced laterally by comparably thick shallow marine rocks within the intervening, only 4.5 to 5 km wide, north-south directed interval. Only the Upper marine member persists essentially unchanged across this interval (Fig. 4). The Lower nonmarine unit of the Mount Millen Member is apparently replaced by shallow marine rocks at the same latitude as does its Upper nonmarine unit. However this southward facies change cannot be as well documented because of the apparent absence of well exposed, undisturbed sections of the lower part of the Husky Formation on the southern side of the "Pacific Rat River".

The southward facies changes of the Husky Formation described above indicate clearly that the Vittrekwa River Promontory of the Peel Landmass was separated from the Little Bell deltaic lobe by a fairly wide marine strait (Fig. 7). This Late Jurassic Canoe Strait connected the previously discussed (see p. 15, 16) offshore facies of the Husky Formation that occupied the northeastern part of the McDougall Pass area and the Snafu Mountain area with the mid-basinal belt of the Richardson Mountains – Porcupine Plain Trough that occupied the area of the present Eagle Plain in the Late Jurassic. This facies pattern of the Husky rocks further negates the hypothesis (Young, 1975; Young et al., 1976, p. 13, 15, Fig. 5) for the existence of the Late Jurassic Eagle Arch said to have occupied the site of the present Eagle Plain, and to have separated the Keele – Kandik Trough of Norris (1972) from the Vittrekwa Embayment of the Husky Sea.

The observed southward progradation of the Little Bell deltaic lobe over the prodeltaic deposits of the Lower marine member of Husky Formation and the existence of the early Portlandian s. str. generation of the Canoe Strait south of its front is compatible with the rapid southward filling out of the erosional hiatus separating the southwestern facies of the Husky Formation from the overlying mid-Lower Cretaceous rocks in Section 7 (see Fig. 4, Sections 3, 4). This southward decrease of the hiatus indicates that the southwestern corner of McDougall Pass area was a much more positive area than the adjacent part of the Mount Millen area and other areas (including the Eagle Plain) flanking it from the south. This southwestern corner may have been within the mountainous northern source area of the Little Bell deltaic lobe during the time when the Upper nonmarine unit of the Mount Millen Member and the equivalent, shallow water marine early Portlandian s. str. rocks of the Canoe Strait were being deposited farther south.

The above environmental interpretation of the southwestern facies of the Husky Formation within the report area and, particularly, the quite evident north-south-directed facies changes of all its members and subordinate units indicate that the Little Bell deltaic lobe was derived from a northern source area. This conclusion is valid not only for the deltaic-alluvial Mount Millen Member of this facies but for its prodeltaic Lower marine and postdeltaic Upper marine members as well. It is concluded accordingly that a sizeable landmass must have existed throughout Husky time in the central part of northern Richardson Mountains. Only such a Late Jurassic landmass could support the shortheaded (as defined by Flores, 1975) but sizeable, south- or southwest-flowing river(s) required to produce the localized but bulky depocentre of the southwestern facies of the Husky Formation in the southwestern corner of McDougall Pass area and the adjacent part of Mount Millen area. The writer visualizes this previously unsuspected Late Jurassic landmass (compare Jeletzky, 1975a, p. 29, 31; 1977, Fig. 1, 5 with Fig. 4, 5, 6, 7 of this paper) as a high mountainous (cordillera-like) tectonic island that included the western part of the Rat Uplift of Aklavik Arch and extended northward at least into the central part of White Mountains (i.e. their present day Paleozoic core). This island may have extended yet farther northward into the headwaters of Cache Creek and Fish River and this idea is favoured by the writer in spite of the absence of any positive evidence confirming it. The name White Island is proposed herein for this Late Jurassic Island of east-central Richardson Mountains.

The high mountainous character of White Island is inferred from its relatively small size which could hardly exceed 100 km in the north-south direction and ≈40 km in the east-west direction (Fig. 6, 7). An island of that size could only support short-headed but sizable, fast flowing river(s) capable of producing the Little Bell deltaic lobe if it had a high relief amounting to at least 2000 m.

White Island did not extend much west (if at all) of the north- south-trending upper segment of Bell River, judging by the predominantly marine, although pronouncedly arenaceous, facies of the Husky Formation outcropping in the lower courses of western confluents of Bell River directly west of White Mountains (Jeletzky, unpubl.). Nor did this island extend eastward beyond the present day Paleozoic core of White Mountains, judging by the entirely marine, although partly arenaceous, facies of the Husky Formation outcropping just east therefrom in the westernmost headwaters of Fish Creek (Jeletzky, 1972, p. 18, 19; 1975a, p. 14, 15, Fig. 7, Col. F4).

The inferred White Island of north-central Richardson Mountains must have existed already in the late Oxfordian to early Kimmeridgian time (i.e. time of **Buchia (Anaucella) concentrica** s. lato) when the exceptionally thick (up to 542.5 m) prodeltaic rocks of the Lower marine member of the southwestern facies of Husky Formation was being deposited in the southwesternmost corner of McDougall Pass area. There is no evidence suggestive of the previous existence of White Island anywhere near the McDougall Pass area as the Middle Jurassic Bug Creek Formation is uniformly thin and represented by the same shallow marine facies in the report area and in its close proximity. However, Poulton and Callomon's (1976) discovery of pronounced east-west facies changes of the Bug Creek Formation farther north suggests, to the writer, that by Middle Jurassic a nucleus of White Island may have existed there.

Even if the central facies belt of Poulton and Callomon (1976, p. 347, 350, Fig. 61.1, 61.2) represented only a shoal area in the Early and Mid-Jurassic seas of the Richardson Mountain – Porcupine Plain Trough, the southern part of that belt, at least, must have been strongly uplifted subsequently on the onset of the late Oxfordian (i.e. **Buchia (Anaucella) concentrica** s. lato time) and transformed into a mountainous island. This uplift apparently was a somewhat retarded effect of that tectonic pulse which was responsible for the deposition of the eastward-prograding ?mid- or late-Callovian to late Oxfordian nonmarine facies of the Dave Lord Ridge deltaic lobe of the Porcupine River Formation farther west (Jeletzky, 1977, p. 11, 12, Fig. 1, 4, 5 and 6; this paper, Fig. 5 and 6).

The previously inferred derivation of the wedge of prodeltaic rocks of the Lower marine member from a nearby northern area suggests that the southern shoreline of the late Oxfordian to early Kimmeridgian White Island was situated immediately north of the report area at the junction of the Rat Uplift of Aklavik Arch with the Cache Creek Uplift as defined by Jeletzky (1975a, p. 35, 37, Fig. 12, 13). The writer believes that the Mount Russell – Mount Dennis area (Fig. 2, 6) was situated within this generation of White Island.

So far as known, this southern shoreline of White Island remained more or less stationary until the end of the early (i.e. mid- to late-Kimmeridgian) phase of **Buchia mosquensis** s. lato time. Then the apparently high destructive (in the sense of Fisher et al., 1972) late Oxfordian to late Kimmeridgian delta of the south- or southwest-flowing river(s) that drained the White Island became highly constructive (in the sense of Fisher et al., 1972) and prograded southward into the southwesternmost corner of McDougall Pass area and adjacent part of Mount Millen area. This event, which lasted through the late (i.e. early Portlandian s. str.) phase of **Buchia mosquensis** s. lato time, is recorded by the deposition of the Mount Millen Member of the southwestern facies of Husky Formation (Fig. 7) atop its prodeltaic Lower marine member. This southward progradation of the delta created the short lived (probably early Portlandian s. str. only) Little Bell deltaic lobe proper within the report area (Fig. 4, 7).

The abrupt change in the nature of the Little Bell delta was presumably caused by a strong latest Kimmeridgian or ?earliest Portlandian s. str. tectonic pulse which caused a pronounced uplfit of White Island. Is is remarkable that this was not felt in the more westerly areas of the Richardson Mountains – Porcupine Plain Trough as the areas around and within the by then completely flooded area of Dave Lord Ridge deltaic lobe remained submerged throughout that time (Jeletzky, 1977, p. 9-12, 20-21, Fig. 3, 4, 6; this paper, Fig. 7). However, other areas on the western limb of the trough, such as the southeastern Keele Range and Barn Mountain deltaic lobes (Jeletzky, 1977, p. 15, 18, Fig. 5, 7), experienced uplifts which were approximately contemporary with that which affected White Island of north-central Richardson Mountains.

The earliest Portlandian s. str. and (?)latest Kimmeridgian tectonic uplift of White Island was followed by its subsidence sometime in the late Portlandian s. str. This subsidence and the resulting drowning of the Little Bell deltaic lobe are recorded in the deposition of the Upper marine member of the southwestern facies of Husky Formation atop the Upper nonmarine unit of its Mount Millen Member (e.g. Section 4 of Fig. 4). The open marine, mostly neritic rocks of the Upper marine member do not seem to be distinctly influenced by a nearby northern source area. It is assumed, therefore, that the southern part of White Island, at least, was submerged at that time. The strongly arenaceous character of the upper part of Husky Formation on the eastern and western flanks of White Mountains (Jeletzky, 1972, p. 18, 19 and unpublished) suggests, nevertheless, that the northern part of the island was not submerged during the late Portlandian s. str. episode of subsidence. However, this topic is beyond the scope if this paper because of the insuficient data now available.

Tectonic control of Late Jurassic facies changes. The drastic facies changes of the Husky Formation within the McDougall Pass area, as well as the inferred, highly diversified Late Jurassic relief of that area and of adjacent areas of Richardson Mountains – Porcupine Plain Trough, must have been tectonically controlled. The alternative hypothesis of a rapid, exclusively depositionally controlled lateral changes of facies across the about 4.8 km wide southwest-northeast oriented interval separating the northeastern and southwestern facies of the Husky Formation is untenable. Furthermore, this hypothesis fails to account for the all but diametrically opposed depositional regimes of these parts of McDougall Pass area. As already pointed out, the tectonically negative and, at the same time, tectonically quiescent northeastern part of McDougall Pass area is juxtaposed to the tectonically positive and, at the same time, tectonically active southwestern corner. This sedimentological and tectonic contrast suggests that these areas formed parts of adjacent fault blocks separated by a major fault and were characterized by almost independent tectonic regimes (compare Jeletzky, 1977, p. 20-22, Fig. 6). The tectonically quiescent northeastern part of McDougall Pass area apparently formed part of the tectonically negative limb of that fault which was more or less steadily subsiding throughout the Late Jurassic (i.e. Husky time). The tectonically active southwestern corner of the area apparently formed the easternmost part of the relatively positive, tectonically active limb of the same fault. The rapid, probably abrupt, lateral replacement of the pronouncedly thickened, southwestern facies of the Husky Formation by an attenuated, open sea facies yet farther west within the adjacent part of Bell Basin (see p. 16 and Fig. 5) suggest that the western boundary of this facies was also fault-controlled. It is inferred therefrom that the southwestern facies of the Husky Formation was deposited within a positive fault block that controlled the depositional pattern of Late Jurassic time in the north-central Richardson Mountains. This positive fault block, which must have protruded horst-like within the northern part of Richardson Mountains – Porcupine Plain Trough, was evidently much more active tectonically than the relatively negative, graben- or halfgraben-like fault blocks flanking it. Its tectonic regime must have been dominated by oscillating (i.e. alternatively positive and negative) vertical movements.

The major fault inferred to separate the northeastern part of McDougall Pass area from its southwestern corner, must have been roughly north-south trending. This is indicated by the rather regular north-south oriented pattern of facies on the eastern flank of the Cache Creek Uplift (p. 20, Fig. 6-8). This north-south trending fault must have been controlling the general geographic position and the north-south orientation of the eastern shoreline of Late Jurassic White Island throughout its known and inferred extent. The same reasoning applies also to the western shoreline of Late Jurassic White Island as the facies belts are quite regularly north-south oriented on the western side of the Cache Creek Uplift (Fig. 5, 6, 7).

The existence of major, north-south-trending faults limiting the Cache Creek Uplift from east and west was suggested by Yorath and Norris (1975). Poulton and Callomon (1976, p. 347) also admitted that the boundaries of their Early to Mid-Jurassic central facies belt may have been controlled by north-south trending faults, even though they concluded conservatively that: "The nature of the boundaries of the central facies belt remain unknown...". There may be a valid reason for these different opinions. Namely, the major, north-south trending faults limiting the Cache Creek Uplift must have been active throughout the Late Jurassic, judging by the above described juxtaposition of the depositional-tectonic regimes of the northeastern part of McDougall Pass area and its southwestern corner and the facies pattern observed farther west. However, the persistence of the same thin, shallow water facies of Bug Creek Formation across the sites of these faults within the report area and in its proximity suggests that they were either inactive or did not yet exist in the Middle Jurassic. The same may have been true of the more northerly areas where the three facies belts described by Poulton and Callomon (1976) are well defined. However, the writer prefers to interpret these Early to Mid-Jurassic facies belts as being caused by the north-south oriented, Early (?earliest) Jurassic normal faulting which did not yet extend farther south into the immediate proximity of the Aklavik Arch (see Fig. 8).

While explaining the juxtaposition of the facies patterns and tectonic regimes of the northeastern part of McDougall Pass area and its southwestern corner, the fault block hypothesis does not explain the attenuation of the northeastern facies of Husky Formation, the apparently complete absence of arenaceous interbeds in the argillaceous sediments of this facies, and the absence of an appreciable increase of these arenaceous interbeds in the westernmost studied sections of this facies (i.e. in Section 5). It seems as if the Little Bell deltaic lobe was not supplying any amount of arenaceous sediment to the northeastern part of McDougall Pass area in spite of their very close proximity. This suggests, in turn (compare with the Early Cretaceous situation discussed by Jeletzky, 1975a, p. 37), that the tectonically positive fault block underlying White Island was not simply uplifted relative to the tectonically negative fault block underlying the northeastern part of the area but was also tilted either southwestward or westward. Such tilting could produce a precipitous, mountainous northeastern or eastern flank on White Island combined with a gradually sloping western or southwestern flank. Such topography could, in turn, result in the concentration of the principal streams on the western or southwestern slope and, in either almost complete absence, or at least a scarcity of eastward directed streams within the island. This hypothesis accounts satisfactorily for the scarcity of westerly derived arenaceous sediments in the northeastern facies of Husky Formation and the observed exclusively southward or southwestward progradation of Little Bell deltaic lobe throughout Mount Millen Member time. It also accounts satisfactorily for the sediment-starved character and the continuing existence of outer neritic or ?upper bathyal depths in the Husky sea immediately flanking White Island from the east.

Tectonic nature of the Jurassic generation of Cache Creek Uplift, its structural relationship with ancestral Aklavik Arch and some general implications. The above discussed new data about the tectonic nature of the Late Jurassic generation of the Cache Creek Uplift that existed within the McDougall Pass area and adjacent areas of north-central Richardson Mountains supports the following, previously expressed opinion about the tectonic nature of this uplift based on the data available about its early Early Cretaceous generation: "the markedly asymmetrical cross-section of the uplift with the most strongly uplifted eastern side and considerably less uplifted western side (as indicated by the above discussed areal restriction of the Valanginian to Hauterivian hiatus, etc.) is somewhat suggestive of its being a relatively uplifted north-south trending, westward tilted fault block..." (Jeletzky, 1975a, p. 37). It is concluded that the Late Jurassic generation of the Cache Creek Uplift is an earlier, previously unknown phase of the development of this fault block. This horst-like, north-south trending structure presumably arose as the result of an Early (?earliest) Jurassic faulting transecting (i.e. cross-faulting) the northern flank of the much older Aklavik Arch (compare Jeletzky, 1975a, p. 12).

The alternative, previously favoured hypothesis (Jeletzky, 1975a, p. 37, 49), suggesting that the Cache Creek Uplift probably represented a north-trending cratonic arch subsiduary to the Aklavik Arch appears to be most unlikely in the light of the new information concerning its Late Jurassic generation. This hypothesis is rejected in this paper and the Cache Creek Uplift is renamed herein the Cache Creek Horst (Fig. 8).

The inferred fault-caused nature and the Jurassic (Early Jurassic) inception time of the Cache Creek Horst are even more incompatible with the "en echelon" arrangement of the Dave Lord Uplift, Rat Uplift and White Uplift proposed by Norris (1972, p. 91, 93, Fig. 1) than the alternative hypothesis of the Cache Creek Arch being subsidiary to the Aklavik Arch. As now interpreted by the writer (Fig. 8), the Cache Creek Horst is one of the Jurassic – probably earliest Jurassic (Jeletzky, 1963, p. 77, Fig. 5) – disjunctive structures which arose during the fault controlled inception phase of the north-south-trending Richardson Mountains-Porcupine Plain Aulacogene (Jeletzky, 1975a, p. 2, 3). This horst, and the flanking grabens, transect the much older – either Precambrian or Early Paleozoic (Jeletzky, 1963, p. 66, Fig. 2–4) – northeast-trending cratonic structure of the ancestral Aklavik Arch (see Jeletzky, 1963, p. 61-77, Fig. 2-4 for further details). As already suggested (Jeletzky, 1975a, p. 2, 3), this interpretation of the structural history of the Richardson Mountains – Porcupine Plain Aulacogene agrees perfectly with the characteristically fault-controlled nature of all known examples of aulacogenes (see Burke, 1977 for further details).

The structural relationships now inferred to exist in the north-central Richardson Mountains during most or all of the Jurassic appear to parallel closely the relationships inferred to exist in the same area in the Cretaceous. So far as it is possible to tell, this presently favoured structural pattern of Jurassic-Cretaceous times only differed from the Cretaceous pattern previously suggested by Jeletzky (1961a, p. 574-578, Fig. 22; 1963, p. 63, Fig. 5) in the absence of any appreciable lateral displacement of the Dave Lord and Rat uplifts of the Aklavik Arch since its inception. The reasons for the abandonment of this hypothesis (i.e. the idea of appreciable lateral displacement) have already been published elsewhere (Jeletzky, 1975a, p. 49).

Upper Shale-Siltstone Division

Lower Member

Like the Husky Formation (see p. 1), the Lower member of the Upper shale-silstone division exhibits pronounced lateral facies changes in the northeast-southwest direction within the McDougall Pass area. Therefore, the stratigraphy of the peculiar, previously misinterpreted (see p. 8) facies of the member outcropping in the northeastern part of the area confined between Sheep Creek and the Summit Lake will be described separately from its so called eastern argillaceous facies (Jeletzky, 1974, p. 13, 17, Fig. 5) outcropping in the southwestern corner of the area south of the confluence point of Bell and Little Bell rivers (see Section 6 in Appendix and Fig. 2, 4).

Arenaceous facies of the Lower member

Stratigraphy and nomenclature. The 610 m thick, almost unfossiliferous rock sequence of interbedded argillaceous and arenaceous units (cf p. 21) previously called members by Jeletzky, 1974, p. 6, 7)) outcrops extensively on the southern side of Rat River between the Sheep Creek and Summit Lake (Fig. 2). This sequence was previously mistaken for the offshore, largely argillaceous facies of the Bug Creek Formation (Jeletzky, 1974, p. 6, 7; 1975a, p. 10, Fig. 9). However, it is re-interpreted herein as the much thickened equivalent of the arenaceous facies of the Lower member of the Upper shale-siltstone division for reasons presented below (see p.21) and is renamed accordingly. This informally named Arenaceous facies merges into the marginal or "southern" facies of Upper shale-siltstone division which is widespread in the basins of Stony Creek and Vittrekwa River (Jeletzky, 1960, p. 11; 1972; 1974; 1975a, p. 4-6, 8, Fig. 2, 4, 14). Therefore, and because of a very close lithological resemblance of these two facies, the "southern" facies is considered the same as the Arenaceous facies in this report. The lithostratigraphy of this Arenaceous facies was described elsewhere (Jeletzky, 1974, p. 6, 7) and these data do not need to be recapitulated here. However, the lithological subdivisions of this Arenaceous facies proposed previously (i.e. "Lower sandstone member", "Intermediate siltstone member" and "Upper sandstone member" of Jeletzky, 1974, p. 6, 7) are renamed herein as its units in accordance with the nomenclature used for their lateral equivalents outcropping on the eastern slope of White Mountains (Jeletzky, 1974, p. 17-19; 1975a, p. 16, 17, Fig. 7, 14).

Age and correlation. The rock sequence assigned herein to the Arenaceous facies of the Lower member of the Upper shale-siltstone division was found to overlie the **Buchia okensis**-bearing beds of the Husky Formation with an abrupt, apparently erosionally disconformable and probably regionally discordant contact (p. 8 and Fig. 4). Therefore, it is considerably younger than the true Bug Creek Formation of the report area and cannot represent its lateral facies. The sequence concerned is overlain, apparently conformably and possibly gradationally, by an about 195 m thick siltstone unit containing **Aucellina** ex gr. **aptiensis-caucasica** fauna in the topmost beds and so correlative with the Upper member of the Upper shale-siltstone division of adjacent areas (see below). Therefore, this sequence can only be equivalent to one or more of the following units of the standard Lower Cretaceous sequence of the Richardson Mountains: a) Lower sandstone division; (b) Coal-bearing division and its equivalents; and c) Lower member of the Upper shale-siltstone division.

Macrofossils found so far in the sequence are nondiagnostic. The previously published, (Jeletzky, 1974, p. 7) tentative identifications (field identifications only) of macrofossils found at the base of its "Lower sandstone member" (GSC loc. 92203) in Section 2 (Fig. 2, 4) are withdrawn herewith following a more detailed office study of the same (see unit 1 of Section 2 in the Appendix). Poor inocerami of this fauna identified as **Inoceramus (Retroceramus)** cf. **menneri** Koshelkina are now considered to be subgenerically and specifically indeterminate. Poor and fragmentary ammonites of the same fauna previously identified tentatively as "?**Cranocephalites**-like cadoceratid ammonites" are better comparable with **Simbirskites (Simbirskites)** but are not determinable on the family and genus level.

The tentative field identification of "very rare generically indeterminate ?cadoceratid ammonites" (Jeletzky, 1974, p. 7) in the basal beds of the "Upper sandstone member" of the same section (Fig. 2, 4) is also withdrawn herewith (see unit 3 of Section 2 in the Appendix). These ammonite fragments (GSC loc. 92202) are better comparable with **Simbirskites (Craspedodiscus)** but cannot be identified definitely either on the generic or the family level. The micropalaeontological samples collected by the writer have not yet been processed.

The apparently complete absence of **Buchia** in the above mentioned sparsely fossiliferous beds of the succession, the predominantly to ?exclusively nonmarine facies of the Lower sandstone division, wherever it occurs in the adjacent areas (Jeletzky, 1974, p. 9-11, 1975a, p. 11-12), and the prevalence of either deep erosion or nondeposition of this division within the McDougall Pass area (p. 11) and everywhere in the adjacent areas of north-central Richardson Mountains (Jeletzky, 1974, p. 11, Fig. 2; 1975a, p. 35, 37, Fig. 12, 13) are against the correlation of the here discussed succession with the Lower sandstone division. The same considerations contradict the correlation of this sequence with the Coal-bearing division (inclusive of the White and coaly quartzite divisions). This division is entirely nonmarine and lithologically quite unlike the here discussed sequence of the McDougall Pass area. Furthermore, like the Lower sandstone division, the Coal-bearing division is largely to entirely absent (either due to nondeposition or trough subsequent erosion; see Jeletzky, 1974, p. 11, Fig. 2; 1975a, p. 35, 37, Fig. 12, 23) in all adjacent areas of Richardson Mountains situated either astride or in a close proximity of the crests of Aklavik Arch and Cache Creek Horst.

The above data alone are strongly suggestive of a post-Coal-bearing division age for this McDougall Pass sequence and its correlation with the Lower member of the Upper shale-siltstone division of the eastern slope of Richardson Mountains (see Jeletzky, 1958, p. 10, 56-66). This correlation is strongly supported by the close lithological similarity of this succession with the reliably dated Arenaceous facies of the Upper shale-siltstone division outcropping on the eastern flank of White Mountains (see Jeletzky, 1974, p. 17-19; 1975a, p. 16-17, Fig. 7, 14). This Arenaceous facies includes (ascending order):

1. An 8 m thick, Basal arenaceous unit correlated with the "Lower sandstone member" of the northeastern part of McDougall Pass area because of a similar stratigraphic position and lithology. The "Lower sandstone member" is considerably thicker (i.e. 80 m) in the principal section described by Jeletzky (1974, p. 7 and Section 2 in Appendix) than is the Basal arenaceous unit of the White Mountain area. However, the correlative but considerably attenuated unit 5 of another section (Jeletzky, 1974, p. 8 and in Section 5 of the Appendix) situated about 3.2 km farther west and previously assigned to the Husky Formation is not much thicker (12 m). The same appears to be true of the southwestern extension of this unit on the same slope of McDougall Pass on the eastern side of Little Bell River (see Fig. 2, 3).
2. An about 50 m thick unit of black to dark grey shale which corresponds to the about 430 m to 213.5 m thick "Intermediate siltstone member" of the northeastern part of the McDougall Pass area because of a closely similar lithology and stratigraphic position; and
3. An about 17 m thick "Upper sandstone unit" which is correlative with the 91.5 to 106.5 m thick "Upper sandstone member" of the northeastern part of McDougall Pass area.

Because of these considerations, the succession of the northeastern part of the McDougall Pass area is now correlated with the lithologically similar and stratigraphically equivalent lower part of the Arenaceous facies of the Lower member of Upper shale-siltstone division outcropping on the eastern flank of White Mountains. This name is accordingly extended to cover the above discussed succession of the report area.

The presence of late Hauterivian **Simbirskites (Simbirskites)** ex gr. **kleini** (Neumayr and Uhlig) in the Lower sandstone unit of the member on the eastern slope of White Mountains (Jeletzky, 1974, p. 18) and that of the not definitively determinable but distinctly **Simbirskites (Simbirskites)**-like ammonites in the equivalent unit of the McDougall Pass area does not prove the geological contemporaneity of the basal beds of the Arenaceous facies to these of the argillaceous, deeper water facies of the Lower member outcropping on the eastern slope of the Richardson Mountains (Jeletzky, 1958, 1960). As already reported by Jeletzky (1972, p. 25; 1975a, p. 20), this zonal ammonite is known to range down into the shallow marine facies of the immediately underlying uppermost beds of the Coal-bearing division in the Martin Creek – Canoe Lake area. Therefore, the Lower sandstone unit of the Arenaceous facies, at least, could be correlative with the Upper member of the Coal-bearing division of northeastern Richardson Mountains. However, the writer assumes that these basal beds of the Arenaceous facies, and the equivalent Lower sandstone unit of the northeastern part of McDougall Pass area, are either correlative with or somewhat younger than the basal beds of the Argillaceous facies of the Lower member. It is difficult to envisage that the regional late Hauterivian marine transgression would flood such relatively positive areas of the Richardson Mountains – Porcupine Plain Trough as the Rat Uplift or the Cache Creek Horst at the same time (let alone earlier than) as it did the central part of the relatively negative Canoe Lake Depression.

The upper age limit of the Arenaceous facies of the member cannot be determined closely in terms of the regional fossil zones and international standard stages because of the absence of definitively determinable diagnostic fossils in its upper part. However, it seems likely that the topmost beds of the Arenaceous facies are of earliest Barremian age because of the presence of very poorly preserved ammonite fragments resembling the latest Hauterivian **Simbirskites (Craspedodiscus)** at the base of the Upper sandstone unit in the northeastern part of the McDougall Pass area (see p. 21). If so, the upper age limit of the Arenaceous facies is roughly the same as that of the Argillaceous facies of the Lower member (Jeletzky, 1958, 1960, p. 13).

Geographical extent and lateral facies changes. The thickness and lithology of the Arenaceous facies of the Lower member vary widely within the northeastern part of McDougall Pass area. In the principal section studied (i.e. Sections 2, 3, 4; see Jeletzky, 1974, p. 6, 7; Appendix, this paper; and Fig. 2, 4) it is much thicker than its equivalent exposed on the eastern slope of White Mountains. Furthermore, only the Lower sandstone and Intermediate siltstone units of the principal section are represented by the same littoral to neritic facies as their equivalents in the White Mountains section. The much thickened Upper sandstone unit of this section differs from its White Mountains equivalent also in the partly nonmarine facies. The partly nonmarine character of this Upper sandstone unit is indicated by the presence of carbonaceous to coaly interbeds throughout its principal unit (see unit 3 of Section 2 in the Appendix) combined with the total absence of marine fossils (except in the basal beds), presence of carbonaceous subvertical structures presumably representing plant rootlets in several of these interbeds, and the local presence of poor, coalified or lithified plant remains. This unit is interpreted accordingly as a series of barrier bar cycles. Furthermore, the Upper sandstone unit definitely coarsens upward and its relatively coarser grained, carbonaceous to coaly, topmost beds include some interbeds of very poorly sorted and rounded grit and fine pebble conglomerate (e.g. units 2, 3 of Section 4; see Appendix and Fig. 4). These interbeds are interpreted as channel deposits of either deltaic or alluvial plain origin which suggest a nonmarine, presumably deltaic, origin of the topmost beds of the Upper sandstone unit. The also possible tidal channel origin of these features seems less probable because of a general paleogeographic setting of the Upper sandstone unit. The paleogeographical significance of this facies of the Upper sandstone unit is discussed below (p. 23, 25, Fig. 9).

All three units of the Arenaceous facies are known to become more attenuated and finer grained southwestward and northeastward of the principal section. The Lower sandstone unit thins and fines markedly northeastward and southwestward within the northeastern part of the report area. Though the unit retains its arenaceous lithology in Section 1 measured by J. Callomon and T.P. Poulton at the point about 3.2 km northeast of the principal section (see p. 8, Fig. 2), its thickness does not seem to exceed 30.5 m in that section according to the visual observations of the writer (Pl. I, Fig. 1). The Lower sandstone unit thins out even more markedely between the principal section and Section 5 (see unit 5, Section 5, in the Appendix) situated only about 4.8 km farther west as it is only about 12 m thick in the latter. The Lower sandstone unit is, furthermore, distinctly finer grained and more silty in Section 5 compared with its equivalent in the principal section. The unit must shale out completely a few miles farther to the west and southwest as it is completely absent in the equivalent Lower member of Section 6 (see unit 2, Section 6, in the Appendix) measured in the southwestern corner of the McDougall Pass area at the point about 9.5 km south-southeast of the confluence of Bell and Little Bell rivers (Fig. 2).

The Intermediate siltstone unit is about 430 m thick in the principal section (see Jeletzky, 1974, p. 6, 7). However, it was estimated to be only about 215 m thick in Section 5 situated about 4.8 km farther west. The siltstones of the unit are, furthermore, either considerably less sandy or pure in Section 5, in contrast with their equivalents in the principal section.

No sections of the Intermediate siltstone unit were studied east of the principal section within the northeastern part of McDougall Pass area. However, the presence of an entirely normal Argillaceous facies of the Lower member of the Upper shale-siltstone division to the east and northeast of the northeastern part of the McDougall Pass area (i.e. at both ends of the Rat River Gorge, on lower Rat River, and on Treeless Creek; see Jeletzky, 1960, p. 11; 1975a, p. 12, Fig. 6, Col. E5) indicates that both sandstone units of its Arenaceous facies continue to thin and to fine east of Sheep Creek. They must be replaced laterally by argillaceous rocks of the Intermediate siltstone unit somewhere within the interval separating the line of Fish and Sheep creeks from Horn Lake.

The Upper sandstone unit of the member shows even more drastic facies changes within the area. Its orographic prominence, considerable thickness (about 90 m) and partly nonmarine facies appear to be strongly localized features. Evidence for this comes from unit 3 of Section 5 (see Appendix and Fig. 2-4), which represents the apparent equivalent of the Upper sandstone unit in this section (only about 4.8 km west of the principal section) and is only about 15 m thick and represented exclusively by hard and weathering-resistant, sandy, strongly bioturbated and worm-burrow rich, presumably neritic siltstone. Farther southwest, no traces of the Upper sandstone member have been noted in the relatively attenuated section of the Argillaceous facies of the Lower member of the Upper shale-siltstone division situated about 8 km south-southeast of the confluence of Bell and Little Bell rivers (Jeletzky, 1974, p. 17, Fig. 5; section 6 in Appendix; and the next section). The member evidently shales out completely somewhere within the 4.8 km long interval separating these two sections (Fig. 2).

Northeastward of Section 2 (Fig. 2) the Upper sandstone unit was traced by distant observation and on air photographs (e.g. on airphoro EMR A 14361-7) to the lower course of Sheep Creek. At that point the unit is cut off by a strong fault and the writer was unable to discern its further northeastward continuation on the air photographs.

The orographic prominence and thickness of the Upper sandstone unit decrease gradually northeastward until it appears to be no more than 45 m thick on the southwestern bank of Sheep Creek, judging by distant observations. Therefore, and because of an apparent absence of any correlative sandstone interbeds from all sections of the Upper shale-siltstone division studied in the proximity of Rat River Gorge, the member is assumed to shale out completely closely east of the mouth of Sheep Creek.

The strong reduction of thicknesses of the Lower and Upper sandstone units of the Arenaceous facies (cf. p. 21) outcropping on the eastern slope of White Mountains (Jeletzky, 1974, p. 17, 18; 1975a, p. 16, 17, Fig. 7, Col. F4) in comparison with their equivalents in the principal section of McDougall Pass area and the presence of an entirely normal argillaceous facies of the Lower member farther east within the Canoe Depression and on the eastern slope of Richardson Mountains (Jeletzky, 1958, 1960, p. 11; 1975a, p. 16, 17, Fig. 7, Col. F5) indicate that the McDougall Pass depocentre of the Arenaceous facies of the Lower member did not extend far either directly northward or northeastward of the report area. However, this depocentre could conceivably extend toward the north-northwest across the Mount Russell – Mount Dennis area and then directly north into the present Paleozoic core of White Mountains as the writer does not know of any erosional remnants of Upper shale-siltstone division preserved among the Paleozoic and Jurassic rocks which occupy this crestal part of Cache Creek Horst.

There was no opportunity to trace the equivalents of the above described Arenaceous facies of the Lower member of the Upper shale-siltstone division on the ground either southeastward or southward of McDougall Pass area. However, it is possible to infer its facies changes in these directions using some of the older data obtained by industrial geologists and published earlier by the writer.

Southeastward of McDougall Pass area the Upper and Lower sandstone units appear to persist essentially unchanged at least to the crest of Snafu Mountain, about 16 km southwest of Horn Lake. This is indicated by an extreme lithological similarity of the so far unfossiliferous units 13 to 6 inclusive of the previously published Section H-W-90 (see Jeletzky, 1967, p. 164-165) to the Arenaceous facies of the Lower member of McDougall Pass area (see in preceding section). These units are now re-interpreted as follows in terms of the units of McDougall Pass area (downward sequence):

a) Units 13 to 9 inclusive correspond to the Upper member of the Upper shale-siltstone division.

b) the about 61 m thick unit 8, consisting of fine grained quartzose sandstone corresponds to the Upper sandstone unit of the Lower member.

c) The almost entirely covered interval 7 underlain by ?366 m thick unit of dark grey shale corresponds to the Intermediate siltstone unit of the Lower member.

d) The about 33 m thick unit 6 of fine grained, quartzose sandstone corresponds to the Lower sandstone unit of the Lower member.

The facies and thicknesses of the individual units of the arenaceous Lower member outcropping in the Snafu Mountain section do not differ materially from those of the corresponding units of the principal section in the northeastern part of the McDougall Pass area, except that the brief description of the 61 m thick Upper sandstone unit does not allow any conclusion as to whether it is of a shallow marine or nonmarine origin.

The above data suggest that the arenaceous, partly nonmarine depocentre of the Lower Member extended for at least 16 km southwestwards of the northeastern part of McDougall Pass area without either marked attenuation or fining. The Snafu Mountain section of the Member is situated close to the west of the Barrier River sections of the so called southern facies of the Upper shale-siltstone division. These sections are unusually thick and sandstone-rich. They include a thick basal sandstone member (Jeletzky, 1960, p. 11; 1975a, p. 9; Fig. 5, Col. D4) that obviously corresponds to the Arenaceous facies of the Lower member of McDougall Pass-Snafu Mountain depocentre. The Snafu Mountain section of the Arenaceous facies is also close to the northwest of the Stony Creek – upper Vittrekwa River sections of the southern facies of the Upper shale-siltstone division which are just as thick (more than 915 m) and just as arenaceous as those of the Barrier River basin (Jeletzky, 1960, p. 11; 1975a, p. 68, Fig. 4, Col. C4, C5). There is, accordingly, every reason to conclude that the McDougall Pass – Snafu Mountain depocentre of the Arenaceous facies of the Lower member extended right into the Barrier River Basin and into the headwaters of Stony Creek and Vittrekwa River gradually becoming coarser and thicker in these directions. This depocentre was, therefore, derived from a source area situated within the Stony Creek – Vittrekwa River segment of the mid-Early Cretaceous generation of Peel River Landmass (Fig. 9).

Environmental and paleogeographical interpretation. The above data concerning the geographical distribution and lateral facies changes of the Arenaceous facies of the Lower member necessitate a somewhat drastic re-evaluation of its environmental and paleogeographical significance.

Previously, the Richardson Mountains part of the Richardson Mountains – Porcupine Plain Trough was believed to have been occupied almost exclusively by the Argillaceous facies of the Upper shale-siltstone division. The Arenaceous facies of the division (inclusive of its already mentioned "southern" facies; see Jeletzky, 1960, p. 11, and in the preceding section) was known only on the eastern slope of Richardson Mountains in the basins of Stony Creek, Barrier River, and Vittrekwa River (Jeletzky, 1960, p. 11, 12; 1975a, p. 6, Fig. 2, col. C4, C5) and on the eastern slope of White Mountains (Jeletzky, 1974, p. 17, 18; 1975a, p. 16, 17, Fig. 7, Col. F4). The Stony Creek – Barrier River – Vittrekwa River outcrop area of the facies was interpreted as a preserved segment of the eastern shoreline of the trough (Jeletzky, 1975a, p. 37, 38, Fig. 14). The outcrop area of eastern White Mountains was, however, believed: "to be related to the continuing existence of a major shoal, or even a residual source area (an island?), within the area of the present White Mountains. Although it was largely submerged, the White Mountains area of the Cache Creek Uplift evidently remained relatively positive in late Hauterivian to late Barremian time".

The new data presented in the preceding section suggest strongly that the White Mountains outcrop area of the Arenaceous facies was directly connected with the Stony Creek – Vittrekwa River outcrop area via its McDougall Pass – Snafu Mountain depocentre. The geographic localization of this apparently continuous, at first directly south- and then southeast-trending outcrop belt of the Arenaceous facies indicates that it was confined to the crestal part of the previously unrecognized younger generation of the previously discussed Late Jurassic and Valanginian to mid-Hauterivian Cache Creek Horst (see p. 20, Fig. 9). The previously recognized (Jeletzky, 1974, p. 11, Fig. 2; 1975a, p. 35, 37, Fig. 12, 13) Valanginian to mid-Hauterivian generation of this tectonically positive fault block evidently persisted into the late Hauterivian to ?earliest Barremian time (i.e. time of deposition of the Lower member of Upper shale-siltstone division). However, its late Hauterivian to ?earliest Barremian generation was much reduced in prominence as compared with the Valanginian to mid-Hauterivian predecessor. The Lower and Upper sandstone units of the Arenaceous facies are strongly attenuated (cf. p. 21) and represented exclusively by a shallow marine facies on the eastern slope of White Mountains. The much thicker Lower and Upper sandstone units of the McDougall Pass – Snafu Mountain depocentre of the Arenaceous facies are also represented by a shallow marine facies, except for the presumably strongly localized barrier bar (cf. p. 22) to deltaic or alluvial development of the Upper sandstone unit in the principal section (i.e. unit 3 of Section 2; see Appendix and Fig. 4). It is inferred therefrom that the part of the Cache Creek Horst confined between the Snafu Mountain area in the south and the present day Paleozoic core of White Mountains in the north formed a narrow (probably only from 8 to 24 km)

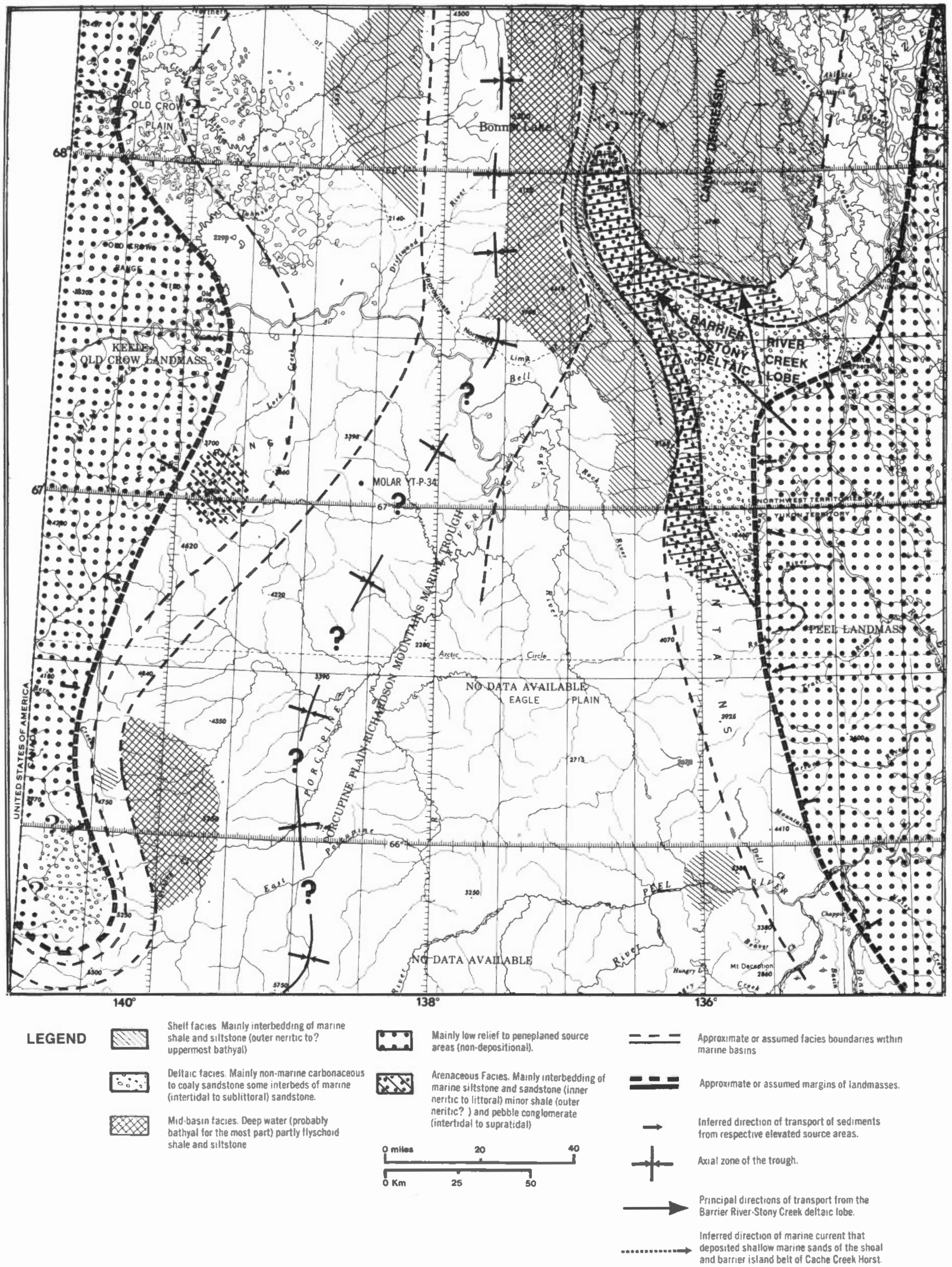


Figure 9. Late Hauterivian to ?earliest Barremian (i.e. time of the Lower member of the Upper shale-siltstone division and its littoral to nonmarine equivalents) paleogeography. The paleogeographic map is intended to reflect the peak time of epeirogenic uplift registered in the deposition of the Upper sandstone unit.

north-trending zone of lower to upper littoral shoals within the late Hauterivian to ?earliest Barremian generation of the Richardson Mountains – Porcupine Plain Trough (Fig. 9). This shoal belt presumably included some shortlived (i.e. restricted to the peak times of epeirogenic uplifts) offshore island bars. However, it probably did not include any significant local source areas of sediment similar to the previously discussed Late Jurassic White Island. In the writer's opinion, most or all of the arenaceous sediment deposited within this shoal and barrier island belt was derived from a sizeable late Hauterivian to ?earliest Barremian deltaic-alluvial lobe situated in the upper Stony Creek-upper Barrier River-upper Vittrekwa River area. This still insufficiently understood Barrier River – Stony Creek deltaic lobe (named herein) must have been restricted to the southern flank and crestal part of the Rat Uplift, except for rare and brief peak times of epeirogenic uplifts when the delta front prograded northward into the northeastern part of McDougall Pass area. The deposition of medium to coarse grained deltaic and/or alluvial sands and coarser clastics of the uppermost part of the Upper sandstone unit in the northeastern part of McDougall Pass area appears to represent an example of such northward progradation of the Barrier River – Stony Creek deltaic lobe. This inferred moment of progradation is reconstructed diagramatically in Fig. 9.

The strongly elongated, narrow shape of the shoal and barrier island belt that occupied the Snafu Mountain – White Mountains part of the Cache Creek Horst in late Hauterivian to ?earliest Barremian time is combined with its position off the tip of the Barrier River – Stony Creek deltaic lobe. This suggests that the shallow marine sands of this belt had been deposited by a marine current that flowed northward along its western margin. This inferred current, which was redistributing the arenaceous sediments dumped into the main Richardson Mountains – Porcupine Plain Trough by the river(s) of the Barrier River – Stony Creek deltaic lobe, is indicated in Fig. 9.

The presence of a continuous belt of shoals and barrier islands in late Hauterivian to ?earliest Barremian time indicates that the Canoe Depression also persisted into that time in the form of an outer neritic depositional trough characterized by an apparently exclusively Argillaceous facies of the Lower member of Upper shale-siltstone division. This negative structure formed an embayment of the main Richardson Mountains – Porcupine Plain Trough. This embayment was wide open in the north and northwest but was limited by the Barrier River – Stony Creek deltaic lobe in the south and southwest and by the shoal and barrier island belt of the Cache Creek Horst in the west (Fig. 9).

The bulk of the argillaceous sediments of the Lower member of the Upper shale-siltstone division deposited within the Canoe Depression was probably derived directly from the Barrier River – Stony Creek deltaic lobe (Fig. 9). However, some of these sediments may have been carried into the depression from the northwest by the same north-flowing marine current which deposited the sands of the late Hauterivian to ?earliest Barremian shoal and barrier island belt farther south (Fig. 9).

The limited data available clearly indicate that the Cache Creek Horst remained tectonically active throughout the time of deposition of the late Hauterivian to ?earliest Barremian shoal and barrier island belt. The deposition of the Lower sandstone unit registers the initial early late Hauterivian (late phase of **S. (S.)** cf. **kleini** Zone) marine transgression throughout its extent. This transgression was presumably caused by a large amplitude regional subsidence of the Cache Creek Horst and Aklavik Arch which must have continued through most of the time of deposition of the Intermediate siltstone unit. This is attested by the deposition of outer neritic, pure to sandy silts of this unit atop of the inner neritic to upper littoral sands of the Lower sandstone unit. The shoal and barrier island belt may have been drowned temporarily at the peak of this transgression. However, the transgression was replaced by a regional regression toward the end of the time of deposition of the Intermediate siltstone unit. This is indicated by a gradual increase of the sand content in the uppermost beds of the unit. This regression continued throughout the time of deposition of the Upper sandstone unit and culminated in the northward progradation of the frontal part of the Barrier River – Stony Creek deltaic lobe into the northeastern part of McDougall Pass area. This regional regression indicates a latest Hauterivian or ?earliest Barremian pulse of uplift of the Cache Creek Horst. The upward coarsening of the Upper sandstone unit and the appearance of grit and conglomerate interbeds in its uppermost beds suggests, furthermore, that this uplift extended also into the source area of the Barrier River – Stony Creek deltaic lobe.

Upper Bell Belt of shelf facies of the Lower member

Introductory remarks and nomenclature. The exposures of the Upper shale-siltstone division surveyed in the southwestern corner of the McDougall Pass area belong to that, almost exclusively argillaceous, outer neritic, relatively attenuated (thickness ranges from 131 m to 535 m) facies of the division named informally its "eastern facies" by Jeletzky (1974, p. 13, 16, Fig. 5). This is exemplified by the only complete section of the division measured in 1975 in the southwestern corner of the McDougall Pass area (i.e. Section 6 of the Appendix; Fig. 2 and 4). This section is about 420 m thick, does not include any significant sandstone interbeds, except in the topmost part of the Upper member and, for the most part, is not distinctly flyschoid.

The "eastern facies" of Upper shale-siltstone division was traced as a continuous outcrop belt from the point of confluence of Bell and Little Bell rivers to the eastern headwaters of Rock River. Between "Pacific Rat River" and the eastern headwaters of Rock River the "eastern facies" of the Upper shale-siltstone division was observed to extend eastward all the way to the eastern slope of Richardson Mountains and to merge into the marginal or "southern" facies of the division (Jeletzky, 1972; 1974; 1975a, p. 4-6, 8, Fig. 2, 4, 14) which is renamed the Arenaceous facies in this paper. The same facies relationships have been inferred to exist in the southwestern corner of the McDougall Pass area and farther north. The designation of the outer neritic, argillaceous, relatively thin facies of the Upper shale-siltstone division encountered in the north-central Richardson Mountains north of the Rat Uplift of the Aklavik Arch as its "eastern facies" was, therefore, based solely on the assumption that, like the eastern facies of more southerly areas, it retains its principal distinguishing characters all the way eastward to the adjacent segments of the eastern slope of the Richardson Mountains and merges into shoreface facies of the division beneath the western Mackenzie Delta. So interpreted, the "eastern facies" of the north-central Richardson Mountains was believed to outcrop right across the broad, relatively positive, shelf-like belt occupying the eastern part of the Richardson Mountains – Porcupine Plain Trough. This belt flanked that of the much thicker, deeper water (predominantly upper bathyal), in part distinctly flyschoid, "western facies" of the division from the east (Jeletzky, 1974, p. 11, 13, 16). This hypothesis is, however, discredited by a subsequent discovery (see p. 23, Fig. 9 of this paper) of a presumably continuous belt of the Arenaceous facies of the division extending from Snafu Mountain area into the present Paleozoic core of White Mountains. This belt, which apparently extended the length of the Cache Creek Horst and merged into the Barrier River – Stony Creek deltaic lobe of the Peel Landmass (Fig. 9), separates the belt of the "eastern facies" of the Upper shale siltstone division that occupies the eastern part of Bell Basin from another belt that is confined to the late Hauterivian and ?earliest Barremian generation of the Canoe Depression and disappears beneath the western Mackenzie Delta. Consequently it is only the second, or Canoe Depression, belt of the "eastern facies" that could be meaningfully designated as such. Another name must be introduced for that belt of the "eastern facies" of the division which occurs in eastern Bell Basin and separates the belt of the Arenaceous facies of the division crowning the Cache Creek Horst from its deeper water "western facies" which occurs in the western part of Bell Basin and elsewhere in the mid-basin zone of the Richardson Mountains – Porcupine Plain Trough (Fig. 9). It is possible to remedy this situation by introducing supplementary terms such as the Canoe and Upper Bell belts of the "eastern facies" for the above discussed outcrop belts. However, the terms "eastern facies" and "western facies" of Upper shale-siltstone division introduced by Jeletzky (1974, p. 11, 13, 16) and perpetuated in a subsequent paper dealing with paleogeography and depositional tectonics of the Richardson Mountains – Porcupine Plain Trough (Jeletzky, 1975a, p. 37, 19, Fig. 14) are rather misleading when applied to the whole width of the trough. The "eastern facies" actually occurs on the eastern as well as on the western flank of the trough while the "western facies" is actually confined to its mid-basinal, deeper water zone (Jeletzky, 1975a, p. 37, 39, Fig. 14). Therefore, it seems best to discard these terms completely rather than to try to perpetuate them in a modified form. It is proposed accordingly to rename the "eastern facies" as the Shelf facies of the Upper shale-siltstone division and to rename the "western facies" as the Mid-basin facies of the same division. The new nomenclature is incorporated in the legend of Figure 9. The two outcrop belts of the Shelf facies of the division, confined respectively to the eastern part of Bell Basin and the Canoe Depression are designated herein the Upper Bell and Canoe belts of the Shelf facies (Fig. 9).

Stratigraphy and depositional environment. The only complete section of the Shelf facies of the Lower member measured in the southwestern corner of McDougall Pass area (i.e. Section 6 of the Appendix; fig. 2, 4) does not include any interbeds of sandstone resembling those of the Arenaceous facies of the Lower member in its approximately equivalent beds. Furthermore, the same is true of the adjacent incomplete Section 7 (see unit 25, Section 7 in the Appendix) and other incomplete and poorly exposed sections briefly visited in the southwestern corner of the report area.

The lithologically distinguishable Lower member of the Shelf facies of Section 6 (i.e. its unit 2; see Appendix) is about 155 m thick. It is represented exclusively by dull to bluish grey, slightly to very sandy, commonly micaceous, apparently invariably nonferruginous, noncarbonaceous and noncalcareous siltstone. Most of the siltstone retains its dull to bluish grey colour and distinctly mottled appearance in fresh and weathered state. It is friable to fairly friable and weathers recessively, and platy to fine chunky. This almost invariably results in poorly exposed, deeply weathered and talus-covered outcrops. The siltstone is generally thinly bedded to laminated but includes numerous interbeds and units of uniformly coloured, indistinclty bedded to massive-looking (i.e. mudstone-like) siltstone.

Large, rounded to ellipsoidal concretions and bands of intensely orange-, wine-red-, or rust weathering, hard clay ironstone, which abound in the Canoe Belt of the Shelf facies (e.g. Jeletzky, 1958, p. 10, 56-65) are notably absent in all studied outcrops of the Lower member of the report area. Their place is taken by much smaller (mostly 3 to 6 cm in diameter), angular to disc-like concretions of bright yellow to orange-weathering, hard clay ironstone. The relative rarity of these different sized and shaped clay ironstone concretions and the general absence of rust- to chocolate-brown weathering of siltstone differentiates the Shelf facies of the Lower member of the Upper Bell Belt from that of the Canoe Belt. The predominantly thin bedding and lamination combined with considerably lighter, commonly blue-grey colour differentiate this siltstone from that of the Intermediate siltstone unit of the Arenaceous facies.

The bedding planes are generally well defined, abrupt and uneven. They are commonly covered by worm burrows and do not exhibit any traces of erosion of the underlying beds. No crossbedding of any kind was noted. Individual beds seldom exhibit any grading as they are commonly intensely bioturbated and commonly exhibit variously shaped worm burrows. The lack of crossbedding and grading differentiates the siltstones of the Lower member from those of the Upper member which are commonly crossbedded on a small scale and may exhibit incomplete Bouma (1962) sequences.

The siltstone of the Lower member appears to be a neritic (mid- to ?outer neritic) deposit representing a low energy milieu. This is indicated by a complete absence of belemnites and heavily shelled, shallow water pelecypods combined with the presence of very rare, deeply burrowing pelecypods (e.g. **Pleuromya** sp.). These pelecypods are preserved in life-like position with their valves either still closed or gaping.

The Lower member of the Upper Bell Belt of the Shelf facies overlies disconformably and presumably regionally unconformably the deeply eroded surface of the southwestern facies of the Husky Formation (see p. 11, 32; Col. 4 of Fig. 4) and is overlain conformably and gradationally by the lithologically distinctive siltstones of the Upper member of the Upper shale-siltstone division.

The lithology and stratigraphic relationships of the Shelf facies of the Lower member of the Upper Bell Belt reflects the drastic lateral facies changes of the lower part of the Upper shale-siltstone division within the McDougall Pass area described in the section devoted to the Arenaceous facies of the Lower member.

Age and correlation. No diagnostic fossils have been found in the investigated sections of the Shelf facies of the Lower member in the southwestern corner of McDougall Pass area. Therefore, neither the lower nor the upper age limit of the member can be determined there. In light of the considerations presented in the discussion of the age and correlation of the Arenaceous facies of the member (see p. 21), it is assumed that the age limits of its Shelf facies in the southwestern corner of the report area are roughly the same as those of the paleontologically well dated Shelf facies of the Canoe Belt (Jeletzky, 1958, 1960, p. 13).

Upper Member

Unlike the Lower member, the Upper member of the Upper shale-siltstone division does not exhibit any pronounced facies changes within the McDougall Pass area. The same is true, also, of all adjoining areas of north-central Richardson Mountains which are characterized by a typical to fairly typical (sometimes transitional to the Mid-basin facies) development of the Shelf facies of the member (see p. 25). Therefore, the stratigraphy, lithology and depositional environment of all outcrop areas of this member surveyed in different parts of the report area will be treated in the same section.

Stratigraphy and depositional environment. The following description of the stratigraphy, lithology, and depositional environment of the Upper member of Upper shale-siltstone division is based on the following best exposed and most complete sections: 1) The only measured complete section in the southwestern corner of McDougall Pass area (see units 3-6 of Section 6 in Appendix, Fig. 2 and Section 3 of Fig. 4); and 2) Several adjacent, mostly faulted sections surveyed in the northeastern part of the area on the crest of an unnamed rocky ridge adjoining the lower course of Two Ocean Creek from the east. These sections (e.g. that shown in Pl. 2, Fig. 2), of which the complete Section 4 (see its units 5–6 in Appendix and Fig. 2, 4) is representative, also overlook Long Lake from the south.

Judging by the only two complete sections studied (i.e. Sections 4 and 6 in Appendix), the member is about 260 m thick in the southwestern corner of the area and about 195 m thick in its northeastern part. However, it is uncertain whether or not this apparent decrease of thickness in southwest-northeast direction reflects a regional pattern.

In the northeastern part of McDougall Pass area, the basal bed of the member overlies conformably the Upper sandstone unit of the Lower member (see description of unit 5, Section 4 in Appendix). In the southwestern part of the area, the contact between the Argillaceous shelf facies of the Lower and Upper members is definitely gradational (see units 2, 3 of Section 6 in Appendix). The contact of the member with the overlying Upper sandstone division is conformable but abrupt and uneven throughout the McDougall Pass area (see descriptions of units 6, 7 of Section 6 and those of units 6, 7 of Section 4 in Appendix). However, it is not accompanied by any basal conglomerate or even gritty layer in any of the suitably exposed sections studied.

All studied sections of the Upper member are characterized by a distinctly cyclical interbedding of two or more lithologically distinctive varieties of siltstone which differentiates the member from the underlying Shelf facies of the Lower member. This interbedding varies widely. One extreme apparently restricted to the southwestern corner of the report area is represented by the thinly bedded (2 to 15 cm) to laminated, mostly regularly banded alternation of several kinds of variably coloured siltstones in units 4 and 5 of Section 6 (see Appendix and Pl. 2, Fig. 2). The other extreme apparently restricted to the northeastern part of the area is represented by thin (7.5 to 15 cm) to thick (0.3 to 1.5 m) interbedding of only two to three kinds of siltstone in unit 6 of Section 4 (see Appendix and Pl. 3, Fig. 2). In the latter lithological extreme – the northeastern subfacies – one end variant is represented by siltstones which are sandy to very sandy, intensively crossbedded and symmetrically to asymmetrically ripple marked on a small to medium scale (7.5 to 20 cm between crests). These siltstones are usually hard to very hard and strongly to completely silicified. The other lithological end variant of this subfacies is represented by only slightly sandy to pure, moderately hard to friable, indistinctly and irregularly (conchoidally to corrugatedly) bedded to massive, commonly strongly bioturbated siltstone. These extremes are connected by intermediate varieties exhibiting various combinations of the above mentioned lithological features. The sandy to very sandy, intensively crossbedded and ripple marked varieties are usually, but not always, light grey to brown- or orange-coloured while the slightly sandy to pure, moderately hard to friable varieties are invariably dark grey to black. All investigated varieties are non-carbonaceous and noncalcareous. The lower contacts of the sandy to very sandy siltstones are usually abrupt while their upper contacts are usually gradational.

The southwestern sections of the Upper member exemplified by units 4 and 5 of Section 6 (see Appendix) differ from its northeastern sections exemplified by unit 6 of Section 4 (see Appendix) in the abrupt character of the lower contacts of their sandy to very sandy, intensively crossbedded and ripple marked siltstones. These abrupt contacts may be combined with a distinclty graded appearance of many siltstone cycles in these southwestern sections. These cycles were only observed to include units D-F or E-F of Bouma's (1962) sequence. Therefore, the siltstones of the southwestern facies are not believed to be turbidites in spite of their somewhat flyschoid appearance. Yet another distinctive feature of the southwestern facies of the Upper member consists in the common presence of irregularly distributed 10 cm to 1.5 m thick interbeds of very fine grained, more or less silty, hard and dense, cross-bedded and ripple marked sandstones (e.g. in units 5 and 6 of Section 6; see Appendix). Unlike the adjacent sandy to very sandy, intensively crossbedded and ripple marked siltstones, these sandstones exhibit uneven, erosional lower contacts. The erosional nature of these contacts is indicated by the common presence in the base of the sandstone beds of angular to rounded fragments of the underlying black, slightly sandy to very sandy siltstone (rip up of unconsolidated to semi-consolidated sediment). However, the sandstones are not graded. The abrupt and uneven contacts are interpreted as evidence of brief periods of depositional unrest caused by storms or temporary strong currents. So far as known, the above discussed sandstone interbeds are restricted to the upper part of the Upper member in those sections where it is overlain by the well developed basal sandstone unit of the Upper sandstone division (e.g. in Section 6; see Appendix). In such sections the ratio of sandstone interbeds gradually increases upward in the Upper member until they become either equally common or somewhat more common than the siltstone interbeds in its uppermost beds (i.e. in unit 6 of Section 6; see Appendix). These upward lithological changes, presumably reflecting a gradual shallowing of the basin, result in an intergradation of this lithological variant of the Upper member into the basal part of the Upper sandstone division (Pl. 3, Fig. 1).

Basically similar upward lithological changes of the Upper member were observed in the northeastern sections exemplified by Section 4 (see its unit 6 in Appendix). These changes consist in the gradual increase of the ratio of hard, sandy to very sandy siltstone interbeds, lithologically similar to that of the overlying basal beds of the Upper sandstone division (see unit 7 of Section 4 in Appendix) in the upper part of the member. This lithological intergradation of the Upper member into the Upper sandstone division, too, is believed to reflect a gradual shallowing of the basin. However, it occurred in a milieu characterized by a decreased supply of the arenaceous particles, as compared with the southwestern corner of McDougall Pass area.

The lower part of the Upper member exemplified by unit 5 of Section 4 (see Appendix) and unit 3 of Section 6 (see Appendix) is characterized by a rarity or absence of interbeds of the previously described sandy to very sandy, intensively crossbedded and ripple marked siltstone and lithologically similar, very fine grained sandstone. Regardless of whether the siltstone of this part of the member is indistinctly bedded to massive (e.g. in unit 5 of Section 4; see Appendix) or laminated and multicoloured (e.g. in unit 3 of Section 6; see Appendix and Pl. 3, fig. 2) it is, commonly, only feebly sandy to pure and exhibits the above discussed partial grading but rarely. A greater admixture of sand is only present in the basal beds of the lower part of the member, where it overlies the Arenaceous facies of the Lower member (e.g. in unit 5 of Section 4; see Appendix). In the Argillaceous shelf facies of Upper shale-siltstone division, the lower beds of the Upper member grade into uniformly coloured, massive to indistinctly bedded siltstone of the underlying Lower member because of a gradual downward decrease of the ratio of multicoloured, laminated siltstones (e.g. in unit 3 of Section 6; see Appendix).

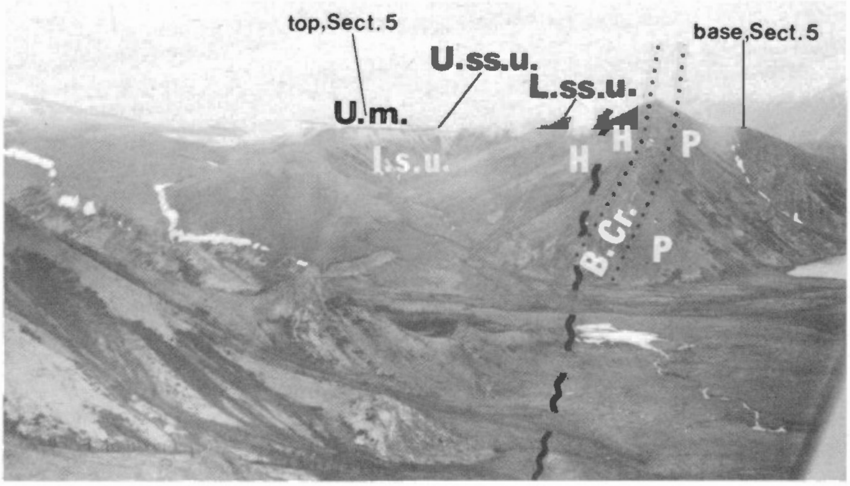
PLATE II

Figure 1. General view of the axial part and the northwestern flank of the Jurassic-Lower Cretaceous syncline occurring on the southeastern side of McDougall Pass area (see p. 1 for further details). View due southwest across the lower course of Two Ocean Creek from a helicopter flying approximately above the lower course of a nameless creek next east of Two Ocean Creek. The western bank of Long Lake is visible in the lowermost right foreground and the southeastern end of Summit Lake is visible at the right margin of the photograph in the middle background. The snow-covered flat-topped butte in the far middle background exposes the but gently flexed and otherwise undisturbed axial part of syncline underlain by the Upper member (marked U.m.) of the Upper shale-siltstone division. The saddle and the sharp-topped mountain north of it expose the older Cretaceous, Jurassic and Permian rocks of the northwestern flank of the syncline. These strongly faulted rocks dip steeply to vertically toward southeast. The individual rock units are designated as follows: 1. Upper sandstone unit of the Arenaceous facies of Upper shale-siltstone division – U.ss.u.; 2. Intermediate siltstone unit of the same division – I.s.u.; 3. Lower sandstone unit of the same division – L.ss.u.; 4. Husky Formation (undivided) – H.; 5. Bug Creek Formation – B. Cr.; and 5. Permian rocks (undivided) – P. Section 5 (see Appendix and Figs. 2, 3) was measured on the crest of the rocky ridge extending from the top of the butte northward to the northern slope of sharp-topped mountain underlain by the Bug Creek Formation and Permian rocks. The top of this section is marked as "top, Sect. 5" and its base as "base, Sect. 5". The assumed course of the strong, high angle normal fault repeating the Porcupine River tongue of Husky Formation in Section 5 (see Appendix and Fig. 3) is indicated by dashed line. The age of rocks outcropping in the mid- and left foreground northeast of the bed of Two Ocean Creek is unknown. GSC Photo 164382.

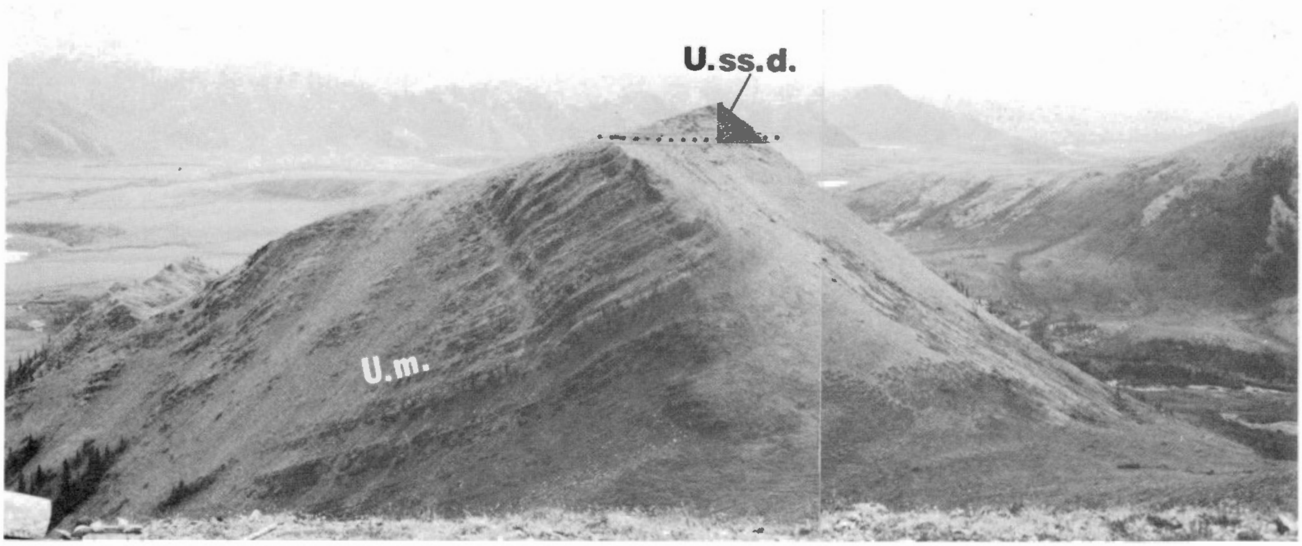
Figure 2. View of the typically developed and well exposed upper part of the Upper member of the Upper shale siltstone division (marked U.m.) overlain by the basal part of the Upper sandstone division (marked U.ss.d.). These equivalents of the units 6 and 7 of Section 4 (see p. 27, 32 and Appendix for further details) outcrop in an unmeasured section situated 400 to 800 m northeast of the northern end of the Section 4 across a faulted depression. The thickness of the upper part of the Upper member exposed in the steep slope in the foreground is estimated at 180 to 190 m. That of the Upper sandstone division exposed in the background is believed to be (distant observation only) in order of 50 m. View due northeast from station situated about 200 m north of the northern end of the Section 4. The characteristically banded, differentially weathered appearance of the outcrop of the upper part of the Upper member reflects the cyclical, thin to thick bedded alternation of different siltstones described in the text (see p. 27 and in the description of the unit 6 of Section 4; see Appendix). Long Lake is situated just outside of the left margin of the photograph. The broad and flat, lake dotted valley of Rat River on the northeastern side of McDougall Pass is in the middle background. GSC Photo 165480.

Figure 3. General view of Sections 2 and 3 (see p. 8, in Appendix and Fig. 2 for further details). View generally due north from the same station as for the Pl. I, fig. 4. The large sandstone slabs and blocks in the foreground are derived from the high ridge of Bug Creek sandstone (i.e. unit 1 of Section 3; see Appendix) situated behind the camera.

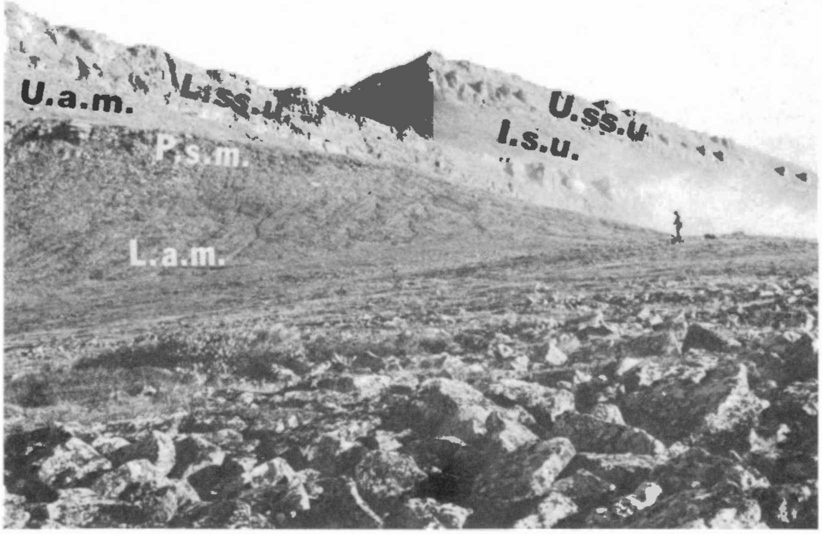
The upper part of the Intermediate siltstone unit (marked I.s.u.) and the 45 to 55 m high bluff of the Upper sandstone unit (marked U.ss.u.) of the Arenaceous facies of the Lower member of Upper shale-siltstone division are visible in the middle background behind the bluff of the Lower sandstone unit (marked L.ss.u.) of the same member. These units are respectively units 3 to 1 of Section 2 (see Appendix). The Lower and Upper argillaceous members (marked respectively L.a.m. and U.a.m.) and the tongue of Porcupine River sandstone (marked P.R.s.) of Section 3 (see Appendix) outcrop in the foreground. All rocks dip obliquely away form the camera (i.e. toward the left lower corner of the photograph) at moderate angles and are not otherwise disturbed. GSC Photo 164410.



164382 1



165480 2



164410 3

The lower part of the Upper member was presumably deposited in the same low energy, neritic (presumably mid- to outer neritic) milieu as the Shelf facies of the Lower member. The upper part of the member was, however, deposited in considerably higher energy, neritic milieu. This milieu must have been characterized by frequently repeated periods of moderate to ?strong wave and/or current activity reflected in the deposition of the sandy to very sandy, intensely crossbedded and ripple marked siltstones and lithologically similar sandstones. These periods of environmental unrest alternated with periods of relative calm when slightly sandy to pure, indistinctly bedded to massive-looking, mostly strongly bioturbated siltstones were deposited. The incompletely graded, flyschoid appearance of many of the above described lithological cycles in the southwestern part of the report area (e.g. in units 5 and 6 of Section 6; see Appendix) seems to reflect a gradual settling of finer and finer particles during the periods of depositional calm rather than a repeated occurrence of feeble to moderate turbidity currents in the here discussed mid- to outer neritic milieu.

Age and correlation. The lower part of the Upper member of Upper shale-siltstone division exemplified by unit 5 of Section 4 and unit 3 of Section 6 (see Appendix) did not yield diagnostic fossils anywhere within the McDougall Pass area. Therefore, these beds can only be dated indirectly on their stratigraphic position and using marine zonal fossils found either in the underlying Arenaceous facies of the Lower member (see p. 21 for further details) or in the presumably correlative lower part of the Upper member in the Aklavik Range (Jeletzky, 1958, p. 13, 14; 1960, p. 13).

The upper part of the Upper member exemplified by unit 6 of Section 4 and units 4-6 of Section 6 (see Appendix) was dated directly in the northeastern part of McDougall Pass area. There the beds equivalent to the upper third of unit 6 of Section 4 (see Appendix) have yielded numerous and well preserved **Aucellina** ex gr. **aptiensis-caucasica** either conspecific with or closely allied to **Aucellina anadyrensis** Verestchagin (see Verestchagin et al., 1965, p. 29, Pl. 14, Fig. 4, 5) in an unpublished section situated some 300 m north of the top of Section 4 and separated from it by a strong east-west trending fault. As mentioned previously in this paper (see p. 21 and the Table of Formations), **Aucellina** ex gr. **aptiensis-caucasica** appear for the first time in the uppermost part of the Upper member of Upper shale-siltstone division and range up through the whole thickness of the Upper sandstone division. Combined with the presence of lithologically typical, richly and diagnostically fossiliferous basal beds of the Upper sandstone division immediately above the top of unit 6 in the adjacent Section 4 (see unit 7, Section 4, in Appendix) this **Aucellina** fauna (GSC loc. 92955) attests to the late Barremian age of the uppermost part of the Upper member of the report area and its equivalence to the uppermost 61 to 67 m of the member in Aklavik Range (Jeletzky, 1958, p. 12).

The so far unfossiliferous upper part of the Upper member outcropping in the southwestern corner of McDougall Pass area and exemplified by units 4-6 of Section 6 (see Appendix) is obviously correlative with the fossiliferous section in the northeastern part of the report area (described above). This is indicated by the presence of lithologically typical, richly and diagnostically fossiliferous Upper sandstone division (i.e. units 7-11 of Section 6; see Appendix) immediately above the assigned top of the Upper member.

Remarks on paleogeography and depositional tectonics. The presence of a more arenaceous, possibly shallower water subfacies of the Upper member to the southwest of its more argillaceous, possibly somewhat deeper water subfacies could be interpreted as either depositionally or tectonically caused. It could reflect the presence of either a late Barremian shoal or a secondary late Barremian source area closely to the south or southwest of the southwestern corner of McDougall Pass area. This hypothetical shoal or source area could be either the unbevelled remnant of the crest of the Rat Uplift of Aklavik Arch or that of the adjacent part of the Cache Creek Horst (or both). The fact that the arenaceous subfacies of the Upper member occurring in the southwestern corner of McDougall Pass area exhibits distinct but incomplete grading, and may have a somewhat flyschoid appearance, does not contradict this hypothesis either. This partly flyschoid character of the arenaceous subfacies of the member could reflect a repeated presence of wave-caused clouds of silty to argillaceous particles above the relatively steepened slope of the sea bottom near the suggested late Barremian shoal or secondary source area. However, this flyschoid character of the arenaceous subfacies could also be interpreted as suggestive of a repeated presence of weak to moderate turbidity currents on the above mentioned steepened shelf slope. These currents could have been caused by repeated late Barremian uplift(s) either within the crestal

---

PLATE III

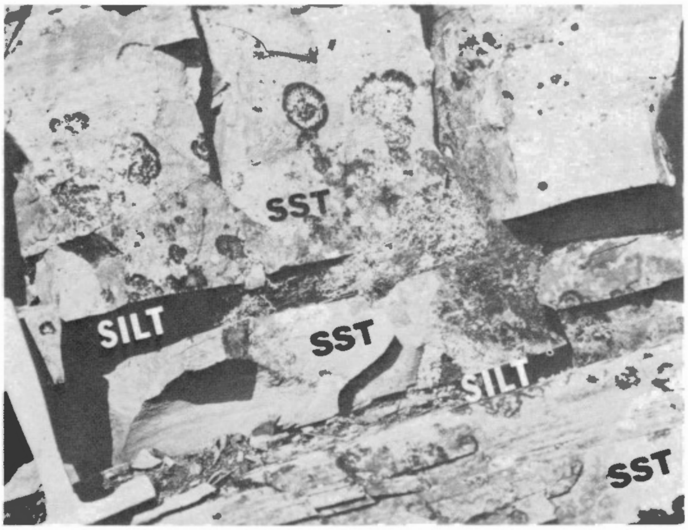
Figure 1. Basal part of the Arenaceous subfacies of Upper sandstone division. Unit 7 of Section 6 (see Appendix and p. 33 of the text for further details). Interbedding of prevalent very fine grained, hard and weathering-resistant sandstones (marked sst.) with subordinate black, friable, sandy siltstone (marked silt.). Note the sharp and uneven character of lower and upper contacts of sandstone beds. Photograph taken 5 to 7 m above base of the division. The hammer is about 27.5 cm long. View due north-northwest (i.e. obliquely downdip). GSC Photo 202819-U.

Figure 2. Basal part of the Upper member of Upper shale-siltstone division. Typical alternation of rust-, yellow-, and black-coloured siltstone laminae at 213-215 m level in the unit 3 of Section 6 (see Appendix and p. 27 of the text for further details). Note some concretionary, heavily worm burrowed inclusions of ferruginous siltstone marked "w.b.". Rocks dip at 30 to 40°W at the level photographed. View due north (i.e. approximatley into the strike). GSC Photo 203231.

Figure 3. Basal part of the Arenaceous subfacies of Upper sandstone division. Unit 7 of Section 6 (see Appendix and p. 33 of the text for further details) at the level 14 to 16 m above the base of the division. Large scale, low angle crossbedding typical of the sandstone units of the division in the southwestern corner of McDougall Pass area. View due north-northwest (i.e. obliquely downdip) with the valley of Little Bell River in the background. GSC Photo 165458.

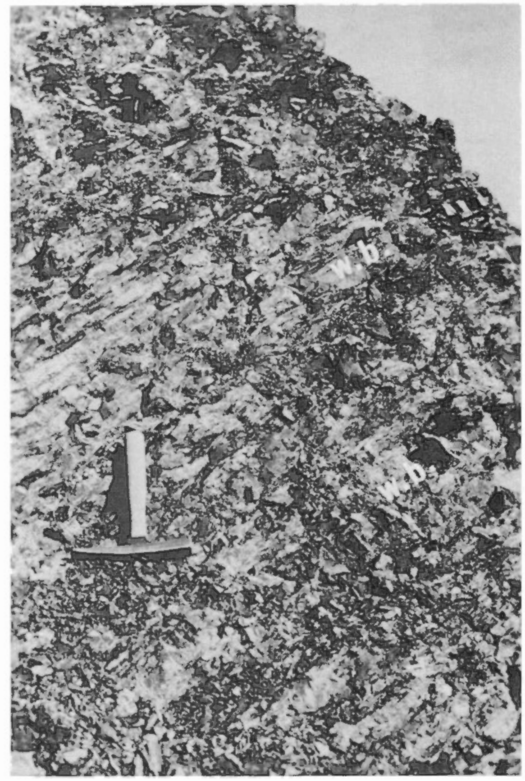
Figure 4. Basal part of the Arenaceous subfacies of Upper sandstone division. Unit 7 of Section 6 (see Appendix for further details). A series of climbing ripples at 34.5 m level in the unit. All these ripples climb in northerly to north-northwesterly direction suggesting an approximately northward current direction at that spot in the latest Barremian or earliest Aptian. Vew approximately northwest. The scale is 9 cm long. GSC Photo 165459.

PLATE III



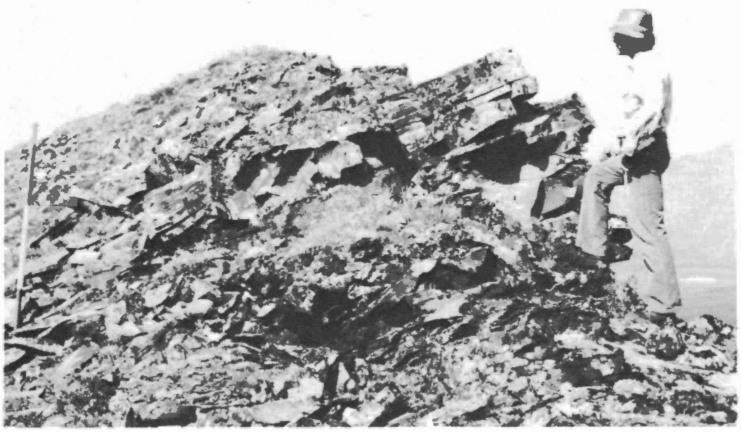
1

202819-U

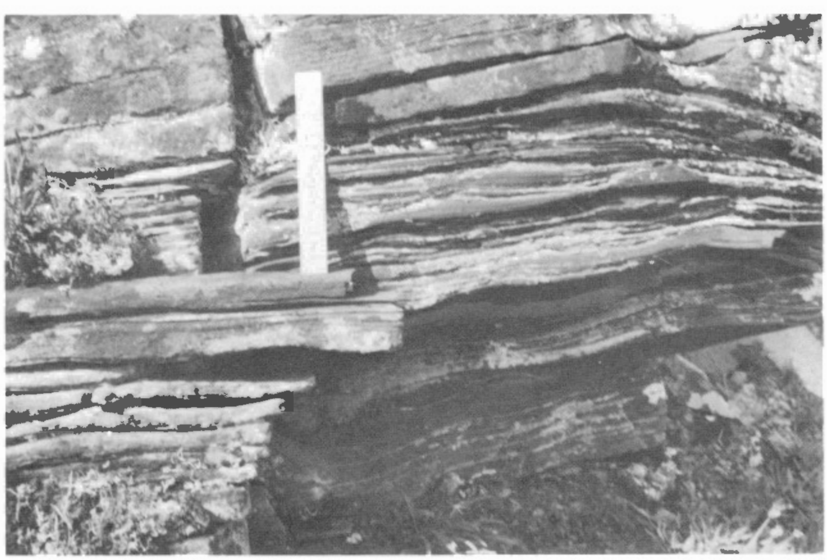


2

203231


3

165458


4

165459

part of the Rat Uplift of Aklavik Arch or within the adjacent part of Cache Creek Horst. Hence, the late Barremian paleogeography and depositional tectonics of north-central Richardson Mountains could have been more complicated than was recently suggested by Jeletzky (1975a, p. 37, Fig. 14). The data now available are insufficient for a definitive solution of this problem, although they favour a non-turbiditic depositional solution (cf. p. 27), which is also proposed below for the rather similar lateral facies changes of the Upper sandstone division.

Depositional-Structural Implications of the Absence of Upper Jurassic to Middle-Hauterivian Rocks

As demonstrated in the preceding sections (e.g. p. 21, col. 4, 5 of Fig. 4), the slightly to deeply eroded Husky Formation is overlain directly by the Upper shale-siltstone division throughout the surveyed part of the McDougall Pass area. The resulting hiatus comprises either the uppermost (in the northeastern part of the area) or the middle and upper (in the southwestern corner) beds of the Husky Formation, the Lower sandstone division (and/or the Blue-grey shale division) and the Coal-bearing division (Fig. 4, 5). This hiatus matches that observed previously (i.e. Jeletzky, 1961a, p. 537-39, Fig. 1; 1974, p. 11, Fig. 2; 1975a, p. 11, 12, 31, 35, Fig. 11, 12) in other areas situated on or close to the crests of the Aklavik Arch and the Cache Creek Horst. However, it is much more prolonged than any of the Valanginian to mid-Hauterivian hiatuses occurring in the areas flanking these positive tectonic structures (see Jeletzky, 1975a for further details). The exceptional duration of the hiatus within the McDougall Pass area obviously reflects its position on the crest of the Rat Uplift of Aklavik Arch and either at or near the junction of this uplift with the north-trending Cache Creek Horst as defined in the preceding section. This pronouncedly positive part of the Richardson Mountains – Porcupine Plain Trough obviously was much more strongly uplifted in the aftermath of the regional Valanginian orogenic phase than were the other areas of the trough situated farther off the crest of Aklavik Arch. The effects of this uplift lasted through the late Valanginian and early to mid-Hauterivian time in the McDougall Pass area and caused it to act as a source area throughout that time (Jeletzky, 1974, p. 11, Fig. 2; 1975a, p. 12, 35, 37; Fig. 12, 13).

Upper Sandstone Division

The lower part of the Upper sandstone division is the youngest Lower Cretaceous unit known to be present in the McDougall Pass area, its upper part being removed by subsequent erosion in all sections studied. Like the Upper member of Upper shale-siltstone division, the Upper sandstone division does not exhibit pronounced facies changes within the area. The same appears to be true of all adjoining areas of north-central Richardson Mountains. Therefore, the stratigraphy, lithology and depositional environment of all presently known outcrop areas of the division within the report area are discussed together.

The terms "eastern facies" and "western facies" of the Upper sandstone division introduced by Jeletzky (1974, p. 16, 17) and used in a subsequent paper dealing with paleogeography and depositional tectonics of the Richardson Mountains – Porcupine Plain Trough (Jeletzky, 1975a, p. 37, 39, Fig. 15) are rather misleading when applied to the whole width of the trough. As with the correspondingly named facies of the Upper shale-siltstone division (see p. 25), the "eastern facies" of the Upper sandstone division actually occurs on the western as well as on the eastern flank of the trough. At the same time, the "western facies" is actually confined to its mid-basinal, deeper water facies (Jeletzky, 1975a, p. 39, Fig. 15). Therefore, as with the corresponding terms previously used for lateral facies of the Upper shale-siltstone division (p. 25), the writer prefers to discard these terms completely rather than to try to perpetuate them in a modified form. It is proposed accordingly to rename the "eastern facies" as the Shelf facies of the Upper sandstone division and to rename the "western facies" as the Mid-basin facies of the same division.

Distribution within the report area. In the northeastern part of the area, the Upper sandstone division is only known to be preserved in the form of several small erosional outliers in the axial part of the Jurassic-Lower Cretaceous syncline between the lower courses of Sheep and Two Ocean creeks (p. 8). The only measured, very small, outlier of the division is represented by unit 7 of Section 4 (see Appendix) which exposes only its basal beds. However, judging by distant observation, a more extensive and presumably thicker section of the lower part of the division caps a round topped ridge situated 400 to 800 m northeast of this section (see Pl. 2, Fig. 2). This ridge overlooks from the southeast the lower course of a nameless creek situated between Two Ocean and Sheep creeks (see Fig. 2 and Pl. 2, Fig. 2). Other sections of the division are believed to be present on strongly disturbed and poorly exposed, low, rounded parts of the ridge where Callomon and Poulton's Section 1 of the Bug Creek and Husky formations was measured (Fig. 2). These sections are situated about 1.2 km east of Twin Lakes.

In the southwestern corner of McDougall Pass area a much thicker Section 6 (see Appendix) of the lower part of the Upper sandstone division was measured. There a large erosional outlier of the division caps the nameless about 1220 m high mesa-like mountain previously figured by Jeletzky (1974, Fig. 5). This about 100 m thick section of the Upper sandstone division (i.e. units 7 to 11 of Section 6; see Appendix) is its thickest section known in the report area. So far as known from a few spot checks and distant observations, none of the adjacent erosional outliers of the Upper sandstone division capping the mountain tops to the southwest and northeast of Section 6 offers a thicker, more nearly complete section of the division.

Stratigraphy and depositional environment. As already mentioned in the description of the Upper member of Upper shale-siltstone division (p. 27), the 15.5 m thick unit assigned to the basal part of the Upper sandstone division in Section 4 measured in the northeastern part of McDougall Pass area (i.e. its unit 7; see Appendix) consists exclusively of sandy to very sandy siltstone instead of being dominated by fine to very fine grained, quartzose to silty sandstone (as for example in the equivalent unit 7 of Section 6; see Appendix). The siltstone is dull grey when fresh, weathers dark to rust brown and slabby, sandy to very sandy and grades locally into very fine grained, very silty sandstone. This very dense and mostly thoroughly silicified siltstone is thinly and pronouncedly bedded throughout. For the most part it is crossbedded and ripple marked on a large scale (20.5 to 46 cm between crests).

Although so far known to occur only in a solitary, very short section, this silty development of basal beds of the Upper sandstone division does not seem to be accidental. The underlying uppermost beds of the Upper member of Upper shale-siltstone division at this locality is characterized by an aberrant lithology which also deviates from the normal lithology of these beds in the complete absence of sandstone interbeds. These uppermost beds of the Upper member consist exclusively of a cyclical interbedding of sandy to very sandy, intensively crossbedded and ripple marked siltstones with feebly sandy to pure, indistinctly bedded to massive, intensely bioturbated siltstones. It is suggested accordingly (subject to confirmation by additional field work) that the northeastern part of McDougall Pass area is characterized by an unusually silty facies of the Upper sandstone division. This apparently resembles closely that variant of its Shelf (previously eastern) facies (Jeletzky, 1974, p. 16, 17) encountered on the "Pacific Rat River" (see Jeletzky, 1972, p. 16 and unpublished) where the fine to very fine grained sandstones appear to be restricted to the middle part of the division. The upper third and, apparently, the lower third of the "Pacific Rat River" subfacies of the division are represented predominantly by sandy to very sandy siltstones.

Like the "Pacific Rat River" subfacies of the Upper sandstone division, that of the northeastern part of McDougall Pass area apparently was deposited in an environment which, for one reason or other, received much less arenaceous material than the adjacent areas (e.g. the southwestern corner of the report area and the Big Bend of Rat River) characterized by a much more arenaceous development of the Shelf facies of the division.

The intensively crossbedded and ripple marked (commonly on a large scale) character of siltstones of the division in the northeastern part of the report area suggest that this silty subfacies was deposited in the relatively shallow, inner or ?innermost part of neritic zone which was fairly strongly affected by waves and/or currents. The moderately high energy neritic environment of deposition of this subfacies agrees well with the presence of coquinoid interbeds and pods of a rich and diversified pelecypod fauna (see unit 7 of Section 4 in Appendix). Although rarely abraded or fragmented, the shells of these open marine pelecypods are mostly single valves oriented with their convex side upward. After the death of these predominantly burrowing pelecypods their shells must have been washed out of their original living stations, disarticulated, and congregated in pods or lenticular layers during periods of particularly strong depositional unrest.

Judging by the detailed study of one about 100 m thick, well exposed section (i.e. units 7 to 11 of Section 6; see Appendix), supplemented by spot landings on a few other shorter and less satisfactorily exposed sections, the Upper sandstone division of the southwestern corner of McDougall Pass area differs from that of its northeastern part in being dominated by fine to very fine grained, quartzose sandstones (Pl. 3, Fig. 1, 3, 4). This arenaceous variant of the Shelf facies of the division is underlain by the uppermost beds of the Upper member of Upper shale-siltstone division which contain a great number of fine to very fine grained sandstone interbeds (e.g. unit 6 of Section 6; see Appendix). These uppermost beds of the Upper member differ from their previously described silty equivalents (e.g. upper part of unit 6 of Section 4; see Appendix) in the northeastern part of the McDougall Pass area in exactly the same way as does the overlying Arenaceous subfacies of the Upper sandstone division from its equivalent there.

It must be pointed out that the lithological distinctions between the here discussed silty and Arenaceous subfacies of the Upper sandstone division are not nearly as great as may appear at the first sight. Namely, many of the very fine grained, quartzose to silty sandstones of the Arenaceous subfacies are rather similar lithologically to the sandy to very sandy, hard and siliceous siltstones which predominate in the basal beds of the silty subfacies (e.g. in unit 7 of Section 4; see Appendix). These two rock varieties are situated, commonly, at the borderline between the sandstone and siltstone classes. Consequently they cannot be easily assigned to either without a detailed lithological analysis which is beyond the scope of the writer's research.

The lithology of the Arenaceous subfacies of the Upper sandstone division outcropping in the southwestern corner of the report area is distinctly finer grained than the almost exclusively arenaceous, partly fine to medium grained, and locally gritty and very fine pebbly lithology of its sections measured in Aklavik Range (Jeletzky, 1958, p. 54, 68, 75-78 and unpublished) and on lower Rat River (Jeletzky, unpublished). No medium grained sandstone or coarser grained clastics have been observed in this facies and even the fine grained sandstones are all but absent. Furthermore, the Upper sandstone division of the southwestern corner of McDougall Pass area is characterized by an alternation of very fine grained sandstone units with almost equally thick units in which sandy to very sandy siltstone predominates. Section 6 (see Appendix) consists, for example, of three units of weathering-resistant sandstone which are respectively 15 m (i.e. unit 7), 11 m (i.e. unit 9) and 43 m (i.e. unit 11) thick. The first two units consist of sandstone that is dull grey to light grey when fresh and weathers mottled light- to ash-grey and dull-to rust-brown. This sandstone is predominantly quartzose but contains an admixture of mica flakes, dark mineral (?chert) and limonite grains. It is invariably very fine grained and grades locally into superficially similar, sandy to very sandy siltstone. Although dense, hard, and weathering-resistant, the sandstone is neither quartzite-like nor true quartzite. It is thick (0.3 to 1.5 m) and pronouncedly bedded with individual beds separated from each other by laminae, thin (1 to 2 cm) layers, or 20 to 30 cm beds of siltstone lithologically similar to that occurring in the underlying beds of the Upper member of Upper shale-siltstone division. The bedding planes separating the sandstone beds from siltstone laminae and interbeds are invariably abrupt (Pl. 3, Fig. 1). These bedding planes may be either planar or covered by loadcast-like structures. Alternatively, they may commonly carry series of medium to large scale (from 6 to 40 cm amplitude) symmetrical, sharp- to round-crested ripple marks and interference ripples. The individual sandstone beds may be either massive-looking or thinly bedded to laminated. If the latter, they are usually crossbedded and ripple marked on a medium to large scale throughout (Pl. 3, Fig. 3). No grading was noted either in the sandstone beds or the siltstone interbeds. Worm burrows and signs of bioturbation are mostly absent in sandstone beds but may be present in siltstone interbeds. No fossils have been found in either unit.

Because of the common presence of medium to large scale crossbeds and ripple marks, apparent absence of bioturbation and worm burrows, and other above mentioned lithological features, the very fine grained, commonly silty sandstones of the lower two sandstone units apparently were deposited in the same inner or ?innermost neritic, open marine environment as the sandy to very sandy siltstone of the silty subfacies of Upper sandstone division. The absence of fossils in the arenaceous subfacies of the division is believed to be a secondary feature reflecting their local destruction. However, the southwestern corner of McDougall Pass area apparently had a relatively high energy regime which resulted in winnowing out of the finer, silty particles and their transportation into the northeastern part of the area characterized by a quieter depositional regime.

The uppermost sandstone unit of the arenaceous subfacies differs from the underlying two units in that its sandstones are mostly ferruginous and commonly calcareous. The sandstones are dull brown to brown-grey when fresh and weather rust to orange coloured. Only a few poorly preserved pelecypods have been seen on bedding planes in the lower 20 m of the unit. Above the 20 m level, however, frequent 1-5 cm thick interbeds of coquinoid, calcareous sandstone replete with various pelecypods appear. Only a few ripple marks or large crossbeds have been seen either on the abrupt bedding planes separating sandstone beds from the intervening siltstone interbeds or within the individual sandstone beds. The siltstone interbeds become calcareous, strongly ferruginous and rich in the same pelecypods as those occurring in the calcareous sandstone interbeds beginning with the 20 m level above unit's base. The siltstone interbeds are dull grey to brown when fresh but become rust-, or orange-coloured, or vermillion-red in weathered state; they have a "clay ironstone-like" appearance, even though rarely approaching true clay ironstone in the lithology. The ratio of interbeds of these "clay ironstone-like" sandy to very sandy siltstone gradually increases in the topmost 12 to 15 m of the unit until they comprise at least 40 to 50 per cent of the thickness in the uppermost couple of metres exposed.

The pelecypods of the rich fauna characteristic of the upper part of the unit lived exactly where they were found as most of them are bivalved specimens either closed shut or only gaping. Furthermore, the fauna consists almost exclusively of thin shelled, deeply burrowing forms, such as **Astarte, Pleuromya, Tancredia, Thracia** and **Nucula,** and lacks surface-living, byssus-attached forms, such as **Aucellina** and **Inoceramus.** In combination with the very fine grained, silty character of enclosing sandstones, lack of rarity of ripple marks and large scale crossbeds this fauna indicates a low to very low energy, neritic (possibly outer neritic) depositional environment for the "clay ironstone-like" siltstones of the upper richly fossiliferous part of the unit. The same environment can be inferred also for the bulk of enclosing sandstones. The calcareous coquinoid interbeds of these sandstones presumably reflect relatively rare periods of depositional unrest when either currents or waves (or both) became sufficiently strong to winnow out most of the silty and very fine sand particles surrounding dead pelecypods, to concentrate the shells in thin layers or pods, and to disarticulate some or most of these shells.

The gradual upward increase of the ratio of clay ironstone-like siltstone in the upper part of the unit parallels similar lithological changes observed in the upper part of the Upper sandstone division in the eastern headwaters of Rock River (Jeletzky, 1972, p. 8) and in headwaters of "Pacific Rat River" (Jeletzky, 1972, p. 16). It is suggested accordingly that the topmost beds of the division exposed in Section 6 (see Appendix) correspond to the basal part of its topmost silty zone in the headwaters of the "Pacific Rat River". If this hypothesis is correct, the complete thickness of Upper sandstone division in the southwestern corner of the report-area does not exceed 150 to 180 m.

The two intervening siltstone-sandstone units of the arenaceous development of the Upper sandstone division in the southwestern corner of the report area (e.g. units 8 and 10 of Section 6; see Appendix) consist of a regular and distinctly cyclical interbedding of the same hard, intensively ripple marked and crossbedded, sandy to very sandy siltstone and very fine grained sandstone as in the underlying upper part of the Upper member of Upper shale-siltstone division (see upper part of unit 5 and unit 6 of Section 6 in Appendix). The abrupt lower contacts of the relatively less common sandstone interbeds do not seem to be erosional and neither the sandstone nor the siltstone interbeds are graded. These units were, therefore, deposited in the same fairly high to high energy, neritic (?inner) milieu as the upper part of the Upper member of the Upper shale-siltstone division (see p. 27). It is not certain whether the deposition of these siltstone-sandstone units registers brief periods of subsidence of the seabottom. The strong increase of the ratio of sandy to very sandy, intensively ripple marked and crossbedded siltstone in these beds could have been equally caused by a frequent alternation of brief periods of current- or/and wave-caused depositional unrest with those of a relative depositional quiescence when silty particles were deposited instead of being winnowed out.

Paleogeography and depositional tectonics. Like its very fine grained sandy to silty equivalents occurring in the eastern headwaters of Rock River (Fig. 1 and Jeletzky, 1972, p. 8) and the headwaters of "Pacific Rat River" (Fig. 1 and Jeletzky, 1972, p. 16), the Upper sandstone division of the McDougall Pass area is an offshore subfacies of the eastern shelf facies of the division. This subfacies was deposited on the outermost part of the broad, relatively slowly subsiding eastern shelf which characterized the Aptian generation of the Richardson Mountains – Porcupine Plain Trough (Jeletzky, 1975a, p. 39, Fig. 15). This is evidenced by its being flanked by the littoral, coarser grained arenaceous facies of the division in the east (i.e. in Aklavik Range and Big Bend of Rat River; see Jeletzky, 1958, 1960, 1975a) and its much thicker, deep water, mid-basin facies in the west (i.e. in Bell Basin; Jeletzky, 1974, p. 16, 17; 1975a, p. 39, Fig. 15).

The new paleogeographical and depositional-tectonic data presented in this paper do not change the opinion of the writer that the Aklavik Arch and the Cache Creek Horst were largely bevelled in the late Barremian and remained essentially inactive throughout the Aptian. Where the northern part of the trough is concerned, their depositional-tectonic influence was accordingly restricted to the control of the areal distribution of the eastern shelf (formerly eastern) and mid-basin (formerly deeper water western) facies of the Upper sandstone division.

The gradual upward increase of the ratio of clay ironstone-like, outer (?outermost) neritic siltstone in the uppermost preserved beds of the Upper sandstone division in the southwestern corner of the report area (e.g. in unit 11 of Section 6) suggest an equally gradual deepening of the Aptian sea throughout the area. It parallels the gradual fining observed in the upper part of the division in the eastern headwaters of Rock River (Jeletzky, 1972, p. 8) and in headwaters of "Pacific Rat River" (Jeletzky, 1972, p. 16) where it grades imperceptibly into the entirely argillaceous rocks of the Albian shale-siltstone division. This suggests that the effect of the late Aptian orogenic phase that caused the hiatus separating the Upper sandstone division from the overlying Albian shale-siltstone division on the eastern slope of Richardson Mountains (Jeletzky, 1960, p. 15, 16), was restricted to the eastern and western flanks of the Richardson Mountains – Porcupine Plain Trough. The apparently complete absence of the effects of these tectonic movements in the McDougall Pass area and farther south in the central Richardson Mountains (see above and in Jeletzky, 1972, p. 8, 16) indicates an overestimation of their extent and strength by Jeletzky (1975a, p. 39, 41).

Age and correlation. The general composition of the pelecypod fauna collected in unit 7 of Section 4 and unit 11 of Section 6 (see Appendix) is diagnostic enough for the assignment of this unit to the Upper sandstone division in spite of the extremely poor preservation of all specimens compared with **Aucellina** ex gr. **aptiensis-caucasica** and the absence of such diagnostic forms as **Tropaeum.** Furthermore, the general Aptian dating of this fauna is confirmed by the previously discussed presence (see p. 20, 26) of numerous and well preserved **Aucellina anadyrensis** Verestchagin, 1965 in the uppermost beds of the Upper member of the Upper shale-siltstone division equivalent to unit 6 of the above mentioned section.

REFERENCES

Bouma, A.H.
1962: Sedimentology of some flysch deposits; Elsevier, Amsterdam.

Burke, K.
1977: Aulacogens and continental breakup; Ann. Rev., Earth Planet. Sci., v. 5, p. 371-396.

Fisher, W.L., Brown, L.F. Jr., Scott, A.J., and McGowen, J.H.
1972: Delta Systems in the Exploration of Oil and Gas: A Research Colloquium, Aug. 27-29, 1969; Bur. Econ. Geol., Univ. Texas, Austin. First Printing.

Flores, R.M.
1975: Short-headed stream delta: model for Pennsylvanian Haymond Formation; Am. Assoc. Pet. Geol., Bull. 59 (12), p. 2288-2301.

Frebold, H., Mountjoy, E.W., and Tempelman-Kluit, D.J.
1967: New occurrences of Jurassic rocks and fossils in central and northern Yukon Territory; Geol. Surv. Can., Paper 67-12.

Jeletzky, J.A.
1958: Uppermost Jurassic and Cretaceous rocks of Aklavik Range, northeastern Richardson Mountains, Northwest Territories; Geol. Surv. Can., Paper 58-2

1960: Uppermost Jurassic and Cretaceous rocks, east flank of Richardson Mountains between Stony Creek and lower Donna River, Northwest Territories; Geol. Surv. Can., Paper 59-14.

1961a: Eastern slope, Richardson Mountains, Cretaceous and Tertiary structural history and regional significance; Geology of the Arctic, 1st International Symposium on Arctic Geology, Proc. v. I, p. 532-583.

1961b: Upper Jurassic and Lower Cretaceous rocks, west flank of Richardson Mountains between headwaters of Blow River and Bell River; Geol. Surv. Can., Paper 61-9.

1963: Pre-Cretaceous Richardson Mountains Trough; Its place in the tectonic framework of Arctic Canada and its bearing on some geosynclinal concepts; Trans. Roy. Soc. Can., v. LVI, p. 55-84.

1964: Illustrations of Canadian fossils. Lower Cretaceous marine index fossils of the sedimentary basins of Western and Arctic Canada; Geol. Surv. Can., Paper 64-11, 100 p., 36 pl., 1 table.

1967: Jurassic and (?) Triassic rocks of the eastern slope of Richardson Mountains, Northwestern District of Mackenzie, 106M and 107B (parts of); Geol. Surv. Can., Paper 66-50.

1972: Stratigraphy, facies and paleogeography of Mesozoic and Tertiary rocks of northern Yukon and northwest Mackenzie District, N.W.T. (NTS-107B, 106M, 117A, 116-O(N 1/2), 116-I, 116H, 116J, 116K(E 1/2); Geol. Surv. Can., Open File 82.

Jeletzky, J.A. (cont'd)
1974: Contribution to the Jurassic and Cretaceous geology of northern Yukon Territory and District of Mackenzie, N.W.T. (NTS-116I, 116J, 116L, 116-O, 116P, 117A); Geol. Surv. Can., Paper 74-10.

1975a: Jurassic and Lower Cretaceous paleogeography and depositional tectonics of Porcupine Plateau, adjacent areas of northern Yukon and those of Mackenzie District; Geol. Surv. Can., Paper 74-16.

1975b: Sharp Mountain Formation (new): A shoreline facies of the Upper Aptian-Lower Albian flysch division, eastern Keele Range, Yukon Territory (NTS-117-0); in Report of Activities, Part B, Geol. Surv. Can., Paper 75-1B, p. 237-244.

1977: Porcupine River Formation: A new Upper Jurassic sandstone unit, northern Yukon Territory; Geol. Surv. Can., Paper 76-27.

Norris, D.K.
1972: Structural and stratigraphic studies in the tectonic complex of Northern Yukon Territory, north of Porcupine River; in Report of Activities, Part B, Geol. Surv. Can., Paper 72-1B, p. 91-99.

Poulton, T.P. and Callomon, J.H.
1976: Major features of the Lower and Middle Jurassic stratigraphy of northern Richardson Mountains, northeastern Yukon Territory and northwestern District of Mackenzie; in Report of Activities, Part B, Geol. Surv. Can., Paper 76-1B, p. 345-352.

Tempelman-Kluit, D.J.
1970: Stratigraphy and structure of the "Keno Hill Quartzite" in Tombstone River – Upper Klondike River Map-Areas, Yukon Territory (116B/7, B/8); Geol. Surv. Can., Bull. 180.

Young, F.G.
1975: Stratigraphic and sedimentological studies in northeastern Eagle Plain, Yukon Territory; in Report of Activities, Part B, Geol. Surv. Can., Paper 75-1B, p. 309-319.

Young, F.G., Myhr, D.W., and Yorath, C.J.
1976: Geology of the Beaufort-Mackenzie Basin; Geol. Surv. Can., Paper 76-11.

Yorath, C.J. and Norris, D.K.
1975: The tectonic development of the southern Beaufort Sea and its relationship to the origin of the Arctic Ocean Basin; in Canada's continental margins and offshore petroleum potential, C.J. Yorath, E.R. Parker, and D.J. Glass, eds.; Can. Soc. Pet. Geol., Mem. 4, p. 589-612.