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STRATIGRAPHY AND MICROFOSSILS OF THE JURASSIC BUG CREEK GROUP OF NORTHERN RICHARDSON MOUNTAINS, NORTHERN YUKON AND ADJACENT NORTHWEST TERRITORIES

T.P. POULTON
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Preface

Detailed field studies by the Geological Survey in northern Yukon and adjacent Northwest Territories began in 1955 following recognition of the hydrocarbon potential of the Mesozoic rocks of these areas including the Mackenzie Delta and offshore Beaufort Sea. A major helicopter-supported project carried out in 1963 resulted in the publication of a reconnaissance-scale map and some measured sections. At present updated maps resulting from this operation area being published at the 1:250 000 scale and reports on various aspects of the Mesozoic geology are being prepared. The framework established in 1963 permitted the identification of critical study areas and subsequently numerous more detailed studies have been undertaken. This report presents the results of some of these. In this report the Lower Jurassic to early Upper Jurassic rocks of the northern Richardson Mountains are described in detail and a new nomenclature is presented for these units. Macrofossils, especially ammonites, form the biostratigraphic foundation for the correlations. These are complemented by micropaleontological and palynological data and the report illustrates for the first time the varied microfauna and microflora contained in the Bug Creek Group.

R.A. Price
Director General
Geological Survey of Canada

OTTAWA, March 1982.

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Abstract

The Bug Creek Group comprises the southeastern basin-marginal arenaceous facies of the Brooks-Mackenzie Basin during Sinemurian through early Oxfordian times. It is a northwesterly thickening wedge of shelf sandstones and siltstones that grades into a basinal shale facies of the Kingak Formation.

The Bug Creek Group is subdivided into the following new formations and members, in upward succession: Murray Ridge Formation (Sinemurian; argillaceous, with a basal conglomeratic sandstone, the Scho Creek Member); Almstrom Creek Formation (Pliensbachian approximately; sandstone); Manuel Creek Formation (Toarcian and Lower Bajocian; argillaceous; with a local sandstone, the Anne Creek Member); Richardson Mountains Formation (Middle Bajocian through early Oxfordian; argillaceous and sandstone facies; with a distinctive basal sandstone, the Little Bell Member; and a higher sandstone package, the Waters River Member); and Aklavik Formation (Early Oxfordian; sandstone). The sandstones are quartz-rich and contain abundant locally derived chert and siltstone fragments wherever they directly overlie Paleozoic rocks.

The Almstrom Creek and Aklavik Formations are two major marine sandstone units each probably storm-wave or tide-dominated, that prograded onto a shallow shelf and which represent regressive phases. Another regressive phase, without a significant sedimentary wedge is represented by the Manuel Creek Formation. This is associated with uplift and minor erosion of the basin margin.

The Bug Creek Group yields ammonites, bivalves, and other marine macrofauna locally, and a poorly preserved marine microbiota that is only locally prolific. Of this, 24 species of agglutinated foraminifera, 1 species of calcareous foraminifera, 1 species of ostracod, 1 species of radiolarian, 8 species of dinoflagellate, 7 species of spore or pollen, and 2 species of undifferentiated microplankton are figured, none as new species.

Résumé

Le groupe de Bug Creek comprend le faciès arénacé de la marge sud-est du bassin de Brooks-Mackenzie; il date du Sinémurien jusqu'à la base de l'Oxfordien. Il s'agit d'un coin formé de grès et de siltstone de plate-forme qui tend graduellement vers un faciès shale: la formation de Kingak.

Les nouvelles subdivisions du groupe de Bug Creek sont les suivantes, en ordre ascendant: la formation de Murray Ridge (Sinémurien; argiles, avec grès à conglomérats de base, membre de Scho Creek); la formation d'Almstrom Creek (probablement du Pliensbachien; grès); la formation de Manuel Creek (Toarcien et Bajocien inférieur; argiles, avec grès de l'endroit, membre d'Anne Creek); la formation de Richardson Mountains (Bajocien moyen jusqu'à la base de l'Oxfordien; faciès argileux et grèseux; grès basal distinct, membre de Little Bell); plus haut, grès (membre de Waters River); la formation d'Aklavik (base de l'Oxfordien; grès). Les grès sont riches en quartz et là où ils sont susjacents aux roches paléozoïques ils contiennent d'abondants fragments de silex et de siltstone de provenance locale.

Les formations d'Almstrom Creek et d'Aklavik sont deux unités de grès marins importantes probablement formées dans un milieu dominé par des raz-de-marée ou des marées; ces unités se sont avancées sur une plate-forme peu profonde et présentent des phases de régression. La formation de Manuel Creek, sans coin sédimentaire important, est une autre phase de régression, associée au soulèvement et à l'érosion mineure de la marge du bassin.

Localement, le groupe de Bug Creek contient des ammonites, des bivalves et d'autres macrofossiles marins. Microfaune et microflore mal préservées sont abondantes localement. De celles-ci 24 espèces de foraminifères à test arénacé, 1 espèce de foraminifère à test calcaire, 1 espèce d'ostracode, 1 espèce de radiolaire, 8 espèces de dinoflagellés, 7 espèces de spores ou de pollen et 2 espèces de microplancton non différenciées sont presentées dans le texte. Aucune de ces espèces n'est nouvelle.

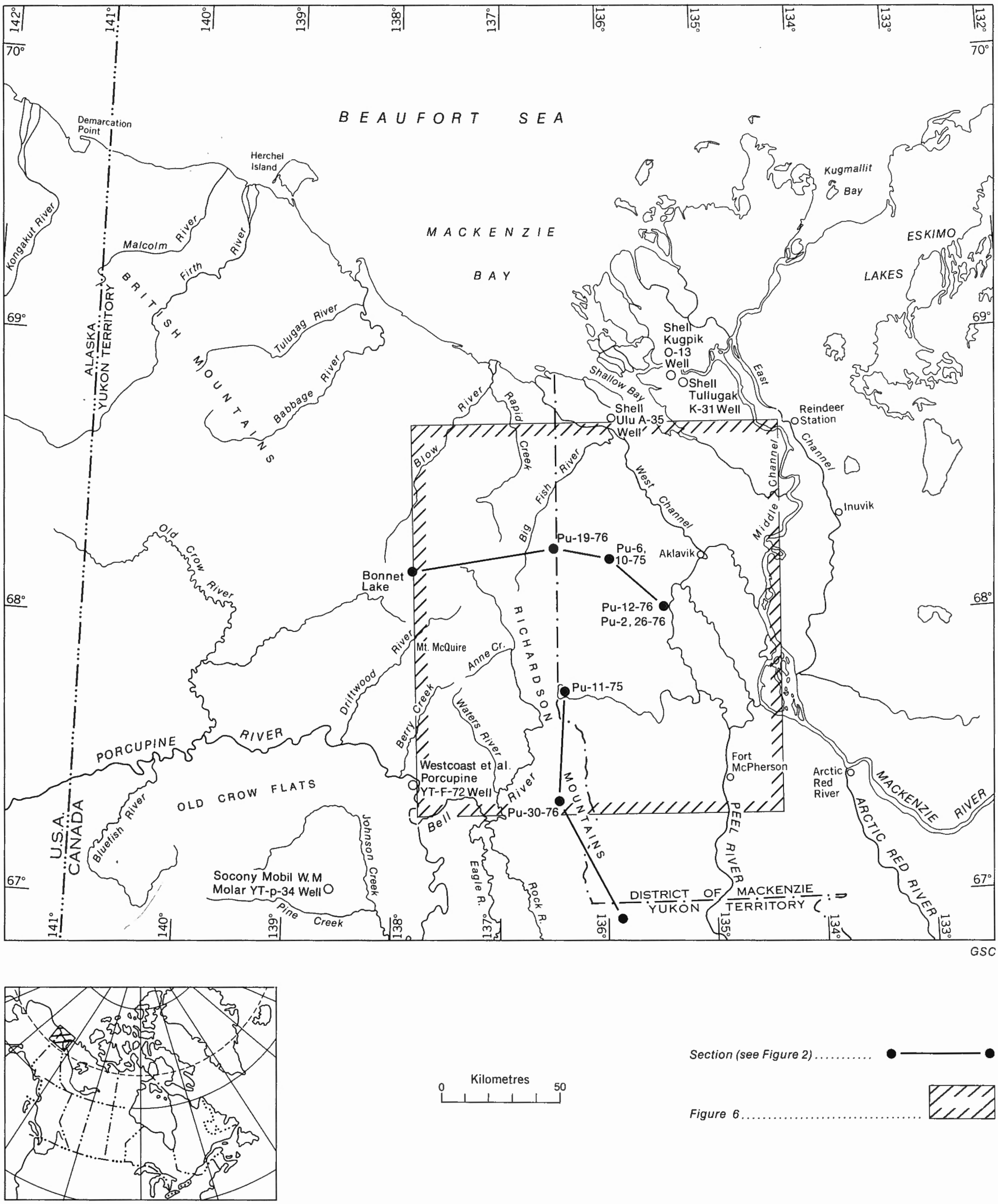


FIGURE 1. *Index map, northern Yukon and adjacent Northwest Territories.*

STRATIGRAPHY AND MICROFOSSILS OF THE JURASSIC BUG CREEK GROUP OF NORTHERN RICHARDSON MOUNTAINS, NORTHERN YUKON AND ADJACENT NORTHWEST TERRITORIES

INTRODUCTION

Jurassic rocks form a quantitatively important and physiographically conspicuous element of the geology of the northern Yukon Territory and adjacent parts of the District of Mackenzie (Fig. 1). They also have been encountered by drilling in the subsurface of the southwestern part of the Mackenzie River delta to the east, where they were thought to have significant potential for hydrocarbon at the time of initiation of this project.

This report describes the lithology, distribution, age, depositional environments, microfauna and microflora of the pre-Late Oxfordian Jurassic rocks of the northern Richardson Mountains. These rocks comprise the Bug Creek assemblage, formerly designated as a formation but here raised to group status. New formations are erected here to replace the earlier informally designated members of Jeletzky (1967) and another not recognized by him. They are, in upward succession, the Murray Ridge Formation, the Almstrom Creek Formation, the Manuel Creek Formation, the Richardson Mountains Formation and the Aklavik Formation.

Previous work

Because of their hydrocarbon potential, primarily outside the present report area, the Mesozoic rocks of northern Richardson Mountains and adjacent areas have been studied by petroleum exploration companies and the Geological Survey since approximately 1946. The earliest major publications resulting are regional geological reports, by Martin (1959, 1961, 1963). Unpublished reports, placed on open file with the then Department of Indian Affairs and Northern Development, were listed in a regional synthesis by Miall (1973).

E.W. Mountjoy was responsible for Mesozoic stratigraphy during the course of Operation Porcupine in 1962, a large-scale Geological Survey mapping project under the co-ordination of D.K. Norris. Some of the measured sections have been released (Mountjoy and Procter, 1969) as well as a verbal communication and abstract (Mountjoy, 1970). Since the geologic map resulting from Operation Porcupine was published (Norris et al., 1963), the geology has been updated and released on maps at the scale of 1:250 000 (Norris, 1975-1980; in press); and summaries of the geology, including the Jurassic rocks by Poulton (in press) and by J.A. Jeletzky are being prepared for a volume being edited by D.K. Norris.

Jeletzky's studies (1958-1980) formed the basic foundation of our present knowledge of the Jurassic stratigraphy of northern Richardson Mountains and also yielded preliminary syntheses of the geologic framework of northern Yukon. Recent publications by Norris (1972-1980) and Young (1973, 1975) are also major contributions and regional summary papers by Lerand (1973), Yorath and Norris (1975), Young et al. (1976), Norris and Yorath (in press), and Balkwill et al. (in press) incorporate further data relevant to the present report.

Present work and acknowledgments

This paper is based mainly on fieldwork by Poulton in 1975, 1976, 1978 and 1979. The micropaleontologic results are by Leskiw, and the palynological results by Audretsch. All other parts of this bulletin are the responsibility of Poulton. These studies were supplemented by stratigraphic data, both published and unpublished, provided by J.A. Jeletzky, D.K. Norris, F.G. Young and J. Dixon. Locality information provided by J.A. Jeletzky and D.K. Norris, and the structural and stratigraphic framework available in unpublished maps by Norris, were essential to the success of this investigation. E.W. Mountjoy, W.W. Nassichuk and E.W. Bamber also supplied specific stratigraphic information and Bamber permitted publication of his stratigraphic section 116P-1.

Logistical facilities were provided to Poulton in 1975 by D.K. Norris and F.G. Young. In that year, he was particularly fortunate to have the company, advice, and assistance of J.H. Callomon (University College, London) in the field. R.W. Smith (Shell Canada) joined Poulton in 1976 and collected the microfossil samples which are described in parts of this report. They were assisted by D.C. Hope. In 1978, C.M. Henderson assisted Poulton; logistical help and some stratigraphic information was provided by Petro-Canada Exploration and by D.K. Norris. R. Warters assisted in 1979.

Macrofossil collections by Poulton, by colleagues in the Geological Survey, and by oil companies who had earlier submitted material for identification and stratigraphic interpretation, form the biostratigraphic foundation for the correlations. They provide data without which the initial identification of mappable units would not have been possible. The ammonites, which are of paramount importance for these purposes, were mainly identified by H. Frebold, although a few identifications made in the field by Poulton, or J.H. Callomon, are used, as are a few published field determinations by Jeletzky. Some stratigraphic problems were resolved by the identification of belemnites by J.A. Jeletzky, which are included in major reports presently being prepared by him, and by his identifications of Buchia species which occur in the rocks that overlie the Bug Creek Group. N.S. Ioannides and J.H. Wall provided advice on the presentation of the micropaleontological data. The remainder of the manuscript was read by J.A. Jeletzky, A.F. Embry and D.K. Norris, all of whose comments significantly improved it. Appendix 3 on paleogeography was also read and improved by R.L. Detterman (U.S.G.S.), J. Dixon and E.R.W. Neale.

New geographic names

The following new geographic names relevant to this report have been approved by the Canadian Permanent Committee on Geographic Names:

Anne Creek: tributary of Bell River, rising near the head of Waters River and meeting Bell River at 67°54'N Lat., 136°53'W Long.

Manuel Creek: tributary of Fish Creek, flowing southward along east side of White Mountains, meeting Fish Creek at 67°52'N Lat., 136°23'W Long.

Murray Ridge: ridge lying between head of Manuel Creek to the southwest and head of Scho Creek to the northeast, centred at 68°N Lat., 136°25'W Long.

Almstrom Creek: eastern major tributary of Little Fish Creek rising near head of Little Fish Creek, flowing north, and meeting it at 68°25'N Lat., 136°10'W Long.

REGIONAL GEOLOGICAL SETTING

The Lower and Middle Jurassic succession of northern Richardson Mountains and adjacent areas becomes thinner, less complete, and richer in sandstones and conglomerates to the southeast, toward the North American craton (Fig. 2). The hiatus between Paleozoic rocks and overlying Mesozoic units also increases in magnitude southward, as progressively younger units overstep each other. The northwestern portion of the craton, has been called Peel Landmass (Jeletzky, 1972a, 1975; Young et al., 1976) (see Fig. 3).

The name Brooks-Mackenzie Basin for the depositional basin to the northwest during Late Paleozoic to mid Early Cretaceous time was proposed by Balkwill et al. (in press), to indicate the physical continuity and similarity of the Kingak successions in northern Alaska and in northern Yukon where the names 'Brooks Geosyncline' and 'Beaufort-Mackenzie Basin', respectively had been used by earlier authors. Nevertheless, as noted below, the paleogeographic integrity of the basin during Jurassic time, is not entirely certain and the present relative distributions of Jurassic facies and stratigraphic sections are not necessarily the same as they were when deposited. The Kaltag Fault Zone, including the Blow Fault Zone, the Porcupine Fault, and the Rapid Fault Array of previous authors (Norris, 1974; Yorath and Norris, 1975; Young, 1974; Young et al., 1976) might be the site of major strike-slip dislocation (see Fig. 3). It has not been possible to make any reliable palinspastic reconstruction involving significant dislocation. Thus, the relationship of the Alaskan and northwestern Yukon portion of Brooks-Mackenzie Basin with that of northern Richardson Mountains area are treated in this paper as they also were by Jeletzky (1975, p. 49) and Young et al. (1976) as if there was no differential movement between them during or subsequent to Jurassic time. It seems also that counter-clockwise rotation of northern Alaska away from northern Canada during the Jurassic as suggested by some authors (e.g. Carey, 1955; Tailleur, 1973; Newman et al., 1977) might have resulted in volcanism, submarine slumping, or more extreme sediment thickness and facies variations in the area of distension than have been recognized here. The Lower and Middle Jurassic history of the area, by contrast, is relatively simple, implying stable tectonic conditions, as already suggested by Young (1973). Those erratic facies and thickness variations that accompany the irregularities of the unstable cratonic margin (e.g. White Mountains Uplift; depositional depression at head of Waters River) may possibly have been related to penecontemporaneous strike-slip faulting although no firm evidence for this is available either.

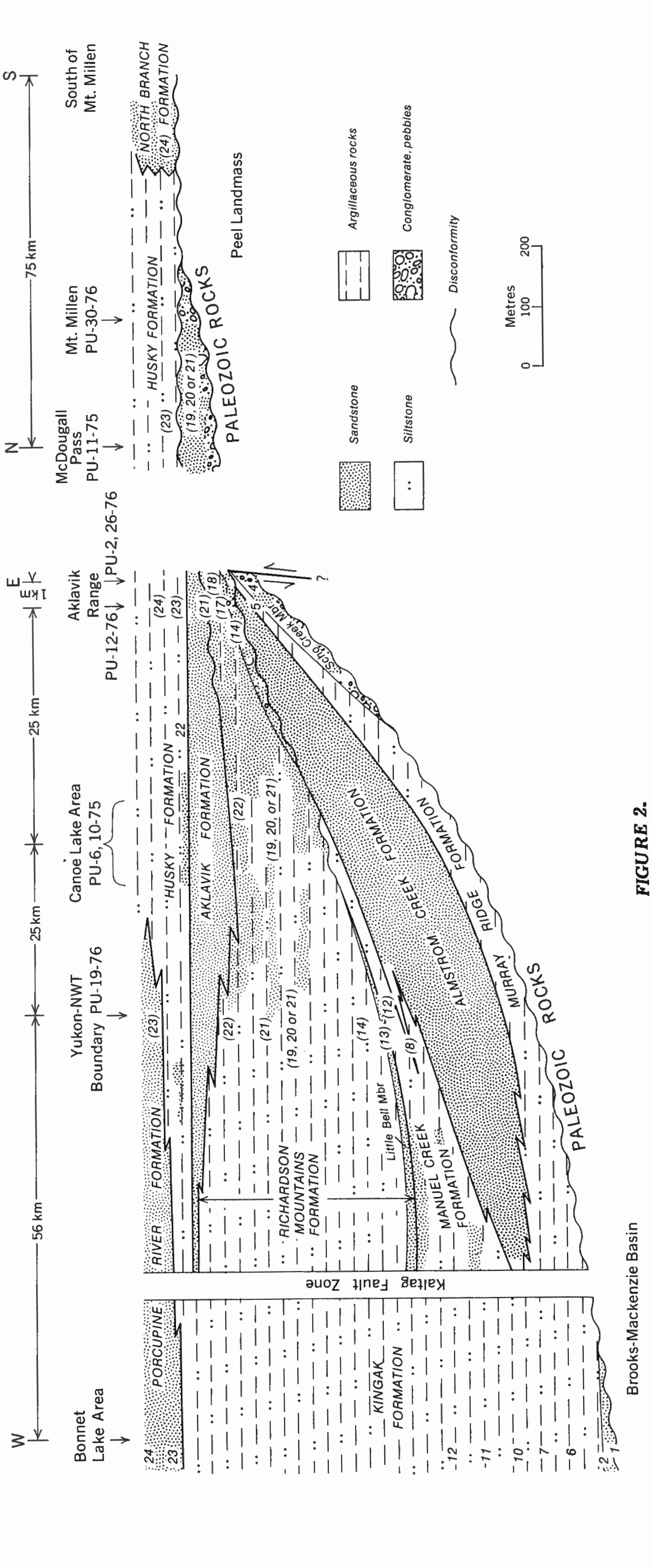


FIGURE 2.

An original contiguous basin-marginal to basin-centre relationship of the Bug Creek Group and the Kingak Formation is suggested by the close similarity of the faunas between these areas and by the northwestward facies and thickness trends documented in the Bug Creek Group. Jurassic sandstone beds at the head of Johnson Creek, approximately 15 km south-southeast of Bonnet Lake and in eastern and southeastern Old Crow Flats (see Fig. 1), support extension of the Richardson Mountains stratigraphic package westward to there. They do not appear to extend farther northwestward, however, beyond the locus of the northwesternmost splays of the Kaltag Fault Zone, where the lithologies and faunal succession are closely similar from Bonnet Lake area through British Mountains, to northern Alaska, judging by descriptions of Detterman et al. (1975). Assumption of relatively little differential movement

SERIES	STAGES		KEY TO GUIDE AMMONITES AND BUCHIA SPECIES NORTHERN YUKON AND ADJACENT NORTHWEST TERRITORIES
UPPER JURASSIC	UPPER VOLGIAN		
			26 *Buchia fischeriana*
	PORTLANDIAN		25 *Buchia piochii*
	KIMMERIDGIAN		24 *Buchia mosquensis*,
			Amoeboceras
			23 *Buchia concentrica*
	OXFORDIAN	U	
		L	22 *Cardioceras* sp.
MIDDLE JURASSIC	CALLOVIAN	U	
		M	
		L	21 *Cadoceras septentrionale, C. voronetsae, C. canadense, Kepplerites (?)* *Cadoceras (Pseudocadoceras) (?)*
	BOREAL BATHONIAN	U	20 *Cadoceras* sp. aff. *C. barnstoni, C. crassum*
			19 *Arcticoceras* sp.
		M	18 *Arctocephalites greenlandicus*
			17 *A.* sp. cf. *A. arcticus, A. elegans*
		L	16 *Cranocephalites* sp. aff. *C. vulgaris*, aff. *C. pompeckji*, aff. *C. maculatus*
	BAJOCIAN	U	15 *Cranocephalites* sp. cf. *C. indistinctus*
			14 *C. borealis, C. warreni*
		M	13 *Arkelloceras tozeri, A. elegans*
		L	12 *Erycitoides* sp. aff. *E. howelli*
			11 *Pseudolioceras mclintocki*
			10 *Leioceras* sp. cf. *L. opalinum*
LOWER JURASSIC	TOARCIAN	U	
			9 *Peronoceras* sp. cf. *P. polare*
		M	
			8 *Dactylioceras* sp. aff. *D. commune, Pseudolioceras* sp.
		L	7 *Harpoceras* sp. aff. *H. exaratum, Dactylioceras* spp.
	PLIENSBACHIAN	U	6 *Amaltheus* spp.
		L	
	SINEMURIAN	U	5 *Echioceras aklavikense, E.* sp. cf. *arcticum*
			4 *Oxynoticeras oxynotum, Gleviceras* sp. *Arctoasteroceras jeletzkyi*
		L	3 *Coroniceras (?), Arietites (?)*
	HETTANGIAN	U	
		L	2 *Psiloceras* sp. cf. *P. johnstoni*
			1 *Psiloceras* sp.

GSC

FIGURE 2. *Simplified cross-section showing stratigraphic relationships of Jurassic rocks across northern Richardson Mountains from northwestern basinal facies area to south-eastern basin-marginal area (modified from Poulton, 1978b). Numbers refer to age-diagnostic fossil occurrences shown in key to the guide ammonites and Buchia species of the region. Lines of section appear on Figure 1.*

between these areas for the purposes of this report does not preclude the possibility of Jurassic or younger strike-slip movement of one part against the other on a scale smaller than that of the basin. Norford (1964), A.W. Norris (1968) and Bamber and Waterhouse (1971) were able to explain the Late Cambrian through Permian stratigraphy and facies distributions without invoking post-depositional juxtaposition of unlike facies, although Bamber and Waterhouse (1971, Figs. 12, 13) showed a major northeasterly swing of facies trends across the locus of the Kaltag Fault.

The interpretation that Bug Creek rocks of probable southeasterly provenance extend as far west as southeastern Old Crow Flats (see Fig. 1 and Appendix 3) differs from that of Jeletzky (1975, Fig. 9) who thinks these western sandstones to have been independently derived from a western source.

Brooks-Mackenzie Basin is one of two Late Paleozoic to mid-Early Cretaceous depositional basins of Arctic North America that were located more or less over Middle Paleozoic tectonic belts (see Balkwill et al., in press). The other is Sverdrup Basin of the Canadian Arctic Archipelago (see Fig. 3). The tectono-stratigraphic phase during which these basins maintained their configuration has been called the Ellesmerian tectono-stratigraphic regime by Lerand (1973), Norris and Yorath (in press), and Balkwill et al. (in press). The extent of the crystalline Precambrian Canadian Shield westward beyond Mackenzie River area, into northern Yukon and Alaska is not known. However, the older Paleozoic rocks are of epicontinental aspect.

The unstable cratonic margin was characterized by localized, periodically active uplifts and depressions, some of which influenced the deposition, and preserved record, of the Bug Creek rocks. They are shown in Figure 38, and discussed in the later section under "Notes on tectonic elements".

The present-day tectonic configuration (e.g. Norris, 1974; Young et al., 1976) results from 'Laramide' tectonism, during which the Bug Creek Group was subject to vertical faulting, possibly with strike-slip components as discussed earlier, arching, and tilting of individual fault blocks.

STRATIGRAPHY

Bug Creek Group

The Bug Creek Group is a southeastern arenaceous equivalent to part of the Kingak Shale (Leffingwell, 1919; Detterman et al., 1975) of Alaska, which also appears in northwestern and north-central Yukon Territory. The group as a whole thickens and contains a greater proportion of argillaceous rocks west-northwestward into Brooks-Mackenzie Basin (Fig. 2).

The Bug Creek Group is here extended in concept to embrace all of the Lower Jurassic to Lower Oxfordian units in the mainly arenaceous basin-marginal facies originally assigned to the Bug Creek Formation by Jeletzky (1967), as well as others along regional depositional strike that are equivalent to them, even where differences in sequence or facies may not necessarily permit recognition of the formations described here within the group. Three major easterly-thinning tongues of the argillaceous Kingak facies extend eastward into the northern Richardson Mountains (Poulton, 1978b and Fig. 2), two of them having been described in their easternmost development as members of the Bug Creek Formation by Jeletzky (1967), namely the grey siltstone member and the sandstone-siltstone member.

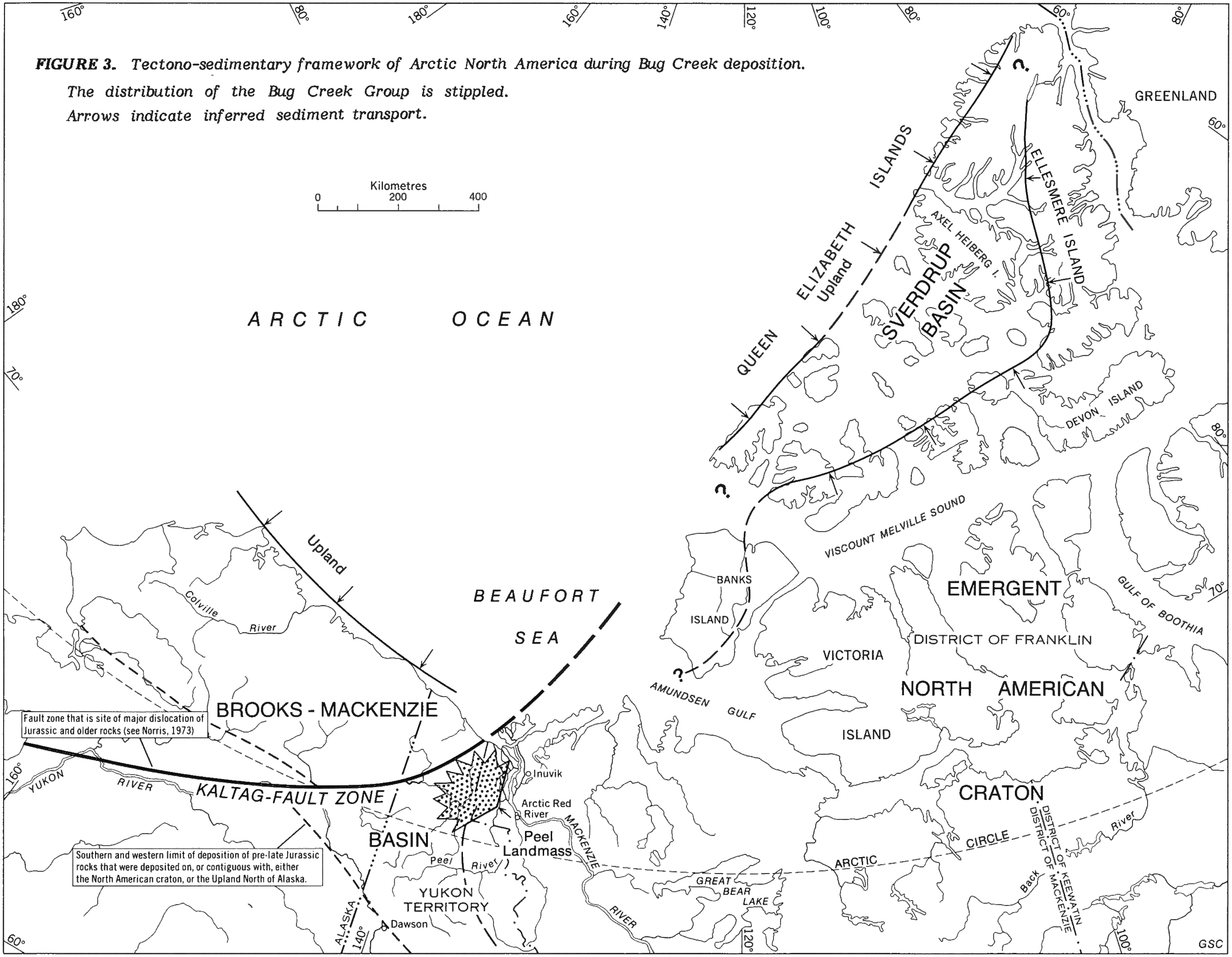
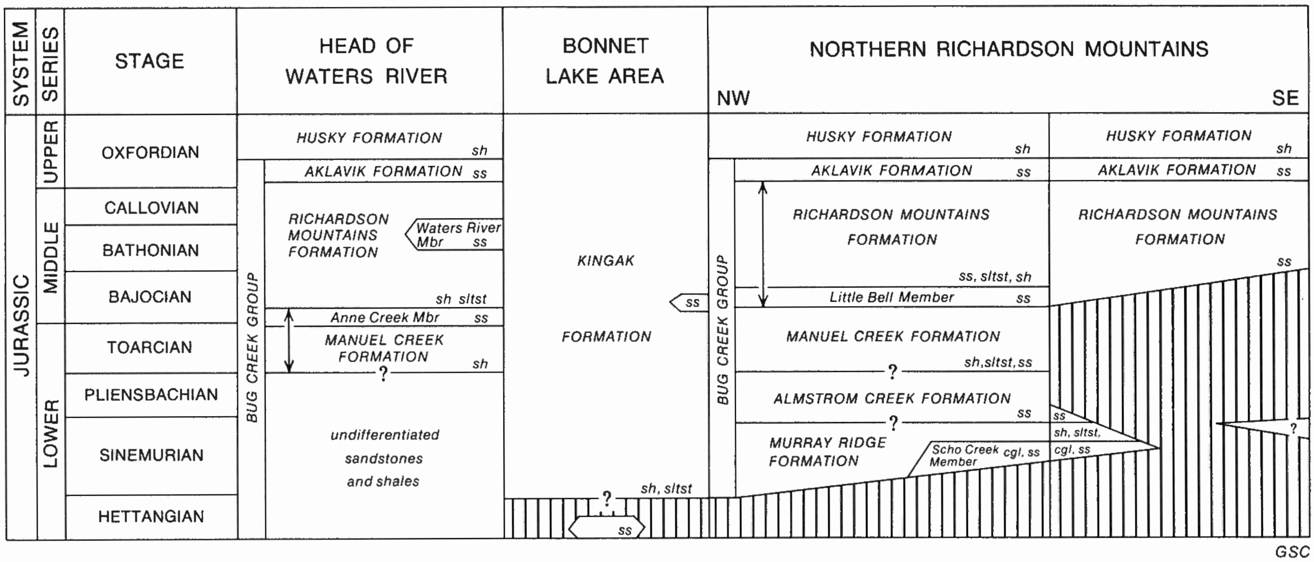


FIGURE 3. *Tectono-sedimentary framework of Arctic North America during Bug Creek deposition. The distribution of the Bug Creek Group is stippled. Arrows indicate inferred sediment transport.*

TABLE 1

Table of formations



These argillaceous units are included within the Bug Creek Group because of the common presence within them of sandstones and siltstones and in order to eliminate nomenclatural problems caused by the repeated interdigitation of Bug Creek and Kingak Formations. Jeletzky (e.g. 1971, p. 203-204; 1975), on the contrary but with equal validity, has consistently assigned the argillaceous intervals in the western parts of the present report area to the Kingak Formation.

New formations

The basic elements of the stratigraphy and much of the tectono-sedimentary history and paleogeography of the Bug Creek Group in the northeastern and east-central parts of the northern Richardson Mountains have been described by Jeletzky (1967), and summarized by Jeletzky (1975), Young et al. (1976), and Poulton (1978b). In most respects Jeletzky's members correspond with the new formations erected here (Table 1, Fig. 4). However, the type section designated by Jeletzky (1967) (section PU-7-75 of this paper; Fig. 5), situated as it is high on the North American Craton, is thinner, less complete in terms of units represented, and richer in sandstone than argillaceous rocks, compared to the basinward sections farther north and west (Figs. 4, 5). A more typical succession of the Bug Creek Group occurs at Murray Ridge (sections PU-12, 14-75 of Fig. 4 and PU-9-76 of Appendix 1). The well exposed sections here (Fig. 7) have served as reference sections for preliminary reports of this study (Poulton and Callomon, 1976; Poulton, 1978b, c), and as type sections for the lower four formations of the group formally named in this paper.

Furthermore, Jeletzky (1967) misinterpreted the stratigraphic position of a major unconformity that he recognized in the type section by placing it at the base of his Intermediate sandstone member instead of within it. This resulted in amalgamation of two different sandstone formations (part of Almstrom Creek and the lower part of Richardson Mountains Formation) in this member. Poulton and Callomon (1976) distinguished these unrelated components of the Intermediate sandstone member when they found them to be separated by the unconformity, at which another, intervening formation, the Manuel Creek, is entirely absent (see Fig. 4). In this section, the base of the Richardson Mountains Formation more or less corresponds with the lowermost beds with belemnites.

Additionally, significant hiatuses may be present in the thin succession of Bajocian through Callovian rocks in the Bug Creek-Jurassic Butte area, because ammonites of quite different ages are present in beds that are not distantly separated stratigraphically (see Fig. 5).

The formal erection of formations in this paper (Table 1) and the raising of the Bug Creek Formation to group status is based on the regional extent of the subunits, the ease with which the resistant sandstone formations can be mapped and the long time span encompassed by the group. The new nomenclature reflects our greatly increased knowledge of the group in its thick development north and west of the original type section, and the diversity of lithologies and inferred paleoenvironmental conditions under which they were deposited. Furthermore, two of the formations (Aklavik and Almstrom Creek Formations) have been used as marker units in wells drilled in the Mackenzie Delta (Poulton, 1978a; Dixon, in press).

Detailed descriptions of the stratigraphic sections studied are presented in Appendix 1, and they are graphically illustrated in Figures 5, 9, 11, 13, 16 and 39, and are presented photographically in Plates 7-11. Other fossil localities are documented in Appendix 2.

The recognition of the formations is easily accomplished throughout most of the northern Richardson Mountains, based on a combination of topographic expression of resistant sandstones and recessive argillaceous rocks, distinctive lithologic characteristics of many of the units, and the presence of characteristic suites of macrofossils in each unit. Norris (1975a), in the vicinity of Murray Ridge (see Fig. 6), mapped three units (Jbc 1, 2 and 3) in the Bug Creek, each of them characterized by a resistant sandstone, corresponding to the Almstrom Creek, basal Little Bell Member of Richardson Mountains, and Aklavik Formations of this report (Fig. 4). The lower two of Norris's map-units also included adjacent argillaceous formations.

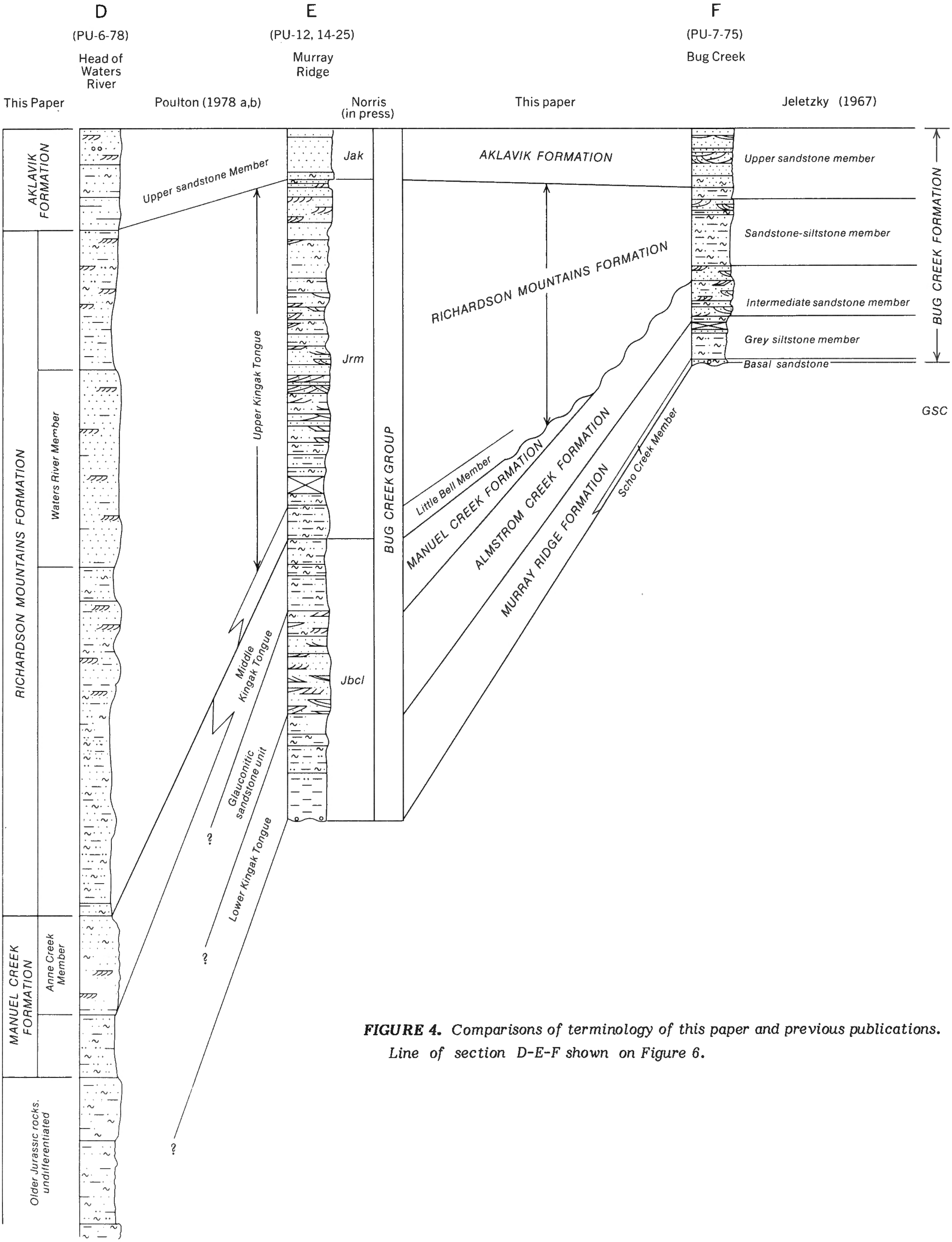


FIGURE 4. Comparisons of terminology of this paper and previous publications. Line of section D-E-F shown on Figure 6.

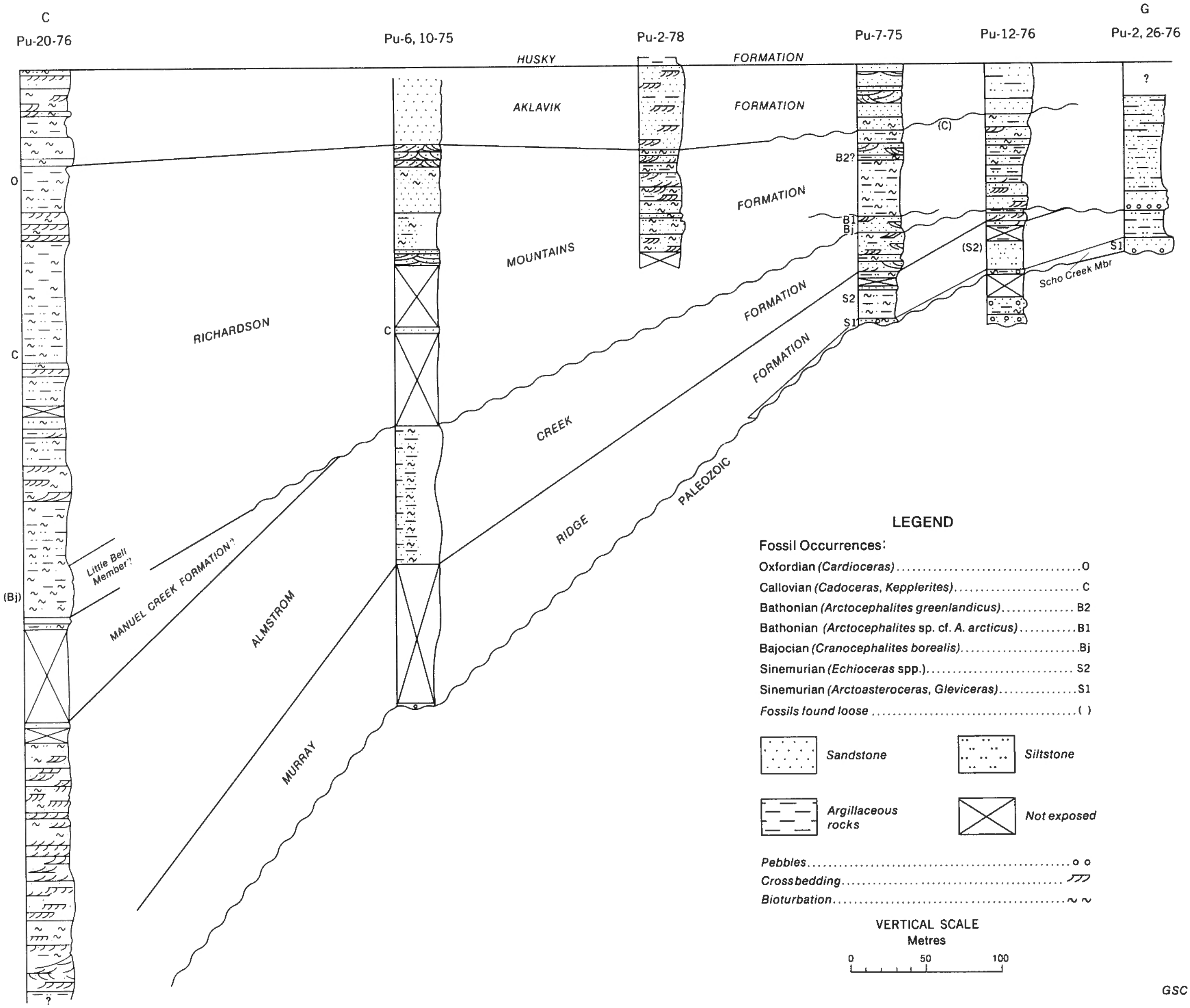


FIGURE 5. *Graphic illustration of stratigraphic sections in a northern cross-section across facies and thickness trends of Bug Creek Group, northwest (section PU-20-76) to southeast (section PU-2, 26-76). Line of section C-G shown on Figure 6.*

They are designated as Jak, Jrm and Jbcl in the final version of these maps (Norris, in press). The correspondence of these units with those of the present report is shown in Figure 4. Because he lacked some of the critical data described in this report, Norris did not trace these units far from Murray Ridge. The lateral variability, time-transgressive and discontinuous character of the sandstone formations is not as great as stated by Jeletzky (1967) or by Poulton and Callomon (1976), although individual beds or groups of beds within each formation do exhibit variability in both thickness and lateral extent.

Sandstone units occur in the vicinity of the head of Waters River (sections PU-11-76; PU-5-78; PU-6-78 of Appendix 1; see Fig. 6) that are not present or are less important to the east. These include the Waters River Member in the dominantly argillaceous Richardson Mountains Formation, and the Lower Bajocian Anne Creek Member in the upper part of the Manuel Creek Formation.

Regional thickness trends

The Bug Creek Group as a whole thickens west-northwestward into Brooks-Mackenzie Basin, more or less regularly except for minor local anomalies that are due to contemporaneous or subsequent erosional thinning and localization of depocentres (Figs. 2, 8, 9). Throughout most of the report area, the group falls naturally into two major stratigraphic subdivisions, respectively older than and younger than Middle or Upper Bajocian separated one from the other by a widespread hiatus reflecting regional regression. In the more marginal southeastern areas (Fig. 10) and over White Mountains Uplift (Fig. 11), the lower subdivision is missing below an unconformity at the base of the upper subdivision. The two are essentially conformable in the more basinal areas, however. The succession and northwestward thickening has been recognized also in the western Mackenzie Delta at least as far north as Unak B-11 well (see Poulton, 1978a, in press; Dixon, in press), but farther north its extension is uncertain.

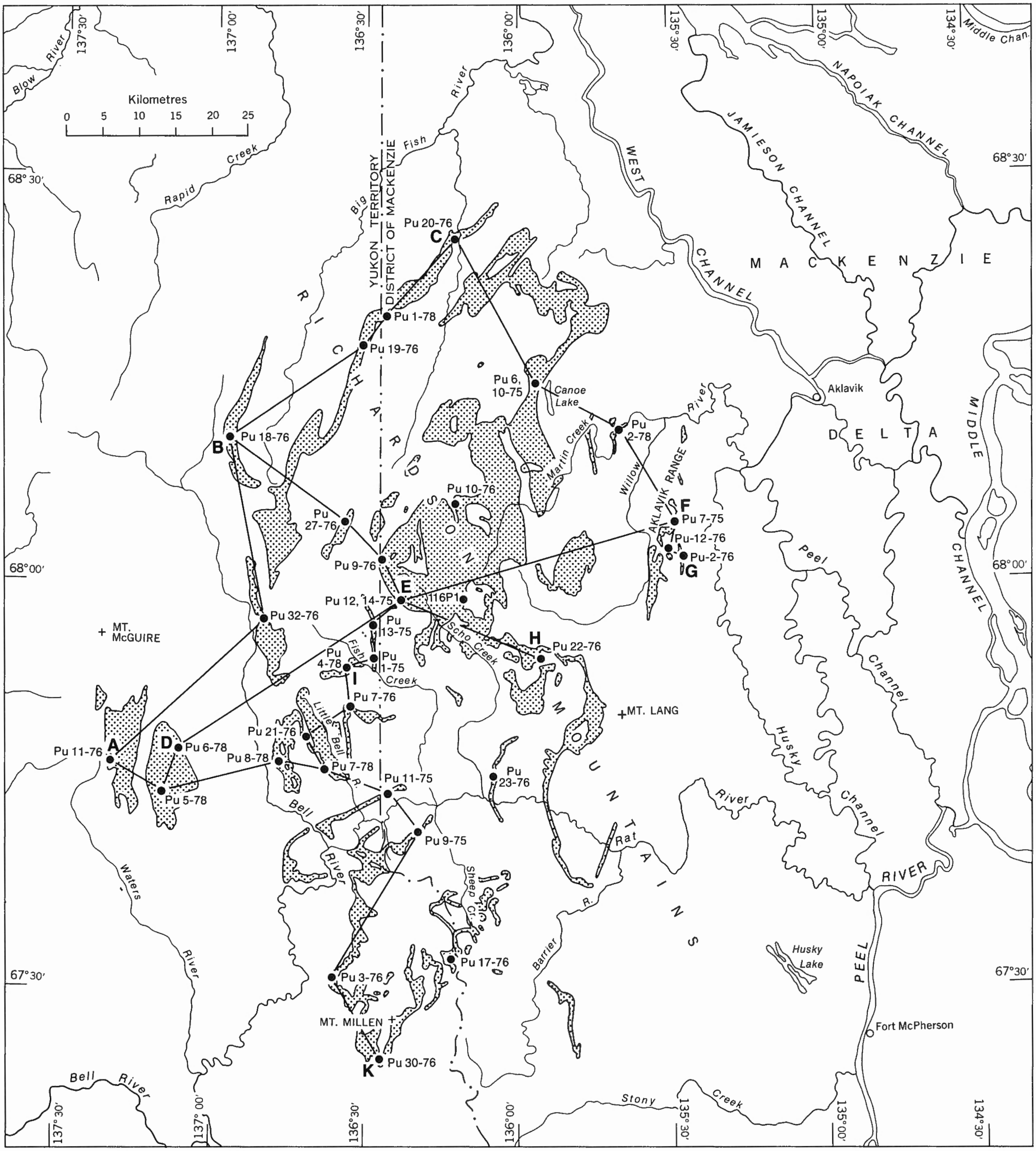


FIGURE 6. Index map, northern Richardson Mountains, showing locations of stratigraphic sections and outcrop pattern of Bug Creek Group (stippled) (adapted from Norris, 1975a, b).

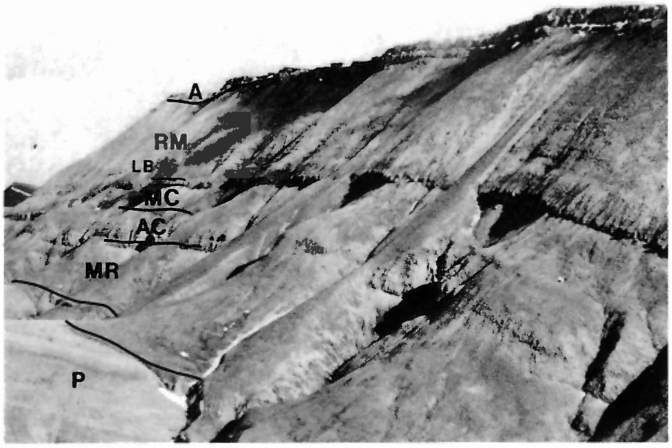


FIGURE 7. Bug Creek Group at Murray Ridge (section PU-12, 14-75). GSC Photo 202973-P. Symbols for this and other photographs: P=Permian; MR=Murray Ridge Formation; AC=Almstrom Creek Formation; MC=Manuel Creek Formation, RM=Richardson Mountains Formation; A=Aklavik Formation.

The thickness trends in the lower, mainly Lower Jurassic subdivision (Fig. 12) are determined above all by the variation in thickness of the Almstrom Creek Formation (see Fig. 22), a sandstone formation whose depocentre appears to have been north of White Mountains. This inference is tentative, due to difficulty of correlating precisely in the vicinity of the head of Waters River, where equivalents of the formation may be thicker than is thought, but where the units that appear to be equivalent with the Almstrom Creek Formation are significantly thinner than is that formation farther north. The minimum thickness of Early Bajocian and older rocks that are probably Jurassic near the head of Waters River (239 m; section PU-5-78; Figs. 13, 14) also is uncertain because their contact with older rocks has not been located. It either lies within the succession of sandstone and shale units or, more likely, lies lower in the succession and is not exposed.

Regional thickness and facies trends within some of the Lower Jurassic units indicate that the southeasterly thinning onto the craton is partly due to original depositional thickness variation (see Fig. 9). In part, the absence of Lower Jurassic rocks on White Mountains Uplift (Fig. 11) and thinning of them onto the craton probably is due also to pre-Middle or Upper Bajocian erosion (see Poulton and Callomon, 1976; Poulton, 1978b) (Figs. 2, 9, 10).

Bajocian and younger rocks are also relatively thinner over White Mountains Uplift and in a salient northwestward from it (Fig. 15). This is expressed in the Richardson Mountains Formation as far northwest as sections PU-18-76 and PU-19-76 (see Fig. 6). The salient of relatively thin Middle Jurassic rocks extending northwestward from White Mountains area coincides geographically with the depocentre of the Almstrom Creek Formation (Fig. 15) which may well have been a causative factor in its development and that of depocentres of the Richardson Mountains Formation astride it to the southwest and northeast. East and northeast of this salient, the northwestward thickening of the Richardson Mountains Formation is very gradual. West and west-southwest of White Mountains and the salient of relatively thin Bajocian and younger rocks, however, basinward thickening of the Richardson Mountains Formation is very pronounced (Figs. 15, 16). This pattern is partially obscured by erosional removal of as much as 115 m (est., section PU-32-76) of the upper parts of the Bug Creek Group west of White Mountains below the Hauterivian and Barremian "Upper shale-siltstone division" of Jeletzky (1958b). This uplift is apparently part of that which Jeletzky (1980) called the White Mountains Uplift of the Upper Jurassic and Early Cretaceous and interpreted to be fault-bounded. This part of it lies farther west than the earlier Jurassic White Mountains Uplift identified by Poulton (1978b). The combined effects of the White Mountains Uplift (sense of Poulton, 1978b and of this paper; see section on "Notes on tectonic elements") and its northwestward extension in the Middle Jurassic, together with pre-Hauterivian erosion west of it, are expressed by the Bug Creek Group as a whole exhibiting relatively abrupt thickening southwest of White Mountains along a line that corresponds with the southwestern edge of the pre-Hauterivian arch (Fig. 8). The Bug Creek Group may be even thicker than shown west-southwest of White Mountains because no base to the Jurassic succession has been identified with certainty there, and rapid thickening of the Lower Jurassic rocks, similar to that of the Middle Jurassic, may possibly have occurred.

The variation in thickness of the Middle and Upper Jurassic rocks that extend southward onto Peel Landmass beyond the limits of the Lower Jurassic south of Richardson Mountains Formation (Figs. 10, 15) is probably due in large part to original depositional variation. However, it may also be related in part to localized erosion of upper parts of the succession below the Husky Formation (see section on "Underlying and overlying units").

The present data in the northern part of the report area do not support the concept of the strata thinning basinward from an axis of deposition which led Young et al. (1976, p. 56, Fig. 4) to propose distinct shelf, slope and basinal depositional regimes. Rather, the more or less constant northwestward thickening of the Bug Creek Group and the estimated thicknesses and lithologies of the Kingak Formation farther northwest (e.g. Jeletzky, 1975; Fig. 8) suggest gradual northwesterly deepening on a shallow shelf. There are no features diagnostic of 'upper bathyal' environments, as Jeletzky (1975, p. 18) questionably postulated. Westerly basinward thinning of the Bug Creek Group and equivalent rocks away from the more southerly of two depocentres figured by Young et al. (1976, p. 56, Fig. 4), that is west from the head of Waters River, may well be the case although poor outcrop to the west precludes a firm conclusion.

Overlying and underlying units

The Bug Creek Group overlies the Permian "Upper sandstone unit" paraconformably or with gentle, regional angular relationships over most of the northern Richardson Mountains (Bamber and Waterhouse, 1971; Bamber, 1972; Norris et al., 1963 and Norris, 1973-1980). Locally, however, as for example between McDougall Pass and Mt. Millen, the Permian rocks have been removed and the Jurassic overlies the Devonian Imperial Formation (Norris, 1975a). Rocks with Late Triassic marine fossils occur in two localities south of the present study area (Mountjoy, 1967, locs. 8, 9; see Norris, in press). They may be erosional remnants of the Shublik Formation far southeast of its main outcrop area in northern Alaska and northwestern Yukon, or of a different equivalent unit that mainly outcrops far to the southwest. The record of other Triassic(?) units, the Brat Creek Formation and overlying Coaly Shale division of Jeletzky (1967; see also Mountjoy, 1967, locs. 7, 8), is possibly erroneous. The Triassic dating was based on imperfectly known stratigraphic relationships in sections (e.g. 154 of Jeletzky,

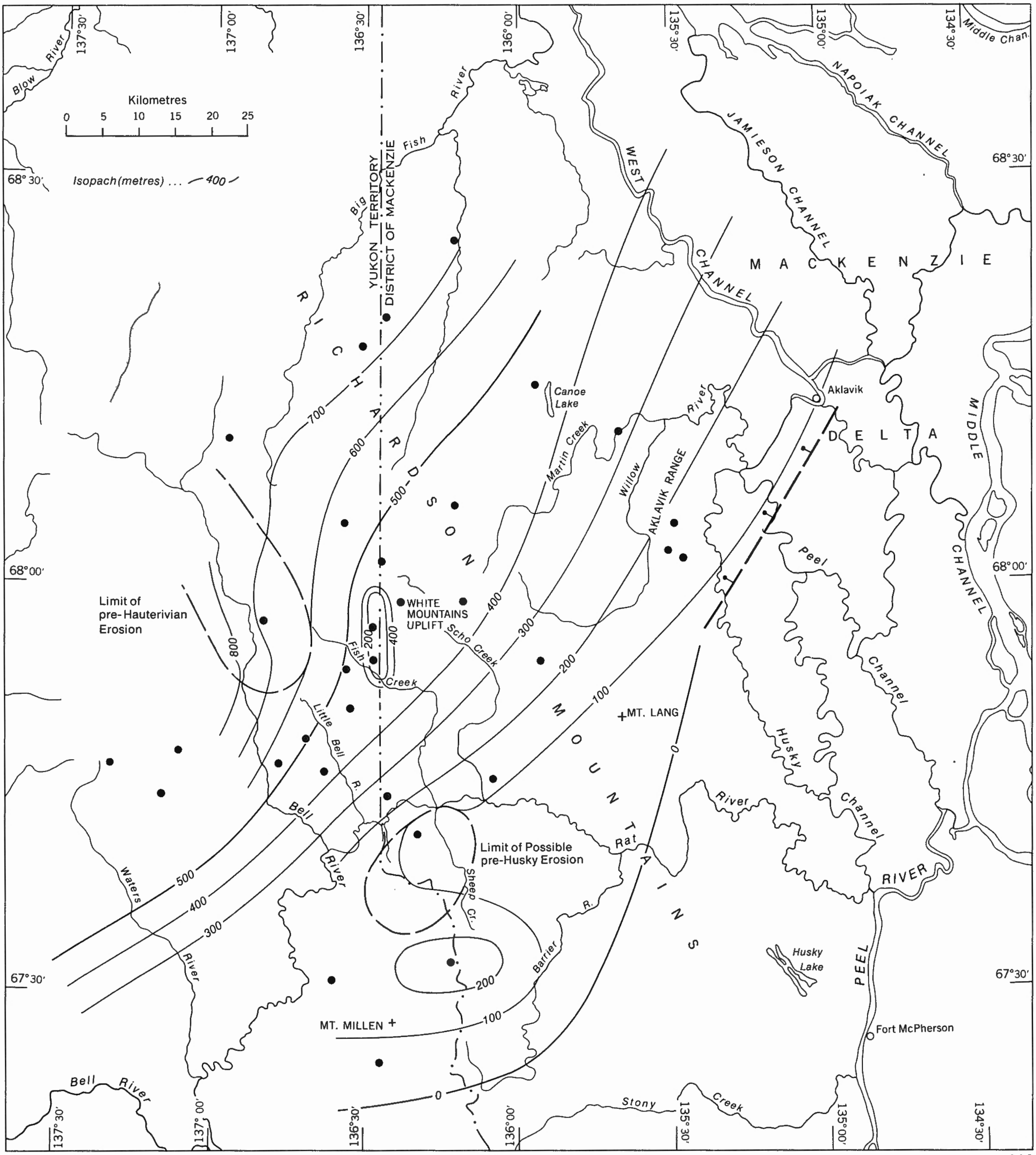


FIGURE 8. *Isopach map, Bug Creek Group.*

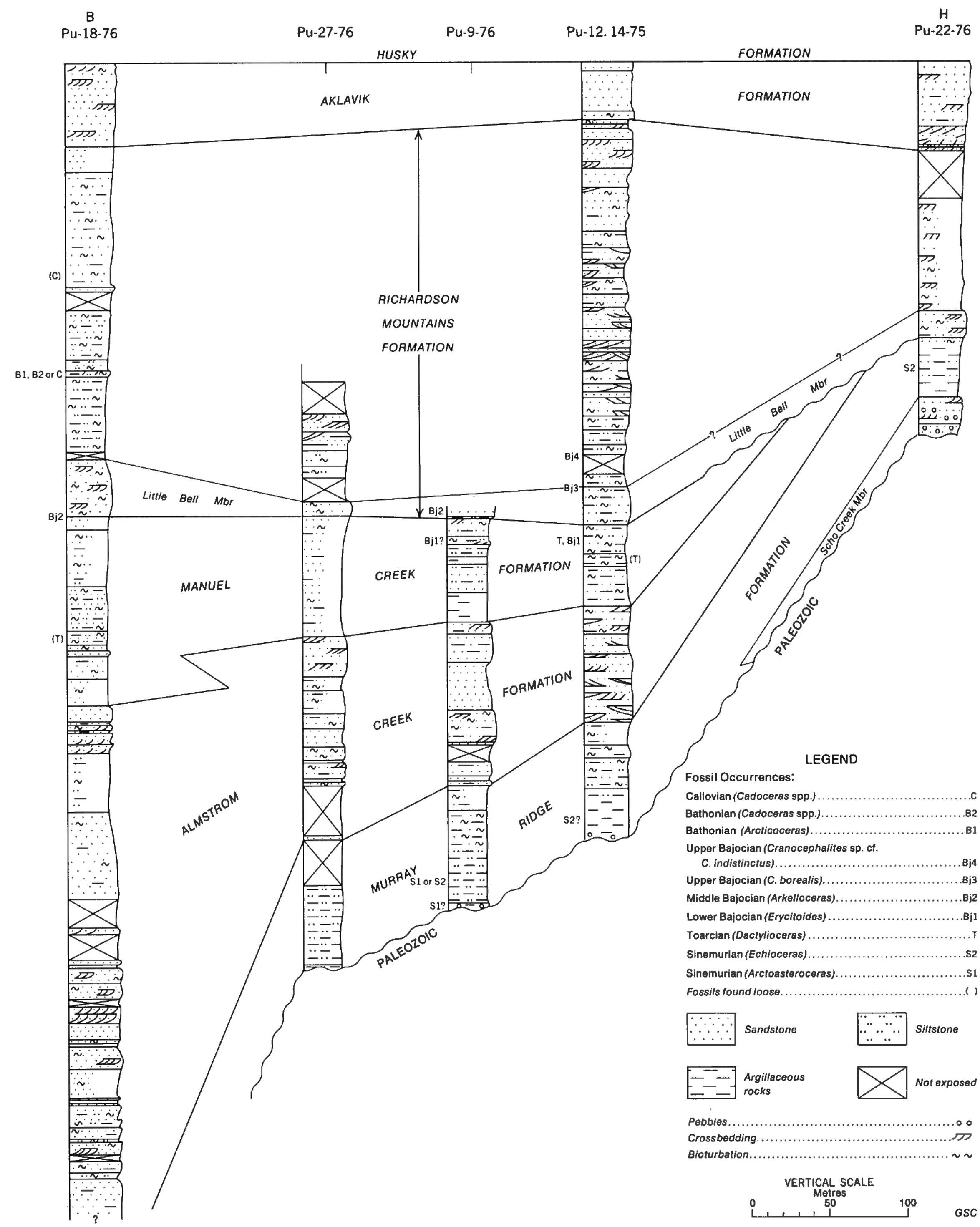


FIGURE 9. *Graphic illustration of stratigraphic sections in a central cross-section, across facies and thickness trends of Bug Creek Group, west-northwest (section PU-18-76) to east-southeast (section PU-22-76). Note the pronounced southeast truncation of formations below the lower sandstones of Richardson Mountains Formation. Line of section B-E-H shown on Figure 6.*

1967) where the contact with overlying reliably dated formations is not well exposed and on dating of palynomorphs that are either Permian (Audretsch in Jeletzky, 1967, p. 7), non-diagnostic and questionably identified, or possibly reworked (e.g. McGregor in Jeletzky, 1967, p. 9, 148, 149). D.K. Norris (in press and pers. comm.) now considers some of these rocks at least to be a conglomerate facies of a Cretaceous unit, faulted into its present position, that was informally designated the "Upper Sandstone division" by Jeletzky (1958b). Others, such as those described by Jeletzky (1967, p. 125, 126), that directly overlie probable Permian sandstones may represent the same Permian conglomeratic sandstone unit that has been described at the top of the Permian succession elsewhere in the northeastern Richardson Mountains (Nassichuk et al., 1978).

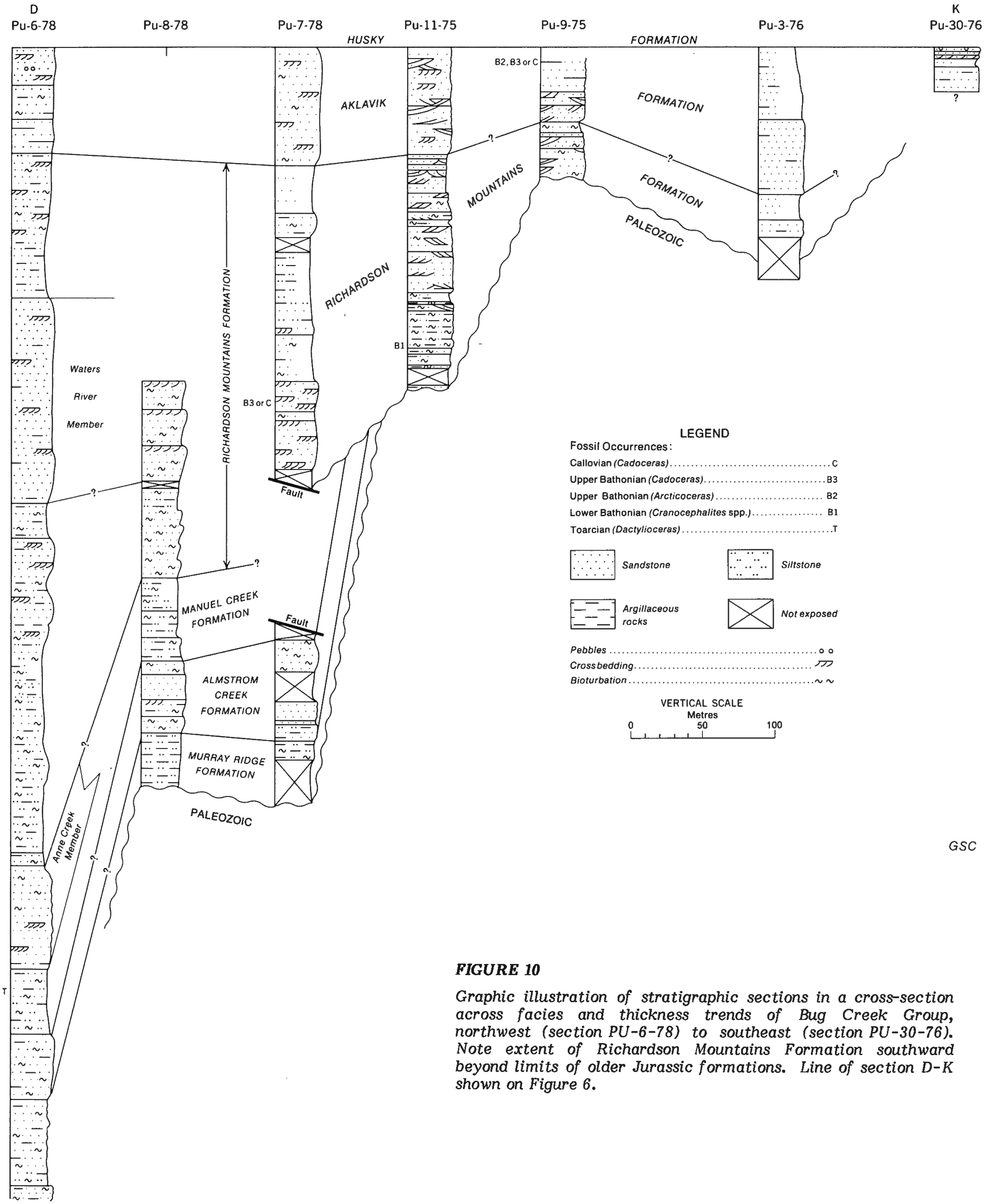


FIGURE 10

Graphic illustration of stratigraphic sections in a cross-section across facies and thickness trends of Bug Creek Group, northwest (section PU-6-78) to southeast (section PU-30-76). Note extent of Richardson Mountains Formation southward beyond limits of older Jurassic formations. Line of section D-K shown on Figure 6.

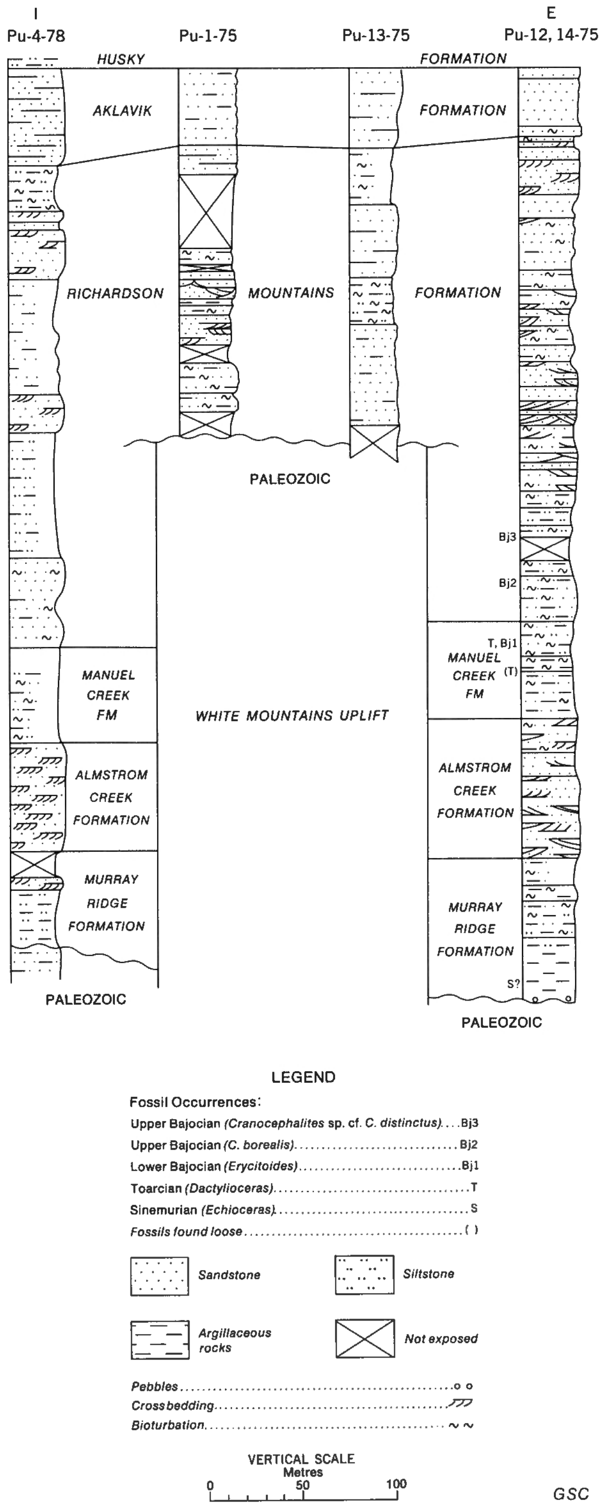


FIGURE 11. *Graphic illustration of stratigraphic sections in a cross-section of Bug Creek Group from southwest (section PU-4-78) to northeast (section PU-12, 14-75), illustrating the absence of older Jurassic rocks over White Mountains Uplift. Line of section I-E shown on Figure 6.*

The Bug Creek Group is overlain in most of the northern Richardson Mountains by Upper Jurassic and Lower Cretaceous shale and siltstone with minor sandstone beds, the Husky Formation (Jeletzky, 1967). The contact of the Husky with the Aklavik Formation is only locally well exposed. It is generally abrupt, with minor thin sandstone beds near the base of the Husky, such as are well seen in section PU-20-76 (Appendix 1), probably a result of reworking of the uppermost Bug Creek sands during the transgression. The presence of Cardioceras or Amoeboceras sp. in the lower part of the Husky Formation at Martin Creek (listed as Cardioceras by Poulton, 1978d, GSC locality 93596) precludes the possibility of a long hiatus between the time of its deposition and that of the underlying Bug Creek Group there. Nearly everywhere else, Buchia concentrica (Sowerby) is the next younger diagnostic fossil in the Husky Formation, first appearing from 16 to 60 m above its base from place to place. This indicates a Late Oxfordian to Early Kimmeridgian age (Jeletzky, 1967).

The Husky Formation just south of McDougall Pass (section PU-9-75; Fig. 10) is underlain by sandstone with possibly Middle Jurassic ammonites, belemnites, and Inoceramus, which led Poulton and Callomon (1976) to suggest pre-Late Oxfordian, i.e. pre-Husky, erosion. These sandstones resemble the Richardson Mountains Formation, with which they are identified, and the absence of the Aklavik Formation in this anomalously thin succession, in contrast to its presence both north and south, may indicate pre-Husky erosion over a localized high. The paleontologically unsupported suggestion that the overlying Husky Formation here contains beds as old as Callovian (Jeletzky, 1980, p. 8) seems unlikely because this would involve a sand to shale facies change in the inferred source direction to the southeast.

West of the report-area argillaceous rocks equivalent to the Husky Formation overlie older Jurassic Kingak shales directly, and form part of the Kingak Formation. Norris (in press) has mapped the shale unit above the Aklavik Formation but below the Porcupine River, as part of the Kingak Formation in much of the northern Richardson Mountains also, and additionally in places has assigned all of the units between the Almstrom Creek and the Porcupine River Formations south and west of White Mountains to the Kingak Formation.

The informal Hauterivian and Barremian "upper shale-siltstone division" of Jeletzky (1958b), rests unconformably on older rocks of varying ages throughout much of the northern Yukon (Norris, 1975a). It rests directly on the Bug Creek Group in a small area west of White Mountains where the Bug Creek Group is abnormally thin (section PU-32-76; Figs. 8, 15, 16).

Murray Ridge Formation (new name)

Definition, distribution and description

The name Murray Ridge Formation is proposed to replace the grey siltstone member of Jeletzky (1967), and also includes his basal sandstone member at its base. It is widespread in the northernmost Richardson Mountains, where, except for the resistant basal sandstone, it commonly forms a recessive interval offering only limited exposure. The basal sandstone is named here as a distinct member, the Scho Creek Member that is localized in the southeastern area of outcrop of the formation.

The type section is on the western face of the north part of Murray Ridge (section PU-9-76; 68°01'45"N Lat., 136°26'30"W Long., approx., see Fig. 6), where the formation is typical lithologically and, together with its upper and lower contacts, is well exposed. Here, as also at nearby section PU-12-75 on the southern part of Murray Ridge (see Figs. 6, 7), and to the north at Canoe Lake (section PU-6, 10-75), the basal 1 m of the formation is ferruginous

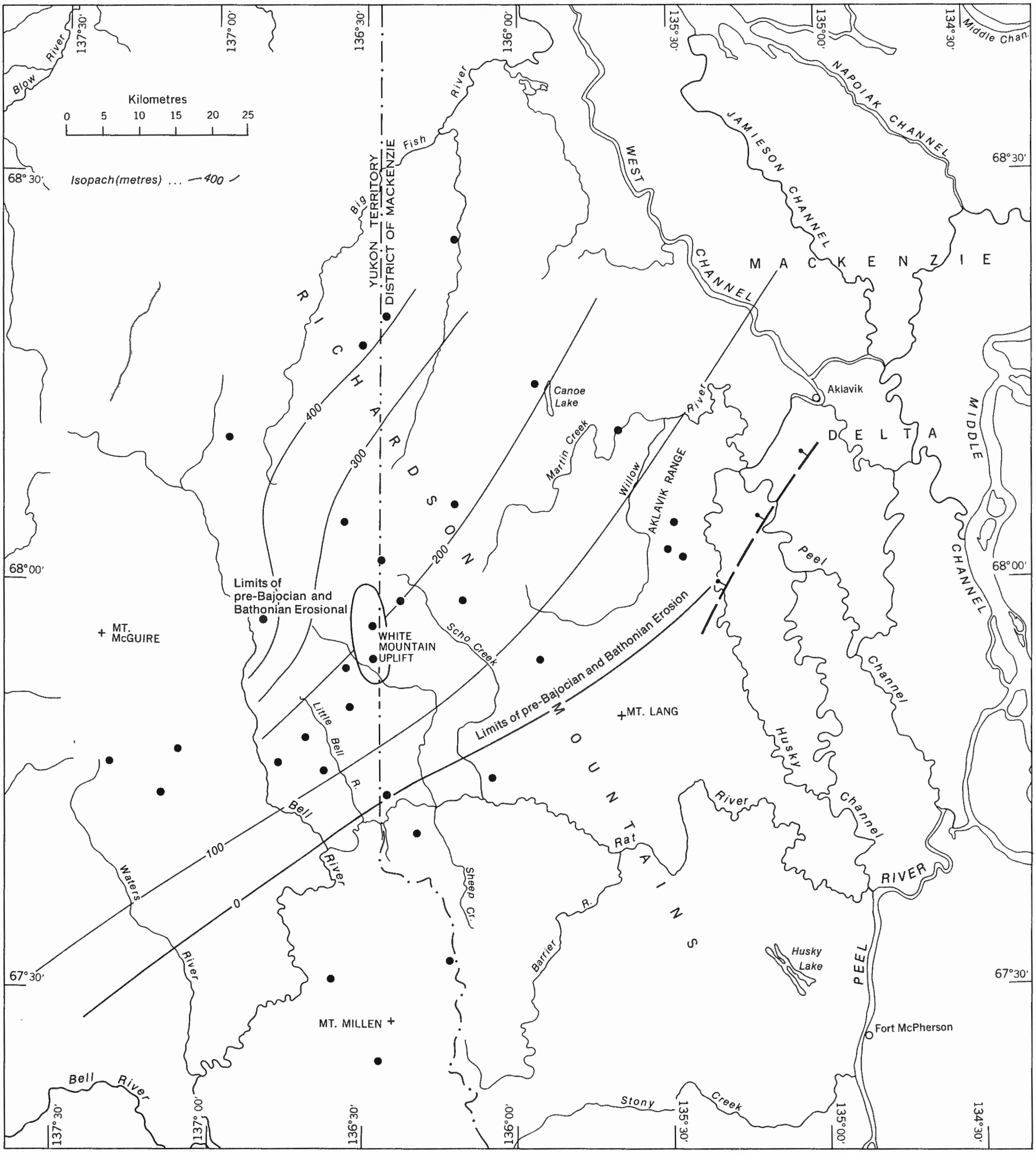
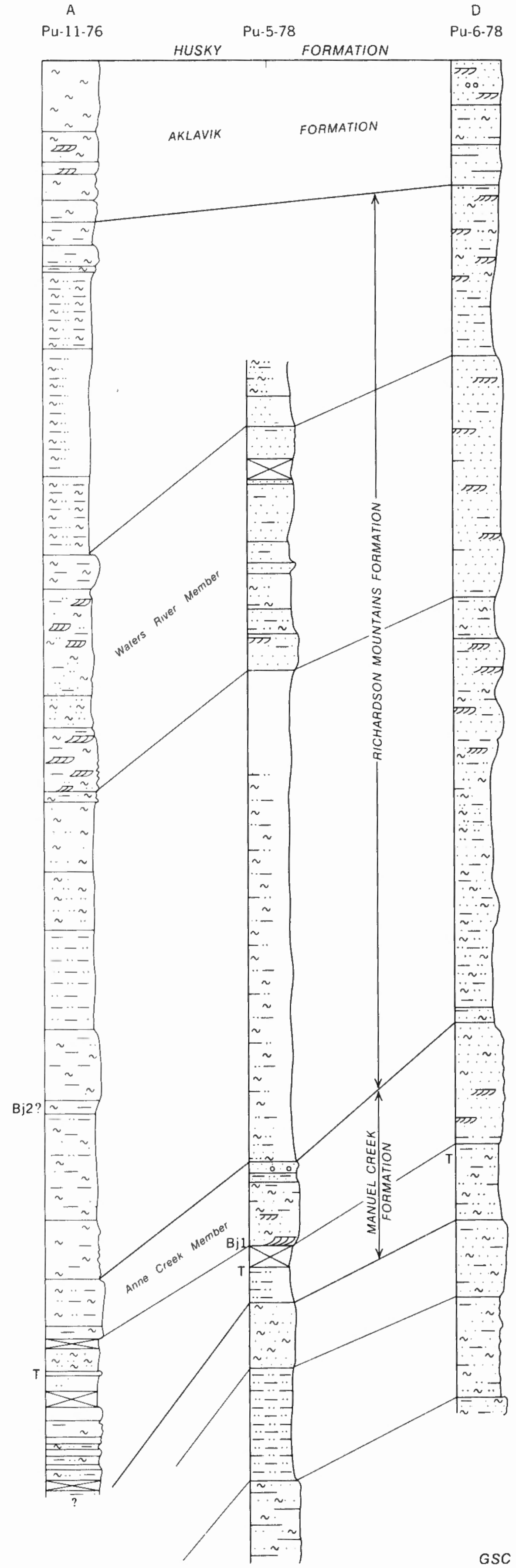


FIGURE 12. *Isopachs of the lower formations of the Bug Creek Group, those that underlie the Richardson Mountains Formation.*



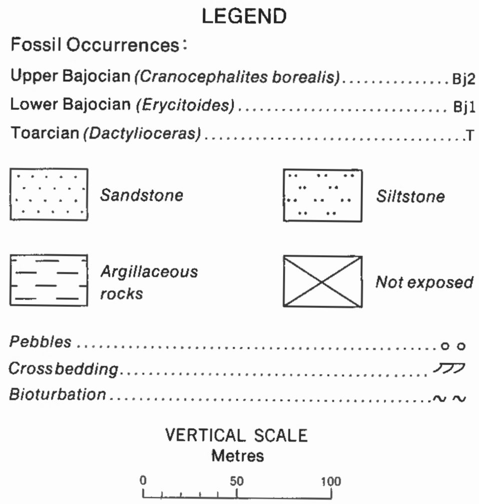


FIGURE 13. *Graphic illustration of stratigraphic sections and correlations of Bug Creek Group in the vicinity of the head of Waters River and Anne Creek. Note the greatly thickened Richardson Mountains Formation relative to its thickness in all localities to the east, as well as the presence of a significant Early Bajocian sandstone unit, the Anne Creek Member, and the questionable character of the correlation of lower units of the section with those established to the east. Line of section A-D shown on Figure 6.*

mudstone which is locally richly fossiliferous and contains pebbles of black argillite and chert. In these localities, the contact with underlying Permian rocks is sharp and paraconformable. At Murray Ridge, the lower part of the formation, above the basal 1 m, varies to soft, black, fissile shale, with hard, red-weathering, siliceous nodules that commonly contain poorly preserved fossils, including Echioceras(?) or Arietites(?), Gryphaea, and Entolium. Higher parts of the formation here are slightly more resistant due to a greater silt content and discontinuous bands of concretions which impart a faint banding to the unit. In the upper part of the formation banded sandstone interbeds occur (Fig. 17) so that the contact with the overlying Almstrom Creek Formation is gradational. It is placed for mapping purposes where the sandstones begin to form resistant bluffs.

In the Aklavik Range (sections PU-7-75, PU-2, 26-76, PU-12-76), except for the basal Scho Creek Member, the Murray Ridge Formation is predominantly poorly consolidated shale, argillaceous siltstone and fine-grained sandstone. As at Murray Ridge, the lower part is softer, contains less silt, and is less abundantly bioturbated than the upper part. Minor, better consolidated beds create an indistinctly banded appearance in the upper part at some localities (e.g. Plate 11, fig. 2). Fossils, mainly Echioceras and 'Pentacrinus' while scattered sparsely throughout the unit, occur more frequently in the slightly harder beds. In these beds, and in the isolated, or more-or-less continuous bands of ferruginous, siliceous nodules that occur here and there, whatever original bedding there was can be seen to have been nearly completely destroyed by fine intensive bioturbation, although small lenses preserving fine lamination and small-scale crossbedding occur here and there. Certain hard, red-weathering beds (e.g. unit 5 of section PU-22-76) have abundant rip-up clasts of ferruginous siltstone indicating penecontemporaneous reworking of early-cemented sediments. The upper parts of the formation in Aklavik Range are less strongly carbonaceous and less stained with jarosite than they are in the Murray Ridge localities.

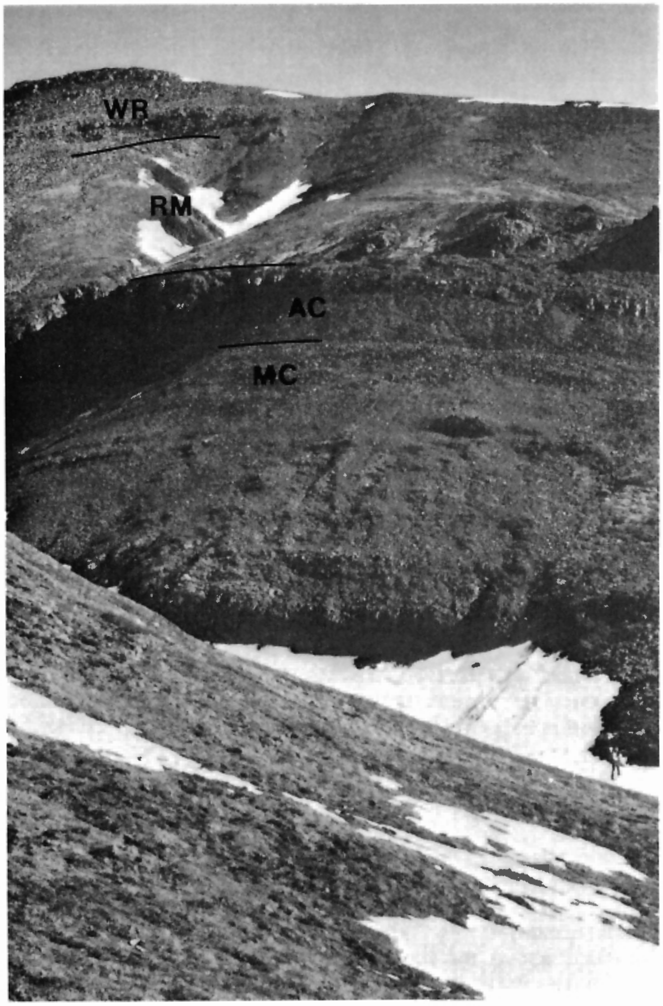


FIGURE 14. *Early Bajocian and older beds up to Bathonian beds near head of Waters River, units 4 to 11, section PU-6-78. MC=Manuel Creek Formation (lower part); AC=Anne Creek Member; RM=Richardson Mountains Formation (lower part); WR=Waters River Member. ISPG Photo 1202-I.*

The lower contact in the Aklavik Range is described below under the description of the Scho Creek Member. The upper contact is variable, being either gradational with the overlying Almstrom Creek Formation (e.g. section PU-12-76 at Jurassic Butte), in sharp and possibly erosional contact with it (e.g. section PU-7-75 at Bug Creek), or in paraconformable contact with the Richardson Mountains Formation. East of Jurassic Butte (section PU-2, 26-76) and west-southwest from there (section PU-22-76), Middle Jurassic erosion has cut into the Murray Ridge Formation down to one or another of the hard, ferruginous beds within it (Fig. 33).

This formation is essentially the same in thickness and lithology in the northwesternmost localities studied (sections PU-19-76; PU-1-78). No coarse clastic lithologies occur in this formation north of White Mountains (section PU-27-76) where argillaceous rocks directly and abruptly overlie Permian rocks. Basal pebbly sandstone beds, as thick as 9 m at one locality (section PU-1-78) closely resemble the Scho Creek Member which occupies the same stratigraphic position to the southeast, but are geographically separated from it (Fig. 6), and are probably not part of the same depositional unit. The upper contact of the formation in these northwestern localities, as at Murray Ridge, is located at the base of bluff-forming sandstones in a gradational succession.

The Murray Ridge Formation is identified south of White Mountains (e.g. section PU-4-78) by its stratigraphic position and lithology.

The Murray Ridge Formation thickens from 30 m in the Aklavik Range to 80 m more or less at Murray Ridge and north of White Mountains (see Fig. 6), where the thickness can be measured accurately. Elsewhere, the thickness is uncertain because of its burial beneath talus of the overlying Almstrom Creek Formation, and the unit is absent at some surface localities where faulting has juxtaposed older and younger units. For these reasons, original depositional thickness trends over the entire region cannot be determined confidently. However, gradual westerly or northwesterly thickening of a blanket-like unit would fit the available data (see Fig. 18).

Scho Creek Member (new name)

The Scho Creek Member is restricted to the east-central part of the northern Richardson Mountains (Fig. 18), where it varies in thickness from 3 m at Bug Creek to 24 m near the head of Scho Creek. Jeletzky's (1967) estimation of the thickness of this member at Bug Creek was shown by Poulton and Callomon (1976) to be too great; repeated measurement of beds was apparently due to partially obscured slumping. This section, designated by Jeletzky (1967) as the type section of the Bug Creek Formation, serves as the type section for the Scho Creek Member (section PU-7-75; 68°04'30"N Lat., 135°28'20"W Long., approx.).

At the type section on the eastern side of Aklavik Range, the Scho Creek Member is mainly fine to medium grained sandstone, with minor thin argillaceous interbeds. Bedding is commonly indistinct and irregular, as a result of intensive bioturbation of an originally laminated and low-angle crossbedded sediment. Poorly to moderately well rounded pebbles, as large as 2.5 cm, mainly of black or grey chert or siliceous argillite, occur in small lenses or trains. Boulders of the underlying rocks were incorporated as lag in the basal beds which are in sharp contact with the immediately underlying Permian beds that contain Zoophycos. The contact with overlying argillaceous siltstones of the Murray Ridge Formation is more or less abrupt.

The sand fraction at Bug Creek is dominated by clear quartz and there is as much as 45 per cent (estimated) chert (Fig. 19). Feldspar and polycrystalline quartz form less than one per cent of the sand fraction; accessory detrital minerals, primarily zircon with rounded surfaces, are rare (2 samples examined in thin section: GSC loc. C-80876 and C-76370). The sandstones locally contain abundant glauconite and phosphate pellets, and are commonly rich in limonite. Quartz, and minor calcite and dolomite cement varies from pervasive to nearly absent. Ferruginous, siliceous, and phosphatic concretions are present from place to place. Marine fossils occur scattered throughout some beds, and are richly concentrated, together with reworked phosphatic nodules, in the uppermost ones.

No fossils were found in the Scho Creek Member at Jurassic Butte (section PU-12-76) where the contact with Permian rocks of similar lithology is tentatively placed within a conglomeratic sandstone sequence at a contact with angular relationships that may represent the unconformity

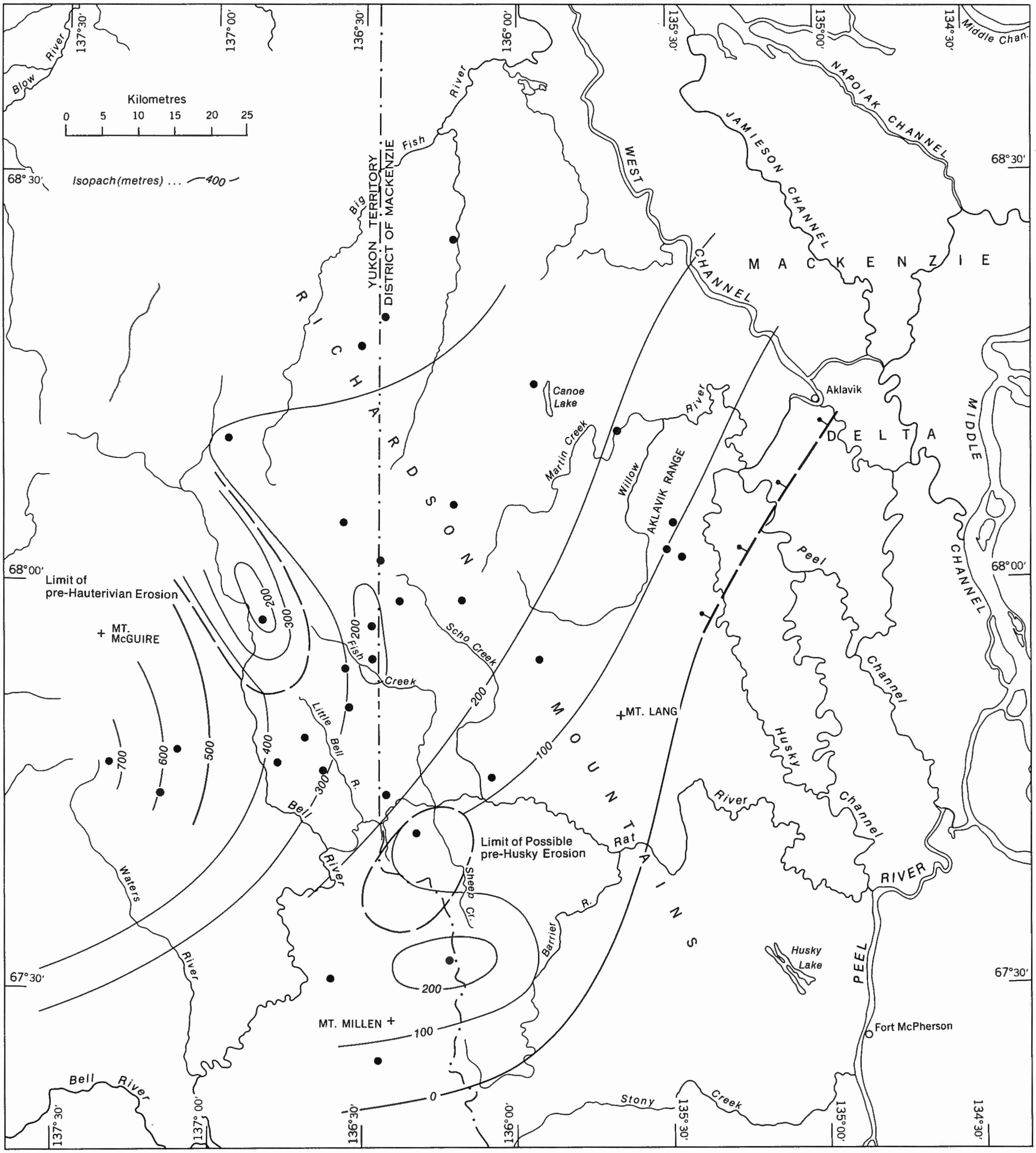
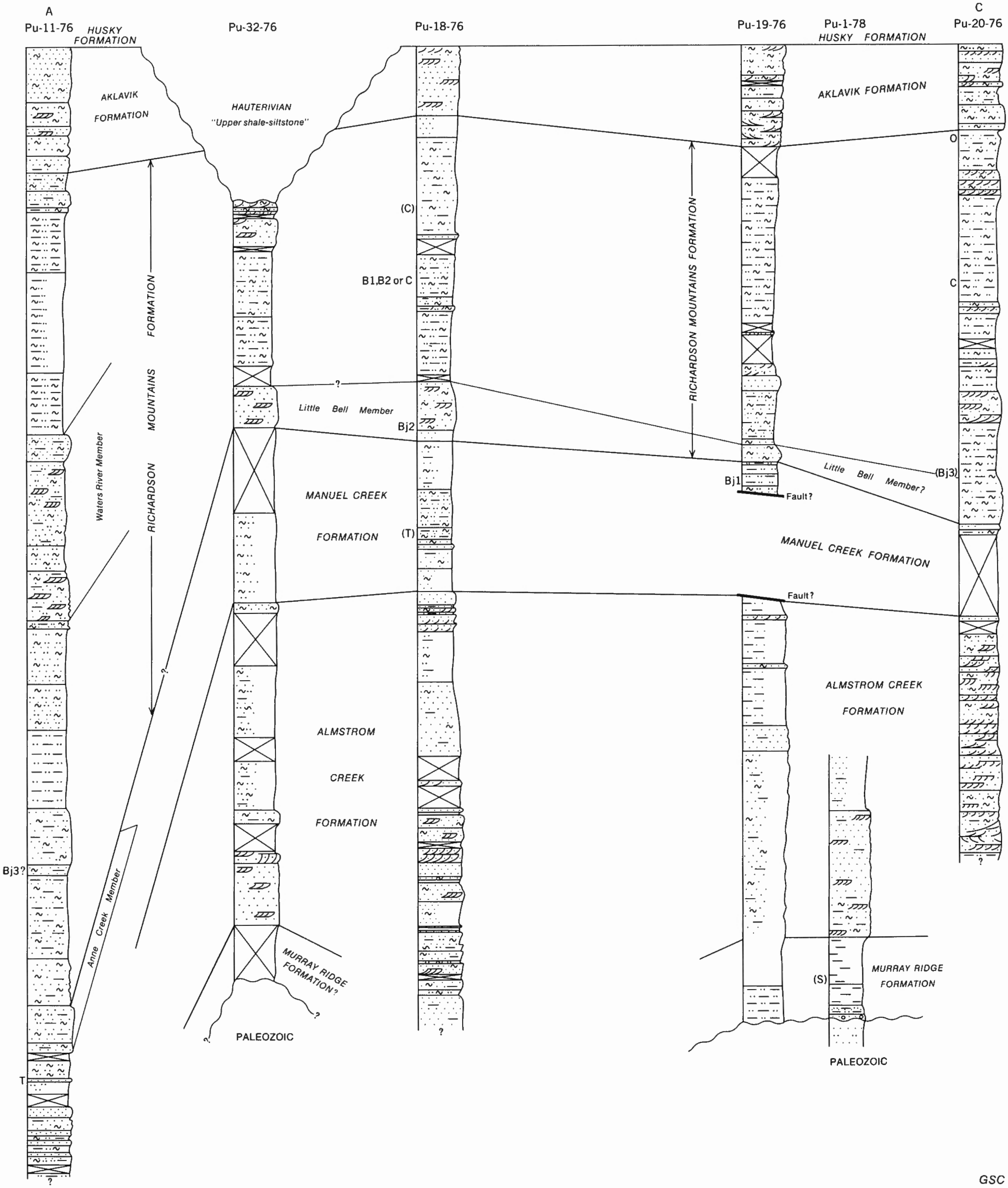


FIGURE 15. *Isopachs of upper subdivisions of Bug Creek Group, that is, the Richardson Mountains and Aklavik Formations.*


A
Pu-11-76
HUSKY FORMATION
Pu-32-76
Pu-18-76
Pu-19-76
Pu-1-78
HUSKY FORMATION
C
Pu-20-76
AKLAVIK FORMATION
HAUTERIVIAN
"Upper shale-siltstone"
AKLAVIK FORMATION
RICHARDSON MOUNTAINS FORMATION
RICHARDSON MOUNTAINS FORMATION
(C)
B1,B2 or C
Little Bell Member
Bj2
Waters River Member
MANUEL CREEK FORMATION
(T)
Bj1
Fault?
Little Bell Member?
(Bj3)
MANUEL CREEK FORMATION
Fault?
O
C
ALMSTROM CREEK FORMATION
ALMSTROM CREEK FORMATION
Bj3?
Anne Creek Member
MURRAY RIDGE FORMATION?
PALEOZOIC
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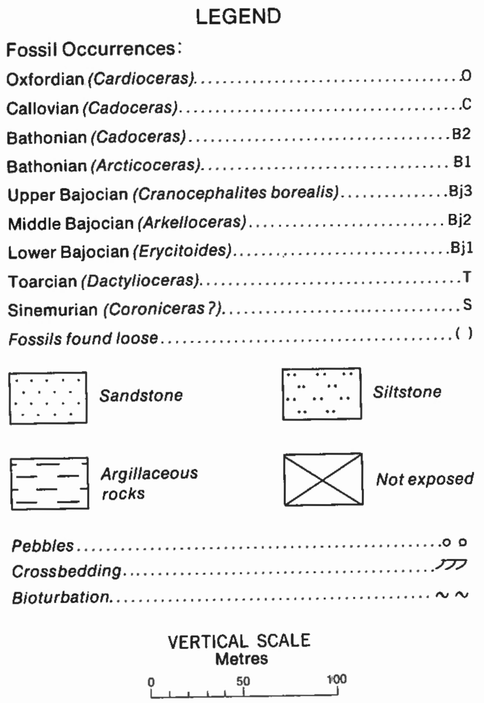


FIGURE 16. Graphic illustration of stratigraphic sections in a basinward cross-section oriented along facies and thickness trends of Bug Creek Group, southwest (section PU-11-76) to northeast (section PU-20-76). Note the extreme thickening of the Richardson Mountains Formation in the southwesternmost section. Line of section A-C shown on Figure 6.

(Plate 10, fig. 5 and Plate 11, fig. 2; Poulton in Nassichuk et al., 1978). The contrast in thickness and fossil content between here and the section on the spur just to the east (section PU-2, 26-76), together with the locally obvious angularity at the Paleozoic-Jurassic contact throughout Aklavik Range, and the variation in the underlying units, are related partly to relief on the sub-Jurassic erosional surface and partly to nearness of the depositional edge. Near the head of Scho Creek to the west-southwest (section PU-22-76), marine fossils occur only in the lower beds of this member and they are less diverse than the assemblage in Aklavik Range. Fluvial beds with strong crossbedding, abundant conglomeratic lenses and laminae may possibly be present above these basal marine beds at the head of Scho Creek. Both Jeletzky's (1967, p. 15, 158) conglomerate and basal sandstone members are taken to represent the Scho Creek Member in the section (155a) he described between Jurassic Butte and the head of Scho Creek.

Age and paleontology

The Murray Ridge Formation is Late, and possibly also Early, Sinemurian.

Oxynoticeras oxynotum (Quenstedt) from the Scho Creek Member near Jurassic Butte has been identified and dated as Late Sinemurian Oxynotum Zone by Frebold (1960, p. 26). Other elements of this fauna, which occur in the vicinities of Bug Creek and Jurassic Butte (GSC locs. 25762, 25763, 25765, 26973, 26975, 26978, 94027, 94091, C-4232, C-80305) include the ammonites Arctoasteroceras jeletzkyi Frebold and Gleviceras sp., and a rich and varied assemblage of bivalves, brachiopods, gastropods, and other fossils (see Frebold, 1960; 1975, p. 17). Ager and Westermann (1963, p. 602-604) listed also "Phylloceras" (Partschiceras? sp.), Rimirhynchia anglica (Rollier), Hastites? sp., "Turbo" sp., Oxytoma cf. inaequivalvis (Sowerby), Pholadomya sp. aff. P. ambigua Sowerby, Nuculana (Dacryomya) cf. N. compalana (Dunker and Koch), Lima (Plagiostoma?) sp., Inoceramus(?) sp., Pleuromya cf. unioides (Agassiz), "Onychites" sp., and Serpula cf. S. tetragona Quenstedt. Their identification of Inoceramus(?) sp. is almost certainly erroneous, since that genus is not known elsewhere in the North American Arctic from beds older than Toarcian. Also, the locality from which these fossils came may be erroneously documented, like that from which Frebold (1975, p. 3, GSC loc. 88066) reported A. jeletzkyi (see later section on "Notes on tectonic elements"). The low-diversity assemblage of bivalves near the head of Scho Creek (GSC loc. 94163) is not diagnostic biostratigraphically.

The overlying, recessive argillaceous beds of the Murray Ridge Formation at Bug Creek contain Echioceras aklavikense Frebold (1975, p. 9) which was dated (Frebold, 1960, p. 26) as late Sinemurian, Raricostatum Zone. Echioceras sp. cf. E. arcticum Frebold was recently identified from the same locality (GSC loc. 92582). Macrofossil localities in this area and at nearby Jurassic Butte are GSC localities 25756, 26974, 26976, 26977, 94027, 94090 and C-80309.

Other localities where Echioceras and Echioceras(?) or Arietites(?) have been collected are near the head of Scho Creek (GSC locality 94169) and at Murray Ridge (GSC locs. 94055, 92602). The poorly preserved specimen previously identified as Arietites sensu lato gen. et sp. indet. by Frebold (1960) [= Vermiceras sp. of C.R. Stelck according to Jeletzky (1967, p. 169)] from near the head of Fish Creek (i.e. at Murray Ridge) may be Echioceras (Frebold, pers. comm., 1976) and is presumed to come from near the same locality as GSC loc. 92602. Another specimen found between Big Fish River and Little Fish Creek (GSC loc. C-53357 of section PU-1-78) was identified by H. Frebold as Coroniceras(?), for which an early Sinemurian age is indicated.

Other macrofossils in the Murray Ridge Formation include ubiquitous but nowhere very common Pentacrinus, Gryphaea(?) and other unstudied bivalves in the western localities.

FIGURE 17. Upper part of Murray Ridge Formation (MR), with banded sandstone, forming gradational boundary with overlying Almstrom Creek Formation (AC), unit 4a, near section PU-12, 14-75, Murray Ridge. ISPG Photo 1217-1.

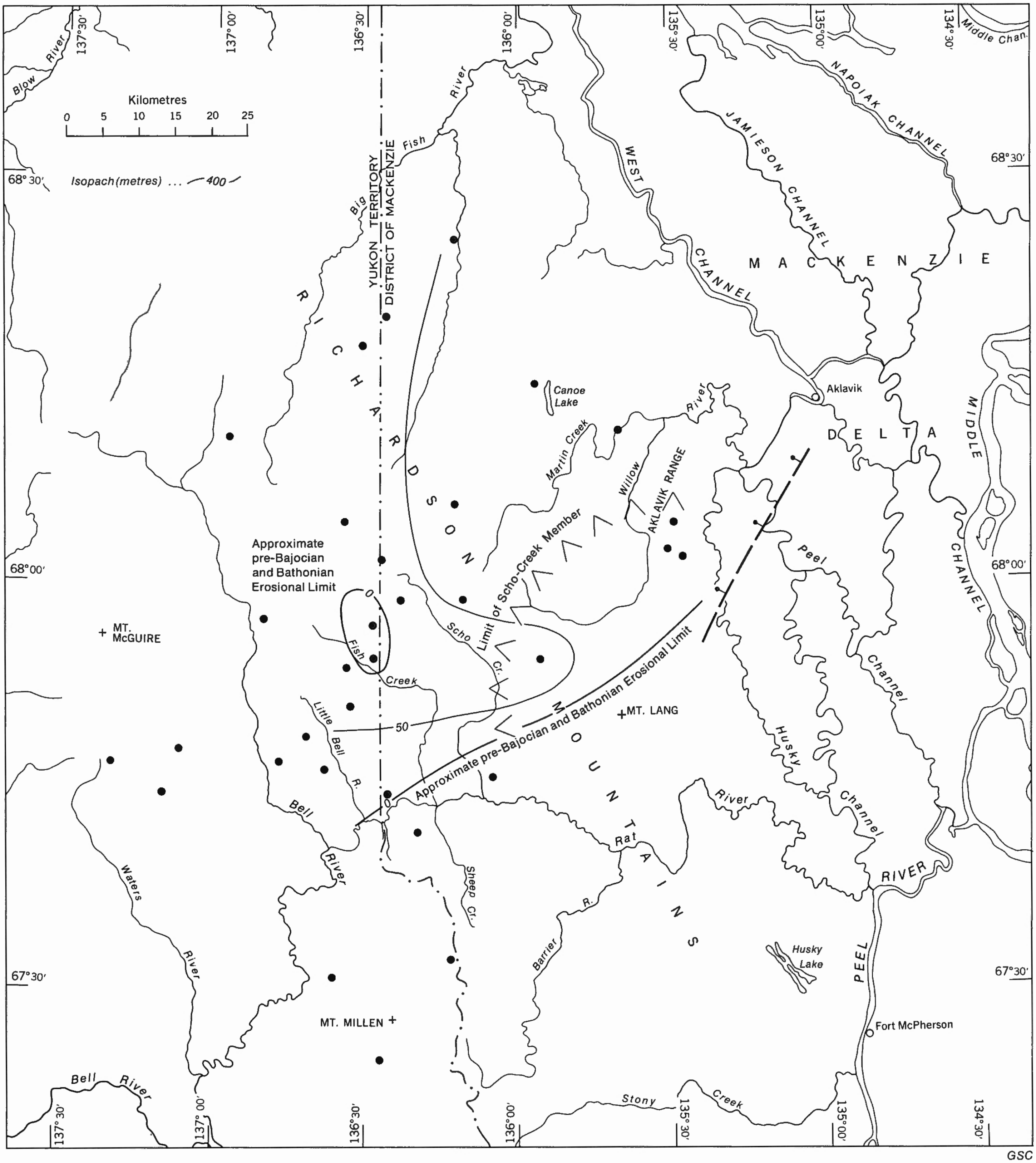


FIGURE 18. *Thickness of Murray Ridge Formation and distribution of Scho Creek Member.*

The basal thin pebbly mudstone near Canoe Lake (GSC locs. 94058, C-65041) has yielded a varied assemblage of bivalves and gastropods and that at Murray Ridge (GSC locs. 94053, 94194) contains a varied fauna of "Pentacrinus", bivalves and gastropods. The basal pebbly beds between Big Fish River and Little Fish Creek (section PU-1-78) contain Gryphaea, Entolium, Aequipecten(?) and gastropods, all yet to be studied. Ferruginous concretions rich in small Corbula(?) are common at Murray Ridge and localities northwest from there.

The Foraminifera from the Murray Ridge Formation (sections PU-2, 26-76, PU-9-76 and PU-22-76) which constitute Assemblage A (Tables 2-4) are dominated by agglutinated forms. Only two species, Ammobaculites sp. 4925 (Plate 4, fig. 9) and Trochammina sp. 5267 (Plate 5, figs. 4-5), appear to be restricted to the unit. The long chronostratigraphic ranges of the genera and the provinciality of the species recovered preclude determination of the age of the formation by means of foraminifera.

Samples from near the head of Willow River (section PU-22-76) yielded spores and pollen with possibly some microplankton (Table 3). Most of the identifiable palynomorphs have ranges which extend throughout the Jurassic, only one species, Contingnisporites dunrobinensis having a more limited range, lower to middle Jurassic. This is true also of the formation on the spur east of Jurassic Butte, where no dinoflagellates were found (section PU-2, 26-76; Table 2). Classopollis is common in the upper part of section PU-22-76, as it is also in the Almstrom Creek Formation at Almstrom Creek (Table 5).

Samples from the Murray Ridge Formation north of White Mountains (section PU-27-76) are strongly carbonized and the preservation of the palynomorphs is extremely poor. Only minor bisaccate (e.g. Podocarpus sp.) and reworked Mississippian spores (e.g. Densosporites, Reticulatisporites) were recognized.

If the inferred model of an easterly or southeasterly transgressing sea and a subsequent westerly or northwesterly prograding clastic wedge is correct, the lower part of this unit would be expected to be progressively younger to the east and the upper part progressively younger to the west; the meagre fossil data available are not sufficient to confirm or negate this suggestion.

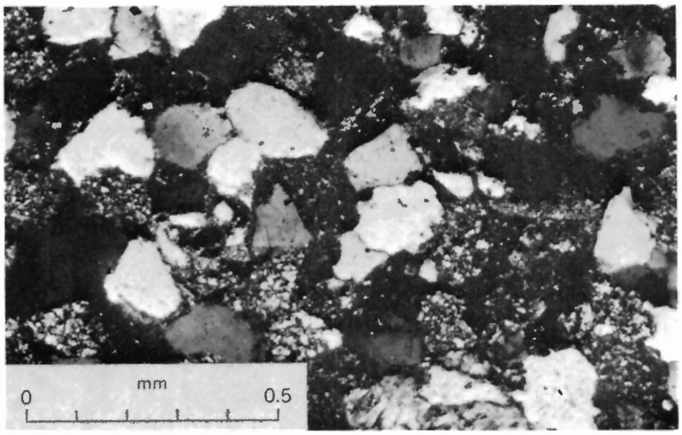


***FIGURE 19.** Photomicrograph, X-nicols, sandstone from Scho Creek Member at Bug Creek, GSC loc. C-80876 from section PU-7-75; showing high chert and siltstone content, undulating extinction in quartz and interstitial grains of limonite. ISPG Photo 1264-11. Scale in millimetres.*

Depositional environments

The localization of the Scho Creek Member to Jurassic Butte-Willow River area was controlled by probable minor faulting along the edge of the Peel Landmass. The unit varies from a thin marine basal transgressive sandstone, to somewhat thicker nearshore and, in part, possibly fluvial or fan-type sandstone. The source of the coarse clastic material, dominantly chert, is presumed to have been the adjacent late Paleozoic rocks in and south of Aklavik Range. All of those chert pebbles, and the minor conglomerate pebbles which contain red chert clasts, in the unit at Jurassic Butte could well be reworked from the similar underlying Permian(?) conglomerate, which was itself presumably locally derived from the subjacent Road River Formation. This is probably not true of the minor feldspar and polycrystalline quartz content, perhaps products of a more distant source. The basal metre of the Murray Ridge Formation to the north and west where the Scho Creek Member is absent, consists of clastic material that was essentially entirely reworked from underlying rocks. The fauna of gastropods, "Pentacrinus" columnals, Gryphaea, and a limited variety of other bivalves and brachiopods, probably represents a mixture and concentration of littoral elements of the basal transgressive environment, and shells reworked from the adjacent offshore environment by storm activity, at least in part.

The marine faunas and argillaceous character of the Murray Ridge Formation, except for the Scho Creek Member, are of open-marine environment. Subtle eastward coarsening of the main argillaceous part of the Murray Ridge Formation coincides with the equally subtle thinning trend in that direction (Fig. 18). The roughly uniform thickness of this unit regionally indicates that there was little relief on the pre-Jurassic erosional surface, except in the Aklavik Range. In addition to the poorly sorted textures, articulated crinoid stalks as long as 0.6 m attest to the absence of significant agitation, and deposition of the formation below the regime of wave or tidal influence. It is likely that those bivalves and ammonites which occur singly or in small groups in the middle parts of the unit are preserved essentially in their living habitats.

As silt and sand increase upward in the succession, so also do the effects of bioturbation, reflected in a rubbly weathering character in the upper part of the formation, in contrast to the fissile or chippy character of the lower part. Upward shallowing is indicated. This succession is similar to those described off Holocene deltas (e.g. Coleman, 1976), and a similar coarsening and shallowing-upward succession should presumably be found wherever coarse clastic sediments prograde over finer sediments, whether they are transported by fluvio-deltaic, or entirely marine mechanisms. The upper coarser clastic portion of this model is the Almstrom Creek Formation, which carries many of the same fossils as does the Murray Ridge Formation and consists of marine sands. Shallowing in the succession is further indicated by the abundance of current bedding in the uppermost part of the Murray Ridge and in the Almstrom Creek Formation; progradation is indicated by the increase in grain size upward. Progradation cannot be further documented because of insufficient fossil control that would indicate a time-transgressive boundary between the two formations.

The microfossil content is consistent with an interpretation of lower shoreface to offshore open marine conditions, with introduction of terrestrial spores and pollen.

Almstrom Creek Formation (new name)

Definition, distribution and description

The name Almstrom Creek Formation is proposed for a commonly glauconitic, fine grained sandstone unit that forms many of the banded bluffs and ridges in the Richardson Mountains north of approximately 68°N latitude. This formation near its southeastern pinchout edge was included, together with part of the unconformably overlying Richardson Mountains Formation, in Jeletzky's (1967) Intermediate sandstone member at Bug Creek (his units 11 and 12, p. 90).

The type section for this formation is at Murray Ridge (section PU-12, 14-75; 67°58'30"N Lat., 136°22'30"W Long.; see Figs. 6, 7), where the unit and its upper and lower contacts are well exposed. The lower contact is arbitrarily placed on the basis of resistance to weathering, for mapping purposes, in a gradational succession where bluff-forming sandstones lie above less resistant beds of the predominantly argillaceous, underlying Murray Ridge Formation (see Fig. 17). The upper contact, with the recessive Manuel Creek Formation is abrupt, although a few thin sandstone beds occur at the base of that formation. Particularly good exposures of a thicker section of this formation are at the confluence of Little Fish Creek and Almstrom Creek for which the formation is named (section PU-20-76; see Fig. 6), and west of the head of Big Fish River (section PU-18-76), although its lower contact is not exposed in either location, and the upper contact is not exposed in the former.

At Murray Ridge, (sections PU-12, 14-15; PU-9-76), the Almstrom Creek Formation is subdivisible into lower, middle and upper parts. The lower and upper parts form resistant bluffs that are distinctly banded due to the presence of red- or brown-weathering ferruginous, concretionary lenses and discontinuous bands in an otherwise grey or greenish-grey sandstone. The middle part is less resistant and less distinctive. Whereas scattered oysters characterize the upper part of the formation, the presence of bedding surfaces littered with Lingula distinguishes the lower part. Neither are abundant however. The relative distributions of oysters in the upper part, and Lingula, as well as a limited but varied bivalve fauna, including Myophoria sp. aff. M. lingonensis (Dumortier), Pholadomya, Oxytoma, and "Pentacrinus" in the lower part, characterize the Almstrom Creek Formation as far north as its northernmost occurrence in outcrop (section PU-20-76), suggesting a widespread, but crude subdivision of the formation. However, oysters have not been found in the sections farther west (sections PU-18-76 and PU-19-76).

Low-angle crossbedding, trough crossbedding and channelling are conspicuous features of the Almstrom Creek Formation, as are ripples locally, and vertical and horizontal burrows and other bioturbation structures. Interbedding of laminated or crossbedded and bioturbated sandstones are characteristic (e.g. Fig. 20) and crossbedded to bioturbated cycles are common locally. A great variety of trails on bedding surfaces, and of inorganic shallow marine sedimentary structures can be found at nearly any locality. Chondrites is characteristic sporadically, but is uncommon in the other formations of the Bug Creek Group. Small-scale scouring and trough crossbedding occur in the lower part of the unit wherever it is exposed.

Locally (e.g. sections PU-7-75; PU-7-76; PU-9-76; PU-27-76; and PU-19-76) the lowest beds of the formation contain red-weathering ferruginous siltstone or mudstone pods and lenses, and have pockets or laminae of Corbula(?), and various other small bivalves, and "Pentacrinus" columnals. In part, the local presence or absence of this ferruginous interval, of these concentrations of fossils, and of local phosphatic concretions, are probably related to erosion and reworking of the underlying Murray Ridge Formation. In other localities, the contact between the two formations is clearly gradational and similar faunas occur well up in the Almstrom Creek Formation, indicating the short duration and local character of any hiatus.

Large-scale crossbedding is rare or absent to the west (sections PU-18 and 19-76), particularly in the upper parts of the formation, where planar-laminated, burrowed, intensely bioturbated or apparently structureless beds prevail. In these same western sections, fossiliferous concretions with phosphatic cores occur low in the unit, whereas they were not seen in the eastern localities. These western localities, furthermore, exhibit a lesser quantity of otherwise very abundant glauconite, and are instead characterized by particularly hard, pervasive, quartz cementation. This last feature, together with abundant limonite, rusty-weathering, and massive, blocky character also are typical of the unit south of White Mountains (sections PU-4-78; PU-7-76; and PU-21-76).

The Almstrom Creek Formation is recognized lithologically in the southwestern part of the northern Richardsons between Berry Creek and Waters River. It probably is represented by the sandstone unit with

FIGURE 20. *Thinly interbedded laminated or crossbedded sandstone and bioturbated sandstone between thick, indistinctly crossbedded sandstone beds which show small-scale scouring: lower part of unit 6; section PU-20-76; Almstrom Creek Formation. ISPG Photo 1225-13.*

ferruginous siltstone "inclusions" and bands, with Lingula, described by Jeletzky (1972b, p. 38, unit 8). However, it has not been confidently identified in the somewhat different, less easily subdivisible succession between Mt. McGuire and the head of Waters River (see Figs. 6, 13). The formation is now also recognized in the section at the northeastern major bend of Porcupine River (67°25'N, 137°45'W; see Fig. 6) although it had not been distinguished by Poulton and Callomon (1976, sec. 5; Poulton, 1978d, Fig. 2). It has also been recognized beyond there again to the west in Old Crow Flats, at least as far southwest as Lat. 67°24'N, Long. 138°28'W (e.g. GSC locs. C-53458, 88278) where Amaltheus(?) and Lingula occur (Poulton, 1978d).

The detrital sand fraction in the Aklavik Range and Canoe Lake area is well sorted but exhibits poor rounding and sphericity (Fig. 21). It is dominated by clear quartz, but chert and argillite, polycrystalline quartz, siltstone fragments and feldspar together comprise as much as 10 per cent of it (estimated) in some samples (4 samples examined in thin section: GSC locs. 92580a, b; C-80873; C-6129). Detrital mica, zircon and other accessory minerals are rare.

Depositional thickness variations indicate northwestward and westward thickening (Fig. 22). Certain of the thicknesses shown for this formation are minimum partial thicknesses, however, due to removal of lower parts of the unit by erosion (e.g. sections PU-7-75, PU-12-76; see Fig. 6) or by faulting (sections PU-10-76; PU-20-76; PU-18-76); and the poor quality of exposure at other localities (e.g. sections PU-6, 10-75; PU-19-76) precludes precise placement of isopachs.

Age and paleontology

This unit is not yet conclusively dated. Its age is limited by the presence of late Sinemurian fossils in the underlying Murray Ridge Formation and Middle Toarcian fossils in the overlying Manuel Creek Formation. A small, poorly preserved ammonite identified by Poulton (1978d) as Amaltheus(?) occurs with Lingula in an extension of this formation to the southwest in Old Crow Flats and indicates a probable Pliensbachian age there (GSC locs. C-53458, 88278). Macrofossils from this formation in the northern Richardson Mountains that further suggest a Pliensbachian age are:

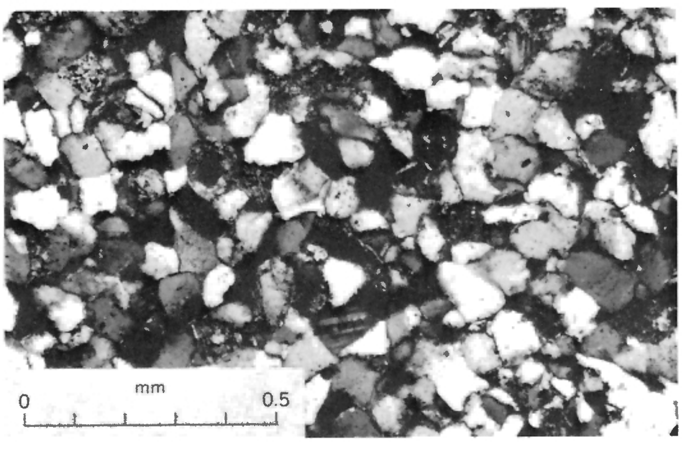


FIGURE 21. *Photomicrograph, X-nicols, sandstone from Almstrom Creek Formation near Canoe Lake, GSC loc. 92580a of section PU-6, 10-75; showing high chert and siltstone, and lesser feldspar content. ISPG Photo 1264-2 scale in millimetres.*

Myophoria sp. aff. M. lingonensis (Dumortier), which occurs in Lower Pliensbachian rocks of east Greenland (Rosenkrantz, 1934, 1942), Pliensbachian rocks of eastern U.S.S.R. (Savel'ev, 1962), and the Pliensbachian Jamesoni through Spinatum Zones of England and France (Lycett, 1872-79); and "Pentacrinus" sp. which occurs in the Pliensbachian rocks of Siberia (Efimova et al., 1968) and is particularly common in the Upper Pliensbachian beds with Amaltheus in northwestern Yukon.

In addition to the fossils named above, the following bivalve genera, whose potential as biostratigraphic correlation tools has not yet been established, have been tentatively identified from the Almstrom Creek Formation: Pholadomya, Oxytoma (Oxytoma) and O. (Palmoxytoma), Corbula(?), Cardinia(?), Chlamys(?), Variamussium(?), Aequipecten(?), Entolium, Meleagrinella, Camptonectes, Pleuromya, Gryphaea, "Ostrea", Isognomon(?), and Modiolus.

The pollen Classopollis is common throughout the formation at Almstrom Creek (section PU-20-76; Table 5) and is the dominant palynomorph in a grab sample from the Almstrom Creek Formation near section PU-19-76 (see Fig. 6). No microplankton was recognized at the last locality, and other palynomorphs identified include Klukisporites spp., Eucommiidites minor, bisaccate pollen, and unidentifiable spores. Eucommiidites minor and Classopollis occur also in the Murray Ridge Formation (Sinemurian) elsewhere (Tables 2-4). A few bisaccate pollen and reworked Mississippian spores occur in the lower part of the formation north of White Mountains (section PU-27-76).

At Almstrom Creek (section PU-20-76; Table 5) Mancodinium semitabulatum occurs relatively abundantly, from GSC loc. C-80277 up to C-80274 which conforms with a Pliensbachian to Toarcian age for this portion of the section. It is joined by Nannoceratopsis sp. in sample GSC loc. C-80274, a form between N. senex and N. pelucida.

The radiolarian Eucyrtidium sp. occurs in abundance in some beds in the upper part of the formation at Almstrom Creek (Table 5). It also occurs in the upper part of the Manuel Creek Formation elsewhere (see Table 4) which is probably Early Bajocian in age, and has also been reported in Bajocian rocks of Alberta (Weihmann, 1964). Tentatively, however, regional correlations make it seem unlikely that rocks as young as Bajocian occur in the upper part of the Almstrom Creek Formation.

Only one species of Foraminifera, and only one specimen of this species, Trochammina sp. 5264, was recovered in the Almstrom Creek Formation, near its base.

Depositional environments

This sandstone formation is a shallow marine shelf deposit with evidence of extensive redistribution of the sand by storm or tidal mechanisms. A model of an extensive subtidal or low intertidal, storm-wave- or tide-dominated, shallow shelf seems particularly applicable. Stacked successions of fining-upward, parallel- or cross-bedded-to-burrowed cycles and laminae of jumbled and broken shell debris and siltstone rip-ups (well exposed and common in section PU-20-76 for example) are particularly suggestive of storm-wave deposition, whose characteristics have been treated recently by Johnson (1978) and Walker (1979). Another recent analogue in which locally abundant Lingula and glauconite suggest particularly close similarities with the Almstrom Creek Formation are the deposits of the Klang River Delta of Malaysia where, however, the fluvial source of sediment is nearby and tidal activity is the dominant agent of

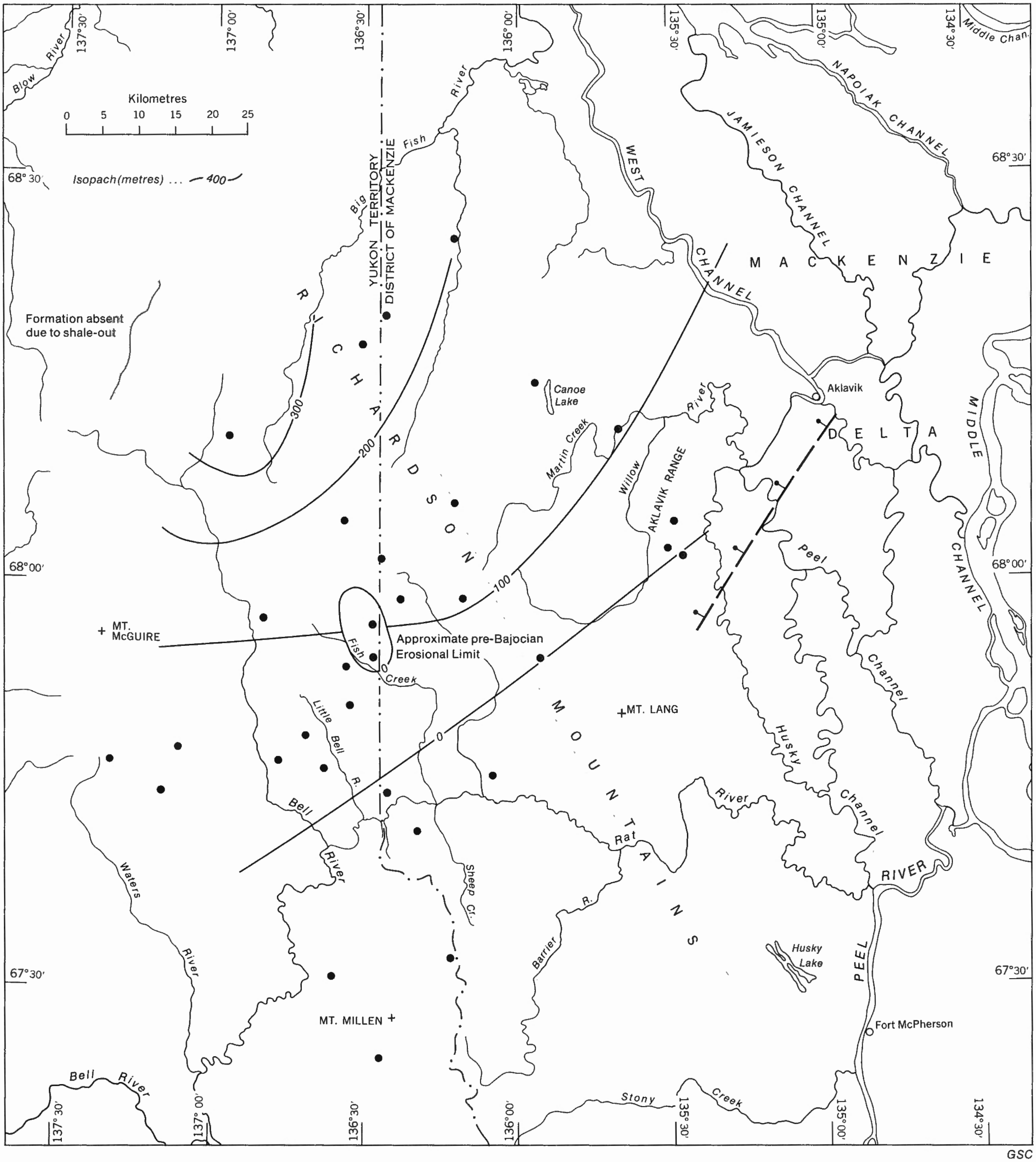


FIGURE 22. *Isopachs of Almstrom Creek Formation. Neither the formation nor its limits are identified with certainty in the vicinity of the head of Waters River.*

sedimentation (Coleman and Wright, 1975). The subtidal shelf sands off the Ord River Delta of northern Australia (Coleman and Wright, 1975, 1978) provide a further Holocene analogue in the large lateral extent of the unit as a whole. No unequivocal evidence of subaerial exposure of the sands in the Almstrom Creek Formation was recognized, and there are few occurrences of herringbone cross-lamination, pin-stripe lamination, or other structures indicative of intertidal deposits, as described by Klein (1977) or other authors (e.g. in Ginsburg, 1975).

Increasing distance and depth of deposition, northwestward from a shoreline is suggested in the Almstrom Creek Formation by: decrease in that direction of the abundance and proportion of cross-stratification in contrast to bioturbation structures; decrease in that direction in the proportion of glauconite; and loss in that direction, in the upper part of the formation, of oysters which were presumably euryhaline. No great water depth was reached however, because the presence of significant proportions of vertical as well as horizontal burrows throughout most of its outcrop area, the predominance of sandstone but presence of relatively thinner, sharply bounded, intervals of argillaceous siltstone that is more thoroughly bioturbated (e.g. Fig. 20), the thickness of most bedding units, and the interbedding of crossbedded or plane-laminated beds with bioturbated beds (e.g. units 6 and 7 of section PU-20-76), conform with the 'lower shoreface' and immediately adjacent paleobiologic regimes as described by Howard (1972), for example.

The scarcity, limited variation, and localized distribution of marine macro- and microfaunas together with the local relative abundance of eurytopic Lingula, oysters, spores and pollen, may suggest near-shore and brackish influence. The presence of oysters but little other macrofauna in the upper part of the formation, in contrast to the limited but relatively more varied marine fauna in the lower part, may indicate gradual progradation of a relatively more brackish facies over a more typically marine facies.

Manuel Creek Formation (new name)

Definition, distribution and description

The name Manuel Creek Formation is proposed for a mainly recessive, dominantly argillaceous unit that is widespread in the Richardson Mountains north of approximately 67°45'N Latitude. Dark grey-black shales, mudstone and siltstone, with thin sandstone interbeds and rusty concretions characterize this unit.

The type section is on the north part of Murray Ridge (section PU-9-76; 68°01'45"N Lat., 136°26'30"W Long.; Figs. 7, 23, 24), overlooking Manuel Creek, for which the formation is named. The contacts are located at the top and bottom of the recessive interval which contrasts with underlying and overlying bluff-forming sandstones. Their locations are clear and sharp at Murray Ridge, although sandstone beds increase upward within the formation toward the contact with the overlying Richardson Mountains Formation (Figs. 31, 32).

A distinct sandstone member, the Anne Creek Member, is present at the top of the formation in the vicinity of the head of Waters River (see below and Figs. 4, 13).

The lower, most strongly recessive, part of the formation at Murray Ridge is soft, argillaceous, carbonaceous siltstone and shale or mudstone, with small, spheroidal-weathering, ferruginous, calcareous and locally pyritic concretions. The concretions contain minor, poorly preserved

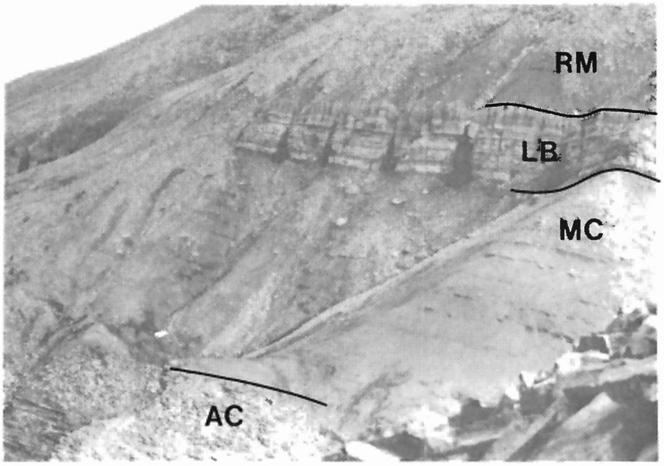


FIGURE 23. *Manuel Creek Formation (MC) and overlying resistant Little Bell Member (LB) of Richardson Mountains Formation at Murray Ridge, section PU-9-76. GSC Photo 202973-0.*

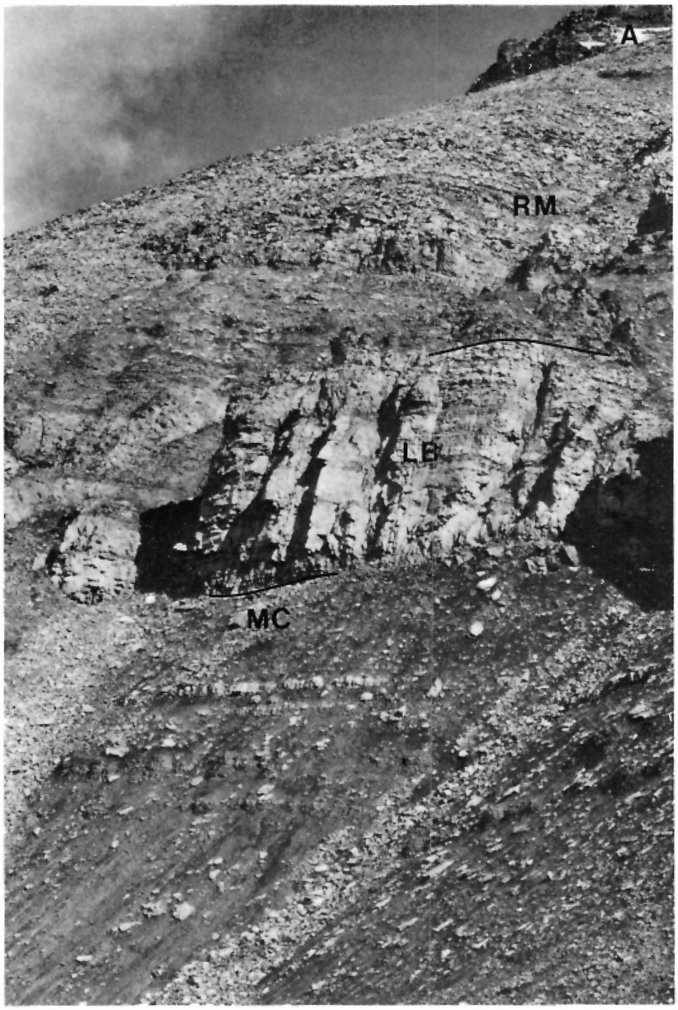


FIGURE 24. *Upper part of Manuel Creek Formation (MC) overlain by Richardson Mountains Formation (RM), with well-developed resistant basal Little Bell Member (LB), and succeeded by bluff-forming Aklavik Formation (A) on skyline, Murray Ridge. ISPG Photo 1217-6.*

fossil fragments and preserve ubiquitous fine burrowing structures. Minor thinly laminated, or rippled sandstone beds occur here and there. The detrital fraction of a representative calcareous nodule from near the base of the formation at Murray Ridge (GSC loc. 92604 from section PU-12, 14-75) is nearly entirely quartz, in a ferruginous calcite matrix.

Siltstones and fine grained sandstone interbeds in the upper 20 m or so of the formation at Murray Ridge are thinly bedded, laminated and platy, crossbedded and ripple-marked. They are bioturbated to varying degrees, and locally have many burrows and trails. They have argillaceous, carbonaceous partings and some surfaces are strewn with comminuted shell debris. Ferruginous, rusty red weathering, concretionary pods and beds are common. Some have phosphatic cores, and are rich in small ammonites, bivalves, and belemnites.

These lithologies characterize the unit everywhere although the subdivision into lower and upper parts, the former more recessive and with less sandstone, cannot be seen elsewhere. The abundance, sedimentary structures, and hardness of the sandstone interbeds appears to be somewhat variable from place to place although the unit is not sufficiently well exposed in most places to document the variations in detail. In northwestern localities (e.g. section PU-18-76; see Fig. 6), the formation, identified by its dominantly recessive, argillaceous character, contains sandstone interbeds as thick as 15 m, which are probably pinchout tongues of the upper parts of the Almstrom Creek Formation (see Figs. 2, 9). They are very hard and quartz-cemented, and they generally weather rusty red.

The Manuel Creek Formation thickens gently toward the west-northwest (Fig. 25). It is entirely absent in the Bug Creek-Jurassic Butte area where the Richardson Mountains Formation rests unconformably on older Jurassic or Paleozoic rocks.

Anne Creek Member (new name)

The Manuel Creek Formation in the vicinity of the head of Waters River comprises a black, recessive shale that contains Dactylioceras, and an overlying resistant, rusty-weathering sandstone that contains Erycitoides (see Fig. 13). The sandstone unit is here named after nearby Anne Creek, with type section on an unnamed mountain, at approximately 67°44'20"N Lat., 137°08'W Long. (section PU-5-78; Fig. 26). The sandstone is lithologically similar to the equivalent thin sandstone beds in the upper part of the formation at Murray Ridge. It is variably thinly laminated or apparently massive, and locally crossbedded or wavy-laminated. Trails are abundant in some of the upper units and the lower part is strongly bioturbated. Ferruginous rip-ups are common throughout and fossiliferous phosphatic nodules with ammonites, belemnites and bivalves occur in the lower part. Neither contact is entirely exposed, but both appear to be gradational to underlying and overlying recessive units. They are placed where sandstones become dominant in the gradational interval.

The Anne Creek Member increases from 33 to 72.5 m in thickness from west to east (from sections PU-11-76 to PU-6-78). It is recognized also on the western slopes of the northern part of the ridge between Berry Creek and Waters River where it forms a resistant ridge and where it has been described by Jeletzky (1972b, p. 38, unit 6). The thin sandstone beds in the upper part of the Manuel Creek Formation at Murray Ridge (section PU-12, 14-75; PU-9-76) represent the northeast pinchout of the member. Similar sandstones also occur as far north as the divide between Bell River and Big Fish River (section PU-18-76) but are less conspicuous farther north (section PU-19-76).

Age and paleontology

Toarcian and Early Bajocian ammonites have been found at several localities in the Manuel Creek Formation.

Pseudolioceras sp. cf. P. mclintocki (Haughton) was found in place approximately 10 m below the top of the formation at Murray Ridge (GSC loc. C-53364; section PU-12, 14-75) and nodules lying loose below it but probably from the same or nearly the same level contain Pseudolioceras together with Dactylioceras sp., Inoceramus, Variamussium(?), other bivalves and belemnites (GSC locs. 92605, 94041, C-53663, C-6609, C-65011 of section PU-12, 14-75). Pseudolioceras, Erycitoides(?) and Ostrea(?) occur together approximately 15 m below the top of the formation at another locality on Murray Ridge (GSC locs. 94190, 94192 of section PU-9-76; Table 4). At Murray Ridge, the only macrofossils found in place in the lower and middle parts of the formation are undeterminable ammonite and belemnoid(?) fragments, the bivalves Entolium, Ostrea(?), Variamussium(?) and Vaugonia sp. aff. V. literata (Young and Bird), among others. Thus the upper part of the formation contains beds of both Toarcian and Early Bajocian age; the lower part is not confidently dated by macrofossils at Murray Ridge.

The microfauna recovered from the Manuel Creek Formation (Assemblage B) at Murray Ridge (section PU-9-76) include both calcareous and agglutinated Foraminifera and the radiolarian Eucyrtidium sp. (see Table 4). Trochammina sp. cf. T. canningensis (Pl. 3, figs. 4-6) and Marginulinopsis sp. 5000 (Pl. 1, fig. 2) appear to have their lower limits in this assemblage.

Carbonization of the microflora is severe in the section at Murray Ridge where the Manuel Creek Formation is best suited for collection of samples by virtue of the quality of exposure, and microflora was not recovered in other localities. The spores and pollen that can be recognized are all long-ranging forms. Classopollis (Pl. 6, figs. 20, 25) seems to be the most common palynomorph present. The Pliensbachian to Toarcian age range of Mancodinium semitabulatum (Pl. 6, figs. 12, 13) which occurs in the lower part of the formation (GSC locs. C-53593 and C-53591 from section PU-9-76; see Table 4) provide the best indication of its age.

Elsewhere, Dactylioceras, Erycitoides sp. aff. E. howelli (White), and other less biostratigraphically useful fossils occur in this formation (e.g. GSC locs. 94106 of section PU-18-76; 94121 of section PU-19-76).

Other macrofaunas associated with the ammonites of this formation include the belemnites Brachybelus sp., B.? sp. ex gr. B. gingensis (Oppel), Pseudodicoelites sp. cf. P. bidgievi (Saks), P. spp. (all identified by J.A. Jeletzky), and the bivalves Inoceramus (Retroceramus) sp. and "Variamussium" sp. (e.g. GSC locs. 52670, 85824, 85825). The belemnites have a general Toarcian to Middle Bajocian range (J.A. Jeletzky, pers. comm.); the bivalve "Variamussium" has most commonly been found with Toarcian or Early Bajocian ammonites. The presence of these faunas in many localities where ammonites have not been found, therefore, serve to date approximately the formation throughout the area. The fossils from the head of Waters River identified by J.A. Jeletzky (in Young, 1975, p. 314; GSC loc. C-29248) probably come from the Anne Creek Member.

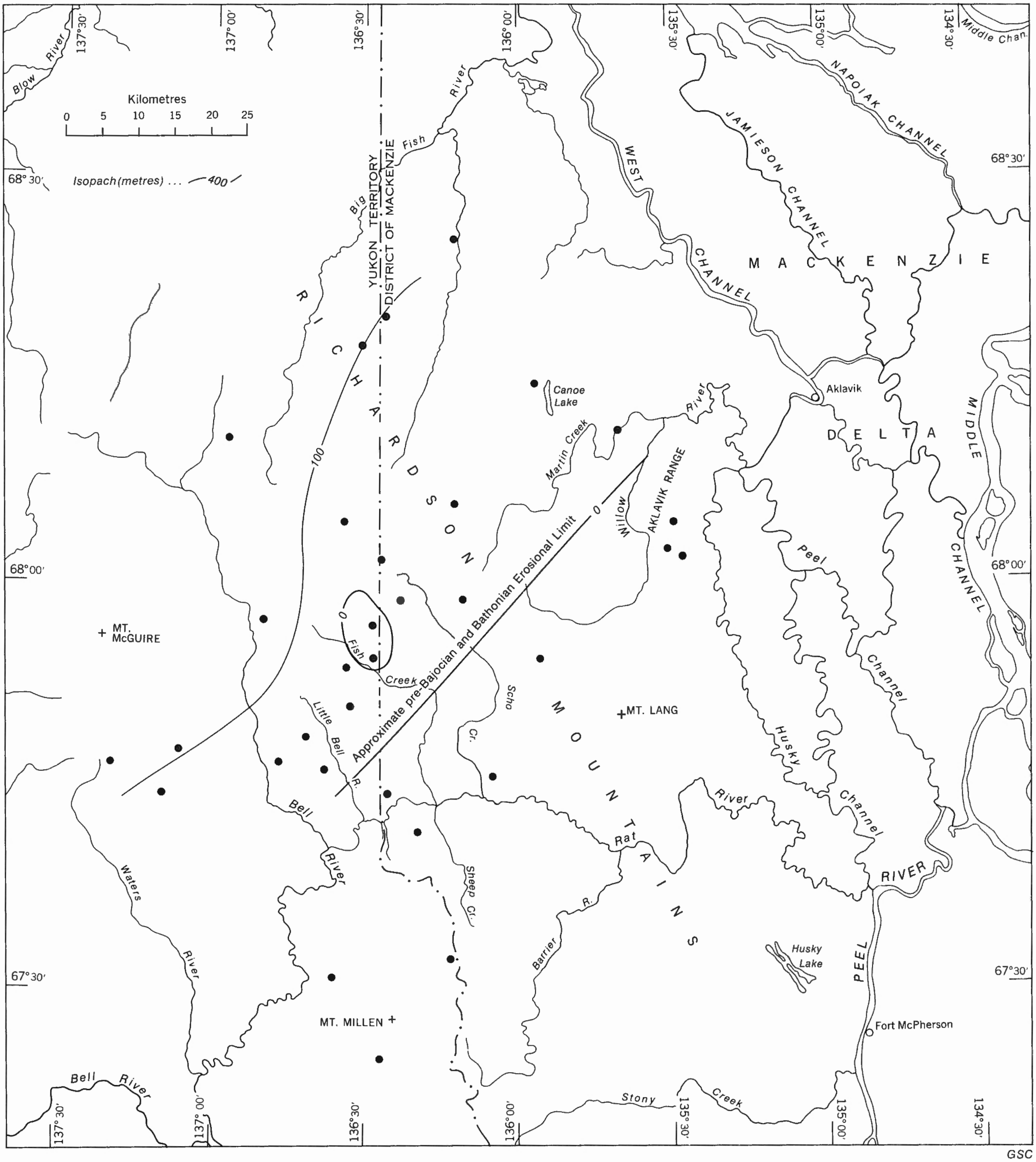


***FIGURE 25.** Thickness of Manuel Creek Formation in northern Richardson Mountains.*

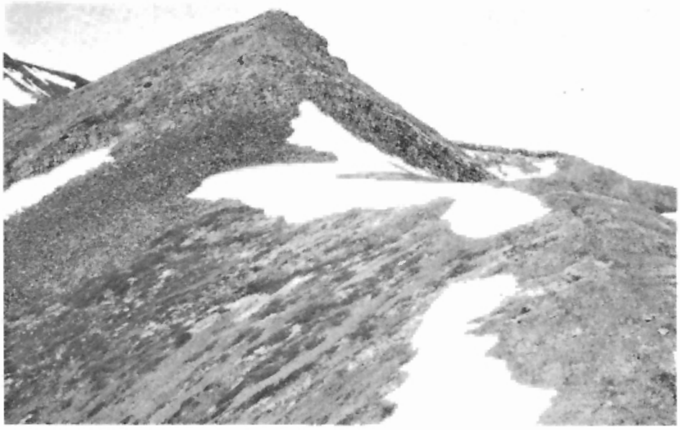


FIGURE 26. Anne Creek Member (resistant bluffs) and underlying recessive part of Manuel Creek Formation near head of Waters River (section PU-5-78) (ISPG Photo 1426-1).

Microfauna of the formation, in addition to those listed from Murray Ridge, include Trochammina spp. 4965, 5267 and 5271, T. sp. cf. T. canningensis, Ammobaculites sp. 4925, Spiroplectammina sp. 5273, Haplophragmoides sp. 5272, Lenticulina sp. 5274, Ammodiscus sp. cf. A. cheradospirus, and Reophax sp. 5274 (GSC locs. C-53564 and C-53565 of section PU-18-76; C-53571, C-53572 and C-53573 of section PU-21-76).

The shale that represents the Manuel Creek Formation immediately below the Anne Creek Member in the vicinity of the head of Waters River contains Dactylioceras sp. aff. D. commune (Sowerby), Parvamussium(?) sp., and belemnites (GSC locs. 94075 of section PU-11-76; C-53375 of section PU-5-78; and C-53386 of section PU-6-78). The following previous records of Toarcian fossils are assumed to have come from this unit in this area but cannot be assigned to the formation with complete confidence because they were collected before the current stratigraphic scheme was set up and locality information is not sufficiently precise to locate them stratigraphically. Dactylioceras sp. and harpoceratid fragments were reported by Frebold (1960, p. 4) from the headwaters of Bell River, 35.2 km (22 miles) northwest of Summit Lake (GSC loc. 39342). In the same approximate area (GSC loc. 86535), Frebold (1975, p. 5, 19) recorded Peronoceras sp. cf. P. polare (Frebold) and tentatively (op. cit., p. 20, Table 1) assigned it to the Thouarsense Zone of the Upper Toarcian. Erycitoides sp. aff. E. howelli (White), Pseudolioceras sp. cf. P. spitsbergense (Frebold), P. sp. and other ammonites occur low in the Anne Creek Member near the head of Waters River (GSC loc. C-53387 of section PU-6-78; GSC loc. C-53376 of section PU-5-78). Jeletzky (1972b, p. 38, unit 6) reported Pseudolioceras sp., Brachybelus sp. and Pseudodicoelites sp. from sandstone that probably represents the Anne Creek Member in the same area (GSC loc. 87820). Erycitoides sp. aff. E. howelli has been identified in another collection from nearby in the Bell River area (67°44'N, 137°09'W).

Other localities which yield specifically undetermined Pseudolioceras specimens of Toarcian or Early Bajocian age are in the area of the headwaters of Bell River (Jeletzky, 1975, Figs. 6, 7) and from a locality, not given in detail, north of Rat River and east of Summit Lake (Frebold, 1960, p. 4, 22; GSC loc. 35969). A loose boulder containing a fragment resembling Erycitoides (Kialagvikes) levis Westermann may have come from this formation at the junction of Almstrom and Little Fish Creeks, where it is not well exposed (GSC loc. 94141). Those specimens that Frebold (1975, p. 19) considered to possibly represent Dactylioceras commune (Sowerby) come from Bonnet Lake area, west of the Richardson Mountains and not the Aklavik Range as Frebold stated.

Depositional environments

The Manuel Creek Formation is an open marine shelf deposit. The thin sandstones at the base of the formation at Murray Ridge are probably reworked from the underlying Almstrom Creek sands. Otherwise, the abundance of fissile argillaceous rocks, and the rippled surface preserved on the upper surface of Almstrom Creek Formation south of White Mountains (section PU-7-76), probably indicate tranquil transgression of the sandstone formation by the Manuel Creek, and deposition of the lower part of the latter below wave base. The nearly monogeneric nature of both microfauna and macrofauna in the lower part (see Table 4) may indicate some biologically unfavourable water condition.

The relative scarcity and limited variety of fossils at localities other than the type section may, however, be due in part to the poorer quality of exposure. The faunas in sections more basinward and presumably deeper successions than that at Murray Ridge are dominated by Inoceramus and belemnites, and still farther offshore by Dactylioceras alone.

The small pockets rich in small fossils of great variety, the bedding surfaces littered with shell debris, and the abundant small scale current structures in the upper part of the formation at Murray Ridge indicate increased current activity and may indicate shallowing to or near the wave base. The abundance of bioturbated structures and the microfauna in the upper part of the formation (GSC locs. C-53586 to C-53584), particularly the calcareous foraminifera Marginulinopsis and the radiolarian Eucyrtidium sp., are consistent with offshore open shelf environments, with unrestricted circulation. Shoaling together with introduction of sand is also indicated for the upper part of the section at the head of Waters River as indicated by the structures, including abundant thin rip-up laminae in the Anne Creek Member (section PU-5-78). The shallow-marine sandstone at the head of Waters River already recognized as part of a shoaling sequence by Young (1975, p. 314) probably represents the Anne Creek Member. The same is probably also true of the ferruginous sandstone near the mouth of Driftwood River described by Jeletzky (1972b, p. 43-45) where he described evidence of subaerial exposure such as mud-cracks, flattened clay balls, and subvertical rootlets in the upper part of the sandstone, which also contains grit and pebbles of quartz and chert in its upper part. Transport of sediment from these western areas toward the northeast along the inferred depositional strike of the formation was probably the source of the sandstones in the upper part of the formation at Murray Ridge.

Richardson Mountains Formation (new name)

Definition, distribution and description

The name Richardson Mountains Formation is proposed to replace what Jeletzky (1967) informally called the sandstone-siltstone member of the Bug Creek Formation, and it also includes the upper part of his intermediate sandstone member and the lowest part of his upper sandstone member (Fig. 4). It is moderately or well exposed in nearly every stratigraphic section described, although its predominant weathering character is recessive. A widespread, distinctive, resistant sandstone unit at its base is here named the Little Bell Member, and a higher package of resistant sandstone beds within the dominantly argillaceous formation in the vicinity of the head of Waters River is here named the Waters River Member (see below).

The Richardson Mountains Formation is the most widespread, and the thickest, of all the Bug Creek formations, occurring throughout the northern Richardson Mountains, for which it is named, and overstepping the underlying Jurassic formations south beyond McDougall Pass. The section at Murray Ridge (section PU-12, 14-75; 67°58'30"N Lat., 136°22'30"W Long.; Fig. 7) is typical and is designated the type section. Reference sections to the northwest (PU-18-76 and PU-20-76) provide better fossil control for upper parts of the formation, however, and have more significant argillaceous intervals. At Murray Ridge the lower contact is at the base of the Little Bell Member, described below. The top of the formation there is placed within a gradational sandstone succession where thick-bedded, bluff-forming sandstones of the overlying Aklavik Formation overlie less resistant, thinner bedded sandstones.

The basal unit of the formation at Bug Creek and Jurassic Butte area, i.e. the upper part of Jeletzky's (1967) intermediate sandstone member is a resistant sandstone, somewhat similar to the Little Bell Member described below. It is more strongly crossbedded, however, and less strongly bioturbated, without the thinly and irregularly banded character that typifies that member. Furthermore, it has not yielded Arkelloceras, but rather the younger ammonite Cranocephalites borealis in its lower part. The basal beds here, where the unit unconformably overlies the Almstrom Creek and Murray Ridge Formations contain wood fragments, abraded fossils, phosphatic pellets and nodules, minor glauconite and coaly seams and particles. The few palynomorphs recovered from this basal unit are of terrestrial derivation, and some are reworked from Paleozoic formations.

Still different sandstones occur at the base of the formation where it paraconformably overlies Paleozoic rocks at McDougall Pass and southward, and east of White Mountains. In most of these localities they can be readily differentiated from the lithologically similar Permian sandstones by the presence of Zoophycos in the latter, and belemnites or Inoceramus in the former. Pebble-bearing sandstone that underlies belemnite-bearing beds and unconformably overlies Permian rocks at Horn Lake (section PU-23-76) and northeast of Mt. Millen (section PU-17-76) are the basal unit of the Richardson Mountains Formation. In some western localities the lowest unit of the Richardson Mountains Formation is a recessive argillaceous unit that overlies the resistant Anne Creek Member of the Manuel Ridge Formation (see Fig. 13).

The upper contact is everywhere located in a gradational succession at the base of the bluff-forming beds of the Aklavik Formation, because the mappability of these units relies above all on their resistance to weathering. Thus it is placed higher in the section at Bug Creek than Jeletzky (1967) placed the top of the sandstone-siltstone member.

At the type section and throughout the report-area north and west of McDougall Pass, the Richardson Mountains Formation consists of interbedded sandstone, siltstone and shale or mudstone. Argillaceous content increases in westerly and northerly directions as does overall thickness of the unit. Argillaceous beds die out in the upper parts of the unit in the eastern localities, where sandstone beds are strongly carbonaceous and commonly weather with a blue-grey tinge and are covered with jarosite stain. The sandstone beds and many of the siltstone beds of this formation (e.g. Figs. 27, 28) are mainly well sorted and are characterized by fine planar lamination, ripples, low-angle crossbedding, crawling trails, or intense bioturbation. Subunits of parallel- or trough crossbedded-to-burrowed sets (Figs. 29, 30) occur in some places, generally with the proportion of crossbedding and thickness of beds increasing upward. In other places, cycles showing the reverse succession are present. Some of the bedding surfaces are strewn with whole or fragmentary shells of Inoceramus and other bivalves, ammonites, belemnites, rip-up clasts of mudstone and siltstone that is commonly ferruginous, carbonaceous plant debris, and, particularly in upper beds, scaphopods. Laminae of belemnites have already been illustrated (Jeletzky, 1967) at Bug Creek and were also noted by him (op. cit.) east of Jurassic Butte. The basal part of crossbed foresets is rich in belemnites in some localities. Carbonaceous or ferruginous siltstone partings commonly separate individual beds.

The argillaceous siltstone and silty mudstone beds are generally strongly carbonaceous, pyritic, poorly consolidated and intensely bioturbated, although thin siltstone or sandstone laminae are not uncommon in them. Belemnites and wood fragments occur scattered throughout these beds, the former mainly in lower parts of the unit. Those beds

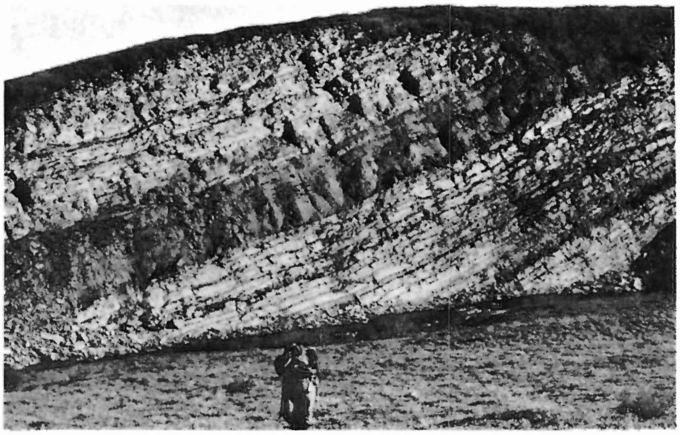


FIGURE 27. *Richardson Mountains Formation near junction of Almstrom and Little Fish Creeks (units 21 to 23 of section PU-20-76). ISPG Photo 974-39.*

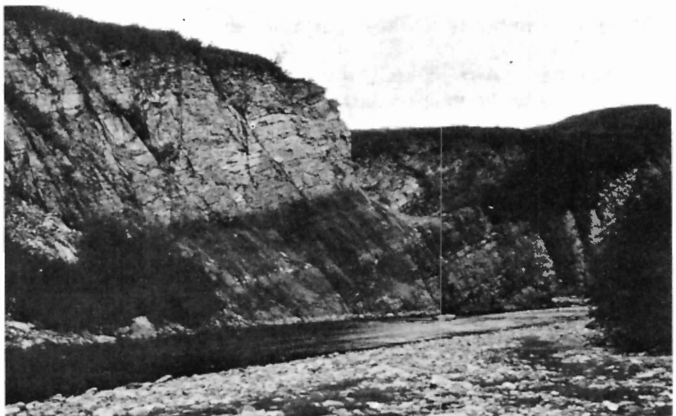


FIGURE 28. *Upper part of Richardson Mountains Formation on Little Fish Creek just below confluence with Almstrom Creek (units 35 to 38 of section PU-20-76). ISPG Photo 974-40.*

FIGURE 29. Parallel and crossbedded-to-burrowed sets, lower part of Richardson Mountains Formation, junction of Almstrom and Little Fish Creeks (unit 21 of section PU-20-76). ISPG Photo 974-41.

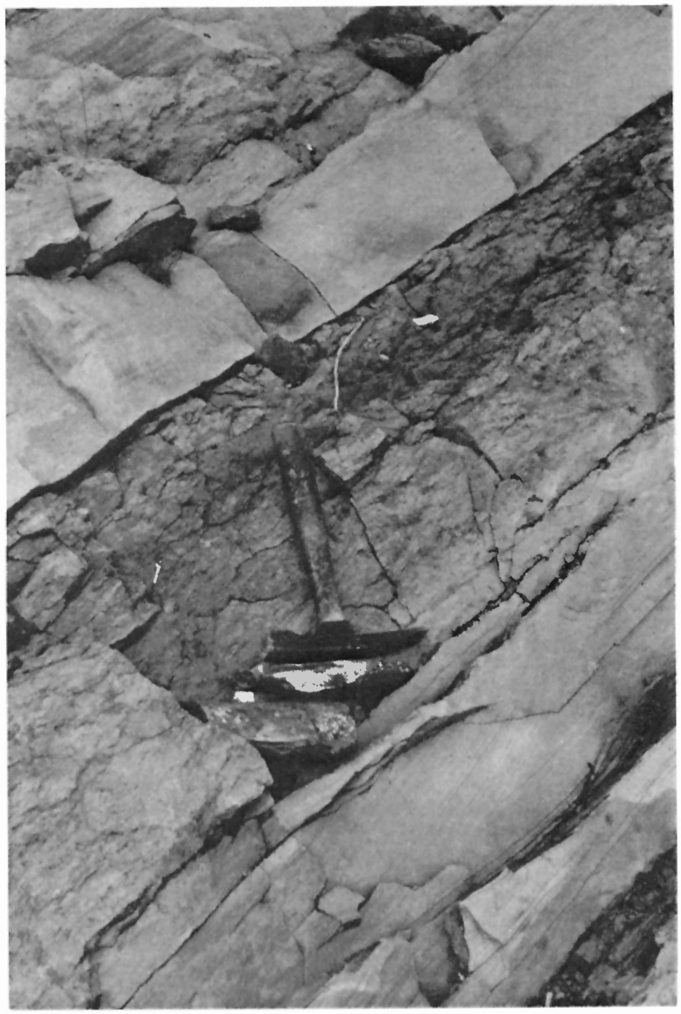


FIGURE 30. Bioturbated upper part of crossbedded sandstone bed, Richardson Mountains Formation on Little Fish Creek; unit 21 of section PU-20-76. ISPG Photo 1225-11.

immediately overlying the Little Bell Member as well as some of the higher beds, are locally glauconitic and this interval is commonly a black, carbonaceous shale.

Farther west (e.g. sections PU-11-76, PU-18-76, PU-19-76), the formation with the exception of the Waters River Member is dominated by black or dark grey fissile shale or siltstone, or by strongly bioturbated, rubbly argillaceous siltstone with minor thin siltstone and sandstone beds that are either laminated or bioturbated as described above. There are minor concretions, belemnites and Inoceramus within it.

From McDougall Pass southward, and on the immediate east side of White Mountains, resistant sandstone beds of the Richardson Mountains Formation, together with the overlying Aklavik Formation in some places, comprise the entire Bug Creek Group. Here, the Richardson Mountains Formation overlies Paleozoic rocks unconformably, having overstepped the limits of earlier Jurassic rocks. It contains Inoceramus and belemnites at most localities. Previously reported older Jurassic beds in the area south of McDougall Pass (see section on "Notes on tectonic elements") were not found by the writer and their existence there is doubtful. Those units just south of the west end of McDougall Pass that have been described as a thick, 'mid-basinal' facies of the Bug Creek Group by Jeletzky (1971, p. 213; 1974, p. 6, 7; 1975, p. 9-11, Fig. 6, col. E3, E4) are now known to be Cretaceous (Jeletzky, 1980, p. 1).

Sandstones high in the formation at Bug Creek, Murray Ridge, Canoe Lake, and the White Mountains area (GSC locs. C-76371 and C-80872 from section PU-7-75; C-80877 from section PU-12, 14-75; 92595 and 92579 from section PU-6, 10-75; C-80860 to C-80862 and C-80864 of section PU-1-75; 92600 from section PU-13-75) predominantly contain quartz, with as much as 15 per cent (est.) chert, polycrystalline quartz and siltstone fragments in some samples, 1-2 per cent feldspar of several varieties, and minor detrital mica and chlorite, zircon, and other heavy minerals (Fig. 31). The lowest Jurassic sandstone unit at White Mountains, where the Richardson Mountains Formation unconformably overlies Permian rocks, contains 15 per cent (estimated) siltstone and chert grains, the former dominant, and insignificant amounts of accessory detrital components (GSC loc. 92510 from section PU-1-75). The sand fraction of the lowest part of the Bell River Member (1 representative sample examined in thin section: GSC loc. 94152 of section PU-21-76) is well sorted but angular and far from spherical. Chert and siltstone comprise 25-30 per cent (estimated) of

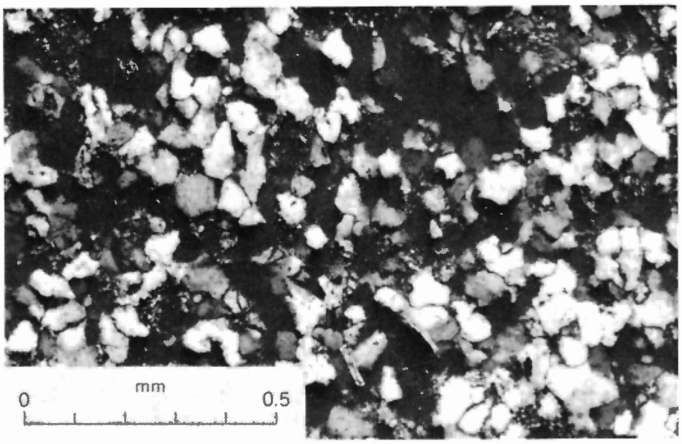


FIGURE 31. Photomicrograph, X-nicols, of sandstone from upper part of Richardson Mountains Formation at Bug Creek; GSC loc. C-76371 from section PU-7-75; showing high chert and siltstone content, minor feldspar, and two detrital fragments of mica. ISPG Photo 1264-5. Scale in millimetres.

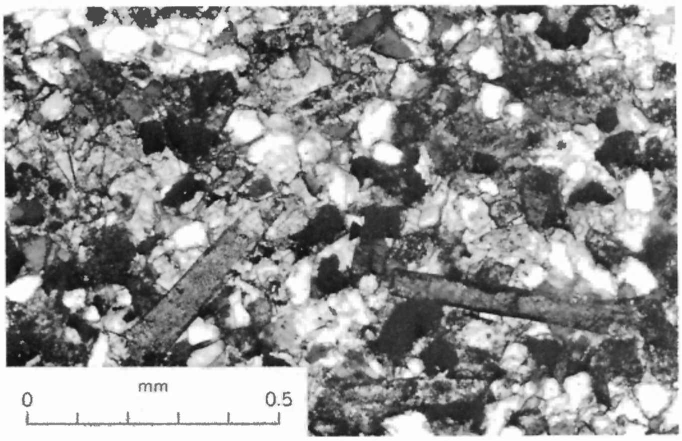


FIGURE 32. Photomicrograph, X-nicols, of sandstone from a fossiliferous calcareous lensoid bed in the Richardson Mountains Formation near Canoe Lake, GSC loc. 92592 from section PU-6, 10-75; ISPG Photo 1264-8. Scale in millimetres.

the grains, and there are minor amounts of detrital mica, chlorite and feldspars. Upper beds of this member at Murray Ridge (e.g. GSC loc. 92466 of section PU-12, 14-75) are similar but contain somewhat less chert and siltstone grains.

Chert and argillite granules and pebbles occur in the lower beds at Bug Creek and east of Jurassic Butte. Here chert comprises 25 per cent (estimated) of the sand fraction in some beds (e.g. GSC loc. 92480). The presence of this much chert and particularly siltstone and argillite clasts, contrasts with the older units of the Bug Creek Group and allies the basal unit here with the Bell River Member elsewhere in spite of their slight differences in age and sedimentary structures.

Calcite and limonite occur as cements in varying amounts through the formations. Some of the ferruginous carbonate occurs as rounded pelletoidal grains. Where calcite is abundant it is presumed to be recrystallized from the fossil fragments which are common in the calcareous beds (e.g. GSC loc. 92595; Fig. 32). Many of the clasts, but particularly the fossil fragments, the chert and the feldspar grains are coated by a ferruginous rim. Minor small dolomite rhombs occur in the calcareous samples. The patchy calcitic cementation in the Richardson Mountains Formation results in resistant pods some of which weather rusty orange due to their ferruginous content, standing out in a dominantly recessive unit. In part, at least, the localization of these pods is related to the occurrence of well sorted siltstone or sandstone lenses that may have been preferentially cemented early. Rusty red weathering, slightly ferruginous, siliceous concretions occur sporadically throughout the unit. In the western localities (e.g. units 17c to 19a of section PU-11-76), small, subspherical siliceous nodules occur in the black shale units.

The Richardson Mountains Formation is a westerly thickening wedge which varies from 50 m (approx.) in the east at Jurassic Butte to 324 m (approx.) in the west near the head of Waters River, and from 31.5 m (min.) in the south, south of Mt. Millen, to 208 m in the north, at the junction of Almstrom and Little Fish Creeks (Fig. 15). An extreme thickening occurs in the vicinity of the head of Waters River which coincides with the localization of a major sandstone member within the formation, the Waters River Member. Besides the Little Bell Member described below, other thin resistant sandstone units of the formation occur in shales as far west as the head of Johnson Creek (68°02 1/2'N Lat., 137°47'W Long.).

Little Bell Member (new name)

The basal unit of the Richardson Mountains Formation in many, but not all, localities north of McDougall Pass (e.g. sections PU-12, 14-75, PU-9-76, PU-18-76, PU-21-76, PU-22-76; Fig. 33) is a resistant sandstone with widespread uniformity of lithology and thickness (Figs. 23, 24, 33). It is named the Little Bell Member, with type section at Murray Ridge (section PU-12, 14-75; 67°58'30"N Lat., 136°22'30"W Long.).

It is characteristically a strongly bioturbated, fine to medium grained sandstone that weathers rusty buff due to the abundance of small pyrite nodules. Belemnites and Inoceramus are nearly ubiquitous, commonly occurring in ferruginous concretions. Locally, original lamination and crossbedding have been only slightly effaced by bioturbation. At many localities (e.g. sections PU-9-76, PU-18-76, PU-21-76), the lower metre or so contains ferruginous beds as thick as 0.3 m with phosphatic nodules that are rich in Arkelloceras sp., Inoceramus, and belemnites.

The base of the Little Bell Member, with its characteristic fossiliferous, phosphatic, ferruginous lenses is sharp everywhere, and is resistant in contrast to the generally recessive underlying rocks. The top is placed at the top of the finely and irregularly bedded, bioturbated, bluff-forming sandstones that characterize the member; overlying beds are more recessive, and either platy- or rubbly-weathering.

The Little Bell Member is sheet-like, showing little variation in thickness where it is present, reaching 30 m. It is absent here and there however, apparently having been deposited only in the low areas on a somewhat irregular surface. A sandstone unit lithologically similar to the Little Bell Member and, like it, probably overlying shales that contain Erycitoides, occurs as far west as the headwaters of Johnson Creek in northeastern Old Crow Flats (e.g. Lat. 68°03'N, Long. 137°46'W; Lat. 68°03'N, Long. 138°01 1/2'W; Lat. 68°03'N, Long. 137°54'W).

FIGURE 33. Basal contact of resistant Little Bell Member unconformably overlying the recessive Murray Ridge Formation, east of head of Scho Creek (section PU-22-76). ISPG Photo 974-4.

Waters River Member (new name)

A resistant sandstone unit within the otherwise dominantly argillaceous Richardson Mountains Formation in the vicinity of the head of Waters River is named the Waters River Member. Its type section is on the east face of an unnamed ridge between the heads of Anne Creek and Waters River (section PU-11-76; 67°47'N Lat., 137°19'W Long.; see Fig. 13, Pl. 7, fig. 4).

The base of the Waters River Member at its type section and elswhere is placed within a gradational succession where resistant, bluff-forming sandstones overlie resistant more argillaceous rocks. The top here and elsewhere is generally sharp, where recessive argillaceous rocks abruptly overlie bluff-forming sandstones.

A three-fold subdivision of the Waters River Member is recognized at its type section and nearby localities (Fig. 13). The upper and lower parts are resistant, the middle part recessive. Inoceramus and belemnites are scattered throughout.

The lower resistant part consists of interbedded, bioturbated and laminated or crossbedded units, some of which form bioturbated-to-crossbedded cycles 1 m-thick.

The middle recessive part of this member is soft, strongly bioturbated carbonaceous siltstone with interbeds of laminated and crossbedded siltstone and sandstone.

The upper resistant part at the type section is strongly bioturbated, argillaceous siltstone and fine grained sandstone with minor laminated intervals. It forms banded bluffs. Poorly defined lamination and crossbedding can be recognized in the mainly structureless beds in its much thicker development just to the east (section PU-6-78; see Fig. 13).

The thickness of the Waters River Member seems to be relatively constant, 140 m approximately in its type area, although the thickness and distribution of different lithologic types are not definitive in some localities because the unit commonly occurs as frost-shattered felsenmeer or talus slopes. It may be represented near the head of Berry Creek (see Fig. 1) by sandstones described by Jeletzky (1972b, p. 37-38, unit 2). Resistant sandstones of similar character and position which occur south of White Mountains (e.g. sections PU-7-76, PU-4-78, PU-7-78, PU-8-78; see Fig. 39) probably also represent the Waters River Member.

Age and paleontology

The Richardson Mountains Formation contains ammonites which indicate Middle Bajocian through Early Oxfordian ages. The basal beds are Middle Bajocian in the basinward central, northern and northwestern outcrops, and Late Bajocian or younger to the south and east. The youngest beds are Early Oxfordian in the northwestern and central localities and the youngest fossils in the southern and eastern localities are Early Callovian (see key to fossil occurrences in Fig. 2).

Arkelloceras mclearni Frebold and other specifically indeterminable specimens of Arkelloceras occur, together with Inoceramus lucifer Eichwald and belemnites, in a ferruginous concretionary bed near the base of the basal Bell River Member between the heads of Bell and Big Fish Rivers (GSC locs. 94107 and 94108 in section PU-18-76), and near the head of Little Bell River (GSC loc. 94152 in section PU-21-76). Arkelloceras sp. was found in abundance at Murray Ridge (GSC loc. 94048 of section PU-9-76) and A. elegans Frebold, described by Frebold et al.; (1967, GSC loc. 52699) comes from what appears to be the same horizon in E.W. Mountjoy's section near that locality (Mountjoy and Procter, 1969, 158MJ, unit 26). A. tozeri Frebold, collected by Shell Oil Company geologists between Bell River and White Mountains (GSC loc. 88073), is assumed to come from the base of the formation also. Increasing evidence, listed by Poulton (1978d) indicates that the beds with Arkelloceras in the Boreal Middle Jurassic succession are equivalent to the Middle Bajocian Substage of the Standard Northwest European zonal scheme.

However, the oldest diagnostic fossils in the Richardson Mountains Formation in the east-central parts of the report-area, such as near the head of Scho Creek (section PU-22-76) and in Bug Creek - Jurassic Butte area (section PU-7-75, PU-2, 26-76, PU-12-76), are Cranocephalites spp. of Upper Bajocian age. Here the Richardson Mountains Formation unconformably overlies significantly older members of the Bug Creek Group.

Thus, the basal unit of this formation varies from Middle Bajocian in the basinward, apparently conformable succession, to Upper Bajocian in the marginal southeastern succession where it overlies a significant unconformity.

Cranocephalites borealis (Spath) and C. warreni Frebold have been described (Frebold, 1961, p. 2, 12-15; GSC locs. 26882, 26883, 26972) from the base of the formation at Bug Creek Canyon, that is, in the upper part of what Jelezky (1967, p. 17, 90) called the intermediate sandstone member. C. borealis also occurs near the top of the basal Bell River Member at Murray Ridge (GSC locs. 92466, 94046 in section PU-12, 14-75). Cranocephalites sp. aff. C. borealis Spath has been found low in the formation near the head of Waters River (GSC loc. 94082 of section PU-11-76), and similar forms occur low in the formation between Canoe Lake and Big Fish River (GSC loc. 94142 of section PU-20-76).

Beds immediately overlying the Little Bell Member at Murray Ridge (GSC loc. 92474 of section PU-12, 14-75) yield Cranocephalites sp. cf. C. indistinctus Callomon. C. indistinctus is considered by Callomon (1959, p. 507, 508) to be the guide fossil for the highest Upper Bajocian zone of the boreal zonation, and the other Cranocephalites species listed above represent a lower Upper Bajocian zone.

Only a few poorly preserved ammonites represent the Lower Bathonian (boreal) in the report-area. Cranocephalites sp. aff. C. pompeckji (Madsen) and C. sp. aff. C. maculatus Spath were found together approximately 80 m above the probable base of the Richardson Mountains Formation on the north side of McDougall Pass (GSC locs. 92475, 92481 of section PU-11-75) and also occur at Bug Creek Canyon (GSC loc. C-80310 of section PU-7-75). C. sp. aff. C. vulgaris Spath occurs just east of the upper part of Waters River and possibly also near the junction of Almstrom and Little Fish Creeks (GSC loc. C-80312). As pointed out by Frebold (1961, p. 27) many other occurrences of specifically undeterminable Cranocephalites specimens may represent the Lower Bathonian (boreal) as well.

The Middle Bathonian (boreal) is indicated at Bug Creek Canyon by Arctocephalites sp. cf. A. arcticus (Newton), identified by J.H. Callomon, which occurs just above the basal sandstone beds of the Richardson Mountains Formation there. Poorly preserved Arctocephalites sp. cf. A. greenlandicus also has been found in the upper part of the formation on the north side of Bug Creek Canyon (GSC loc. 92590 of section PU-7-75). A. arcticus characterizes the lower Middle Bathonian (boreal) Nudus Zone in Greenland, and A. greenlandicus the higher Greenlandicus Zone (Callomon, 1959, p. 508).

Arctocephalites has been identified from the west side of Mt. Dennis (GSC loc. 88184) and other poorly preserved Arctocephalites or Cranocephalites specimens occur at GSC localities 94110 (section PU-18-76), 52613 (section PU-12, 14-75) and C-80303 (Bug Creek Canyon).

The identification of Arcticoceras henryi (Meek) by C.R. Stelck (in Jeletzky, 1967, p. 165) on the south side of McDougall Pass is taken to indicate the presence of the Upper Boreal Bathonian Ishmae Zone in this area. At this locality, only Unit 2 of Jeletzky (*ibid.*) i.e. the beds that yielded the fossil, represents the Bug Creek Group (Poulton, 1978d; see also Jeletzky, 1980). Certainly identified or probable Arcticoceras specimens also occur in a section between Canoe Lake and Big Fish River (GSC loc. C-80311) and in talus at Murray Ridge (GSC loc. 52610).

The Variabile Zone, assigned to the Upper Boreal Bathonian by Callomon (1959, p. 508, 509), is probably indicated by Cadoceras crassum (Madsen) and C. sp. aff. C. barnstoni (Meek), identified by H. Frebold, in the headwaters of Berry Creek just west of Waters River (Jeletzky, 1972b, p. 38), and by C. crassum and a related species from a locality 51 km (i.e. 32 miles) northwest of Aklavik (locs. 16, 18 of Frebold, 1961; University of Alberta loc. 10061; Jeletzky, 1967, p. 17). Many other determinations of poorly preserved Arcticoceras, Cadoceras and Kepplerites(?) specimens suggest the widespread occurrence of Upper Bathonian strata in the northern Richardson Mountains (e.g. GSC locs. 94123 of section PU-19-76, 94112 of section PU-18-76, 94307 near section PU-20-76).

Early Callovian faunas occur in several localities. Cadoceras septentrionale var. latidorsata, C. canadense Frebold, and C. voronetsae Frebold occur in the upper part of the Richardson Mountains Formation between Bug Creek and Jurassic Butte (Frebold, 1964b, p. 16, 17; Jeletzky, 1967, p. 17). Kepplerites sp. and Pseudocadoceras sp. come from what is nearly the same stratigraphic interval just west of Canoe Lake (GSC loc. 92579) and Cadoceras voronetsae occurs in the vicinity of the headwaters of Bell River (Frebold, 1964b, p. 9, 10). Other occurrences of certainly identified or probable Cadoceras species of Lower Callovian affinities are at GSC locs. 94113 (section PU-18-76), 94148 (section PU-20-76), and 39390 (Frebold, 1961).

No certainly documented occurrences of diagnostic Middle to Late Callovian fossils have yet been recorded in the northern Yukon or adjacent Northwest Territories. The specimens identified as Quenstedtoceras(?) by Poulton (1978b) are now known to be Cardioceras, whose occurrences are described below.

Lower Oxfordian rocks are present in the upper beds of the Richardson Mountains Formation, as indicated by Cardioceras (Scarburgiceras) at several localities. C. (S.) sp. cf. C. (S.) alphacordatum Spath occurs 17 km southwest of Canoe Lake (GSC loc. C-53353, section PU-10-76) and at Beaverhouse Creek (GSC loc. C-80306), and C. (S.?) sp. occurs at the junction of Little Fish and Almstrom Creeks (GSC loc. 94318, section PU-20-76).

The presence of Arctocephalites sp. cf. A. greenlandicus at one locality (GSC loc. 92590) and of Cadoceras spp. at others (Jeletzky, 1967, p. 17) in beds high in the Richardson Mountains Formation in the Bug Creek-Jurassic Butte area, where Early Oxfordian fossils have not been found and where there is little room for them below the Aklavik Formation, may indicate that this latter formation rests paraconformably on the former here. Alternatively, the lower part of the Aklavik Formation may possibly be as old as Callovian in these southeastern localities although there is no direct evidence to support this suggestion.

The lower part of the formation at Almstrom Creek (section PU-20-76, Table 5) and on the spur east of Jurassic Butte (section PU-2, 26-76, Table 2) is very poor in palynomorphs, only locally contains rare Dinoflagellates and is barren of Foraminifera. The microfauna of the formation above its lower part contains more genera and species but fewer specimens of each species than any of the other formations. Two microfaunal assemblages, C and D, are found in Section PU-20-76 (see Table 5). Two species of Foraminifera, Marginulinopsis sp. aff. M. phragmites and Geinitzinita sp. cf. G. praenodulosa, indicate a Callovian to Oxfordian age for the upper part of the formation, in agreement with the megafossils. From GSC loc. C-80265 (see Table 5, section PU-20-76) upwards, the number of species of palynomorphs increases and microplankton appears in the samples. The microplankton is generally badly preserved and therefore difficult to identify. Some are totally new (Pl. 6, figs. 1, 2, 5-7). The total assemblage conforms with the middle to upper Jurassic age indicated by megafossils. Psaligonyaulax dualis in GSC locs. C-80264 and C-80259 is also known from the Husky

Formation. Gonyaulacysta sp. cf. G. cladophora and Pareodinia ceratophora in GSC locs. C-53575 and C-53574 at Jurassic Butte (Table 2) confirm that this middle part of the succession here is time equivalent to the interval from GSC locs. C-80267 to C-80259 at Almstrom Creek (Table 5). Reworked Devonian and Mississippian spores are common throughout the Jurassic Butte section.

Depositional environments

The Richardson Mountains Formation as a whole represents a wide range of marine, mainly muddy, open-shelf deposits with localized sand bodies. Northwesterly increasing distance from shore and probable deepening is indicated by the greater proportion of argillaceous rocks in that direction. In addition to the greater thickness and argillaceous content, as well as the lesser degree of current-deposited sediments discussed below, more abundant and larger plant debris in the Richardson Mountains Formation in the southeastern localities indicate approach to shorelines in that direction where logs as large as 0.3 m in diameter have been found.

The uniform lithology and Middle Bajocian age of the basal Little Bell Member over a wide area, indicate essentially contemporaneous deposition under stable conditions. The abundant ferruginous phosphatic nodules, high fossil content, intense bioturbation and abundant ferruginous rip-ups in the basal metre suggest a period of stillstand and reworking of underlying sediment, with only limited introduction of sediment from outside the area of its deposition. The composition of the sand fraction indicates some external source, however, and its angularity suggests that mechanical agitation was minimal. The somewhat spotty distribution of the unit probably reflects its original deposition in low areas on the shelf that may have been shoaling in association with contemporary emergence of the adjacent areas to the southeast (e.g. Aklavik Range) where Middle Bajocian rocks are absent. Higher beds of the Little Bell Member, which are intensely bioturbated and rich in carbon and pyrite reflect similar although somewhat less restricted conditions.

The sandstones which dominate the higher, thicker parts of the Richardson Mountains Formation in some of the southern and eastern sections (e.g. section PU-12, 14-75, east from there, and almost as far south as Mt. Millen, i.e. to sections PU-3-76 and PU-17-76) exhibit a wide variety of shallow sedimentary structures that include bioturbation structures of various styles, trough crossbedding, large-scale low-angle (hummocky?) crossbedding, planar lamination, and ripples. Belemnites, minor Inoceramus and rare ammonites indicate marine conditions in even the southernmost localities where they also serve to identify the formation. Fossils are invariably concentrated, and commonly comminuted, on bedding surfaces, where they occur with relatively abundant carbonaceous plant debris. The fine planar lamination which characterizes some beds that are intimately associated with ripples, cross-lamination and bioturbation, resembles that which is considered to characterize tidal deposition (e.g. Klein, 1977, p. 44, Fig. 42). Burrows are predominantly horizontal in these sandstones conforming with their mainly subtidal origin, 'offshore' rather than 'shoreface' in the terminology of Howard (1972), although vertical burrows are not uncommonly locally. In those other southern and eastern localities (e.g. Bug Creek Canyon, on its south side) where poorly sorted, argillaceous, strongly bioturbated lithologies are prevalent as they are to the north and west, fossils are apparently little reworked. These differences in predominant character from one locality to another probably reflect relief on the seafloor and the greater degree of reworking of the shallower sediments by tidal, wave or storm activity.

Some occurrences of the Waters River Member and of thick sandstones of similar character and stratigraphic position immediately south of White Mountains (e.g. units 11 to 14 of section PU-8-78) exhibit the characteristic shoaling succession that becomes increasingly coarser and dominated by traction-current deposition upwards. No firm evidence was recognized either for aggradation above sea level that would suggest barrier island development nor for a back-barrier facies. Judging by the unusually great thickness of the Richardson Mountains Formation here, these areas of thickest sandstone development coincide spatially with those which were most rapidly subsiding.

The greater part of the Richardson Mountains Formation, with its high content of chert and siltstone grains probably had its source in the Paleozoic rocks of the area. The introduction of sediment probably was related in part to uplift and erosion of the Aklavik Arch portion of Peel Landmass (see section on "Notes on tectonic elements").

The shallow shelf environments of the main, middle part of the Richardson Mountains Formation in the central and southern parts of the report-area included a variety of depositional styles, in which marine currents (following Berg, 1975), tidal currents (following Houbolt, 1968; see also Klein, 1977) and storm activity introduced, transported and reworked sand in an otherwise muddy, tranquil subtidal regime (see models of these environments by Johnson, 1978 and Walker, 1978).

In the northern and northwestern localities (sections PU-18, 19 and 20-76), the main part of the Richardson Mountains Formation, however, is dominated by carbonaceous silty mudstone and siltstone that is intensely bioturbated and only in a few places can relict fine lamination be seen. The articulated Inoceramus shells that occur scattered here and there in these argillaceous beds are probably preserved in their living habitats, below the regime of tidal or wave activity. Rare concentrations of ammonites or belemnites in certain of the argillaceous beds probably represent mass mortality concentration rather than winnowing. There is no evidence for slopes such as slump features, nor for "deeper-water" depositional processes, particularly not for the "(?) upper bathyal" depths suggested by Jeletzky (1975, p. 18) in the northern part of the area. Several units of well-sorted fine grained sandstones which occur within this argillaceous succession (Figs. 27, 28) suggest generally shallow environments for the entire unit. Some of them (e.g. unit 35a of section PU-18-76) are the upper parts of coarsening upward cycles and these probably constitute the bulk of the 'shale-mudstone-argillaceous sandstone-clean sandstone' cycles already recognized by Young (1973; Young et al., 1976) in the Jurassic rocks and compared by him with offshore sand bar successions. They resemble the progradational sequences described by Brenner and Davies (1974) and Berg (1975) in the Late Jurassic and Cretaceous respectively of western United States and there is no unequivocal evidence of subaerial exposure, nor for diagnostic indicators of restricted lagoonal deposition associated with them as might be expected in some cases if they aggraded to sea level in the form of barrier islands. These units and the other, more common, sandstone units that show no consistent sequence of lithologies, are commonly planar-laminated, low-angle or trough crossbedded, or are more or less strongly bioturbated, or entirely massive. Some of the crossbedding, as also in the southern localities, resembles the hummocky crossbedding considered by Walker (1978) as diagnostic of subtidal storm deposition. Abrupt, in places scoured, bases are not uncommon. The foraminiferal content of argillaceous rocks associated with some of them at least (e.g. GSC locs. C-80270 to C-80261 of section PU-20-76; see

Table 5) suggests deposition in the marine upper to lower shoreface. They probably result from transport of sand into the dominantly muddy environments. The concentrations of unarticulated and often comminuted Inoceramus and other bivalve shells, belemnites, scaphopods and ammonites that litter some bedding planes probably were concentrated by reworking of adjacent muddy bottoms, by storms. The stacked crossbedded sets with bioturbated tops (e.g. unit 21 of section PU-20-26, Figs. 27, 29, 30) and beds where concentrations of belemnites form the well-developed lower parts of foresets, document periodic and regular introduction of sand for short periods. They may represent submarine sand shoals, bars, or ridges, such as those described on modern shelves by Jordan (1962), Off (1963), Stride (1963), Duane et al. (1972), Johnson (1978) and Walker (1979) for example, and in part, at least, ascribed to tidal currents.

The upper part of the Richardson Mountains Formation everywhere, together with the overlying Aklavik Formation, constitute a general coarsening-upward succession that is characteristic of sands prograding over muds. The succession of sedimentary structures of the Richardson Mountains Formation are, in general, those of the shelf, pro-delta, and delta front (sensu Coleman, 1976, p. 28, 29) environments, although the Aklavik Formation cannot be described as typically deltaic. Bioturbated and laminated or low-angle crossbedded subunits in the upper part of the Richardson Mountains Formation resemble distal bars and distributary mouth bar successions (e.g. units 17 to 19 of section PU-7-75, units 34 to 37 of section PU-20-76) and barrier island successions may be represented at the top of the formation in the northwestern sections (PU-19 and 20-76), where they are arbitrarily included in the Aklavik Formation, for reasons of mappability. Diagnostic evidence of subaerial exposure or deposition in these last units was not recognized, however, nor were restricted environments that would have occurred behind barriers. The Foraminifera of the top of the unit (GSC locs. C-80257 to C-80253 of section PU-20-76; see Table 5) suggest deposition in offshore open shelf conditions.

Aklavik Formation (new name)

Definition, distribution and description

The name Alkavik Formation is proposed for the widespread upper sandstone member of the Bug Creek Formation of Jeletzky (1967). It is easily mappable, forming bluffs that readily locate the top of the Bug Creek Group throughout the area. The type section is at Martin Creek (section PU-2-78, 68°11'30"N Lat., 135°39'30"W Long.; Fig. 34) where the gradational lower and sharp upper contacts are well exposed. The name comes from the Aklavik Range.

The base of the Aklavik Formation is placed, for mappability, at the base of the bluff-forming, apparently massive or generally indistinctly bedded sandstone which dominates the unit, and distinguishes it from less resistant, mainly distinctly and thinner bedded sandstones below. This boundary is somewhat higher than where Jeletzky (1967, p. 4-5) originally placed the base of the upper sandstone member at Bug Creek. He included at the base a 6 to 7.5 m, approx. (20 to 25 foot) covered interval below the massive sandstone unit, that is undoubtedly recessive, argillaceous siltstone and sandstone. Both the present definition of the Aklavik Formation and Jeletzky's definition of the upper sandstone member artifically differentiate the upper part of a regional coarsening-upward succession. These definitions are arbitrary insofar as they may incorporate the upper parts of different, but lithologically similar, coarsening upward cycles from one place to another.

The upper contact with soft, black shales of the Husky Formation is nearly everywhere sharp although a few thin sandstone beds occur low in the latter unit at some localities.

Two prominent sandstones separated by shale in the Beaverhouse Creek H-13 well were included by Dixon (in press) in the Aklavik Formation, where Poulton (1978a) had placed the upper of them in the Husky Formation. The unusually thick and heterogeneous section of sandstone at Canoe Lake (Pl. 7, fig. 5) may also indicate the presence of more than one sandstone there. Other sandstones at the base of the Jurassic succession in other wells farther south (Aklavik F-17, Treeless Creek I-51, Rat Pass K-35) where Poulton (1978a) considered Bug Creek rocks to be absent, were also included in the Aklavik Formation by Dixon (in press). Nevertheless his sedimentation model treats them as basal units related to Husky transgression.

The lower beds of the Aklavik Formation (Figs. 34, 35) are variably laminated or thinly bedded, small-scale crossbedded, or indistictly bedded, and commonly strongly bioturbated. These lower facies are not present in all localities. The higher, bluff-forming, main part of the unit is commonly a pile of trough or low-angle crossbedded, scour-based subunits, each as thick as 2 m (approx.). Here and there they are intensively bioturbated and superficially appear to be massive. This simplified cycle is more

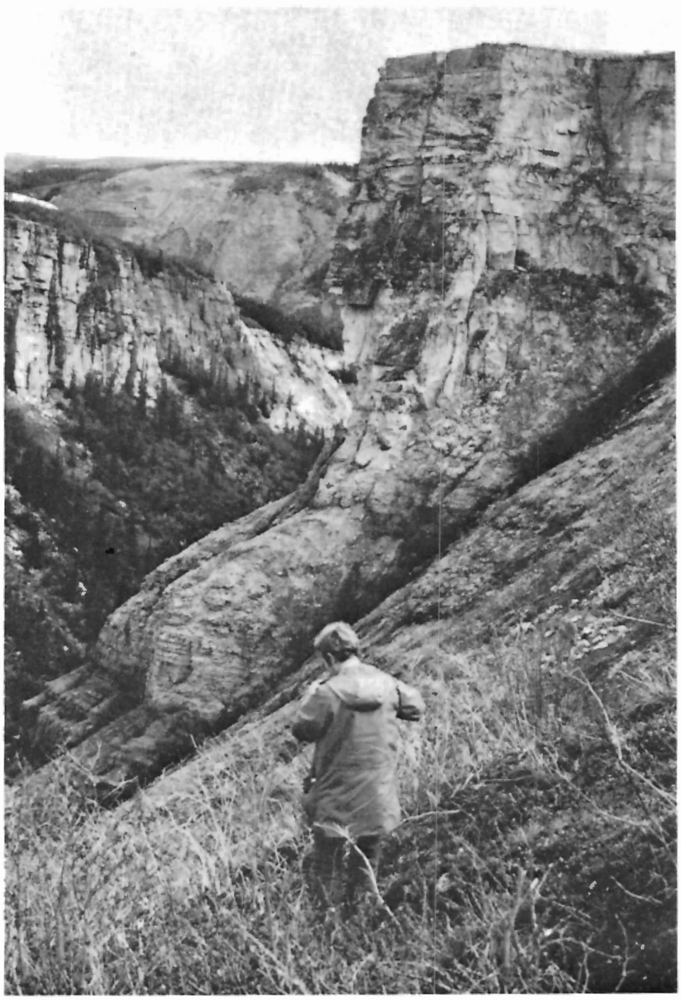


FIGURE 34. Aklavik Formation and upper part of Richardson Mountains Formation at Martin Creek, section PU-2-78. ISPG Photo 1217-8.

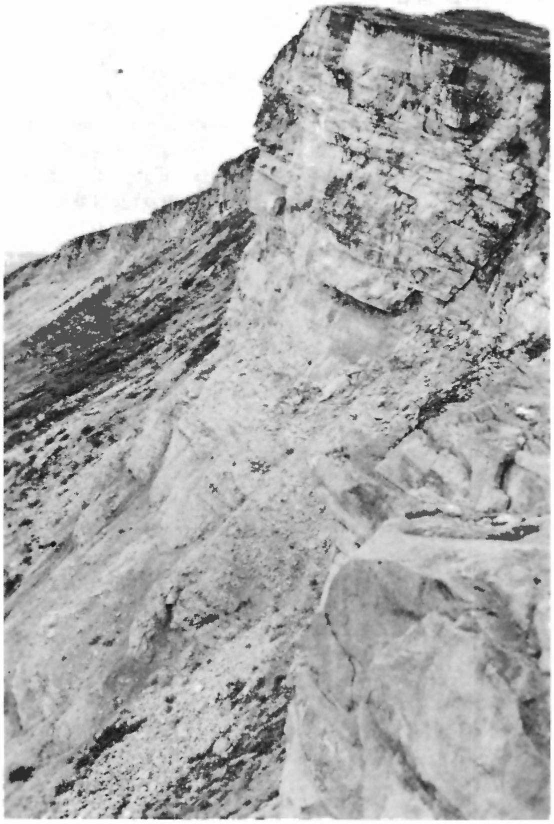


FIGURE 35. Aklavik Formation and upper part of Richardson Mountains Formation, Bug Creek Canyon, section PU-7-75. GSC Photo 202910.

complicated in northwestern exposures (e.g. sections PU-19-76 and PU-20-76) where argillaceous, bioturbated beds occur within upper parts of the unit. Parallel-to-burrowed sets, on the order of 1 m thick, are not uncommon, particularly in the lower part of the unit. Some bedding planes exhibit ripple, rip-up clasts and trails, although none of these features are common.

Randomly chosen samples (e.g. GSC locs. C-80870 and C-80871 of section PU-7-75) are very well sorted texturally and fine grained (average diameter 0.15 to 0.2 mm). Minor coarse-grained and granuliferous sandstone beds occur in the upper part of the formation in the eastern part of the area (sections PU-10-76, PU-2-78), as do carbonized logs localized in small channels, root casts(?), and coniferous plant fragments (sections PU-12-76, PU-2-78). Chert-granule and fine pebble laminae were also seen near the head of Waters River (sections PU-11-76, PU-6-78). Fine carbonaceous plant debris occurs locally throughout the unit. Fossils are rare in the upper part. They are mainly bivalves of morphologically generalized marine or brackish aspect, which form thin near-coquina beds, particularly in western exposures (e.g. section PU-6-78). Scaphopods, belemnites, and marine bivalves occur here and there in some of the lower beds of the Aklavik Formation elsewhere.

Detrital grains other than monocrystalline quartz constitute from less than 1 per cent to approximately 3 per cent (estimated) of the sand fraction in most samples (samples examined in thin section: GSC locs. C-80875 of section PU-11-75; C-80870 and C-80871 of section PU-7-75; C-80857 to C-80859 of section PU-1-75), and of this small amount, chert predominates (Fig. 36). Chert granule beds and stringers occur at several localities, mentioned above, however, and chert sand locally occurs in significant quantities. Polycrystalline quartz and quartz with highly undulatory extinction, siltstone and microcline comprise the remainder. Chlorite or glauconite that may have originated as pellets comprises as much as 5 per cent of one sample (GSC loc. C-80857 from section PU-1-75) which is representative of a black, carbonaceous facies common in the lower part of this formation. Heavy minerals are insignificant in quantity and were not identified systematically, although zircon seems to be the most characteristic. The grains are tightly welded together and quartz overgrowths can be seen here and there. Where the overgrowths are well developed the original grains are moderately to well rounded, but this cannot be seen clearly in most samples. A small amount of limonite distributed sparsely along the grain boundaries, together with dispersed organic material, gives the rock its characteristic brown colour in many localities, a feature already shown to have value for purposes of correlating the formation in the subsurface (Poulton, 1978a). A very small amount of interstitial carbonate occurs which in some places has weathered out to produce pock-marked outcrop surfaces, and to outline bedding. Concretions of any kind are rare in the lower beds. Small rusty specks consisting of interstitial limonite are characteristic in some localities. Jarosite stain, a dark red ferruginous stain, and a pale blue-grey weathering colour characterize lower parts of the unit. The upper beds are generally very hard, and support a flora of black and green lichens.

The Bug Creek Group from McDougall Pass southward almost as far as Mt. Millen comprises a lower part that contains belemnites and is identifed as the Richardson Mountains Formation, and an upper part that is more resistant, blocky, commonly covered with black and green lichen, and is otherwise typical of the Aklavik Formation with which it is identified. Commonly (e.g. sections PU-3-76, PU-17-76) the lower part weathers dark grey, and the upper part white to buff, as is also the case in certain other localities (e.g. section PU-6-78).

The Aklavik Formation is relatively uniform in thickness, varying from 50 to 100 m (approx.). It was probably deposited over the entire report-area although it is now absent between Bell River and White Mountains (section

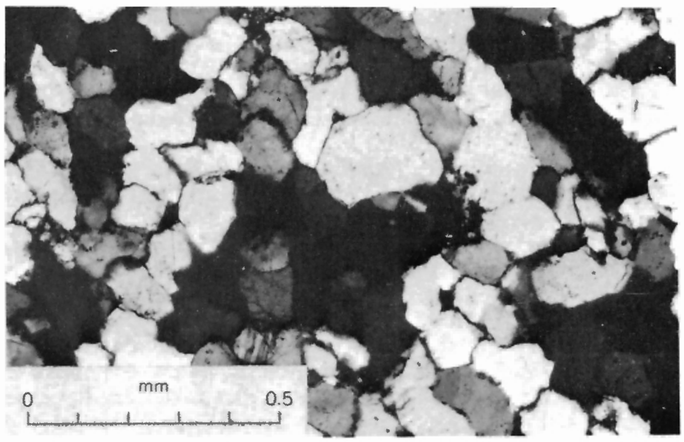


FIGURE 36. Photomicrograph, X-nicols, of sandstone from Aklavik Formation at Bug Creek; GSC loc. C-80871 of section PU-7-75; showing minor chert and feldspar grains, overgrowths and welded texture of predominant quartz grains, and limonite along many grain boundaries. ISPG Photo 1264-20. Scale in millimetres.

PU-32-76; see Fig. 16) below a sub-Cretaceous unconformity, and may be absent below a possible sub-Husky unconformity just south of McDougall Pass (section PU-9-75; see earlier section on "Overlying and underlying units"). The formation is typical at the head of Waters River (Fig. 37).

The entire interval (31.4 m minimum) that represents the Bug Creek Group because of regional geologic relationships, south of Mt. Millen (e.g. section PU-30-76) is included within the Aklavik Formation. It contains chert and other sedimentary rock pebbles and boulders as large as 25 cm in diameter, particularly in its upper 2.4 m, and is more heterogeneously bedded and noticeably crossbedded, than is typical of the formation to the north. The correlation of this unit with the Aklavik Formation is supported by beds and stringers of chert granules that occur in the formation regionally, in contrast to the other formations, and by the inferred paleogeographic-paleoenvironmental relationships within the formation (see below) that indicate approach to shorelines and sediment source to the south.

To the west of the report-area, the Aklavik Formation is identified lithologically and by its similar morphologically generalized, as yet unstudied, bivalve fauna at the major northeastern bend of Porcupine River southwest of the head of Waters River (section 5 of Poulton and Callomon, 1976; Poulton, 1978d, Fig. 2) and also occurs on the west slope of the ridge between Waters River and Berry Creek (see Fig. 1). In these western localities, however, these sandstones cannot be differentiated clearly from the younger Porcupine River Formation which apparently directly overlies them. Jeletzky (1977, p. 11, 12) grouped the sandstones together in the Porcupine River Formation, but representatives of the Aklavik Formation are here considered to be present in the lower part of the sandstone succession at those localities because of the identity of the entire interval, including the underlying argillaceous units, with the Richardson Mountains-Aklavik transition nearby to the north and east. The lower part of the combined sandstone unit in the headwaters of Berry Creek, although unfossiliferous, has already been thought to be early Oxfordian to mid-Callovian (Jeletzky, 1972b, p. 40).

Age and paleontology

The age of the Aklavik Formation in the Aklavik Range and adjacent area is limited by the occurrence of Lower Oxfordian Cardioceras sp. cf. C. (S.) alphacordatum Spath in

FIGURE 37. *Aklavik (A), Husky (H), Porcupine River (PR) and overlying formations near head of Waters River, section PU-6-78. Rubble in foreground is Richardson Mountains Formation. The Husky Formation is hidden in the valley behind the bluff-forming Aklavik Formation. ISPG Photo 1202-2.*

the upper part of the underlying Richardson Mountains Formation (see there) and of one poorly preserved specimen of probably Oxfordian Cardioceras or Amoeboceras sp. in the lower part of the overlying Husky Formation (Poulton, 1978d).

In the northernmost outcrops of the Bug Creek Group (section PU-20-76) also, one specimen of Cardioceras (?Scarburgiceras) sp. indet. (identified by H. Frebold; GSC loc. 94318) was found in the upper part of the Richardson Mountains Formation. Elsewhere the limits are less precise, being indicated by Callovian Cadoceras spp. below, and Upper Oxfordian to Lower Kimmeridgian Buchia concentrica above the formation in many places throughout the northern Richardson Mountains. Judging by its sedimentary structures, the Aklavik Formation was rapidly deposited and may well be entirely Early Oxfordian in age in the northern part of the report-area, and thus essentially synchronous to the limits of detection by paleontology (Table 1). Alternatively, it may become younger to a paleontologically imperceptible degree from southeast to northwest within the narrow time limits described above, as required by the inferred prograding sand model. There is no direct evidence that diachroneity of the contact between the Aklavik and Husky Formations is as marked as Jeletzky (1977, Fig. 5) indicated.

Depositional environments

The Aklavik Formation is a high-energy, marine shelf sandstone. Progressively increasing energy is indicated by the upward predominance, in most localities, of well-sorted and crossbedded sandstone over argillaceous and bioturbated lithologies. An approach to shoreline and fluvial(?) sediment source toward the southeast is possibly indicated, as documented below.

Young (1973, Fig. 3) already pointed out the similarity of the sequence at the type section on Martin Creek to marine sandbar or barrier island sequences. The sedimentary structures, including extensive bioturbation, the well-sorted textures, the rare occurrences of marine fossils, and the widespread distribution of this major sandstone unit are consistent with an interpretation of deposition in entirely marine, tide- or storm wave-dominated, shoreface to foreshore beach environments. The trough crossbedding which dominates the upper part of the unit in some localities may well be due to marine, possibly tidal activity, as also may the scours observed here and there. Nevertheless, these structures, together with the presence, in the Aklavik Range, of structures that may be root casts and carbonized logs suggest that distributary channel sands may be present. The fine carbonaceous fragments that occur commonly throughout the area, in part concentrated in laminae and in part totally dispersed throughout the sandstone, as well as the larger plant debris that is present in some places are consistent with the former interpretation of entirely marine deposition. A Holocene analogue off the Mississippi River delta has been described by Coleman (1976, p. 33). Carbonaceous debris and bioturbation structures are less common or absent, and marine fossils have not been found in the southern and southeastern parts of the report-area. The larger plant remains, including logs and coniferous leaves also have been seen only in the eastern part of the area. Coarse-grained sandstones and granule-bearing beds occur primarily in, but are not entirely restricted to, the Aklavik Range and vicinity. These data further suggest that large-scale marine transport did not take place and may indicate proximity to a fluvio-deltaic system in the southeast. There is, however, no unequivocal evidence that any part of the Aklavik Formation represents nonmarine depositional agencies or was deposited above sea level.

The southernmost, conglomeratic and crossbedded outcrops examined in the present study (section PU-30-76) may possibly be fluvial although they too could be shoreline or nearshore entirely marine deposits.

Characteristic regressive barrier island successions at the top of the Bug Creek Group in its northwestern outcrop areas (sections PU-19-76 and PU-20-76) are included in the Aklavik Formation for reasons of mappability. They resemble those Holocene successions described by Bernard et al. (1962) and Reinson (1979) for example, comprising argillaceous, strongly bioturbated siltstones and sandstones at their base, with increasing proportions of well-sorted, well-bedded sandstones upward.

NOTES ON PALEONTOLOGY AND BIOSTRATIGRAPHY

The most conspicuous faunas of the Bug Creek Group can often be distinguished from those in older and younger rocks relatively easily by the field geologist even if fossils are sparse. Because, in the writers' experience, mapping and exploration geologists have generally had difficulty recognizing or subdividing the Bug Creek Group in a consistent manner from place to place, the following brief summary of fossil distributions is given.

Underlying Permian rocks

The Permian rocks which unconformably underlie the Bug Creek Group are characterized in most localities by a distinctive trace fossil which resembles that illustrated as Zoophycos by Häntzschel (1975) and which has been referred to "Spirophyton" by previous authors. Although this facies-controlled trace fossil ranges through most of the Phanerozoic on a world-wide scale, its abundance in Permian rocks in the Canadian Arctic and rarity in younger rocks, make it a useful stratigraphic tool. Nevertheless, Zoophycos has been found at a small number of localities in Jurassic and Cretaceous rocks of northern Yukon area. Here and there within the upper parts of the Permian succession, beds rich in brachiopods occur.

Overlying Husky Formation

The Husky, like the Porcupine River Formation, is distinguished by Buchia faunas. These bivalves tend to be prolific where they occur, and to dominate the fauna in which they occur. They are not known to occur in beds as low in the succession as the Bug Creek Group.

Bug Creek Group - macropaleontology

Ammonites, although sparsely distributed and commonly poorly preserved, are nevertheless sufficiently abundant to indicate the ages and correlations of the major stratigraphic units. They have been of paramount importance in the preparation of this stratigraphic compilation. The significant ammonites are listed in the key to fossil occurrences accompanying Figure 2. The age determinations are based on comparison with ammonites of Northwest Europe (Arkell, 1956) and East Greenland (Callomon, 1959) primarily, where their succession and the definition of biostratigraphic units has been established. Only at rare localities, such as Murray Ridge (see Fig. 6) or on Porcupine River (see Fig. 1 and Poulton, 1978d) is there a sufficiently good succession of well preserved ammonites within the northern Yukon area to serve as a local standard. Although several reports on the Jurassic fossils have appeared in press (Frebold, 1960, 1961, 1964a, b, 1970, 1975; Frebold et al., 1967; Frebold and Poulton, 1977; Ager and Westermann, 1963), the majority, particularly the non-ammonite faunas, are still not completely known and research is in progress. Poulton (1978d) reviewed knowledge to 1978 of the biostratigraphy and ammonite succession of the Bug Creek Group and equivalent parts of the Kingak Formation to the west.

Other macrofossils, which currently are being studied serve to identify gross biostratigraphic packages. They have approximately the same time ranges in the Kingak Formation of northwestern Yukon and of Alaska (Detterman et al., 1975) in spite of the more argillaceous, possibly deeper-water facies present there, although shelly bivalve-brachiopod faunas are less abundant. Detterman et al. (1975), however, reported crinoids in Bajocian beds at which level they have not been found in the Richardson Mountains or in northwestern Yukon.

Most of the macrofauna are closely similar to those of the Canadian Arctic Islands, east Greenland, and northern Eurasia. They differ from contemporaneous faunas in more southerly parts of western Canada in the boreal character of most of the Middle Jurassic ammonites, the lesser diversity of other species present, and the near absence of certain characteristically southern faunal elements, such as trigoniid bivalves.

Belemnites occur with Toarcian ammonites, and are common in many of the younger units, but do not occur in the older beds of the Bug Creek Group (Jeletzky, 1967, p. 12). That is, their lowest occurrence is in the Manuel Creek Formation and they continue upward into the Husky Formation. They are currently being studied by J.A. Jeletzky.

The lowest appearance of Inoceramus (sensu lato) is also in Toarcian beds, the Manuel Creek Formation. Individual species of Inoceramus (Retroceramus) probably can be differentiated biostratigraphically to approximately the level of the stage. However, until further taxonomic studies are done, no biostratigraphic subdivision of the genus can be given. Like the belemnites, Inoceramus is very rare in the Aklavik Formation, because of its facies, and does not reappear until higher in the Cretaceous succession, above the Buchia-dominated faunas. Look-alike Atomodesma in the Permian beds in certain places is distinguishable from Inoceramus only if well preserved material is collected.

Rich and varied faunas with abundant gastropods, brachiopods and 'Pentacrinus' are restricted to beds which are Upper (or possibly Lower) Sinemurian and Pliensbachian in age, i.e. the Murray Ridge and Almstrom Creek Formations. The bivalves Pholadomya, Gryphaea, Oxytoma (Palmoxytoma) and Myophoria sp. aff. lingonensis Dumortier also characterize these units, and 'Ostrea' and 'Lingula' appear to be restricted to the Almstrom Creek Formation. A variety of 'Parvamussium'-and Aequipecten-like pectinid bivalves occur in these beds and in the overlying Manuel Creek Formation, but do not appear higher in the column. In contrast, other bivalves such as Oxytoma (Oxytoma) and Meleagrinella are longer ranging, and appear sporadically throughout the succession.

Small scaphopods litter many beds in the upper part of the Richardson Mountains Formation (Bathonian to Lower Oxfordian) and also appear less commonly in the Aklavik and the younger Porcupine River Formation.

Bug Creek Group - micropaleontology and palynology

This is the first publication that deals with the microfauna and microflora of the Bug Creek Group. Both are generally poorly preserved. Nearly the entire microfauna and some of the palynomorphs are illustrated here (Plates 1-6). Of the nine stratigraphic sections sampled systematically and thoroughly, only four (i.e. PU-9-76; PU-20-76; PU-2, 26-76; PU-22-76) yielded a variety of both microfauna and microflora from several different horizons (see Tables 2-5). Four other sections (i.e. PU-18-76; PU-19-76; PU-21-76; PU-27-76) yielded a limited variety of Foraminifera from relatively few horizons. They are listed in the description of the beds in which they occur in Appendix 1. In these four sections, no palynomorphs were recovered, because of intense carbonization which appears to characterize all localities near and west of the Northwest Territories-Yukon boundary. The few samples from these sections that yielded microfauna are included and listed in the description of the sections. Section PU-32-76 yielded no microfossils whatsoever. These and other sections studied are illustrated in Plates 7 to 11, in Figures 5, 9-11, 13, 15 and 39, and are described in Appendix 1.

The majority of the microfossils recovered are long-ranging forms of little biostratigraphic value in themselves; those that appear, from this or previous studies elsewhere, to have restricted ranges are indicated in this report. For the most part, however, the microfossil assemblages documented here should be considered as new data whose age determinations are based on the ammonites with which they occur, or on the interpretation of the age of units in which they occur by lithologic correlation with ammonite-bearing sections.

Agglutinated foraminiferids dominate the microfaunal assemblages of the Bug Creek Group. The succession can be roughly subdivided by Foraminifera into four biostratigraphic assemblages which approximate the length of a stage in duration, although many species occur in more than one of these assemblages. They are approximately Sinemurian, Toarcian to early Bajocian, Bathonian, and Callovian, respectively. The listings below are based on samples which are highly variable in quantity and quality of preservation, and the range charts (Tables 2-5) should be consulted for abundance of specimens. Only sample localities which were productive are indicated in these tables.

The oldest assemblage of Foraminifera, Assemblage A, is best seen in sections PU-2, 26-76, PU-22-76 and PU-9-76 (Tables 2-4). This assemblage has been recovered from the Murray Ridge Formation which has been dated as Sinemurian by ammonites. Spiroplectammina sp. 5274, Astacolus sp. 5269 and Textularia sp. 5270 appear to be confined to this formation, whereas Ammobaculites sp. 4925, A. sp. 5261, Haplophragmoides sp. 5268, Trochammina sp. 5267, T. sp. 4965 and Ammodiscus sp. cf. A. orbis Lalicker also occur in the younger Assemblage B of the Manuel Creek Formation.

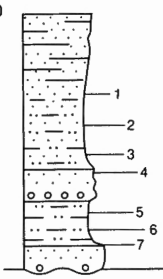
Foraminifera Assemblage B characterizes the Manuel Creek Formation of Toarcian to early Bajocian age, as dated by ammonites in section PU-9-76 (Table 4). Foraminiferids that appear to be confined to this formation are Haplophragmoides sp. 4914 and Marginulinopsis sp. 5000. Additional elements of this assemblage which also appear in older rocks are discussed above, under Assemblage A.

The youngest Foraminifera assemblages, C and D, have been recognized in section PU-20-76 in the Richardson Mountains Formation of Bathonian to Oxfordian age (Table 5). Species that appear to be confined to Assemblage C are Ammobaculites sp. 5262, Haplophragmoides sp. 5263, H. sp. 5265, and Lingulina sp. 5259.

TABLE 2

Distribution of ammonites, foraminifera, palynomorphs and other microfossils, in stratigraphic section PU-2, 26-76, on a spur extending eastward from Jurassic Butte

SYSTEM	SERIES	STAGE	FORMATION	METRES	LITHOLOGY	SAMPLE
JURASSIC	MIDDLE	BAJOCIAN - CALLOVIAN	RICHARDSON MOUNTAINS FORMATION	100, 50		1, 2, 3, 4
	LOWER	SINEMURIAN (late)	MURRAY RIDGE FORMATION	0		5, 6, 7



SAMPLES	GSC LOCALITY NUMBERS	AMMONITES	MICROFOSSILS: *Recurvoides* sp. 5009	*Trochammina* sp. 4965	Megaspore 10	*Ammobaculites* sp. 4925	*Ammodiscus* sp. cf. *A. cheradospirus*	*Lenticulina* sp. cf. *L. biexcavata*	MICROFAUNAL ASSEMBLAGE	PALYNOMORPHS: Bisaccates sp. indet.	Spores, undiff.	Microplankton, undiff.	*Classopollis classoides*	Reworked Paleozoic spores	*Gonyaulacysta cladophora*	*Cerebropollenites mesozoicus*	*Caytoniales* sp.	*Pareodinia cerathophora*	*Podocarpidites* sp.	*Taxodiaceaepollenites* sp.	Striate bisaccate pollen	*Eucommiidites minor*	Taxodiaceae sp.	*Scriniodinium* sp. cf. *S. grossii*
1	C-53574		1	1						X	X	X	cfR	X	X	X								
2	C-53575				1					X	X	X	cfR	X		C	R	X	R					
3	C-53576									R			R	X										
4	C-53577												R	X										
5	C-53578	*Echioceras* sp.		2		1	1			X	X		C			X	X					R	X	
6	C-53579							1	A	X	X		R											R
7	C-53580	*Arctoasteroceras jeletzkyi*	BARREN										C			X	R			C	R	R	X	

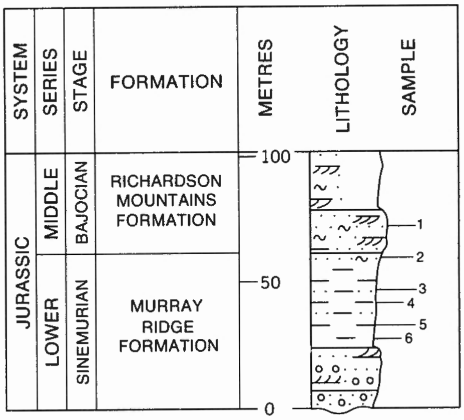
GSC

No Recovery .... BARREN
Present X
Rare .... R
Common C
Abundant .... A
Identification questionable ..... cf

	Microfossil Samples		Palynomorph Samples
1	(1-5)	1	(1-10)
2	(6-20)	2	(11-50)
3	(>20)	3	(>50)

TABLE 3

Distribution of ammonites, foraminifera, palynomorphs and other microfossils, in stratigraphic section PU-22-76 (lower part), at head of Willow River. Key to abundance of microfossils same as in Table 2



SAMPLES	GSC LOCALITY NUMBERS	AMMONITES	MICROFOSSILS: *Ammodiscus* sp. cf. *A. cheradospirus*	*Trochammina* sp. 4965	*Ammobaculites* sp. 4925	*Astacolus* sp. 5269	*Trochammina* sp. 5267	*Textularia* sp. 5270	MICROFAUNAL ASSEMBLAGE	PALYNOMORPHS: Bisaccate Pollen	*Cerebropollenites mesozoicus*	Microplankton sp., indet.	Spores, indet.	*Classopollis* sp.	*Taxodiaceaepollenites* sp.	*Laevigatosporites* sp.	*Contignisporites dunrobinensis*	*Eucommiidites minor*	*Gleicheniidites* sp.	*Podocarpidites* sp.	*Densosporites* sp. (reworked)	Taxodiaceae	Reworked Paleozoic spores	*Densosporites* sp. cf. *D. scanicus*	*Stereisporites* sp.	*Lycopodiumsporites marginatus*
1	C-80285									X	X	cfX														
2	C-80286		1	1	1					X			X	cfX	cfX											
3	C-80287	*Echioceras* sp.	1	2	1					X	X		X	X		X	1									
4	C-80288		1	1					A	X	X		X	X	X			X	X	X	X	X	X	X		
5	C-80289				1					X			X										X		X	
6	C-80290		1	2	1	1	2	1		X	X	cfX	X	X								X	X			X

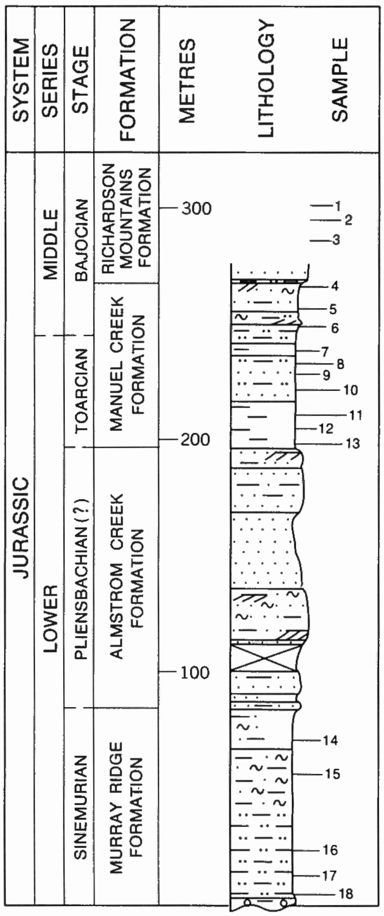
GSC

No Recovery .... BARREN
Present X
Rare .... R
Common C
Abundant .... A
Identification questionable ..... cf

	Microfossil Samples		Palynomorph Samples
1	*(1-5)*	1	*(1-10)*
2	*(6-20)*	2	*(11-50)*
3	*(>20)*	3	*(>50)*

TABLE 4

Distribution of ammonites in stratigraphic section PU-9-76 and of foraminifera, palynomorphs and other microfossils from samples collected in an equivalent section approximately 330 to 400 m south of it. Key to abundance of microfossils same as in Table 2



SAMPLES	GSC LOCALITY NUMBERS	AMMONITES (Name in brackets - position approximate)	MICROFOSSILS: *Eucyrtidium* sp.	*Eoguttulina* sp. cf. *E. amygdalina*	*Haplophragmoides* sp. 4914	*Haplophragmoides* sp. 5268	*Trochammina* sp. 5267	*Ammobaculites* sp. 5261	*Marginulinopsis* sp. 5000	*Ammodiscus* sp. cf. *A. orbis*	*Trochammina* sp. cf. *T. canningensis*	*Trochammina* sp. 4965	*Ammobaculites* sp. 4925	MICROFAUNAL ASSEMBLAGE	PALYNOMORPHS: Spores, indet.	*Classopollis* sp.	*Densosporites* sp.	Bisaccates sp.	*Vitreisporites pallidus*	Taxodium pollen?	*Lycopodiumsporites* sp.	*Stereisporites cicatricosus*	*Mancodinium semitabulatum*	*Tigrisporites* sp.	*Baltisphaeridium* sp.
1	C-53581														X										
2	C-53582														X	1									
3	C-53583														X		X								
4	C-53584	*Arkelloceras* sp.	1	1											X	2		1							
5	C-53585				1	1									X	2		1							
6	C-53586	*Erycitoides* (?) sp.			1		1	1	1						X	1									
7	C-53587														A	2			1						
8	C-53588						1	1		1				B	A	1		1	1						
9	C-53589							1		1					X	2		X							
10	C-53590						2			1	1				X	2		R			1	1	cf1		
11	C-53591						1				1				C	2		R					2	1	1
12	C-53592						1								X	cf1		X							
13	C-53593														X	1		X			1		1		
14	C-53594														X	1									
15	C-53595						1			1		1			X	1									
16	C-53596						1	1		1		1		A	X			cfX							
17	C-53597	*Echioceras* sp.				1	1			1			1		X										
18	C-53598	*Arctoasteroceras* (?) sp.										2	1		X		X								

GSC

No Recovery .... BARREN
Present X
Rare .... R
Common C
Abundant .... A
Identification questionable ..... cf

	Microfossil Samples		Palynomorph Samples
1	*(1-5)*	1	*(1-10)*
2	*(6-20)*	2	*(11-50)*
3	*(>20)*	3	*(>50)*

Species that appear to be confined to the younger Foraminifera Assemblage D are Haplophragmoides sp. cf. H. canui Cushman, H. sp. cf. H. volgensis Myatliuk, Geinitzinita sp. cf. G. praenodulosa Dain, and Marginulinopsis sp. aff. M. phragmites Loeblich and Tappan.

Species common to Assemblages C and D are Lenticulina sp. cf. L. biexcavata Myatliuk, Reophax sp. cf. R. hounstoutensis Lloyd, Recurvoides sp. 5009, and Trochammina sp. cf. canningensis Tappan.

The upper two microfaunal assemblages C and D, found in the Richardson Mountains Formation bear some resemblance to the equivalent assemblages in the Fernie Formation of northeastern British Columbia and adjacent Alberta (Brooke and Braun, in press) and to that on Amund Ringnes Island (Wall, in Balkwill et al., 1977).

Only one ostracod specimen was found, an undetermined genus, sp. 81, in probable Bathonian beds of the Richardson Mountains Formation (GSC loc. C-80264, section PU-20-76) (Table 5).

The radiolarian Eucyrtidium sp. occurs abundantly in the upper part of the Almstrom Creek Formation in section PU-20-76 (GSC loc. C-80277) (Table 5) and in the upper part of the Manuel Creek Formation in section PU-9-76 (GSC loc. C-53584) (Table 4). The latter occurrence conforms more or less with its Bajocian age indicated by Weihmann (1964), in southeastern British Columbia and Alberta, but the former may possibly represent an older extension of its range in northern Canada.

The samples generally contain low amounts of spores, pollen and dinoflagellates. The preservation is extremely poor, probably in part due to a high energy environment of deposition. Consequently, identification of the palynomorphs is not always possible. Those forms that have been described previously from the Arctic Islands, the northern Yukon and adjacent Northwest Territories, Alberta and Saskatchewan bear little resemblance to the palynomorphs recovered in this study, some of which appear to be new.

Most of the palynomorphs are long ranging and of little use as stratigraphic tools other than to suggest a Jurassic age. Others noted below, however, have more restricted ranges in other areas, and therefore are useful tools for correlating the Bug Creek Group.

Mancodinium semitabulatum Morgenroth which occurs in the Manuel Creek Formation (section PU-9-76, Table 4) and in the top of the Almstrom Creek Formation (section PU-20-76, Table 5) also is known from the Arctic Islands (van Helden, 1977) and Europe (Morgenroth, 1970). Its stratigraphic range is from possibly late Pliensbachian to Toarcian.

Psaligonyaulax dualis Brideaux and Fisher occurs in the upper part of the Richardson Mountains Formation (section PU-20-76, Table 5). This cyst has been described previously from the Husky Formation in the Richardson Mountains (Brideaux, 1976) and the Ringnes Formation of the Canadian Arctic Islands (Tan and Hills, 1978). It ranges in age from Oxfordian to Kimmeridgian, and possibly is also as old as Callovian.

Nannoceratopsis pelucida Deflandre occurs above Mancodinium semitabulatum but below Psaligonyaulax dualis (section PU-20-76, Table 5). Its total known range is from possibly Bajocian to Lower Kimmeridgian (Johnson, 1972). This form is known also from the Canadian Arctic Islands, Saskatchewan and Europe.

Gonyaulacysta cladophora (Deflandre) Dodekova has a worldwide range from Bajocian to Kimmeridgian. It occurs in Sections PU-2, 26-76 and PU-20-76 (see Tables 2, 5) and is known also from Europe, the Canadian Arctic Islands, Alberta, Saskatchewan, and the Canadian eastern offshore area.

A few specimens of a megaspore, sp. 10, occur in the Almstrom Creek Formation (GSC locs. C-80282 and C-80275, section PU-20-76, Table 5) and in the Richardson Mountains Formation (GSC loc. C-53575, section PU-2-26-76, Table 2).

NOTES ON PETROGRAPHY AND PROVENANCE

Representative samples were studied cursorily in thin-section and by semi-quantitative x-ray diffraction to determine major constituents and trends.

The Bug Creek siltstones and sandstone comprise predominantly monocrystalline quartz grains as pointed out by Young (1973). They are invariably angular to poorly rounded, except in the Aklavik Formation, where some grains, preserved within secondary overgrowths in textures otherwise commonly obscured by recrystallization and welding, can be clearly seen to be well rounded. The quartz grains rarely exceed fine sand grade in size. The quartz sand probably was largely derived in its last cycle, from the Permian sandstones which immediately underlie the Bug Creek Group, but in part may have come from greater distances, in association with the feldspars and polycrystalline quartz, which as discussed below, cannot be ascribed to local origins. The low degree of rounding and sphericity of quartz in all formations except the uppermost suggests predominantly little transport, and the high degree of rounding in the Aklavik Formation may be related to the greater number of recycling episodes it reflects rather than to transport distance.

The chert pebbles and grains in the Scho Creek Member at Jurassic Butte are in part rusty-red and probably are derived locally from the unnamed sandstone and conglomerate units of Permian and possible Permian age respectively, that immediately underlie it (see Nassichuk et al., 1978). These, in turn, can claim a local primary source in the chert-bearing Lower Paleozoic Road River Formation which is also exposed there. These superjacent, areally restricted, conglomerate units probably indicate a long history of minor fault movements along the margin of Peel Landmass.

Chert dominates the granules, pebbles, and coarser clasts that occur wherever basin-marginal deposition is inferred, i.e. in the Scho Creek Member, and marginal facies of the Richardson Mountains and Aklavik Formations, where they unconformably overlie Paleozoic rocks progressively southward. At these stratigraphic levels where major oversteps occur, chert forms a particularly high (as high as 45 per cent) proportion of the sand-grade fraction, even well into the depositional basin. The proportion of chert remains as much as 15 per cent throughout the Richardson Mountains Formation but is much less (less than 10 per cent) in the Almstrom Creek Formation.

Siltstone, argillite, and related sedimentary rocks form the remaining small proportion of allochthonous grains. They are most abundant in beds which immediately overlie, or are inferred to have been deposited close to, Permian rocks below, and were probably derived from them locally. Accessory detrital minerals, dominantly zircon, are only significant in quantity locally. This mineral, and detrital mica and chlorite that occur sporadically in the Richardson Mountains Formation can be ascribed to local, subjacent sources. There is no obvious local source for the feldspars of several types, and the polycrystalline quartz, which comprise less than one per cent of the fine grained sand fraction in all formations. A likely source of these materials lies in the late Precambrian "Grit Unit" of Mackenzie Mountains, which may well have been uplifted and exposed to erosion throughout Jurassic time. This hypothesis involves transport distance of a minimum of 300 to 400 km. Derivation from the Canadian Shield would involve no less than 750 km. The small intrusive bodies of Paleozoic age in the vicinities of Mount Sedgwick, Mount Fitton, and Old Crow, northwest and west of the report areas probably do not constitute potential source areas, first because as far as is known they are surrounded by Jurassic shales in a basinward facies which show no indication of source material within them in Jurassic time; and second because they lie in a direction opposite to the southerly or southeasterly source of Bug Creek sediments inferred from facies and thickness trends. Those intrusives in the Old Crow area and adjacent parts of Alaska, together with the late Paleozoic sedimentary rocks of those areas, have previously been considered to have been a source of Jurassic and Cretaceous sediments that were westerly-derived equivalents of the Bug Creek Group (Jeletzky, 1972b; 1975, p. 42). Documentation of data currently in preparation suggests that their contribution of significant amounts of sediment of Bug Creek age is unsubstantiated.

The term 'glauconite' is used here for a green mineral, which is seen to be pelletoidal in thin-section. X-ray diffraction of representative samples from the Almstrom Creek and Richardson Mountains Formation shows it to be mineralogically an illite (G.P. Michael, pers. comm.).

NOTES ON TECTONIC ELEMENTS

The regionally northeasterly-trending unstable cratonic margin of Peel Landmass (Fig. 3) in northern Yukon and adjacent Northwest Territories comprised a series of uplifts and depressions (see Fig. 5) which influenced sedimentation of different Mesozoic units and whose existence and character are documented or further enlightened by the present study. A positive element called the Aklavik Arch was recognized first by Jeletzky (1961a, p. 538, 539, Fig. 22) in the mid-Valanginian stratigraphic and structural record and visualized as a simple anticlinal structure extending from near the junction of Bell and Rock Rivers northeastward to near Inuvik. He later (Jeletzky, 1962) considered this structure to be one part of a previously existing more extensive 'ancestral Aklavik Arch', which he postulated to have been fragmented prior to Cretaceous time by strike-slip tectonics (see also Norris, 1973), a suggestion he later retracted (Jeletzky, 1975, p. 49). Jeletzky (1962) also gave evidence for the presence of this feature since mid-Cambrian time. The complexity and intermittent activity of different parts of this and other structures in the region from late Proterozoic through Tertiary time was shown by Martin (1959), Knipping (1960), Bamber and Waterhouse (1971), Jeletzky (1961a, 1962) and Norris (1973, 1974) among others and summarized by Yorath and Norris (1975; see also Lerand, 1973; Young et al., 1976) who treated it as a complex unit, the Aklavik Arch Complex. Norris (1972, 1974) considered the different parts to have an en échelon arrangement although this has been repudiated by Jeletzky (1975).

Discussion of the positions of Jurassic shorelines, troughs and high areas to the southwest of the present study area, and the conflicting interpretations of Jeletzky (1975) and Young (Young et al., 1976) are presented in Appendix 3. The northeast-southwest trend of the Lower and Middle Jurassic basin margin continues southwestward toward the Yukon-Alaska border and then, near the border, trends southward. The presence, during Early and Middle Jurassic time, of Keele-Old Crow Landmass, or uplift of Brooks Geanticline is not indicated by the evidence presently available.

A similar trend pertained in the southwestern parts of Mackenzie Delta to the east of the present report-area (Poulton, 1978a), but a major northwesterly swing of isopachs, the limit of pre-Husky Jurassic rocks and possibly also of their shorelines, has been noted by J. Dixon (pers. comm.) in north-central Mackenzie Delta (see Fig. 38). He suggests that the Bug Creek Group is entirely unrepresented in Kugpik O-13 (see Fig. 1) and adjacent wells there, where Young et al. (1976) and Poulton (1978a) thought a relatively thin Bug Creek section to be present. If Cretaceous and uppermost Jurassic rocks (Husky Formation) unconformably overlie Paleozoic rocks there and if that area was a tectonically positive feature during Bug Creek time (J. Dixon, pers. comm.) it should probably be treated as a separate element from the Cache Creek High (see below), preceding it in time and being geographically removed from the area of its main activity (Tununuk High of Lerand, 1973; Dixon, in press). The presence of a more or less typically developed Bug Creek succession in the Tullugak K-31 well a short distance southeast of Kugpik O-13, however (see Fig. 1) suggests if Dixon is correct, that a fault may possibly separate the two wells (Fig. 38). Farther northeast, in northeastern Mackenzie Delta area, the Bug Creek Group is now known to be absent although it had been assumed to be present in a siltstone facies in the subsurface (Young et al., 1976, Fig. 4; see also Lerand, 1973). It was apparently overstepped by the Husky Formation and younger rocks, below which the Bug Creek rocks may well have been eroded away, if they were ever present.

Thus the Bug Creek Group has the configuration of a wedge thinning laterally along regional depositional strike both northeastward to where the younger Husky Formation overlies Paleozoic rocks in northeastern Mackenzie Delta, and southwestward to where rocks equivalent to the Husky lie only a short distance stratigraphically above Triassic rocks in northern Ogilvie Mountains (see Fig. 1). The apex of the wedge conforms geographically with Vittrekwa Embayment of Young et al. (1976; see Fig. 38) although the extent of the embayment is much reduced (see below) if it was present at all as such. The dimensions of this Jurassic complex of marine, but presumably originally delta-related sandstones and argillaceous rocks approximate those of the modern Mississippi River and Mackenzie River deltas both along regional and depositional strike and across it.

Those elements of the unstable cratonic margin (i.e. of Aklavik Arch Complex) which were significant, or interpreted as significant, in the Jurassic history of northern Richardson Mountains area include Rat Uplift, Vittrekwa Embayment, Eagle Arch, White Mountains Uplift and Cache Creek High (Fig. 38).

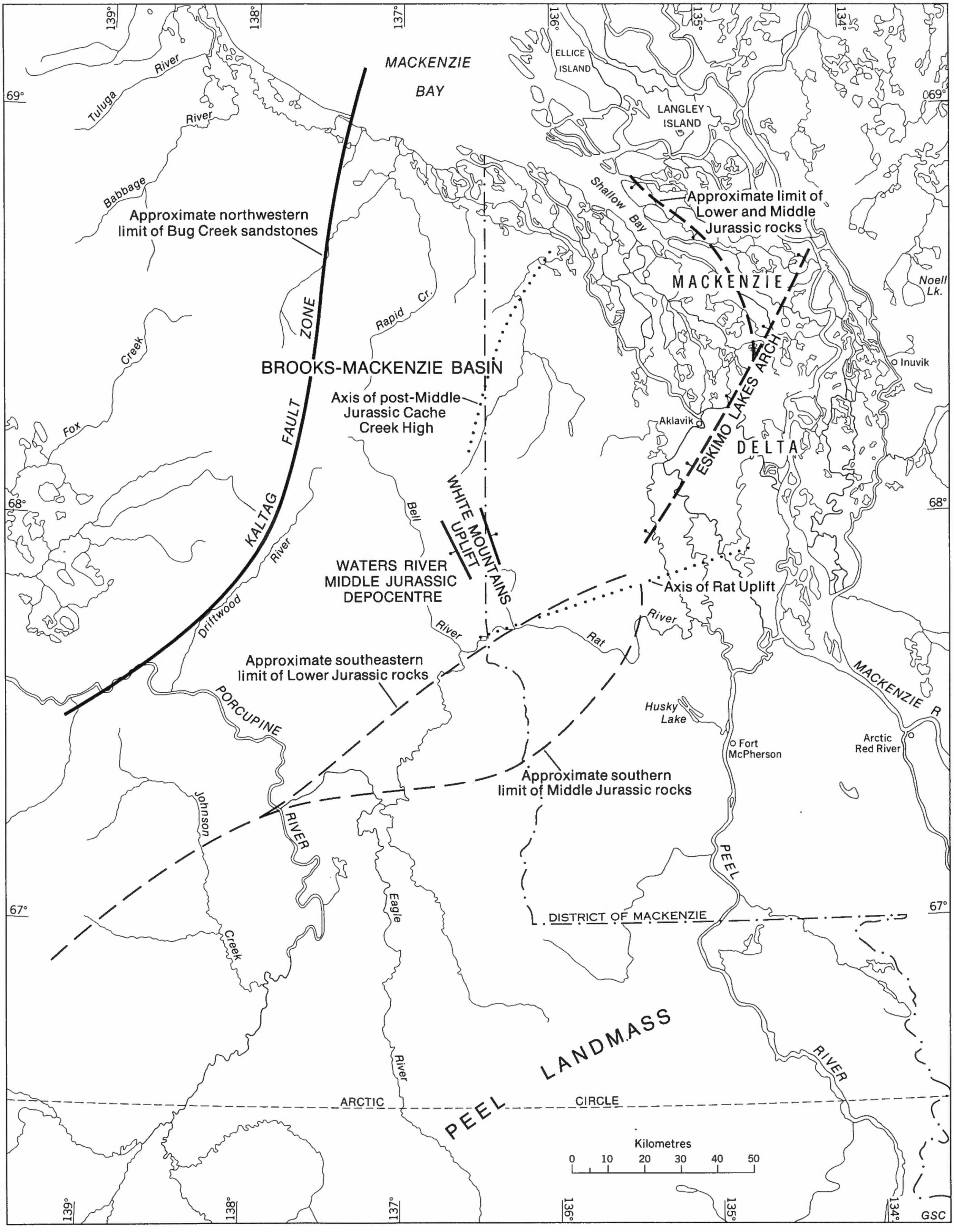


FIGURE 38. *Paleogeographic and tectonic elements that affected Early and Middle Jurassic sedimentation in northern Yukon and adjacent Northwest Territories. Also shown are major fault zones that affect or may affect the present distribution of Bug Creek rocks.*

TABLE 5

Distribution of ammonites, foraminifera, palynomorphs and other microfossils in stratigraphic section PU-20-76, at junction of Almstrom and Little Fish Creek. Key to abundance of microfossils same as in Table 2

			MICROFOSSILS																						PALYNOMORPHS																													
SAMPLES	GSC LOCALITY NUMBERS	AMMONITES (Name in brackets - position approximate)	*Haplophragmoides* sp. cf. *H. canui*	*Haplophragmoides* sp. cf. *H. volgensis*	*Reophax* sp. cf. *R. hounstoutensis*	*Recurvoides* sp. 5009	*Ammobaculites* sp. cf. *A. alaskensis*	*Trochammina* sp. cf. *T. canningensis*	*Ammobaculites* sp. cf. *H. pokrovkaensis*	*Lenticulina* sp. cf. *L. biexcavata*	*Geinitzinita* sp. cf. *G. praenodulosa*	*Marginulinopsis* sp. aff. *M. phragmites*	*Ammodiscus* sp. cf. *A. cheradospirus*	*Ammobaculites* sp. 5260	*Haplophragmoides* sp. 5263	*Trochammina* sp. 5264	*Eoguttulina* sp. cf. *E. amygdalina*	Ostracoda genus indet. sp. 81	*Lingulina* sp. 5259	*Haplophragmoides* sp. 5265	*Ammobaculites* sp. 5262	Megaspore 10	*Eucyrtidium* sp.	MICROFAUNAL ASSEMBLAGE	Bisaccate pollen	Spores, indet.	Microplankton indet.	*Cerebropollenites mesozoicus*	*Pareodinia / Kalyptea*	*Lycopodiumsporites marginatus*	*Psaligonyaulax dualis*	Reworked Paleozoic spores	*Nannoceratopsis pellucida*	*Pareodinia borealis*	*Gonyaulacysta* sp. cf. *G. cladophora*	*Classopollis classoides*	*Nannoceratopsis* sp. cf. *N. gracilis*	Microplankton indet sp. 1	*Gonyaulacysta* sp. cf. *G. jurassica*	*Stereisporites aulosensis*	Microplankton indet. sp. 2	Microplankton indet. sp. 3	*Osmundacidites* sp.	*Nannoceratopsis* sp.	*Mancodinium semitabulatum*	*Classopollis* sp.	*Horologinella* sp.	*Podocarpidites* sp.	*Uvaesporites puzzlei*	*Auritulinasporites scanicus*	*Stereisporites cicatricosus*	*Micrhystridium* sp.	*Taxodium / Pollen ?*	*Cyathidites* sp.
1	C-80251		1																						X	X																												
2	C-80252		1	1																					X	X																												
3	C-80253		1	1	1	1																			X		X	cfX	X	X																								
4	C-80254	*Cardioceras (Scarburgiceras)* sp.	1			1																			X	X	X				X	X																						
5	C-80255		1	1	1	1	1																																BARREN															
6	C-80256		1	1	1	1		1	1															D															BARREN															
7	C-80257		1	1		1		2	1	1	1																												BARREN															
8	C-80258			1		1		1	1	1		1													X	X	X					C	R																					
9	C-80259	*Cadoceras* sp.	1	1		1		1	1	1		1	1												X	X	X	X	C					X	X																			
10	C-80260		1	1		1		1	1				1												X	X		X	C					X	R	R																		
11	C-80284													1	1										X	X		X									cfX																	
12	C-80261					1				1					1																																							
13	C-80262				1					1						1									X	X			X						X			X																
14	C-80263									1						1									X	X		R	X						X			X																
15	C-80264							1		1						1	1	1	1						X	X	R	C			cfX		X																					
16	C-80265												1		1									C	X	X	X											X	cf1															
17	C-80266														1					1					X	X	X	X				X			X			X																
18	C-80267																				1				R	X		X							X	R				R														
19	C-80268																1								R	R												X		X	X	R												
20	C-80269												BARREN												X	X	X	X																										
21	C-80270					1								1	1	1				1					X	X	cfX	X																										
22	C-80272	(*Cranocephalites* sp.)											BARREN												X	R			cfX																									
23	C-80273												BARREN												R		R	C															X											
24	C-80274												BARREN												X			X	cfX	X						C								C	R									
25	C-80275																								X			X		X						X									X									
26	C-80276												BARREN												C	X		X															X		X	X	X							
27	C-80277																						1		X			X							cfX	R							X		X	X								
28	C-80278																								X	X		cfX								X																		
29	C-80279												BARREN												X	X		X		X						R							X		X				R	R				
30	C-80280																								X	X		X								X																		
31	C-80281												BARREN												X			R		cfX						R															X	R	X	X
32	C-80282															1						1			X	X		C		X						X																R	X	X
33	C-80283												BARREN												C	C		cfX								R																		

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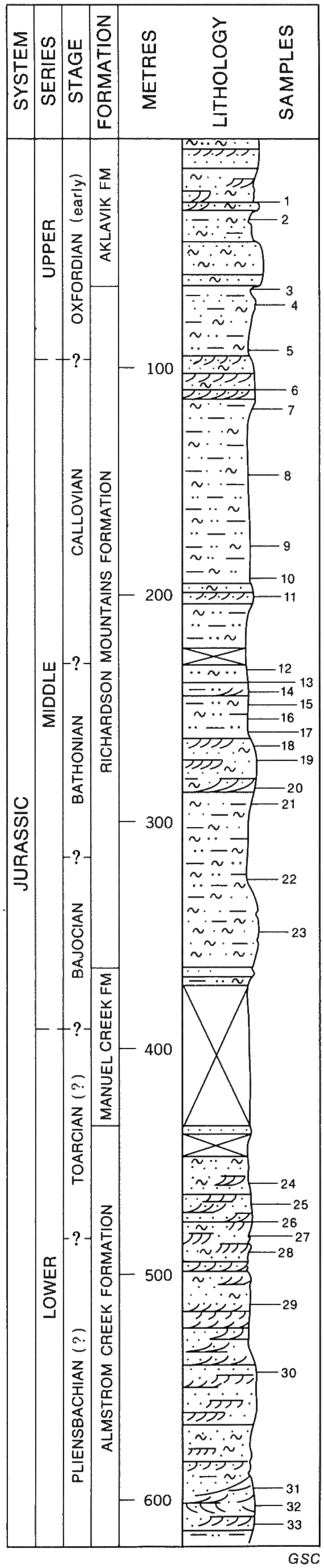
Key	
No Recovery	BARREN
Present	X
Rare	R
Common	C
Abundant	A
Identification questionable	cf

	Microfossil Samples		Palynomorph Samples
1	*(1-5)*	1	*(1-10)*
2	*(6-20)*	2	*(11-50)*
3	*(>20)*	3	*(>50)*

Rat Uplift (Norris, 1973) was illustrated by Jeletzky (1975, Fig. 9) as a localized, in part arch-like uplift in Jurassic time on that portion of the cratonic margin which lay just south of McDougall Pass, and which formed much of the southeastern margin of deposition of, and in part underlay, the Bug Creek Group. During Lower and Middle Jurassic time however, and until mid-Hauterivian time, there is little reason to think that this positive tectonic feature was, in the strict sense, a narrow, two-sided arch. Rather, during Bug Creek time at least, it can better be interpreted as the simple, gently northwesterly sloping surface of the craton. To the southeast, subaerial exposure or nonmarine deposition presumably was the prevailing condition during Jurassic time, and to the northwest lay the marine Brooks-Mackenzie Basin.

However, two lower Jurassic fossil localities have been reported south of Rat River, on the east side of the northern Richardsons. One, reported by Ager and Westermann (1963) was taken by Jeletzky (1967) to indicate the re-appearance of Lower Jurassic rocks on the south side of the Aklavik Arch. The locality could not be found by Poulton in the field and could not be substantiated in a search of the records of the alleged collector, Shell Canada. Another locality described by Frebold (1975; GSC loc. 88066; see Appendix 2), also from the area south of Rat River, near the head of Barrier River, is equally elusive. The narrow, two-sided nature of the arch cannot be considered to be documented reliably by either of these reported occurrences. If the localities indicated for these collections are correct, and they are represented by outcrop, the Upper Sinemurian rocks they represent are small

TABLE 5 (cont'd)



GSC

remnants that survived pre-Bajocian or Bathonian erosion, as shown by Jeletzky (1975, Fig. 9). If a narrow uplift existed at this position in Early Jurassic or early Middle Jurassic time, it is clearly of secondary importance to the general northwesterly basinward trend indicated by thicknesses and facies of the Bug Creek formations. That Lower Jurassic rocks appear to have been at least slightly eroded suggests, however, a Bajocian interval of minor upwarping (e.g. Jeletzky, 1967). The absence of the lower formations of the Bug Creek Group at McDougall Pass (see Figs. 10, 12) and at all localities seen by Poulton or Jeletzky (1975; 1980) south of there is due in part to erosion of the lower members prior to deposition of the Bajocian or Bathonian beds of the Richardson Mountains Formation. It is also due in part to non-deposition because approach to shorelines toward the south and southeast is documented by thinning of some of the lower formations and by facies changes within them, as described earlier in this report.

Two major contrasting opinions have been published regarding the paleogeography and sedimentary-tectonic elements lying immediately west and west-southwest of Rat Uplift. Briefly, Young (1975; Young et al., 1976) considered a tectonically positive feature, the Eagle Arch, to underlie Eagle Plain (see Fig. 38; Young et al., 1976, Fig. 2) in the same place where Jeletzky (1975, Fig. 9) had placed the axis of his Porcupine Plain - Richardson Mountain Trough and (Jeletzky, 1980) placed the Canoe Strait portion of that trough. Young (loc. cit.) described the Eagle Arch as being shorter than did Moorhouse (1966 and unpubl.) who extended it northeastward to the Yukon-Northwest Territories border, across Young's (Young et al., 1976) Vittrekwa Embayment (see below and Fig. 38). Moorhouse's (loc. cit.) Eagle Arch lay southeast of a major trough, Kandik-Richardson Trough, whose axis he placed northwest of that of Jeletzky's (loc. cit.) Porcupine Plain-Richardson Mountain Trough. His paleogeographic-tectonic reconstructions of these features and the similar one of Young (Young et al., 1976) are closest to those adopted in this report (see Appendix 3). However, the re-interpretation of the basal Jurassic beds in the southern part of Vittrekwa Embayment as North Branch Formation (Norris, in press) imparts a simpler form to the Lower and Middle Jurassic shorelines than Young (*ibid.*) showed (see Fig. 38) and also imparts to Eagle Arch the character not of a two-sided arch but rather a gently northwesterly-dipping shelf, overstepped to the southeast in Late Jurassic time.

The existence of a positive feature rather than a trough in Eagle Plain in the early Mesozoic is based on the following criteria listed by Young (1975): 1) the progressively older ages toward the crest of the inferred arch, of Paleozoic rocks below the sub-Mesozoic unconformity; 2) basal Mesozoic units become thinner and onlap onto the crest of the arch, and 3) these basal units are of littoral and sublittoral character. As pointed out by Jeletzky (1972b, 1975, 1980) the absence of rocks of Lower and Middle Jurassic age in many areas of Eagle Plain cannot be used as evidence of non-deposition; this could be a case of deposition and subsequent erosion. Some rocks of Early and Middle Jurassic age were stated by Chamney (in Norford et al., 1971) to be present in well YT-P-34 (see also Poulton, 1978d; Jeletzky, 1975; and alternative interpretation of Young, 1975). These rocks, and those others on which Young (1975) based his list of criteria are subsurface samples that may have suffered caving, and their age, thickness, and the distinctiveness of structures and petrographic characters that would indicate depositional environments are open to question. Re-examination of the samples by J.H. Wall (pers. comm.) suggests that Jurassic rocks are absent here. Erosion of basinal early Mesozoic deposits cannot be ruled out conclusively, even where thinning of nearshore Jurassic and Neocomian rock units

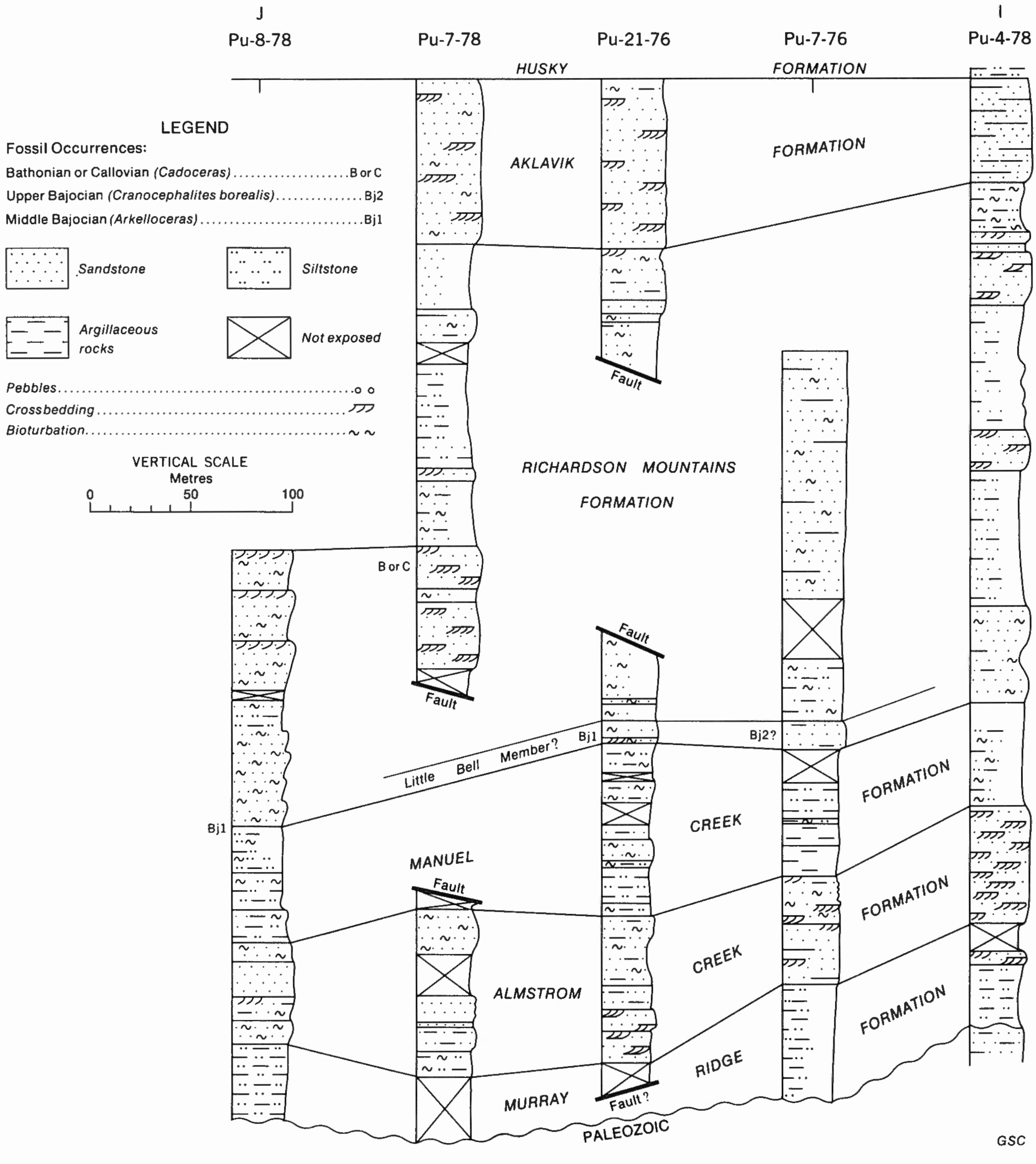


***FIGURE 39.** Graphic illustration of stratigraphic sections and correlations of Bug Creek Group, in the area between White Mountains Uplift to the north, and Rat Uplift to the south (see Fig. 38). Line of Section I - J shown on Figure 6.*

toward the inferred arch is recognized (Young, 1975) without much more precise dating of individual units, and without the recognition of thinning and of depositional environments of several units independently in a succession that is not truncated at its top by erosion; criteria which are not yet achieved. These arguments do not compromise the validity of a late Paleozoic or Triassic manifestation of the arch as shown by Young (1975). The relatively thin section of the Middle, and particularly the Lower, Jurassic rocks at the northeastern major bed of Porcupine River (see Fig. 1) (Poulton and Callomon, 1976, section 5; Poulton, 1978d, Fig. 2), in contrast to localities northeast and west of there (approx. Lat. 67°44'N, 137°33'W and Lat. 67°23'N, Long. 138°30'W, respectively) indicates thinning southeastward onto Peel Landmass in the area.

Similarly the presence or absence in Lower and Middle Jurassic times of Vittrekwa Embayment separating Eagle Arch from Rat Uplift, as shown in Figure 38 (see Young et. al., 1976, Fig. 4) is not conclusively demonstrated. The embayment was inferred to be present at those times because of the absence now of Bug Creek rocks on either side of it and their purported presence within it. The sandstones and feldspathic conglomeratic rocks in southern Richardson Mountains and the southern part of northern Richardson Mountains that Jeletzky (1972a, p. 3, 4, 9; 1975, p. 5, 6, 8, Figs. 2, 4) and Young (1975, Fig. 2) thought to be nonmarine facies of the Bug Creek Formation have later (Norris, in press) been re-interpreted as belonging to the North Branch Formation. Neither assignment is based on any firm paleontological data. For the map in the present report (Fig. 38) the interpretation of Norris is followed arbitrarily, so that the southerly extent of the Bug Creek Group is less than indicated by Jeletzky (1975, Fig. 9) and Young et al. (1976, Fig. 4). Also, therefore, the presence of nonmarine environments of the Bug Creek in its southernmost exposures, and particularly the east-west facies variations in these rocks interpreted by those earlier authors, are not substantiated by the evidence available.

Nevertheless, the unusually thick, dominantly argillaceous succession in a more basinward depocentre to the northwest near the head of Waters River (see Fig. 6) suggests that there may have been a re-entrant in the basin margin in this vicinity. The greatest thickening in this area is in the Middle Jurassic rocks (Fig. 8) which also dominate the Bug Creek Group south of McDougall Pass. The transgression of Upper Bajocian and Bathonian rocks southward beyond the limits of preservation of Lower Jurassic rocks may be related to continued subsidence. In part, however, both the deposition and the preservation of the Middle Jurassic rocks may be related to north-northwesterly trending faults, as suggested by the similar trend, alignment, and age relationships of the northeastern boundary of Vittrekwa Embayment and of the Waters River depocentre (see Fig. 38).

Bajocian or Bathonian sandstones are the basal Jurassic rocks in a small region on the immediate east side of the White Mountains (sections PU-1-75 and PU-13-75) in contrast to the presence of thick, mutually similar Lower Jurassic successions surrounding it (Fig. 11). The Lower Jurassic succession characteristic of the northern Richardson Mountains (e.g. section PU-12, 14-75) is inferred to have been deposited on, and subsequently eroded from the White Mountains area during Bajocian time because there is no evidence in the adjacent Lower Jurassic rocks (e.g. sections PU-4-78; PU-7-76; PU-12, 14-75) of nearby high relief or of sediments derived from a contemporaneous nearby high area. The name White Uplift for the present-day dome with Paleozoic rocks in the core was first used by Norris (1973); the manifestation of an ancestral uplift in this area in the Jurassic was recognized by Poulton and Callomon (1976); and the name White Mountains Uplift for this feature was introduced by Poulton (1978b, Fig. 5, 4). Poulton (*ibid.*) also showed that the uplift was not as extensive in the Middle Jurassic as had been previously stated (Poulton and Callomon, 1976) and that it was not connected directly with Aklavik Arch to the south, because there are stratigraphic sections between the two uplifts that expose all the Lower Jurassic formations (Fig. 39). Jeletzky (1980) considered this Middle Jurassic manifestation of White Mountains Uplift to have been the initial nucleus of what became a more strongly expressed source of sediment in Late Jurassic and Cretaceous time in the same position. This later and more extensive positive feature he called "White Island". It was a paleogeographic expression of the positive tectonic element he called "Cache Creek Horst", to replace "Cache Creek High" of Young et al. (1976) or "Cache Creek Uplift" of Norris (1973). Fault boundaries are suggested by the extreme isopach gradients of Bug Creek rocks (Poulton, 1978b; Jeletzky, 1980, Fig. 8) and the possibility of a transcurrent component of movement on these faults cannot be rejected. A fault with the requisite west-side-down displacement has been mapped on the west side of White Mountains by Norris (in press). Diagnostic criteria in the many sandstones of the Richardson Mountains Formation are not present to indicate which of them were derived from White Mountains Uplift. Some may be represented in the area of the head of Waters River, where the unusually thick Middle Jurassic succession occupies a depocentre just west of White Mountains Uplift. Depression of this depocentre, which is also sharply defined on its east side, and therefore perhaps fault-bounded, may well have been related tectonically to the origin of adjacent and contemporary White Mountains Uplift.

Cache Creek High is a linear north-south to northwest-southeast-trending uplift whose primary expression is in Late Jurassic and Cretaceous isopach and lithologic and stratigraphic relations, at which times it separated the depositional basin into two elements, Blow Trough foredeep or Rapid Depression (Norris, 1972) to the west and Kugmallit Trough or Canoe Depression of Norris (1972); to the east (Young et al., 1976; see also Fig. 38 and Jeletzky, 1980). Cache Creek Uplift is not represented in the Lower and Middle Jurassic record except possibly very feebly by the thin or absent Manuel Creek Formation of Toarcian to Early Bajocian age, in a belt extending northward from White Mountains Uplift to Big Fish River and northeastward to Canoe Lake (sections PU-6, 10-75(?); PU-19-76; PU-27-76). It is also probably represented in the post-Middle Jurassic and pre-Barremian record on the west side of Shallow Bay where the lower Cretaceous rocks probably directly overlie Bajocian sandstones at the Ulu A-35 well (see Figs. 1, 38). The section between Big Fish River and Little Fish Creek (section PU-19-76 of this paper) where Norris (1976) and Young et al. (1976) described an angular unconformity that they cited as evidence for the effects of the Cache Creek High on deposition during later episodes of Bug Creek time was re-examined by Poulton who considers the unconformable relationship to be unsubstantiated.

SUMMARY OF JURASSIC SEDIMENTATION HISTORY

The earliest Jurassic event recorded in the northern Richardson Mountains is marine transgression over an erosional surface at which Triassic and older rocks were removed to varying degrees. The surface had only minor relief judging by the nearly uniform regional thickness of the lowest formation (Murray Ridge Formation). Except for locally derived and locally deposited basin-marginal sandstones and conglomerates in the Bug Creek-Jurassic Butte-Scho Creek area (Scho Creek Member), and local basal lag deposits elsewhere, the lowest Bug Creek rocks are in a shale and siltstone facies. West of the Richardson Mountains, at Bonnet Lake, the basal transgressive unit is Hettangian (Frebold and Poulton, 1977). It is Late Sinemurian in Aklavik Range as are the oldest diagnostic fossils at a section on Porcupine River (67°58'30"N Lat., 136°23'00"W Long.; Poulton, 1978d, Fig. 2) indicating progressive easterly and southerly transgression. These argillaceous facies have the character of open shelf deposits and, in their upper parts, grade to a shelf sandstone unit (Almstrom Creek Formation) that was deposited by storm and probably tidal agencies. It is presumed to be mainly, if not entirely, Pliensbachian in age. Its maximum thickness lies in the vicinity of the heads of Bell and Big Fish Rivers.

Continued subsidence resulted in a blanket of argillaceous rocks (Manuel Creek Formation) being deposited over the sandstones mainly below the influence of waves or tides. They are from Toarcian to Early Bajocian in age. Laterally equivalent rocks to the southwest, in the vicinity of the head of Waters River, are somewhat thicker and include significant sandstone units. The upper one of these sandstones (Anne Creek Member) is a shoal development associated with a regressive event that continued into a period of stillstand and negligible sedimentation in the Middle Bajocian. This last event and the succeeding transgression, during which sedimentation continued to be very slow, is represented by a thin blanket sandstone (Little Bell Member).

The southeasterly limit of the Lower Jurassic and lowest Middle Jurassic rocks in the vicinity of McDougall Pass is controlled by pre-Upper Bajocian erosion along the basin margin, although it is probably near the original southeasterly limit of their deposition. Minor uplift of the southeastern basin margin more or less coincided with uplift of the small White Mountains Uplift to its north, on which the earlier Jurassic record was entirely stripped off during the Bajocian.

Resumption of subsidence, in the Middle and Upper Bajocian, and introduction of clastic material resulted in widespread deposition of a shelf shale, siltstone and sandstone complex that is thicker and more argillaceous toward the north and west (Richardson Mountains Formation). In the vicinity of its depocentre near the head of Waters River where subsidence was most rapid, certain particularly thick sandstone units (Waters River Member) represent shoals and some may have been barrier islands. Increasing storm or tidal influence, and then eventual progradation of sands of possible delta-front facies is indicated. The uppermost, basinward-extensive sandstone unit (Aklavik Formation) may possibly include nonmarine beds, in the southernmost localities.

Three major regressive phases are thus represented in the Bug Creek Group. The first and last resulted in shelf sandstone complexes (Almstrom Creek and Aklavik Formations) of Pliensbachian and Early Oxfordian ages, approximately, in a subsiding shale and siltstone-dominated basin that lay to the northwest. The intermediate regressive phase (Early and Middle Bajocian) more or less coincided with uplift of the basin margin and of at least one intrabasinal uplift (White Mountains Uplift).

The arenaceous basin-marginal clastic wedge which the Bug Creek Group comprises was limited along depositional strike to an area between the present Ogilvie Mountains and the northeastern Mackenzie River delta. The basin margin was complicated by local uplifts and depressions, some of which may have been fault-bounded.

Cessation of the supply of sand in Oxfordian time, and continued subsidence resulted in a thick and extensive shale unit being deposited regionally (Husky Formation), which transgressed beyond the limits of occurrence of Bug Creek rocks. Equivalent basin-marginal and shelf sandstone facies are represented to the south by the North Branch Formation and over a large area to the west and southwest by the Porcupine River Formation.

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The figured specimens are placed in repository at the Geological Survey of Canada, Institute of Sedimentary and Petroleum Geology, Calgary, Alberta.

PLATE 1

Figure 1. Marginulinopsis sp. aff. phragmites Loeblich and Tappan, figured specimen GSC 58514 from GSC loc. C-80258, section PU-20-76; lateral view, X146.

Figure 2. Marginulinopsis sp. 5000, figured specimen GSC 58515 from GSC loc. C-53586, section PUH-2-76; lateral view, X158.

Figure 3. Lingulina sp. 5259, figured specimen GSC 58516 from GSC loc. C-80264, section PU-20-76; lateral view, X248.

Figures 4, 5. Lenticulina sp. cf. biexcavata (Myatliuk), 1939: Figure 4, figured specimen GSC 58517, lateral view, X159; Figure 5, figured specimen GSC 58518, peripheral view, X225; both from GSC loc. C-80258, section PU-20-76.

Figure 6. Eoguttulina sp. cf. amygdalina Loeblich and Tappan, figured specimen GSC 58519 from GSC loc. C-80264, section PU-20-76; lateral view, X225.

Figure 7. Ostracod sp. 81, genus indet., figured specimen GSC 58520 from GSC loc. C-80264, section PU-20-76; X135.

Figure 8. Geinitzinita sp. cf. praenodulosa Dain, figured specimen GSC 58521 from GSC loc. C-80257, section PU-20-76; lateral view, X170.

PLATE 1

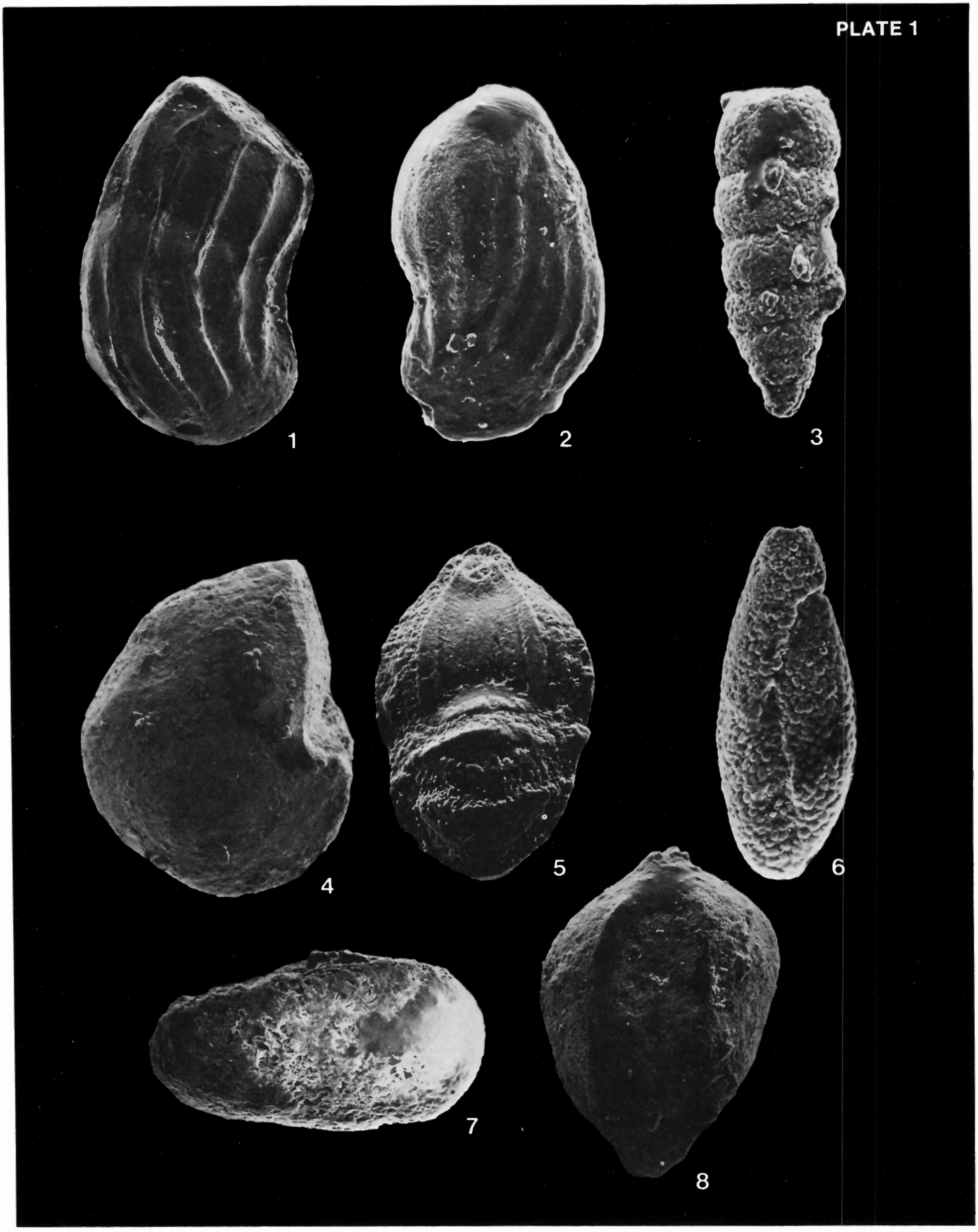

PLATE 2

Figures 1, 2. *Ammobaculites* sp. cf. *alaskensis* Loeblich and Tappan: Figure 1, figured specimen GSC 58522, lateral view, X81; Figure 2, figured specimen GSC 58523, lateral view, X100; both from GSC loc. C-80255, section PU-20-76.

Figure 3. *Ammobaculites* sp. 5260, figured specimen GSC 58524 from GSC loc. C-80284, section PU-20-76; X124.

Figures 4, 5. *Ammobaculites* sp. cf. *pokrovkaensis* (Kosyreva) Figure 4, figured specimen GSC 58525, lateral view, X135; Figure 5, figured specimen GSC 58526, lateral view, X63 both from GSC loc. C-80259, section PU-20-76.

Figures 6, 7. *Reophax* sp. cf. *hounstoutensis* Lloyd: Figure 6, figured specimen GSC 58528, X100; Figure 7, figured specimen GSC 58527, X45; both from GSC loc. C-80253, section PU-20-76.

Figure 8. *Ammobaculites* sp. 5261, figured specimen GSC 58529 from GSC loc. C-53589, section PUH-2-76; X90.

Figure 9. *Ammobaculites* sp. 5262, figured specimen GSC 58530 from GSC loc. C-80267, section PU-20-76; X124.

PLATE 2

PLATE 3

Figures 1-3. Recurvoides sp. 5009: Figure 1, figured specimen GSC 58531, peripheral view, X135; Figure 2, figured specimen GSC 58532, side view, X147; Figure 3, figured specimen GSC 58533, side view, X116; all from GSC loc. C-80253, section PU-20-76.

Figures 4-6. Trochammina sp. cf. canningensis Tappan 1955: Figure 4, figured specimen GSC 58534, peripheral view, X250; Figure 5, figured specimen GSC 58535, dorsal view, X203; Figure 6, figured specimen GSC 58536, ventral view, X180; all from GSC loc. C-80256, section PU-20-76.

Figures 7, 8. Trochammina sp. 5264: Figure 7, figured specimen GSC 58537, dorsal view, X180; Figure 8, figured specimen GSC 58538, ventral view, X248; both from GSC loc. C-80263, section PU-20-76.

Figure 9. Eucyrtidium sp., figured specimen GSC 58539 from GSC loc. C-80277, section PU-20-76; X225.

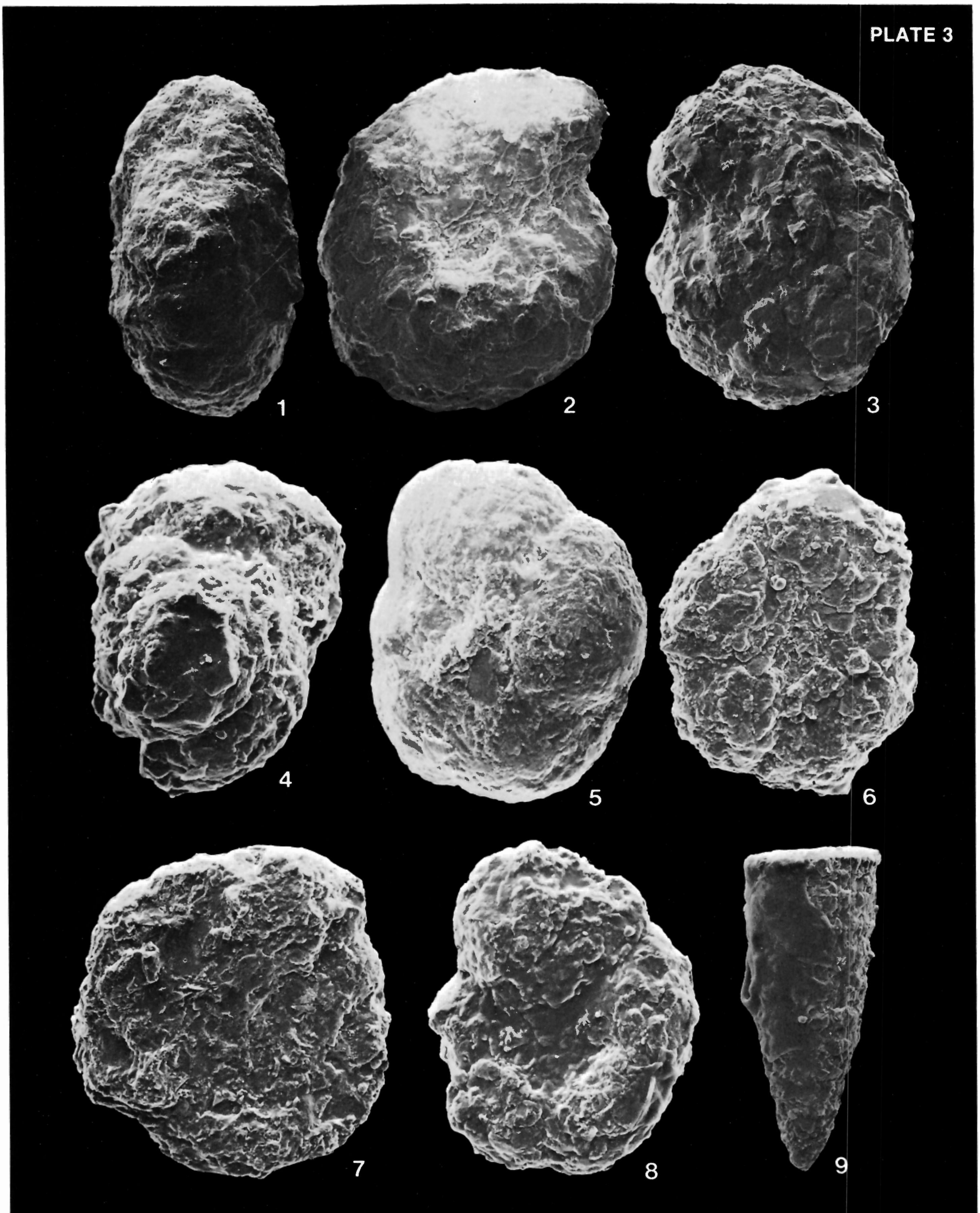
PLATE 3
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PLATE 4

Figures 1, 2. Haplophragmoides sp. cf. canui Cushman 1930: Figure 1, figured specimen GSC 58540, peripheral view, X135; Figure 2, figured specimen GSC 58541, lateral view, X147; both from GSC loc. C-80251, section PU-20-76.

Figures 3, 4. Haplophragmoides sp. cf. volgensis Myatliuk 1939: Figure 3, figured specimen GSC 58542, peripheral view, X90; Figure 4, figured specimen GSC 58543, lateral view, X90; both from GSC loc. C-80255, section PU-20-76.

Figures 5, 6. Haplophragmoides sp. 5263: Figure 5, figured specimen GSC 58544, peripheral view, X170; Figure 6, figured specimen GSC 58545, lateral view, X225; both from GSC loc. C-80262, section PU-20-76.

Figures 7, 8. Haplophragmoides sp. 5265: Figure 7, figured specimen GSC 58546, peripheral view, X135; Figure 8, figured specimen GSC 58547; lateral view, X136; both from GSC loc. C-80266, section PU-20-76.

Figure 9. Ammobaculites sp. 4925, figured specimen GSC 58548 from GSC loc. C-53564, section PU-18-76; X225.

PLATE 4

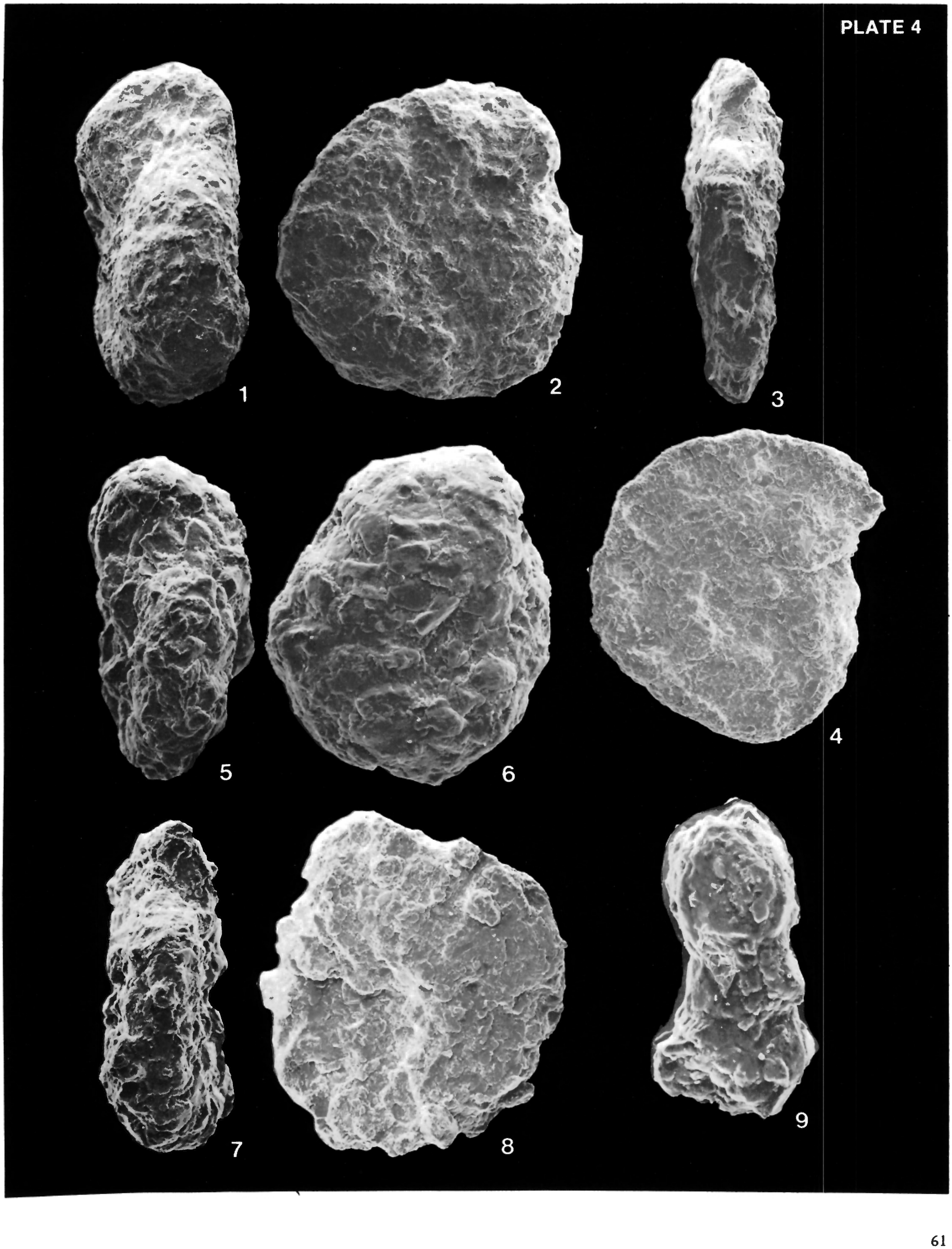

PLATE 5

Figures 1, 2. Haplophragmoides sp. 5268: Figure 1, figured specimen GSC 58549, lateral view, X157; Figure 2, figured specimen GSC 58550, peripheral view X146 both from GSC loc. C-53585, section PUH-2-76.

Figure 3. Ammodiscus sp. cf. cheradospiras Loeblich and Tappan 1950, figured specimen GSC 58551 from GSC loc. C-80259, section PU-20-76; X90.

Figures 4, 5. Trochammina sp. 5267: Figure 4, figured specimen GSC 58552, dorsal view, X316; Figure 5, figured specimen GSC 58553, peripheral view, X316; both from GSC loc. C-53564, section PU-18-76.

Figure 6. Ammodiscus sp. cf. orbis Lalicker 1950, figured specimen GSC 58554 from GSC loc. C-53590, section PUH-2-76; X180.

Figures 7, 8. Trochammina sp. 4965: Figure 7, figured specimen GSC 58555, peripheral view, X315; Figure 8, figured specimen GSC 58556, dorsal view, X315; both from GSC loc. C-53595, section PUH-2-76.

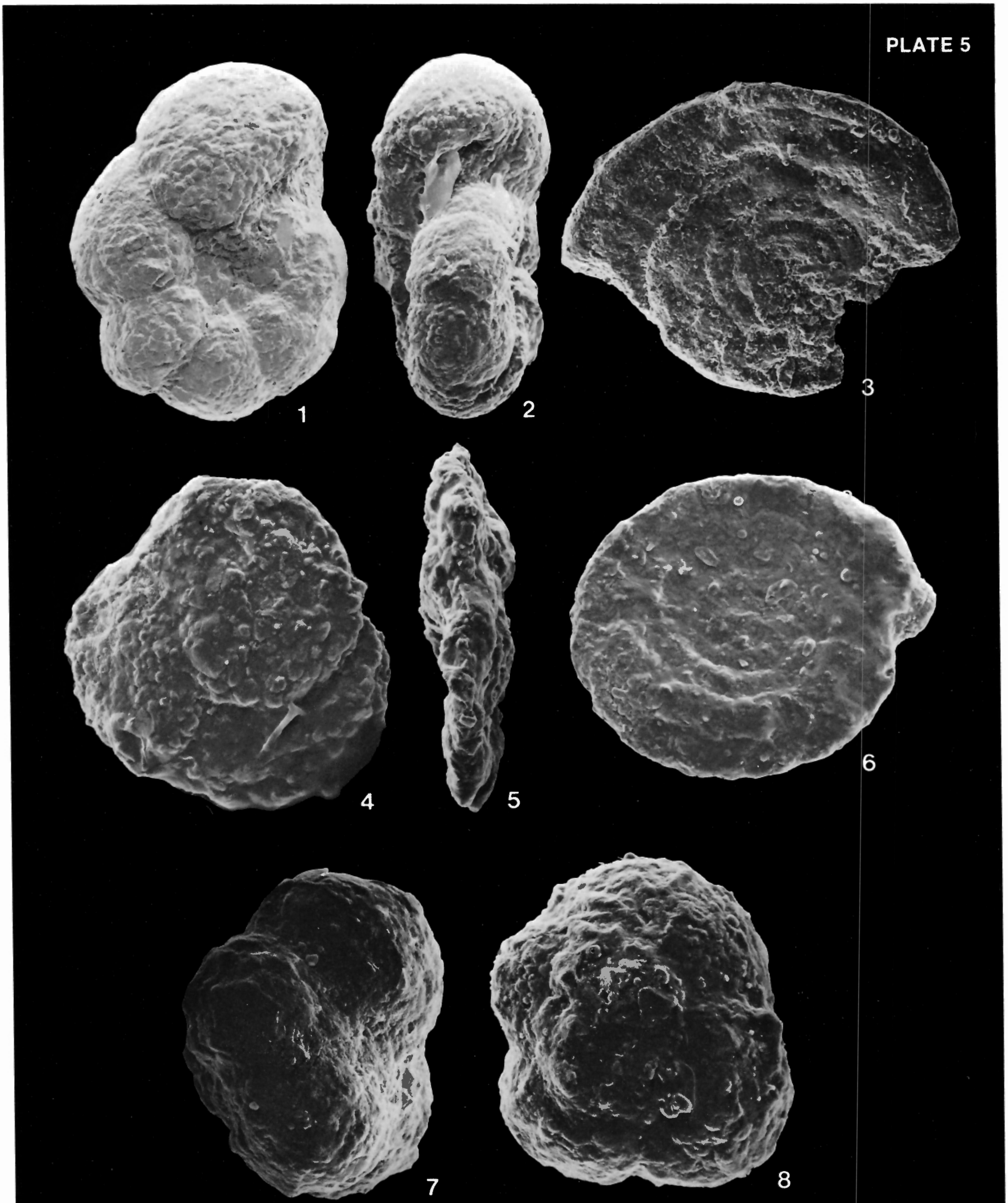
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PLATE 6

Figures 1, 2. Microplankton indet. sp. 1, figured specimens GSC 58908 and 58909, both from GSC loc. C-80268, section PU-20-76; X375.

Figures 3, 4. Nannoceratopsis sp., figured specimens GSC 58910 and 58911, both from GSC loc. C-80274, section PU-20-76; X375.

Figures 5-7. Microplankton indet. sp. 2, figured specimen GSC 58912 (5, 6) and 58913 (7), both from GSC loc. C-80268, section PU-20-76; X375. No. 6 is interference contrast.

Figures 8, 9. Gonyaulacysta sp. cf. G. cladophora, (Deflandre) Dodekova, figured specimens GSC 58914 from GSC loc. C-80259, section PU-20-76, and GSC 58915 from GSC loc. C-53574, section PU-2, 26-76; X375.

Figure 10. Pareodinia sp., figured specimen GSC 58916 from GSC loc. C-80272, section PU-20-76; X375.

Figure 11. Pareodinia ceratophora Deflandre, figured specimen GSC 58917 from GSC loc. C-80259, section PU-20-76; X375.

Figures 12, 13. Mancodinium semitabulatum Morgenroth, figured specimens GSC 58918 and 58919 from GSC loc. C-80275, section PU-20-76; X1000 (12), X375(13).

Figure 14. Horologinella sp., figured specimen 58920 from GSC loc. C-80277, section PU-20-76; X375.

Figure 15. Michrystridium sp., figured specimen GSC 58921 from GSC loc. C-80275, section PU-20-76; X375.

Figure 16. Pareodinia ceratophora Deflandre, figured specimen GSC 58922 from GSC loc. C-80260, section PU-20-76; X375.

Figure 17. Taxodiaceae indet., figured specimen GSC 58923 from GSC loc. C-80288, section PU-22-76; X375.

Figure 18. Taxodiaceae indet., figured specimen GSC 58924 from GSC loc. C-53578, section PU-2, 26-76; X375.

Figure 19. Osmundacidites sp., figured specimen GSC 58925 from GSC loc. C-80277, section PU-20-76; X375.

Figure 20. Classopollis classoides Pflug, figured specimen GSC 58926 from GSC loc. C-80276, section PU-20-76; X1000.

Figure 21. Uvaesporites puzzlei Guy, figured specimen GSC 58927 from GSC loc. C-80279, section PU-20-76; X375.

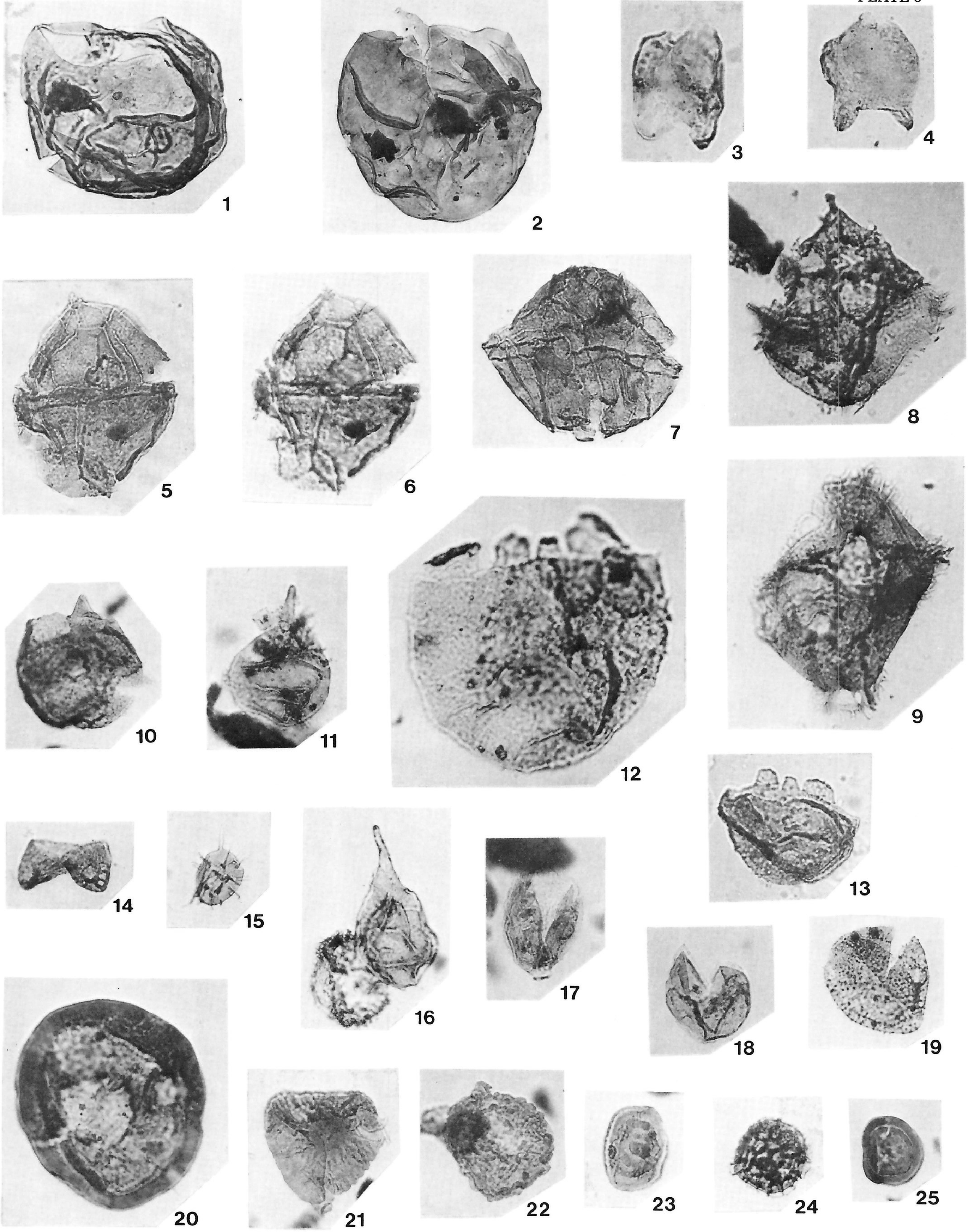
Figure 22. Cerebropollenites mesozoicus (Couper) Nillson, figured specimen GSC 58928 from GSC loc. C-80279, section PU-20-76; X375.

Figure 23. Taurocusporites reduncus (Bolkhovitine) Stover, figured specimen GSC 58929 from GSC loc. C-80273, section PU-20-76; X375.

Figure 24. Lycopodiumsporites marginatus Singh, figured specimen GSC 58930 from GSC loc. C-80279, section PU-20-76; X375.

Figure 25. Classopollis classoides Pflug, figured specimen GSC 58931 from GSC loc. C-80279, section PU-20-76; X375.

PLATE 6



Abbreviations for photographs of stratigraphic sections (Plates 7-11):

PR	=	Porcupine River Formation
H	=	Husky Formation
A	=	Aklavik Formation
RM	=	Richardson Mountains Formation
WR	=	Waters River Member
LB	=	Little Bell Member
MC	=	Manuel Creek Formation
ACM	=	Anne Creek Member
AC	=	Almstrom Creek Formation
MR	=	Murray Ridge Formation
SC	=	Scho Creek Member
P	=	Permian rocks

PLATE 7

Stereoscopic aerial photograph pairs illustrating stratigraphic sections.

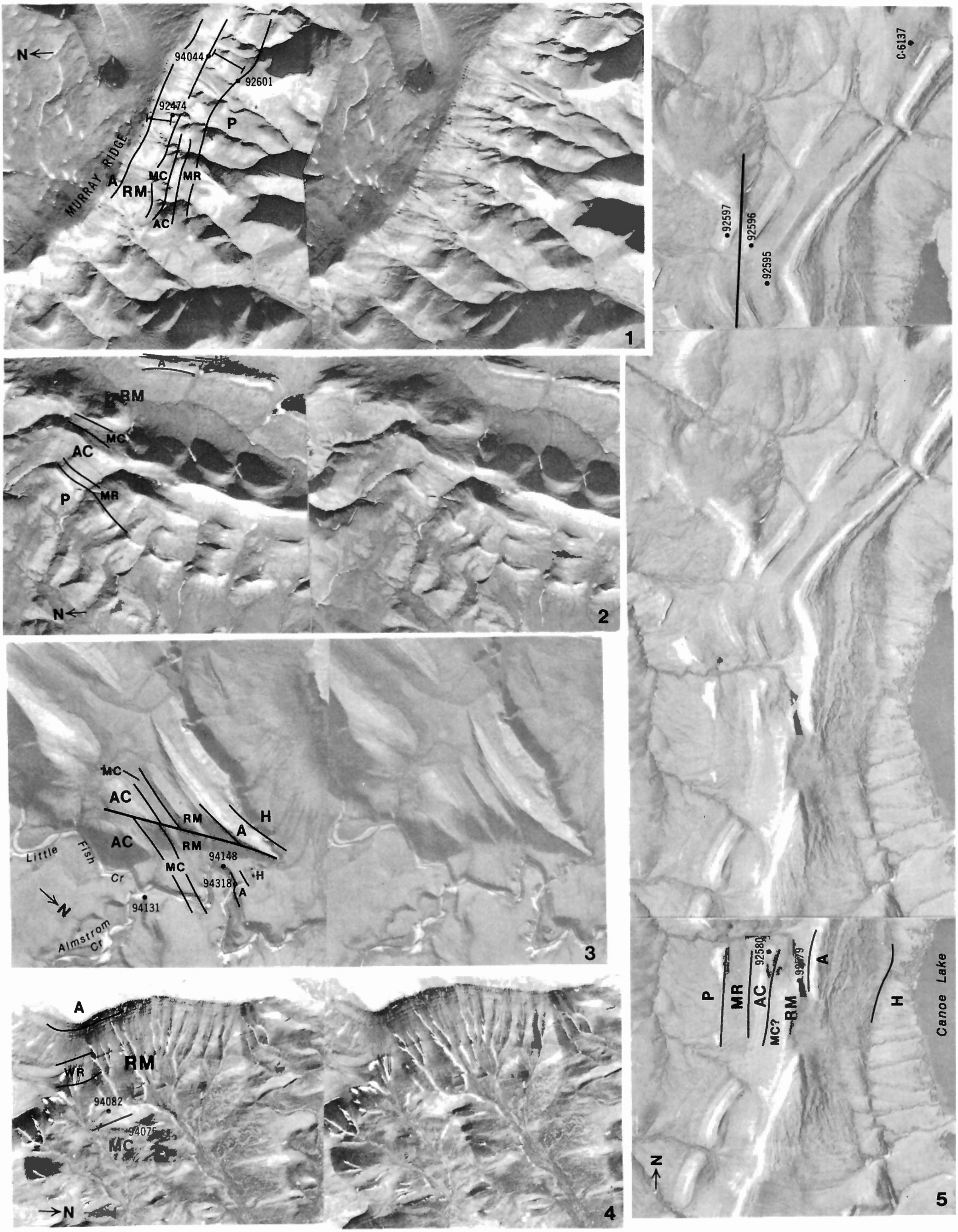
Figure 1. Section PU-12, 14-75, Murray Ridge. Photos A22883-50 and 51. Upper and lower parts of composite section are indicated.

Figure 2. Section PU-27-76, north of White Mountains. Photos A22883-24 and 25.

Figure 3. Section PU-20-76; junction of Almstrom and Little Fish Creeks. Photos A22883-107 and 108.

Figure 4. Section PU-11-76, head of Waters River. Photos A22882-116 and 117.

Figure 5. Section PU-6, 10-75, Canoe Lake. Photos A22883-113 to 115.


N
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92474
P
MURRAY RIDGE
A
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MR
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1
A
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2
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Little
Fish
94148
Cr
MC
H
94318
A
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94131
Almstrom
Cr
3
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RM
WR
94082
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92597
92596
92595
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92580
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Canoe Lake
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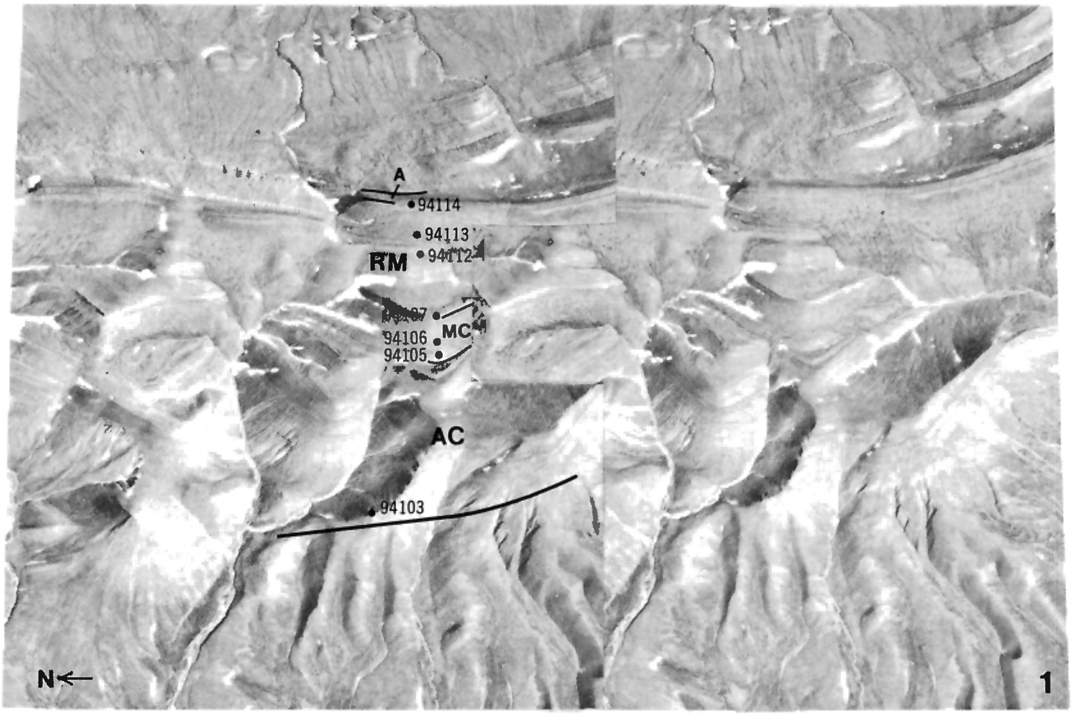
5

PLATE 8

Stereoscopic aerial photograph pairs illustrating stratigraphic sections.

Figure 1. Section PU-18-76, heads of Bell River and Big Fish River. Photos A22882-154 and 155.

Figure 2. Section PU-19-76, between Little Fish Creek and Big Fish River. Photos A22883-29 and 30.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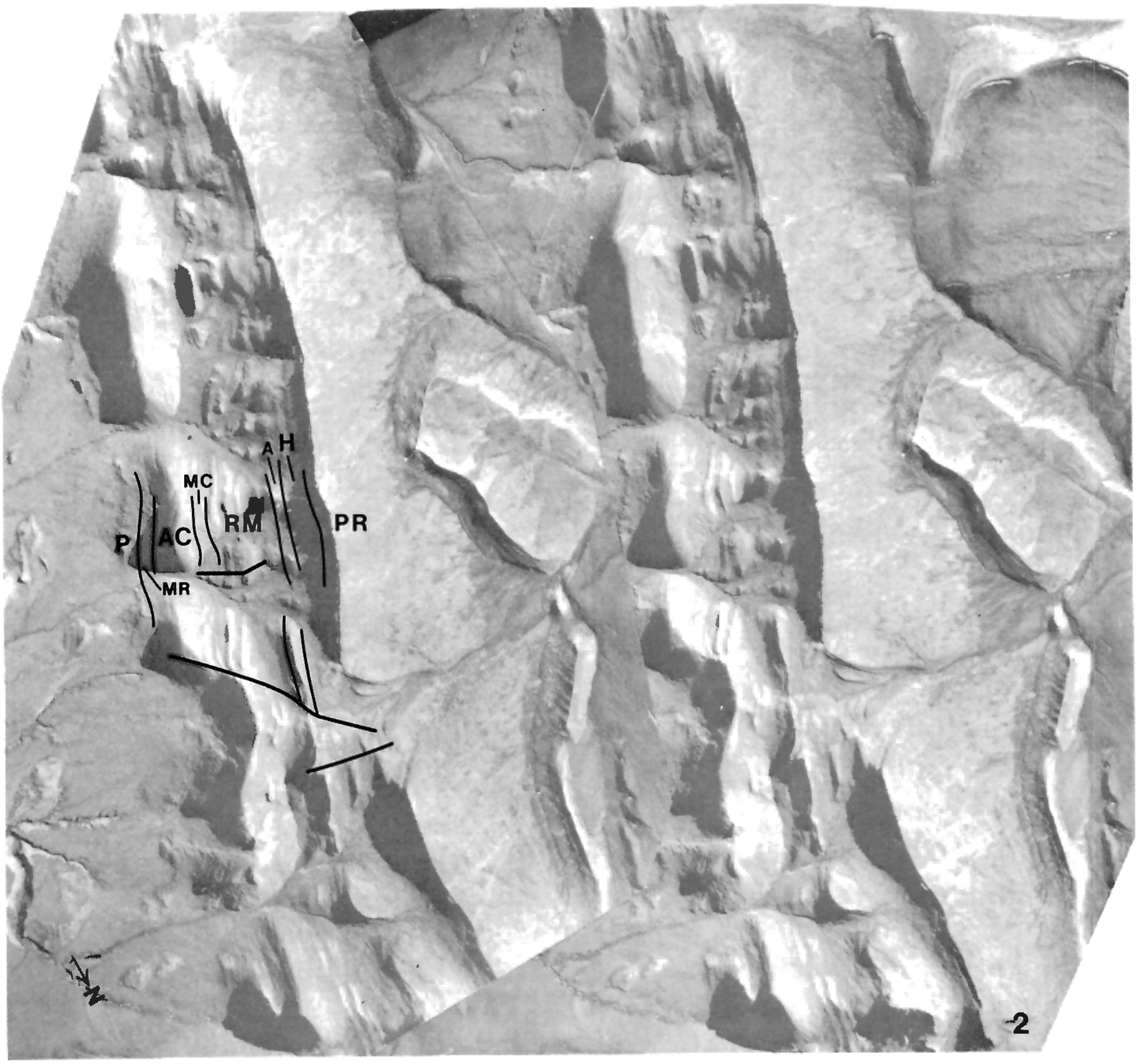
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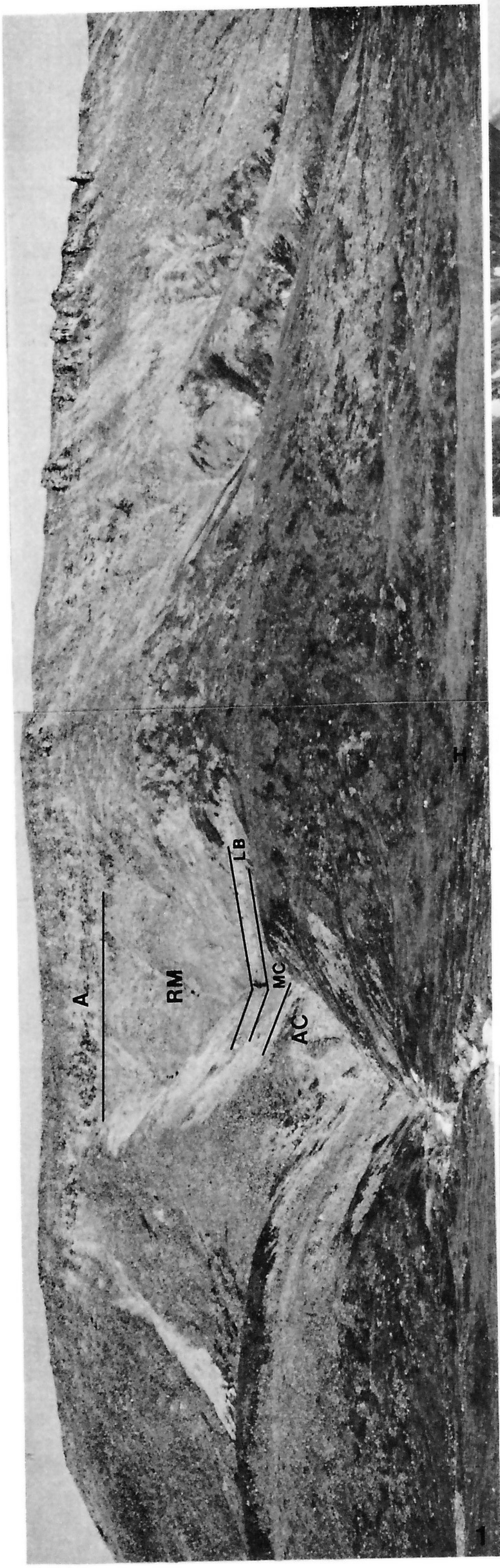
PLATE 9

Figure 1. Bug Creek section southwest of Canoe Lake (PU-10-76). ISPG Photos 974-45, 46.

Figure 2. Bug Creek section, near head of Fish Creek (PU-13-75). ISPG Photo 974-17.

Figure 3. Bug Creek section, near head of Fish Creek (PU-1-75). GSC Photo 202910-0.

Figure 4. Bug Creek section, north of McDougall Pass (PU-11-75). ISPG Photo 974-49.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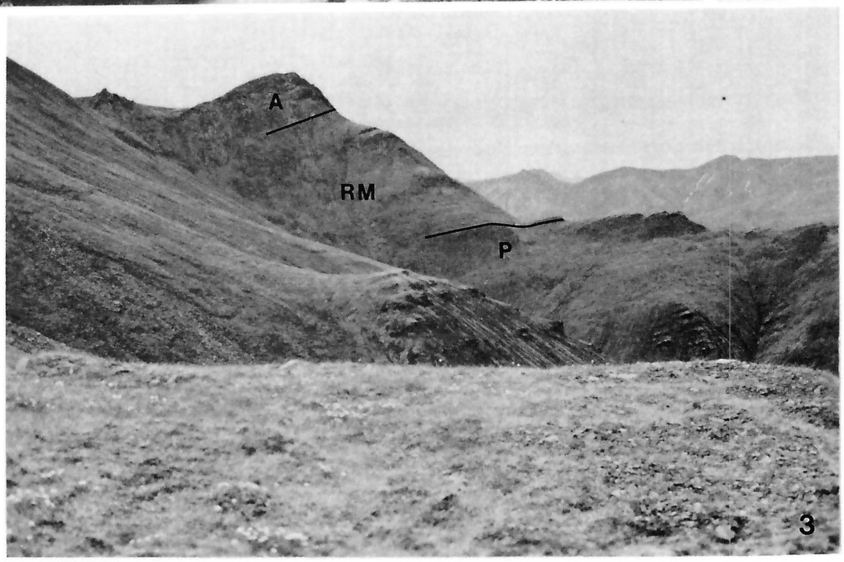
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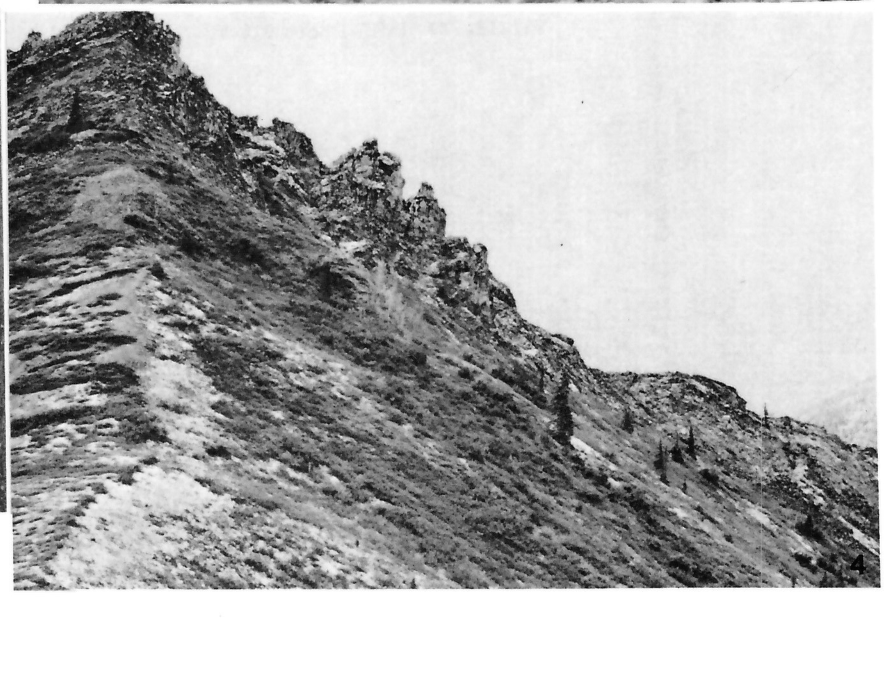
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PLATE 10

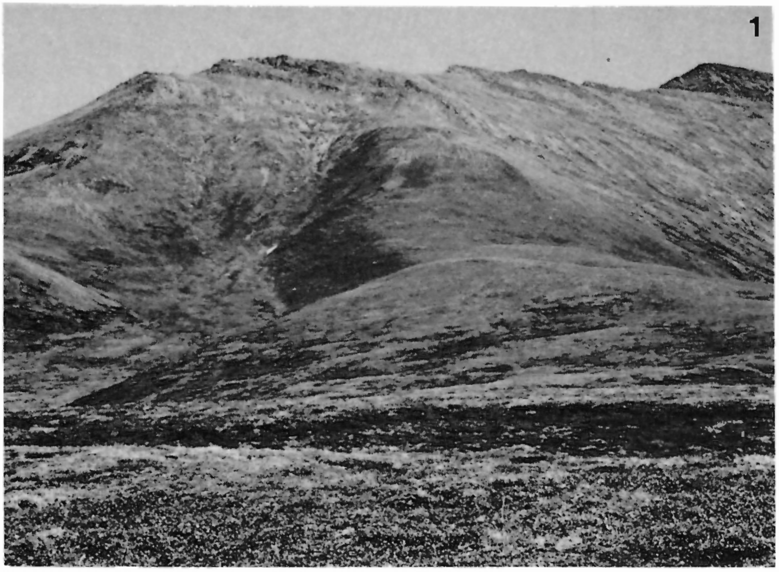
Figure 1. Almstrom Creek Formation (upper banded unit) in fault contact with Cretaceous argillaceous unit (lower slopes), section PU-18-76, head of Big Fish River. ISPG Photo 974-48.

Figure 2. Bug Creek Group on ridge immediately north of, and apparently identical with, section PU-18-76, head of Big Fish River. ISPG Photo 974-28.

Figure 3. Bug Creek Group at head of Little Bell River (section PU-21-76). ISPG Photo 974-44.

Figure 4. Middle and upper parts of Bug Creek Group at head of Big Fish River (section PU-18-76). ISPG Photo 974-25.

Figure 5. Bug Creek Group at Jurassic Butte (section PU-12-76). ISPG Photo 974-1.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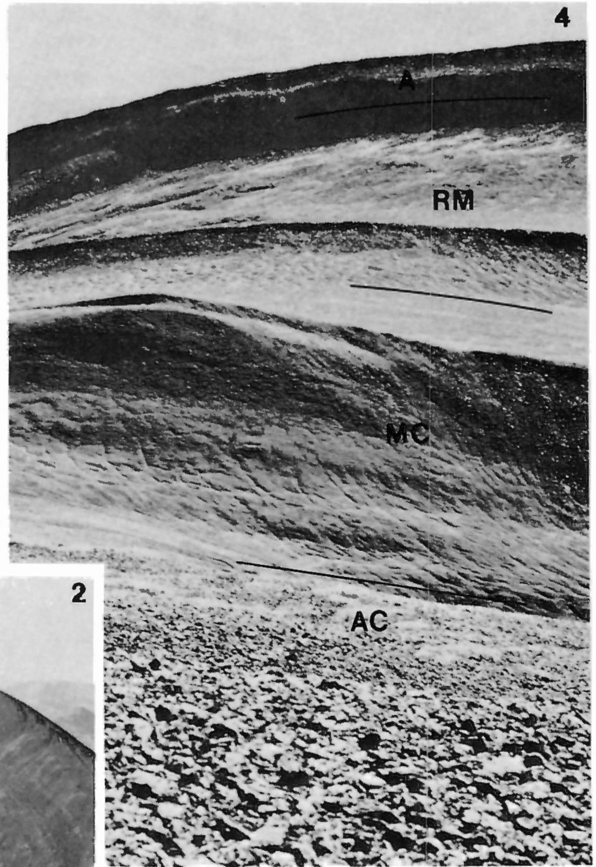
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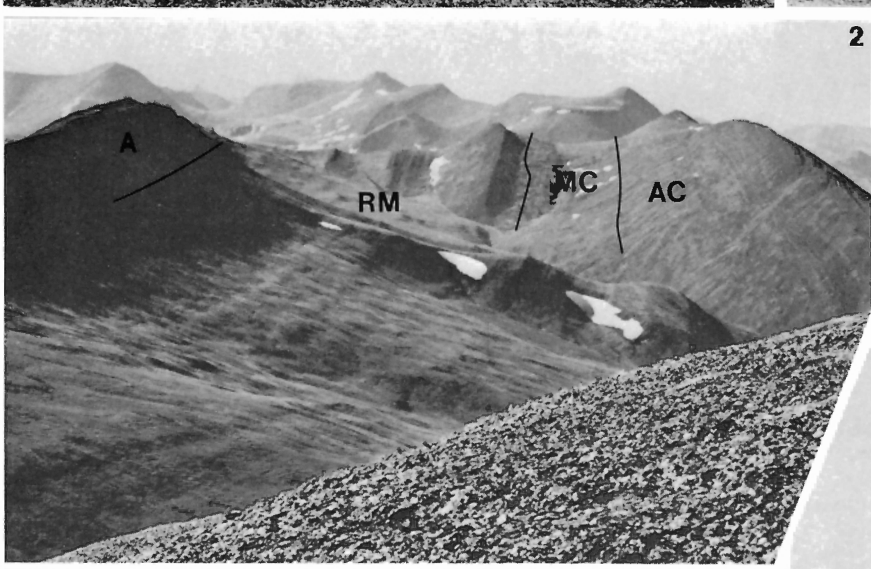
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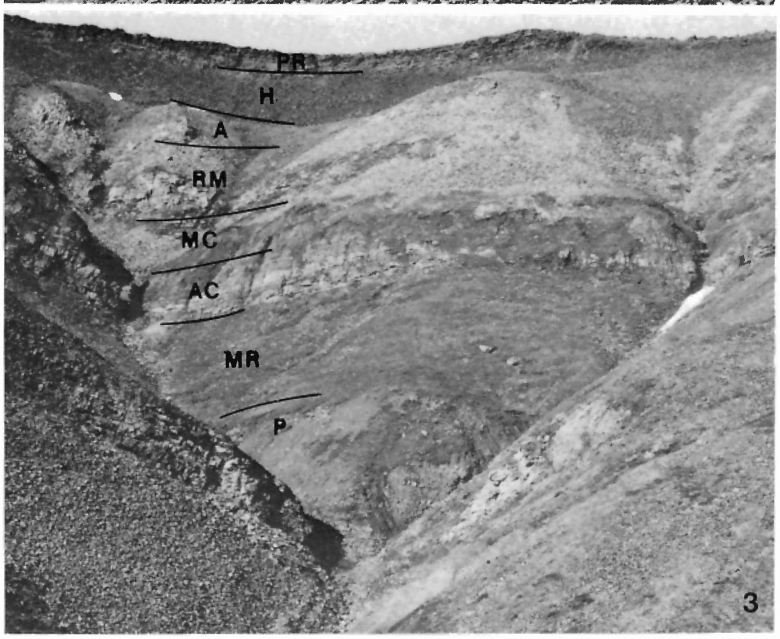
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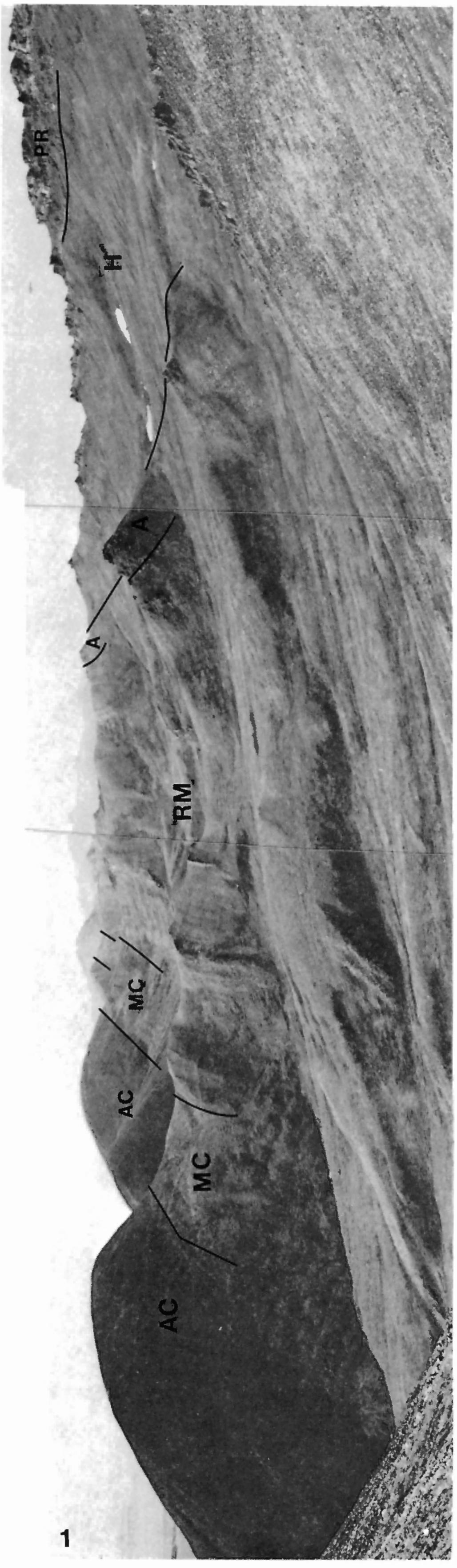
PLATE 11

Figure 1. Bug Creek Group and overlying Husky and Porcupine River Formations between Little Fish Creek and Big Fish River (section PU-19-76). ISPG Photos 974-31, 33, 34.

Figure 2. Bug Creek Group at Jurassic Butte (section PU-12-76). The Permian(?)-Jurassic contact is uncertainly located at a surface with angular relationships in a poorly fossiliferous, pebbly sandstone succession (Poulton, in Nassichuk et al., 1978). ISPG Photo 974-23, 24.

Figure 3. Bug Creek Group, overlying Permian upper sandstone unit; east of head of Scho Creek (section PU-22-76). ISPG Photo 974-8.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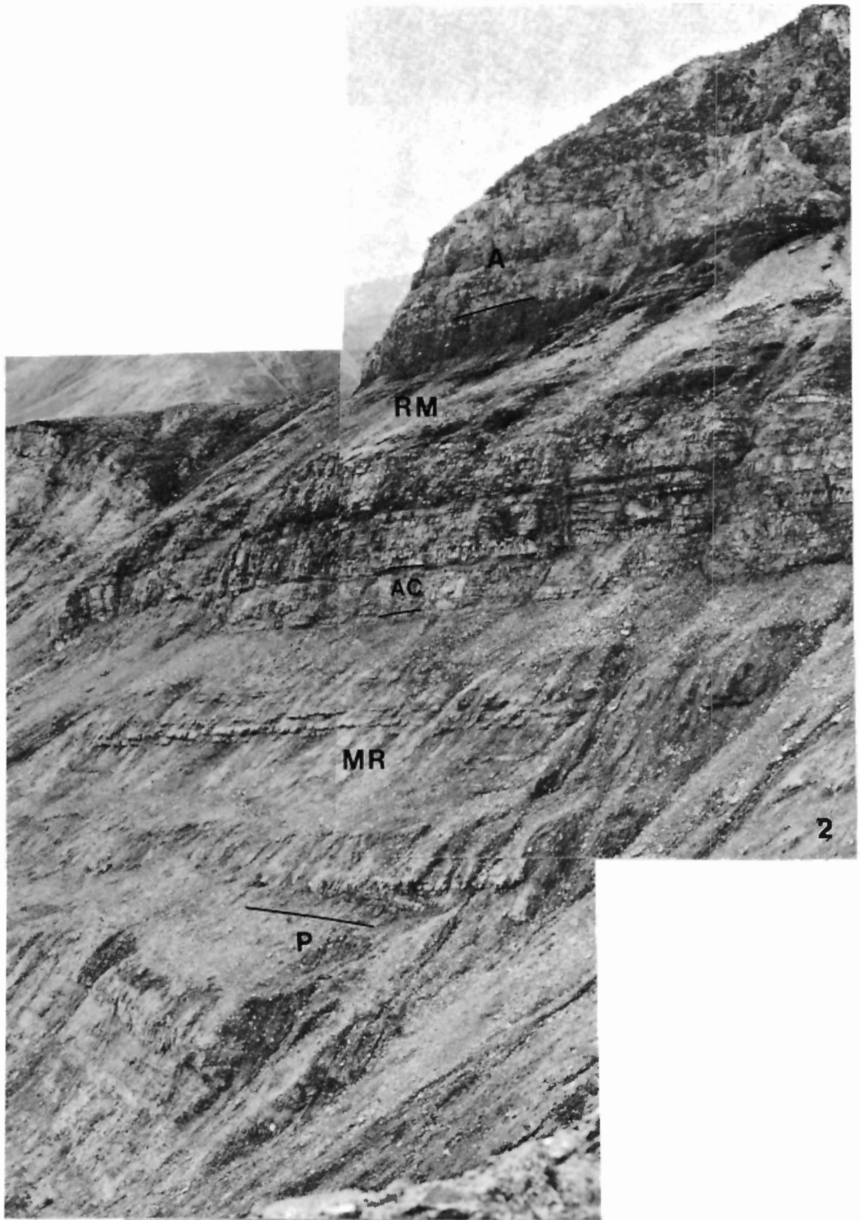
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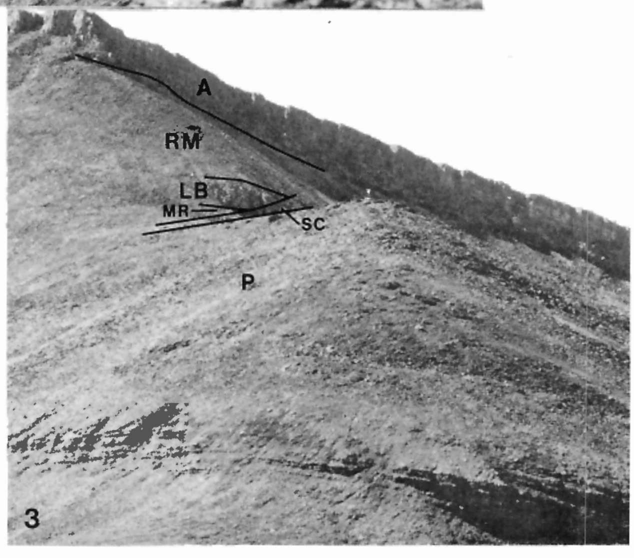
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APPENDIX 1

Detailed Descriptions of Measured Stratigraphic Sections

SECTION PU-1-75. Southwesterly-directed spur of ridge immediately east of White Mountains and of headwaters of Fish Creek (approx. Lat. 67°54'30"N, Long. 136°28'40"W). The section was previously illustrated graphically in a preliminary report (Poulton and Callomon, 1976, sec. 9), and is also shown in Figure 11 and Pl. 9, fig. 3 of this paper. Most of it is not well exposed. All measurements are in metres.

Husky Formation	
Bug Creek Group (total)	182.8 m (approx.)
Aklavik Formation	42.0 m
Richardson Mountains Formation	140.8 m (approx.)
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	The Bug Creek Group is overlain by a recessive argillaceous interval with minor thin sandstone interbeds assigned to the Husky Formation. *Buchia concentrica* (Sowerby), *Astarte* sp. and *Tancredia*(?) sp. were collected from approximately 60 to 70 m above the top of the Bug Creek Group (GSC loc. 92512), and *B. concentrica* as well as *B.* ap. aff. *mosquensis* have also been identified by J.A. Jeletzky from this unit at the top of the section (GSC loc. C-6146). The upper contact of the Bug Creek Group here is structurally contorted on a small scale.		
	TOP OF BUG CREEK GROUP		
	Aklavik Formation		
13b	Sandstone, hard, quartz-cemented; white, fine- to medium-grained; thick-bedded to massive and structureless; minor rusty-brown-weathering limonitic pods and specks; unit forms resistant bluffs at top of hill. GSC localities C-80857 to C-80859 from Unit 13. There may possibly by an additional 12 m (approx.) of section within the dip slope at top of hill	27.0	182.8
13a	Sandstone, hard, quartz-cemented; light brown to medium grey, fine- to medium-grained; massive and structureless in part, planar-laminated and large-scale low-angle crossbedded in part; minor rusty-brown-weathering limonitic pods and specks; forms lowest unit of resistant bluffs	15.0	155.8
	Richardson Mountains Formation		
12c	Totally covered, recessive	35.0	140.8
12b	Siltstone to fine-grained sandstone; dark grey-black; argillaceous, carbonaceous; fine rubbly-weathering; recessive	12.0	105.8
12a	Covered interval, recessive	4.5	93.8
11b	Sandstone, light to medium grey, fine-grained; finely planar-laminated; platy-weathering; unit recessive	4.5	89.3
11a	Sandstone, hard, quartz-cemented; light to medium grey; fine-grained; massive or with local indistinct planar lamination and large-scale low-angle crossbedding; minor poorly defined ripples; with brick-red and rusty-orange-weathering ferruginous-cemented pods; weathering blocky with conchoidal fracture; unit forms resistant bluffs; minor poorly preserved large belemnites and pectinid bivalves	10.0	84.8
10	Shale, black, fissile; carbonaceous, very finely micaceous; with siltstone, weathering brick-red, at base; unit recessive, very poorly exposed	3.3	74.8
9c	Sandstone, light brown-grey, fine-grained; laminated to massive; slightly limonitic, calcite-cemented in part and with pods as thick as 0.6 m that are limonite-cemented; weathering light rusty-brown; unit moderately resistant. GSC localities C-80860, C-80861	2.5	71.5
9b	Sandstone, fine-grained; carbonaceous; strongly and finely bioturbated; finely, indistinctly, and very irregularly bedded; weathering rubbly; carbonaceous plant fragments, minor poorly preserved belemnites. GSC locality C-80862	2.5	69.0
9a	Sandstone, light to medium grey, fine-grained; finely planar-laminated; platy-weathering; unit recessive	2.5	66.5
8	Sandstone, hard, quartz-cemented; light to medium grey, fine-grained; massive or with indistinct fine lamination; limonite disseminated and in small concretions; light rusty brown grey weathering; blocky-weathering with conchoidal fracture; unit forms resistant bluffs; locally abundant large belemnites, minor *Inoceramus* (GSC loc. 92511 loose). GSC locality C-80864	13.0	64.0
7	Covered interval, recessive	10.5	51.0
6	Sandstone, fine-grained; argillaceous, carbonaceous; strongly and finely bioturbated, thinly and irregularly bedded; minor rusty-orange- and brick-red-weathering ferruginous pods; unit more or less recessive; local *Inoceramus*, belemnites, wood fragments	15.0 (approx.)	40.5
5	Sandstone, fine-grained; carbonaceous: strongly and finely bioturbated; indistinctly and rubbly bedded or massive, with minor laminated subunits as thick as 15 cm; minor hard, rusty-weathering ferruginous concretions as large as 2.5 cm in diameter; minor lenses or discontinuous beds of brick-red-weathering fine-grained sandstone, as thick as 19 cm; poorly preserved belemnites, trails, wood fragments common; unit bluff-forming. *Inoceramus*, *Oxytoma* (GSC loc. 92510) from talus probably derived from this unit	10.5	25.5
4	Covered by talus from overlying unit, recessive	15.0 (approx.)	15.0
	The Jurassic/Permian contact is uncertainly placed within the recessive interval above the highest common occurrence of *Zoophycos*. Underlying beds are recessive bioturbated, carbonaceous, fine- to medium-grained sandstone and hard, quartz-cemented laminated, fine-grained sandstone, both commonly rusty-weathering.		

SECTION PU-6, 10-75. Hill just west of Canoe Lake (approx. Lat. 68°14'N, Long. 135°56'W). Thicknesses are estimated. Except for the bluff-forming Aklavik Formation, the section is poorly exposed, forming bands of felsenmeer and terraces. This composite section represents the general stratigraphy of the area. It was illustrated graphically in preliminary reports (Poulton and Callomon, 1976, sec. 3; Poulton, 1978a, fig. 8.2), and is also shown in Figure 5 and Pl. 7, fig. 5 of this paper. All measurements are in metres.

Bug Creek Group (total)	413 m (est.)
Aklavik Formation	100 m (est.)
Richardson Mountains and Manuel Creek(?) Formations	135 m (est.)
Almstrom Creek Formation	145 m (min. est.)
Murray Ridge Formation(?)	35 m (est.)
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	The Bug Creek Group is overlain by the recessive, unexposed Husky Formation which forms the broad valley in which lies Canoe Lake.		
	TOP OF BUG CREEK GROUP		
	Aklavik Formation		
1	Sandstone, fine- to medium-grained, white or light grey to medium brown; lower part planar-laminated or low-angle crossbedded, ferruginous; above this strongly bioturbated, thinly and irregularly bedded, slightly carbonaceous; upper part massive or with indistinct lamination and large-scale low-angle crossbedding; unit mainly poorly exposed as felsenmeer, locally forms resistant bluffs, buff, weathering blocky to platy; rare, poorly preserved belemnites, locally abundant scaphopods; upper half (at least) is felsenmeer at top of hill and forming dip slope, and probably comprises additional thickness	100.0 (est.)	413.0 (approx.)
	Richardson Mountains Formation		
2	Covered interval, recessive; probably siltstone to fine-grained sandstone; bioturbated; thinly and irregularly bedded	20.0 (approx.)	313.0 (approx.)
3	Sandstone, mainly light grey, fine- to medium-grained; in part massive, in part laminated or bioturbated; weathering light grey to buff, blocky; poorly exposed as felsenmeer; minor outcrops of harder sandstone in places, in part calcareous, thin-bedded, with trails; rusty-orange-weathering, platy; with belmnites, *Meleagrinella*, *Inoceramus*, rare poorly preserved *Cadoceras*-like ammonites, *Pseudocadoceras*, *Kepplerites* (GSC locs. 92579, 92595, 92954, C-53352).	55.0 (approx.)	293.0 (approx.)
	Top of Manuel Creek(?) Formation covered		
4	Covered interval	60.0 (approx.)	238.0 (approx.)
	Almstrom Creek Formation		
5	Siltstone to medium-grained sandstone, glauconitic, light khaki- or grey-green with brown or rusty-orange-brown lensoid patches; mainly planar or irregularly laminated to thin-bedded; in part bioturbated; burrows and trails abundant; rare poorly preserved ammonites, minor beds rich in *Pholadomya*, *Gryphea*, *Oxytoma (Palmoxytoma)*, *Liotrigonia*(?) (GSC locs. 92580, 92596, 94186, 94187, C-53351); unit poorly exposed as slabby, platy or rubbly rusty felsenmeer	35.0 (approx.)	178.0 (approx.)
6	Covered interval, recessive	18.0 (approx.)	143.0 (approx.)
7	As in unit 5; rubble includes *Liotrigonia*(?), *Gryphaea*, pectinids (GSC locs. 92597, 94184, 94185)	35.0 (approx.)	125.0 (approx.)
	Top of Murray Ridge Formation(?) covered		
8	Covered interval, recessive with minor terraces that represent somewhat resistant beds that are nevertheless not exposed; bivalves near centre of unit (GSC loc. C-80869), at base is a thin, ferruginous, pebbly bed with fossils (GSC locs. 94058, C-65041)	90.0 (approx.)	90.0 (approx.)
	Top of Permian, at top of small limestone bluffs		

SECTION PU-7-75. Canyon of Bug Creek (approx. Lat 68°04'30"N, Long. 135° 28'20"W). The lower part of this section is a redescription of the lower part of the type section of the Bug Creek Formation, which was originally described by Jeletzky (1967) on the south side of the canyon. The upper part of this section is on the north side of the canyon overlooking the Mackenzie Delta, downstream from where the upper part of the type section was originally described and illustrated by Jeletzky (1967, p. 86-92, sec. 4, Pl. III-V). This section was illustrated graphically in preliminary reports (Poulton and Callomon, 1976, sec. 4; Poulton, 1978a, fig. 8.2; 1978d, fig. 4), and also shown in Figure 5 of this report. The Intermediate Sandstone Member of Jeletzky (1967) is now known to consist of parts of two distinct formations: part of the Almstrom Creek Formation, and the lower part of the Richardson Mountains Formation, the two being separated from each other by an unconformity below which the otherwise widespread Manuel Creek Formation is missing. All measurements are in metres.

Bug Creek Group (total)	165.2 m
Aklavik Formation	40.2 m
Richardson Mountains Formation	72.7 m
Unconformity	
Almstrom Creek Formation	18.7 m
Murray Ridge Formation	33.6 m
Scho Creek Member	3.3 m
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	The top of the section is at the top of the canyon wall; nearby, the Husky Formation overlies the Bug Creek.		
	TOP OF BUG CREEK GROUP		
	Aklavik Formation		
21	Sandstone, hard, quartz-cemented; white to light brown; fine- to medium-grained; massive or evenly and distinctly bedded with minor shallow scour surfaces and large-scale low-angle crossbedding; weathering rusty-buff, forms resistant bluffs, GSC loc. C-80870	33.0 (approx.)	165.2 (approx.)
20	Sandstone, fine- to medium-grained; distinctly and evenly bedded; beds 5 to 60 cm thick, with minor vertical burrows at upper bedding surfaces; rare thin bioturbated intervals; weathering rusty-buff, resistant GSC loc. C-80871	7.2	132.2 (approx.)
	Richardson Mountains Formation		
19b	Sandstone, medium brown-grey, fine- to medium-grained; argillaceous, carbonaceous; strongly bioturbated and indistinctly bedded with minor relict 5 cm-thick beds; pyritic; unit resistant, grades over 15 cm to overlying unit. GSC loc. C-80872	7.8	125.0 (approx.)
19a	Siltstone, argillaceous, and silty mudstone; strongly bioturbated; unit weathering light to medium grey with slight blue tinge, recessive, poorly exposed, grades to overlying unit	1.5	117.2 (approx.)
18	Sandstone, fine- to medium-grained; laminated, low-angle crossbedded; minor 15 cm-thick recessive interbeds of bioturbated silty mudstone and argillaceous siltstone; unit resistant, weathering rusty-buff GSC loc. C-76371	9.0	116.7 (approx.)
17	Siltstone and fine-grained sandstone; lower part interbedded laminated and bioturbated, argillaceous, grading upward to strongly bioturbated argillaceous siltstone to silty mudstone; unit buff-weathering and somewhat resistant in lower part, recessive and light grey-weathering in upper part	1.2	107.7 (approx.)
16	Silty mudstone and argillaceous siltstone to fine-grained sandstone, dark grey; strongly bioturbated; pyritic; with minor thin beds and laminae of siltstone to fine-grained sandstone, in part rusty-brown-weathering, friable; lowest 10 cm strongly glauconitic, poorly consolidated; next 2.4 m soft, black, carbonaceous shale; locally abundant *Arctocephalites* sp. cf. *A. arcticus* (Newton) 3 m above base [GSC locs. 92488, 92585 (part)] and *Cranocephalites* sp. aff. *C. maculatus* (Spath) and aff. *C. pompeckji* Madsen appear to have come from near here (GSC loc. C-80310); pyritic, rusty-weathering, siliceous, subspherical concretions 0.3 m (approx.) in diameter occurring sporadically about 1.2 m below top of unit, contain *Arctocephalites* sp. cf. *A. greenlandicus* Spath(?) (GSC loc. 92590); upper 0.3 m is bioturbated, rubbly-weathering, argillaceous siltstone, with minor thin laminated lenses, gradational to overlying unit; unit recessive, weathering rubbly and muddy, rusty	36.0	106.5 (approx.)
	This is the top of what Jeletzky (1967) and Poulton, in preliminary reports following Jeletzky, called the Intermediate Sandstone member of the Bug Creek Formation.		
15	Sandstone, light grey, fine- to medium-grained; thick-bedded to massive, festoon crossbedded, beds lensoid; with minor thin-laminated to thin-bedded interbeds; minor rusty red-brown-weathering ferruginous siltstone concretionary beds as thick as 10 cm; unit forms resistant buff-weathering bluffs; belemnites, *Inoceramus*, *Ostrea*(?) near top [GSC locs. 92480, 92585 (part), 92589]	6.0	70.5 (approx.)
14	Siltstone, argillaceous, strongly bioturbated; strongly pyritic; abundant 10 cm by 9 m (approx.) lenses of dark red-weathering ferruginous siltstone; unit fine rubbly and muddy-weathering, recessive; basal contact abrupt, strongly pyritic and jarosite-stained	1.5	64.5 (approx.)

Unit	Lithology	Thickness	Height Above Base
13	Sandstone, light grey, fine- to medium-grained; laminated to massive; with festoon-crossbedded lenses; minor bioturbated lenses, with abundant and varied burrows, trails and rootcasts; belemnites scattered throughout; lowest 4.5 m with abundant thin lensoid beds strewn with belemnites (GSC loc. C-80304, see Jeletzky, 1967, Pl. V, fig. 1), with locally abundant phosphatic nodules, pyrite, and ferruginous-cemented lenses, minor *Cranocephalites borealis* [GSC loc. 92487 (loose)], fossil wood fragments, thin coal seams; unit forms resistant bluffs, weathering buff- and rusty-brown	9.0	63.0 (approx.)
12	Siltstone, argillaceous; strongly bioturbated; pyritic; weathering fine rubbly and muddy, recessive	1-1.7	54.0 (approx.)
	<u>Almstrom Creek Formation</u>		
11	Sandstone, light grey to green-grey, fine- to medium-grained; massive and with lenses 1 to 2.4 m thick that are large-scale, low-angle crossbedded; with interbeds 5 to 30 cm thick of laminated to thin-bedded, commonly low-angle cross-bedded siltstone to fine-grained sandstone; unit resistant, bluff-forming, weathering buff- to light rusty-brown with light green tinge, banded (GSC locs. C-80873, C-80874)	7.5	52.3 (approx.)
10b	Siltstone, dark grey argillaceous; thinly planar-bedded or bioturbated grading upward to 2.5 to 10 cm - interbedded, wavy-bedded, rippled siltstone to medium-grained sandstone and soft nearly fissile, gypsiferous, argillaceous siltstone; with several pockets as large as 1.3 by 12 m (approx.) of hard, dark red-brown-weathering, strongly burrowed, slightly pyritic, ferruginous siltstone, with local pockets of *Oxytoma*, *Ostrea(?)*, *Variamussium(?)*, *Meleagrinella(?)* (GSC locs. 92584, 94023, 94025); unit recessive	2.4	44.8 (approx.)
10a	Covered interval, recessive; probably as in Unit 10b	2.4	42.4 (approx.)
9	Sandstone, fine- to medium-grained; finely laminated or massive; abundant ripples and festoon crossbeds; bedding lenticular on outcrop scale; minor 0.3 m - thick interbeds that are slightly recessive, laminated to thin-bedded siltstone with abundant and varied trails; locally abundant 15 to 30 cm - thick beds and lenses that are ferruginous-cemented, hard, heavy, weathering dark rusty-red-brown; upper part with a 2.5 cm - thick phosphatic (?) concretionary bed with rare ammonites and minor bivalves (GSC loc. 94024); unit weathers buff-grey, increasingly rusty upward, bluff-forming; unit lenticular; basal contact abrupt	0-8.0	40.0 (approx.)
	<u>Murray Ridge Formation</u>		
8	Siltstone, light grey; argillaceous; bioturbated; weathering fine rubbly to muddy, recessive, rusty; a slightly better consolidated bed occurs 2.1 to 2.3 m above base	3.6	33.6
7b	Covered interval, recessive	6.7	30.0
7a	Siltstone to fine- or medium-grained sandstone, very light grey; strongly argillaceous; strongly bioturbated; poorly consolidated; slightly pyritic locally; weathering fine platy to fine rubbly and muddy, slightly rusty in places; unit mainly recessive and poorly exposed with thin, moderately resistant, better consolidated fine-grained sandstone interbeds at 12.6 to 13 m, 14.6 to 15 m, and 19 to 20 m above base; *Echioceras* and minor indeterminate bivalves 13 m above base (GSC locs. 92582; C-80309)	20.0	23.3
	<u>Scho Creek Member</u>		
6	Sandstone, medium-grained; bioturbated, with *Ophiomorpha* and other burrows; glauconitic; moderately abundant phophatic(?) nodules; abundant wood and other plant fragments; weathering buff and rubbly; *Arctoasteroceras jeletzkyi*, oxynoticeratid ammonites, *Pleuromya*, *Pholadomya*, *Pleurotomaria*(?) crustaceans (GSC locs. 92581, 94091, C-80308, in place and loose on outcrop	0.3	3.3
5	Sandstone, medium-grained; strongly bioturbated, particularly upper part; strongly glauconitic; weathering rusty-buff to very dark brown, particularly upper part, rubbly; minor *Pleuromya*, *Pholadomya*, *Pleurotomaria*(?)	0.97	3.0
4	Sandstone, medium-grained; massive with abundant vertical root casts and burrows(?), ferruginous, glauconitic; minor pebbles as in Unit 1; upper boundary gradational (GSC loc. C-80876)	0.83	2.03
3	Sandstone, medium-grained; massive or finely laminated; slightly glauconitic; weathering blocky, structureless, resistant	0.6	1.2
2	Sandstone, medium grey-brown, medium-grained; indistinctly and finely laminated, slightly bioturbated; slightly glauconitic	0.3	0.6
1	Pebble conglomerate; poorly consolidated; pebbles mainly less than 2 cm in diameter, as large as 5 cm, variable in lithology but mainly chert or silicified "argillite", rounded; minor boulders of Permian sandstone; minor thin lenses of laminated fine- to medium-grained sandstone (GSC loc. C-76370)	0.1-0.3	0.3
	PERMIAN		
	Contact with underlying Permian rocks abrupt; Permian sandstones are fine-grained, argillaceous, thinly and irregularly bedded, rubbly, with abundant *Zoophycos*		

SECTION PU-9-75. Section on north nose of mountain just south of McDougall Pass, and west of Symmetry Mountain (approx. Lat. 67°41'30"N, Long. 136°19'W). The section was illustrated graphically in a preliminary report (Poulton and Callomon, 1976, sec. 7), and is also shown in Figure 10 of this paper. All measurements are in metres. Jeletzky (in press) described other similar sections in the same area.

Husky Formation	
Unconformity(?)	
Bug Creek Group (total)	84.5 m (approx.)
Aklavik Formation	45.0 m
Richardson Mountains Formation	39.5 m (approx.)
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	The top of the section is within the Husky Formation. Kimmeridgian to Early Portlandian *Buchia mosquensis* (von Buch) was identified by J.A. Jeletzky from beds just above the Bug Creek Group 3 and 6 km west along strike from this section (GSC locs. 70556 and C-27145 respectively).		
8	Sandstone, fine-grained, fine planar bedded, weathering to medium brown-grey plates; abundant *Buchia concentrica* (Sowerby), identified by J.A. Jeletzky (GSC loc. 92593)	3.0 (approx.)	105.5 (approx.)
7	Shale, black, fissile, with minor laminae and thin beds of siltstone and fine-grained sandstone; minor siliceous concretions, medium grey, weathering dark red, hard; unit poorly exposed, recessive	18.0	102.5 (approx.)
	BUG CREEK GROUP		
	Aklavik Formation(?)		
6	Sandstone, fine- to medium-grained; hard; weathering to massive blocks; poor impressions of *Inoceramus* and *Arcticoceras?* or *Cadoceras?* in talus (GSC loc. 92592); forms talus slope on north side of hill	24.0 (approx.)	84.5 (approx.)
5	Sandstone, fine- to medium-grained, very light grey; strongly low-angle cross-bedded; weathering platy to massive, with indistinct lamination, weathering light buff to light rusty-orange; resistant, forms northern peak of hill, upper part (talus on dipslope) with thin rusty orange brown weathering, calcareous, crossbedded lenses	21.0 (approx.)	60.5 (approx.)
	Richardson Mountains Formation		
4	Sandstone, thinly and irregulary bedded, strongly bioturbated; recessive, forms notch on top of hill	7.5	39.5
3	Sandstone, fine- to medium-grained, laminated and thinly bedded, platy-weathering, with poorly exposed strongly bioturbated, argillaceous interbeds; minor ferruginous lenses	6.0	32.0
2	Sandstone, light grey, fine- to medium-grained; strongly crossbedded with lenses that are laminated or strongly bioturbated; trails and vertical burrows, and a large (1 m diam.) radiating feeding burrow; belemnites common, uniformly oriented, in places forming conquinoid laminae; minor thin lenses are more ferruginous and contain abundant bivalves, including *Inoceramus*, and belemnites (GSC loc. 92479); unit forms southern peak of hill	23.0	26.0
1	Sandstone, light grey, fine- to medium-grained; hard; regularly and distinctly bedded, beds 15 cm thick; rare belemnites	3.0	3.0
	Covered interval	6.0	
	Permian		
	Sandstone, dark grey, fine- to medium-grained; strongly bioturbated; argillaceous variably recessive and resistant-weathering; generally rusty-buff-weathering; abundant *Zoophycos*		

SECTION PU-11-75. South nose of hill at headwaters of Rat River, north side of McDougall Pass, just north of, and overlooking, Twin Lakes (approx. Lat. 67°44'10"N, Long. 136°25'W). The section was illustrated graphically in a preliminary report (Poulton and Callomon, 1976, sec. 8), and is also shown in Figure 10 and Pl. 9, fig. 4 of this paper. All measurements are in metres.

Husky Formation	
Bug Creek Group (total)	232.2 m
Aklavik Formation	71.0 m
Richardson Mountains Formation	161.2 m
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	Top of section within Husky Formation.		
17	Sandstone, fine-grained, thin platy bedded; with *Buchia concentrica* (Sowerby), identified by J.A. Jeletzky (GSC loc. 92477)	4.5	266.7 (approx.)
16	Shale, black, fissile, recessive	30.0 (approx.)	262.2 (approx.)
	The upper contact is somewhat disturbed tectonically.		
	TOP OF BUG CREEK GROUP		
	Aklavik Formation		
15	Sandstone, white to very light grey, fine- to medium-grained; hard; small and large-scale crossbedded, in part avalanche-style; minor limonite specks; weathering light orange or yellow buff, resistant, forms bluffs at top of hill, with long vertical chimneys (GSC loc. C-80875)	29.0	232.2
14	Sandstone, light grey; hard, fracturing conchoidally; weathering buff to dark brown with abundant rusty stain; minor simple trails; lower 3 m bioturbated, recessive; above this mainly massive with minor laminated and large-scale low-angle crossbedded intervals weathering to thin brittle plates; upper 6.75 m with minor calcareous cement	42.0	203.2
	Richardson Mountains Formation		
13	Sandstone, fine-grained; planar laminated and large-scale, low-angle crossbedded; weathering to thin plates, minor 0.6 m-thick structureless beds; weathering buff- to medium or dark grey-brown with dark rusty stain on fracture surfaces	27.0	161.2
12	Sandstone, fine-grained; regularly 0.6 to 1.5 m-thick-bedded, in part indistinctly laminated or structureless, in part large-scale low-angle cross-bedded; minor thin finely laminated, platy-weathering intervals; rare 15 cm to 0.6 m-thick strongly bioturbated interbeds; a 3 m-thick interval in centre of unit is covered, recessive	39.0	134.2
11	Sandstone, fine-grained; large-scale low-angle crossbedded; weathering to thin plates, buff with large rusty-orange-weathering dolomite(?)-cemented patches; minor belemnites, *Inoceramus*, other bivalves (GSC loc. 92598)	29.0	95.2
10	Covered, recessive interval; probably argillaceous sandstone, fine-grained, soft, bioturbated	7.8	66.2
9	Sandstone, fine-grained; argillaceous; strongly bioturbated; indistinctly bedded	1.2	58.4
8	Sandstone, fine- to medium-grained; large-scale low-angle crossbedded weathering to thin plates, in 0.6 m-thick units, with minor interbeds 1 m thick that are indistinctly bedded, strongly bioturbated; unit somewhat resistant; *Inoceramus* (GSC loc. 92476); lower contact sharp	4.8	57.2
7	Sandstone, fine-grained; strongly argillaceous; strongly and finely burrowed; 0.3 to 0.6 m-thick somewhat irregularly bedded; ferruginous siltstone concretions in beds or forming lenses between beds, approx. 10 to 15 cm by 0.6 to 1.5 m in size; abundant poorly preserved large belemnites; unit forms bluffs, with strong vertical fracture systems	18.0	52.4
6	Sandstone, fine-grained; strongly argillaceous; strongly bioturbated; soft, somewhat recessive; several thin ferruginous siltstone lenses; minor *Cranocephalites* sp. aff. *C. pompeckji* (Madsen)(?) and *C.* sp. aff. *C. maculatus* Spath (GSC locs. 92475, 92481 loose)	2.4	34.4
5	Sandstone, fine-grained, strongly argillaceous; strongly and finely burrowed; indistinctly 0.3 to 0.6 m-thick, irregularly bedded; minor ferruginous lenses 15 to 20 cm by 1.2 m; abundant poorly preserved large belemnites; unit forms resistant bluff with strong vertical fracture system; upper 4.5 m particularly resistant, massive	9.5	32.0
4	Interval covered with talus from bluffs above; probably same lithology as underlying unit	7.2	22.5
3	Sandstone, fine-grained, medium to dark grey, strongly argillaceous, carbonaceous; indistinctly bedded, strongly and finely bioturbated; minor belemnites; unit forms a small knob with discontinuous outcrop	1.8	15.3
2	Covered, recessive interval	9.0	13.5
1	Shale, black, fissile; with spherical ferruginous concretions, weathering yellow-orange-brown; poorly exposed	4.5	4.5
	PERMIAN		
	Sandstone, fine-grained, argillaceous; in part strongly bioturbated, in part finely laminated; rusty stained; *Zoophycos* seen considerably below presumed top of Permian		

SECTION PU-12, 14-75. South part of Murray Ridge (approx. Lat. 67°58'30"N, Long. 136°22'30"W). This composite section represents the succession on several spurs at this location. The section, or one very close to it, was previously described by geologists of the British American Oil Company (as published by Jeletzky, 1967, p. 166-171; 1975, fig. 7) and by Mountjoy (Mountjoy and Procter, 1969; Bamber, 1972; sec. 116P6), and it was graphically illustrated in preliminary reports by Poulton and Callomon (1976, sec. 10) who also commented on the previous, in part erroneous, interpretations, and by Poulton (1978c, fig. 14; 1978d, fig. 5). It is also shown in Figures 7, 9 and 11 and Pl. 7, fig. 1 of this paper. A nearly identical section 9 km to the east (sec. 116P-1), measured by E.W. Bamber and reproduced in this report, documents the southeasternmost reasonably well-exposed exposure of the entire Bug Creek Group, where all its formations are present. Lower parts of the Bug Creek Group in a section along strike to the north, are also described in Section PU-9-76. All measurements are in metres.

Bug Creek Group (total)	489.0 m
Aklavik Formation	37.8 m
Richardson Mountains Formation	250.5 m
Manuel Creek Formation	52.0 m
Almstrom Creek Formation	72.0 m
Murray Ridge Formation	76.6 m
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	The overlying Husky shale has yielded Kimmeridgian to Portlandian *Buchia* sp. cf. *B. mosquensis*, identified by J.A. Jeletzky at two localities 4.6 and 7 km north of the present section (GSC locs. 44165 and 44158 respectively).		
	TOP OF SECTION AT TOP OF HILL		
	TOP OF BUG CREEK GROUP		
	Aklavik Formation		
19a	Sandstone, fine-grained; lower part is planar-laminated to thinly, evenly and regularly bedded, recessive, interbedded with thinly bedded, bioturbated sandstone; minor trails; weathering to hard plates with light blue-grey and very light yellow-green stains; upward beds become as thick as 0.6 m; upper 1.5 m hard, white-weathering	30.0 (approx.)	489.0 (approx.)
18a	Sandstone, white to light grey, fine- to medium-grained, hard; thickly planar, and evenly bedded to massive; locally bioturbated; weathering with minor yellow stains; bluff forming	7.8	459.0
	Richardson Mountains Formation		
17a	Siltstone to fine-grained sandstone, glauconitic(?); strongly bioturbated, thinly and irregularly bedded; weathering light blue-grey with light yellow-green stain; a 0.6 to 2 m-thick interbed occurs in centre of unit, massive with internal crossbedding; minor belemnites	6.8	451.2
16a	Sandstone, fine- to medium-grained; locally pyritic, glauconitic(?); thin-bedded to massive or indistinctly laminated, large-scale low-angle crossbedded; with 2 x 6 m (approx.) concretions at base that are calcite-cemented, weathering rusty-yellow-orange; buff-weathering with rusty and yellow-green stains; slabs below with *Dentalium* and *Entolium(?)* or *Camptonectes(?)* may have come from this unit; wood fragments; forms lower part of bluffs at top of ridge	29.0	444.4
15a	Sandstone, fine-grained; fine planar-laminated and low-angle crossbedded; with carbonaceous, argillaceous partings; some beds massive, as thick as 1.2 m; minor thin beds argillaceous, strongly bioturbated; upward weathers increasingly light blue-grey with yellow (jarosite?) stain	24.0	415.4
14a	Sandstone, light grey; fine-grained; massive with minor poorly developed internal lamination; weathering white, with light rusty-yellow-orange concretionary patches at base; blocky, resistant	3.0	391.4
13a	Sandstone, fine-grained; finely planar-laminated to 15 cm-bedded with planar carbonaceous, argillaceous partings; trails; local rusty-red stain	7.5	388.4
12a	Siltstone, argillaceous, pyritic; indistinctly, thinly and irregularly bedded, strongly and finely bioturbated; minor wood fragments; rusty-weathering, recessive, poorly exposed	7.5	380.9
11a	Siltstone to fine-grained sandstone, argillaceous, carbonaceous, pyritic, glauconitic(?), strongly bioturbated, in 0.3 to 1.5 m-thick units, with 20% lenses of finely laminated, low-angle crossbedded fine-grained sandstone; forms resistant bluffs, weathering rubbly and in thin slabs, buff with rusty stain and light green-orange stain	10.4	373.4
10a	Sandstone, fine-grained; pyritic; finely laminated with carbonaceous partings, low-angle cross-laminated and rippled; interbedded on 0.6 to 1.5 m scale, with indistinctly, thinly and irregularly bedded, bioturbated, argillaceous, carbonaceous, fine-grained sandstone; abundant trails; locally abundant rusty stains 1 cm in diameter; interval 7.5 to 8.5 m above base with abundant dark red stain on fracture surfaces; upper 8.5 m of unit dominantly finely laminated sandstone; recessive (GSC loc. C-80877)	19.0	363.0
9a	Sandstone, light grey, fine-grained, pyritic, hard; massive or with poorly defined lamination; weathering to large blocks; minor rusty-red-stained fracture surfaces; locally with rusty stains 1 cm in diameter; minor large belemnites	6.0	344.0

Unit	Lithology	Thickness	Height Above Base
8a	Sandstone, fine-grained, massive or with indistinct lamination and abundant large-scale low-angle crossbedding in 0.6 to 3 m-thick units; weathering buff, resistant; minor thin bands with lenses of rusty-orange and red-weathering siltstone; some surfaces with ripples and abundant current-swept fragments of large belemnites, *Inoceramus*, ammonites(?); minor siltstone partings with trails; abundant isolated *Inoceramus* shells; a discontinuous row of 3 by 15 to 30 m (approx.) concretions occurs about 20 m above base, of calcareous cemented sandstone otherwise as described above, weathering medium rusty-orange-brown, with abundant non-oriented *Pachyteuthis*, *Cylindroteuthis*(?), and *Inoceramus*; upper 4.5 m of unit recessive, laminated, low-angle crossbedded fine-grained sandstone interbedded on 5 cm to 0.6 m scale with thinly and irregularly bedded, strongly bioturbated, fine-grained sandstone with irregular argillaceous, carbonaceous partings	36.0	338.0
7a	Sandstone, fine-grained, laminated, low-angle crossbedded with local ripples, platy-weathering; with thin soft beds of argillaceous, bioturbated siltstone to fine-grained sandstone; abundant *Inoceramus*; slabs in talus below, with *Dentalium*(?) may be from this unit; buff-weathering, banded	7.5	302.0
6a	Siltstone to fine-grained sandstone, argillaceous, carbonaceous, pyritic; strongly and finely bioturbated, thinly, irregularly and indistinctly bedded; minor 0.6 x 3 m, finely laminated, low-angle crossbedded lenses at base; unit buff-weathering with abundant rusty stains 1 cm in diameter	4.5	294.5
5a	Sandstone, fine-grained; massive or with indistinct lamination and abundant large-scale, low-angle crossbedding; minor lenses 0.3 x 2 m of dark red-weathering siltstone; minor belemnites and trails; weathering in large angular blocks or plates; a discontinuous dolomite-cemented bed 0.3 m thick, occurs at base, weathering light rusty-yellow-orange	18.0	290.0
4a	Sandstone, fine-grained; mainly indistinctly bedded and strongly bioturbated at base with increasing proportions upward of 0.3 to 0.6 m-thick, laminated and low-angle crossbedded units; large belemnites; unit buff-weathering, forms resistant bluff	6.5	272.0
3a	Siltstone to fine-grained sandstone, argillaceous, pyritic, glauconitic; strongly bioturbated, thinly and indistinctly bedded in part, varying to distinctly banded, due to varying proportions of mudstone-siltstone partings; large burrows; abundant large belemnites; abundant poorly developed ferruginous concretions 1 cm in diameter; a 15 cm-thick medium to dark red-weathering ferruginous siltstone band at base; unit weathers buff with slight green stain, pyritic, glauconitic; forms resistant bluff	7.8	265.5
2a	Siltstone to fine-grained sandstone, argillaceous, with mudstone and siltstone partings; *Cranocephalites* fragments; unit recessive grades into overlying unit	9.0	257.7
1a	Siltstone to fine-grained sandstone, argillaceous, glauconitic; thinly and irregularly bedded, finely and strongly bioturbated; with thin irregular interlaminae of mudstone and siltstone, weathering fine rubbly; minor rusty-red-weathering loaflike concretions; abundant poorly preserved *Cranocephalites* sp. cf. *C. indistinctus*, *Inoceramus*, and very large belemnite holes (GSC loc. 92474); unit recessive, upper part harder, forming small bluff with very light olive-green stain	6.0	248.7
	Lower part of section measured on next ridge to south; correlation of the two parts of the section is not thought to involve any stratigraphic error.		
15	Siltstone to fine-grained sandstone, argillaceous; strongly bioturbated; rubbly-weathering, poorly exposed; upper part largely covered with boulders from overlying units	20.0	242.7
14	Sandstone, light to medium grey, fine- to medium-grained; argillaceous, carbonaceous; strongly bioturbated; indistinctly, irregularly and thinly bedded, rarely well-laminated; locally abundant vertical burrows; abundant small pyrite nodules with rusty stain; irregularly distributed, rusty-orange-red-weathering concretions 15 to 30 cm-thick x 0.6 to 18 m long; minor large belemnites and *Inoceramus* scattered throughout; at top of unit is a discontinuous row of rusty-brown-weathering siltstone nodules rich in *Cranocephalites borealis*, *Inoceramus*, *Camptonectes*, *Oxytoma* sp. cf. *O. septentrionalis* Haughton, *Goniomya*(?) sp., gastropods and large belemnites (GSC locs. 92466, 94046 and C-6610); *Inoceramus* collected near middle of unit (GSC loc. 94044); unit forms resistant bluff, weathering buff; minor boulders in talus below, containing *Arkelloceras* sp. cf. *A. mclearni* Frebold (GSC loc. C-53365), with laminae rich in belemnites and phosphatic pebbles may come from this unit; *Arkelloceras elegans* Frebold and *Inoceramus lucifer* (Eichwald) were collected by E.W. Mountjoy in the basal 5 m of this unit (GSC loc. 52699	24.0	224.7
	<u>Manuel Creek Formation</u>		
13,12	Siltstone and fine-grained sandstone, thinly and irregularly bedded, strongly bioturbated; with argillaceous partings; minor 5 to 15 cm-thick wavy, rippled, laminated and cross-laminated interbeds, weathering buff, varying to 30% and 0.3 m thick in upper 9 m, with some laminae rich in comminuted shell debris; locally abundant 2.5 cm by 15 to 30 cm lenses and more or less continuous laminae of rusty-red-weathering, concretionary ferruginous mudstone; *Pseudolioceras* sp. cf. *P. mclintocki* (Haughton) 9 m above base (GSC loc. C-53364); rubble of red-weathering concretions as large as 0.3 m in diameter, probably from this interval, some with black phosphatic cores, rich in *Pseudolioceras*, sp. aff. *P. mclintocki*, *Dactylioceras*, *Inoceramus*, *Oxytoma* sp. cf. *O. septentrionalis* Haughton, *Variamussium*(?), belemnites (GSC locs. 92605, 94041, C-6609, C-53363, C-65011)	19.0	200.7
11	Siltstone to fine-grained sandstone, very light to medium grey; in part argillaceous, glauconitic; strongly bioturbated, finely and irregularly bedded; with minor black mudstone or shale interbeds; unit recessive, poorly exposed, weathering very light grey with faint blue and yellow tinges, banded on 0.3 to 1 m scale	7.5	181.7

Unit	Lithology	Thickness	Height Above Base
10	Siltstone, argillaceous, strongly bioturbated, thinly and irregularly bedded, rubbly weathering; and shale or mudstone, black, locally fissile; abundant small calcareous, ferruginous concretions, weathering spheroidally, rusty-orange- and dark red, with minor poorly preserved ammonite and belemnoid(?) fragments, *Entolium* and other bivalves [GSC locs. 92604, 94040 (loose)]; unit recessive, poorly exposed	25.5	174.2
	<u>Almstrom Creek Formation</u>		
9	Sandstone, light grey to greenish-grey, fine- to medium-grained; hard; massive or with fine lamination and large-scale (in part) low-angle crossbedded, in 1.5 to 3 m-thick subunits that are strongly bioturbated, carbonaceous, and argillaceous in their upper 10 cm to 0.3 m; bioturbated intervals increase in abundance upward; surfaces of some beds with trails, or rippled, strewn with plant fragments, *Entolium*, and carbonaceous, argillaceous rip-up clasts; minor beds with poorly preserved large *Ostrea* [GSC locs. 92603, 94942 (loose)]; unit weathering moderately resistant, particularly in upper parts, light grey with green tinge, with light brown bands	33.0	148.7
8	Sandstone, light brownish-grey, fine- to medium-grained; strongly bioturbated; indistinctly, thinly and irregularly bedded, with abundant trails; carbonaceous, slightly argillaceous, glauconitic; weathering buff with slight yellow-green tinge	1.5	115.7
7	Sandstone, very light grey-brown; fine- to medium-grained; indistinctly planar-laminated and large-scale low-angle crossbedded in 0.3 to 1 m-thick beds; ferruginous lenses mainly 5 to 15 cm x 1.3 to 6 m, rarely as thick as 2 m; rare pyrite nodules as large as 5 mm in diameter; unit weathering buff, with light brown bands; locally abundant, poorly preserved *Entolium*, *Camptonectes*, *Lingula*	24.0	114.2
6	Sandstone, fine- to medium-grained; massive or with indistinct lamination, low-angle crossbedded; ferruginous lenses as large as 25 cm x 6 m; unit weathering buff with rusty patches	6.0	90.2
5	Sandstone, hard, light grey to brown, fine-grained; low-angle crossbedded, in 2.5 cm to 0.6 m-thick well-developed, even and regular beds that have carbonaceous(?), argillaceous partings, trails, and ripples; minor thin bioturbated beds; common rusty-red-weathering lenses, 8 to 15 cm x 0.6 to 1.5 m, of ferruginous siltstone to fine-grained sandstone; unit weathering buff- to rusty-brown, forms well-banded resistant bluffs; lower contact very sharp and even	7.5	84.2
	<u>Murray Ridge Formation</u>		
4b	Largely covered by talus from above; upper 0.3 m at least is strongly bioturbated argillaceous siltstone, recessive	15.0	76.7
4a	Mudstone to argillaceous siltstone, grey; thinly and irregularly bedded, strongly bioturbated; minor large, hard, red-weathering concretions, some with abundant *Corbula*(?), "*Pentacrinus*", and other fossils; upper half of unit with 40% 0.3 m-thick hard, finely laminated beds; unit forms somewhat resistant small bluffs	8.0	61.7
3	Shale or mudstone, in part black, fissile, with red-weathering concretions; upper part varies to argillaceous siltstone; strongly bioturbated, finely and irregularly laminated; soft; unit recessive, poorly exposed; fossils collected in hard, siliceous concretions on surface on lower part of unit, include *Echioceras*(?) and *Gryphaea*(?) (GSC locs. 92602, 94047, C-53362 in lowest 12 m)	53.0	53.7
2	Mudstone, medium grey; local rusty concretions, weathering wine-red; unit weathering black, fine chippy to muddy, recessive; lowest 0.3 m with abundant pebbles of black 'argillite', well-rounded, as large as 8 cm in diameter; abundant fossils including *Oxytoma*, other ostreiid and pectinid bivalves, *Pleurotomaria*(?), rhynchonellid brachiopods, "*Pentacrinus*", and wood fragments (GSC locs. 92601, C-53361); unit variably recessive or resistant, where it weathers maroon	0.6	0.7
1	Shale, purplish- to brownish-grey; very soft, clayey; occurs as small pockets on upper hard surface of Permian rocks	0-0.1	0.1
	Jurassic/Permian paraconformable contact is sharp, occurs in recessive argillaceous siltstone unit; upper beds of Permian are strongly bioturbated, dark grey, argillaceous, siltstone to fine-grained sandstone with abundant '*Zoophycos*'; beds 30 to 35 of Bamber (1972, sec. 116P6) are Lower Jurassic rather than Permian as he thought.		

SECTION PU-13-75. Small ridge on east side of White Mountains (approx. Lat. 67°57'N, Long. 136°29'W). Thicknesses are estimated; units are only briefly and generally described. The section is illustrated in Figure 11 and Pl. 9, fig. 2. All measurements are in metres.

Husky Formation	
Bug Creek Group (total)	190.0 m (est.)
Aklavik Formation(?)	40.0 m (est.)
Richardson Mountains Formation	150.0 m (est.)
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	The overlying thick recessive unit is assumed to represent the Husky Formation.		
	TOP OF BUG CREEK GROUP		
	Aklavik Formation(?)		
5	Sandstone as in Unit 3; resistant ridge	40.0 (est.)	190.0 (est.)
	Richardson Mountains Formation		
4	Recessive interval, probably as in Unit 2	30.0 (est.)	150.0 (est.)
3	Sandstone, in part hard and quartz-cemented; in part calacareous; very light grey to brown-grey, fine- to medium-grained; weathering blocky; with belemnites, *Inoceramus* (GSC loc. 92600); resistant ridge, poorly exposed, mainly felsenmeer	40.0 (est.)	120.0 (est.)
2	Sandstone, fine-grained, argillaceous, strongly bioturbated; with interbeds of siltstone to fine-grained sandstone, laminated to thinly bedded, platy; unit recessive, poorly exposed	20.0 (est.)	80.0 (est.)
1	Sandstone, hard, quartz-cemented; white to light brown, fine- to medium-grained; slightly ferruginous; weathering in large blocks and slabs, rarely with abundant *Dentalium* and poorly preserved belemnites; locally abundant ferruginous siltstone, weathering rusty-red and brown; very minor chips of sandstone weathering with light blue-grey tinge; unit poorly exposed, mainly felsenmeer	50.0-60.0 (est.)	50.0-60.0 (est.)
	PERMIAN		
	Contact with underlying fossiliferous Permian rocks is uncertainly placed within a recessive covered interval		

SECTION PU-2, 26-76. 1.5 km from Jurassic Butte, at end of flat-topped spur projecting east-southeastward (approx. Lat. 68°01'30"N, Long. 135°25'30"W). This overturned section was previously described and illustrated by Jeletzky (1967, sec. 24, p. 102-104, pl. VI, fig. 1), graphically illustrated in preliminary reports by Poulton (1978a; 1978b, fig. 5.3; in Nassichuk et al., 1978, figs. 37, 38), and is also shown in Figure 5 of this paper. The present description, based on fieldwork by Poulton, differs only in detail from, and incorporates data from, that of Jeletzky (op. cit.). Microfossil distributions are shown in Table 2. All measurements are in metres.

Upper Jurassic or Lower Cretaceous rocks	
Fault	
Bug Creek Group (part?)	97.5 m (approx.)
Aklavik(?) and Richardson Mountains Formations (part?)	72.0 m (approx.)
Unconformity	
Murray Ridge Formation	25.5 m
Scho Creek Member	7.5 m
Unconformity	
Permian(?) red conglomerate	

Unit	Lithology	Thickness	Height Above Base
	Jeletzky (1967) and Poulton (in Nassichuk et al., 1978), following him, considered the upper part of the Bug Creek Group to be absent by faulting, which juxtaposed the group against Upper Jurassic or Lower Cretaceous argillaceous rocks to the east. The uppermost beds of this section, however, could well represent the Aklavik Formation in a poorly lithified manifestation, judging by their lithology and thickness, and the upper part of the section may therefore be complete.		
	Aklavik(?) and Richardson Mountains Formations		
6	Sandstone, light white-grey to buff, fine-grained; buff-weathering, somewhat resistant	30.0 (est.)	97.5 (approx.)
5	Siltstone and fine-grained sandstone, light white-grey to buff; fine platy and buff-weathering; unit recessive, poorly exposed. Foraminifera *Recurvoides* sp. 5009, *Trochammina* sp. D and palynomorphs 5 m below top (GSC loc. C-53574); megaspore 10, and palynomorphs, at 12 to 15 m above base (GSC loc. C-53575), palynomorphs 1.5 to 3 m above base (GSC loc. C-53576)	30.0	67.5

Unit	Lithology	Thickness	Height Above Base
4	Sandstone, light grey to buff, fine-grained; carbonaceous; finely laminated and low-angle crossbedded, in units 0.3 to 1 m thick; with 50% strongly bioturbated, argillaceous interbeds in lower part; abundant very small pyrite nodules in lower part; basal 10 cm locally glauconitic; minor granule- and pebble-bearing lenses, some rich in belemnites and bivalves (GSC loc. C-94173) throughout, but most common in basal few centimetres; a more or less continuous, rusty-red-weathering limonitic(?) band as thick as 0.3 m, with large carbonaceous wood fragments and thin buff-weathering interlaminae, occurs 1.5 m above base; six red-weathering, ferruginous siltstone to fine-grained sandstone beds, 10 to 30 cm thick approximately, occur from 4.5 to 9 m above base; minor laminae rich in belemnites in lowest 9 m; minor belemnites throughout (e.g. GSC loc. 25771), bivalves, *Cranocephalites* sp. (GSC loc. 92029 loose on surface; GSC loc. 94172 3 m above base); upper 20 cm of unit finely and irregularly bedded, rippled(?), with fine interbeds of medium to dark grey, dark rusty-red-weathering, ferruginous siltstone; unit rusty-buff-weathering, moderately resistant; palynomorphs from 1.5 to 3 m below top of unit (GSC loc. C-53577)	12.0	37.5
	Murray Ridge Formation		
3	Siltstone, light rusty-brown, ferruginous; weathering rusty-red; abundant small irregular pyritic nodules; abundant trace fossils and rare *Entolium* and gastropods (GSC loc. 25764); unit hard, resistant	0.3-0.6	25.5
2	Shale and argillaceous siltstone, medium to dark grey; *Echioceras*(?) *"Pentacrinus"*, *Gryphaea*(?) in middle of unit (GSC locs. 94028, 94174); palynomorphs 1.5 m above base (GSC loc. C-53580); Foraminifera *Lenticulina* sp. cf. *biexcavata* and palynomorphs at 7.5 m above base (GSC loc. C-53579); Foraminifera *Ammobaculites* sp. 4925 and *Ammodiscus* sp. cf. *cheradospirus* and palynomorphs 15 m above base (GSC loc. C-53578); unit recessive, but moderately well exposed	17.4	24.9
	Scho Creek Member		
1	Sandstone, light brown-grey, fine-grained; local phosphatic nodules, minor chert granules and pebbles throughout; basal 0.3 to 1 m is chert granule and pebble conglomerate; *Arctoasteroceras jeletzkyi* Frebold, *Oxynoticeras* sp., *Gleviceras* sp., *Pleuromya* sp. cf. *P. galathea* Agassiz, *Pholadomya* sp., *Atractites*(?) sp., gastropods, and other fossils in recessive beds 2.1 to 2.7 m above base (GSC loc. 94026), 2 m (GSC loc. 25765) and 0.6 m (GSC loc. 25762) below top of unit, and loose (GSC locs. 94027, C-6612); unit weathering resistant, rusty-buff	7.5	7.5
	PERMIAN(?) RED CONGLOMERATE UNIT		
	See Nassichuk et al., 1978		

SECTION PU-3-76. Small peak east of Bell River 10 km northwest of Mount Millen (approx. Lat. 67°30'50"N, Long. 136°35'30"W). This section is somewhat contorted and shattered tectonically. It is illustrated in Figure 10. All measurements are in metres.

Husky Formation	
Unconformity	
Bug Creek Group (total)	132.0 m
Richardson Mountains Formation	132.0 m
Unconformity	
Devonian	

Unit	Lithology	Thickness	Height Above Base
	The overlying rocks (Husky Formation) are dark grey-black fissile shale, with thin- to medium-bedded, planar- to irregularly-bedded, rusty siltstone to fine-grained sandstone interbeds. *Buchia* sp. (GSC loc. 94031) was collected 50 m (approx.) above the top of the Bug Creek Group.		
	BUG CREEK GROUP		
	Aklavik Formation(?)		
4	Dip slope, probably underlain by additional thickness of sandstone as in Unit 3	50.0 (approx.)	132.0 (approx.)
3	Sandstone, hard, quartz-cemented; light grey, fine- to medium-grained; indistinctly finely laminated to massive; with ferruginous spots; with minor brown-weathering calcareous pods, 0.3 by 1.5 m (approx.); unit resistant, forms peak; lower beds with minor belemnites, *Inoceramus*; upper beds with ferruginous burrows	52.0	82.0
	Richardson Mountains Formation		
2	Covered by talus from Unit 3; lithology presumed to be as in Unit 1; minor belemnites, *Inoceramus*	18.0	30.0
1	Sandstone, hard, quartz-cemented; light grey, fine- to medium-grained; indistinctly finely laminated to massive; with ferruginous spots; with minor brown-weathering calcareous pods, 0.3 by 1.5 m (approx.); locally abundant large belemnites, minor *Inoceramus*; rare poorly preserved *Arctocephalites*(?) (GSC loc. 94030)	12.0	12.0
	DEVONIAN		
	Contact with underlying Devonian rocks uncertainly placed within a 30 m thick (approx.) covered interval; the underlying rocks are finely laminated dark grey-black siltstone and medium grey, brown-weathering, siltstone to fine-grained sandstone, evenly bedded, with abundant trails.		

SECTION PU-7-76. North face of east-west-trending ridge southeast of White Mountains, east of head of Little Bell River (approx. Lat. 67°51'10"N, Long. 136°33'W). The section is illustrated in Figure 39. All measurements are in metres.

Bug Creek Group (part)	365.0 m (approx.)
Richardson Mountains Formation (part)	193.5 m (approx.)
Manuel Creek Formation	63.0 m
Almstrom Creek Formation	52.5 m (approx.)
Murray Ridge Formation	56.0 m (approx.)
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	BUG CREEK GROUP (PART)		
	Richardson Mountains Formation		
14	Sandstone, in part hard, quartz-cemented; light brown-grey, fine- to medium-grained; massive, laminated or bioturbated; minor scattered belemnites, *Inoceramus* throughout; minor beds rich in large belemnites; unit resistant, forms bluffs at top of ridge; dip slope possibly includes 50 to 75 m of additional thickness	120.0 (est.)	365.0 (approx.)
13	Covered by talus from overlying unit	30.0 (est.)	245.0 (approx.)
12	Siltstone to fine-grained sandstone; argillaceous, carbonaceous; strongly bioturbated; weathering rubbly, recessive, poorly exposed	30.0	215.0 (approx.)
11	Sandstone, hard quartz-cemented, light grey, fine- to medium-grained; 15 cm-bedded to massive, irregularly bedded; very slightly ferruginous; together with units 9 and 10, forms resistant bluffs	13.3	185.0 (approx.)
10	Sandstone, hard, quartz-cemented, light grey, fine- to medium-grained; abundant 2.5 cm (diameter) phosphatic nodules with abundant belemnite and *Inoceramus* fragments	0.1	171.7 (approx.)
9	Mudstone-siltstone, ferruginous; brown-weathering; lower 2.5 cm phosphatic, with abundant belemnite and *Inoceramus* fragments, minor *Cranocephalites*(?) (GSC loc. 94074)	0.1	171.6 (approx.)
	Manuel Creek Formation		
8	Covered by boulders from overlying units	16.5	171.5 (approx.)
7	Shale to siltstone, dark grey-black, in part fissile; abundant planar 1 to 2.5 cm-thick interbeds of hard siltstone; abundant 10 to 15 cm-thick bands and lenses of red-weathering ferruginous mudstone or siltstone; minor yellow-buff-weathering ferruginous concretions 15 by 30 cm (approx.)	18.0	155.0 (approx.)
6	Siltstone to fine-grained sandstone; argillaceous, carbonaceous; strongly bioturbated; weathering fine rubbly, recessive	3.0	137.0 (approx.)
5	Shale, medium to dark grey-black, fissile; fine chippy- and muddy-weathering; abundant continuous concretionary beds of slightly pyritic, red-weathering, ferruginous mudstone, containing poorly preserved fossils, collected 5 m above base (GSC loc. 94073)	10.5	134.0 (approx.)
4	Covered interval, recessive; probably shale as in overlying unit	15.0	123.5 (approx.)
	Almstrom Creek Formation(?)		
3	Siltstone to fine-grained sandstone, light grey; carbonaceous, argillaceous; strongly bioturbated, with irregular argillaceous partings, abundant trails and burrows; fine rubbly-weathering; abundant interbeds, particulary near base, as thick as 20 cm, of hard, quartz-cemented sandstone, light grey, laminated and low-angle crossbedded, with trails, ripples and wallows on upper surface, resistant; unit forms small bench	22.5	108.5 (approx.)
2	Sandstone, hard, quartz-cemented, light brown to light grey, fine- to medium-grained; massive or with indistinct planar laminae and low-angle crossbedding; minor small ferruginous mudstone nodules, forming abundant red-brown-weathering concretionary bands in upper 1 m (approx.); unit resistant, weathering rusty-red-brown	30.0 (approx.)	86.0 (approx.)
	Murray Ridge Formation		
1	Siltstone, black; argillaceous; recessive, poorly exposed, largely covered by boulders from overlying unit	56.0 (est.)	56.0 (approx.)
	PERMIAN		
	Underlying rocks are a thick succession (150 m minimum est.) of fine-grained, rusty, bioturbated sandstone with abundant *Zoophycos*		

SECTION PU-9-76. North part of Murray Ridge (approx. Lat. 68°01'45"N, Long. 136°26'30"W). Only the lower parts of the Bug Creek Group are described here; they provide additional, more detailed information to the nearby Section PU-12, 14-75, corresponding to beds 1 to 14 (lower part) of that section; and they are overlain by a similar succession to that which is described there. The section is illustrated in Figures 9 and 23. The approximate horizons from which microfossils were recovered, collected 100 m south of Section PU-9-76, are shown in Table 4. All measurements are in metres.

Bug Creek Group (part)	250.0 m
Richardson Mountains Formation (part)	1.5 m
Manuel Creek Formation	65.75 m
Almstrom Creek Formation	105.25 m
Murray Ridge Formation	77.5 m
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	Top of described section is low in Richardson Mountains Formation.		
26	Siltstone to fine-grained sandstone; hard, ferruginous; in part laminated and cross-laminated, in part strongly bioturbated; ferruginous rip-up clasts; 10 cm thick beds of black carbonaceous shale-siltstone at 0.3 and 0.6 m (approx.) above base are rich in black phosphatic nodules as large as 5 cm in diameter, which contain *Arkelloceras*, *Inoceramus*, and other bivalves, belemnites (GSC loc. 94048); unit weathering rusty-red	1-1.5	250.0 (approx.)
	Manual Creek Formation		
25	Sandstone, hard, quartz-cemented; very light grey, fine-grained; 1 to 15 cm bedded, planar-bedded, rippled, and crossbedded; partly bioturbated in upper 4 m; unit recessive, poorly exposed; probably with minor soft, bioturbated siltstone interbeds in lower parts	11.0	248.5
24	Siltstone to fine-grained sandstone, light grey; carbonaceous, argillaceous; strongly bioturbated; weathering rubbly, somewhat resistant; lowest part ferruginous in part, burrowed	1.0	237.5 (approx.)
23	Mudstone or siltstone, ferruginous; weathering red, concretionary, forms continuous band; local pods with *Variamussium*, *belemnites*, *Inoceramus* (GSC loc. 94050)	0.3	236.5 (approx.)
22	Siltstone, carbonaceous, argillaceous; finely and irregularly bedded, strongly bioturbated; weathering fine-rubbly; recessive, poorly exposed	2.5	236.25 (approx.)
21	Sandstone, hard, quartz-cemented; very light grey, fine-grained; strongly bioturbated; abundant trails; unit resistant; minor fossils including *Erycitoides*? sp., *Pseudolioceras* sp., and *Ostrea*(?) (GSC locs. 94190, 94192 loose)	0.5	233.75 (approx.)
20	Sandstone, hard, quartz-cemented; very light grey, fine-grained; laminated and cross-laminated; weathering light buff-grey with slight greenish tinge; minor ferruginous nodules; a continuous red-weathering ferruginous band 20 cm thick occurs at base; near base, shell hash on some surfaces with *Ostrea*(?), *Variamussium*(?), *Entolium*, other pectinids, belemnites, and rare *Vaugonia* (GSC locs. 94051, 94188, 94189); upper surface of unit rippled, carbonaceous, argillaceous; unit resistant	0.5	233.25 (approx.)
19	Shale, medium to dark grey or black, soft, fissile; varying to argillaceous siltstone, fine chippy-weathering, rusty-stained; very minor small lenses, 15 cm to 3 m of siltstone to fine-grained sandstone, laminated or strongly bioturbated; unit recessive	6.0	232.75 (approx.)
18	Siltstone, light grey; slightly argillaceous; weathering light grey, fine chippy or rubbly; upper 0.3 m hard, ferruginous, red-weathering, strongly burrowed	2.0	226.75 (approx.)
17	Covered interval, recessive; probably shale, dark grey-black; soft; fissile, silty	5.0	224.75 (approx.)
16	Siltstone (60%), light to medium grey; argillaceous, carbonaceous; weathering fine-chippy with rusty stain; and sandstone (40%), hard, quartz-cemented; very light grey, fine-grained; laminated, rippled, abundant trails; minor beds at 3 m, 7 m, 14 m, and 17 m above base of unit, as thick as 1 m, very light grey, hard; strongly bioturbated; finely and irregularly bedded with carbonaceous, argillaceous partings and minor 2.5 cm thick planar laminae and crosslaminae; pectinid bivalve near base (GSC loc. 94057); unit recessive; lithology gradational to underlying unit	19.0	219.75 (approx.)
15	Covered interval, recessive; presumed to be largely shale or mudstone; medium to dark grey or black, silty	18.0	200.75 (approx.)
	Almstrom Creek Formation		
14	Sandstone, light grey-brown, fine- to medium-grained; thin- to thick-bedded, indistinctly laminated and crosslaminated; abundant 5 to 50 mm (diameter) subspherical to irregular light rusty-yellow-brown-weathering concretions; abundant ferruginous, red-weathering pods 15 to 60 cm by 3 to 6 m; rare scattered oysters; unit bluff-forming, weathering light buff-grey, conspicuously banded with red; upper surface forms prominent terrace	7.5	182.75 (approx.)
13	Sandstone, light grey, fine-grained; laminated, rippled; carbonaceous, argillaceous partings with abundant *Chondrites*; minor hard resistant beds, quartz-cemented; unit weathering moderately resistant, upper surface forms small terrace	18.0	175.25 (approx.)
12	Sandstone, light grey, fine-grained; well-bedded; not examined in detail; moderately recessive	16.5	157.25 (approx.)

Unit	Lithology	Thickness	Height Above Base
11	Sandstone, hard, quartz-cemented, light grey, fine-grained; laminated, rippled, in 0.3 to 1.5 m-thick subunits; with red-weathering, ferruginous pods and bands as thick as 1 m; unit moderately resistant, weathering very light green-grey to buff, conspicuously banded with red	15.0 (approx.)	140.75 (approx.)
10	Sandstone, fine-grained; 50% light grey, hard, quartz-cemented, 20 to 60 cm-bedded with indistinct lamination and ripple crosslamination in upper parts of beds, in part with burrows and trails, weathering light grey and rusty-brown; 50% medium grey argillaceous, carbonaceous, strongly bioturbated, soft, spheroidal-weathering; abundant marcasite nodules, minor 15 to 30 cm by 3 to 6 m red-weathering ferruginous pods; unit bluff-forming, weathering buff with slight green tinge, banded	21.0	125.75
9	Sandstone, grey, fine-grained; in part 0.5 to 5 cm planar-bedded, hard, quartz-cemented, weathering rusty-brown; in part argillaceous, strongly bioturbated, rubbly, with rusty-red stain; recessive	1.0	104.75
8	Covered by blocks from above; probably as in overlying unit; recessive	11.0	103.75
7	Sandstone, light grey; hard; thin to medium planar-bedded and low-angle crossbedded; abundant trails, minor carbonaceous partings, in part rippled; abundant 10 to 15 cm by 3 to 6 m ferruginous pods, weathering red; minor small feruginous rip-up clasts; weathering platy, buff, somewhat resistant, banded	9.0	92.75
6	Covered, probably as in underlying unit	3.15	83.75
5	Sandstone, light grey, fine-grained; carbonaceous, argillaceous; irregularly 1 cm to 5 cm-bedded, with carbonaceous partings; minor 10 cm by 0.6 m red-weathering siliceous concretions near base, rich in *Corbula*(?) (GSC locs. 94056, 94195 loose); unit moderately resistant, weathering buff, rubbly	3.1	80.6

Unit	Lithology	Thickness	Height Above Base
	<u>Murray Ridge Formation</u>		
4	Covered by blocks from overlying unit; probably siltstone to very fine-grained sandstone, argillaceous, carbonaceous; strongly bioturbated, weathering fine rubbly	16.5	77.5
3	Shale and mudstone in lower part, medium to dark grey to black; soft, in part fissile; in part rusty-weathering; interval 12 to 40 m above base varies in part to silty mudstone, weathering fine chippy with rusty stain; upper 20 m grades to siltstone and fine-grained sandstone, strongly bioturbated, finely and irregularly laminated, weathering rubbly, buff-grey; unit with minor hard, concretionary lenses, approx. 15 cm by 1 to 3 m, medium to dark grey, siliceous, weathering rusty-red-brown; unit recessive, *Arctoasteroceras*(?) and pectinids in lower 15 m (GSC loc. 94054), *Arctoasteroceras*(?) and *Echioceras* sp. 37.5 m above base (GSC loc. 94055)	60.0	61.0
2	Mudstone or siltstone, ferruginous; medium grey to rusty-red-brown; abundant fossils including bivalves, gastropods, *Pentacrinus*, rare *Arctoasteroceras*(?) (GSC locs. 94053, 94194)	0.85	1.0
1	Mudstone or siltstone, ferruginous; medium grey; abundant 5 to 25 mm (diameter) siliceous argillite, chert and siltstone pebbles; mainly black, moderately well rounded; unit weathering rusty-red	0.15	0.15
	PERMIAN		
	Siltstone to medium-grained sandstone; argillaceous; strongly bioturbated; finely, indistinctly and irregularly bedded; weathering rubbly, brown-grey, banded; abundant "*Zoophycos*"		

SECTION PU-10-76. Section well exposed in gully on east side of canyon in north-flowing tributary of Almstrom Creek (approx. Lat. 68°05'40"N, Long. 136°11'30"W). All measurements are in metres. The section is illustrated in Plate 9, fig. 1.

Bug Creek Group (part)	420.53 m (min.)
Aklavik Formation	49.5 m
Richardson Mountains Formation	231.58 m
Manuel Creek Formation	51.75 m
Almstrom Creek Formation (part)	87.7 m
Fault	
Permian	

Unit	Lithology	Thickness	Height Above Base
	TOP OF HILL; TOP OF BUG CREEK GROUP		
	Aklavik Formation		
41	Sandstone, hard, quartz-cemented, white to very light grey; massive or with indistinct lamination and large-scale crossbedding; minor laminae or coarse-grained sandstone or grit, cherty; unit weathering buff with light rusty-brown stain, forms resistant bluffs	13.5	420.53
40	Covered by blocks from above; float with abundant belemnites and carbonaceous plant fragments on bedding surfaces; probably same as overlying unit but with interbedded recessive rocks	16.5	407.03
39	Sandstone, medium grey, fine- to medium-grained; carbonaceous; burrowed, 2.5 to 5 cm - irregularly-bedded; carbonaceous plant fragments; weathering buff, platy	19.5	390.53
	Richardson Mountains Formation		
38	Sandstone, light grey, fine- to medium-grained; laminated to 0.6 m-bedded, low-angle crossbedded, in part cut by vertical burrows; with minor interbeds, as thick as 0.3 m strongly bioturbated, in part carbonaceous; and minor interbeds 0.3 to 0.6 m thick, of thinly-parallel-laminated siltstone to fine-grained sandstone; abundant ripples on carbonaceous, argillaceous surfaces, minor rip-up clasts, trails; minor calcite cement; unit weathers blocky, platy, rubbly, buff with abundant rusty stain; resistant except upper 7.5 m which is partly covered; *Cardioceras (Scarburgiceras)* sp. aff. *C. (S.) alphacordatum* Spath belemnites, *Brachidontes*, *Inoceramus*, *Modiolus*, *Entolium*, and other small bivalves, scaphopods, wood fragments (GSC locs. 94067, 94068, 94069, 94070) collected in float and in place (GSC loc. C-53353)	45.0	371.03
37	Sandstone, light to medium grey, fine- to medium-grained; interbedded equal proportions strongly bioturbated in 0.3 - 0.6 thick beds, and laminated and low-angle crossbedded; in part parallel-to-burrowed sets; unit weathering buff	4.5	326.03
36	Siltstone to fine-grained sandstone; strongly bioturbated; carbonaceous, argillaceous; weathering fine rubbly, light grey, rusty, with slight blue tinge and yellow stain, recessive in lower 2 m and in upper part of unit, moderately resistant otherwise; rare, large, belemnites; *Arctocephalites*(?) scaphopods, pectinids loose in float probably from this unit (GSC locs. 94064, 94065, 94066)	18.0	321.53
35	Sandstone, hard, quartz-cemented, light to medium grey, fine- to medium-grained; laminated, in beds as thick as 1 m, low-angle crossbedded; upper 15 to 30 cm of each bed carbonaceous, argillaceous, strongly bioturbated with conspicuous vertical burrows; unit recessive, poorly exposed	4.5	303.53
34	Siltstone to fine-grained sandstone; strongly bioturbated; carbonaceous, argillaceous; weathering fine rubbly, light grey with slight blue tinge and yellow stain; recessive, poorly exposed	4.0	299.03
33	Sandstone, hard, quartz-cemented, light to medium grey, fine- to medium-grained; laminated, in beds as thick as 1 m, low-angle crossbedded; upper 15 to 30 cm of each bed carbonaceous, argillaceous, strongly bioturbated with conspicuous vertical burrows; unit recessive, poorly exposed	6.75	295.03
32	Sandstone, in part hard and quartz-cemented, light to medium grey, fine- to medium-grained; laminated to 0.6 m bedded, abundantly low-angle crossbedded, surfaces commonly carbonaceous and argillaceous with ripples, trails, argillaceous siltstone rip-up clasts, belemnite and *Inoceramus* fragments, *Entolium*, scaphopods; with minor interbeds 0.3 to 0.6 m-thick strongly bioturbated; and minor interbeds as thick as 0.6 m of siltstone to fine-grained sandstone, carbonaceous, argillaceous, strongly bioturbated; soft, with local red-weathering, siliceous concretionary bands; unit weathering rusty-buff, moderately resistant	34.5	288.28
31	Sandstone, hard, quartz-cemented; light to medium grey; massive or with indistinct lamination; some laminae rich in belemnite and *Inoceramus* fragments; minor pyrite nodules as large as 5 mm in diameter; unit weathering rusty-buff, blocky, resistant	2.5	253.78
30	Siltstone to fine-grained sandstone, carbonaceous, argillaceous; strongly bioturbated, soft, rubbly-weathering; with equal proportions of interbedded siltstone to fine-grained sandstone, light grey, planar-laminated to 0.3 m-bedded, in part low-angle crossbedded, platy- to blocky-weathering; bedding planes irregular, carbonaceous, argillaceous, with abundant ripples, trails, burrows; abundant pyrite nodules as large as 5 mm in diameter; local 15 cm by 0.6 m rusty-red-brown-weathering siliceous concretions; unit recessive	7.0	251.28

Unit	Lithology	Thickness	Height Above Base
29	Sandstone, fine-grained; carbonaceous, argillaceous; strongly bioturbated, irregularly bedded; locally abundant '*Zoophycos*'-like trace fossils; abundant pyrite nodules as large as 5 mm in diameter; weathering buff, resistant	9.0	244.28
28	Siltstone to fine-grained sandstone, carbonaceous, argillaceous; strongly bioturbated, soft, rubbly-weathering; with equal proportion at base, decreasing upward, of interbedded siltstone to fine-grained sandstone, light grey, planar-laminated to 0.3 m-bedded, in part low-angle crossbedded; platy- to blocky-weathering; bedding planes irregular, carbonaceous, argillaceous with abundant ripples, trails, burrows; abundant pyrite nodules as large as 5 mm in diameter; local 15 cm by 0.6 m rusty-red-brown-weathering siliceous concretions; unit recessive	10.5	235.28
27	Sandstone, hard, quartz-cemented; very light brown-grey, fine- to medium-grained; massive or indistinctly laminated; unit weathers rusty-buff, blocky, resistant; locally abundant belemnites, scaphopods and *Inoceramus* fragments (GSC loc. 94063)	3.0	224.78
26	Siltstone to fine-grained sandstone, light grey; thinly laminated to 15 cm-bedded; minor strongly bioturbated, rubbly beds; in part hard, quartz-cemented; unit recessive	10.5	221.78
25	Sandstone, light grey, fine- to medium-grained; in part hard, quartz-cemented; in part strongly bioturbated, thinly and irregularly bedded, in part thinly laminated to 0.6 m-bedded; minor beds with pyrite nodules as large as 5 mm in diameter; weathering platy, blocky, and rubbly, forms resistant bluff	13.5	211.28
24	Siltstone to fine-grained sandstone; light grey; thinly laminated; weathering thin-platy recessive	0.33	197.78
23	Sandstone, hard, quartz-cemented, light grey, fine- to medium-grained; beds structureless, as thick as 0.6 m, thinly laminated at top; resistant	1.5	197.45
22	Siltstone to fine-grained sandstone, light grey; thinly laminated; weathering thin-platy, recessive	0.5	195.95
21	Sandstone, hard, quartz-cemented, light grey, fine- to medium-grained; laminated; slightly calcareous; weathering rusty-buff, blocky, resistant; abundant scaphopods	2.0	195.45
20	Siltstone to fine-grained sandstone, interbedded equal proportions strongly bioturbated and laminated to thin bedded; with argillaceous partings, trails, and rip-up clasts; a red-weathering lens, 15 cm by 6 m, of hard, medium grey, siliceous siltstone, 15 cm below top; unit recessive	6.0	193.45
19	Sandstone, light to medium grey, fine- to medium-grained; laminated, minor vertical burrows; weathering blocky and massive near base, platy at top; rusty-buff, resistant; minor large belemnites and *Inoceramus* fragments throughout	15.0	187.45

Unit	Lithology	Thickness	Height Above Base
18	Sandstone, light to medium grey, fine- to medium-grained; carbonaceous, argillaceous; strongly bioturbated, thinly and irregularly bedded; abundant pyrite nodules as large as 5 mm in diameter; a red-weathering siliceous band occurs 7.5 m above base; minor large belemnites throughout; unit weathering rubbly, buff with rusty patches, recessive	21.0	172.45
17	Sandstone, light grey, fine- to medium-grained; carbonaceous, argillaceous; in part strongly bioturbated; laminated to massive; richly small-scale trough-crossbedded; bedding irregular, lenticular; in lower half of unit, abundant and conspicuous, continuous, white-weathering beds 15 to 45 cm-thick, without internal structures; at 1.5 m above base, a 10 to 15 cm-thick soft silty mudstone bed with siltstone flasers; local red ferruginous concretions as large as 15 cm by 1 m; abundant pyrite nodules as large as 5 mm in diameter; *Inoceramus* and belemnites; black-cored, red-weathering phosphatic nodules with *Variamussium* in float probably from low in this unit; unit forms resistant bluffs	12.0	151.45
	<u>Manuel Creek Formation</u>		
16	Covered by talus from above; recessive	3.75	139.45
15	Silty mudstone, medium grey, very fine chippy; varying to siltstone to fine-grained sandstone, carbonaceous, argillaceous, strongly bioturbated, fine rubbly-weathering; unit recessive, weathering with rusty patches	6.0	135.7
14	Sandstone, hard, quartz-cemented, light grey, fine-grained; laminated to 15 cm-bedded; near centre a hard, red-weathering, siliceous band 15 cm-thick	1.5	129.7
13	Mudstone, medium grey, fine chippy; a soft rusty-weathering band at top; unit recessive	1.5	128.2
12	Recessive, covered; probably as in underlying unit	7.5	126.7
11	Siltstone to mudstone, medium grey, soft, weathering fine-chippy; between 2.25 and 4.5 m above base is sandstone, fine-grained, carbonaceous, strongly bioturbated, irregularly bedded, weathering light buff-grey, fine rubbly, somewhat resistant; 15 cm-thick rusty-red-weathering, hard, siliceous bands at 0.3, 2.25 and 4.75 m above base; minor pyrite nodules as large as 5 mm in diameter; unit recessive	6.0	119.2
10	Covered, recessive	25.5	113.2
	<u>Almstrom Creek Formation</u>		
9	Sandstone, hard, quartz-cemented, light grey; thin-bedded to massive; in places laminated and crossbedded; minor 0.6 m thick strongly bioturbated beds; minor small troughs; upper 0.3 m (approx.) with abundant argillaceous siltstone rip-up clasts and ripples; minor 15 cm by 6 m ferruginous lenses; unit resistant, weathering very light greenish-grey with minor rusty patches, in places distinctly green- and red-banded; upper part not exposed; locally abundant poorly preserved *Entolium*, *Aequipecten*(?), oysters, *Lingula*, wood fragments (GSC locs. 94059, 94060, 94061)	10.5	87.7

Unit	Lithology	Thickness	Height Above Base
8	Sandstone, light grey, fine- to medium-grained; as in Unit 7 but with nearly equal parts hard, laminated, quartz-cemented, sandstone and bioturbated sandstone, interbedded	15.0	77.2
7	Sandstone, light grey, fine- to medium-grained; mainly strongly bioturbated with relict lamination; 0.3 to 1 m-bedded, interbedded with harder, quartz-cemented sandstone, laminated and crossbedded; bedding surfaces with ripples and trails, minor calcite cement; abundant small pyrite nodules; large oysters scattered in some beds; unit weathering rubbly and blocky, light buff-grey with slight greenish tinge and rusty stain, forms resistant bluffs	4.5	62.2
6	Covered by blocks from above, recessive	22.5	57.7
5	Sandstone, hard, quartz-cemented, light grey, fine- to medium-grained; slightly glauconitic; massive or with indistinct lamination and crossbedding; minor rusty-red ferruginous patches; minor 10 cm to 0.3 m-thick beds strongly bioturbated, with abundant carbonaceous plant fragments; bedding surfaces carbonaceous, argillaceous, with ripples and trails; small pyrite nodules; unit weathers light grey with slight greenish tinge, platy to blocky, resistant	13.5	35.2
4	Sandstone, light grey, fine-grained; 1 cm to 5 cm irregularly bedded, with argillaceous carbonaceous partings, with ripples and trails; moderately abundant lenses, as thick as 0.3 m of hard, laminated and crossbedded sandstone; abundant small pyrite nodules and rusty stain; forms small resistant bluff	1.5	21.7
3	Siltstone, light grey; strongly argillaceous, micaceous; recessive, fine-chippy-weathering with minor rusty-brown patches; varies upward to sandstone, fine-grained, strongly bioturbated, weathering buff, rubbly and moderately resistant, with minor 2.5 to 10 cm-thick mudstone to argillaceous siltstone interbeds	8.2	20.2
2	Sandstone, hard, quartz-cemented, light grey to greenish-grey, fine- to medium-grained; micaceous; planar-bedded laminated to 15 cm-bedded, varying upward to thick-bedded or massive with indistinct lamination and crossbedding, with carbonaceous, argillaceous partings with abundant trails; small pyrite nodules throughout, upper 2.5 cm particularly strongly pyritic; minor lenses or beds ferruginous; unit weathering light grey to greenish-grey with rusty patches	7.5	12.0
1	Sandstone, hard, light grey to greenish-grey, fine-grained; carbonaceous; strongly bioturbated, thinly and irregularly bedded; weathering rubbly, buff-grey with slight yellow-green tinge and slight rusty stain; in 15 cm-thick subunits interbedded with 1 m-thick beds of soft, recessive argillaceous siltstone; abundant 5 cm-thick interbeds of soft, fine-chippy, grey silty mudstone to siltstone; moderately abundant pyrite nodules as large as 5 mm in diameter; minor 15 cm by 1.3 m medium grey, hard, siliceous nodules, weathering red; upper 1.5 m with 15 to 20 cm-thick interbeds of hard sandstone as in Unit 2	4.5	4.5
	Lower part of Jurassic Bug Creek Group and its contact with underlying Permian sandstone unit not exposed, locally faulted		

SECTION PU-11-76. East face of ridge between headwaters of Waters River and Anne Creek, approximately 17 km south of Mt. McGuire (approx. Lat. 67°47'N, Long. 137°19'W). This section was previously described by E.W. Mountjoy (Procter and Mountjoy 1969, sec. 116P-8), and is illustrated in Figures 13 and 16; Pl. 7, fig. 4 of this paper. All measurements are in metres.

Bug Creek Group (part)	832.5 m
Aklavik Formation	94.5 m
Richardson Mountains Formation	613.5 m
Manuel Creek Formation (part)	124.5 m (min.)

Unit	Lithology	Thickness	Height Above Base
	The overlying unit is inferred to be the Husky Formation, because *Buchia concentrica* (Sowerby), identified by J.A. Jeletzky, was collected immediately above what appear to be the uppermost beds of this section, 4.6 km (approx.) to the southeast, and because correlation of the upper part of this section with the Aklavik Formation in other sections to the north and east, and particularly in nearby section PU-6-78 is supported by remarkable similarities of the lithological characteristics and succession.		
	TOP OF HILL;		
	TOP OF BUG CREEK GROUP		
	Aklavik Formation		
31	Sandstone, hard, quartz-cemented, white- to light grey, fine- to medium-grained; strongly bioturbated; indistinctly and irregularly 5 to 60 cm-bedded; with irregular carbonaceous, argillaceous partings; minor thin beds of chert grit and fine pebble conglomerate in float, probably from this unit; unit forms top of mountain; minor bivalves at top (GSC loc. 94086)	43.5 (approx.)	832.5

Unit	Lithology	Thickness	Height Above Base
30	Sandstone, medium to dark grey-brown; carbonaceous; strongly bioturbated; indistinctly and irregularly 15 cm-bedded; minor massive or low-angle crossbedded intervals; unit resistant, bluff-forming	16.5	789.0
29	Sandstone, hard quartz-cemented, light grey, massive or with large-scale low-angle crossbedding; weathering blocky and platy, resistant	6.0	772.5
28	Sandstone, hard, quartz-cemented, as in upper part of Unit 27e, minor platy, planar-bedded intervals and minor bioturbated sandstone as in lower part of Unit 27e; unit variably resistant, in part bluff-forming, banded	16.5	766.5
27e	Siltstone to fine-grained sandstone, medium to dark grey-brown; carbonaceous, argillaceous; indistinctly and irregularly 5 to 15 cm-bedded; grading upward to hard, quartz-cemented sandstone, light grey; indistinctly 15 to 60 cm-bedded; beds structureless; blocky-weathering; unit forms resistant bluff	12.0	750.0

Richardson Mountains Formation

Unit	Lithology	Thickness	Height Above Base
27d	Siltstone to fine-grained sandstone as in Unit 27a; recessive	13.5	738.0
27c	Siltstone to fine-grained sandstone as in Unit 27a; forms small resistant bluff	12.0	724.5
27b	Siltstone to fine-grained sandstone as in Unit 27a, with several 15 to 30 cm-thick lenticular beds of hard, quartz-cemented sandstone, light brown, fine- to medium-grained, planar laminated, with minor pyrite; carbonaceous surfaces with abundant plant fragments, ripples, trails	3.0	712.5
27a	Siltstone to fine-grained sandstone, medium to dark grey-brown; carbonaceous, argillaceous; strongly bioturbated; indistinctly and irregularly 2 to 5 cm-bedded; abundant trails; minor small pyrite nodules; slightly calcareous; weathering medium to dark-grey with abundant rusty patches, yellow stain, and slight blue tinge; moderately resistant	43.5	709.5
26	Covered by talus from above; probably as in Unit 25, possibly with sandstone interbeds as in Unit 27	75.0	666.0
25	Siltstone, black, argillaceous, carbonaceous; strongly bioturbated; and minor black, nearly fissile argillaceous siltstone; unit recessive	45.0	591.0
24	Siltstone to fine-grained sandstone, argillaceous; distinctly bedded, 15 cm to 0.6 m-bedded; each bed bioturbated; black, carbonaceous, argillaceous partings and thin finely laminated siltstone partings; unit weathering buff, resistant, forms banded bluff; minor belemnites, *Inoceramus*	21.0	546.0
23	Siltstone as in Unit 22, in 15 cm to 1.5 m-thick subunits; interbedded with an equal proportion of siltstone to medium-grained sandstone, in part light grey, in part black and carbonaceous, platy laminated and low-angle crossbedded, with abundant trails, *Zoophycos*-like traces fossils; slightly calcareous; abundant rusty-orange-red-weathering ferruginous concretions 15 cm by 1 m; buff-weathering; undeterminable ammonite fragment, *Inoceramus*, belemnites at 25.5 m above base (GSC loc. 94085)	60.0	525.0
22	Siltstone, black; carbonaceous; strongly bioturbated; weathering rubbly, recessive	18.0	465.0
21	Siltstone and fine-grained sandstone; interbedded equal proportions bioturbated, argillaceous, and laminated or low-angle crossbedded, on 1 m scale; slightly calcareous; abundant rusty orange red weathering concretions; unit moderately resistant, buff-weathering; poorly preserved indeterminable ammonite, *Inoceramus*, *Oxytoma*, belemnite near top (GSC loc. 94084)	22.5	447.0
20b	Repeated sandstone cycles, each 1 m (approx.) thick: bioturbated, argillaceous, with vertical burrows (dominant), grading upward to laminated and low-angle crossbedded; abundant carbonaceous plant fragments; abundant rusty orange red weathering ferruginous concretions 15 cm by 1 m; slightly calcareous; unit moderately resistant, buff-weathering; *Inoceramus*, belemnites (GSC loc. 94083)	7.5	424.5
20a	Siltstone as in Unit 19d with abundant hard sandstone interbeds as in Unit 19c; and moderately abundant sandstone, light grey, fine-grained; finely laminated and low-angle crossbedded; 0.3 to 0.6 m-bedded; slightly calcareous; abundant rusty orange red weathering concretions, 15 cm by 1 m; abundant carbonaceous plant fragments; belemnites and *Inoceramus* scattered throughout; unit moderately resistant, buff-weathering	7.5	417.0
19d	Siltstone, carbonaceous, argillaceous; irregularly laminated; bioturbated, with trails; fine chippy-weathering; recessive, poorly exposed	5.7	409.5
19c	Sandstone, fine-grained; carbonaceous, argillaceous; strongly bioturbated; weathering buff, rubbly, moderately resistant	0.3	403.8
19b	Siltstone, black; carbonaceous; laminated and fine chippy-weathering; in part bioturbated, with trails; abundant interbeds of siltstone to fine-grained sandstone as in Unit 19a; recessive, poorly exposed	40.5	403.5
19a	Siltstone to fine-grained sandstone; strongly carbonaceous, strongly bioturbated; black-weathering; minor black, subspherical, hard, siliceous concretions 2 to 5 cm in diameter; recessive, poorly exposed	34.5	363.0
18	Shale, black to dark grey-black, fissile, carbonaceous; and minor argillaceous siltstone, fine rubbly, locally abundant subspherical, hard, siliceous nodules 2 to 5 cm in diameter; locally abundant rusty-orange-brown-weathering ferruginous concretions; unit recessive	58.5	328.5
17d	As in Unit 17b but forms a very slightly resistant ridge; minor subspherical nodules, 2 to 5 cm in diameter, hard, siliceous, except in upper 7.5 m (approx.); locally abundant small pyrite nodules and light rusty orange brown weathering concretions	40.5	270.0
17c	Probably as in Unit 17b, strongly recessive, poorly exposed; minor subspherical nodules 2 to 5 cm in diameter, hard, siliceous; minor *Cranocephalites* aff. *C. borealis* (Spath), belemnites, *Inoceramus* (GSC loc. 94082)	7.5	229.5
17b	Siltstone to fine-grained sandstone, grey; carbonaceous, argillaceous, strongly bioturbated, rubbly; recessive, poorly exposed	61.5	222.0

Unit	Lithology	Thickness	Height Above Base
17a	Siltstone to fine-grained sandstone, grey; carbonaceous, argillaceous, strongly bioturbated, rubbly; abundant larminae and interbeds as thick as 15 cm of grey- and red-weathering, hard, quartz-cemented, fine- to medium-grained sandstone with red-orange-weathering ferruginous nodules; unit recessive, poorly exposed, rubbly only	36.0	160.5
	<u>Manuel Creek Formation</u>		
16	Interbedded bioturbated and hard, quartz-cemented sandstone, as in Unit 15, equal proportions of each, in 0.6 to 1 m-thick beds, the hard sandstone increasing in proportion upwards and forming upper 2.5 m; *Entolium*, other pectinids, poorly preserved belemnites 9 m above base; unit forms top of resistant bluffs, upper 10.5 m is involved in dip slope	25.5	124.5
15	Siltstone to fine-grained sandstone, grey; carbonaceous, argillaceous; strongly bioturbated, fine rubbly-bedded; with interbeds, increasing in proportion upwards, of sandstone, hard, quartz-cemented, light grey, fine- to medium-grained; laminated to 15 cm-bedded; considerable red-orange-weathering ferruginous concretions 15 cm by 1 m; unit forms resistant bluffs; belemnites, *Oxytoma* (GSC loc. 94080 loose)	7.5	99.0
	<u>Manuel Creek Equivalent(?)</u>		
14b	Covered, recessive	6.5	91.5
14a	Siltstone, dark grey-black; argillaceous; micaceous; fine chippy and rubbly, strongly bioturbated; with rusty yellow orange weathering ferruginous mudstone concretions as large as 5 cm in diameter; unit recessive; minor *Dactylioceras* aff. *D. commune* (Sowerby) in lowest 2 m (GSC loc. 94075)	13.0	85.0
13c	Sandstone, hard, quartz-cemented, fine- to medium-grained; laminated to thin-bedded; weathering light to medium brown, platy	3.0 (approx.)	72.0
13b	Covered, recessive, with abundant rubble of siltstone, weathering light brown, finely chippy	7.5	69.0
13a	Covered, talus on dip slope of Unit 12	10.5	61.5
12	Sandstone, hard, quartz-cemented; light grey- to brownish-grey; fine- to medium-grained; slightly ferruginous; laminated to thick-bedded; minor carbonaceous burrows; weathering buff, blocky; unit forms top of resistant bluff, involving Units 9 to 12; rare poorly preserved pectinids	7.5	51.0
11f	Sandstone; interbedded lithologies as in Units 11b and 11e, on 1 m (approx.) scale	9.0	43.5
11e	Sandstone, hard, quartz-cemented, fine- to medium-grained; thin-bedded to massive and with indistinct lamination; moderately abundant red-weathering, hard, siliceous concretions 15 cm by 1 m; buff- and rusty-red-weathering	4.5	34.5
11d	Siltstone to fine-grained sandstone as in Unit 11b	3.0	30.0

Unit	Lithology	Thickness	Height Above Base
11c	Sandstone, hard, quartz-cemented, fine- to medium-grained; thin-bedded to massive and with indistinct lamination; buff- and rusty-red-weathering; moderately abundant red-weathering, hard, siliceous concretions 15 cm by 1 m; a 20 cm-thick distinctly laminated bed occurs in centre of unit; *Variamussium* and belemnites near base (GSC loc. 94076)	3.0	27.0
11b	Siltstone to fine-grained sandstone, carbonaceous, argillaceous; strongly bioturbated; finely, rubbly and irregularly bedded; with carbonaceous, argillaceous partings, abundant ripples and trails; slightly calcareous; moderately abundant hard, siliceous, red-weathering concretions 15 cm by 1 m	4.5	24.0
11a	Sandstone, hard, quartz-cemented, fine- to medium-grained; thin-bedded to massive and with indistinct lamination; moderately abundant red-weathering, hard, siliceous concretions 15 cm by 1 m; buff- and rusty-red-brown-weathering; belemnites in place; belemnites, *Inoceramus*, *Variamussium* loose from Units 11a to 11f (GSC loc. 94079)	3.0	19.5
10	Sandstone, hard, quartz-cemented, light grey, fine-grained; 2.5 cm-platy-bedded, weathering medium grey; interbedded with siltstone to fine-grained sandstone, medium grey, carbonaceous, argillaceous, strongly bioturbated, 15 cm-bedded; moderately abundant red-weathering, hard, siliceous concretions 15 cm by 1 m; belemnites	6.0	16.5
9	Covered by talus from overlying units	7.5	10.5
8	Siltstone, black, argillaceous; with rusty-yellow-orange-weathering ferruginous mudstone concretions as large as 5 cm in diameter; rare, poorly preserved belemnites; unit recessive, poorly exposed	3.0	3.0
	The lower part of the section (Units 8 to 12) is interpreted to be tectonically repeated more than once below this level on the ridge; the base of the Jurassic system is not exposed in this area. The description of repeated units follows, to indicate fossil localities		
7	Interbedded equal proportions sandstone as in Unit 6; siltstone to fine-grained sandstone, carbonaceous, argillaceous, strongly bioturbated, rubbly, finely and irregularly bedded; and sandstone, hard, quartz-cemented, white to light grey, laminated, ripple-cross-laminated and crossbedded, weathering light grey, platy; forms upper part of bluff	19.5	
6	Sandstone, hard, quartz-cemented; light brown, fine- to medium-grained; massive or with minor indistinct lamination, minor siltstone rip-up clasts; minor 2 to 5 mm (diameter) pyrite nodules; unit weathering rusty-brown, blocky; forms lower part of resistant bluffs; *Phylloceras*? (GSC loc. 94078 probably from here)	4.5	
5	Siltstone, argillaceous; strongly bioturbated, in 15 to 20 cm-thick beds with abundant 1 to 2.5 cm-thick planar interbeds of similar lithology; minor poorly preserved belemnites	1.5	

Unit	Lithology	Thickness	Height Above Base
4	Covered by talus from above; *Inoceramus*, *Variamussium*, belemnites, a poorly preserved ammonite fragment loose (GSC loc. 94078)	10.5	
3	Siltstone, dark grey-black; argillaceous, micaceous; fine chippy to fissile; recessive, poorly exposed, with rubble of rusty orange brown weathering, concretionary ferruginous mudstone, and minor rusty-brown-weathering laminated or thin-bedded siltstone to fine-grained sandstone	3.0	
2	Siltstone to fine-grained sandstone as in Unit 1 (50%) in 1 to 2.5 m thick beds; interbedded with sandstone (50%), hard, quartz-cemented, light olive-grey, fine-grained; massive, with minor ripples at top; slightly calcareous; weathering rusty-red-brown, blocky, fracturing conchoidally; unit forms resistant bluff; unit structurally disturbed	13.5	
1	Siltstone to fine-grained sandstone, medium to dark grey; carbonaceous, argillaceous, strongly bioturbated finely and irregularly bedded; weathering rubbly, recessive, very poorly exposed; *Dactylioceras* sp., poorly preserved belemnites (GSC locs. 94077, 94087 loose)	102.0	

Pseudolioceras sp., *Dactylioceras* sp., a harpoceratid fragment, and other Toarcian fossils have been found also in what appears to be the same stratigraphic interval 3 km (approx.) east-northeast of the base of section PU-11-76 (GSC locs. 39342, 39343; identified by H. Frebold; the locality citation by Frebold, 1960, p. 4 for the latter locality is apparently wrong). It is not known what underlies the Toarcian beds in this area.

SECTION PU-12-76. North face of Jurassic Butte (approx. Lat. 68°02'N, Long. 135°30'W). The section was illustrated previously by Jeletzky, (1967, Pl. II, fig. 2), graphically illustrated in preliminary reports by Poulton (1978a; 1978b, fig. 5.3; in Nassichuk et al., 1978, figs. 36, 38), and is also shown in Figure 5 and Pl. 10, fig. 5 of this paper. All measurements are in metres.

Bug Creek Group (total)	135.75 m
Aklavik Formation	33.00 m
Richardson Mountains Formation	62.75 m
Unconformity	
Almstrom Creek Formation	7.00 m
Murray Ridge Formation	33.00 m
Scho Creek Member	1.50 m
Unconformity (?)	
Permian (?)	

Unit	Lithology	Thickness	Height Above Base
	TOP OF HILL		
	TOP OF BUG CREEK GROUP		
	Aklavik Formation		
30	**Sandstone, hard, quartz-cemented; white to light grey, fine- to medium-grained; 5 cm-bedded to massive or with indistinct lamination; bedding gently lenticular; slightly calcareous; unit weathering buff, resistant, bluff-forming**	24.0	171.75
29	**Sandstone, hard, quartz-cemented; white to light grey, fine- to medium-grained; irregularly 5 to 30 cm-bedded; abundant carbonaceous burrows and root casts(?); minor conifer fragments; unit resistant**	9.0	147.75
	Richardson Mountains Formation		
28	Siltstone to fine-grained sandstone, medium grey; carbonaceous, argillaceous; strongly bioturbated; indistinctly, finely, and irregularly bedded; upward grading to 5 to 10 cm-bedded, and then 15 to 20 cm-bedded near top, with carbonaceous, argillaceous material confined to burrows, root casts(?) and irregular partings; unit weathering light grey with slight blue tinge and jarosite; increasingly resistant upward	9.0	138.75
27	Siltstone to fine-grained sandstone as in Unit 26, with abundant rusty stain	7.5	129.75
26	Siltstone to fine-grained sandstone, hard, quartz-cemented, light grey; bioturbated, irregularly 2.5 to 5 cm bedded with irregular carbonaceous, argillaceous partings; upwards becoming predominantly hard, light grey, brittle, laminated to 10 cm-bedded, low-angle crossbedded; unit weathering light grey with abundant jarosite(?), forms resistant bluff; grades to underlying unit	4.5	122.25
25	Siltstone to fine-grained sandstone, light to medium grey; carbonaceous, argillaceous; strongly bioturbated, fine rubbly and irregularly bedded; weathering light grey with jarosite(?); with moderately abundant 5 to 10 cm-thick beds of hard, quartz-cemented siltstone to fine-grained sandstone, light grey, laminated, platy; unit weathering dark grey with thin buff bands, recessive	6.0	117.75
24	Siltstone to fine-grained sandstone, light to medium grey; soft; carbonaceous, argillaceous; strongly bioturbated; weathering grey and rusty, fine rubbly; with moderately abundant 2.5 to 5 cm thick beds of hard, quartz-cemented sandstone, light grey, fine-grained, laminated and crossbedded		

Unit	Lithology	Thickness	Height Above Base
	with abundant trails; a band of sparsely spaced, rusty-red-brown-weathering siliceous concretions, 15 cm by 0.6 m (approx.), occurs near top; similar concretions occur rarely scattered throughout unit; unit recessive	6.0	111.75
23	Siltstone, argillaceous, to silty mudstone, soft recessive; very poorly exposed	7.5	105.75
22	Siltstone, medium to dark grey; in part (particularly in lowest 1 m) argillaceous, finely laminated, fine chippy- to muddy-weathering; in part strongly bioturbated, carbonaceous, argillaceous; abundant small ferruginous siltstone nodules locally; abundant carbonaceous plant fragments; unit weathering fine rubbly with abundant jarosite; forms somewhat resistant upper part of bluffs of Unit 21; large belemnites scattered throughout; poorly preserved indeterminable ammonites, *Corbula*, rhynchonellid brachiopod near top (GSC loc. 94089)	4.75	98.25
21	Sandstone, hard, quartz-cemented, light grey to brown-grey, fine- to medium-grained; a structureless 1 m-thick bed at base, varying upward to laminated to medium-bedded and low-angle crossbedded; 0.3 m-thick recessive, finely planar-laminated hard, fine-grained sandstone beds occur at 1.2 m (approx.) intervals; a 1.5 m-thick recessive, finely laminated argillaceous siltstone bed occurs from 7.5 to 9 m above base; abundant large belemnites, a 2.5 cm-thick belemnite-rich bed occurs 0.5 m above base; abundant carbonaceous plant fragments as large as 0.3 m; unit weathering buff with abundant rusty stain, forms resistant bluffs	17.5	93.5
	<u>Almstrom Creek Formation</u>		
20	Siltstone, medium grey; ferruginous; weathering spheroidally, rusty-orange-red, recessive	0.5	76.0
19	Mudstone; soft; with spheroidal-weathering, rusty-red-brown-weathering concretions, particulary in upper part; unit recessive; muddy	0.5	75.5
18	Sandstone, in part hard, quartz-cemented; very light grey to greenish-grey, fine- to medium-grained; laminated to thin-bedded with abundant low-angle cross-bedding and channelling; locally glauconitic; locally abundant pyrite nodules as large as 5 mm in diameter; upper surface with abundant trails and ripples; base channelled into underlying unit; weathering buff-grey, locally slightly greenish, with abundant 15 to 60 cm by 1 to 5 m rusty-brown and red patches; unit forms resistant bluffs	6.0	75.0
	<u>Murray Ridge Formation</u>		
17	Siltstone to fine-grained sandstone, light grey; soft; finely, irregularly and rubbly-bedded; minor resistant lenses as thick as 10 cm of laminated and crossbedded, fine- to medium-grained, hard sandstone in upper 1 m; unit recessive, weathering rubbly	3.0	69.0
16	Covered by talus from above	10.5	66.0

Unit	Lithology	Thickness	Height Above Base
15	Siltstone to fine-grained sandstone, light grey; soft; finely, irregularly and rubbly bedded; weathering rubbly, recessive, with abundant rusty patches; somewhat more resistant, spheroidal-weathering, fine-grained sandstone bands, as thick as 1 m, occur 9 m above base and in upper 4.5 m of unit; unit only partly exposed	18.0	55.5
	<u>Scho Creek Member</u>		
14	Sandstone, hard, quartz-cemented, light grey, fine- to medium-grained; indistinctly and irregularly bedded; minor pockets of pebble conglomerate (pebbles chert and "argillite", as large as 2.5 cm in diameter); with abundant medium grey, siliceous concretions, weathering rusty-red, 20 cm by 1 to 1.5 m, locally pervading the entire rock; angular unconformity at base; unit forms small resistant bluff	1.5	37.5
	PERMIAN(?)		
	The contact is uncertainly placed at a conspicuous angular relationship within an unfossiliferous essentially similar conglomeratic succession. Underlying rocks which were included in the basal sandstone member of the Bug Creek Formation by Poulton (1978a, fig. 8.2) are now treated as Permian. They are thought to be part of a Permian sandstone unit that is progressively truncated below Jurassic rocks southeastward onto Aklavik Arch (Nassichuk et al., 1978).		
13	Mudstone, light to medium grey; weathering muddy and fine chippy, recessive	0.5	36.0
12	Covered, recessive; probably as in underlying unit	16.5	35.5
11	Shale and mudstone, medium to dark grey, weathering muddy to fine chippy; abundant concretionary lenses, 15 cm by 1 to 1.5 m of rusty-brown, ferruginous, siliceous mudstone; unit recessive	1.5	19.0
10	Sandstone, hard, quartz-cemented, light grey, fine- to medium-grained; indistinctly- and irregularly-bedded; weathering light grey, resistant; grades over small interval to underlying unit	1.5	17.5
9	Sandstone, hard, fine- to coarse-grained; with minor grit and pebble conglomerate in small pockets and trains; limonitic; weathering light rusty-orange; resistant	3.0	16.0
8	Siltstone, light- to medium-grey; in part planar-laminated, in part strongly bioturbated; weathering fine-chippy; abundant red-weathering, hard, siliceous concretions 15 cm by 1 to 1.5 m; a 5 to 10 cm-thick hard, quartz-cemented, fine-grained sandstone bed occurs in centre; unit recessive	5.5	13.0
7	Grit- to pebble-conglomerate; limonitic; base cut into underlying unit; unit weathering light rusty-orange; locally developed	0.5-1.0	7.5
6	Sandstone, hard, light grey, fine- to medium-grained; with abundant small pockets and trains of grit and fine pebble conglomerate (in part chert); maximum pebble size 2.5 cm (not common); unit weathering buff, resistant	7.0	7.0

Unit	Lithology	Thickness	Height Above Base
5	Siltstone, hard, quartz-cemented; light grey; fine planar-laminated; recessive	0.5	
4	Mudstone, medium grey; soft; weathering muddy- to fine-chippy, recessive	0.5	
3	Mudstone or siltstone, brown; strongly ferruginous; weathering rusty-red-brown; spheroidal	0.5	
2	Shale or mudstone, medium grey; muddy- to fine-chippy-weathering, recessive	0.5	
1	Sandstone, hard, quartz-cemented, light grey, fine-grained; thin planar-bedded to massive; *Zoophycos*-like trace fossils; unit weathering buff, resistant	3.0	

SECTION PU-17-76. East-facing bluffs at head of a small tributary of Barrier River, 12 km northeast of Mt. Millen (approx. Lat. 67°32'15"N, 136°12'30"W). All measurements are in metres.

Bug Creek Group (total)	268.5 m (est.)
Aklavik Formation	118.5 m (est.)
Richardson Mountains Formation	150.0 m (est.)
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	TOP OF HILL		
	TOP OF BUG CREEK GROUP		
	Aklavik Formation		
4	Sandstone, hard, quartz-cemented; white, fine- to medium-grained, weathering white, bluff-forming; forms top of hill	45.0 (est.)	268.5 (approx.)
3	Sandstone, hard, quartz-cemented; light grey, fine- to medium-grained; thick-bedded to massive, with minor indistinct lamination; bedding units gently lenticular; weathering yellow-buff, upper half forms massive, resistant bluffs	73.5	223.5 (approx.)
	Richardson Mountains Formation		
2	Covered	150.0 (est.)	150.0 (approx.)
1	Boulders of sandstone, hard, quartz-cemented, with scattered poorly preserved belemnites, and with abundant thin lenses and beds of pebble conglomerate (pebbles mainly chert and argillite), laminated and crossbedded. These boulders could well be a solifluction lobe, derived from higher in the section; this lower part of Jurassic section is therefore not well known. Permian (assumed) *Zoophycos* are abundant 200 to 300 m lower.		

SECTION PU-18-76. Ridge between heads of Bell River and Big Fish River (approx. Lat. 68°10.6'N, Long. 136°56.6'W). The section is illustrated in Figures 9 and 16; Pl. 8, fig. 1. All measurements are in metres.

Bug Creek Group (part)	736.5 m (min.)
Aklavik Formation	51.0 m
Richardson Mountains Formation	237.5 m
Manuel Creek Formation	121.5 m
Almstrom Creek Formation (part)	326.5 m (min.)
Fault	
Lower Cretaceous argillaceous unit	

Unit	Lithology	Thickness	Height Above Base
	The top of the section is at the presumed top of the Aklavik Formation. Overlying the highest unit measured is a recessive argillaceous unit 65 m (approx.) thick, followed in succession by a 35 m (approx.) thick ridge-forming sandstone, and a thick argillaceous unit with sandstone interbeds. Norris (1975a) considers these to represent Cretaceous rocks unconformably overlying the Bug Creek Group.		
	TOP OF BUG CREEK GROUP		
	Aklavik Formation		
38	Sandstone, hard, medium brownish-grey, fine-grained, ferruginous; massive or with indistinct large-scale low-angle crossbedding; a 1.5 m-thick bed, 3 m below top of unit, of sandstone, carbonaceous, argillaceous, dark grey-black, fine-grained, strongly bioturbated; unit weathering medium grey, blocky or slabby, resistant, forms bluffy ridge; abundant generalized bivalves in upper 3 m (GSC loc. 94115)	51.0	736.5

Unit	Lithology	Thickness	Height Above Base
	Richardson Mountains Formation		
37a	Covered by talus from overlying units; *Yoldia*-like bivalve from talus (GSC loc. 94114)	15.0	685.5
37	Siltstone to very fine-grained sandstone, carbonaceous, argillaceous, dark grey; strongly bioturbated; fine rubbly-weathering, with minor interbeds, possibly increasing in abundance upward, of sandstone, fine-grained; laminated and bioturbated; unit recessive; poorly exposed; poorly preserved *Cadoceras*(?), *Inoceramus*, belemnites loose on surface in lower part of unit (GSC loc. 94113); one specimen each of *Recurvoides* sp. 5009 and *Haplophragmoides* sp. 5265 from sample collected over entire unit (GSC loc. C-53563)	76.0	670.5
36	Sandstone, light grey to brown-grey, fine-grained; massive or with indistinct lamination; minor calcareous cement; weathering buff, blocky or in 5 to 10 cm-thick plates, minor pods, 15 cm by 30 cm (approx.) of ferruginous mudstone and siltstone, weathering spheroidally, rusty-orange-brown; unit forms small resistant ridge	3.0	594.5
35b	Covered by blocks from overlying units	11.5	591.5
35a	Siltstone, carbonaceous, argillaceous, dark grey; bioturbated; fine rubbly-weathering; with minor concretions as large as 15 cm by 30 cm (approx.), hard, siliceous, medium grey, weathering rusty-orange-red; with thin interbeds, increasing in abundance upward, of sandstone, light grey, fine-grained; planar-laminated or bioturbated; weathering buff and fine platy; unit recessive, poorly exposed; minor large belemnites, poorly preserved *Arcticoceras*(?), *Kepplerites*(?), abundant *Inoceramus* (GSC loc. 94112)	32.0	580.0
34	Siltstone, carbonaceous, argillaceous, dark grey-black; strongly and finely bioturbated; finely interbedded with sandstone, hard, quartz-cemented, very fine- to fine-grained, low-angle cross-bedded or planar-laminated; a lens 0.6 m by 20 m at 1 m above base is calcareous, weathers light rusty-orange-yellow; upper 2.25 m is solely sandstone, laminated, weathering in 1 to 2.5 cm-thick plates; unit recessive	6.0	548.0
33	Sandstone, hard, quartz-cemented, light grey, very fine- to fine-grained; low-angle crossbedded, channelled; weathering buff, platy, discontinuous 15 cm to 20 cm-thick lenses of siltstone in centre of unit, ferruginous, strongly bioturbated, finely and irregularly bedded, rusty-brown-weathering, soft; unit bluff-forming, forms small resistant ridge together with underlying unit	2.0	542.0
32	Siltstone to very fine-grained sandstone, carbonaceous, argillaceous, dark grey-black, strongly bioturbated; fine rubbly-weathering; with minor 15 cm to 30 cm-thick interbeds of sandstone, light grey to brown, fine-grained; low-angle crossbedded; platy-weathering; poorly exposed, weathering buff and rusty-brown; abundant *Inoceramus* fragments (GSC loc.94111)	2.0	540.0
31a	Siltstone to very fine-grained sandstone, carbonaceous, argillaceous, dark grey-black, minor ferruginous stain; strongly bioturbated; fine chippy- to very fine rubbly-weathering; unit recessive, poorly exposed; poorly preserved ammonite fragments (*Cranocephalites*? or *Arctocephalites*?), *Inoceramus*, belemnites, scaphopods (GSC loc. 94110)	49.5	538.0
31	Covered by float from overlying units	3.0	488.5
30	Sandstone, light brown-grey, fine- to medium-grained; 5 to 10 cm irregularly bedded to massive and strongly bioturbated with laminated, low-angle crossbedded channel-fill lenses; locally abundant ripples; many nearly straight, vertical burrows; minor calcareous cement; minor small pyrite nodules; lensoid beds as large as 15 cm by 16 m of rusty orange brown weathering ferruginous siltstone; continuous bands of fossiliferous rusty-red concretions, some with black phosphatic cores occur, mostly in lowest 4 m; unit weathers buff with rusty patches and 10 cm (diameter) rusty spots, forms resistant bluffy ridge; minor belemnites and *Inoceramus* fragments throughout; *Arkelloceras* sp., *Inoceramus lucifer* Eichwald, *Oxytoma*, belemnites (GSC locs. 94107, 94108) 1.5 m above base; minor poorly preserved bivalves 4.5 m above base; *Inoceramus* locally abundant in uppermost beds (GSC loc. 94109)	37.5	485.5
	Manuel Creek Formation		
29	Probably as in overlying unit; covered by blocks from it; recessive	7.5	448.0
28d	Probably as in underlying unit; largely covered with blocks and slabs of overlying unit; recessive	37.5	440.5
28c	Mudstone to argillaceous siltstone, dark grey-black, poorly exposed; rubble and slabs on surface of hard silica-cemented, laminated and bioturbated siltstone to fine-grained sandstone, some with belemnites and pectinid bivalves; rubble with rusty-weathering ferruginous concretions; unit recessive	27.0	403.0
28b	Silty mudstone to argillaceous siltstone; dark grey-black; weathering fine chippy; abundant small ferruginous concretions weathering rusty-orange-brown-red; moderately abundant thin interbeds of siltstone to fine-grained sandstone, light grey, laminated, rippled and cross-bedded, with trails and minor bioturbated intervals, and with shell hash and minor rip-up conglomerate laminae, in part ferruginous-cemented; *Pseudolioceras*(?), *Dactylioceras* sp., belemnites, pectinid bivalves, collected loose in rubble (GSC loc. 94106); *Trochammina* spp. 5267 and 5271, *Ammobaculites* sp. 4925, *Spiroplectammina* sp. 5273, *Haplophragmoides* sp. 5272, and *Lenticulina* sp. 5274 (GSC locs. C-53564, C-53565)	10.5	376.0
28a	Siltstone to very fine-grained sandstone; light grey; strongly bioturbated; slightly carbonaceous; weathering fine rubbly, recessive; poorly exposed	3.0	365.5

Unit	Lithology	Thickness	Height Above Base
27a	Sandstone, hard, quartz-cemented, light brown-grey, fine-grained; laminated to massive; weathering to angular blocks or 2.5 to 5 cm-thick plates, resistant, forms small ridge	3.0	362.5
27	Sandstone, hard (in part), quartz-cemented, light grey, very fine- to fine-grained; in part laminated, in part strongly bioturbated, and finely and irregularly bedded; bedding surfaces planar, wavy, or irregular, with abundant trails; unit poorly exposed; poorly preserved *Aequipecten*-like bivalves (GSC loc. 94105)	15.0	359.5
26	Covered interval, recessive; abundant fine rubble of siltstone to very fine-grained sandstone, strongly bioturbated, with abundant ferruginous patches; upper half with abundant thin plates of siltstone to fine-grained sandstone, very light grey, finely laminated, with trails on bedding surfaces	18.0	344.5
	Almstrom Creek Formation		
25	Sandstone, hard, quartz-cemented, light grey to brown-grey, fine-grained; massive; minor ferruginous concretions; weathering somewhat resistant, blocky, forms felsenmeer	10.5	326.5
24	Covered interval, recessive; fine rubble of siltstone, strongly bioturbated, weathering with brown-rusty stain	0.75	316.0
23	Siltstone to fine-grained sandstone, hard, quartz-cemented; light grey; in part finely laminated and crossbedded(?), platy-weathering; in part bioturbated, fine rubbly-weathering; poorly exposed; forms small ridge	3.75	315.25
22	Covered interval, recessive; fine rubble of siltstone, strongly bioturbated, weathering with brown rusty stain	1.5	311.5
21	Sandstone, hard, silica-cemented, light grey, fine-grained; unit comprises two cycles - each platy, low-angle large-scale crossbedded and wavy bedded, with ripples and trails at base and massive, resistant at top; minor small spheroidal-weathering, rusty-red and orange ferruginous concretions; unit weathering buff with general rusty stain, resistant, bluff-forming	13.5	310.0
20	Covered interval, recessive; abundant rubble of siltstone, light grey; laminated, fine platy-weathering, and bioturbated, fine rubbly-weathering; weathering buff with slight blue-grey tinge and minor jarosite; unit forms valley	37.5	296.5
19	Sandstone, hard, quartz-cemented, light grey, fine-grained; mainly massive with indistinct lamination, in part well-laminated with trails, minor ripples and carbonaceous and argillaceous material; minor rubbly-weathering, strongly bioturbated pockets; slightly calcareous; locally abundant 0.5 cm to 2.5 cm irregularly sub-spherical ferruginous concretions, 0.3 m by 10 m lenses and minor 2.5 cm to 5 cm-thick continuous beds of		

Unit	Lithology	Thickness	Height Above Base
	red-weathering ferruginous-cemented sandstone; abundant slickensides; weathering somewhat resistant, blocky with minor plates and fine rubble; minor poorly preserved *Cardinia*-like bivalves; unit forms brow of hill, upper part felsenmeer	57.0	259.0
18	Covered by blocks from above, interval recessive	18.0	202.0
17	Sandstone, hard, quartz-cemented light grey, fine-grained; laminated and cross-laminated, surfaces carbonaceous with trails and burrows; local ferruginous-cemented patches; weathering somewhat resistant, light grey with rusty stain	3.0	184.0
16	Covered interval, recessive	18.0	181.0
15a	Sandstone, hard, quartz-cemented, light grey, fine-grained; laminated to 2.5 cm-bedded; ferruginous-cemented lenses; platy-weathering, poorly exposed	0.75	163.0
15	Sandstone, hard, quartz-cemented, light grey, fine-grained; 0.3 m-thick bedded to massive; rusty patches and concretions; resistant	1.0	162.25
14	Covered interval, recessive	2.25	161.25
13	Sandstone, light grey, fine-grained; strongly bioturbated, minor 15 to 30 cm-thick beds that are strongly and finally laminated and cross-laminated; 5 to 10 cm by 0.3 to 1 m pods of rusty-red-weathering ferruginous mudstone and sub-spherical concretions as large as 2.5 cm in diameter, weathering dark red-maroon; resistant, bluff-forming	9.5	159.0
12	Sandstone, light grey, fine- to medium-grained; finely laminated, cross-laminated, in part strongly bioturbated; abundant carbonaceous, argillaceous partings with trails on surfaces; abundant 5 to 10 cm by 0.3 to 1 m pods and subspherical concretions 1 cm to 5 cm in diameter of soft, rusty-red-weathering ferruginous mudstone, some with carbonaceous plant fragments and black phosphatic cores; weathering resistant, bluff-forming, buff with rusty stain and slight blue-grey and yellow tinge; upper 3 m recessive, poorly exposed; locally pockets with abundant *Corbula* (GSC loc. 94104)	10.5	149.5
11	Covered interval, recessive	4.5	139.0
10	Sandstone, quartz-cemented, carbonaceous, light grey, fine- to medium-grained; laminated, large-scale low-angle crossbedded, minor ripples; abundant 15 to 20 cm by 1 to 3 m pods of ferruginous siltstone, weathering spheroidally; unit weathering light grey, lower part platy, upper part hard, resistant, blocky with indistinct lamination, bluff-forming	18.0	134.5
9c	Sandstone, hard, quartz-cemented, very light grey, very fine-grained; laminated; weathering flaggy	4.5	116.5
9b	Sandstone, hard, quartz-cemented, very light grey-brown, very fine-grained; finely- and irregularly-bedded, strongly bioturbated; abundant pods 0.5 m by 3 m of light rusty-orange-brown-weathering, ferruginous, hard siltstone; recessive, fine rubbly-weathering	1.5	112.0

Unit	Lithology	Thickness	Height Above Base
9	Covered interval, recessive	1.5	110.5
8	Sandstone, hard, quartz-cemented, light grey, fine-grained; laminated to 15 cm-bedded, low-angle small-scale crossbedded; abundant pockets strongly bioturbated; local ripples, trails and ferruginous rip-up clasts; weathering resistant and bluff-forming, grey-buff with abundant rusty-red-brown-stained, and minor soft rusty-orange laminae and pods as large as 15 cm by 6 m; fossils occur throughout, include *Oxytoma*, *Meleagrinella*, a trigoniid bivalve, *Pentacrinus* (GSC loc. 94103)	15.0	109.0
7c	Covered interval, recessive; rubble of sandstone, hard, quartz-cemented, light grey, fine-grained; in part strongly bioturbated, in part finely laminated with abundant trails on laminar surfaces; abundant spheroidal-weathering, ferruginous nodules	18.0	94.0
7b	Sandstone, hard, quartz-cemented, light grey, fine-grained; strongly bioturbated; slightly resistant	1.0	76.0
7a	Covered interval, recessive; fine rubble of siltstone; strongly bioturbated; abundant brown, ferruginous-cemented patches	2.0	75.0
7	Sandstone, hard, quartz-cemented, light grey, fine-grained; laminated; platy-weathering; minor ferruginous siltstone concretions approx. 10 cm by 25 cm; recessive	1.0	73.0
6	Sandstone, hard, light grey, fine-grained; strongly bioturbated with minor local lamination; in part argillaceous, upper 4.5 m with abundant ferruginous concretions, approx. 10 cm by 30 cm, soft, weathering spheroidally, rusty-brown; unit weathering recessive and resistant, forming two cycles that are harder and more resistant upward, the lower one thinner	15.0	72.0
5	Sandstone, hard, quartz-cemented, light grey to grey-brown, fine-grained; 2.5 to 10 cm indistinct bedding, strongly bioturbated; argillaceous in lower half; weathering rubbly and in irregular blocks	7.5	57.0
4	Siltstone, quartz-cemented, light grey; strongly and finely bioturbated; weathering recessive, fine rubbly, light brown	1.5	49.5
3	Sandstone, hard, quartz-cemented, light grey, fine-grained; 2.5 to 10 cm indistinct bedding, strongly bioturbated, locally with small-scale low-angle crossbedding indicated by fine carbonaceous lamination; abundant ferruginous concretions 5 to 15 cm in diameter; weathering resistant and bluff-forming, particularly upper 3 m, strongly fractured; minor poorly preserved pectinid bivalves near top (GSC loc. 94102)	9.0	48.0
2	Covered interval, recessive	3.0	39.0
1b	Sandstone, hard, quartz-cemented, light grey, very fine- to medium-grained; massive with fine indistinct lamination and minor bioturbated beds; strongly sheared and broken; weathering blocky and splintery, resistant and bluff-forming, light grey with rusty stain, in part related to ferruginous fracture-filling material	9.0	36.0
1a	Siltstone, quartz-cemented, light grey; strongly bioturbated; abundant ferruginous cement in places; weathering to fine rubble, recessive	3.0	27.0
1	Sandstone, hard, quartz-cemented, light grey, very fine- to medium-grained; massive with fine indistinct lamination; minor glauconite; weathering blocky, moderately resistant and bluff-forming, light grey; abundant ferruginous-cemented concretions varying from spheres 2.5 cm in diameter to lenses 1.5 m by 6 m, in places forming lensoid interbeds, weathering rusty-brown; local laminae, as large as 2.5 cm by 1 m, of ferruginous siltstone, weathering rusty-brown, spheroidal; minor beds with burrows filled by ferruginous siltstone	24.0	24.0

Lowest part of Bug Creek Group not exposed; base of section faulted against *Buchia*(?)-bearing shale and siltstone unit to the west.

SECTION PU-19-76. Ridge between Big Fish River and Little Fish Creek (approx. Lat. 68°18'N, Long. 136°31'W). This section was measured on the east side of the ridge and was illustrated by Norris (1976, fig. 97.3). Jeletzky (1971, p. 203, 205, fig. 2) recognized only 70 feet (21 m, est.) of Bug Creek rocks here and did not assign the overlying 1000 feet (300 m, est.) of recessive rocks to any particular formation. They are here included in the Bug Creek Group, except for the topmost of them, which is a lower tongue of the Husky Formation. The poorly exposed lower part of the section was also measured 5 km north-northeast (see Sec. PU-1-78). The section is illustrated in Figure 16 and Pl. 8, fig. 2, Pl. 11, fig. 1 of this paper. All measurements are in metres.

Husky Formation	
Bug Creek Group (total)	731.0 m (approx.)
Aklavik Formation	76.5 m
Richardson Formation	236.5 m
Manuel Creek Formation	100.0 m (assumed)
Almstrom Creek Formation	260.0 m (approx.)
Murray Ridge Formation	58.0 m (assumed)
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	The top of the ridge is formed by resistant sandstone of the Porcupine River Formation, approximately 24 m in thickness. Gradationally underlying it, and overlying the Bug Creek Group is a recessive Husky tongue, consisting of black shale and increasing amounts of sandstone upward, approximately 207 metres thick. Oxfordian to Kimmeridgian *Buchia concentrica* (Sowerby) was identified by J.A. Jeletzky (1970, p. 205) in sandstones approximately 2 km south-southwest along strike from this section (GSC loc. C-18174) and he also identified *B. concentrica* in what appears to be the same unit 13 km south-southwest of the section (GSC loc. C-6148). *B. concentrica*, as well as mid-Kimmeridgian to Portlandian, and late Berriasian *Buchia* faunas collected by D.K. Norris were identified by J.A. Jeletzky in beds overlying the Bug Creek Group in Section PU-19-76 (GSC loc. C-71753).		
	Beds in the vicinity yielded Kimmeridgian to Portlandian fossils 5 km (approx.) west of the section (GSC loc. 44079) and Purbeckian as well as Berriasian fossils 5 km (approx.) west-southwest of it (GSC locs. 44128 and C-18176 respectively).		
	The significance of the apparent angular relationship between the Bug Creek Group and overlying rocks is thought to have been overestimated by Norris (1976).		
	TOP OF BUG CREEK GROUP		
	Aklavik Formation		
23	Sandstone, very hard, quartz-cemented; light grey, fine-grained; carbonaceous; strongly bioturbated; mainly massive; upper 3 m with thin interbedded 'parallel to burrowed sets' and large-scale low-angle crossbedded lenses weathering to 5 to 15 cm-thick slabs; unit white-weathering, forms resistant bluffs	9.0	731.0 (approx.)
22	Sandstone, hard, quartz-cemented; light grey, fine-grained; carbonaceous; strongly bioturbated and burrowed (burrows mainly vertical, straight); indistinctly and irregularly 2.5 cm to 1 m-bedded; moderately resistant; minor poorly preserved unidentified bivalves	9.0	722.0 (approx.)
21	Sandstone, hard, quartz-cemented; light grey, fine-grained; carbonceous; strongly bioturbated and burrowed; indistinctly and irregularly 2.5 cm to 1 m-bedded; forms resistant bluffs	4.5	713.0 (approx.)
20a	Sandstone, hard, quartz-cemented; light grey, fine-grained; laminated, large-scale low-angle crossbedded; weathering buff with rusty stain; grades into underlying unit	0.75	708.5 (approx.)
20	Sandstone, hard, quartz-cemented; light grey, fine-grained; carbonaceous; strongly bioturbated; weathering buff with rusty stain	0.75	707.75 (approx.)
19	Sandstone, hard, quartz-cemented, white to light-grey, fine-grained; in part finely-laminated, small-scale low-angle crossbedded; in part bioturbated and slightly carbonaceous; subunits 10 to 15 cm-thick	1.5	707.0 (approx.)
18	Covered by talus from overlying units	4.5	705.5 (approx.)
17	Siltstone, dark grey; carbonaceous, argillaceous; strongly bioturbated; weathering fine-rubbly; upward varies to fine-grained sandstone, otherwise similar, weathering light grey with slight blue tinge and with jarosite; unit recessive, poorly exposed	10.5	701.0 (approx.)
16	Sandstone, light grey, fine-grained; carbonaceous; slightly calcareous; strongly bioturbated, indistinctly and irregularly 15 cm- to 0.6 m-bedded, minor 1 to 5 cm planar lamination; near center of unit, a 2 m-thick bed, hard, quartz-cemented, white, massive; unit weathering light buff; forms resistant bluffs	9.0	690.5 (approx.)

Unit	Lithology	Thickness	Height Above Base
15	Sandstone, light grey to brown-grey, fine-grained; slightly calcareous; in part planar-laminated with carbonaceous partings and abundant small-scale low-angle crossbedding, in part strongly bioturbated; summits equal in proportion, 15 cm to 1.5 m-thick; there are 8 (approx.) of these 'parallel-to-burrowed sets'; unit weathers with abundant rusty stain, somewhat resistant; *Trochammina* sp. 4755 (GSC loc. C-53566)	27.0	681.5 (approx.)
	Richardson Mountains Formation		
14	Covered by talus from overlying units	24.0	654.5 (approx.)
13b	Siltstone to fine-grained sandstone, dark grey, carbonaceous; strongly bioturbated; weathering light grey with slight blue tinge, minor jarosite, increasing upward; fine rubbly, becoming coarser upward; poorly exposed; lithology grades downward into similar softer underlying unit	58.5	630.5 (approx.)
13a	Siltstone to fine-grained sandstone, dark grey, carbonaceous; strongly bioturbated; soft; weathering fine rubbly, buff with rusty patches; poorly exposed; *Trochammina* sp. 4755, *Haplophragmoides* sp. cf. *canui*, *H.* sp. cf. *volgensis* (GSC loc. C-53567)	49.5	572.0 (approx.)
13	Covered interval; lowest unit of broad col; covered by blocks from underlying unit	7.5	522.5 (approx.)
12	Sandstone, light grey to brownish-grey, fine-grained; carbonaceous; finely laminated, large-scale low-angle crossbedded; weathering buff, platy; a more or less continuous band of concretionary calcite-cemented lenses occurs near top, each 0.3 m by 6 m approx., weathering bright orange; unit forms very small resistant ridge	1.5	515.5 (approx.)
11	Covered interval, recessive; rubble from underlying unit	22.5	514.0 (approx.)
10	Siltstone to fine-grained sandstone, light grey; in part finely laminated and low-angle crossbedded (?), in part bioturbated; weathering buff, fine platy and rubbly; poorly exposed	9.0	491.5 (approx.)
9	Sandstone, hard, quartz-cemented, light grey, fine-grained; massive or with indistinct lamination; very slightly ferruginous; weathering buff, blocky; breaking conchoidally into larger blocks; minor *Inoceramus*, large belemnites (GSC loc. 94124); unit forms small resistant ridge	10.5	482.5 (approx.)
8a	Siltstone, medium grey; argillaceous, carbonaceous; poorly exposed, very fine chippy- to rubbly-weathering; with flags on surface, probably interbeds that increase in abundance upward, of siltstone to fine-grained sandstone, hard, quartz-cemented, medium grey, carbonaceous; in part bioturbated and 1 cm irregularly-bedded, in part planar-laminated; minor poorly preserved *Arctocephalites*(?) or *Cranocephalites*(?), *Inoceramus*, *Pinna*, large belemnites (GSC loc. 94123); together with underlying unit forms recessive col	36.0	472.0 (approx.)
8	Siltstone to fine-grained sandstone, hard, quartz-cemented, medium grey; carbonaceous; bioturbated, 1 cm irregularly-bedded	4.5	436.0 (approx.)
7	Sandstone, hard, quartz-cemented, medium grey, fine-grained; carbonaceous; strongly bioturbated, 4 cm irregularly-bedded; buff-weathering with general rusty stain and minor jarosite; abundant small ferruginous siltstone pods weathering rusty-red-brown; minor *Inoceramus*, belemnites (GSC loc. 94122); unit forms small resistant ridge	13.5	431.5 (approx.)
	Manuel Creek Formation		
6b	Siltstone, argillaceous, medium to dark grey; fissile to very fine chippy-weathering; abundant bands of rusty-red-brown-weathering concretions; unit recessive	1.5	418.0 (approx.)
6a	Siltstone, argillaceous, as in overlying unit; surface with abundant loose rubble, probably from interbeds, of sandstone, hard, quartz-cemented, light grey, fine-grained; laminated; in part ferruginous, weathering rusty-red-brown; with minor *Erycitoides* sp. aff. *E. howelli* (White), *Inoceramus*, *Variamussium*, belemnites(?) loose on surface (GSC loc. 94121); unit recessive	7.5	416.5 (approx.)
6	Siltstone, argillaceous, medium to dark grey; fissile to very fine chippy-weathering; abundant rusty red brown weathering concretions and minor hard, siliceous, medium grey concretions weathering rusty-orange-red; unit recessive, poorly exposed	9.0	409.0 (approx.)
5	Siltstone to very fine-grained sandstone, carbonaceous, dark grey-black; strongly bioturbated; fine rubbly-weathering; with hard, siliceous concretions, weathering rusty-red; unit recessive, poorly exposed, largely covered with blocks from underlying unit	6.0	400.0 (approx.)
	Top of Almstrom Creek Formation covered		
4d	Covered by blocks and slabs probably locally derived; sandstone, hard, quartz-cemented, white to light grey or buff, fine- to medium-grained; slightly glauconitic, recessive; this felsenmeer unit occurs at crest of a major resistant ridge; there may be additional thickness in the dipslope; thickness of covered interval is estimated, and includes a small fault that is inferred to be present because of unusually thin Manuel Creek Formation	93.0 (approx.)	394.0 (approx.)

Unit	Lithology	Thickness	Height Above Base
4c	Sandstone, light brown-grey, fine-grained; laminated, low-angle crossbedded(?); weathering to 2.5 cm-thick plates, buff	1.0	301.0 (approx.)
4b	Covered by blocks and slabs probably largely derived from this interval; sandstone, hard, quartz-cemented, light grey, fine- to medium-grained; slightly glauconitic; massive	34.0	300.0 (approx.)
4a	Sandstone, buff, fine-grained; slightly ferruginous, carbonaceous, with plant fragments; bioturbated(?), irregular 2.5 to 10 cm-bedding; buff-weathering	1.0	266.0 (approx.)
4	Covered by talus of blocks and slabs probably largely derived from this interval; sandstone, hard, quartz-cemented, light grey, fine- to medium-grained; slightly glauconitic; rare rusty-red ferruginous patches; mainly massive, rare burrowed and laminated blocks	42.0 (approx.)	265.0 (approx.)
3	Siltstone to fine-grained sandstone, buff; strongly bioturbated; slightly glauconitic; irregular ferruginous patches, weathering rusty-red-brown; abundant irregular or sub-spherical phosphatic nodules, black, 1 to 10 cm in diameter; unit forms small somewhat resistant outcrops in talus slope; a single brown ferruginous siltstone pocket contains abundant *Meleagrinella*, *Oxytoma*, minor *Pleuromya* (GSC loc. 94120)	18.0	223.0 (approx.)
2	Covered by talus consisting of blocks and slabs largely derived from this interval; sandstone, hard, quartz-cemented, light grey or grey-green, fine- to medium-grained; in part bioturbated, in part laminated with locally abundant burrows, *Rhizocorallium*, minor ferruginous siltstone rip-up clasts; abundant rusty-red-stained, ferruginous blocks probably representing lenses and nodules; minor *Pentacrinus* (GSC loc. 94119)	178.0 (approx.)	205.0 (approx.)
	<u>Top of Murray Ridge Formation covered</u>		
1	Silty mudstone to argillaceous siltstone, dark grey black; nearly fissile locally; fine chippy to fine rubbly-weathering; minor small siliceous concretions, weathering bright red and orange, and ferruginous mudstone concretions, weathering rusty-brown; locally abundant nests of *Corbula*(?) and small pectinid bivalves (GSC locs. 94116, 94117, 94118); upward grades to siltstone, argillaceous, finely laminated, very fine platy-weathering; unit recessive, poorly exposed. *Trochammina* sp. 5267, *Astacolus* sp. 5269, and *Lenticulina* sp. cf. *biexcavata* (GSC loc. C-53568)	27.0	27.0
	Top of Permian covered, contact estimated to within approximately 3 metres.		
	Siltstone to fine-grained sandstone; strongly bioturbated, finely and irregulary bedded; rusty orange grey brown weathering, recessive; minor '*Zoophycos*'		

<u>SECTION PU-20-76</u>. Little Fish Creek, northward from where it is joined from the east by Almstrom Creek, and continuing to the west up the small tributary entering Little Fish Creek just to the north (approx. Lat. 68°25'10"N, Long. 136°10'30"W). This section was graphically illustrated in a prelimnary report (Poulton, 1978a, fig. 8.2), and is reproduced in Figures 5 and 16; Pl. 7, fig. 3 of this paper. Microfossil distributions are shown in Table 5. All measurements are in metres.

Husky Fromation	
Bug Creek Group (part)	601.5 m
Aklavik Formation	63.0 m
Richardson Mountains Formation	293.5 m (approx.)
Manuel Creek Formation(?)	67.5 m
Almstrom Creek Formation (part)	177.5 m (min.)

Unit	Lithology	Thickness	Height Above Base
	The section is overlain by the Husky Formation, which here is a predominantly recessive siltstone with thin sandstone interbeds. Large buff-weathering septarian concretions occur here and there. Two coarsening-upward sandstone units, the upper one yielding *Buchia* (GSC loc. 94180) occur in the lower 60 to 80 m (est.) of the unit.		
	BUG CREEK GROUP		
	<u>Aklavik Formation</u>		
43	Sandstone, light grey to medium brown-grey, fine- to medium-grained; carbonaceous; strongly bioturbated with faint relict lamination, ripples, crossbedded in part; mainly irregularly 10 cm-bedded; weathering light rusty-buff, hard, resistant	4.5	601.5

Unit	Lithology	Thickness	Height Above Base
42	Sandstone, light grey, fine-grained; lower 0.6 m distinctly planar-bedded on 2.5 to 10 cm scale; middle part massive or with indistinct lamination; upper 3 m large-scale low-angle crossbedded; weathering buff with rusty stain and jarosite, hard, platy or massive, resistant	7.5	597.0 (approx.)
41	Siltstone to very fine-grained sandstone, argillaceous, carbonaceous; strongly bioturbated; forming irregular 2.5 to 5 cm-thick flags; with lenses as thick as 25 cm, decreasing in size and abundance upward, of sandstone, very light grey, fine-grained; laminated low-angle crossbedded	14.25	589.5 (approx.)
40	Sandstone, very light grey, fine-grained; laminated, large-scale low-angle crossbedded; abundant ripples, and carbonaceous partings with trails; lower 1.5 m bioturbated argillaceous siltstone and very fine-grained sandstone interbedded on 15 cm scale, and with abundant sub-spherical, calcareous concretions, weathering light ochre-yellow, mainly 5 to 10 cm in diameter, one reaching 1.5 m; unit weathering buff, resistant	2.25	575.25 (approx.)
39	Siltstone to very fine-grained sandstone, argillaceous, carbonaceous; strongly bioturbated; indistinctly-, finely-, and irregularly-bedded; weathering fine-rubbly and to thin irregular slabs, rusty with abundant jarosite stain, recessive	13.5	573.0 (approx.)
38	Sandstone, light grey to brownish-grey, fine-grained; carbonaceous, argillaceous; lowest 4.5 m is finely-laminated and strongly bioturbated, the two interbedded on 5 cm to 15 cm scale, bedding distinct, vertical burrows cut lamination; upper 17.5 m is finely-, irregularly- and indistinctly-bedded, strongly bioturbated varying upward to massive or with indistinct 0.3 to 0.5 m-thick banding; a massive bed occupies interval 17.5 to 18.2 m above base; upper 10 m with minor hard, siliceous, sub-spherical concretions 2.5 to 5 cm in diameter; locally abundant scaphopods (GSC loc. 92150); unit weathers buff, faintly banded, with abundant jarosite in upper 10 m, forms resistant bluffs	21.0	559.5 (approx.)

Richardson Mountains Formation

Unit	Lithology	Thickness	Height Above Base
37	Siltstone, argillaceous; indistinctly, finely- and irregularly-bedded; friable, soft; weathering to grey mud and silt; recessive	6.0	538.5 (approx.)
36	Sandstone, light to medium grey or brownish-grey, fine-grained; carbonaceous; strongly bioturbated, irregularly 2.5 cm-bedded; upper 3 m with softer 0.3 m-thick very argillaceous, recessive interbeds at 1 m intervals; unit weathering rubbly and to thin irregular plates, very light grey to buff with slight blue tinge, abundant jarosite; *Cardioceras (Scarburgiceras)* sp. occurs 9 m above base (GSC loc. 94318); unit moderately resistant; lower contact gradational	12.0	532.5 (approx.)
34	Sandstone, light grey, fine-grained; very finely-laminated, small-scale low-angle crossbedded; units 15 cm- to 1 m-thick; upper parts of some beds strongly bioturbated; abundant small-scale channelling; platy-weathering; interbedded with equal proportions of siltstone to fine-grained sandstone, argillaceous, strongly bioturbated, beds mainly 10 cm to 1 m-thick, rarely 3 m; slightly calcareous; abundant trails on carbonaceous bedding surfaces; abundant ripples; minor jarosite; locally abundant pyrite nodules as large as 1 cm in diameter; locally laminae rich in scaphopods; near base, a band of hard, siliceous, ferruginous siltstone pods, light to medium-grey, light ochre-yellow-weathering, 0.6 to 1 m by 2 to 3 m; unit banded, resistant, rusty stained at top; exposed in small, gentle syncline	21.0	507.0 (approx.)
33	Siltstone to very fine-grained sandstone, argillaceous, medium grey; strongly bioturbated with minor relict thin lamination, indistinctly bedded to massive except in upper 10 m where lamination is distinct; abundant subspherical or ovoid, hard, siliceous concretions, light grey to greenish-grey, slightly pyritic, buff-weathering, 1 to 5 cm in diameter at base varying upward to 20 cm in diameter but absent in upper 10 m (approx.), except for a layer 0.3 m below top of unit; unit weathering light to medium grey	33.75	486.0 (approx.)
32	Siltstone, medium to dark grey; argillaceous, carbonaceous; strongly bioturbated; finely, indistinctly, and irregularly bedded; soft; with minor rusty-brown-weathering, loaf-like concretions in lowest 3 m, 0.3 x 0.6 m; pyritic, dark rusty-brown-stained bands at 6 m, 1.3 m and 0.3 m below top; unit fine rubbly-weathering, recessive	12.0	452.25 (approx.)
31	Siltstone to fine-grained sandstone; strongly bioturbated with minor relict fine lamination and ripples; indistinctly-, irregularly- and finely-bedded, in 1 to 1.5 m-thick subunits varying from very soft and recessive to moderately resistant, the latter slightly rusty-weathering; abundant pyrite nodules as large as 2.5 cm; abundant *Cadoceras* sp., minor *Pleuromya*(?), *Entolium*(?), pointed belemnites from 10.5 to 15 m (approx.) above base (GSC loc. 94148); unit recessive, lower part inaccessible	30.0 (approx.)	440.25 (approx.)
30	Sandstone, fine-grained; strongly bioturbated; very finely-, indistinctly- and irregularly-bedded with carbonaceous partings; abundant very small pyrite nodules; a band of ferruginous, rusty-orange-brown-weathering pods 10 cm by 1.5 m (approx.) at 1 m above base; 15 cm-thick beds of finely-laminated and rippled, fine-grained sandstone at 1 to 1.5 m intervals throughout; 10 cm-thick, very soft, argillaceous siltstone bands throughout; unit moderately resistant	5.0	410.25

Unit	Lithology	Thickness	Height Above Base
29	Sandstone, light grey-buff, fine-grained; slightly calcareous and glauconitic; massive or with indistinct lamination near base; large-scale low-angle crossbedded upward, channelled; carbonaceous partings; trails, belemnites and *Entolium*(?) abundant on some surfaces; locally abundant pyrite nodules as large as 2.5 cm in diameter; local ferruginous mudstone lenses, 10 to 20 cm by 0.3 to 3 m, weathering dark rusty-brown; weathering to large conchoidally-fractured blocks at base, to thin plates at top, resistant	4.0	405.25
28	Siltstone to fine-grained sandstone; slightly argillaceous; strongly bioturbated; very finely-, indistinctly-, and irregularly-bedded; friable; abundant very fine, irregular, carbonaceous, argillaceous partings; abundant sub-spherical calcareous concretions in lowest 1.5 m, light grey, light ochre-buff-weathering, 15 to 45 cm in diameter; abundant small pyrite nodules with rusty halos in upper 1.5 m	3.0	401.25
27	Siltstone, argillaceous, friable, recessive; poorly exposed	6.0	398.25
26	Siltstone to fine-grained sandstone, light grey; strongly bioturbated; very finely-, indistinctly-, and irregularly-bedded; weathering light buff-grey, friable, recessive in lowest 3 m, moderately resistant above that; at 3 to 3.5 m above base and at 5.1 to 5.4 m above base are calcareous, ochre-yellow-weathering, harder bands; belemnites scattered throughout	9.0	392.25
25	Covered interval, recessive	7.5	383.25
24	Siltstone to fine-grained sandstone, argillaceous, soft, rubbly-weathering to finely and irregularly platy-weathering, poorly exposed, in 1 m-thick beds; a 0.3 m-thick interbed occurs 1.5 to 1.8 m above base of sandstone, light grey, fine-grained, strongly bioturbated with relict fine lamination and ripple cross-lamination, abundant trails, buff-weathering; a 0.6 m-thick bed of similar sandstone occurs 2.4 to 3 m above base; unit recessive	4.5	375.75
23	Siltstone, argillaceous; strongly bioturbated; indistinctly and irregularly 2.5 cm to 15 cm-bedded; soft, friable, with minor thin shaly interbeds; with lensoid interbeds 2.5 to 30 cm-thick of sandstone, fine-grained; laminated, low-angle crossbedded; bedding surfaces carbonacous, with abundant ripples, trails, *Inoceramus* and belemnite fragments (GSC locs. 94145, 94146); abundant radial feeding furrows; a 0.3 m-thick bed, at 4.5 m above base, of ferruginous, siliceous mudstone/siltstone, hard, medium grey, weathering dark red; a 0.6 m-thick band at 12 m above base, of calcareous sandstone, very finely-laminated, with ripples, abundant trails, belemnites (GSC loc. 94147), weathering light ochre-yellow; minor belemnites scattered throughout unit, abundant large *Inoceramus* on a bedding surface 1 m above base (GSC loc. 94144); undeterminable ammonite fragment collected loose, probably from near base (GSC loc. 94146)	13.5	371.25
22	Siltstone, argillaceous, strongly bioturbated; soft, friable, weathering light grey with rusty stain; minor belemnites	14.5	357.75
21	Sandstone, light grey-buff, fine-grained; laminated and low-angle crossbedded, in 15 cm- to 0.6 m-thick subunits; minor 2.5 to 15 cm-thick interbeds of soft, strongly bioturbated sandstone, increasing upward in proportion to 30% and in thickness to 0.6 m; carbonaceous partings, ripples, trails, radial feeding burrows, minor wood fragments; above about 14 m above base, abundant parallel-laminated or crossbedded to rippled to burrowed sets as thick as 0.6 m; abundant small pyrite nodules in some beds; between 6 and 12 m above base of unit and in upper 2 m, abundant dark rusty-red-weathering bands of hard, medium grey, siliceous, ferruginous mudstone as thick as 25 cm, at 1 to 1.5 m intervals; at 13.5 and 17.5 m above base, rusty orange red brown weathering lenses of hard, light khaki-grey, siliceous, ferruginous mudstone, as large as 0.6 x 10 m; unit buff-weathering with minor rusty stain; forms resistant bluffs; belemnites scattered throughout (GSC loc. 94143), locally concentrated in thin beds	23.25	343.25
20	Siltstone varying upward to fine-grained sandstone, argillaceous; strongly bioturbated; a 15 cm-thick particularly soft shaly bed occurs 0.6 m above base; belemnites scattered throughout, minor wood fragments; slightly calcareous; upper 3 m approx. is indistinctly and irregularly 5 cm to 15 cm-bedded with carbonaceous argillaceous partings; unit fine rubbly-weathering, recessive at base, more resistant upwards; a particularly hard band occurs 31.5 to 34.5 above base; by interbedding grades into overlying unit; *Cranocephalites* sp. and belemnites, probably from this unit, collected in talus (GSC loc. 94142)	42.0	320.0
19	Sandstone, medium grey to brownish-grey, fine- to medium-grained; carbonaceous; strongly bioturbated and indistinctly-bedded; abundant trails and burrows, some *Zoophycos*-like; abundant small pyrite nodules with rusty halos; a single 10 cm-thick soft argillaceous siltstone band about 1 m above base; lowest 0.3 m of unit and interval 1.1 to 1.4 m above base are hard dark red-weathering ferruginous bands with pockets rich in *Inoceramus*, and with rare unidentifiable ammonites (GSC loc. 94140); abundant, scattered, unoriented		

Unit	Lithology	Thickness	Height Above Base
	belemnites; minor rusty red-brown-weathering siliceous concretions 15 cm by 1.5 m approx. occur throughout and form a discontinuous band about 6 m above base of unit; soft, laminated, argillaceous siltstone beds 0.3 m-thick occur approx. 11 and 22 m above base of unit; unit weathers buff, forms resistant bluffs	33.0	278.0
	Manuel Creek Formation(?)		
18	Covered interval, recessive; a 1.5 m-thick (approx.) sandstone(?) bed in centre of unit, not visited	3.0	245.0
17	Silty mudstone to argillaceous siltstone, medium to dark grey; bioturbated(?); thin interbeds of sandstone, light grey, fine-grained, slightly glauconitic, laminated and low-angle cross-bedded, weathering buff and platy; hard, grey siliceous concretions, weathering dark red; unit poorly exposed, recessive; minor poorly preserved pectinid bivalves, rhynchonellid brachiopods (GSC loc. 94139)	4.5	242.0
16	Covered interval, recessive	60.0	237.5
	Almstrom Creek Formation		
15	Sandstone, hard, quartz-cemented, light grey, fine-grained; finely laminated; locally abundant ripples and trails; weathering platy, light rusty-buff with red stain; a particularly hard, dark wine-red-weathering bed, 0.3 m-thick, occurs at base; unit somewhat resistant but poorly exposed and may include soft covered interbeds	4.5	177.5
14	Covered interval, recessive	9.0	173.0
13	Sandstone, light grey, fine-grained; strongly bioturbated; indistinctly and irregularly 2.5 to 7.5 cm-bedded; weathering rusty-buff, slabby, recessive; minor unidentifiable pectinids	1.5	164.0
12	Sandstone, light grey, fine-grained; large-scale low-angle crossbedded; from 15 cm to 1 m above base is a subunit that is strongly bioturbated, soft, recessive; local rusty-orange-weathering limonitic siltstone pods 10 cm x 1 m approx.; considerable dark wine-red-weathering bands of medium grey, hard, siliceous concretions, 15 cm by 6 m approx.; abundant trails, mud-cracks, ripples, minor ferruginous and argillaceous siltstone rip-up clasts; slightly calcareous; unit weathering massive or slabby; minor pectinid bivalves (GSC loc. 94138)	3.0	162.5
11	Sandstone, light grey, fine-grained; slightly carbonaceous; strongly bioturbated; in part soft, recessive, nearly friable; in part (especially near top) somewhat harder and 2.5 to 5 cm irregularly-bedded; abundant 15 cm by 0.6 m medium grey, hard siliceous concretions, weathering wine-red, at 1.5 m above base of unit; locally abundant oysters, minor *Pholadomya*, pectinid and other bivalves (GSC loc. 94137)	3.75	159.5
10	Sandstone, light grey, fine-grained; slightly carbonaceous; strongly bioturbated; 2.5 to 30 cm-bedded; interbedded with equal proportions of sandstone, fine-grained, laminated to 2.5 cm-bedded, small-scale low-angle crossbedded, with ripples and trails	3.75	155.8
9	Sandstone, light grey, fine-grained; slightly carbonaceous; strongly bioturbated with minor relict lamination and ripples; abundant pyrite nodules as large as 5 mm in diameter; unit weathering fine-rubbly, buff and rusty; somewhat resistant	4.5	152.0
8	Sandstone, light greenish-grey, fine-grained; large-scale low-angle crossbedded in 15 cm to 1.5 m-thick subunits; abundant ripples and trails; carbonaceous bedding surfaces, glauconitic; minor friable siltstone beds as thick as 10 cm; a single 0.6 m-thick bed of soft, friable fine-grained sandstone occurs 1.5 m above base of unit, carbonaceous, strongly bioturbated, rusty-stained; abundant concretionary bands as large as 15 cm by 1.5 to 12 m, hard, siliceous, medium grey, weathering dark wine-red; unit weathering light grey-buff with slight green tinge and locally abundant rusty patches, somewhat resistant	15.0	147.5
7	Siltstone to fine-grained sandstone, glauconitic, light grey to greenish-grey; in 0.3 to 1.6 m-thick cycles, each grading upward from soft, nearly friable, argillaceous, strongly bioturbated, rusty-weathering siltstone to fine-grained sandstone with minor mudstone or shale partings as thick as 2.5 cm, through indistinctly and irregularly 2.5 cm-bedded bioturbated fine-grained sandstone, to laminated, small-scale low-angle crossbedded fine-grained sandstone; abundant trails and ripples on carbonaceous bedding surfaces; locally abundant pyrite nodules as large as 5 mm in diameter; abundant hard ferruginous, siliceous siltstone pods, 15 cm by 1.5 m (approx.), in upper 3 m of unit, medium grey, weathering dark wine-red; abundant large oysters 3 m (approx.) below top of unit (GSC loc. 94135); unit somewhat resistant, rusty-stained	12.0	132.5
6	Sandstone, fine-grained; low-angle crossbedded, laminated, in subunits as thick as 2.5 m; with interbeds increasing in proportion upward to 50% (approx.) and in thickness to 1 m, of finely interbedded laminated to 15 cm-bedded, rippled siltstone to fine-grained sandstone and slightly carbonaceous, strongly bioturbated, rusty- and fine rubbly-weathering, fine-grained sandstone with *Chondrites;* trails on bedding surfaces; slightly calcareous; minor hard, ferruginous, siliceous concretions, weathering rusty-orange-red, as large as 15 cm by 2.5 m	42.0	120.5

Unit	Lithology	Thickness	Height Above Base
5	Sandstone, light grey to greenish-grey, fine-grained; in subunits 0.3 to 1.3 m-thick, massive or with indistinct large-scale low-angle crossbedded lamination; with 20% interbeds as thick as 1.3 m of siltstone to fine-grained sandstone, 1 cm- to 5 cm-thick platy-bedded with carbonaceous, argillaceous partings, ripples and abundant trails; minor laminae with abundant argillaceous siltstone and minor ferruginous siltstone rip-up clasts; slightly calcareous; minor subovoid ferruginous nodules 1 cm to 10 cm in diameter, weathering rusty-orange-brown; unit weathering light khaki-buff, with abundant rusty-red and brown patches as large as 15 cm by 6 m; unit forms resistant bluffs, grades into underlying unit	29.5	78.5
4	Sandstone, fine-grained; slightly carbonaceous; in part strongly bioturbated, indistinctly and irregularly 10 cm-bedded; in part laminated with carbonaceous partings; the lithologies are finely interbedded; varies upward to 10 cm-bedded, low-angle crossbedded, laminated sandstone; unit weathering recessive, rusty-buff with minor rusty-red bands as thick as 15 cm; grades into underlying unit	10.5	49.0
3	Siltstone to fine-grained sandstone, light grey; carbonaceous; strongly bioturbated; minor beds as thick as 15 cm of finely-laminated fine-grained sandstone, particularly near top of unit where they are low-angle crossbedded; abundant hard, light grey, subspherical, siliceous nodules 1 cm in diameter (approx.); locally abundant pyrite nodules as large as 5 mm in diameter; a single hard, ferruginous, siliceous band 30 cm-thick, weathering rusty-red-brown, occurs approx. 1.5 m below top of unit; unit recessive and fine rubbly-weathering at base, somewhat resistant at top; minor pockets with abundant *Meleagrinella* (GSC loc. 94134)	6.0	38.5
2b	Sandstone, light grey, fine-grained; large-scale low-angle crossbedded, weathering to 2.5 to 5 cm-thick plates; minor 10 to 15 cm-thick bioturbated beds; weathering buff with minor rusty stain	4.45	32.5
2a	Siltstone to fine-grained sandstone, light grey; carbonaceous, argillaceous, strongly bioturbated; soft, rubbly-weathering	0.3	28.05
2	Sandstone, light grey, fine-grained; finely-laminated, in large-scale low-angle cross-bedded subunits 0.3 to 1.3 m-thick; minor glauconite locally; abundant carbonaceous partings; local 1 cm-to 5 cm-thick recessive beds of finely-laminated argillaceous siltstone; locally abundant ferruginous siltstone and argillaceous siltstone rip-up clasts on bedding surfaces; abundant and varied trails and markings, minor ripples, minor localized burrows, mainly horizontal; abundant 15 cm- to 50 cm-thick interbeds of 2.5 cm-bedded, platy and strongly rippled rusty-stained sandstone in upper 15 m of unit; upper halves of the 1 to 1.3 m-thick crossbedded lenses are strongly bioturbated in upper 12 m of unit, bioturbated subunits increasing in abundance upward; abundant irregularly distributed laminae, bands, and patches weathering wine-red to rusty-red-brown, as large as 15 cm by 6 m; unit weathering light grey with yellow-green tint and red bands, abundant localized rusty stain; bluff-forming; localized 2.5 to 30 cm by 0.6 to 1.0 m lenses and laminae rich in *Melagrinella* and *Oxytoma*, with minor oysters, *Liotrigonia*, other bivalves, *Lingula* and *Pentacrinus* (GSC locs. 94182, 94132, 94133, 94181, 94182, 94183), particularly abundant in lower 3 m of unit	25.5	27.75
1	Siltstone to fine-grained sandstone, light grey; carbonaceous, argillaceous, pyritic; strongly bioturbated(?); soft, friable, rusty-weathering; interbedded on 10 to 20 cm scale with sandstone, light grey, fine-grained; finely-laminated, small-scale low-angle crossbedded; weathering rusty-buff; unit recessive; outcrops at base of bluffs above gravel bar in river	2.25	2.25

SECTION PU-21-76. On east side of ridge just west of headwaters of Little Bell River (approx. Lat. 67°48'35"N, Long. 136°41'W). The section is illustrated in Figure 39 and Pl. 10, fig. 3. All measurements are in metres.

Bug Creek Group	483.0 m
Aklavik Formation	82.5 m
Richardson Mountains Formation (corr.)	238.5 m
Manuel Creek Formation	85.5 m
Almstrom Creek and Murray Ridge(?) Formations	
Fault(?)	
Permian	

Unit	Lithology	Thickness	Height Above Base
	Porcupine River Formation		
25	Sandstone, hard, quartz-cemented, light grey, fine-grained; massive or laminated and large-scale low-angle crossbedded, in subunits as thick as 3 m; slightly ferruginous and calcareous; rare poorly preserved scaphopods; unit weathering platy or blocky; top of unit is top of hill	24.0	555.0
	Husky Formation		
24	Siltstone to fine-grained sandstone, dark grey; strongly and finely bioturbated; carbonaceous, argillaceous, slightly ferruginous; rare platy, light rusty-brown-weathering interlaminae; unit weathering medium grey, very fine rubbly, recessive, poorly exposed	48.0	531.0
23	Sandstone, hard, quartz-cemented, light grey, fine-grained; massive or with minor lamination and large-scale low-angle crossbedding; slightly calcareous; minor 0.6 by 10 m ferruginous and calcareous lenses, particularly near top, weathering rusty-orange-red-brown or ochre-yellow; minor pyrite nodules as large as 5 mm in diameter; minor 10 to 15 cm-thick recessive bands, carbonaceous, thinly laminated, with dark rusty-red-weathering, ferruginous mudstone concretions 5 to 10 cm by 0.6 m; laminae with *Inoceramus* and belemnite debris (GSC loc. 94157), especially in lower part; unit resistant, forms top of prominent banded bluff; upper few meters poorly exposed, interbedded on scale 1.5 to 2.5 m, with a less resistant lithology, poorly exposed, probably as in overlying unit	82.5	483.0
	Richardson Mountains Formation		
22	Sandstone, light to medium brownish-grey, fine-grained, strongly bioturbated; finely, indistinctly- and irregularly-bedded; carbonaceous, argillaceous; with 30% interbeds hard, light grey, finely laminated, with carbonaceous, argillaceous partings; minor small-scale low-angle crossbedded and rippled beds 10 to 50 cm-thick; slightly calcareous	4.5	400.5
21	Sandstone, light to medium brownish-grey, fine-grained; strongly bioturbated; finely, indistinctly- and irregularly-bedded; carbonaceous, argillaceous; minor pyrite nodules as large as 5 mm in diameter; unit weathering medium grey, fine-rubbly, somewhat resistant	7.5	396.0
20	Sandstone, hard, quartz-cemented; light grey, fine-grained; massive or indistinctly-laminated, in 0.6 to 1.2 m-thick beds; minor ferruginous patches, 0.3 by 1.2 m (approx.), weathering dark red; at 1.5 m above base, a 0.3 m-thick bed, hard, light to dark grey, carbonaceous, finely-laminated, weathering rusty-red-brown; belemnites throughout; poorly preserved ammonite(?), scaphopods, *Perna* and other small bivalves 3.75 m below top of unit (GSC loc. 94155); unit forms top of banded part of resistant bluff	13.5	388.5
19	Sandstone, hard, quartz-cemented, light grey, fine-grained; fine planar-laminated or structureless, in 15 cm- to 1 m-thick beds; minor rusty-stained bioturbated beds; in part slightly calcareous; very minor 5 to 10 cm-thick siltstone and mudstone beds with 5 by 15 cm (approx.) ferruginous mudstone concretions, medium grey, weathering bright rusty-orange-red; abundant belemnites, and minor *Inoceramus* and scaphopod fragments on some surfaces; unit forms the base of banded bluffs	7.5	375.5
18	Recessive, covered; probably as in unit 15	3.0	368.0
17	Sandstone, medium to dark grey, fine-grained; strongly bioturbated, massive or finely and indistinctly-bedded; argillaceous, carbonaceous, abundant pyrite nodules as large as 5 mm in diameter; unit weathering medium grey with rusty stain; abundant wood fragments, belemnites, minor *Inoceramus*, *Teichichnus*(?)-like trace fossils (GSC loc. 94154)	4.5	365.0
16	Covered interval, recessive; probably same as in underlying unit; presumably this interval contains a fault, judging by anomalous thinness of formation here	49.5 (180 corr.)	361.5
15	Siltstone to fine-grained sandstone; strongly bioturbated; finely, indistinctly, and irregularly-bedded; weathering grey-brown with local rusty stain; recessive	3.0	181.5
14	Covered interval, recessive; probably same as overlying unit	9.0	178.5
13	Sandstone, hard, quartz-cemented, light grey, fine-grained; strongly bioturbated, massive or indistinctly and irregularly 2.5 cm-bedded; minor thin lenses with relict lamination;		

Unit	Lithology	Thickness	Height Above Base
	slightly carbonaceous; minor ferruginous mudstone and siltstone concretions, subspherical, 5 cm in diameter (approx.), weathering rusty-orange to dark red; minor pyrite nodules as large as 5 mm in diameter; unit weathering light buff-grey, forms upper part of banded, resistant bluff	7.5	169.5
12	Sandstone, hard, quartz-cemented, light grey, fine-grained; finely-laminated, small-scale low-angle crossbedded; slightly ferruginous and calcareous, abundant 2.5 to 15 cm by 1.5 to 10 m lenses and pods of rusty-brown-weathering ferruginous siltstone to fine-grained sandstone, thinly-laminated, with abundant ferruginous siltstone rip-up clasts; approx. 1 m above base, a bed 0.4 m-thick rich in large belemnites, and within it a 10 cm-thick bed rich in pebbles or nodules of ferruginous and phosphatic mudstone, in part oolitic; fossils include *Arkelloceras mclearni* Frebold and *Inoceramus*(?) (GSC loc. 94152); upper 10 cm of unit bioturbated; unit forms prominent resistant bluffs	3.0	162.0
	Manuel Creek Formation		
11	Siltstone, dark grey-black; finely bioturbated; argillaceous, carbonaceous; with rusty-orange-brown-weathering concretions; unit recessive, poorly exposed, fine rubble	15.0	159.0
10	Covered interval, recessive	3.0	144.0
9	Sandstone, hard, silica-cemented, fine-grained; finely bioturbated with minor relict fine lamination, indistinctly-bedded; carbonaceous, argillaceous; somewhat resistant	4.5	141.0
8	Siltstone to very fine-grained sandstone; strongly bioturbated, indistinctly-bedded; argillaceous, carbonaceous; weathering medium grey with rusty stain, recessive	7.5	136.5
7	Covered interval	10.5	129.0
6	Silty shale to argillaceous siltstone, dark grey-black; fissile; micaceous; soft, varies upward to argillaceous siltstone, carbonaceous, micaceous, strongly bioturbated, indistinctly, finely and irregularly-bedded; with medium grey siliceous mudstone concretions, 2.5 to 5 cm by 15 to 30 cm; weathering light rusty-orange-brown; unit recessive	6.75	118.5
5	Siltstone to fine-grained sandstone, light to medium grey; strongly bioturbated, indistinctly and irregularly 2.5 cm-bedded; locally abundant hard, siliceous, medium grey mudstone concretions, 2.5 to 5 cm by 0.3 to 1.0 m (approx.), weathering rusty-orange-brown; unit weathering buff-grey with rusty patches and abundant jarosite stain, fine-rubbly, somewhat resistant. Foraminifera (GSC loc. C-53571); *Ammodiscus* sp. cf. *cheradospirus*, *Trochammina* sp. cf. *canningensis*, and T. sp. 4965	11.25	111.75
4b	Siltstone to fine-grained sandstone, light to medium grey; strongly bioturbated, indistinctly-bedded; carbonaceous, argillaceous; with hard, siliceous, medium grey mudstone concretions; unit recessive	3.0	100.5
4a	Siltstone, argillaceous, dark grey-black; fissile; micaceous; with minor bioturbated pockets; with locally abundant hard, siliceous, medium grey mudstone concretions; unit recessive	18.0	97.5
4	Siltstone to fine-grained sandstone, light to medium grey; strongly bioturbated, indistinctly 2.5 cm-(approx.) bedded; carbonaceous, argillaceous; locally abundant subspherical or ovoid siliceous mudstone and siltstone concretions, light to medium grey, hard, light rusty yellow brown weathering; locally abundant lenses, 10 cm by 1.2 m (approx.) of siliceous mudstone to fine-grained sandstone, hard, rusty-brown-weathering; unit recessive, weathering medium grey with slightly rusty stain, and fine-rubbly or fine-chippy at base, varying to hard and moderately resistant at top; small gastropod and Foraminifera (GSC loc. C-53572) from near top of unit: *Trochammina* sp. cf. *canningensis*, *T.* sp. 4965, *Lenticulina* cast(?), *Reophax* sp. 5274; Foraminifera from near base of unit (GSC loc. C-53573): *Trochammina* sp. cf. *canningensis* *T.* sp. 5271	6.0	79.5
	Almstrom Creek Formation		
3	Sandstone, light grey, fine-grained; finely-laminated or with super-imposed bioturbation; 2.5 cm to 15 cm, or rarely 0.6 m, irregularly-bedded with irregular carbonaceous partings; in part hard, quartz-cemented; interval 7.5 to 25.5 m above base strongly bioturbated, carbonaceous, argillaceous, indistinctly-bedded, weathering fine-rubbly, recessive; unit as a whole moderately resistant, upper beds forming small ridge	34.5	73.5
2	Sandstone, hard, quartz-cemented; light brown-grey; fine-grained; in structureless beds, increasing in thickness and proportion upwards, 15 cm- to 1.2 m-thick; with 1 cm- to 5 cm-thick partings of black, fissile shale and soft, argillaceous, carbonaceous siltstone, with locally abundant trails; unit weathering rusty-brown with local yellow stain, somewhat resistant; minor poorly preserved *Pholadomya* loose on surface (GSC loc. 94151)	12.0	39.0
1	Sandstone, hard, light grey to brownish-grey; fine-grained; large- and small-scale low-angle crossbedded in 0.6 to 1.2 m-thick subunits; in part ferruginous; thin inter-laminae of rusty orange-red-brown-weathering ferruginous mudstone and siltstone; abundant rip-up clasts of this ferruginous mudstone; minor pyrite nodules as large as 5 mm in diameter; minor calcareous nodules as large as 2.5 cm in diameter; unit weathers light brownish-buff with abundant dark red-brown bands as large as 25 cm by 15 m (approx.), forms resistant bluff	10.5	27.0

Unit	Lithology	Thickness	Height Above Base
	Sandstone, hard, light grey, fine-grained; finely-laminated with abundant small-scale low-angle cross-lamination; bedding units 2.5 cm to 0.5 m-thick, with carbonaceous, argillaceous partings with abundant trails; abundant lenses, 5 to 8 mm (less commonly to 0.5 m) thick and as long as 1.5 m, of rusty-brown-weathering ferruginous siltstone, finely-laminated; minor beds 0.3 to 1.0 m thick, strongly bioturbated, rubbly, massive; *Chondrites* common; unit weathers banded, moderately resistant, very rusty, particularly in upper part	16.5	16.5
	Top of Murray Ridge Formation covered		
	Exact location of contact with Permian not determined and possibly faulted; below the section described is a covered interval approximately 15 m-thick, and below that a thick succession of argillaceous, strongly bioturbated siltstone and sandstone with abundant '*Zoophycos*', that represents the Permian Upper Sandstone Unit.		

SECTION PU-22-76. East side of hill overlooking the headwaters of the next creek east of Bear Creek that flows south into Rat River (Lat. 67°54'20"N, Long. 135°55'W). The section is illustrated in Figure 9 and Pl. 11, fig. 3. Microfossil distributions are shown in Table 3. All measurements are in metres.

Bug Creek Group (total)	237.0 m
Aklavik Formation	57.0 m
Richardson Mountains Formation	117.0 m
Unconformity	
Murray Ridge Formation	63.0 m
Scho Creek Member	24.0 m
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	TOP OF BLUFF; TOP OF BUG CREEK GROUP		
	Aklavik Formation		
	Unit 11 as a whole forms a coarsening- and hardening-upward cycle.		
11d	Sandstone, hard, quartz-cemented, white, fine- to medium-grained; massive or with indistinct crossbedding, in ripples; slightly calcareous; weathering blocky with finely chipped surface, local red stain; bluff-forming, particularly upper 27 m	42.0	237.0
11c	Sandstone, light grey, fine-grained; large-scale low-angle crossbedded; platy-weathering; grading to underlying unit	8.0	195.0
11b	Sandstone, medium grey, fine-grained; carbonaceous; bioturbated, indistinctly and irregularly 2.5 to 5 cm-bedded; lower 0.6 m and upper 1 m with 15 cm-thick lensoid bands fine-laminated, low-angle cross-bedded; grading to underlying unit	3.0	187.0
11a	Siltstone, argillaceous; soft; finely and strongly bioturbated, 1 cm to 2.5 cm-thick bedding, increasingly coarse upward; rare 2.5 cm-thick wavy beds of rippled, finely-laminated siltstone, increasing in abundance upwards; unit weathering fine-rubbly to fine-platy	1.0	184.0
10	Sandstone, light grey, fine-grained; finely-laminated, large-scale low-angle cross-bedded; minor carbonaceous laminae; hard; slightly calcareous; weathering light grey with jarosite stain	3.0	183.0
	Richardson Mountains Formation		
9	Covered by blocks from overlying units; belemnites in talus	30.0	180.0
8	Sandstone, light grey, fine-grained; laminated and large-scale low-angle crossbedded with carbonaceous laminae; slightly calcareous; occupies 25% of interval in 1.5 to 3 m units; between them talus only, in part strongly bioturbated and with jarosite stain; talus with locally abundant ferruginous and argillaceous siltstone rip-up clasts, ripples, burrows, *Chondrites* and other trails, belemnites, minor wood fragments, *Inoceramus*, scaphopods, and *Cranocephalites* (?) (GSC locs. 94165, 94166, 94167, 94168); hard, siliceous, ferruginous siltstone concretions, large calcareous sandstone lenses weathering rusty-orange-yellow	70.45	150.0
7	Sandstone, light grey, fine-grained; large-scale low-angle crossbedded; bedding units 5 cm- 1.2 m-thick, upper parts of some beds strongly bioturbated, indistinctly and irregularly-bedded; abundant belemnites in laminae in lowest 0.6 m of unit; lowest 5 cm with abundant flattened pebbles of black and rusty-red mudstone and siltstone, minor glauconitic fragments and bone fragments; upper 3 m with minor dark red-weathering sandstone pods 10 cm by 0.6 m to 30 cm by 6 m in size; unit weathering buff with rusty stain, bluff-forming; GSC loc. 94164	16.5	79.55

Unit	Lithology	Thickness	Height Above Base
6	Argillaceous siltstone to mudstone; with abundant flattened black mudstone pebbles	0.05	63.05
	Murray Ridge Formation		
5	Siltstone to fine-grained sandstone, hard, medium grey; strongly laminated, finely bioturbated; abundant ferruginous siltstone rip-up clasts; weathering dark red, rusty	0.5	63.0
4	Siltstone to fine-grained sandstone; light to medium grey; strongly and finely bioturbated; argillaceous; a 10 cm-thick, hard, siliceous, dark rusty-red-weathering band occurs 40 cm below top; unit weathering light grey with slight blue tinge and abundant jarosite stain; recessive	2.5	62.5
3	Mudstone and shale, light to medium grey or black; fissile to very fine-chippy; local thin rusty laminae and jarosite stain; minor interbeds as thick as 15 cm of argillaceous siltstone to very fine-grained sandstone; in these and throughout unit are abundant 10 cm by 0.6 m (approx.) pods of ferruginous siltstone, medium grey, weathering dark rusty-red, hard and siliceous or soft; *Echioceras*(?) sp. and bivalves occur about 22 m below top of unit (GSC loc. 94169); unit very recessive, poorly exposed or covered in measured section; samples and description from next gully to south from where section was measured, same hill	36.0	60.0
	Scho Creek Member		
2	Sandstone, medium-grained; large-scale low-angle crossbedded; with 5 to 30 cm-thick gritty and pebbly lenses; calcite or dolomite(?)-cemented; weathering rusty-orange-brown to buff; platy, rubbly or friable; somewhat resistant and forms hoodoos on terrace to 10 m above base, recessive beyond that	16.5	24.0
1	Sandstone, fine- to medium-grained, granule- and pebble-bearing; finely- and irregularly-laminated, small-scale crossbedded; calcite-cemented; weathering light rusty-orange-buff; unit recessive, friable, poorly exposed except for harder lenses; marine bivalves (GSC loc. 94163) in certain laminae	7.5	7.5

PERMIAN

The Permian upper sandstone unit here varies from a laminated or well-bedded, hard, glauconitic orthoquartzite to an argillaceous, bioturbated, finely- and irregularly-bedded siltstone. Rusty ferruginous beds and concretions are not uncommon; the unit as a whole is distinctly rusty-weathering; *Zoophycos*, *Rhizocorallium*, and *Skolithos* are abundant, as are brachiopods locally. 527 m (minimum) were measured.

SECTION PU-23-76. Small hill just northwest of Horn Lake and northeast of confluence of Scho Creek with Rat River (approx. Lat. 67°45'40"N, Long. 136°04'W). Thicknesses are visual estimates only; descriptions of units are generalized. All measurements are in metres.

Husky Formation	
Bug Creek Group (total)	107.0 m (approx.)
Aklavik Formation	60.0 m (approx.)
Richardson Mountains Formation	47.0 m (approx.)
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	The Bug Creek Group here is overlain by a thick, recessive, black, carbonaceous shale unit with thin sandstone ribs assigned to the Husky Formation.		
	BUG CREEK GROUP		
	Aklavik Formation		
4	Sandstone, hard, quartz-cemented, light grey, fine-grained; massive or with minor indistinct lamination; weathering light grey, slightly rusty, more resistant toward top	60.0 (approx.)	107.0 (approx.)
	Richardson Mountains Formation		
3	Sandstone, hard, quartz-cemented, light grey; weathering rusty-brown; abundant poorly preserved long thin belemnites near top	8.0 (approx.)	47.0 (approx.)
2	Sandstone, fine- to medium-grained, minor coarse-grained sandstone; calcareous; weathering light rusty-orange-brown; recessive; poorly exposed as rubble only	30.0 (approx.)	39.0 (approx.)
1	Sandstone, hard, light grey, largely coarse-grained with minor granules; 20 cm to 1 m-bedded; weathering banded, resistant	9.0 (approx.)	9.0 (approx.)
	PERMIAN		
	Sandstone, in part hard, light grey to very light brown, fine- to medium-grained; 15 cm to 0.6 m-bedded; locally ferruginous; abundant vertical burrows and *Zoophycos*; weathering light grey to light brown; exposed as jagged ribs in a dominantly recessive interval	80.0 (approx.)	

SECTION PU-27-76. Ridge at head of Almstrom and Little Fish Creeks; north of White Mountains (approx. Lat. 68°04'40"N, Long. 136°34'W). The section is illustrated in Figure 9 and Pl. 7, fig. 2. All measurements are in metres.

Bug Creek Group (part)	376.0 m
Richardson Mountains Formation (part)	86.7 m
Manuel Creek Formation (?)	76.5 m
Almstrom Creek Formation	130.0 m
Murray Ridge Formation	82.8 m
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	The upper part of the Bug Creek Group, including a resistant unit probably representing the Aklavik Formation, appears to be exposed in the valley east of the top of the section (D.K. Norris, pers. comm.); these upper units were not examined.		
	Richardson Mountains Formation		
27	Covered by talus of Unit 26 on its dipslope; considerable bright rusty orange yellow weathering calcite-cemented pods 0.6 by 3.5 m (min.); abundant belemnites, *Inoceramus* (GSC loc. 94179 loose)	21.0	376.0
26	Siltstone to fine-grained sandstone as in Unit 24; upper part (at least) 5 to 15 cm-bedded; locally abundant small ferruginous rip-up clasts, and belemnite-bivalve hash; a light yellow buff weathering calcite-cemented pod 1 by 2.5 m near top; a 0.3 by 12 m (min.) lens weathering rusty-brown near centre; rare poorly preserved ammonite fragments	10.5	355.0
25	Covered, recessive; abundant fine plates of siltstone, finely-laminated	1.5	344.5
24	Siltstone to fine-grained sandstone, light brown-grey; hard, brittle, finely-laminated, large-scale low-angle crossbedded, in 0.3 to 1 m-thick bedding units (in part); very minor gentle channelling; rare irregularly 1 to 2 cm-bedded, bioturbated lenses in lower 0.3 m; minor rusty-brown-weathering limonitic lenses 2.5 to 5 cm by 2 m (approx.); minor poorly preserved isolated belemnites and bivalve hash on rare surfaces; poorly developed bioturbated to massive to laminated cycles; unit weathering buff, fine-platy, forms small resistant ridge	6.0	343.0
23	Sandstone, hard, quartz-cemented, light grey, fine-grained; finely-laminated; weathering very fine-platy, buff but light brown in lowest 0.3 to 0.5 m; recessive	4.5	337.0
22	Covered, recessive; rubble of siltstone to fine-grained sandstone, strongly bioturbated; rare wood fragments; weathering fine-rubbly, buff and rusty	10.2	332.5
21	Covered, recessive; abundant fine chips and flakes of siltstone, medium grey; argillaceous, finely and strongly bioturbated; weathering very light grey with slight yellow stain and blue tinge; minor rusty stain	7.5	322.3
20	Covered by talus from Unit 18, recessive	13.5	314.8
19	Covered by talus of Unit 18 on dipslope of that unit; recessive	3.0	301.3
18	Sandstone, light buff-grey, fine-grained; strongly bioturbated, irregularly 2.5 to 7.5 cm-bedded; abundant 15 cm by 1.5 m (approx.) rusty brown spheroidal weathering ferruginous siltstone pods and local bright rusty-yellow-weathering calcareous patches; rare wood fragments; unit mainly weathering buff, forms small, resistant bluffs	9.0	298.3
	Manuel Creek Formation(?)		
17	Covered interval, recessive; abundant rubble, probably locally derived, of siltstone to very fine-grained sandstone, light grey; fine wavy-laminated, less commonly finely- and irregularly-bedded and bioturbated; unit weathering light khaki-grey with minor dark red-weathering, finely laminated rubble	76.5	289.3
	Almstrom Creek Formation		
16	Covered by large blocks and slabs, probably largely in place, of sandstone, hard, quartz-cemented, very light grey, fine-grained; 15 to 60 cm-bedded; large-scale low-angle crossbedded in part; minor medium to dark rusty-brown-weathering ferruginous pockets as large as 0.3 by 3 m; a 0.6 m-thick (approx.) interval 7.5 m above base recessive, finely-laminated, light rusty-brown-weathering; upper 7.5 m as in unit 14; unit forms felsenmeer on highest peak of hill	25.5	212.8
15	Covered interval, recessive; abundant rubble of siltstone to fine-grained sandstone, in part hard, quartz-cemented, light khaki-grey, finely-laminated with trails on the wavy irregular surfaces; in part argillaceous, strongly bioturbated, finely- and irregularly-bedded; oysters (GSC loc. 94178 loose)	9.0	187.3
14	Covered by large blocks and slabs as thick as 15 cm of grey, hard sandstone as in Unit 13; probably largely locally derived; surfaces of blocks finely-chipped; interval moderately resistant	15.0	178.3

Unit	Lithology	Thickness	Height Above Base
13	Sandstone, hard, quartz-cemented, light grey, fine-grained; in part laminated, in part bioturbated, bedding units 0.6 to 1.5 m-thick; abundant limonite specks; rusty-weathering ferruginous pods	9.0	163.3
12	Sandstone, light grey to brownish-grey, fine-grained; finely planar-laminated, minor ferruginous siltstone rip-up clasts, minor burrows; rare small pyrite nodules; rusty-weathering ferruginous pods as thick as 1.5 m	12.0	154.3
11	Sandstone, light grey- to brownish-grey, fine-grained; carbonaceous; strongly bioturbated with minor relict lamination; 0.6 to 1.2 m-bedded, with irregular bedding surfaces; abundant dark rusty-red-brown-weathering ferruginous bands 15 to 50 cm by 2.5 to 6 m; unit weathering buff, somewhat resistant	9.25	142.3
10	Covered interval	2.25	133.05
9	Sandstone, hard, quartz-cemented, light grey, fine-grained; laminated, with ripples and minor superimposed bioturbation; irregularly 2.5 to 30 cm-bedded, with irregular carbonaceous, argillaceous (in part) partings; minor small-scale low-angle crossbedding; locally abundant varied trails; a bed 0.3 m-thick, approx. 6 m above base, and upper 1 m of unit are argillaceous, strongly bioturbated, 1 to 2.5 cm irregularly- and indistinctly-bedded, khaki-brown, weathering rusty; unit weathering medium brown-grey	9.0	130.8
8	Covered interval	3.0	121.8
7	Sandstone, hard, quartz-cemented, light grey, fine-grained; slightly carbonaceous; strongly bioturbated; indistinctly-,finely-, and irregularly-bedded; weathering khaki-brown with rusty stain, *Trochammina* sp. 5271 (GSC loc. C-53569)	1.5	118.8
6	Covered interval	32.25	117.3

Unit	Lithology	Thickness	Height Above Base
5	Sandstone, hard, quartz-cemented, light grey, fine-grained; finely planar-laminated, in 10 cm to 0.3 m even bedding units with carbonaceous partings, and trails on surfaces; minor low-angle small-scale crossbedding; basal 0.15 m light brown-grey, limonitic, argillaceous; next higher 0.1 m with abundant glauconite and small bivalves (GSC loc. 94177); unit weathering light grey with rusty stain	2.25	85.05
	Murray Ridge Formation		
4	Covered by talus from overlying units	30.0	82.8
3	Shale or mudstone and argillaceous siltstone, dark grey-black; fissile to fine chippy-weathering, minor rusty stain and jarosite; minor nodules or thin interbeds (judged from rubble) of medium rusty-brown-grey, ferruginous siltstone, laminated and bioturbated; unit recessive, poorly exposed in upper half; bivalves and *Pentacrinus* (GSC loc. 94175), and	51.0	52.8
2	Siltstone to very fine-grained sandstone, medium grey; argillaceous; poorly exposed, probably forms 10 to 20 cm-thick beds within recessive shale; minor poorly preserved *Gryphaea* and other bivalves (GSC loc. 94175), and *Spiroplectammina* sp. 5274 (GSC loc. C-53570) near base	1.5	1.8
1	Shale, medium grey, very soft, muddy	0.3	0.3
	PERMIAN		
	Contact is abrupt, irregular on 1 to 2 cm scale; Permian rocks are a thick, mainly recessive succession of rusty-red- and buff-weathering, rubbly, bioturbated siltstone to fine-grained sandstone, with locally abundant *Zoophycos*		

SECTION PU-30-76. Canyon of creek running south from Mount Millen into tributary of Bell River (approx. Lat. 67°24'45"N, Long. 136°27'W). Thicknesses are estimated; units are described only generally. The section is illustrated in Figure 10 . All measurements are in metres.

Husky Formation	
Bug Creek Group (total?)	31.4 m
Unconformity	
Permian (assumed)	

Unit	Lithology	Thickness	Height Above Base
	The section is overlain by a thick recessive unit, assigned to the Husky Formation. Tithonian and Portlandian fossils were identified by J.A. Jeletzky from horizons low in this unit, respectively 3 and 6.2 km north-northeast alongstrike from the present section (GSC loc. C-29252, 86208).		
	BUG CREEK GROUP		
5	Coarse-grained sandstone, grit, and conglomerate; with abundant pebbles and boulders as large as 25 cm in diameter, largely chert, poorly to moderately well rounded; structureless	2.4	31.4 (approx.)
4	Sandstone as in Unit 1, massive to thick slabby	3.5	29.0 (approx.)
3	Sandstone, hard, quartz-cemented; light grey, fine-grained; 1 to 5 cm-bedded, large-scale low-angle crossbedded; slightly ferruginous; weathering rusty-brown, platy	1.5	25.5 (approx.)
2	Recessive interval, covered with 1 to 5 cm-thick plates of sandstone as in Unit 3, large-scale low-angle crossbedded(?)	6.0 (approx.)	24.0 (approx.)
1	Sandstone, hard, quartz-cemented; light grey, fine-grained; massive with rare poorly defined lamination; slightly ferruginous; weathering rusty-brown, to large jagged blocks, with minor 2.5 to 10 cm-thick plates	18.0 (approx.)	18.0 (approx.)
	Unit 1 is the lowest unit exposed in the creek; it is probably not far above the contact with underlying presumed Permian rocks.		

SECTION PU-32-76. Ridges west of White Mountains, east of Bell River (approx. Lat. 67°57'15"N, Long, 136°49'20"W). The section is illustrated in Figure 16. All measurements are in metres.

Upper Shale-Siltstone Division	
Unconformity	
Bug Creek Group (part)	587.5 m
Richardson Mountains Formation (part)	169.5 m
Manuel Creek Formation(?)	132.0 m
Almstrom Creek and Murray Ridge(?) Formations	286.0 m
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	This section is overlain by a thick recessive argillaceous unit assigned by D.K. Norris (pers. comm.) to the "upper shale-siltstone division" informally named by Jeletzky (1958). Thin sandstone subunits within it, occur 50 to 60 m above its base.		
	BUG CREEK GROUP		
	Richardson Mountains Formation		
19a	Sandstone, hard, quartz-cemented, light to medium grey, fine-grained; 50% laminated to 15 cm-bedded, large-scale low-angle cross-bedded; 50% bioturbated(?), in beds as thick as 0.5 m; unit resistant, buff-brown-weathering	9.0	587.5 (approx.)
19	Covered, recessive	3.0	578.5 (approx.)
18	Sandstone, hard, quartz-cemented, light to medium grey, fine-grained; beds 2.5 to 15 cm thick, less commonly finely-laminated; large-scale low-angle crossbedded; minor structureless beds as thick as 0.5 m, bioturbated(?), increasing in proportion upward to 50% in upper half of unit; unit weathering light to medium brown-buff, forms resistant bluffs	21.0	575.5 (approx.)
17	Covered by blocks from above	3.0	554.5 (approx.)
16	Siltstone to very fine-grained sandstone; soft, argillaceous, carbonaceous; strongly bioturbated; fine rubbly-weathering; abundant very finely-laminated carbonaceous, slightly calcareous siltstone to very fine-grained sandstone; minor jarosite abundant carbonaceous partings, in part irregular; unit recessive	49.5	551.5 (approx.)

Unit	Lithology	Thickness	Height Above Base
15	Siltstone to very fine-grained sandstone; soft; argillaceous, carbonaceous; strongly bioturbated; fine rubbly-weathering; minor concretionary fragments weathering spheroidal, rusty-orange-brown; unit recessive	36.0	502.0 (approx.)
14	Covered by talus from Unit 13	16.5	466.0 (approx.)
13	Sandstone, light grey to brownish-grey, fine-grained; laminated to massive; low-angle crossbedded; peak of ridge 12 m above base of unit; here and in dipslope beyond this, are 0.5 by 12 m (approx.) ferruginous lenses weathering bright rusty-orange; some bedding surfaces with abundant trails and horizontal burrows; scattered *Inoceramus*; unit weathering mainly buff, forms bluffy ridge	31.5	449.5 (approx.)
	Manuel Creek Formation(?)		
12	Covered by boulders from Unit 13; talus with abundant belemnites, locally concentrated in laminae to 0.3 m-thick beds; minor poorly preserved bivalves in places forming shell hash	63.0	418.0 (approx.)
11	Covered, recessive; abundant fine rubble of siltstone to fine-grained sandstone, light grey; carbonaceous; strongly bioturbated, fine rubbly-weathering; minor concretionary fragments, weathering spheroidal, rusty-ochre-yellow and brown to dark red; upper 20 m covered largely by boulders from Unit 13	69.0	355.0 (approx.)
	Almstrom Creek Formation		
10	Sandstone, hard, quartz-cemented; light grey, fine-grained; carbonaceous; strongly bioturbated, indistinctly-bedded; weathering irregularly-blocky, medium rusty-brown-grey; unit forms small resistant bluffs	7.5	286.0 (approx.)
9	Covered by boulders from Unit 10; of sandstone, hard, quartz-cemented, light grey to brownish-grey; fine-grained; massive with minor indistinct lamination	39.0	278.5 (approx.)
8	Covered, recessive; with abundant rubble as in Unit 6; very thin plates, in part dark rusty-red-weathering; and boulders probably derived from Unit 10; Units 6 to 8 form a broad recessive saddle	54.0	239.5 (approx.)
7	Covered, recessive; with quartzite boulders near top probably derived from Unit 5	19.0	185.5 (approx.)
6	Covered interval, recessive; abundant fine rubble of siltstone to very fine-grained sandstone, light grey, very finely- and irregularly-laminated, strongly bioturbated; fine-rubbly; locally abundant ferruginous fragments, weathering spheroidal, bright orange to rusty-brown	36.0	166.5
5	Sandstone, hard, quartz-cemented; white to very light grey, fine-grained; massive, in part bioturbated, with minor relict fine lamination and ripples; moderately abundant ferruginous pods and lenses as large as 10 cm by 1 m (approx.), weathering spheroidally, rusty-orange to dark red-brown; unit weathering rusty-grey, in jagged blocks, forms resistant ridge	10.5	130.5 (approx.)
4	Covered by blocks from Unit 5	21.0	120.0 (approx.)
3	Sandstone, hard, quartz-cemented; white to light brown, fine-grained; in 10 cm- to 0.6 m-thick beds, finely-laminated, with large-scale low-angle crossbedding; minor carbonaceous surfaces with trails, ripples; unit weathering light brown to buff, forms small resistant, jagged bluffs; strongly slickensided	9.0	99.0 (approx.)
2	Sandstone, as in Unit 3; not studied in detail; forms somewhat resistant small bluff	45.0 (approx.)	90.0 (approx.)
1	Covered, recessive; assumed to include Murray Ridge Formation and Permian-Jurassic contact, although underlying rocks were not examined	45.0 (approx.)	45.0 (approx.)

SECTION PU-1-78. East-facing slope of ridge between Big Fish River and Little Fish Creek (approx. Lat. 68°19'30"N, Long. 136°26'30"W). The section is illustrated in Figure 16 . All measurements are in metres.

Bug Creek Group (part)	156.0 m
Almstrom Creek Formation (part)	96.0 m
Murray Ridge Formation	60.0 m
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	Almstrom Creek Formation		
	This section corresponds with the lower part of section PU-19-76, which is 5 km alongstrike to the south-southwest. Talus of sandstone, as in unit below, covers hillside above top of measured section; there is minor exposure, not examined.		
6	Sandstone, light grey to buff, fine- to medium-grained; medium- to thick-bedded with minor flaggy carbonaceous interbeds and rusty lamination; locally abundant vertical and horizontal burrows, scours, crossbedding, intra-formational conglomerates; minor strongly bioturbated intervals; rare pebbles as large as 1 cm; abundant rusty-weathering ferruginous pods and beds; minor bivalves; unit weathering rusty-yellow-buff, resistant	65.0	156.0
5	Sandstone, light grey-buff, fine- to medium-grained; argillaceous; strongly bioturbated; thinly- and irregularly-bedded; abundant scouring, local crossbedding; locally with hard, wine-red-weathering, grey, siliceous concretions as thick as 25 cm; a nearly continuous band of them lies 1.5 m (approx.) above base of unit; unit bluff-forming, resistant, with recessive argillaceous interbeds	31.0	91.0
	Murray Ridge Formation		
4	Probably shale as in unit below, but totally covered by blocks from overlying unit	37.5	60.0
3	Shale, dark grey-black; soft; fissile to fine chippy-weathering; with hard, grey, wine-red-weathering siliceous concretions, some rich in *Corbula* (GSC loc. C-53356); unit recessive, poorly exposed; *Coroniceras*(?), identified by H. Frebold, was collected loose below, probably from here (GSC loc. C-53357)	13.5	22.5
2	Siltstone to fine-grained sandstone, light to medium grey; argillaceous; thinly- and irregularly-bedded; minor clean, fine-grained sandstone beds as thick as 20 cm, structureless, buff-weathering; locally finely and intensively bioturbated; unit weathering light grey with rusty patches, chippy; *Gryphaea* in upper 15 cm (GSC loc. C-53355)	6.75	9.0
1	Sandstone, grey, fine-grained; scattered black chert pebbles, especially near base, as large as 1 cm in diameter; black sub-spherical 2.5 cm-diameter, phosphatic nodules; unit weathering rusty-red; minor gastropods, *Gryphaea*, *Entolium*, *Aequipecten* (GSC loc. C-53354); small carbonaceous plant fragments	2.25	2.25
	PERMIAN		
	Siltstone to fine-grained sandstone; grey; 2.5 cm- to 0.3 m-bedded, more or less regularly-bedded; weathering rusty-brown-grey; upper half poorly exposed	30.0	
	Covered	49.5	
	Underlying beds are rusty-grey siltstone forming 6 m high bluffs on hillside; with abundant '*Zoophycos*'		

SECTION PU-2-78. South bank of Martin Creek 6 km (approx.) west of junction with Willow River (approx. Lat. 68°11'30"N, Long. 135°39'30"W). The section is illustrated in Figure 5. All measurements are in metres.

Husky Formation	
Bug Creek Group (part)	121.15 m
Aklavik Formation	54.00 m
Richardson Mountains Formation (part)	67.15 m

Unit	Lithology	Thickness	Height Above Base
	Overlying Husky Formation is black, soft, recessive, fissile shale, with large, light orange-buff-weathering concretions. Contact appears to be sharp.		
	BUG CREEK GROUP		
	Aklavik Formation		
13	Sandstone, light grey-brown, fine- to medium-grained; varying to 50% coarse-grained between 19.5 and 24 m (approx.) above base; well sorted; basal 1.5 m massive, next 0.3 m bioturbated, overlying bed large-scale low-angle crossbedded; remainder massive, structureless or indistinctly-laminated, planar-bedded, low-angle and trough crossbedded; minor ripples; in part 0.5 to 1.5 m-bedded; bedding units separated by undulose surfaces; in part with fining upward cycles on 15 to 30 cm scale; interval 31.5 to 34.5 m above base finely-, irregularly-, wavy-bedded, with abundant irregular coal partings (logs?); unit weathering buff with yellow-orange stain; bluff-forming	54.0	121.15
	Richardson Mountains Formation		
12	Sandstone, light grey-brown, fine-grained; slightly to moderately carbonaceous; strongly bioturbated; 5 to 30 cm irregularly- and indistinctly-bedded; weathering buff with minor rusty stain	4.75	67.15
11	Sandstone, light grey-brown, fine-grained; strongly carbonaceous; small-scale low-angle crossbedded; 0.5 to 10 cm-bedded, with minor 15 cm-thick bioturbated intervals; abundant root casts(?) or small subvertical burrows; upper 0.6 m weathering very rusty	4.5	62.4
10	Siltstone to very fine-grained sandstone, dark grey-black; argillaceous, carbonaceous; very thinly- and irregularly-bedded; strongly and finely bioturbated; root casts(?); minor 2.5 cm-thick, fine-grained, clean sandstone interbeds, strongly bioturbated, increasing in abundance upward, to 70% at 3.5 m above base; unit soft, crumbly, weathering buff with abundant jarosite	6.75	57.90
9	Sandstone, very light brown-grey, fine-grained, well sorted, finely-laminated to 10 cm-bedded, and low-angle cross-bedded as in underlying unit, but with no bioturbation; upper 1.5 m recessive	9.0	51.15
8	Sandstone, light brown-grey, very fine- to fine-grained; finely planar-laminated and low-angle planar-crossbedded; with 50% beds, as thick as 0.5 m, strongly bioturbated; bedding planes carbonaceous; minor shallow channels(?); a 20 cm-thick, rusty-orange-weathering concretionary band near top; unit weathering rusty-buff; moderately resistant	9.0	42.15
7	As in Unit 6 below, but with 5 to 10 cm-thick finely laminated, well sorted sandstone interbeds in upper 1 m	3.9	33.15
6	Siltstone to very fine-grained sandstone, light to dark grey; finely and strongly bioturbated; carbonaceous; soft, recessive; with 0.3 to 0.6 m-thick interbeds of similar but harder sandstone	3.0	29.25
5	Sandstone, light brown-grey, very fine- to fine-grained; finely and strongly bioturbated; thinly- and irregularly-bedded; argillaceous; soft; abundant jarosite stain	5.0	26.25
4	Siltstone, dark grey-black; carbonaceous, argillaceous; finely and intensively bioturbated; soft, recessive; grades to overlying unit	1.0	21.25
3	Sandstone, light brown-grey, fine-grained; strongly bioturbated with abundant vertical burrows; irregularly finely laminated to 10 cm-bedded; strongly carbonaceous; soft; weathering crumbly, buff and rusty, spotty; forms resistant bluffs	9.0	20.25
2	Sandstone, light grey, fine- to medium-grained; strongly bioturbated, in thinly- and irregularly-bedded units as thick as 2.5 m; with 30% 15 to 45 cm small-scale low-angle crossbedded and planar-laminated interbeds; unit buff-weathering	8.25	11.25
1	Sandstone, light brown-grey, fine- to medium-grained; 0.5 to 5 cm-bedded; small-scale low-angle crossbedded; abundant limonite specks; weathering buff with rusty patches, thin-flaggy; a thin, unexposed bioturbated interval occurs at top	3.0	3.0
	Covered below, to river level		

SECTION PU-4-78. White Mountains, 3 km southwest of confluence of Vunta and Fish Creeks (approx. Lat. 67°54'N, Long. 136°35'W). The section is illustrated in Figures 11 and 39. All measurements are in metres.

Husky Formation	
Bug Creek Group (total)	465.75 m
Aklavik Formation	51.00 m
Richardson Mountains Formation	255.00 m
Manuel Creek Formation	51.00 m
Almstrom Creek Formation	57.75 m
Murray Ridge Formation	51.00 m
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	The section is overlain by grey-black argillaceous siltstone of the Husky Formation. Three (at least) sandstone lenses, each as thick as 15 m, are present in the lowest 100 m of this unit.		
	BUG CREEK GROUP		
	Aklavik Formation		
14	Sandstone, light grey, fine-grained; hard, quartz-cemented; mainly thin to medium planar-bedded; weathering light grey with minor rusty and bright red stain, blocky and flaggy; minor undetermined *Yoldia*-like bivalves; resistant, bluff-forming	51.0	465.75
	Richardson Mountains Formation		
13	Siltstone, black; carbonaceous, argillaceous; mainly strongly bioturbated; rubbly, soft; minor finely laminated siltstone; recessive, poorly exposed	24.0	414.75
12	Sandstone, fine-grained; thin- to thick-bedded; low-angle crossbedded to structureless; abundant disseminated limonite; weathering flaggy, slabby, medium grey-brown; bluff-forming	6.0	390.75
11	Sandstone, light grey, fine-grained; hard; finely laminated, recessive	4.5	384.75
10	Sandstone as in Unit 8, but less richly fossiliferous; forms small resistant peak	25.5	380.25
9	Sandstone as below, in part at least probably interbedded with black, chippy, recessive siltstone; in part forming talus-covered dipslope of underlying unit; three small resistant terraces formed by lowest 1/2 of unit	61.5	354.75
8	Sandstone, light grey, fine-grained; hard, quartz-cemented; with abundant limonite specks; indistinctly-laminated and large-scale, very low-angle crossbedded; with 0.6 by 2 m (min.) calcareous patches weathering ochre-yellow-orange and rusty-brown-grey, a particularly prominent band of them 0.6 to 1.5 m-thick, 1.6 m below top of unit; minor dark brown-weathering, soft, limonitic patches as large as 2.5 cm by 3 m; minor rusty-red-weathering, siliceous patches; local pyrite nodules, as large as 1 cm in diameter, subspherical or irregular; minor argillaceous, carbonaceous partings; unit weathering blocky and slabby, bluff-forming; local *Inoceramus* and *Pachyteuthis*, and considerable shell hash beds, including ammonite fragments and scaphopods (GSC locs. C-53369, C-53370)	19.5	293.25
7	Covered by talus, interval recessive; probably thinly-laminated siltstone and fine-grained sandstone with abundant argillaceous siltstone partings	67.5	273.75
6	Sandstone, light brown-grey, fine-grained; hard; carbonaceous; strongly and finely bioturbated; irregularly and indistinctly medium-bedded; minor disseminated limonite; minor limonitic and red-weathering concretions and irregular patches; minor thin laminae rich in belemnite and bivalve fragments; some entire *Inoceramus* specimens in lower part of middle 1/3 (GSC loc. C-53367); upper and lower 15 m resistant; middle 15 m thin-bedded, with ripples and abundant argillaceous partings, recessive; upper 15 m with abundant 0.3 by 1.6 m dark red concretions; unit weathering medium grey and rusty	46.5	206.25
	Manuel Creek Formation		
5	Siltstone to fine-grained sandstone, dark grey-black; argillaceous, carbonaceous; varying to fine-chippy and nearly fissile black silty shale; strongly bioturbated; thinly- and irregularly-bedded; ochre-yellow and rusty-red-weathering concretions; unit recessive, rubbly-weathering, poorly exposed; upper 1/3 totally covered by talus from above; *Inoceramus* and other bivalves, belemnites, loose on surface (GSC loc. C-53366)	51.0	159.75
	Almstrom Creek Formation		
4	Sandstone, light grey and rusty-red-brown, fine-grained; hard, quartz-cemented; mainly very low-angle cross-laminated, rare thin bioturbated intervals and small-scale moderately steep crossbedding, minor burrows;		

Unit	Lithology	Thickness	Height Above Base
	partings commonly gently irregular, carbonaceous, with trails; strongly limonitic; subspherical pyrite(?) nodules as large as 2.5 cm in diameter; rare bright red (hematitic?) irregular patches as large as 1 cm by 10 cm; rare *Entolium* and other undetermined bivalves; unit weathering blocky, bluff-forming	57.75	108.75
	<u>Murray Ridge Formation</u>		
3	Covered by talus from overlying unit	15.0 (approx.)	51.0
2	Sandstone, light grey, fine-grained; hard, quartz-cemented; thinly- and irregularly-bedded; upper 1/2 with 50% 0.3 m-thick beds of similar quartzite, finely laminated and low-angle cross-bedded; bluff-forming	6.0 (approx.)	36.0
1	Siltstone, black, argillaceous, with rusty-brown to ochre-yellow-weathering, 2.5 cm-thick, platy concretions; fine-chippy-weathering; unit recessive, poorly exposed	30.0 (approx.)	30.0
	PERMIAN		
	Below measured section, is a thick succession of fine- to medium-grained light grey sandstone, strongly bioturbated, hard and quartz-cemented, thinly- and irregularly-bedded, forming a succession of small rusty bluffs; with "*Zoophycos*" locally (D.K. Norris, pers. comm.)		

<u>SECTION PU-5-78.</u> Between Bell and Waters Rivers, 23.5 km south-southeast of Mt. McGuire (approx. Lat. 67°44'20"N, Long. 137°08'W). The section is illustrated in Figures 13 and 26. All measurements are in metres.

Bug Creek Group (part)	713.0	m
Richardson Mountains Formation (part)	474.0	m
Early Bajocian and older units (part)	239.0	m

Unit	Lithology	Thickness	Height Above Base
	Sandstone similar to Unit 21 is exposed on the ridge above the measured section, and there are interbeds of platy-weathering, pyritic, fine-grained, dark grey argillaceous sandstone. These are structurally deformed and an accurate description is not possible. There may be an additional 150 m of upper Bug Creek Group above Unit 21.		
	<u>Richardson Mountains Formation</u>		
21	Sandstone, fine-grained; argillaceous; strongly bioturbated with minor brown-weathering concretions; poorly exposed fine rubbly only, weathering light grey and rusty-brown; ammonites, bivalves, belemnites, collected 15 m (approx.) above base (GSC loc. C-53381)	20.0 (est.)	713.0
20	As in Unit 19 below but poorly exposed felsenmeer on top of ridge	18.0	693.0
19	Sandstone as in Unit 17 below but mainly dull grey with rusty-brown-weathering patches; minor platy-weathering 2.5 to 5 cm-thick beds and indistinct laminae of siltstone and fine-grained sandstone near top of unit; unit mainly weathering blocky, slabby, resistant	18.0	675.0
18	Covered, recessive	15.0	657.0
17	Sandstone, light brown-grey, fine-grained; hard, quartz-cemented; limonitic; massive or with indistinct thin- to medium-bedding; with ochre-yellow brown weathering calcareous, ferruginous pods; minor ferruginous siltstone concretionary pods, weathering spheroidally, yellow-brown; upper 10 cm fine planar-laminated; unit weathering blocky, slabby, bluff-forming	34.5	642.0
16	Poorly exposed; probably partly sandstone as in Unit 15 below; partly thinly-laminated siltstone with carbonaceous argillaceous partings; recessive	12.0	607.5
15	Sandstone as in Unit 13 below; abundant calcareous pods as large as 0.6 by 4 m, weathering ochre-yellow; rare burrows and trails; poorly fossiliferous, minor *Inoceramus*, belemnites, ammonite fragments collected (GSC loc. C-53380); unit weathering buff, blocky, slabby, moderately resistant	7.5	595.5
14	Siltstone to fine-grained sandstone, black; carbonaceous, argillaceous; strongly bioturbated; thin irregularly-bedded with abundant trails; fine rubbly-weathering, poorly exposed, recessive; upper 1/2 totally covered	36.0	588.0
13	Sandstone, light grey to light brown-grey, fine-grained; very hard; limonitic; massive with minor planar-lamination and low-angle crossbedding; minor grey and argillaceous, carbonaceous or brown and ferruginous beds, thinly, irregularly and wavy-laminated, as thick as 15 cm; locally abundant ferruginous siltstone to fine-grained sandstone		

Unit	Lithology	Thickness	Height Above Base
	concretions as large as 20 cm x 1 m, dark red-brown-weathering; minor scattered *Inoceramus* and belemnites, fossils collected in lowest 2 m (GSC loc. C-53379), unit weathering blocky, bluff-forming	21.0	552.0
12	Covered by talus from above; *Inoceramus*, other bivalves, belemnites collected from blocks (GSC loc. C-53378)	60.0	531.0
11	Siltstone, black; argillaceous, carbonaceous; soft; fine-chippy-weathering, locally varying to sandstone as in unit below; with thin inter-laminae of rusty-brown-weathering ferruginous siltstone; unit recessive, poorly exposed; lithology judged from scattered patches of rubble, undeterminable ammonites loose on surface 15 m (approx.) below top of unit (GSC loc. C-53377)	210.0 (est.)	471.0
10	Siltstone and fine-grained sandstone, medium grey; carbonaceous, argillaceous; strongly bioturbated; with interbedded ferruginous, finely-laminated siltstone and sandstone containing belemnites and minor finely-laminated, hard, quartz-cemented fine-grained sandstone beds; unit poorly exposed, rubbly-weathering, lithologies judged from rubble	22.0 (approx.)	261.0
	Lower Bajocian Sandstone Unit		
9	Sandstone, light grey to light brown-grey, fine-grained; hard; limonitic; indistinctly laminated, with minor siltstone-chip rip-up layers; with minor soft, limonitic, ochre-yellow-weathering pods; unit weathering rusty-red-brown, blocky and rubbly, somewhat resistant; upper 1/2 not exposed in dipslope	6.75	239.0
8	Siltstone to fine-grained sandstone, medium grey; argillaceous; thinly, irregularly, and wavy-laminated, with abundant carbonaceous argillaceous partings and trails; with 10 to 15 cm-thick interbeds of light grey, fine-grained, hard sandstone as in underlying unit; finely-laminated and low-angle cross-laminated; unit recessive	5.25	232.25
7	Sandstone, light grey, fine-grained; hard, quartz-cemented; lower part mainly massive and structureless or locally laminated and low-angle crossbedded; some beds as thick as 10 cm, wavy- or irregularly-laminated, strongly bioturbated, with abundant argillaceous, carbonaceous partings with trails; ripples; soft, ferruginous siltstone and mudstone beds as thick as 20 cm; with limonitic concretions as large as 15 cm by 2 m; minor laminae rich in medium-grained chert, ferruginous mudstone and siltstone rip-up clasts, and at 6 m above base, belemnites; upper part mainly strongly bioturbated, carbonaceous, argillaceous, thin- to thick-irregularly-bedded, with minor 2 mm in diameter pyrite nodules and 1 to 2.5 cm diameter subspherical black phosphatic nodules; unit weathering blocky, medium grey, and rusty-red-brown, bluff-forming; *Erycitoides* sp. cf. *E. howelli* (White), minor belemnites and bivalves in lower 3 m (GSC loc. C-53376)	37.5	227.0
	Manuel Creek Equivalent		
6	Covered by blocks from overlying unit	13.5	189.5
5	Shale and siltstone, dark grey-black; weathering fine-chippy and splintery; abundant ferruginous mudstone concretions, weathering ochre-yellow-brown, spheroidally; minor hard, grey, siliceous mudstone concretions, subspherical, 1 cm in diameter; unit recessive, lower 1/2 not exposed; *Dactylioceras*, *Parvamussium*(?), belemnites collected loose on surface (GSC loc. C-53375)	21.0	176.0
	Older Lower Jurassic Rocks		
4	Covered; rubble of sandstone and ferruginous concretions as below	6.0	155.0
3	Sandstone, light to medium grey, fine-grained; hard, quartz-cemented; strongly bioturbated; 0.5 to 5 cm-irregularly-bedded; minor fine-lamination, ripples; carbonaceous, argillaceous partings with abundant trails; some 8 cm by 50 cm ferruginous mudstone concretions weathering rusty-brown and ochre-yellow; unit weathering rubbly, light rusty-grey, moderately resistant; rare *Entolium* (GSC loc. C-53374)	33.0	149.0
2	Shale and argillaceous siltstone, medium grey; fissile to fine-chippy and splintery; with abundant medium grey, hard, siliceous and ferruginous mudstone concretions weathering spheroidally, ochre-yellow and rusty-red-brown, in places strongly bioturbated; unit recessive	66.0	116.0
1	Sandstone, medium grey, fine-grained; hard, quartz-cemented; strongly bioturbated, 2.5 to 30 cm-irregularly-bedded; rare ripples; weathering rubbly, moderately resistant, rusty grey, banded	50.0 (approx.)	50.0

Another shale unit, and below that a sandstone unit, are thought to represent the Jurassic below the measured section. Structural complications preclude the confident description of these lowest parts of the succession.

SECTION PU-6-78. At 1430 m (approx.; 4728 feet) high mountain 6.5 km south of Anne Creek (approx. Lat. 67°47.5'N, 137°06.5'W). The section is illustrated in Figures 10, 13 and 14. All measurements are in metres.

Husky Formation	
Bug Creek Group (part)	801.5 m
Aklavik Formation	73.0 m
Richardson Mountains Formation	495.0 m
Early Bajocian and Older Units (part)	233.5 m

Unit	Lithology	Thickness	Height Above Base
	Overlying rocks are soft, recessive, bioturbated, argillaceous siltstone and very fine-grained sandstone with thin-laminated very fine-grained sandstone interbeds (Husky Formation). This is overlain by bluff-forming sandstones (Porcupine River Formation) containing Early Kimmeridgian to mid-Portlandian *Buchia* sp. according to J.A. Jeletzky (GSC locs. C-53393 and C-53394).		
	BUG CREEK GROUP		
	Aklavik Formation		
18	Sandstone, light grey, mainly fine-grained; very hard, quartz-cemented; in part 15 cm to 0.6 m-bedded, structureless; in part medium-scale low-angle crossbedded; minor laminae rich in chert granules; locally some beds are rich in large but generalized bivalves (GSC loc. C-53395); weathering light to dark grey, resistant	25.0	801.5
17	Sandstone, fine-grained; hard; carbonaceous, argillaceous; in part fine-laminated, in part strongly bioturbated and 10 to 15 cm-bedded; weathering platy and rubbly, grey with jarosite, rusty, resistant	24.0	776.5
16	Sandstone, light grey, fine-grained; very hard; mainly massive, in 1.5 to 2.5 m-thick beds that are more or less even and regular but with irregular, burrowed(?) surfaces; minor bedding as thin as 10 cm to 0.3 m; rare belemnites(?); unit weathering medium to dark grey, rusty, blocky, forms banded bluffs; unidentifiable ammonite in talus below probably from this unit (GSC loc. C-53412)	24.0	752.5
	Richardson Mountains Formation		
15	Siltstone to fine-grained sandstone, black; argillaceous, carbonaceous, strongly bioturbated; thinly-, indistinctly- and irregularly-bedded; interbedded on 0.3 to 1 m scale with 50% finely laminated and low-angle crossbedded sandstone with carbonaceous, argillaceous partings; weathering dull grey with blue tinge, rusty in part, with abundant jarosite, somewhat resistant	60.0	728.5
14	Siltstone to very fine-grained sandstone, black; argillaceous, carbonaceous; very strongly bioturbated; thin- to medium-irregularly- and indistinctly-bedded; minor rusty-brown-weathering, otherwise similar beds; becomes finer and softer upwards; upper part with 1 to 5 cm diameter subspherical concretions; abundant jarosite; unit recessive, forms major col	40.5	668.5
13	Sandstone, light brown-grey, fine-grained; hard, quartz-cemented; limonitic; laminated in lowest few metres, mainly massive with poorly defined laminae and low-angle cross-bedding; some calcareous pods, rusty-yellow-orange-weathering, as large as 0.6 by 3 m; rare poorly preserved belemnites and minor rusty-red-brown ferruginous beds in upper part of unit; unit weathering light to medium rusty-grey; blocky, becoming partly rubbly and slabby in upper part; forms resistant peak; upper 5 m poorly exposed in dipslope; *Inoceramus* collected in upper part (GSC loc. C-53411)	144.0	628.0
12	Sandstone, medium grey, very fine-grained; argillaceous, strongly bioturbated; minor poorly preserved belemnites; *Inoceramus* locally common, collected 2 m below top (GSC loc. C-53397); unit weathering medium grey with local rusty stain, rubbly, recessive	24.0	484.0
11	Sandstone, light grey, fine-grained; hard, quartz-cemented; limonitic; mainly finely-laminated and low- to medium-angle crossbedded, in 2.5 cm- to 1.2 m-thick units; carbonaceous, argillaceous bedding surfaces; upper 1/3 of unit with rare ferruginous siltstone rip-up layers, minor 0.6 by 3 m, calcareous, ochre-yellow-weathering pods; unit weathering light to medium grey with ochre-yellow stain, resistant; middle 1/3 of unit argillaceous, strongly bioturbated, rubbly, recessive; with abundant jarosite and small pyrite nodules; *Inoceramus* from middle 1/3 of unit (GSC loc. C-53396); *Cranocephalites*(?) and *Inoceramus* from upper 1/3 (GSC loc. C-53392); ammonite in talus below probably from this unit (GSC loc. C-53391)	59.0	460.0
10	Shale and siltstone, black; fissile to very fine-chippy; soft, recessive	2.5	401.0
9	Sandstone, medium grey, very fine- to fine-grained; argillaceous; strongly bioturbated; 15 cm- to 0.6 m-irregularly- and indistinctly-bedded; abundant ferruginous siltstone concretions 8 cm by 0.6 m; upper 1/2 1 m-bedded with 50% 20 cm- to 1 m-thick interbeds that are finely laminated and low-angle crossbedded; unit weathering medium grey and rusty-brown, with rusty stains, moderately resistant; strongly fractured	12.0	398.5

Unit	Lithology	Thickness	Height Above Base
8	Siltstone to fine-grained sandstone, black, argillaceous; strongly bioturbated; minor poorly preserved belemnites and *Inoceramus* fragments; weathering rusty-grey, mainly recessive	10.5	386.5
7	Siltstone to very fine-grained sandstone, black; argillaceous; strongly bioturbated; minor poorly preserved belemnites and *Inoceramus* fragments; abundant 0.25 cm diameter pyrite nodules; weathering medium dark rusty-grey with abundant jarosite, mainly fine-rubbly; somewhat harder, light (blue-) grey-weathering in centre of unit, indistinctly thin- to medium-bedded; upper 6 m with abundant ochre-yellow-brown-weathering pods, not exposed	135.0	376.0
6	Sandstone, grey, fine-grained; argillaceous; strongly bioturbated; burrow-mottled; weathering light to dark grey, rubbly, recessive	7.5	241.0
	<u>Lower Bajocian Sandstone Unit</u>		
5	Sandstone, light khaki-grey, fine-grained; hard, quartz-cemented; thinly- to thickly-indistinctly-bedded to massive; minor fine-lamination and low-angle cross-bedding; upper 1/2 is 80% strongly bioturbated, in beds as thick as 4 m; upper 3 m with abundant ochre-yellow-brown-weathering pods; unit resistant, rusty-grey- and red-brown-weathering, blocky; strongly sheared; forms jagged bluffs; talus with *Pseudolioceras* sp. cf. *P. spitsbergense* (Frebold), *P.* sp., identified by H. Frebold, and other fossils (GSC loc. C-53387 probably from lower part of unit), with belemnite-rich laminae, red siltstone rip-up layers, small phosphate nodules	72.0	233.5
	<u>Manuel Creek Equivalent</u>		
4	Shale and siltstone, dark grey-black; argillaceous; soft; minor trails; fissile to fine-chippy-weathering; with 0.3 to 0.6 m-thick interbeds of siltstone to very fine-grained sandstone, argillaceous, strongly bioturbated, weathering rubbly, rusty, resistant; they begin 20 m above base and form 60% in upper 15 m; unit recessive; *Dactylioceras* loose on surface in lower 22 m, probably nearly in place (GSC loc. C-53386)	45.0	161.5
	<u>Older Jurassic Rock Units</u>		
3	Sandstone, light grey, fine-grained; hard, quartz-cemented; strongly bioturbated, indistinctly 2.5 to 30 cm-irregularly-bedded with irregular carbonaceous partings; minor local relict lamination; locally abundant small vertical burrows; 1 to 5 cm-thick soft, fine-chippy to nearly fissile, grey siltstone beds occur at 0.5 to 1 m intervals; minor rusty-brown-weathering ferruginous siltstone nodules 5 cm by 25 cm; unit weathering khaki-grey, moderately resistant	46.5	116.5
2	Siltstone to fine-grained sandstone, dark grey-black; argillaceous; strongly bioturbated; thinly-, irregularly- and indistinctly-bedded with argillaceous partings; fine rubbly-weathering; a 3 m-(est.) thick particularly resistant, otherwise similar, band occurs about 40 m above base; unit variably recessive, strongly sheared	60.0 (est.)	70.0
1	Sandstone, fine-grained; in part black, argillaceous, strongly bioturbated; thinly-, irregularly- and indistinctly-bedded; in part light brown-grey, limonitic, thin- to medium-bedded with indistinct fine lamination; thin interbeds that are fine wavy-laminated; soft carbonaceous partings; minor trace fossils; strongly sheared, rusty-weathering, moderately resistant	10.0 (est.)	10.0
	Section begins at lowest outcrop in creek		

SECTION PU-7-78. West side of Little Bell River, 9 km northwest of Summit Lake (approx. Lat. 67°46'N, Long. 136°37.5'W). The section is illustrated in Figures 10 and 39. All measurements are in metres.

Husky Formation	
Bug Creek Group (total)	523.75 m (approx.)
Aklavik Formation	81.00 m
Richardson Mountains Formation (part)	211.50 m (min.)
Fault; interval assumed	118.00 m
Almstrom Creek Formation(?)	69.75 m
Murray Ridge Formation(?)	43.50 m (approx.)
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	The section is overlain by 30 to 40 m (approx.) of recessive dark grey-black argillaceous siltstone (Husky Formation), then 20 m (est.) of ridge-forming sandstone (Porcupine River Formation). *Buchia concentrica* (Sowerby) was collected in talus of this unit (GSC loc. C-53417).		
	BUG CREEK GROUP		
	Aklavik Formation		
20	Sandstone, medium to dark grey, fine-grained; hard; both finely laminated and bioturbated, in 10 to 60 cm-thick bedding units, minor large-scale low-angle crossbedding; weathering light to medium grey with minor red and rusty stain, blocky and slabby; bluff-forming	81.0	523.75 (approx.)
	Richardson Mountains Formation		
19	Covered by talus from above; probably sandstone as below, or thinner-bedded	31.5	442.75 (approx.)
18	Sandstone, medium to dark grey to light brown, fine-grained; hard; with locally abundant limonite; finely laminated, in 5 to 60 cm-thick units; minor 10 cm-thick strongly bioturbated beds; bedding planes commonly carbonaceous, with trails, some with scaphopods; weathering dark grey and rusty with abundant jarosite and blue-grey tinge, blocky, slabby and thin-platy; bluff-forming	18.0	411.25 (approx.)
17	Covered by blocks from above	10.5	393.25 (approx.)
16	Siltstone to very fine-grained sandstone, black; argillaceous; strongly bioturbated; 0.5 to 10 cm-irregularly- and indistinctly-bedded to massive; local relict lamination and finely-laminated, hard beds up to 20 cm-thick; ammonites, bivalves, scaphopods in red concretions loose on surface, probably from 3 to 10 m above base of unit (GSC loc. C-53416); weathering dark rusty-grey, rubbly; upper 36 m poorly exposed, probably softer argillaceous siltstone	52.5	382.75 (approx.)

Unit	Lithology	Thickness	Height Above Base
15	Sandstone, light grey, fine-grained; hard, quartz-cemented; limonitic; finely laminated and locally low-angle crossbedded, lightly burrowed; planar and even or irregular carbonaceous, argillaceous partings with trails; a 0.5 m-thick, strongly bioturbated (with minor relicit lamination), thinly- and irregularly-bedded, argillaceous siltstone to very fine-grained sandstone interval occurs in centre of unit; minor scattered belemnites; unit weathering medium rusty-grey, thin-platy to blocky	6.0	330.25 (approx.)
14	Covered by talus from unit above; probably partly argillaceous bioturbated sandstone, possibly with minor sandstone as in unit below	33.0	324.25 (approx.)
13	Sandstone as in Unit 11; *Cadoceras* sp. in a 40 cm-thick rusty bed 12 m above base (GSC loc. C-53415)	21.0	291.25 (approx.)
12	Covered, recessive; probably interbedded bioturbated, argillaceous sandstone and thinly-laminated sandstone	6.0	270.25 (approx.)
11	Sandstone, light to medium grey to light brown, fine-grained; hard, quartz-cemented; locally limonitic; laminated and medium- to large-scale low-angle crossbedded, in 0.3 to 1.5 m-thick bedding units; rare carbonaceous, argillaceous partings; minor scattered *Pachytenthis* and rare belemnite-*Inoceramus* shell-hash laminae; minor carbonaceous plant debris; a 0.75 m-thick calcareous band, weathering bright rusty-orange, occurs 21 m above base; minor rusty-brown-weathering beds, in part spheroidal-weathering; unit weathering light to medium grey to brown-grey with minor rusty stain, platy to blocky or slabby, resistant	33.0	264.25 (approx.)
	Top of Manuel Creek Formation(?) faulted out		
10	Covered interval; thought to include a small fault; thickness assumed from regional relationships	118.0	231.25 (approx.)
	Almstrom Creek Formation(?)		
9	Siltstone to fine-grained sandstone, light to medium grey; carbonaceous; strongly bioturbated; massive, abundant small pyrite nodules;		

Unit	Lithology	Thickness	Height Above Base
	minor local hard, medium grey, siliceous concretions as large as 15 by 60 cm, rusty-orange-brown-weathering; unit weathering rusty grey with abundant jarosite, moderately resistant; upper 1/2 only partly exposed	10.5	113.25 (approx.)
8	Siltstone to fine-grained sandstone, light to medium grey; carbonaceous; strongly bioturbated with rare relict lamination; abundant small pyrite nodules; some bands of 20 by 60 cm, medium grey, hard siliceous concretions, weathering rusty-orange-red, and some continuous 15 to 50 cm-thick, hard, siliceous bands, thinly- and irregularly-bedded, weathering rusty-red and rubbly, in lower 1/2 of unit; minor 8 cm by 0.6 m ferruginous siltstone concretions, weathering spheroidally, rusty-ochre-yellow-brown, and 15 cm-thick beds of finely-laminated, light grey, hard, quartz-cemented sandstone, in upper 1/2 of unit; unit weathering medium grey with local rusty stain and jarosite, moderately resistant	12.0	102.75 (approx.)
7	Covered interval; may harbor small fault	20.0 (approx.)	90.75 (approx.)
6	Sandstone, light grey, fine-grained; hard; massive; with large, irregular red and rusty-red-brown patches, strongly fractured; resistant; intermittently exposed	13.0	70.75 (approx.)
5	Covered	1.5	27.75 (approx.)
4	Sandstone, light grey, very fine- to fine-grained; hard; thinly-laminated to 1 cm-bedded, with wavy, carbonaceous, argillaceous partings, that have abundant irregular trails; fine platy-weathering; with minor 20 cm-thick interbeds of hard, strongly bioturbated, fine-grained sandstone	2.0	56.25 (approx.)
3	50% shale-siltstone as in Unit 2, in 1 to 10 cm-thick beds with very thin, rusty-weathering, clean siltstone interlaminae; 50% sandstone, light grey, very fine- to fine-grained; hard; thinly-laminated in 1 to 40 cm-thick lenticular beds; rusty-weathering; *Chondrites*, other trails, and small carbonaceous plant fragments near base; abundant irregular trails on the carbonaceous, argillaceous bedding surfaces throughout unit; unit strongly cleaved, somewhat resistant, forms small waterfall	10.75	54.25 (approx.)
	Murray Ridge Formation(?)		
2	Shale-siltstone, medium to dark grey; soft, nearly fissile; with hard, grey, siliceous concretions, 10 cm by 1.5 m, rusty-weathering; unit recessive, weathering rusty with jarosite	4.5	43.5 (approx.)
1	Siltstone to fine-grained sandstone, dark grey; argillaceous, strongly bioturbated; abundant 5 to 10 cm- thick, hard, grey, siliceous, concretionary beds, weathering dark rusty-red-brown; some similar scattered concretions, as large as 20 by 60 cm, weathering rusty-orange-brown; unit weathering medium to dark rusty-grey, rubbly, in part soft and recessive, in part fine-chippy, with strong cleavage; locally abundant jarosite	9.0	39.0 (approx.)
	Covered interval	30.0 (min.)	30.0 (approx.)

PERMIAN

The Permian beds are strongly bioturbated, ferruginous, argillaceous siltstone with abundant '*Zoophycos*'.

SECTION PU-8-78. East side of Bell River, 14.5 km northwest of Summit Lake (approx. Lat. 67°46.5'N, Long. 136°46'W). The section is illustrated in Figures 10 and 39. All measurements are in metres.

Bug Creek Group (part)	281.0 m
Richardson Mountains Formation (part)	135.0 m
Manuel Creek Formation	58.5 m
Almstrom Creek Formation	50.0 m
Murray Ridge Formation	37.5 m
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	Above the measured section is a broad recessive interval, then the resistant Aklavik Formation; these were not studied in detail.		
	Richardson Mountains Formation		
14	Sandstone, light grey, fine-grained; hard; mainly massive and strongly bioturbated with minor large-scale low-angle crossbedding; minor small irregular hematitic(?) pods and soft, ochre yellow brown weathering concretions as large as 10 by 60 cm and large yellow-weathering calcareous pods; minor *Inoceramus* and belemnites throughout and rare shell hash beds, some with abundant belemnites; unit weathering medium brown-grey; unit forms three equally-spaced small bluffs of massive sandstone capped by several metres of crossbedded sandstone; unit resistant, forms peak; ammonite, bivalves, scaphopods collected in talus below, from this unit (GSC loc. C-53424); *Inoceramus* and belemnites collected loose 24 m above base (GSC loc. C-53425)	69.0	281.0
13	Covered by talus from above	6.0	212.0
12	Siltstone, black; argillaceous, carbonaceous; strongly bioturbated; soft; with minor small concretions weathering spheroidally, ochre-yellow-brown; in upper 1/2 grades to siltstone to fine-grained sandstone, fine rubbly-weathering, otherwise similar; unit recessive	15.0	206.0
11	Sandstone, light brown-grey, fine-grained; limonitic; strongly bioturbated; indistinctly-bedded to massive; minor small hematite (?) pockets in lower 3 m; minor small carbonaceous wood fragments in upper part; scattered belemnites and belemnite-rich layers in lower 3 m; rare *Inoceramus* fragments throughout; *Arkelloceras*, another ammonite, bivalves collected in a 20 cm-thick, rusty-brown- and yellow-spheroidal-weathering, concretionary lens 3 m above base, that also contains 3 to 4 cm diameter sub-spherical phosphate nodules (GSC loc. C-53422); unit weathers with local bright red stain; forms a series of 12 m-high (approx.) bluffs of massive, blocky or rubbly-weathering sandstone separated by less resistant, thinly- and irregularly-bedded, rubbly-weathering sandstone	45.0	191.0
	Manuel Creek Formation		
10	Siltstone, black; argillaceous; strongly bioturbated; soft; weathering very fine-rubbly, very poorly exposed; upper 1/2 totally covered by blocks from above	24.0	146.0
9	Shale to siltstone as in Unit 7; upper 1/3 of unit with 50% interbeds as thick as 2.5 cm, strongly bioturbated, thinly- and irregularly-bedded; abundant concretions as below; upper 2.1 m soft, nearly fissile; unit recessive	19.5	122.0
8	Siltstone to very fine-grained sandstone, medium grey; argillaceous; strongly bioturbated; minor rusty-orange-weathering concretions as in Unit 7, as large as 5 by 20 cm; unit weathering fine-rubbly, medium grey, somewhat resistant but poorly exposed	6.0	102.5
7	Shale to siltstone, medium grey to black; nearly fissile, soft; abundant hard, medium grey, siliceous concretions, weathering rusty-orange-red, and others weathering spheroidally, ochre-yellow-brown, both as large as 10 by 30 cm; unidentifiable ammonite near base (GSC loc. C-53420); unit forms recessive col	9.0	96.5
	Almstrom Creek Formation		
6	Sandstone as in Unit 4 but mainly strongly bioturbated; weathering fine-rubbly, rusty; with 0.3 to 0.6 m-thick, hard, blocky beds near top	9.0	87.5
5	Sandstone as in underlying unit but particularly hard, in massive units as thick as 1.5 m; weathering rusty-red, blocky, slabby, forms resistant ridge	18.0	78.5
4	Sandstone, light grey, fine-grained; hard, quartz-cemented; finely-laminated to 0.3 m-bedded; with carbonaceous partings; locally large-scale low-angle crossbedded and small-scale trough-crossbedded; locally interbedded on 10 to 30 cm scale with bioturbated sandstone; minor *Chondrites*, other trails locally abundant, subvertical burrows common; minor hard, septarian concretions as large as 10 by 25 cm, weathering spheroidally, rusty-red- and orange to ochre-yellow-brown; weathering rusty-grey and red, blocky to thin-platy, moderately resistant	9.0	60.5

Unit	Lithology	Thickness	Height Above Base
3	Shale to siltstone, soft; probably strongly bioturbated; probably with concretions as below; recessive, very poorly exposed	2.75	51.5
2	Siltstone to very fine-grained sandstone, medium grey; argillaceous; strongly bioturbated; 1 to 5 cm-irregularly- and indistinctly-bedded; minor 10 by 25 cm medium grey, hard, siliceous concretions, weathering red; upper 0.6 m with thin interbeds of finely-laminated, platy, light grey, fine-grained sandstone with carbonaceous partings; unit slightly resistant	11.25	48.75
	Murray Ridge Formation		
1	Shale to siltstone, dark grey-black, soft, nearly fissile to fine-chippy; abundant soft, brown-weathering argillaceous siltstone interlaminae; minor medium grey, hard, siliceous, septarian concretions, as large as 10 by 25 cm, weathering orange-red; unit recessive, poorly exposed	37.5	37.5
	PERMIAN		
	Underlying beds are argillaceous siltstone, weathering rubbly and chippy, rusty-grey, with abundant '*Zoophycos*'. Minor brachiopods occur near its top (GSC loc. C-53426).		

SECTION 116P-1. Corner of south- and east-facing bluffs east of head of Scho Creek, 26 km north-northeast of Horn Lake (approx. Lat. 67°58'30"N, Long. 136°10'30"W); measured by E.W. Bamber and W. Kisluk 1962; rewritten and interpreted by T. Poulton. Except for the thinner Murray Ridge Formation at the base of the Jurassic, this section is practically identical with that (Sec. PU-12, 14-75) measured by Poulton 9 km to the west. It is presented as documentation of the easternmost reasonably well-exposed nearly complete section of the Bug Creek Group. All measurements are in metres.

Bug Creek Group (total)	486.7 m
Aklavik Formation	56.0 m
Richardson Mountains Formation	229.1 m
Manuel Creek Formation	59.0 m
Almstrom Creek Formation	110.3 m
Murray Ridge Formation(?)	32.3 m
Unconformity	
Permian	

Unit	Lithology	Thickness	Height Above Base
	Aklavik Formation		
1	Sandstone; quartzose, light brownish-grey to medium grey; fine- to medium-grained; 0.3 to 1 m-thick bedding; rare beds or lenses as thick as 0.6 m that are very coarse-grained; in part finely laminated and with 15 cm-thick crossbedded sets; weathering light rusty-brown to light grey with rusty specks, in 15 cm to 0.6 m-thick blocks; unit forms cliff at top of hill	27.3	486.7
2	Sandstone, as in Unit 1, but dark grey, fine- to very fine-grained; laminae and poorly defined crossbedding on weathered surface; splits into 2.5 to 15 cm-thick slabs and blocks; poorly preserved bivalves 9 m above base (GSC loc. 53864)	21.2	459.4
3	Sandstone, as in Unit 2 but with numerous 1 mm- to 5 cm-thick partings and somewhat recessive beds of argillaceous sandstone; rare silty shale partings; weathering light grey with yellow-green stain	7.5	438.2
	Richardson Mountains Formation		
4	Poorly exposed, apparently sandstone as in Unit 3; upper 14 m light to medium grey; rubble of slabs and blocks 2.5 to 15 cm-thick, weathering light brownish-grey with orange-brown and dark red-brown stain	37.0	430.7
5	Sandstone, quartzose, dark grey, fine-grained; slightly argillaceous; 15 cm to 0.6 m-bedded; strongly bioturbated; breaking into 15 to 30 cm blocks; interbedded with 30% laminated, well sorted sandstone, carbonaceous, thin platy; unit weathers medium brownish-grey with orange-brown stain	25.5	393.7
6	Covered interval	4.5	368.2
7	Sandstone as in upper part of Unit 4, interbedded with 30% laminated sandstone as in Unit 5	15.0	363.7
7a	Covered	5.7	348.7
8	Sandstone as in Unit 7, but medium grey-brown with slight pink tinge; slightly calcareous; cross-laminated in part	4.5	343.0
8a	Covered	5.7	338.5
9	Sandstone, quartzose; medium brown-grey with slight pink tinge; carbonaceous laminae abundant in some beds; in part cross-laminated; 10 cm to 0.6 m-bedded; weathering medium grey-brown with orange-brown stain, in 1 to 5 cm-thick slabs and 15 to 30 cm blocks; interval 9.5 to 25.5 m below top totally covered; belemnites, collected in place 7.5 m below top of unit (GSC loc. 53866) and loose in talus (GSC loc. 53867); scaphopods 3.9 m above base (GSC loc. 53868)	30.0	332.8

Unit	Lithology	Thickness	Height Above Base
10	Sandstone, argillaceous, medium to dark brownish-grey, very fine-grained; 0.3 to 0.45 m-bedded with argillaceous, carbonaceous partings and irregular laminae; upper 3 m with several 0.3 m-thick beds of sandstone as in Unit 9 but not calcareous; rare beds of reddish-brown weathering mudstone; unit weathering light brownish-grey with dark reddish-brown patches, breaks into irregular 2.5 to 10 cm-thick pieces; interval 13 to 16 m below top covered; belemnites throughout unit, collected 5 m below top (GSC loc. 53869) and 11 m above base (GSC loc. 53870)	34.2	302.8
11	Sandstone, quartzose, light grey with slight brownish tinge, fine-grained; limonitic specks; 15 cm- to 0.6 m-thick-bedded, in part with ferruginous stain accentuating fine internal lamination; unit weathering light brownish-grey, breaks into 5 to 30 cm-thick slabs and blocks; belemnite fragments	7.0	268.6
11a	Covered interval	21.0	261.6
12	Sandstone, quartzose, medium greenish-grey, in part with light brown tinge; fine-grained; limonite specks; 5 to 30 cm-bedded; weathering light to medium greenish-grey with brown tinge and numerous orange-brown patches, breaks into irregular 2.5 to 10 cm-thick slabs; unit poorly exposed, largely rubble-covered	16.5	240.6
12a	Covered interval	7.5	224.1
12b	Sandstone as in Unit 12 but light brown with slight greenish tinge, weathering light greenish-brown	11.0	216.6
13	Sandstone, quartzose, medium grey, very fine-grained; 5 to 15 cm-bedded; rare ferruginous mudstone nodules near base; 0.5 to 5 cm-thick beds of shale, dark grey, silty in lower 3 m; unit weathering light greyish-brown with rusty orange-brown patches; somewhat resistant with recessive interbeds	4.0	205.6
	Manuel Creek Formation		
14	Covered interval, recessive	40.5	201.6
14a	Shale, silty; dark brownish-grey; with 5 cm- to 15 cm-thick interbeds of siltstone, dark grey, argillaceous; unit poorly exposed in creek bottom, weathering dark grey	2.0	161.1
14b	Covered interval, recessive	16.5	159.1
	Almstrom Creek Formation		
15	Sandstone, quartzose, medium to dark grey with green tinge, fine- to very fine-grained, glauconitic; 0.3 to 0.6 m-bedded; poorly defined *Zoophycos*-like trace fossils; weathering medium greenish-grey with dark reddish-brown stain; breaks into irregular 5 to 10 cm-thick blocks; unit resistant	2.1	142.6
15a	Sandstone as in Unit 15, but somewhat more recessive, more strongly glauconitic, contains numerous oblong siltstone nodules as large as 2.5 cm in diameter	3.0	140.5
15b	Covered interval	2.1	137.5
15c	Sandstone as in Unit 15	3.3	135.4
16	Sandstone, quartzose; medium greyish-brown, fine-grained; glauconitic; interval 1.7 to 3 m above base calcareous; 30% of beds interlaminated dark green and medium brown; *Zoophycos*-like trace fossils abundant; unit weathering orange-brown with greyish-green intervals, breaks into irregular 5 to 15 cm-thick blocks and slabs, resistant	4.5	132.1
17	Sandstone as in Unit 15; *Zoophycos*-like trace fossils and "worm tubes"; interval 2.7 to 10.5 m above base covered	15.5	127.6
18	Sandstone as in Unit 15; more strongly glauconitic; cavities filled with chalcedony and quartz; *Lingula* throughout (GSC loc. 53871 at 1 m above base)	6.6	112.1
19	Sandstone, quartzose, medium grey, fine-grained; rare black chert grains; 0.3 to 0.6 m-bedded; numerous carbonaceous partings; *Zoophycos*-like trace fossils and "worm tubes"; unit weathering light grey with abundant dark orange-brown stain, breaks into 0.3 to 0.6 m blocks, resistant	3.9	105.5
19a	Covered interval	17.0	101.6
20	Sandstone as in Unit 19	1.5	84.6
20a	Covered interval	4.2	83.1
21	Sandstone as in Unit 19; more carbonaceous partings, *Zoophycos*-like trace fossils, and "worm tubes"; interval 9.3 to 11.8 m below top covered; interval 5.7 to 8 m above base slightly argillaceous, with a 15 cm-thick silty shale bed at top; basal 5.7 m with 40% of interval covered	46.6	78.9
	Murray Ridge Formation		
21a	Covered interval	5.0	32.3
22	Sandstone as in Unit 19; with 60% of interval comprising 1.5 to 2.4 m-thick intervals of sandstone, quartzose, dolomitic, light brownish-grey, fine-grained, with limonitic specks, 0.3 to 0.45 m-bedded; unit weathering orange-brown with light grey patches, breaks into 15 to 30 cm-thick blocks, resistant	10.6	27.3
22a	Covered interval	16.7	16.7

PERMIAN

The underlying unit is 44 m of silty limestone with chonetid brachiopods. This is Unit 8 of the section described by Bamber (1972, p. 126). The overlying units 9 to 21 of his section are interpreted to be Jurassic by Poulton. The abundant '*Zoophycos*' recorded by Bamber in these rocks are taken to indicate *Diplocraterion*-like or *Rhizocorallium*-like burrows.

APPENDIX 2

List of GSC Localities Cited

Detailed locality data are given only for those localities not included in a measured section (Appendix 1).

GSC Loc.

25756 J.A. Jeletzky, 1955. Near Jurassic Butte, Aklavik Range. Upper Sinemurian (Frebold, 1960, p. 4), Murray Ridge Formation.

25762 J.A. Jeletzky, 1955. Ridge extending eastward from Jurassic Butte, the next south of the longest ridge of this direction; collected on east side of the hogsback 30 m (100 ft) west of top of ridge at elevation approximately 340 m (1121 ft) and lower down slope along the hogsback. Upper Sinemurian (Frebold, 1960, p. 4), Scho Creek Member, 0.6 m below top (section PU-2,26-27 of this paper).

25763 J.A. Jeletzky, 1955. Ridge extending eastward from Jurassic Butte, the second north from the longest ridge of this direction; collected on north slope of the ridge at approximately elevation 220 m (728 ft). Upper Sinemurian (Frebold, 1960, p. 6), Scho Creek Member.

25765 J.A. Jeletzky, 1955. Same locality as 25762, 2 m below top of Upper Sinemurian Scho Creek Member. (*see* Frebold, 1960, p. 4).

26882 J.A. Jeletzky, 1955. Bug Creek canyon, Aklavik Range, west of canyon, loose at base of 30 m (100 ft) cliff at west end of canyon. Upper Bajocian (Frebold, 1961), Richardson Mountains Formation.

26883 J.A. Jeletzky, 1955. Bug Creek canyon, Aklavik Range, about 110-118 m (120-130 yards) upstream from a 30 m (100 ft) high cliff on south side of stream, 1.2 to 1.5 m (4 to 5 ft) above water level. Upper Bajocian (Frebold, 1961), Richardson Mountains Formation.

26972 J.A. Jeletzky, 1955. Bug Creek canyon, same area as G.S.C. Locs. 26882 and 26883, loose in creek bed. Upper Bajocian (Frebold, 1961), Richardson Mountains Formation.

26973 J.A. Jeletzky, 1955. Ridge extending eastward from Jurassic Butte; collected from a pronounced cross-ridge of sandstone in the upper part of ridge, at elevation 400 m (1340 ft). Upper Sinemurian (Frebold, 1960, p. 6), Scho Creek Member.

26974 J.A. Jeletzky, 1955. Ridge next North of that extending eastward from Jurassic Butte; collected at top of its middle dome-like part, at elevation 530 m approximately (1779 ft). Upper Sinemurian (Frebold, 1960, p. 6), Murray Ridge Formation.

26975 J.A. Jeletzky, 1955. Bug Creek canyon, Aklavik Range, about 320 m (350 yards) downstream from the 30 m (100 ft) high cliff, on south side of creek, rim of slumped terrace, elevation approximately 570 m (1898 ft); collected loose. Upper Sinemurian, (Frebold, 1960, p. 6), Scho Creek Member.

26976 J.A. Jeletzky, 1955. Bug Creek canyon, Aklavik Range; outcrops on the south side of the canyon, about 90 m (100 yards) downstream of 30 m (100 ft) cliff on south side of canyon, at its west end, about 1-2 m (3-6 ft) above water level. Upper Sinemurian (Frebold, 1960, p. 6), Murray Ridge Formation.

26977 J.A. Jeletzky, 1955. Bug Creek canyon, Aklavik Range, collected in fresh float in creek bottom about 90 m (100 yards) downstream from 30 m (100 ft) high cliff on south side of the canyon, at its west end. Upper Sinemurian (Frebold, 1960, p. 6), Murray Ridge Formation.

26978 J.A. Jeletzky, 1955. Ridge extending eastward from Jurassic Butte; collected on the upper part of the ridge at south side of a pronounced sandstone cross-ridge at elevation 400 m (1340 ft). Upper Sinemurian (Frebold, 1960, p. 6), Scho Creek Member.

35969 Shell Oil Co., 1958. North of Rat River and east of Summit Lake. Toarcian or Early Bajocian (Frebold, 1960, p. 4), Manuel Creek Formation.

39342 Texaco Exploration Co., 1959. 35 km (22 miles) northwest of Summit Lake, 67°50'N, 137°12'W. Toarcian (Frebold, 1960, p. 4), Manuel Creek Formation.

39390 Texaco Exploration Co., 1959. Near headwaters of Little Bell River, approximately 13 km (8 miles) north of Summit Lake, Lat. 67°49'N, Long. 136°36'W. Upper Bajocian or Bathonian (Frebold, 1961), Richardson Mountains Formation.

52610 E.W. Mountjoy, 1962. Near south end of Murray Ridge, same as section PU-12,14-75 of this paper; collected loose at top of Unit 14, probably derived from a higher unit (26C of Mountjoy and Procter, 1969, 116P6). Upper Bathonian (?), Richardson Mountains Formation.

52613 E.W. Mountjoy, 1962. Near south end of Murray Ridge, section PU-12,14-75 of this paper; collected 7.2 m above base of unit 14 (Unit 26 of Mountjoy and Procter, 1969, 116P6). Bajocian or Bathonian, Richardson Mountain Formation.

52670 E.W. Mountjoy, 1962. Murray Ridge; Unit 25 of Section 116P6 of Mountjoy and Procter (1969) (same as section PU-12,14-75 of this paper, Unit 12, 13.) 67°58'N, 136°25'W. Toarcian or Early Bajocian, Manuel Creek Formation.

52699 E.W. Mountjoy, 1962. South end of Murray Ridge, section PU-12,14-75 of this paper (*see* there, Unit 14). Middle Bajocian, basal Richardson Mountains Formation.

85824 Shell Canada, 1970. 'Cache' (i.e. Little Fish) Creek. Lat. 68°25'30"N, Long. 136°11'00"W. Approximately 0.3 m (1 ft) above base of section KS-117A/8E-7-N70. Toarcian to Lower Bajocian (J.A. Jeletzky, unpubl.), Manuel Creek Formation.

85825 Shell Canada, 1970. 'Cache' (i.e. Little Fish) Creek. Lat. 68°25'30"N, Long. 136°11'00"W. 5.8 m (19 ft) above base of section KS-117A-8E-7-N70. Upper Toarcian to Lower Bajocian (J.A. Jeletzky, unpubl.), Manuel Creek Formation.

GSC Loc.

86535 Shell Oil Co., 1961. Bell River area, Yukon. Lat. 67°44'N. Late Toarcian, Manuel Creek Formation.

88066 Shell Canada, 1958. Lat. 67°37'N, 136°10'W (?). Upper Sinemurian, Scho Creek Member(?).

88073 Shell Canada, 1961. Lat 67°51'N, 136°42'W. Middle Bajocian, Richardson Mountains Formation.

88184 Shell Canada, 1971. Mt. Dennis, west of Summit Lake. Lat 67°42'N, Long. 136°39'W. Probably Bathonian, Richardson Mountains Formation.

92466 T.P. Poulton, 1975. Murray Ridge (section PU-12,14-75 of this paper). 67°58'30"N, 136°23'W. Upper Bajocian, Richardson Mountains Formation.

92474 T.P. Poulton, 1975. Murray Ridge (section PU-12,14-75 of this paper). Upper Bajocian(?), Richardson Mountains Formation.

92475 T.P. Poulton, 1975. North side of McDougall Pass (section PU-11-75 of this paper). 67°44'20"N, 136°25'W. Middle Jurassic, probably Lower Bathonian, Richardson Mountains Formation.

92480 T.P. Poulton, 1975. Bug Creek canyon (section PU-7-75). Upper Bajocian or Lower Bathonian, Richardson Mountains Formation.

92481 T.P. Poulton, 1975. Hill at headwaters of Rat River, north side of McDougall Pass (section PU-11-75). Lower Bathonian, Richardson Mountains Formation.

92510 T.P. Poulton, 1975. Ridge immediately east of White Mountains (section PU-1-75). Bajocian or Bathonian, Richardson Mountains Formation.

92579 T.P. Poulton, 1975. Top of hill west of Canoe Lake. Bright orange patch of sandstone outcrop overlooking small lake to north. Approximately 68°14'N, 135°56'W. (Section PU-6,10-75 of this paper). Lower Callovian, Richardson Mountains Formation.

92580 T.P. Poulton, 1975. Just west of Loc. 92579 (*see* there); Pliensbachian(?), Almstrom Creek Formation.

92582 T.P. Poulton, 1975. Bug Creek canyon, from about 16 m (53 ft) stratigraphically above base of Jurassic. Section PU-7-75 of this paper. Upper Sinemurian, Murray Ridge Formation.

92590 T.P. Poulton, 1975. Bug Creek canyon, north side (section PU-7-75 of this paper). Middle Bathonian(?), Richardson Mountains Formation.

92592 T.P. Poulton, 1975. South side of McDougall Pass, ridge west of Symmetry Mountain (section PU-9-75 of this paper). Bathonian(?) or Callovian(?), Aklavik Formation(?).

92595 Near GSC Locality 92579 (*see* there).

92600 T.P. Poulton, 1975. Ridge on east side of White Mountains, Lat. 67°57'N, Long. 136°29'W. (Section PU-13-75 of this paper). Richardson Mountains Formation.

92602 T.P. Poulton, 1975. Murray Ridge (section PU-12,14-75 of this paper); concretions loose on surface from 37 m (125 ft) above base of Jurassic. Probably Upper Sinemurian, Murray Ridge Formation.

92604 T.P. Poulton, 1975. Murray Ridge (section PU-12,14-75). Toarcian or Early Bajocian, Manuel Creek Formation.

92605 T.P. Poulton, 1975. Murray Ridge (section PU-12,14-75 of this paper); Toarcian or Early Bajocian, Manuel Creek Formation.

93596 W.W. Brideaux and A. Hedinger, 1975. Martin Creek, 68°11'20"N, 135°38'00"W. Oxfordian, probably Lower; lower Husky Formation.

24027 T.P. Poulton, 1976. Lat. 68°01.6'N, Long. 135°26.5'W. Small ridge southeast of Jurassic Butte (section PU-2,26-76 of this paper); collected loose. Upper Sinemurian, Scho Creek Member and Murray Ridge Formation (mixed).

94037 T.P. Poulton, 1976. Ridge just southwest of junction of Little Fish and Almstrom Creeks, approximately 68°24 1/2'N, 136°12 1/2'W. Upper Bathonian, Richardson Mountains Formation.

94041 T.P. Poulton, 1976. Murray Ridge (section PU-12,14-75 of this paper). Lat. 67°58.6'N, Long. 136°22.5'W. Lower Bajocian, upper 1/2 of Manuel Creek Formation.

94046 T.P. Poulton, 1976. Murray Ridge (section PU-12,14-75 of this paper). Lat. 67°58.6'N, Long. 136°22.5'W. Upper Bajocian, Richardson Mountains Formation.

94048 T.P. Poulton, 1976. Murray Ridge (section PU-9-76 of this paper). Middle Bajocian, basal Richardson Mountains Formation.

94053 T.P. Poulton, 1976. Murray Ridge (section PU-9-76 of this paper). Sinemurian, basal Murray Ridge Formation.

94054 T.P. Poulton, 1976. Murray Ridge (section PU-9-76 of this paper). Sinemurian, Murray Ridge Formation.

94055 T.P. Poulton, 1976. Murray Ridge (section PU-9-76 of this paper). Upper Sinemurian, Murray Ridge Formation.

94058 F.G. Young, 1976. Hill west of Canoe Lake overlooking Almstrom Creek to the west. Approximately 68°14.75'N, 135°03'W. Sinemurian, basal Murray Ridge Formation.

94075 T.P. Poulton, 1976. East face of ridge between headwaters of Waters River and Anne Creek, approximate Lat. 67°47'N, 137°19'W. (section PU-11-76 of this paper). Middle Toarcian, Manuel Creek Formation equivalent.

GSC Loc.	
94082	T.P. Poulton, 1976. Same section (PU-11-76) as 94075 (*see* there). Upper Bajocian, Richardson Mountains Formation equivalent.
94090	T.P. Poulton, 1976. Flat top of hill immediately northwest of Jurassic Butte, approximate Lat. 68°01.5'N, Long. 135°27.5'W; collected loose beside section PU-12-76 of this paper. Upper Sinemurian, Murray Ridge Formation.
94091	T.P. Poulton, 1976. Bug Creek canyon, same as locality 26975, approximately. (section PU-7-75 of this paper). Upper Sinemurian, Scho Creek Member.
94106	T.P. Poulton, 1976. Ridge between heads of Bell River and Big Fish River, approximate Lat. 68°10'55"N, Long. 136°56'W. (section PU-18-76 of this paper). Probably Middle Toarcian, Manuel Creek Formation.
94107	T.P. Poulton, 1976. Same section as locality 94106. Middle Bajocian, basal Richardson Mountains Formation.
94108	T.P. Poulton, 1976. Same as locality 94107.
94110	T.P. Poulton, 1976. Same section as locality 94106. Bathonian, Richardson Mountains Formation.
94112	T.P. Poulton, 1976. Same section as locality 94106. Upper Bathonian(?), Richardson Mountains Formation.
94113	T.P. Poulton, 1976. Same section as locality 94106. Lower Callovian(?), Richardson Mountains Formation.
94121	T.P. Poulton, 1976. Ridge between Big Fish River and Little Fish Creek, approximate Lat. 68°19'30"N, Long. 136°30'W. (section PU-19-76 of this paper). Late Lower Bajocian, Manuel Creek Formation.
94123	T.P. Poulton, 1976. Same section as locality 94121. Bathonian, Richardson Mountains Formation.
94135	T.P. Poulton, 1976. Little Fish Creek, just north of where it is joined from the east by Almstrom Creek, approximate Lat. 68°25'10"N, Long. 136°10'30"W. (section PU-20-76 of this paper). Pliensbachian(?) or Toarcian(?), Almstrom Creek Formation.
94141	T.P. Poulton, 1976. Loose in Little Fish Creek bed, next to section PU-20-76. 68°25'N, 136°11'W. Probably Late Lower Bajocian, Manuel Creek Formation.
94142	T.P. Poulton, 1976. Same section as locality 94135. Upper Bajocian or Lower Bathonian, lower Richardson Mountains Formation.
94148	T.P. Poulton, 1976. Same section as locality 94135. Lower Callovian, Richardson Mountains Formation.
94152	East side of ridge just west of headwaters of Little Bell River, approximate Lat. 67°48'35"N, 136°41'W. (section PU-21-76 of this paper). Middle Bajocian, basal Richardson Mountains Formation.
94163	T.P. Poulton, 1976. East side of hill overlooking headwaters of the next creek east of Bear Creek that flows south into Rat River, Lat. 67°54'20"N, Long. 135°55'W. (section PU-22-76 of this paper). Early Jurassic, Scho Creek Member.
94169	T.P. Poulton, 1976. East side of hill overlooking headwaters of the next creek east of Bear Creek that flows south into Rat River (section PU-22-76 of this paper). Upper Sinemurian, Murray Ridge Formation.
94190	D. Hope, 1976. Murray Ridge (section PU-9-76 of this paper). Late Lower Bajocian, Manuel Creek Formation.
94192	D. Hope, 1976. Same as locality 94190 (*see* there).
94194	D. Hope, 1976. Murray Ridge (section PU-9-76). Sinemurian, basal Murray Ridge Formation.
94318	T.P. Poulton, 1976. Same section as locality 94135. Lower Oxfordian, Richardson Mountains Formation.
C-4232	D.K. Norris, 1970. 68°02'N, 135°27'W. Upper Sinemurian, Scho Creek Member.
C-6129	D.K. Norris, 1970. 68°13.5'N, 135°57'W. Probably Pliensbachian, Almstrom Creek Formation.
C-6609	Elf Oil, 1971. Murray Ridge (section PU-12,14-75 of this paper). Lower Bajocian, Manuel Creek Formation.
C-53353	T.P. Poulton, 1978. 17 km southwest of south end of Canoe Lake, 68°04'40" Lat., 137°10'20" Long. (section PU-10-76 of this paper). Lower Oxfordian, Richardson Mountains Formation.
C-53357	T.P. Poulton, 1978. About 24 km west-northwest of north end of Canoe Lake, 68°13'30" Lat., 136°25'50" Long., collected loose. (section PU-1-78 of this paper). Lower Sinemurian, Murray Ridge Formation.
C-53363	T.P. Poulton, 1978. Murray Ridge (section PU-12,14-75 of this paper). Toarcian to Early Bajocian, Manuel Creek Formation.
C-53364	T.P. Poulton, 1978. Murray Ridge, near south end (section PU-12,14-75 of this paper). Lower Bajocian, Manuel Creek Formation.
C-53375	T.P. Poulton, 1978. Approximately 28 km west-northwest of Summit Lake, 67°43'30" Lat., 137°08'05" Long. (section PU-5-78 of this paper). Toarcian, Manuel Creek Formation.
C-53386	T.P. Poulton, 1978. Approximately 19 km southeast of Mt. McGuire, 67°46'45" Lat., 137°07'25" Long. (section PU-6-78 of this paper). Toarcian, Manuel Creek Formation, collected loose.
C-53458	T.P. Poulton, 1976. Approximately 32 km west-southwest of major northeastern bend of Porcupine River (approx. 67°24'N, 138°28'W). Upper Pliensbachian(?), Almstrom Creek Formation.
C-53564	T.P. Poulton and R. Smith, 1976. Section PU-18-76 (*see* there). Manuel Creek Formation.
C-53565	Same as locality C-53564.
C-53571	T.P. Poulton and R. Smith, 1976. Section PU-21-76 (*see* there). Manuel Creek Formation.
C-53572	T.P. Poulton and R. Smith, 1976. Section PU-21-76 of this report (*see* there). Manuel Creek Formation.
C-53573	T.P. Poulton and R. Smith, 1976. Section PU-21-76 (*see* there). Manuel Creek Formation
C-53574	T.P. Poulton and R. Smith, 1976. Section PU-2,26-76 (*see* Figure 3).
C-53575	T.P. Poulton and R. Smith, 1976. Section PU-2,26-76 (*see* Figure 3).
C-53584	R. Smith and D. Hope, 1976. Section PUH-2-76 (*see* Figure 5).
C-53586	R. Smith and D. Hope, 1976. Section PUH-2-76 (*see* Figure 5).
C-53591	R. Smith and D. Hope, 1976. Section PUH-2-76 (*see* Figure 5).
C-53593	R. Smith and D. Hope, 1976. Section PUH-2-76 (*see* Figure 5).
C-65041	W.W. Nassichuk, 1976. Hill west of Canoe Lake, 68°14'30"N, 135°57'W. Sinemurian, basal Murray Ridge Formation.
C-76370	T.P. Poulton, 1975. Bug Creek canyon, south side (section PU-7-75 of this paper). Basal Scho Creek Member.
C-76371	T.P. Poulton, 1975. Bug Creek canyon, north side (section PU-7-75). Richardson Mountains Formation.
C-80253	T.P. Poulton and R. Smith, 1976. Section PU-20-76 (*see* Figure 6).
C-80257	T.P. Poulton and R. Smith, 1976. Section PU-20-76 (*see* Figure 6).
C-80259	T.P. Poulton and R. Smith, 1976. Section PU-20-76 (*see* Figure 6).
C-80261	T.P. Poulton and R. Smith, 1976. Section PU-20-76 (*see* Figure 6).
C-80264	T.P. Poulton and R. Smith, 1976. Section PU-20-76 (*see* Figure 6).
C-80265	T.P. Poulton and R. Smith, 1976. Section PU-20-76 (*see* Figure 6).
C-80274	T.P. Poulton and R. Smith, 1976. Section PU-20-76 (*see* Figure 6).
C-80275	T.P. Poulton and R. Smith, 1976. Section PU-20-76 (*see* Figure 6).
C-80277	T.P. Poulton and R. Smith, 1976. Section PU-20-76 (*see* Figure 6).
C-80278	T.P. Poulton and R. Smith, 1976. Section PU-20-76 (*see* Figure 6).
C-80282	T.P. Poulton and R. Smith, 1976. Section PU-20-76 (*see* Figure 6).
C-80303	Petro-Canada Exploration, Inc., 1978. Bug Creek Canyon, south side, probably near locality 26833. Lower Bathonian (?), Richardson Mountains Formation.
C-80305	Petro-Canada Exploration, Inc., 1978. Bug Creek Canyon, south side, probably same as locality 26975, approximately. Upper Sinemurian, Scho Creek Member.
C-80306	Petro-Canada Exploration, Inc., 1978. Southern tributary of Beaverhouse Creek, 68°19.25'N, 135°42.25"W. Lower Oxfordian, Richardson Mountains Formation.
C-80309	Petro-Canada Exploration, Inc., 1978. Bug Creek Canyon, Aklavik Range, 68°42'N, 135°23.75"W. (Section PU-7-75 of this paper). Collected loose. Upper Sinemurian, Murray Ridge Formation.
C-80310	Petro-Canada Exploration, Inc., 1978. Bug Creek Canyon, Aklavik Range, 68°42'N, 135°23.75'W, collected loose on south side of gorge. Probably Lower Bathonian, Richardson Mountains Formation.
C-80311	Petro-Canada Exploration, Inc., 1978. Little Fish Creek below its confluence with Almstrom Creek. 68°25'15"N, 136°11'W. Probably Upper Bathonian, Richardson Mountains Formation.
C-80312	Petro-Canada Exploration, Inc., 1978. Little Fish Creek below its confluence with Almstrom Creek. 68°25'15"N, 136°11'W. Probably Lower Bathonian, Richardson Mountains Formation.
C-80857	T.P. Poulton, 1975. Ridge immediately east of White Mountains. Lat. 67°54'30"N, Long. 136°28'40"W. (Section PU-1-75 of this paper). Aklavik Formation.
C-80858	Same as locality C-80857.
C-80859	Same as locality C-80857.
C-80860	Same section as locality C-80857. Richardson Mountains Formation.
C-80861	Same as locality C-80860.
C-80862	Same section as locality C-80857. Richardson Mountains Formation.
C-80864	Same section as locality C-80857. Richardson Mountains Formation.
C-80870	T.P. Poulton, 1975. Bug Creek Canyon, north side (Section PU-7-75 of this paper, unit 21). Aklavik Formation.
C-80871	T.P. Poulton, 1975. Same as locality C-80870, unit 20.
C-80872	T.P. Poulton, 1975. Same as locality C-80870, approximately, unit 19b. Richardson Mountains Formation.
C-80873	T.P. Poulton, 1975. Bug Creek Canyon, south side (Section PU-7-75, unit 11). Almstrom Creek Formation.
C-80875	T.P. Poulton, 1975. North side of McDougall Pass (Section PU-11-75, unit 15). Aklavik Formation.
C-80876	T.P. Poulton, 1975. Bug Creek Canyon, south side (Section PU-7-75). Scho Creek Member.
C-80877	T.P. Poulton, 1975. Murray Ridge (Section PU-12, 14-75). Richardson Mountains Formation.

APPENDIX 3
Evaluation of Paleogeographic Evidence

INTRODUCTION

Several quite different paleogeographic-tectonosedimentary interpretations of the Jurassic of northern Yukon Territory have been published. One of these interpretations argues for western sources for the Jurassic rocks on the western side of a north-south-trending depositional trough that extended through northern Yukon. An upland in that position has been shown on paleogeographic maps since those of Schuchert (1910) and arguments for its presence and that of a marine trough to its east have been presented by Jeletzky (1975). In contrast, Moorhouse (1966), Young (1973) and Young et al. (1976) have argued for entirely southerly and easterly cratonic sources for the Jurassic rocks which were thought to have been deposited on a broad, continuous shelf prior to major orogenic events which resulted in western (Cordilleran) sediment sources being uplifted in Cretaceous time. The paleogeographic scheme proposed by Poulton in this bulletin was independently developed following fieldwork conducted since 1975, which was oriented toward a biostratigraphic, paleogeographic, and paleoecological synthesis of the Jurassic of the northern Yukon. It is most similar, in its major characteristics, to that of Young (1973) and Young et al. (1976) who in turn supported that of Moorhouse (1966). Because a large volume of data based on extensive field studies has been published to support contrary interpretations (Jeletzky, 1962-1980), re-evaluation of that data is necessary and comprises a significant part of this Appendix. Only the pre-Upper Oxfordian Jurassic beds have been studied in detail by the writer and only they are treated here.

The studies listed above were either 'fixist' in terms of the current interest in large-scale horizontal translations of parts of the crust against one another (Jeletzky, 1975) or were presented in a format that did not permit illustration of large-scale horizontal movements (Young et al., 1976). Some recent hypotheses concerning the geologic development of northern Alaska, however, indicate that large-scale motion of northern Alaska relative to adjacent parts of North America may have taken place. The principal of these include Mesozoic counter-clockwise rotation away from the Canadian Arctic Island (e.g. Tailleur, 1973; Grantz et al., 1979) and strike-slip movement along a transcurrent fault system (Kaltag Fault), that extends southwest-northeast through central Alaska (Patton and Hoare, 1965; Tailleur and Brosgé, 1970) and across northern Yukon (Norris, 1974). Additionally, the recognition of north-south-telescoping of different geologic terranes in a disturbed belt extending east-west across northern Alaska near the northern margin of Brooks Range (e.g. Brosgé and Tailleur, 1970) is relevant for interpretation of a western source landmass for the Jurassic rocks of adjacent parts of northern Yukon.

Northern Yukon is tectonically interesting because of its situation at the junction of several different geological provinces in whose development it must have played a part: the northern Cordillera, Brooks Range, Beaufort Sea and Canada Basin, and the unstable northwestern cratonic margin of ancient North America. The Jurassic rocks of this area are of particular interest because they must record the events immediately preceding major Cordilleran tectonic movements, and because they can provide evidence of possibly major horizontal displacements related to the development of all of Arctic North America. It is therefore important that any evidence in the Jurassic rocks that is or may be of paleogeographic and tectonic significance be evaluated critically.

The interpretation of paleogeography, tectonics, and sedimentary history of the Jurassic of the western parts of northern Yukon is by no means straightforward, largely because of insufficient exposure of rocks and scarcity of fossils in areas where recognition of facies trends is critical. The rocks are relatively uniform lithologically, there are few reliable paleocurrent indicators in them, and analysis of clasts does not resolve their source direction because southeastern and western source materials are closely similar in these areas. Therefore arguments of their derivation resolve to perceptions of directions of facies changes. In a few cases, paleontological control is insufficient for accurate correlation, and lithologic correlations have played a disproportionate role in the interpretations of succession of general similar lithologies. In spite of the uncertainties which remain, the present treatment is believed to best accommodate the available data in the simplest way. It involves alternating sandstone and shale formations with regularly changing thicknesses over a large area, and structures consistent with a relatively stable tectonic setting.

PALEOGEOGRAPHIC FRAMEWORK

The major tectonic elements of northern Yukon and Alaska in their regional setting during the Jurassic are shown in Figure 3. The name Brooks-Mackenzie Basin was coined by Balkwill et al. (in press) for the pre-orogenic basin which was similar throughout northern Yukon and Alaska in Late Paleozoic through Hauterivian (approximately) times in order to distinguish it from the younger basins of the same area that were foredeeps related to the Cordilleran-Brooks Range orogeny.

Some of the tectonic elements that affected Jurassic sedimentation have received common acceptance by current workers and therefore are not treated at length in this report. These include the southeastern basin margin against the North American craton (e.g. Jeletzky, 1975; Young et al., 1976), and a landmass lying just offshore of northern Alaska (e.g. Imlay, 1955, p. 77-78; Jeletzky, 1962; Detterman, 1970; Richwood, 1970; Imlay and Detterman, 1973; Miall, 1973) that shed sediment southward in Triassic and early Jurassic times at least. Summaries of these tectonic elements and their documentation are given by Balkwill et al. (in press). Additionally, Norris (1972, 1973, 1974) has given evidence for northerly overstepping of the Triassic and Jurassic rocks onto a high in Spring River area of northwestern Yukon. This high differs from that of northern Alaska in terms of the pre- Mesozoic rocks present and is separated from it by an area with thick, fossiliferous Kingak shale sections in the lower Firth River area. Therefore, it need not be a direct connection of that of northern Alaska.

Another high is now recognized farther east in the north-central Mackenzie Delta, where Bug Creek rocks (Jurassic) appear to be absent abruptly against a fault separating wells Kugpik O-13 and L-24 (J. Dixon, pers. comm., in press). Whether this phenomenon is related to a Jurassic depositional edge or to post-depositional erosion, and the extent and trend of the edge of the Jurassic, are uncertain. The rocks thought by Young et al. (1976) to be siltstone equivalents of the Bug Creek elsewhere in the subsurface of the northeastern Mackenzie Delta are in fact the younger Husky Formation unconformably overlying Paleozoic rocks.

Two tectonic elements that are prominent in the literature but whose existence has been the subject of controversy are a landmass in central Alaska (e.g. Imlay and Detterman, 1973) that extended eastward into northern Yukon (Keele-Old Crow Landmass of Jeletzky, 1975) and a north-south marine trough to its east through Yukon Territory (Jeletzky, 1975). The former has been thought to have formed a southerly margin for Brooks-Mackenzie Basin of northern Alaska and a western margin for the basin in northern Yukon. The latter was thought to have connected the Jurassic Arctic Ocean with the seas of southern Alaska or of the western Canadian Interior and Rocky Mountains and to provide an explanation for perceived mixing of the marine faunas of the north and south. Critical examination of the evidence for the existence in the pre-Late Oxfordian Jurassic of a landmass in central Alaska and of a north-south-trending marine trough in northern Yukon to its east is the principal subject of this Appendix.

These two tectonic elements are interdependent in that the failure to demonstrate the former also means failure to demonstrate the narrow, trough-like character of the latter. Rather, the absence of a central Alaska landmass would indicate the presence of a broad, oceanic connection of Arctic and western North American seas around the northwestern part of the craton. The detailed configuration of the southeastern margin of Brooks-Mackenzie Basin is likewise interdependent with the existence or character of a north-south-trending trough through northern Yukon, in that recognition of the westernmost extent of Jurassic shoreline facies related to the craton delimits the extent of the eastern margin of the basinal facies.

Central Alaska Landmass

The absence of Jurassic rocks over virtually all of central Alaska was the reason for early workers' (e.g. Willis, 1907, p. 397, 398, 410; Schuchert, 1910, pl. 88-90) depiction of central Alaska as a positive element during Jurassic time. Willis (1907, p. 398) thought the central Yukon positive element to have been the source of Paleozoic and Mesozoic sediments to both the north and south, and Schuchert appears to have extended that idea into his Jurassic maps. Crickmay (1931, p. 31, 64) gave as criteria for the existence of the central Alaska landmass in the Jurassic, i.e. "Juroberingia"; the lack of Jurassic deposits, the unconformable overlapping relationships of Cretaceous rocks around its edges, and the northerly derivation of the Middle Jurassic Tordrillo Sandstone of southern Alaska. The relationships of this southern Alaskan sandstone are the first evidence for a central Alaska Jurassic landmass that is more than simply the absence of Jurassic rocks there. It is, however, irrelevant to a discussion of northern Alaska and Yukon paleogeography in light of the now widely accepted hypothesis (e.g. Jones and Silberling, 1979; Churkin et al., 1980; Coney et al., 1980) that southern and central Alaska comprises allochthonous fragments of several differing origins that are unrelated to each other and to northern Alaska. The first two arguments of Crickmay are untenable as evidence for non-deposition as opposed to deposition and subsequent erosion of Jurassic rocks.

The absence now of Jurassic rocks in central Alaska has been considered to be a major argument for elevation of that area in Jurassic time by some current workers also. For example, Imlay and Detterman (1973), proposed that, as in south-central parts of Alaska, the apparent absence of marine Jurassic rocks in other central parts of Alaska, may be due to erosion during Middle and late Jurassic time, or to non-deposition. Because marine Triassic rocks are overlain by lowermost Cretaceous marine rocks, those authors did not consider post-Jurassic erosion to be a likely explanation for the absence of Jurassic rocks.

Disturbed belt of northern Alaska

A narrow "disturbed belt" extends the breadth of Alaska along the north edge of Brooks Range. It is a zone of telescoping of the Kingak shale facies to the north and equivalent volcanic-related facies to the south. It also has been thought to have been a positive area during the Jurassic (Jones and Grantz, 1964) and is significant because it extends eastward at least as far as the Yukon-Alaska boundary, at the same latitude as Jeletzky (1975) proposed a positive area to have been located at that time. "The Disturbed Belt is indicated by the thrust faults that cross the region from east to west. In the western Brooks Range and De Long Mountains, the Disturbed Belt lies just north of a series of broad thrust sheets composed of Jurassic mafic and ultramafic rocks and of Devonian and Mississippian carbonate rocks that are unlike the Devonian and Mississippian rocks they override. The narrow Disturbed Belt itself comprises mostly lower Mesozoic and upper Paleozoic rocks in the western and central areas. The disorderly arrangement of facies of these rocks indicates that they also include allochthonous plates that moved north in Early Cretaceous time. These plates cannot be mapped at this scale because they are incompetent rocks and were strongly deformed during Cretaceous or Tertiary orogeny. The Disturbed Belt projects eastward into the Brooks Range along major thrust faults in the Paleozoic rocks. Near the Canadian border these thrusts may terminate against the high-angle fault that strikes southwestward down the Porcupine River." (Brosgé and Tailleur, 1970.)

The tectonic history of this belt in the western Brooks Range has been extensively treated recently (e.g. Roeder and Mull, 1978; Churkin et al., 1979; Mull, 1980) although a widely accepted consensus does not appear to have been reached. It seems, however, that northerly-directed overthrusting of large magnitude, involving ophiolites, and possibly related to collision of different continental plates, characterizes western Brooks Range. Roeder and Mull (1978, p. 1701) thought some of the northward overthrusting to have begun in Jurassic time as indicated by pebbly shales of the Kingak Formation. The pebble shales were described as Early Cretaceous by Detterman (1973).

Brosgé and Tailleur (1970, p. D4), following Jones and Grantz (1964), suggested that the disturbed belt may have contained a stable positive area during Jurassic and early Cretaceous time, which prevented coarse detritus from the Brooks Range from entering the shale basin to the north. This suggestion attempted to explain the very thin sequence of Jurassic shale and Neocomian coquina to the north and the differences between the Jurassic rocks to the north and south. The sequences of chert, shale, oil shale, graywacke and intrusive rocks in the western and central Brooks Range that are different lithologically from the

Kingak shales, also are well south of them and are separated from them by thrust faults (Brosgé and Tailleur, 1970, p. D4, Fig. 7; Detterman, 1973). They are allochthonous (Brosgé and Tailleur, 1969, Fig. 5) and were transported into their present positions from farther south (Detterman, 1973). Tailleur and Brosgé (1970, p. E5) thought the 193 my diabase bodies with Early and Middle Jurassic chert, limestone and oil shale to indicate Jurassic rifting, to have been associated with extensive mafic volcanism along and beyond the south edge of the Brooks Range, and 150 to 160 my maffic and ultramafic stratiform intrusive complexes to have been emplaced far offshore.

The allochthonous package of rocks includes the tuffaceous graywacke with intercalated mafic volcanics that was described by Patton (1956) with the Tiglukpuk Formation (name now abandoned) in the Killik-Itkillik Rivers area in the central part of northern Alaska. Its age has been controversial but Imlay (in Patton and Tailleur, 1964, p. 444, 445 and in Jones and Grantz, 1964) has most recently considered them to be Middle Jurassic. These rocks are separated from the equivalent Kingak shales which lie to the north by faults of large displacement (Brosgé and Tailleur, 1969, 1970).

A Hettangian sandstone and quartzite in the Porcupine River area of northeastern Alaska (Imlay and Detterman, 1973, p. 14) also occurs south of the disturbed belt. It is a basal transgressive sandstone for which no evidence of source direction is known. Brosgé and Tailleur (1970, D4, Fig. 7) thought it to occur on an old high. A massive sandstone along the north flank of the Brooks Range in northeastern Alaska (Imlay and Detterman, p. 9), which had earlier been described as a basal Kingak unit of Sable (1965) and others has now been named the Karen Creek Sandstone and was dated as uppermost Triassic (Detterman et al., 1975, p. 17, 18). Even if some parts of it are Jurassic there are no indicators that it derives from a southerly source and Detterman et al. (1975, p. 17) considered it to have been derived from the north.

The Upper Jurassic and sandy turbidites in northwestern Alaska (Campbell, 1967) were faulted into their present position from farther south also (e.g. Brosgé and Tailleur, 1970).

The initial uplift of the Brooks Range Geanticline is marked by an unconformity beneath the Neocomian Okpikruak Formation. These graywackes are the first recognizable detritus from the Brooks Range uplift in Delong Mountains and in the "disturbed belt", except for more silt near the disturbed belt, in the upper part of the Kingak Formation (Upper Jurassic) (Brosgé and Tailleur, 1970, p. D1, D4; 1971; Detterman, 1973, p. 381). Tailleur and Brosgé (1970, p. E6) stated that the first major orogenic pulse were reflected by 115-130 my granites. The volcanogenic welt in the south was uplifted and probably dislocated along thrusts; at this time a major reversal of sediment transport occurred, with orogenic deposits shed into and beyond a trough or foredeep in the basin-margin side of the uplift.

Some of the Upper Jurassic southerly derived sediments in the basin north of the disturbed belt have been described in detail. Imlay (1955, p. 71, 72, 75) has described southward overlap of older Jurassic shales and siltstones by Upper Jurassic coarser clastic facies between Sagavanirktok and Canning Rivers in the vicinity of the northern boundary of Brooks Range. Similarly, Keller et al. (1961) described in detail southerly derived Upper Jurassic sediments which directly overlie Triassic rocks, in the Elusive Lake area of northeastern Alaska. They are the Tiglukpuk Formation, which was named by Patton (1956; see also Patton and Tailleur, 1964) in the Colville River area of central North Alaska, and the upper part of the Kingak Shale. The name Tiglukpuk Formation has since been abandoned because it came to include several different rock units of different ages (Imlay and Detterman, 1973, p. 14). The older Jurassic rocks to the northeast in that area are Kingak shale for which no evidence of source direction is known.

In summary of Alaskan evidence, no major landmass or sediment-source to the south of the Kingak shale belt is documented prior to Upper Jurassic time, either by sediments derived from that direction in the Kingak or by southerly transgressive relationships. On the contrary, the facies relationships point to the greater importance of a northerly uplift and source of sediment, and the southern margin of Brooks-Mackenzie Basin is enigmatic before late Jurassic time. Some volcanic rocks and volcanic-bearing sedimentary rocks of Jurassic age that lie south of the Kingak shale belt are separated from it by major faults that may be the sites of major movement along which unlike facies have come closer after they were deposited. No direct evidence indicates that the disturbed belt characterized by these faults was a positive element shedding sediment during pre-Late Oxfordian time.

The large-scale north-south telescoping of facies across the disturbed belt in northwestern Alaska is not so strongly expressed in northeastern Alaska although here also Kingak shale lies to the north, and radiometrically dated Jurassic igneous rocks (Reiser et al., 1965) lie to the south. Brosgé and Tailleur (1970) showed the disturbed belt cutting into the Brooks Range in northeastern Alaska where the range approaches Beaufort Sea, and suggested that it terminates on the east against a high angle fault that trends along the Porcupine River. On the Yukon side of the border in the vicinity of the head of Old Crow River, Jurassic rocks are absent. Some quartzites mapped as Precambrian (Norris, 1980) resemble and may actually correlate with a Lower Cretaceous unit that occurs to the east and south (D.K. Norris, pers. comm.). This region is therefore similar to the terrane contained in the disturbed belt of northern Alaska, where similar relationships pertain and is presumably its continuation. This belt cannot continue farther east into Canada however, because Jurassic Kingak shales outcrop all around its northern, eastern and southern sides. They are in the Bonnet Lake area (see Fig. 1), at the head of Babbage and Blow Rivers and near Old Crow. Also, similar Jurassic rocks also occur to the south as far as the head of Kandik River, where they are apparently parts of the same unit as that described by Brabb (1969) as the Glenn Shale.

"Keele-Old Crow Landmass"

Several occurrences of Lower and Middle Jurassic rocks in the western part of northern Yukon have been interpreted (Jeletzky, 1962-1980) as being nearshore deposits of a western landmass from which they were derived. They comprise sandstones in the vicinities of Berry Creek and Driftwood Rivers, at Salmon Cache Canyon of Porcupine River, and siltstones at the mouth of Old Crow River, and in a belt from Keele Range to northern Ogilvie Mountains. Jeletzky (1975) called the western landmass 'Keele-Old Crow Landmass' and Young et al. (1976) followed

Jeletzky in illustrating it on their maps. In geographic position it conforms with an eastern extension of the disturbed belt of northern Alaska into the Yukon. The re-evaluation of the outcrops that follows ("Examination of stratigraphic relationships") indicates that they can be accommodated easily as southeasterly-derived shelf sediments. The rocks, which are all in marine shelf facies, do not contain direct indicators of their provenance.

In the absence of criteria in the western sandstones themselves that can lead to recognition of a unique source direction, documentation of facies changes eastward away from a source landmass are critical to arguments concerning its existence and that of a trough to its east. However, as discussed below under 'Trough and western basin-marginal facies', some of the argillaceous rock occurrences that Jeletzky (1962-1980) has considered to be "mid-basinal facies" of the trough have been re-interpreted subsequently as entirely younger unrelated stratigraphic packages. The remainder of them do not in fact lie eastward of those coarser facies that he thought to be westerly derived, but rather lie northward of them, consistent with the simple model of northwesterly passage into the depositional basin as illustrated in Figure 38.

North-south marine trough

A marine trough trending north-south or northeast-southwest through Yukon Territory and joining Arctic with Pacific or western Interior seas in Jurassic times has been illustrated on speculative paleogeographic maps since those of Schuchert (1923, Fig. 14). The lack of evidence for such a marine connection between Arctic and southern seas in that area has, however, been repeatedly brought up since 1900 (Logan, 1900, p. 265; Crickmay, 1931, p. 51; Frebold, 1957a, b).

Certain arguments have been cited as evidence for a trough in that position, however. The earlier illustrations of the trough (e.g. Schuchert, 1923) served to connect the then-recent discoveries of marine Jurassic fossils of several different ages in northeastern Alaska (Leffingwell, 1919, p. 119-120; see also Martin, 1926) with those that were long known from the western Interior. Such a connection tied in neatly with Schuchert's view of the craton bounded to the west, and to the south in Alaska, by great geosynclinal belts.

More recently, a marine trough through central Yukon has been thought necessary to explain the presence in common of certain ammonite genera between northern and southern Alaska (Imlay, 1953, p. 11, 12, Fig. 2; 1955, p. 78; 1957; Fig. 1; 1975, p. 15). These arguments are not necessary if no landmass existed in central Alaska which would have inhibited connections of those faunas from one another. The model proposed here entails possible circulation and intermigration of the marine faunas along the entire west and Arctic coasts of Early and Middle Jurassic North America around the northwestern cratonic margin which extended almost or entirely to the Yukon-Alaska border at approximately Latitude 66°30'N (see Fig. 3). At any rate, connections of the Jurassic boreal and Pacific oceans through Siberia are probably sufficient to explain the similarities between the marine faunas of the two realms. That the two faunas as a whole are not closely similar has been shown by Imlay (1953, 1965, 1971) for example, who also suggested water depth, temperature differences and physical barriers to explain their differences.

Jeletzky (1961a) was impressed with the similar structural styles of both northeastern and northwestern Yukon, and like Frebold (1957b) could not accept the presence of a geosyncline between them as had been illustrated by Schuchert (1923). He has, however, (Jeletzky, 1960-1980) brought up several arguments based on perceived facies variations within the sedimentary rocks to support the presence of a marine intracratonic trough in that position. They involved identification of westerly derived nearshore facies, central mid-basinal facies, and easterly and southeasterly derived nearshore facies. The identification of westerly derived facies and of a trough facies to their east are refuted in the following pages, and the basin margin against the craton does not indicate a generally north-south-trending eastern margin of a depositional trough. Rather, all of the rocks previously interpreted to illustrate these three facies regimes are part of a broad shelf facies, the northeast-southwest-trending epicratonic southeastern margin of Brooks-Mackenzie Basin.

The basin-marginal facies (Bug Creek Group; see Fig. 2) is recognized along strike southwestward as far as northeastern Keele Range and similar relationships pertain in northern Ogilvie Mountains. Therefore it seems most unlikely that any marine trough facies transects it. This diminishes the likelihood that the absence of a trough facies in Eagle Plain area may be explained by sediment starvation of the trough (Jeletzky, 1975, p. 14) and erosion of Lower to Middle Jurassic deposits over uplifts following mid-Valanginian and Aptian orogenic phases (Jeletzky, 1980, p. 15). A narrow, north-south-trending trough through northern Yukon is simply not indicated by the stratigraphic evidence presently available.

EXAMINATION OF STRATIGRAPHIC RELATIONSHIPS

In this section, each of the arguments (Jeletzky, 1960-1980) for the existence of a trough in northern Yukon and a western landmass which served as its western side and source of sediments in the Lower and Middle Jurassic is re-examined individually. They do not necessarily indicate the presence of those elements but rather are easily interpretable in a simpler pattern of northwesterly transition across a marine shelf into Brooks-Mackenzie Basin.

Trough and western basin-marginal facies

A local depocentre with a thick Middle Jurassic argillaceous succession occupies the vicinity of the heads of Waters River and Anne Creek (Jeletzky, 1974, p. 6; this bulletin, sections PU-11-76, PU-5-78, PU-6-78; see Fig. 38). Its development was associated with and presumably related to tectonic events associated with a regional Early Bajocian regressive event. Sediment supply was sufficient to keep it filled to shallow water depths.

Jeletzky (1975, p. 14, Fig. 7, col. F2) characterized the succession between Berry Creek and Waters River as mid-basinal, and considered it to indicate the axial portion of the trough. Interbeds of neritic to ?lower littoral sandstone (p. 14) and the absence of any convincing evidence of deeper, particularly bathyal depths, which he considered to be represented, indicate shallow depositional environments for the succession as a whole. The "almost complete absence of belemnites and inner neritic pelecypods and a rarity of ammonites" (p. 18) are hardly diagnostic criteria for deep-water deposition. Imlay (1955, p. 76) has discussed several other possible reasons for the scarcity of fossils in equivalent similar rocks in adjacent

Alaska. He thought depths below the neritic zone to be unlikely because of the presence of disconformities and similarities of strata throughout the shale-siltstone facies which indicate little variation in depth accompanying the non-depositional or erosional periods.

Sandstone units in the Waters River sections extend eastward beyond White Mountains where they are interbedded, as their pinchout ends, with typical Bug Creek sandstone units clearly related to the cratonic margin to the southeast (sections PU-12, 14-75, PU-4-78, PU-7-78). The more prominent of these sandstones, the Anne Creek and Waters Rivers Members are in offshore or possible barrier bar facies in part.

The Anne Creek Member may well be related to an Early Bajocian regressive event recognized regionally in northern Richardson Mountains which further explains its relatively basinward occurrences. Just to the southwest in the headwaters of Berry Creek, the same sandstone units that occur in the sections near the head of Waters River, are probably represented also. Thus the sandstones at Berry Creek were probably deposited in physical continuity with the Bug Creek epicratonic succession, and the former are not necessarily evidence of a western source as Jeletzky (1971, p. 211-213; 1972a, p. 39; 1975, p. 14, 15, Fig. 7) indicated. The intervals between the sandstones are covered at Berry Creek, which precludes accurate measurement of thicknesses, but there is no firm evidence for significantly less shale in the Middle Jurassic there than at the head of Waters River.

The Anne Creek Member is probably represented also by the ferruginous sandstone (Jeletzky, 1972a, p. 43-45) which is lithologically and paleontologically similar, near the mouth of Driftwood River. This unit can similarly be regarded as an offshore bar or a shoreline facies related to regional regression of shoreline facies of the craton and is not necessarily a western shoreline facies as thought by Jeletzky (1972a).

There is no direct evidence that the lower parts of the sandstones described as the Porcupine River Formation by Jeletzky (1977) in the headwaters of Berry Creek and east of Waters River are as old as Callovian as Jeletzky thought, the diagnostic fossils, Cadoceras spp., coming from underlying Kingak beds. The lower parts of the sandstone are identical to, and probably represent the Aklavik Formation which outcrops nearby and which here is undifferentiable from the younger Upper Jurassic sandstones which directly overlie it. There is thus physical continuity of this sandstone with the Bug Creek epicratonic succession and there is no easterly facies change from Berry Creek area to a shaly facies east of there.

Other arguments (Jeletzky, 1971, p. 211-213) that sandstones in the headwaters of Berry Creek (described by Jeletzky, 1971, p. 211; 1972a, p. 37-39; 1975, Fig. 7, cols. F1, F2, Fig. 8, p. 14, 15) are replaced in central and western Richardson Mountains by dark grey marine shales and siltstone that he had described in two earlier publications, are not valid. Some of those occurrences of shale facies (Jeletzky, 1961b, p. 9; "lower shale-siltstone division", i.e. Kingak Formation) were thought to be present in central Richardson Mountains by extrapolation from where they were described at a locality 11 to 12 miles southwest of Bonny (Bonnet) Lake, west of the Richardsons. That is, the paleontologically-dated Jurassic shale facies (by Callovian Cadoceras) was actually documented north-northwest not east, of the sandstone occurrences. The stratigraphic cross-section in which Jeletzky (1962, p. 79, Fig. 5) claimed to demonstrate thickening of all paleontological zones in the central part of the Richardson Mountains compared to their flanks was not a straight transect across the presumed trough of the Richardson Mountains. Rather it jutted westward from Aklavik Range into the depositional basin (or trough) and back southward, i.e. cratonward, to where the succession is thinner at Salmon Cache Canyon of the Porcupine River.

Other occurrences of those shaly facies considered by Jeletzky (1971, p. 211-213) to indicate a trough lying east of the sandy facies at Berry Creek (i.e. at western McDougall Pass; Jeletzky, 1967, p. 24; 1971, p. 213; 1974, p. 6-7; 1975, p. 9-11, Fig. 6, cols. E3, E4) have since been shown to belong to an entirely unrelated younger package of rocks (Jeletzky, 1980).

The relatively thin and shallow facies of the Bathonian rocks at Salmon Cache Canyon section (see Poulton, 1978d, Fig. 2) indicate its more cratonward position from thicker successions. They were thought by Jeletzky (1975, p. 11, sec. E1) to "provide positive evidence of the approximate position of the eastern shoreline of the Early to mid-Jurassic Keele-Old Crow Landmass". The line of cross-section shown by Jeletzky (1975, Fig. 6) makes a dog-leg northward and basinward (to E2), so that the shaling out of rocks at Salmon Cache Canyon (col. CE1) toward the area east of Waters River (col. E2) is northeastward and is not part of an easterly facies variation.

Thus there is no evidence that the Lower and Middle Jurassic sandstones in the vicinities of Berry Creek, Driftwood River, and Salmon Cache Canyon are necessarily derived from, nor adjacent to, a westerly source-landmass. Rather, they are normal occurrences of the Bug Creek epicratonic formations with which they are physically continuous. Similarly, there is no transition from Berry Creek area eastward into a trough facies in the Lower and Middle Jurassic.

The earlier suggestion (Jeletzky, 1962, p. 79, Fig. 5) that Lower and Middle Jurassic sediments were derived from both flanks of a two-sided depositional trough - "Richardson Mountains Trough" - was not supported by any detailed evidence presented and is no longer of consequence. He (op. cit., p. 81) described the demise of the Richardson Mountains Trough in early Upper Jurassic time, when sediments derived from uplifted ancestral Brooks Range to the northwest and west(?) reached as far east as Aklavik Range. These are the first large quantity of sediments that he explicitly stated to have come from the western side of the trough.

Considerable new evidence has accumulated regarding some of the rocks that Jeletzky (1962) originally thought to be Jurassic. The "initial Jurassic deposits" that he described at Bonney (Bonnet) Lake area are now known to be Mississippian (Jeletzky, 1971, p. 205), and the "Sinemurian" beds above them Hettangian (Frebold and Poulton, 1977). The 900 foot conglomerate at Bonney (Bonnet) Lake that was thought to be early(?) Jurassic has now been dated at late Aptian (Jeletzky, 1971, p. 205). Those conglomerates that Jeletzky (1962, p. 79) thought to be equivalent to them at and south of Rat River were re-dated (Jeletzky, 1967) as presumably Triassic, and in this bulletin have been considered to be more likely a mixture of different Permian and early Cretaceous units.

The Almstrom Creek Formation of the Bug Creek succession occurs in northeastern Keele Range. It contains Amaltheus(?) (Poulton, 1978d, p. 452; GSC locality 88278) and abundant Lingula, as does that formation in the northern Richardsons, unlike other sandstone formations in the area. The outcrops lie within the axis of what Jeletzky (1975, Fig. 9) called Dave Lord Uplift, an eastern extension of Keele-Old Crow Landmass. It was partly on the basis of the supposed absence of marine Lower and Middle Jurassic rocks that Jeletzky (*ibid.*) based his argument for the presence of a western landmass there.

Two other areas have been thought to exhibit nearshore facies derived from a westerly source during the Lower and Middle Jurassic. Bathonian siltstones described by Jeletzky (1972a, p. 45, 46) near the mouth of Old Crow River were interpreted by him as a western, shallow neritic facies deposited in the proximity of, and derived from, Keele-Old Crow Landmass. They are predominantly black fissile to finely chippy shale and siltstone with ammonite-bearing concretions. Sandy and carbonaceous material is minor in the rocks here that are clearly associated with, and thus dated by, the ammonites. They are shallow marine sediments that contain no direct evidence of proximity to a nearby landmass nor of a source direction and they are little different in character from equivalent beds of the Kingak Formation elsewhere throughout northern Yukon, at about the same distance basinward of the southeastern basin margin. New occurrences of Kingak outcrops found by D.K. Norris along Caribou Bar Creek and the next creek west of it near Porcupine River contain Bathonian Ammonites, Lower or Middle Jurassic Foraminifera (J.H. Wall, pers. comm.) and are in a carbonaceous black shale facies (D.K. Norris, pers. comm.). These are in a complex terrane that had been mapped (Norris, 1980) as Proterozoic.

The sections in Keele Range and northern Ogilvie Mountains from which Jeletzky (1971, p. 214; 1972a, p. 9a, b; 1975, p. 4, 6) interpreted south ,easterly basinward facies and thickness changes away from Keele-Old Crow Landmass are accommodated easily in a model in which the opposite direction of transition into a basin is postulated, as discussed below.

South-southeasterly facies change toward a mid-basin facies was thought (Jeletzky, 1971, p. 214, 215) to be represented from a locality at the headwaters of Bern (Drifting Snow) Creek and Fishing Branch of Porcupine River (66°05' to 66°12'N; 140°15' to 140°30"W) to one at the headwaters of Fishing Creek to the south-southeast (65°48'N; 139°52'W). He described south-southeastward thinning from an approximate minimum of 540 m (1800 ft) of interbedded shale and sandstone at the first locality to only about 255 to 265 m (850 to 880 ft) of mostly shale and siltstone at the other. He considered (1972a, p. 9a, b) the "northwest-derived, mostly arenaceous" rocks to have been separated from their equivalents in the southern Richardson Mountains (i.e. Bug Creek Group) "by a broad zone of high marine, predominantly or entirely argillaceous facies". The thinning of the basinal facies was ascribed to sediment starvation (Jeletzky, 1975). Jeletzky (1975, p. 4, 6), re-iterated his interpretation of shoreward facies changes in close proximity of southeastern Keele Range, i.e. northward, and described what he called the Lower and Middle Jurassic rocks of Kandik River-Nahoni Range area (described previously by Jeletzky, 1971, p. 213, 214, 218, Fig. 3) as outer neritic to upper bathyal. He (1975, p. 6) used them to infer the extension of a deep sea as far southward as Selwyn Mountains, connecting to outcrops of Glenn Shale in Kandik Basin (Brabb, 1969) of east-central Alaska and farther south to Tombstone-Mayo area (Frebold et al., 1967).

The section at the head of Fishing Branch of Porcupine River near the head of Bern (Drifting Snow) Creek, described by Jeletzky (1971, p. 214; 1975, Fig. 2, col. A3; wrong co-ordinates given) has been re-studied by Poulton in 1975 and 1979. The lower 65 m (approx.) that lies immediately above the 1 m-thick basal conglomerate, is dominated by ferruginous siltstone with sandstone interbeds, features which differentiate it from the abruptly overlying shales and siltstones. The lower interval may well be equivalent, in part, to the basal Jurassic siltstone and sandstone of Bonnet Lake area, described as Hettangian by Frebold and Poulton (1977), as Jeletzky (1971, p. 214) suggested. This correlation is particularly valid because of the presence of oolitic rocks, noted by Jeletzky, which also are present near the base of the Jurassic succession at the head of Johnson Creek near Bonnet Lake. There they have not been firmly dated, but appear to overlie beds with Cardinia, a bivalve which has been taken (Frebold and Poulton, 1977) to characterize the Hettangian in northern Yukon.

The overlying rocks are pervasively sheared shale and siltstone which grade upward into a unit of siltstone and sandstone that contains Upper Jurassic Buchia concentrica (Jeletzky, 1971, p. 214). The age of these intermediate beds, between about 65 and 400 m above the base of the Jurassic, is not entirely certain. Jeletzky (1972a, Fig. 2; 1972b, Fig. 2; 1975, Figs. 2, 3, col. A3) identified Acrocoelites approximately 150 m above the base of the Jurassic, and Buchia concentrica about 275 m above the base. Poorly preserved B. concentrica(?), Boreionectes(?), and other bivalves were found by the writer approximately 400 m above the base of the Jurassic. The former is Middle Toarcian to Middle Bajocian in age (Jeletzky, pers. comm., 1976), the last are Upper Jurassic. These beds differ from the lower 65 m of the section in the rusty dark grey-black monotonous colours of the siltstone, and in the presence of large yellow-orange-weathering septarian concretions. Stellate nodules occur about 300 m above the basal Jurassic conglomerate. These distinct concretions typify lower parts of the Upper Jurassic Husky Formation in the Richardson Mountains and the equivalent Ringnes Formation of the Arctic Islands, and, together with the bivalves, confirm a correlation with those units. They are, in contrast, absent in all of the pre-Upper Oxfordian beds of the Kingak seen by the writer throughout northern Yukon.

Thus the lower 200 m or so of the Jurassic in this section are probably Lower and Middle Jurassic in age and the lower 65 m are coarser than the remainder, siltstone with a basal conglomerate.

In several sections farther north in northern Ogilvie Mountains, no basal coarse clastic deposits are known. The basal unit at one locality (66°31'N. Lat., 140°15'W. Long.) is hematitic oolite, 9 m thick, overlying an undated siltstone-fine sandstone succession. Overlying this oolite is soft, recessive siltstone and shale, which are the basal Jurassic lithologies elsewhere in the northern Ogilvies. In a section between Salmon Fork and Bern (Drifting Snow) Creek (66°25'N. Lat., 140°23'W. Long.), D.H. McNeil (pers. comm.) has identified, among other Foraminifera, Pseudonodosaria sp. with affinities to P. turbinata of the Lower Jurassic of northern Alaska, from 55 m above the base of the Kingak (GSC locality C-81373), and Conorbina sp. of probable Upper Jurassic age, from 75 m above the base (GSC locality C-81375). Jeletzky (1975, Fig. 2, col. A2) has identified Acrocoelites from the lower part of a section whose base is faulted, at the head of Bern Creek.

Therefore, the Lower and Middle Jurassic rocks of the northern Ogilvies are soft shales and siltstones with basal coarser clastics at the head of Fishing Branch and a basal hematitic oolite at another locality north of there. The thickness of the rocks of this age is variable. Neither facies nor thickness variations indicate basinward thinning and fining trends away from a landmass to the north.

The rocks are inadequately dated nearby in the Kandik River area (see Fig. 1) where Jeletzky (1971, p. 213, 214, 218, Fig. 3) described thinning of the Jurassic and basal Cretaceous black to dark grey shale and siltstone from 240 to 255 m (800 to 850 ft) in a more northerly section to 140 m (467 ft) some 13 km to the south. the writer, with D.K. Norris in 1975, measured an even thinner section, 120 m (390 ft), of these concretionary black mudstones and shales at the southern locality, below the sandstones from which Jeletzky (*ibid.*) reported Buchia species. The rocks in Kandik River-Nahoni Range area described by Jeletzky (1971, p. 213, 214, 218, Fig. 3) were called by him (1975, p. 4) "outer neritic to upper bathyal Kingak shale" and considered to ". . . indicate the absence of land either within the area or in its immediate vicinity in Early and Middle Jurassic (i.e. Kingak) time". The sandstone in the lower part of the section may well be Lower or Middle Jurassic although no paleontologic evidence is available to date the lower parts of any of these sections. The overlying shale may represent Husky equivalents.

South-southeasterly shaling out into a mid-basin facies in the Lower and Middle Jurassic in Keele Range and northern Ogilvie Mountains (Jeletzky, 1971) is unsubstantiated. The stratigraphic relationships described conform well with those in a generalized cross-section drawn southeastward in the vicinity of the central Mackenzie Delta, or in Richardson Mountains where the Husky Formation oversteps the Bug Creek Group southward and eastward (see Fig. 2). Given the paleontological control available, southeastward thinning of the Kingak shales in northern Ogilvie Mountains and Keele Range may well take place in equivalents of the Upper Jurassic Husky Formation in its typical facies, and indicate cratonward thinning associated with progressive transgression of that unit over older Jurassic and Paleozoic rocks.

Jeletzky (1975, p. 8, Fig. 4) also considered easterly shaling out and thinning to be indicated in the Jurassic and lowest Cretaceous rocks between Keele Range to Molar YT P34 well of northern Eagle Plain. In neither section has the base of the Mesozoic succession been positively identified, and the oldest Jurassic fossils in the former locality are Upper Jurassic Buchia concentrica.

Jurassic rocks are probably absent in the YT P34 well in Eagle Plain, where Jeletzky (1975, p. 8, Fig. 9) considered a thick basinal Jurassic sequence to be present. The evidence in this well has been discussed by Young (1975) and earlier in this bulletin. The identification by Chamney (in Norford et al., 1971), of Lower to Middle Jurassic Foraminifera in the well was not definitive and J.H. Wall (pers. comm.) who has re-examined the prepared micropaleontological material available, concluded that Jurassic rocks are not present. There are no Jurassic outcrops in Eagle Plains and no indication of Lower or Middle Jurassic rocks in other wells, facts which Jeletzky (1975) ascribed to "their total or almost total erosion during and after the strong Aptian tectonic movements". Although the absence of these rocks there now is not conclusive evidence of their not having been deposited at one time, the regional facies trends are consistent with the presence of a landmass (Eagle Arch of Young et al., 1976; see Fig. 4a) in that vicinity in Lower and Middle Jurassic time.

Eastern basin-marginal facies

The northwesterly basinward transition in the Bug Creek Group of northern Richardson Mountains is shown in Figure 38. The general aspects had been recognized earlier by Jeletzky (1967; 1974, Figs. 7, 8) and Young et al. (1976). The direction of shaling out is more strongly northwesterly rather than westerly as has been illustrated by those other authors in, and south of, the vicinity of McDougall Pass. No facies changes document westerly transition into a marine trough at or south of McDougall Pass.

Interpretation of a change of facies of the Bug Creek Formation from nonmarine or littoral in the east near the head of Stony Creek, to littoral or inner neritic in the west, in the northern headwaters of "Pacific Rat River" described by Jeletzky (1972a, p. 1, 9, 10; 1975, p. 6, 8, Fig. 4) was based on rocks that have since been differently identified at least in part. It is therefore not firmly documented. Those in the eastern area, where no diagnostic fossils have been found, have been mapped as the entirely unrelated and younger North Branch Formation by Norris (1979). Those in the western area (Jeletzky, 1972a, p. 9; 1975, Fig. 4, col. C3) may possibly belong to the Bug Creek, although Poulton (this bulletin, sec. PU-30-76) found conglomeratic rather than coaly sandstones to characterize the Bug Creek in this general area. Norris (1980) also identified as North Branch Formation rocks in the headwaters of Rock River and a few miles west and northwest of North Branch Valley (of Vittrekwa River) of southern Richardson Mountains which Jeletzky (1972a, p. 3, 4; 1974, p. 5, 6, 7; 1975, p. 5, Fig. 2) described as conglomerate and sandstone facies of the Bug Creek. Norris's re-identification of these rocks is based on similarity of lithology and stratigraphic position, and on nearly complete physical continuity with the North Branch Formation in its type area. That formation has been dated there as Late Jurassic by the presence of Buchia species (Jeletzky, 1967, p. 43, 44) and is entirely younger than the Bug Creek Group. Regional considerations favour this re-interpretation, but the general lithological similarity of these arenaceous rocks with the Bug Creek Group, which like them lies between Paleozoic rocks below and younger Cretaceous rocks above, preclude a firm commitment at this stage. At any rate, Jeletzky's (1972a, 1974, 1975) allusions to westerly or southwesterly basinward facies changes in rocks of Bug Creek age in these areas are not firmly documented. Regardless of the actual identity of these rocks, the North Branch Formation and its basinward equivalent, the Husky Formation, have overlapped older Jurassic rocks southward or southeastward onto the craton in this area.

Neither are Bug Creek rocks thought to be present in Rat River Gorge, where Jeletzky (1975, p. 9-11, Fig. 6), indicated them to be an easterly sandy facies equivalent to a mid-basinal shaly succession south of Summit Lake in McDougall Pass. The sandstones in Rat River Gorge have been mapped as probably Cretaceous by Norris (1976a). They have not been firmly dated, and while Norris's re-interpretation is therefore not entirely certain, neither is there sufficient documentation to interpret westerly basinward facies changes in the Jurassic. Northward rather than westward basinward facies changes in the Barrier Ridge area (near head of Barrier River, Fig. 1) of northern Richardson Mountains area conform with the evidence in outcrop.

The so-called mid-basin facies which Jeletzky (1971, p. 213; 1974, p. 6, 7; 1975, p. 9-11, Fig. 6, col. E3, E4) argued to lie west of these sandstones, in the western McDougall Pass area have now been re-dated as Lower Cretaceous (Jeletzky, 1980), following studies by Poulton and Callomon (1976). The thick argillaceous succession here is therefore younger than the Bug Creek rocks, which are thin there. Jeletzky (1980) concluded that the Bug Creek is similar in thickness, lithology, and depositional environment in both southwestern and north eastern McDougall Pass area.