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PAPER 73-9

RECONNAISSANCE STUDIES OF PROTEROZOIC AND CAMBRIAN STRATIGRAPHY, LOWER MACKENZIE RIVER AREA (OPERATION NORMAN), DISTRICT OF MACKENZIE

Report, 9 figures, 3 tables and 22 plates

J.D. Aitken, R.W. Macqueen and J.L. Usher

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CONTENTS

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ABSTRACT

Proterozoic rocks of the interior part of the Mackenzie Mountains are divisible into two successions of probable Helikian and Hadrynian ages respectively. Probable Helikian rocks, from 5,000 to more than 15,000 feet (≃ 1,500 - 4,500 m), in thickness include, in ascending order: unnamed map-unit H1 - dolomite and chert; Tsèzotene Formation - shale, dolomite, quartzite; Katherine Group, lower and upper parts - quartzite, minor amounts of shale and dolomite; unnamed map-unit H5 - dolomite, shale, limestone, gypsum, stromatolitic reefs; and Little Dal Formation - massive, varied limestones and dolomites. This succession is overlain unconformably by a succession of probable Hadrynian age, up to 8,000 feet thick (≃ 2,400 m), including in ascending order: the Rapitan Group - conglomerate, sandstone, shale, iron formation; Keele Formation - dolomite, sandstone/quartzite, shale; and Sheepbed Formation - shale. The Helikian formations are present on both sides of the north-trending Mackenzie Arch, but are more thickly and completely developed on the west side. The Hadrynian units, on the other hand, are confined to the area west of the Mackenzie Arch.

Striking changes in the Proterozoic succession take place across the Mackenzie Arch and on the east side of the arch along the Mackenzie Mountain front. In the latter area, Paleozoic rocks lie directly on Helikian rocks belonging to unnamed map-unit H5, and the Katherine Group. The intervening Little Dal (Helikian) to Sheepbed (Hadrynian) sequence is missing on the crest and the east flank of the arch. These changes are attributed in part to eastward depositional thinning in the platform wedge sequence, but erosion, associated with sub-Rapitan, sub-Cambrian and sub-Upper Cambrian unconformities, has had a dominant effect.

Paleozoic rocks of the Mackenzie Mountain interior include the Lower Cambrian Backbone Ranges Formation - sandstone, dolomite, mudstone; and Sekwi Formation - limestone, varicoloured dolomite. Together these units may have a thickness of 4,000 feet (≃ 1,200 m) in the Operation Norman area. They are overlain by the Road River Formation of Middle Cambrian to Early Ordovician age, consisting of shale and thin-bedded limestone up to 4,000 feet (≃ 1,200 m) in thickness; this unit is probably the "deep-water" equivalent of the Saline River and Franklin Mountain Formations occurring farther east.

Along the frontal Mackenzies, the Lower and Middle Cambrian Mount Cap Formation - shale, sandstone, minor limestone - is present only locally beneath the sub-Upper Cambrian unconformity. The Upper Cambrian sequence there consists of the Saline River Formation - shale, evaporites, sandstone; and the lower part of the Franklin Mountain Formation - carbonates. The type Macdougal Group, located in the frontal Mackenzies, contains rocks of Proterozoic, probably Helikian, age in the lower part, and equivalents of the Mount Cap and Saline River Formations in the upper part, and accordingly the name Macdougal Group is abandoned.

Within the Franklin Mountains, Proterozoic rocks are known only near Wrigley (south of the Operation Norman area), where 6,000 feet (≃ 1,800 m) of shale, carbonate, and quartzite are tentatively assigned an Helikian age. Elsewhere, the oldest rocks seen in the Franklins are the Lower Cambrian Mount Clark Formation of quartzite and sandstone, and the overlying Mount Cap, Saline River, and Franklin Mountain Formations. Sub-Franklin Mountain Paleozoic units may have a thickness of 2,000 feet (≃ 600 m) in the Franklins.

Lowermost Paleozoic rocks of the Interior Platform include the Old Fort Island Formation of orthoquartzitic sandstone, and the Mount Cap, Saline River and Franklin Mountain Formations. Sub-Franklin Mountain Paleozoic rocks of the Interior Platform may be as much as 1,000 feet (≃ 300 m) thick. Interior Plains Proterozoic rocks of the Shaler Group were not studied in detail.

RÉSUMÉ

Les roches protérozoïques de la partie intérieure des monts Mackenzie peuvent être réparties en deux successions appartenant probablement à l'Hélikien et à l'Hadrynien. Les roches qui datent probalement de l'Hélikien, d'une puissance de 5,000 à plus de 15,000 pieds (≃ 1,500 à 4,500 m), comprennent, par ordre ascendant, l'unité H1 (sans nom) composée de dolomie et de chert; la formation de Tsezotene constituée de schiste, de dolomie et de quartzite; le groupe de Katherine, parties inférieure et supérieure, composé de quartzite, d'un peu de schiste et de dolomie; l'unité H5 (sans nom) comprenant de la dolomie, du schiste, du calcaire, du gypse, des récifs stromatolitiques; et la formation de Little Dal composée de calcaires et de dolomies massifs et variés. Cette succession est recouverte en discordance par une succession de couches qui datent probablement de l'Hadrynien, d'une puissance qui atteint 8,000 pieds (≃ 2,400 m) et qui comprend par ordre ascendant le groupe de Rapitan constitué de conglomérat, de grès, de schiste et d'une formation ferrifère; la formation de Keele composée de dolomie, de grès/quartzite, de schiste; et la formation de Sheepbed composée de schiste. On retrouve les formations de l'Hélikien des deux côtés de l'arc Mackenzie orienté en direction du nord, mais elles sont plus épaisses et mieux développées du côté ouest. Les unités de l'Hadrynien par contre, sont confinées à la région située à l'ouest de l'arc Mackenzie

Des modifications importantes à la succession protérozoïque se sont produites en travers l'arc Mackenzie et sur le côté oriental de l'arc, le long de la partie frontale des monts Mackenzie. Dans cette dernière région, les roches paléozoïques reposent directement sur les roches de l'Hélikien appartenant à l'unité H5 (sans nom) et au groupe de Katherine. La séquence intermédiaire entre Little Dal (Hélikien) et Sheepbed (Hadrynien) est absente du sommet et du flanc oriental de l'arc. On attribue ces modifications en partie à l'amincissement des dépôts vers l'est dans la séquence qui constitue un coin en plate-forme, mais l'érosion, ainsi que les discordances stratigraphiques antérieures au groupe de Rapitan, au Cambrien et au Cambrien supérieur ont exercé une influence prépondérante.

Les roches paléozoïques de l'intérieur des monts Mackenzie comprennent la formation de Backbone Ranges du Cambrien inférieur, composée de grès, de dolomie, de pélite; la formation de Sekwi constituée de calcaire et de dolomie à couleur varié. Prises dans leur ensemble, ces unités peuvent atteindre une puissance de 4,000 pieds (≃ 1,200 m) dans la région de la Mission Norman. Elles sont recouvertes par la formation de Road River, du Cambrien moyen au début de l'Ordovicien, composée de schiste et de calcaire finement stratifié atteignant jusqu'à 4,000 pieds (≃ 1,200 m) d'épaisseur; cette unité est probablement l'équivalent "en eau profonde" des formations de Saline River et Franklin Mountain qui se trouvent plus à l'est.

Le long de la partie frontale des monts Mackenzie, la formation de Mount Cap du Cambrien inférieur et moyen, composée de schiste, de grès et d'un peu de calcaire, ne se retrouve que localement sous une discordance antérieure au Cambrien supérieur. La séquence de Cambrien supérieur comprend la formation de Saline River composée de schiste, d'évaporites et de grès et la partie inférieure de la formation de Franklin Mountain, constituée de carbonate. Le groupe type Macdougal situé à la partie frontale des monts, comporte des roches protérozoïques, probablement de l'Hélikien, dans la partie inférieure, et des équivalents des formations de Mount Cap et de Saline River dans la partie supérieure et en conséquence, le nom de groupe de Macdougal a été abandonné.

Dans les monts Mackenzie, on ne rencontre des roches protérozoïques que près de Wrigley (au sud de la région de la Mission Norman) où les 6,000 pieds (≃ 1,800 m) de schiste, de carbonate et de quartzite remontent approximative-

ment à l'Hélikien. Ailleurs, les roches les plus anciennes trouvées dans les monts Franklin font partie de la formation de quartzite et de grès de Mount Clark du Cambrien inférieur et des formations de Mount Cap, de Saline River et de Franklin Mountain qui les recouvrent. Les unités paléozoïques antérieures à la formation de Franklin Mountain atteignent une épaisseur de 2,000 pieds (≈ 600 m) dans les monts Franklin.

Des roches paléozoïques les plus basses de la plate-forme intérieure comprennent la formation de Old Fort Island constituée de grès orthoquartzique et les formations de Mount Cap, de Saline River et de Franklin Mountain. Des roches paléozoïques de la plate-forme intérieure, et antérieures à la formation de Franklin Mountain, peuvent atteindre jusqu'à 1,000 pieds (≈ 300 m) d'épaisseur. Les roches protérozoïques des plaines intérieures qui font partie du groupe de Shaler n'ont pas été étudiées en détail.

RECONNAISSANCE STUDIES OF PROTEROZOIC AND CAMBRIAN STRATIGRAPHY, LOWER MACKENZIE RIVER AREA (OPERATION NORMAN), DISTRICT OF MACKENZIE

INTRODUCTION AND ACKNOWLEDGMENTS

Geological studies of the lower Mackenzie River area were carried out between 1968 and 1970 as a part of Operation Norman, an airborne, regional geological reconnaissance of the area bounded by 64°N, 132°W, the Arctic Ocean, and the boundary between Paleozoic rocks of the Interior Platform and the underlying Precambrian rocks of the Bear and Slave Provinces (Fig. 1). The region has an area of about 145,000 square miles (≃ 375,000 sq. km). Until the inception of Operation Norman in 1968, the northern Interior Plains constituted the single remaining, large sedimentary terrain in Canada lacking geological map coverage at a scale of one inch to eight miles (1 cm ≃ 5 km) or larger.

Bedrock mapping and structural interpretation in the Mackenzie Mountains, Mackenzie Plain, Franklin Mountains, and the southern part of the Interior Plains were carried out by J. D. Aitken, D. G. Cook, H. R. Balkwill, and M. E. Ayling (Aitken *et al.*, 1969; Cook and Aitken, 1969a, b, 1971a, b; Aitken *et al.*, 1970; Balkwill, 1971; *see* Fig. 2, this paper). Proterozoic and lower Paleozoic rocks underlie large areas of the Mackenzie and Franklin Mountains, and the Interior Plains. During 1969 and 1970, J. L. Usher studied these rocks within the Mackenzie and Franklin Mountains, with emphasis on Proterozoic strata (Usher, 1970). In 1968 and 1969, R. W. Macqueen examined rocks mainly of Cambrian to Silurian age in the Mackenzie and Franklin Mountains, and the Interior Plains (Macqueen, 1969, 1970).

The present report is a summary, compiled by Aitken and Macqueen, of Usher's and Macqueen's Proterozoic through Middle Cambrian stratigraphic sections, combined with regional observations by Aitken, Cook, Balkwill, and others of the Operation Norman project. Cambrian faunas were identified by W. H. Fritz, who also collected an important fauna from the original Macdougal Group type section at Dodo Canyon, Carcajou Range, Mackenzie Mountains. Ordovician and Silurian faunal collections were studied by B. S. Norford, who participated in the field project in 1969. The appendix of this report contains both stratigraphic sections and reports on faunal collections made in the area and hitherto unpublished. Because many of the Proterozoic and lower Paleozoic formations recognized in the Operation Norman area also occur to the south in the Flat River, Wrigley Lake, and Glacier Lake map-areas, collaboration in the field in 1969 and 1970 with S. L. Blusson of the Geological Survey's Cordilleran

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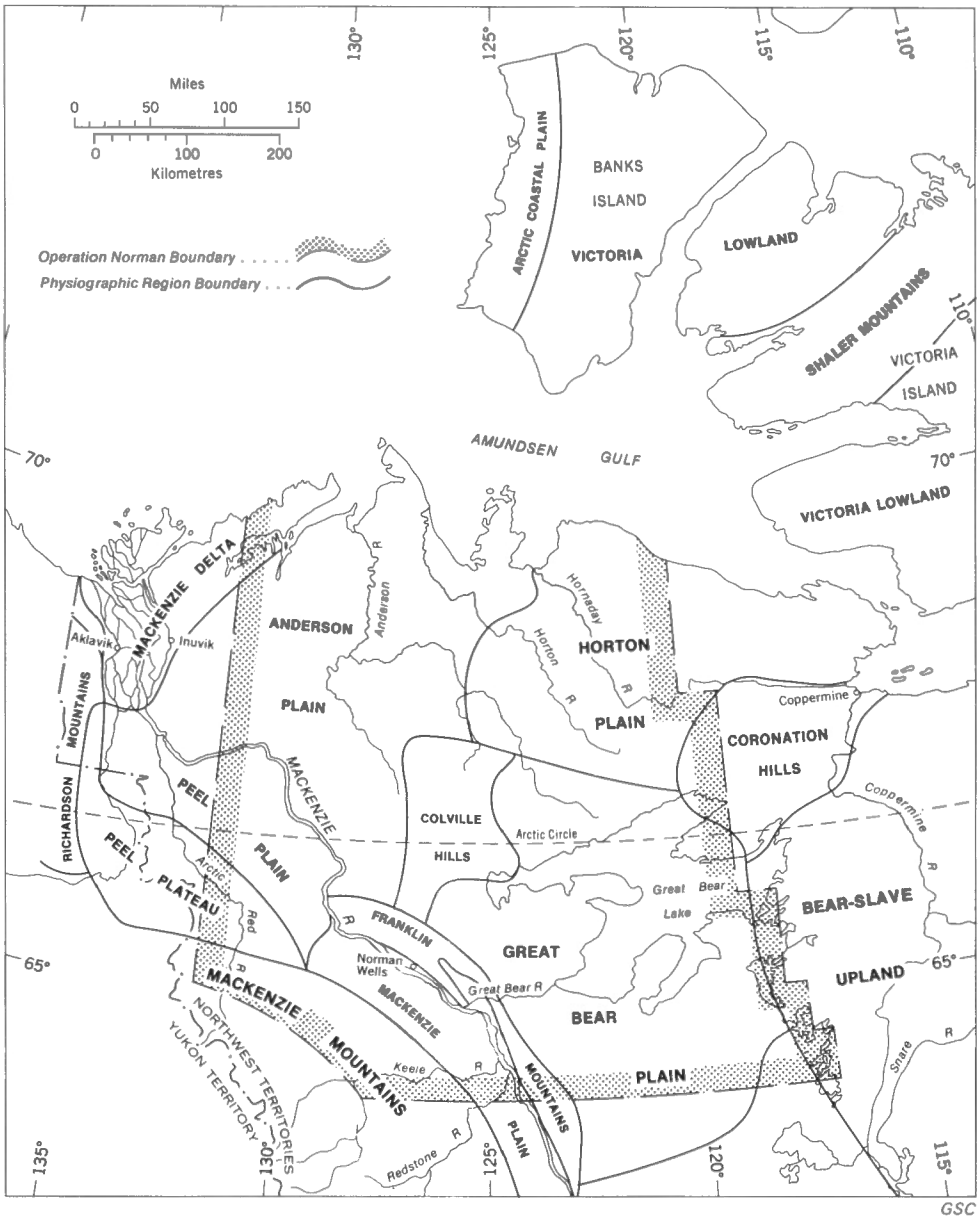


Figure 1. Physiographic provinces, Mackenzie and Franklin Mountains, Interior Plains and environs, with Operation Norman area indicated (Largely after Bostock, 1970)

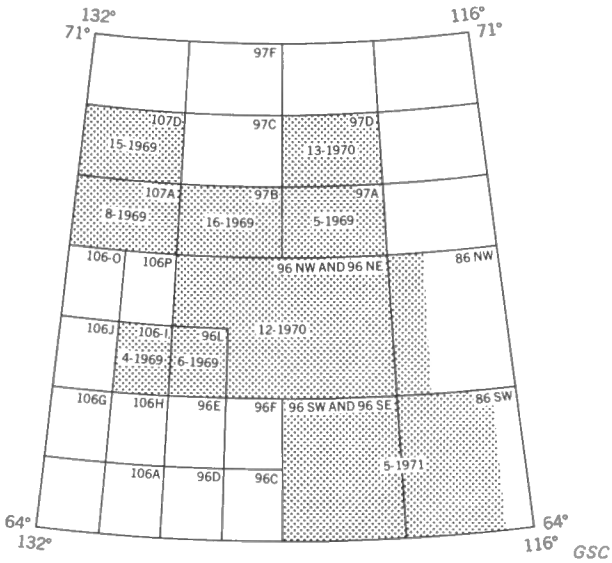


Figure 2. Index to Geological Survey of Canada geological maps of Operation Norman area published to March, 1973. National Topographic System designations indicate other quadrangles mapped geologically during Operation Norman

and Pacific Continental Margin Section proved valuable in integrating the geology and stratigraphic nomenclature of the two areas. A. W. Norris provided details of the extensive Proterozoic and Cambrian section studied by him in 1957 at Cap Mountain near Wrigley, south of the Operation Norman area (Aitken, Macqueen, and Foscolos, 1973). D. K. Norris contributed petrographic data on the diabase sills which form part of the Proterozoic sequence in the Mackenzie Mountains near Arctic Red River. Mrs. Alyce Campbell helped considerably in the compilation of an early draft of this paper. R. D. Cruickshank helped appreciably in assembling the final version. We are grateful to H. Gabrielse, W. H. Fritz and A. W. Norris, all of the Geological Survey of Canada, for their thorough critical reading of this paper.

PHYSIOGRAPHY AND ACCESS

Much of the Operation Norman area lies within the northern Interior Plains (Fig. 1; also Bostock, 1970). Several physiographic subdivisions are recognized, the dominant ones being: Horton Plain, a barren-lands area in which there are widespread exposures of lower Paleozoic rocks; Anderson Plain,

a poorly drained area underlain by Cretaceous clastic rocks with a thick veneer of glacial deposits; and Great Bear Plain, a relatively flat region underlain by slightly indurated Cretaceous clastic sedimentary rocks. The subdued relief of the Interior Plains is broken by Colville Hills (Fig. 1), which consist of widely separated ridges of variable trend. Excepting the most northerly areas, elevations within the Interior Plains range from about 1,500 to 2,300 feet (≃ 450 - 700 m). Norman Wells and Inuvik, located along the Mackenzie River, are the main points of access to the Interior Plains; travel is primarily by helicopter or float-equipped, fixed-wing aircraft.

The southwestern part of the area contains the northern parts of the Mackenzie and Franklin Mountains of the Cordilleran orogen. There, relief is appreciable, with elevations in the Mackenzies ranging from 3,000 to 8,000 feet (≃ 900 - 2,450 m); and in the Franklins from about 2,800 to 5,000 feet (≃ 850 - 1,500 m). River valleys in the northern Mackenzies have been cut primarily in recessive rocks in the cores of synclines and consequently drainage reflects the structural grain of the country. The Mackenzies and the Franklins are underlain by relatively resistant Proterozoic and Paleozoic clastic and carbonate rocks, which are commonly displayed in broad, open anticlinal folds in the northern Mackenzies and in anticlines and thrust plates in the Franklins. Access to the Mackenzies and Franklins of the Operation Norman area is best achieved by helicopter from the Norman Wells area. A few lakes suitable for float-equipped, fixed-wing aircraft occur in the Mackenzie Mountains and along the mountain front.

PREVIOUS GEOLOGICAL WORK

A history of early exploration in the Lower Mackenzie River area includes the names of Hearne, MacKenzie, Franklin, Richardson, Dease and others firmly established in the history of the Canadian nation.

Early geological surveys completed by R. G. McConnell, J. M. Bell, and others have been summarized in Hume (1954, p. 3-4). Lower Paleozoic rocks, which are the subject of this report, were first systematically studied in the area by M. Y. Williams (1922, 1923), who established the names Mount Clark, Mount Cap, and Saline River Formations for Cambrian rocks of the Franklin Mountains in the vicinity of Wrigley (950), and indicated the presence of probable Proterozoic rocks below the Mount Clark Formation near Wrigley. Following the discovery of the Norman Wells oil field in 1920, Link (unpublished, dated 1921) also carried out investigations in the Norman Wells area.

The northern Franklins and northeastern Mackenzies were the subject of extensive geological investigations which formed part of the Canol Project from 1942 to 1944, with more detailed work in the Norman Wells area (Hume and Link, 1945; Hume, 1954). Proterozoic and lower Paleozoic rocks were not dealt with in any detail under the Canol Project, probably because the major interest centred around discovery of possible petroleum reservoirs in Devonian and younger rocks. In particular, relationships were unclear between Proterozoic and/or lower Paleozoic rocks in the Mackenzies (Katherine Group and Macdougal Group, both published in Canol reports; *see* Hume, 1954) and those in the Franklins (Mount Clark, Mount Cap, Saline River Formations and underlying unnamed units).

In 1957, the Geological Survey of Canada mounted a large-scale regional airborne geological study, known as Operation Mackenzie, of the Interior Plains and of Mackenzie and Franklin Mountains between 60°N and 64°N (Douglas, 1959; Douglas *et al.*, 1963). Lower Paleozoic formational units

proposed by Williams (1922, 1923) and underlying Precambrian strata were re-examined at exposures in the McConnell Range of the Franklin Mountains. No formations older than Late Cambrian are exposed in the easternmost ranges of the Mackenzie Mountains at these latitudes. The Wrigley area lower Paleozoic sequence of the Franklins was mapped by Douglas and A. W. Norris (1960) and Douglas and D. K. Norris (1960, 1961, 1963) over a wide area of the Franklin Mountains and Interior Plains. Bell (1959) reviewed the stratigraphy and sedimentation of Middle Ordovician and older sediments in the Wrigley-Fort Norman area, at the southern boundary of the Operation Norman project.

Within the Mackenzie Mountains to the south and southwest of the Operation Norman area, Gabrielse and his co-workers (Gabrielse, Roddick, and Blusson, 1965; Gabrielse, Blusson, and Roddick, in press) have described the regional geology of the Flat River (95E), Glacier Lake (95L) and Wrigley Lake (95M) map-areas, in which a thick sequence of Proterozoic through Middle Cambrian rocks is present. Many of the formational units established by Gabrielse *et al.* (ibid.) are recognized within the Operation Norman area and are discussed below.

Regional geology of the area to the west of Operation Norman, in the western Mackenzie, Wernecke, Ogilvie, and Richardson Mountains, was studied by personnel of Operation Porcupine, a GSC regional airborne geological study carried out in 1962 under the direction of D. K. Norris (Norris, Price, and Mountjoy, 1963). The names Katherine Group and Macdougal Group were applied in the Mackenzie Mountains within the Operation Porcupine area, although relationships with the type sections, located farther east, were poorly known. Relationships between Proterozoic and lower Paleozoic units of the northeastern Mackenzies and those of the Ogilvies and Richardsons consequently were incompletely understood.

Through work completed in part by personnel of Shell Canada Ltd., and published data, Ziegler (1967, 1969) prepared a series of interpretive paleogeographic maps of northwestern Canada, including maps of the Proterozoic, and Lower and Middle Cambrian strata. These maps (Ziegler, 1969, p. 8, 9) indicate the interpreted limits of "miogeosynclinal" facies for the intervals presented and show, for the Proterozoic, the progressive updip wedgeout in an easterly direction of Hadrynian and Helikian rocks beneath Paleozoic shelf and miogeoclinal cover rocks (*see* also Fig. 3, this paper). Lower and Middle Cambrian clastic and carbonate sediment distribution also is shown by Ziegler, as is the presence of a prominent positive feature, known as the Redstone Arch, between Keele and Redstone Rivers (Douglas *et al.*, 1970; Gabrielse, 1967).

A comprehensive report on the subsurface stratigraphy of the Operation Norman area was prepared by Tassonyi (1969). Tassonyi's study includes a thorough review of the lithology, distribution, and nomenclature of all formations present in the area, including those of the lower Paleozoic. Precambrian rocks are not treated in Tassonyi's study, however, because the Precambrian was not intersected in wells drilled up to March, 1961, the most recent data included in the Tassonyi report.

Additional information on both surface and subsurface geology is contained in unpublished reports by petroleum companies and consultants. These reports are on file with the Department of Indian Affairs and Northern Development.

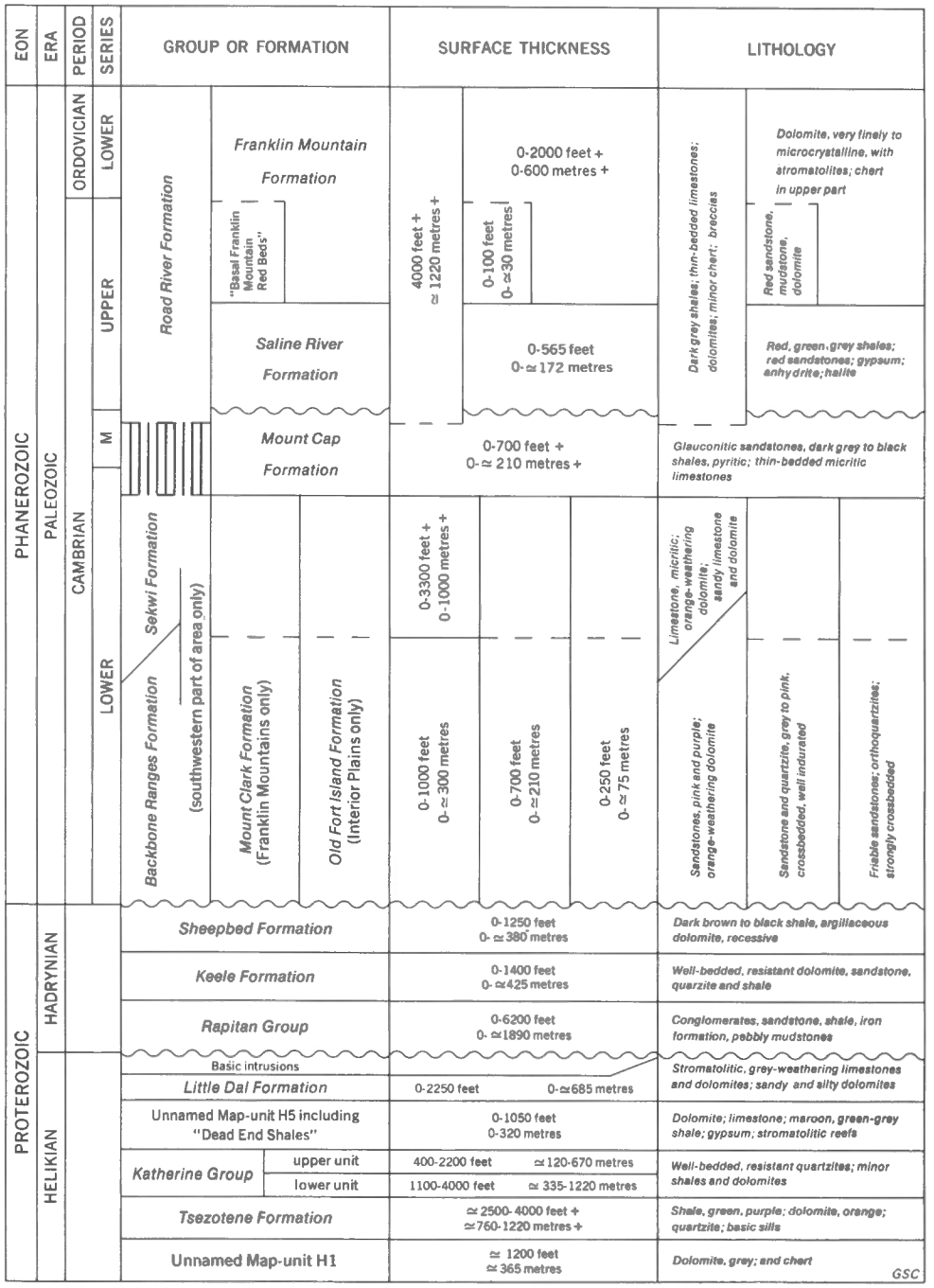


Table 1. Proterozoic and Lower Paleozoic formations, Operation Norman area

EON	ERA	PERIOD	SERIES	UNITS	MACKENZIE MOUNTAIN FRONT								MACKENZIE MOUNTAIN INTERIOR						
					U-2	U-3	U-4	U-5	U-11	U-12, MQ-6	U-13	MQ-33	U-1	U-6	U-7	U-8	U-9	U-10	AC-540
PHANEROZOIC	PALEOZOIC	ORD		MIDDLE CAMBRIAN-LOWER ORDOVICIAN *Road River Formation*										2464' (751 m)	1207' (368 m)				
		CAMBRIAN	U	"Basal Franklin Mountain Red Beds"	285' (87 m)			131' (40 m)											
			U	*Saline River Formation*					318' (97 m)	421' (128 m)		565' (172 m)							
			M	*Mount Cap Formation*					83' (25 m)	329' - 354' (100-108 m)	165' (50 m) (incomplete)								
			L	*Sekwi Formation*									3303' (1007 m) (incomplete)	talus only	418' (127 m) (incomplete)	base only			
			L	*Old Fort Island Formation*															
			L	*Mount Clark Formation*															
			L	*Backbone Ranges Formation*												730' (223 m) (incomplete)			
PROTEROZOIC	HADRYNIAN			*Sheepbed Formation*												1252' (382 m) maximum			
	HADRYNIAN			*Keele Formation*												5353' (1632 m)			
	HADRYNIAN			*Rapitan Formation*															6253' (1906 m)
	HELIKIAN			*Little Dal Formation*	1153' (351 m)						414' (126 m) (incomplete)					813' (248 m) (incomplete)	base only	1953' (595 m)	
	HELIKIAN			Unnamed Map-unit H5	≥ 1046' (319 m)			622' (190 m)		538' (164 m)	638' (194 m)					top only	643' (196 m)	1157' (353 m)	
	HELIKIAN			"Dead End Shale" Sub-unit				460' (140 m)		315' (96 m)	156' (48 m)							370 (113 m)	
	HELIKIAN			*Katherine Group*					2191' (688 m)										
	HELIKIAN			*Upper Part*				944' (288 m)	245' (75 m)	488' (149 m)	516' (157 m)							2221' (677 m)	
	HELIKIAN			*Upper quartzite*				508' (155 m)		133' (41 m)	127' (39 m)							1387' (423 m)	
	HELIKIAN			*Lower Part*			1390' (424 m)		1946'(593 m) (incomplete)			55' (17 m) (incomplete)						top only	
	HELIKIAN			*Tsezotene Formation*		1450' (442 m)													GSC

Table 2. Formational thickness data, Mackenzie Mountains

EON	ERA	PERIOD	SERIES	UNITS	FRANKLIN MOUNTAINS					INTERIOR PLATFORM			
					U-14	U-15	MQ-2	MQ-3	AC-541	MQ-20	MQ-22	MQ-23	MQ-24
PHANEROZOIC	PALEOZOIC	ORD		MIDDLE CAMBRIAN LOWER ORDOVICIAN *Road River Formation*									
		CAMBRIAN	U	"Basal Franklin Mountain Red Beds"									
				Saline River Formation	129' (39 m) (incomplete)		532' (162 m) (incomplete)	110' (34 m) (incomplete)		195' (59 m)	85' (26 m) (incomplete)		95' - 118' (29-36 m)
			M	*Mount Cap Formation*		695' (212 m) (incomplete)				230' (70 m)			120' (37 m) (incomplete)
			L	*Sekwi Formation*									
				Old Fort Island Formation						30' (9 m) (incomplete)		± 243' (74 m)	
				Mount Clark Formation		top only							
				Backbone Ranges Formation									
PROTEROZOIC	HADRYNIAN												
	HELIKIAN			*Lone Land Formation*					743' (226 m)				
				Map-unit 3					1815' (553 m)				
				Map-unit 2					1723' (525 m)				
				Map-unit 1					1667' (508 m)				GSC

Table 3. Formational thickness data, Franklin Mountains and Interior Platform

STRATIGRAPHY

PROTEROZOIC

Introduction

Eight Proterozoic map-units are recognized in the Operation Norman area. All of these units extend beyond the area, and six of them have been named previously. Age assignments to Helikian or Hadrynian Eras (Stockwell, 1964, 1970) are made for all units, although conclusive evidence is lacking. Age assignments for the younger Precambrian rocks of the Canadian Cordillera are based on tenuous evidence as discussed by Gabrielse (1972), and the assignments made to units herein must be regarded as tentative. Problems of age assignments and correlation of the Proterozoic units are discussed following presentation of descriptive data on the units. In the interim the reader should bear in mind that each Helikian or Hadrynian age stated could be questioned.

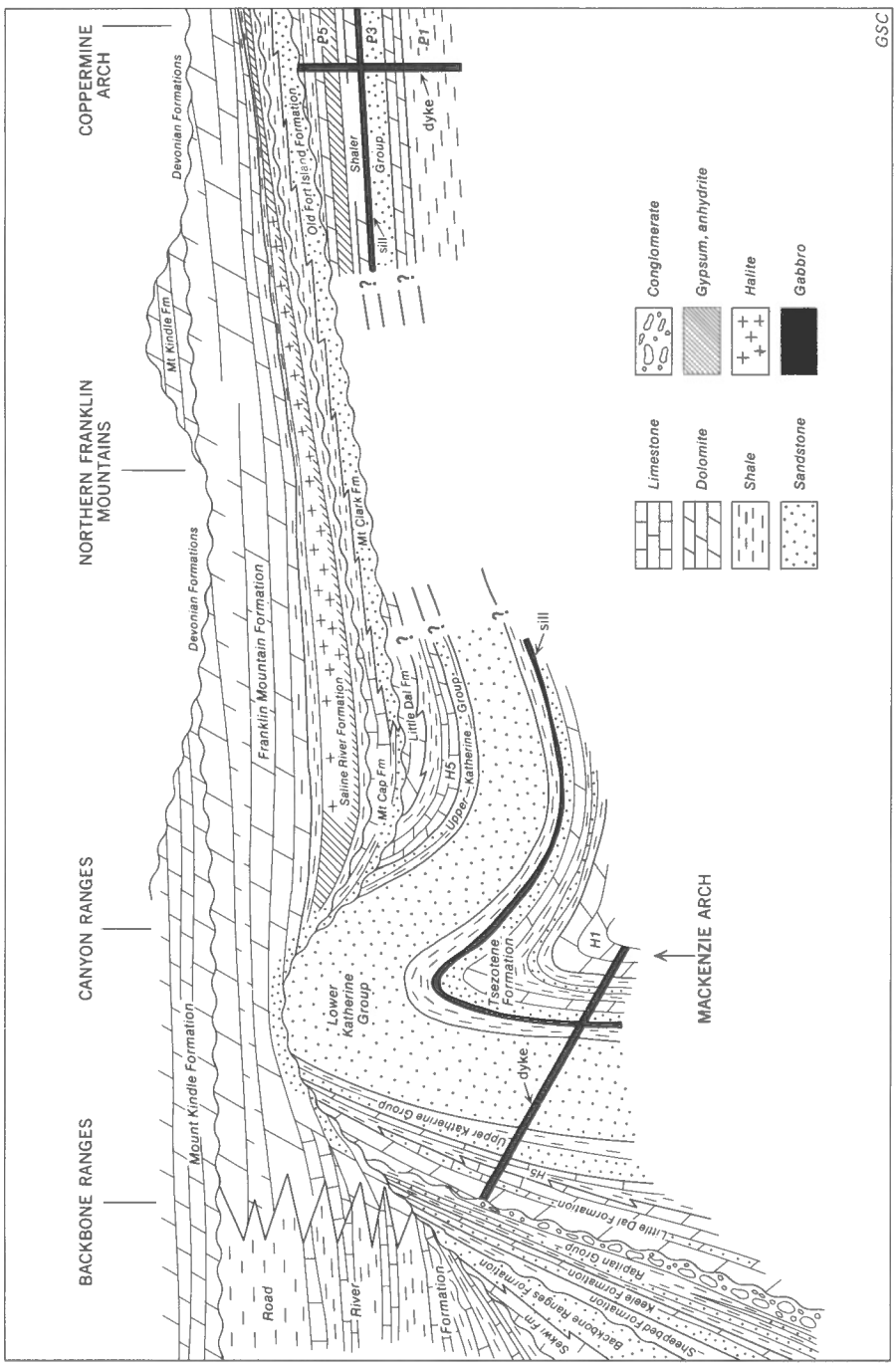


Figure 3. Diagrammatic restored stratigraphic cross-section, interior Mackenzie Mountains (Backbone Ranges) to Coppermine Arch

Figure 3, a generalized cross-section from the Mackenzie Mountains interior to the Interior Plains, illustrates relationships outlined in the following discussion.

Helikian(?)

Unnamed map-unit H1

Map-unit H1, a resistant unit of pale grey dolomite with minor amounts of chert, is exposed locally in the cores of the most deeply eroded anticlines in the frontal Mackenzie Mountains. There, the Proterozoic section is relatively thin, owing to pre-Late Cambrian erosion (*see* Figs. 6, 7, 8). Map-unit H1 probably is the oldest formation exposed in the northeastern Mackenzies, and only once has been referred to in print (Usher, 1970).

The formation consists mainly of pale grey weathering, medium grey, microcrystalline dolomite that is mostly thick bedded and massive. Crinkly cryptalgal-type lamination (Aitken, 1967) is common, while low-domal algal stromatolites are relatively rare. "Birdseye" (fenestral) dolomite, and dolomite derived from pellet grainstone and flat-pebble conglomerate limestones are other minor rock types; the original fabrics are normally well preserved only where silicified. Thin, discontinuous beds of black chert are characteristic of much of map-unit H1. Fluorite was observed in two beds of the unit in a canyon 13 miles (21 km) east of Arctic Red River, where the most northerly anticline brings the formation into view. An upper bed contained only traces of the mineral, but a lower bed, consisting of two feet (61 cm) of dolomitic sandstone, was estimated to contain about 5 per cent fluorite.

The base of map-unit H1 is not exposed. At a measured section near the fluorite locality mentioned above, the formation is at least 1,200 feet (370 m) thick. The upper contact generally is covered and has not been observed but, because of the contrast with the Tsezotene Formation in lithology and resistance, is easily traced.

Tsezotene Formation

A thick, lithologically heterogeneous unit that underlies the Katherine Group and is characterized by exposures of well-bedded strata and sombre colours, interrupted by bright orange weathering dolomite beds, was named the Tsezotene Formation by Gabrielse, Blusson, and Roddick (in press).

Although the formation, as a mappable unit, is recognized easily over a wide area of the Mackenzie Mountains, in map-areas 96D, 106A, 106G, 106H, and others to the south, it nevertheless displays marked lithologic variation from place to place. At the type section in the Tsezotene Range (95M), the formation is described as consisting of about 3,630 feet (≈ 1,100 m) of: dark grey, green and medium brown shale; purple, maroon, grey and green argillite; light grey and green, grey and brown siltstone; fine- to medium-grained quartzite; and interbeds of orange- and buff-weathering dolomite and sandy dolomite (Gabrielse *et al.*, in press).

Sedimentary structures such as crossbedding, ripple-marks, mud cracks and stromatolites are mentioned in connection with various rock types; lamination appears to be characteristic. A 500-foot-thick (152 m) member dominated by quartzite forms the basal part of the upper half of the formation.

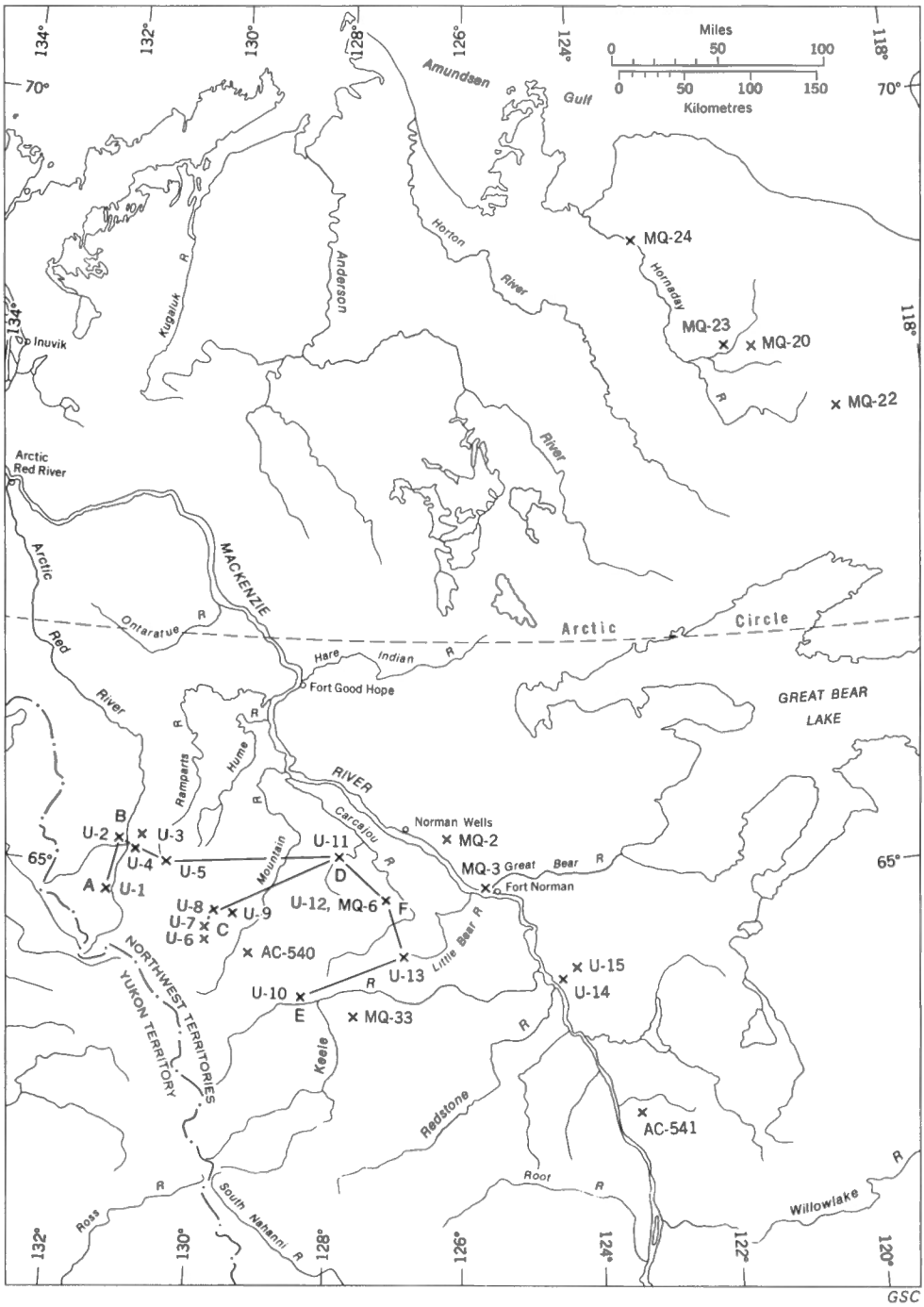


Figure 4. Location of Proterozoic through Middle Cambrian sections, Operation Norman area

No complete section of the Tsezotene was obtained in the Operation Norman area, partly because of the relatively recessive character of the formation, and partly because of its characteristically incompetent structural behaviour which gives rise to complex folds of small wavelength. Parts of the formation, however, have been examined at various localities.

Near Mount Eduni on Keele River (106A), the upper part of the formation, about 1,000 feet (300 m) thick, is dominated by an apparently cyclic repetition of quartzite, mudstone, and dolomite that gives a regular thick-bedded appearance. The quartzite is greyish green, very fine grained, thin bedded and flaggy. The mudstone is grey and greyish green, becoming partly purple upward in the succession, and is non-fissile. The dolomite beds, characteristically about one foot (≃ 30 cm) thick, are grey, microcrystalline, mainly laminated but partly with a relict particulate texture, and weather orange. Beds underlying this cyclic-appearing interval include an interval of sandstone and quartzite 30 to 40 feet (9-12 m) thick that is greenish white, very fine grained, and mainly flaggy, with ubiquitous cross-lamination and prominent ripple-marks and mud cracks. At the bottom of the examined interval is a carbonate member peculiar to the vicinity of Mount Eduni, estimated to be about 200 feet (60 m) thick. The lower three-quarters of this member consist of flaggy, laminated, recrystallized grey limestone that appears to be derived from calcarenite and calcisiltite, with a three-foot (90 cm) bed at the top composed of club-shaped, SH-type (stacked hemispheroid) algal stromatolites. The upper quarter of the member is dolomite, weathering yellowish grey. This described interval of the Tsezotene ends upward at a gabbro sill with an estimated thickness of 100 feet (30 m) near the top of the formation.

A measured and described section, 1,450 feet (442 m) thick, of the upper one-half to one-third of the Tsezotene Formation, from the north flank of the first frontal anticline of the Mackenzies immediately east of Arctic Red River (U-3, 106G, Fig. 4), is lithologically rather different in detail from that described above. Although the lithologies present - shale/mudstone/argillite, siltstone, sandstone/quartzite and dolomite - are similar, no repetitive cyclic character is apparent, and the various rock types occur either as thin interbeds or in intervals of a single lithology ten to forty feet (3-12 m) thick. Thicker intervals or members, lithologically heterogeneous but dominated by one rock type, also can be distinguished. One of these, near the bottom of the studied part of the section, is a 310-foot (95 m) interval consisting almost entirely of thin-bedded quartzite that is very fine grained, poorly sorted, silty and argillaceous, with the usual suite of "shallow-water" sedimentary structures, especially mud cracks. Interbedded with the quartzite are intervals of silty argillites and mudstones, generally pale greenish grey in colour but locally dark red or maroon and making up 5 to 20 per cent of the whole. Section U-3 also contains a lower, 115-foot-thick (35 m) and an upper, 60-foot-thick (18 m) gabbro sill. From lithologic notes taken at mapping stations, it appears that immature, argillaceous, poorly sorted sandstones are more prominent in the Tsezotene, or its upper half, in map-area 106G than in 106A.

No section of the lower half of the Tsezotene has been measured or described. It appears to contain more shale and argillite and less quartzite than the upper half. The eye-catching orange-weathering dolomites are present, both as widely spaced beds and as intervals dominated by dolomite, with interbeds of shale.

The Helikian(?) gabbro sills are confined to the Tsezotene Formation, even though gabbro dykes cut higher formations. Of particular note is a sill, 60 to 100 feet (18-31 m) thick that lies within the upper 500 feet (152 m) of the Tsezotene throughout the map-areas studied.

Because of structural complications and the fact that the base of the Tsezotene is rarely exposed, the thickness of the formation within the Operation Norman area is unknown. At Mount Eduni, in map-area 106A, the thickness definitely exceeds 4,000 feet (≃ 1,220 m) as mapped (base concealed). In the frontal anticline at Arctic Red River, in map-area 106G, the minimum thickness as mapped is 2,500 feet (≃ 760 m). The true thickness at this locality may be much greater, since the base is concealed.

The basal contact of the Tsezotene Formation has not been studied. The Tsezotene-Katherine contact at the top is gradational; it is drawn where the slightly recessive, obviously bedded, and lithologically heterogeneous Tsezotene beds give way upward to thick, massive, essentially uninterrupted intervals of pale pinkish quartzite. The approximate contact is usually easy to identify on aerial photographs. Relationships observed in the course of mapping in map-area 106G suggest that the contact may be intertongued and diachronous, and that the contact, as drawn, moves to lower levels as thin quartzite units in the upper Tsezotene thicken and become "Katherine-like". The regional sill near the top of the Tsezotene also helps to locate the contact.

Katherine Group

A thick sequence of well-bedded, resistant quartzites with minor shales and dolomites (Pl. 1) is widespread within the Mackenzie Mountains in map-areas 106A (Mount Eduni), 106B (Bonnet Plume Lake) and 106G (Upper Ramparts River). This sequence is encountered commonly within the cores of anticlines in the frontal Mackenzies, and was designated the "Katherine Group" or "Mount Katherine Series" by workers of the Canol Project, who indicated a Cambrian and/or earlier age (*see* Hume, 1954; name originally used by Link, unpublished). The type locality is Katherine Creek, or Mount Katherine, in the upper Carcajou River area (96D). There, the top of the group was placed at the base of a succession of dusky red, nodular shales (a sub-unit in unnamed Helikian map-unit H5, this report; *see* Pls. 3, 8, 16), although that horizon does not correspond to the top of the quartzite-dominated section. The base was not seen by the Canol geologists. The type section was described briefly by Nauss (1944, unpublished Canol Project report; *see* Hume, 1954). A nearby section measured by Usher at Loretta Canyon (U-11, 96E; 16 mi., or 26 km. NW of the Katherine Group type locality; *see* also Fig. 9) provides a reference section for the group. The Katherine Group was recognized by D. K. Norris *et al.* (1963) in the Mackenzie Mountains of the Operation Porcupine area to the west of Operation Norman. To the south in the Wrigley Lake map-area (95M), Gabrielse *et al.* (in press) have proposed the name Tigonankweine Formation for a unit that subsequently has been shown to be equivalent to the Katherine Group. The type section of the Tigonankweine Formation is located near Little Dal Lake in Glacier Lake map-area (95L), where the unit is 4,268 feet (1,411 m) thick (Gabrielse *et al.*, in press).

In the Operation Norman area, the Katherine Group is divided into a lower and an upper part. The lower part consists of orthoquartzites, well bedded and resistant, with minor amounts of interbedded, recessive, red and green shales and mudstone, and minor stromatolitic dolomites. A conspicuous purple shale unit, about 100 to 200 feet (30-60 m) thick, occurs within the top third of the unit at Arctic Red River (U-4, 106G, Fig. 4) and Loretta Canyon (U-11, 96E, Fig. 4; Pl. 1) and may be a regional marker. The lower part of the Katherine ranges from 1,100 to more than 4,000 feet (≃ 335-1,220 m) in thickness. From the point where Keele River crosses the Mackenzie Mountain front, the unit thickens toward the interior ranges and thins northwestward along the mountain front, as is probably true of the Katherine Group as a whole (*see* Figs. 6, 9).

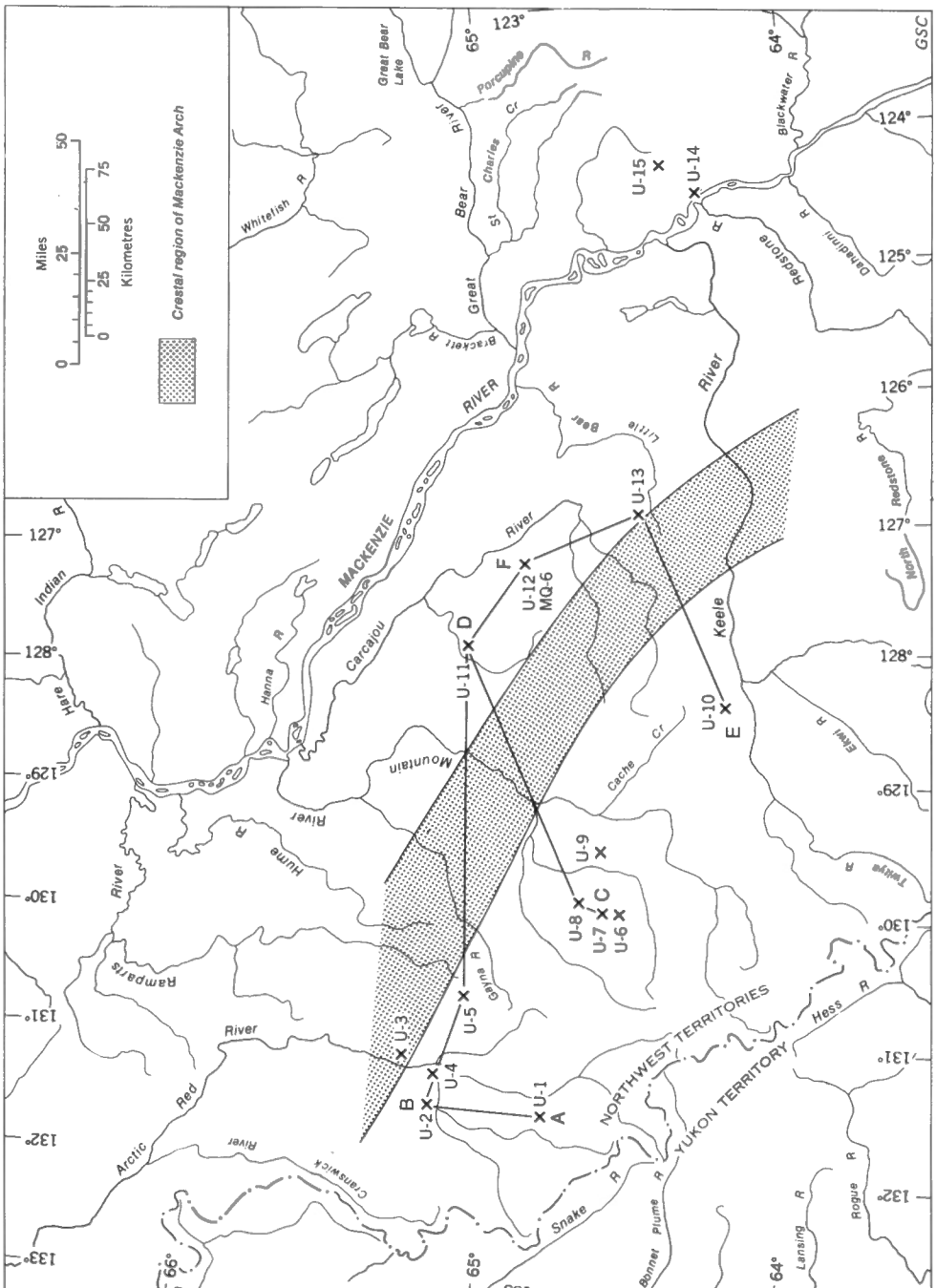


Figure 5. Location of stratigraphic cross-sections and Mackenzie Arch, Operation Norman area

The upper part consists of two sub-units which can be traced readily on aerial photographs. These include a lower, recessive sub-unit of dark grey to black shale, with some interbeds of quartzite, and dolomite; the dolomite is commonly stromatolitic and orange weathering. This sub-unit ranges in thickness from about 250-350 feet (≃ 80-110 m) along the Mackenzie Mountain front (U-11, 96E; U-12, 96D, Fig. 4) to over 800 feet (244 m) at the most southwesterly localities examined (U-10, 106A). Above this occurs a distinctive and widespread sub-unit called informally the 'upper quartzite' (Pl. 2). It consists of white to grey, in part purplish, quartzite, and brick-red sandstone. The unit is well bedded, resistant, and ranges in thickness from about 130 feet (40 m) along the mountain front (U-12, U-13; 96D, Fig. 4) to almost 1,400 feet (≃ 430 m) in interior range sections (U-10, 106A; stratigraphic cross-section E-F, Fig. 6). Both of these sub-units commonly are present throughout the northern Mackenzie Mountains except in the area along the Mackenzie Mountain front between Gayna and Imperial Rivers, where they have been removed by erosion at one or more subsequent unconformities (*see* cross-section B-D-F, Fig. 9).

Unnamed map-unit H5

Conformably overlying the Katherine Group is a lithologically diverse, recessive unit of group rank characterized by orange-weathering, partly stromatolitic dolomites; black, flaggy micritic limestones and secondary, flaggy microcrystalline dolomites; and maroon, red, green, grey and black shales (Pls. 3 to 8, 16). A thick interval of white gypsum occurring in the interior ranges is considered tentatively to be correlative (Pls. 5, 6, 7). The unit represents about the lower one-third (i.e., the Precambrian part) of the type Macdougal Group (obsolete) (Nauss, 1944; *in* Hume, 1954).

Although the lithology of the unnamed unit displays pronounced lateral variation, sequences developed throughout an extensive region of the Mackenzie Mountains can be seen as variations of the following typical sequence developed in the Dodo Creek-Rouge Mountain area (map-area 96D).

A basal member conformably overlying the Katherine Group consists of a lower shale part and an upper carbonate part. The carbonate part, more commonly exposed because of its relatively great resistance to weathering, is composed of dark grey or black micritic limestone, that is uniformly thin bedded and flaggy except for some nodular intervals and intervals with algal stromatolites. This limestone is altered in some intervals and at some localities to dark grey, flaggy, cryptocrystalline, yellow-weathering dolomite and to orange-weathering stromatolitic dolomite. Beds of dolomite with relict particulate and flatstone and roundstone conglomerate textures usually are present. The carbonates are interrupted by minor intervals of grey to black, commonly calcareous shale. The lower part of the basal member is characterized by shales, notably black, but including red, green and grey varieties. The shales are interbedded with various amounts of limestones, including stromatolitic and flat-pebble conglomerate types, derived dolomites, and quartzites. This interval is recessive and generally poorly exposed.

The basal member of the unnamed unit is present (with characteristic lithology) beneath the lowest beds ("Dead End Shale") described by Nauss (1944; cited *in* Hume, 1954) near the type section of the Macdougal Group (obsolete). Its thickness in sections studied to date ranges from 162 feet (49 m; U-5, 106G) to 498 feet (151 m; U-10, 106A).

The second member of the unnamed unit is of distinctive lithology and widespread distribution and constitutes a regional marker. It is characterized and dominated by brick-red to deep brownish red, calcareous,

thin-bedded shale with abundant ellipsoidal nodules of red to pinkish grey, cryptocrystalline limestone (Pl. 3, 8). Some intervals of green-weathering strata interrupt the general reddish colouration and the unit is locally grey in map-area 106G. Nauss (1944; cited *in* Hume, 1954) named this member the "Dead End Shale", and showed it as the lowest described unit of his type Macdougal Group. He and other Canol Project workers have described the shale as "chocolate-coloured", an unfortunate and misleading choice of words. The member ranges in thickness from 156 feet (49 m; U-13, 96D) to 490 feet (149 m; U-5, 106G) in sections measured to date.

Hume (1923, p. 53) reported collecting fossils identified as indicative of Middle or Late Cambrian age from a Macdougal Group section in the "Carcajou Mountains". From his description (1923, p. 53), we assign these fossiliferous beds to the Mount Cap Formation. His later reference to this collection (Hume, 1954, p. 10) has been taken by the authors and others to imply that the fossils occur in the upper part of the nodular red shale member. Careful reading of his report of 1923 and our restudy of the section reveal that this is not so. Furthermore, mapping in the immediate area of Dodo Canyon shows that the fossiliferous Mount Cap unconformably overlies unnamed map-unit H5; in the interior ranges, the nodular "Dead End Shale" is separated from fossiliferous Lower Cambrian beds by two major unconformities and thousands of feet of unfossiliferous, Proterozoic strata (Figs. 6, 9).

Although widely recognizable, the interval that includes the unnamed Helikian unit (H5) is one in which numerous facies changes occur. In the frontal range of the Mackenzie Mountains immediately east of Arctic Red River (U-5, 106G, Fig. 4), steep-sided "reefs", "bioherms" or "buildups" of stromatolitic dolomite occur within the "Dead End Shale" interval. Regional observations suggest that, at least locally, the basal part of the Little Dal Formation includes equivalents of unit H5. Similarly, thick gypsum in parts of the interior ranges of the Mackenzie Mountains, locally enveloping "reefs" of dolomite, probably is equivalent to part of unit H5.

In some ranges, the contact between unit H5 and the overlying Little Dal Formation has been drawn at the top of the "Dead End Shale". Elsewhere, it has been drawn between weakly resistant, thin-bedded carbonates, or carbonates interbedded with dark grey shale that overlie the red nodular shales but are grouped with unit H5, and the more massive, resistant carbonate rocks typical of the Little Dal Formation (*see* Pl. 3). Mapping practice, therefore, has been inconsistent in this regard; it is reasonably clear, however, that the contact between the unnamed unit (H5) and the Little Dal Formation is a facies contact. Where the Little Dal is missing, various members of the unnamed unit (H5) are separated from overlying Lower to Upper Cambrian strata by an unconformity that is commonly angular (Pls. 3 to 6).

Little Dal Formation

At the type section in the Glacier Lake map-area (95L), the Little Dal Formation consists of a thick succession of resistant carbonate strata (Gabrielse *et al.*, in press). Two members are recognized: a lower one of stromatolitic grey-weathering limestone and dolomite, and an upper one of yellowish or reddish orange weathering, variably quartzose dolomite. Elsewhere in the area, the two members are seen to be in part lateral equivalents of one another (Gabrielse *et al.*, in press).

In the Operation Norman area, the Little Dal is a persistent, feature-forming unit characteristic of, but not confined to, the interior ranges of the Mackenzies (Pls. 9, 10). In sections so far measured, its thickness ranges

from 414 feet (126 m) at a position near the Mackenzie Mountain front (U-13, 96D), to 2,259 feet (688 m) at a section deep in the Mackenzies (U-10, 106A). This striking increase in thickness, clearly evident in stratigraphic cross-section E-F (Fig. 6), is due in part to depositional thickening and facies change, and in part to differential preservation beneath subsequent unconformities. The Little Dal is missing, through erosion at subsequent unconformities, facies change, or both, in wide areas of the more frontal Mackenzie Mountains (*see* also stratigraphic cross-section A-B, Fig. 7).

The twofold division of the formation noted by Gabrielse *et al.* (ibid.) has not been recognized in the Operation Norman area: however, a three-fold division has been noted at many localities. It consists of a lower member of resistant, grey-weathering carbonate; a thin, less resistant, yellow-weathering middle member characterized by sandy, silty, and argillaceous carbonate, commonly of platy to flaggy character, with thin units of shale; and an upper, resistant, massive member of grey-weathering carbonate (Pl. 9). As in the type area, remarkable changes have been noted where grey-weathering Little Dal (mainly limestone) passes along strike into dolomite with brilliant yellow-, orange- and red-weathering colours. The Little Dal Formation near Rouge Mountain (96D; Lat. 64° 30 1/2'N; Long. 127° 03'W) consists almost entirely of orange- to brick-red weathering, partly stromatolitic dolomite that obviously suggested the name for the topographic feature.

A variety of carbonate rocks characterizes the Little Dal. Included are: micritic limestone with mud cracks; nodular micritic limestone; oolitic limestone and dolomite; flat-pebble limestone and dolomite conglomerate; rhythmically interbedded micritic limestone and calcareous shale showing delicate cross-lamination and small-scale scour-and-fill structure; sandy, silty, and argillaceous limestone and dolomite; carbonates with domal, columnar, and digitate algal stromatolites and algal oncolites; beds with "molar tooth" structure (O'Connor, 1972); and a variety of brownish grey to predominantly orange-weathering cliff-forming dolomites. Thin intervals of grey, green, and purple-red shale also occur, especially in the middle of the formation. In summary, the Little Dal displays a pronouncedly "lower Paleozoic" aspect and, locally, may be difficult to distinguish from the Franklin Mountain Formation, where stratigraphic sequence is not clear. In this regard, the presence of beds with "molar tooth" structure has been found to be diagnostic of the Little Dal.

The Little Dal Formation is overlain unconformably by formations as old as the Rapitan (Hadrynian) and as young as the Bear Rock (Early and Middle Devonian). Most commonly, it conformably overlies one or other of the sub-units of the unnamed Helikian unit (H5) but, in the northwestern part of map-area 106A and the northeastern part of map-area 106B, it overlies a thick unit of bedded gypsum that is probably an equivalent of part of unit H5. Gabrielse *et al.* (in press and pers. com., 1972) suggest that red beds, gypsum and dolomite locally overlying the Little Dal in Thundercloud Range, Glacier Lake map-area (95L) may be a facies equivalent of the upper part of the Little Dal. In the Glacier Lake, Flat River, and Wrigley Lake map-areas, (95L, 95E, 95M), the Little Dal apparently overlies the Tigonankweine Formation (Katherine equivalent). This suggests an unconformity beneath the Little Dal. At present, however, it appears more likely that the Little Dal of the type area includes equivalents of the unnamed Helikian(?) unit (H5) of the Operation Norman area. If this is so, no unconformity need be postulated.

Obviously, a number of significant relationships involving the Little Dal Formation and the underlying unnamed unit remain to be resolved:

(a) To what extent the unnamed unit (H5) is older than the Little Dal, and to what extent it is a facies of the Little Dal (*see* Pl. 3).

(b) The relationships of the sub-Little Dal gypsum unit to the Little Dal and to unnamed unit H5.

(c) The architecture and origin of pinnacle "reefs" of dolomite that interrupt the sub-Little Dal gypsum and the "Dead End" shale.

Basic intrusions

In the ranges of the Mackenzie Mountains southwest of those studied during Operation Norman, Precambrian and Paleozoic rocks include volcanic intercalations and concordant and discordant intrusions (Gabrielse *et al.*, in press). Within the Operation Norman area, however, no igneous rocks of Paleozoic or Mesozoic age are known; igneous rocks are limited to a single suite of Precambrian (Helikian?) basic (diabase) sills and presumably related dykes.

Basic sills are restricted to the Helikian Tsezotene Formation. At some localities, for example, the frontal range of the Mackenzies along Arctic Red River, and Keele River near Mount Eduni, three or more sills are present. Most prominent, however, is what appears to be a single sill of regional extent, sixty to one hundred feet (≃ 18-30 m) thick that lies within the uppermost 500 feet (≃ 150 m) of the Tsezotene wherever the appropriate interval has been observed.

In connection with the studies of Operation Porcupine, D. K. Norris has collected and examined a representative suite of samples from several of the sills along the Mackenzie Mountain front in the vicinity of Arctic Red River, and has provided the following data (Norris, pers. com., 1972):

> The diabase is dark greenish grey and is characteristically medium crystalline, except near its chilled margins. In thin section it is commonly observed to comprise approximately 70 per cent mildly sericitized plagioclase (An50-60), with 15 to 20 per cent highly altered clinopyroxene (augite), 10 per cent altered amphiboles (hornblende and tremolite-actinolite) and minor amounts of disseminated magnetite and chloritized biotite.

Columnar jointing is well developed in the sills. Where the upper contacts of sills have been studied, the overlying beds are thermally altered, and no indications of origin as lava flows, such as scoriaceous flow tops or agglomerate zones, have been observed.

Diabase dykes, lithologically similar to the sills and as much as 200 feet (≃ 60 m) wide, have been observed to cut all pre-Rapitan formations, although the dykes appear to be best developed in the Tsezotene Formation and the Katherine Group. Most of the dykes, which are essentially perpendicular to the strata they intrude, strike N10°-20°W. This trend is, interestingly, close to that of the "pre-Upper Cambrian" faults of the region.

Hadrynian(?)

Rapitan Group

Exposures of the Rapitan Group (Green and Godwin, 1963; Gabrielse *et. al.*, 1965), comprising a thick succession of mainly clastic rocks including conglomerate, sandstone, shale and lesser amounts of carbonate beds, are confined to the southwestern part of the Operation Norman area. Rocks of the group were originally described by Green and Godwin (1963) from the Snake River area (106F) of northwestern Mackenzie Mountains, adjoining Upper Ramparts River (106G) of the Operation Norman area. To the south of the Operation Norman area, the group is widespread near Keele River in the Wrigley Lake map-area (95M; Gabrielse *et al.*, in press) where three well-defined units, Lower, Middle and Upper Rapitan, are recognized, each bounded by an unconformity. These units can be recognized in the Operation Norman area, but have not been mapped separately everywhere. A prominent angular unconformity marks the base of the Rapitan and erosion, associated with this unconformity, has removed variable thicknesses of the underlying Little Dal Formation. In the Wrigley Lake area to the south (Gabrielse *et al.*, in press), up to 4,000 feet (≃ 1,220 m) of Little Dal Formation rocks were eroded prior to deposition of the lower part of the Rapitan.

Two sections of the Rapitan were measured in the Operation Norman area. At the most complete of these (AC-540; 106A), all three units are well represented, and have a total thickness of more than 6,150 feet (1,875 m). The lower unit, over 2,400 feet (≃ 730 m) thick, commences at the base with one hundred feet (≃ 30 m) of "megaconglomerate" consisting of blocks of Little Dal Formation as much as 15 feet (4 1/2 m) in greatest dimension. Overlying the "megaconglomerate" is a thick sequence of dull purplish red argillite with fine, planar, graded sandy laminations, interrupted by varying amounts of conglomerate and pebbly mudstone, and minor beds and laminae of sandstone of quartz greywacke composition. Clasts in the rudites are mainly dolomite, with minor grey, green, and pink to red chert; clasts obviously of Rapitan derivation are common. No iron formation was observed.

The middle unit at locality AC-540 is 835 feet (255 m) thick and consists entirely of pebbly mudstone. The phenoclasts are generally well-rounded pebbles and cobbles up to 30 centimetres in diameter, mainly of dolomite of several kinds, with subordinate quartzite, chert, dark grey argillite, and jasper; they rarely exceed 20 per cent of any bed. Most of the phenoclasts could be derived from the Little Dal Formation and many clearly are so derived, for example, dolomite with "molar tooth" structure. The matrix of the pebbly mudstones is a sandy mudstone, medium grey and dull yellow weathering, in which the sand-size grains are calcareous; it might be called a matrix-rich calcareous greywacke. The middle unit is essentially non-bedded, but possesses an irregular platy/shaly fracture parallel to bedding.

The upper unit at locality AC-540 is about 2,960 feet (≃ 900 m) thick. It is dominated by hard, grey, platy argillite and grey shale, weathering brown and dark grey, with varying amounts of siltstone and very fine grained sandstone (subgreywacke). A unit 535 to 580 feet (163-177 m) above the base is dominated by thick beds of pebbly mudstone. The siltstones and sandstones are partly calcareous and/or sideritic, and weather deep rusty brown ("basalt-like"). Plane-parallel lamination, small-scale cross-lamination, and convoluted lamination all are common in the upper unit. Slope-controlled penecontemporaneous overfolds and slides affect discrete intervals each a few feet (1-2 m) thick throughout the unit. It is of interest that the only formation within the Operation Norman area that resembles the Upper Rapitan is the Upper Devonian Imperial Formation.

At Section U-8 (106A, stratigraphic cross-section C-D, Fig. 8), which is situated closer to the mountain front than AC-540, the Lower Rapitan is missing, either through nondeposition or erosion prior to deposition of the Middle Rapitan, and the Middle Rapitan unit, there basal, is 950 feet (290 m) thick. In addition to the pebbly mudstones described, it contains intervals of shale and of well-bedded, silty and argillaceous, partly laminated dolomite and limestone, and a few beds of coarse sand to pebble conglomerate. In this area, the Upper Rapitan is non-typical in that it contains, in addition to the characteristic Upper Rapitan lithologies described above, many intervals of limestone and limestone-granule conglomerate and mature, well-sorted, fine- to coarse-grained sandstones and pebble conglomerates. Because intervals containing rock types characteristic of the Keele Formation occur throughout the Upper Rapitan, the Upper Rapitan/Keele contact is indefinite at section U-8.

In the southeastern quarter of map-area 106A, the pinchout or cutoff of the Lower Rapitan can be traced on aerial photographs. Where the Middle Rapitan is the basal unit of the group, its lithology differs from that described above. Prominent are beds of dark grey to pale grey and maroon, thin-bedded to laminated and partly stromatolitic cryptocrystalline dolomite; purple-red shale; red, laminated sandstone; and subordinate red, laminated sandstone.

As noted by Gabrielse *et al.* (in press), the base of the Rapitan Group is an angular unconformity with pronounced topographic relief. Observations were made at several localities within the Operation Norman map-area which tend to confirm the presence of the two intra-Rapitan unconformities reported by Gabrielse *et al.* These authors (in press) report the presence, at least locally, of a low-angle unconformity at the Rapitan-Keele contact. Our observations, on the other hand, strongly suggest intertonguing of Keele and Upper Rapitan lithologies, especially at section U-8 (106A), where the Rapitan-Keele contact is indefinite. Thus a facies relationship is believed to exist between the Upper Rapitan and the Keele in some areas. The field character of the Rapitan is seen in plates 9 to 12.

Keele Formation

Rapitan beds are conformably overlain by the Keele Formation, a thick unit of well-bedded dolomite, sandstone, quartzite, and shale, which has its type section in the Keele River area of the Wrigley Lake map-area (95M), as described by Gabrielse *et al.* (in press). The unit forms a prominent ribbed succession between the underlying, somewhat recessive, Upper Rapitan and the overlying recessive Sheepbed Formation (Pls. 11 to 14).

The single measured section described herein (U-8, 106A; stratigraphic cross-section C-D, Fig. 8) is located near the headwaters of Mountain River. Unfortunately, it overlies a section of the upper unit of the Rapitan Group that is atypical in its content of limestones. Normally, the appearance of carbonate rocks and/or pale, thick-bedded quartzite in significant amounts marks the Keele/Rapitan contact; at locality U-8 this criterion is not applicable, and the contact, and hence the thickness of the Keele Formation, is indefinite.

Strata characteristic of the Keele in the Operation Norman area are: yellow- to orange-weathering dolomites that commonly are medium to coarsely crystalline and rarely stromatolitic; dolomite-pebble and dolomite-cobble conglomerates; pale grey to medium grey quartzites that are commonly rust-specked; quartz-jasper pebble conglomerates and grits similar to some conglomerates in the Rapitan; and subordinate limestone beds. All of these rock-types alternate with intervals of varicoloured but mainly black shales.

In map-areas to the south, the Keele ranges in thickness from about 1,500 feet to more than 2,000 feet (≃ 460-610 m) (Gabrielse *et al.*, in press). In Operation Norman territory, the formation occurs only in map-areas 106A, 106B, and 106G, and direct measurements of its thickness are lacking. It is about 1,400 feet (≃ 430 m) thick as mapped at latitude 64°31'N; longitude 129°27'W in map-area 106A.

The Keele-Rapitan contact in the map-areas studied is considered to be intertongued and conformable, as described earlier (Pls. 11, 12). The contact of the Keele with the overlying Sheepbed Formation apparently is conformable.

Sheepbed Formation

A recessive and dark grey weathering unit, composed of dark brownish grey to black, non-calcareous shale, with interbeds of dark grey, silty, argillaceous and micaceous dolomite, conformably overlies the Keele Formation in the western parts of the Operation Norman area and corresponds to the Sheepbed Formation of Gabrielse *et al.* (in press). This unit forms a distinctive air photo map-unit, owing to its dark colour and recessive character (Pls. 11 to 14).

In the type area to the south, the Sheepbed appears to exceed 2,500 feet (≃ 760 m) in thickness but thins northward to approximately 1,500 feet (≃ 460 m) near North Redstone River (Gabrielse *et al.*, in press). This northward reduction in thickness of the unit appears to persist into the Operation Norman area; its thickness at U-8, where it is poorly exposed, is thought to be about 1,250 feet (≃ 380 m; *see* stratigraphic cross-section C-D, Fig. 8), and its thickness as mapped at latitude 64°30'N; longitude 129°27'W (106A) is about 1,200 feet (≃ 370 m).

The Sheepbed is considered to be the youngest Proterozoic formation of the Mackenzie Mountains. Gabrielse, Blusson, and Roddick (in press) concluded that it is overlain unconformably by the Lower Cambrian succession.

Age assignments and correlations of Precambrian formations

As briefly noted above, the assignment of Helikian (middle Proterozoic) and Hadrynian (late Proterozoic) ages to Precambrian formations of the Mackenzie Mountains is based on tenuous evidence, and reflects *pro tem* acceptance of the views of Gabrielse (1972) more than conclusions based on firm evidence. Serious attempts have been made to date Precambrian rocks of the Mackenzies by radiometric methods, but these attempts so far have failed. Proterozoic diabase dykes and sills of the area lack any potassium-rich mineral, and are too low in whole-rock potassium content to yield reliable potassium-argon radiometric ages. Furthermore, no potassium-rich minerals have been recognized in the feebly metamorphosed wall-rocks of the intrusions. D. K. Norris (pers. com., 1972) has attempted to date the diabases by paleomagnetic methods, but the scatter of calculated paleo-poles is too broad to allow firm conclusions to be drawn as to the age of these rocks.

In the absence of information as to absolute ages, the Proterozoic formations have been dated questionably on the basis of long-range correlations based on gross lithology, sequence, and structural relations, as follows.

In British Columbia and Alberta near the 49th Parallel, two Proterozoic sequences of group or supergroup rank occur, separated by a major unconformity (Price, 1964, 1965; Gabrielse, 1972; Harrison, 1972). The lower of these, the Purcell System (Belt of northwestern U.S.A.) is characterized in the eastern part of its extent by mature clastic sedimentary rocks, carbonate rocks, and a suite of sedimentary structures generally characteristic of shallow-water sedimentation.

The upper sequence, the Windermere System, is characterized by immature and commonly coarse-grained clastic sediments and minor amounts of carbonate sediments; evidence indicative of shallow-water sedimentation is meagre. Suggested ages for these two supergroups or systems, based on radiometric and lead-isotope methods, are 850-1,450 m.y. (Helikian) and 600-800 m.y. (Hadrynian), respectively (Harrison and Peterman, 1971, supported by Gabrielse, 1972).

A thick Precambrian succession of mainly clastic and partly coarse-grained sedimentary rocks, the "Grit-Unit" (Gabrielse, 1967, p. 275), forms a nearly continuous belt along the western margin of the Eastern Cordillera from the type area of the Windermere in southeastern British Columbia into the Selwyn Mountains to the west of the Mackenzies. Because of its lithologic similarity to the Windermere, and its stratigraphic position between Lower Cambrian strata above and Purcell-like strata below, the "Grit-Unit" has been assigned to the Hadrynian (Gabrielse, 1967; Gabrielse *et al.*, in press). The "Grit-Unit" does not occur in the Operation Norman region, but Gabrielse *et al.* (in press) suggest a tentative correlation with the Rapitan Group.

Distribution of Purcell-like strata is notably discontinuous as compared with that of Windermere-like strata. The rocks of the type Purcell System plunge northward below the surface in southeastern British Columbia. Lithologically similar Purcell-like rocks reappear at the surface in the Tuchodi Lakes map-area (94K) of northeastern British Columbia (Bell, 1968; Taylor and Stott, in press). Farther north, these Purcell-like rocks again plunge from view, reappearing within the central part of the Mackenzie Arc. The assignment of Purcell-like rocks in the Mackenzie Mountains to the Helikian, therefore, is based essentially on their lithology and their position unconformably beneath the Rapitan Group, of supposed Hadrynian age. This correlation is supported by suggestive evidence in the form of the widespread occurrence of copper mineralization and the presence of "molar-tooth" structure (O'Connor, 1972), both features of the classical Purcell, in the putatively Helikian rocks of the Mackenzie Mountains (Gabrielse, 1972; Taylor and Stott, in press). Nevertheless, it is important not to lose sight of the uncertainties about the ages of the Precambrian rocks described in this report.

Several of the descriptions of measured stratigraphic sections included in the Appendix of this report contain references to "burrows(?)" and "*Arthrophycus(?)*" in unit H5 and older, supposedly Helikian, formations. All other evidence leads to the conclusion that these strata are older than any metazoan animals, and only metazoans generally are considered to have produced macroscopic burrows and trails (*see*, for example, Crimes and Harper, 1970). For this reason, no age significance has been attached to these questionable trace-fossils. The reported occurrences, however, do merit further, detailed study.

Strata of uncertain correlation

Proterozoic strata at Cap Mountain

On the flanks of Cap Mountain in the Franklin Mountains near Wrigley (950) to the south of the Operation Norman area, four Proterozoic formations crop out (Section AC-541, Appendix), totalling nearly 6,000 feet (≈ 1,830 m) in thickness. The units, which were originally mapped by Douglas and D. K. Norris (1963), were recently re-examined by Aitken and Macqueen (Aitken *et al.*, 1973), who tentatively assigned the entire sequence to the Helikian on the basis of the high degree of textural maturity of the clastics, abundance of carbonates, shallow-water aspect of most of the succession, and presence of widespread traces of copper mineralization - all features characteristic of Purcell but not Windermere strata. The Helikian age assignment for the entire sequence is in contrast to earlier assignments of the uppermost map-unit, the Lone Land Formation, to the Hadrynian by Douglas *et al.* (1970, p. 373), although the lower three map-units were regarded as Helikian (Douglas, ibid.). The Hadrynian assignment for the Lone Land was based on a supposed angular unconformity between the Lone Land and the underlying three map-units. Aitken *et al.* (1973) have demonstrated that no angular unconformity exists.

Shaler Group

In the northeastern part of the Operation Norman area (Fig. 1), moderately folded Proterozoic sedimentary rocks unconformably underlying Cambrian strata crop out on the Coppermine Arch. The succession consists of over 6,000 feet (≈ 1,830 m) of strata including limestone and dolomite (partly stromatolitic), orthoquartzite, shale, siltstone, and gypsum, all of probable shallow-water origin. They were assigned to the Shaler Group by Cook and Aitken (1969a) and Balkwill (1971).

The Shaler Group of the Coppermine Arch is not well understood. In terms of sedimentary rock suites, it resembles the Helikian(?) succession of the Mackenzie Mountains. On the other hand, gabbro dykes and sills that intrude the type Shaler Group on Victoria Island yield radiometric ages of 635 m.y. and 640 m.y. (Christie, 1964). The Shaler Group, however, may be older than the Hadrynian age implied by these dates. In the first place, the intrusions may significantly postdate the sedimentary rocks they intrude and, in the second place, the regional event that updated many K-Ar radiometric ages from the Coppermine River country (Wanless *et al.*, 1968, p. 66) may have affected the Victoria Island gabbros as well.

PHANEROZOIC

Paleozoic

Cambrian

Lower Cambrian

Backbone Ranges Formation

At its type area in the northeastern Backbone Ranges to the south of the Operation Norman area, the Backbone Ranges Formation consists of 4,700 feet (1,433 m) of resistant quartzite, sandstone, and sandy dolomite

(Gabrielse *et al.*, in press). Three members are recognized: a lower sandstone and quartzite unit, 1,600 feet (488 m) thick; a middle sandy and silty dolomite member, 500 feet (152 m) thick; and an upper pink-, brown- and purple-weathering sandstone unit, 2,500 feet (762 m) thick. A pronounced thinning of the formation takes place in an easterly direction within the Glacier Lake (95L) and Wrigley Lake (95M) map-areas, where it is reduced to only 180 feet (55 m) of clastic rocks near Little Dal Lake.

In the Operation Norman area, the formation consists of pink- to red-weathering, thick-bedded quartzite and sandstone, commonly crossbedded; and minor amounts of orange-weathering stromatolitic dolomite and green, yellowish brown, and red non-calcareous shale and mudstone (Pls. 11 to 14). Some of the quartzite contains thin lenses, beds and crossbeds of coarse sand through granule to fine pebble conglomerate; these grain size variations also characterize the type section (Gabrielse *et al.*, ibid.). At the single measured section of the Backbone Ranges Formation near the headwaters of Mountain River (U-8, 106A; stratigraphic cross-section C-D, Fig. 8), the formation is at least 659 feet (201 m) thick; both upper and lower contacts are covered. At latitude 64°48'N, longitude 131°00'W in map-area 106B, it is about 1,700 to 1,800 feet (520-550 m) thick as mapped.

In the Wrigley Lake map-area to the south, fossils of late Early Cambrian age have been collected from beds high in the Backbone Ranges Formation (Gabrielse *et al.*, in press).

The Backbone Ranges Formation is overlain conformably and gradationally by the Lower Cambrian Sekwi Formation (Pl. 14). In map-areas to the south, the upper beds of the Backbone Ranges Formation are believed to change laterally as well as vertically to strata assigned to the Sekwi Formation, and the basal contact is believed to be unconformable (Gabrielse *et al.*, in press).

Mount Clark Formation

The oldest Paleozoic rocks present in the Franklin Mountains are purplish or pinkish grey to white, thick-bedded, in part crossbedded, and resistant sandstones. They were assigned to the Mount Clark Formation by Williams (1923), with a designated type section near Cap Mountain in the Wrigley map-area (95O).

At the type section (section AC-541, Appendix), the formation consists of orthoquartzitic sandstone and subordinate quartzite, white to pale yellow at the base, with purplish and reddish grey intervals increasing upward from 300 feet (91 m) above the base, to the exclusion of other colours. The sandstone, in part somewhat friable, is mainly fine and very fine grained and well sorted, except for the basal 25 feet (8 m), which are not well sorted and contain layers of granules and pebbles. The formation is almost entirely very thick bedded and massive. Crossbedding of the tangential type is widespread, but prominent only in the basal 100 feet (≈ 30 m). Of particular importance is the development of the trace-fossil *Skolithos* (straight cylindrical sand-filled shafts perpendicular to bedding and 4 to 12 mm in diameter) in extraordinary numbers in the basal 300 feet (≈ 92 m) of the formation (Pl. 22).

Williams (1923) indicated a thickness at the type section of "about 620 feet" (≈ 190 m); Bell (1959) measured a thickness of 735 feet (224 m). In a hasty remeasurement over the difficult exposures of the type section, Aitken and Macqueen, in 1972, confirmed a thickness in excess of 700 feet (215 m) (Aitken *et al.*, 1973).

As noted by Douglas and D. K. Norris (1963), the basal contact of the Mount Clark Formation at Cap Mountain is an angular unconformity (Pl. 21). Williams (1923) made no mention of an unconformity between the Mount Clark and the overlying Mount Cap Formation, but Usher and Macqueen saw relationships suggestive of disconformity at the boundary at Mount Clark (Section U-15, 96C).

According to our present view, the Mount Clark Formation is restricted to the Franklin Mountains; within the Operation Norman area, the formation crops out in the vicinity of Mount Clark in the Fort Norman (96C) map-area, from which the name was adopted. The name was used for a basal Paleozoic sandstone unit exposed along the Coppermine Arch in the Erly Lake map-area (97A; Cook and Aitken, 1969a), but the term Old Fort Island Formation now appears more appropriate for that region (*see* below).

The Lower Cambrian assignment of the Mount Clark Formation is based on: (a) its position conformably or disconformably beneath the fossiliferous, later Lower and Middle Cambrian Mount Cap Formation, and specifically beneath Mount Cap beds bearing olenellid trilobites at the type section (A. W. Norris, *in* Douglas and D. K. Norris, 1963); (b) the angular unconformity with unfossiliferous Proterozoic strata at its base, and (c) the abundant *Skolithos* burrows in the formation. Although the evidence from identifiable skeletal remains dates the Mount Clark only as Early Cambrian or earlier, the presence of *Skolithos* is taken as strongly suggestive, if not diagnostic, of Paleozoic and hence Early Cambrian age.

Geologists of the Canol Project (*see* Tassonyi, 1969, p. 14, 15) were inclined to correlate the Mount Clark with the Katherine Group of the frontal Mackenzie Mountains (*see* Hume, 1954, p. 10-12). Although the Mount Clark Formation and Katherine Group are lithologically similar, they are almost certainly non-correlative for the following reasons:

(a) The Mount Clark Formation, wherever it has been observed, underlies the fossiliferous, Lower Cambrian Mount Cap Formation, whereas the Katherine Group is separated from fossiliferous Lower Cambrian strata by at least two regional angular unconformities and by intervening, unfossiliferous Proterozoic strata that are over 500 feet (≈ 153 m) thick in the type area of the Katherine Group and up to 6,000 feet (≈ 1,830 m) thick farther into the Mackenzie Mountains.

(b) The trace-fossil *Skolithos* is characteristic of the Mount Clark Formation, but has not been observed in the Katherine.

(c) The base of the Katherine Group, wherever observed, is conformable and gradational with the underlying Tsezotene Formation, whereas the base of the type Mount Clark is marked by an angular unconformity underlain by rocks totally unlike the Tsezotene.

An Early Cambrian age is, therefore, most likely for the Mount Clark Formation.

Old Fort Island Formation

Friable, crossbedded and, in part, recessive quartz arenites overlie Precambrian rocks along the western shore of Great Slave Lake: to these, A. W. Norris (1965) applied the name Old Fort Island Formation. The type

locality is at Old Fort Island, located near Wrigley Point about mid-way up the west shore of the North Arm of Great Slave Lake (A. W. Norris, 1965, p. 15). Although the unit locally is discontinuous, H. R. Balkwill (1971) has established the essential physical continuity of the Old Fort Island with the "basal Paleozoic sandstone" or Mount Clark Formation of the eastern updip edge of the Paleozoic strata in the Operation Norman area (Balkwill, 1971; Cook and Aitken, 1969a, 1971b). In the southern part of Great Bear Plain, the Old Fort Island occupies paleo-depressions between knobs and ridges on the Precambrian erosional surface (Balkwill, 1971); to the north, in the Erly Lake and Coppermine map-areas, it is somewhat more continuous, although relief on the lower surface is commonly as much as 200 feet (≃ 60 m) (Cook and Aitken, 1969a, 1971b).

At the two measured section localities along Little Hornaday River in the Erly Lake map-area (97A; Cook and Aitken, 1969a; MQ-20, MQ-23, this report), the Old Fort Island ("Mount Clark") consists of about 200 feet (60 m) of fine- to coarse-grained quartz arenite to conglomerate, weakly cemented with silica and friable, virtually mono-mineralic, locally iron stained, and commonly showing well-developed tangential crossbedding. Similar sandstone units extend from Great Slave Lake (A. W. Norris, 1965) into the Arctic Islands, where a basal Paleozoic sandstone unit occurs on Banks and Victoria Islands (Thorsteinsson and Tozer, 1962). Trilobites (GSC loc. 75239) assigned to the Early Cambrian *Bonnia-Olenellus* Zone were collected from this basal sandstone on Victoria Island by B. P. Plauchut of Elf Oil Company in 1967. The unit is, therefore, either contemporaneous with, or very slightly older than, the lower part of the Mount Cap Formation (*see* below). Correlation with the lower part of the upper limestone member of the type Sekwi Formation also is indicated (GSC internal reports C6-1967-WHF; C7-1971-WHF). Only the trace-fossil *Skolithos* has been recorded from the Old Fort Island Formation in the Operation Norman area.

Relationships between quartz arenite units

Use of the name Old Fort Island is restricted to essentially flat-lying quartz arenites which crop out along the eastern edge of the Paleozoic outcrop belt. The name Mount Clark Formation also is restricted in usage, to the sandstone and quartzite sequence of the McConnell Range of the Franklin Mountains; the Backbone Ranges Formation is recognized only in the Mackenzie Mountains. The Backbone Ranges Formation is definitely Early Cambrian in age, at least in its upper part; the Mount Clark Formation is very probably Early Cambrian. The Old Fort Island, being overlain at three localities by strata of the Middle Cambrian *Glossopleura* Zone (*see* below), is unlikely anywhere to be younger than early Middle Cambrian. Although the three formations are similar lithologically, their time relationships are only partly resolved at present. There is no compelling reason to suspect either that they are all of the same age, or that significant differences in age do not occur from place to place within one particular formation. Many Paleozoic successions in both eastern and western North American continental terrace wedge or miogeoclinal assemblages are underlain by quartz arenite units which range in age from latest Precambrian to Early Ordovician, despite strong lithologic similarities (Wheeler, 1960).

Sekwi Formation

The Sekwi Formation, with its type section in the Sekwi Range at latitude 63°31'N, longitude 128°41'W (105P) is a resistant, brightly coloured, and usually thick carbonate unit recognized over a wide area in the interior ranges of Mackenzie Mountains (Handfield, 1968; Fritz, 1972).

A variety of rock types, many of which have bright colours when weathered, characterizes the Sekwi; prominent among them are: pale grey to pale yellowish brown micritic and skeletal limestone; silty, rusty brown dolomite; green, red, and brown shale and argillite; dark brown to greyish green mudstone; and red, green, purple and grey quartzite. The formation, however, is dominated by limestone which contains trilobites at many levels (*see* sections U-1, 106B; U-7, 106B; U-8, 106A; also Pls. 13, 14).

In the Operation Norman area, two factors contribute to restriction of the Sekwi to the interior ranges of the Mackenzie Mountains. The first of these is depositional thinning onto the Mackenzie Arch (Douglas *et al.*, 1970, Fig. VIII-11); the second is erosional bevelling at the sub-Upper Cambrian unconformity, most pre-Upper Cambrian formations being completely removed along the Mackenzie Arch (*see* Fig. 3; stratigraphic cross-section B-D-F, Fig. 9; also stratigraphic cross-section A-B, Fig. 7).

Near the headwaters of Arctic Red River at section U-1 (106B), the Sekwi Formation is at least 3,303 feet (1,007 m) thick and consists predominantly of grey to brownish grey, nodular, micritic limestone with trilobites at several levels. The base of the section is marked by an interval, 183 feet (56 m) thick, of colourful quartzite with dolomitic argillite interbeds. Sixteen miles (25 km) to the east at section U-7 (106B; stratigraphic cross-section C-D, Fig. 8), the Sekwi is incompletely exposed, but consists of interbedded argillaceous limestone and dolomite in the upper part, and white, yellowish brown, and light grey, finely crystalline to microcrystalline dolomite in the lower part. To the south, the Sekwi is known to exhibit considerable variation in thickness and particularly in lithology. This variation has been outlined and interpreted in terms of middle carbonate (shelf) and outer detrital (basinal) facies by Fritz (1973). Lithological and paleontological relationships in the Wrigley Lake-Glacier Lake-Flat River map-areas indicate that the Sekwi Formation is in part equivalent to the underlying Backbone Ranges Formation (Gabrielse *et al.*, in press).

The type Sekwi Formation is entirely Early Cambrian in age (Handfield, 1968; Fritz, 1972), and contains three trilobite faunal zones. The lowermost is the *Fallotaspis* Zone, which is succeeded by the *Nevadella* Zone, and then by the uppermost or *Bonnia-Olenellus* Zone (Fritz, 1972). Collections made by Usher from the incomplete easterly Sekwi section U-7 (106B) belong to the *Bonnia-Olenellus* Zone, and indicate that the interval from which they were collected correlates with the upper limestone unit of the Sekwi Formation at the type section (Fritz, 1972; GSC internal report C8-1971-WHF). For Usher's section U-1, to the west, Fritz indicates that the 183-foot (56 m) thick quartzite unit at the base of the Sekwi probably lies just below the boundary between the *Nevadella* and *Bonnia-Olenellus* Zones. In the same section, the presence of *Wanneria* sp. 1,418 feet (432 m) above the top of the quartzite unit indicates a mid-*Bonnia-Olenellus* age for the upper part of the Sekwi Formation (Fritz, GSC internal report C9-1971-WHF).

Lower and Middle Cambrian

Mount Cap Formation

M. Y. Williams proposed the name Mount Cap Formation in 1922 for a sequence located on the flanks of Cap Mountain in the Wrigley map-area (95O), consisting of about "100 feet or more of green and rusty, thin-bedded sandstone, and overlying grey and rusty shale or phyllites" (Williams, 1922; 1923, p. 76B-77B; quoted *in* Tassonyi, 1969, p. 15). The Mount Cap is underlain, conformably

according to Williams (1923), Bell (1959) and Douglas and Norris (1963), by the Mount Clark Formation at the Mount Cap type section, and is overlain by red gypsiferous shale of the Saline River Formation, although the top of the Mount Cap Formation does not crop out at the type section. Bell (1959, p. 12) described the Mount Cap at a location on the east side of Franklin Range south of Blackwater Lake, where much of the formation is covered, to consist of more than 560 feet (171 m) of dolomite and limestone with minor amounts of grey shale.

The name Mount Cap was not generally used in the Mackenzie Mountains by Canol Project workers, who assigned to the Macdougal Group of Nauss (1944; cited *in* Hume, 1954) the interval from the base of the "Dead End" shales (Helikian unnamed map-unit H5, Dodo Canyon, U-12, MQ-6; *see* Pls. 16, 17) to the top of the gypsiferous beds. Hume (1954, p. 11) suggested that the Mount Cap and Saline River Formations are equivalent to the middle and upper parts of the Macdougal Group, respectively, based on the similarity in lithology. This correlation is confirmed by the present study (although the term Macdougal Group is regarded herein as obsolete). Tassonyi (1969, p. 15) supported this view and suggested, in addition, that stratigraphic equivalents of the Mount Cap are probably present in the subsurface of the entire area.

Rocks assigned to the Mount Cap within the Operation Norman area occur along the updip edge of the Paleozoics in the Interior Plains, within the Franklin Mountains, and at scattered localities within the Mackenzie Mountains. The Mount Cap interval includes glauconitic sandstone, quartzose and glauconitic limestone, and non-calcareous, sandy or silty, red, green, dark grey and black shale. The Mount Cap Formation is encountered relatively rarely within the Mackenzie Mountains, owing to sub-Saline River or sub-Franklin Mountain erosion (*see* stratigraphic cross-sections E-F, Fig. 6; and A-B, Fig. 7). However, the Mount Cap does occur within the Mackenzies at Dodo Canyon (MQ-6, 96D; Pls. 17, 19), where it is 329 to 354 feet (100-108 m) thick and overlies "Dead End Shale" beds of the unnamed Proterozoic unit (H5) of probable Helikian age. About 22 miles (35 km) northwest at Loretta Canyon (U-11, 96E), the interval assigned to the Mount Cap is only 83 feet (25 m) thick (*see* stratigraphic cross-section C-D, Fig. 8). A fairly thick section (695 ft., 212 m) of the formation was examined on the flanks of Mount Clark at locality U-15 (96C).

In southern Great Bear Plain, the Mount Cap together with the overlying Saline River Formation have been treated as a single map-unit (Balkwill, 1971) owing to the recessive nature of the Mount Cap-Saline River interval. Along strike to the north, the two formations can be mapped separately in the Colville Lake-Coppermine and Erly Lake map-areas (Cook and Aitken, 1969a, 1971b). Within this eastern outcrop belt, the Mount Cap reaches a maximum known surface thickness of about 230 feet (70 m; section MQ-20), and consists of grey, green and rarely red shale with interbedded burrowed glauconitic sandstone and siltstone, the burrows resembling those shown in plate 19. Subordinate dolomite occurs at some localities. The lower contact is conformable with the underlying Old Fort Island sandstone. In the southern part of Great Bear Plain, the Mount Cap of the Operation Norman area, together with the overlying Saline River, is in physical and mappable continuity with the lower part of A. W. Norris' (1965) La Martre Falls Formation of Great Slave Plain (*see* Balkwill, 1971, p. 14)

In comparison with the Mount Cap of the eastern outcrop belt (*see* sections MQ-20, MQ-24, this report; Balkwill, 1971; Cook and Aitken, 1969a, 1971b) the Mount Cap of the Franklin and Mackenzie Mountains (sections U-15, 96C; U-11, 96E; MQ-6, 96D) is: (a) thicker, (b) composed of impure pyritic limestone, dark grey to black shale, and subordinate well-burrowed sandstone and siltstone, (c) lacking in the green and red shale of the eastern belt, and (d) moderately fossiliferous.

Fossils are rare in the Mount Cap in the eastern outcrop belt, but collections from exposures of the combined Mount Cap - Saline River Formation interval near Hottah Lake (86L) are of Middle Cambrian age, and belong to the *Glossopleura* or possibly the *Bathyuriscus-Elrathina* Zone (Fritz; *in* Balkwill, 1971, p. 36; also p. 13). Additional collections, probably from the Mount Cap Formation as encountered in a seismic shot hole southwest of Mount Clark, were made by G. K. Williams in the Fort Norman area (96C); these were identified tentatively by W. H. Fritz as of Middle Cambrian age (GSC internal report C13-1971-WHF). Collections made by W. S. MacKenzie from the upper part of a combined Mount Cap-Old Fort Island interval in the almost completely cored Mobil Colville Hills E-15 well on the west side of Colville Lake (96M) contain the Lower - Middle Cambrian boundary, including the Early Cambrian *Bonnia-Olenellus* Zone fauna, as identified by W. H. Fritz (GSC internal report C6-1973-WHF) and discussed by Macqueen and MacKenzie (in press). The 17 collections identified were obtained from cored interval 4,755-4,902 feet, and occur in glauconitic shales which resemble those described from section MQ-6, at Dodo Canyon in the Mackenzie Mountains. Fritz postulates little or no break across the Lower - Middle Cambrian boundary (Fritz, ibid.). Farther west, in the Imperial Vermilion Ridge No. 1 well of the Norman Wells area (96E), 7 collections from probable Mount Cap Formation beds were dated by W. H. Fritz as of Middle Cambrian age, belonging to the early Middle Cambrian *Glossopleura* Zone (GSC internal report C3-1970-WHF). According to Tassonyi (1969, p. 16), the basal 392 feet of this well, from which the collections were made, are assigned to the Mount Cap Formation.

Within the Franklin Mountains, all the collections made at section U-15 are of late Early Cambrian age, belonging to the *Bonnia-Olenellus* Zone (Fritz, GSC internal report C19-1969-WHF). At Dodo Canyon (MQ-6; 96D) in the Mackenzie Mountains, however, the Lower-Middle Cambrian boundary occurs within strata assigned to the Mount Cap Formation, at a probable disconformity located 128 feet (39 m) above the base of the Mount Cap. There, a late Early Cambrian *Bonnia-Olenellus* Zone fauna is overlain by Middle Cambrian *Albertella* Zone and *Glossopleura* Zone faunas (GSC internal report C10-1968-WHF; Appendix, section MQ-6). Fritz (1970, p. 110) postulates that the *Plagiura-Poliella* Zone (lowermost Middle Cambrian) and the lower part of the *Albertella* Zone may be missing at this probable unconformity within the Mount Cap at Dodo Canyon. Farther south in the Carcajou Canyon area (96D), the Mount Cap has yielded an early Middle Cambrian fauna which may belong to the *Plagiura-Poliella* Zone that is missing at Dodo Canyon (Fritz, GSC internal report C24-1969-WHF).

The widespread presence of *Bonnia-Olenellus* Zone fossils within the Mount Cap indicates that at least the lower part of the unit at Dodo Canyon, and probably all of the exposed part of the unit at Mount Clark, can be correlated with the upper part of the type Sekwi Formation discussed above (*see* also Fritz, 1972). It will be noted that the Mount Cap of the frontal Mackenzie Mountains includes beds younger (up to Middle Cambrian *Glossopleura* Zone) than any reported from the type section. At the scale of mapping currently being done in the region, Middle Cambrian beds cannot be separated from Lower Cambrian beds in the Franklin Mountains and frontal Mackenzies. Furthermore, the type section of the Mount Cap is incompletely exposed, the top being covered.

Upper Cambrian

Saline River Formation

Williams (1923) proposed the name "Saline River Formation" for a poorly exposed succession of red and green shale with salt casts and gypsum

beds, located on Saline River about 1 1/2 miles (2 1/2 km) upstream from the confluence of Saline and Mackenzie Rivers (U-14, 96C, this report). The upper contact, which is conformable and gradational with the overlying cyclic unit of the Franklin Mountain Formation (=basal Ronning Group of Macqueen, 1969, 1970), is exposed at the type section; the lower contact is not exposed. Williams correctly indicated (1923, p. 77B) that the Saline River Formation also is present at Mount Kindle where only scattered exposures occur below the Franklin Mountain cyclic unit. Near Bear Rock (96C; locality MQ-3, this report), Stelck (cited *in* Hume, 1954, p. 12) correctly considered 175 feet (53 m) of red and green shale, gypsum, and dolomite to be correlative with the Saline River Formation. Hume (ibid., p. 11), in summarizing Canol Project reports, suggested that the Saline River Formation is correlative with the upper part of the Macdougal Group in the Mackenzie Mountains. Neither the Mount Cap nor the Saline River Formation was recognized in the Mackenzies by Canol Project workers.

In the Dahadinni River (95N) and Wrigley (95O) map-areas to the south of the Operation Norman area, Douglas and D. K. Norris (1963) mapped the recessive Saline River-Mount Cap as one unit, as did Balkwill (1971) in the southern part of Great Bear Plain of the Interior Plains. Tassonyi (1969, p. 17) has provided details of the thick Saline River Formation rocks intersected in the Imperial Vermilion Ridge No. 1 well (map-area 96E), where some 2,782 feet (848 m) of section are assigned to the Saline River Formation. Two members are recognized: a lower salt and anhydrite unit, about 2,200 feet (670 m) thick; and an upper shale unit, 562 feet (171 m) thick.

In the Operation Norman area, the Saline River Formation is exposed in three areas (Fig. 1): (a) along the up-dip edge of the Interior Plains Paleozoic outcrop belt which fringes Bear and Slave Provinces of the Canadian Shield; (b) in the Franklin Mountains, and (c) along the Mackenzie Mountain front, and locally in Mackenzie Mountain interior (northern half of map-area 106A only). In the Interior Plains (MQ-20, 97A; MQ-22, 86M; MQ-24, 97D; also Cook and Aitken, 1969a, 1971b; Balkwill, 1971), the unit at the surface is from 100 to 200 feet (≃ 30-60 m) thick, and consists typically of recessive, red and green papery shale and mudstone commonly with salt crystal casts (Pl. 20), thin interbeds of very finely crystalline yellowish brown to pale green dolomite, and rare intercalated gypsum beds, commonly as displacive seams which indicate solution and reprecipitation on the surface (e.g. MQ-22, 86M). Ripple-marks and mud cracks are abundant on bedding surfaces (Pl. 20). The Saline River Formation of the southern part of Great Bear Plain, together with the underlying Mount Cap, is in physical continuity with the lower part of the La.Martre Falls Formation (A. W. Norris, 1965) of Great Slave Plain to the south (*see* Balkwill, 1971, p. 14).

Within the Franklin Mountains, the Saline River Formation was examined at the type section (U-14, 96C), near Bear Rock (MQ-3, 96C), and in the Norman Range (MQ-2, 96E). The upper contact is gradational and apparently conformable with the overlying cyclic unit of the Franklin Mountain Formation, and is arbitrarily drawn at the top of the stratigraphically highest, 5-foot (1 1/2 m) thick or more, red shale or mudstone unit (Pl. 15). The lower contact is not exposed at any of these localities. The maximum thickness seen in the Franklins is at section MQ-2 within the Norman Range, where 532 feet (162 m) of red mudstone, red and green shale, dolomite, and gypsum are assigned to the Saline River Formation (Pl. 15). This may be a tectonically thickened section. There is evidence, as pointed out by Cook and Aitken (in press) that the Saline River has acted as a zone of décollement along which horizontal translation of overlying units has occurred in the

Franklins and in Colville Hills. Contorted dolomite beds enveloped in gypsum occur at section MQ-2, indicating at least local flowage of evaporite beds. At sections examined in the Franklin Mountains (MQ-2, MQ-3), the Saline River appears to be dominated by red and green mudstone closely associated with massive gypsum or, less commonly, fibrous selenite. Thin intercalated beds of dolomite occur at several levels, and some dolomite beds contain stromatolites. The dolomite beds are tightly enveloped in gypsum and shale, and commonly show boudinage in addition to quasi-flexural folds.

Rock types within the Saline River Formation along the Mackenzie Mountain front are similar to those of the Franklin Mountains, with red and green gypsiferous shale or mudstone and pale pink to grey gypsum dominant. Interbedded with these are thin beds of yellowish brown dolomite, locally brecciated and stromatolitic. At Loretta Canyon (U-11, 96E; Pl. 18), a quartz sandstone unit, 20 feet (6 m) thick, occurs near the base of the Saline River Formation; to the south near Keele River (MQ-33), fine- to coarse-grained, light grey quartz sandstone dominates the Saline River and is interbedded with dusky red to greyish green, sandy mudstone or shale. Some sandstone beds are well cemented; others are virtually uncemented and thus are recessive. Ripple-marks and salt crystal casts are common within the shale and mudstone.

Along the arc of the Mackenzie Mountain front, the Saline River Formation is continuously present only east of Mountain River. West of Mountain River, it may be discontinuously present (though very thin) for about another 25 miles (40 m). Elsewhere, Franklin Mountain Formation carbonates rest directly either on the Katherine Group, or on the unnamed Helikian unit (H5). It is significant that the Franklin Mountain Formation cyclic unit also is missing in those areas in which the Saline River is absent. Thicknesses change rapidly, ranging in the three measured sections from 318 feet (97 m) at Loretta Canyon (U-11, 96E) to 590 feet (180 m) along a tributary of Keele River (MQ-33, 96D).

Usher observed evidence of an unconformity at the Saline River-Mount Cap contact at Loretta Canyon (U-11, 96E), and subsequent mapping has provided incontrovertible evidence for this unconformity by demonstrating that in the Mackenzie Mountains the Saline River successively overlies formations ranging downward from Mount Cap to the Katherine Group. This is clearly the "sub-Franconian" unconformity of Gabrielse *et al.* (in press), although in the Operation Norman area Dresbachian trilobites collected from the basal Franklin Mountain Formation indicate that the unconformity must be at least locally sub-Dresbachian. Indeed, on the basis of present data it cannot be proved that the unconformity does not range into uppermost Middle Cambrian beds, such that the Saline River includes beds of latest Middle Cambrian age. Faunal data do not support such a relationship, but it cannot be ruled out at present. The distribution and thickness variations of the Saline River and the overlying Franklin Mountain Formation cyclic unit, and the onlapping relationship of the Franklin Mountain Formation rhythmic unit suggest that the Saline River accumulated in paleotopographic lows as the earliest deposits following a pre-Late Cambrian tectonic event.

The views of the Canol geologists, based on local observations and scarce fossil data, that the Saline River was conformable with the Mount Cap and unconformably overlain by the "Ronning Group" (Franklin Mountain Formation) cannot be supported.

Upper Cambrian(?)

"Basal Franklin Mountain red beds"

A unit characterized by red beds and homotaxial with the Saline River Formation and/or the cyclic unit of the Franklin Mountain Formation, but lacking gypsum and containing much more sandstone, has been mapped over an extensive area peripheral to that in which Saline River evaporites occur.

At the head of Cache Creek (106A), the unit is about 100 feet (30 m) thick and consists mainly of sandstone that weathers dull purplish red. It is medium to very fine grained, dull brownish purple to pale purplish brown on fresh surfaces, and thin to thick bedded. Numerous beds of conglomerate occur, mainly shale-pebble conglomerates, but including pebbles of dolomite, quartz, and quartzite near the base, which is in contact with Helikian unit H5.

Near the main branching of Mountain River, at latitude 64°47'N, longitude 129°16'W (106A), the thickness is similar. The sandstone resembles that described above, and is largely dolomitic; deep red shale is present in subordinate amounts, as are thin beds of conglomerate and breccia. Also present are a few beds of yellow-weathering microcrystalline dolomite and thin discontinuous beds or lenses of grey chert. The sandstone and shale contain rare salt-crystal impressions.

At about half of the localities at which the basal Franklin Mountain red-beds unit has been seen, the corrugated grazing-track *Arthrophycus* is developed prominently on bedding surfaces of sandstones. Such a development of *Arthrophycus* has not been noted in any other formation of the Mackenzie Mountains: several reports of *Arthrophycus* in probable Helikian strata, noted in the stratigraphic sections found in the appendix, are considered doubtful and require further investigation.

No measured sections were obtained of a typical manifestation of the basal Franklin Mountain red-beds unit. The uppermost 5 units of section U-2 (106G) probably represent the red-beds unit but, like other occurrences near the pinchout of the unit, lack the pronounced reddish and purplish colouration.

The unit is considered to be in conformable, gradational contact with the overlying beds of the Franklin Mountain Formation (*see* Pls. 3, 5); where it occurs, the basal Franklin Mountain cyclic unit (Macqueen, 1969, 1970) is not developed. Lithology, stratigraphic position, and distribution of the basal Franklin Mountain red-beds unit, and the local presence of salt-crystal impressions, all support the interpretation that it is a marginal facies deposited around the shoreline of the Saline River evaporite basin.

At many localities at which the cyclic member is missing, and especially where the underlying rocks are sandstones or quartzites, thick beds of sandstone, dolomitic sandstone, and sandy dolomite are incorporated in the base of the Franklin Mountain Formation. These beds are generally pale grey or yellowish grey; only locally are they pale red. For this reason, their colour when weathered is similar to that of the overlying and interbedded dolomites, and their limits cannot be seen from any distance. Therefore the basal sandstone and sandy beds have not been mapped separately, although their position and lithology obviously suggest correlation with the basal red-beds unit.

Cambrian and Ordovician

Road River Formation

In the northeastern quarter of map-area 106B and the northwestern quarter of map-area 106A, a thick interval of dark grey or brown shale and thin-bedded, argillaceous and silty limestone with lesser amounts of secondary dolomite overlies the Lower Cambrian Sekwi Formation (*see* sections U-6, U-7, 106B; also stratigraphic cross-section C-D, Fig. 8). Because of its position and lithology, this interval is identified as the Road River Formation of Jackson and Lenz (1962).

The type Road River Formation is located in the Richardson Mountains of the northeastern Yukon, where it consists of dominantly Ordovician and Silurian micritic limestone and graptolitic shale with associated carbonate breccia and conglomerate characteristic of slope and basin deposits. Jackson and Lenz (1962, p. 32) indicated that the oldest Road River rocks exposed in the type area are conformably underlain by shale, siltstone, and sandstone of Cambrian age. Work by Norford (1964) in the type area indicated, however, that Upper Cambrian beds (Dresbachian) are present in the Road River (Norford, ibid., p. 3).

In the Operation Norman area, the interval identified as Road River Formation ranges in age from Middle Cambrian to Early Ordovician on reliable faunal evidence cited below. Identification of Middle Cambrian faunas in this distinctive basinal facies is new, but not unexpected, because all younger units up to Middle Devonian are known to change facies from platform carbonates in the northeast to basinal shales and carbonates (Road River) in the southwest. The new fossil discoveries reported herein merely extend this relationship further back in time.

The faunas collected from the Road River of the Operation Norman area correspond to those of the Rockslide and Broken Skull Formations of map-areas 95L and 95M (Gabrielse *et al.*, in press) to the south, and the lithologies are similar. On the other hand, the unconformable Rockslide-Broken Skull contact, described as being identifiable at a distance and in aerial photographs, was not recognized, nor was a contact recognized between Broken Skull equivalents and overlying beds of the Road River.

In the Operation Norman area the Road River Formation is characterized by thin-bedded to laminated, flaggy to shaly impure limestone, commonly with argillaceous, dolomitic or siliceous mottling. Interbedded with the limestone are subordinate intervals of dolomite of similar character. Dark grey to black shale occurs as thin interbeds or thick intervals, the latter especially in the lower part of the unit. Black chert lenses and nodules in dolomite are prominent at the highest part of the unit seen at section U-6 (106B). Well-developed sedimentary overfolds and conglomeratic beds showing evidence of having been emplaced by sliding and/or rolling demonstrate that the Road River consists, in significant part, of slope deposits.

Two measured sections of the Road River are included here; together they contain a nearly complete sequence of trilobite zones from Middle Cambrian to Early Ordovician in age. If sections U-6 (106B; 2,464 ft., 751 m) and U-7 (106B; 1,625 ft., 495 m) are combined [and they are less than four miles (6.5 km) apart, and in the same structure], the following zones are represented, no zone being common to the two measured sections (W. H. Fritz, GSC internal reports C8-1971-WHF and C9-1972-WHF):

Early Ordovician

Zone A or B

Late Cambrian

Saukia Zone
Ptychaspis-Prosaukia Zone
Conaspis Zone
Elvinia Zone
Aphelaspis or *Dunderbergia* Zone
Cedaria or *Crepicephalus* Zone
Cedaria Zone

Middle Cambrian

Bolaspidella Zone
Bathyuriscus-Elrathina Zone

It is noteworthy that the youngest fauna within the uppermost 338 feet of Road River beds underlying the Mount Kindle Formation of U-7 belongs to the late Middle Cambrian *Bathyuriscus-Elrathina* Zone, whereas the youngest fauna recovered from the Road River at section U-6 belongs to Early Ordovician Zone A or B. The gross difference in the ages of the youngest Road River beds at the two localities is believed to be due to erosional bevelling at the base of the Mount Kindle Formation.

TECTONICS AND PALEOGEOGRAPHY

PROTEROZOIC

Helikian continental terrace wedge (H1, Tsezotene Formation, Katherine Group, H5, Little Dal Formation)

Rocks herein tentatively regarded as correlative with the Belt-Purcell sequence of the southern Canadian Cordillera (Helikian, Table 1) range in exposed thickness from 5,000 to 15,000 feet (≃ 1,500-4,500 m) within the Operation Norman area. All of the five map-units of this sequence contain abundant evidence of shallow-water deposition, and are reasonably interpreted as constituting the shallow-water part of a continental terrace-wedge assemblage (coastal plain; shelf; slope; continental rise) which flanked the exposed low-relief craton to the east (Gabrielse, 1967, 1972). The mature clastic sediments within this wedge appear to have been derived from the craton (Gabrielse, ibid.), although this interpretation requires further study. Within the terrace wedge of the Operation Norman area, several depositional units, particularly the Tsezotene Formation, Katherine Group, and Little Dal Formation, thicken southwestward or westward (*see* cross-section E-F, Fig. 6). Data on textural characteristics of the sediments are incomplete, but some units (e.g. Tsezotene Formation) are increasingly argillaceous and less well sorted in a southwesterly direction, probably indicating the onset of slope environments. Gabrielse (1972, p. 526) noted the presence of a thick argillite unit of probable deep-water origin in the lower part of the Helikian sequence in the western Mackenzies. This unit may be the slope or continental rise equivalent of the shallow-water sediments of the eastern Mackenzie Mountains, although the margin of the craton, which ought to underlie continental rise sediments according to the Atlantic Continental Margin model (e.g. Dietz and Holden, 1966; and others),

is unknown for the Belt-Purcell sequence. For Belt-Purcell sediments of the Canadian Cordillera, the continental terrace-wedge interpretation was best established by Price (1964) for the Purcell sequence of southern British Columbia, where geometry, thickness, and grain-size changes all support such an interpretation, and the succession compares favourably with the upper Tertiary and Quaternary Gulf Coastal Plain succession (Price, ibid., *see* also Gabrielse, 1972). Monger, Souther, and Gabrielse (1972), in applying modern concepts of global tectonics to the evolution of the Canadian Cordillera, viewed the Cordilleran terrace wedge of Purcell age as having developed on the western flank of the Hudsonian crystalline basement, following a mid-Proterozoic episode of rifting. In contrast, Stewart (1972) has suggested that rifting and subsequent terrace-wedge development is post-Purcell, pre-Windermere (Hadrynian) based on differing depositional trends between Belt-Purcell sediments, and overlying Windermere sediments. Stewart's data are largely (but not exclusively) derived from upper Precambrian sequences in the United States; more data on geometry, tectonic and depositional trends within the Canadian Belt-Purcell succession are needed to test Stewart's interpretation.

Racklan Orogeny

The regional unconformity between the Rapitan Group and underlying units is an expression of the Racklan Orogeny (Gabrielse, 1967, p. 274). In the Mackenzie Mountains, it appears to have caused extensional block faulting and tilting of the Helikian succession prior to deposition of the Hadrynian succession. Monger, Souther and Gabrielse (1972, p. 584) attempted to relate this event to a change in plate-tectonic regime, but reliable data are few, and their argument is not particularly compelling.

North-northwesterly trending basic dykes, which cut all pre-Rapitan formations in the Operation Norman area, are common also in supposed Helikian rocks of northeastern British Columbia (Bell, 1968; Taylor and Stott, in press), and may have been emplaced along fractures developed during the Racklan Orogeny.

No one has succeeded yet in obtaining realistic absolute ages for these igneous rocks: ages derived to date are Paleozoic and Mesozoic, and are clearly impossible on structural grounds. Their dating and compositional variation is an urgent subject for intensive investigation.

Hadrynian succession

(Rapitan Group, Keele Formation, Sheepbed Formation)

The Hadrynian (Windermere) succession, viewed along the length of the Cordillera, appears also to consist of a continental terrace-wedge assemblage, offlapping the underlying Helikian (Belt-Purcell) sequence (Gabrielse, 1967). In contrast to Helikian rocks, Hadrynian rocks are texturally and compositionally immature, and comprise large volumes of argillite, siltstone, feldspathic sandstone, grit, conglomerate and diamictite (diamictite = non-sorted sedimentary rock consisting of sand and/or larger particles in a muddy matrix; Crittenden *et al.*, 1971, after Flint *et al.*, 1960).

The supposed Hadrynian succession of the Operation Norman area is 9,000 feet (≈ 2,750 m) or more thick west of the Mackenzie Arch, but thins rapidly toward the Arch, and is not known to occur east of it (Figs. 3, 7,

8, 9). Regional unconformities are present at the base of the Lower, Middle, and Upper Rapitan members (Gabrielse *et al.*, in press; Cook and Aitken, 1971a). A basal diamictite unit is overlain directly by a bedded hematite-jasper iron formation in the Snake River area (Green and Godwin, 1963; Gross, 1965; Gabrielse, 1972; Gabrielse *et al.*, in press). No iron formation is known in the Rapitan of the Operation Norman area. The diamictites of the Lower and Middle Rapitan members in the Operation Norman area (termed conglomerate or megaconglomerate in sections U-8, AC-540, Appendix) are dominated by clasts of the underlying Little Dal Formation; diverse other lithologies also are present.

Two major problems posed by the diamictites are their lateral persistance and origin. Diamictites are known at approximately the stratigraphic level of the Lower Rapitan over a vast area of the Cordillera, from Alaska to California (Gabrielse, 1967, 1972; Crittenden *et al.*, 1972). What is not known is whether or not all of these occurrences are contemporaneous. The basal diamictite is regarded by Crittenden *et al.* (1972) as sufficiently distinctive to enable its usage as a reference unit for regional correlation within the upper Precambrian of western North America. They further regard the basal diamictite deposits as broadly contemporaneous. Many authors have attributed a glacial origin to these diamictite units, either as tillites or closely related, subaqueous mudflows derived from tillites. Aalto (1971) has presented a convincing case for glacial phenomena leading to the origin of the Toby conglomerate, a 2,000-foot (≃ 770 m) thick unit which forms the base of the classical Windermere sequence in southeastern British Columbia. According to Gabrielse (pers. com., 1972), the basal Rapitan diamictite at a number of localities in the Mackenzies closely resembles the Toby conglomerate of southern British Columbia. Alternatively the basal diamictite may be wholly or in part a result of rapid erosion along active fault scarps (Douglas *et al.*, 1970).

The lower part of the Rapitan, within which both diamictite and iron formation occur, is strongly tuffaceous in parts of the Wrigley Lake map-area (95M; Gabrielse *et al.*, in press). Tuffaceous beds have not been observed in the Operation Norman area, although some of the Lower Rapitan siltstones may be of volcaniclastic origin.

Where examined in the Operation Norman area, the Upper Rapitan contains many mudstones, shales, and siltstones in which plane-parallel lamination and sedimentary overfolds (slumps?) are evident; these suggest accumulation of Rapitan rocks within slope and relatively deep-water environments. On the other hand, intercalations of carbonates and especially stromatolitic carbonates at some localities suggest a shallow-water environment; these apparently contradictory implications have yet to be resolved into a plausible model for Upper Rapitan deposition. No rocks of Rapitan age are known to be preserved east of the Mackenzie Arch. The Lone Land Formation of the Mount Cap succession (section AC-541, Appendix), formerly regarded as Hadrynian (Douglas *et al.*, 1970), is regarded by Aitken *et al.* (1973) and herein as more probably of Helikian age.

In view of the unconformities beneath the Middle and Upper Rapitan and the striking lithologic differences among the three units, it is plausible that each unit accumulated in a different tectonic environment.

The Keele Formation, a unit of alternating carbonate and relatively mature clastic rocks which, in the Operation Norman area, is apparently conformable with the Upper Rapitan, marks a return to shelf conditions over the northeastern Mackenzies. Little is known of the conformably overlying Sheepbed Formation, but the recessive, brown to black, non-calcareous shale which dominates this unit suggests slope deposition on the flanks of the Selwyn Basin (Gabrielse, 1967, Fig. 1), which was probably established by late Proterozoic time.

Mackenzie Arch

Proterozoic and lower Paleozoic stratigraphic relationships in the northeastern part of the Cordilleran Orogen outline the existence of several prominent positive tectonic elements. One of these is the Redstone Arch of Gabrielse (1967), which is located well within the Mackenzie Mountains south of Keele River, and is defined on lower Paleozoic formational thicknesses and facies. A second is the Ogilvie Arch (Gabrielse, 1967), located in the Ogilvie Mountains to the northwest of the Operation Norman area. Neither the geographic extent (i.e. whether the Redstone and Ogilvie Arches are coincident) nor the locus of these arches through time are known presently in any detail. In an attempt to identify these positive elements on a regional scale, Douglas *et al.* (1970) applied the name Mackenzie Arch, apparently as a blanket term to encompass these Proterozoic/Paleozoic features in the northeastern Cordilleran orogen (*see* also Wheeler *et al.*, 1972, Fig. 7, p. 16).

Within the Operation Norman area, Proterozoic and sub-Upper Cambrian stratigraphic relationships outline a positive feature in the northeastern Mackenzies from Keele River to the Gayna River area (Figs. 3, 4). It is not continuous with the Redstone Arch of Gabrielse (1967), which is located somewhat deeper within the Mackenzie Mountains. Rather than introducing a new name for this feature, we identify it as the Mackenzie Arch, with the recognition that it may be only one component of a long-lived and non-geographically coincident series of positive tectonic elements of Proterozoic and lower and middle Paleozoic ages in the northeastern Cordilleran orogen.

Within the Operation Norman area, the following facts appear to relate to the history of the Mackenzie Arch:

1. Deposition of Helikian formations was not affected by the Arch; but rather, Helikian units appear to thicken progressively southwestward across the site of the Arch without important lithologic change (Figs. 3, 6, 9).

2. Hadrynian formations are known only from the region southwest of the Arch. The Rapitan Group, basal to the Hadrynian succession, clearly postdates a tectonic event, and clasts derived from the Helikian succession are abundant in Rapitan sediments. This suggests that the Arch may have arisen initially during the Racklan Orogeny, although the absence of known derived deposits to the east suggests a hinge-line rather than an "arch" (Fig. 8).

3. Lower Cambrian strata thin markedly toward the Arch from both northeast and southwest and disappear in a broad belt centred on the Arch. Although not proven, it is possible that the Arch, during Early Cambrian time, was emergent and a source of detritus for Lower Cambrian clastic strata (Figs. 3, 6-9).

4. All pre-Upper Cambrian formations down to and including the Katherine Group have undergone erosional thinning and, in most instances, truncation over the Arch crest, which is characterized by Franklin Mountain strata in contact with the underlying Katherine. These relationships testify to a major pulse of uplift of the Arch in late Middle or earliest Late Cambrian time. It is difficult, however, to distinguish the effects of this uplift from those of preceding pulses.

Subsequent activity along the Mackenzie Arch which, in the southern Mackenzies, continued intermittently until at least Early Devonian time (Douglas *et al.*, 1970), is not germane to this report.

If the crestal region of the Mackenzie Arch is defined as that region from which post-Katherine Group Helikian strata have been eroded, then the crest of the Arch, about 20 miles (32 km) wide, extends obliquely across the "Laramide" structural trend, striking a little more northerly, from about latitude 64°00'N, longitude 126°30'W, to reach the Mackenzie Mountain front a short distance east of Arctic Red River, at about latitude 65°20'N, longitude 130°30'W (Fig. 5). By projection, the crest of the Arch would then appear to pass beneath Peel Plateau to the north of the frontal Mackenzies. Alternatively, it could be confined to the mountain front: critical data are lacking at present. The position and trend of the Mackenzie Arch south of the Operation Norman area have been outlined by Douglas *et al.* (1970; *see* also Gabrielse, 1967; and Ziegler, 1967, 1969, for location of Redstone Arch).

PALEOZOIC

Lower and Middle Cambrian sequence

(Backbone Ranges, Mount Clark, Old Fort Island, Mount Cap, Sekwi Formations; lower part of Road River Formation)

In the interior ranges of Mackenzie Mountains, shallow-water sandstones of Early Cambrian age (Backbone Ranges Formation) overlie the Hadrynian Sheepbed Formation with slight unconformity (Gabrielse *et al.*, in press; Cook and Aitken, 1971a). In the Franklin Mountains, however, and locally in the frontal Mackenzies, sandstones of Early Cambrian age (Mount Clark, Mount Cap) overlie Helikian formations with angular unconformity (Pl. 21). In the Interior Plains, the Old Fort Island Formation, of Early or Middle Cambrian age, overlies Hudsonian crystalline basement south of Great Bear Lake. North of Great Bear Lake, it overlies poorly dated Proterozoic sedimentary rocks with angular unconformity. It seems probable that these three formations formed part of a transgressive, quartz-arenite blanket-like deposit which may have been discontinuous if, as seems probable, the Mackenzie Arch was emergent during Early Cambrian time.

Lower Paleozoic rocks west of the Mackenzie Arch in the Selwyn Basin are much thicker and more complete than their equivalents developed on the flanks of the Arch, or east of the Arch in the Mackenzie Trough.

Within the Operation Norman area, carbonates of the Sekwi Formation, which is locally over 3,000 feet (≈ 900 m) thick, contain many features clearly of shallow-water origin, and probably represent accumulation in the "middle carbonate belt" (Palmer, 1960; *see* also Fritz, 1972, 1973). The Mount Cap, which is present in the Franklins and Mackenzies only as discontinuous remnants beneath the sub-Upper Cambrian unconformity, contains late Early Cambrian trilobites of the *Bonnia-Olenellus* Zone which is found in the upper part of the Sekwi (Fritz, 1972), and thus Early Cambrian sedimentation could have been at least locally continuous across the Mackenzie Arch into Mackenzie Trough. Although little is left of the Mount Cap beneath the sub-Upper Cambrian erosion surface within the Mackenzies, the diverse lithologies of the Mount Cap, including glauconitic sand, black, brown, or green shale and siltstone, with only a few carbonate beds, point to a shallow-water, relatively near-shore origin (inner detrital belt of Palmer, 1960) as part of a Middle Cambrian transgression over a surface

of little relief. Mount Cap remnants are underlain by a locally angular unconformity at Dodo Canyon and Loretta Canyon along the Mackenzie Mountain Front (*see* Figs. 5, 9).

On the margin of the Selwyn Basin in the Mackenzie Mountains interior, Sekwi Formation shelf carbonates give way southwestward to dark grey shale and thin-bedded limestone characteristic of slope and basinal (deep-water) environments (*see* Fritz, 1973). These Lower Cambrian rocks are lithologically similar and possibly continuous with the Middle Cambrian and younger Road River Formation, which is the basinal equivalent of shelf carbonates of Middle Cambrian to Middle Devonian age deposited as widespread blankets to the east and northeast over a large area of the Mackenzie and Franklin Mountains and Interior Plains.

Sub-Upper Cambrian unconformity and overlying rocks

[Saline River Formation and Franklin Mountain Formation (basal red beds, cyclic unit, rhythmic unit and equivalents), Road River Formation]

Renewed uplift must have taken place along the axial region of the Mackenzie Arch (Fig. 5) in pre-late Cambrian (pre-Dresbachian) time. The Upper Cambrian (Dresbachian and younger) Franklin Mountain Formation, dominantly a cyclic carbonate blanket succession deposited in a shallow, subtidal to intertidal environment (Macqueen, 1970), is the oldest unit to cross the Mackenzie Arch uninterrupted in the Operation Norman area. The discontinuous distribution of the Saline River Formation in the northeastern Mackenzie Mountains, the fact that it is normally underlain by a clearly apparent unconformity, and the gradational contact between Saline River rocks and overlying Franklin Mountain carbonates wherever this contact has been examined in the Operation Norman area, all indicate that the Saline River evaporites, shales, and lesser carbonates accumulated within shallow, partly discontinuous depressions developed on the sub-Upper Cambrian erosional surface. To the east of Mackenzie Mountains within the Mackenzie Trough (*see* Douglas *et al.*, 1970), the Saline River depositional area appears to have been a more widespread and continuous basin, as the Saline River is known over a large area including the subsurface of the Mackenzie Plain and Interior Plains, at the surface within the Franklins and along the updip edge of the Paleozoics in the eastern part of the Interior Plains. The orientation, depth, and form of these shallow depressions and basins, and the nature of the probable barriers which restricted circulation between them and the open sea area of the Selwyn Basin within which the contemporaneous shales and argillaceous carbonates of the Road River Formation accumulated, are all unknown. Presumably the shallow depressions and basins formed a series of brine ponds within which increased salinities precluded most higher organic life. Evaporation to dryness, at least locally, is suggested by the abundant desiccation cracks, salt pseudomorphs, and (?)rain or hail prints commonly observed within Saline River mudstones (Pl. 20).

The uniform surface achieved by accumulation of the Saline River in depressions and larger basins apparently was preserved through the onset of Franklin Mountain carbonate sedimentation, as no areas of solution of underlying evaporite are known, nor are anomalously thick sequences of the Franklin Mountain carbonate blanket. The great thickness of Saline River salt encountered in the Imperial Vermilion Ridge No. 1 well, overlain by a normal Franklin Mountain succession, may have accumulated in a tectonic and/or erosional depression, although tectonic ("Laramide") thickening of the salt is not precluded.

Three informal units characterize the lower part of the Franklin Mountain: these are the basal red beds, cyclic unit, and rhythmic unit or equivalent (Macqueen, 1970). Two of them (basal red beds and cyclic unit) may be partly contemporaneous, as they do not occur together. Where the Saline River is present, it is overlain with complete gradation by rocks of the Franklin Mountain Formation, normally the Franklin Mountain cyclic unit which is in turn overlain gradationally by the rhythmic unit or its equivalent. Elsewhere, the Franklin Mountain succession may begin with a basal red-bed unit which grades up to rhythmic unit equivalents, or it may begin directly with rhythmic unit rocks or their equivalents. Both the red-bed unit and/or the rhythmic unit at these localities are rich in sand-size clastic quartz, and normally overlie rocks of Helikian age (Little Dal, H5, or Katherine Group). These localities, therefore, are inferred to represent areas which were either sites of non-deposition, or were emergent during deposition of most or all Saline River strata before the onset of regional subsidence which initiated widespread Late Cambrian carbonate deposition of the Franklin Mountain Formation.

REFERENCES

Aalto, K. R.
1971: Glacial marine sedimentation and stratigraphy of the Toby Conglomerate (Upper Proterozoic), southeastern British Columbia, northwestern Idaho and northeastern Washington; Can. J. Earth Sci., v. 8, no. 7, p. 753-787.

Aitken, J. D.
1967: Classification and Environmental Significance of Cryptalgal Limestones and Dolomites, with Illustrations from the Cambrian and Ordovician of Southwestern Alberta; J. Sediment. Petrol., v. 37, no. 4, p. 1163-1178.

Aitken, J. D. and Cook, D. G.
1969: Lac Belot, District of Mackenzie; Geol. Surv. Can., Prelim. Ser. Map 6-1969.

Aitken, J. D., Cook, D. G. and Balkwill, H. R.
1970: Operation Norman, District of Mackenzie; *in* Report of Activities, Pt. A, April to October, 1969; Geol. Surv. Can., Paper 70-1, Pt. A, p. 202-206.

Aitken, J. D., Macqueen, R. W. and Foscolos, A. E.
1973: A Proterozoic Sedimentary Succession with Traces of Copper Mineralization, Cap Mountain, Southern Franklin Mountains, District of Mackenzie; *in* Report of Activities, Pt. A, April to October, 1972; Geol. Surv. Can., Paper 73-1, Pt. A, p. 243-246.

Aitken, J. D., Yorath, C. J., Cook, D. G. and Balkwill, H. R.
1969: Operation Norman, District of Mackenzie, Northwest Territories; *in* Report of Activities, Pt. A, April to October, 1968; Geol. Surv. Can., Paper 69-1, Pt. A, p. 223-229.

Balkwill, H. R.
1971: Reconnaissance Geology, Southern Great Bear Plain, District of Mackenzie; Geol. Surv. Can., Paper 71-11.

Balkwill, H. R. and Yorath, C. J.
1970: Brock River map-area, District of Mackenzie (97D); Geol. Surv. Can., Paper 70-32.

Bell, R. T.
1968: Proterozoic Stratigraphy of Northeastern British Columbia; Geol. Surv. Can., Paper 67-68.

Bell, W. A.
1959: Stratigraphy and Sedimentation of Middle Ordovician and Older Sediments in the Wrigley-Fort Norman area, Mackenzie District, N.W.T.; Can. Mining Met. Bull., v. 52, no. 561, p. 1-16.

Bostock, H. S.
1970: Physiographic Subdivisions of Canada; Geology and Economic Minerals of Canada, Ec. Geol. Rept. No. 1; Geol. Surv. Can., Ch. II, p. 9-30.

Christie, R. L.
1964: Diabase-gabbro sills and related rocks of Banks and Victoria Islands, Arctic Archipelago; Geol. Surv. Can., Bull. 105.

Christie, R. L., Cook, D. G., Nassichuk, W. W., Trettin, H. P. and Yorath, C. J.
1972: The Canadian Arctic Islands and the Mackenzie Region; Int. Geol. Cong., 24th Session, Guidebook to Field Excursion A66, 146 p.

Cook, D. G. and Aitken, J. D.
1969a: Erly Lake, District of Mackenzie (97A); Geol. Surv. Can., Prelim. Ser. Map 5-1969.

1969b: Fort Good Hope, District of Mackenzie (106I); Geol. Surv. Can., Prelim. Ser. Map 4-1969.

1971a: Operation Norman, District of Mackenzie; *in* Report of Activities, Pt. A, April to October, 1970; Geol. Surv. Can., Paper 71-1, Pt. A, p. 197-201.

1971b: Geology, Colville Lake map-area and part of Coppermine map-area, Northwest Territories (96 NW and NE; part of 86 NW); Geol. Surv. Can., Paper 70-12.

(in press): Tectonics of Northern Franklin Mountains and Colville Hills, District of Mackenzie, Canada; Am. Assoc. Petrol. Geologists, Arctic Symposium (1970), Memoir.

Crimes, T. P.
1970: The significance of trace fossils in sedimentology, stratigraphy and paleoecology with examples from Lower Paleozoic strata; *in* Crimes, T. P., and Harper, J. C. (eds.), Trace Fossils, Liverpool Geological Society, Seel House Press, Liverpool, p. 101-126.

Crimes, T. P. and Harper, J. C. (eds.)
1970: Trace Fossils: Liverpool Geological Society, Seel House Press, Liverpool, 547 p.

Crittenden, M. D., Jr., Schaeffer, F. E., Trimble, D. E., and Woodward, L. A.
1971: Nomenclature and correlation of some upper Precambrian and basal Cambrian sequences in western Utah and southeastern Idaho; Bull. Geol. Soc. Am., v. 82, p. 581-602.

Crittenden, M. D., Jr., Stewart, J. H. and Wallace, C. A.
1972: Regional Correlation of Upper Precambrian strata in western North America; Int. Geol. Cong., 24th Session, Sec. 1, Precambrian Geology, p. 334-341.

Dietz, R. S. and Holden, J. C.
1966: Miogeoclines in space and time: J. Geol., v. 65, p. 566-583.

Douglas, R. J. W.
1959: Light Helicopter Reconnaissance in Interior Plains and Mountains (Operation Mackenzie); *in* Helicopter Operations of the Geological Survey of Canada, by Officers of the Geological Survey of Canada; Geol. Surv. Can., Bull. 54, Ch. IV, p. 21-32.

Douglas, R. J. W., Gabrielse, H., Wheeler, J. O., Stott, D. F., and Belyea, H. R.
1970: Geology of Western Canada; Geology and Economic Minerals of Canada, Ec. Geol. Rept. No. 1; Geol. Surv. Can., Ch. VIII, p. 365-488.

Douglas, R. J. W. and Norris, A. W.
1960: Horn River map-area, Northwest Territories (parts of north halves of 85 and 95): Geol. Surv. Can., Paper 59-11.

Douglas, R. J. W. and Norris, D. K.
1960: Virginia Falls and Sibbeston Lake map-areas, Northwest Territories, 95F and 95G; Geol. Surv. Can., Paper 60-19.

1961: Camsell Bend and Root River map-areas, District of Mackenzie, Northwest Territories, 95J and 95K; Geol. Surv. Can., Paper 61-13.

1963: Dahadinni and Wrigley map-areas, District of Mackenzie, Northwest Territories, 95N and 95O; Geol. Surv. Can., Paper 62-33.

Douglas, R. J. W., Norris, D. K., Thorsteinsson, R. and Tozer, E. T.
1963: Geology and petroleum potentialities of Northern Canada; Geol. Surv. Can., Paper 63-31.

Flint, R. F., Sanders, J. F. and Rogers, J.
1960: Diamictite, a substitute term for symmictite: Bull. Geol. Soc. Am., v. 71, p. 1809.

Fritz, W. H.
1969: Cambrian Biostratigraphy (12H, 22A, 93H); *in* Report of Activities, Pt. A, April to October, 1968; Geol. Surv. Can., Paper 69-1, Pt. A, p. 124-125.

1970: Cambrian Biostratigraphy in the Canadian Cordillera; *in* Report of Activities, Pt. A, April to October, 1969; Geol. Surv. Can., Paper 70-1, Pt. A, p. 110.

1972: Lower Cambrian Trilobites from the Sekwi Formation Type Section, Mackenzie Mountains, Northwestern Canada; Geol. Surv. Can., Bull. 212.

1973: Cambrian Biostratigraphy, Mackenzie Mountains and Labrador; *in* Report of Activities, Pt. A, April to October, 1972; Geol. Surv. Can., Paper 72-1, Pt. A, p. 254-259.

Gabrielse, H.
1967: Tectonic Evolution of the Northern Canadian Cordillera; Can. J. Earth Sci., v. 4, p. 271-298.

1972: Younger Precambrian of the Canadian Cordillera; Am. J. Sci., v. 272, p. 521-536.

Gabrielse, H., Blusson, S. L., and Roddick, J. A.
(in press): Flat River, Glacier Lake, and Wrigley Lake map-areas (95E, L, M), District of Mackenzie and Yukon Territory; Geol. Surv. Can., Mem. 366.

Gabrielse, H., Roddick, J. A. and Blusson, S. L.
1965: Flat River, Glacier Lake, and Wrigley Lake, District of Mackenzie and Yukon Territory, 95E, 95L and 95M; Geol. Surv. Can., Paper 64-52.

Green, L. H. and Godwin, C. I.
1963: Mineral Industry of Yukon Territory and southwestern District of Mackenzie, 1962; Geol. Surv. Can., Paper 63-38.

Gross, G. A.
1965: Geology of iron deposits and iron-formations of Canada - 2. Iron-formation, Snake River area, Yukon and Northwest Territories; *in* Report of Activities: Field, 1964; Geol. Surv. Can., Paper 65-1, p. 142-143.

Handfield, R. C.
1968: Sekwi Formation, a new Lower Cambrian Formation in the Southern Mackenzie Mountains, District of Mackenzie (95L, 105I, 105P); Geol. Surv. Can., Paper 68-47.

Harrison, J. E.
1972: Precambrian Belt Basin of Northwestern United States: Its Geometry, Sedimentation, and Copper Occurrences; Geol. Soc. Am. Bull., v. 83, p. 1215-1240.

Harrison, J. E. and Peterman, Z. E.
1971: Belt-Windermere Rocks and their correlatives in the western United States (abs.); Geol. Soc. Am., Abs. with Program, v. 3, no. 7, p. 592-593.

Hume, G. S.
1923: Geology of the Norman Oil Fields and a Reconnaissance of Part of Liard River; Geol. Surv. Can., Summ. Rept. 1922, Pt. B, p. 47-64.

1954: The Lower Mackenzie River Area, Northwest Territories and Yukon; Geol. Surv. Can., Mem. 273.

Hume, G. S., and Link, T. A.
1945: Canol Geological Investigations in the Mackenzie River area, Northwest Territories and Yukon; Geol. Surv. Can., Paper 45-16.

Jackson, D. E. and Lenz, A. C.
1962: Zonation of Ordovician and Silurian graptolites of northern Yukon, Canada; Bull. Am. Assoc. Petrol. Geologists, v. 46, no. 1, p. 30-45.

Lenz, A. C.
1972: Ordovician to Devonian history of Northern Yukon and adjacent District of Mackenzie; Bull. Can. Petrol. Geol., v. 20, no. 2, p. 321-361.

Lenz, A. C. and Pedder, A. E. H.
1972: Lower and middle Paleozoic sediments and paleontology of Royal Creek and Peel River, Yukon and Powell Creek, N.W.T.; Int. Geol. Cong., 24th Session, Guidebook to Field Excursion A14, 43 p.

Link, T. A.
(Unpubl.): Geological Report on the Fort Norman Area; Imperial Oil Ltd., Calgary, Alberta, 1921, 81 p.

Logan, B. W., Rezak, R. and Ginsburg, R. N.
1964: Classification and environmental significant of algal stromatolites; J. Geol., v. 72, p. 68-83.

Macqueen, R. W.
1969: Lower Paleozoic Stratigraphy, Operation Norman, 1968; *in* Report of Activities, Pt. A, April to October, 1968; Geol. Surv. Can., Paper 69-1, Pt. A, p. 238-241.

1970: Lower Paleozoic Stratigraphy and Sedimentology; Eastern Mackenzie Mountains, Northern Franklin Mountains (96C, D, E, F; 106G, H); *in* Report of Activities, Pt. A, April to October, 1969; Geol. Surv. Can., Paper 70-1, Pt. A, p. 225-230.

Macqueen, R. W. and MacKenzie, W. S.
(in press): Lower Paleozoic and Proterozoic Stratigraphy, Mobil Colville Hills E-15 well and environs, Interior Platform, District of Mackenzie; *in* Report of Activities, Pt. B, November, 1972 to March, 1973; Geol. Surv. Can., Paper 73-1, Pt. B.

Maiklem, W. R., Bebout, D. G. and Glaister, R. P.
1969: Classification of anhydrite - a practical approach; Bull. Can. Petrol. Geol., v. 17, no. 2, p. 194-223.

McKee, E. D., and Weir, G. W.
1953: Terminology for stratification and cross-stratification in sedimentary rocks; Bull. Geol. Soc. Am., v. 64, p. 381-390.

Monger, J. W. H., Souther, J. G. and Gabrielse, H.
1972: Evolution of the Canadian Cordillera: a plate-tectonic model; Am. J. Sci., v. 272, p. 577-602.

Norford, B. S.
1964: Reconnaissance of the Ordovician and Silurian Rocks of Northern Yukon Territory; Geol. Surv. Can., Paper 63-39.

Norris, A. W.
1965: Stratigraphy of Middle Devonian and older Paleozoic rocks of the Great Slave Lake region, Northwest Territories; Geol. Surv. Can., Mem. 322.

Norris, D. K.
1972: A method for the determination of geographic position; *in* Report of Activities, Pt. B, November 1971 to March 1972; Geol. Surv. Can., Paper 72-1, Pt. B, p. 124-125.

Norris, D. K., Price, R. A. and Mountjoy, E. W.
1963: Geology (of) Northern Yukon Territory and northwestern District of Mackenzie; Geol. Surv. Can., Map 10-1963.

North, F. K.
1971: Cambrian of Canada and Alaska, *in* Holland, C. H. (ed.), Lower Paleozoic Rocks of the World, v. I, Cambrian of the New World; p. 219-324, Wiley-Interscience, New York, 456 p.

O'Connor, M. P.
1972: Classification and environmental interpretation of the cryptalgal organosedimentary "molar-tooth" structure from the Late Precambrian Belt-Purcell Supergroup; J. Geol., v. 80, no. 5, p. 592-610.

Palmer, A. R.
1960: Some aspects of the Upper Cambrian stratigraphy of White Pine County, Nevada, and vicinity; Intermountain Assoc. Petroleum Geologists, E. Nevada Geol. Soc., Guidebook, Joint Field Conf., p. 43-52.

Price, R. A.
1964: The Pre-Cambrian Purcell System in the Rocky Mountains of Southern Alberta and British Columbia; *in* Special Guidebook Issue, Flathead Valley, A. J. Goodman, ed.; Alberta Soc. Petrol. Geologists, v. 12, special issue, p. 399-426.

1965: Flathead Map-area, British Columbia and Alberta; Geol. Surv. Can., Mem. 336.

Price, R. A. and Douglas, R. J. W. (eds.)
1972: Variations in Tectonic styles in Canada; Geol. Assoc. Canada, Spec. Paper No. 11, 688 p.

Stewart, J. H.
1972: Initial deposits in the Cordilleran Geosyncline: evidence of late Precambrian (< 850 m.y.) continental separation; Bull. Geol. Soc. Am., v. 83, p. 1345-1360.

Stockwell, C. H.
1964: Age Determinations and Geological Studies; Pt. II, Fourth Report on Structural Provinces, Orogenies, and Time-Classification of Rocks of the Canadian Precambrian Shield; Geol. Surv. Can., Paper 64-17 (Pt. II), p. 1-21.

1970: Geology of the Canadian Shield; Geology and Economic Minerals of Canada, Ec. Geol. Rept. No. 1; Geol. Surv. Can., Ch. IV (Introduction), p. 44-54.

Taylor, G. C. and Stott, D. F.
(in press): Tuchodi Lakes map-area, British Columbia (94K); Geol. Surv. Can., Mem. 373.

Tassonyi, E. J.
1969: Subsurface Geology, Lower Mackenzie River and Anderson River Area, District of Mackenzie; Geol. Surv. Can., Paper 68-25.

Thorsteinsson, R. and Tozer, E. T.
1962: Banks, Victoria and Stefansson Islands, Arctic Archipelago; Geol. Surv. Can., Mem. 330.

Usher, J. L.
1970: Upper Proterozoic to mid-Cambrian Stratigraphy, District of Mackenzie (96D, 106A, G, H); *in* Report of Activities, Pt. A, April to October, 1969; Geol. Surv. Can., Paper 70-1, Pt. A, p. 240-242.

Wanless, R. K., Stevens, R. D., Lachance, G. R. and Edmonds, C. M.
1968: Age determinations and geological studies, K-Ar Isotopic Ages, Report 8; Geol. Surv. Can., Paper 67-2, Pt. A.

Wheeler, H. E.
1960: Early Paleozoic tectono-stratigraphic patterns in the United States; Proc. 21st. Int. Geol. Cong., Sec. 8, p. 47-56.

Wheeler, J. O., Aitken, J. D., Berry, M. J., Gabrielse, H., Hutchison, W. W., Jacoby, W. R., Monger, J. W. H., Niblett, E. R., Norris, D. K., Price, R. A., and Stacey, R. A.
1972: The Cordilleran Structural Province; *in* Price, R. A., and Douglas, R. J. W. (eds.), Variations in Tectonic Styles in Canada; Geol. Assoc. Canada, Spec. Paper No. 11, p. 1-81.

Williams, M. Y.
1922: Exploration east of Mackenzie River between Simpson and Wrigley; Geol. Surv. Can., Summ. Rept. 1921, Pt. B, p. 56-66.

1923: Reconnaissance across northeastern British Columbia and the geology of the northern extension of Franklin Mountains, N.W.T.; Geol. Surv. Can., Summ. Rept. 1922; Pt. B, p. 65-87.

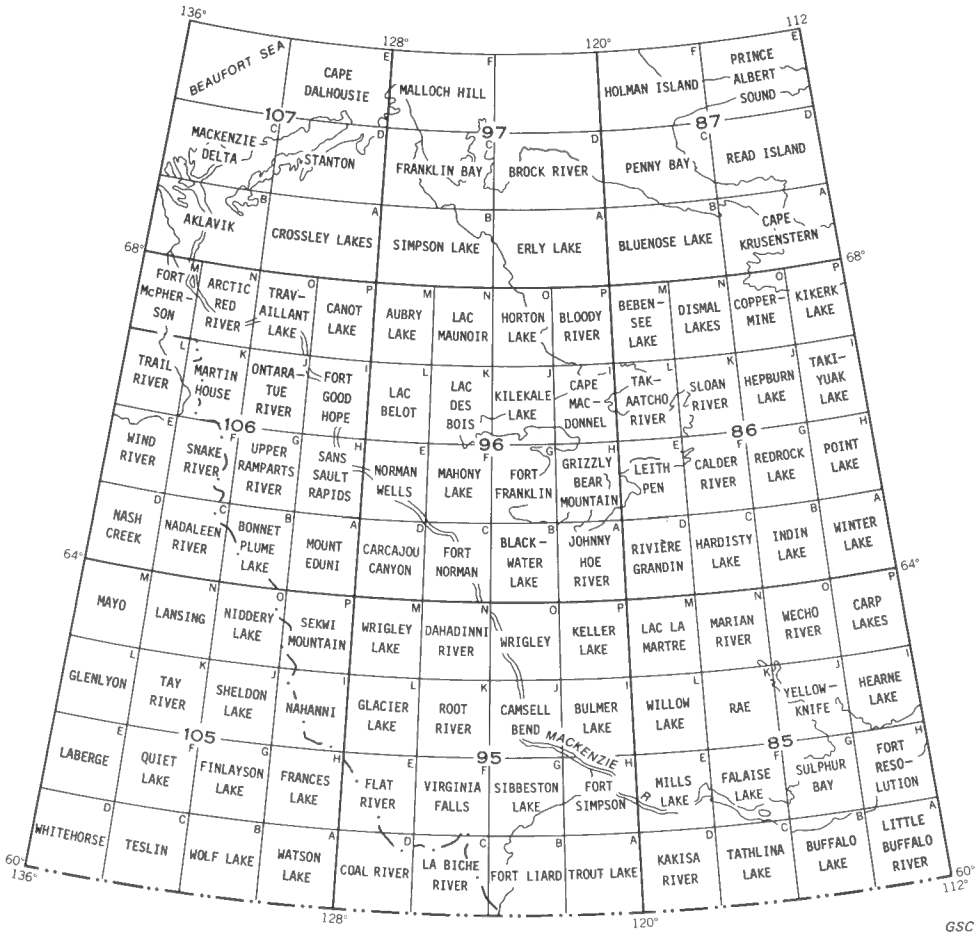
Ziegler, P. A.
1967: Guidebook for the Canadian Cordillera Field Trip - International Symposium of the Devonian System; Alberta Soc. Petrol. Geologists, Calgary, Alberta.

1969: The development of sedimentary basins in western and arctic Canada; Alberta Soc. Petrol. Geologists, Calgary, Alberta, 89 p.

APPENDIX

Stratigraphic Sections

The stratigraphic sections described on the following pages were measured by one or more of the three authors of this publication during Operation Norman (field seasons 1968-1970). Measurements were made using a 5-foot Jacob's staff and a 100-foot tape; descriptions are mainly those compiled in the field with additional laboratory observations on some samples, including thin section observations. X-ray diffraction data also supplement some stratigraphic sections. Section locations (Fig. 4) are given in terms of latitude and longitude, and by aerial photograph number and co-ordinates (except section AC-541 at Cap Mountain for which aerial photograph data are not included). The co-ordinates were obtained using a method described by D. K. Norris (1972), in which X and Y co-ordinates were determined with respect to the centre of the aerial photograph with the aid of a millimetre grid overlay, and with the photograph oriented with north toward the top. For description of the rocks, the Udden-Wentworth scale of grain size was used, and the McKee and Weir (1953) scheme for thickness of stratification (in general).



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SECTION U-1. HEADWATERS ARCTIC RED RIVER (106B)

Located in Mackenzie Mountains, along a creek tributary to headwaters of Arctic Red River; Latitude 64°48'N, Longitude 131°35'W; aerial photograph A12258-234, base of section at photo co-ordinates X=+4.7, Y=-1.3; top of section at photo co-ordinates X=+0.5, Y=-3.3. Measured and described by J. L. Usher, July 28, 1970; through Sekwi Formation, upper and lower contacts covered; dip 55° SW. Fossil collections identified by W. H. Fritz (GSC internal report C9-1971-WHF).

PHANEROZOIC

PALEOZOIC

LOWER CAMBRIAN

Sekwi Formation ..... 3,303 feet (1,007 m) (incomplete)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Sekwi Formation (Lower Cambrian)		
24	Siltstone, very argillaceous, calcareous; brown; medium bedded, blocky; brown weathering	3	3,303
23	Mudstone, calcareous, dark brown to green-grey; silty, very crumbly, non-fissile	80	3,300
22	Dolomite, grey; silty, hard; weathering rusty brown. Not well exposed on back slope	60	3,220
21	Quartzite, whitish grey to medium grey, very fine grained; crossbedded, very thick bedded; grey to white weathering; cliff forming	12	3,160
20	Limestone, nodular, very argillaceous; argillite (or mudstone) matrix predominant; weathering dark brown. This forms basal 65' of cliff. Upwards argillaceous content decreases, and nodular limestone becomes prominent; dark brown weathering cliff even though the rock is essentially thinly bedded. From about 175' above base, silt appears and rock changes to limestone, argillaceous, dark grey, thinly bedded; dark brown weathering. At 3,083' part of trilobite thorax, essentially in place (GSC loc. C7553)	300	3,148
19	Argillite, calcareous, with some thin, very pale grey limestone beds; thin bedded; clayey feeling; weathering pale grey to pale buff	130	2,848

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
18	Limestone and argillite. Five resistant ridges of limestone separated by four recessive argillaceous and very thinly bedded silty shale zones which are calcareous and weather pale brown to buff or pale brown-grey. Limestones are blocky, fine-grained, silty, hard, dark grey, uniform and nodular. Lower two zones weather dark grey; upper three limestone zones weather pale grey with touches of orange. Limestones become more silty and argillaceous upward	194	2,718
17	Limestone, argillaceous, nodular, blue-grey; thinly bedded; very rough nodular to cindery; probably a cliff former when near horizontal, forms dark brown-grey talus slope, dip 50°; weathers tan to brown; abundant *Salterella* sp. throughout, occasional *Olenellid* spines	445	2,524
16	Limestone, dark grey, very fine grained; well bedded; blocky weathering limestone with anastomosing threads and stringers of orange-weathering argillaceous material; coarser grained upwards, passing into very coarse, argillaceous skeletal limestone	64	2,079
15	Argillite, smooth, homogenous, dark silver-grey; noncalcareous at base, becoming calcareous upwards; in top 10', 4-inch beds of flat-pebble limestone conglomerate occur with very thin pebbles or chips	27	2,045
14	Limestone, argillaceous; varies from coarse nodular to very fine calcilutite, thinly bedded but thicker bedded than unit 13; locally laminated, blocky weathering; locally oolitic, great variety; unit weathers darker brown-grey than unit 13; some fossil debris	111	1,988
13	Limestone; silty and argillaceous; medium grey; very thin bedded; slabby weathering, cindery, sharp-edged, resonant; forms recessive back slope; medium grey and buff weathering; abundant *Salterella* sp. throughout; weathering orange; basal 20' are yellow, fissile, calcareous, laminated argillite forming large, wafer-thin slabs, and weathering light brown with grey overcast	141	1,877
12	Limestone, fine nodular, dark grey; very thinly bedded with argillaceous interbeds and zones up to 5' thick of fine crumbly dark grey shale;		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	thicker bedded upward and less nodular with top one-third comprising finely laminated, silty, thinly bedded, blocky to thin, slabby or fissile weathering limestone; weathering dark blue-grey; abundant fossil debris in lower part, including *Salterella* sp. and *Wanneria* sp. (GSC loc. C7552) at 1,601'	180	1,736
11	Argillite, thin, platy, calcareous; weathering pale grey to light brown and buff; interbedded with limestone, silty and argillaceous, grey, fine grained, very thinly bedded; and rare thin, nodular, rough-weathering limestone; much fossil debris throughout unit, particularly from 1,457' to 1,479', with *Olenellus?* sp. and *Salterella* sp. (GSC loc. C7551)	172	1,556
10	Limestone, bedding averages 1"; thin, knobby bedded to small irregular nodular, with abundant clay and some silt; some oolite beds; weathering dark blue-grey, slabby; a shallow-water detrital limestone; contains a few spines of *Olenellus* sp. 1 and *Olenellus* sp. 2 (GSC loc. C7550) at 1,226'. From 100' to 143' above base, unit contains very thin platy, silty and calcareous argillite, thinly bedded shale, and very thinly bedded limestone, somewhat paler weathering than lowest 100'; from 143' to 177' above base, knobby, rough limestone as before	173	1,384
9	Argillite, finely calcareous; fissile to slabby weathering; pale silver-grey, green, brown; weathers dark red-brown; interbedded with limestone, argillaceous and silty; thin to thick bedded; dirty to clean, rough slabby to clean breaking; some thin beds of very fine argillaceous sandstone; limestone varies from pale to dark grey; weathers orange and brown. Mud cracks and ripple-marks throughout unit; individual lithologies seldom more than several feet thick; as a whole the unit weathers multi-coloured, dark grey, brown, or green. A mixed assemblage of shallow-water sediments	270	1,211
8	Limestone, sub-lithographic to very fine grained; finely laminated, some beds with silt laminae, others with fine small vuggy porosity; blocky, hard; alternating very pale yellow, white and pale grey weathering; top 15' to 20' weather very rough, pitted	95	941

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
7	Limestone, dark grey, very fine grained; thin beds and laminations present, but unit weathers massive; blocky; top 5' less resistant, very fine grained and finely laminated; unit weathers very pale to pale bluish grey; unit is a prominent marker	55	846
6	Limestone, dark grey, very fine grained; thin (1"-2") regularly bedded; with thin anastomosing threads, layers and beds of brown-weathering argillaceous material; occasional oolite beds near base; unit weathers blue-grey	66	791
5	Argillite, calcareous; thin platy bedded; interbedded with thin grey limestone layers and laminae; unit weathers smoother than unit 4, and tan rather than mottled grey-brown	45	725
4	Limestone, silty, grey; thinly bedded, somewhat nodular; at 160' above base, skeletal limestone with oolites; fairly massive weathering, occasional smooth- but generally rough-weathering beds, weathers grey and mottled rusty-brown; *Olenellus* spines sparse throughout unit; at 635', unit contains *Fremontella* sp. or *Bristolia* sp., *Obolella?* sp., *Ollenellus?* sp., *Proliostracus* sp., *Variopelta?* sp. (GSC loc. C7549)	205	680
3	Limestone, grey; thin to thick bedded; irregular layers of rusty brown argillaceous material; limestone forms basal part of unit only: overlain by argillite, calcareous, platy, irregular; abundant fossil debris. Occasional bed of dolomite; up to 3' thick; brown weathering. At 263', unit contains *Olenellus truemani* Walcott (GSC loc. C7546); at 353', *Fremontella* sp. or *Bristolia* sp., *Olenellus laxocules* Fritz (GSC loc. C7547); at 400', *Fremontella* sp. or *Bristolia* sp. (GSC loc. C7548)	242	475
2	Argillite, dolomitic, green and brown; with trilobite spines; one zone of dark rusty brown weathering dolomite as below base of unit 1	50	233
1	Quartzite, white at base, becoming red, green, and grey in alternating beds upward; very fine grained; thick to massive beds (5'), ripple-marks; weathering dark greenish black (lichen covered in part); interbeds of argillite, dolomitic, dark brown weathering; *Skolithos* occurs in quartzites	183	183

Unit	Lithology	Thickness (feet)	Height Above Base (feet)

Base of section is located near the base of quartzite unit 1 (lower part is covered). Quartzite is directly underlain by dolomite, finely crystalline, grey, distinctive dark brown weathering; with silicified fossil debris.

GSC Fossil Report No. C9-1971-WHF, by W. H. Fritz:

Remarks: A tentative correlation can be made between the present section (U-1) and a Sekwi section measured 15 miles to the west (Report C1-1971-WHF). The quartzite unit at the base of the present section probably lies just below the boundary between the *Nevadella* and *Bonnia-Olenellus* Zone. In the present section, olenellids with advanced spines (C7547-C7549), *Olenellus truemani* (C7546) and *Variopelta?* sp. all indicate the lowest portion of the *Bonnia-Olenellus* Zone, and therefore agree with the physical correlation of the underlying quartzite to the western section.

The presence of *Wanneria* sp. (C7552) near the middle of the present section (U-1) indicates a mid-*Bonnia-Olenellus* age. No fossils are reported above this horizon, except for a portion of a large, non-diagnostic trilobite thorax in collection C7553. Without fossils and intermediate stratigraphic control, correlation above unit 17 is very difficult. Units 18-20 may correlate with the unnamed Lower Cambrian dark shale formation 15 miles to the west (Report C1-1971-WHF) and unit 21 to the overlying unnamed quartzite formation.

SECTION U-2. ARCTIC RED RIVER, WEST SIDE (106G)

Located in Mackenzie Mountains, on the north side of a creek tributary to Arctic Red River from the west, and approximately 16 miles from the Mackenzie Mountain front, measured perpendicular to the strike of the mountains; Latitude 65°11 1/2'N, Longitude 131°34 1/2'W; aerial photograph A12258-253; base of section at photo co-ordinates X=+4.4, Y=-6.0, top of section at photo co-ordinates X=+6.2, Y=-9.7. Measured and described by J. L. Usher, July 27, 1970; through Franklin Mountain Formation (lower part), Little Dal Formation, and unnamed Proterozoic map-unit H5.

PHANEROZOIC

PALEOZOIC

?UPPER CAMBRIAN

"Basal Franklin Mountain red beds"..... 285 feet (87 m)

(Unconformity)

PROTEROZOIC

HELIKIAN?

Little Dal Formation ..... 1,153 feet (351 m)

Unnamed map-unit H5 ..... 1,046 feet (319 m) (est.)

Franklin Mountain dolomite above "Basal Franklin Mountain red beds" is thin to thick bedded, finely crystalline, medium grey, weathering pale grey, with silt laminations in places. Obviously a dolomitized fine calcarenite. Cherty laminae and blebs. Some stromatolitic laminae parallel to bedding. Occasional black bed. Chert mostly white, occasionally black layers of it. Basal 10' silty to fine sandy, with crossbedding, and cherty. Unit cliff forming, blocky weathering.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	"Basal Franklin Mountain red beds" (?Upper Cambrian)		
5	Quartzite, pale grey to white or buff, fine grained; thin to mainly thick bedded, occasional crossbedding; weathering pale grey; at 50' from top, a 5' thick, brown argillaceous sandstone zone; below 55', the unit has dolomitic cement, weathering orange-brown. Dolomitic cemented quartzite alternates with pure quartzite	78	285
4	Covered interval. Lithology apparently similar to unit 3 with quartz sand appearing near top; presumably contact with unit 5 gradational	46	207
3	Dolomite, slightly argillaceous, dark red; very thinly bedded, with thin buff to pale yellow bands; interbedded with dark red fissile shale	15	161
2	Dolomite and argillaceous dolomite, pink to pale grey to grey; thin to thick bedded (6" to 2') with fine silt(?) laminations that weather in relief; dark red and buff weathering; dolomites are restricted marine type, sublithographic; interbedded with dolomite, argillaceous; or shale, dolomitic; beds 6" to 4' thick; platy weathering; red weathering. About 3:2 buff:red weathering.	55	146

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
1	Dolomite and argillaceous dolomite, as above; finely laminated and cross-laminated; pale buff to orange and grey weathering; shale occupies 50% of section in beds averaging 2' thick; chert layers and fragments present, not abundant; ?worm tracks on bedding planes	91	91
	(Unconformity)		
	Little Dal Formation (Proterozoic, Helikian?)		
10	Dolomite, argillaceous, grey; very thinly bedded to fissile, platy; black shale partings; weathers medium to pale grey; partly covered and recessive. Intercalated dolomite, argillaceous, grey; beds 6" thick, dense, irregularly laminated; resistant; stromatolitic	35	1,153
9	Dolomite, cliff-forming, very finely silty to argillaceous; medium to dark grey, very fine grained; thinly bedded; weathers pale grey; alternates with shale, black, fissile; beds 1" to 2" thick; lower one-third of unit with more black shale than upper two-thirds; in upper part of unit, beds up to 12" thick with highly contorted organic-rich laminae	55	1,118
8	Covered interval. Appears to be shale, dolomitic, black, very thinly bedded and fissile; and dolomite, argillaceous, dark grey, platy	70	1,063
7	Dolomite, silty and argillaceous; pale grey, very finely crystalline; very thinly bedded; mud cracks with red chert filling; platy; weathers pale yellow; top 15' only. Underlain by limestone, pale grey, sublithographic; very thinly bedded, laminated; mud cracks and/or animal tracks; weathers pale grey to white, occasional pale orange weathering beds in zones up to 2' thick; 30' thick. Underlain by dolomite, 32' thick, medium grey, extremely finely crystalline to aphanitic; very thin platy laminae, with black shale partings; beds thicker upwards; rare, thin layers of flat, white chert fragments; weathers pale yellow	77	993

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
6	Dolomite, slightly argillaceous, with black argillaceous partings in fine laminae; dark grey, very finely crystalline to aphanitic; thin bedded; cliff-forming; weathers pale to medium grey; in top 50' occasional 1/2" bed of possible silicified coquina. Below 170' from top, a 40' thick recessive zone, possibly more argillaceous. Basal 40' contain more numerous dark grey to black shale partings and thin beds. Throughout unit occasional ?stromatolitic bed	252	916
5	Covered interval	30	664
4	Dolomite, dense, hard, aphanitic; medium grey, thin to thick and well bedded; occasional chert lens; weathering pale yellow, blocky	50	634
3	Covered interval; grey shale debris	45	584
2	Dolomite, cliff-forming, massive, medium to dark grey, very finely crystalline; thin bedded with occasional thick bed; some beds finely laminated, finely detrital carbonate, blocky weathering; others with peculiar curved parallel lines, white or leached; unit weathers medium grey. Lower 300' made up of thick to massive (8' to 10'), irregular, bulbous, stromatolitic beds; most beds dark grey, medium crystalline, less than 2' thick	515	539
1	Dolomite, slightly calcareous, finely crystalline, argillaceous to silty; dark grey; thinly bedded; pale grey weathering; very blocky; thin laminae and interbeds of dark grey shale increase in number downwards, passing gradationally into unit 7 of underlying unnamed map-unit H5	24	24
	Unnamed map-unit H5 (Proterozoic, Helikian?)		
7	Limestone, black; thinly bedded, blocky; interbeds of black shale	52	1,046
6	Shale, calcareous, black; fissile to platy; thin ribbons of black shale	123	994

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
5	Limestone, dark grey; thin to thick bedded, finely laminated; coarse nodular beds in top 30'; slightly argillaceous; forms steep banks to cliffs; weathering thin slabby, and brown	120	871
4	Shale, black; fissile; calcareous	76	751
3	Limestone, massive, argillaceous, black; coarsely nodular, laminated; weathering brown; in 3 zones; interbedded with 2 zones of black calcareous shale	200(est.)	≈675
2	Limestone, argillaceous, black; thinly bedded, laminated; interbedded with black shale; thin, fine-grained sandstone layers appear towards base; interval recessive; occasional orange-weathering layer; passes down gradationally into unit 1	175(est.)	≈475
1	Shale, red; sandstone; and limestone; in thin beds	300(est.)	≈300
	The lower 500' to 600' of section contain numerous faults and folds. Accurate measurements not possible.		

SECTION U-3. ARCTIC RED RIVER, EAST SIDE (106G)

Located in Tawu Range of Mackenzie Mountains, on a narrow divide trending south-southwest from the mountain immediately east of a small unnamed lake in Arctic Red River valley, first range, Mackenzie Mountains; Latitude 65°14'N, Longitude 131°01'W; aerial photograph A12149-404; base of section at photo co-ordinates X=+1.5, Y=-1.3; top of section at photo co-ordinates X=+1.5, Y=+6.1. Measured and described by J. L. Usher, August 4, 1969; through the upper, well-exposed and structurally simple part of the Tsezotene Formation; top of this section is base of Katherine Group and approximate stratigraphic equivalent of base of section U-4.

PROTEROZOIC

HELIKIAN?

Tsezotene Formation, upper part ..... 1,450 feet (442 m) (incomplete)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Tsezotene Formation (Proterozoic, Helikian?)		
	The following section is overlain by scree slope of basal Katherine Group described in section U-4; scree is thinly bedded quartzite, flaggy, fine to medium grained, brown weathering.		
20	Siltstone, speckled, pale brown; very thinly bedded, with greenish grey silty shale; basal 1' to 2' quartzite, speckled, brown, thinly bedded, contains ripple-marks	25	1,450
19	Sandstone, argillaceous, green; thin and irregularly bedded; poorly sorted; interbedded with shale, silty; fissile, laminated; and dolomite, argillaceous, grey, aphanitic; thinly bedded; lends a pale orange to buff colour to the zone. Unit is recessive	25	1,425
18	Quartzite, very fine grained, grey; thinly bedded to thick bedded; thinly bedded at top, blocky below; weathers flaggy to blocky and dark grey	10	1,400
17	Covered interval; debris of successive bands of shale, silty, yellow-brown; shale, grey; shale, silty, grey and green; dolomite, very thinly bedded, silty to finely sandy, orange weathering; sandstone, green, as in unit 19, and quartzite, hematitic, thinly bedded	60	1,390
16	Upper and lower quarters shale, dark bluish grey to black, fissile. Middle half dolomite, pale grey; very thinly bedded; buff weathering	19	1,330
15	Mostly covered. Top 10' dolomite; thinly bedded; thin interbeds of grey silty shale; weathers pale orange; topmost bed quartzite or sandstone, green-grey, very fine grained, thinly bedded, argillaceous. Basal 15' dolomite, medium to dark grey; finely silty, with interbedded grey dolomitic shale; weathering dark greenish grey; and with limestone, argillaceous, pale grey weathering in beds up to 8" thick; base "baked"	25	1,311
14	Diabase sill	60	1,286

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
13	Limestone, pale grey, and shale, grey, hard, immediately below contact with sill; below that, shale, dark grey, silty; and thin quartzite beds	20	1,226
12	Dolomite, pale grey; thinly bedded; weathering pale orange to buff; interbedded with grey silty shales (latter predominantly in lower half of unit); a few beds of quartzite, grey, thinly bedded, poorly sorted; dolomite in mid-unit with grey chert layers up to 2" thick	76	1,206
11	Quartzite, dark grey; thinly bedded, many laminae of black carbonaceous shale; ledge forming	11	1,130
10	Dolomite, pale grey, aphanitic, thin to thick bedded, in part laminated, weathering pale orange; and dolomite, medium grey, finely crystalline and silty to very finely sandy; interbedded with dark grey shale, silty shale, and occasionally very thin, fine quartzite in the shales; dolomites become thick bedded and more abundant downward, and interbedded with grey-weathering quartzites up to 6" thick, and thin dark grey silty shale; some chert in dolomite. Basal 25' dolomite, forms steep slopes; thin to thick bedded; silty and finely sandy bands; thin intervals of grey, ripple-marked quartzite	300	1,119
9	Diabase sill	115	819
8	Argillite, non-silty; and argillite, silty to finely sandy; forms cliffs; base of unit mainly quartzite, argillaceous, very fine grained, with mud cracks; top of unit "baked"	20	704
7	Covered interval; probably underlain by grey silty shale	15	684
6	Dolomite, pale grey, cryptocrystalline; thin to thick bedded, some silt laminae; cliff forming; orange weathering; forms prominent orange marker in the section	25	669
5	Shale, silty, greenish grey and bluish grey; interbedded with dolomite, thin bedded; locally with soft sediment flow structures; orange weathering; local dolorudites (fine pebble size)	37	644

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
4	Shale and mudstone, silty, greenish grey; interbedded with siltstone, greenish grey and brown, thin bedded; in 4' to 10' intervals; separated by quartzite, hard, argillaceous, greenish brown, very fine grained, and laminated; unit has a pronounced ribbed appearance. Near top, dolomitic cement in silty argillites. 80' from top is the top of an interval of quartzite, 45' thick, forms steep slope, dark grey to whitish, fine to coarse grained; thin to thick and very irregularly bedded; poorly sorted; in places wavy laminated with argillaceous partings. 125' to 192' above base, increase in argillaceous beds to 50%. Along strike, unit weathers somewhat recessively into pale greenish grey slope with rib of quartzite 45' thick, in central part of unit	192	607
3	Quartzite, cliff forming; very fine grained; argillaceous/silty; poorly sorted; thinly bedded; irregularly wavy bedded; in cliffs and ledges 10' to 15' thick separated by argillite or mudstone, silty; generally pale green-grey but at some levels dark maroon or dark red, in beds 1' to 3' thick. Below 150' from top of unit shale zones are less numerous and thinner, and unit is 95% very fine quartzite (or very coarse siltstone), very poorly sorted; argillaceous material occurs in thin irregular laminae to produce thinly bedded appearance. Basal 150' are massive, rough, ribbed cliff; quartzite beds show abundant shallow-water structures and coarse ?"burrows"	310	415
2	Shale or mudstone, pale grey-green; silty to very finely sandy. Interbedded with siltstone, dolomitic, coarse; very rough, blocky. Bedding of unit is irregular, wavy, irregularly laminated in some beds, massive in others; weathers rusty yellow and brown; unit is recessive. Occasional bed of quartzite, light grey, fine grained, hard. Interval of mudstone, 15' thick, dark grey, silty, 10' above base	95	105
1	Quartzite, argillaceous, thinly bedded; as in unit 18; forms steep slope	10	10
	Beds below unit 1 are made up of 1,000'-2,000' of shale, dark brown weathering, with ribs of dolomite, silty, orange weathering; and siltstone, dolomitic (entire interval assigned to Tsezotene Formation). Minimum thickness of Tsezotene Formation is 2,450 feet (747 m).		

SECTION U-4. ARCTIC RED RIVER VALLEY (106G)

Located in the Mackenzie Mountains, on escarpment face immediately west of the confluence of its first large tributary and the Arctic Red River proper, first range of Mackenzie Mountains; Latitude 65°9 1/4'N, Longitude 131°17 1/2'W; aerial photograph A12148-29; base of section at photo co-ordinates X=+2.6, Y=+4.1; top of section at photo co-ordinates X=+1.2, Y=+3.8, measured and described by J. L. Usher, August 6, 1969; through lower part of Katherine Group; top of this section is equivalent to base of section U-5; bottom of this section closely approximates the top of section U-3.

PROTEROZOIC

HELIKIAN?

Katherine Group, lower part ..... 1,390 feet (424 m)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Katherine Group, lower part (Proterozoic, Helikian?)		
15	Sandstone, slightly argillaceous, brown; thin to thick bedded; with extremely argillaceous interbeds; dark brown weathering; platy	18	1,390
14	Quartzite, cliff forming, white, fine to medium grained; very thick bedded; large gentle cross-beds; clean, well sorted and rounded	75	1,372
13	Dolomite, stromatolitic; with 2" thick small chert pebble conglomerate at base; orange weathering, top 2" only. Underlain by shale, dolomitic and sandy, and quartzite, very thickly bedded; 2' thick. Underlain by quartzite, dark brownish grey	5	1,297
12	Quartzite, white, fine grained; thick and massive beds; top 2'of unit are dolomite, sandy brown; from 243' to 311' above base, quartzite is pale green to green-grey, clean, well sorted, cross-bedded; thinner beds weather flaggy; from 242' to 243' above base, sandstone, very thinly bedded, argillaceous; from 142' to 144' above base, quartzite, very thinly bedded, platy; from 97' to 99' above base quartzite is brown, thinly bedded, strongly crossbedded; poorly sorted; from 95' to 97' above base, shale, silty, green and red	311	1,292
11	Shale, red and green; poorly exposed	20	981

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
10	Quartzite, partly argillaceous; thin to thick bedded; with shale, and silty and sandy shale interbeds. From 195' to 215' above base, sandstone, very argillaceous, red and green; interbedded with shale, silty, sandy, and dolomitic; contact with unit 11 arbitrary. From 180' to 195' above base, sandstone, flaggy white, thinly bedded, and laminated. From 125' to 180' above base, quartzite is grey and brown; with local dolomitic sandstone and mudstone. From 95' to 125' above base, quartzite is clean, less argillaceous. Basal 58' of unit are greyish green	215	961
9	Purple shale zone (informal); shale, purple; very finely fissile, laminated; silty; micaceous bedding planes; occasional sandstone, purple, very fine grained, thinly bedded; above 180' from base, unit changes to mudstone, dark greenish grey, massive, non-fissile; above 85' from base, unit forms steep slopes, below that level, unit is recessive; unit is an important marker interval	223	746
8	Quartzite, dark grey, fine to very fine grained; thin bedded, blocky; occasional paler grey beds. From 110' to 171', unit is cliff forming, thinly and wavy bedded; argillaceous, laminated. From 57' to 59' above base, black shale zone, very thinly bedded with black carbonaceous seams and shale chip breccias	171	523
7	Covered interval; top 2' are dolomite, thin bedded, orange weathering	45	352
6	Quartzite, dark grey; very fine grained, thin bedded; interbedded with shale, sandy, silty, grey, thin bedded	37	307
5	Quartzite and shale, as in unit 6, but less shale and more cliff forming as in unit 8; occasional grey silty shale up to 12" thick; weathers yellowish brown or rusty	90	270
4	Quartzite, thin to generally thick beds; more massive than above; weathers dark grey, occasionally orange	58	180
3	Covered interval	17	122
2	Quartzite, very fine grained; thin bedded, laminated (wavy); argillaceous partings; weathers dark grey and forms steep slopes	52	105
1	Quartzite, fine grained; thin to thick bedded; weathers dark grey; similar to unit 2; base concealed	53	53

SECTION U-5. ARCTIC RED RIVER, TAWU RANGE (106G)

Located in Tawu Range of Mackenzie Mountains, on the north side of the first main tributary entering Arctic Red River from the east, inside the mountain front; Latitude 65°04'N, Longitude 130°40'W; aerial photograph A12251-289; base of section at photo co-ordinates X=+8.9, Y=-1.7, top of section at photo co-ordinates X=+8.8, Y=-7.3. Measured and described by J. L. Usher, August 2, 1969; through "basal Franklin Mountain red beds" unit, unnamed Proterozoic map-unit H5, and upper part of Katherine Group.

PHANEROZOIC

PALEOZOIC

UPPER CAMBRIAN

Franklin Mount Formation, rhythmic unit equivalent(?) ..... basal beds only

"Basal Franklin Mountain red beds" unit ..... 131 feet (40 m)

(Unconformity)

PROTEROZOIC

HELIKIAN?

Unnamed map-unit H5 ..... 622 feet (190 m)

Katherine Group, upper part ..... 944 feet (288 m)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)

Franklin Mountain Formation, rhythmic unit equivalent(?)
(?Upper Cambrian)

Dolomite, medium grey, thick bedded, finely crystalline with small vuggy porosity and abundant white chert blebs and tracery on weathered surface. Rock brittle, hard, siliceous. Upward, thicker bedded. Occasional platy, yellow-grey weathering zones. Dolomite weathers grey, cliff forming as at Mountain River (section U-8).

"Basal Franklin Mountain red beds" unit
(?Upper Cambrian)

4 Quartzite, white to grey, very fine grained; thin to thick bedded. Interbedded with dolomite, pale orange-buff; in beds 1" to 10" thick. Above 48' from base, unit is dolomite, pale grey, aphanitic; thick bedded; brittle, with occasional argillaceous interval; weathering pale yellow to pale grey;

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	dolomite in this interval becomes more and more silty downward. From 24' to 48' above base, interbedded dolomite, silty; sandstone, dolomitic; and quartzite, grey, in beds 6" to 24" thick. Basal 24' are 90% quartzite	87	131
3	Dolomite, grey (purplish pink at base), thin to thick bedded; silty to very silty; some argillaceous beds at top; weathering buff	14	44
2	Shale, red, silty in basal one third; overlain by siltstone, red, coarse grained, very well bedded, blocky and platy, cliff forming; and by sandstone, hematitic; a few beds of dolomite, silty, pale yellow, up to 4" thick	26	30
1	Conglomerate, carbonate pebbles; red sandstone matrix	1.5 to 4	4
	(Unconformity)		
	Unnamed map-unit H5 (Proterozoic, Helikian?)		
	"Dead End Shale" sub-unit (unit 8 only)		
8	Shale (clay), red-brown; very thinly fissile and crumbly; generally calcareous; interbedded with limestone; grey to pink, cryptocrystalline, thinly bedded; locally with beds of flat nodules; limestone increases upward and is most prominent in upper half. Above 456' from base, dolomite, buff, silty; overlain by limestone, argillaceous, red, thinly laminated, platy. From 446' to 460' above base, shale, grey to bluish grey and buff. From 437' to 446' above base, sandstone, red, very fine grained; very thinly bedded, calcareous. From 385' to 437' above base, buff-weathering limestone nodules occupy 50% of interval. Above 324' from base, a 17' thick grey band occurs which thickens westward along strike to occupy the middle third of unit (*see* remarks at end of section); 304' above base, an interval of limestone occurs, 20' thick, thin bedded, resistant	460	622
7	Mainly covered, with black shale debris; some grey shale; one 3' thick bed of stromatolitic limestone; some beds of conglomerate, flat pebbles of limestone in sandstone matrix; also limestone, black, aphanitic, very thinly bedded, argillaceous; siltstone, calcareous, dark brown, very thinly bedded; and sandstone, very fine grained, weathering dark brown and ledgey at top of unit	34	162

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
6	Dolomite, stromatolitic; stromatolites columnar, 1" to 2" in diameter; upper part of unit is mainly limestone, grey, with orange-weathering inter-stromatolite strips perpendicular to bedding; rare black shale interbeds or partings; unit forms massive cliff. This unit forms base of massive, grey, isolated bioherm (±400' thick), the lower one third of which is orange-weathering dolomite, and the upper two thirds grey limestone. The off-reef facies of this (and other along-strike bioherms) is the "Dead End Shale" sub-unit (unit 8 in this section)	18	128
5	Covered interval, probably black shale in upper two thirds with dolomite, black, sooty, very thinly bedded, dense, and silty to argillaceous; grey-brown quartzite bed in lower one third of unit	60	110
4	Dolarenite, silty; brownish grey, coarse grained; thin to thick bedded; weathering orange-brown; with algal oncolites	13	50
3	Shale, black; interbedded with quartz sandstone, black and white, medium to coarse grained, thinly bedded, strongly cross-bedded; brown, 18" thick dolomite bed at 9' above base	15	37
2	Dolarenite, dark grey, thin bedded (< 6"); with quartz sand, fine to medium grained, well rounded, floating, also dolomitic fragments, oolites, pisolites, and other rounded particles; weathers deep brownish orange; basal few inches are sandstone in dolomitic matrix	14	22
1	Shale, black; carbonaceous, non-calcareous	8	8
	Katherine Group, upper part (Proterozoic, Helikian?)		
	Upper quartzite sub-unit (units 10 to 21 inclusive)		
21	Quartzite, brown, fine to medium grained; thick to very thick bedded, intense cross-bedding; well-rounded quartz grains; rare carbon film on bedding planes, some coarse shale chip breccias; weathers grey or dark grey-brown	18	944

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
20	Shale, grey; occasional silty to very fine sandy thin layers; 10' from top, one bed of dolomite, argillaceous, orange weathering; underlain by dolomite, argillaceous, pale grey, laminated	25	926
19	Quartzite, white to brown, generally fine to very fine grained, some medium grained; thin to thick bedded; very poorly sorted; much argillaceous matter as greyish green and grey wavy laminae; thin sandy shale interbeds and shale chip breccias. Basal 5' to 6' are quartzite, dark grey, fine grained, thick bedded, and thickens east and west along strike cutting into interval of shales in unit 18. Much evidence of shallow-water deposition	45	901
18	Shale, very silty to finely sandy, dark grey to blue-grey to black	45	856
17	Quartzite, brown and yellow at top, whitish at base; thin to thick bedded; weathers dark blackish brown with yellow-rusty overlay	40	811
16	Shale, as in unit 14, silty to very fine sandy; dark grey to blue-grey; with quartzite beds < 1" thick; top 15' covered, unit underlain by 12' thick quartzite as in unit 17	60	771
15	Quartzite, yellowish brown; thin and thick bedded; interbedded with shale, dark grey; weathers yellow to grey; pinches out along strike	15	711
14	Shale, silty; dark grey to blue-grey; locally mud-cracked, poorly sorted, thin quartzite and quartz sandstone beds	15	696
13	Quartzite, cliff forming, brown, fine grained; homogenous, massive. Interbedded in alternating 15' to 20' zones with quartzite, thin bedded, crossbedded and ripple-marked; contains argillaceous seams, black shale partings, thin argillaceous sandstone layers, and shale chip conglomerates; some beds strongly coated with hematite. Basal 23' are sandstone, very fine grained; or shale, brown, very sandy, silt laminated; and shale, dark grey; with thin to thick, fine-grained quartzite beds	128	681

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
12	Quartzite, white, very fine grained; massive, homogenous, interbedded with argillaceous quartzite, red, 2" to 6" thick zones every 3' to 5'; weathers dark grey-brown. Basal 15' are whitish pinkish red, thin to thick bedded, with pronounced red and buff hematite banding	90	553
11	Shale, red; in 1" to 6" beds; very finely sandy, or very shaly weathering argillaceous sandstone; interbedded with quartzite, hematitic, red and white, thin bedded	10	463
10	Quartzite, very fine grained; massive; in beds 2' to 4' thick, with 6" argillaceous and hematitic beds between; quartzite strongly hematitic	17	453
9	Shale, dark grey, grey, or greenish grey; silty; some very fine grained sandstone to siltstone lenses and layers in top one third of unit; unit weathers grey to brown; at 115' above base, about 6' thick zone of dolomite, orange weathering, thin bedded, with one 12" thick stromatolitic layer at top; unit is poorly exposed	174	436
8	Dolomite, grey, aphanitic; thin and thick bedded; wavy argillaceous seams; weathers orange	5	262
7	Dolomite, grey; very thinly bedded to laminated; increases in argillaceous content downward, argillaceous beds silty to finely sandy near base; several 6" to 8" beds of orange dolomite in basal 3'; several beds of flat-pebble conglomerate; dolomite is platy weathering	20	257
6	Dolomite, massive; domal stromatolites present in 4' to 5' layers; black argillaceous dolomite interbeds; weathers orange	18	237
5	Dolomite, grey; thin bedded; passing into shale in lower half; recessive	10	219
4	Dolomite, dark grey; thin bedded; slightly argillaceous, with black argillaceous partings; weathers coarse knobby and orange; basal 6' are shale, dolomitic, dark grey	46	209

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
3	Shale, dark grey; upper 35' very finely silty with rare thin laminae and lenses of sandstone, very fine grained, quartzose; basal 48' clay shale, very finely fissile; unit is poorly exposed	83	163
2	Dolomite, dark grey; laminated in alternating more to less argillaceous layers; interbeds of shale, dolomitic, dark grey; unit weathers pale orange; the more argillaceous beds are platy weathering and recessive	41	80
1	Covered interval; grey shale debris. Basal 10' to 15' are shale, silty to finely sandy; and quartzite, greyish brown or whitish brown, in beds up to 4" thick, rusty to dark brown weathering; some thin layers of black chert debris	39	39

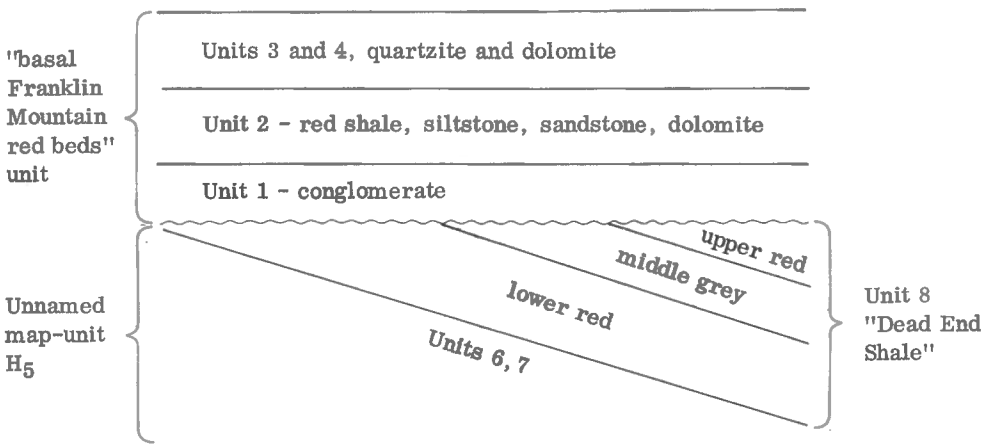
Base of unit 1 is also top of lower part of Katherine Group.

Remarks: In a series of "fly-bys", the "Dead End Shale" interval is seen to change colour along strike while maintaining its shale and nodular limestone nature. The change, for instance, from the site of section U-5, from red to a red with middle grey unit, a mile or so to the west, is interrupted at that locality by a small biohermal build-up, west of which the "Dead End Shale" interval is totally dark grey to blackish.

Wider ranging observations by helicopter indicate that the "Dead End Shale" interval in the area can be exceedingly thick (estimated up to 1,000 feet) and varies from red, to greys, blacks, and even pale buff in weathered colour.

The unconformity at the top of the "Dead End Shale" interval is angular and its position within the upper "Dead End Shale" is, expectedly, at various stratigraphic positions. At U-5, its angularity is not obvious and I would be inclined to use the conglomerate, unit 30, as the marker for it. The overlying red siltstones and sandstones, with dolomitic beds, would then be the "basal Franklin Mountain red beds" unit.

Along strike to the west, where the grey unit splits the shale into three parts, the angularity is clearly shown, as in the following diagram:



SECTION U-6. VICINITY OF HEADWATERS OF MOUNTAIN AND GAYNA RIVERS - SOUTH (106B)

Located in interior part of Mackenzie Mountains, at a position midway between the headwaters of Mountain and Gayna Rivers, and close to the eastern edge of NTS 106B; Latitude 64°35 1/2'N, Longitude 130°00 1/2'W; aerial photograph A12249-130; base of section at photo co-ordinates X=-0.9, Y=-5.1, top of section at photo co-ordinates X=-1.5, Y=-8.6. Measured and described by J. L. Usher, August 4 and 5, 1970. Section ends downward at a covered contact with the Sekwi Formation; upward, it ends at the mountain peak without crossing or reaching any of the lithologic contacts recognized in Operation Norman to this date. GSC fossil localities C7554 - C7559: GSC report 0-1-BSN-1971, by B. S. Norford. GSC fossil localities C7560 - C7576: GSC internal report C9-1972-WHF, by W. H. Fritz.

PHANEROZOIC

PALEOZOIC

MIDDLE CAMBRIAN TO LOWER ORDOVICIAN

Road River Formation. At this locality, equivalent of the Rockslide (Middle Cambrian) and Broken Skull (Upper Cambrian and Lower Ordovician) Formations .....2,464 feet (751 m)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Road River Formation (Middle Cambrian to Lower Ordovician)		
21	Dolomite, dark grey, very finely crystalline to aphanitic; thin and thick bedded, semi-flaggy to semi-blocky, becoming thick bedded and coarse blocky towards base; some vuggy porosity parallel to bedding and partly filled with orange dolomite; black chert lenses parallel to bedding, some round black chert nodules, local bed of flat-pebble breccia; unit weathers sooty grey; wavy siliceous silt tracery weathered on surface	83	2,464
20	Limestone, argillaceous; dark grey, aphanitic; wavy bedded, becoming very finely laminated in lower parts; with argillaceous partings and anastomosing seams of argillaceous material; rare, thin, black nodular chert layers; small pyrite crystal clusters common; weathering medium grey and rough platy, becoming thin platy towards base. At 59' below top, a 6' thick zone of dolomite, orange weathering, and shale, dolomitic, thin platy weathering. At 2,369': inarticulate brachiopod, non-diagnostic (GSC loc. C7555); at 2,361': inarticulate brachiopod, *Symphysurina* sp., Early Ordovician, Early Canadian, Zone A or B (GSC loc. C7556); at 2,341': inarticulate brachiopod, olenid and undetermined trilobites, *Symphysurina* sp., Early Ordovician, Early Canadian, Zone A or B (GSC loc. C7557); at 2,329': inarticulate brachiopod, *?Symphysurina* sp., Early Ordovician, probably Early Canadian, probably Zone A or B (GSC loc. C7558); at 2,296': inarticulate brachiopods, agnostid, olenid, and undetermined trilobites, *Symphysurina* sp., Early Ordovician, Early Canadian, Zone A or B (GSC loc. C7559); at 2,272': *Bayfieldia* sp., or *Eurekia* sp., *Geragnostus* sp., *Gymnagnostus* sp., Late Cambrian, *Saukia* Zone (GSC loc. C7560); at 2,264': *Bayfieldia* sp., *Geragnostus* sp., *Yukonaspis* sp., Late Cambrian, *Saukia* Zone (GSC loc. C7561)	117	2,381

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
19	Limestone, argillaceous; thinly bedded; with thin irregular anastomosing threads and very thin beds of dolomitic limestone or dolomite, and with some silicification; unit weathers pale buff, dolomitic beds weather in relief; essentially the same as unit 20, but somewhat dolomitic, contact between the two units is arbitrary. At 2,250': *Bayfieldia* sp. or *Eurekia* sp., *Gymnagnostus* sp., *Idiomesus* sp., cf. *Keithiella* sp., aff. *Koldinoidia* sp., *Lecanopyge?* sp., *Loganellus?* sp., *Pseudagnostus clarki* Kobayashi, *Yukonaspis* sp.,: Late Cambrian, *Saukia* Zone (GSC loc. C7562)	47	2,264
18	Dolomite, finely crystalline; dark grey, thin to thick bedded, wavy banded, very hard; locally slightly calcareous; weathering buff	45	2,217
17	Limestone, aphanitic; grey, thinly bedded, platy. Contains 25 to 30% dolomite, ultra finely crystalline; thinly bedded (1/4" to 1" beds); finely laminated, grey or buff-grey weathering; proportion of dolomite increases downwards. Entire unit is argillaceous and very finely silty; proportion of thin argillaceous beds and thin interbedded shales increases downwards. Top 37' are mostly covered, but appear to consist of thin-bedded bluish grey limestone, and dark grey shale debris. Basal 140' of unit contain up to 50% grey shale; remainder is laminated dolomite as before	251	2,172
16	Dolomite, aphanitic; thin bedded, with irregular wavy bands of silty dolomite 1/2" thick, separated by bands up to 1" thick of slightly argillaceous dolomite; weathers orange-buff	57	1,921
15	Limestone, generally aphanitic; thin bedded, with argillaceous and dolomitic seams, threads, and very thin beds; weathers grey, ribbed, with orange overcast, becoming light brown-grey weathering downward. At 1,841': *Hungaia?* sp. (cranidial axis only), *Pseudagnostus* sp., *Wilbernia?* sp., Late Cambrian, *Ptychaspis-Prosaukia* Zone (GSC loc. C7563)	234	1,864
14	Limestone, very argillaceous; extremely finely and regularly laminated; numerous beds 1" to 2" thick of limestone, grey, aphanitic; shale partings; unit weathers into light brownish grey wafers	81	1,630

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
13	Dolomite, silty, grey, finely crystalline; finely blocky; largely covered	28	1,549
12	Limestone, as in unit 14, varying from wafer-thin weathering to 1/2" flags; orange-weathering dolomite zones at 135' to 140' and at 273' to 276' from top of unit. At 1,481': *Comanchia* sp., *Pseudagnostus* sp., *Taenicephalus?* sp., cf. *Wilbernia* sp., Late Cambrian, *Conaspis* Zone (GSC loc. C7564); at 1,267': aff. *Brabia* sp., *Peratagnostus* sp., *Pseudagnostus* sp., Late Cambrian *Elvinia* Zone? (GSC loc. C7565	287	1,521
11	Dolomite, massive, brecciated; weathers orange	10	1,234
10	Limestone, wafer-thin beds as in unit 12	19	1,224
9	Dolomite, very finely crystalline; rough bedded at top, but in very well bedded, 2" to 6" thick, beds below; laminated; massive, blocky; weathers orange-grey in lower parts	48	1,205
8	Limestone, argillaceous, grey; thinly bedded, in lower part of unit beds up to 6" thick; 100' below top of unit, beds of limestone pebble conglomerate, up to 10' thick (one is 4' thick), show evidence of sliding and rolling (slope deposits), not abundant; shale partings between beds; unit becomes more argillaceous downwards; lower third of unit is well bedded, and regularly interbedded with calcisiltite, very fine grained; in beds 1" to 3" thick; and limestone, argillaceous, dark grey to black in beds up to 1" thick; limestone weathers medium grey, shale dark grey; slope appears black with lighter grey overlay. At 1,123': cf. *Parabolina* sp., *Peratagnostus* sp., *Proceratopyge* sp., Late Cambrian, *Elvinia* Zone? (GSC loc. C7567); at 1,082': *Pseudosaratogia* sp., *Quebecaspis* sp., cf. *Stenambon* sp., Late Cambrian, *Elvinia* Zone (GSC loc. C7568); at 987': *Anechocephalus* sp., *Dellea* sp., *Dokimocephalus* sp., cf. *Homagnostus* sp., or *Geragnostus* sp., *Iddingsia* sp., *Pseudagnostus* sp., *Pseudosaratogia* sp., Late Cambrian, *Elvinia* Zone (GSC loc. C7569); at 961': *Pseudagnostus* sp., Late Cambrian, *Aphelaspis* or *Dunderbergia* Zone (GSC loc. C7570); at 957': *Aphelaspis?* sp., *Dunderbergia?* sp., *Pseudosaratogia?* sp., cf. *Prehousia* sp. (pygidium only), Late Cambrian		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Aphelaspis or *Dunderbergia* Zone (GSC loc. C7571); at 853': *Cedaria* sp., inarticulate brachiopod, Late Cambrian, upper *Cedaria* or lower *Crepicephalus* Zone (GSC loc. C7572); at 805': *Arapahoia?* sp., *Cedaria* sp., *Coosia* sp., or *Coosella* sp., *Kingstonia* sp., *Meteoraspis* sp., *Pseudagnostus* sp., *Tricrepicephalus* sp., Late Cambrian - upper *Cedaria* or lower *Crepicephalus* Zone (GSC loc. C7573); at 670': *Brassicicephalus* sp., *Cedaria* sp., cf. *Oedorhachis* sp., Late Cambrian *Cedaria* Zone (GSC loc. C7574	535	1,157
7	Covered interval; slope of talus which is increasingly argillaceous and very thinly bedded; talus of basal zone is 85% shale, dark grey, calcareous, with thin ribbons of limestone as in unit 8	413	622
6	Covered interval; talus consists of a variety of dolomites, very finely to finely crystalline, thin to thick bedded, weathering buff to dark grey; trilobite collection made from dark grey type; common spongy silicification in surface relief. Talus from entire unit contains: *Alokistocare?* sp., *Baltagnostus incertus* (Robison), *Bathyuriscus* sp., *Hemirhodon* sp., aff. *Lejopyge* sp., *Metisella?* sp., *Modocia* spp., *Trymataspis* sp., Middle Cambrian, upper *Bolaspidella* Zone (GSC loc. C7575)	67	209
5	Dolomite, grey, finely crystalline; thin to thick bedded, faintly laminated; dense, hard; weathers buff and very rough as though silicified	11	142
4	Dolomite, slightly argillaceous; black, very finely crystalline; thin to thick bedded, becoming thinly bedded at base; white dolomite-filled vugs; fetid; weathering dark grey	4	131
3	Dolomite, very finely crystalline; silty; grey; thin to thick bedded, finely laminated; rare, thin argillaceous layers; weathers buff	10	127
2	Covered interval	47	117
1	Dolomite, very finely crystalline; grey; thin to thick bedded, irregularly laminated; silty; very dense, cliff forming, weathers buff and blocky	70	70
	End of outcrop. Talus below is Sekwi Formation; talus collection *Salterella* sp., Early Cambrian (GSC loc. C7576).		

SECTION U-7. VICINITY OF HEADWATERS OF MOUNTAIN AND GAYNA RIVERS - NORTH (106B)

Located in interior part of Mackenzie Mountains, at a position approximately midway between the headwaters of Mountain and Gayna Rivers, and close to the eastern edge of NTS 106B; immediately north of section U-6; Latitude 64° 37 3/4'N, Longitude 130°00 1/2'W; aerial photograph A12243-384; base of section at photo co-ordinates X=+9.8, Y=+0.6, top of section at photo co-ordinates X=+8.6, Y=-1.5. Measured and described by J. L. Usher, August 7, 1970, from the base of a cliff-forming carbonate unit mapped as Mount Kindle Formation (but not confirmed as such by fossil evidence) downward to the top of the Sekwi Formation. Because of the argillaceous nature of the rocks, exposure is poor. GSC fossil localities C7577 to C7579; GSC internal report C9-1972-WHF; C7580 to C7589; GSC internal report C8-1971-WHF; by W. H. Fritz.

PHANEROZOIC

PALEOZOIC

MIDDLE CAMBRIAN

Road River Formation (Rockslide Formation equivalent at this locality) ..... 1,207 feet (368 m)

(Unconformity?)

LOWER CAMBRIAN

Sekwi Formation (atypical lithology) ..... 418 feet (127 m) (incomplete)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Road River Formation (Middle Cambrian at this locality)		
6	Shale, very dark grey to black; interbedded with limestone, dark grey, very fine grained, in thin beds and laminae; fissile and argillaceous; limestone content decreases in basal part of unit. From 1,040' to 1,207' (talus): *Alokistocarella?* sp., *Bathyuriscus adaeus* Walcott, *Kootenia* sp., *Ogygopsis* sp., *Pagetia* spp., *Spencella* sp., *Zacanthoides* sp. (GSC loc. C7577); at 1,007': *Corynexochides* sp., *Kootenia* sp., *Micromitra* sp., *Pagetia* sp., *Spencella* sp. (GSC loc. C7578); at 869': *Alokistocarella?* sp., *Bathyuriscus* sp., *Micromitra* sp., *Pagetia* sp., *Spencella* sp. (GSC loc. C7579). Collections C7577 to C7579 belong to the upper portion of the Middle Cambrian *Bathyuriscus-Elrathina* Zone, and probably equate with the *Bathyuriscus adaeus* faunule from the lower beds of the Eldon Formation in the southern Canadian Rocky Mountains	458	1,207

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
5	Shale, silty, calcareous; dark grey; occasional 3" layer of limestone (calcarenite), weathering brownish grey, and a few beds of limestone conglomerate and flat-pebble conglomerate; shale weathers very thin platy and brown-grey in lower 240', crumbly and black in upper 60'	299	749
4	Shale, as in unit 5, but interbedded with rare beds of dolomite, grey, very finely crystalline; thinly bedded, dolomite weathers blocky and orange	141	450
3	Shale, dark grey to black, but otherwise as in unit 5; from 130' to 165' above base, many limestone nodules, dark grey, very finely crystalline, irregularly shaped, slightly flattened, weathering grey; unit poorly exposed, mostly talus	244	309
2	Covered interval; talus of limestone, platy, argillaceous; and shale, as above	51	65
1	Covered interval; medium to coarse nodular limestone talus, much fragmentary trilobite debris; at 0' to 14'?: dolichometopid or zacanthoidid cranidium, *Paterina* sp., *Syspacephalus* sp., *Zacanthopsis?* sp., latest Early Cambrian or Middle Cambrian (GSC loc. C7579a)	14	14
	Sekwi Formation (atypical lithology) (Lower Cambrian)		
14	Dolomite, very argillaceous; very finely crystalline; dark grey; thin to thick bedded at top, becoming thin irregularly bedded at base; weathers platy at base	22	418
13	Covered interval	4	396
12	Dolomite, very finely crystalline, slightly argillaceous, dark grey; resistant; thin and thick bedded; weathers dark sooty grey; siliceous tracery on weathered surface and irregular argillaceous tracery occurs in coarse laminae and layers; alternately weathering dark and light grey	78	392
11	Dolomite, argillaceous, very finely crystalline, dark grey; thin bedded (1/2"), with argillaceous partings, and near base, a 2 1/2' thick		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	zone of black shale; unit weathers dark grey, and to small elongate blocks; moderately cliff-forming	27	314
10	Mainly covered; small outcrops of limestone, argillaceous to silty; thin bedded to platy, alternating with calcisiltite, finely silty, very hard, thin bedded	17	287
9	Dolomite, argillaceous; grey, becoming dark grey to black downward; thin to thick bedded at top, becoming thinly bedded (1/2" to 1") downward; irregularly laminated; weathers dark grey; moderately cliff forming	27	270
8	Covered interval	17	243
7	Limestone, argillaceous; thin bedded, nodular; fossil debris	13	226
6	Covered interval	8	213
5	Limestone, very finely crystalline; dark grey; massive; weathers bluish grey	13	205
4	Covered interval	13	192
3	Limestone, argillaceous; thin bedded, finely nodular; argillaceous; *Olenellus* fragments; collection from talus, units 3 to 5: *Olenellus romensis?* Resser and Howell (GSC loc. C7589)	27	179
2	Dolomite, very finely crystalline, grey; finely laminated, weathers buff to white	3	152
1	Limestone, very finely crystalline; dark grey; thin to thick bedded, semi-nodular; much argillaceous tracery; top 18' are principally limestone, very thinly bedded, shaly weathering; or shale, highly calcareous; abundant trilobites. From talus, upper part of unit: *Olenellus romensis?* Resser and Howell (GSC loc. C7588); from talus at 120': *Olenellus romensis?* Resser and Howell (GSC loc. C7587); from talus at 97': *Olenellus* sp. (GSC loc. C7586); from talus at 95': *Olenellus romensis?* Resser and Howell (GSC loc. C7585); at 93': *Olenellus romensis?* Resser and Howell (GSC loc. C7584); from talus at 80': *Olenellus* sp. (GSC loc. C7583); from talus at 75': *Olenellus* sp., aff. *O. romensis* Resser and Howell (GSC loc. C7582); from talus, at base of unit: *Olenellus* sp. 1?., aff. *O. romensis* Resser and Howell (GSC loc. C7580)	149	149

W. H. Fritz states in GSC internal report No. C8-1971-WHF: "Only species of *Olenellus* are present in the above collections (C7580 to C7589). The front cephalic margins are broadly curved (plan view), which differentiates these specimens from most Cordilleran species known to me. The close resemblance between the present material and *O. romensis* Resser and Howell (Geol. Soc. Am., Bull. 49, p. 221) is striking. However, the type material of *O. romensis*, from the Rome Formation, southwestern Virginia, needs additional preparation (to expose more details) before it can be fully compared with the present material.

The above collections belong to the *Bonnia-Olenellus* Zone, and correlate with the upper limestone unit (above the orange dolomite) in the Sekwi Formation at the type section."

Unit 1 is underlain by a series of white-, buff-, yellow-, and pale grey weathering, cindery to blocky weathering, light grey, very finely crystalline to sub-lithographic, well-bedded dolomites, assigned to the Sekwi Formation.

SECTION U-8. HEADWATERS OF MOUNTAIN RIVER (106A)

Located in interior part of Mackenzie Mountains, in headwaters of Mountain River; Latitude 64°43'N; Longitude 129°55'W; aerial photograph A12697-174. Composite section. Measured and described by J. L. Usher, July 31 and Aug. 3, 1970; through Little Dal Formation, Rapitan Group, Keele, Sheepbed, and Backbone Ranges Formations, and basal beds of Sekwi Formation. Section AC2524-70 and AC2525-70, base Little Dal Formation to marker bed in Rapitan-Keele unit: base of section at photo co-ordinates X=-2.7, Y=+6.1, top of section at photo co-ordinates X=+1.9, Y=-0.4. Section AC2526-70, marker bed in Rapitan-Keele to base of Sekwi Formation: base of section at photo co-ordinates X=+5.8, Y=+4.2; top of section at photo co-ordinates X=+10.1, Y=+0.4.

PHANEROZOIC

PALEOZOIC

LOWER CAMBRIAN

Sekwi Formation ..... 63 feet (19 m) (incomplete, basal beds only)

Backbone Ranges Formation ..... 730 feet (223 m) (incomplete)

(Unconformity)

PROTEROZOIC

HADRYNIAN(?)

Sheepbed Formation ..... maximum 1,252 feet (382 m) (mostly covered)

Keele Formation and Upper Rapitan Group, undifferentiated ..... 4,403 feet (1,342 m) (incomplete)

Rapitan Group, middle unit ..... 950 feet (290 m)

HELIKIAN(?)

Little Dal Formation ..... 813 feet (248 m) (incomplete)

Unnamed map-unit H5 ..... 58 feet (18 m) (incomplete)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Sekwi Formation (Lower Cambrian)		
	Dolomite, medium crystalline; pale grey; bedding irregular, up to 2' thick; porous. Interbedded with dolomite, very finely crystalline, dense, blocky weathering; and dolomitic shale; in zones up to 2' thick. Porosity is intercrystalline and small vuggy, parallel to bedding; top bedding planes are hummocky; ?organic origin	63	63
	Backbone Ranges Formation (Lower Cambrian)		
13	Covered interval	8	730
12	Quartzite, as in unit 10; top 8' becoming thinly bedded and somewhat argillaceous, with planes of shale-chip conglomerate and very coarse sand to coarse granule and small pebble conglomerate beds	58	722
11	Covered interval	33	664
10	Quartzite, fine grained, pale grey; thick bedded; clean, with numerous beds of thick bedded, crossbedded, very coarse sand to granule beds in basal 30' to 40'; weathers grey	147	631
9	Sandstone, white; very finely crossbedded, with black tracery outlining the beds; poorly cemented and thus very friable, yielding thick loose sand accumulations; occasional coarse sand layer and rare layers of granule conglomerate; weathers white	48	484
8	Mainly covered; talus is sandstone, white, medium to coarse grained, soft; and interbedded shale	39	436

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
7	Quartzite, fine to medium grained; very thick to thick bedded, with some very thinly bedded zones near top; resistant; near top contains rare silty shale interbeds, and thin lenses, beds, and crossbeds of coarse sand to fine-pebble conglomerate; top weathers flame red to brilliant orange, but this characteristic is not as persistent along strike as in unit 1	66	397
6	Mainly covered; with shale, green, buff-brown and ochre, soft, muddy; and brown sandstone beds near top and base	32	331
5	Shale, mainly brown, but maroon in upper 10' to 15', and grey in basal 5' to 10'; interbedded with sandstone, fine grained, brown; thin bedded; weathers deep maroon; non-calcareous	106	299
4	Dolomite, sub-lithographic; argillaceous; pale grey or rose-grey, thin and thick bedded, very well bedded; top few feet silty; argillaceous content decreases downward, very thin shale partings between some dolomite beds; at base, unit is an orange-brown weathering stromatolitic "reef" that thickens and thins along strike, thinning to 0' in places; stromatolitic zone sits on interbedded shale and dolomite, 2" to 3" thick; unit weathers orange	77	193
3	Quartzite, fine to medium grained, grey; in beds 6" to 20" thick; weathers grey. Interbedded with dolomite, sub-lithographic; pale to medium grey; in beds 4" to 12" thick; brown weathering; and shale, pale green and brown, in beds 1" to 2" thick. Top 5' with beds of coarse to very coarse, crossbedded sandstones, and shale beds 12" to 18" thick	25	116
2	Mainly covered; quartzite, dolomite, and shale	20	91
1	Quartzite, fine grained, grey; thin to thick bedded; top 21' contain dolomite, very finely crystalline, pale grey; in beds up to 4" thick; and beds of shale, pale grey and green; unit weathers brilliant red in basal 50'	71	71
	(Unconformity?)		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Sheepbed Formation (Proterozoic, Hadrynian?)		
1	Covered along creek; partly exposed in gullies on slope. General lithology is shale, dark grey to dark brown-grey and black, non-fissile, non-calcareous; with interbeds of dolomite, silty, argillaceous, and micaceous, dark grey	1,252	1,252
	Keele Formation and Upper Rapitan Group, undivided (Proterozoic, Hadrynian?)		
23	Dolomite, very finely crystalline, grey; thin to thick bedded, very well laminated, becoming faintly laminated at base; dense, very hard; base of cliff has unique cleavage effect, set off by alternation of colour along cleavage; weathers yellow. Top 9' are dolomite, finely crystalline, grey, thin to thick bedded, weathering orange-brown	53	4,403
22	Covered interval	47	4,350
21	Dolomite, finely crystalline, grey; thin bedded; upper 27' mainly pebble conglomerate, in fine-grained muddy matrix, some pebbles floating in mud matrix; also with shale stringers and lenses; upper 27' also contain interbedded limestone, argillaceous, grey, thin bedded, wavy, laminated; upper 2' are limestone cobble conglomerate in rusty orange weathering matrix; unit weathers dark grey on slope, deep red to purple-red in creek bed	47	4,303
20	Covered interval	82	4,256
19	Quartzite; bedding very regular; occasional shale layers 4" to 8" thick; blocky weathering; otherwise as in unit 17	58	4,174
18	Covered interval	6	4,116
17	Quartzite, fine grained, light grey; thick bedded, with some thin beds; some shale partings; thin black shale laminae within beds are discontinuous; iron oxide speckled, weathers very rusty brown	19	4,110
16	Shale, dark grey; very thinly bedded but not fissile; soft, crumbly; non-calcareous; occasional bedding plane rusty	51	4,091

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
15	Mainly covered. One mid-unit ridge of calcareous dolomite or dolomitic limestone, medium crystalline, light grey; coarse, flaggy; orange speckled, light grey weathering; ridge about 20' thick	44	4,040
14	Dolomite; as in unit 12	30	3,996
13	Covered interval	50	3,966
12	Dolomite, medium to coarsely crystalline; light and medium grey bands, 1/2" to 2" thick; very thick bedded, broadly crossbedded; massive, cliff forming; porous, with intercrystalline and small vuggy porosity parallel to bedding; weathers yellow-grey	94	3,916
11	Many varied lithologies. Interval 3,836' - 3,717 1/2': shale, grey, green, and black; recessive. Interval 3,717 1/2' - 3,716': stromatolitic limestone. Interval 3,716' - 3,676': dolomite, finely crystalline, grey, weathering light grey with orange overcast. Interval 3,676' - 3,460': shale, fissile, black; and limestone, black, very thin bedded. Interval 3,460' - 3,270': limestone, medium crystalline, dark grey, thick bedded; weathered surface showing irregular bands of oolites, silicified and buff weathering. Interval 3,270' - 3,110': quartzite, interbedded with shale and sandstone; interval capped by quartzite, pale coloured, thick bedded. Interval 3,110' - 2,863': typical Rapitan lithologies, including sandstone, green, and sandstone, red, hematitic; shale, green; and limestone granule conglomerate. Interval 2,863' - 2,710': shale, dolomitic, green; interbedded with siltstone, argillaceous and dolomitic; interval is capped by limestone granule conglomerate in beds 1' to 5' thick and including well-rounded and spherical quartz grains	1,112	3,822
10	Mostly covered; includes beds of quartzite, whitish to medium grey, thick bedded, iron oxide flecked, weathering pale grey to buff; one 4' thick zone of limestone, dolomitic, grey, massive, buff weathering	186	2,710
9	Sandstone, dark green, as in unit 8; with thick beds of jasper conglomerate (one bed, 5' below top, crossbedded, containing quartz pebbles) and shales; underlain by 50' of limestone-granule conglomerate, very well rounded in beds up to 16" thick, interbedded with siltstones and dolomitic shales	100	2,524

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
8	Sandstone, mainly dark grey to dark green, but in part very hematitic red, fine to coarse grained; thin to thick bedded, well bedded, grains well rounded and spherical; shale interbeds; beds, stringers and lenses of jasper pebble conglomerate	137	2,424
7	Variety of clastic lithologies, including shale, siltstone, sandstone, and conglomerate. Shale is green and dolomitic, and includes green, chunky mudstones; siltstone, medium to coarse grained, laminated, hard, dense, greywacke composition; sandstone, green and brown, fine and medium grained, poorly sorted; green carbonate(?) sands; flat limestone pebble conglomerate; and in top 15' of unit, conglomerate, jasper pebble, in thin beds. Bedding mostly thin to thick; unit weathers very dark brown and green	68	2,287
6	Limestone, very finely crystalline to finely crystalline, grey; thin to thick bedded; massive; numerous well-rounded coarse granules to fine pebbles of limestone, which weather slightly in relief, show grain gradation in individual beds, are most numerous in lower part, and are floating in fine matrix in upper part; thin (1" to 4" thick) argillaceous beds between limestone beds	18	2,219
5	Limestone, shale, and dolomite. Limestone, stromatolitic, grey, massive, up to 4' thick, weathering grey-brown, irregular; limestone beds separated by zones 5' to 25' thick of thin-bedded dolomitic shales and silty green dolomites	77	2,201
4	Shale, as in unit 3, top few feet distorted; with numerous beds of limestone, up to 8" thick, giving unit a more cliff-like and brown-weathering aspect than unit 3	230	2,124
3	Shale, dolomitic, non-calcareous; dark greyish green; regularly bedded and finely laminated; non-calcareous, occasionally silty; weathering dark green; shale black when wet. Unit contains rare beds of limestone, grey, in thin beds (1" to 2"), in some cases cone-in-cone calcite; commonly dark fibrous calcite layers up to 1" thick on top and bottom of beds; also beds of limestone nodules, flat, discoidal, weathering deep red-brown	801	1,894

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
2	Siltstone, argillaceous, calcareous to dolomitic; grey; delicate crossbeds in many layers; many argillaceous beds; many layers of siltstone, ripple-marked, crossbedded, very calcareous, lighter brown weathering; basal foot of unit contains occasional lens up to 1' long of pebble conglomerate; siltstone weathers dark brown and blocky. Considerable distortion within lowest 200'; section may be repeated	509	1,093
1	Shale, black to dark grey; very finely laminated and fissile; containing, especially in middle of unit, beds of siltstone, dark green-grey, beds up to 1" thick, highly dolomitic, hard; occasional limestone layers, nodules, or nodule layers	584	584
	Rapitan Group, middle unit (Proterozoic, Hadrynian?)		
8	Limestone, grey, thin to thick bedded, speckles of pyrite, rusty brown weathering; interbedded with shale, black, very finely laminated, fissile, non-calcareous; predominance upwards of limestone, black, thin bedded, very argillaceous	413	950
7	Limestone, very fine grained; black; becoming grey below, thin and thick bedded; finely laminated near top of unit; argillaceous and silty in top of unit, becoming homogeneous downwards, dolomitic in basal 18"; conglomerate beds between 147' - 154' and 130' - 132' above base; strongly fetid in places; upper portion weathers flaggy to fissile; abrupt contact with underlying unit	161	537
6	Conglomerate, mudstone matrix as unit 1, but more argillaceous, less dolomitic; units 5, 6, and upper 10' to 12' of unit 4 are recessive and weather brown and dark grey	72	376
5	Shale, thinly bedded, finely fissile to blocky; interbedded with conglomerate, many beds up to 2' thick	12	304
4	Conglomerate, as in unit 1, massive, dark grey; poorly bedded; greyish brown weathering	170	292
3	Shale, thinly bedded, up to 18" thick; alternating with silty dolomites, up to 1' thick, and conglomerate, up to 5' thick	46	122

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
2	Dolomite, argillaceous and silty; grey, thin and thick bedded, very well bedded, alternating with dolomitic shale and siltstone; a few beds of conglomerate, with coarse sand, granule, and fine pebble-size clasts, very angular; basal 1 foot conglomerate, angular to subrounded, weathering yellow	18	76
1	Conglomerate, dark blue-grey; poorly bedded; massive; weathers dark brownish grey; pebbles: matrix = 1:20, pebbles range from sand size to more than 12" in diameter, majority pebble size; fragments of low sphericity, multi-shaped, flat ones tend to be oriented parallel to bedding; orientation and size distribution random - a "dumped" greywacke conglomerate. Unit does not appear to change or become less coarse upward; however pebbles not abundant in upper 3', except at very top. Where abundant, pebbles are embedded in flow-structures showing laminae contorted by flow. Matrix of unit is mudstone, dolomitic, slightly calcareous; larger fragments are dolomite, limestone, chert, siltstones, claystones, quartzites, and two silicified pisolite cobbles; no igneous rocks or jasper noted	58	58
	Little Dal Formation (incomplete) (Proterozoic, Helikian?)		
	Section above Unit 6 is extremely faulted and not measured or described. Contact with overlying Rapitan Group is covered.		
6	Dolomite, as in unit 5; at 75' above base of unit and above, chert nodules, black, grey, or pink, along bedding, or as irregular layers of lens-like nodules	128	813
5	Dolomite, very finely to finely crystalline; pale grey to pale greenish grey; very thick bedded; dense, hard	115	685
4	Dolomite, very finely crystalline; pale grey, pink and red; in thick to thin beds; thin beds laminated; abundant dolomite pebble conglomerates at bases of thicker beds; interbedded with shale, maroon, less commonly greenish grey; slightly recessive; dolomite weathers buff to pink in streambed, pale orange-brown on dry slopes	144	570

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
3	Dolomite, finely to very finely crystalline; medium grey; thick to very thick bedded; beds up to 10' thick with stromatolitic structures parallel to bedding, separated by 2' to 10' thick zones of thinner bedded dolomite, with 1' thick zones of dolomite, argillaceous, laminated; grey weathering; cliff-former; top 17' dolomite, pale grey to pale greenish grey, and weathering buff to cream. Distortion within this zone renders thickness questionable	322	426
2	Mostly covered; rubbly exposures of thin-bedded limestones, as in unit 1	90	104
1	Limestone, dark grey; single massive bed; stromatolitic	14	14
	Unnamed map-unit H5 (Proterozoic, Helikian?)		
1	Limestone, finely to very finely crystalline; dark grey to black; well bedded, thick to thin bedded; interbeds of black calcareous shale or very argillaceous limestone; from 20' to 30', gypsiferous zone; a few beds of flat limestone pebble conglomerate, some with gypsum matrix. This unit is the stratigraphic equivalent of units 17 to 20 inclusive in unnamed map-unit H5, section U-9	58	58

SECTION U-9. TRIBUTARY TO MOUNTAIN RIVER (106A)

Located in interior part of Mackenzie Mountains, along strike to southeast of section U-8; Latitude 64°38'N, Longitude 129°41'W; aerial photograph A12230-7; base of section at photo co-ordinates X=-8.8, Y=-7.6; top of section at photo co-ordinates X=-9.5, Y=-8.3. Measured and described by J.L. Usher, August 6, 1970, through unnamed Helikian unit to base of Little Dal Formation. Section U-9 underlies, and is in stratigraphic continuity with, section U-8.

PROTEROZOIC

HELIKIAN?

Little Dal Formation..... 15 feet (5 m) (basal beds only)
Unnamed map-unit H5 ..... 643 feet (196 m)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Little Dal Formation (Proterozoic, Helikian?)		
1	Limestone, aphanitic to very fine grained; pale grey; thick bedded, massive; becoming stromatolitic upwards. This unit correlates with unit 1 of Little Dal Formation, section U-8	15	15
	Unnamed map-unit H5 (Proterozoic, Helikian?)		
	Units 17 to 20 correlate with unit 1, unnamed map-unit H5 in section U-8.		
20	Limestone, black; thin bedded, becoming thick bedded upwards. Units 18 to 20 are gradational from shale to limestone	9	643
19	Limestone and shale, black; limestone is micritic in beds 4" to 6" thick, with black shale interbeds, 2" to 4" thick	19	634
18	Shale, black, some zones dark chocolate-brown; calcareous; rare thin beds of limestone, black, argillaceous	20	615
17	Limestone, micritic, argillaceous; black; thin to thick bedded, laminated; some beds of fine calcarenite, very argillaceous and in thin beds; basal 10" pale grey dolomite; limestone weathers very dark grey	8	595
16	Quartzite, medium grained, light brown-grey; thin to thick porous beds; top 24" and basal 18" dolomite, silty to finely sandy, grey; unit rusty stained. Unit is a prominent orange-weathering marker above black and brown slope of unit 15 and below grey ribbing of unit 17	13	587
15	Shale, dolomitic, rarely slightly calcareous; black, dark grey and grey, rarely green-grey; very thin, poorly fissile to crumbly beds; weathers alternately black and rusty. Interbedded with dolomite, sub-lithographic, very argillaceous; dark grey and greenish grey, in extremely thin beds; weathers rusty brown and recessive. Top 4' of unit are shale, non-calcareous, black, fissile. Silt throughout most of section; unit weathers brown or, where wet and recently exposed, black; recessive	97	574

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
14	Mostly covered; black to dark grey shale	19	477
13	Quartzite, medium grained, brown-green, thin to thick bedded, with irregular green laminae and lenses; numerous bedding plane features of shallow water, including mud cracks and *Anthrophycus*-like markings; top 13' thinner bedded, more argillaceous and weathering rusty to ochre-brown; unit weathers dark red to purple. Interbedded with shales, dark red to maroon, silty and sandy	37	458
12	Dolomite, very argillaceous, pale to medium green; very thinly bedded; occasional ribs 4" to 6" thick of purer dolomite; sandy and silty beds common; weathers rusty brown and shaly	46	421
11	Quartzite, dark red to maroon, fine grained; in beds up to 8" thick; pyritic. Interbedded with shale, maroon to dark red, silty and sandy; and with sandstone, thinly bedded, very argillaceous; some thin green layers	12	375
10	Shale, from pure clayey to silty to finely sandy; colour varies from distinct green, through greyish green, brown and grey, with one 7' thick zone of maroon, 8' from base; all thinly bedded, some laminated, most not; all non-calcareous and probably dolomitic, many beds with disseminated pyrite; weathers rusty brown and dark grey (from black argillaceous partings). Occasional bed of dolomite, medium grey, aphanitic, hard, dense; weathering dark brown	134	363
9	Dolomite, stromatolitic, grey to pinkish grey; thick bedded; stromatolites columnar and 1" to 2" wide; weathering pale to medium rusty brown	18	229
8	Shale, thin bedded, some beds silty or with floating sand grains; top 31' locally dolomitic, shales crumbly, weathering ochre-brown; lower 36' more resistant, in places laminated but poorly fissile, breaks into small irregular plates; weathers grey	67	211
7	Dolomite, aphanitic; dark grey; thin to thick bedded; weathering orange-brown. Interbedded with dolomite, argillaceous, grey and greenish grey, thin bedded; and with shale, weathering grey and green	27	144

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
6	Shale and mudstone; alternating zones of shale, 12" to 16" thick, dark grey, laminated, poorly fissile, non-calcareous; and mudstone, green, chunky, non-calcareous	9	117
5	Limestone, argillaceous, grey, banded, fine to medium grained; in 18" thick beds; basal 4', limestone and shale as in unit 2; weathers rusty to orange-brown; on weathered surface looks like a very fine grained oolite	15	108
4	Dolomite, massive, pale grey; as in unit 1; two zones of interbedded argillaceous dolomite and shale	20	93
3	Limestone, very finely crystalline; argillaceous; dark grey to black; thin to thick bedded; laminated with clay, numerous shale partings, 6" thick black shale at top; weathers greyish brown in thin to thick beds	24	73
2	Dolomite, aphanitic; pale grey; very thick bedded; weathers buff	24	49
1	Interbedded dolomite and limestone; limestone dark grey to black, aphanitic, thin bedded, laminated, dense; light grey	25	25
	Underlain by gypsum, pink, white, grey, and maroon; highly contorted and intricately folded; estimated 200' to 400' thick, but not measured (assigned to unnamed map-unit H5).		

SECTION U-10. DECA CREEK (106A)

Located in interior part of Mackenzie Mountains, along small creek tributary to Deca Creek from the north; Latitude 64°13'N, Longitude 128°26 1/2'W; aerial photograph A12225-312; base of section at photo co-ordinates X=+8.6, Y=+3.7, top of section at photo co-ordinates X=+1.3, Y=-2.2. Measured and described by J.L. Usher, July 15-18, 1969, from top of lower part of Katherine Group through unnamed map-unit H5 and Little Dal Formation. The evaporitic section at the top, originally considered to be Saline River Formation, is here reinterpreted on the basis of structural and stratigraphic relationships along strike to the northwest to be the evaporitic facies of map-unit H5, superposed on rocks of the Little Dal Formation by a reverse fault.

PROTEROZOIC

HELIKIAN?

Evaporitic facies of map-unit H5..... 863 feet (263 m)

(fault)

Little Dal Formation..... 1,953 feet (595 m)

Unnamed map-unit H5..... 1,157 feet (353 m)

Katherine Group, upper part..... 2,221 feet (677 m)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Evaporitic facies of map-unit H5 (Proterozoic, Helikian?)		
	At a nearby locality, the interval equivalent to units 1 to 4 is of about the same thickness (800 ft.) and better exposed. Within it, the uppermost 340' are thin-bedded, yellow-weathering silty dolomites and silty argillaceous limestones with hard siliceous(?) dolomite, as in unit 4. This is underlain by 409' of well-bedded, thin- to very thick bedded, white and silver-grey gypsum interbedded with thin red shales. Underlying the gypsum are yellow breccia beds.		
4	Covered; probably interbedded breccia and limestone. Breccia carbonaceous, with lime mud matrix, and weathering greyish brown to rusty. Limestone very finely argillaceous, laminated, weathering brown. Also containing dolomite, thin bedded, sheared to fractured, hard; ?siliceous, with numerous carbonaceous veins	392	863
3	Covered, soft, grey, earthy slope. Blocks of breccia, carbonaceous, coarse to very coarse; matrix is yellowish brown, calcareous, porous; a collapse breccia. Some pieces dolomite, thinly bedded, very argillaceous	325	471
2	Dolomite, very finely crystalline; light grey to brown; thin to thick bedded; hard; silty, carbonate veined, ?siliceous, presumably with much quartz silt and with argillaceous dolomite partings or thin interbeds; weathers rough, slabby, and deep yellow to dark orange-brown	56	146

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
1	Mostly covered; limestone, micritic, argillaceous; grey, very thinly bedded; finely laminated; weathers yellow	90	90
	(Reverse fault)		
	Little Dal Formation (Proterozoic, Helikian?)		
13	Dolomite, mainly coarsely crystalline, but very finely crystalline in upper part; dark grey, generally thick bedded; with chert, black, white, and dark grey; weathering brown, orange-brown, or yellow. Topmost 25' very thinly bedded (< 1/2"), laminated; silty, with stringers and beds, < 1/2" thick, of chert; lenses of conglomerate, chert granule to fine pebble. Below this, zone 225' thick of dolomite, very finely crystalline, faintly laminated; becoming coarsely crystalline and vuggy downward. Below this, zone 100' thick with some thinly bedded microcrystalline zones, slightly calcareous. Basal 20' thinly bedded, with thin (< 1/2"), coarsely crystalline layers and zones of brecciation parallel to bedding (bedding-plane slippage?)	379	1,953
12	Dolomite, very coarsely crystalline; pale grey, abundant fine vuggy and intercrystalline porosity in beds about 8" thick; becomes darker and finely sandy downwards. Bottom 6' are dolomite, sandy, brown-grey; thin to thick bedded, very finely laminated and cross-laminated; weathers thin bedded to thin slabby; originally a calcarenite mixed with fine quartz sand grains. Unit passes imperceptibly downward into unit 11; boundary arbitrary	22	1,574
11	Dolomite, microcrystalline to very finely crystalline; pale to medium grey; in 2" to 6" thick beds, laminated, finely silty; weathering orange. Interbedded with dolomite, argillaceous, grey; finely laminated; argillaceous to finely silty; in zones up to 14" thick; recessive	43	1,552
10	Shale, dolomitic to slightly calcareous, grey; bedding very thin, regular, with very fine cross-laminations; mud cracks and ripples; thin (< 1") siltstone layers that weather orange-brown; shale weathers brown to orange-brown	47	1,509

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
9	Limestone, dark grey, thinly bedded, argillaceous; interbedded with dolomite, calcareous, grey, with shale partings. Unit displays mud cracks and ripple-marks, and thin layers of flat-pebble conglomerate; somewhat like unit 10, but more cliff forming	42	1,462
8	Limestone, dark grey, micritic; in laminated beds to 4' thick; brittle to conchoidal fracturing; silty and/or argillaceous, dolomitic, with shale partings; forms steep slope, weathers grey with pale brown overcast; contact with unit 7 sharp	78	1,420
7	Limestone, micritic, argillaceous to finely silty; dark grey, very thinly (< 1"), uniformly and regularly bedded; interbedded with limestone, dolomitic, micritic; pale grey; weathers orange-brown	55	1,342
6	Limestone, stromatolitic, grey; large domal heads; separated by limestone, dark grey, micritic; thin and well bedded, blocky; unit swells and thins along strike; massive; major cliff former	278	1,287
5	Limestone, as in unit 3; in beds 12" to 30" thick; interbedded with beds 2" to 4" thick of argillaceous limestone; moderately cliff forming	115	1,009
4	Limestone, as in unit 3; beds 6" to 8" thick; argillaceous interbeds average 1" thick; occasional chert pebble conglomerate	89	894
3	Limestone and very calcareous shale interbedded in rhythmic beds 2" thick, with some beds up to 6" thick; unit recessive. Limestone is micritic, dark grey to black, occasional pinch and swell structures, weathering dark bluish grey. Shale, very calcareous; very fine laminae showing delicate crossbedding, small cut and fill structures; finely silty	267	805
2	Limestone, grey; thick to thin bedded, very well bedded (2" to 6" beds on average); finely and perfectly laminated; beds separated by argillaceous partings, or 1" to 2" argillaceous limestone; occasional 1' to 2' thick unlaminated, massive stromatolitic layer; slightly resistant. Overlying unit 3 is very similar, but much less resistant	243	538

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
1	Dolomite, stromatolitic, grey; carbonate fractured; thick irregular masses of stromatolitic carbonate; inter-stromatolitic areas are dolomite; aphanitic; well bedded, thin bedded, blocky weathering; interbedding of two types complex; weathers bright orange at site of section. Passes into plain grey limestone along strike	295	295
	Unnamed map-unit H5 (Proterozoic, Helikian?)		
19	Covered interval; talus of pale grey calcareous shale	148	1,157
18	Limestone, micritic; dark grey, thinly bedded; interbedded in 2" to 10" beds with very argillaceous limestone (or very calcareous shale); weathers thin platy and pale grey; in upper two thirds, weathered surface ribbed, with irregular protruding limestone ribs	141	1,009
	"Dead End Shale" sub-unit (units 17 and 16 only)		
17	Covered interval; apparently all "Dead End Shale" sub-unit	157	868
16	Shale, clay, calcareous, deep brownish red, thinly and very well bedded; with thin (< 1") beds of argillaceous red limestone and layers of red limestone nodules, occasionally weathering buff; in about middle of unit, one zone 7' to 8' thick of pale green-grey shale beds; rare single beds of green-grey shale elsewhere in unit; basal half of unit mostly covered. Except for top 20', limestone beds here not as abundant as in section on Dodo Creek (U-12; MQ-6)	213	711
15	Limestone, micritic; thinly bedded (< 1/4"), argillaceous to very finely silty; thin partings and beds of calcareous shale; occasional thin bed of limestone pebble conglomerate in shale matrix; at least two beds, 3' to 4' thick, of limestone, stromatolitic, crudely bedded, massive, grey weathering; unit weathers pale buff-brown; partly covered	70	498

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
14	Limestone, stromatolitic; thick bedded; top surface consists of large stromatolitic domes; massive, cliff forming; weathers pale grey	32	428
13	Limestone, micritic; black to very dark grey, thin to thick bedded, coarsely nodular bedded, some fine lamination; dense; with thin, black shale or argillaceous limestone partings; cliff forming, weathers greyish brown	26	396
12	Covered interval. From talus, appears to be mainly black calcareous shale; with intervals of limestone, grey, micritic, platy, argillaceous to silty; and some thin sandy limestone beds	35	370
11	Limestone, argillaceous to locally silty; black to very dark grey; thin to thick bedded, and very irregularly bedded; on fresh surface, highly convoluted laminae up to 1/4" thick (soft sediment slump feature?) in many directions; numerous black calcite veins; thin calcareous black shale interbeds also tightly convoluted; fetid	70	335
10	Shale, calcareous; black, fetid; with interbeds of limestone, micritic, thin, pyritiferous; weathering platy	48	265
9	Dolomite and limestone, black; in beds up to 2' thick; with peculiar fragmental texture suggesting rounded pellets, ?oolites, intraclasts, that in a single bed may end abruptly to be followed along an uneven undulating surface by silty to very finely sandy dolomite; interbedded with shale, dolomitic, or calcareous, black; and with argillaceous dolomite, black, very thinly bedded, platy. At 20' above base, abrupt change from dolomite below to limestone above, without any outward change of appearance	42	217
8	Dolomite, black, thinly bedded, finely laminated; silty, carbonaceous, with 1/2" beds of very fine sandstone, and shale, silty to sandy, carbonaceous, non-calcareous. One unusual bed of sandstone, argillaceous, black and white, crossbedded	12	175

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
7	Shale, variegated (maroon, green, grey and buff), but dark grey in upper 16'; ranging from clay shale to fine sandy shale; locally slightly calcareous; interbedded with thin (< 1/2") quartzite beds and sandy dolomite up to 6" thick with rounded pebble conglomerate; many sandy beds contain flat shale pebbles; upper 16' of unit dark grey dolomitic shales	46	163
6	Shale, maroon, locally green to buff; non-calcareous, with silty laminae < 1/4" thick; basal 9' are grey-brown with green bedding planes, calcareous, soft, fissile; a bed of quartzite, 6" thick, ripple-marked, fine grained, brown, mud cracked, occurs 2' from top; basal 9' weather yellow to grey-brown	20	117
5	Quartzite, argillaceous, slightly calcareous; brown; in beds up to 8" thick, weathering maroon; interbedded with red sandy shales in basal 7'. In top 6' quartzite is very thinly bedded; mud cracked, ripple-marked; argillaceous, with deep maroon shales; weathering yellow; with numerous layers of flat-pebble conglomerate	13	97
4	Quartzite, pale grey, greenish grey and maroon, fine grained; thick bedded, with broad gentle crossbedding; basal foot argillite, thinly bedded; weathers blocky	12	84
3	Shale, sandy, maroon and grey; very thinly bedded; fissile to crumbly; some thin pale green sandy shale; rare thin (up to 1") maroon quartzite layers	11	72
2	Shale, dark grey to dark greenish grey, very thinly bedded, silty; interbedded with dolomite, silty, grey, microcrystalline, thin bedded; beds of sandstone or quartzite throughout, particularly in top 30'; sandstone is grey, medium grained, in beds from 1" to 12" thick, with brown cross-lamination, and very fine gradations; shale weathers various hues of grey; quartzite and dolomite weather dark rusty and rusty brown. Unit non-calcareous	51	61
1	Shale, black, finely sandy to silty; thin dark grey argillaceous sandstone beds in basal 2'	10	10

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Katherine Group (Proterozoic, Helikian?)		
	Latitude: 64°14 1/2'N; Longitude 128°26 1/2'W (units 1 to 8 inclusive)		
	Upper quartzite sub-unit (unit 8 only)		
8	Quartzite, fine to medium grained; white to pale brown; thin bedded at base, thicker bedded upward; gentle crossbedding, commonly with ripple-marks; and minor red shales with mud cracks; local small, pebble conglomerates (clay fragments); sands well rounded; much hematite cement, some beds very hematitic with specularite on fracture planes; upper part weathering black (from lichens), at base weathering red and purple and platy; some *Arthrophychus*-like markings on beds at base of unit	1,387	2,221
7	Shale, silty to finely sandy; black to very dark grey; and showing numerous shallow-water structures, including ripple-marks, mud cracks, and clay galls; thin beds of dirty, blackish green, poorly sorted quartzite	187	834
6	Shale, silty; grey, with some green or red bands; possibly an argillaceous, coarse siltstone; weathers pale orange-brown with deep maroon and grey streaks throughout; upper 66' mostly covered, with grey shale debris	162	647
5	Quartzite, fine grained, brown; thin to thick bedded, well sorted; weathers dark grey	10	485
4	Dolomite, microcrystalline; grey; thin to thick bedded; platy; weathers orange	28	475
3	Covered interval; shale debris	29	447
2	Dolomite, pale brownish grey; thin to thick bedded; fine pebble breccia in regular beds 4" to 8" thick; interbeds up to 16" thick of rough-weathering algal dolomite; probable interbeds of grey shale at base; slight ridge maker; weathers pale orange-brown	218	418
1	Covered interval; debris of very fine, crumbly grey shale	200	200

SECTION U-11. LORETTA CANYON (96E)

Located in Carajou Range, first range of Mackenzie Mountains; Latitude 65°06'N, Longitude 127°57'W; aerial photograph A12599-288; Section AC2506 - upper part of Katherine Group, Mount Cap and Saline River Formations: base of section at photo co-ordinates X=+5.4, Y=-0.6, top of section at photo co-ordinates X=+1.6, Y=-3.4. Section AC2520 - lower part of Katherine Group: base of section at photo co-ordinates X=+2.3, Y=-3.5; top of section at photo co-ordinates X=+0.8, Y=-6.7. Measured and described by J.L. Usher, July 10 and July 27, 1969; from base of Franklin Mountain Formation to a position within the lower part of the Katherine Group.

PHANEROZOIC

PALEOZOIC

UPPER CAMBRIAN

Saline River Formation..... 318 feet (97 m)

(Unconformity)

LOWER AND MIDDLE CAMBRIAN

Mount Cap Formation..... 83 feet (25 m)

(Unconformity)

PROTEROZOIC

HELIKIAN?

Katherine Group, upper part..... 245 feet (75 m)

Katherine Group, lower part.....1,946 feet (593 m) (incomplete)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Saline River Formation (Upper Cambrian)		
	Contact with overlying cyclic unit of Franklin Mountain Formation is conformable, and is drawn at top of unit 12		
12	Shale, green to dark green-grey; very finely fissile to crumbly; with 1/8" layers and lenses of very fine grained sandstone to coarse-grained siltstone; basal foot is dolomite, argillaceous, thinly bedded, pale grey; and interbedded grey shale in beds up to 1" thick	4	318

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
11	Alternating beds of dolomite, pale to dark grey, clean to silty or very sandy, with sandstone lenses and laminae; and shale, sandy to finely conglomeratic, locally dolomitic, with intra-formational breccias a few inches thick. Basal bed of unit is dolomite, sandy; 3' thick; small calcareous vugs, and 2" thick coarse, flat-pebble conglomerate at base; massive, resistant; this bed weathers brown to dark brown	12	314
10	Dolomite, silty to sandy; grey to buff; thinly bedded; with greenish grey shale partings; recessive	3	302
9	Shale, dolomitic, silty; reddish brown, maroon, green, and red; thinly bedded, blocky, crudely fissile; some salt crystal casts; contains coarse, well-rounded, frosted quartz sand and granules, some thin sandstone beds; basal 4' are dolomite, green, grey, or buff, silty to argillaceous	7	299
8	Dolomite, buff and pale grey, aphanitic; in beds up to 14" thick; laminated; argillaceous; separated by very argillaceous dolomites, very thinly bedded, in zones up to 3' thick; dolomite weathers pale yellowish buff, argillaceous dolomite weathers dark grey	18	292
7	Siltstone, shale, unindurated clays (gypsiferous?), silty dolomites, pure dolomites, and dolomitic limestones; very thinly bedded; mud cracks, salt crystal casts; contorted beds common, recessive. Basal 3' shale, dolomitic, maroon-brown, very fissile and laminated; underlain by a dolomite bed, dark grey, 1' thick, laminated, argillaceous, blocky	32	274
6	Alternating beds of dolomite, pale grey, aphanitic, thin bedded; dolomitic shale, pale grey, whitish, pale green, grey, and maroon; and gypsum, white; much of unit is laminated in pale and dark colours; unit generally recessive, and very finely ribbed near more resistant dolomites	25	242
5	Shale, pale green-grey; and gypsum, rosy pink, white, and grey to dark grey; gypsum massive, contorted; with white gypsum veins; poorly exposed	150	217

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
4	Gypsum, shale, dolomite, and calcareous dolomite; thinly bedded; like unit 6 but more regularly laminated; thin green sandy dolomite or dolomitic sandstones at base of unit	22	67
3	Mostly covered; at top, one 3' thick zone of dolomite, dark grey, very finely crystalline, recessive; red and green shales apparently below that	12	45
2	Sandstone, medium to coarse grained, quartz arenite; red and green, in thin to thick beds; gypsum cemented; separated by 1" to 2' thick beds of red, green, and grey shale, sandy shale, siltstone, dolomite, and thin white gypsum; all very finely laminated	20	33
1	Shale, red, green, grey, and black; thinly bedded; interbedded with dolomite, sandstone, siltstone, and gypsum; basal 3' limestone, dark grey to black, thinly bedded, laminated, and dolomite, dark grey, orange weathering. The unit appears to thin to the west along strike	13	13
	(Unconformity)		
	Mount Cap Formation (?Lower and Middle Cambrian)		
5	Sandstone, very fine grained; greyish brown; much lamination, cross-lamination, slump or flow structures, wavy bedding, brecciated bedding; sandy dolomite beds in top 4'; numerous partings, laminae, and thin beds of dark grey to black silty shale; black chert abundant in large coarse lenses, up to several feet long and 6" to 8" thick; unit weathers orange-brown. Unit characterized by slumped bedding and black and rusty orange banding	16	83
4	Sandstone, glauconitic, argillaceous, brown; finely laminated, alternating from buff to dark grey or black; broadly crossbedded; organic markings on bedding planes (carbon); silt and claystone conglomerates present; at 17' from top, a 1' thick bed of argillaceous siltstone or very fine sandstone, weathering like mudstone; unit massive, hard, cliff forming	25	67

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
3	Sandstone, siltstone, and shale; top 2' shale, silty to finely sandy, black, pyritic, rotten, covered with sulphur bloom; below this, 3' of siltstone, sandy, pale green, iron stained (rusty yellow); underlain in turn by 1' of silty-sandy shale; then by 3' of quartzite, medium whitish brownish yellow intensely cross-bedded, hard; weathers strong rusty yellow and red	9	42
2	Partly covered; with shale and sandstone, weathering rusty; top 5' shale, silty, dark grey and brown; underlain by 5' of sandstone, soft, crumbly; deeply iron stained; balance of unit covered	13	33
1	Quartzite, fine to medium grained; white, grey, or mauve, in beds up to 3' thick, with thinner laminated bands showing within the thicker units; poorly sorted; massive, hard; many laminae and occasional 6" thick beds of black, very argillaceous, recessive sandstone; abundant *Skolithos* beds. This unit is remarkably similar to the lower part of the Mount Cap Formation at section U-13	20	20
	Unconformity - clearly seen here (northwest side of creek) and again on cliff on southeast side where it cuts a deep channel into the dolomite of unit 20 and has a thick red coarse conglomerate and red hematitic sandstone filling the channel and occupying perhaps 500' of strike along outcrop.		
	Katherine Group, upper part (Proterozoic, Helikian?)		
20	Dolomite, aphanitic, dull soft purple to pale maroon, becoming grey lower down; in somewhat irregular 2" to 4" thick beds; slightly argillaceous; weathers pinkish buff, locally pale orange-buff and pinkish violet	16	2,191
19	Dolomite, grey, argillaceous and slightly silty, recessive; grades downward to shale, dolomitic, dark grey, slightly calcareous; conchoidal fracture; unit transitional from unit 18 to unit 20	13	2,175
18	Shale, very dark grey to black; very finely fissile and crumbly; random lenses and flat nodules of dolomite with pyrite; weathers black, in some places rusty; forms soft talus	130	2,162

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
17	Shale, dark grey to black, as in unit 18, interbedded with dolomite, grey, aphanitic, in beds 1" to 6" thick, very finely laminated, weathering orange; unit is transitional between units 18 and 16	11	2,032
16	Dolomite, argillaceous, silty; thin bedded, much soft sediment flow structure, laminated and cross-laminated; occasional fine sandy bed, interbeds of silty dolomitic shale increasing to base; glauconitic sands in basal foot; weathers orange	25	2,021
15	Shale, silty to finely sandy, but abrupt alteration from clay shale to sandy shale; glauconitic sands in top foot of unit; occasional beds of dolomite, up to 2" thick, silty, argillaceous, weathering orange; numerous beds throughout (especially common in basal 8') of sandstone, brown, very fine grained; thinly bedded (< 1"), but thicker bedded in basal 8', poorly sorted, cross-laminated; 7' above base a 4" thick bed of flat-pebble conglomerate with pebbles of quartz and chert	50	1,996
	Contact with Katherine Group, lower part, exposed on south side of river; conformable.		
	Katherine Group, lower part (Proterozoic, Helikian?)		
14	Quartzite, fine to medium grained; generally pale grey to white; thick bedded; non-calcareous, with iron specks throughout, top 15' a single bed, massive, broadly cross-bedded; below 212' from top, zone 15' thick of green, argillaceous sandstone; 125' below this, zone 4' thick of red and green silty shale; basal 31' in places thinly bedded and crossbedded, and with beds of argillaceous sandstone; unit weathers rusty yellow or purple to red, due to hematite content	547	1,946
13	Quartzite, fine grained to very fine grained; white, pink, pale green and pale grey; thin to thick bedded; much of unit micaceous, with beds of shale, bright green, sandy, micaceous; top 3' are purple shale; from 71' to 104' above base, zone with ripple-marks, crossbeds, and mud cracks; lower 71' crossbedded, with iron specks, clean, and weathering pinkish grey to yellowish grey	226	1,399

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
12	Purple shale zone (informal). Shale, clay, deep burgundy or red purple; some silty and micaceous beds; in top 15', interbedded in three zones with green and red fine-grained siltstones; other zones of sandstone, very fine grained, finely laminated and cross-laminated; proportion of sandstone decreases downward; basal 38' poorly exposed	120	1,173
11	Quartzite, fine grained to very fine grained; white to very pale grey, thin to thick bedded and crossbedded; iron specks; well sorted; top of unit medium grained, strongly resistant, square blocky and somewhat dark weathering, underlain by a zone 4' thick of silty, argillaceous sandstone; balance of unit weathers slabby and pinkish grey to yellowish grey	51	1,052
10	Quartzite, very fine grained; grey; in beds up to 24" thick; iron speckled; clean; interbedded with shale, green, locally red; in beds 2" to 12" thick; with sand-filled burrow-like structures on some bedding planes; silty to finely sandy or pure clay and micaceous; thin sandstone laminae in shales. Unit weathers strongly ribbed	39	1,002
9	Dolomite, aphanitic; pale and dark grey; in 6" to 18" beds; locally with laminated domal or wavy bedding with clastic textures and coarse flat-pebble conglomerate, with "floating" quartz grains; dolomite weathers pale orange-brown; interbedded with shale, clay, dark purplish grey, in places green, sand in shale commonly very coarse grained; shale weathers black. Basal 15' are interbedded dolomite, sandy green shale, and quartzite, the latter often with flat dolomite pebbles. Unit contains ripple-marks and mud cracks	39	963
8	Quartzite, green-grey; very thinly bedded (1/4" to 1/2"); laminae and chips of bright green shale; persistent 4" thick green shale 3' above base; mud cracks, burrow-like markings on shaly bedding planes; unit resistant, cliff forming	20	924
7	Quartzite, pale greenish grey, very fine grained to fine grained; in beds 5' thick, crossbedded; clean; weathers light grey, resistant	42	904
6	Shale, green and purple, silty to very finely sandy	3	862

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
5	Quartzite, as in unit 8	24	859
4	Quartzite, as in unit 7	47	835
3	Shale, greyish green; silty, with quartz laminae; recessive	9	788
2	Siltstone or very fine grained sandstone, green and greyish white; thin bedded (1" to 12"), no crossbedding apparent, faintly laminated; argillaceous matter in top 4', where shale laminae and chips occur; very blocky and regular, breaking to thick flags, but below 50' from top unit recessive; weathers pale pinkish grey and pale green	212	779
1	Quartzite or sandstone, pale greyish green, very fine grained; thin to thick bedded and irregularly bedded in top 17', well bedded and thinly bedded (like unit 2) in next 17'; some thin green argillaceous partings; sandstone weathers grey with faint green tinge. Below 34' from top, sandstone is thin to thick bedded, becoming crossbedded downward; clean sandstone with rare argillaceous interbeds; occasional beds 2" to 6" thick of dark green, laminated, very fine grained sandstone; unit resistant; weathers buff with pale reddish brown overcast. Unit measurement incomplete because of inaccessibility; an estimated 200' remain to base of unit	567	567
	Below probable base of Katherine Group is brown shale with yellowish brown to pale orange dolomite ribs, tentatively assigned to the Tsezotene Formation (Proterozoic, Helikian?).		

SECTION U-12. DODO CANYON, CARCAJOU RANGE (96D)

Located along Dodo Creek, with base of section about 2 miles upstream from abandoned Canol Project pumping station, measured on northwest side of creek; Latitude 64°52 1/2'N, Longitude 127°13'W; aerial photograph A12147-15; base of section at photo co-ordinates X=+1.1, Y=+3.1, top of section at photo co-ordinates X=0.0, Y=+0.2. Measured and described by J.L. Usher, July 23, 1969; from top of "Dead End Shale" sub-unit of unnamed Helikian map-unit H5 to top of lower part of Katherine Group. Top of "Dead End Shale" sub-unit of section U-12 = top of unit 3 of section MQ-6, Dodo Canyon.

PROTEROZOIC

HELIKIAN?

Unnamed map-unit H5..... 475 feet (145 m)

Katherine Group, upper part..... 488 feet (149 m)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Unnamed map-unit H5 (Proterozoic, Helikian?)		
	"Dead End Shale" sub-unit (units 9, 10)		
10	Shale, calcareous; brick red-brown; in well-bedded, finely fissile to flaky strata; slightly finely silty; interbeds every 2" to 12" (average 4") of limestone, micritic; nodular, red-brown, weathering lighter brown; at 67' from top an 8' thick green-grey zone; near base, 6" beds of limestone conglomerate with rounded pebbles	230	475
9	Shale, greyish greenish brown; includes several beds of conglomerate, limestone pebbles and cobbles, in beds up to 12" thick, with fine-grained calcareous siltstone matrix. Unit part of "Dead End Shale" but not red	22	245
8	Limestone, micritic; dark grey; in 1" to 12" beds; argillaceous to finely silty, rare purple nodules; and shale, grey, calcareous in part, silty. At 12' from top and at base is quartzite or quartz sandstone, medium to coarse grained, in 2" thick beds; poorly sorted, poorly rounded; calcareous matrix	21	223
7	Shale, silty, slightly calcareous; black to very dark grey; interbedded with sandstone, medium grained; argillaceous, silty, calcareous, black, poorly sorted; middle part of unit contains a bed of limestone, stromatolitic, dark grey, 3' thick, irregular; in basal 8' shale intercalated with limestone, black, silty to finely sandy	20	202
6	Limestone, micritic; argillaceous, black to very dark grey; beds up to 12" thick, well bedded; silty, with some very fine silt laminae, some disseminated pyrite; interbeds of shale, calcareous, black, coarse silty to fine sandy. Basal 8' are clastic carbonate, dark grey; top few inches limestone, changing abruptly downward to dolomite; limestone contains ?oolites, pellets, lithic fragments	60	182

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
5	Dolomite, dark grey to black, aphanitic, in 1" to 6" thick beds, laminated, silty, slightly calcareous, with shale partings; or as dolarenite, up to 24" thick, with oolites, lithic fragments, etc.; inter-bedded with shale, dolomitic, silty, black, very thinly bedded. Near base unit contains sandstone, fine to medium grained; thin bedded, cross-laminated; poorly sorted, lens-like. Unit slightly recessive, with pronounced ribbing effect of yellowish grey weathering carbonates and black shale	73	122
4	Shale, dolomitic; grey; mainly clay shale; weathering medium grey to black with some lighter strips; with interbedded siltstone (< 1/2" thick), and sandstone, fine grained, brown weathering, lens-like and cross-laminated; with rare beds of dolomite, thin bedded, yellow-grey weathering; at 8' from top, one bed of dolomite pebble conglomerate, 6" thick; one bed of pyritiferous vuggy dolomite near top; basal 6" are conglomerate in sandstone matrix; gradational into unit 5	20	49
3	Shale, red (claystone) with some yellow beds near base; local siltstone; and sandstone, quartzose, very fine grained, in thin lenses and laminae, weathering rusty	8	29
2	Sandstone and shale, dark greyish purple, thin bedded (1" to 2" thick). Sandstone is fine grained, brown to purple; very finely cross-laminated, quartzose, silty. Shale is silty to finely sandy, multi-coloured greys, pale silvery green, dusky greyish purple, and deep reddish brown. In top 1 foot of unit, bed of conglomerate, thin pebble to coarse granule, well rounded, 2" thick	9	21
1	Shale, grey; possibly slightly silty; weathering dark grey with rusty patches; partly covered	12	12
	Katherine Group, upper part (Proterozoic, Helikian?)		
	(Contact conformable?)		
	Upper quartzite sub-unit (unit 9 only)		
9	Quartzite, fine to coarse grained; white, pale brown, and purple, thick bedded, crossbedded;		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	closely spaced layers of fine granules on crossbeds; fairly well sorted, well rounded; massive, locally weathering thinly slabby, and dark brown; top 7' are sandstone, maroon with white patches, silty to slightly argillaceous; at 78' from top, erosion surface with small pebble conglomerate	133	488
8	Covered interval	27	355
7	Dolomite, argillaceous and silty, possibly stromatolitic; thickly bedded; weathers orange	15	328
6	Shale, maroon with green bands; one bed of dolomite two-thirds of distance above base; weathers orange	23	313
5	Dolomite, light to dark grey, aphanitic; thin bedded in lower part, thin to thick bedded in upper part, some beds very finely laminated, slightly argillaceous and silty; and dolarenite, fine pebble to fine sand; in beds up to 2' thick, beds with wavy top and bottom surfaces; some layers conglomerate, pebbles up to several inches long; dolarenite ?glauconitic in lower 4' of unit. Rare dark argillaceous partings; in top 20', thin lenses of greenish grey and black chert; unit weathers orange; upper 35' of interval contain massive beds of domal stromatolites	88	290
4	Dolomite, very argillaceous, massive to slightly recessive and weathering pale orange. Middle third of unit is mudstone, argillaceous; with less dolomite; some silt and clay lithic fragments on bedding planes; mudstone weathers black	12	202
3	Shale, very finely silty, dolomitic; very dark grey; weathering deep brownish black above, and black below; at 40' from top, and in basal 10', unit contains dolomite, in beds up to 4" thick, laminated and cross-laminated, weathers bright orange	90	190
2	Dolomite, silty and argillaceous; thinly bedded, very finely cross-laminated; numerous dark argillaceous partings; weathers bright orange to yellowish orange	30	100

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
1	Shale, dark grey; weathering grey, with alternating strips of dark grey and light grey; interbedded with dolomite, silty, in thin lensoid to flat beds (mostly 1/2" thick, but some up to 6") weathering orange or buff; top 5' with quartz sandstone, medium to coarse grained, thin bedded (generally < 1" thick, but some up to 6"); basal 20' of interval covered	70	70

Top of lower part of Katherine Group is quartzite, deep rusty weathering, with pebble conglomerate in top foot. Contact is conformable.

SECTION U-13. HEADWATERS OF LITTLE BEAR RIVER (96D)

Located in first range of Mackenzie Mountains, along north side of river valley, headwaters of Little Bear River, Latitude 64°29'N, Longitude 126°48'W - 126°55'W; aerial photograph A12056-158. Composite section. Measured and described by J.L. Usher, July 3 and 5, 1969. Two different sections separated by a fault are combined. The upper, AC2503-69, is an incomplete section of the Mount Cap Formation; base of section at photo co-ordinates X=+6.8, Y=-1.8; top of section at photo co-ordinates X=+8.4, Y=-1.7. Lower section, AC2502-69, consists of Little Dal Formation, unnamed map-unit H5, and Katherine Group, upper part: base of section at photo co-ordinates X=-0.2, Y=-3.0; top of section at photo co-ordinates X=+8.4, Y=-1.7. No beds common to the two sections are exposed. Fossil collections (GSC locs. 84400-84403) identified by W.H. Fritz (GSC internal report C19-1969-WHF).

PHANEROZOIC

PALEOZOIC

LOWER AND MIDDLE CAMBRIAN

Mount Cap Formation..... 165 feet (50 m) (incomplete)

(Fault)

Mount Cap Formation(?)..... ±50 feet (15 m) (incomplete)

PROTEROZOIC

HELIKIAN?

Little Dal Formation..... 414 feet (126 m) (incomplete?)

Unnamed map-unit H5..... 638 feet (194 m)

Katherine Group, upper part..... 516 feet (157 m)

Katherine Group, lower part..... not measured

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Mount Cap Formation (Lower and Middle Cambrian)		
	The following section is in fault contact with beds of the Little Dal Formation. Section begins immediately east of the fault, and continues along the shore line of the river; beds described are east-dipping. Interval described and sampled appears to be repeated about 650 feet downstream.		
5	Dolomite, thin bedded in beds 1/2" to 6" thick, averaging 1" thick in lower part; interbedded with shale, dark grey, in beds 1" thick. Upper part of unit is less than 20% dolomite	25	165
4	Shale, black; very finely fissile; from 30' to 60' above base, contains multitude of small, pinhead to granule size, spheroidal pyrite nodules; basal 10' and locally elsewhere, layers of dolomite, light grey, aphanitic, hard, with a few flat discoidal pyrite nodules (up to 6"); shale weathers black to grey and very crumbly; topmost 20' poorly exposed, no fossils; probably faulted. At 60' to 86': *Bathyuriscus?* sp., aff. *Glossopleura* sp. (GSC loc. 84400); at 86' to 90': *Amecephalus* sp., *Hyolithes* sp. (GSC loc. 84401); at 90' to 92': aff. *Glossopleura* sp. (GSC loc. 84402); at 92' to 119': aff. *Glossopleura* sp. (GSC loc. 84403). From GSC internal report C19-1969-WHF, by W.H. Fritz; Fritz reports that the above collections are approximately the same age, and probably all belong to the Middle Cambrian *Glossopleura* Zone	80	140
3	Dolomite, in beds to 12" thick; with argillaceous and silty material, high in carbon, bedding planes covered with network of plant-like markings; contains carbonaceous shale partings; sandstone beds at base; weathers dirty black to greenish brown	38	60
2	Shale, black, crumbly, poorly exposed	15	22
1	Dolomite, very finely crystalline; black; thickly bedded; silty to finely sandy; abundant pyrite and green material (?glauconite) along top inch of unit; weathers dirty dark grey	7	7

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Mount Cap Formation, ?lower part (Lower and Middle Cambrian?)		
	The following section is in fault contact with the section described above, and lies to the west of it. The uppermost beds described are assigned to the Mount Cap, but must be lower than any described above.		
1	Quartzite or quartz sandstone, widely varied; varies from clean, thick-bedded, fine-grained sandstone, with thin beds of cobble and pebble conglomerate; to *Skolithos*-burrowed, thin-bedded, less well sorted types; to silty and argillaceous, unsorted, thin-bedded sands and argillaceous siltstones, with plant-like markings on bedding planes. Exposed as felsenmeer; upper contact with dolomite obscured; at a nearby exposure, thin dykes of quartzite extend downward into the underlying dolomite of the Little Dal Formation (Unit 3)	±50	±50
	Little Dal Formation (Proterozoic, Helikian?)		
	Cutting the Little Dal Formation (units 1 to 3) is a series of at least three very basic, dark green-grey to blackish, medium crystalline dykes, ranging from 10' to 40' thick, exposed in the canyon cut by Little Bear River. They strike parallel to the fault and the strata that form the leading edge of the Little Dal Formation escarpment at the top of the section.		
	The most easterly, which outcrops in 3 places along the front of the scarp, above the fault, is seen to cut the Little Dal dolomite but not the overlying quartzite north of the river along the scarp edge (Mount Cap Formation).		
3	Dolomite, massive; stromatolitic in part, more persistent laterally than mounds in unit 1; stromatolitic dolomite interlensed with and capped by ribbed dolomite; unit weathers brick red	50	414
2	Dolomite, in part argillaceous; in beds 2" to 8" thick; subordinate 1' to 3' thick stromatolitic zones; weathers orange-red and ribbed; prominent brilliantly coloured, cliff-forming unit	255	364

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
1	Dolomite, with domal algal beds up to 20' thick and 200' or more long; algal beds do not follow any particular stratigraphic level for any great distance, but appear to have been more or less isolated masses with bedded carbonate between and separating the mounds laterally and vertically; in places, dolomitization is incomplete, and blue-grey limestone remains; above is interlensed and interbedded with ribbed dolomite, and dark argillaceous beds as in unit 7 of unnamed Proterozoic map-unit H5; dolomites weather orange-red	109	109
	Unnamed map-unit H5 (Proterozoic, Helikian?)		
7	Limestone, micritic, blue-grey; very well bedded, very finely laminated; conchoidal fracturing; blocky; interbedded with shale, calcareous, in beds 8" to 12" thick; upwards, shale beds replaced by beds 2" to 6" thick of argillaceous limestone; unit has distinct ribbed appearance. At 104' above base, a distinct 6" thick shale break forms a continuous marker in the section, and above this (locally below) the limestone is dolomitized, orange weathering, and in 2" to 6" beds with 2" shaly weathering beds between	116	638
6	Limestone, micritic; medium grey, in beds 6" thick near top, thinning to 2" to 4" below; brittle, conchoidal fracturing; interbedded with shale, calcareous, fissile, platy; local layer of rounded limestone nodules in shale; at 32' above base, a 2' thick bed of red nodular shale (like unit 5), and top 15' the same but including green and buff shale and limestone zones; unit weathers pale greenish to greyish brown	59	522
	"Dead End Shale" sub-unit (unit 5 only)		
5	Shale, calcareous, deep reddish brown; in beds 2" to 6" thick; with layers of similar coloured limestone nodules, nodular beds, and regular, blocky breaking limestone beds up to 2" thick; some limestone interbeds weather buff to greenish, giving unit a marked striped appearance	156	463

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
4	Limestone, stromatolitic, dark bluish grey; mainly thick bedded (up to 5' thick), but thinner bedded in top 15'; stromatolites as narrow columns, but in massive domes 20' to 30' in diameter in top 15'; random orange-weathering dolomite zones; limestone weathers bluish grey, intercolumnal strips weather brown	105	307
3	Limestone and shale, black; interbedded in beds 4" to 6" thick. Limestone varies from micritic to oolitic to coarse fragmental; fetid, contains pyrite. Shale calcareous, very fissile and crumbly	36	202
2	Dolomite, grey, aphanitic; in beds 1' to 2' thick (6" to 8" thick in basal 15'); some beds finely laminated; local mud cracks; texture varies from micritic to coarse sand and fine gravel clastic fragments; inter-bedded with shale, grey, silty to fine sandy. Top 15' are calcarenite, dolomitized, coarse; thin bedded (6"); with clastic frag-ments, oolites, and quartz sand grains; top 2' very irregular, lacking good bedding, ?algal or slumped	65	166
1	Mainly covered; basal 15' to 20' containing clay-stone, shale, sandstone, and dolomite; in beds 8" to 10" thick; claystone is red, silty, con-taining well rounded, frosted, coarse quartz sand grains; shale is grey, silty; sandstone is grey to green or purplish brown, fine grained, ripple-marked; dolomite is grey, microcrystalline, thinly bedded	101	101
	Katherine Group, upper part (Proterozoic, Helikian?)		
	(Contact conformable?)		
	Upper quartzite sub-unit (units 10 to 12 only)		
12	Quartzite, medium to fine grained; white; uniform beds 1' to 2' thick, broad gentle crossbedding, ripple-marks; clean, well sorted, well rounded; occasional layers of coarse sand or granules; top 4" to 10" a pebble conglomerate; contact with unit 11 abrupt, with small pockets of pebble conglom-erate 1" thick	32	516

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
11	Siltstone, hematite red; well bedded, ripple-marks, bedding plane markings; quartz siltstone cemented with hematite; contains quartz siltstone, white, very fine grained, in lenses and thin irregular laminae; and interbeds of shale, silty, maroon and/or buff, in beds 6" to 12" thick	17	484
10	Shale and sandstone. Shale, grey; finely laminated; fissile and friable; silty, with proportion of silt decreasing downwards, top 20' contain interbedded siltstone; shale is dolomitic and contains rare zones of discoid, dark purple, very finely crystalline dolomite nodules up to 3" in diameter. Sandstone is white to purple, very fine grained; laminated; with crossbedding and scour structures in top 50'; in 4" to 8" thick beds in top 5'; iron stained, weathering dark rusty grey-brown	78	467
9	Covered; probably shale, as in unit 8	13	387
8	Shale, grey, very thinly and irregularly fissile; near base is a bed of dolomite, sandy/silty, brown, colour banded, containing pyrite	38	376
7	Covered interval; probably shale, similar to unit 8	22	338
6	Dolomite, very finely crystalline; grey; very thick bedding; with columnar stromatolites, columns at right angles to bedding, locally radiating; weathers bright orange with scattered hematitic nodules	32	316
5	Mainly covered; top 5' are shale, silty, greenish grey, very thin and irregularly bedded; talus from this interval is shale, maroon and pale green, with mud cracks and bedding plane markings	40	284
4	Pebble conglomerate, dolomitic; pebbles flat and small (1/4" to 1/8") at base, coarser above, with top 23' very coarse; bedding up to 6' thick (only up to 2' thick in basal 6' of unit); commonly with grain gradation; evidence of scour in top 23'; with interbeds of dolomite, argillaceous, dark grey, aphanitic; conglomerate beds separated by black carbonaceous films in basal 6'; rare beds of dolomitized oolite; in top 23' the dolomite interbeds are micritic, laminated, showing cross-lamination, with elongate lenses of black chert up to 6' long and parallel to bedding (some chert lenses appear to be silicified oolite lenses); unit weathers orange, with top 23' massive, cliff-forming	85	244

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
3	Covered, except for top 19' which are shale, grey, non-calcareous, in very thin, regular, fissile laminae; top 19' also with local beds of dolomite, slightly calcareous, grey, finely crystalline, weathering orange	74	159
2	Dolomite and shale, interbedded in thin beds from shale partings to 6" thick; dolomitic strata average 1" to 2" thick; dolomite decreases downward in proportion and thickness of beds, except for top 3' which are shale. Shale is grey, micaceous. Dolomite is silty to argillaceous, pale grey, very finely crystalline; finely laminated and cross-laminated, with evidence of soft-sediment deformation; dolomite weathers orange	35	85
1	Covered interval; probably underlain by shale	50	50

SECTION U-14. SALINE RIVER FORMATION, TYPE SECTION (96C)

Located on north side of Saline River, approximately 1 1/2 miles upstream from confluence of Saline and Mackenzie Rivers; Latitude 64°18'N, Longitude 124°28'W; aerial photograph A11974-160; base and top of section at photo co-ordinates X=-5.7, Y=-0.5. Measured and described by J.L. Usher, July 7, 1969; from base of Franklin Mountain Formation, cyclic unit to base of exposure.

PHANEROZOIC

PALEOZOIC

UPPER CAMBRIAN

Franklin Mountain Formation, cyclic unit..... 25.5 feet (8 m) (basal beds only)
Saline River Formation, type section.....129 feet (39 m) (incomplete)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Franklin Mountain Formation, cyclic unit (Upper Cambrian)		
4	Shale, slightly silty; dolomitic; dark grey; locally slightly calcareous; with beds of dolomite, aphanitic, dark grey; in beds up to 6" thick (mostly less), argillaceous, locally slightly calcareous	18	25.5

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
3	Dolomite, aphanitic; slightly argillaceous; pale grey, with buff shale partings; weathers buff	3	7.5
2	Shale, medium to dark grey; very finely fissile and crumbly; slightly calcareous	4	4.5
1	Conglomerate, flat pebble, grey; almost concretionary in hardness; fragments of mudstones, siltstones, and dolomite set in slightly calcareous clay matrix; weathers orange-yellow	.5	.5
	Saline River Formation, type section (Upper Cambrian)		
	Contact with overlying cyclic unit is conformable, and is placed at top of unit 6, which is the stratigraphically highest prominent red mudstone unit within the section. (*See* also sections MQ-2 and MQ-3, this report).		
6	Mudstone, red; some beds buff to yellow; in thin beds 1" to 3" thick; in places very finely laminated; very hard; locally very calcareous, with salt casts on bedding planes; interbedded with partings of shale, red and maroon, thin	6	129
5	Shale, greenish grey; with bed 1' thick of shale, buff, silty, calcareous, at base	4	123
4	Limestone, micritic; argillaceous; deep pink to reddish brown, with partings of shale, red, thin; and one or two bright green partings up to 1/2" wide; unit weathers blocky to papery	6	119
3	Siltstone, very fine grained; pale grey; thin to thick bedded, with faint laminations; siliceous, and probably dolomitic; thin shale partings; hard, blocky fracturing; weathers pinkish buff in detail and pale yellowish buff overall	8	113
2	Siltstone, shale, and dolomite; pale grey, buff, and red; in thin interbeds; siltstone and shale are calcareous and dolomitic; top 3' of unit a band of shale, dark grey; recessive	20	105
1	Shale, gypsiferous, predominantly pink, but basal 22' pale green; very thinly bedded, crumpled and distorted; interbedded with gypsum, white, in thin (< 1/2") beds; thin, silty and calcareous layers towards top; numerous layers of buff and grey siltstone and shale in upper half	85	85
	No further exposure. Base of Saline River Formation not exposed.		

SECTION U-15. MOUNT CAP FORMATION, MOUNT CLARK (96C)

Located on north flank of Mount Clark in McConnell Range, Franklin Mountains; Latitude 64°26'N, Longitude 124°15'W; aerial photograph A12796-42; base of section at photo co-ordinates X=+9.6, Y=+8.3; top of section at photo co-ordinates X=+8.2, Y=+9.8. Measured and described by J.L. Usher and R.W. Macqueen, July 7, 1969; from uppermost exposed beds of Mount Cap Formation to contact with underlying Mount Clark Formation. Fossil collections (GSC locs, 84404-84406) identified by W.H. Fritz (GSC internal report C19-1969-WHF).

PHANEROZOIC

PALEOZOIC

LOWER AND MIDDLE CAMBRIAN

Mount Cap Formation..... 695 feet (212 m) (incomplete)

LOWER CAMBRIAN

Mount Clark Formation..... not measured

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Mount Cap Formation (Lower and Middle Cambrian)		
	No further exposure above unit 25.		
25	Siltstone, slightly argillaceous; coarse grained; grey; very thin bedded, with many bottom markings and ?burrows; weathers blocky in alternating deep brown and yellowish brown	8	695
24	Shale, micaceous; dark grey; very crumbly to poorly fissile	5	687
23	Siltstone, as in unit 25	10	682
22	Shale, as in unit 24	5	672
21	Siltstone (or very fine grained sandstone); very argillaceous, thinly bedded; topmost 3' very thin beds, with interbeds of shale, silty, greenish, non-calcareous; a 1' thick very calcareous bed at base; recessive in lower half	23	667
20	Shale or mudstone, silty; grey; non-calcareous; weathering very crumbly	21	644
19	Shale or mudstone; ?dolomitic; weathering rusty brown, very crumbly	42	623

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
18	Shale or mudstone, as in unit 20	20	581
17	Limestone, varied; alternating beds of limestone, grey, nodular, cliff forming; and limestone, thinner bedded, nodular, argillaceous; and limestone, thin bedded, silty. Fossils throughout: at 496' to 516': *Olenellus* sp. (GSC loc. 84406); at 516' to 526': *Nisusia* sp., *Olenellus* sp. (GSC loc. 84407); at 526' to 546': *Bonnia* sp., *Olenellus* sp. (GSC loc. 84408), late Early Cambrian	65	561
16	Siltstone, argillaceous, calcareous; dark grey; blocky bedding; very crumbly	15	496
15	Limestone, micritic; nodular, grey; basal 4' interbedded lithology as in unit 14; talus trilobite collection at base of unit: *Bonnia* sp., *Olenellus?* sp., *"Paedeumias"* sp. (GSC loc. 84405), late Early Cambrian	10	481
14	Sandstone; thinly (< 1") and very regularly bedded; well burrowed; very argillaceous; bedding planes covered by a network of interwoven black organic matter (algal?); top 9' thicker bedded, much more argillaceous, more blocky weathering	26	471
13	Siltstone, argillaceous, dolomitic; dirty dark brownish green; organic black markings on bedding planes; some sandy laminated layers; as in unit 6	30	445
12	Shale, silty; non-calcareous; weathering rusty to dark ochre greyish brown	13	415
11	Shale, grey; silty, calcareous; weathering grey	5	402
10	Limestone, micritic; dark grey; massive; conchoidal fracturing; dolomitic ribs in top 3', weathering buff; top 3' weather brown and grey with brown dolomitic ribs and grey pock-like depressions; trilobites collected from slabs that have peeled off the unit: from 378' to 397': *Onchocephalus* sp., *"Paedeumias"* sp. (GSC loc. 84404), late Early Cambrian	19	397
9	Shale, dark grey; micaceous; crumbly; weathers dark silvery grey	9	378
8	Shale; silty; crumbly, non-fissile; weathers reddish brown to rusty brown	75	369

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
7	Mudstone; very silty; crumbly, weathering reddish brown	7	294
6	Siltstone; as in unit 4, but more argillaceous, and with numerous layers of siltstone, laminated; abundant fine mica; weathers dark greyish brown to blackish brown	35	287
5	Sandstone, medium grained at top, grading to very fine grained at bottom; medium brown and grey; thinly bedded, and colour banded, limonitic at top; basal 3' argillaceous; weathers dark rusty to orange-brown	9	252
4	Siltstone, dolomitic, dark green; thin to thick bedded; bedding planes with organic markings, silty to very finely sandy; in lower few feet interbedded with shale, silty, dark grey, thin, rubbly; unit weathers blocky and dark brownish green	66	243
3	Mudstone and sandstone. From 110' above base, to top of unit: sandstone, very fine grained; top 5' thin bedded; with black burrow markings distorting laminations; ?organic debris; top 5' weather nodular, deep brown; from 73' to 74' above base, a bed of sandstone, very fine grained, greenish brown, argillaceous and silty, with black chert granules and fine pebbles (< 1/4"), and thin layers of limonitic nodules. Mudstone is greyish green; dolomitic; silty in upper portion of unit; non-fissile; with interbedded dolomite, argillaceous, green, with ?carbon markings on bedding planes; above 32' from base interbedded with finely sandy, finely laminated zones; from 63' to 73' above base, mudstone is greenish, more fissile; mudstone weathers brown to dark brown, locally rusty or grey	162	177
2	Quartzite, purple, medium grained; one massive bed; abundant oxidized iron and some pyrite at the top; quartz grains rounded; fresh surface with porosity from leaching of iron-rich cement	10	15
1	Dolomite, argillaceous, green, in beds 4" to 6" thick; interbedded with shale, green. This unit appears to thicken rapidly on the west side of the gully, and to pinch out downdip, as though the Mount Cap basal units overlapped northward or eastward onto the underlying Mount Clark Formation quartzites	5	5

Contact disconformable? Underlying beds are Mount Clark Formation quartzites, thickly bedded, well indurated, resistant.

SECTION MQ-2. NORMAN RANGE (96E)

Located in Norman Range, Franklin Mountains, in creek bed on northeast side of range midway between headwaters of southwesterly flowing Francis Creek and Helava Creek; Latitude 65°17'N, Longitude 126°16'W; aerial photograph A12611-428; base of section at photo co-ordinates X=-1.9, Y=-2.4; top of section at photo co-ordinates X=-2.2, Y=-3.9. Measured and described by R.W. Macqueen, assisted by R.D. Cruickshank, June 2, 1968; through Franklin Mountain Formation (rhythmic and cyclic units; only lowest beds included here), and Saline River Formation. Attitude 134°/35°SW.

PHANEROZOIC

PALEOZOIC

UPPER CAMBRIAN

Franklin Mountain Formation, cyclic unit.....basal beds only

Saline River Formation.....532 feet (162 m) (incomplete)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Franklin Mountain Formation, cyclic unit (Upper Cambrian)		
1	Dolomite, very finely crystalline, argillaceous in part, pale yellowish brown; contains stromatolites, LLH type (Logan *et al.*, 1964), up to 2" across individual columnar heads; sharp contact with lithologies above and below	5	5
	Contact conformable with underlying Saline River Formation; contact between Franklin Mountain Formation cyclic unit and Saline River Formation on a regional scale is arbitrarily placed at top of stratigraphically highest red or green mudstone which is 5' or more thick; unit 23 in this section. Beds overlying unit 21 consist of cyclic alternations of argillaceous dolomite, flat-pebble conglomerates, stromatolitic and/or oolitic dolomite, and uniform, structureless dolomite.		
	Saline River Formation (Upper Cambrian)		
23	Mudstone, slightly dolomitic, red to dark reddish brown	8	532

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
22	Mudstone, dolomitic, moderate green; laminated to very thin-bedded; recessive; grades upward into dolomite, very finely crystalline, yellowish brown, resistant. Middle part of unit contains flat-pebble conglomerate subunit 1/2' thick, pebbles are wafer-like and show diverse orientations. Top 1/2' of unit contains algal stromatolites of the LLH mode S type. Sharp upper contact, with stromatolitic beds overlain by red mudstone	3	524
21	Mudstone, red, very slightly dolomitic; slightly resistant, sharp upper contact	8	521
20	Mudstone, red to pale or dark reddish brown, rare green bands 1 to 5 cm thick; rubbly; a few interbeds of dolomite, 1' to 1 1/2' thick, very finely crystalline, yellowish brown	35	513
19	Covered interval	28	478
18	Mudstone, gypsiferous, red with local thin green bands; platy, recessive	7	450
17	Dolomite, very finely crystalline, yellowish brown fresh and weathered colour; brecciated in basal foot with 2 to 3 cm fragments set in a pink calcite matrix. Top 1/2' contains prominent stromatolites of the LLH mode S type, maximum diameter of stromatolitic heads is ±3 cm. Sharp contact with overlying unit, defined by top surface of algal heads	3	443
16	Mudstone, red to dark reddish brown bands interbedded with greyish green to moderate green bands; banding is on a scale of a few inches to a few feet; unit 75% red mudstone variety. Gypsiferous, local 2 to 5 cm selenite crystals and nodular masses of gypsum with spherulitic crusts and coatings indicative of solution-reprecipitation of gypsum, probably at the surface. Much contortion. Sporadic yellowish brown, finely crystalline dolomite beds, 1 to 5 cm thick, occur throughout unit; these show sedimentary boudinage with mudstone, or are (locally) involved in quasi-flexural folds in which mudstone and gypsum have been deformed by a passive flow mechanism. Unit is moderately resistant, especially in upper part; partly covered in lower part	145	440
15	Covered interval; possibly massive gypsum	100	295

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
14	Dolomite, very finely crystalline, greenish grey, one bed	5	195
13	Mudstone, gypsiferous, greyish green to moderate green, local dime-size red mottling	2	190
12	Mudstone and gypsum(?), mostly covered, talus is distinctive red to dark reddish brown	22	188
11	Covered interval	27	166
10	Mudstone, gypsiferous, much contortion. Scattered 1 to 2 cm white to pink selenite crystals; generally recessive	39	139
9	Gypsum and mudstone, red to pale or dark reddish brown, platy weathering. Sporadic thin interbeds (< 6") of yellowish brown dolomite; one zone, one foot thick, of greyish green mudstone 2' above base	10	100
8	Gypsum, massive, argillaceous, greenish grey, recessive	5	90
7	Gypsum, argillaceous, yellowish grey to grey, scattered thin bands of selenite; recessive and partly covered	16	85
6	Dolomite, finely crystalline, slightly calcareous, pale yellowish brown, weathering same, laminated; contains scattered small circular vugs of pinhead to pea-size, continuous in plane of bedding, one bed	4	69
5	Mudstone, gypsiferous, or gypsum, argillaceous, mostly covered. Fabric of gypsum resembles bedded mosaic (non-crystal shaped) class of Maiklem *et al.* (1969)	32	65
4	Dolomite, very finely crystalline, brownish grey, weathering brownish grey, laminated; resembles unit 2	3	33
3	Mudstone, grey, gypsiferous, as in unit 2, very poorly exposed	16	30
2	Dolomite, finely crystalline, grey, weathers grey to light grey; contains about 10% clastic quartz silt and very fine sand; one bed; blocky to platy weathering; sharp contacts	2	14

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
1	Mudstone, grey, gypsiferous with numerous bands of white selenite averaging 3 to 5 mm in thickness; poorly exposed	12	12
	No further exposure; unit is probably near base of Saline River Formation?		

SECTION MQ-3. BEAR ROCK, FRANKLIN MOUNTAINS (96C)

Located in Franklin Mountains, on south-facing flank of Bear Rock; section measured in gully about 500 feet above Mackenzie River and approximately 2 miles west of confluence of Great Bear River and Mackenzie River, and approximately 4 miles due south of Bear Rock (elevation 1,488 ft.); Latitude 64°55'N, Longitude 125°41'W; aerial photograph A12033-48; base of section at photo co-ordinates X=+8.5, Y=+8.6; top of section at photo co-ordinates X=+7.9, Y=+7.8. Measured and described by R.W. Macqueen with W.S. MacKenzie, June 4, 1968 through Franklin Mountain Formation (rhythmic and cyclic units; only lowest beds included here), and Saline River Formation.

PHANEROZOIC

PALEOZOIC

UPPER CAMBRIAN

Franklin Mountain Formation, cyclic unit.....145 feet (44 m)

Saline River Formation.....110 feet (34 m) (incomplete)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Franklin Mountain Formation, cyclic unit (Upper Cambrian)		
1	Dolomite, very finely crystalline, containing stromatolites, or flat-pebble conglomerates with wafer-like pebbles showing diverse fan-like orientations, or structureless; interbedded with argillaceous dolomite to dolomitic shale, papery to platy weathering, recessive; sharp lower contacts, upper contacts normally gradational. The four distinct types of dolomite tend to recur upward within the succession, in a cyclic, ABCD pattern (*see* Macqueen, 1969). Unlike exposures in the Norman Range, approximately 1 in 10 dolomite beds is extensively brecciated and calcite-veined (?solution breccia). Total thickness of cyclic unit	145	145
	Contact covered		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Saline River Formation (Upper Cambrian)		
2	Covered interval	35	110
1	Mudstone, gypsiferous, red to pale or dark reddish brown, thin bands of white or delicate pink selenite; local greyish green to moderate yellow-green zones (bands?); much contortion, jointing, and small-scale faulting. From 60' to 70' above base, dolomite interbeds 2 to 5 cm thick occur; highly fractured; local quasi-flexural folding	75	75
	End of exposure. Talus below unit 1 consists of gypsiferous red and green mudstone.		

SECTION MQ-6. DODO CANYON, CARCAJOU RANGE (96D)

Located along Dodo Creek, in Carcajou Range, Mackenzie Mountain Front, on northeast limb of broad anticline; base of section approximately 1 1/2 miles downstream from junction of Echo Creek and Dodo Creek (locality is type section of Macdougal Group as described by A.W. Nauss, 1944, *in* Hume, 1954, p. 10); Latitude 64°57'N, Longitude 127°16'W; aerial photograph A12147-16; base of section at photo co-ordinates X=-5.1, Y=-3.6, top of section at photo co-ordinates X=-2.8, Y=+4.5. Measured and described by R.W. Macqueen assisted by R.D. Cruickshank, June 8, 1968; from Franklin Mountain Formation cyclic unit through Saline River and Mount Cap Formations to "Dead End Shale" sub-unit of unnamed Helikian map-unit H5. Fossil collections identified by W.H. Fritz (GSC locs. C1762, C1763: GSC internal report C10-1968-WHF. GSC locs. 84275-84283; GSC internal report C14-1969-WHF). Top of "Dead End Shale" sub-unit in unnamed Helikian map-unit H5, section U-12, = top of unit 3 in section MQ-6.

PHANEROZOIC

PALEOZOIC

UPPER CAMBRIAN

Franklin Mountain Formation, cyclic unit.....basal beds only

Saline River Formation.....421 feet (128 m)

(Unconformity)

LOWER AND MIDDLE CAMBRIAN

Mount Cap Formation.....329-354 feet (100-108 m)

(Unconformity)

PROTEROZOIC

HELIKIAN?

Unnamed map-unit H5
"Dead End Shale" sub-unit.....193-218 feet (59-66 m)
(incomplete)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Franklin Mountain Formation, cyclic unit (Upper Cambrian)		
2	Dolomite, calcareous, finely crystalline, grey, weathers pale yellowish brown	3	6
1	Dolomite, very argillaceous, greyish green, papery to platy weathering, recessive	3	3
	Contact conformable with overlying cyclic unit of Franklin Mountain Formation; contact between cyclic unit and underlying beds on a regional scale is arbitrarily placed at top of highest red mudstone or shale, which is unit 10 of the Saline River Formation, this section. Overlying beds of cyclic unit contain alternations of argillaceous dolomite, flat-pebble dolomite conglomerates, and stromatolitic dolomite.		
	Saline River Formation (Upper Cambrian)		
10	Shale, distinctive red to dark reddish brown, papery to platy weathering; sharp upper contact	8	421
9	Covered interval. Appears to be underlain by gypsum and moderate red mudstone and/or shale, similar to units in upper part of Saline River Formation of Norman Range (Section MQ-2)	150(approx.)	413
8	Gypsum, banded with black argillaceous and bituminous(?) material; mudstone, moderate red, appears to occupy this interval also	5	263
7	Covered interval	40	258
6	Gypsum, mostly fibrous selenite crystals, some argillaceous banding, much contorted	5	218
5	Covered interval	60	213
4	Gypsum, grey to white, prominent banding consisting of alternating argillaceous seams and gypsum; much contorted	20	153
3	Covered interval	30	133

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
2	Gypsum, grey, weathering grey, banded and/or laminated, much contorted (passive flow folds); argillaceous; scattered selenite crystals, white to delicate pink. Approximately 80% covered; exposed interval is rubbly	63	103
1	Covered interval, probably underlain by gypsum, grey, weathering light grey. Probably belongs to Saline River Formation	40	40
	Contact with Mount Cap Formation covered.		
	(Unconformity)		
	Mount Cap Formation (Lower and Middle Cambrian)		
19	Shale, non-calcareous, greyish black to black, papery, in bands 1/2" to 6" thick, interbedded with limestone, dolomitic, micritic, dark grey, weathering brownish grey, with pelletoid grains, and very abundant pyrite replacing grains. Unit is recessive; contains about 70% shale, 30% limestone. Top 15' mostly limestone, partly dolomitized	45	354
	Section continued about 1,000' upstream on west side of Dodo Creek. Units 5 - 18 are exposed in small gully; beds here dip 10°E. Unit 18 is sharply overlain by Pleistocene sand and gravel of lateral moraine, at top of gully		
18	Shale, dark grey, weathering medium to dark grey, recessive; minor interbeds of dolomite, calcareous, grey, weathering yellowish brown. Unit approximately 90% shale, 10% carbonate	31	309
17	Limestone, micritic, slightly dolomitic, light to medium grey, weathers rusty medium grey to yellowish brown; interbedded with shale, calcareous, dark grey, weathering dark grey to rusty yellowish brown, plate. GSC loc. 84283 (273 1/2 ft.): *Glossopleura?* sp.	5	278

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
16	Shale, non-calcareous, very dark grey, papery, recessive; rare interbeds of micritic limestone, argillaceous, dark grey; a persistent unit. At 231': *Cambrotrypa* sp., aff. *Glossopleura* sp., *Micromitra* sp. (GSC loc. 84279); at 236': *"Albertella" levis?* Walcott, *Albertella* sp., *Cambrotrypa* sp., aff. *Glossopleura* sp. (GSC loc. 84280); at 243': aff. *Bathyuriscus* sp., *Glossopleura* sp. (GSC loc. 84281); at 252': aff. *Bathyuriscus* sp., *Glossopleura* sp., *Hyolithes* sp. (GSC loc. 84282)	61	273
15	Limestone, micritic, dolomitic, laminated, dark grey, weathers rusty yellowish orange; argillaceous laminae are permanent and indicate some reworking by infauna	9	212
14	Shale, dark brownish grey, weathers rusty yellowish orange, recessive, thin interbeds of dolomite as in unit 13	6	203
13	Dolomite, calcareous, dark grey, weathers rusty yellowish orange, abundant silt-size to very fine sand-size quartz; evenly laminated (1-2 mm), a few thin argillaceous partings	10	197
12	Shale, greyish green, recessive, interbedded with limestone, grey, weathering greenish grey, nodular	13	187
11	Sandstone, fine to medium grained, greyish green fresh and weathered surfaces; contains abundant very fine to coarse-grained glauconite grains or pellets, and limestone grains (rock fragments?). Numerous burrows and bottom markings preserved on basal bed, which indents underlying shale unit. Thin micritic limestone beds at 172' and 174', containing trilobites. At 172': *Amecephalus* sp., dolichometopid or zacanthoidid trilobite, *Micromitra* sp. (GSC loc. 84278); at 174': aff. *Albertella* sp., *Micromitra* sp. (GSC loc. C1763), both collections from Middle Cambrian *Albertella* Zone	5	174
10	Shale, greyish green, recessive; interbedded with limestone, micritic, grey, weathering greenish grey, nodular. At 167': *Albertella* sp., *Amecephalus* sp., cf. *Kochaspis chares* (Walcott) 1917, *Micromitra* sp., *Spencia* sp. (GSC loc. 84277), Middle Cambrian *Albertella* Zone	13	169

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Remarks on fauna: Collections from GSC localities 84277 to 84283 and C1763 belong to the *Albertella* and *Glossopleura* Zones. The transition between the two zones is not abrupt, and the boundary is placed below the lowest collection (GSC loc. 84281) containing trilobites that can unquestionably be assigned to the genus *Glossopleura*.		
9	Sandstone, very fine to medium grained, calcareous, argillaceous, greyish green, in part nodular; interbedded with shale, greyish green, recessive. Top 6' of unit consist predominantly of micritic limestone, greyish green, argillaceous, quartzose. Unit slightly resistant	17	156
8	Sandstone, fine grained, greyish green, weathers prominent rusty yellowish brown, argillaceous, much evidence of reworking by infauna; bottom markings prominent on base of sandstone units indenting shales; thin to thick bedded. Minor interbeds of shale, greyish green, recessive; and micritic limestone, grey, containing trilobites. Top 6' of this unit comprise a massive, rusty weathering sub-unit, resistant. At 127': *Olenellus* sp., *"Paedeumias"* sp. (GSC loc. 84276), late Early Cambrian *Bonnia-Olenellus* Zone. Fritz (1970, p. 72) postulates an unconformity at 128' (321' *in* Fritz, 1970) based upon the apparent absence of the *Plagiura-Poliella* and early *Albertella* Zones in strata occupying the interval between 127' and 231' above the base of the section	16	139
7	Limestone, micritic, dark greyish green, weathers greyish green, recessive; contains abundant very fine to fine-grained glauconitic grains, and "floating" well-rounded fine- to coarse-grained quartz sand (mud supported). Glauconite is closely associated with, and partly replaced by, small pyrite euhedra; unit contains trilobites; interbedded with shale, greyish green, quartzose, calcareous, recessive. Unit is 40% limestone, 60% shale. Unit forms recessive notch on cliffside. At 116': *Onchocephalus* sp. (GSC loc. 84275); at 123': *Olenellus* sp. (GSC loc. C1762); both collections late Early Cambrian *Bonnia-Olenellus* Zone	14	123
6	Limestone, micritic, dolomitic, argillaceous, greyish olive-green, glauconitic and with scattered well-rounded, fine- to medium-grained quartz grains; thin bedded; interbedded		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	with sandstone, fine to medium grained, calcareous, weathers rusty yellowish orange, thin bedded; minor interbeds of shale, calcareous, papery weathering. Unit is about 85% limestone/sandstone, 15% shale	34	109
5	Limestone, micritic, dark grey, weathers rusty brownish grey to light yellowish grey, thin bedded; basal one foot contains abundant fine quartz grains, well rounded; skeletal fragments (trilobite?) in upper part; dolomite euhedra	13	75
4	Covered interval	28	62
3	Sandstone, generally coarse grained, pale olive to greyish olive, weathers same; locally rusty; abrupt changes vertically in grain size from fine to coarse grained; sharp contacts. Quartz arenite with well-rounded quartz grains; rare glauconitic grains	2	34
2	Dolomite, very finely crystalline, calcareous, argillaceous, dark grey, weathering greyish orange; thin to very thin bedded; minor interbeds of shale, calcareous, dark grey, papery. Unit is 80% dolomite	7	32
1	Covered interval; talus suggests similarity with overlying unit	25	25
	Contact with underlying unnamed Helikian unit is covered.		
	(Unconformity)		
	Unnamed map-unit H5 (Proterozoic, Helikian?)		
	"Dead End Shale" sub-unit		
6	Shale or mudstone, generally poor fissility; moderate red to dark reddish brown; contains abundant calcareous nodules; similar to unit 3. Unit is last prominent red mudstone exposed and was used as a marker to move approximately 3/4 mile upstream to resume section	5	193
5	Limestone, micritic, grey, weathering light grey to pale yellowish brown; thin bedded; interbedded with shale, calcareous, greyish green with local red zones; in part rusty weathering. Unit has a rhythmic character, and is slightly resistant. Limestones dominant in upper half of unit	49	188

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
4	Shale, calcareous, greyish green, weathering pale green with 4 thin, moderate red bands, 1/2' to 1' thick; contains poorly formed calcareous nodules, partly boudinaged; unit very thin bedded, recessive	9	139
3	Mudstone, moderate red to dark reddish brown; abundant well-formed calcareous nodules; thin greyish green zones, 2 to 5 cm thick; similar to unit 1	58	130
2	Limestone, micritic, argillaceous, dark grey; weathers dark grey; laminated, platy weathering, and slightly resistant. A sub-unit of red mudstone with scattered poorly formed calcareous nodules occurs from 13' to 17' above base of unit. Unit is thin to very thin bedded	25	72
1	Mudstone, moderate red to dark reddish brown, lacks fissility; abundant well-formed calcareous nodules about 1" to 1' in diameter, and occurring in discrete beds; concretions are boudinaged, and some show contortion in plane of bedding; minor zones of greyish green colouration which occur as colour mottling and cut across bedding; green zones locally have abundant pyrite; in bands to 1/2' thick; interbedded with shale, moderate red to dark reddish brown, fissile, non-calcareous. A band 1/2' thick of greyish green, platy-weathering shale occurs 30' above base of unit	47	47
	Lowest beds exposed in core of anticline at this locality. Beds below were sampled and described by Usher (section U-12, this report) at a locality upstream in Dodo Canyon, on west side of anticline.		
	Top of unit 3 of this section is equivalent to top of highest beds measured at section U-12 (this report).		

SECTION MQ-20. TRIBUTARY TO LITTLE HORNADAY RIVER (97A)

Located on Horton Plain, on north side of tributary to Little Hornaday River, about 6 miles from confluence of tributary creek with Little Hornaday River (indicated on GSC Map 5-1969, Erly Lake, 97A); Latitude 68°24'N, Longitude 120°53'W; aerial photograph A12813-452; base of section at photo co-ordinates X=-5.3, Y=-1.5; top of section at photo co-ordinates X=-4.4, Y=+2.4. Measured and described by R.W. Macqueen assisted by R.E. Moulton, July 13, 1968; from base of Franklin Mountain Formation cyclic unit through Saline River Formation and Mount Cap Formation, to uppermost beds of Old Fort Island Formation. Flat-lying.

PHANEROZOIC

PALEOZOIC

UPPER CAMBRIAN

Franklin Mountain Formation, cyclic unit.....basal beds only

Saline River Formation.....195 feet (59 m)

LOWER AND MIDDLE CAMBRIAN

Mount Cap Formation.....230 feet (70 m)

LOWER CAMBRIAN

Old Fort Island Formation..... 30 feet (9 m) (incomplete)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Franklin Mountain Formation, cyclic unit (Upper Cambrian)		
1	Dolomite, finely crystalline; argillaceous at base, grading up to poorly defined flat-pebble conglomerate, non-argillaceous	5	
	Contact between Saline River Formation and overlying cyclic unit of Franklin Mountain Formation is conformable, and on a regional scale is arbitrarily placed at top of highest red mudstone or shale, which is unit 12 of this section. Cyclic unit at this locality is mostly covered.		
	Saline River Foramtion (Upper Cambrian)		
12	Shale, greyish red, as in unit 9, mostly covered	7	195
11	Dolomite, finely crystalline, silty, greyish green, weathers yellowish orange, talus rings underfoot; minor interbedded greyish green shale, non-calcareous	2	188
10	Shale, non-calcareous, mottled greyish red and greyish green; abundant salt-crystal casts; poorly exposed, very thin bedded to laminated	16	186
9	Sandstone, fine grained, light grey, dolomitic and calcareous cement; well sorted, ripple-marked at top; one bed	1	170

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
8	Dolomite, very finely crystalline, argillaceous, mottled greyish red and greyish green; shows salt-crystal casts up to 5 cm in diameter; ripple-marks with associated small-scale cross-lamination of lower flow regime	3	169
7	Covered interval, probably underlain by gypsum, selenite (both seen in talus), and red shale or mudstone; salt-crystal casts present on talus pieces of mudstone	85	166
6	Shale, greyish green, non-calcareous, poorly exposed	3	81
5	Shale, greyish red to dark reddish brown, as in units 3 and 7; greyish green shale band 14' to 16' above base of unit; partly covered; green shale shows ripple-marks and small-scale cross-lamination of lower flow regime. Salt-crystal casts also present in talus	40	78
4	Dolomite, finely crystalline, calcareous, silty, light brown, weathering pale yellowish orange, slightly rusty; slight intercrystalline porosity; thin bedded	14	38
3	Shale, greyish red to dark reddish brown; non-calcareous, papery; becomes generally greyish green in uppermost 3'	8	24
2	Dolomite, finely crystalline, yellowish brown to dark grey; laminations, less than 1 mm thick, platy weathering	1	16
1	Covered interval, probably belongs to Saline River Formation	15	15
	Mount Cap Formation (Lower and Middle Cambrian)		
7	Sandstone, very pale yellowish brown, weathers rusty pale yellowish brown to pale grey; fine grained, locally medium grained; well-sorted (significantly better sorted than Old Fort Island Formation, unit 1), well rounded; quartz arenite; weakly cemented by silica, friable, excellent intergranular porosity; abundant planar and tangential crossbedding; thick bedded; top 10' generally medium grained; traces of glauconite in top 7'; unit mostly exposed	40	230

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
6	Covered interval; probably mainly green shale, with minor dolomite as in unit 5	71	190
5	Dolomite, finely crystalline, slightly calcareous, silty, argillaceous, pale brownish grey, weathering pale to rusty dark yellowish orange; thin bedded; recessive	5	119
4	Covered interval, probably underlain by lithology similar to unit 3	20	114
3	Dolomite (estimated 80%), finely crystalline, greyish green, weathering medium brownish grey, thin bedded; interbedded with greyish green shale (estimated 20%); unit is recessive, 80% covered	13	94
2	Dolomite, finely crystalline, argillaceous, silty, greenish grey, weathering rusty yellowish orange; much disturbed lamination, appears to be extensively reworked, thin to very thin bedded; unit is 80% covered	18	81
1	Covered interval; probably belongs to Mount Cap Formation	63	63
	Old Fort Island Formation (Lower Cambrian)		
1	Sandstone, very pale grey, fine grained, poorly sorted (ranging from very fine to coarse grained); coarser grain sizes form laminae; quartz arenite; grains well rounded and only weakly cemented by siliceous cement; friable, excellent porosity. Abundant planar to tangential crossbedding; soft; much superficial slumping	30	30

SECTION MQ-22. NORTHWEST OF BEBENSEE LAKE (86M)

Located on Horton Plain, along a small creek approximately 40 miles northwest of Bebensee Lake; Latitude 67°55'N, Longitude 119°32'W; aerial photograph A12620-138; base and top of section at photo co-ordinates X=+4.3, Y=+4.9. Measured and described by R.W. Macqueen assisted by R.E. Moulton, July 14, 1968; through upper part of Saline River Formation. Flat-lying. Section begins within upper half of Saline River Formation, and continues downsection; mostly continuous outcrop. No further outcrop above 85 ft. from base, but base of Franklin Mountain Formation cyclic unit is apparent in distance to the east. Top of this section estimated to be within 20 to 40 ft. of base of cyclic unit.

PHANEROZOIC

PALEOZOIC

UPPER CAMBRIAN

Saline River Formation.....85 feet (26 m) (incomplete)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Saline River Formation (Upper Cambrian)		
13	Shale, greyish red to greyish red-purple, interbedded with shale, greyish green, about 80% covered. Displacive orange fibrous gypsum occurs as several 2 to 5 cm bands in lowest 1 1/2'; none seen above	16	85
12	Shale, greyish green, interbedded with dolomite, very finely crystalline; gypsum within this unit is not displacive, but occurs as masses of drusy crystals on "free" fracture or bedding surfaces, indicating near-surface precipitation. Gypsum is most common on fracture surfaces oriented at angles to bedding. One "bed" about 20 cm thick at top of unit, consisting of nodular, white to pale grey gypsum, made up of small crystals randomly oriented in large part	6	69
11	Shale, lower half of unit distinctive greyish red to greyish red-purple; upper half is greyish green, and has several 2 to 5 cm interbeds of yellowish orange weathering dolomite. Only one thin band of fibrous gypsum present	7	63
10	Gypsum, moderate reddish orange to light brown; minor mudstone, greyish green, with ripple-marks on surface. "Nodular" gypsum in lower part of unit, remainder of gypsum is fibrous; unit seems to be a mélange of gypsum masses which have undergone surface solution-reprecipitation to form the distinctive fibrous masses with crystals oriented perpendicular to bedding	2	56
9	Shale, greyish red to greyish red-purple, interbedded with shale, greyish green; and minor orange fibrous gypsum, some occurring as thin displacive seams filling vertical to near vertical joints developed within shale beds	5	54

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
8	Shale, as in unit 5, greyish red to greyish red-purple, distinctive, minor green mottling	3	49
7	Shale, greyish green, with displacive orange gypsum bands about 2 cm thick making up 10% of unit	1.5	46
6	Shale, greyish green, similar to that of unit 3, also contains several bands of orange, displacive gypsum, up to 3 cm thick. All of these bands show good lateral persistence, measured at least in tens of feet	6.5	44.5
5	Shale, greyish red to greyish red-purple, distinctive, platy and splintery weathering; in part contains greyish green mottling; recessive	3.5	38
4	Shale, greyish green, non-calcareous, similar to that of unit 3, contains several bands of orange, displacive gypsum. A few interbeds of dolomite, argillaceous, greyish green, thinly bedded. Unit about 5% gypsum	2.5	34.5
3	Shale, greyish green, non-calcareous, weathers to book-like packets; no gypsum seen; 60% covered	12	32
2	Shale, as in unit 1, in bands, 2 to 20 cm thick, interbedded with fibrous gypsum, moderate reddish orange to light brown, 1/2 to 5 cm thick; fabric of gypsum is displacive--each band contains a central undisturbed portion of gypsum, or rarely a surface, oriented in the plane of bedding, out of which displacive gypsum crystals, oriented perpendicular to the surface (or bedding), have grown (surface phenomenon?). Salt-crystal casts in shale from this unit	5	20
1	Shale, dolomitic, greenish grey, papery, recessive; with rare thin interbeds, 1 to 5 cm thick, of dolomite, very finely crystalline, grey, weathering pale yellowish orange. Some shale bedding surfaces show salt-crystal casts to 1 cm in maximum dimension	15	15

SECTION MQ-23. LITTLE HORNADAY RIVER (97A)

Located on Horton Plain, on the north side of Hornaday River and approximately 16 miles upstream from confluence of Little Hornaday River with Hornaday River (indicated on GSC Map 5-1969, Erly Lake, 97A); Latitude 68°23'N, Longitude 121°20'W; aerial photograph A13632-39; base of section at photo co-ordinates X=-2.8, Y=+0.9, top of section at photo co-ordinates X=-2.9, Y=+1.4. Measured and described by R.W. Macqueen assisted by R.E. Moulton, July 15, 1968; from top of Old Fort Island Formation to top of Shaler Group (Proterozoic) dolomite, map-unit P4 (GSC Map 5-1969). Flat-lying. (Unit identified here as Old Fort Island Formation was mapped as Mount Clark Foramtion on GSC Map 5-1969).

PHANEROZOIC

PALEOZOIC

LOWER CAMBRIAN OR OLDER

Old Fort Island Formation.....≈243 feet (74 m)

PROTEROZOIC

NEOHELIKIAN OR HADRYNIAN

Shaler Group dolomite, map unit P4.....uppermost beds only

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Old Fort Island Formation (Lower Cambrian or older)		
7	Sandstone, probably as in unit 6, but very little outcrop, interval consists largely of loose weathered sand and/or weathered rock rubble. Extremely friable, medium to very coarse grained	56	243
6	Sandstone, pinkish grey, weathering very pale grey, medium to generally coarse or very coarse grained; grains subangular to sub-rounded; many abrupt vertical changes in grain size, but fining-upward cycle is present characteristically on a scale of as little as 3 cm to as much as several feet. Mainly weakly cemented, friable and showing excellent intergranular porosity. Sorting at any one depositional face (i.e. within a cross-bed set) is moderately good, but is generally poor over even short vertical distances. Granules and rare pebbles in coarser bands are mostly quartz, with very rare potash feldspar evident at several levels. Planar and tangential crossbedding common	91	187
5	Covered interval	12	91
4	Sandstone, fine to very coarse grained with abrupt changes in grain size characteristic; coarse lenses contain granules up to 3 mm in		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	diameter. Resembles units 1, 2. Very friable, excellent intergranular porosity throughout, excepting rare intervals in which siliceous cement is sufficiently well developed to eliminate friability (pressure solution?). Hematite(?) or other iron oxide nodules, up to 5 cm in diameter, occur rarely and stand out in relief on weathered surface. Tangential and planar crossbedding common	34	84
3	Covered interval	18	50
2	Sandstone, generally medium grained; pinkish grey, weathering very pale grey, poorly exposed, tangential crossbedding common	7	32
1	Sandstone, fine to generally medium grained; pinkish grey, weathering very pale grey, weak siliceous cement, slightly friable, excellent intergranular porosity. Lenses of granules up to 5 mm in dimension, but generally less than 1 to 2 cm. Quartz arenite; grains other than quartz are extremely rare, but include potash feldspar granules. Sorting moderate, excepting granule lenses; abrupt vertical changes in grain size are common. Tangential crossbedding widespread	25	25
	Contact with underlying Shaler Group dolomite (map-unit P4, GSC Map 5-1969) is covered, but is a slight angular unconformity.		

SECTION MQ-24. HORNADAY RIVER, LA RONCIÈRE FALLS (97D)

Located on Horton Plain, at and immediately west of La Roncière Falls on north side of river; Latitude 69°09'N, Longitude 122°54'W; aerial photograph A13607-176; base of section at photo co-ordinates X=+3.7, Y=-1.5; top of section at photo co-ordinates X=+3.7, Y=-2.8. Measured and described by R.W. Macqueen assisted by L.A. Love, July 26, 1968; from base of Franklin Mountain Formation, cyclic unit through Saline River Formation and upper part of Mount Cap Formation. Beds dip about 5° west-southwest.

PHANEROZOIC

PALEOZOIC

UPPER CAMBRIAN

Franklin Mountain Formation, cyclic unit...basal beds only

Saline River Formation.....95-118 feet (29-36 m)

LOWER AND MIDDLE CAMBRIAN

Mount Cap Formation.....120 feet (37 m) (incomplete)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Franklin Mountain Formation, cyclic unit (Upper Cambrian)		
1	Dolomite, very finely crystalline, pale greenish grey, argillaceous, in well-defined beds, 1/4" to 4" thick, weathers pale yellowish brown, in part laminated (cryptalgal lamination of Aitken, 1967)	5	5
	Saline River Formation (Upper Cambrian)		
9	Covered interval, containing contact with underlying Saline River Formation. Probably underlain by greyish green shale similar to that of unit 7	23	118
8	Dolomite, very finely crystalline, light greenish grey, weathering yellowish grey, argillaceous, recessive	3	95
7	Shale, light greyish green, weathers light green; dolomitic; weathers to cardboard-thin plates, slightly resistant	14	92
6	Dolomite, very finely crystalline, greenish grey, weathers pale yellowish brown, argillaceous; interbedded with shale, greyish green, dolomitic; unit 80% dolomite, very thin to thin bedded, recessive	10	78
5	Covered interval	18	68
4	Sandstone, fine to medium grained, very dolomitic, pale greyish brown, contains disturbed green shale laminations; minor thin interbeds of green shale resembling that of units 1 and 3. Rubbly, poorly exposed	5	50
3	Shale, greyish green, as in unit 1	4	45
2	Covered interval	21	41
1	Shale, greyish green, weathers greyish green to pale yellowish brown; non-calcareous, papery to platy, recessive and poorly exposed, local interbeds 1 to 3 cm thick, of dolomitic-micritic limestone. Salt crystal casts seen in talus from this unit; none seen in place. About 70% covered	20	20

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Section continued on north side of Hornaday River about 1,000' upstream on east side of southward-flowing tributary creek to Hornaday River. Top of unit 5 of Mount Cap Formation traced to new location. Contact between Saline River Formation and underlying Mount Cap Formation is covered.		
	Mount Cap Formation (Lower and Middle Cambrian)		
5	Sandstone, very fine to fine grained, pale grey to mottled pink and green, weathers rusty yellowish brown, very well cemented, non-porous, thick bedded and resistant in basal 20'; higher beds recessive, soft, probably less well cemented. Local ripple-marks	28	120
4	Sandstone, very fine grained, pale greyish brown, weathering same or rusty greyish brown; much disturbed argillaceous laminations; thin to very thin bedded; interbedded with shale, greyish green, argillaceous, sandy, recessive. Sandstone beds show slight intergranular porosity, and are slightly friable. Three main shale zones occur at 0' to 2', 5' to 6', and 12' to 13 1/2' above base of unit. Local bottom markings on sand sub-units, where these indent shale	15	92
3	Sandstone, orthoquartzite, fine grained generally to locally medium grained, pale greenish grey with local purplish mottling. Sorting poor to moderate, grains subangular; very well cemented, fractures across grains; non-porous; lacks glauconite; thick bedded, only top 13' noticeably crossbedded, tangential type. Top 13' show zebra-like arrangement of pink mottled and non-mottled zones, which follow individual crossbeds. Unit resistant	41	77
2	Sandstone, very fine to fine grained, light greenish grey, weathers greenish grey to rusty yellowish brown; glauconitic with disseminated glauconite grains comprising about 5% in lower beds and up to 20% in uppermost 5'; some beds finely cross-laminated; much disturbed lamination and local burrow casts on bases of some beds throughout unit; well cemented, very slight intergranular porosity; very thin to thin bedded, recessive. Bedding planes are slightly more glauconitic than interval between bedding planes in uppermost 5'	14	36

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
1	(Cap rock of falls) Sandstone, fine grained, very well cemented orthoquartzite, light brownish grey, weathering rusty yellowish brown, not obviously crossbedded; sorting moderate; grains subangular to subrounded, fractures across grains; very slight intergranular porosity. Central part of unit contains much disturbed argillaceous laminations. Basal 7' are inaccessible	22	22
	Section is concluded at level of top of La Roncière Falls, which flow directly over unit 1. Below this unit is a unit of thin- to thick-bedded, variably glauconitic sandstone, weathering greyish green, with interbedded reddish weathering sub-units; unit continues to base of falls, approximately 80' to 90' below cap rock at top of falls.		

SECTION MQ-33. TRIBUTARY TO KEELE RIVER (96D)

Located on first range of Mackenzie Mountains, along small creek tributary to Keele River from the south; Latitude 64°4 1/2'N, Longitude 126°37'W; aerial photograph A12055-310; base of section at photo co-ordinates X=-4.3, Y=+4.0, top of section at photo co-ordinates X=-3.3, Y=+4.3. Measured and described by R.W. Macqueen assisted by H. Lenstra, June 25, 1969; from Franklin Mountain Formation, rhythmic unit through Saline River Formation to uppermost part of Katherine Group. Attitude at base of section 180°/15°E. Section measured on east limb of broad anticline. Beds assigned to Saline River Formation are transitional in lithology to beds mapped as "basal Franklin Mountain red beds" in Mackenzie Mountain interior (*see* sections U-2, U-5, this report).

PHANEROZOIC

PALEOZOIC

UPPER CAMBRIAN

Franklin Mountain Formation, rhythmic unit.....basal beds only

Saline River Formation.....565 feet (172 m)

(Unconformity)

PROTEROZOIC

HELIKIAN?

Katherine Group, lower part..... 55 feet (17 m) (incomplete)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Franklin Mountain Formation, rhythmic unit (Upper Cambrian)		
	Rhythmic unit continues upward with familiar interbedding of reddish brown, oolitic dolomite in which oolites have been partly replaced by ?hematite, and pale yellowish orange, very finely crystalline dolomite (*see* Macqueen, 1969, 1970).		
	Dolomite, medium crystalline, abundant medium-grained quartz sand; yellowish brown, weathering pale yellowish orange; contains dolomitized oolites near top of unit, with quartz grains as nuclei, and partly replaced by red-weathering iron mineral, probably hematite	20	20
	Contact with underlying Saline River Formation appears conformable, but Franklin Mountain Formation cyclic unit is absent, and abundance of clastic quartz in lower part of rhythmic unit suggests erosional conformity with beds described below.		
	Saline River Formation (Upper Cambrian)		
17	Covered interval	5	565
16	Sandstone, fine to coarse grained, distinctive pale yellowish orange matrix; interbedded with dolomite, finely crystalline, sandy, pale yellowish orange fresh and weathered surfaces; and showing several thin solution breccia intervals. Thin bedded throughout	25	560
15	Mudstone, dusky red, calcareous, abundant fine- to medium-grained quartz sand, soft weathering, recessive	40	535
14	Covered interval, probably mainly mudstone	60	495
13	Sandstone, fine to medium grained, abundant dusky red material in matrix; interbedded with dusky red mudstone or shale; very poorly exposed; sandstones occur as ribs between recessive mudstone/shale intervals	90	435
12	Sandstone, fine grained, calcareous, greyish orange-pink to dusky red, weathering same; fairly well cemented; thin bedded; interbedded with mudstone or shale, dusky red with local green mottling, sandy, poorly exposed	50	345

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
11	Sandstone, fine to coarse grained, light grey, weathers very pale orange, weakly cemented and friable, weathers to hoodoo-like shapes surrounded by unconsolidated yellow sand; highly porous; thin bedded	38	295
10	Sandstone, fine to coarse grained, light grey, imparting a distinctive colour to unit; interbedded with dusky red, sandy mudstone and thin greyish green shale; strong colour contrast between sandstone, mudstone and shale imparts distinctive striping to unit; unit is thin bedded	65	257
9	Sandstone, fine grained, pale yellowish grey, weathering yellowish grey; rare 1/2' green shale zones; thin bedded	17	192
8	Dolomite, calcareous, very finely crystalline, pale yellowish brown, weathering same, laminated with fine-grained quartz; thin bedded, recessive	6	175
7	Sandstone, medium grained, quartz arenite, light grey, weathering light yellowish grey, very well cemented, fractures across grains, non-porous, rare interbeds of greyish green (glauconitic?) sandstone, less well cemented; unit is thick bedded	29	169
6	Sandstone, fine to coarse grained, poorly sorted, dusky red or yellowish green, poorly cemented in part and friable, porous, thin bedded, slightly resistant	15	140
5	Covered interval	60	125
4	Sandstone, fine to medium grained, light grey or dusky red, weathers dusky red to moderate reddish orange, thin bedded; interbedded with mudstone, dusky red, sandy, recessive. Unit approximately 70% sandstone, 30% mudstone	8	65
3	Covered interval	12	57
2	Sandstone, very fine to fine grained, pale grey to moderate reddish orange, weathering moderate reddish orange, calcareous cement, well cemented and slightly porous; thin bedded	3	45
1	Covered interval, probably dusky red mudstone?	42	42

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Contact with underlying Katherine Group sandstones and quartzites is not exposed at this locality. Along strike to the north it is sharp and erosional, but shows no obvious angularity.		
	Katherine Group, lower part (Helikian?)		
5	Sandstone, calcareous, fine to coarse grained, striking dusky red throughout except for local green zones; thin bedded; interbedded with shale or mudstone, dusky red, sandy, poorly exposed. Unit is about 80% covered; of the exposed parts, sandstone comprises about 20%, mudstone/shale 80%. Ripple-marks common in mudstone/shale; no salt-crystal casts seen	5	55
4	Sandstone, fine to medium grained, dusky red owing to iron-bearing mineral in matrix, except for green zones which tend to occur as small blebs and lenses; thin bedded	4	50
3	Covered interval	16	46
2	Sandstone, fine grained, very well cemented as unit 1, but abundant dusky red mottling in matrix--hematite? Ripple-marks and mud cracks common in talus probably from this unit	10	30
1	Sandstone, fine grained, medium grey, weathering same, scattered medium size grains, sorting poor; well-cemented orthoquartzite, unit is thin bedded. Some beds are green, probably due to presence of glauconite; no discrete grains of glauconite seen	20	20
	No further measurement. Below unit 1 are about 100' to 125' of thin- to thick-bedded, fine-grained quartzite, purple or purple mottled, and weathering back to form rubbly purple blocks. Below this purple zone are about 175' to 200' of thick-bedded quartzite, almost white in colour, fine grained in general but with rare medium-grained to conglomeratic lenses which include pink chert? pebbles. No lower beds are exposed.		

SECTION AC-540. UPPER MOUNTAIN RIVER (106A)

Located on a north-trending, northerly descending mountain spur immediately west of upper Mountain River; Latitude 64°29'N, Longitude 129°17'W; aerial photograph A12055-130; base of section at photo co-ordinates X=-5.2, Y=+7.8; top of section at photo co-ordinates X=-4.6, Y=-4.9. Described and hastily measured by J.D. Aitken, August 8, 1970. Representative specimens re-examined by hand lens June 29, 1972. Section commences near base of Rapitan Formation, although the basal contact is not exposed, and continues up-section and southward through the three members of the Rapitan Formation to the contact with the overlying Keele Formation. The strike of the lower part of the section is N35°--55°W, swinging to N50°--80°W in the upper part. The dip averages 30° southwest, flattening slightly near the top.

PROTEROZOIC

HADRYNIAN?

Keele Formation.....not measured

Rapitan Group.....6,253 feet (1,907 m) approx.

Upper member.....2,958 feet (902 m) approx.

Middle member..... 835 feet (255 m) approx.

Lower member.....2,460 feet (750 m) approx.

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Keele Formation (Hadrynian?)		
1	Limestone, dark grey, finely crystalline, dolomitic, thin to medium bedded, flaggy to blocky, weathers pale grey	(not meas.)	
	Contact with Rapitan here is abrupt on line of section but, in the immediate vicinity, intertonguing of Rapitan clastic rocks with carbonate rocks of the Keele is obvious.		
	Rapitan Group (Hadrynian?)		
	NOTE: All of the Upper Rapitan has a sombre grey-brown weathered aspect, in contrast to the pale yellow of the Middle member, and the purple of the Lower member.		
27	Sandstone, sideritic, pale grey, mostly fine to very fine grained, with some gritty bedding surfaces; nearly all laminated, platy, with gently dipping cross-laminations; partly flaggy at the top	40	6,153

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
26	Sandstone, very coarse grained, grit, and pebble conglomerate, grey to yellow-grey, massive, strongly crossbedded; coarsely crystalline calcite cement. The sand grains are colourless and pink quartz, grey quartzite, green, red, and dark grey chert. The granules and pebbles are mainly dolomite, grey to yellow, microcrystalline to very finely crystalline	30	6,113
25	Basal beds similar to unit 23, grading upward into beds as in unit 24	84	6,083
24	Limestone, grey, very finely crystalline, laminated, platy, weathers tan	9	5,999
23	Interbedded sandstone, siltstone, and shale as in unit 12, in 1:1:1 proportions. Distinct penecontemporaneous overfolds	60	5,990
22	Shale, partly grey, weathering greenish grey, and medium reddish brown, weathering dull greyish red; hard, chippy, recessive. A few 1 cm beds of siltstone as below appear near the top	100	5,930
21	Interbedded sandstone (subgreywacke), very fine grained, and coarse siltstone, as below. At base, partly medium to thick bedded, blocky, becoming increasingly thin to very thin bedded and flaggy/platy upward. Siltstone increases to dominance upward, and lamination becomes general. Unit is resistant	240	5,830
20	Interbedded sandstone (subgreywacke), very fine grained, and siltstone, medium greenish to bluish grey, partly sideritic, flaggy to massive, weathering deep rusty brown ("basalt-like"); local slump structures, minor intervals of platy argillite as in unit 10	280	5,590
19	Argillite and siltstone, as below, very thinly interbedded. Sedimentary overfolds, slope-controlled, are abundant	70	5,310
18	Argillite, siltstone and sandstone, as below. An interval of penecontemporaneous folding, containing several slump-masses. One bed of sideritic sandstone	40	5,240
17	Monotonous lithology as in unit 16; 90% platy argillite, 10% beds 1 to 1.5 cm thick of siltstone to very fine sandstone (subgrey-wacke), medium greenish to bluish grey, platy to flaggy	755	5,200

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
16	Platy argillite and siltstone/very fine sandstone as in unit 12, with argillite subordinate. At the top, very hard, platy siltstone/sandstone exclusively, very resistant, forming a minor peak and stripped dip-slope	145	4,445
15	At the base, platy argillite and siltstone, as in unit 12. Upward, packets of flaggy beds 2 to 3 cm thick, of sandstone, as in unit 12, appear and increase to prominence at the top	250	4,300
14	A 2' bed of massive sandstone as in unit 12, overlain by a 3' slumped zone with well-developed sedimentary overfolds	5	4,050
13	Entirely hard grey platy argillite and siltstone, as in unit 10, weathering brown and dark grey	175	4,045
12	Alternating units, in proportions of about 1:1:1, of platy argillite, as in unit 10, sandstone (subgreywacke), very fine grained, medium greenish to bluish grey, calcareous, thick bedded, massive, weathering deep rusty brown ("basalt-like"), and platy siltstone similar to sandstone	95	3,870
11	Mainly thick beds of pebbly mudstone, grey, weathering dull brown-grey. Phenoclasts range up to 2 cm in diameter, are mainly grey to yellow dolomite and grey, very finely crystalline limestone, and make up 10% to 20% of the whole. The muddy matrix is sandy, and approaches matrix-rich quartz greywacke in composition	45	3,775
10	Finely interlaminated argillite, grey, silty and sandy (dominant), and siltstone/very fine sandstone, grey, calcareous. Minor one-inch beds of sandstone, very fine grained, sideritic. Cross-lamination and convolute bedding are common, but in parts of the unit the lamination is perfectly planar. Unit contains three one-foot beds of pebbly mudstone as in the overlying unit	230	3,730
9	Covered	305 (est.)	3,500

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Middle member		
	NOTE: The middle Rapitan weathers to a uniform, pale dull yellow or tan colour, and hence contrasts markedly with the dark-weathering lower and upper members, showing distinctly on aerial photographs and distant views. It is the least resistant of the three members.		
8	Pebbly mudstone. The generally well-rounded phenoclasts comprise pebbles and a few cobbles up to 30 cm in diameter, rarely larger. They are mainly dolomite, pale grey to dark grey, yellow-grey, microcrystalline to finely crystalline, with minor grey quartzite, chert, dark grey argillite and jasper. Phenoclasts rarely exceed 20% of any bed. The matrix is sandy mudstone (calcareous grains), and might be called a calcareous greywacke; it is medium grey and generally weathers to a uniform dull yellow (tan). The unit is essentially non-bedded, but posesses an irregular platy/shaly fracture parallel to bedding. 110' above base, a 3' bed of shale, medium grey, platy. 195' above base a 1 1/2' bed of sandstone (grey, calcareous, pyritic quartz greywacke). Most of the clasts seen could be derived from the Little Dal Formation, and some certainly are, e.g., dolomite with "molar-tooth" structure	835	3,195
	Lower member		
	NOTE: The lower Rapitan forms resistant, cliff-forming outcrops of sombre aspect. The characteristic purplish red colour is visible at medium range, e.g., from an aircraft in a close pass. The basal "megaconglomerate" weathers pale grey, and can be easily mistaken for the underlying Little Dal Formation.		
7	Pebbly mudstone, non-bedded, massive, very resistant. The matrix is purple-red mudstone as in unit 2. Pebble content is low, everywhere less than 10%; cobbles and boulders are lacking. Phenoclasts have the same composition as those in unit 6	280	2,360

Unit	Lithology	Thickness feet)	Height Above Base (feet)
6	Unit dominated by conglomerates and pebbly mudstones (70 - 80%), with intervals of mudstone with minor sandstone beds and laminae, as in units 2 to 5 (20 - 30%). In the conglomerates, the pebbles are in contact, a measure of sorting is evident, and few clasts exceed 10 cm in diameter. The most abundant phenoclasts are finely crystalline grey dolomite, with minor chert including rare pink chert. Clasts of obvious Rapitan derivation are common. Beds range in thickness from a few inches to five feet. In contrast, the largest phenoclasts--up to 70 cm in diameter--occur in the pebbly mudstones, although few clasts exceed 30 cm. The phenoclasts are supported by the mudstone matrix, and comprise less than 5% in some beds. The clasts have the same composition as those of the conglomerates, and are generally subangular to subrounded. Abundant evidence of slumping is present, in the form of contorted bedding, contorted pebble-rich layers, etc. Bases of some beds are clearly erosional, others concordant. Locally, pebbly mudstone and conglomerate are regularly interbedded on an 8" to 12" scale	390	2,080
5	Argillite with very thin beds and laminae of sandstone, as in unit 4, but lacking layers of granules and pebbles. Most sandstone layers are clearly graded in the normal sense; some have erosional bases; some have rip-up clasts at base	190	1,690
4	Argillite, dull purple-red, as in unit 2, with very minor thin beds and laminae of sandstone. Graded beds with a few granules or pebbles at the base occur; such beds are rare near the base of the unit; but increase upward in frequency and thickness, becoming one bed up to 3 inches thick in each 10' to 20', in the upper part	400	1,500
3	Argillite, dull purple-red, as below. Lamination is prominent, and the laminae are obviously graded, many commencing with a 1-mm layer of very fine sandstone. Rare, thicker beds of sandstone, up to 8" thick, occur. The sandy layers are calcareous, the argillite non-calcareous. Fine cross-lamination is common	620	1,100

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
2	Argillite, dull purplish red, minor pale green, calcareous; predominantly fine planar laminated with graded, sandy laminae; minor low-angle cross-lamination and rare convolute lamination; massive, blocky, very hard, very resistant. Minor, generally cross-laminated thin beds of sandstone (quartz greywacke), very fine grained, brown weathering, with abundant clasts of chlorite. 45' above base, is a 6" bed of pebbly mudstone, comprising phenoclasts (10% - 20%) of dolomite and chlorite-rock in purple argillite matrix. All joints and bedding surfaces are coated with dark green chlorite	480	480
	Contact between units 1 and 2 taken as the zero datum for the section.		
1	"Megaconglomerate" consisting of unsorted, mostly unrounded, dolomite clasts of all sizes ranging up to 15' x 15' in exposed section. All clasts can be accounted for by reference to the Little Dal Formation as source. The unit is non-bedded, resistant, craggy, and weathers greyish yellow to greyish orange. Contact with the overlying beds is near-planar and parallel to stratification in the overlying beds. Not measurable by Jacob's staff; minimum thickness estimated. Base not exposed on line of section, but exposures in the immediate vicinity reveal the unconformable relationship with the underlying Little Dal Formation	100 (est. minimum)	0

SECTION AC-541. CAP MOUNTAIN (950)

Located in Franklin Mountains on the northeast-facing scarp of Cap Mountain, Latitude 63°26'N, Longitude 123°14'W. Measured and described by J.D. Aitken and R.W. Macqueen, July 15-17, 1972; through Mount Clark Formation, Lone Land Formation, and map-units 3, 2, and 1 of Douglas and D.K. Norris, 1963, p. 5-9, 30-31; Aitken, Macqueen and Foscolos, 1973. Semi-quantitative X-ray analyses by A.E. Foscolos and A.G. Heinrich, Clay Mineralogy Laboratory, Institute of Sedimentary and Petroleum Geology.

PHANEROZOIC

PALEOZOIC

LOWER CAMBRIAN

Mount Clark Formation.....714 feet (218 m) (incomplete)

(Unconformity)

PROTEROZOIC

HELIKIAN?

Lone Land Formation..... 743 feet (227 m)
(thickness varies with line of section chosen because of unconformity at base of Cambrian)

Map-unit 3 (Douglas and Norris, 1963).....1,815 feet (553 m)

Map-unit 2 (Douglas and Norris, 1963).....1,723 feet (525 m)

Map-unit 1 (Douglas and Norris, 1963).....1,667 feet (508 m)

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Contact with overlying beds of the Mount Cap Formation is covered, and the Mount Cap is poorly exposed; however, in 1957, A.W. Norris (pers. com., 1972) collected several specimens of *Olenellus* sp. from shales that immediately overlie the Mount Clark Formation, near the top and west flank of Cap Mountain.		
	Mount Clark Formation (Lower Cambrian)		
4	Sandstone, orthoquartzitic, white to pale yellow or pink, mainly very fine grained, thin to thick bedded; crossbedding not prominent, where present it occurs in 2" to 6" sets. *Skolithos* intermittent near base, disappears 90' above base. Ferruginous beds, dull purple to dark brick-red, minor near base, becoming dominant upward	503	714
3	Sandstone, orthoquartzitic, white to pale yellow or pale pink; very minor hematitic beds, pale purple; fine to very fine grained, well sorted; *Skolithos* throughout	106	211
2	Sandstone, orthoquartzitic, white to pale yellow, mainly fine grained and well sorted. Alternating massive *Skolithos*-riddled units, up to 15' thick, and 2'-4' thick units with large scale tangential crossbedding and a few *Skolithos* burrows; rare layers of granules of shale	35	105
1	Sandstone, orthoquartzitic, white to pale yellow, mostly fine grained, not well sorted, semi-friable and porous, in very		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	thick beds; some medium-scale tangential crossbedding but mostly destroyed by intense development of *Skolithos* burrows. Layers of granules and pebbles of shale, dolomite, quartz and quartzite; twenty-five feet above base of unit these disappear and sorting becomes generally good. Slightly recessive, red-mottled hematitic units 1' to 4' thick, alternate with non-hematitic, very resistant units, 8' to 12' thick. From the base up, virtually all beds riddled with *Skolithos* burrows	70	70
	Covered interval--not measured. Because of angular unconformity beneath Mount Clark Formation, thickness of Lone Land Formation depends on line of section chosen. Unconformity is clearly marked by discordance in dip. Attitude at base of Mount Clark Formation is 120°/13°SW; attitude at top of Lone Land Formation is 125°/35°SW.		
	Lone Land Formation (Proterozoic, Helikian?)		
6	Shale, brownish grey to olive-grey, mostly silty and very fissile, alternating with intervals of interlaminated sandstone and shale. Twenty per cent of unit made up of medium to thin beds of grey to pale green, quartzose, very fine grained sandstone, as in unit 5 with fine dark grey or green shaly laminae. Small-scale load-casts, ripple-marks, ripple-drift cross-lamination, local scour-and-fill and paper-thin rip-up clasts of shale characterize the sandstone. Ovoid carbonaceous films, 1/8" to 1/2" (≈3 mm-1 cm) in diameter, almost certainly organic, are abundant on upper surfaces of sandstone laminae	210	743
5	Interbedded shale (90%) and sandstone (10%). Shale, brownish grey to olive-grey, mostly silty; sandstone, quartzose, grey to pale green-grey, very fine grained, in thin beds weathering smooth, brown. Nodular concretions containing pyrite are common. The carbonaceous films, as in unit 6, are well developed. At 10' below top of unit occurs an 18" thick quartzite bed with broad flow rolls	110	533

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
4	Interlaminated white sandstone and black shale, as in unit 3, recessive	34	423
3	Sandstone, white, very fine grained, thinly interbedded to interlaminated with dark grey silty to sandy shale. 5% medium to thick sandstone beds as in unit 2, but generally platy to shaly. Ubiquitous scour-and-fill structures. Ovoid carbonaceous films, 1/8" to 1/2" (≈3 mm - 1 cm) in diameter, almost certainly organic, are abundant	78	389
2	Interbedded sandstone (70%) and shale (30%). Sandstone, orthoquartzitic, white with local purple-red blotches, very fine grained, very well sorted; in lower half, alternating thin beds, flaggy with festoon cross-lamination, and thick beds; in upper half, very thin to very thick beds with the thinnest interlaminated with shale; medium- to large-scale tangential cross-lamination and ripple-drift cross-lamination; ripple-marks. Shale, olive to pale green and dark grey, poorly exposed; shrinkage cracks up to 1 cm wide	222	311
1	Sandstone, orthoquartzitic, white with patches stained pink or purple; weathers grey, mainly medium grained, well sorted, friable, porous; layers of quartz granules and intervals of quartz grit; medium- to large-scale tangential, medium-angle cross-lamination common; thick to very thick bedded, very resistant and cavernous. At the top, largely pebbly sandstone. Contact conformable with underlying unit 23 of map-unit 3	89	89
	Map-unit 3 (Douglas and D.K. Norris, 1963) (Proterozoic, Helikian?)		
23	Sandstone, orthoquartzitic, white but strongly speckled with limonite, very fine grained, very well sorted, uniform; mostly thick bedded, massive, widespread tangential, partly high-angle cross-lamination in 2" to 30" sets; ripple-drift cross-lamination common; pyrite nodules common on bedding planes. 20% of unit is shale, deeply weathered, poorly exposed, fissile, yellow to purplish	111	1,815

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
22	Interbedded shale, sandstone and siltstone. Shale, dull to deep green and olive-grey to green-grey with minor purple in upper part; weathers rusty brown, khaki and minor purple; fissile. Sandstone and siltstone, very fine grained, green-grey to deep green, brown weathering, very well sorted, thinly interbedded with shale in thin to medium laminae. Sandstone/siltstone dominates the slightly resistant middle third of unit; shale dominates remaining two-thirds. Concordant, slightly irregular contact at top	137	1,704
21	Sandstone, orthoquartzitic, white with prominent rusty spots, fine grained, poorly cemented, medium-scale cross-lamination; abundant hematite blebs in matrix, and as coatings on grains. At base and 8' above base, pebble conglomerate occurs, pebbles comprise notably pale green chert and lithic fragments, including some fragments which are up to 20% hematite (altered volcanics?), in orthoquartzitic sandstone matrix. Unit forms a resistant rib	11	1,567
20	Interbedded shale (60%) and sandstone (40%). Shale, partly dull yellow--weathering yellow to rusty, partly dull reddish grey--weathering purple; fissile, silty, micaceous. Sandstone, grading to siltstone, yellow to pale green, weathering rusty, very fine grained, thin bedded, crudely flaggy; mud cracks. In middle part of unit occurs a 6-inch tabular bed of sandstone, orthoquartzitic, pale green, strongly bimodal, with small mode of coarse quartz, minor chert grains in dominant, very fine grained, very well sorted matrix; structureless; jasper grains present. Whole unit is ribby, topographically neutral	66	1,556
19	Interval consists of an alternation of units "A" and "B" as follows: Units "A" (60%): Sandstone, orthoquartzitic, pale grey with green, black, and pink laminations, very fine and fine grained, well sorted; regularly thin bedded, tending to massive, resistant. Units "B" (40%): Recessive units of siltstone and shale, as in unit 16. Unit consists of three resistant ribs of "A" with two recessive zones of "B". Entire interval is affected by penecontemporaneous slide-surfaces and folds	112	1,490

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
18	As in unit 19, but "A" units comprise only 5%	30	1,378
17	Covered	36	1,348
16	Interbedded siltstone (45%), shale (35%) and sandstone (20%). Siltstone, pale green, grey with pink laminae; laminated, platy, rusty weathering. Shale, dull green with pink laminae, fissile; in middle of unit, partly reddish purple and pale green as unit 12. Sandstone, orthoquartzitic, pale green, white, rust speckled, thin to thick bedded. All lithologies show lenticular, discontinuous, and discordant bedding, interpreted as gravity slumping. Unit is slightly recessive	84	1,312
15	Sandstone, orthoquartzitic, medium to pale grey, tangential and planar crossbedding; tops of some beds red due to hematite mineralization. Base of unit strongly erosional, with up to 1 1/2' of relief. 33' above base, a lens of sandstone 50' to 60' long and 3' thick in the middle, with spectacular planar crossbedding at 35° dip. Conglomeratic lens(?) at 48' above base of unit, with pebbles of quartz and chert	125	1,228
14	Sandstone as below, in 4" to 12" beds, with 1" to 6" interbeds (10%) of purple mudstone. 5' above base, a bed of conglomerate and very coarse grained sandstone with pebbles of chert, jasper and blue quartz	35	1,103
13	Sandstone, orthoquartzitic, medium to pale grey, mainly fine grained, but tops of beds are fine to medium grained and locally coarse grained; beds broadly lenticular, mainly 0.5' to 2', rarely up to 5' thick; thin interbeds of purple mudstones locally bleached green. 31' above base, an erosional channel 3' deep is filled with sandstone crossbedded at 20° to 25°. Thin-section from sample collected 50' below top shows minor chert grains, much pressure-welding of quartz grains	64	1,068
12	Interbedded mudstone (70%) and sandstone (30%). Mudstone is red to purplish red, less commonly green, silty, platy to blocky weathering. Sandstone is orthoquartzitic, greenish grey, very fine grained, in 4" to 12" beds. 17' above the base, a packet of low-angle crossbeds suggests a beach unit	46	1,004

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
11	Sandstone, medium to pale grey, speckled with iron oxides, very fine grained, in distinct beds 4" to 12" thick. Thin (1" - 3") interbeds of shale. Thin section from sample at 2' above base shows minor chlorite in matrix; hematite as grain coatings and fracture fillings	40	958
10	In basal 20' mudstone, red to purplish red; with sandstone interbeds increasing upward to 60%. Sandstone is grey to green-grey, very fine grained, grading to siltstone, in beds 6" to 18" thick	58	918
9	Sandstone, orthoquartzitic, pale grey, generally fine grained and well sorted, but in basal 4' medium to coarse grained and poorly sorted; beds thin to very thick, very resistant; commonly rusty weathering; purplish quartz grains present, flow rolls in lower part of unit. Uppermost 80' of unit contain mudstones, purplish, thin-bedded, 2" to 1' thick, evenly laminated and with sharp contacts with overlying sands. Sandstones within upper 80' are in beds 2" to 2' thick. Unit overall is 85% sandstone, 15% mudstone	153	860
8	Sandstone, orthoquartzitic, very fine grained, to siltstone, orthoquartzitic; pale grey, weathering rusty grey; poorly sorted, rubbly weathering, thin bedded; indents underlying mudstone sequence	37	707
7	Interbedded mudstone (80%) and sandstone (20%). Mudstone, purplish, laminated to very thin bedded, recessive, locally contains abundant specular hematite. Sandstone, thin bedded, very fine grained, grading to siltstone, generally rusty grey; contains distinctive purplish liesegang ring structures; some beds green, reduced, with purplish blotches; sandstone/siltstone beds are lenticular, and indent underlying mudstone beds. Semi-quantitative X-ray diffraction analysis of very fine grained sandstone sample collected at 135' above base of unit (615' above base of map-unit 3, 4,025' above base of section): quartz, 5%; talc or pyrophyllite?, 26%; illite, 6%; malachite, 3%; chlorite, 3%; montmorillonite, 3% (sample chosen for visible malachite content, and is not representative of average Cu content of exposed rock)	170	670

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
6	Mudstone, red to purplish red, recessive like lower units but lacks mud cracks; very minor (5%) interbeds of argillaceous siltstone/ sandstone and silty mudstone, which are slightly more resistant, forming ribs; monotonous, uniform; much specular hematite locally	118	500
5	Sandstone, orthoquartzitic, generally fine to partly medium grained, well sorted at base, less well sorted above; ripple-drift cross-lamination, small-scale cross-lamination, and small-scale scour-and-fill evident. Red mudstone pebbles on tops of some sandstone beds. Unit is strongly resistant. A pressure-welded mosaic of quartz grains; minor chert grains. Very minor chlorite in matrix	20	382
4	Mudstone, laminated, colour-banded with interbeds of green and purple mudstone in basal 60', above it entirely purple mudstone. Shale chips and ?mud cracks present locally throughout	97	362
3	Sandstone, generally fine grained, locally coarse grained, pale reddish grey, weathers reddish purple; laminated to very thin bedded, shows rip-up clasts, small-scale cross-lamination, and local ripple-lamination, grains well rounded but sorting poor, hematite occurs as interstitial blebs and as grain coatings; interbedded with mudstone, purplish red to red	35	265
2	Interbedded mudstone and shale (evenly laminated or shows good fissility); greenish grey, weathering rusty greyish brown to brownish grey; has slump overfolds(?), suggestive of slope deposits; lacks ripple-marks or mud cracks; contrasts strongly with mudstone of unit 4; 90' above base is a 20' unit containing sandy mudstone, showing sedimentary (compactional) boudinage, and interbedded with shale as above and below	180	230
1	Sandstone, very fine grained, to siltstone (70%); abundant argillaceous matrix, sorting poor; medium greyish green, weathers yellowish green to greyish green, thin bedded; interbedded irregularly with mudstone (30%), silty, purplish red or green, very thin bedded. Contact conformable with beds of underlying map-unit 2	50	50

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	Map-unit 2 (Douglas and D.K. Norris, 1963) (Proterozoic, Helikian?)		
15	Mudstone, dominantly green, locally reddish purple, especially in upper part; laminated; shows some fissility; relatively resistant	47	1,723
14	Mudstone, brick red to purplish red, chippy to blocky weathering; much fractured; some poorly fissile zones; some rare thin (under 1") dolomitic zones; rare 1/2" to 3/4" thick green bands, probably zones of reduction (ferrous iron); zones impart slight banding to outcrop, but comprise well under 1% of unit. At 36' above base, a 1/2" to 1" thick band occurs which is rich in specular hematite. At 100' above base, a 55' interval occurs which consists of sandy mudstones or argillaceous sandstones, interbedded with mudstones as above and below. This zone is thin bedded, but weathers with prominent ribs. Hematite occurs as pore-fillings, as coatings on grains and (?) as discrete grains	274	1,676
13	Siltstone, argillaceous, red, hematitic; very thick bedded and resistant, forming small falls on creek; very sharp upper contact. Contains two prominent thin silty dolomite interbeds, pale yellowish brown, in lower half of unit	81	1,402
12	Dolomite, finely crystalline, pale greenish yellow, weathering bright yellowish orange; prominent, thick bedded, sharp upper and lower contacts	8	1,321
11	Mudstone, green in basal 8', red above; abundant fine-grained quartz sand in top 5'; curl-up desiccation cracks prominent 10' below top of unit	22	1,313
10	Siltstone, argillaceous, to mudstone, silty, pale green with red mottling, thin bedded, local mudstone chip conglomerates evident; minor desiccation cracks, sand-filled at 8' above base. Basal 8' are sandstone, orthoquartzitic, fine to locally medium grained, pale grey to greenish grey; siltstone/mudstone contains several thin interbeds of yellowish brown weathering dolomite resembling those in overlying unit. Unit is resistant. Thin-section of sandstone sample, collected 1' above base shows lithic		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	fragments of microcrystalline dolomite showing gypsum pseudomorphs, also minor single ooids and lithic fragments of oolitic dolomite, in orthoquartzitic matrix. Quartz grains show abundant evidence of pressure welding. Unidentified zeolite mineral locally abundant in thin-section from 17' above base of unit	36	1,291
9	Dolomite, finely crystalline, pale green, weathers rusty yellowish brown, laminated to very thin bedded. Contains two varieties of stromatolites, both laterally-linked hemispheroids, one about 6" high and 6" to 8" wide, the other about 1/2" to 1 1/2" wide, and 1" to 2" high. Top 3' of unit contain flat-pebble conglomerate with dolomite clasts. Unit is resistant, cliff forming. Gradational to underlying unit	36	1,255
8	Siltstone to sandstone, very fine grained, pale green, laminated to very thin bedded, platy weathering. Dominant lithology appears to be delicately laminated siltstone. Joint faces are mineralized with bright green malachite. Resistant, cliff-forming unit, much more resistant than units directly above and below. Well jointed, two directions approximately at right angles and approximately at right angles to bedding. Semi-quantitative X-ray diffraction data from sandstone sample, containing malachite and collected from 8' above base of unit (1,183' above base of map-unit 2, 2,850' above base of section): quartz, 43%; chlorite, 22%; dolomite, 22%; illite, 11%; malachite, 2%; (sample chosen for visible malachite content--not representative of average Cu content of exposed rock)	44	1,219
7	Mudstone, sandy, brick red to purplish red, in bands 1' to 5' thick, slightly resistant and alternating irregularly with mudstone?, thin bedded, lacking sand, recessive, as in unit 6. Unit comprises about 40% sandy mudstone, and 60% mudstone. Sandy mudstone contains mudstone or shale chip conglomerate locally. Unit is prominently banded owing to alternation of two rock types. Semi-quantitative X-ray diffraction analysis of red sandstone sample collected from 989' above base of map-unit 2: quartz, 79%; illite, 9%; hematite, 7%; chlorite, 5%	202	1,175

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
6	Mudstone (85%), brick red to purplish red, well jointed, chippy to blocky weathering, with irregularly distributed interbeds of sandy mudstone (15%), as in unit 7. This unit resembles overlying unit, but proportions of two rock types are considerably different. Bleached "mottles" occur at several levels, are about 1/2" to 1" thick, slightly irregular but generally follow a single stratigraphic level. Uppermost 90' are almost without sandy mudstone interbeds. Oscillation ripple-marks occur rarely on tops of non-sandy mudstones. Contortion and minor faulting(?) present in a zone 50' below top of unit	223	973
5	Mudstone (60%), brick red to purplish red, as in unit 6; interbedded with sandy mudstone (40%). Sandy mudstone shows delicate cross-lamination, ripple-drift cross-lamination in part, and many wispy, wafery shale or mudstone chips. A few beds are actually argillaceous sandstones. They are pale green with green and red mottling. Mud cracks and ripple-marks are common in talus from this unit. Specular hematite is locally abundant on joint faces. Unit is generally thin bedded, recessive	129	750
4	Mudstone, red to purplish red, locally showing poor fissility, in bands 1' to 3' thick; alternating with very sandy mudstone, very thin bedded, in bands 1' to 1 1/2' thick. Unit is about 75% recessive non-sandy mudstone, 25% sandy mudstone. Mud cracks and shale chip breccias are common in parts of non-sandy mudstone which show some fissility. Much fractured; chippy weathering with thicker beds blocky. Local malachite and specular hematite on joint surfaces. Curled up mud cracks are evident locally. Semi-quantitative X-ray diffraction analysis of red sandstone sample collected at 546' above base of map-unit 2: quartz, 75%; chlorite, 10%; illite, 8%; hematite, 7%	180	621
3	Massive sandstone in purple-red mudstone, as below, in resistant beds 1' to 8' thick; sandstone is dark greyish purple proto-quartzite, mainly very fine grained with significant amounts of matrix--a very minor proportion is medium and coarse grained. Small- to large-scale tangential crossbedding is general; ripple-marks, especially		

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
	current ripples, are common. Two beds and several lenses of grit and pebble conglomerate are present, with pebbles of white and pink quartz, jasper, and black argillite. Semi-quantitative X-ray diffraction analysis of purple mudstone sample from 16' above base of unit (411' above base of map-unit 2; 2,078' above base of section): quartz, 42%; dolomite, 26%; chlorite, 14%; illite, 9%; hematite, 7%; malachite, 2% (sample chosen for malachite content, and is not representative of average Cu content of rock exposed). Thin section of sandstone sample from 18' below top shows hematite occurring as coatings on quartz grains and concentrated in individual laminae. Semi-quantitative X-ray diffraction analysis of red sandstone sample collected at 411' above base of map-unit 2: quartz, 71%; chlorite, 11%; illite, 9%; hematite, 2%, dolomite, 2%. Similar analysis of red sandstone sample collected from 423' above base of map-unit 2: quartz, 83%; chlorite, 7%; hematite, 6%; illite, 4%	46	441
2	Mudstone, non-fissile, and shale, crudely fissile, deep reddish purple to near brick-red, generally silty, with abundant mud cracks and ubiquitous shale pebbles. Round spots (spheroids?), bleached green and containing micaceous malachite, are common along bedding planes. Near the base only, minor thin and medium beds of sandstone, greyish purple, very fine grained	190	395
1	Recessive interval, covered except for minor outcrop of purple mudstone, yellow-weathering dolomite, and minor sandstone similar to those in Map-unit 1	205	205
	Map-unit 1 (Douglas and D.K. Norris, 1963) (Proterozoic, Helikian?)		
26	Sandstone, protoquartzitic, grey-green, pepper-and-salt, with brown laminae (hematite); mostly thick bedded, massive, with large-scale tangential crossbeds; shale pebbles prominent; very minor interbeds of green and purple shale. Thin section of sandstone sample from 1,591' shows less chlorite in matrix than in samples lower in section; almost orthoquartzite	81	1,667

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
25	Reddish purple shale as below, with 10% mostly thin beds of sandstone as in unit 16	28	1,586
24	Purple shale (50%) as in unit 10, laminated dolomite (50%) as in unit 9, still commonly vuggy; some crinkly algal-type laminations	44	1,558
23	A single, massive, resistant unit of dolomite, microcrystalline, grey, pale green, pale pink, yellow, nodular, with dolomitic siltstone between nodules. Nodules develop upward into indistinct columnar stromatolites	7	1,514
22	Persistent, recessive, mainly covered interval with purple shale exposed at top	308	1,507
21	Shale and silty mudstone (70%) as in unit 10, reddish purple, subordinate green; and siltstone and minor very fine grained sandstone (30%), grey, yellow, green, purple, thin bedded, platy, dolomitic	65	1,199
20	Shale (85%), purple, as in unit 10, with a very few thin beds of sandstone, as in unit 16; and dolomite, (15%) as in unit 9, in beds 1' and less in thickness	38	1,134
19	Siltstone (80%), earthy, very dolomitic, dull brownish yellow, shale fracturing, weathering rusty orange; and dolomite (20%), as in unit 9, tending to platy	40	1,096
18	Mudstone (70%), as in unit 10, with very minor thin beds of sandstone as unit 16, and dolomite (30%), yellow weathering, laminated, mud cracked, as unit 9	75	1,056
17	Recessive, mostly covered. Exposure is mainly mudstone as in unit 10, with minor sandstone and dolomite as in units 16 and 9	279	981
16	Sandstone (70%), protoquartzite, grey-green, mostly fine grained, well sorted, in beds 1" to 10' thick, the thick beds are massive and resistant. Tangential cross-lamination and rip-up clasts of mudstone are general; bases of sandstones are commonly erosional. At the top, extensive low-angle planar cross-lamination suggests a beach unit. Dolomite (15%) as in unit 9. Shale/mudstone (15%) as in unit 10	93	702

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
15	Purple shale/mudstone (33%) as in unit 10; laminated dolomite (34%) as in unit 9; sandstone (33%), protoquartzite, greyish green, pepper-and-salt, fine and very fine grained, in beds 1" to 36" thick. The thin beds alternate with shale; thick beds overlie mudstone with erosional contact. Tangential crossbedding, with heavy-mineral layers, is common. Semi-quantitative X-ray diffraction analysis of malachite-bearing protoquartzitic sandstone sample collected from talus at 570' above base of section: quartz, 74%; chlorite, 12%, feldspar, 5%; illite, 3%; malachite, 2%; calcite, 2%; dolomite, 2% (sample chosen for malachite content, and is not representative of average Cu content of rock exposed	70	609
14	Purple shale/mudstone (70%), as in unit 10. Control of local green colouration by joints shows that green colouration is secondary. Resistant intervals of laminated yellow-weathering dolomite (30%) as in unit 9. Both shale and dolomite contain laminae and inch-thick beds of sandstone, very fine grained, pepper-and-salt, as below. Malachite occurs along bedding planes and joints 117' and 187' above base of unit. Semi-quantitative X-ray diffraction analysis of: a) laminated argillaceous dolomite sample from 473': dolomite, 46%; quartz, 35%; chlorite, 8%; illite, 8%; feldspar, 3%; b) dolomitic mudstone sample from 545': quartz, 56%; dolomite, 27%; chlorite, 8%; illite, 6%; feldspar, 3%	181	539
13	Shale/mudstone (55%) as in unit 10; laminated dolomite (25%) as in unit 9; sandstone (20%), protoquartzitic as in unit 11, but partly fine grained; trough and herringbone cross-laminations. Thin section shows numerous lithic fragments; minor chlorite in matrix	34	358
12	Shale/mudstone (85%), as in unit 10; dolomite (7%), as in unit 9; sandstone (8%) as in unit 11, in beds 6" to 24" thick, generally with rippled tops	90	324
11	Sandstone, protoquartzitic, dark green, black specked, very fine grained, slightly dolomitic; laminations parallel to bedding, with local tangential cross-lamination and oscillation ripple-marks, massive. Top 6" are flat-pebble conglomerate. Base is erosional, with 4" relief. Thin section shows abundant lithic fragments; minor carbonate rock grains; minor chlorite in matrix; minor hematite coatings on grains	3	234

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
10	80% fissile shale and non-fissile, massive silty micaceous mudstone, both deep reddish purple, minor green. Shale is pitted with up-curled mud-cracks; mudrocks have scattered vugs. Ribs of laminated dolomite (20%), exactly as in unit 9, weathering yellow to pale orange	71	231
9	Mudstone (60%), mainly purple, minor green, with lenses and laminae of yellow-weathering dense dolomite, in recessive 5' to 10' intervals; and laminated dolomite (40%) as in unit 2, with vugs and breccia zones and more or less partings of green dolomitic shale. Apparent casts of gypsum rosettes in dolomite	29	160
8	Sandstone, protoquartzitic, greyish purple, very fine grained, very well sorted, very porous, slightly dolomitic with minute calcite-filled vugs; massive. In the middle, a one-inch thick bed of purple shale shows polygons 12" across with strongly up-curled edges	2	131
7	Shale, medium olive-green, weathering same, with laminae, lenses and nodules of dolomite, greyish green, microcrystalline, cross-laminated; many calcite-filled vugs	6	129
6	Dolomite, laminated, as in unit 2, vuggy, contorted intervals; prominent mud cracks	5	123
5	Massive bed consisting at the base of nodules of dense dolomite, as unit 2 but non-laminated in a matrix of mudstone, dull olive, dolomitic. Nodules change upward into indistinct columnar stromatolites; top of unit has 1" to 3" relief	7	118
4	Dolomite, conspicuously laminated as unit 2, argillaceous and silty, commonly with partings of shale and siltstone. Calcite-lined vugs common; one horizon of low domal LLH (laterally linked hemispheroids) stromatolites, near the base. Interval includes two fault-contorted and fault-thickened intervals	53	111
3	Dolomite as below, partly laminated, but up to 50% of unit is made up of beds of flat-pebble breccia. Breccia beds and laminated beds are commonly filled with leachable calcite "eyes", suggesting evaporite removal. Large-scale mud cracks general. Local contortion also suggests former presence of evaporites	10	58

Unit	Lithology	Thickness (feet)	Height Above Base (feet)
2	Mainly dolomite, greenish grey to pale green, microcrystalline, laminated, variably argillaceous and silty, locally grading to dolomitic shale; shaly to massive; weathers pale yellow-grey to pale orange, minor pale green. One very sandy bed. Two beds spotted with pale grey, medium crystalline dolomite. Local curled-up mud cracks; several beds of flat-chip breccia; three beds of calcareous micro-breccia suggestive of evaporite leaching. Very minor beds of shale, green and purple, dolomitic	40	48
1	Clay shale, waxy, chippy, green at top and bottom, purple in middle half. Minor lenses and laminae of dolomite, pale green, microcrystalline, laminated, yellow weathering. No additional exposure	8	8

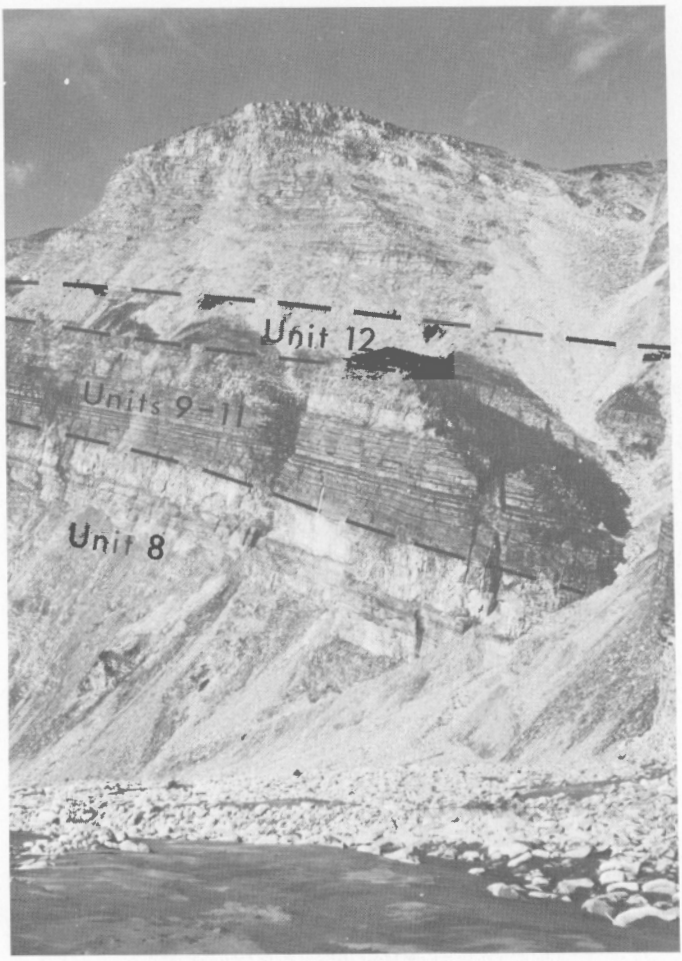


Plate 1. Character of lower part of Katherine Group (Hkl) at Loretta Canyon on Imperial River; locality U-11 (96E). Unit 12 indicated is purple shale zone (see section description) GSC 199000

Plate 2 (opposite-top). Contact between upper Katherine Group (Hku) and lower Katherine Group (Hkl), Keele River. The "upper quartzite" capping the mountain overlies relatively recessive dolomites, black shales, and subordinate quartzite beds. View northward from about 64°16'N, 127°34'W (96D) GSC 199001.

Plate 3 (opposite-bottom). Sequence showing: upper Katherine Group (Hku), unnamed Helikian map-unit (H5) including the "Dead End Shale", and the "basal Franklin Mountain Formation Red beds"(ЄOfa). The upper part of Unit H5 at this locality is transitional to Little Dal Formation as indicated by the tongue of resistant dolomite. View westward from about 64°57'N, 130°29'W (106B) GSC 199002.

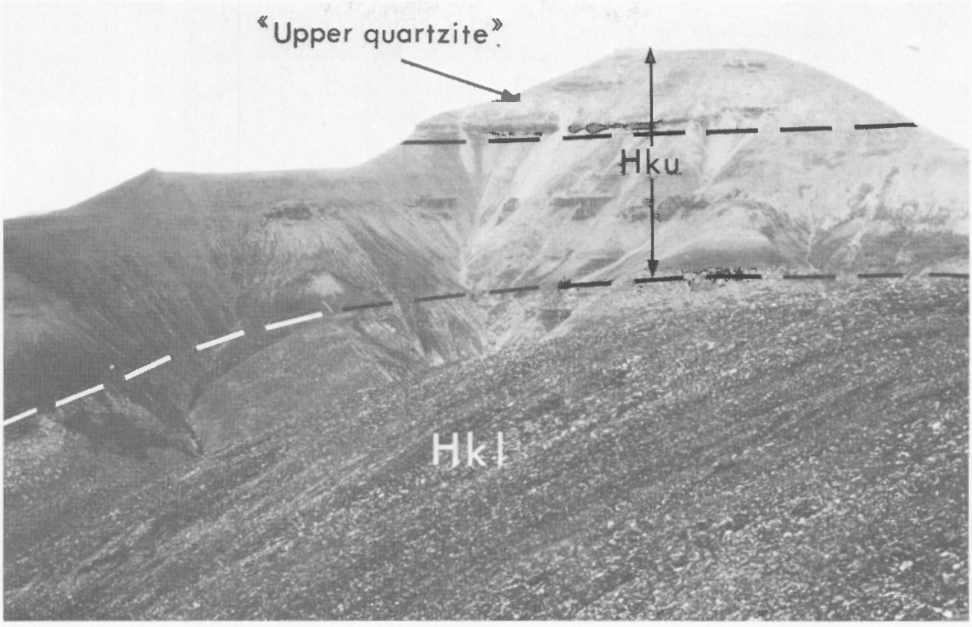


Plate 2.

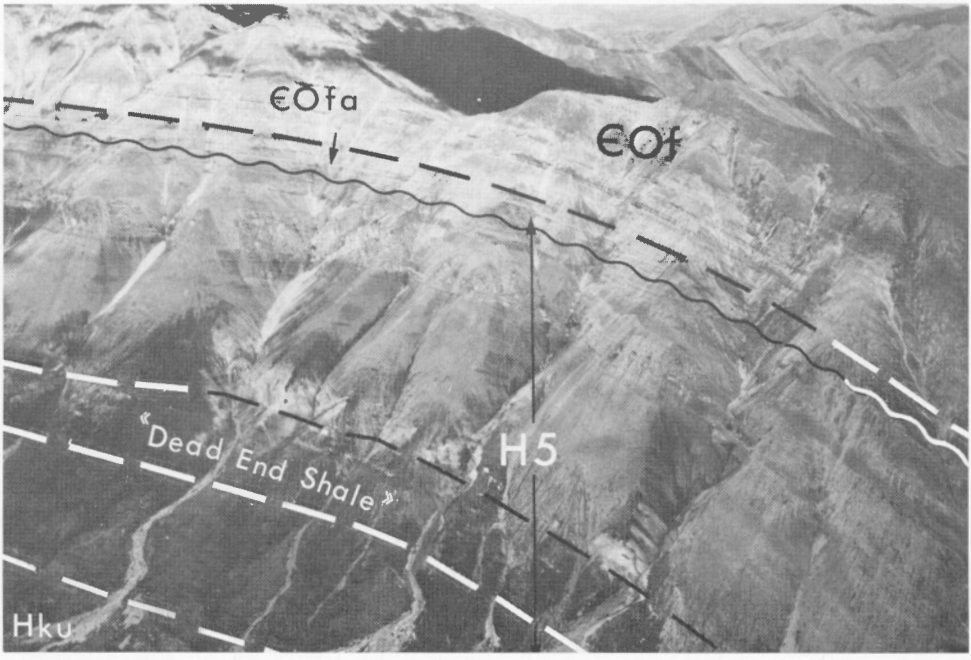


Plate 3.

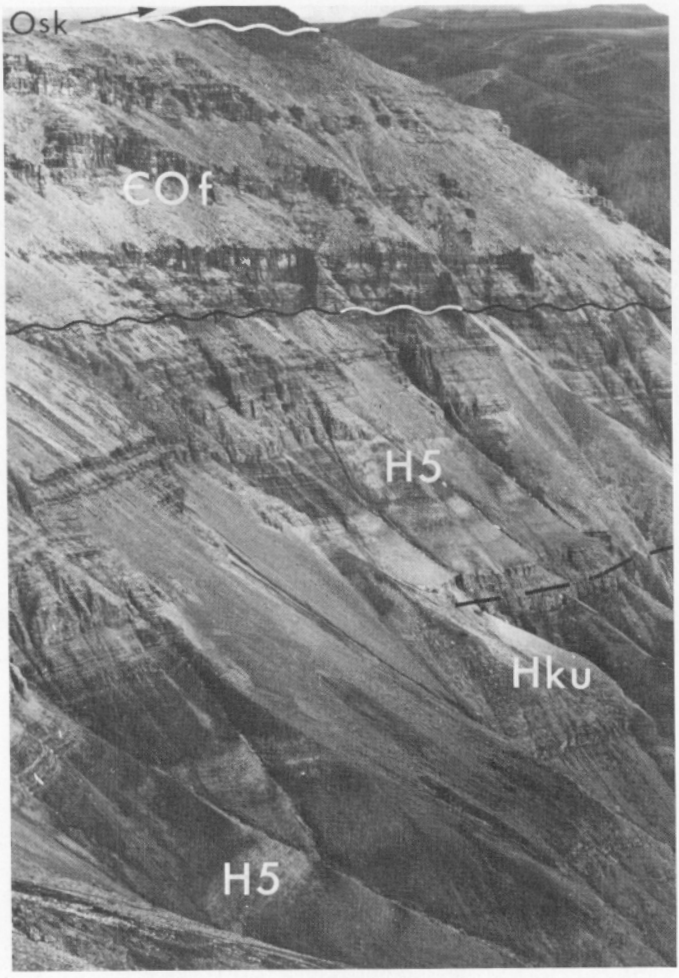


Plate 4. Sequence showing: Katherine Group (upper part, Hku), unnamed Helikian map-unit (H5), Franklin Mountain (ЄOf) and Mount Kindle (OSk) Formations. Note angular unconformity at the base of the Franklin Mountain. View northeastward from about 64°04'N, 127°24'W (96D) GSC 199003

Plate 5 (opposite-top). Gypsum beds, in unnamed Helikian map-unit (H5), overlain unconformably by Franklin Mountain Formation (ЄOf) with red beds (ЄOfa) at the base. View southwestward from about 64°47'N, 129°39'W (106A) GSC 199004

Plate 6 (opposite-bottom). View showing sequence: unnamed Helikian map-unit (H5) containing gypsum beds at this locality, Little Dal (Hld) and Franklin Mountain (ЄOf) Formations in a fault-repeated section. Note the low-angle unconformity at the base of the Franklin Mountain Formation. View northwestward from about 65°00'N, 131°07'W (106G) GSC 199005

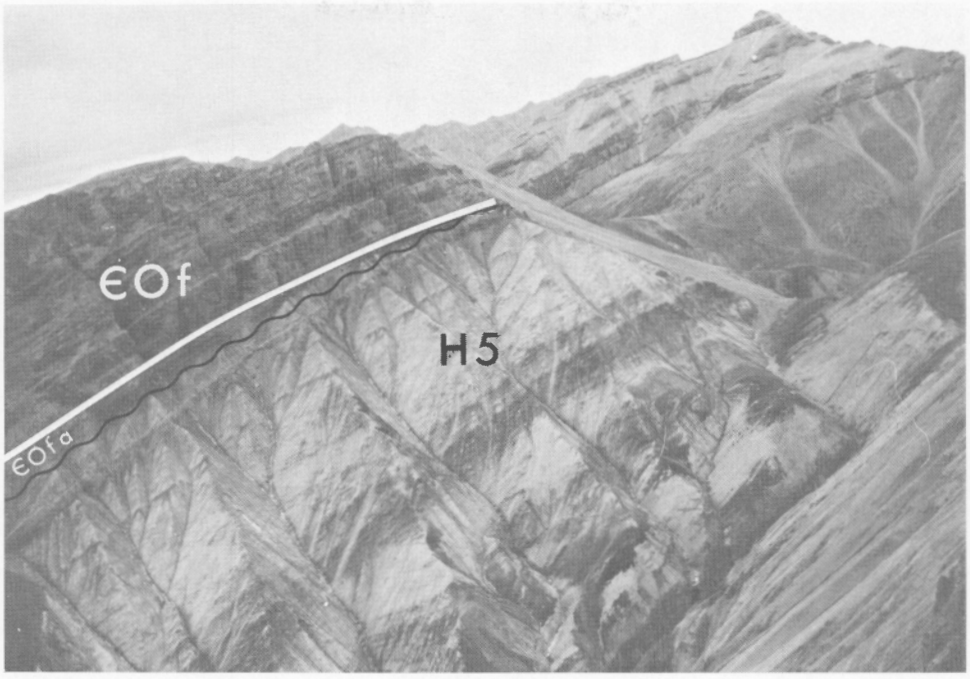


Plate 5.

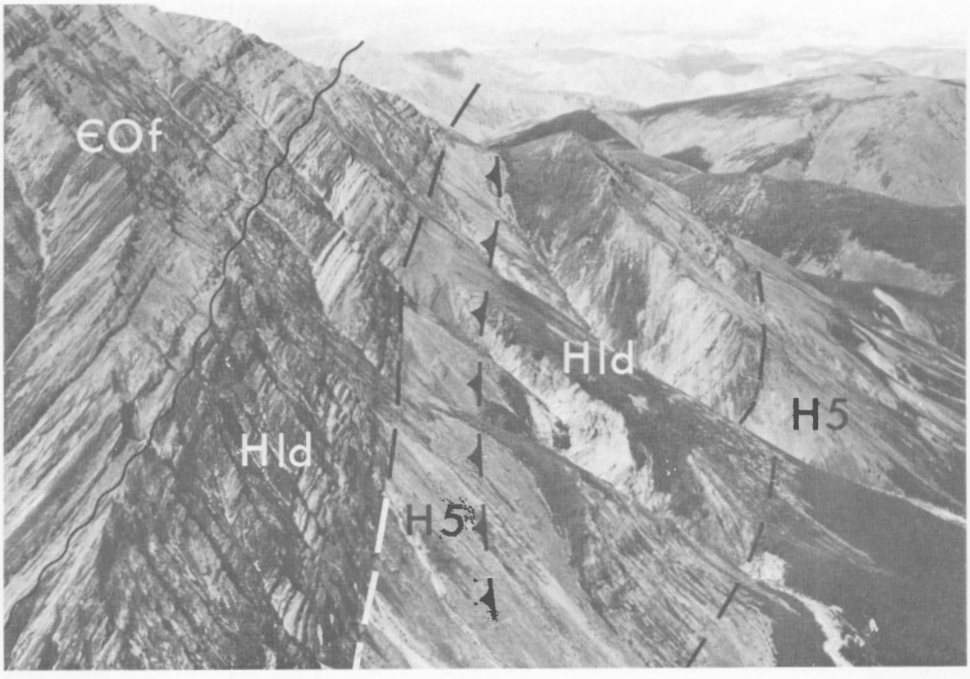


Plate 6.

Plate 7.

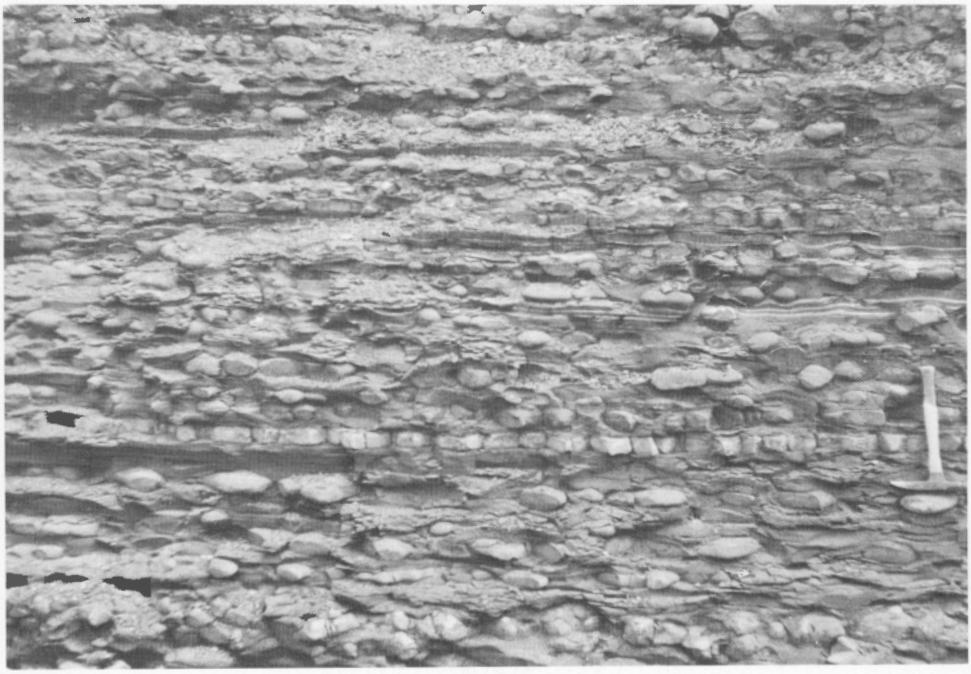


Plate 8.

Plate 7 (opposite). View of contorted gypsum beneath unit 1 at locality U-9, tributary of Mountain River (106A). Gypsum unit and overlying beds are part of unnamed Helikian map-unit (H5) GSC 199006

Plate 8 (opposite). Nodular shale of the "Dead End Shale" unit at the type section of the Macdougal Group (obsolete), Dodo Canyon (96D). Unit is assigned to the unnamed Helikian map-unit (H5). Section MQ6 GSC 199007

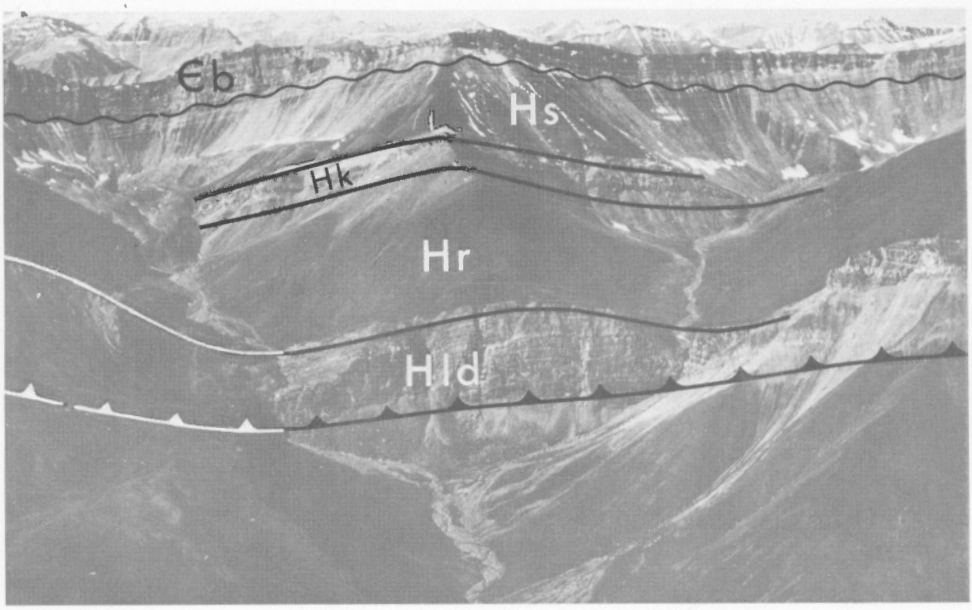


Plate 9. View showing sequence: Little Dal Formation (Hld), Rapitan Group (Hr), Keele (Hk), Sheepbed (Hs) and Backbone Ranges (Cb) Formations. The Little Dal is in thrust-fault contact with underlying, relatively non-resistant Devonian strata. View southwestward from about 64°50'N, 130°24'W (106B) GSC 199008

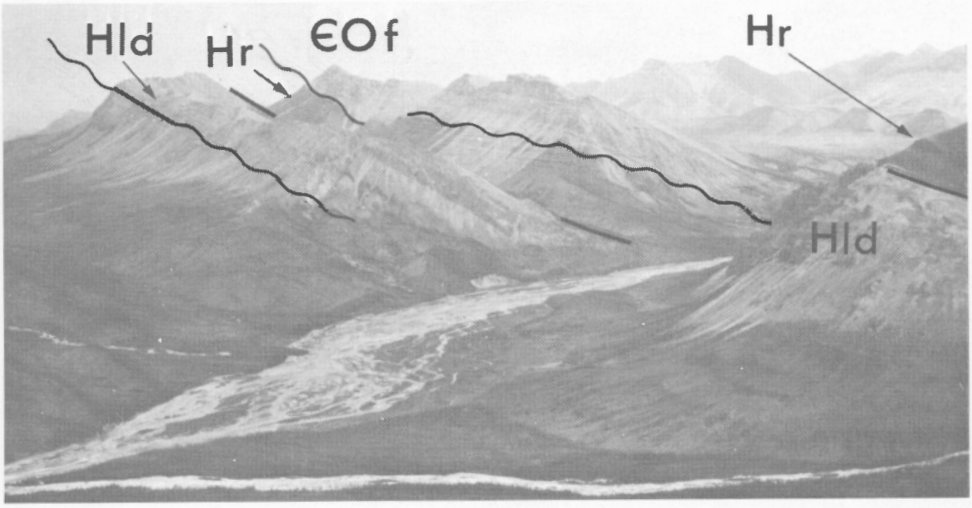


Plate 10. View showing sequence: Little Dal Formation (Hld), Rapitan Group (Hr), and Franklin Mountain Formation (COf). View southeastward from about 64°44'N, 129°42'W (106A) GSC 199009

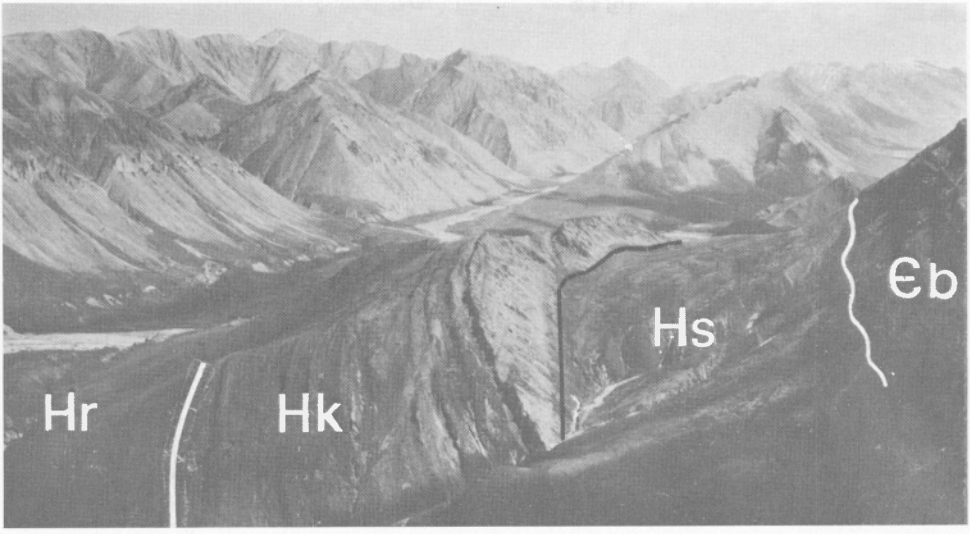


Plate 11. View showing sequence: Rapitan Group (Hr), Keele (Hk), Sheepbed (Hs) and Backbone Ranges (Єb) Formations near locality U-8 (106A), Mackenzie Mountains interior GSC 199010

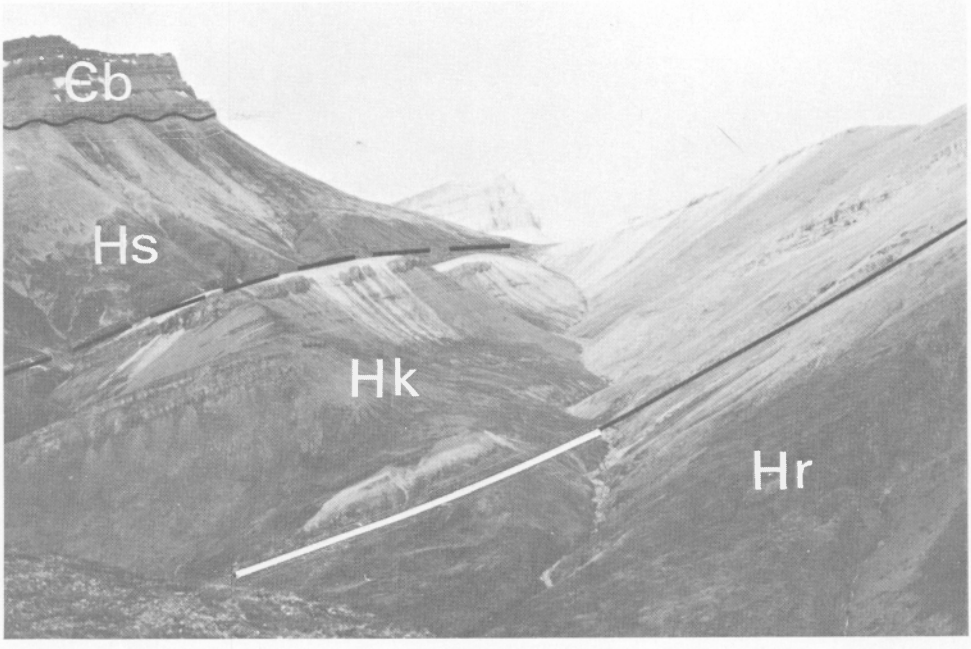


Plate 12. View showing sequence: Rapitan Group (Hr), Keele (Hk), and Sheepbed (Hs) Formations overlain unconformably by the Lower Cambrian Backbone Ranges Formation (Єb). View northwestward from about 64°29'N, 129°25'W (106A) GSC 199011

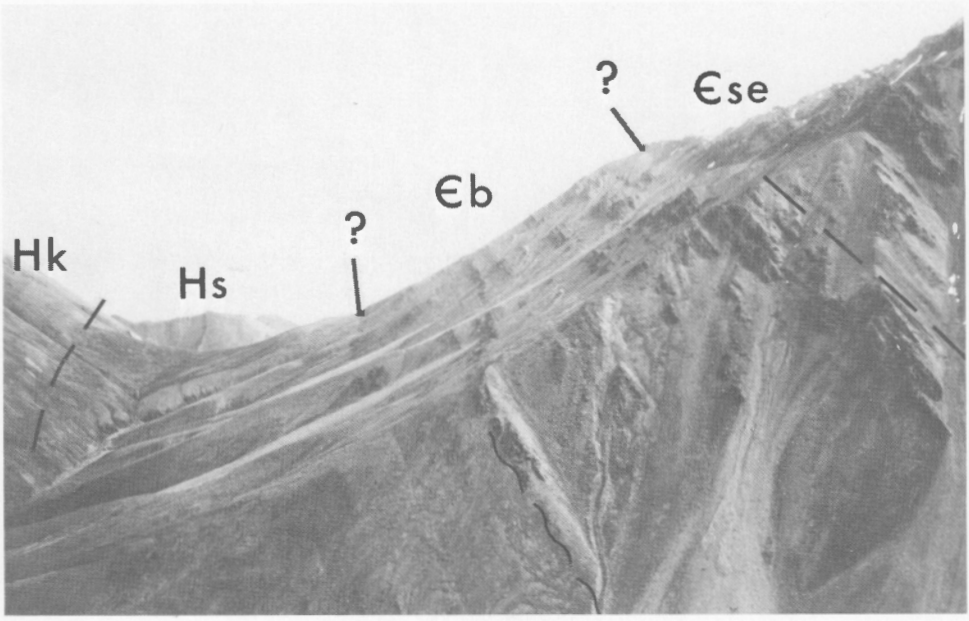


Plate 13. View showing sequence: Keele (Hk), Sheepbed (Hs), Backbone Ranges (Cb) and Sekwi (Cse) Formations. View northwestward from about 64°29'N 129°25'W (106A) GSC 199012

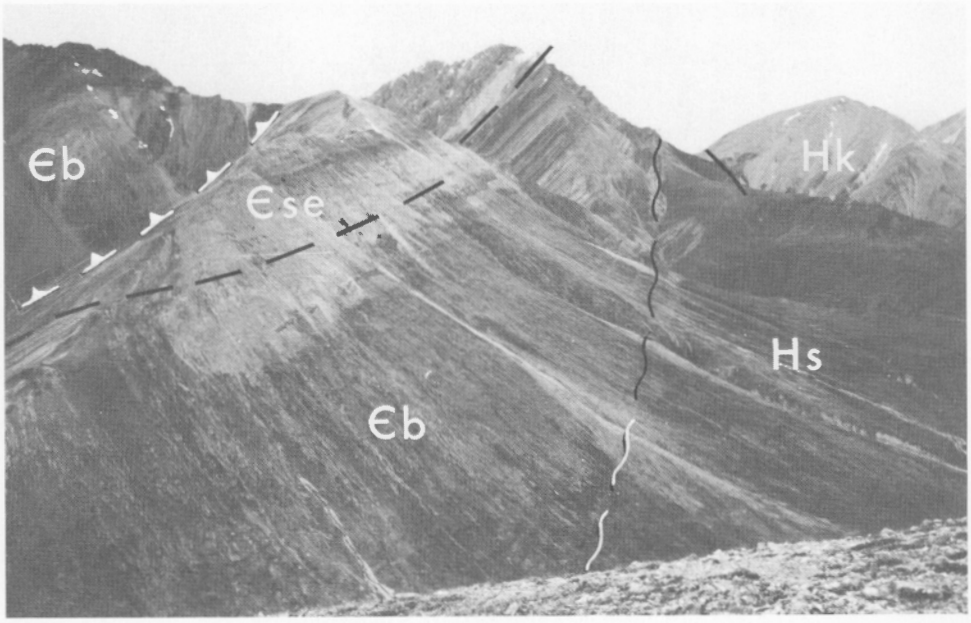


Plate 14. View showing sequence: Keele (Hk), Sheepbed (Hs), Backbone Ranges (Cb) and Sekwi (Cse) Formations in a fault-repeated section. View west-northwestward from about 65°03'N, 131°53'W (106G) GSC 199013

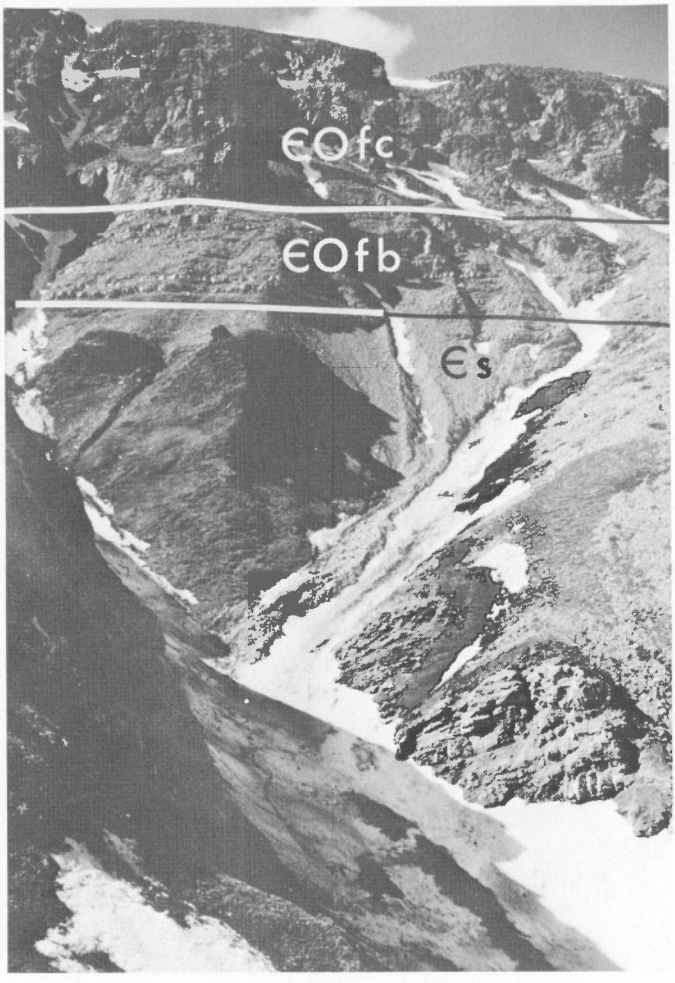


Plate 15. View showing character of Saline River Formation (Cs), Franklin Mountain Formation cyclic unit (Cfb) and Franklin Mountain Formation rhythmic unit (Cfc) at locality MQ-2 Norman Range, Franklin Mountains; locality MQ-2 (96E) GSC 199014

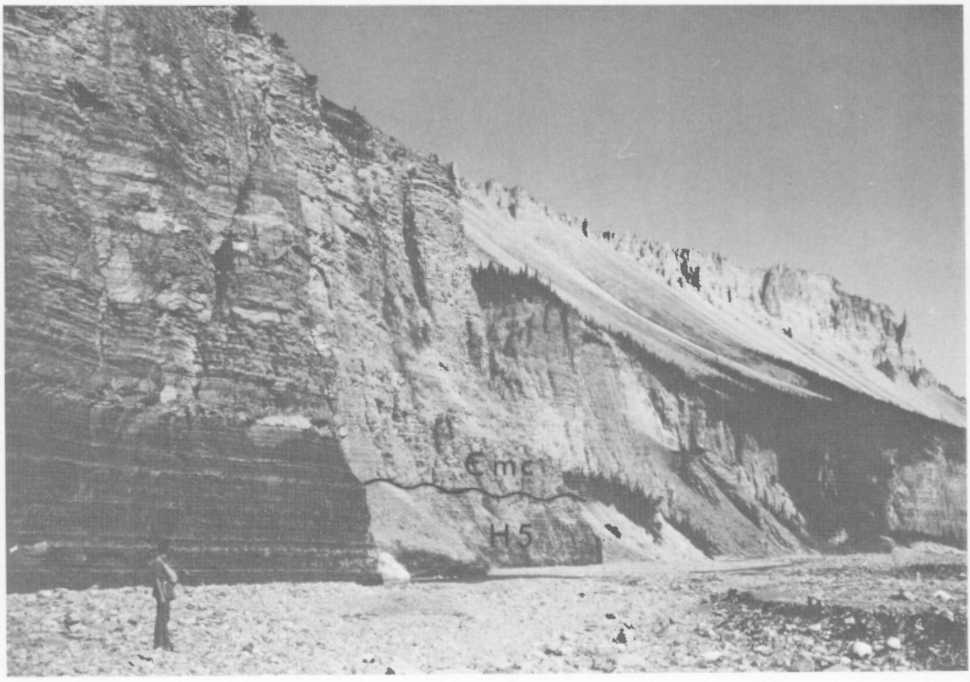


Plate 16.

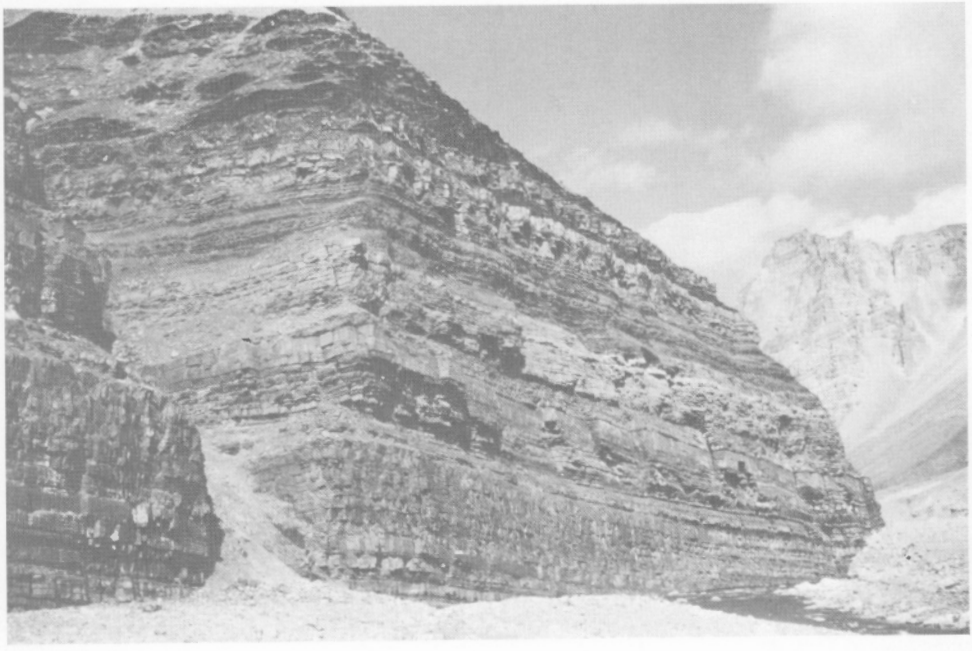


Plate 17.

Plate 16. Contact between "Dead End Shale" sub-unit of unnamed Helikian map-unit (H5), and overlying basal beds of Cambrian Mount Cap Formation (Cmc). Dodo Canyon, Carcajou Range, Mackenzie Mountain front; locality MQ-6, U-12 (96D) GSC 199015

Plate 17. Mount Cap Formation, Dodo Canyon, Carcajou Range, Mackenzie Mountain front, MQ-6 (96D). Units 1 to 19 of Mount Cap Formation, section MQ-6, were examined in the small gully at left side of photo GSC 199016

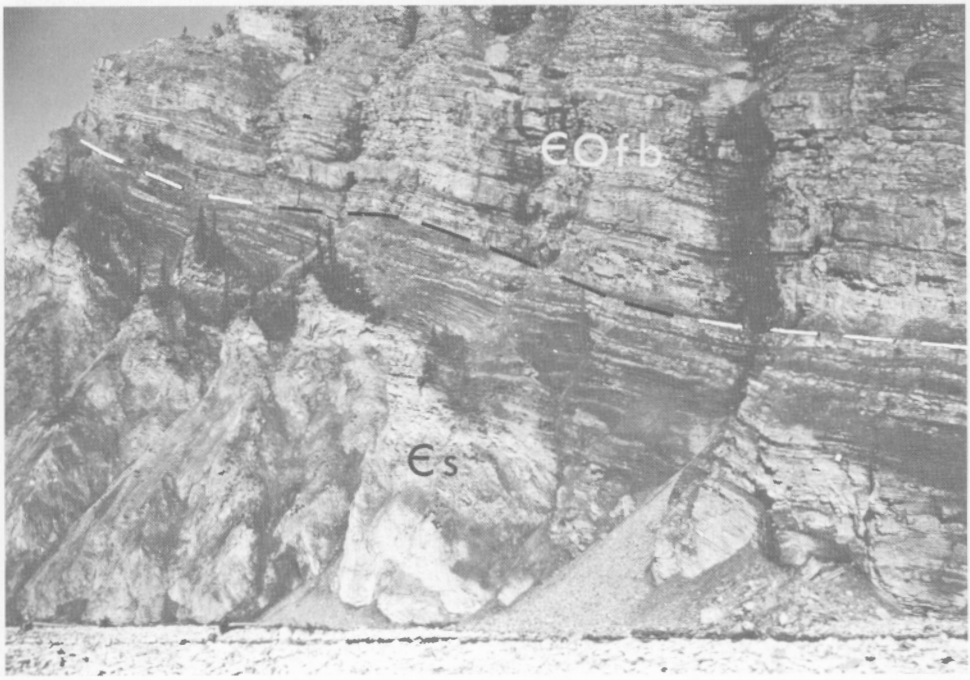


Plate 18. Contact between Saline River Formation (Cs) and Franklin Mountain Formation cyclic (COfb) exposed on north side of Loretta Canyon, Mackenzie Mountain front; locality U-11 (96E) GSC 199017

Plate 19 (opposite-top). Casts of bottom markings on base of glauconitic sandstone bed from basal bed of unit 11, Mount Cap Formation, Dodo Canyon, Carcajou Range, Mackenzie Mountain front; locality MQ-6 (96D) GSC 199018

Plate 20 (opposite-bottom). Salt crystal casts and ripple marks developed in mudstones from upper part of Saline River Formation, northwest of Bebensee Lake, Horton Plain, Interior plains; locality MQ-22 (86M) GSC 199019

Plate 19.

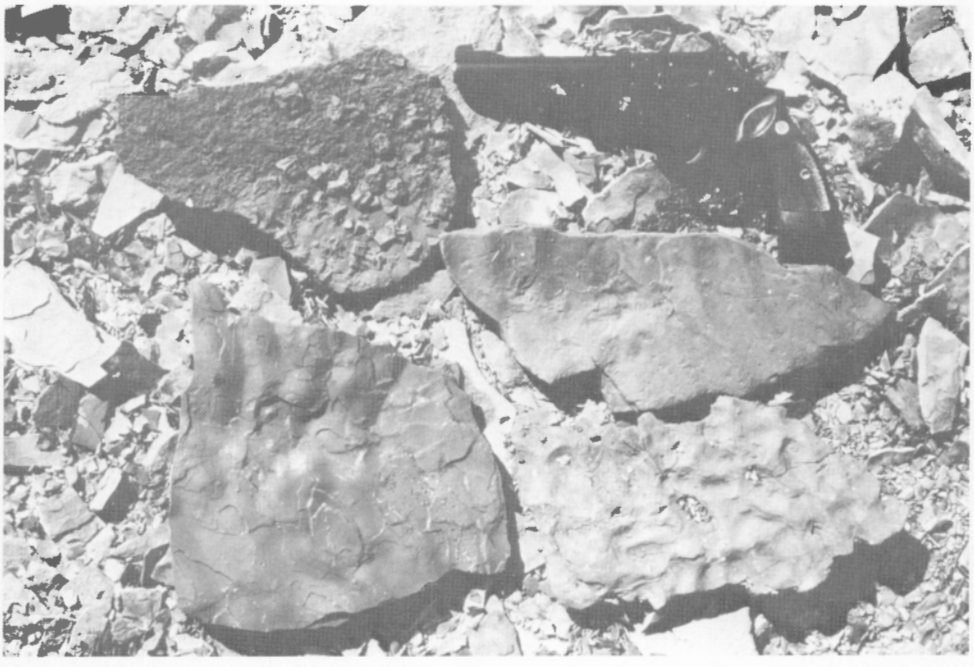


Plate 20.

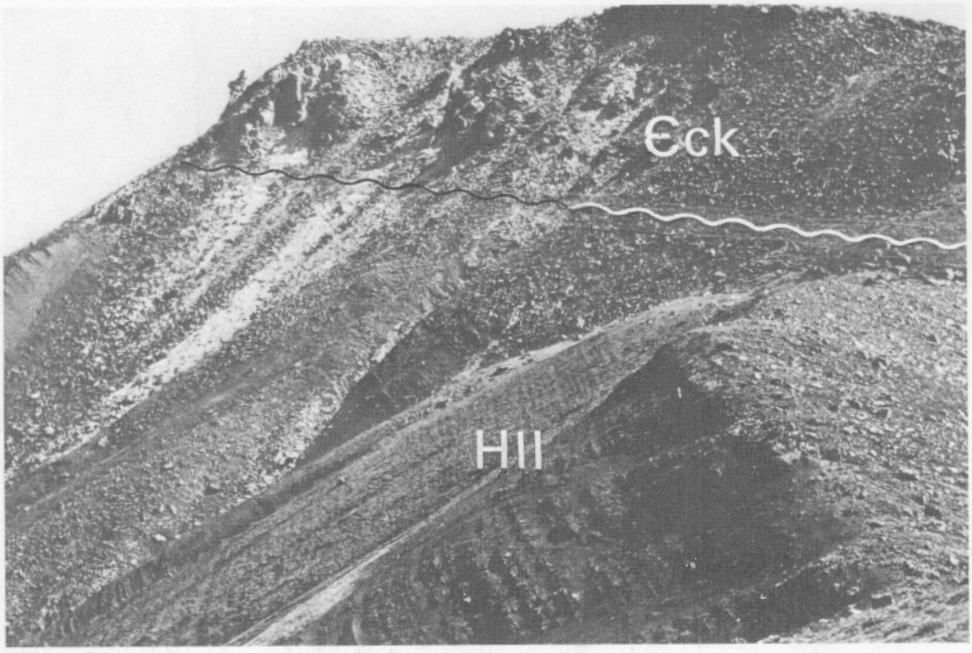


Plate 21. Angular unconformity beneath the Mount Clark Formation at Cap Mountain, the type locality; Lone Land Formation (Hll), Mount Clark Formation (Eck). View southeastward along the strike of the Proterozoic strata; locality AC-541 (95-O) GSC 199020

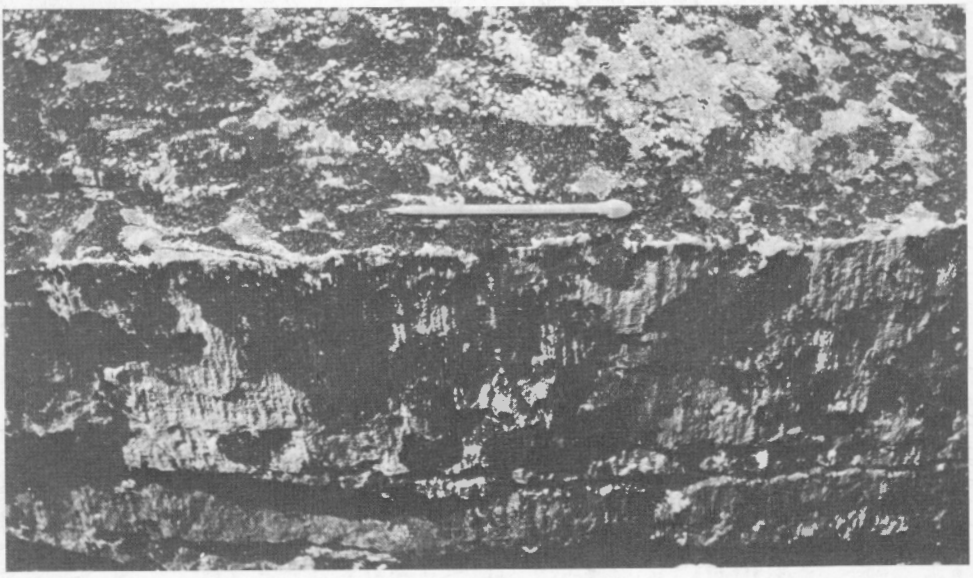


Plate 22. Characteristically abundant Skolithos burrows in unit 1 of the Mount Clark Formation at the type section; locality AC-541 (95-O) GSC 199021