GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

MEMOIR 364

GEOLOGY OF NASH CREEK, LARSEN CREEK, AND DAWSON MAP-AREAS, YUKON TERRITORY

L. H. Green

Ottawa
Canada
1972

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GEOLOGY OF NASH CREEK, LARSEN CREEK, AND DAWSON MAP-AREAS, YUKON TERRITORY

(106D, 116A, 116B, and 116C ($E\frac{1}{2}$))

Operation Ogilvie

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By
L. H. Green

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PREFACE

The discovery of gold in the Klondike in 1896 led to one of the greatest mining rushes in history and many parts of the region covered by this report were carefully prospected for placer gold at that time. In the intervening years there has been a small but steady production from various deposits. A large deposit of asbestos west of Dawson was brought into full production in 1968 and became an important revenue-producing operation in the Yukon. Other mineral showings in the area include silver–lead–zinc, copper, lode gold, antimony, and iron.

With helicopter support the author mapped 14,800 square miles of this most interesting area. Preliminary results were made available soon after the completion of the field studies but in this report the author presents a comprehensive description of the bedrock geology, discusses the structural and historical geology, and presents details of all the known mineral deposits of this economically important part of Yukon Territory.

Y. O. FORTIER,

Director, Geological Survey of Canada

OTTAWA, December 9, 1968

MEMOIR 364 — Geologie des Kartenblattes Nash Creek, Larsen Creek und Dawson (Yukon Territorium)

Von L. H. Green

Dieser Bericht beschreibt ein Gebiet mit beträchtlichen Mineralvorkommen, darunter Asbest und Waschgold. Altersmäßig reichen die Gesteine vom Proterozoikum bis zur oberen Kreide und zeigen Spuren von Gebirgsbildungen im Proterozoikum und in der Oberkreide.

МЕМУАР 364 — Геология картографированного района Нэш Крик, Ларсен Крик и Даусон, территория Юкон

Л. Х. Грин

Описывается район со значительным минеральным производительством, включая асбест и золото в россыпях. Возраст пород определяется временем от протерозойского до верхнемелового периодов. Эти горные породы подверглись влиянию орогенезиса в протерозойском и меловом периодах.

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GEOLOGY OF NASH CREEK, LARSEN CREEK, AND DAWSON MAP-AREAS, YUKON TERRITORY, OPERATION OGILVIE

Abstract

Operation Ogilvie, a helicopter-supported project, mapped an area of about 14,800 square miles in central Yukon, bounded by latitudes 64° and 65°N and longitudes 134° to 141°W, and comprising the Nash Creek, Larsen Creek, and Dawson map-areas. The area embraces parts of the Wernecke Mountains, Southern Ogilvie Ranges, Tintina Trench, and Yukon Plateau.

In the main part of the area east of Tintina Trench, the bedrock formations range in age from Proterozoic to Upper Cretaceous and later(?). A marked unconformity separates rocks of probable Cambrian age from older rocks, and other important unconformities occur at the base of both Ordovician and Cretaceous strata. Two orogenies have taken place, an older *Racklan Orogeny* involving Proterozoic strata and a later *Columbian Orogeny* of Cretaceous age. Sedimentary rocks have been intruded by sills of diorite and gabbro, both now much altered, and stocks of granitic rocks ranging from granodiorite to syenite; all are of probable Cretaceous age.

Tintina Trench, believed to be a major fault structure extending from southern Yukon deep into Alaska, separates relatively unmetamorphosed sedimentary rocks to the east from metamorphic rocks to the southwest. Evidence along the trench, in part from the present area, suggests a right-hand movement of over 200 miles. The trench is floored by deformed, poorly sorted, clastic sediments of Tertiary age.

Southwest of Tintina Trench, metamorphic rocks have been mapped on the basis of variations in metamorphic rank and original composition. Rocks of Paleozoic age are known to be present and there is no evidence for an older crystalline basement. The metamorphic rocks have been intruded by ultrabasic and granitic rocks.

There has been significant production of placer gold from the area. The northern tip of the Klondike goldfield, discovered in 1896, lies within it as do the less important Sixtymile and Dublin Gulch–Haggart Creek goldfields. A large deposit of chrysotile asbestos northwest of Dawson is currently being brought into production. Other showings known in the area include silver–lead–zinc (particularly in the southern part of Nash Creek map-area), copper, lode gold, antimony, and iron.

Résumé

L'opération Ogilvie, entreprise à l'aide d'hélicoptères, avait pour objectif la cartographie d'une superficie d'environ 14,800 milles carrés du centre du Yukon, et pour limites les 64° et 65°N et les 134° et 141°W et comprenait les régions couvertes par les coupures de cartes de Nash Creek, de Larsen Creek et de Dawson. La zone comprend une partie des monts Wernecke, la partie sud des monts Ogilvie, le fossé de Tintina et le plateau du Yukon.

La région située à l'est du fossé de Tintina possède, dans sa plus grande partie, des formations de socle dont l'âge va du Protézoïque au Crétacé supérieur, ou plus récent(?). Une discordance marquée sépare les roches datant probablement du Cambrien des roches plus anciennes, et deux autres discordances importantes existent à la base des couches de l'Ordovicien et du Crétacé. Deux phases tectoniques ont pris place, la *phase tectonique de Racklan*, la plus ancienne, qui affecte les couches du Protérozoïque, et la *phase tectonique Colombienne*, plus récente du Crétacé. Les roches sédimentaires ont subi l'intrusion de laccolites de diorite et de gabbro, actuellement l'un et l'autre fortement altérés, ainsi que de petits batholites de roches granitiques allant de la diorite à oligoclase à la syénite; toutes datent probablement du Crétacé.

Le fossé de Tintina, qui est, croit-on, une structure de faille très importante, s'étendant depuis le sud du Yukon jusque dans l'Alaska, sépare les roches sédimentaires de l'est, relativement peu métamorphisées, des roches métamorphiques du sud-ouest. Des observations le long du fossé, certaines dans la zone étudiée, inclinent à croire à un rejet horizontal de décrochement de plus de 200 milles. Le fossé est tapissé de sédiments clastiques, du Tertiaire, peu homogènes et déformés.

Au sud-ouest du fossé de Tintina, la cartographie des roches métamorphiques a été faite en se fondant sur les variations du degré de métamorphisme et sur la composition d'origine. On sait qu'il y existe des roches d'âge paléozoïque, mais aucune preuve d'un socle cristallin plus ancien. Les roches métamorphiques ont subi des intrusions de roches ultrabasiques et granitiques.

La région a fourni une importante production d'or alluvial. Elle comprend d'ailleurs la pointe nord du gisement aurifère du Klondike, découvert en 1896, ainsi que les gisements moins importants de Sixtymile et de Dublin Gulch-Haggart Creek. On prépare actuellement la mise en production d'un gisement important d'amiante du type chrysotile, au nord-ouest de Dawson. Parmi les autres indices connus de la région se trouvent du minerai d'argent, de plomb et de zinc (notamment dans la partie sud de la région de Nash Creek), du cuivre, de l'or filonien, de l'antimoine et du fer.

Chapter I

INTRODUCTION

Location and Access

The three map-areas Nash Creek (lat. 64° to 65°N, long. 134° to 136°W), Larsen Creek (lat. 64° to 65°N, long. 136° to 138°W), and Dawson (lat. 64° to 65°N, long. 138° to 141°W) cover about 14,800 square miles in central Yukon (*see* Maps 1282A, 1283A, and 1284A, *in pocket*).

The area around Dawson is accessible by an all-weather road. Dublin Gulch in Nash Creek map-area and Chapman Lake and the Sixtymile district in Dawson map-area are accessible by road in summer. Yukon River is the only river navigable by large boats. The rest of the area is accessible by helicopter or, with difficulty, by horses. Most larger lakes within the area are suitable for float-equipped aircraft. In recent years, such aircraft have been available for charter in either Dawson or Mayo.

Previous Geological Work

The first recorded geological work in the area was done by McConnell, who made brief notes (1890, pp. 134–143) while ascending Yukon River in the summer of 1888. With the exception of a reconnaissance made by Spurr in 1896 which included notes on Fortymile River (Spurr and Goodrich, 1898), no further work was done until after the discovery of the Klondike goldfields on 17 August, 1896. The rush to these goldfields, most of which lie to the south of the area covered in this report, also resulted in further development of those outlying, such as Sixtymile and Dublin Gulch, and extensive lode prospecting. Both placer mining and lode prospecting are well documented by geological reports, many of which are in Annual and Summary Reports of the Geological Survey. Much of this material, exclusive of most plates and maps, has been reprinted in a compilation by Bostock (1957), which is invaluable as a ready reference.

In 1898 R. G. McConnell began a study of the Klondike goldfields and returned to the area in 1899 to 1901, 1903, and 1906. He published a preliminary report (1902a), a final report (1905b*),[1] and a later report on gold values in the High Level Gravels (1907*). His other reports covering parts of the present map-area include notes on lignite coal areas along Tintina Trench (1903*, 1906*) and on the Sixty Mile River area (1905a*).

Project 580008.
Manuscript received January 31, 1968.
Revised manuscript received 9 December, 1968.

[1]Reports marked * are reprinted in Bostock, 1957.

In 1904 and 1905 J. Keele examined the placers of the Duncan Creek area and mapped a part of the Upper Stewart River region. The reconnaissance topographical and geological map that accompanies his report (Keele, 1906a*) is an outstanding piece of work. Also in the summer of 1905, Camsell did a reconnaissance from Stewart River to Fort McPherson, near the mouth of Peel River. His route passed through Nash Creek map-area (Camsell, 1906*).

In 1911 and 1912 D. D. Cairnes was engaged in geological mapping of a strip about 5 miles wide along the Alaska–Yukon boundary from Yukon River to Porcupine River. Only a small part of the area covered by his report (1914) lies within Dawson map-area but the stratigraphy established to the north applies to much of it.

In 1912 T. A. MacLean (1914, pp. 127–158) examined the lode deposits of the Dublin Gulch district of Nash Creek map-area.

In 1915 and 1916 D. D. Cairnes reported on both lode and placer deposits of the same district (1916*, 1917*).

In 1917 W. E. Cockfield was engaged in geological mapping of the Sixty Mile and Ladue River areas, a portion of which lies within Dawson map-area (Cockfield, 1921). From 1918 to 1930 he examined lode deposits and did geological mapping in Yukon Territory. His more important reports dealing with the Nash Creek area include those on lode and placer deposits of Haggart Creek and Dublin Gulch (Cockfield, 1919a*, pp. 7–14) and lode deposits of the Davidson Mountain (1922*) and Upper Beaver River area (Cockfield, 1924*); for Dawson map-area, silver–lead deposits of the Twelve Mile area (1919b*), explorations in the Ogilvie Range (1920a*), and silver–lead deposits of Fifteenmile Creek (1928*).

In 1930 J. B. Mertie Jr. mapped an area in Alaska that extends to the Alaska–Yukon boundary between the Yukon and Nation Rivers (Mertie, 1932). This report and a later one (Mertie, 1937) covering a much larger area contain much stratigraphic information relevant to the northern part of Dawson map-area.

In 1942 H. S. Bostock did reconnaissance geological mapping in a portion of Nash Creek map-area (Bostock, 1943). In 1942 and 1943 he examined the tungsten deposits, both placer and lode, of Dublin Gulch (*in* Little, 1959, pp. 21–29, 34–36).

In 1954 to 1955 and 1957, the writer was engaged in geological mapping at a scale of 1 mile to 1 inch of McQuesten Lake and Scougale Creek map-areas, both of which lie within Nash Creek map-area (Green, 1958).

Present Geological Work

The three map-areas were mapped geologically in 1961 by a helicopter-supported party, known as 'Operation Ogilvie'. Staff members on the party were J. A. Roddick of the Geological Survey and the writer. Previous to this, in the summer of 1958, the writer made a brief reconnaissance of a portion of the area, mainly within the Dawson map-area. P. Vernon was attached to the party and studied the surficial geology of the area under the supervision of O. L. Hughes, of the Geological Survey, who at that time was undertaking studies in the nearby Klondike district. Their report (Vernon and Hughes, 1966) has been published.

The writer was Resident Geologist in Whitehorse, Yukon, from 1962 to 1966, and many of the properties in the project area were visited and some additional geological mapping was carried out during this period.

In 1964 and 1965 D. J. Tempelman-Kluit mapped the Tombstone area (parts of 64°15′N to 64°30′N, 138°00′W to 139°00′W) within Dawson map-area as a thesis project. The thesis was completed at the time the present report was prepared and some results have been incorporated.

Acknowledgments

The writer acknowledges the kindness and cooperation of many of the residents of Dawson and Mayo. Special thanks are due to R. F. Connelly and R. Minaker of Connelly-Dawson Airways and H. Mostert of Canadian National Telecommunications. The excellent radio service from Dawson provided by the latter company and the Meteorological Station of the Department of Transport on a standby basis forestalled numerous possible delays and provided an excellent safety factor in the event of accident.

The contribution of J. A. Roddick to both the planning and the mapping did much to make the project possible. Able assistance in the field work was given by D. B. Craig and A. E. Kennedy in 1958 and K. E. Northcote, G. R. Turnquist, D. C. Burnett, C. K. Roberts, and J. J. Sample in 1961. Thanks are also due to E. Dopp and A. P. D. Lorraine, who were members of the party in 1958 and 1961 respectively.

Excellent air support for the project was supplied by Klondike Helicopters Limited of Whitehorse, Y.T. The aircrew consisted of A. C. Green Jr., pilot, and M. M. O'Reilly, engineer. The skill and interest of these men combined with the support of others from the company, particularly E. P. Callison and G. R. Cameron, did much to make the project a success.

TABLE I | *Climatological Table, Elsa, Yukon Territory*

Month	Air temperature			Precipitation		
	Daily mean (°F)	Mean of daily Max. (°F)	Mean of daily Min. (°F)	Mean total of all forms (in.)	Mean snowfall (in.)	Number of days of precipitation of 0.01 inch or more—all forms
January	−9.0	−4.5	−14.4	0.86	8.6	8
February	−0.4	5.9	− 6.9	0.76	7.6	9
March	7.9	17.7	− 2.0	0.55	5.5	6
April	24.8	35.0	14.6	0.59	5.7	6
May	41.3	50.3	32.1	0.92	1.4	7
June	53.6	63.8	43.4	1.27	0.0	10
July	57.1	67.1	46.9	2.53	0.0	11
August	50.5	60.4	41.6	2.50	0.0	14
September	39.9	31.0	48.7	1.52	1.5	10
October	22.1	28.9	15.2	1.31	10.5	10
November	6.0	11.5	0.4	1.50	13.4	12
December	−1.8	4.4	− 7.9	1.38	13.6	11
Annual mean	24.3	31.0	17.6			
Mean, total				15.69	67.8	114
Number of years of observation	14 years were used; although observations are missing for some months of some years, means are representative for the Elsa area					

NOTE: Lat. 63°55′, long. 135°29′; elevation 3,000 feet above mean sea level. As compiled in Weather Office, Whitehorse, based on data 1950–1963.
Highest temperature +83.
Lowest temperature −51.

Climate

The area has a continental climate characterized by low precipitation and a wide temperature range. Winters are cold and long but the short summer is generally pleasant with almost continuous daylight during June and July. Climatological tables for Dawson and Mayo are given in Kendrew and Kerr (1955, pp. 212, 216). The data given for Elsa (Table I) are probably more representative of the entire project area as both the Dawson and Mayo Meteorological Stations have a local climate controlled by their setting in deep valley bottom. In contrast to higher elevations, typical of most of the area, these stations have lower precipitation, and air temperatures show higher summer maxima and lower winter minima.

Within the project area summer weather is extremely variable and may change suddenly from warm and sunny to cool and overcast. Precipitation may occur either in sudden thundershowers or as scattered light showers during periods of prolonged overcast. Frequently showers are confined to the immediate vicinity of the higher peaks. Rainstorms, with snow at higher elevations, are common in late August and early September, when field work is frequently hindered for periods as long as a week. Frost may occur at any time during the summer.

The larger lakes at lower elevations commonly break up during the first week of June but those at higher elevation may not until late June. Long warm days in late May and early June may result in a very rapid runoff, and water in the rivers is usually highest early in June. Most of the mountain ridges are free of snow by mid-June.

The summer of 1961 was particularly favourable and only 13 days were totally lost owing to poor weather in the period May 31 to September 25.

Flora

Heavy forest growth is restricted chiefly to the main valley floors but sparse growth extends up the hillsides to about 4,000 feet above sea level in the southern part of the area. The uplands and many of the valleys in the northern part are devoid of timber. Black spruce, white spruce, alpine fir, and willows are abundant; aspen poplar, balsam poplar, white birch, and alder are less common.

In the southern part of the area, south-facing slopes and the gravel terrace in the larger valleys are characterized by white spruce, aspen, and balsam poplar. Most of these valleys have been burnt or logged but a few mature stands contain trees as much as 24 inches in diameter. Most of the north-facing slopes, and the areas in the larger valleys underlain by permafrost, are heavily moss-covered and timbered by widely scattered, stunted black spruce. Near timberline alpine fir is mixed with the spruce and locally becomes dominant at higher elevations. Many of the small valleys contain dense willow thickets, and the higher uplands are characterized by moss and lichen with scattered areas of dwarf birch.

In the unglaciated area west and southwest of Yukon River, the valley bottoms and hillsides are timbered with stunted black spruce and small stands of birch. The upland surfaces above 3,000 feet are now covered with dwarf birch and scattered willows, both about 5 feet high, but ubiquitous, partly burnt snags indicate that spruce was formerly widespread.

In the northern part timber is sparse even in the lower valleys. In general the areas underlain by carbonate rocks support little vegetation. The broad basins formed on soft shales, such as that at the forks of Hart River, are underlain by permafrost and carpeted by wet, spongy vegetation, referred to as niggerheads. These are tussocks, commonly about

1 foot but to 3 feet in both diameter and height, composed principally of sphagnum moss, a variety of sedges, and minor dwarf bushes such as blueberry. A few stunted and twisted black spruce and willows dot the morass.

Fauna

The area supports a varied fauna but numbers of many species appear to be low. Large mammals include stone caribou, moose, grizzly and black bear, timber wolf, Dall sheep, and wolverine. During 1961, a herd of stone caribou estimated at more than 10,000, chiefly cows and calves, was scattered between Worm Lake (64°28'N, 136°02'W) and Elliott Lake (64°29'N, 135°34'W). Small groups of caribou, mainly bulls, were common in the open uplands throughout the area and it is assumed that many of these would join the main herd later in the season. Numerous timber wolves and a few grizzly bears were observed in the vicinity of the main caribou herd.

Moose live in all parts of the area but do not appear to be abundant. Dall sheep were observed in the northern parts of all three map-areas but appeared to be most abundant in a relatively inaccessible part of Dawson map-area between Dempster Highway and Yukon River.

Fur-bearing animals trapped in the area in the past include red squirrel, muskrat, marten, mink, lynx, fox, beaver, and weasel. With the exception of a heavy beaver population along Beaver River, fur-bearing animals are relatively scarce.

The common game birds are spruce grouse and ptarmigan, and less common are blue grouse, ruffed grouse, and sharp-tailed grouse. Ducks and geese are rare except in the southern lakes of Nash Creek map-area.

Fish known in the district include grayling, jackfish, lake trout, and whitefish. Chinook or king and dog salmon are trapped in fish wheels along Yukon River in the summer months.

Mosquitoes are a nuisance from late May until early August. Biting flies, including black, moose, and deer flies, are not overly troublesome to man, but black flies in particular may be a serious nuisance to horses from late July to early September.

Settlements

Dawson is the largest settlement in the area, with a population of about 600 in 1961. The settlement was the main supply point for the Klondike goldfield, and during the height of the rush in 1898 is estimated to have had a temporary population of 25,000.[1] Dawson still contains many buildings dating to the gold rush, most abandoned and falling further into disrepair every year. It remained the capital of the Yukon until 1953. Nearby settlements, including Moosehide, an Indian village about 2 miles downstream from Dawson, are now abandoned.

Up to late 1966, The Yukon Consolidated Gold Corporation operated gold dredges in the Klondike district; their operations within Dawson map-area included housing, gold room, offices, and shops at Bear Creek, about 7 miles east of Dawson, and a hydroelectric plant about 20 miles east of Dawson. This used water from both the North and South Klondike Rivers and supplied electric power to both the gold dredges and Dawson. All these operations have now closed.

[1]Encyclopedia Canadiana (vol. 3, p. 211). Most authors describing the gold rush give a figure close to this; for example, McConnell (1905a, p. 6B) gives a population of about 30,000 for the entire camp. Much of this population was transient, and later census figures are 9,142 (1901), 3,013 (1911), 1,975 (1921), 819 (1931), 1,043 (1941), 783 (1951), and 881 (1961).

During 1961 there was one permanent inhabitant at the settlement of Sixtymile (Glacier Creek P.O.) although a number of others were engaged in placer mining in the vicinity. Along Yukon River the settlements of Moosehide and Forty Mile (Fig. 1) have been abandoned although many of the buildings are still usable. Nothing remains at the sites of Fort Reliance and Boundary.

In 1967, a new townsite, Clinton Creek, located about 3½ miles upstream on the Fortymile River and 45 miles northwest of Dawson, was developed in conjunction with the Clinton Creek asbestos property. The present population (1971) is about 500.

The part of the area east of Tintina Trench is uninhabited with the exception of summer placer operators in the Haggart Creek – Dublin Gulch district of the Nash Creek area. Scattered remains of trapper's cabins indicate that this area supported a small population in the past.

136485

FIGURE 1. Forty Mile, Yukon, in 1958. The settlement, about 40 miles northwest of Dawson, dates from about 1886 and was abandoned in 1953. Discovery claim of the Klondike goldfield was recorded here by George Carmack in 1896.

Chapter II

PHYSIOGRAPHY AND GLACIATION

Physiography

The project area lies within the Northern Plateau and Mountain area of the Interior System of the Canadian Cordillera (Bostock, 1948b and 1961). Six physiographic units are present (Fig. 2): Wernecke Mountains; Southern Ogilvie Range and Taiga Valley, both part of the Ogilvie Mountains; and Tintina Trench, Stewart Plateau, and Klondike Plateau, all within the Yukon Plateau.

The Wernecke Mountains lie in the 'transition zone' between the northwest-trending Mackenzie Mountains and the east-trending Southern Ogilvie Range. Formed from resistant rocks, principally Precambrian argillite and dolomite and early Paleozoic carbonate, they are characterized by irregular, jagged ridges incised with numerous cirques (Fig. 3). The mountains have in excess of 5,000 feet of relief, some peaks exceeding 7,500 feet elevation. Small areas with less rugged topography, such as the valley containing Hart Lake (Fig. 4), are underlain by less resistant rock.

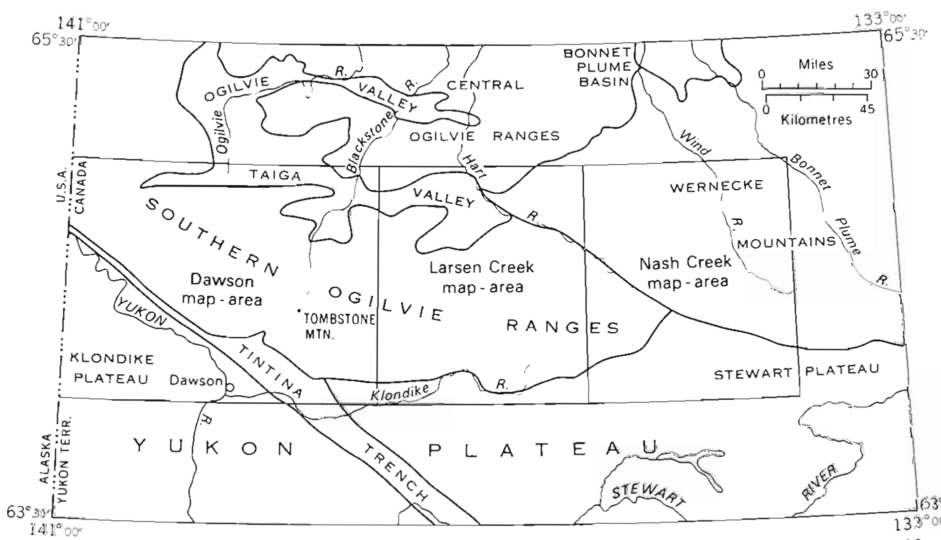

FIGURE 2. Physiographic divisions of Operation Ogilvie area, Yukon Territory (adapted from Bostock, 1961).

116727,28,29

FIGURE 3. Complex folding in dolomite of Ordovician to Silurian age (unit 8) near a fault contact with dark coloured argillite of Proterozoic age (unit 1), upper Bond Creek, Nash Creek map-area. Shows typical topography of the Wernecke Mountains.

124843

FIGURE 4. Hart Lake, Nash Creek map-area. Low, dark coloured hills across the lake are underlain by weakly resistant shale of probable Permian age (unit 14), and peaks in the background by resistant dolomite of Ordovician to probable Devonian age (units 8 and 10).

The Southern Ogilvie Ranges are, for the most part, less rugged than the Wernecke Mountains and there is a close relationship between topography and underlying bedrock. Locally, extremely rugged topography has developed in areas underlain by stocks of porphyritic syenite. These stocks form a northwest trending belt about 45 miles long with the centre of the belt about 30 miles northeast of Dawson. The effect is most striking in the Tombstone area (Fig. 5), near the centre of the belt, where the intrusive rocks form jagged spines often with vertical, joint-controlled faces. These are spectacularly developed on Tombstone Mountain, particularly the north face; viewed from a distance the peak dominates the skyline.

Taiga Valley and the related Ogilvie Valley to the north are low areas with subdued topography developed on poorly resistant late Paleozoic rocks. These rocks seldom outcrop and the area is mantled by muskeg dotted with deformed black spruce. Here and there ridges of more resistant underlying rocks outcrop where brought to the surface by fold or fault structures.

Stewart Plateau, a minor subdivision of the Yukon Plateau, is marked by broad uplands, generally between 4,000 and 5,000 feet elevation, separated by deep broad valleys (Fig. 6). Here and there higher peaks, generally formed of more resistant rocks than those underlying most of the area, rise above the upland surface. In the southern part of Nash Creek area, two such ranges with elevations exceeding 6,500 feet are present. In the same area, glacial action has produced wide, deep valleys, in part filled by lakes and underfit streams, that divide the area into irregular blocks.

116714

FIGURE 5. Jagged peaks developed on intrusive rock, principally syenite (unit 21b), in the Tombstone district, Dawson map-area.

136434

FIGURE 6. Upland surface typical of Stewart Plateau; a view westward from near the head of Rambler Creek, Davidson Range, Nash Creek map-area. The ridge of felsenmeer or rubble in the foreground has developed on a greenstone sill (unit 20) that has intruded phyllitic rocks of the 'Lower Schist Division' (unit 17). Other resistant ridges in the background are also greenstone.

Tintina Trench is developed along the trace of a major fault that separates metamorphic rocks of uncertain age from sedimentary rocks of Precambrian and younger age in Dawson map-area. Northwest of Dawson the trough-like feature, little more than a mile wide, is spectacular when viewed from the air, despite the fact that creeks and rivers draining the Southern Ogilvie Ranges cut through it to join the Yukon River. Scattered outcrops of deformed Tertiary coal-bearing sediments occur in the floor of the Trench.

Klondike Plateau, another minor subdivision of Yukon Plateau, is marked by long, twisted, irregular main and spur ridges produced by a highly developed dendritic stream pattern. The crests of most of the ridges are between 3,000 and 4,000 feet elevation and probably represent an old uplifted erosion surface. Locally, broad domes rise a few hundred feet above the upland surface. The main streams and rivers have gentle gradients and are slow-flowing whereas the tributary streams occupy narrow 'V-shaped' valleys with steep gradients.

Glaciation

The surficial geology of the main part of the area lying east of Tintina Trench has been studied by Vernon and Hughes (1966). Their report contains more detailed information and surficial geology maps of all three areas on a scale of 1 inch to 4 miles.

East of Tintina Trench, ice from alpine glaciers filled and modified the shape of most of the major valleys. In Dawson map-area, valley glaciers emerged from the mountains along North Klondike, Chandindu, and Fifteenmile Rivers but generally failed to reach Tintina Trench. No evidence of glaciation was noted southwest of Tintina Trench. In Larsen Creek map-area ice moved north along the branches of Hart River, depositing morainal material in the low area northeast of Two Beaver Lake. Some ice also moved south along the valleys of Hamilton and Davidson Creeks. In Nash Creek map-area, ice, partly of local origin and partly from east of the area, moved north to northwest along the major valleys in the northern part and south in the valley of McQuesten Lake. The southwest corner of Nash Creek map-area was only slightly affected by glaciation.

Vernon and Hughes (1966, p. 6) infer three periods of glaciation and give the following summary:

> Three glaciations, hereinafter referred to as *old*, *intermediate*, and *last*, are inferred with intervening periods when ice was absent or nearly absent from the three map-areas. Evidence for these three glaciations is best displayed in and near the valley of East Blackstone River in the western region (northeast part of Dawson map-area), where the limits of the intermediate and last glaciations are marked by recognizable moraines. The distribution of the more extensive old glaciation is marked by erratics outside the moraines of the later glaciations: moraines of the old glaciation have not been identified.

Chapter III

GENERAL GEOLOGY

Tintina Trench, a major structural feature, separates a larger area underlain principally by sedimentary rocks of Proterozoic to Mesozoic age from metamorphic rocks that underlie the southwest corner of the project area (*see* Table of formations, *in pocket*). As no direct correlation of rock units appears possible across this feature the two are described separately.

East of Tintina Trench

Dark weathering shale and quartzite (1)[1] of Proterozoic age are the oldest rocks exposed and underlie much of the northeast part and a smaller area in the northwest of the project area. These grade upwards into a thick sequence comprised principally of fine-grained arenaceous dolomite of clastic origin (2).

A thick sequence of impure quartzite, grit, slate, argillite, and minor limestone and chert (3) of probable Proterozoic age underlies much of the southern part of the project area. These rocks were not observed in contact with fine-grained Proterozoic rocks (1 and 2) to the north.

Altered volcanic rocks (4), probably of early Paleozoic age, occur with rocks of units 3 and 9 and may be contemporaneous.

A thick sequence of iron-bearing conglomerate, sandstone, and siltstone (5) overlies Proterozoic rocks (1 and 2) in the northeast part of the area with marked angular unconformity. Unit 5 is overlain conformably by carbonate rocks (6) of Late Cambrian age. Somewhat similar carbonate rocks (7) in the northwest corner of the project area are believed to range from Cambrian to Ordovician.

A thick sequence of carbonate rocks (8) of Ordovician to Silurian age, widespread in the northern part of the project area, overlies many of the older units unconformably. These rocks (8) grade into dark shale and chert (9) of equivalent age and are more prevalent in the southern part of the project area.

Thinly banded dolomite (10) of probable Late Silurian to lower Middle Devonian age overlies carbonate rocks (8) conformably.

Thick bedded, abundantly fossiliferous limestone (11) of lower Middle Devonian age overlies rocks of unit 10 conformably in the northwest part of the project area.

Dark limestone and shale (12) containing distinctive faunas from Late Silurian to lower Middle Devonian age overlie carbonate rocks (8), probably with slight unconformity.

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[1]Numbers and letters in parentheses refer to units on the accompanying maps (*see* Maps 1282A–1284A, *in pocket*). The introduction of new formational names has been avoided as the present work is of a reconnaissance nature covering a large area. A few of the map-units described already have formational names originating from studies beyond the project area and others will doubtless be named when additional work is undertaken in the region.

Dark argillite and chert with minor limestone (13) of probable Late Devonian age overlie older rocks unconformably and occupy many low muskeg-covered areas in the northern part.

Poorly resistant rocks including limestone, sandstone, and shale (14) occur between shale of probable Late Devonian age (13) and overlying massive carbonate (15) of Permian age.

Massive chert and limestone (15) of the Tahkandit Formation overlie rocks of unit 14, apparently conformably, in the north-central to northeast part of the project area. Thinner limestone (15a) with an identical fauna occurs in the southern part.

Dark limestone and shale (16) of Triassic age outcrop in the southeast part of both Nash Creek and Dawson map-areas, and along the southern limb of Monster Syncline in the northwest part of Dawson map-area, where they overlie Permian rocks (15) with slight unconformity.

A band of thinly bedded shale and quartzite (17, the Lower Schist division) of probable Jurassic age sweeps across the project area, terminating against Tintina Trench. It overlies older rocks of various ages without marked unconformity.

Distinctive massive quartzite (18, the Keno Hill Quartzite) overlies rocks of unit 17 without marked angular discordance. A late Mesozoic, possibly Cretaceous age is suggested.

Varicoloured shale and siltstone (19) overlie the Keno Hill Quartzite (18) near the east margin of Dawson map-area.

Diorite and gabbro sills (20) have intruded rocks of the Lower Schist division (17) and Keno Hill Quartzite (18). Lithologically similar sills (20a) intruding older rocks (units 1, 2, 3, and 9) may be of the same age or possibly older.

Granitic rocks, principally granodiorite to quartz monzonite (21a), intrude older rocks in the southern Nash Creek area, and syenitic rocks (21b) intrude similar rocks in southeast Dawson map-area.

Terrestrial shale, sandstone, and chert-pebble conglomerate (22) form the core of the Monster Syncline and another smaller syncline in the northwest corner of the project area.

Lignite-bearing sediments, including much poorly sorted conglomerate (23), are present in the core of Tintina Trench.

Thin sills of quartz and rhyolite porphyry (25) have intruded older rocks throughout the project area.

Southwest of Tintina Trench

Low rank metamorphosed sedimentary rocks (A), principally quartzite, schist, and limestone, underlie much of the area southwest of Tintina Trench.

Distinctive, light coloured quartz and white mica schist (B, the Klondike Schist) extends northwest from the Klondike area into Dawson map-area, and a smaller area occurs near the International Boundary.

A belt containing greenstone and related rock types (C) outcrops on both sides of Yukon River downstream from Dawson, Yukon.

Quartz–feldspar–biotite gneiss (D) is present along Sixty Mile River in the southwestern corner of the project area.

'Alpine-type' ultramafic rocks, generally altered to serpentine (E), are strung out along a belt parallel to Tintina Trench and extending up to 12 miles southwest of this feature.

Granodiorite and quartz monzonite (21a) similar to rock of this type across Tintina Trench have intruded the metamorphic rocks.

Volcanic rocks with minor associated sedimentary rocks (24) of probable Tertiary age underlie one larger area and a number of smaller ones.

Small sills of quartz and rhyolite porphyry (25) have intruded the metamorphic rocks.

Unit 1

Rocks of the map-unit consist of a thick sequence of dark weathering shale, argillite, siltstone, and fine-grained quartzite that underlies large areas in the north-central part of Dawson map-area, the northeast part of Larsen Creek map-area, and the eastern part of Nash Creek map-area. The base of the unit is not exposed and the thickness appears to exceed 5,000 feet.

Outcrop Characteristics

Much of the area underlain by rocks of unit 1 is mountainous, with elevations up to 7,000 feet, many steep faces, and rough ridges, the latter often impassable on foot. The rock supports little vegetation and weathers a sombre brown or grey, in striking contrast to the bright orange and light grey weathering colours of the overlying rocks (units 2 and 8 respectively) (Fig. 3).

Lithology

The unit consists mainly of dark shale and argillite, with some siltstone to fine-grained quartzite, and very minor limestone. Almost all the rocks are dull coloured, commonly dark grey but also green to buff. Some jasper and specular hematite were observed, commonly near the contact with the overlying rocks of unit 2. Locally, shales and argillites have been altered to phyllite with a characteristic silky sheen. Hornblende diorite or greenstone sills (unit 20a) occur in the unit and are believed to be more widespread than is indicated on the map. The weathered appearance of the greenstone is very similar to that of unit 1, and most of the greenstone bodies mapped are those actually crossed in ground traverses.

Unit 1a outcrops on both sides of Bonnet Plume River in the northeast corner of Nash Creek map-area and consists of grey weathering, silicated carbonate rocks and brown biotite-bearing hornfels. It has an apparent thickness of several thousand feet and appears to underlie the rest of unit 1, but the structure is uncertain.

In thin section the rocks are seen to consist of very fine grains of quartz and mica darkened by fine carbonaceous (?) material. Grain size of the quartz-rich material seldom exceeds 0.1 mm. Some graded bedding was observed. The rocks frequently contain minor amounts of an iron-bearing carbonate.

Structural Relations

Only limited structural information was obtained for rocks of unit 1 as in most places the rocks lack distinctive units that can be traced for any distance. Dips are frequently moderate to steep with slaty cleavage often steeper to near vertical, suggesting open folds within rocks of the unit. Rocks of unit 1, together with those of unit 2, have undergone considerable folding and faulting before the deposition of the carbonate rocks of unit 8. In several places rocks of both groups were observed standing vertically beneath essentially flat-lying rocks of unit 8. In contrast, Cambrian rocks (units 5, 6, and 7) appear to postdate this orogeny (Racklan Orogeny of Gabrielse, 1967a, p. 274), and to have been subjected to little more than minor block faulting and erosion before the deposition of the overlying carbonate rocks of unit 8.

Age and Correlation

Rocks of unit 1 are believed to be of Proterozoic age although they were not observed directly beneath Early Cambrian rocks. Similar rocks have been mapped north of the project area (Norris *et al.*, 1963), and Gabrielse (1967a) indicated the distribution of fine-grained, clastic, 'Purcell-like' sedimentary rocks of Proterozoic age throughout the northern Canadian Cordillera.

Unit 2

This unit comprises a thick succession of orange weathering rocks, chiefly dolomite, that are present in all three map-areas and that locally have been separated into subunits on the basis of lithology. In Nash Creek and Larsen Creek map-areas the unit underlies much of the eastern part of the Nash Creek map-area and forms a belt along the north side of Beaver River valley which extends into the Larsen Creek map-area, where it is narrowly restricted and intensely deformed. In Dawson map-area rocks assigned to the unit underlie an east-west trending area about 50 miles long and 20 miles wide, referred to as the Coal Creek Dome. Here, orange weathering dolomite, so distinctive of rocks of the unit to the east, is present only in part and a number of subunits are separated.

Outcrop Characteristics

The brilliant orange weathering colour of rocks of the unit is the dominant characteristic and can often be recognized at distances of 20 miles or more. These rocks support little vegetation, and most of the area underlain by the unit has relatively rugged topography. Some of the higher summits are underlain by greenstone sills (unit 20), and in some the dark weathering sill is separated from the brilliant orange enclosing rocks by a white band of dedolomitized rock up to several hundred feet thick.

Lithology

Gillespie Lake area, Nash Creek map-area. The most common lithology in this area is a thin-bedded, brown to orange, dolomitic siltstone. The following partial section was measured about 2 miles east of the map-area near Gillespie Lake and is typical of lithology:

Unit	Lithology	Thickness (feet) Unit	Thickness (feet) Total from base
	Top not exposed		
	UNIT 2		
4	Slate, dark grey-green grading to olive-green towards the base..	50	2,550
3	Slate, chiefly maroon and red with minor interbedded green slate and some silty beds grading downward to dark grey to light tan weathering interbedded slate, gritty siltstone, and argillaceous dolomite	200	2,500
2	Dolomite, medium- to thick-bedded, fine-grained, grey, green, pink to buff on fresh surface, weathers orange, contains some siliceous beds which weather cream to grey to maroon; a few thin beds of pink quartzite	1,300	2,300
1	Dolomite, thin-bedded, fine-grained, grey, pink to buff on fresh surface, orange weathering; interbedded with minor argillite and slate	1,000	1,000
	Base not exposed		

In the same general area an inaccessible section with an estimated thickness of 7,200 feet was composed of distinctive beds with weathering colours ranging from black, to grey-buff, to brown, and to brilliant orange. Lithology is believed to be much the same as that in the measured section.

Kathleen Lakes area (Nash Creek map-area) to Middle Hart River area (Larsen Creek map-area). Rocks of the unit outcrop intermittently between these two areas, a distance of about 100 miles. Near Kathleen Lakes the unit commonly consists of orange weathering dolomite but farther west many more variegated rocks appear.

Between Elliott Lake (Nash Creek map-area) and just west of Middle Hart River (Larsen Creek map-area), for about 55 miles unit 2a, containing relatively minor amounts of orange weathering rocks, has been separated within the unit. West of Worm Lake, rocks mapped as unit 2a include pink and grey weathering dolomite, white, green, and mauve sugary quartzite, dark grey, green, and maroon shale, and maroon to buff weathering conglomerate containing fragments of fine-grained dolomite, argillite, grey chert, and locally jasper. A minor amount of mottled maroon and green shale, somewhat similar to that of unit 3, was also observed. Iron staining is common in rocks of the subunit and minor amounts of hematite were observed. Boundaries of unit 2a are drawn on the basis of scattered traverses and should not be considered definite. With more detailed mapping in this area a number of mappable units could doubtless be established within units 2 and 2a.

The following section measured about 8 miles west of Worm Lake is typical of the lithology of unit 2 in this area:

		Thickness (feet)	
Unit	Lithology	Unit	Total from base
	Overlying beds—Paleozoic dolomite (map-unit 8) Probable unconformity		
	UNIT 2a		
7	Dolomite, thin-bedded, fine-grained, argillaceous, grey-green on fresh surface, weathers orange to tan	50	5,050
6	Interbedded dolomite, sandstone, siltstone, slate, and conglomerate. Dolomite, fine-grained, cream to grey, weathers orange; sandstone, well-rounded grains in a carbonate matrix, cream to grey, weathers orange to grey; siltstone and slate, mainly grey but some purple, one band weathers bright orange	750	5,000
5	Conglomerate, large angular fragments of chert, shale, and dolomite in a maroon to grey dolomite-rich matrix; weathers buff	50	4,250
4	Dolomite; cherty, thin-bedded, fine-grained, weathers grey; contains minor black chert fragments	250	4,200
3	Quartzite, medium- to thick-bedded, fine-grained, green, maroon, and grey	50	3,950
2	Dolomite, thick-bedded to massive, fine-grained, cream, grey, pink, and maroon on fresh surfaces, weathers grey, pink, and maroon; minor argillite and dolomite breccia	2,700	3,900

Unit	Lithology	Thickness (feet) Unit	Total from base
	UNIT 2		
1	Dolomite with interbedded shale and siltstone, thin bedded, greenish, grey to flesh-coloured on fresh surface, weathers buff to orange	1,200	1,200
	Conformable contact Map-unit 1		

Coal Creek Dome (*Dawson map-area*). In the Coal Creek Dome, centred about 45 miles north of Dawson, rocks assigned to unit 2 and to a lesser extent unit 1, outcrop in an oval-shaped area about 50 by 20 miles. On the flanks, rocks forming the core of the dome are believed to be overlain unconformably by Paleozoic rocks of units 8 and 9. Some of the rocks within the dome bear a striking similarity to younger rocks outcropping to the north and there is a possibility that some younger rocks may be included through folding or faulting. Rocks assigned to unit 2 have been separated into four subunits on the basis of variations in lithology. The subunits are believed to be in order of stratigraphic succession, with 2b at the base and 2e at the top; however, the dome was not mapped in detail and neither the structure nor stratigraphy is known with certainty. Apparent repetition of some of the subunits may arise either through faulting or folding or through the deposition of similar rocks at various stages of the original sedimentation.

Rocks assigned to subunit 2b consist principally of fine-grained dolomite and dark shale to slate with lesser amounts of brightly coloured shale, varicoloured quartzite, limestone, dolomite conglomerate, and jasper-bearing conglomerate. Some of the rocks weather bright orange similar to rocks of unit 2 to the east but many weather buff and the shales are commonly dark. The thickness of the subunit is unknown but is probably more than 5,000 feet. On the north side of the Coal Creek Dome, about 14 miles north of Mount Harper, rocks of unit 2b, overlying those of unit 1, consist of a conglomerate containing pebbles of jasper, grey chert, and fine-grained quartzite in a green groundmass containing some specularite. The conglomerate grades upward into finer grained rocks, principally buff weathering dolomite but including maroon to pink weathering dolomite, grey to maroon quartzite, black shale and argillite, maroon to olive drab shale, and minor buff weathering dolomite conglomerate. On the west flank of the dome maroon shale and quartzite are common near the contact between 2b and 2c. On the south flank, rocks assigned to 2b and lying between a northern band of unit 2c and the main band to the south consist mainly of buff weathering grey dolomite with black shale and minor quartzite and chert.

Rocks assigned to unit 2c consist mainly of grey weathering dolomite, the main band sweeping around the south and west sides of the Coal Creek Dome for about 50 miles. The dolomite appears to overlie the buff to orange weathering beds of unit 2b conformably and to be overlain along parts of this distance by buff weathering dolomite conglomerate (2d). Thickness of the dolomite is not known with certainty but 2,000 feet appears to be a minimum. Much of the dolomite is fine grained and bedding is commonly thick to massive. Small amounts of chert are common in much of the dolomite, and on the ridge north of Mount Harper about 800 feet of dolomite-cemented chert breccia is present. On the south side of Coal Creek Dome, just west of Seela Pass, a blood-red weathering, dark grey quartzite about 10 feet thick forms a marker horizon near the top of unit 2c, and other thin orange to red weathering marker beds occur near the base. Aside from the main band, scattered bands of grey weathering dolomite occur elsewhere within the dome and have been assigned to unit 2c although the stratigraphic relationship of these bands to the main band is unknown. About 6 miles north of Mount Harper there are several thousand feet of grey weathering dolomite, somewhat buff and thin-bedded near the base but massive with much chert and siliceous material in the upper part. A few thin bands of quartzite and dark shale occur within this band. Another band has been traced to the north, close to the contact with the underlying rocks of unit 1. It consists mainly of thin-bedded, grey weathering, dark grey, fine-grained dolomite and may be interbedded with the buffish weathering rocks of unit 2b.

Rocks assigned to unit 2d consist of buff weathering dolomite conglomerate that occurs intermittently along the south and west flank of the Coal Creek Dome for about 30 miles. This rock weathers buff to orange and contains boulders as much as 3 feet in diameter, but commonly 1 foot or less in a matrix of fine-grained silty dolomite. The bulk of the fragments in the conglomerate are fine-grained, grey weathering dolomite similar to that of unit 2c, but other rock types present in lesser amounts include orange weathering, buff to grey dolomite (similar to the matrix), grey chert, and light coloured quartzite. On the ridge north of Mount Harper the conglomerate also includes a tiny amount of distinctive blood-red chert pebbles. On this same ridge the conglomerate was observed to have a gradational contact with the overlying volcanic rocks of unit 4a, varying from volcanic pebbles in a volcanic matrix, to dolomite pebbles in a green matrix rich in volcanic materials, to the usual dolomite conglomerate. On the same ridge near the base of the unit the conglomerate is crowded with angular fragments of grey dolomite similar to rock a few feet below. In general, sorting in the conglomerate is poor and many fragments are angular. Pisolites to 15 mm in diameter were observed in a number of scattered outcrops and these are often partially silicified to yield fossil-like forms (stromatolites?). Unit 2d varies greatly in thickness but is believed to be about 300 feet north of Mount Harper and several thousand feet in the large exposure about 15 miles farther northwest.

Rocks assigned to unit 2e consist mainly of grey shale, greenish grey argillite, buffish weathering dark grey siltstone, minor buff to orange weathering dolomite, and buff weathering dolomite conglomerate. The unit is probably several thousand feet thick. On the west side of the Coal Creek Dome it appeared to consist of the following from the base up: minor dolomite conglomerate and buff to orange weathering dolomite; brown weathering, dark grey shale, with an estimated thickness of about 800 feet; and brown weathering dark grey dolomitic siltstone and minor dolomitic quartzite with an estimated thickness of about 400 feet.

Viewed in thin section rocks assigned to unit 2 consist principally of fine-grained clastic material, contain considerable amounts of carbonate, mainly dolomite, and show little evidence of metamorphism. Much of the dolomite is believed to be iron-bearing and is responsible for the bright rusty weathering colours of rocks of the unit. It occurs both as fine-grained cementing material and as clasts to 1 mm in some of the coarser grained material. Rock types vary from a dolomite-cemented quartzite, to carbonate-rich siltstone, to fine-grained carbonate rocks containing varying amounts of fine quartz and argillaceous material, the latter mainly in the form of very fine grained white micas.

Structure

In the Gillespie Lake area (Nash Creek map-area) rocks of unit 2 are moderately folded and faulted at high angles. In the belt between Kathleen Lakes (Nash Creek map-area) and Middle Hart River (Larsen Creek map-area) tight folding, shearing, and high-angle faulting are common. In this area it is difficult to obtain a section free from structural complication. The structural pattern of the Coal Creek Dome (Dawson map-area) is unknown. Locally the rocks show much variation in strike and dip and much thickening within the subunits, and repetition of subunits may arise through either faulting or folding. No large folds were observed in the mapping but many of the slopes are covered with a fine scree masking the underlying structure.

In most places rocks of unit 2 appear to overlie those of unit 1 conformably and to have a gradational contact with them, although in a few localities field relationships suggest an unconformity. Rocks of both units (1 and 2) have undergone considerable folding and faulting (Racklan Orogeny of Gabrielse, 1967a, p. 274) before the deposition of overlying Paleozoic rocks, particularly those of unit 8. Thus, in many areas rocks of unit 2 have been completely removed by erosion before deposition of the overlying carbonate rocks (8), and the latter lie with marked unconformity on rocks of unit 1.

The contact between rocks of unit 2 and ferruginous sandstone and conglomerate (5) of Cambrian(?) age was not observed, but the presence of numerous fragments of orange weathering silty dolomite, typical of unit 2, in the conglomerate of the younger unit (5) suggests an unconformity.

Age and Correlation

No identifiable fossils were obtained from rocks of the unit within the project area. Stromatolite-like forms were observed in the dolomite conglomerate (2d) of Coal Creek Dome. Outside the area Brabb and Churkin (1964a) found stromatolites in limestone structurally beneath orange weathering dolomite in the vicinity of the International Boundary, a few miles north of Dawson map-area. Wheeler (1954, p. 13) found concentrically banded circular forms believed to be algal structures similar to *Cryptozoon* or to *Collenia* (Fenton and Fenton, 1937) in reddish brown weathering dolomite in the area southeast of Gillespie Lake eastward of Nash Creek map-area.

The close structural association of rocks of unit 2 with those of unit 1, and the marked difference in lithology from known Early Cambrian rocks in the Royal Mountain area (about 10 miles north of Nash Creek map-area) and in the Jones Ridge area (along the International Boundary about 7 miles north of Dawson map-area), suggest a Proterozoic age for rocks of unit 2.

Unit 2 as mapped is believed to include part of the Katherine Group (Hume, 1954, p. 9) of the Norman Wells area and as subsequently extended by Norris *et al.* (1963). It is also believed to include part of the Tindir Group as described by Cairnes (1914, pp. 44–58) along the Yukon–Alaska boundary and subsequently by Mertie (1932, pp. 369–392; 1937, pp. 59–65). However, the term Tindir as used by Cairnes and particularly Mertie also includes ferruginous rocks now believed to be younger. Similar rocks have been mapped about 250 miles southeast (principally unit 4 of Gabrielse *et al.*, 1965) and are known from reconnaissance work to outcrop along an arc extending from this area to the east margin of Nash Creek map-area. Distribution and origin of these 'Purcell-like' rocks of Proterozoic age is discussed by Gabrielse (1967a).

Unit 3

Rocks assigned to unit 3 consist of impure quartzite, grit, slate, argillite, and minor limestone and chert and extend in a broad band across the southern part of all three map-areas. Throughout much of its length the outcrop pattern is split by a narrow belt composed mainly of rocks of units 14 and 17, and all three units are truncated by faults along Tintina Trench. The thickness of the unit is unknown as the base is not exposed and the internal structure appears complex. However, the outcrop pattern suggests that it is probably many thousands of feet. Distinctive lithology has resulted in the informal name 'Grit unit (division)' for rocks of this type (Gabrielse, 1967b).

Outcrop Characteristics

Much of the area underlain by unit 3 is characterized by rather smooth ridges to 7,000 feet elevation. Outcrops are particularly susceptible to frost action, and smooth talus-covered slopes with a light moss cover are common. The unit contains distinctive mottled maroon and green shale that supports little vegetation and frequently produces brilliant splashes of colour extending from ridge to valley bottom, making the unit readily recognizable from the air.

Lithology

The formation contains impure quartzite, grit, quartz–pebble conglomerate, shale, and slate, and minor limestone and black chert.

The quartzite is commonly brown on both fresh and weathered surfaces and consists of fine quartz grains with minor sericite and brown flecks of limonite resulting from the oxidation of iron-bearing carbonate. The quartzite grades to grit containing coarser grains of quartz up to several millimetres in maximum diameter, to quartz–pebble conglomerate with grains of quartz and occasionally feldspar to 10 millimetres in diameter. Viewed in thin section the grit consists of well-rounded grains of quartz and less commonly feldspar and chert in a matrix of finer quartz, white mica, and iron-bearing carbonate, the last frequently altered to limonite. Quartz clasts generally show undulose extinction, and feldspar clasts, commonly microcline, are often crushed and partially altered. Plagioclase feldspar occurs mainly in the matrix in fine grains similar to those of quartz.

Soft shales, locally altered to slate or schist, are interbedded with the quartzite. With the exception of the spectacular maroon and green shale most are drab green, grey, or black. Viewed in thin section, the shale consists of fine-grained minerals that are largely indeterminate but appear to include much white mica.

Thin limestone bands occur throughout the unit, but thick limestone bands (3a) are prominent in the group in a band parallel to Tintina Trench in Dawson map-area. These limestones are commonly coarsely crystalline and often show a distinctive dark and light grey banding.

Black chert occurs locally within the group but may be infolds of younger rocks of the Road River Formation (unit 9; Poole 1965, p. 34).

Typical lithology of rocks assigned to unit 3 is given in the following partial section measured along North Klondike River immediately south of North Fork Pass on Dempster highway (64°32½'N, 138°14'W). Deformation of the unit appears much less severe in this area but, even so, the section given may be complicated by either tight folding or faulting.

Rocks of unit 3 lying south of Eagle Ridge in the southwest corner of Nash Creek map-area differ somewhat in lithology from those of the unit elsewhere. Rock types here include quartzite, in part gritty, quartz–mica schist, phyllite, black slate, minor graphitic schist, and limestone. The distinctive maroon and green shales are lacking, possibly destroyed through metamorphism. In general, the rocks are of somewhat higher metamorphic rank and there is more evidence of shearing and the development of bedding plane foliation.

Unit	Lithology	Thickness (feet) Unit	Total from base
	Top not exposed but scattered outcrops of maroon and green shale occur for about 3,000 feet downstream		
	UNIT 3		
26	Shale, dark maroon (80%) and green (20%)	420	3,635
25	Talus, quartzite, gritty, brown weathering	130	3,215
24	Quartzite, scattered grit grains, iron-flecked, brown weathering	70	3,085
23	Covered	220	3,015
22	Quartzite, gritty and in part with mica flakes, beds to 3 feet with thin partings of grey-green shale mottled by dark carbonaceous (?) spots	100	2,795
21	Quartzite, gritty, beds 2 to 3 feet with a few shaly partings	30	2,695
20	Shale, maroon (50%) and green (50%) in bands about 4 feet thick but with some mottling	20	2,665
19	Quartzite, grains to 1 mm, grey, brown weathering; minor shale partings	20	2,645
18	Shale, maroon with minor green mottling (90%) and minor blue-green bands	120	2,625
17	Limestone, brown, lithographic to crystalline	5	2,505
16	Chert, brownish grey, brown weathering, beds to 6 inches separated by thin shale partings	240	2,500
15	Quartzite and shale; quartzite, buff weathering and iron-flecked; shale, buff with dark grey patches	50	2,260
14	Quartzite, light buff to dark grey, brown weathering, beds to about 6 feet; minor gritty beds	100	2,210
13	Grit, clasts to about 2 mm, brown weathering, slightly limy	20	2,110
12	Quartzite, grain size about 0.5 mm, grey, buff weathering, a few shaly bands and in part limy	110	2,090
11	Quartzite, sugary, grey with iron flecks, brown weathering; minor shale interbeds	140	1,980
10	Shale, grey and green; minor interbedded limy shale and laminated limy siltstone	140	1,840
9	Grit, dark grey with minor shale fragments	190	1,700
8	Grit, clasts commonly about 3 mm but some to 10 mm, grey with iron flecks, brown weathering; minor shale partings	1,040	1,510
7	Covered	135	470
6	Grit	10	335
5	Covered	75	325

Unit	Lithology	Thickness (feet) Unit	Thickness (feet) Total from base
4	Grit, clasts to 3 mm, grey, brown weathering; minor brown weathering phyllite	70	250
3	Shale, grey, brown weathering, with a few sandy layers	35	180
2	Covered	30	145
1	Grit, clasts of quartz and a few rock fragments both to 3 mm in a fine-grained quartzose matrix with iron flecks; brown weathering, beds to about 6 feet	115	115
	Base not exposed		

Internal Structural Relations

The internal structure of rocks assigned to unit 3 is not known with certainty. Most outcrops have been heavily disturbed through frost action and, in addition, in many the original bedding appears to have been destroyed through deformation. In rare large outcrops, such as in the headwalls of cirques, complex folds with axial planes parallel to the bedding were observed. Strong deformation is also suggested by the broken and strained quartz clasts of the grit and quartz–pebble conglomerate. Near Tintina Trench in northwestern Dawson map-area, rocks of the unit are strongly folded parallel to this major structure and many of the limestone bands outline chevron folds with an amplitude of several thousand feet.

External Structural Relations

The external structural relations can be considered for two bands, a northern one extending from just south of Kathleen Lakes on the eastern margin of Nash Creek map-area to just north of Yukon River on the western margin of Dawson map-area, and a southern band running from McQuesten Lake in south-central Nash Creek map-area to Dempster highway in southeast Dawson map-area. The base of the rocks assigned to unit 3 is not exposed in either band.

In the northern band unit 3 appears to be overlain without angular unconformity by the Road River Formation (unit 9) in much of the Dawson and Larsen Creek map-areas. In the central part of Dawson map-area the relationship is obscured by large areas of carbonate-rich volcanic rock (unit 4). In the eastern part of Nash Creek map-area, southwest of Kathleen Lakes, the unit is overlain unconformably by Ordovician to Silurian carbonate rocks (unit 8). In southern Nash Creek map-area the unit appears to be overlain by the Lower Schists (unit 17) and at one location Permian limestone (unit 15a) was observed along this contact. There appears to have been much faulting along this contact and the relationship is uncertain. Farther west, this particular contact lies along an alluvium-covered depression.

In the southern band the contact from just west of McQuesten Lake (Nash Creek map-area) to Dempster highway (Dawson map-area) is believed to be a major thrust that places the rocks of unit 3 on the younger Mesozoic rocks of units 17 and 19. Southward this band is overlain, apparently conformably, by Ordovician rocks of the Road River Formation (9).

Age and Correlation

Throughout much of the area mapped the rocks of unit 3 are overlain without observed unconformity by the Road River Formation (9) of Ordovician to Silurian age, suggesting a pre-Ordovician age for this unit. Two collections of possible fossils were made from the group, one consisting of questionable algal remains and the other of echinoderm columnals. The second collection, from a siliceous limestone near the contact of the unit with the carbonate-rich volcanic rock of unit 4 (64°38½'N, 138°46'W), may represent an infold of younger rock. Field relationships within the map-area suggest a Precambrian or possibly Cambrian age for unit 3.

Beyond the project area, rocks of the 'Grit unit', as it is informally called, can be traced southeast in a great arc extending into northern British Columbia, a distance of about 400 miles (Green and Roddick, 1961; Roddick and Green, 1961 a and b; Gabrielse, Roddick, and Blusson, 1965; Blusson, 1966; Gabrielse, 1967b; and other unpublished reconnaissance reports). In the Flat River area towards the southeast end of the band Gabrielse, Roddick, and Blusson (1965, Map 35-1964) show rocks correlative to unit 3 (their unit 11) underlying rocks of Lower Cambrian age and suggest a Cambrian or earlier age for the rocks concerned. Westward, in Alaska, Mertie (1937, pp. 65–76) has described rocks lithologically similar to the 'Grit unit' (3) as "Undifferentiated Pre-Middle Ordovician Rocks". The present author examined rocks described by Mertie (op. cit.) on the Livengood road, about 200 miles west of the Alaska Boundary, and considers them to have the same distinctive lithology and to be of the same metamorphic rank as those of unit 3 in the present area.

Gabrielse (1967b, p. 275) correlates rocks of the 'Grit unit' with Kaza, Miette, and Windermere strata to the south in British Columbia. A crystalline source area lying to the west or southwest of the present outcrop pattern is suggested. If any remnants of this source are still exposed they must lie in the metamorphic belt of southern Yukon (so-called 'Yukon Group' rocks) or central Alaska (Birch Creek rocks).

Unit 4

Distribution

Rocks assigned to unit 4 are principally highly calcareous volcanic rocks. A main band extends east–west across Dawson map-area about 60 miles, following the northern boundary of rocks of unit 3. The thickness of unit 4 varies but appears to exceed several thousand feet in some places. Rocks assigned to unit 4a, underlying Mount Harper in Dawson map-area, are similar in lithology but appear to grade downward into rocks of unit 2d and to be in part interbedded with rocks of unit 2 about 5 miles northwest. The rocks of unit 4b, located in the west-central part of Larsen Creek map-area, are fresh and lack the calcite that is characteristic of the rest of the unit. However, they have been included with it because of their location along the northern contact of unit 3.

Outcrop Characteristics

Rocks assigned to unit 4 are fairly competent and commonly form rough irregular ridges, often with hoodoos, that stand well above nearby ones underlain by different rock types. Weathering colours include light to dark brown and dark green but in many places rocks are streaked and stained light grey from the deposition of secondary calcite on the weathered surfaces.

Lithology

Most of the rocks mapped as unit 4 are believed to be altered andesite (principally vesicular flows), breccia, and agglomerate. Interbedded with the volcanic rocks are lesser amounts of shale, siltstone, chert, and limestone. The volcanic rocks are remarkable for their carbonate content, locally as high as 50 per cent, with calcite filling vesicles and frequently a major constituent of the matrix.

Viewed in thin section, the matrix of the rocks consists of fine feldspar laths, about 0.2 mm long and believed to be altered to secondary albite, very fine grained secondary chlorite, calcite, and minor amounts of a white opaque mineral (leucoxene?). Vesicles are common, seldom forming less than 20 per cent of the rock and often as much as 60 per cent. Most are 1 mm or less in diameter but a few are up to several millimetres. They are commonly filled with calcite, less commonly quartz, and, rarely, chlorite.

Structure

Individual flows could not be distinguished in many of the outcrops but in a few they appeared to range from a few feet to about 100 feet thick. Vague pillow-like shapes about 3 feet in maximum dimension were observed on one traverse about 5 miles northwest of Mount Harper. Because bedding is lacking in most outcrops, little is known of the internal structure of the unit.

Age

No fossils were collected from unit 4. However, the close association with rocks of units 3 and 9 suggests they are contemporary. It is not known whether the presence of volcanic rocks of unit 4 within rocks of units 3 and 9 resulted from an extended period of extrusion or later folding and faulting.

Unit 5

Unit 5 underlies rather small areas in the northwest corner of Nash Creek map-area and the northeast corner of Larsen Creek map-area. It is best exposed in Nash Creek map-area, where it may exceed 3,500 feet in thickness and consists of conglomerate, sandstone, and siltstone, with interbedded flows. Elsewhere the unit is seldom more than a few hundred feet thick and sandstone is the dominant lithology.

Outcrop Characteristics

The unit weathers a deep maroon and contrasts vividly with other units in the area. In regions of essentially flat-lying rocks such as the northwest corner of Nash Creek map-area, steep cliff faces, stacks, and 'layer-cake' structure are characteristic (Fig. 7).

Lithology

The following composite section measured in the northwest corner of Nash Creek map-area (lower part 64°55½'N, 135°39'W; upper 64°53'N, 135°34'W) is typical of lithology in this area.

		Thickness (feet)	
Unit	Lithology	Unit	Total from base
	Overlying beds—unit 6 Conformable contact		
	UNIT 5		
3	Sandstone, fine-grained, silty, brick red, massive-bedded, weathers brick red	500	1,990
	Break in section		
2	Sandstone, brick red, with some conglomeratic layers; interbedded greenstone sills, dark greenish grey, about 15 feet thick; weathers whitish grey	290	1,490
1	Conglomerate, red near top, buff towards base, massive bedded; boulders to 1 foot diameter of red sandstone, grey quartzite, greenstone, black shale; minor orange dolomite and red jasper; a few greenstone sills	1,200	1,200
	Base not exposed		

Elsewhere the unit is much thinner and the following section was measured across it on the ridge between the forks of Royal Creek, about 12 miles east (64°52½'N, 135°11'W):

		Thickness (feet)	
Unit	Lithology	Unit	Total from base
	Overlying beds—unit 8 Unconformity		
2	Sandstone, brick red, beds to 3 feet, scattered conglomerate lenses	200	220
1	Basal conglomerate with boulders to 1 foot diameter of quartzite and white quartz	20	20
	Angular unconformity Underlying beds—unit 1		

In thin section the sandstones are seen to contain angular quartz and argillite (?) grains, composed mainly of white mica and fine quartz, in a matrix of hematite or carbonate, either calcite or dolomite. The greenstone sills are much altered porphyritic volcanic rocks, probably andesite. Altered remnants of intermediate plagioclase feldspar to about 3 mm may form up to 10 per cent of the rock, and the occasional ghost of an altered pyroxene phenocryst was observed. Groundmass of the rock consists of fine plagioclase feldspar laths, in part altered to albite (?), magnetite, chlorite, and up to 25 per cent fine-grained calcite. Some

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FIGURE 7
Stack formed of maroon siltstone with thin conglomerate bands of probable Cambrian or earlier age (unit 5). Near Little Wind River, Nash Creek map-area.

of the finer conglomerate contains altered volcanic material corresponding to both the matrix and the phenocrysts, suggesting that the sills or flows were essentially contemporaneous with the deposition of the clastic rocks.

Structure

Throughout much of the area the unit is flat lying or has gentle dips. It appears to have undergone the same structural history as the overlying rocks, particularly unit 8, rather than the underlying rocks of units 1 and 2. The base of unit 5 was observed in a number of places where it was too thin to indicate on the map, and generally it overlies rocks of unit 1 with marked unconformity. In the northeast Larsen Creek area beds of unit 5 are downfaulted against unit 1. Near the fault, beds are dragged from a nearly flat-lying position to almost vertical.

Age and Correlation

No fossils were found in the unit. However, in Nash Creek map-area it is overlain, apparently conformably, by unit 6, which contains fossils of probable Middle and definite Upper Cambrian age. Because of this close relationship with rocks of Cambrian age, unit 5 is considered of probable Cambrian rather than Proterozoic age.

Rocks of unit 5 are very similar in lithology to the Rapitan Formation of Proterozoic age that is well exposed in the Snake River area, about 80 miles east of the better exposures of unit 5 in Nash Creek map-area. In the Snake River area, the Rapitan Formation (Green and Godwin, 1963, pp. 15–18) consists of about 3,000 feet of conglomeratic mudstone with up to about 400 feet of hematite and jasper iron-formation near the base. Originally, there was considerable question as to whether the Rapitan Formation was of Proterozoic or Early Cambrian age; however, later work to the southeast (unit 7 of Gabrielse, Roddick, and Blusson, 1965) indicates that the formation is indeed Proterozoic. Possibly rocks of unit 5 were formed through erosion and redeposition of rocks correlative to those of the present Rapitan Formation.

Along the Tatonduk River in Alaska, a few miles from the northwest corner of Dawson map-area, Mertie (1932, pp. 369–392), followed by Brabb and Churkin (1964 a and b), described red beds with some hematite and jasper that are associated with basalt. These rocks may, in part, be correlative with the Rapitan Formation or, less likely, with those of unit 5.

Unit 6

Unit 6 is restricted to the northwest corner of Nash Creek map-area. It is about 1,400 feet thick and consists mainly of limestone and dolomite that weathers buff, brown, and grey.

Outcrop Characteristics

Rocks of the unit are comparatively competent and generally form steep faces. The unit supports little vegetation. The buff rock contrasts strongly with the underlying maroon beds of unit 5 and the overlying grey to white beds of unit 8.

Lithology

The following section was measured in the northwest corner of the Nash Creek area (64°53′N, 135°35′W):

Unit	Lithology	Thickness (feet): Unit	Thickness (feet): Total from base
	Overlying beds of unit 8 Disconformity		
	UNIT 6		
11	Limestone, dark grey, medium- to thick-bedded, weathers dark grey	80	1,420

		Thickness (feet)	
Unit	Lithology	Unit	Total from base
10	Dolomite, silty, dark grey, thin-bedded, weathers buff	190	1,340
9	Dolomite, dark grey, medium-bedded, weathers grey and buff; minor buff weathering silty interbeds	190	1,150
8	Dolomite, dark grey, thick-bedded, weathers bright orange	50	960
7	Dolomite, dark grey, medium-bedded, weathers light grey; minor buff silty interbeds; one brown dolomite band about 50 feet thick, weathers cherry red	180	910
6	Limestone, dark grey, thin-bedded, weathers dark grey; minor buff silty interbeds	50	730
5	Limestone, sandy to silty, dark brownish grey, thin-bedded, weathers buff to brown	320	680
4	Limestone, silty with honeycomb structure, dark grey, thin-bedded, weathers buff	220	360
3	Sandstone, fine-grained, brick red	20	140
2	Limestone, silty with honeycomb structure, grey, weathers orange-buff, yellow-buff, and grey; a few beds of brick-red sandstone.	70	120
1	Slate, greenish grey, tuffaceous (?)	50	50
	Conformable contact Underlying brick-red sandstone of unit 5		

Most of the carbonate rocks are fine grained and contain variable amounts of silt-size quartz grains. The term 'honeycomb structure' is applied to a carbonate rock containing irregular blobs of purer limestone in a silty limestone matrix; the former weather out more readily and produce a buff rock with an irregularly pocked surface. In the section above it is possible that some of the upper beds, particularly those above the bright orange weathering dolomite band, may belong to unit 8 rather than unit 6 as the base of the unit is frequently marked by an orange weathering carbonate bed in this area.

Structure

Most of the outcrops of unit 6 are flat-lying or have gentle dips. The unit is believed to overlie unit 5 conformably and this is supported by the presence of bands of brick-red sandstone, characteristic of unit 5, within the lower part of unit 6. Unit 6 is overlain without angular unconformity, but probably disconformably, by lower Paleozoic dolomite (8).

The absence or marked thinning of units 5 and 6 beneath the Paleozoic dolomite (8) elsewhere in the map-areas may be a result of a period of block-faulting and erosion after the deposition of units 5 and 6 and before the deposition of unit 8. Thus unit 8 might appear to overlie unit 6 conformably in the northwest corner of Nash Creek map-area, but elsewhere these units would have been removed by erosion and unit 8 would rest directly on units 1 or 2.

Age

The following fossil collections were made from rocks of unit 6:

F 1 GSC loc. 47142 (64°57'N, 135°34'W), triangulation station, elevation 6,850 feet, Nash Creek map-area
lingulid brachiopod
indeterminate trilobite
Meteoraspis sp.
Densonella sp.
Age: early Late Cambrian, Dresbach

F 2 GSC loc. 47221 (64°53½'N, 135°42½'W), 4½ miles east-northeast of peak with spot elevation 6,190 feet, Nash Creek map-area
cf. *Geneviella* sp.
Kormaspidella sp.
Remarks: early Upper Cambrian, *Cedaria* or *Crepicephalus* Zone

F 3 GSC loc. 47220 (64°53'N, 135°33'W), 5 miles south of triangulation station, elevation 6,850, Nash Creek map-area
cf. *Blountia* sp. (partial impression of pygidium only)
?*Tricrepicephalus* sp. (cranidium only)
Lingulella sp.
Remarks: early Upper Cambrian, *Cedaria* or *Crepicephalus* Zone

Collection F 1 was identified by B. S. Norford and F 2 and F 3 by W. H. Fritz, both of the Geological Survey of Canada. All indicate that rocks of unit 6 are of early Late Cambrian age.

Correlation

A partial correlation between units 6 and 7, the latter occurring near the International Boundary in Dawson map-area, is suggested. Elsewhere Late Cambrian faunas have been reported (Norford, 1964, p. 3) from the lower part of the Road River Formation (*see also* unit 9) north of the map-area and from the Nahanni area (Green and Roddick, 1961) about 300 miles to the southeast. Other buff weathering, silty carbonate rocks occur in the unmapped areas of the Mackenzie Mountains between Nash Creek and Nahanni map-areas, and, in the author's opinion, it is probable that some of these rocks are of Cambrian age.

Unit 7

Rocks assigned to the unit outcrop in the northwest corner of Dawson map-area. In addition to a main band, about 15 miles long and extending southeast parallel to Monster River, three small areas to the south and southeast have been included on the basis of similar lithology. The unit is believed to consist of an upper recessive band (7), probably less than 1,000 feet thick, and a lower competent band (7a) of limestone and dolomite, probably several thousand feet thick. Some Precambrian rocks may be included in the latter unit (7a). Mapping in Alaska and in a narrow strip east of the International Boundary, Brabb and Churkin (1964a) were able to separate rocks herein assigned to unit 7 and 7a into three units but insufficient information was obtained in the present mapping to extend their units. More recently Brabb (1967) has modified somewhat the mapping in Alaska and suggested formational names.

Outcrop Characteristics

Rocks assigned to unit 7 are recessive, and areas underlain by them are characterized by subdued topography and heavy vegetation. In contrast those of unit 7a support little vegetation, and large, bald, buff- to cream-coloured outcrops are common. Spectacular canyons are formed in these rocks on the Tatonduk River and its tributary Monster River.

Lithology

The following composite section was measured near the International Boundary (about 64°55′N, 140°54′–58′W):

Unit	Lithology	Thickness (feet) Unit	Thickness (feet) Total from base
	Overlying beds of unit 9 (thin-bedded limestone and shale)		
12	Covered	25	
	UNIT 7		
11	Limestone and limestone conglomerate, tan to buff, very finely crystalline, massive, conglomerate matrix finely crystalline, tan to buff, containing rounded, elongate, and flat fragments of carbonate, generally up to 3 inches in diameter	75	725
10	Covered	350	650
9	Limestone, thin-bedded, medium grey-brown, fragmental; fossiliferous F 4	25	300
8	Covered	250	275
7	Breccia, light apple green, fine-grained calcareous matrix; coarse fragments	5	25
6	Covered, talus of red and green shale fragments	15	20
5	Limestone, mottled light greenish grey to creamy green, argillaceous, grades to sandstone	5	5
	Break in section—probable conformable contact	—	—
	UNIT 7a		
4	Dolomite and limestone, cream to tan, finely crystalline	75	3,050
3	Limestone, varies from crystalline to lithographic, cream to tan	175	2,975
2	Dolomite, finely crystalline to sugary, light cream, buff, and grey	1,900*	2,800
1	Limestone, mainly finely crystalline to lithographic but some sugary, in part pisolitic, cream, buff, and brown	900*	900
	Base not exposed		

*Thickness may be in error owing to structural complications.

Structure

Little is known of the structure of the unit. Much of the limestone is massive and does not show bedding although the few attitudes obtained are variable and suggest folding. The lower part of the section described may be repeated by a strong northwest-trending fault.

The base of the unit is not exposed in the map-area. In the section measured the unit appears to be overlain conformably by Ordovician rocks.

Age and Correlation

One fossil collection was made from the rocks of unit 7 within the map-area:

F 4 GSC loc. 47170 (64°55½'N, 140°57½'W), 1 mile east of boundary marker 105

archaeocyathid fragments
?*Botsfordia* sp.
edelsteinaspid? pygidium
Helcionella sp.
Kulorgina sp.
cf. *Proliostracus* sp.
Stenothecoides sp.

Remarks: Lower Cambrian. The edelsteinaspid? pygidium in this collection suggests a tentative correlation with the Mural Formation. In Jasper Park, Alberta, edelsteinaspid pygidia are fairly common in the Mural.

Identified by W. H. Fritz of the Geological Survey of Canada.

The following collections from rocks of unit 7a were made by Cairnes (1914, pp. 64, 65) and identified by L. D. Burling of the Geological Survey of Canada. Much of the material in the original collections is believed to have been sent to other institutions or misplaced. That remaining has been re-identified by Fritz:

F 5 GSC loc. 278 (64°56½'N, 140°56½'W), 2.3 miles northeast of boundary marker 105 (McCann Hill), Cairnes' XXc29

Burling (about 1912):
Obolus sp.
Acrotreta sp.
Agraulos sp.
Ptychoparia sp.
Anomocare sp.
Solenopleura sp.

Fritz (1968):
brachiopod and trilobite fragments

Remarks: probably Upper Cambrian, perhaps early Upper Cambrian

F 6 GSC loc. 279 (64°58½'N, 140°57½'W), 1.8 miles southeast of boundary marker 104 (south bank of Tatonduk River), Cairnes' XXe39

Burling (about 1912):
Curticia? sp.
Acrotreta sp.
Agnostus sp.
Dicellocephalus? sp.

Fritz (1968):
?*Elkania* sp.
trilobite fragments

Remarks: probably Upper Cambrian

F 7 GSC loc. 282 (64°57½'N, 140°59'W), 2.7 miles south-southeast of marker 104 (south bank of Tatonduk River), Cairnes' XXi34

Burling (about 1912):
- Foraminifera
- *Hyolithellus* ? sp.
- *Stenotheca* 2 sp.
- *Conularia* sp.
- *Micromitra (Iphidella) pannula* (White)
- *Acrotreta* 4 sp.
- ostracods 4 sp.
- *Agnostus* 3 sp.
- *Agraulos* 3 sp.
- *Ptychoparia* 2–3 sp.
- *Anomocare* sp.
- *Dorypyge* ? sp.
- *Neolenus* ? sp.
- *Solenopleura* 3 sp.

Fritz (1968):
- ? *Hypagnostus* sp.
- *Lejopyge* sp.
- ? *Peronopsis* sp.
- *Micromitra* sp.
- *Modocia* sp.
- *Stenothecoides* sp.
- ? *Svealuta* sp.

Remarks: the presence of *Lejopyge* sp. in this collection dates it as latest Middle Cambrian (Late *Bolaspidella* Zone)

Mapping on Jones Ridge, approximately 8 miles north of Dawson map-area and along the International Boundary, Cairnes and later Burling (Cairnes, 1914, pp. 58–65) collected Cambrian and Ordovician fossils from a competent limestone and dolomite unit very similar to units 7 and 7a (*see also* Brabb and Churkin, 1964b and Brabb, 1967).

More recently Brabb (1967) proposed three new formations just west of Dawson map-area: an upper Hilliard Limestone, in excess of 500 feet in the type section, and throughout the area mapped containing fossils ranging from Early Cambrian to Early Ordovician age; a middle Adams Argillite, about 300 feet thick in the type section and containing fossils of Early Cambrian age; and a lower Funnel Creek Limestone, about 1,300 feet thick in composite section and unfossiliferous. In the Jones Ridge area, about 10 miles north, Brabb (1967) has proposed the Jones Ridge Limestone Formation comprising a lower member 2,940 feet thick that may range in age from Early Cambrian to Early Ordovician and an upper member about 60 feet thick of Middle or Late Ordovician age. Differences in lithology between the two areas are believed due to facies changes over relatively short distances.

Unfortunately, mapping done on the present project is not sufficiently detailed to either confirm Brabb's proposed stratigraphy or utilize it in this report. A less resistant band corresponding to his Adams Argillite can be recognized in the border area, and unit 7 as mapped is believed to include his Adams Argillite and Hilliard Limestone Formations and be of Early Cambrian to Early Ordovician age. Immediately underlying carbonate rocks (7a) are probably his Funnel Creek Limestone Formation but farther eastward the rocks (7a) are entirely carbonate and the three formations cannot be separated. Rocks in this latter area contain fossils (localities F 6 to F 7) of Middle to Late Cambrian age and are probably correlative with Brabb's Jones Ridge Limestone Formation rather than the three formations to the west. Unit 7a as mapped may also contain some rocks of Precambrian age (Tindir Group of Brabb, 1967).

A partial correlation of rocks of units 7 and 7a with those of unit 6 is suggested. The latter are very similar in lithology but cover a much smaller time interval (early Upper Cambrian).

Unit 8

Rocks assigned to unit 8 occur in the northern part of all three map-areas. They are almost entirely carbonate but vary considerably, often over relatively short distances, in composition between limestone and dolomite, thickness of bedding, and colour. Distinctive marker beds that can be traced for several miles or more occur locally but none persist throughout the entire area. Much of the rock is unfossiliferous but good collections were made from some beds. The thickness of the unit is variable; the thickest section measured was about 4,700 feet and in most places it appears to be a minimum of several thousand feet.

Outcrop Characteristics

The carbonate rocks of unit 8 are competent and outcrop well. In Nash Creek map-area they underlie jagged peaks some of which exceed 7,500 feet elevation. They support little vegetation, and the white to light grey weathering rocks may be recognized many miles away (Fig. 3).

Lithology

Carbonate rocks, principally dolomite, are the main type included in the unit. The dolomites are commonly thick-bedded, grey weathering rocks, composed of sugary crystals and commonly porous. Limestones are thinner bedded and finer grained and lack the porosity of the dolomite. Locally, interbeds of black shale and chert correlative with the Road River Formation (unit 9) occur within unit 8 but are seldom more than a few hundred feet thick and can seldom be traced for more than a few miles. A band of black shale and limestone, about 150 feet thick and bearing the distinctive Silurian *Aulacopleura socialis* fauna (Raasch, Norford, and Wilson, 1961), occurs near the head of Royal Creek in Nash Creek map-area (especially 64°47½'N, 135°06'W); on a more detailed scale of mapping these beds could have been traced for 100 square miles or more. The base of unit 8 is frequently marked by a band of orange weathering sandy or silty dolomite 50 feet or thicker.

Rocks of volcanic origin (8a) occur within unit 8 in an area about 30 by 10 miles centred south of Hart Lake in Nash Creek map-area. About 4 miles south of the lake they are altered volcanic rocks containing about 10 per cent feldspar phenocrysts, now altered to epidote-group minerals, set in a matrix of lath-like crystals of altered feldspar, chlorite, magnetite, and leucoxene (?). To the northwest and southeast the rocks become tuffaceous and consist of poorly rounded grains up to about 0.2 mm across of carbonate, feldspar crystals, and fine-grained volcanic rock, now much altered, in a fine-grained matrix that appears to contain much chlorite. In places these tuffaceous rocks are highly fossiliferous and seven collections (F 50 to F 56) were made from them. The unit is believed to be of Middle to Late Ordovician age. In the author's opinion, the flows were extruded in a relatively small area during sedimentation of the rocks assigned to unit 8, and fossil-bearing, waterlain, tuffaceous rocks deposited at the same time over a somewhat wider area.

The following sections, measured where the rocks assigned to unit 8 are particularly well exposed, provide typical examples of the lithology of the unit throughout the three map-areas:

Section of unit 8, Royal Creek area (about 64°53′N, 134°53′W):

Unit	Lithology	Thickness (feet) Unit	Total from base
	Overlying beds—unit 10 (Gossage Formation equivalent) Conformable contact		
	Unit 8		
13	Argillaceous limestone, fine-grained, thin-bedded, dark grey to black, weathers black; fossil collections F 37, 38	110	4,615
12	Dolomite with minor limestone, finely crystalline to sugary, light to dark grey, light to medium grey weathering, beds 3 feet to massive, cliff-forming	710	4,505
11	Dolomite, finely crystalline, dark grey, dark grey weathering, massive	80	3,795
10	Limestone, fine-grained, dark grey to black, weathers dark grey, contains minor pods and lenses of black chert, beds 6 inches to 1 foot; fossil collection F 36	160	3,715
9	Dolomite, fine-grained, dark grey, weathers dark grey, beds 2 to 6 inches	45	3,555
8	Dolomite and limestone, fine-grained, dark grey, weathers dark grey; beds 8 inches to 1 foot; *Bighornia–Catenipora* fauna F 8 and coll. F 35	140	3,510
7	Limestone and minor dolomite, fine- to coarse-grained, dark grey, weathers light grey to buff; beds mostly 1 foot to 6 feet but as much as 10 feet; contains much coarsely crystalline secondary calcite	460	3,370
6	Dolomite, fine-grained, medium grey, weathers medium grey to light buff-grey, beds 1 foot to massive; 5-foot bed of dolomite conglomerate about 300 feet above base	950	2,910
5	Limestone and dolomite, finely crystalline, grey-buff to black, weathers light grey to grey-buff, medium- to thick-bedded, contains coarsely crystalline secondary calcite; clastic limestone with pebbles to ¼ inch at base	280	1,960
4	Dolomite, finely crystalline, medium to dark grey, weathers light grey to cream (often mottled), thick-bedded to massive; 5-foot bed of dolomite conglomerate 80 feet above base that contains irregular fragments of dolomitic shale and argillaceous dolomite	390	1,680
3	Dolomite, mainly sugary to coarsely crystalline, light to medium grey, weathers light grey to creamy grey, thick-bedded, cliff-forming	890	1,290
2	Dolomite, finely crystalline, light tan to medium grey, weathers cream to grey, beds 2 to 5 feet	350	400
1	Dolomite, silty, fine-grained, grey, weathers light orange, beds to 2 feet; minor maroon and grey quartzite	50	50
	Angular unconformity Underlying beds—unit 1		

Section of unit 8, near Royal Creek, Nash Creek map-area (about 63°47½'N, 135°11'W):

Unit	Lithology	Thickness (feet) Unit	Total from base
	Overlying beds—unit 12 Covered—possible fault		
	UNIT 8		
27	Limestone, fine-grained, dark grey, brownish grey weathering, platy, numerous silicified fossil fragments	5	1,495
26	Talus of limestone, fine-grained, dark grey, brownish grey weathering, silicified fossils *Conchidium* fauna F 24	15	1,490
25	Limestone, fine-grained to sugary, dark grey, brownish grey weathering, irregularly bedded often between 2 and 6 inches; minor chert stringers	45	1,475
24	Talus of limestone, brown, brownish grey weathering with crinoids and silicified corals	65	1,430
23	Limestone, coarse-grained, crinoidal, brown, brownish grey weathering, beds to 6 feet	35	1,365
22	Talus of limestone, dark grey, brownish grey weathering, blocky	40	1,330
21	Limestone, fine-grained, crinoidal, dark grey, brownish grey weathering, beds to 6 feet; minor interbedded platy dark grey limestone	30	1,290
20	Talus of limestone, crinoidal, dark grey, grey to brown weathering, *Conchidium* fauna F 23	85	1,260
19	Talus of black shale with fossil fragments F 40	10	1,175
18	Limestone, sugary, crinoidal, brown, grey weathering; limestone, black shaly; fossil collection F 39	5	1,165
17	Talus of limestone, mixed; grey weathering brown crystalline limestone and platy grey weathering black limestone	45	1,160
16	Limestone, sugary, crinoidal, dark grey, brown weathering, beds to 4 feet	25	1,115
15	Limestone, interbedded dark grey, brown weathering crinoidal, and platy black graptolitic	10	1,090
14	Limestone, medium-grained, crinoidal, dark grey, pale brownish grey weathering	20	1,080
13	Talus of platy, thin-bedded, black limestone and minor black graptolitic shale	175	1,060
12	Limestone, black, thin-bedded to platy, sparsely fossiliferous with *Aulacopleura socialis* fauna F 19	15	885
11	Talus of black limestone and shale	30	870
10	Limestone and shale; both black, thin-bedded to platy, with *Aulacopleura socialis* fauna F 18	20	840

Unit	Lithology	Thickness (feet) Unit	Total from base
9	Talus of platy black limestone with a few beds to 6 inches and minor black shale, contains *Aulacopleura socialis* fauna.....	90	820
8	Limestone, fine-grained, dark grey, grey weathering, thick-bedded with chert lenses to 1 foot long and 3 inches thick, contains *Bighornia–Catenipora* fauna F 9..........................	30	730
7	Talus of limestone, blocky, fossiliferous, grey weathering.......	55	700
6	Limestone, mainly lithographic but some recrystallized to white secondary calcite, brownish grey to dark grey, grey weathering, bluff-forming with beds to 6 feet....................	230	645
5	Limestone, mainly lithographic but some siliceous or recrystallized, grey to brown, grey weathering, thick-bedded......	180	415
4	Talus of limestone and dolomite; limestone, lithographic, grey to brown, grey weathering, and dolomite, fine-grained, grey, grey weathering.......................................	35	235
3	Dolomite, fine-grained, dark grey, grey weathering, thick-bedded breaking to form irregular blocky talus..................	60	200
2	Talus of blocky, grey weathering dolomite..................	90	140
1	Dolomite, fine-grained, dark grey, grey weathering, beds to about 1 foot, in part brecciated and cemented by fine dolomite veinlets; contains irregular black chert lenses to 4 inches long	50	50
	Base not exposed		

Across the cirque, about a mile to the east of the section given above, carbonate rock, about 1,000 feet thick, light grey weathering and thick-bedded, lies above the point estimated to be the same as the top of the measured section. It is believed to be part of unit 8. This rock is overlain by a brown-weathering, thin-bedded unit believed similar to unit 12 at the measured section. This apparent change in the thickness of unit 8 probably results from an unconformity at the base of unit 12 but might represent a rapid facies shift during deposition from massive (8) to thin-bedded (12) carbonate rock.

Composite section of unit 8, Hart Lake area (lower part about 64°37′N, 135°30′W; upper part about 64°36′N, 135°32′W):

Unit	Lithology	Thickness (feet) Unit	Total from base
	Overlying beds—unit 10 (Gossage Formation equivalent) Conformable contact		
	UNIT 8		
9	Dolomite, coarsely crystalline (1 mm), vuggy, fetid, light to dark grey, weathers buff to grey; beds 1 foot to 2 feet, some breccia; near top is cliff-forming; *Conchidium* fauna F 25 and collection F 41..................................	435	2,365

Unit	Lithology	Thickness (feet) Unit	Total from base
8	Limestone, grey, slabby, *Bighornia–Catenipora* fauna F 11	20	1,930
7	Sandstone and chert–pebble conglomerate, covered with brownish vegetation	10	1,910
6	Dolomite, coarsely crystalline (1 mm), fetid, grey, grey weathering, beds to 6 feet, cliff-forming; thin limestone bands at top and base, *Bighornia–Catenipora* fauna F 10 near base	230	1,900
5	Limestone, grey to black, weathers buff to grey, platy, fossil collection F 52 near top	190	1,670
4	Tuffaceous argillite and minor argillaceous limestone, weathers brown to dark green, thin-bedded, fossil collections F 50, 51.	580	1,480
	Break in section	—	—
3	Shale and limestone, interbedded; shale, fine-grained, black, slightly calcareous; limestone, fine-grained, dark grey, argillaceous; graptolite collection F 28	250	900
2	Limestone, fine-grained, black argillaceous	50	650
1	Dolomite, fine- to medium-grained, light grey to tan, weathers grey; lower beds contain chert fragments and cherty layers; thin- to medium-bedded	600	600
	Angular unconformity Underlying beds—unit 1		

Section of unit 8, 10 miles west of Elliott Lake (Nash Creek map-area), base of section about 64°27′N, 135°54′W:

Unit	Lithology	Thickness (feet) Unit	Total from base
	Top not exposed		
	UNIT 8		
15	Grey dolomite		
14	Dolomite, orange weathering with thin grey bands to 3 feet	400	4,200
13	Limestone, slaty, weathers dark grey with red coloration in fractures	50	3,800
12	Dolomite, buff weathering; with interbedded bands to 3 feet of black limestone	150	3,750
11	Dolomite, crystalline, grey weathering, shattered; fossil collection F 44 near base, F 45 near top	800	3,600

Unit	Lithology	Thickness (feet) Unit	Thickness (feet) Total from base
10	Limestone, slaty, black, weathers brown	50	2,800
9	Dolomite, grey, contains some limonite and calcite, bedding mashed, fossil collection F 43 near top	500	2,750
8	Slate, black, weathers brown, becomes gritty towards the top with interbedded slate	300	2,250
7	Tuffaceous (?) limestone, brown, highly sheared, fossil collection F 42	5	1,950
6	Thin-bedded black slate, grey quartzite, and black limestone	45	1,945
5	Dolomite, crystalline, dark grey, bedding indistinct, weathers grey	900	1,900
4	Dolomite, somewhat argillaceous, crystalline, buff, weathers orange	200	1,000
3	Dolomite, grey, crystalline, massive	700	800
2	Dolomite, somewhat argillaceous, grey-brown, weathers orange	50	100
1	Dolomite, argillaceous, buff weathering, with minor interbedded grey limestone	50	50
	Possible unconformity Underlying beds—unit 2		

Section of unit 8, near headwaters of Monster River, Dawson map-area (about 64°55′N, 139°35′W), as measured by B. S. Norford (1964, pp. 69–72):

Unit	Lithology	Thickness (feet) Unit	Thickness (feet) Total from base
	Overlying beds—unit 9 (Road River Formation) Conformable contact		
	UNIT 8—rocks of probable Cambrian and/or Ordovician age		
5	Siliceous dolomite, finely to medium crystalline, light grey, weathers light grey, bedding 6 inches to 1 foot, with up to 20 per cent irregular silicified layers that weather dark brownish grey; barren	7	1,562
4	Covered interval	533	1,555
3	Siliceous dolomite, finely to medium crystalline, light brownish grey, light grey, pale yellowish brown, grey, weathers light grey, bedding 1 foot to massive, commonly indistinct; rare calcite-filled vugs, rare poorly silicified patches; covered intervals between 995–1,008, 967–983, 876–958, and 820–834 feet; barren	270	1,022

Unit	Lithology	Thickness (feet) Unit	Total from base
2	Covered interval with rare outcrops of light grey weathering siliceous dolomite	161	752
1	Siliceous dolomite, some slightly limy, very finely to very coarsely crystalline, light brownish grey, grey, yellowish grey, yellowish white, weathers light grey, whitish grey, resistant, bedding 1 foot to massive, commonly indistinct; calcite-filled vugs common; dolomite stringers; poor silicification at a few horizons; commonly 2 to 5 per cent vuggy porosity; covered intervals at 560–568, 511–529, 485–498, 102–124, and 65–70; barren except for echinoderm fragments at 400 feet (GSC loc. 53394)	591	591
	Small covered interval (18 feet) below unit 1, but from neighbouring hillsides the basal contact is an angular unconformity		
	Underlying beds—unit 1 (?)		

Structural Relations

Throughout much of the project area unit 8 has undergone moderate folding and some thrusting. In contrast, complex structures characterized by isoclinal folds, steep faults, and considerable thrusting alternate with open structures in the area north of Hart Lake (Nash Creek map-area) (Fig. 3). Complex folding is particularly well shown along the north side of Hart Lake valley. In the central part of Larsen Creek map-area, complex structures are present in some of the thrust blocks.

Unit 8 overlies units 1, 2, and 3 with profound unconformity and probably overlies unit 7 unconformably, although no certain discordance was observed at this contact. Near Hart Lake in Nash Creek map-area unit 8 is overlain conformably by unit 10 but farther north it is overlain, possibly unconformably, by unit 12. Farther west in Larsen Creek and Dawson map-areas unit 8 may be in part overlain conformably by unit 9 although a fault has been indicated along the southern contact.

Age

Numerous fossils ranging in age from Ordovician to Silurian were collected from unit 8. Locally, distinctive marker bands such as unit 8a or a black limestone bearing an *Aulacopleura socialis* fauna of Early Silurian age can be traced for many miles. Graptolite-bearing black shale and chert are also interbedded locally with the competent carbonates of unit 8. The following includes the more diagnostic collections:

Bighornia–Catenipora fauna:

F 8 GSC loc. 47154 (64°53′N, 134°58′W), section east of Royal Creek, Nash Creek map-area
solitary and favositid corals
Calapoecia sp.
Catenipora aff. *C. rubra* Sinclair and Bolton
rhynchonellid brachiopod
Age: probably Late Ordovician

F 9 GSC loc. 64906 (64°48′N, 135°11′W), Royal Creek section, 13 miles north of Hart Lake, Nash Creek map-area
brachiopods, gastropod, solitary corals
Aulacera sp.
Beatricia cf. *B. nodulosa* Billings
? *Bighornia* sp.
Streptelasma sp.
Catenipora sp.
Age: Late Ordovician

F 10 GSC loc. 47060 (64°37′N, 135°31′W), 11 miles west of Hart Lake, Nash Creek map-area
gastropods
strophomenid brachiopod
Bighornia cf. *B. parva* Duncan*
Streptelasma sp.*
Age: Late Ordovician

F 11 GSC loc. 47055 (64°37′N, 135°31′W), 11 miles west of Hart Lake, Nash Creek map-area
small brachiopods
solitary and favositid corals
Calapoecia sp.
Sarcinula sp.*
Palaeophyllum sp.*
Catenipora rubra Sinclair and Bolton*
? *Parafavosites* sp.*
Age: Late Ordovician

F 12 GSC loc. 47056 (64°35½′N, 134°49′W)
orthoceroid nautiloid
large gastropod
solitary, tabulate, and favositid corals
Palaeofavosites sp.
Catenipora rubra Sinclair and Bolton
Age: Late Ordovician

F 13 GSC loc. 47160 (64°53′N, 134°58′W), section east of Royal Creek, Nash Creek map-area
hesperorthid brachiopod*
Streptelasma sp.*
? *Bighornia* sp.
Sarcinula 2 spp.*
Catenipora 2 spp.*
Palaeophyllum sp.
Age: Late Ordovician

F 14 GSC loc. 64885 (64°46½′N, 135°15′W), Royal Creek section, 12 miles north-northwest of Hart Lake, Nash Creek map-area
Bighornia sp.
Streptelasma sp.
? *Palaeophyllum* sp.
? *Palaeofavosites* sp.
? *Calapoecia* sp.
Catenipora sp.
Age: Late Ordovician

F 15 GSC loc. 47062 (64°36′N, 135°23′W), talus in cirque 6½ miles west of Hart Lake, Nash Creek map-area
large gastropod
solitary coral
Catenipora cf. *C. rubra* Sinclair and Bolton
Age: Late Ordovician

*Indicates material placed in the Index Collection of the Geological Survey of Canada.

F 16 GSC loc. 47188 (64°47′N, 135°22′W), 15 miles northwest of Hart Lake, Nash Creek map-area
Calapoecia sp.
Catenipora cf. *C. rubra* Sinclair and Bolton
solitary corals
stromatoporoid
? orthoceroid nautiloids
Age: Late Ordovician

Aulacopleura socialis fauna:

F 17 GSC loc. 64880 (64°48′N, 135°11′W), Royal Creek section, 13 miles north of Hart Lake, Nash Creek map-area
bryozoans, gastropods
straight and slightly curved cephalopods
rhynchonellid and stropheodontid brachiopods
Atrypa cf. *A. gabrielsi* Norford*
? *Atrypa* sp.
Fardenia sp.
Glassia variabilis Whiteaves
Aulacopleura socialis Poulsen*
Encrinurus sp.
Leonaspis semiglabra Poulsen
Scutellum borealis (Poulsen)
Age: Early Silurian, early late or middle Llandoverian

F 18 GSC loc. 64881 (64°48′N, 135°11′W), Royal Creek section, 13 miles north of Hart Lake, Nash Creek map-area
graptolite fragments, brachiopods
straight cephalopods
Aulacopleura sp.
Age: Silurian

F 19 GSC loc. 64883 (64°48′N, 135°11′W), Royal Creek section, 13 miles north of Hart Lake, Nash Creek map-area
graptolite fragments, brachiopods
Monograptus aff. *M. spiralis* (Geinitz)
Aulacopleura sp.
Encrinurus cf. *E. princeps* Poulsen
Age: Early Silurian, late Llandoverian

F 20 GSC loc. 47038 (64°41′N, 135°03′W), 6½ miles north-northwest of Hart Lake, Nash Creek map-area
indeterminable brachiopods
Atrypa cf. *A. gabrielsi* Norford
Fardenia sp. 2 of Raasch *et al.* 1961
Favosites sp.
Scutellum borealis (Poulsen)*
Encrinurus cf. *E. princeps* Poulsen*
Age: late Llandoverian

F 21 GSC loc. 47040 (64°47½′N, 135°06′W), 3 miles north-northwest of spot elevation 7,624, Nash Creek map-area
echinoderm columnals
cystiphyllid and indeterminable solitary corals
Halysites sp.
Favosites 2 spp.
?*Coenites* sp.
Scutellum borealis (Poulsen)*
Encrinurus cf. *E. princeps* Poulsen
Age: Early Silurian (late Llandoverian)

F 22 GSC loc. 47024, 47026, 47027, 47052, 47057, 47061, 47143; same location as F 21—fauna from seven collections taken over a stratigraphic thickness of about 155 feet
echinoderm columnals
ostracod
cystiphyllid and indeterminable solitary corals
Favosites 2 spp.
Fardenia sp. 2 of Raasch *et al.* 1961
Glassia cf. *G. variabilis* Whiteaves
lingulid, rhynchonellid, and indeterminable brachiopods
?*Delthyris* sp.*
?*Meristella* sp.*
Aulacopleura socialis Poulsen*
Bumastus sp.*
Encrinurus cf. *E. princeps* Poulsen*
Scutellum borealis (Poulsen)
indeterminable trilobite*
Age: Early Silurian (late Llandoverian)

Conchidium fauna:

F 23 GSC loc. 64884 (64°48'N, 135°11'W), Royal Creek section, 13 miles north of Hart Lake, Nash Creek map-area
echinoderm fragments
brachiopod
solitary corals
Favosites sp.
?*Conchidium* sp.
Age: probably Late Silurian, probably early Ludlow

F 24 GSC loc. 64882 (64°48'N, 135°11'W), Royal Creek section, 13 miles north of Hart Lake, Nash Creek map-area
bryozoans, brachiopods, gastropods, trilobite, solitary corals
?*Conchidium* sp.*
?*Coenites* sp.
?*Striatopora* sp.*
Encrinurus sp.
Age: probably Late Silurian, probably early Ludlow

F 25 GSC loc. 47058 (64°37'N, 135°31'W), 10½ miles west of Hart Lake
indeterminable solitary coral
Catenipora sp.
?*Conchidium* sp.
Age: Silurian, probably Ludlow

F 26 GSC loc. 47086 (64°58'N, 136°57'W), 4 miles northeast of forks of Hart River, Larsen Creek map-area
Conchidium sp.
Age: Ludlow

F 27 GSC loc. 47033 (64°58'N, 136°37'W), from talus 4 miles northeast of forks of Hart River, Larsen Creek map-area
cf. *Conchidium* sp.
Age: Silurian, probably Ludlow

Graptolite collections:

F 28 GSC loc. 47216 (64°38'N, 135°29'W), 9 miles west-northwest of Hart Lake
Didymograptus sp. (pendent form)
Age: early Middle Ordovician (Llanvirnian)

F 29 GSC loc. 47110 (64°41′N, 135°03′W), 6½ miles north-northeast of Hart Lake
Monograptus cf. *M. difformis* Tornquist
M. spp. indet.
Age: Early Silurian (early Llandoverian)

F 30 GSC loc. 47217 (64°47′N, 135°22′W), 4½ miles southeast of triangulation station, elevation 6,619
Monograptus spiralis (Geimitz)
Monograptus cf. *M. priodon* (Bronn)
Stomatograptus grandis Suess
Age: late Early Silurian (latest Llandoverian)

F 31 GSC loc. 47108 (64°37′N, 135°26′W), 8 miles west-northwest of Hart Lake
Diplograptus s.l.
Age: Ordovician or Early Silurian, probably Ordovician

F 32 GSC loc. 47213 (64°45′N, 135°40½′W), 7 miles southwest of triangulation station, elevation 6,619
unidentifiable diplograptids
Age: Ordovician or Early Silurian

F 33 GSC loc. 47115 (64°38′N, 136°09′W), 10 miles north-northwest of Worm Lake
Tetragraptus quadribrachiatus (Hall)
Isograptus cf. *I. walcottorun* Ruedemann
Diplograptus s.l. spp. indet.
Age: Early Ordovician (Arenigian)

F 34 GSC loc. 47117 (64°30′N, 136°30′W), 14 miles west of Worm Lake
Monograptus spp. indet.
M. spiralis
Age: late Early Silurian (late Llandoverian)

Other collections:

F 35 GSC loc. 47152 (64°53′N, 134°58′W), section east of Royal Creek, Nash Creek map-area
echinoderm columnals
indeterminable gastropod
orthid brachiopod
trilobite fragments
Age: probably Ordovician or Silurian

F 36 GSC loc. 47174 (64°53′N, 134°58′W), section east of Royal Creek, Nash Creek map-area
gastropod
orthoceroid nautiloid
Favosites 2 spp.
Catenipora sp.*
Halysites sp.*
Age: Silurian, probably Clinton

F 37 GSC loc. 47226 (64°53′N, 134°58′W), section east of Royal Creek
stromatoporoid
rugose corals
?*Coenites* sp.
Favosites sp.
Age: Silurian or Devonian, probably Silurian

F 38 GSC loc. 47224 (64°53′N, 134°58′W), section east of Royal Creek, Nash Creek map-area
Cladopora? sp.
cf. *Adolfia* sp. A (–*Spirifer gregarius* Mayer 1913 non Clapp) — to Index Coll.
large leperditiid ostracods
Age: Upper? Silurian or Lower Devonian

F 39 GSC loc. 64905 (64°48′N, 135°11′W), Royal Creek section, 13 miles north of Hart Lake, Nash Creek map-area
echinoderm fragments, gastropod
solitary and tabulate corals
rhynchonellid, meristinid, and other brachiopods
Favosites sp.
Encrinurus sp.
Age: Silurian

F 40 GSC loc. 64887 (64°48′N, 135°11′W), Royal Creek section, 13 miles north of Hart Lake, Nash Creek map-area
echinoderm fragments
atrypid and rhynchonellid brachiopods
?*Thamnopora*
Age: Silurian to Permian, probably Silurian

F 41 GSC loc. 47046 (64°37′N, 135°31′W), section 10½ miles west of Hart Lake, Nash Creek map-area
stromatoporoid
colonial rugose coral
?*Favosites* sp.
Age: Ordovician–Devonian

F 42 GSC loc. 47051 (64°27′N, 135°56′W), section 25 miles southwest of Hart Lake
echinoderm columnals
coral fragments
indeterminable strophomenid brachiopods
Age: probably Ordovician–Devonian

F 43 GSC loc. 47037 (64°27′N, 135°56′W), section 25 miles southwest of Hart Lake
mamelate stromatoporoid
Favosites sp.
Age: Silurian or Devonian

F 44 GSC loc. 47044 (64°27′N, 135°56′W), section 25 miles southwest of Hart Lake
?*Favosites* sp.
halysitid coral
Age: Ordovician or Silurian, probably Silurian

F 45 GSC loc. 47054 (64°27′N, 135°56′W), section 25 miles southwest of Hart Lake, Nash Creek map-area
stromatoporoid
rugose coral
Age: probably Ordovician or Silurian

F 46 GSC loc. 47068 (64°15′N, 134°33½′W), 10 miles west of Kathleen Lakes, Nash Creek map-area
echinoderm columnals
rugose and favositid corals
Age: probably Silurian or Devonian

F 47 GSC loc. 47186 (64°36′N, 135°06′W), 1½ miles northeast of Hart Lake, Nash Creek map-area
echinoderm columnals
indeterminable brachiopod
favositid and auloporid corals
?*Coenites* sp.
Age: Silurian or Devonian, probably Silurian

F 48 GSC loc. 47176 (64°47′N, 135°22′W), Nash Creek map-area
?stromatoporoid
orthoceroid cephalopods
Catenipora sp.
favositid coral
Age: Ordovician or Silurian, probably Late Ordovician

F 49 GSC loc. 47050 (65°02½′N, 137°12′W), 4 miles west of elevation 5,674 triangulation station, Hart River map-area, about 3½ miles north of project area
echinoderm fragments
brachiopods 3 spp.
unidentified pliomerid trilobite
Leiostegium manitouensis Walcott*
Kainella flagricauda (White)*
cf. *Parapilekia* sp.*
Age: Early Ordovician, early Canadian *Leiostegium–Kainella* fauna

In addition, a large number of less diagnostic collections, many of which suggest ages ranging from Ordovician to Devonian, were made.

The following collections were made from tuffaceous rocks assigned to unit 8a:

F 50 GSC loc. 47064 (64°37′N, 135°31′W), 11 miles west of Hart Lake, Nash Creek map-area
bryozoan
stromatoporoid
strophomenid brachiopod
Catenipora sp.
streptelasmid coral*
Age: Ordovician or Silurian, probably Late Ordovician

F 51 GSC loc. 47158 (64°37′N, 135°28½′W), ridge on south side of Hart River 10 miles west of Hart Lake
gastropod
?bryozoan
strophomenid brachiopod
?trinucleoid trilobite
?*Ampyx* sp.
Age: Early or Middle Ordovician

F 52 GSC loc. 47070 (64°37′N, 135°31′W), 11 miles west of Hart Lake, Nash Creek map-area
streptelasmid coral
Age: Middle Ordovician – Early Silurian

F 53 GSC loc. 47039 (64°37′N, 135°25′W), 8 miles west of Hart Lake, Nash Creek map-area
echinoderm columnals
?orthoceroid fragment
indeterminable brachiopods
strophomenid and orthid brachiopods
Age: probably Ordovician–Mississippian

F 54 GSC loc. 47181 (64°33′N, 135°26′W), 1 mile north of Castle Mountain, Nash Creek map-area
echinoderm columnals
colonial rugose coral
strophomenid brachiopod
Age: Ordovician–Devonian

F 55 GSC loc. 47159 (64°33′N, 135°26′W), 1 mile north of Castle Mountain, Nash Creek map-area
solitary coral
strophomenid and orthid brachiopods
isotelid and trinucleoid trilobites
Age: Middle or Late Ordovician

F 56 GSC loc. 47041 (64°37′N, 135°38′W), 14 miles west of Hart Lake, Nash Creek map-area
gastropod
orthoceroid nautiloid
stromatoporoid
trilobite fragments
strophomenid brachiopod
Catenipora sp.
Age: Ordovician or Silurian, probably Ordovician

The collections were described by B. S. Norford of the Geological Survey of Canada with the exception of F 38 (A. W. Norris, Geological Survey) and those containing graptolitic fauna (F 28 to F 34; R. Thorsteinsson, Geological Survey).

Fossil collections from rocks mapped as unit 8 range in age from Early Ordovician (F 49 early Canadian; F 33 Arenigian) through Middle Ordovician (F 28 Llanvirnian), Late Ordovician (*Bighornia–Catenipora* fauna), and Early Silurian (*Aulacopleura socialis* fauna; F 29 early Llandoverian; and F 30 late Llandoverian), to Late Silurian (*Conchidium* fauna).

Much of the unit is unfossiliferous. Locally subdivision is possible but the subunits cannot be applied throughout the entire project area. In the author's opinion the unit should be considered as a general one composed mainly of carbonate rock and Ordovician to Silurian in age.

Unit 8a is believed to be of Middle to Late Ordovician age. In addition to the fossil collections from unit 8a, early Middle Ordovician (Llanvirnian) graptolites (F 28) were collected from stratigraphically beneath unit 8a and Late Ordovician (*Bighornia–Catenipora* fauna F 10) from stratigraphically above unit 8a in the composite section in the Hart Lake area.

Correlation

Unit 8 is believed to be a facies equivalent of the Road River Formation as described by Jackson and Lenz (1962) and used in this report (unit 9). Carbonate rocks of Cambrian to Silurian age have been mapped by Norris *et al.* (1963) immediately northward of the project area and in the Mackenzie and Northern Ogilvie Mountains. Raasch *et al.* (1961) describe *Aulacopleura socialis* fauna from carbonate rocks in the Prong Creek area (65°17′N, 135°45′W) about 20 miles north of Nash Creek map-area. Norford (1964) has described numerous sections of carbonate-bearing rocks north of the project area. With one exception, formational names have not been suggested.

An andesite or basalt flow, about the same age as rocks of unit 8a, has been described in the Glacier Lake area, about 270 miles southeast (Gabrielse *et al.*, 1965, p. 15).

Unit 9, Road River Formation

Graptolite-bearing rocks referred to as the Road River Formation (9) outcrop in three localities: a northern area in the northwest corner of Dawson map-area, a central area of two bands that extend from the western side of Larsen Creek map-area to Tintina Trench, and a southern area in the southeast corner of Dawson map-area and the southwest corner of Larsen Creek map-area. In the northern area the formation is believed to be about 500 feet thick. In the central and southern areas the relatively wide distribution suggests a minimum thickness of several thousand feet.

The Road River Formation was proposed by Jackson and Lenz (1962) for Siluro-Ordovician graptolitic shales and carbonates of northern Yukon. All the stages and subseries in the Ordovician and Silurian of Britain are recognized. The type section is located on a tributary of Road River approximately 120 miles north of the boundary of Nash Creek and Larsen Creek map-areas (66°44′N, 135°46′W). Other described sections are those by Norford (1964) in northern Yukon, including one in Dawson map-area, and Brabb and Churkin (1965) in Alaska, close to the northwest corner of Dawson map-area.

Outcrop Characteristics

The formation does not outcrop well and areas underlain by rocks assigned to it are characterized by subdued topography and heavy vegetation. Along creek gorges and on a few of the steeper mountain faces thinly bedded black rocks typical of the unit outcrop.

Lithology

The unit consists of black to drab shale with varying amounts of thinly bedded dark chert, chert–pebble conglomerate, and impure gritty quartzite.

In the central area two bands extending from the western part of Larsen Creek map-area to Tintina Trench consist mainly of black and brown shale, with some chert and minor chert–pebble conglomerate and quartzite.

In the southern area scattered exposures of the Road River Formation (9) consist mainly of broken black shale and buff silty argillite with minor amounts of black chert and gritty quartzite.

Typical lithology of the Road River Formation in the northern area is given by the following sections, the first measured in the northwest corner of Dawson map-area, 4 miles southwest of the mouth of Monster River (64°55′N, 140°58′W):

Unit	Lithology	Thickness (feet) Unit	Total from base
	Overlying beds of unit 13 Disconformity?		
	UNIT 9 (ROAD RIVER FORMATION)		
6	Covered	15	500
5	Shale, black, very fine grained, fissile; poorly preserved graptolite fragments	10	485
4	Covered	375	475
3	Chert, thin-bedded, black, grading to siliceous argillite	10	100
2	Covered	75	90
1	Chert, thin-bedded, black, grading to siliceous argillite*	15	15
	Accordant contact Underlying beds—unit 7		

* Fossil collection F 59 was obtained from thin-bedded black shale and dark brown limestone occurring in a 90-foot interval between limestone conglomerate of unit 7 and chert of unit 9, in a branch of the creek lying about one quarter mile south of the branch in which the above section was measured.

Section of the Road River Formation slightly modified from a description given by Norford (1964, pp. 69–71) of a section measured near the headwaters of Monster River in Dawson map-area (64°55′N, 139°35′W):

Unit	Lithology	Thickness (feet) Unit	Thickness (feet) Total from base
	Overlying beds Relationship not observed		
	UNIT 9 (ROAD RIVER FORMATION—Ordovician and Silurian)		
5	Shale, limy, dark grey, weathers dark grey, very recessive, graptolites (GSC loc. 53274; Upper Silurian, lower Ludlow)	10	409 (?)
4	Covered interval, stratigraphic thickness estimated only........	300 (?)	399 (?)
3	Shale, limy, greyish black, weathers greyish black, recessive, moderately to very fissile; very rare bedded chert and argillaceous limestone, graptolites......................	5	99
2	Shale, limy, dark grey, greyish black, weathers dark grey, greyish black, grey, recessive, moderately to very fissile; graphitic sheen on some partings; paper shale, limy, brownish black, greyish black, weathers black, very recessive, very fissile; commonly with off-white mineral dusting; chert, dark grey, weathers dark grey, greyish black, recessive, bedding ½ inch to 3 inches, comprising 5 to 10% of unit; argillaceous limestone dark grey, weathers grey, light grey, recessive, bedding ½ inch to 8 inches comprising 10 to 20% of interval of top 14 feet and as large concretions at some horizons in bottom 24 feet; graptolites, except in bedded cherts (GSC loc. 53270—Ordovician, Caradoc, 34 to 36 feet above base).	70	94
1	Shale, limy, brownish black, black, weathers greyish black, black, brownish black, very recessive, soft, moderately to very fissile; rare calcite stringers and rare pyrites; graptolites....	24	24
	Covered interval including top and back-slope of mountain, and containing a projected fault; stratigraphic thickness unknown, could be negligible or several hundred feet; base positioned at last outcrop of unit 8 and top at base of outcrop of unit 9		

Structure

In most places the Road River Formation (9) is too poorly exposed to determine the structure. However, in a number of creeks where it is reasonably well exposed the rocks of the formation were observed to be highly folded and faulted. Chevron folds in the more competent members and mashed zones in the shale appear to be common. In the southern area rocks similar to those mapped as unit 3 occur within the area mapped as Road River Formation (9) and may be infolded.

In the northern area no disconformity is recognized between the underlying carbonate rocks (8) and the Road River Formation (9), and the formation is believed to be overlain unconformably by unit 13.

In the central area the northern band mapped as the Road River Formation appears to overlie carbonates of unit 2 unconformably, and the relationship to the volcanic rocks (5) and unit 3 south of the band is uncertain. The southern band is believed to overlie rocks of unit 3, probably unconformably, and to be overlain by a thin band of limestone of Permian age (16) followed by younger argillite of unit 17 (Tempelman-Kluit, 1966).

In the southern area the Road River Formation is believed to overlie rocks of unit 3, although the presence of gritty rocks in the area mapped as the Road River Formation (9) suggests that there may be infolding of the two units (3 and 9). No overlying rocks are exposed.

Age

The following collections were made from the northern area:

F 57 GSC loc. 47123 (64°51′N, 140°31′W), 18½ miles northeast of Boundary, Y.T.
Monograptus bohemicus (Barrande)
Age: Late Silurian (Ludlovian)

F 58 GSC loc. 47126 (64°50½′N, 140°31′W), bank of Monster River
Monograptus sp. indet.
Age: Silurian

F 59 GSC plant loc. 5801 (64°56½′N, 140°58′W), 1 mile east of Boundary Marker 105, Dawson map-area
lingulid brachiopod
trilobite
graptolite fragments
?*Dicellograptus* sp.
Climacograptus sp.
Age: Middle or Late Ordovician

The following collections were made from the centre band:

F 60 GSC loc. 47149 (64°42′N, 138°08½′W), 7 miles south-southeast of Lomond Lake
orthoceroid nautiloid
Age: Paleozoic, probably Ordovician or Silurian

F 61 GSC loc. 47116 (64°41½′N, 138°08′W), 7½ miles south of Lomond Lake
Monograptus spp. indet.
Diplograptus s.l. spp. indet.
Age: Early Silurian (Llandoverian)

F 62 GSC loc. 47104 (64°30′N, 138°47′W), 10 miles northeast of Little Twelve Mile power plant
Graptoloidea gen. and sp. indet.
Age: Ordovician or Silurian

F 63 GSC loc. 47112 (64°34½′N, 139°07′W), 10 miles southeast of Seela Pass
Monograptus dubius (Suess)
M. spp. indet.
Age: Middle or Late Silurian, probably Late Silurian (Ludlovian)

F 64 GSC loc. 47218 (64°40½′N, 138°49′W), 3 miles southeast of Seela Pass
unidentifiable graptolites

F 65 GSC loc. 47124 (64°37½′N, 140°07′W), 8 miles southwest of Mount Harper
Monograptus bohemicus (Barrande)
Age: Late Silurian (Ludlovian)

F 66 GSC loc. 37092 (64°38½'N, 140°06'W), Dawson map-area
dendrograptid
?*Lingula* sp.
undet. trilobite fragments
Age: Late Ordovician

The following collections were made from the southern area:

F 67 GSC loc. 47127 (64°11'N, 137°52'W), 11 miles north of mouth of Aussie Creek
Diplograptus s.l.
Age: Ordovician or Early Silurian

F 68 GSC loc. 47129 (64°11'N, 137°52'W), 11 miles north of mouth of Aussie Creek
Dicranograptus sp. indet.
Orthograptus cf. *O. calcaratus* Lapworth
Diplograptus s.l. spp. indet.
Age: Middle Ordovician (probably Caradocian)

F 69 GSC loc. 47118 (64°08'N, 137°53'W), 8 miles north of mouth of Aussie Creek
Dicellograptus cf. *D. complanatus* Lapworth
Diplograptus s.l. spp. indet.
Age: Middle or Late Ordovician, probably Late Ordovician (Ashgillian)

E 70 GSC loc. 47114 (64°04'N, 138°12'W), 4½ miles north of South Fork Intake
Paraplectograptus eiseli (Manck)
Monograptus sp. indet.
Age: Middle or early Late Silurian, probably Middle Silurian (Wenlockian)

F 71 GSC loc. 47119 (64°07'N, 138°10½'W), 8 miles north of South Fork Intake
Monograptus sp. indet.
Age: Silurian

F 72 GSC loc. 47111 (64°09'N, 138°13'W), 9 miles east of mouth of Antimony Creek
Diplograptus s.l.
Age: Ordovician or Early Silurian, but probably Ordovician

F 73 GSC loc. 47125 (64°14'N, 138°09'W), 12 miles northeast of mouth of Antimony Creek
Climacograptus sp. indet.
Orthograptus quadrimucronatus (Hall)
Age: Middle Ordovician (latest Caradocian)

F 74 GSC loc. 47121 (64°14'N, 138°10'W), 12 miles northeast of mouth of Antimony Creek
Diplograptus s.l. sp. indet.
Age: Ordovician or Early Silurian

The collections were examined by R. Thorsteinsson with the exception of F 59 and F 60 examined by B. S. Norford and F 66 by D. J. McLaren and A. W. Norris, all of the Geological Survey of Canada.

Correlation

A complete sequence of the Road River Formation as described by Jackson and Lenz (1962) was not recognized in the present map-areas although graptolitic faunas ranging in age from Middle Ordovician to Late Silurian were collected from widely scattered localities. Fossils, including some graptolitic faunas, collected from the massive carbonate rocks of unit 8 indicate that this unit is, in large part, the facies equivalent of the Road River Formation in much of the present area.

Norris *et al.* (1963) have mapped extensive areas of the Road River Formation in the Ogilvie and Richardson Mountains, north of the project area. About 150 miles southeastward Roddick and Green (1961 a, b) mapped extensive areas of chert, shale, and minor chert–pebble conglomerate of Ordovician to Silurian age which appears to correlate with the Road River Formation as presently mapped.

Unit 10

Unit 10 occurs in the northern half of Nash Creek map-area. Its thickness varies widely but is as much as 3,500 feet in a section near Royal Creek.

Outcrop Characteristics

The carbonate rocks assigned to the unit are competent, and the area underlain by them has steep faces with little or no vegetation. The rocks are strongly banded and this serves to distinguish them from the much more uniform carbonate rocks of both the underlying unit 8 and the overlying unit 11.

Lithology

Rocks assigned to unit 10 consist almost entirely of fine-grained dolomite. Weathered surfaces show a characteristic banding among grey, brown, and occasionally dark grey beds with the individual beds rarely more than 5 feet thick. Two sections were measured where rocks of unit 10 are well exposed.

Section near Royal Creek (about 64°53′N, 134°53′W):

		Thickness (feet)	
Unit	Lithology	Unit	Total from base
	Overlying beds of unit 11 (Ogilvie Formation) Conformable contact		
	UNIT 10		
4	Dolomite, fine-grained, some small patches of secondary calcite, buff, grey, and brownish grey, weathers light grey to dark grey, thinly laminated with distinct colour bands every 3 to 5 feet	1,350	3,540
3	Dolomite, fine-grained, some small patches of secondary calcite, light to dark grey, weathers dark brown to light grey, thin- to medium-bedded	750	2,190
2	Dolomite, fine-grained, some small patches of secondary calcite, light grey and dark brownish grey, weathers buff-grey, alternating light and dark bands 6 inches to 6 feet thick	500	1,440
1	Dolomite, fine-grained, light grey to dark brownish grey, weathers light grey with alternating colour banding 6 inches to 5 feet thick; thin band of dolomite conglomerate 230 feet above base	940	940
	Conformable contact Underlying beds—unit 8 (Silurian carbonate)		

Section 11 miles west of Hart Lake, Nash Creek map-area (about 64°36′N, 135°32′W)

Unit	Lithology	Thickness (feet) Unit	Total from base
	Top not exposed		
	UNIT 10		
6	Dolomite, fine-grained, grey, weathers grey and buff, beds 2 inches to 1 foot; minor dolomite breccia and a thin shale bed about 10 feet above the base	150+	1,070+
5	Dolomite, fine-grained, grey, dark grey, and black, weathers buff, yellow, grey, and black, variegated colour banding in beds 6 inches to 2 feet thick	450	920
4	Dolomite, fine-grained, buff-grey, weathers buff to yellowish grey, beds 2 to 6 feet thick	50	470
3	Dolomite, fine-grained, light grey, weathers buff-grey, beds 2 to 6 feet	70	420
2	Dolomite, fine-grained, vuggy, dark grey with white traces of bryozoan (?), weathers dark grey, beds 6 inches to 1 foot...	110	350
1	Dolomite, fine-grained, interbedded medium to dark grey, weathers light to dark grey, beds 6 inches to 2 feet	240	240
	Gradational contact Underlying carbonate rocks—unit 8		

Structural Relations

Most of the rocks of the unit are exposed in open folds characterized by gentle to moderate dips. A few more complex structures are present near Hart Lake.

The unit is believed to overlie unit 8 conformably and to be overlain conformably by unit 11.

Age and Correlation

No identifiable fossils were found in unit 10. A Late Silurian to lower Middle Devonian age is suggested by its stratigraphic position between rocks of these ages (units 8 and 11).

Unit 10 is correlative to the Gossage Formation as introduced by Tassonyi (1969) in the Mackenzie River area and described by Norris (1968a, Fig. 9) to the north of the present area. One section (9 of Norris, location 65°14′N, 135°11–14′W) containing about 700 feet of the Gossage Formation is about 18 miles north of outcrops of unit 10 in Nash Creek map-area. Norris (op. cit.) reports that the age of the formation in the vicinity of the type section is still in doubt because very few fossils were found. Scattered collections (Norris, op. cit.) suggest that the formation is of Upper Silurian, or possibly Lower Devonian, to early Middle Devonian age.

Both unit 10 and the Gossage Formation appear to correspond closely in lithology to and to occur in about the same stratigraphic position as the Arnica Formation (Douglas and Norris, 1963, p. 16) in Dahadinni map-area, about 250 miles east-southeast of Nash Creek map-area.

Unit 11, Ogilvie Formation

Unit 11 is near Hart Lake and Royal Creek in Nash Creek map-area and east of the forks of Hart River in Larsen Creek map-area. The formation is believed to be more than 500 feet thick.

Outcrop Characteristics

The unit is more competent than the underlying rocks of unit 10 and commonly forms steep light grey to buff weathering bluffs. The much thicker bedding of rocks of unit 11 makes the two readily distinguishable from the air.

Lithology

Rocks assigned to the unit consist mainly of fine-grained, dark grey to black, grey weathering, highly fossiliferous limestone. They are characteristically thick bedded and bluff forming. The following two sections are typical.

Section near Royal Creek, Nash Creek map-area (64°53′N, 134°53′W):

Unit	Lithology	Thickness (feet) Unit	Thickness (feet) Total from base
	Overlying rocks not exposed		
	UNIT 11		
5	Limestone, dark grey to black, fine-grained, weathers buff, thick-bedded, abundantly fossiliferous, collection F 80 from base	100	900
4	Limestone, dark grey to black, fine-grained; weathers buff; medium-bedded; F 79 from centre of unit, F 78 from base.	140	800
3	Limestone, dark brown, fine-grained; weathers buff; massive with a few thin beds of dark limestone, fossil collection F 77, 70 feet from base	240	660
2	Limestone, interbedded dark and light grey, fine-grained, thin-bedded; fossil collection F 76, 180 feet from base, F 75, 152 feet from base	240	420
1	Limestone, light grey, fine-grained, weathers whitish grey, medium- to thick-bedded	180	180
	Conformable contact Underlying carbonate rocks—unit 10		

Section 4 miles northeast of mouth of Middle Fork of Hart River, Larsen Creek map-area (64°57′N, 136°58′W):

Unit	Lithology	Thickness (feet) Unit	Total from base
	Top not exposed		
	UNIT 11		
2	Limestone, fine-grained; dark grey to black; weathers medium grey; beds to about one foot; fossil collections F 82 and F 83 from near top	60	125
1	Limestone, fine-grained, black, weathers medium grey, beds to about 4 feet, fossil collection F 81 about 50 feet above base	65	65
	Relationship unknown Talus of grey-brown, orange to pink weathering, thin-bedded limestone, probably part of unit 8; fossil collection F 27 of Late Silurian age about 325 feet below base of lower limestone		

In the area about 5 miles southeast of Hart Lake the formation is composed mainly of fine-grained grey limestone with some interbedded dolomite and is believed to be a few hundred feet thick.

Structure

Rocks assigned to the formation have undergone the same structural history as the underlying rocks of units 8 and 10. Generally, beds are gently dipping but the unit has undergone some tight folding southeast of Hart Lake.

At Royal Creek and near Hart Lake unit 11 appears to overlie unit 10 conformably but in the Larsen Creek area it overlies unit 8, presumably disconformably. Near Hart Lake unit 11 is overlain unconformably by unit 14.

Age

The following fossil collections were made from unit 11:

F 75 GSC loc. 47239 (64°54′N, 134°57′W), ridge between Royal Creek and Wind River
auloporid?
Trachypora? sp.
Age: Middle? Devonian

F 76 GSC loc. 47225 (64°54′N, 134°57′W), ridge between Royal Creek and Wind River
Trachypora? sp.
large leperditiid ostracod (M.J. Copeland)
Age: lower? Middle Devonian or older

F 77 GSC loc. 47230 (64°54′N, 134°57′W), ridge between Royal Creek and Wind River
stromatoporoid
Favosites sp. — coarse form
Hexagonaria sp.
large rugose coral
crinoid ossicles with two holes
crinoid ossicles with circular single holes
Age: lower Middle Devonian

F 78[1] GSC loc. 47164 (64°54′N, 134°57′W), ridge between Royal Creek and Wind River
crinoid ossicles (some with two holes)
Paracyclas sp.
Atrypa cf. *A. asperanta* Crickmay
Age: early Middle Devonian

F 79[1] GSC loc. 47167 (64°54′N, 134°57′W), ridge between Royal Creek and Wind River
cf. *Alveolites* sp.
cf. *Gypidula* sp.
Age: Silurian or Devonian, probably Devonian

F 80 GSC loc. 47232 (64°54′N, 134°57′W), ridge between Royal Creek and Wind River
Schizophoria sp.
Gypidula sp.
Delthyris? sp.—impression of fragment
Warrenella? sp.
'*Fenestella*' sp.
proetid tails
crinoid ossicles with two holes
crinoid ossicles with cross-like holes
Age: lower Middle Devonian

F 81 GSC loc. 47089 (64°58′N, 136°57′W), 4 miles northeast of forks of Hart River
rugose corals
Longispina? sp. fragment
Age: Middle Devonian

F 82 GSC loc. 47088 (64°58′N, 136°57′W), 4 miles northeast of forks of Hart River
rugose coral fragment
Gypidula? sp.
crinoid ossicles with two holes—to Index Coll.
Age: lower Middle Devonian

F 83 GSC loc. 47094 (64°58′N, 136°57′W), 4 miles northeast of forks of Hart River
rugose coral
undet. productellid? fragment
crinoid ossicles with two holes
crinoid ossicles with cross-like holes—to Index Coll.
Age: lower Middle Devonian

F 84 GSC loc. 47227 (64°55′N, 134°51′W), ridge between Royal Creek and Wind River
Favosites sp.—large form
Hexagonaria? sp.
Schuchertella? sp.
crinoid ossicles with two holes
crinoid ossicles with single large pentagonal holes
Age: lower Middle Devonian

F 85 GSC loc. 47229 (64°59½′N, 134°54′W), on small hilltop 2 miles west of Wind River, near north edge of Nash Creek map-area
stromatoporoid
Favosites sp.
Hexagonaria sp.
gastropod with coarse ornamentation
Atrypa sp.—f. costate
Spinatrypa sp.
Spirifer sp.—impression of a very large form
crinoid ossicles with circular holes
Age: Middle Devonian

[1]Examined by B. S. Norford, Geological Survey of Canada.

F 86 GSC loc. 47103 (64°34′N, 134°56′W), 6 miles east-southeast of Hart Lake
Gladopora sp.
Favosites sp.—large form
undet. rugose corals
undet. planisperal gastropods
Conocardium? sp.—fragment
crinoid ossicles with two holes
crinoid ossicles with cross-like holes
Age: lower Middle Devonian

F 87 GSC loc. 47228 (64°31′N, 134°57′W), 8 miles southeast of Hart Lake
Warrenella? sp.
Age: Devonian

F 88 GSC loc. 47231 (64°31′N, 134°57′W), 8 miles southeast of Hart Lake
undet. rugose coral
Age: Devonian

F 89 GSC loc. 47089 (64°32′N, 134°59½′W), 6 miles southeast of Hart Lake
Favosites sp.
Hexagonaria sp.
rugose corals
crinoid? head
crinoid ossicles
Age: Middle Devonian

F 90 GSC loc. 47097 (64°32′N, 134°59½′W), 6 miles southeast of Hart Lake
Schizophoria? sp.—very large form
Age: Middle Devonian

F 91 GSC loc. 47107 (64°36½′N, 135°25′W), 7.5 miles west of Hart Lake
undet. gastropods
crinoid ossicles with cross-like holes
crinoid ossicles with pentagonal holes
Age: lower Middle Devonian

The collections, with the exception of F 78 and F 79, were examined by A. W. Norris of the Geological Survey of Canada, who comments that rocks of unit 11 where definitely dated appear to be of lower Middle Devonian (Eifelian) age. The crinoid ossicles with two holes, pentagonal-shaped holes, or cross-like holes are tentatively considered to indicate a lower Middle Devonian (Eifelian) age on the basis of their stratigraphic position and association with definitely dated elements.

Correlation

Rocks of map-unit 11 correlate with the Ogilvie Formation proposed by Norris (1968a), to the north of the present map-area, for resistant beds overlying the Michelle and Gossage Formations and underlying a tongue of the Hare Indian Formation, unnamed shales of Middle Devonian and younger (?) age, and clastic rocks and carbonates of Carboniferous age. The type section, near Mount Burgess (63°03′N, 139°35.2′–37′W), is about 74 miles beyond the northern boundary of Dawson map-area. Rocks assigned to the formation occur north of the present map-areas from about 136°W to the International Boundary (141°W) and in a much smaller northwest-trending band extending along Wind River north of outcrops of unit 11 in Nash Creek map-area.

Norris reports (op. cit.) that the lower contact of the Ogilvie Formation is sharp and possibly disconformable with both the Michelle and Gossage Formations and that the upper contact is diachronous, as younger beds are developed to the northwest. The thickness in his measured sections ranges from 615 to 2,638 feet although the latter may not be reliable. Fauna from the lower part of the Ogilvie Formation are dated as lower Middle Devonian (Eifelian) and those from locally developed upper beds as upper Middle Devonian (Givetian).

Unit 12

Rocks assigned to unit 12 underlie a basin about 25 miles long in the northern part of Nash Creek map-area. Thickness in one well-exposed section was about 2,360 feet. The unit as mapped includes parts of the Road River and Prongs Creek Formations proposed north of the project area (Norris, 1968a).

Fossil collections made in 1961 suggested that unit 12 might contain rocks of Lower Devonian age, and the area was revisited in 1964, at which time the section described was measured and a number of intriguing fossils (F 92 to F 103 inclusive) collected.

Outcrop Characteristics

Rocks of unit 12 are incompetent compared with nearby massive carbonate rocks of unit 8, and dark low-lying outcrops of the former contrast vividly with the surrounding peaks of light grey weathering carbonate rock. Most of the rocks of unit 12 are thinly bedded and severely affected by frost action, resulting in long talus slopes of fine black material with minor vegetation cover. Rocks of the overlying units 13 and 15 are also incompetent but can generally be recognized by variegated or brown weathering colours.

Lithology

The main lithology is black, thin-bedded, platy limestone, commonly argillaceous and siliceous, interbedded with lesser amounts of black shale and chert.

The following section was measured where rocks of unit 12 are particularly well exposed near the head of Royal Creek in Nash Creek map-area (about 64°46′N, 135°14′W):

Unit	Lithology	Thickness (feet) Unit	Thickness (feet) Total from base
	Overlying rocks of unit 14 Probable conformable contact		
	UNIT 13 (?)		
25	Covered, talus of dark grey to black shale observed in nearby draw	250	2,850
24	Talus, of soft black shale, non-limy	75	2,600
23	Talus, shale, non-limy, weathers light grey, grey, and reddish brown; minor chert and black limestone	150	2,525
22	Covered	15	2,375
	UNIT 12		
21	Talus, similar to unit 20	45	2,360

Unit	Lithology	Thickness (feet) Unit	Total from base
20	Interbedded chert and limestone, beds to 6 inches; chert, black, weathers brownish grey; limestone, black, weathers black, contains tentaculites	190	2,315
19	Talus of platy black limestone	30	2,125
18	Limestone, lower 35 feet platy black limestone with tentaculites, weathers grey, overlain by fossiliferous brown limestone F 102 and capped by disturbed platy black limestone	50	2,095
17	Limestone, fine-grained, dark grey, brown weathering, well-banded with beds a fraction of an inch to several feet; minor chert lenses parallel bedding and veinlets of recrystallized calcite cut bedding	145	2,045
16	Talus of platy, brown weathering limestone; probably from unit 17	130	1,900
15	Talus of brown weathering, dark grey, platy limestone, breaks in plates ¼ inch or less thick; minor thin beds of crinoidal limestone and chert; small outcrop 205 feet above base contains tentaculites	260	1,770
14	Limestone, fine-grained, dark grey, weathers grey, lower beds platy and a few inches thick grading to as much as 3 feet thick near top; minor chert lenses a few inches long parallel to the bedding; fossiliferous beds throughout, F 100 and F 101 from top few feet	115	1,510
13	Talus and one small outcrop (80 feet above base) of limestone, fine-grained, black, weathers grey, black, and brown, breaks in ¼-inch plates	265	1,395
12	Talus and outcrop of limestone, fine-grained, dark grey, weathers grey, irregular fracturing; contains numerous brachiopods, in part silicified, F 99	45	1,130
11	Limestone, fine-grained, black, weathers grey and black, platy with most beds 1 inch or less, contains abundant tentaculites and scattered graptolites F 98	115	1,085
10	Limestone, interbedded: (i) bioclastic, beds to 6 feet, grey, weathers brownish grey, and (ii) dark grey banded, F 97	30	970
9	Limestone, interbedded: (i) platy, dark grey, weathers grey; and (ii) bioclastic, grey, brown weathering, F 96	65	940
8	Talus and outcrop of limestone, fine-grained, black, weathers grey and black, commonly contains tentaculites	125	875
7	Limestone, bioclastic, dark grey, weathers grey, beds a few inches to 1 foot, F 95	15	750
6	Limestone, mostly fine-grained, dark grey, weathers grey, bedding mainly 2 to 3 inches but a few bioclastic beds to about 1 foot	15	735
5	Talus and outcrop of limestone, black, weathers grey and black, thin-bedded and platy, F 94	100	720

Unit	Lithology	Thickness (feet) Unit	Total from base
4	Limestone, fine-grained but in part bioclastic, dark grey, weathers brown, talus forms irregular platy blocks, F 93	90	620
3	Talus of limestone, black, platy and thin-bedded, small outcrop 45 feet above base	110	530
2	Limestone, fine-grained, crinoidal dark grey, weathers buff to grey, beds to 6 inches, breaks in irregular plates, F 92	20	420
1	Talus of limestone, fine-grained, black, weathers grey, thin-bedded and shaly	400	400
	Unconformable contact (?) Underlying beds of unit 8, containing F 14 of Late Ordovician age		

Structure

Most of the area underlain by unit 12 consists of an open, northwest-trending, synclinal structure. However, the southwest limb of this structure is involved in tight folding and faulting, also with northwest trends. Eastward the basin underlain by rocks of unit 12 ends abruptly against a steep wall of massive carbonate rocks of unit 8. This contact is believed to be faulted but relationships observed where the section was measured on a tributary of Royal Creek (64°48′N, 135°11′W; described under map-unit 8) suggest that rocks of unit 12 overlie those of unit 8 unconformably and that the two sharply contrasting facies have been telescoped together with relatively minor displacement.

Unit 12 is believed to lie unconformably on unit 8 and to be a facies equivalent of parts of units 8 (?), 10, and 11. It is overlain, probably conformably, by unit 13.

Age

The following fossil collections were made from rocks of unit 12 in the section given:

F 92 GSC loc. 64888 (64°46′N, 135°15′W), Royal Creek section, 12 miles north-northwest of Hart Lake, Nash Creek map-area
- *Favosites* sp.
- *Heliolites* sp. A*
- *Tryplasma* cf. *T. devoniana* Soskina*
- *Charactophyllum*? sp.*
- *Neocolumnaria*? sp.*

F 93 GSC loc. 64889
- *Xystriphyllum* sp. B*
- *Favosites* sp.
- *Coenites* sp.
- solitary rugose coral
- echinoderm fragments

F 94 GSC loc. 64896
- *Coenites* sp.
- *Coenites* cf. *C. rectilineatus* (Simpson)

*In Index Collection, Geological Survey of Canada.

Xystriphyllum sp. A*
Striatopora sp.
bryozoan
Fardenia? sp.
Isotrypa? sp.
Cymostrophia sp.
Leptagonia sp.
cf. *Howellella* sp.*
'*Camarotoechia*' sp.
Sphaerirhynchia? sp.
Styliolina sp.
Tentaculites sp.
ostracod
echinoderm ossicles with single axial canals

F 95 GSC loc. 64891
Neostringophyllum sp. A*
Cymostrophia? sp.
Gypidula sp. cf. *G. procerula* (Barr.)*
Gypidula sp.—c. costate*
Gypidula sp.—smooth form*
Leptagonia sp.*
Megastrophia? sp.*
Schuchertella? sp.*
Carinatina? sp. 1*
Atrypa sp. 1*
Atrypa cf. *A. parva* Hume*
Spinatrypa sp.*
Sphaerirhynchia? sp.*
Stegerhynchus? sp.
Conocardium sp.*
pelecypod—f. costate*
Tentaculites sp.
cf. *Parakionoceras* sp.*
orthoconic cephalopod fragments
ostracod

F 96 GSC loc. 64893
Coenites sp.
Favosites sp.
rugose coral
bryozoan
Cymostrophia sp.
Leptagonia sp.
Megastrophia? sp.
Styliolina
Tentaculites sp.
ostracods
Dechenella sp.
echinoderm ossicles with single axial canals
graptolite impressions

F 97 GSC loc. 64897
rugose coral fragments
Heliolites? sp.
bryozoan fragment
Strophonella? sp.
Gypidula? sp.—large form with costae on fold
Leptagonia sp.
Atrypa sp. cf. *A. reticularis* Linnaeus
Platyceras sp.

Tentaculites sp.
orthoconic cephalopod fragment
echinoderm ossicles with single axial canals
Dechenella sp. tail

F 98 GSC loc. 64886
brachiopod
Styliolina sp.
Tentaculites sp.
Monograptus yukonensis Jackson and Lenz

F 99 GSC loc. 64898
Styliolina sp.
Tentaculites sp.
orthoconic cephalopod fragment

F 100 GSC loc. 64894
Favosites sp.
bryozoan
Leptagonia sp.*
Atrypa sp.
Spinatrypa sp.
Warrenella? sp.
Styliolina sp.
orthoconic cephalopod fragment
cf. *Cardiola* sp.*
Platyceras sp.*
ostracod

F 101 GSC loc. 64895
stromatoporoid
"*Hexagonaria*" sp.*
bryozoan
Conocardium sp.
stropheodontid
Gypidula sp.
Carinatina? sp.
Atrypa sp.
Spinatrypa sp.
Styliolina sp.
fairly large echinoderm ossicles with single axial canals

F 102 GSC loc. 64890
Favosites? sp.
Gypidula? sp.
Chonetes? sp.
Atrypa sp.—m. costate
ambocoeliid?
echinoderm ossicles with single axial canals
echinoderm ossicles with double axial canals

Age: Upper Eifelian (early Middle Devonian)

The collections with the exception of F 98 were examined by D. J. McLaren and A. W. Norris, both of the Geological Survey of Canada, who comment as follows:

Comments on Coral Faunas (D. J. McLaren, 28 January, 1965)

The corals are of the greatest interest and as far as we know are new to Canada. They occur in an interval that has yielded few if any corals to date and are presumably of an age whose rocks seldom contain well-preserved compound rugose corals. The preservation is superb, but identification even to genus most difficult. The following remarks are essentially preliminary.

F 92 (64888)

There are few *Heliolites* species in the North American Devonian, and this one is new. The genus is commonly typically Devonian, especially as recent Russian work has split off several new Silurian genera from *Heliolites* sens. lat. The Royal Creek specimen is a true *Heliolites.*

Tryplasma is a Silurian and Lower Devonian genus, with rare species in the Middle Devonian. The specimen is fairly close to *T. devoniana*, which occurs in the Coblenzian of the Urals. *Neocolumnaria*? sp. resembles Soshkina's genus from the Middle Devonian of the Urals, but the corallite is too worn to be sure of generic identity. It is not easily assigned to any other genus. The *Charactophyllum*-like form is not easily assigned to a genus, in some respects it resembles *Mictophyllum* but it is probably distinct. A slightly similar form is reported from the Lower Devonian of New South Wales under the name *Mictophyllum* although the type species of that genus is of Upper Devonian age.

Although the fauna is unfamiliar it is difficult to consider it Silurian. Tentatively, therefore, it is assigned to the Lower Devonian, without attempting to suggest a Stage within the Series.

F 93 (64889)

Identification of some of the cerioid forms is complicated by uncertainty concerning the validity of certain genera. *Xystriphyllum* sp. B might be better assigned to *Spongophyllum* but corresponds with the concept of the former genus as described from the Lower Devonian of Australia. The age is probably Lower Devonian.

F 94 (64896)

Xystriphyllum sp. A also may be a spongophyllid.

F 95 (64891)

Neostringophyllum has been considered an exclusively Middle Devonian genus, although closely related acanthophyllids are widespread in the Lower Devonian.

F 101 (64895)

The *Hexagonaria* is fairly close to a species described from the Lower Devonian of Victoria, Australia; but no real comparison is possible without a longitudinal section, which cannot be obtained.

Comments on Brachiopod Faunas (A. W. Norris, 28 January, 1965)

Collection F 102 (64890) containing echinoderm ossicles with double axial canals and other forms, is dated tentatively as mid-Eifelian (early Middle Devonian). The distinctive 'two-holer' ossicle occurs in beds below the Hume Formation and equivalent strata and above beds containing the fauna referred to below.

The rich brachiopod fauna from beds overlapping the upper range of *Monograptus yukonensis* is new and still not studied. This fauna was first encountered in 1962 on Operation Porcupine and is present in the lower third of an essentially dark shale and carbonate sequence named the Prongs Creek Formation by Norris (1968b). The goniatite *Anetoceras* sp. was found near the top of lower division, which according to M. R. House (personal communication) suggests a late Lower Devonian (Emsian) age for the containing beds. Some of the brachiopods overlapping *M. yukonensis* from the Royal Creek area have been examined by two Lower Devonian experts, Johnson and Boucot (*in* Jackson and Lenz, 1963, p. 752), who concluded that they are post-Ludlow and probably early Gedinnian (early Lower Devonian) in age. From my own comparison, some of the brachiopods are remarkably similar to 'Lower Devonian Brachiopods of the Solovyikhinsky Beds of the Altay Mountains' of Russia, described by N. P. Kulkov (1963).

Other Collections

In addition to those from the Royal Creek section (64°46′N, 135°14′W) one collection was made from the top of a nearby section in 1964 and a number of less diagnostic collections were made during the 1961 field work.

F 103 GSC loc. 64892 (64°48′N, 135°11′W), Royal Creek section, 13 miles north of Hart Lake and about 2 miles northeast of previous collections
Spongophyllum sp. O*
Spongophyllum sp. Q*
Douvillina? sp.
Costispirifer? sp.
Spongophyllum cf. *S. halysitoides* Etheridge*

This collection was examined together with others from the 1964 section by D. J. McLaren, who comments as follows (28 January, 1965):

F 103 (64892)

This is another remarkable assemblage. *Spongophyllum* cf. *S. halysitoides* is very close to Etheridge's species which occurs in the Lower Devonian of Australia, and is reported from the Lower Devonian of the Urals. With further study the species may well prove identical. *Spongophyllum* sp. O is fairly close to *Spongophyllum cyathophylloides* Etheridge from the early Middle Devonian of Australia, the type species of the genus *Australophyllum* Stumm. It is thus difficult to decide which genus sp. O should be assigned to and would seem to combine characteristics of spongophyllid and acanthophyllid corals. The same remarks apply to *Spongophyllum* sp. Q which have some resemblance to the early Middle Devonian coral "*Fasciphyllum*" *varium* Schluter and whose generic assignment remains uncertain. The age of this collection is therefore either Lower or Middle Devonian, but very probably the former, and possibly the same general age as the coral faunas from the Royal Creek section (64°46′N, 135°14′W).

The following lots of less diagnostic fossils were collected during the 1961 field work:

F 104 GSC loc. 47090 (64°39½′N, 135°11′W), 4 miles north of Hart Lake
Favosites? sp.—very small form
Age: Upper Silurian or Lower Devonian

F 105 GSC loc. 47100 (64°39½′N, 135°11′W), 4 miles north of Hart Lake
Cladopora? sp.
Favosites sp.
crinoid ossicles with two holes
crinoid ossicles with cross-like holes
Age: lower Middle Devonian

F 106 GSC loc. 47045 (64°44′N, 135°11′W), 19 miles north of Hart Lake
solitary coral
cf. *Favosites* sp.
rhynchonellid brachiopod
Age: probably Silurian or Devonian

F 107 GSC loc. 47106 (64°46′N, 135°18′W), 12 miles north-northwest of Hart Lake
Tentaculites sp.
Age: Devonian

F 108 GSC loc. 47101 (64°46′N, 135°18′W), 12 miles north-northwest of Hart Lake
Agoniatites? sp.
Bactrites? sp.
undet. tribolite
plant? fragments
Age: Middle Devonian

F 109 GSC loc. 47099 (64°46'N, 135°18'W), 12 miles north-northwest of Hart Lake
stromatoporoid
undet. gastropod
Tentaculites sp.
undet. small finely costate pelecypods
undet. large coarsely costate pelecypod
undet. ammonoids
undet. trilobite head—fragment
Age: probably Middle Devonian

F 110 GSC loc. 47095 (64°46'N, 135°18'W), 12 miles north-northwest of Hart Lake
orthoconic cephalopod—long slender type, very poorly preserved
undet. organic markings
Age: Devonian?

F 111 GSC loc. 47102 (64°48'N, 135°16'W), 6 miles northwest of triangulation station, elevation 7,762, Nash Creek map-area
Coenites? sp.
Favosites sp.
undet. coarsely costate brachiopod fragment
Atrypa? sp. fragments
"*Camarotoechia*" sp.
small echinoderm ossicles with small axial canal
echinoderm ossicles with five pointed star shaped axial canal
Age: probable late Eifelian (lower Middle Devonian)

GSC loc. 47042, same location as 47102
Favosites sp. small form
other rugose and colonial coral fragments
monograptids
Atrypa sp.
Spinatrypa sp.
strophomenids
crinoid ossicles with single circular holes
crinoid ossicles with star-shaped holes
trilobite fragments
Age: probable Lower Devonian on basis of monograptids and echinoderm ossicles

F 112 GSC loc. 47092 (64°41½'N, 135°21'W), 8 miles northwest of Hart Lake
Favosites sp.
undet. rugose corals
undet. brachiopod
crinoid ossicles
Age: Devonian

F 113 GSC loc. 47104 (64°41½'N, 135°21'W), 8 miles northwest of Hart Lake
Favosites sp.—a very small form
Age: Upper Silurian or Lower Devonian

F 114 GSC loc. 47214 (64°47'N, 135°21'W), 4½ miles southeast of triangulation station, elevation 6,619
Styliolina sp.
Tentaculites sp.
Monograptus sp. indet.
Age: This association suggests an Early Devonian age

The above collections were reported by A. W. Norris with the exception of F 106 by B. S. Norford and F 114 by R. Thorsteinsson, all of the Geological Survey of Canada. With the exception of F 111 (GSC loc. 47102), which was reexamined at that time, the collections were reported before those from the Royal Creek section (F 92 to F 102; F 103).

If the fossil collections described above are considered with those described by Lenz (1966, 1968) they indicate that rocks included in unit 12 range in age from Upper Silurian (Ludlovian), through Lower Devonian (Gedinnian, Siegenian, and Emsian), to Middle Devonian (Eifelian). Many collections have been made from this intriguing area and numerous detailed paleontological reports can be expected in the future. In general Royal Creek section (64°46′N, 135°14′W) rocks of unit 12 overlie carbonate rocks of unit 8 of Late Ordovician age (F 14) whereas in a section about 2 miles to the northeast (64°48′N, 135°11′W) they overlie rocks of probable Late Silurian age (F 24), suggesting an unconformity between the two units. Scattered collections from rocks of unit 12 contain fauna similar to those of unit 11 suggesting that the former is, in part, a thinner bedded rock equivalent to the more massive limestone of the latter.

Correlation

Lenz (1966, p. 607) has grouped the rocks assigned to unit 12 loosely within the 'Road River Formation' in his description of the Royal Creek sections, Nash Creek map-area. Rocks assigned to unit 12 are in part correlative with the Prongs Creek Formation proposed by Norris (1968a) for a sequence of dark grey to black shale with interbeds of black argillaceous limestone, and black chert, which overlie shales of the Road River Formation and are overlain by dark grey silty shales of the Canol (?) and Imperial Formations. The type section is on Royal Creek (65°02–04′N, 135°08–10′W) about 20 miles north of the Royal Creek sections described in this report. Norris (1968a) has tentatively drawn the lower contact of the formation above the highest occurrence of monograptids. The formation is separated into three divisions: a lower consisting mainly of dark grey to black shale with thin interbeds of limestone; a middle, of interbedded shale and limestone, in part argillaceous and slightly cherty; and an upper, of interbedded shale and black chert. Norris (1968a) considers the lower division of Lower Devonian age (Gedinnian, Siegenian, and Emsian), the middle of Middle Devonian (Eifelian), and the upper of Middle Devonian (Givetian), or possibly younger. According to Norris, then, rocks of unit 12 would include the upper part of the Road River Formation and the lower and middle divisions of the Prongs Creek Formation. Upper parts of the latter formation have been mapped as unit 13.

Unit 13

Rocks assigned to unit 13 occur in the northern parts of all three map-areas, with the largest area located in northeastern Dawson map-area and the northwestern part of Larsen Creek map-area. Outcrops are poor and little is known of the unit. It is probably several thousand feet thick.

Outcrop Characteristics

Most of the area underlain by rocks assigned to unit 13 is low lying, has little relief, and is mantled by a thick cover of moss and stunted black spruce. Sparse outcrops occur along stream and river valleys and, locally, frost-heaved fragments cap small knolls. Commonly such knolls have a characteristic coloration that is mainly dark grey to black but with bright splashes of yellow, red, and silvery grey.

Lithology

Rocks assigned to the unit consist mainly of thin-bedded, dark grey to black, argillite and chert with minor black limestone. Near the International Boundary, northwest Dawson map-area, unit 13 appears to consist of about 300 feet of brownish grey, thin-bedded shale and siltstone, both with some plant remains, and minor black chert. In Dawson map-area, both northeast of North Fork Pass and north of Monster River, black chert and shale with minor limestone all assigned to unit 13 are in contact with lithologically similar rocks of unit 9, and separation of the two units is arbitrary. In both localities, rocks of unit 13 contain less limestone and frequently weather lighter grey with splashes of red and yellow in contrast to the more sombre weathering rocks of unit 9. Near Lomond Lake in northeast Dawson map-area, unit 13 is capped by a laterally extensive band of chert–pebble conglomerate containing light-coloured chert pebbles to 3 inches in diameter. Fifteen miles northeast of Two Beaver Lake, northwest Larsen Creek map-area, unit 13 consists of black slate and argillite with minor thin beds of dark limestone.

Age

Rocks of the unit contain few fossils although tentaculids or indeterminate plant remains may be present locally. The following collections were made from rocks included in the unit:

F 115 GSC loc. 47194 (64°55′N, 137°33′W), 12½ miles north-northwest of Two Beaver Lake, Larsen Creek map-area
cf. *Spathiocaris* sp.
Age: probably Late Devonian or Early Mississippian

F 116 GSC loc. 47238 (64°54½′N, 137°43′W), 14½ miles northwest of Two Beaver Lake, Larsen Creek map-area
Tentaculites sp.
crinoid ossicles with two holes
crinoid ossicles with single small circular holes
Age: lower Middle Devonian

F 117 GSC loc. 47233 (64°53′N, 137°45′W), 13 miles northwest of Two Beaver Lake, Larsen Creek map-area
Tentaculites sp.
Age: Devonian

F 119 GSC loc. 47234 (64°39′N, 137°47′W), 13 miles southwest of Two Beaver Lake, Larsen Creek map-area
Tentaculites sp.
Age: Devonian

F 120 GSC plant loc. 5797 (64°52½′N, 140°31′W), Dawson map-area, 2 miles north of Monster River
Plant fragments are present in these shales but none are complete enough or diagnostic enough to be identified. Nothing specific can be stated about their age other than that they are very likely post-Silurian and no support can be given to the interpretation that they may be from Upper Devonian sediments.

The collections were examined by A. W. Norris with the exception of F 115 examined by B. S. Norford and F 120 by F. M. Hueber, all of the Geological Survey of Canada. The results suggest a probable Late Devonian age for the unit and that some lower Middle Devonian rocks, probably more correctly belonging to unit 12, have been included within unit 13 as mapped.

Correlation

Lithology of rocks of unit 13 is little known because of poor exposure, and exact correlations to rocks described elsewhere cannot be made. Much of unit 13 in northern Larsen Creek and northeastern Dawson map-areas is probably correlative to Norris' (1968a)

'Unnamed Shale unit' north of the project area. Like the latter, parts of other formations, possibly including the Prongs Creek, Canol, Imperial, McCann Hill Chert, and Nation River, may be included within unit 13. Rocks of unit 13 in the Royal Creek area of Nash Creek map-area are probably correlative with the upper division of the Prongs Creek Formation (Norris, op. cit.).

Unit 13 appears to be, in part at least, correlative with the Canol and Imperial Formations as described by Bassett (1961, pp. 494–497). Norris *et al.* (1963) refer to rocks similar to those of unit 13 as the Imperial Formation but note that as mapped this includes Middle Devonian Hare Indian and Canol Formations. Unit 13 also appears very similar to parts of the Fort Creek and Imperial Formations as described by Hume (1954, pp. 34–46).

Churkin and Brabb (1965, pp. 18–182) have proposed the name McCann Hill Chert for rocks lying west of the International Boundary that are, in part, continuous with those mapped as unit 13 in northwest Dawson map-area. As described, the McCann Hill Chert contains a thinly laminated basal limestone and shale with a fauna of Eifelian (earliest Middle Devonian) age. The rest of the unit consists of alternating chert, siliceous shale, and shale, and contains plant fragments too incomplete for specific identification and some spores of probable Upper Devonian age (op. cit., p. 181).

Unit 13a, Nation River Formation

Rocks assigned to unit 13a occur only in the northwest corner of Dawson map-area. They consist of brown shale, impure brown sandstone, and minor chert–pebble conglomerate. They are described as the Nation River Formation by Cairnes (1914, pp. 88–91), Mertie (1932, pp. 424–428; 1937, pp. 140–145), Churkin and Brabb (1965), and Brabb and Churkin (1964 a and b). Rocks of the unit have been mapped only in the vicinity of the International Boundary and about 15 miles eastward. The lithological similarity of rocks mapped as the Nation River Formation to those of the Monster Formation (unit 22) of Upper Cretaceous and Tertiary (?) age is striking, and it is possible that some of the rocks mapped as the Nation River Formation may, in fact, belong to the younger Monster Formation.

Lithology

The following partial section of rocks assigned to unit 13a was measured near McCann Hill along the International Boundary (64°50′N, 141°00′W):

Unit	Lithology	Thickness (feet) Unit	Thickness (feet) Total from base
	Top not exposed		
	UNIT 13a		
9	Sandstone, grey-brown, weathers brown, thin-bedded to massive.	30	1,205
8	Covered, rubble of brown sandstone	200	1,175
7	Conglomerate, chert–pebble with black, grey, cream, and green pebbles, to 20 mm in a brown sandy matrix	155	975
6	Sandstone, brown, composed mainly of chert grains to 3 mm or less	90	820

Unit	Lithology	Thickness (feet) Unit	Total from base
5	Chert, dark grey to black	10	730
4	Conglomerate, chert–pebble, with black, grey, and cream pebbles, generally 10 mm or less in diameter but to 75 mm near base; medium to dark brown sandy matrix	300	720
	Possible disconformity marked by a thin bed of argillite		
3	Conglomerate, chert–pebble, pebbles to 10 mm in a brown sandy matrix, poorly consolidated	180	420
2	Interbedded chert–pebble conglomerate and chert–grain sandstone; both weather brown, pebbles in conglomerate to 10 mm, poorly consolidated with partly calcareous matrix	30	240
1	Covered	210	210
	Conformable contact Underlying beds of unit 13		

Structural Relations

The internal structure of the subunit is unknown. Most dips observed were 30 degrees or less and it seems probable that some folding is involved. The contact with the underlying rocks of unit 13 is believed conformable and the overlying rocks are not exposed in the area. Farther east, unit 13a appears to be lacking between units 13 and 14.

Age and Correlation

Rocks of the Nation River Formation contain considerable plant material, most in the form of stems that are of no value for identification. Brabb and Churkin (1967) have summarized the stratigraphic evidence for a Late Devonian age for the Nation River Formation. Sections given in an earlier paper (Churkin and Brabb, 1965, pp. 176, 177) indicate that spores of Upper Devonian age were obtained from rocks of the Nation River Formation in two locations about 3 and 10 miles northwest of McCann Hill (Monument 105 on the International Boundary). In the present work, no fossil collections were made but a specimen of plant material (GSC loc. 4729 from 64°57′N, 141°03′W) collected by L. D. Burling in 1913 was reexamined by F. M. Hueber and found to contain spores of probable Upper Devonian age. Although similar to one reported by Churkin and Brabb (1965) the specimen collected by Burling must be treated with caution as the material was poorly preserved and several workers report (*pers. com.*) that macerations from probable Late Cretaceous rocks in the general area may contain reworked Devonian spores in addition to those of Cretaceous age. On the basis of work by Brabb and Churkin rocks of unit 13a are assigned to the Nation River Formation and considered of Upper Devonian age. However, the close proximity and lithologic similarity to rocks of the Monster Formation of Cretaceous age suggest that some of the latter may be included in unit 13a as mapped.

Unit 14

Rocks assigned to unit 14 are present in all three map-areas but differ somewhat in lithology among limestone, sandstone, shale, and chert–pebble conglomerate. In general, the boundaries of the unit are drawn to include poorly resistant rocks lying between shales of probably Upper Devonian age (13) and ridge-forming limestone and chert of Permian age (15). In Nash Creek map-area rocks assigned to unit 14 are poorly exposed and believed to consist mainly of shale with some thin limestone bands; in northern Larsen Creek area they are mainly limestone with minor chert-pebble conglomerate, chert, shale, and quartzite, with a thickness of about 2,300 feet. In northwest Dawson map-area rocks assigned to the unit are calcareous sandstone, limy siltstone, and limestone, and are also about 2,300 feet thick.

Outcrop Characteristics

The unit is slightly more competent than the underlying unit 13 but much less so than the overlying unit 15 which is present in Larsen Creek and Dawson map-areas. In general, the area underlain by the unit is marked by rather subdued topography, with the scattered brown weathering outcrops of unit 14 beneath faces of the more competent unit 15 and along some of the creeks. In the Nash Creek area, where unit 15 is absent, unit 14 tends to occupy low basins such as that near Hart Lake (Fig. 4).

Lithology

Nash Creek map-area. In the vicinity of Hart Lake unit 14 consists of thin platy black shales that weather rusty grey. Associated with these are minor grey weathering shale, brown shale, grey slightly arenaceous beds, platy buff arenaceous limestone, and buff limestone, with beds to about one foot.

Larsen Creek map-area. Composite section of unit 14, Two Beaver Lake area, Larsen Creek map-area (upper part 7½ miles west-northwest of Two Beaver Lake (64°47½′N, 137°38′W); lower part 10 miles west of Two Beaver Lake (64°46′N, 137°46′W)):

		Thickness (feet)	
Unit	Lithology	Unit	Total from base
	Talus of overlying beds of unit 15 Conformable contact		
	UNIT 14		
13	Limestone, medium-grained, dark grey, platy, bedding 3 to 6 inches, weathers dark buff	200	2,285
12	Limy quartzite, dark grey	15	2,085
11	Limestone, dark brownish grey, bedding to 5 feet, weathers buff; a few thin beds of quartzite and chert	150	2,070
10	Limestone, medium-grained, medium to dark brown, bedding to 6 feet, weathers grey-buff to grey	275	1,920
	(Small break in section, minor gap or overlap possible)		
9	Limestone, medium-grained, grey to brown, bedding variable from a few inches to several feet, weathers grey to buff-yellow; 2-foot conglomerate band 30 feet above base contains pebbles of chert and limestone in a limestone matrix; fossil collections F 128 from top of unit, F 127 from talus same general location, and F 126 from 50 feet above base	165	1,645

Unit	Lithology	Thickness (feet) Unit	Total from base
	Main break in section		
	Gap or overlap not known with certainty but probably does not exceed several hundred feet		
8	Limestone; as below, bedding 3 to 10 feet	100?	1,480
7	Shale, cherty, black weathering	50	1,380
6	Limestone, fine- to medium-grained, brown to dark grey, well-bedded at 3 to 10 feet, weathers buff; thin chert–pebble conglomerate with pebbles about 2 inches in diameter 75 feet above base	525	1,330
5	Limestone, brown; thick- to thin-bedded; minor beds of limestone conglomerate and chert–pebble conglomerate, weathers buff	125	805
	Conglomerate with pebbles of white, dark grey, and greenish chert and some quartzite to 10 mm diameter; some calcite in matrix	40	680
	Minor unconformity		
3	Limestone, fine-grained, dark grey, massive at the top and base but thin-bedded (2 to 6 inches) with numerous silty layers in centre of unit, weathers dark orange	160	640
2	Conglomerate, chert–pebble with limestone matrix, weathers orange-buff, F 132 from base of unit	20	480
1	Siltstone and limestone, both black; irregular sequence of beds 1 foot to 4 feet thick; siltstone weathers brown, limestone orange	460	460
	Base not exposed		

Dawson map-area. Section on north side of Tatonduk River (about 64°59′N, 140°51′W):

Unit	Lithology	Thickness (feet) Unit	Total from base
	Rubble of chert from overlying beds of unit 15 Conformable contact		
	MAP-UNIT 14		
22	Limestone, somewhat argillaceous, medium-grained, brown, weathers grey-brown, abundantly fossiliferous, F 143	10	2,180
21	Covered	10	2,170
20	Limestone, fragmental, light brown, weathers grey-brown	5	2,160
19	Covered	70	2,155

Unit	Lithology	Thickness (feet) Unit	Total from base
18	Limestone, fragmental, fossiliferous, light brown, weathers grey-brown	20	2,085
17	Limestone, fragmental, somewhat argillaceous, medium to dark brown, weathers buff, thin bed of chert–pebble conglomerate 25 feet above base; F 142 from base	70	2,065
16	Covered	15	1,995
15	Limestone, fragmental, somewhat argillaceous, medium to dark brown, weathers buff, beds 1 foot to 3 feet; F 141 from base.	80	1,980
14	Covered	1,350	1,900
13	Siltstone, dark brown, thin-bedded	10	550
12	Covered	100	540
11	Siltstone, limy, thin-bedded	10	440
10	Covered	25	430
9	Siltstone, limy, dark brown, beds 1 foot to 2 feet, F 140	10	405
8	Covered	35	395
7	Siltstone, limy, dark brown, beds 1 foot to 2 feet, F 139	5	360
6	Covered	150	355
5	Sandstone, brown, beds 1 foot to 2 feet, thin band of chert–pebble conglomerate about 25 feet from base, some carbonaceous material at base	50	205
4	Covered	50	155
3	Sandstone, limy, brown, overlain by thin band of chert–pebble conglomerate with tan grey, and a few bright green pebbles. .	10	105
2	Covered	40	95
1	Sandstone, grey-brown, thin-bedded with scattered thin beds of limy sandstone to 1 inch thick; F 138, 45 feet from base	55	55
	Base not exposed		

Structural Relations

Throughout most of the project area the rocks of unit 14 are flat lying or in open folds with gentle dips; slightly more complex folding occurs near Hart Lake in Nash Creek map-area. Throughout most of the area unit 14 is believed to lie on unit 13 without unconformity although most contacts are covered. In the vicinity of Hart Lake the unit appears to overlie units 8, 10, and 11 unconformably. Where the overlying rocks are present, unit 15 appears to overlie the unit conformably except in the north-central part of Dawson map-area, where the latter unit appears to be absent and unit 16 may lie on unit 14. These exposures are poor and the exact relationship is uncertain.

Age

The following fossil collections were made from rocks assigned to unit 14:

Nash Creek map-area

F 121 Locations as listed, all about 64°36′N, 135°05–06′W, 1½ miles northeast of Hart Lake
GSC loc. 47074
unidentifiable productoid brachiopods, fenestellid bryozoan, and horn coral
Age: probably late Paleozoic

GSC loc. 47081
fenestellid bryozoan, spiriferid brachiopod, possibly *Pterospirifer*
Age: probably late Paleozoic

GSC loc. 47162
?*Waagenoconcha* sp. poorly preserved
echinoderm ossicles
fenestellid bryozoan
horn coral indet.—crushed
Age: Carboniferous or Permian, probably younger than Mississippian

GSC loc. 47173
fenestellid bryozoan
Cancrinella sp.
other unidentifiable productoid brachiopods
horn coral fragment—too poor to identify
Age: Pennsylvanian or Permian

GSC loc. 47200
chonetid brachiopod — poorly preserved unidentifiable productoid brachiopods
Age: Carboniferous or Permian

F 122 GSC loc. 47075 (64°36′N, 135°07′W), 1 mile northeast of Hart Lake
fenestellid bryozoan
Chonetina cf. *flemingi crassiradiata* Dunbar and Condra
linoproductid brachiopod, young specimen
Age: Pennsylvanian or Permian

F 123 GSC loc. 47071 (64°35½′N, 135°12′W), 1 mile southwest of Hart Lake
fenestellid bryozoan
Cleiothyridina sp.
Spiriferella cf. *saranae* (de Verneuil)
Pterospirifer sp. (same as 47207)
orthotetoid brachiopod (probably *Schellwienella*)
?*Chonetina* sp.
Age: Permian, probably Wolfcampian

Larsen Creek map-area

F 124 GSC loc. 47206 (64°47′N, 137°27½′W), 3 miles north-northwest of Two Beaver Lake
?*Schizophoria* sp.
linoproductid brachiopod
echinoderm columnals
Age: Carboniferous or Permian

F 125 GSC loc. 47076 (64°50′N, 137°35′W), 8 miles northwest of Two Beaver Lake
Punctospirifer sp.
Neospirifer sp.
productoid brachiopod
fenestellid bryozoan
Age: Pennsylvanian or Permian

F 126 GSC loc. 47203 (64°47½'N, 137°38'W), 7 miles northwest of Two Beaver Lake
cf. *Striatifera* sp.
other unidentifiable productoid brachiopods
cyathopsid coral similar to that in F 128
(GSC loc. 47208)
Age: Pennsylvanian or Permian

F 127 GSC loc. 47209 (64°47½'N, 137°38'W), 7 miles northwest of Two Beaver Lake
linoproductid brachiopod
?*Antiquatonia* sp.
Spirifer striatus (Martin) of Nelson (1961)
Wedekindellina sp.—is a well-developed species of the genus
Age . . . [of the last-mentioned species] . . . is Middle Pennsylvanian, early to middle Desmoinsian. This is about the same age as Nelson's "lower limestone unit" elsewhere. A quite different fusulinid fauna in this sample than in the samples that Bamber made on Ettrain and Jungle Creeks (GSC 53963 to 53970).
(Identification and comments by C. A. Ross, Western Washington State College)

F 128 GSC loc. 47208 (64°48'N, 137°38½'W), 7½ miles northwest of Two Beaver Lake
cyathopsid coral — possibly belonging to the genus *Gshelia*
Age: Pennsylvanian or Permian. Corals of this type occur in both Pennsylvanian and Permian rocks of the northern Yukon and Arctic Islands. They are too poorly known at present to be useful for more refined age determination.

F 129 GSC loc. 47078 (64°45'N, 137°44'W), Larsen Creek map-area, 9 miles west of Two Beaver Lake
linoproductid brachiopod
"*Dictyoclostus*" sp. of Nelson (1961)
Buxtonia sp.
Schizophoria sp.
Foraminifera indet.
Age: Late Mississippian (Chesterian). The brachiopods in this collection are similar to those in F 132 (GSC loc. 47201).

F 130 GSC loc. 47077 (64°45'N, 137°44'W), Larsen Creek map-area, 9 miles west of Two Beaver Lake
Spirifer cf. *arkansanus* Girty
?*Buxtonia* sp.
fenestellid bryozoan
Age: Carboniferous, probably Late Mississippian (Chesteran)

F 131 GSC loc. 47079 (64°45'N, 137°44'W), 9 miles west of Two Beaver Lake
linoproductid brachiopod
Age: Carboniferous or Permian

F 132 GSC loc. 47201 (64°46'N, 137°46'W), 10 miles west and slightly north of Two Beaver Lake
linoproductid brachiopod
Buxtonia sp.
?"*Dictyoclostus*" sp. of Nelson (1961) — poorly preserved
Age: Late Mississippian or Pennsylvanian, probably the former. This collection is similar to F 129 (GSC loc. 47078).

Dawson map-area

F 133 GSC loc. 47210 (64°47½'N, 138°02'W), 4 miles east of Lomond Lake
echinoderm columnals
?*Waagenoconcha* sp.
"*Dictyoclostus*" cf. *americanus* Dunbar and Condra
Spirifer striatus (Martin) of Nelson (1961)
?*Spirifer* sp. of Nelson (1961)
other small unidentified productoid brachiopods
Age: definitely Pennsylvanian or Permian, probably Middle Pennsylvanian

F 134 GSC loc. 47072 (64°56′N, 139°38′W), near headwaters of Monster River
Pseudofusulina sp.

Age: early Permian, probably late Wolfcampian or early Leonardian
(Identification by C. A. Ross)

F 135 GSC loc. 47085 (64°52½′N, 140°31′W), 2 miles north of Monster River
gastropod indet.
?*Spiriferella* sp.
?chonetid brachiopod

Age: Probably late Paleozoic, possibly Permian. These fossils are too poorly preserved for more refined age determination.

F 136 GSC loc. 47082 (64°52½′N, 140°31′W), 2 miles north of Monster River
Identification by W.W. Nassichuk: "The 3 ammonoid specimens belong to the genus *Cravenoceras* Bisa 1928 and compare favourably with *Cravenoceras hesperium*. The range of this genus is from Upper Miss. – Lower Penn. (Namurian)."

F 137 GSC loc. 47207 (64°59½′N, 140°49′W), north bank of Tatonduk River
Pterospirifer sp.
Cleiothyridina sp.
?*Martinia* sp.
Crurithyris sp.
plerophyllid coral
echinoderm columnals
gastropod indet.
plant fragments indet.

Age: Permian, probably Wolfcampian

F 138 GSC loc. 47205 (64°59½′N, 140°50′W), section north of Tatonduk River
Waagenoconcha sp.
Chonetes sp.
?*Aviculopinna* sp.
?*Myalina* sp.
"*Spirophyton*"

Age: probably Early Permian

F 139 GSC loc. 47196, as F 138
Linoproductus sp.
Spiriferella cf. *saranae* (de Verneuil)
Crurithyris sp.

Age: Permian (probably Wolfcampian). This collection is stratigraphically lower than fusulinid Foraminifera collected from the same section, which are either late Wolfcampian or early Leonardian in age.

F 140 GSC loc. 47197, same location as F 138
orthotetid brachiopod
dictyoclostid brachiopod

Age: Carboniferous or Permian

F 141 GSC loc. 47195, same location as F 138
?*Linoproductus* sp.
Spiriferella cf. *saranae* (de Verneuil)
?*Choristites* sp.
dictyoclostid brachiopod
plerophyllid coral
echinoderm columnals

Age: Permian, probably Leonardian

F 142 GSC loc. 47202, same location as F 138, Tatonduk River
"*Echinoconchus*" cf. *inexpectatus* Cooper
Spiriferella cf. *saranae* (de Verneuil)
Linoproductus sp.
Chonetina sp.
Muirwoodia cf. *transversa* Cooper
horridonid brachiopod
"*Dictyoclostus*" cf. *neoinflatus* Licharew horn coral indet.
Age: Permian, probably Leonardian

F 143 GSC loc. 47204, same location as F 138, Tatonduk River
Muirwoodia cf. *transversa* Cooper
Spiriferella cf. *saranae* (de Verneuil)
Waagenoconcha payeri (Toula)?
?*Anidanthus* sp.
Dielasma brevicostatum Cooper
pelecypod indet.
Schwagarina cf. *hyperborae* (Salter)
Age: Leonardian (Permian)

All the collections, with the exception of parts of 47072, 47082, and 47209, were examined by E. W. Bamber of the Geological Survey. Most are from the Wolfcampian or Leonardian series of the Permian but a few suggest a Pennsylvanian or Mississippian age.

Correlation

With the exception of Dawson map-area the sections examined are not as complete as those given by Nelson (1961, p. 2) although a rough correlation is suggested. In Larsen Creek map-area both his Middle Recessive and Lower Limestone units appear to be present and his Calico Bluff Formation may be represented by collections F 129 and F 132 immediately above unit 13. In Nash Creek map-area, Permian rocks are probably equivalent to his Middle Recessive unit.

Unit 15, Tahkandit Formation

Rocks assigned to unit 15 consist mainly of bluff-forming, light coloured limestone and chert of Permian age. They are believed in part to be equivalent to the Tahkandit Formation as described in Alaska and Yukon (Mertie, 1932, pp. 428–432; 1937, pp. 146–153; Nelson, 1961). The principal exposures are in northern Larsen Creek and northeastern Dawson map-areas. Minor amounts of limestone of similar age (unit 15a) are present in south-central Nash Creek map-area and the Tombstone district of southeast Dawson map-area.

Outcrop Characteristics

The formation is much more competent than the underlying and overlying units and outcrops prominently, often forming a vertical wall as much as 100 feet high. Most outcrops are light cream but locally some are dark grey owing to a heavy lichen cover.

Lithology

Rocks included in unit 15 are principally thick-bedded, cliff-forming limestone and chert that can be readily mapped as a lithologic unit. Underlying, less resistant and poorly exposed limestone, sandstone, and shale have been arbitrarily placed in unit 14 despite many faunal similarities between the two units (14 and 15).

The following section was measured about 7½ miles northwest of Two Beaver Lake in Larsen Creek map-area (64°48′N, 137°39′W):

Unit	Lithology	Thickness (feet) Unit	Thickness (feet) Total from base
	Top not exposed		
	UNIT 15 (TAHKANDIT FORMATION)		
5	Interbedded limestone and chert; limestone light grey, buff weathering; chert, white; bedding 1 foot to 3 feet, hoodoo-forming	200	1,150
4	Chert and limestone; about equal proportions near the top grading downward to chert with limestone nodules 1 inch or less in diameter and a few beds of interbedded buff limestone	250	950
3	Chert, dark grey to black, weathers dark grey to light grey, beds 1 foot to 3 feet thick	150	700
2	Covered but talus mainly of chert	350	550
1	Covered but talus of brown weathering limy shale, black shale, and thin-bedded chert	200	200
	Probable conformable contact with unit 14		

The following section of the unit was measured in the small syncline (64°59′N, 140°50′W) in the northeast corner of Dawson map-area:

Unit	Lithology	Thickness (feet) Unit	Thickness (feet) Total from base
	Probable unconformity and overlying beds of unit 22		
8	Covered	100	
	UNIT 15 (TAHKANDIT FORMATION)		
7	Thinly interbedded limestone and chert; limestone, cream-coloured, sugary, massive with irregular chert stringers and masses; chert, cream-coloured, cryptocrystalline; fossil collection F 147, 25 feet above base of unit; F 148, 225 feet above base	275	1,120
6	Covered	50	845
5	Thinly interbedded chert and limestone; chert, tan-coloured, cryptocrystalline; limestone, buff, fine-grained, weathers orange-buff	230	795
4	Chert, white to cream, cryptocrystalline, beds 1 foot to 3 feet thick, some bright weathering colours near base	200	565
3	Covered	80	365

Unit	Lithology	Thickness (feet) Unit	Total from base
2	Chert, brownish grey, cryptocrystalline; beds to 2 feet thick......	100	285
1	Rubble of chert, tan to grey, very fine grained................	185	185
	Probable conformable contact Underlying beds of unit 14		

Structural Relations

The Tahkandit Formation (15) is exposed in open folds with gentle dips in both Dawson and Larsen Creek map-areas. It is believed to lie conformably on unit 14. In Dawson map-area, the formation is overlain unconformably by unit 22 in the small syncline northeast of the forks of Tatonduk River and by units 16 and 22 in the large syncline north of Monster River. In the eastern part of the latter structure the formation is believed to have been completely removed and unit 16 rests directly on unit 14. However, exposures are poor in this area and the exact relationship is unknown. In Larsen Creek map-area, overlying beds are lacking.

Age

The following collections were made from the Tahkandit Formation in northern Larsen Creek and Dawson map-areas:

F 144 GSC loc. 47073 (64°47½′N, 137°42′W), Larsen Creek map-area, 9 miles west-northwest of Two Beaver Lake
Spiriferella cf. *saranae* (de Verneuil)
Neospirifer sp.
Cleiothyridina sp.
horn coral indet.
Age: Permian, probably Wolfcampian or Leonardian

F 145 GSC loc. 37094 (64°59½′N, 140°54½′W), Dawson map-area, 1½ miles northeast of fork between Tatonduk and Monster Rivers
Waagenoconcha cf. *irginaeformis* Stepanow
Marginifera? sp.
Punctospirifer sp.
Spirifer cf. *striato-paradoxus* Toula
Spiriferella sp.

F 146 GSC loc. 47198 (64°54′N, 140°37½′W), Dawson map-area, 11 miles east-southeast of the branch in Tatonduk River
gastropod indet.
Chonetina sp.
?*Anidanthus* sp.
Age: This is definitely Pennsylvanian or Permian in age. The ?*Anidanthus* sp. is very similar to that in F 143 (GSC loc. 47204), and therefore a Permian age is likely.

F 147 GSC loc. 47161 (64°59½′N, 140°52′W), Dawson map-area, Tatonduk River
Chonetina sp.
?*Stenoscisma* sp.
Neospirifer sp.
Cancrinella sp.
fenestellid bryozoan
Age: This assemblage could be Pennsylvanian or Permian.

F 148 GSC loc. 47199 (64°59½'N, 140°52'W), Dawson map-area, Tatonduk River
?*Waagenoconcha* sp.
chonetid brachiopod
Age: Pennsylvanian or Permian

The collections were examined by E. W. Bamber with the exception of F 145, examined by P. Harker, both of the Geological Survey of Canada. On the basis of the material collected a Permian (Leonardian) age is suggested for the Tahkandit Formation.

Correlation

The formation as described corresponds closely to the Tahkandit Formation as described by Nelson (1961). It also appears very similar to the Tahkandit limestone formation as originally described by Mertie (1930, pp. 121–130; 1932, pp. 428–432; 1937, pp. 146–153) near the mouth of Nation River, about 25 miles beyond the northwest corner of Dawson map-area.

Unit 15a

Rocks assigned to unit 15a consist of a single outcrop of limestone in south-central Nash Creek map-area and a thin band of limestone that has been traced for about 10 miles in the Tombstone region of southeast Dawson map-area. Both contain fossils similar to those of the Tahkandit Formation (15).

Lithology

Nash Creek map-area. A thin band of fetid brown limestone with minor chert, probably less than 100 feet thick, is exposed along the contacts between rocks of units 3 and 17 where the former crosses a sharp ridge (64°15'N, 135°10'W) about 7 miles north of McQuesten Lake. The contact is not exposed in either direction and the limestone has not been observed elsewhere. No pronounced unconformities were observed in the exposure.

Tombstone region, Dawson map-area. Tempelman-Kluit (1966, pp. 18–21, 1970) has traced a band of limestone and chert (15a) lying between rocks of units 9 and 17 for about 10 miles. Where thickest, rocks of the subunit can be divided into three parts: a basal part about 20 feet thick containing several 6-inch beds of calcite-cemented chert–pebble conglomerate separated by thin beds of crystalline limestone with little detrital chert; a middle part, about 20 feet thick containing interbeds and lenses of black chert, less than a foot thick, between beds of grey crystalline limestone; and an upper part, about 50 feet thick, of massive to thick-bedded crystalline limestone. Rocks of unit 15a are believed to overlie those of the Road River Formation with slight angular unconformity and are overlain, probably disconformably, by rocks of unit 16.

Age and Correlation

One collection was made from rocks of unit 15a in the Nash Creek area and four collections from the Tombstone district of Dawson map-area, the latter by Tempelman-Kluit (1966). All were examined by E. W. Bamber of the Geological Survey of Canada.

F 149 GSC loc. 47212 (64°14'N, 135°10'W), 7 miles north of McQuesten Lake, Nash Creek map-area
?*Muirwoodia* sp.
Cancrinella sp.
?*Chonetina* sp.

Other unidentifiable brachiopods, including a large spiriferid which may be the same as *Pterospirifer* F 137 (GSC loc. 47207)

GSC loc. 47211, as above
?*Pterospirifer* sp. — possibly the same as that in F 137 (GSC loc. 47207)
rhynchonellid brachiopod
Cancrinella sp.
Waagenoconcha sp.
?*Muirwoodia* sp.

Age: Pennsylvanian or Permian, probably Permian. Fossils in both collections are poorly preserved and the identifications are uncertain.

F 150 GSC loc. 64865 (64°24′N, 138°51′W), Tombstone region, Dawson map-area
horn coral indet.
Spiriferella sp.
?*Spirifer striato-paradoxus* Toula

Age: Permian, probably Leonardian or Wordian

F 151 GSC loc. 64867 (64°26½′N, 138°52′W), Tombstone region, Dawson map-area
Spiriferella saranae (de Verneuil)
Horridonia sp.
productoid brachiopod
echinoderm columnals

Age: Permian, probably Leonardian or Wordian. This fauna occurs in the Tahkandit Formation

F 152 GSC loc. 69164 (64°26′40″N, 138°50′W), 5 miles northeast of mouth of Tombstone River, 17 feet above base of unit
Horridonia sp.
Waagenoconcha sp.
?*Cleiothyridina* sp.
dictyoclostid brachiopod
bryozoan indet.

Age: Permian, probably Leonardian or Wordian

F 153 GSC loc. 69167, as above, but 30 feet above base of unit
Waagenoconcha sp.
Spiriferella cf. *keilhavii* (von Buch)
dictyoclostid brachiopod
plerophyllid coral

Age: Permian, probably Leonardian or Wordian

Rocks of unit 15a are similar to and believed to be the same age as those of the Tahkandit Formation (15). Although present only in two very small areas, they afford definite age data in the southern part of the three map-areas, where information of this type is at best fragmentary. Their presence beneath rocks assigned to unit 17 suggests a maximum age for the latter.

Unit 16

Rocks assigned to unit 16 outcrop in Nash Creek map-area in the vicinity of Kathleen Lakes and in Dawson map-area in the Tombstone region and the northwest part of the map-area. The thickness of the unit is uncertain in all three areas.

Outcrop Characteristics

Rocks assigned to the map-unit are not resistant and outcrop poorly and much of the area underlain by it has a heavy mantle of vegetation. Scattered distinctive outcrops of black, thinly banded rocks occur in cutbanks along creeks and rivers.

Lithology

In Nash Creek map-area rocks of the unit exposed along Rackla River consist of two bands separated by massive quartzite of unit 18. The northern band consists of thinly bedded, dark grey to black shale and limestone. Individual beds are seldom more than 6 inches thick. All the rocks are extremely friable and nearly all the shale is somewhat limy. The northern band may be about 900 feet thick. The southern band is similar in lithology. Scattered outcrops suggested a considerable thickness but the unit is probably repeated through folding or faulting. A tiny sliver of black limestone of unit 16 occurs in the vicinity of the triangulation station (elevation 5,742 feet) about 3 miles southwest of Kathleen Lakes.

In the Tombstone district of Dawson map-area (about 64°23′45″N, 138°52′W) Tempelman-Kluit (1966, pp. 21–24) has mapped a thin band of Triassic rocks assigned to unit 16. Here they are estimated to be about 200 feet thick, the lower half consisting of siltstone and shale and the upper of light grey weathering, impure, black carbonaceous limestone containing abundant pelecypod remains. About 18 miles to the east (best exposed about 64°23½′N, 138°11′W) somewhat similar rocks have been traced for about 9 miles and are considered correlative. They consist of about 100 feet of thinly bedded, fetid, dark grey to black, carbonaceous limestone. Indeterminate fragments of ribbed shells, reminiscent of *Monotis*, are present.

Scattered exposures of rocks assigned to unit 16 occur in the northwestern part of Dawson map-area. The largest exposure along the north bank of Monster River (about 64°56′N, 139°55′W) consists of more than 300 feet of thin-bedded, rotten, black weathering, black shaly limestone, with a few thin, grey weathering, limestone bands 1 foot or less thick, the latter forming 1 to 2 per cent of the outcrop. Outcrops along the margin of the map-area (about 65°00′N, 139°38′W) expose 60 feet of black shale, often with thin concretionary nodules as much as 2 inches long, and a few buff weathering carbonate beds to 3 feet thick composed of individual beds 6 inches or less in thickness. A nearby outcrop exposed an overlying section about 20 feet thick composed of grey to black limestone with irregular beds to 6 inches thick. A minor amount of sandstone talus was observed near some of the other fossil collections.

Structural Relations

Outcrops of the unit are poor and the structure is not known. Chevron folds were observed in a number of the outcrops and are probably common. In Dawson map-area unit 16 is believed to lie unconformably on units 14 and 15 and to be overlain unconformably by unit 22. The relationship in Nash Creek map-area is unknown but the unit may be overlain unconformably by both units 17 and 18.

Age

The following collections were made from rocks assigned to map-unit 16:

Nash Creek map-area

F 154 GSC loc. 47135 (64°13′N, 134°07′W), Rackla River, ¼ mile south of creek draining Kathleen Lakes

Juvavites (*Anatomites*) cf. *J. knowltoni* Smith
"*Arcestes*" sp.

Age: Upper Triassic, Upper Karnian

GSC loc. 47136 (as above but about 20 feet higher stratigraphically)
Arcestes sp.
Age: Triassic

GSC loc. 47130 (as above but about 40 feet stratigraphically above 47135)
Halobia
Age: Upper Triassic

GSC loc. 47141 (as above but about 200 feet stratigraphically above 47135)
Monotis sp.
Age: Upper Triassic, Norian

F 155 GSC loc. 47134 (64°14′N, 134°20′W), close to triangulation station, elevation 5,742
Monotis sp.
Steinmannites sp.
Age: Upper Triassic, Norian

Dawson map-area

Tombstone district, collected by D. J. Tempelman-Kluit in 1965:

F 156 GSC loc. 69117 (64°23½′N, 138°50′W), 6 miles west of Tombstone Mountain
Posidonia cf. *P. mimer* Oeberg
Age: Probably Lower Triassic (Smithian)

GSC loc. 68899 (as above), perhaps 75 feet stratigraphically above 69117
Daonella cf. *D. degeeri* Boehm
Age: Middle Triassic, probably Lower Ladinian

GSC loc. 68900 (as above, perhaps 100 feet stratigraphically above 68899)
Monotis subcircularis Gabb
Age: Upper Triassic, Upper Norian

Northwest part of map-area

F 157 GSC loc. 47133 (65°00′N, 139°38′W), east end of Monster Syncline
Halobia sp.
Age: Upper Triassic

GSC loc. 47137 (as above, about 30 feet stratigraphically from 47133)
Monotis sp.
Age: Upper Triassic, Norian

F 158 GSC loc. 47139 (64°56′N, 139°55′W), Dawson map-area, north bank of Monster River, 18 miles north of Mt. Harper
Halobia? sp.
crushed ammonoids
Age: Triassic, probably Upper Triassic

F 159 GSC loc. 47138 (64°57½′N, 139°52′W), 2 miles northeast of F 158
Halobia sp.
Age: Upper Triassic

F 160 GSC loc. 47132 (64°58′N, 140°05′W), about 1½ miles north of Monster River
Monotis sp.
Age: Upper Triassic, Norian

F 161 GSC loc. 47163 (64°56½′N, 140°17′W), southwest limb of Monster Syncline
Halobia sp.
Age: Upper Triassic

All the collections were examined by E. T. Tozer of the Geological Survey of Canada. Most are of Upper Triassic age (Karnian to Norian stage) but, in the Tombstone district, Dawson map-area, Middle Triassic (probable Lower Ladinian stage) and probable Lower Triassic (Smithian stage) ages are also recognized. The stages used are those given by Tozer (1967).

Correlation

Norris *et al.* (1963) have mapped the continuation of the Triassic rocks on the north limb of Monster Syncline and a band to the west about 10 miles from the International Boundary. In Alaska, Mertie (1937, pp. 153–156) has mapped two small areas of similar Triassic rocks on Trout Creek and near the mouth of Nation River, about 20 miles west-northwest and 26 miles beyond the northwest corner of Dawson map-area respectively.

Unit 17, Lower Schist Division

Rocks assigned to unit 17 form a band extending from the southeast corner of Nash Creek map-area westward to Dawson map-area, where it terminates against faulting along Tintina Trench. The name 'Lower Schist division' has been proposed for this map-unit in the Mayo area (Green, 1971) and it has also been referred to as the "Lower Schist formation" (Boyle, 1965, p. 11). Rocks assigned to the unit consist of thin beds of quartzite interbedded with shale that locally grade to phyllite. The proportion of arenaceous to argillaceous rocks varies widely in each outcrop; some are almost entirely slate or phyllite and others thin-bedded quartzite separated by fine partings of argillaceous material.

The unit is believed to have undergone complex internal deformation throughout most of the outcrop area and the thickness is unknown. In the Tombstone region of Dawson map-area, Tempelman-Kluit (1966, p. 24) estimates unit 17 to be about 1,500 feet thick and unit 17a to be at least 1,000 feet. Elsewhere great thicknesses, 20,000 feet or more, must be present unless internal deformation with thickening and repetition has occurred.

Rocks assigned to unit 17a outcrop in a narrow band about 15 miles long lying between two thrust faults in the eastern part of Dawson map-area. The rocks are lithologically similar to those of unit 17 and, in contrast to these, are well dated paleontologically.

In the McQuesten Lake district of Nash Creek map-area (about 64°04′N, 135°15′W) rocks mapped as 17? and apparently overlying the Keno Hill Quartzite (unit 18) are lithologically similar to those of unit 17 in the same area rather than to rocks overlying the Keno Hill Quartzite (18) to the south in the Keno and Galena Hills area (Kindle, 1962). For this reason they have been included with the former.

Outcrop Characteristics

Rocks of the map-unit outcrop poorly as their platy nature makes them particularly susceptible to frost action. In general they form rounded hills with smooth upland surfaces that are mantled by a felsenmeer of fine rock fragments partly covered by yellow caribou moss. Characteristically, these smooth surfaces are broken by lens-shaped mounds of coarse rubble produced through frost action on altered diorite or gabbro sills (unit 20) that commonly intrude unit 17 (Fig. 6). These mounds vary from a few hundred to several thousand feet in length and from a few to several hundred feet in width. On lower slopes, rocks of unit 17 support heavy vegetation.

Lithology

The unit is composed of interbedded black, graphitic shale to phyllite, and dark grey to grey, thin-bedded phyllitic quartzite or siltstone. The relative amount of phyllite to quartzite varies in each outcrop: some are almost entirely phyllite and others are thin quartzite beds separated by fine phyllite partings. Individual beds of phyllite seldom exceed a few inches in thickness whereas beds of quartzite rarely are more than a foot thick and are commonly less than 6 inches. In outcrop, the rock tends to break along the phyllitic partings and a rubble of platy material is characteristic. Some crossbedding was observed in the quartzite but this feature is not common enough to permit widespread top determinations.

Viewed in thin section, the quartz-rich rocks of unit 17 are seen to consist of fine-grained quartz and muscovite with lesser amounts of black opaque material believed to be graphite. Minor amounts of ilmenite, iron oxides, chlorite, and tremolite–actinolite may be present. Ilmenite is commonly altered to leucoxene. The quartz grains are generally subangular and less than 0.05 mm diameter, although a few grains are as much as 0.1 mm. All gradations exist between quartzite or siltstone and phyllitic rocks composed essentially of very fine grained quartz and mica. The phyllitic rocks vary from brown to grey to black dependent upon the amount of graphite (?) present.

Structural Relations

The structure of outcrops of this unit varies widely. A few show only a foliation parallel with the bedding whereas at the opposite extreme some outcrops show the development of a secondary foliation that has completely destroyed the original bedding. The origin and possible significance of the secondary structures are discussed in Chapter IV. Foliation parallel with the bedding is present in almost all outcrops of the map-unit, and it is generally well developed in the more phyllitic layers. In the plane of the bedding foliation these layers commonly show the development of one or more wrinkle lineations, irregular wave-like crenulations with a wavelength of several millimetres and an amplitude of less than one millimetre. Slaty cleavage at an angle to the bedding was observed in some outcrops, and folding is present in many, the folds ranging from open crumples to tight isoclinal folds. 'Gleitbretter' and false cleavage are also common. The spacing of the foliation planes on which the 'Gleitbretter' are developed varies from a fraction of a millimetre to several inches.

In Nash Creek map-area, rocks assigned to unit 17 overlie those of unit 3 and at one point unit 15, with presumed unconformity. Westward, in Larsen Creek map-area, the contact, presumably with units 3 and 9, lies along a topographic depression and is not exposed. Farther west in Dawson map-area, unit 17 overlies rocks of units 9, 15, and 16 unconformably. Where in contact with somewhat lithologically similar rocks of unit 9, the contact is drawn to include all chert and chert–pebble conglomerate in unit 9. In all three map-areas rocks of unit 17 are overlain, apparently conformably, by the Keno Hill Quartzite (unit 18).

Metamorphism

Most of the rocks of the unit are of the chlorite subfacies of the greenschist facies but some biotite is present locally, particularly along both sides of the valley of Rankin Creek in the south-central part of Nash Creek map-area.

Age

Two collections of echinoderm columnals have been made from rocks assigned to unit 17. Although of little stratigraphic value they were recorded, as rocks of the 'Lower

Schist division' were formerly considered to lie at the base of the Precambrian section in the Mayo area (Bostock, 1947; Green, 1957, 1958; Kindle, 1962).

F 162 GSC loc. 47146 (64°22'N, 136°58'W), 12 miles east of One Eighty Lake, Larsen Creek map-area
echinoderm columnals
Age: Phanerozoic

F 163 GSC loc. 47006 (64°21'N, 136°30'W), 16 miles southwest of Worm Lake, Larsen Creek map-area
echinoderm columnals
probable bryozoans
Age: probably post-Cambrian

Two fossil localities are known in rocks assigned to unit 17a. The original locality (F 164) contains fragments of ammonites occurring as rounded concretions in a dark shale band about 300 feet above the base of the unit (Tempelman-Kluit, 1966, p. 26). All collections were examined by H. Frebold of the Geological Survey of Canada.

F 164 GSC loc. 47219 (64°24'N, 138°10'W), Dawson map-area, 11 miles south-southeast of North Fork Pass
Arcticoceras Spath
Arctocephalites Spath
Arcticoceras and *Arctocephalites* are characteristic of the early Callovian and Bathonian respectively and are accordingly of late Middle Jurassic age. It is possible that the two genera came from different beds. If that is so, *Arctocephalites* would be slightly older than *Arcticoceras.*
GSC loc. 68091 (as above, collected by Tempelman-Kluit, 1965)
Cardioceras sp.
Age: Early Oxfordian (early part of Late Jurassic)

F 165 GSC plant loc. 7044 (64°20'N, 138°23'W), Dawson map-area, about 1 mile east of North Klondike River (collected by Tempelman-Kluit, 1965)
Cardioceras? sp. indet.
Pleuromya
fossil wood
Age: Jurassic (Oxfordian?)

On the basis of the above collections unit 17a is considered of Jurassic age, and on the basis of a lithologic correlation between units 17 and 17a a similar age is suggested for the former.

Correlation

In Alaska, Brabb and Churkin (1964a) have mapped a band of greyish black carbonaceous shale and argillite with minor quartzite of Triassic to Early Cretaceous age that extends, with one interruption, about 75 miles from the International Boundary near 66°35'N, westward to near Woodchopper. Norris *et al.* (1963) have mapped Jurassic shale and sandstone east of the Boundary in the same general area. Frebold (1961) has indicated the extent of the Jurassic seas in the North Polar region. Frebold, Mountjoy, and Tempelman-Kluit (1967) indicate the distribution of Jurassic and Lower Cretaceous rocks in northern Yukon and adjacent areas of Alaska.

Unit 18, Keno Hill Quartzite

Rocks assigned to unit 18 outcrop from the southeastern part of Nash Creek map-area westerly to the centre of Dawson map-area, where they are truncated by faulting along Tintina Trench. The name Keno Hill Quartzite has been proposed for this unit in the Mayo area (Green, 1971), and it has also been referred to as the Central Quartzite Formation (Boyle, 1965, p. 11). Rocks assigned to unit 18 consist predominantly of massive dark grey to blue-grey quartzite with associated graphitic phyllite, phyllitic quartzite, and phyllite. In places where the phyllitic rocks constitute a mappable unit they have been separated (18a). The true thickness of the Keno Hill Quartzite is known only in the Tombstone region of Dawson map-area where Tempelman-Kluit (1966, pp. 160–162) measured 1,771 feet. Elsewhere the internal structure is believed to include numerous minor and possible major isoclinal folds. Apparent maximum thicknesses, without allowance for structural repetition are: in the Nash Creek area, Patterson Range, including quartzite to the south of the map-area, 14,000 feet; Davidson Range, 1,200 feet; in the Larsen Creek area, southwest of Worm Lake, 4,500 feet; and in the Dawson area, Tombstone region, 45,000 feet. Deformation in the Tombstone region is believed to be much less severe than elsewhere in the three map-areas, and the discrepancy between the apparent thickness of 45,000 feet and the measured section, 1,771 feet, is indicative of the problems encountered in mapping rocks of the Keno Hill Quartzite.

Outcrop Characteristics

Most of the more rugged topography of the southern part of all three map-areas is underlain by the rocks of this unit, which tend to be more resistant than those of other units nearby. Steep cirque faces are common. Typical outcrops consist of dark grey quartzite, commonly with some iron staining, whereas talus slopes of quartzite appear black because of heavy lichen coating. At lower elevations the unit supports moderately heavy vegetation.

Lithology

Typical outcrops of the unit consist of dark grey to blue-grey quartzite with beds a few feet to 10 feet thick separated by thinner bedded quartzite, and slate or phyllite, commonly graphitic. The thinner bedded rocks occur both as thin partings between beds of massive quartzite and in the thicker bands within the area mapped as unit 18. In general, the phyllitic rocks are less competent than the more massive quartzites and the unit probably contains considerably more phyllitic material than is apparent from outcrops.

Both the quartzite and associated phyllite contain numerous veinlets of white quartz, usually a fraction of an inch thick and as much as several feet long. They occur both as crosscutting veinlets or lenses parallel with the bedding. The lenses commonly follow the outlines of small folds within a quartzite bed.

In the author's opinion the only reliable stratigraphic information on the Keno Hill Quartzite is that obtained by Tempelman-Kluit (1966, pp. 160–162) in the Tombstone region of Dawson map-area. There marker beds are present and the structural pattern, believed much less complex than elsewhere, has been unravelled. Elsewhere marker beds are lacking, and repetitions through folding and faulting, and thickening and thinning of the beds, are probably all present and unrecognized. Sections from these areas must be considered as typical of the lithology only.

The following section of the Keno Hill Quartzite was measured by Tempelman-Kluit (1966, pp. 160–162) in the Tombstone region. The lower part of the section was measured at about 64°29½'N, 138°17½'W, and the upper at 64°27½'N, 138°10½'W.

		Thickness (feet)	
Unit	Lithology	Unit	Total from base
	Overlying beds of unit 19 Conformable contact		
	UNIT 18 (KENO HILL QUARTZITE)		
32	Orthoquartzite, light grey and white, massive, fine-grained, poorly bedded, thick-bedded (10 feet)	95	1,771
31	Covered; black slate float	43	1,676
30	Orthoquartzite, light grey to white, massive, fine-grained, thick-bedded (5 feet), contains 1 per cent black shale chips, ½-inch interbeds of black slate	67	1,633
29	Covered; black shale and slate, and minor black argillaceous fetid limestone float	55	1,566
28	Orthoquartzite, light grey, massive, fine-grained, poorly bedded, thick-bedded (5–10 feet), weathers white	25	1,511
27	Covered; black slate and minor brown siltstone float	30	1,486
26	Orthoquartzite, brownish grey, grey weathering, massive, thick-bedded (5 feet), poorly bedded, rust spots after pyrite; intraformational breccias with as much as 10 per cent black shale chips (3 inches) at 15 feet; few lime-cemented brownish concretions (10 feet) near base	40	1,456
25	Covered; scattered outcrops of interbedded black platy slate and 6-inch interbeds of medium grey orthoquartzite, minor siltstone	75	1,416
24	Sandstone, calcite-cemented, medium-grained, brownish, grain size varies to coarse sand; interbedded black, platy slate makes up about 10 per cent; pyrite and rust spots; black slate chips constitute 5 per cent of rock in upper part	45	1,341
23	Covered; float in lower 10 feet of black slate, above is lime-cemented sandstone float	41	1,296
22	Orthoquartzite, medium grey, fine-grained, massive, thick-bedded (3–10 feet); small shale chips (less than 2 mm) make up 1 per cent throughout; minor interbeds of black slate up to 1 inch thick	94	1,255
21	Covered; scattered outcrops of massive grey orthoquartzite; minor black slate float, trace fossils in slate	40	1,161
20	Orthoquartzite, medium grey and brownish grey, fine-grained, massive, thick-bedded (10 feet); ¼-inch interbeds of black slate; straight quartz veinlets; intraformational breccia with 5 per cent black slate chips up to 5 mm at 53 feet	70	1,121
19	Covered; black slate float with minor brownish siltstone	12	1,051

Unit	Lithology	Thickness (feet) Unit	Total from base
18	Orthoquartzite, medium to dark grey, locally brownish, massive, fine-grained, thick-bedded (10 feet); few lime-cemented, brownish concretions 1 foot across; minor interbedded black slate in ½-inch beds, intraformational breccia at 72 feet has black shale chips up to 5 mm long and weathers rusty	92	1,039
17	Covered; grey massive orthoquartzite float	12	947
16	Orthoquartzite, medium grey, massive, fine-grained, thick-bedded (8 feet); straight white quartz veinlets; some black shale chips; minor ½-inch black slate interbeds	25	935
15	Covered; grey, massive orthoquartzite and black slate float	20	910
14	Orthoquartzite, medium grey and brownish, massive, fine-grained, thick-bedded (3–10 feet); interbedded black slate to 1 foot thick near base	153	890
	Break in section Above here measured east of North Klondike River		
13	Slate, phyllitic slate, shaly slate, black; minor interbedded brownish laminated limy siltstone; intruded by diabase; altered to green spotted slate near diabase; thickness varies from 0 to 500 feet—minor folds preclude measurement—average thickness scaled from cross-sections	250	737
	Break in section Below here measured west of North Klondike River		
12	Orthoquartzite, medium grey to brownish, massive, thick-bedded (5 feet), fine-grained, grey weathering; interbedded black slate up to 1 foot near top	94	487
11	Covered; massive quartzite and black slate float	118	393
10	Orthoquartzite, medium grey, massive, thick-bedded (5–10 feet), fine-grained	29	275
9	Chert and slate, black, interbedded; chert is banded, makes up about 60 per cent, is in 3-inch beds; slate beds thinner	3	246
8	Orthoquartzite, blue-grey to dark grey, black weathering, massive, fine-grained, thick-bedded (3–6 feet); slaty partings up to ¼-inch thick	25	243
7	Covered; scattered outcrops and float of blue-grey, massive, fine-grained quartzite; black slate interbeds to 1 foot thick in lower outcrops	73	218
	Orthoquartzites, medium grey, white weathering, massive, fine-grained	16	145
5	Orthoquartzite, medium grey, brownish yellow weathering, poorly laminated locally, mainly massive, fine-grained; minor black slate chips	27	129
4	Covered; black platy slate float	14	102

Unit	Lithology	Thickness (feet) Unit	Thickness (feet) Total from base
3	Orthoquartzite, medium grey, fine-grained, massive, fractured, rusty spots, thick-bedded (6 feet), poorly bedded	56	88
2	Orthoquartzite, medium grey, brownish weathering, massive, fine-grained; minor small black slate chips	10	32
1	Orthoquartzite, locally calcareous, medium to dark grey, massive, fine-grained; quartz veinlets plentiful	22	22
	Conformable contact Underlying beds of unit 17		

Boyle (1965, p. 22) gives a section of unit 18 (his Central Quartzite Formation) on Galena Hill (63°55′N, 135°24′W) about 6 miles south of Nash Creek map-area, and the following has been generalized from this:

Member	Description	Thickness (feet) Unit	Thickness (feet) Total from base
	UPPER SCHIST FORMATION		
	CENTRAL QUARTZITE FORMATION		
Silver King	Grey, thick-bedded quartzites, beds up to 15 feet thick at Silver King Mine; bed of white cherty quartzite near top; in places two greenstone sills, at other places two zones containing greenstone lenses	350	2,350
	Thin-bedded quartzites, interbedded with graphitic schists and phyllites; a few beds of quartzites 3 feet thick or more	550	2,000
Hector–Calumet	Massive pale grey to grey, thick-bedded quartzites interbedded with minor thin-bedded quartzites, phyllites, and graphitic schists; beds of quartzite from 5 to 25 feet thick; centre of sequence marked by two or more beds of white, to pale grey, thick-bedded, cherty quartzite interbedded with two highly sheared greenstone sills or lenses	800	1,450
	Grey to black, thin-bedded quartzites interbedded with graphitic schists and phyllites, most beds 1 foot to 2 feet thick, some up to 5 feet	350	650
Galkeno	Massive, pale grey to black, thick-bedded quartzites; most beds 5 to 10 feet thick, some 25 feet thick or more; a few interbedded graphitic schist layers and thin-bedded quartzites	300	300
	LOWER SCHIST FORMATION		

Two sections in which the true thickness and structure are unknown but which indicate typical lithology were measured by the author about 5 miles northwest of McQuesten Lake in Nash Creek map-area. The first is a lower band of rocks of the Keno Hill Quartzite and the second an upper band separated from the lower by a septum of rocks of unit 3.

Section of lower part of Keno Hill Quartzite about 64°13′N, 135°20′W:

		Thickness (feet)	
Unit	Lithology	Unit	Total from base
	Remainder of section not exposed		
	UNIT 18 (KENO HILL QUARTZITE)		
27	Talus of phyllite, grey, graphitic	140	2,780
26	Talus of quartzite, massive, in large blocks	95	2,640
25	Greenstone (unit 20) thickens eastward of section	95	2,545
24	Talus, mixed grey quartzite, grey phyllite, and greenstone	130	2,450
23	Quartzite, massive, grey	10	2,320
22	Phyllite, grey-green, buff weathering, pencilled, may have formed from altered greenstone	130	2,310
21	Greenstone (unit 20), saussuritized, thickens to east	100	2,180
20	Talus, mixed; massive grey quartzite; thin-bedded brown quartzite; grey phyllite	140	2,080
19	Quartzite, massive, medium grey; quartzite, buff; and phyllite, grey; all in about equal amounts	150	1,940
18	Interbedded quartzite and phyllite; quartzite, thin-bedded, buff weathering, slightly limy; phyllite, grey	140	1,790
17	Phyllite, graphitic; minor rusty weathering limy quartzite	50	1,650
16	Quartzite, massive, mainly dark grey but minor or light grey and brown, limy, weathers pale brown but generally has black lichen cover, beds often 3 feet thick or more; minor grey phyllite at base; 85 feet above base, graphitic phyllite; some limy quartzites 225 feet above base	240	1,600
15	Quartzite, massive, brown, talus with black lichen cover, beds to 6 feet; a few thin phyllite beds	180	1,360
14	Talus of brown quartzite, beds probably several feet thick; minor limy quartzite	200	1,180
13	Phyllite, graphitic	40	980
12	Quartzite, massive, buff, weathers buff to brown but often with black lichen cover, beds commonly 2 to 3 feet but some to 6 feet	240	940
11	Talus of graphitic phyllite in thin plates	95	700
10	Quartzite, massive, brown to buff, beds originally up to 6 feet thick but much sheared and slickensided	50	605

Unit	Lithology	Thickness (feet) Unit	Total from base
9	Talus of graphitic phyllite	180	555
8	Quartzite, medium grey, beds to 1 foot	10	375
7	Talus of green chloritic phyllite; minor grey phyllite	230	365
6	Quartzite, brown and phyllitic near base but grading upward to massive grey with beds to 10 feet	135	135
	Conformable contact Underlying beds of Lower Schist division (Unit 17)		
5	Talus of mixed quartzite and phyllite	270	
4	Greenstone (unit 20) saussuritized but with outlines of original grains to 3 mm visible	70	
3	Talus of platy grey phyllite	600	
2	Quartzite, massive, dark grey, banded, some beds to 1 foot	40	
1	Talus of phyllite	130	
	Base of measured section		

Section of upper part of Keno Hill Quartzite about 64°11½′N, 135°20½′W:

Unit	Lithology	Thickness (feet) Unit	Total from base
	Overlying crumpled phyllite of unit 3 Thrust fault?		
	UNIT 18 (KENO HILL QUARTZITE), upper part		
14	Quartzite, dark grey, beds to about 3 inches	35	1,145
13	Quartzite, dark grey to blue-grey, beds to several feet; minor interbedded graphitic phyllite; rock shows much evidence of movement between beds	180	1,110
12	Quartzite, brown, beds to several feet but often with partings a few inches apart; minor thin, lime-bearing beds	30	930
11	Phyllite, platy grey to greenish grey, beds a few inches thick	40	900
10	Quartzite, grey, beds to several feet; minor grey phyllite partings and thin lime-bearing beds	90	860
9	Quartzite, blue-grey, massive, beds to 6 feet; minor interbedded graphitic phyllite near base but very little towards top	370	770
8	Covered	85	400
7	Quartzite, massive, medium blue-grey, beds to 2 feet	10	315

Unit	Lithology	Thickness (feet) Unit	Thickness (feet) Total from base
6	Greenstone, dark grey, foliated	10	305
5	Talus of grey phyllite	10	295
4	Altered grey-green, carbonate-bearing rock	5	285
3	Talus of phyllite containing some coarser quartz grains	105	280
2	Quartzite, massive, dark grey, much contorted	145	175
1	Covered	30	30
	Possible fault or unconformable contact? Underlying sheared and contorted grit of unit 3		

Viewed in thin section, quartzites of the Keno Hill Quartzite consist mainly of quartz grains varying from 0.05 to 0.25 mm diameter although a few thin sections contained grains to 0.5 mm. Many of the specimens are banded and show variation in grain size among the bands. Quartz grains are commonly elongated parallel to the foliation of the rock, and grain boundaries vary from sutured to almost straight lines following a crude polygonal outline. Traces of the original grain boundaries or the cementing matrix are rare. Common accessory minerals include tourmaline, zircon, ilmenite, and magnetite. The quartzite commonly contains black carbonaceous material, believed to be graphite, which forms thin streaks and produces a pronounced banding in the rocks. Muscovite and chlorite generally occur as fine grains oriented parallel to the bedding of the quartzite. The purer quartzites are interbedded with thinner bedded and phyllitic quartzites, and graphitic phyllite and all gradations between these rocks and massive quartzite occur. The less siliceous rocks are similar to those of the Lower Schist division (unit 17) described previously.

Structure

The rocks of unit 18 almost invariably show a well-developed foliation that appears to be parallel with the bedding in most places, but in some transects it. Isoclinal folds are common and range in size from a fraction of an inch between the limbs to about 1½ miles in the large overturned fold in Davidson Range (Green and McTaggart, 1960, p. 124). The axial planes of these folds are commonly parallel with the bedding and in most the upper beds have moved to the north or northeast.

The Keno Hill Quartzite is the main unit that can be traced with certainty in the southern part of all three map-areas and much of the structural interpretation is based on observations of rocks of the unit. This interpretation together with a discussion on the origin and possible significance of both foliation and folding is given in Chapter IV.

Throughout the area, rocks of unit 18 overlie those of unit 17, which is of probable Jurassic age. In most places the rocks stratigraphically above those of unit 18 are not exposed, rocks of unit 3 having been thrust onto those of unit 18 throughout most of the three map-areas. However, in the eastern part of Dawson map-area, rocks of unit 18 are overlain, presumably conformably, by those of unit 19, of probable Cretaceous age.

In the Davidson Range, Nash Creek map-area, a band of quartzite (18b) separate from the main band is overlain by rocks mapped as unit 17?. These rocks are lithologically similar to rocks of unit 17 in this region rather than more graphitic rocks that overlie the main quartzite south of the map-area (Boyle, 1965, Map 1147A). The geology of the Davidson Range is complex and not fully understood. Either facies changes or structural repetition may be present. Near Kathleen Lakes in Nash Creek map-area, massive quartzite lithologically resembling that to the south occurs in association with Triassic rocks of unit 16. Exposures are not complete but no evidence of either angular discordance or faulting was observed between rocks of the two units.

Age and Correlation

One collection of non-diagnostic plant remains was made from unit 18. F. M. Hueber, then of the Geological Survey of Canada, examined it and reported:

F 166 GSC plant loc. 5802 (64°16'N, 138°35'W), Dawson map-area, south end of ridge between Klondike River and Benson Creek

> "Plant remains are present, but are too fragmentary for identification. No specific stratigraphic significance can be attached to this collection. The beds can be no older than mid-Palaeozoic. Additional collections at this locality might yield more complete plant remains which could be of better use in dating the beds."

In addition, indeterminate gastropods were collected on a ridge about 2 miles northwest of Dempster highway (64°27½'N, 138°18'W) by Tempelman-Kluit (1966, p. 37).

The Keno Hill Quartzite is tentatively dated as Lower Cretaceous (?) on the basis of fragmentary fossil remains and the stratigraphic position of this unit above rocks of probable Jurassic age (unit 17). Quartzites of Lower Cretaceous age have been mapped as part of the Kandik Formation by Brabb and Churkin (1964a) in a band extending westward for about 75 miles from the International Boundary, at about 65°35'N, to near Woodchopper, Alaska. Rocks close to Yukon River in the latter area were examined briefly by Tempelman-Kluit (*pers. com.*) and are considered lithologically similar to the rocks of the Keno Hill Quartzite mapped by him in the Tombstone region of Dawson map-area.

Frebold, Mountjoy, and Tempelman-Kluit (1967) indicate the distribution of Lower Cretaceous sandstone and quartzite in northern Yukon and adjacent areas of Alaska.

In the vicinity of Keno and Galena Hills, a few miles south of Nash Creek map-area, quartzites similar to and in part continuous with those presently mapped were considered (Bostock, 1947; Green, 1957; McTaggart, 1960; Kindle, 1962) to form part of the Yukon Group of metamorphic rocks of Precambrian and/or Paleozoic age. If the present interpretation that the rocks of the Keno Hill Quartzite are Mesozoic is correct, rocks overlying it to the south may be Precambrian rocks that have been overthrust, similar to those of unit 3 in the present area. Poole (1965, pp. 32–35), mapping in the Dublin Gulch area in the southwest corner of Nash Creek map-area and the Mount Haldane area to the south, found no evidence of such a thrust and assumed that at least part of the overlying rocks postdated the Keno Hill Quartzite. However, he noted that much of the overlying rock seemed to be the metamorphic equivalent of the Precambrian rocks of unit 3.

Dating the Keno Hill Quartzite as Mesozoic leaves a host of unsolved problems in the Keno and Galena Hills area south of Nash Creek map-area (for a discussion of these *see* Green, 1971), but these are of a lesser nature than those raised in any attempt to retain the former concept of a Precambrian age for these rocks.

Unit 19

Rocks assigned to unit 19 outcrop in a narrow band about 25 miles long extending from near the west margin of Larsen Creek map-area southwesterly into Dawson map-area along North Klondike River. Locally, the mottled maroon and green shale of the unit has been mapped (Tempelman-Kluit, 1966, pp. 48–50) to the west where it is infolded with the Keno Hill Quartzite. Rocks assigned to unit 19 consist of a lower band of green shale with some maroon mottling, perhaps 500 feet thick, and overlying brown siltstone and limy siltstone about 1,000 feet thick. Best exposures are on the ridge west of North Klondike River about 64°25′N, 138°11′W.

Outcrop Characteristics

Neither the shale nor the siltstone of unit 19 is resistant and smooth topography characterizes the area underlain. Typical outcrops of the siltstone are light to medium brown and lower slopes and creek bottoms are often mantled by talus of small platy fragments. At higher elevations, rocks of the unit support little vegetation.

Lithology

The lower shale consists of a waxy-appearing olive-green rock with irregular dull maroon mottling. The shale is somewhat similar lithologically to mottled green and maroon shale of unit 3 of Precambrian age but it lacks the deep maroon colour and associated quartzite and grit.

Rocks of the upper part of unit 15 consist of interbedded dark grey shale and brown limy siltstone with a few thin bands of sandstone. Beds are seldom more than a few inches thick. The siltstone frequently shows crossbedding and ripple-marks, and worm trails are common.

Structure

Rocks of unit 19 have undergone the same folding as rocks of unit 18. East of North Klondike River, most of the rocks of unit 19 strike about east-northeast and dip moderately south although some chevron folding is believed present.

Rocks of unit 19 appear to overlie the Keno Hill Quartzite conformably. Rocks overlying unit 19 are not exposed owing to the overthrusting of units 15 and 3.

Age and Correlation

Despite abundant markings in the limy siltstone no identifiable fossils were discovered in unit 19. A tentative Lower Cretaceous age is suggested as the unit is believed to overlie the Keno Hill Quartzites conformably and has been intruded by dykes related to the granitic rocks (unit 21) of the area, the latter of probable Cretaceous age.

West of the International Boundary, about 120 miles northwest of outcrops of unit 19, Brabb and Churkin (1964a) have mapped unit B of the Kandik Formation of Lower Cretaceous age consisting of interbedded dark grey argillite and medium grey sandstone, the latter commonly with a carbonate cement. A tentative correlation is suggested.

Unit 20

Rocks assigned to unit 20 consist of sills of diorite, gabbro, and their altered equivalents that have intruded units 17 and 18. Sills of similar composition (20a) that may be older have intruded rocks of units 1, 2, 3, and 9. In the Mayo district the term 'greenstone' is used to refer to similar sills, and as the term is convenient it is used in this report.

Greenstone sills are most common in unit 17 in Nash Creek map-area and unit 18 in Dawson map-area. They are much more numerous than shown on the map. In some units, particularly 1, 3, and 9, sills weather much like the enclosing rock and often escape notice unless crossed by a ground traverse. Many other sills are either too small or too close together to be shown on the scale of the present map. The sills vary in size from a minimum of a few feet thick and less than 100 feet long to one in the Tombstone region of Dawson map-area reported (Tempelman-Kluit, 1966, p. 53) to be continuous for about 25 miles and as much as 800 feet thick.

Outcrop Characteristics

Greenstone sills (20) commonly form ridges that may rise 100 feet above the upland surface formed on less resistant enclosing rocks, especially those of unit 17. Such ridges are particularly well developed in the Davidson and Patterson Ranges in the southern part of Nash Creek map-area (Fig. 6). Frost action has commonly reduced the rock to a coarse rubble of crudely cubic blocks up to 6 feet in size. Greenstone usually weathers brown or rusty, and a bright orange lichen growth is frequently observed. This distinctive lichen grows in a helical pattern that may be as much as 1 foot diameter.

Lithology

The original composition of the greenstones is believed to have ranged between diorite and gabbro although a few peridotites have been reported (Green, 1971) south of Nash Creek map-area. Most appear to have contained about equal amounts of intermediate plagioclase feldspar and mafic minerals, both commonly in grains of a few millimetres to about 5 millimetres size. However, pervasive secondary alteration is common and in many specimens only ghosts of minerals and textures remain. Original minerals include intermediate plagioclase feldspar, a clinopyroxene (probably augite), and, less commonly, hornblende as major constituents, and minor ilmenite and quartz. Alterations observed in thin section include: saussuritization (replacement of plagioclase feldspar by albite and epidote group minerals); replacement of mafic minerals and part of the feldspar by fine needles of secondary amphiboles, either pleochroic (blue-green) hornblende (?) or non-pleochroic actinolite (?); carbonatization; serpentinization; sericitization; chloritization; and steatitization, or the replacement of pyroxene minerals by talc. Some greenstones show subophitic texture but most are allotriomorphic, although this may be partly due to secondary alteration and partial destruction of original texture. In some highly altered greenstones a pronounced foliation, parallel to that of the enclosing sedimentary rocks, is produced through crushing and rotation of primary grains of both mafic mineral and ilmenite and the 'streaking out' of irregular white and green patches composed of fine-grained secondary minerals replacing feldspar and the mafic minerals, either pyroxene or amphibole, respectively. No essential differences were observed between those greenstones (20) intrusive into Mesozoic rocks of map-units 17 and 18 and those (20a) intrusive into older rocks of units 1, 2, 3, and 9.

More detailed petrographic descriptions of greenstone intrusive into the Lower Schist division (unit 17) in the Mayo Lake district and the southern part of Nash Creek map-area are given in Green (1971).

Metamorphism

Limited metamorphic effects are associated with the greenstone sills. The most spectacular result from dedolomitization of argillaceous dolomite of unit 2 in the vicinity of some of the larger greenstones. There, the greenstone is surrounded by a white halo, as much as 100 feet thick, composed of secondary calcite and talc. Larger greenstones intrusive into the phyllitic rocks of unit 17 are commonly surrounded by rusty weathering, pyrite-rich argillite that lacks the well-developed foliation of the unit farther from the greenstone. The pyrite was presumably derived from the greenstone. In the author's opinion, the lack of foliation adjacent to these greenstones suggests that they may have solidified before the intense deformation that produced the foliation and shielded the enclosing argillites during its development.

Structural Relations

Most of the greenstones are conformable with the bedding of the enclosing sedimentary rocks and may be described as either sills or lens-shaped bodies. Greenstones differing from this general pattern include one crosscutting dyke and several bodies associated with fold-like structures (Green, 1971). In the Tombstone district of Dawson map-area, Tempelman-Kluit (1966, p. 52) has demonstrated that what was formerly mapped as a number of sills (Green and Roddick, 1962, Map 13-1962) is actually repetition of a single sill that is continuous for about 25 miles and is as much as 800 feet thick.

Age

Most of the greenstones (unit 20) intrude rocks of Jurassic (unit 17) and probable Lower Cretaceous (unit 18) age and are presumed younger than these rocks. The greenstones (20) are in turn altered by granitic rocks (21) of Cretaceous (?) age. From these relationships a post-Lower Cretaceous age is suggested for these greenstone sills (20).

The age of greenstones (20a) intruding older rocks (units 1, 2, 3, and 9) is unknown. In the author's opinion the remarkable similarity both in size and lithology between these greenstones and those intruding younger Mesozoic rocks suggests that they are the same age. However, some field evidence suggests an older age. In Nash Creek map-area, greenstone (20a) intrusive into rocks of units 1 and 2 was not observed cutting the overlying rocks of unit 8 of Ordovician to Silurian age. In Dawson map-area, only a few sills were observed in rocks in the Coal Creek Dome (unit 2) but the same relationship is believed to be present. Mapping in the Boundary area for about 45 miles north of Yukon River, Cairnes (1914, pp. 108–110) reported diabase and related rock types present as dykes, sills, and irregular intrusive masses in the Tindir Group (probably equivalent to units 1, 2, and 3 of this report) and rarely in the overlying Cambrian to Devonian carbonate rocks. He considered the diabase to be mainly of pre-Middle Cambrian age.

Unit 21

Intrusive igneous rocks assigned to unit 21 are present in all three map-areas. In general' granitic rocks (21a) occur in southern Nash Creek map-area and west of Tintina Trench in Dawson map-area, and syenitic rocks (21b) in southeastern Larsen Creek map-area and eastern Dawson map-area.

Outcrop Characteristics

Granitic rocks ranging from granodiorite to quartz monzonite (unit 21a, southern Nash Creek map-area and Dawson map-area, west of Tintina Trench) commonly underlie rather subdued topography and do not outcrop well. Many outcrops have crumbled to a coarse sand, presumably as a result of frost action along grain boundaries of the rock.

In marked contrast, the syenitic rocks (unit 21b, southeastern Dawson and southwestern Larsen Creek map-areas) form jagged spires that project far above enclosing rocks (Fig. 5). Deep cirques, impassable ridges, and vertical faces are characteristic of the area underlain by these rocks. They do not appear to have been appreciably affected by frost action.

The reason for the difference in weathering characteristics between the two rock types (21 a and b) is uncertain. Possibly it is in part dependent on the physiographic setting, the granitic rocks (21a) outcropping in the plateau areas that have little evidence of alpine glaciation and the syenitic rocks (21b) at much higher elevations in an area that has undergone extensive alpine glaciation.

Lithology and Structural Relations

Hanson Lakes to Potato Hills, southern Nash Creek map-area. The stocks (21a) between Hanson Lakes and Potato Hills in Nash Creek map-area consist of a medium-grained, grey granodiorite to quartz monzonite composed of potash feldspar (commonly microcline), intermediate plagioclase feldspar (commonly andesine), quartz, biotite, and minor green or black hornblende. Much of the potash feldspar occurs as coarse grains crowded with fine biotite and plagioclase grains. In traverses across the stocks neither markedly porphyritic material nor basic marginal phases were noted.

The stocks have intruded rocks assigned to units 3, 17, and 18. Exposures are poor, but metamorphic effects appear to be restricted to a relatively narrow contact zone. Locally, skarn minerals are developed in limy rocks of unit 3 on the slope above Lynx Creek southeast of the Dublin Gulch stock, and abundant scheelite in the placers of Dublin Gulch (Bostock *in* Little, 1959, pp. 21–29) suggests that similar alteration may have taken place on the Dublin Gulch – Haggart Creek side of the stock.

Southwest of Tintina Trench, Dawson map-area. Two large stocks and a number of smaller bodies of granitic rock (21a) lie southwest of Tintina Trench in Dawson map-area. The larger stocks consist of biotite granodiorite to quartz monzonite similar to rocks in Nash Creek map-area. The small stock near Swede Dome on the Sixtymile road is finer grained, usually less than 2 mm, and consists mainly of lath-like crystals of intermediate plagioclase (frequently zoned), biotite, and ragged grains of hornblende, much altered to secondary amphibole and biotite. The rock contains minor amounts of potash feldspar, quartz, and magnetite.

The stocks have intruded metamorphic rocks of the Yukon Group (units C and D). Exposures of the contact zones are poor with the exception of those along Yukon River southeast of Forty Mile. There both granitic gneiss and amphibolite appear to have developed.

Syenitic rocks of southeastern Dawson and southwestern Larsen Creek map-areas. A belt of related syenitic rocks (21b) extends about 55 miles, from the head of Alder Creek (Dawson map-area) southeast to near Hamilton Creek (Larsen Creek map-area). The principal rock type is biotite–clinopyroxene or biotite–hornblende syenite that grades locally into biotite-rich varieties, quartz monzonite, and quartz diorite. Much of the rock is medium- to coarse-grained but there are variations from a very fine grained rock with phenocrysts of feldspar and mafic minerals a few millimetres in size to coarse-grained rocks containing pink to grey phenocrysts of potash feldspar up to 1 inch or more. The finer grained rocks usually are in smaller bodies near the eastern part of the belt but were observed in some of the larger stocks. Alkali syenite containing pseudoleucite has been reported (Knight, 1906; Tempelman-Kluit, 1966, p. 60) from the Tombstone Mountain stock. Many of the syenitic rocks (21b) show foliation or lineation, the latter often produced through a crude alignment of the feldspar phenocrysts or needle-like crystals of clinopyroxene or hornblende.

Viewed in thin section, the ratio of potash feldspar (principally orthoclase) to plagioclase feldspar (principally andesine) usually varies from about equal amounts to twice as much potash feldspar although a few slides contained a great deal more. The content of mafic minerals may vary from near zero to about 40 per cent of the rock, the common minerals including a clinopyroxene, probably of the aegirine-augite group, hornblende, and biotite. Much of the pyroxene is colourless in thin section but some is strongly pleochroic from medium to dark green. The pleochroism of the hornblende also varies and in some cases the mineral is essentially opaque. A few thin sections contain as much as 20 per cent quartz. Common accessory minerals include sphene, zircon, apatite, and opaques.

A specimen of less common, finer grained rock from one of the small masses between Aussie and Hamilton Creeks in southwest Larsen Creek map-area contained about 60 per cent phenocrysts as much as 2 mm in size, potash and plagioclase feldspar in about equal amounts, lesser amounts of biotite, a clinopyroxene (probably of the aegirine–augite group), and a few rounded grains of quartz. The fine-grained matrix comprised about equal amounts of potash and plagioclase feldspar and minor quartz. A dyke rock about 1½ miles southwest of Dempster highway (64°25½'N, 138°13'W), Dawson map-area, contained about 25 per cent phenocrysts of plagioclase feldspar and hornblende, in a fine-grained matrix rich in potash and plagioclase feldspar. The phenocrysts were as much as 2 mm in size and the hornblende was partly altered to amphibole.

The syenite rocks (21b) have intruded rocks assigned to units 3, 4, 9, 17, and 18. The larger stocks appear to truncate the bedding of the enclosing sedimentary rocks and distort some fold structures (Tempelman-Kluit, 1966, p. 62). Portions of the contacts of two small stocks near the west margin of Larsen Creek map-area are well exposed in cliff faces, and here the igneous rocks appear to have followed fold structures rather than having steep to vertical crosscutting contacts. Metamorphic effects associated with all the stocks appear to be restricted to a zone close to the contact and consist mainly of the development of rusty weathering hornfels. Locally, recrystallization has obscured the bedding of the intruded rocks. Inclusions within the intrusive rocks are rare, and most of those observed were only a few inches in size although Tempelman-Kluit (1966, p. 62) reports a large xenolith of white marble with a skarn margin in the Tombstone stock.

Age and Correlation

The youngest rocks intruded (21 a and b) belong to unit 18 of probable Lower Cretaceous age. Granitic debris is common in the conglomerates of map-units 23 of Tertiary age. A number of isotopic (potassium–argon) age determinations made by the Geological Survey of Canada also suggest a Cretaceous age for the intrusive rocks (*see* Leech *et al.* 1963, pp. 51, 52). These determinations give ages of 81, 91, 102, 106, and 134 m.y.

The radioactive ages appear to extend from near the base of the Cretaceous Period into the Upper Cretaceous according to a recent time scale (Wanless *et al.*, 1966, p. 4). The ages agree reasonably well with those obtained in the Pelly district, about 150 miles southeast (Leech *et al.*, 1963, p. 27), and many similar ages have been found farther southeast along this general trend.

Granitic rocks (21a) in the southern part of Nash Creek map-area are similar to rocks that outcrop about 20 miles to the southeast in Mayo map-area (Bostock, 1947; Green, 1971). Beyond this, scattered stocks and batholiths of similar rock are strung out along the northeast side of Tintina Trench for many hundreds of miles.

Granitic rocks (21a) in Dawson map-area, southwest of Tintina Trench, are similar to those mapped in the metamorphic belt extending to the southeast.

Syenitic rocks (21b) of the Tombstone district are distinct mineralogically from igneous rocks of nearby areas. Some syenite has been reported (Bostock, 1964) in McQuesten map-area about 50 miles southeast but it contains large albite phenocrysts in contrast to the potash feldspar phenocrysts of the Tombstone district. In the author's opinion, the close association in both space and time of the syenitic rocks (21b) with the granitic rocks (21a) extending southeastward suggests that the two suites are closely related despite differences in composition.

Unit 22, Monster Formation[1]

Mountjoy (1967a, pp. 4, 5) has proposed the name Monster Formation for an alternating sequence of sandstone, siltstone, shale, and minor chert–pebble conglomerate. A section about 3,100 feet thick was measured at 65°03′N, 140°14′W, a few miles north of Dawson map-area. There rocks assigned to the Monster Formation form the core of a large syncline, referred to as the Monster Syncline, and a smaller syncline to the west. An incomplete section, about 3,600 feet thick, was measured on the south flank of Monster Syncline, and the formation may be as much as 6,000 feet thick in the area.

Rocks of the Nation River Formation (unit 13a), mapped to the south and east of Monster Syncline, are lithologically similar to rocks of the Monster Formation but are believed of probable Upper Devonian age (Churkin and Brabb, 1965, p. 182). It is possible that some of the rocks included in this older unit may in fact belong to the Monster Formation.

Outcrop Characteristics

The unit contains thin bands of conglomerate, seldom exceeding 100 feet thick, that outcrop well in contrast to the less resistant sandstone and shale that form most of the unit. The area underlain is marked by rather subdued topography containing ridges of brown to olive-green outcrop separated by vegetation-covered slopes.

Lithology

Rocks assigned to unit 22 consist of brown to olive-green weathering, thinly bedded, chert-grain sandstone, siltstone, shale, and minor chert–pebble conglomerate. The sandstone shows much variation in grain size between siltstone and chert–pebble conglomerate. Grains are mainly chert but include some quartz, both generally well rounded. The feldspar content of the rock is negligible. The varicoloured chert grains give the rock a distinctive 'salt and pepper' appearance. Cementing material is mainly argillaceous but includes some iron-bearing carbonate. Shales are frequently flecked with fine flakes of muscovite. The chert–

[1]The name Monster River (and hence Monster Formation and Monster Syncline) is derived from a large Letourneau muskeg vehicle, locally known as "The Monster", that lay abandoned near the centre of the valley (about 64°55′N, 139°46′W) from 1955 to 1961. Much of the following information was supplied by E. P. Callison (*pers. com.*).

"The Monster" consisted of a motor unit with two diesel–electric generators and a number of trailers, all mounted with large low pressure tires about 8 feet in diameter. Each wheel of the power unit and trailers was driven by an individual electric motor. An Alaskan contractor had intended to use the machine freighting supplies for the construction of the Distant Early Warning Line over a winter trail leading from Eagle, Alaska, to the Arctic coast. Supplies were trucked over the rougher portion of the road from Eagle to the open valley of the Monster River, and the machine, which had been brought south from the Arctic coast, had just started north with the first load when the engine was destroyed by fire. In 1961, the machine was salvaged by a crew using a smaller unit of similar design and brought to Bear Creek, near Dawson, where it still remained in 1967.

pebble conglomerate contains well-rounded grains of grey, black, and light grey-green chert plus some quartz in a fine-grained matrix. Most pebbles are an inch or less in maximum dimension but some as large as 4 inches were observed in the small syncline north of Tatonduk River.

The following partial section was measured in the Monster River Syncline about 64°57′N, 140°16′W:

		Thickness (feet)	
Unit	Lithology	Unit	Total from base
	Top not exposed		
	UNIT 22 (MONSTER FORMATION)		
42	Interbedded sandstone and pebble conglomerate; sandstone medium- to coarse-grained, 'salt and pepper', scattered pebbles to ½ inch; conglomerate medium to dark grey with chert pebbles to 2 inches and scattered white quartz pebbles	50	3,585
41	Mainly covered but talus of brown sandstone and siltstone	625	3,535
40	Pebble conglomerate, light to medium grey, chert and quartz pebbles to ½ inch diameter	25	2,910
39	Covered	50	2,885
38	Sandstone and conglomerate; sandstone fine-grained, brown, argillaceous; pebble conglomerate medium to dark brownish grey with scattered pebbles to ½ inch diameter in fine argillaceous matrix; sandstone and conglomerate thinly interbedded; fossil collection F 170 near top	50	2,835
37	Covered	275	2,785
36	Sandstone, medium grey-brown, coarse-grained	10	2,510
35	Covered	140	2,500
34	Sandstone, dark grey-brown, fine-grained, thin-bedded	10	2,360
33	Covered	45	2,350
32	Sandstone, dark brown, fine- to medium-grained, argillaceous, thin-bedded	20	2,305
31	Covered	165	2,285
30	Sandstone, medium brownish grey, fine-grained, very thin bedded	10	2,120
29	Covered	15	2,110
28	Sandstone, medium brown, fine-grained, very thin bedded	10	2,095
27	Covered	30	2,085
26	Interbedded sandstone and pebble conglomerate, both medium brown	45	2,055

Unit	Lithology	Thickness (feet) Unit	Total from base
25	Covered	240	2,010
24	Interbedded siltstone and sandstone, medium brown, very thin bedded	10	1,770
23	Sandstone, medium brown; scattered bands of chert–pebble conglomerate	125	1,760
22	Covered	100	1,635
21	Siltstone, tan-brown, thin-bedded	10	1,535
20	Covered	40	1,525
19	Shale, dark olive-brown with a few beds of siltstone	10	1,485
18	Covered, but talus of siltstone and shale	80	1,475
17	Sandstone, medium brown, thin-bedded; a few chert pebbles	45	1,395
16	Covered	25	1,350
15	Sandstone, medium brown, medium- to coarse-grained, thin-bedded, some plant remains	115	1,325
14	Covered but talus of siltstone	100	1,210
13	Covered	35	1,110
12	Sandstone, medium brown, medium- to coarse-grained, calcareous	65	1,075
11	Covered	115	1,010
10	Sandstone, medium grey-brown, thin-bedded	10	895
9	Covered	50	885
8	Sandstone, medium brown, medium- to coarse-grained, thin-bedded, somewhat calcareous	100	835
7	Covered but talus of siltstone and fine-grained sandstone	85	735
6	Sandstone and siltstone, medium brownish grey, contains angiospermous leaf fragments and stems, fossil collection F 169	15	650
5	Covered	130	635
4	Sandstone, dark brownish grey, medium-grained, thin-bedded	70	505
3	Rubble of siltstone and sandstone	375	435
2	Covered	50	60
1	Conglomerate, medium grey, with pebbles and cobbles to 3 inches diameter	10	10
	Unconformable contact Underlying rocks of unit 16		

Structural Relations

Unit 22 is exposed in Monster River Syncline and in the small syncline northeast of the mouth of Monster River. Both structures are open and dips range from gentle to moderate. Unit 22 lies unconformably on units 15 and 16. The top is not exposed.

Age

The following fossil collections were made from rocks assigned to unit 22:

F 167 GSC plant loc. 5798 (64°59′N, 140°05′W), Dawson map-area, south fork of Tatonduk River

Remarks: Angiosperm leaf fragments are present but are too fragmentary and poorly preserved to be identified. They indicate a general age range of Cretaceous–Tertiary for the beds from which the collection was made.

F 168 GSC plant loc. 5796 (65°00′N, 140°06′W), Dawson map-area, south fork of Tatonduk River

Conifer, indeterminate cone
Trochodendroides (*Cercidiphyllum*) *arctica* (Heer) Berry
numerous other angiosperm leaves which are too fragmentary for purposes of identification

Remarks: *Trochodendroides* (*Cercidiphyllum*) ranges from Upper Cretaceous through Tertiary. The other angiosperm leaf fragments suggest some early Tertiary forms but cannot be specifically identified. Tentatively, the beds from which this collection was made may be thought of as Cretaceous – early Tertiary. Additional and more complete specimens are required before exact dating can be suggested.

F 169 GSC plant loc. 5799 (64°56½′N, 140°16′W), Dawson map-area, south fork of Tatonduk River

Angiospermous leaf fragments and bits of woody stems, all too fragmentary for specific identification

Remarks: On the basis of our present knowledge, the occurrence of angiospermous plant remains indicates that the beds from which this collection was taken are no older than Albian and could possibly be Tertiary.

F 170 GSC plant loc. 5803 (64°57½′N, 140°17½′W), Dawson map-area, south fork of Tatonduk River

Taxodium dubium (Sternberg) Heer

Remarks: This plant may range downward into latest Cretaceous but most certainly is known from Paleocene to early Pliocene. It is very important that additional plant remains be collected from this locality to establish the exact age of the beds.

The collections were examined and commented on by F. M. Hueber, then of the Geological Survey of Canada. A Lower Cretaceous (Albian) to Tertiary age is suggested on the basis of the rather poor material collected. Mountjoy (1967a, p. 4) collected material, also meagre, from the section on the north side of Monster Syncline, and this was examined by the late W. A. Bell, who considers it of probable Upper Cretaceous age.

Correlation

Extensive areas of both Lower Cretaceous and Tertiary rocks with lithology somewhat similar to that of unit 22 have been mapped in Alaska beyond the northwest corner of Dawson map-area by Mertie (1937, pp. 156–180) and more recently by Brabb and Churkin (1964a). Norris *et al.* (1963) have also mapped large areas of Upper Cretaceous rocks in northern Yukon, and correlations with some of these areas are given by Mountjoy (1967a).

Unit 23

Rocks assigned to unit 23 consist of impure sandstone, shale, poorly sorted conglomerate, and lignite. The rocks are restricted to Tintina Trench where they form scattered outcrops often nearly buried by debris. Exposures are so poor that it is not possible to determine the structure or estimate the thickness of the unit.

Outcrop Characteristics

Most of the length of Tintina Trench in Dawson map-area is at low elevation, has little relief, and is blanketed by heavy moss and stunted spruce, typical of permafrost regions. In the vicinity of the Chandindu River a few knobs of glacial material covered by aspen poplars break the monotonous pattern. Nearly all the outcrops of unit 23 are in the cutbanks of creeks crossing Tintina Trench, and sloughing of the poorly consolidated sediments makes it difficult to distinguish between rocks assigned to the unit and unconsolidated glacial material (unit 26).

Lithology

Most of the outcrops of unit 23 are a mixture of poorly consolidated, brown, buff, and grey arkosic and micaceous sandstone, light and dark shale, poorly sorted conglomerate, and minor lignite. Angular schist fragments are common in both conglomerate and sandstone. Other rock types include bull quartz, chert, quartzite, and granitic gneiss. Fragments as much as 2 feet in greatest dimension were observed in the conglomerate. The impure sandstones contain some potash feldspar. The lignite is shiny dark brown to black and is extremely friable. Lignite float is common but no seams were observed in place. Following the Klondike Gold Rush, brief attempts were made to mine lignite on Cliff Creek and Coal Creek (both northeast of Forty Mile) and on Coal Creek, a tributary of Rock Creek, about 15 miles northeast of Dawson.

Structure

Some of the better outcrops of unit 23 show dips of 45 degrees or more, indicating that the unit has undergone at least moderate deformation. The scarcity of outcrops, particularly in the southeastern part of Tintina Trench, precludes further structural interpretation.

Age

The following fossil collections were made from unit 23:

F 171 GSC plant loc. 5792 (64°19'N, 139°40'W), Dawson map-area, Thane Creek, 5 miles from mouth

Abies sp.
angiospermous leaf fragments
angiosperm pollen

Remarks: *Abies*, or the form genus *Abietites*, has been reported from the late Cretaceous but is most commonly identified with the Tertiary. The angiospermous leaf fragments and pollen lend support to the dating of the beds from which this collection was derived as Cretaceous–Tertiary. On the basis of the pollen forms, the time may be narrowed to latest Cretaceous – early Tertiary.

F 172 GSC plant loc. 5219 (64°27½'N, 140°07'W), Dawson map-area, abandoned coal mine, Coal Creek

microfossils

Age: Early Tertiary, probably Eocene

F 173 GSC plant loc. 5793 (64°33½'N, 140°25½'W), Dawson map-area, Cliff Creek, 2 miles from mouth
Metasequoia occidentalis (Newberry) Chaney
angiosperm leaves—too fragmentary for purposes of identification
Remarks: This collection was made from Tertiary deposits. On the basis of the occurrence of *Metasequoia occidentalis* the age of the beds could range from Paleocene to mid-Miocene. The angiosperm leaves are too fragmentary and, therefore, are of no help in narrowing the range suggested by the occurrence of *Metasequoia*.

Collection F 172 was examined by G. E. Rouse of the University of British Columbia, and collections F 171 and F 173 by F. M. Hueber then of the Geological Survey of Canada.

On the basis of these reports an Early Tertiary, probable Eocene age is suggested for unit 23.

Correlation

Mertie (1937, pp. 172–180) has mapped similar rocks extending approximately 85 miles northwest from the boundary of Dawson map-area. The rocks underlie a basin up to 10 miles wide southwest of Yukon River. The lithology as described by Mertie (op. cit.) is identical to that of unit 23 within Dawson map-area. Scattered outcrops of similar rocks southeast have been mapped along Tintina Trench as far as Lapie River, a distance of about 240 miles (Bostock, 1942, 1948a; Roddick and Green, 1961b; Wheeler, Green, and Roddick, 1960). Very similar Tertiary rocks have also been mapped in Rocky Mountain Trench in northern British Columbia (Gabrielse, 1962).

Unit 24

Rocks assigned to unit 24 consist of volcanic rocks with minor associated sedimentary rocks of probable Tertiary age that underlie a number of small areas and one large area southwest of Tintina Trench in Dawson map-area. In most outcrops rocks of the unit are a few hundred feet or less thick, but as much as several thousand feet may be present in the large area underlain by these rocks south of the Sixtymile road.

Outcrop Characteristics

In general, rocks of the unit do not outcrop well and the areas underlain by them are marked by relatively smooth topography with small scattered outcrops. Along the Sixtymile road, west of Dawson, loose gravel forming a thin mantle on the upland surface is believed to have been derived from weathering of conglomerates within unit 24. Frequently, the gravel is present in amounts sufficient for excavation as road material.

Lithology

Volcanic rocks assigned to the unit are principally andesite. There are many variations in colour including darker shades of grey, brown, and green, through lighter shades of these colours, to minor amounts of buff to lavender. The texture varies from dense aphanitic to porphyritic, the latter containing crystals of feldspar and less commonly pyroxene or hornblende. Individual flows could not be distinguished in most outcrops. Lesser amounts of porous, punky tuff and breccia both composed mainly of altered feldspar crystals are present. Associated sedimentary rocks include brown shale, light buff micaceous sandstone, and poorly sorted conglomerates containing pebbles of quartz and metamorphic rocks, the latter principally derived from rocks of map-unit A. All the sedimentary rocks are extremely friable and seldom outcrop.

The small outcrop on the west slope above Yukon River, about 3½ miles south of Forty Mile, consists of about 250 feet of poorly sorted conglomerate. This is overlain by vesicular lava and capped by about 100 feet of dense, dark grey, olivine basalt that shows well-developed columnar jointing.

A thin section examination showed that although some of the volcanic rocks have retained their original mineralogy and texture many have altered extensively to secondary minerals. The alterations include development of secondary micas, replacement of plagioclase feldspar by albite- and epidote-group minerals, and extensive replacement of primary minerals by secondary carbonate. The unaltered rocks often contain phenocrysts of intermediate plagioclase feldspar, commonly 3 mm or less in size, and smaller amounts of a mafic mineral, either a clinopyroxene (probably augite to pigeonite) or dark pleochroic hornblende. The groundmass consists of finely crystalline feldspar often with considerable magnetite.

Structure

Rocks of unit 24 overlie the metamorphic rocks (units A to D) west of Tintina Trench with marked angular unconformity. Most outcrops appear to be flat lying but the continuity of the large outcrop area in the district of Sixtymile from the plateau surface to the valley of Sixty Mile River, a difference in elevation of about 1,500 feet, suggests that the rocks were deposited and either folded or block faulted before the development of the plateau surface.

Age and Correlation

No fossils were obtained from rocks assigned to the unit either in the present mapping or in earlier mapping of the Klondike by McConnell (1905b, pp. 23B–27B) or of the Sixty Mile and Ladue Rivers area by Cockfield (1921, p. 30). Although direct evidence is lacking, a Tertiary age is suggested for the unit.

In the past, correlations have been made between rocks now assigned to unit 24 and unit 23, the latter of probable Eocene age. Sedimentary rocks assigned to the two units are very similar lithologically but, in the author's opinion, a direct correlation should not be attempted as rocks of unit 23 lack the association with volcanic rocks, and more important, are believed to be restricted both in source area and sedimentation to the topographic depression along Tintina Trench.

In the Chicken area of Alaska, about 35 miles west of the large area mapped as unit 24 in Dawson map-area, Mertie (1937, p. 175) has mapped a small area of sandstone, shale, and conglomerate of probable Tertiary age the description of which is very similar to the sedimentary rocks included with unit 24. In Ogilvie map-area, south of Dawson map-area, Bostock (1942) mapped considerable areas of lithologically similar sedimentary rocks (his unit 3) and overlying volcanic rocks (his unit 4). Some plant remains are reported and an Eocene age is suggested for rocks of unit 3 based on correlation with rocks of this age along Tintina Trench. Farther afield, volcanic and sedimentary rocks of probable Tertiary age that are very similar lithologically to unit 24 have been reported from many areas of Alaska and Yukon. However, until definite evidence of age is obtained in the present area, attempts at wider correlation are of little value.

Unit 25

Scattered small bodies of quartz porphyry or rhyolite porphyry assigned to unit 25 occur in all three map-areas. They are most common in the metamorphic rocks along Yukon

River and in the rocks of units 3 and 17 in the southern part of Nash Creek and Larsen Creek map-areas. Most of the exposures are sill-like bodies less than 50 feet thick and can seldom be traced more than a few hundred feet. They commonly seem to parallel the foliation of the enclosing sediments, but one particularly well-exposed body was observed alternately to parallel and to crosscut the foliation of the enclosing rocks.

Outcrop Characteristics

This unit commonly weathers cream to light buff in contrast to the darker colours common in the enclosing rocks, but aside from this, the bodies are too small to have other physical expression. The fact that more have been mapped along Yukon River probably reflects good exposure there rather than a greater concentration of these rocks than elsewhere in the metamorphic rocks southwest of Tintina Trench.

Lithology

The porphyries show considerable variation in composition and texture but in general contain phenocrysts of quartz, feldspar, and less commonly biotite, muscovite, clinopyroxene, and hornblende in a fine-grained sugary matrix. The quartz phenocrysts commonly show rounded crystal shapes that appear corroded.

Quartz porphyries in the southern part of Nash Creek map-area were studied in some detail in connection with more detailed mapping in the general area (Green, 1971). Here the phenocrysts are generally as much as 2 mm in size and may comprise 15 per cent of the rock. Seen in thin section, the sugary matrix consisted of fine quartz grains, lesser amounts of feldspar, and a felted mass of fine muscovite. Part or all of the muscovite may have formed through the alteration of feldspar. Another alteration is the development of a carbonate, commonly ferruginous, that may comprise as much as 50 per cent of the groundmass. The carbonate grains are irregular and crowded with inclusions of muscovite and quartz. The rock may contain as much as 5 per cent pyrite; the oxidation of this and the presence of ferruginous carbonate are believed to be responsible for the buff colour of many weathered surfaces. The feldspar phenocrysts include orthoclase, an acidic plagioclase (probably oligoclase), and some microcline. A granite porphyry northeast of Ladue Lake has also been included in the unit.

Boyle (1965, p. 257) gives an analysis for a composite of three specimens of quartz porphyry from the Galena Hill – Mount Haldane area immediately south of Nash Creek map-area.

In the southeastern part of Larsen Creek map-area, the two quartz porphyries mapped contain the usual phenocrysts of quartz and feldspar (chiefly plagioclase), but in addition the southern part contains about 5 per cent hornblende phenocrysts to 5 mm and the northern about 10 per cent biotite and minor clinopyroxene phenocrysts both to about 2 mm. The rocks mapped as unit 25 along the south boundary of the map-area (136°42′W) underlie an area about 200 yards diameter and consist of punky grey rhyolite breccia containing fragments of the normal buff quartz porphyry as much as several inches in size.

In Dawson map-area, the rocks mapped as unit 25 along Yukon River are light grey to grey-green, fine-grained, and contain phenocrysts of quartz up to several millimetres in size and altered white potash feldspar phenocrysts up to 10 mm. In some specimens the feldspar phenocrysts form as much as 10 per cent of the rock with quartz generally present in lesser amounts. The outcrop near the International Boundary (about 64°33½′N) contains sugary aplitic rock with grains of quartz, potash, and plagioclase feldspar to 0.5 mm and finer grained prophyry with scattered quartz phenocrysts.

Age and Correlation

Within the map-area rocks of unit 25 were not observed cutting rocks younger than early Mesozoic. In the Klondike district, south of Dawson, McConnell (1905b, p. 27B) considered the quartz porphyries to be the youngest igneous rocks in the region (Tertiary?). In the Sixty Mile and Ladue Rivers area Cockfield (1921, p. 34) reported that rhyolites, quartz porphyries, and related rocks cut all the other consolidated formations of the district including his Newer Volcanics (unit 24 of this report), which he (pp. 32, 33) considers of Eocene to Early Miocene age. On the basis of observations by McConnell and Cockfield a Tertiary age is suggested for the rocks of unit 25.

Elsewhere in Yukon, Tertiary ages have also been suggested (Bostock, 1936a, p. 44; 1942; 1948a, p. 6; Wheeler, 1961, p. 102) for what are believed to be lithologically similar rocks. However, as noted by Wheeler (op. cit.) the possibility exists that some of these rocks may be closely related to and the same age as granitic rocks of probable late Lower or early Upper Cretaceous age.

Metamorphic Rocks Southwest of Tintina Trench

Yukon Group (Units A to D)

Most of the area between Tintina and Shakwak Trenches is underlain by metamorphic rocks of uncertain age for which Cairnes (1914, pp. 40–44) proposed the 'wastebasket' term, Yukon Group. The outcrop area of these rocks within Dawson map-area is very small and there they can be divided into four units, following those of McConnell (1905b, pp. 10B–12B) in the adjacent Klondike area. These units are based on relative amounts of certain lithologies present, and the contacts shown between them on the map are, in most cases, interpretative only. Although of use locally, it is doubtful whether they can be extended much beyond the Klondike district and the present map-area. In view of the limited area of metamorphic rocks of the Yukon Group within the present map-area, poor outcrop, and scanty traverse coverage, these rocks are considered somewhat briefly and only limited reference is made to literature describing the metamorphic rocks of southwestern Yukon and central Alaska.

In defining the Yukon Group Cairnes (1914, p. 44) wrote in part as follows:

> It is thus thought that the term Yukon Group should be a useful field name as under this group may be included all the older metamorphic, probably Pre-Cambrian, schistose and gneissoid rocks that are encountered regardless of their origin, which is often difficult or impossible to determine.

Among the previously described units that he included in the Yukon Group are: Brooks' (1900) and McConnell's (1905b) Nasina series, McConnell's (1905b) Klondike series and Pelly gneiss, and Spurr's Birch Creek and Fortymile series (Spurr and Goodrich, 1898). In recent mapping in Yukon, since about 1950, there has been a tendency to avoid the use of the term Yukon Group and to attempt to correlate metamorphic rocks with possible less metamorphosed equivalents. However, in the Dawson area such a correlation does not appear possible and use of the term Yukon Group is justified provided a definite Precambrian age is not implied. In this area the Yukon Group has been subdivided into four units: unit A, metamorphic rocks of sedimentary origin (McConnell's Nasina series); unit B, distinctive muscovite and chlorite schists (McConnell's Klondike schist); unit C, rocks containing much greenstone or, locally, amphibolite gneiss; and unit D, granitic gneiss (McConnell's Pelly gneiss).

In Alaska, immediately west of Dawson map-area, Prindle (1909) followed by Mertie (1937) mapped the metamorphic rocks as two units. An older (?) group to the south (Birch Creek schist) consists of schist, gneiss, and minor intrusive rock whereas a younger group to the north, between about 64°28′N and Yukon River, consists of greenstone, phyllite, quartzite, and limestone of lower metamorphic rank than the southern rocks. Scattered collections of fossils of Devonian age have been made from the northern group.

Age

Rocks of the Yukon Group were formerly considered as part of a Precambrian crystalline complex but, in the author's opinion, the field relationship upon which the Precambrian age was based is invalid. More recent evidence both from the map-area and southeast of it suggests that the metamorphic rocks of the Yukon Group are, in part at least, of Paleozoic age. A number of age determinations using the potassium-argon method give late Paleozoic or younger ages for both the metamorphic rocks of the Yukon Group and granitic rocks intrusive into them.

The Precambrian age given by Cairnes (1914, p. 41) and then Mertie (1937, pp. 55, 56) was based on field relationships along the Yukon–Alaska Boundary between Yukon River and Jones Ridge, about 30 miles north. In the vicinity of Jones Ridge, carbonate rocks of Middle Cambrian age overlie unmetamorphosed carbonate and clastic rocks which Cairnes mapped as the Tindir Group of Lower Cambrian or Precambrian age.

Cairnes (1914, p. 41) compared the contrasting lithologic character and metamorphic rank of the Tindir and Yukon Groups and concluded:

> Therefore, although the most typical and definitely identifiable members of the Tindir Group were not found by the writer in actual contact with the rocks of the Yukon Group, still for the reasons above mentioned, it seems as if there could remain little if any doubt that the members of the Yukon Group are the oldest rocks in the Yukon valley and that they are of Precambrian age.

In the present mapping it was found that the Yukon and Tindir Groups, as mapped by Cairnes, lie on opposite sides of Tintina Trench, a major fault, and age relationships cannot be inferred from differences in metamorphic rank across it.

Within Dawson map-area crinoid columnals were observed or collected in the metamorphic rocks by Cairnes (1914, pp. 39–40), Mertie (1937, p. 100), and the writer. Those observed by the writer occur in a green chlorite-rich limestone that is of the same metamorphic rank as the enclosing rocks. A number of fossil collections have been made a few miles to the west in Alaska in the unit that Mertie (1937, pp. 91–101) mapped as Devonian. From his description it appears that this unit differs from the Birch Creek schist (cf. Yukon Group, in part) in lithology and to a lesser degree in metamorphic rank. Elsewhere in Yukon, definite evidence for a Precambrian age of the Yukon Group is lacking and there is scattered evidence that it may be, in part, Paleozoic. Fossil fragments are reported by Bostock (1936a, p. 18) in the Carmacks area.

Unit A

Rocks assigned to unit A (Nasina series of McConnell, 1905b, pp. 12B–15B) consist of low-rank metamorphosed sedimentary rocks, principally quartzite, quartz–mica schist, and limestone, and underlie much of the area southwest of Tintina Trench in Dawson map-area. Rocks of somewhat higher metamorphic rank occur along the International Boundary near Forty Mile River and are indicated as unit Aa. Mappable bands of limestone and marble within unit A are shown as unit Ab. Rocks lying in the triangle enclosed by Tintina Trench, Forty Mile River, and the International Boundary are included in unit A with some hesitation. There outcrops are poor, and scanty traverse coverage suggests that, in part, the rocks may be less metamorphosed and contain more greenstone than those mapped as unit A elsewhere. Possibly, with additional information, two map-units similar to those of Mertie (1937) could be recognized in this area but, if so, they must be closely folded or faulted together.

Outcrop Characteristics

Much of the area underlain by unit A is unglaciated and characterized by rounded hills, plateau surfaces, and V-shaped valleys with interlocking spurs. Exposures on the upland surfaces are poor with the exception of light grey bands of vegetation-free limestone and scattered black lichen-covered tors of resistant quartzite. Cover on these surfaces is thin and the nature of the bedrock can often be ascertained from float. Outcrops are reasonably common along many of the smaller stream valleys.

Lithology

Rock types in the map-unit include massive quartzite, thin-bedded quartzite, quartz–muscovite, and graphitic quartz–muscovite schist, greenstone, and limestone. Much of the quartzite is dark grey to blue grey and the interbedded schist dark grey to black.

In most outcrops the rock is strongly foliated and tends to break into flags with glistening mica surfaces. The foliation surface is generally parallel to the original bedding as indicated by primary compositional banding in the rock but in some outcrops the foliation has cut the bedding into a series of S-shaped remnants ('Gleitbrett' structure). Lenses and veins of milky to light grey quartz, usually a few inches or less wide and a few feet long, are common following the foliation of the enclosing rock. Much of the limestone (map-unit Ab) is a pale grey or banded grey and white rock with a grain size of about 3 mm. It frequently forms bands as much as several hundred feet, and some of the larger bands can be traced for a mile or more. Typical lithology of the unit is well shown, both as outcrop and float, along parts of the Sixtymile road between Dawson and the International Boundary. A thick-bedded, dark grey quartzite, very similar to the quartzite of the Keno Hill area (unit 18), is particularly well exposed just north of the road at the Boundary.

In thin section the quartz-rich rocks of unit A are seen to consist of quartz grains, generally crudely polygonal and about 0.2 mm dimension, and varying amounts of micas, mainly muscovite but including biotite and chlorite, in bands parallel to the foliation of the rock. Many specimens show variation in the grain size of the quartz between foliation planes, suggesting variations in grain size during sedimentation.

Higher rank metamorphic rocks assigned to unit Aa include quartzite, quartz–mica schist, marble, and greenstone, with biotite, hornblende, and garnet as common metamorphic minerals. Most of the rocks included in the subunit are clearly of sedimentary origin but contain little of the dark grey quartzite and carbonaceous or graphitic quartz–mica schist common to many outcrops of unit A.

Structure

Little is known of the structural history of the unit, and the lack of marker beds and poor outcrop would make detailed study difficult with the possible exception of a few selected areas. The foliation may have resulted from close folding and movement parallel to the foliation planes. Later wrinkle lineations are present on many of the foliated surfaces.

Age and Correlation

One collection (F 174) of echinoderm columnals was made from rocks assigned to the map-unit just west of Yukon River near the Alaska Boundary (64°39½'N, 140°57½'W). A number of collections, of probable Devonian age, have been made in Alaska about 10 miles west of the map-area (Mertie, 1937, pp. 91–103).

The separation of somewhat higher rank metamorphic rocks (unit Aa) along Fortymile River follows recent mapping by Foster (*pers. com.*), who established three units: (1) higher rank rocks on both sides of Fortymile River, presumed to correspond to the Birch Creek schist of Mertie (op. cit.), (2) a band of lower rank metamorphic rocks consisting principally of graphitic quartz–mica schist and dark grey quartzite, outcropping along the boundary between about 64°25'N and 64°33'N, and (3) green schist with minor interbedded graphitic schist, marble, and quartzite outcropping along the boundary between unit 2 and the Yukon River. Mapping was not in sufficient detail to extend the boundary between units 2 and 3 eastward in Dawson map-area.

Unit B

The name 'Klondike series' was applied by McConnell (1905b, pp. 10B–22B) to sericite and minor chlorite schist together with associated gneiss that forms much of the bedrock of the Klondike goldfield. Rocks of the series were believed to have been derived from the alteration of igneous rocks in contrast to rocks of similar metamorphic rank derived from sedimentary rocks (Nasina series of McConnell). Later, similar rocks assigned to both the Klondike and Nasina series were mapped by Cockfield (1921) about 50 miles west, near the International Boundary. In his descriptions McConnell refers to schistose rocks of the 'Klondike series' as the 'Klondike schist', a useful field term that can be applied to a distinctive group of schists in the present area, regardless of their possible origin or relation to gneissic rocks. A term such as Klondike Schist is of local value but probably of little use elsewhere in the vast areas of Yukon and Alaska underlain by metamorphic rocks of roughly comparable rank. Two areas of Klondike Schist are present in Dawson map-area; the first, a continuation of that mapped by McConnell, extends along the Yukon River to about 16 miles downstream from Dawson, and the second, a continuation of that mapped by Cockfield, lies near the Alaska Boundary in the southwest corner of the map-area.

Outcrop Characteristics

Much of the area underlain by Klondike Schist (unit B) is unglaciated and characterized by rounded hills, plateau surfaces, and V-shaped valleys with interlocking spurs. Outcrop is generally poor although scattered outcrops occur on the upland surfaces and are common along streams and rivers. Cover on the upland surfaces is light and in most places the nature of bedrock can be ascertained from float. Most of the rock is silver to green on the fresh surface although many outcrops are stained buff or covered by dark lichen. The rock is highly foliated and a rubble of frost-riven fragments with glistening foliation surfaces lies at the base of many outcrops.

Lithology

The Klondike Schist varies from soft quartz–feldspar–muscovite schist, with varying amounts of chlorite, to dense hard rocks gradational into quartz–feldspar–biotite gneiss. In general, the rocks are well foliated but, in contrast to unit A (Nasina series of McConnell), sedimentary structures resulting from either original bedding or compositional changes between beds are rare. Some outcrops show S-shaped segments of what may be the original bedding cut by and at a high angle to the foliation planes ('Gleitbrett' structure). Most of the rocks are fine grained but locally they contain elongate augen of either quartz or feldspar up to 5 mm maximum dimension. Lenses and veins of milky to light grey quartz are common in the Klondike Schist. Most follow the foliation of the enclosing schist and are commonly up to a few inches wide and a few feet long although some much larger veins occur. Occasionally, the veins trace out S-shaped folds following those outlined by compositional banding in the rock.

In thin section, specimens assigned to the Klondike Schist are seen to be composed mainly of quartz, feldspar (both potash feldspar and plagioclase), and mica (chiefly muscovite with some chlorite and biotite). Other minerals sometimes present in lesser amounts include epidote, one or more carbonates (calcite and ankerite?), pyrite, limonite, leucoxene, and garnet. Thin sections stained for both potash and plagioclase feldspar showed a wide variation in the total feldspar content and the ratio of potash to plagioclase feldspar. Some of the slides contained little feldspar whereas in others the granular material was almost entirely potash feldspar. In individual thin sections quartz and feldspar often show considerable variation in grain size between the various foliation planes, but in most specimens the grains, with the exception of augen, seldom exceed 0.3 mm in diameter. Finer grained material is often wrapped around the augen and the latter appear to have been drawn out and crushed. Quartz grains commonly show strain shadows and fluid pores. The grains are generally regular in outline, with sutured textures less common. Potash feldspar occurs both as large grains, commonly microcline, that frequently appear to have undergone crushing and alteration, and very fine grained material concentrated in some of the foliation layers. The fine-grained material may have developed through metamorphism. Plagioclase feldspar occurs both as larger grains, which frequently appear to have been deformed and partially replaced, and finer grains within the quartz-rich portions of the foliate. Most of the mica is muscovite in books to about 0.3 mm oriented subparallel to the foliation planes. In much of the rock minor chlorite occurs in a similar manner to the muscovite, and the greenish cast associated with much of the Klondike Schist suggests this mineral may be more common than a study of thin sections suggests. Biotite forms ragged reddish brown flakes, commonly almost at right angles to the foliation of the rock and appears to be a secondary mineral formed as the result of later metamorphism.

Lesser amounts of dense, dark green, foliated rocks occur within the Klondike Schist. Examined in thin section, these consist principally of plagioclase feldspar, in part altered to secondary epidote, and hornblende or secondary amphibole minerals with little or no quartz. Rocks of this type appear to have formed through the alteration of diorite.

Modal analyses of 22 specimens of Klondike Schist and 23 specimens of rocks from other units, both within and beyond the map-area, are given in Tables II and III. Those of Klondike Schist show wide variation in the amounts of the principal minerals present but despite this are believed to show the following differences from other units:

Schist from Mayo district: These rocks have a higher quartz content and much less feldspar and white mica.

Grit of unit 3: These rocks have a lower content of feldspar and white mica. Clasts, primarily of quartz, are common and may form more than 50 per cent of the rock.

Gneiss, both of unit D and from south of the map-area: These rocks have a more uniform composition, containing more plagioclase feldspar and biotite and less quartz, potash feldspar, and white mica. Larger mineral grains (augen or clasts) common to other rock types are lacking.

TABLE II *Modal Analyses of Rocks of Unit B (Klondike Schist)*

Specimen	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Quartz	45	45	36	64	43	27	50	69	44	39	45	36	41	57	40	22	49	60	18	39	45	46
Potash feldspar	19	36	x	17	30	—	—	—	—	42	31	—	—	x	x	2	1	3	12	25	47	40
Plagioclase	17	x	14			46	27	—	—	5	18	30	29	9	41	34	39	11	37	19	x	2
White mica	19	18	48	19	20	1	11	9	40	13	6	1	29	24	15	42	2	21	25	9	6	12
Chlorite	—	—	—	x	—	10	11	5	—	—	—	2	—	2	—	x	x	—	x	—	—	x
Biotite	—	1	—	—	6	—	—	1	—	—	—	8	1	—	—	—	2	2	2	3	1	x
Epidote group	—	—	2	—	1	11	—	—	3	—	—	22	x	x	x	—	7	3	6	5	1	—
Opaques	x	x	x	x	x	x	1	1	1	1	x	x	x	x	x	x	x	x	x	x	x	x
Other						5c		15c	12c			1c		8c	4h							
Clast-like grains	A	A	—	—	A	A	B	A	—	A	A	—	—	A	B	—	B	B	B	A	A	B

KEY:
x: less than 1%
c: carbonate
h: hornblende
A: trace to 10%
B: 10 to 50%

NOTE: Counts made by H. T. Carswell and based on 700 points at 0.5-mm intervals on traverses spaced at 1 mm across the foliation. Most sections stained for feldspar.
Specimens 1 to 14: from Klondike area, south of Dawson, Yukon.
15 and 16: from Yukon River area, about 7 miles north of Dawson, Yukon.
17 to 19: from Sixtymile area, about 45 miles west of Dawson, Yukon.
20 to 22: from Sixtymile road area, about 16 miles northwest of Dawson, Yukon.

TABLE III *Modal Analyses of Rocks of Various Other Units*

	Schist, Mayo district						Grit, unit 3			Gneiss, unit D								Gneiss, south of Dawson					
Specimen	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Quartz	82	87	65	21	86	66	83	85	74	31	58	—	15	19	33	25	37	—	45	27	32	28	24
Potash feldspar	3	—	—	—	—	—	—	—	x	1	5	x	19	1	6	11	9	—	—	6	4	x	—
Plagioclase	1	7	15	32	8	11	6	x	12	61	33	26	62	56	58	63	36	59	51	57	48	67	62
White mica	12	3	5	—	5	13	8	11	10	—	1	—	3	x	x	x	—	—	x	x	x	x	x
Chlorite	x	—	3	5	—	5	—	—	x	1	x	x	—	x	x	x	1	1	2	1	x	x	x
Biotite	—	—	12	40	—	3	2	2	4	6	3	11	1	24	3	1	14	3	1	9	15	4	12
Epidote group	—	—	—	2	—	—	—	—	—	—	—	5	x	—	—	x	3	x	x	x	1	1	—
Opaques	2	2	x	x	1	1	x	2	x	x	x	x	x	x	x	x	x	x	1	x	x	x	1
Other		1c				1c	1c					58h						37h					1g
Clast-like grains	A	A	—	A	A	A	B	C	C	—	—	—	—	—	—	—	—	—	—	—	—	—	—

KEY:
x: less than 1%
c: carbonate
g: garnet
h: hornblende
A: trace to 10%
B: 10 to 50%
C: over 50%

NOTE: Counts made by H. T. Carswell and based on 700 points at 0.5-mm intervals on traverses spaced at 1 mm across the foliation. Most sections stained for feldspar.

Specimens 23 to 28: schist from Mayo district, Yukon.
23: 63°54′N, 134°26′W; 24: 63°47½′N, 135°43′W; both unit 5, Bostock (1947).
25: 63°23′N, 136°40′W; 26: 63°27′N, 136°56′W; both unit 4, Bostock (1964).
27: 63°47′N, 135°33′W; unit 5, Bostock (1947).
28: 63°23½′N, 136°37′W; unit 4, Bostock (1964).

29 to 31: grit of map-unit 3.
29: 64°09½′N, 135°37′W; 30: 64°18′N, 135°05½′W; 31: 64°11′N, 136°42′W.

32 to 39: gneiss of unit D about 30 miles west of Dawson, Yukon.

40 to 45: gneiss along Yukon River, south of Dawson, Yukon.
40 and 41: 62°58′N, 139°32½′W.
42: 63°21′N, 139°32½′W; unit A, Bostock (1942).
43 and 44: 63°28½′N, 139°38′W; unit E, Bostock (1942).
45: 63°45′N, 139°42′W; unit A, Bostock (1942).

TABLE IV — *Mean Modal Composition of Rocks from Various Map-units*

	Klondike Schist, unit B (22)*	Schist, Mayo district (6)	Grit, unit 3 (3)	Gneiss, unit D (8)	Gneiss south of Dawson (6)
Quartz	44	68	80	27	26
Potash feldspar	13	1	x	7	2
Plagioclase	18	13	6	49	58
White mica	18	6	10	1	x
Chlorite	1	2	x	x	1
Biotite	1	9	3	8	7
Epidote group	3	x	—	1	x
Opaques	x	1	1	x	x
Other	2	x	x	7	6

*Number of specimens.
NOTE: One chemical analysis of a specimen of Klondike Schist is available (Table V).

In addition to the modal analyses, a large number of thin sections of Klondike Schist were studied and compared with those of schist from the Mayo district. The suite from the latter area was collected from rocks of the Yukon Group between Stewart Crossing and Keno Hill (unit 4 of the McQuesten area (Bostock, 1964) and unit 5 of the Mayo area (Bostock, 1947)) and consists of silver, pale brown to greenish schist, and schistose quartzite with parting planes generally a few to 100 mm apart. The matrix of the rock is fine grained but often contains scattered gritty grains of quartz and less commonly feldspar. The gritty grains are often drawn out into augen and are usually 5 mm maximum dimension although much coarser pebbles of 2½ inches have been reported (Bostock, 1947).

The results of this comparison may be summarized as follows:

	Klondike Schist	Schist from Mayo area
Distribution	Occurs over a wide area, with other types of sedimentary rocks relatively rare	Occurs over a wide area with other types of sedimentary rocks relatively rare
Foliation	Strongly developed and most rock fragments have a pearly sheen; little evidence of original bedding	Good foliation that appears to parallel original bedding as shown by compositional banding
Internal structure	Unknown	Unknown

	Klondike Schist	Schist from Mayo area
Augen	Present in some specimens but seldom form more than 20 per cent of the rock; generally 2–3 mm or less in maximum dimension; composed of quartz, potash feldspar, commonly microcline, and less commonly plagioclase; some blue rutilated (?) quartz	Present in some specimens but seldom form more than 20 per cent of the rock; generally 2–3 mm or less in maximum dimension; composed of quartz and less commonly potash feldspar; some beds contain blue rutilated (?) quartz
Quartz	Variable, generally 50 per cent or higher but lacking in some specimens and over 75 per cent in others; grains generally 0.3 mm or less maximum dimension	Quartz content generally 75 per cent or higher; grains generally 0.2 mm or less in maximum dimension
Feldspar content	Variable but seldom less than 20 per cent and may form up to 60 per cent of specimen; potash feldspar occurs as coarse augen of microcline and as fine structureless grains in bands parallel to the foliation; plagioclase feldspar generally the same grain size and occurs with the quartz although a few "augen" were observed	Seldom exceeds 10 per cent; much potash feldspar as augen with plagioclase feldspar generally the same grain size and occurring with the quartz
Mica content	Commonly 10 to 20 per cent, mainly muscovite	Commonly 5 to 20 per cent, mainly muscovite

Relationship to Gneissic Rock

McConnell (1905b, pp. 18B, 19B) described the transition from the Klondike Schist to gneissic rocks in the Klondike area, and Cockfield (1921, pp. 22, 23) described a similar one about 50 miles northwest. McConnell considered that there was a close genetic relationship between the schist and gneiss, both being derived through variations in the metamorphism of an original granite porphyry. Cockfield, on the other hand, considered that the gneisses were formed through deformation and alteration of later igneous rocks intrusive into the Klondike Schist. The Klondike Schist and gneiss are not in contact in the present map-area; however, in the author's opinion, relationships observed in reconnaissance work to the south suggest that a complete gradation between schist and gneiss may occur and that sharp, clearly defined contacts are lacking.

Structure

Very limited structural information was obtained in the present mapping. In general, the foliation of the Klondike Schist in the band extending northwest from Dawson strikes in this direction and dips gently southwestward. In the smaller area near the Alaska Boundary, the strike ranges from west to northwest and the dips are gently north to northeast. As no marker beds occur within the Klondike Schist and the original bedding cannot be determined, the structural pattern and probable thickness of the unit are unknown. Contacts between the Klondike Schist (map-unit B) and the altered sedimentary rocks of map-unit A are well exposed on the trail to Moose Creek, just north of the Sixtymile road near the International

Boundary, and in the valley of Moose Creek, about four miles north. In the former, the contact appears to be gradational in scattered exposures over several hundred feet, with rocks of obvious sedimentary origin (schistose quartzite and graphitic schist of unit B) grading through chloritic schist of uncertain origin, to Klondike Schist (greenish micaceous rocks containing augen of both quartz and feldspar). There both units strike about east and dip about 30 degrees northward with the rocks of unit A apparently underlying those of the Klondike Schist (map-unit B). The contact to the north is exposed in an old placer working in the bed of Moose Creek where platy grey quartzite is separated from typical Klondike Schist by a broken zone of graphitic phyllite shot full of vein quartz. Both units strike northeasterly and dip to the northwest, the Klondike Schist at about 50 degrees and the apparently overlying sedimentary rocks of unit B at about 75 degrees.

Origin

McConnell (1905b, p. 16B) and Cockfield (1921, p. 19) both concluded that the Klondike Schist was produced through regional metamorphism of igneous rocks. This suggestion is based on the presence of phenocrysts of quartz and feldspar in some of the rock, the lack of recognizable sedimentary rock (i.e. quartzite, graphitic phyllite, and limestone within the area of Klondike Schist), and sharp intrusive contacts between the Klondike Schist and altered sedimentary rocks (Nasina series of McConnell). In the author's opinion, the Klondike Schist may have formed through the metamorphism of gritty arkosic rocks somewhat similar to those known on the northeast side of Tintina Trench.

The views of McConnell and Cockfield may be summarized by extracts from their reports. McConnell (1905b, p. 16B) stated:

> . . . The original rocks varied widely in character, as both acid and basic surface and deep-seated varieties were present, and possibly tuffs as well. The principal types recognized consist of quartz porphyries, granite porphyries and basic porphyritic rocks. The former are now represented by sericite schists and ordinary and augen gneiss, and the latter by chlorite and occasionally amphibolite schists. All the varieties have a common schistosity which is also conformable, as a rule, to that of the bordering clastic schists.

He quotes (pp. 19B–21B) a detailed petrological report by A. E. Barlow based on a study of specimens of the schists and associated rocks in which the breakdown of massive rocks through dynamic metamorphism followed by silicification is described.

Cockfield (1921, p. 19), describing rocks similar to Klondike Schist in the Sixty Mile and Ladue Rivers area, west of the Klondike, wrote:

> These rocks owe their origin to the extrusion or intrusion of igneous material subsequently deformed. The intrusive contacts with those of the Nasina series, and the porphyritic texture, remnants of which can be readily detected, leave little doubt as to their igneous origin. Further, the mineral composition strongly suggests that many of the rocks were originally quartz porphyries, and that from these there is a gradation to more basic types represented by the chlorite schists.

In the author's opinion most of the rocks mapped as Klondike Schist may have originated through the metamorphism of a sedimentary rock of arkosic composition. The following features are cited in support of this proposal:

Composition. The chemical analysis available (Table V) differs from those of common igneous rocks (Nockolds, 1954) in the high quartz content (70.8%) and the relative amounts of potassium (5.9%) and sodium (1.2%) oxides but is very close to some of the analyses of arkose given by Pettijohn (1956, p. 324). The approximate chemical composition

TABLE V | *Chemical Analysis of Klondike Schist*

Constituent	Per cent	Constituent	Per cent
SiO_2	70.8	TiO_2	0.41
Al_2O_3	14.2	P_2O_5	0.07
Fe_2O_3	2.1	MnO	0.02
FeO	0.68	CO_2	0.02
CaO	0.80	S	
MgO	1.5	BaO	0.56
Na_2O	1.2	Total	100.4
K_2O	5.9	Less	—
H_2O (total)	2.1	Net total	100.4

NOTE: Analysts: W. U. Romeny and K. G. Hoops, Geological Survey of Canada.
The modal analysis of this specimen is given as No. 4 in Table II.
Field number: HH-BRY-34
Laboratory number: C-149
Location: from a deep drain in the Bunker Hill hydraulic pit on Upper Bonanza Creek (63°55′N, 139°16½′W).

estimated from the mean of the modal analyses is remarkably close to the chemical analysis given. An analysis of quartz–sericite schist from the Mayo district (Boyle, 1965, p. 252) has a higher silica content (80.8%) but shows almost the same ratio of potassium (1.3%) to sodium (0.3%) oxides.

Variation in composition. The wide variation in mineral, and presumably chemical, composition shown by the modal analyses might reasonably be expected to result through differences in sedimentation rather than variations in the composition of an igneous rock suite.

Metamorphism. The rocks of the Klondike Schist show a strong foliation controlled by white mica that is identical to that in adjacent metamorphosed sedimentary rocks of unit A. If rocks of one unit formed through metamorphism of relatively massive igneous rock and the other through that of thinly bedded argillaceous sedimentary rock, greater differences in the end product might be expected.

Presence of coarser grains (augen, clasts, or phenocrysts). These are believed to be of sedimentary rather than of igneous origin as suggested by McConnell and Cockfield. Grains of this type, clearly of sedimentary origin, are present in schist from the Mayo district, immediately south of Nash Creek map-area, and in grit of unit 3. Rocks from both groups show deformation and elongation of the coarser grains similar to that observed in the Klondike Schist.

Age

Two age determinations of the Klondike Schist have been made by the Geological Survey of Canada (*see* Lowdon, 1961, p. 19; and Leech *et al.*, 1963, p. 25). These gave ages of 138 and 175 m.y. The Klondike Schist cannot be dated by stratigraphic methods.

Unit C

Unit C contains much greenstone and related rock types in addition to some rocks lithologically similar to those included in both units A and B. It outcrops near Dawson and in a narrow belt, about 33 miles long and as much as 5 miles wide, extending along Yukon River from a point about 5 miles above the mouth of Chandindu River northwest almost to Forty Mile. Boundaries of the unit as shown were decided solely on the prevalence of greenstone and should not be considered as discrete contacts. Limited traverse coverage in the area north of Fortymile River and west of Yukon River suggests that similar rocks may occur in this area but insufficient information is available to suggest possible contacts. Cockfield (1921) mapped small areas of what are probably similar rocks in the Sixty Mile and Ladue Rivers area, west of Dawson.

Outcrop Characteristics

Rocks of the map-unit are best exposed along Yukon River where they form massive dark green bluffs as high as several hundred feet. Commonly the rock shows good banding and some foliation but lacks the shiny mica-coated partings of the rocks of units A and B.

Lithology

Main rock types included within the map-unit are dense greenstone and light to dark green gneiss which appears to have developed from the greenstone, particularly near granitic rocks (unit 21) along Yukon River. Other rock types include greenish quartz–feldspar–mica schist (similar to unit B, the Klondike Schist) and quartz–mica schist, limestone, and dolomite (all similar to unit A). The greenstones commonly show irregular patches of green and white minerals to about 3 mm diameter often streaked-out to form a poor foliation. Locally, greenstones have been altered to a brown weathering rock composed essentially of quartz and an iron-bearing carbonate, either of the dolomite or magnesite group.

In thin section, some specimens are seen to contain large grains of hornblende, probably an original constituent of the rock, and patches of saussurite composed of fine grains of untwinned plagioclase feldspar, probably albite, and an epidote group mineral, probably clinozoisite. None of the specimens examined appeared to contain original plagioclase. The principal mafic mineral is often a fine-grained actinolite which may have formed through the alteration of earlier hornblende. In some specimens, actinolite appears to have replaced part or all of the original plagioclase grains so that the rock is composed essentially of it. Another alteration of the plagioclase feldspar involves carbonatization with the development of albite, secondary calcite, and epidote group minerals.

Structural Relations, Origin, Age, and Correlation

Both the internal structure of the rocks and their relationship to rocks of the other map-units (A, B, and D) west of Tintina Trench are unknown.

Regional metamorphism and, in some areas, later contact metamorphism adjacent to granitic rocks, mask the original nature of the rocks assigned to the map-unit. Many of the greenstones probably originated through the alteration of sills with an original composition close to that of gabbro or diorite, and volcanic rocks, in the form of flows and tuffaceous sediments, may also have been involved.

Sills of this type are known to be present east of Tintina Trench where lithologically similar greenstone (unit 20) has intruded sedimentary rocks (units 14 and 17) of probable Mesozoic age.

There is no direct evidence concerning the age of rocks assigned to the map-unit. In general, as they appear to contain interbedded rocks similar to those of units A and B, they are presumably about the same age.

Unit D, Gneissic Rocks

Gneissic rocks assigned to unit D occur only in the Sixty Mile River area in the southwest corner of Dawson map-area. Cockfield (1921) mapped larger areas of gneiss south of the present map-area, and the writer has observed large areas of similar rock along Yukon River between the mouth of Pelly and Sixty Mile Rivers.

Outcrop Characteristics

The area underlain by unit D is unglaciated and marked by V-shaped valleys tributary to the Sixty Mile River valley. The gneiss is more resistant than other metamorphic rocks west of Tintina Trench, and good outcrops occur both along the ridge lines and where the larger creeks and the Sixty Mile River have cut over to their valley walls.

Lithology

Rocks assigned to the map-unit consist mainly of fine- to medium-grained, quartz–feldspar–biotite gneiss. The most common type contains much quartz and feldspar with minor biotite, but dark varieties composed essentially of hornblende and feldspar also occur. Rocks near the upper part of the unit, close to the contact with unit A, are distinctly bedded but as they are traced downward bedding disappears and only foliation remains. In general, contacts with the metamorphosed sedimentary rocks of unit A are gradational.

In thin section it can be seen that the rocks generally have a grain size up to 2 mm and contain variable amounts of potash feldspar (probably orthoclase), plagioclase feldspar (generally oligoclase), quartz, biotite, and less commonly, hornblende. Epidote group minerals are a common accessory. Most of the rocks are fresh and there is little evidence of alteration.

The quartz content of the rock is variable but is commonly 40 per cent or less and there is a wide variation both in the ratio of quartz to feldspar and of potash to plagioclase feldspar. Modal analyses of eight specimens are given in Table III.

Structure, Origin, Age, and Correlation

Within Dawson map-area, the gneissic rocks appear to form a homoclinal structure that strikes east and dips from 25 to 55 degrees northward. In most outcrops the foliation of the gneiss is uniform and no appreciable amount of folding was observed.

The gneisses of unit D appear to have formed through the alteration of sedimentary rocks. In Dawson area sedimentary rocks of unit A are probably involved. In the author's opinion, areas of Pelly gneiss mapped by McConnell (1905b) in the Klondike area may have originated through subsequent metamorphism of rocks of the Klondike Schist (unit B) of this report.

One age determination, 202 m.y., has been made from rocks of the map-unit within Dawson map-area (*see* Leech *et al.*, 1963, pp. 53, 54).

Two additional paired age determinations are available for gneissic rocks collected along Yukon River south of Dawson (*see* Wanless *et al.*, 1966, pp. 22–25): 187 ± 10 and 181 ± 28 m.y. and 178 ± 7 and 182 ± 8 m.y.

None of the age determinations support the Precambrian age suggested by earlier workers for the gneissic rocks. Rather they seem either to have formed in early Mesozoic time or to have undergone an early Mesozoic metamorphism that masks their previous history.

Gneissic rocks mapped as unit D appear to correlate with the Pelly gneiss as described by Mertie (1937, p. 51) but not separated in his mapping from the Birch Creek schist (metamorphic rocks of sedimentary origin). Both Mertie (1937, p. 57) and Cockfield (1921, pp. 24–26) considered the gneissic rocks intrusive into the metamorphosed sedimentary rocks.

Unit E, Ultramafic Rocks

Numerous small bodies of ultramafic rock intrude the metamorphic rocks southwest of Tintina Trench. Those mapped were either crossed in ground traverses or observed from the air and many more are probably present in the general area.

Outcrop Characteristics

Many of the ultramafic bodies do not support a heavy vegetation cover and the characteristic dark green to orange weathering blocky talus they produce can frequently be recognized from the air. In some, bright reflections are produced from serpentine-coated slip faces.

Lithology

Most of the rocks assigned to unit E consist of dark green serpentinite. A number of thin sections examined were found to consist of serpentine minerals, principally antigorite, with minor magnetite. Relict textures were lacking. A common alteration observed in the field involves the replacement of serpentine by quartz- and iron-bearing carbonate, generally of the magnesite group but sometimes dolomite. In several of the ultramafic bodies this alteration occurs later than the formation of asbestos fibre and has resulted in its partial or complete replacement. Many of the serpentines contain traces of asbestos fibre, and one, at Clinton Creek (*see* Chapter VI), is currently being brought into production. Some of the ultramafic bodies are associated with greenstone and basic igneous rocks; others lack intermediate rocks and occur as small lenses or sill-like bodies in the enclosing sedimentary rocks of unit A.

Age and Correlation

The time of emplacement of the ultramafic rocks is unknown. Most are highly sheared, suggesting that they were emplaced either before or during the main deformation of the enclosing metamorphic rocks.

Scattered outcrops of similar ultramafic rock occur along a southwest-trending zone, crudely parallel to Tintina and Rocky Mountain Trenches, that extends far into British Columbia.

Chapter IV

STRUCTURAL GEOLOGY

The structure of the area will be considered in four belts:

1. *Northern Belt*: including the northern parts of all three map-areas lying north of rocks of map-unit 3 in Nash Creek and most of Larsen Creek map-areas, then following the northern outcrops of rocks of unit 9 and, in places, unit 4 from the western edge of Larsen Creek map-area west to the head of Eagle Creek and then north of rocks of unit 3 to the International Boundary.
2. *Southern Belt*: south of (1) but exclusive of Tintina Trench and the area to the southwest of it.
3. *Tintina Belt*: in and adjacent to Tintina Trench.
4. *Metamorphic Belt*: including the metamorphic rocks and minor younger rocks southwest of Tintina Trench.

Northern Belt

The structure of the belt involves two major periods of folding, the first restricted to Precambrian rocks and the second involving both Precambrian and later rocks. The Precambrian rocks (units 1 and 2) underwent considerable folding before the deposition of the overlying Paleozoic rocks of units 5 and 8 (Racklan Orogeny of Gabrielse, 1967a, p. 274). This is particularly well shown in some places where steeply dipping to vertical Precambrian rocks are unconformably overlain by gently dipping to horizontal Paleozoic rocks of unit 8. On a regional scale, many of the rocks of unit 2 have been cut out by the unconformity so that those of unit 8 rest directly on unit 1. Between Wind River and Gillespie Lake in Nash Creek map-area, rock of units 1 and 2 show relatively open folds. Elsewhere folding is more complex and the development of steeply dipping to vertical foliation is common in rocks of unit 1. In the domal structure north of Mount Harper in Dawson map-area the rocks of unit 2 appear to show relatively open folds but the lack of continuity and the rather complex outcrop pattern of the subunits suggest considerable faulting.

No angular unconformity was observed between rocks of units 5 and 6 and those of unit 8. The absence of rocks of units 5 and 6 in many places beneath unit 8 and the variation in thickness observed elsewhere suggest the former may have undergone block faulting or gentle folding followed by erosion before the deposition of rocks of unit 8.

In the Northern Belt most of the Paleozoic and later rocks (map-units 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, and 22) have relatively open structures, generally with dips less than 30 degrees. Within these structures, however, complex folding is present locally, particularly in the less competent units. In the northern half of Nash Creek map-area, relatively simple folds pass quickly into areas with very complex folds, many of which are isoclinal and overturned to recumbent, and steeply dipping faults (Fig. 3). Two fault directions seem to be present in the belt, the stronger being northwest and the weaker north. West of the more complex area near Hart Lake, rocks of unit 8 and unit 1 are brought into contact by steeply dipping to vertical faults. West of Worm Lake in Larsen Creek map-area, Paleozoic rocks of unit 8 and Precambrian rocks of units 1 and 2 occur together in complex thrust structures.

In addition to the major unconformity beneath unit 8, unconformities are believed to be present, at least locally, at the base of units 12, 13, 14, 16, and 22. None of the latter shows major differences in the fold pattern above and below unconformity.

Southern Belt

The structure of the Southern Belt is characterized by the strong development of foliation, isoclinal folding, and overthrusting in contrast to more open folding in the Northern Belt. The pattern of deformation varies considerably between rocks of various map-units. Complex folding is best shown in rocks of the Keno Hill Quartzite (unit 18), where isoclinal folds several hundred feet between the limbs are common and almost all the axial planes of these folds parallel the regional strike and dip of the unit. The largest fold of this type is in Davidson Range in Nash Creek map-area, where the entire unit (18) forms a large recumbent fold. Small-scale folds and the development of a strong foliation, mostly parallel with the bedding, are common. Much of the bedding of rocks of unit 3 has been destroyed through folding and the development of foliation. In a few of the larger outcrops, particularly in the headwalls of cirques, complex isoclinal folds were observed. Rocks of unit 9 outcrop poorly, and the structure is unknown except that most of the strikes are similar and considerable variation in dip suggests repetition by folding within the unit. Rocks of the Lower Schist division (unit 17) commonly show well-developed foliation parallel with the bedding and some small-scale isoclinal folding. In unit 17 some relatively large fold-like structures are associated with sills of unit 20 (Green and McTaggart, 1960). Unit 19 appears to be relatively undeformed and the well-bedded rocks show little if any foliation. A major fault has thrust rocks of unit 3 over those of units 18 and 19. This thrust is clearly exposed on some of the ridges in the western part of Larsen Creek map-area. Another large thrust places rocks of unit 3 on those of unit 8 across most of Nash Creek and Larsen Creek map-areas and separates the structures of the Northern and Southern Belts.

Tintina Belt

Tintina Trench is believed to represent the topographic expression of a major fault extending from deep in Alaska to southwestern Yukon where it is *en echelon* with the northwest end of the Rocky Mountain Trench. Roddick (1967) has discussed the fault and suggested a right-hand movement of from 220 to 260 miles along it. The writer has seen most of the areas described by Roddick and is in general agreement with the view expressed in his paper.

In the project area, the only rocks that occur on both sides of the trench are the granitic rocks (unit 21) and the quartz porphyry clan (unit 25). Altered sedimentary rocks southwest of Tintina Trench (units A, B, and D) are of higher metamorphic rank than those northeast and no direct correlation is possible, although some rocks in units A and B show similarities to some in unit 3 (Grit division). In this respect it should be re-emphasized that the Tindir and Yukon Groups, as described by Cairnes (1914, p. 40), lie on opposite sides of Tintina Trench, and age relationships, based on the difference in metamorphism in this area, cannot be considered valid.

Structures related to Tintina Trench were observed in the trench and along the northeast side but not on the southwest side. Outcrops are poor within the trench but some of the scattered outcrops of rocks of unit 23 have dips as much as 45 degrees, indicating that this unit has undergone some folding. On the northeast side of the trench rocks of unit 3 appear to swing northwest, parallel with the trench, whereas those of units 9, 17, and 18 trend at right angles to the trench and appear truncated by it. Unfortunately, outcrops are poor in this area and the exact relationship is uncertain. Where rocks of unit 3 parallel Tintina Trench, chevron folding is shown by limestone bands (unit 3a). These folds commonly have an amplitude of 500 to 1,000 feet and a wavelength of about twice the amplitude. The folds have vertical axial planes that strike parallel with the trench. Outcrops are poor along the southwest side of the trench but no marked increase in metamorphism or deformation was noted in the metamorphic rocks of map-units A, B, and C near it.

Metamorphic Belt (Southwest of Tintina Trench)

In this belt the structural pattern is believed to be tight, small-scale (and possibly large-scale) isoclinal folding with the development of a strong foliation, that in places has obliterated the bedding. The foliation varies considerably in attitude, suggesting that the area may have undergone further folding after foliation. Rocks of unit 24 are younger than the foliation and appear to have undergone only open folding or block faulting.

Most outcrops of rocks of units A and B are strongly foliated along micaceous partings. Much of the bedding appears to be parallel with this foliation but in many outcrops these are places where the bedding is at an angle to the foliation and beds have been sliced into tiny segments between micaceous foliation planes ('Gleitbrett' structure). Also, attenuated isoclinal folds as much as 10 feet amplitude are fairly common, mostly with axial planes parallel with the foliation. Much of the 'Gleitbrett' structure may represent the axial parts of folds that are so drawn out and deformed that the complete fold cannot be recognized. Foliation near the top of gneisses of unit D is parallel with the bedding, but lower in the valley of Sixty Mile River all trace of bedding has been destroyed and only foliation remains.

Chapter V

HISTORICAL GEOLOGY

An outline of the historical geology of the project area based on the writer's interpretation of field observations is presented. As direct correlation of rock units on opposite sides of Tintina Trench has not proven possible the area southwest of the trench is discussed separately.

East of Tintina Trench

Proterozoic

During Proterozoic time well-sorted arenaceous and argillaceous sediments followed by dolomite-rich arenaceous sediments were deposited over much of the northern part of the area. All appear to be of clastic origin. They form part of a belt of 'Purcell-like rocks' outcropping from northern British Columbia, through the Mackenzie and Ogilvie Mountains, and thence north to near the Arctic coast (Gabrielse, 1967a). During the Racklan Orogeny, probably soon after deposition, these rocks were deformed; the resultant structures range from block faulting through open folds, to complex fold structures, the last often with steeply dipping to vertical foliation.

Late Proterozoic and Cambrian

Poorly sorted clastic sedimentary rocks, commonly referred to as the 'Grit unit', and consisting of quartz–pebble conglomerate, grit, quartzite, argillite, and minor limestone, were deposited in the southern part of the area, probably in late Proterozoic time. Similar 'Windermere-like' or 'Grit unit' rocks occur from northern British Columbia, through much of central Yukon, to the present area and thence north to near the Arctic coast. Gabrielse (1967a, p. 275) has proposed a crystalline source area south and southwest of the outcrops.

Possibly somewhat later, in the northern part of the area, ferruginous mudstone and conglomerate, possibly equivalent to the Rapitan Group, were deposited in restricted basins. This was followed by Late Cambrian carbonate sedimentation which locally appears to have continued into Ordovician time. There seems to have been some volcanic activity in the southern part of the area about this time.

Ordovician and Silurian

Ordovician and Silurian sedimentation is widespread. Black shale and chert of the Road River Formation in the south intertongue northward with a thick succession of dolomite and some limestone. Locally, black shaly beds within the carbonate form distinctive markers. The carbonate rocks overlie older rocks with slight angular unconformity, the latter having been subjected to block faulting and open folding before deposition of the former.

Flows and tuffaceous rocks indicate some volcanic activity in Middle to Late Ordovician time in what is now the central part of Nash Creek map-area. Greenstone sills in the Cambrian rocks of the north may possibly be of the same age. The source of the volcanic material was probably local.

Late Silurian to Early Middle Devonian

Above Royal Creek, north–central Nash Creek map-area, a richly fossiliferous succession of platy black limestone with minor shale and chert ranges from Late Silurian to early Middle Devonian age. Elsewhere in the northern Nash Creek map-area, a thick succession of thinly banded, unfossiliferous, clastic dolomite may be of Late Silurian or Early Devonian age. The latter rocks are overlain with slight unconformity by thick-bedded, abundantly fossiliferous limestone of lower Middle Devonian age.

Middle Devonian to Carboniferous

In the northern part of the mapped area a variable succession of argillaceous, arenaceous, and carbonate rocks was deposited. There appears to be wide variation in thickness and lithology over relatively short distances but the nature of the units is little known because of mediocre resistance to weathering. Coarse clastic sediments, including chert-pebble conglomerate, of Upper Devonian age occur near the northwest corner of the project area (Churkin and Brabb, 1965).

Permian

A thick sequence of limestone and chert was deposited in the north–central and northwest parts of the project area and there are minor amounts of similar limestone farther south. More extensive Permian sedimentation occurred north of the area considered in this report (Gabrielse, 1967a).

Triassic

Scattered outcrops of highly fossiliferous, marine limestone and shale of Triassic age suggest extensive sedimentation. In the western part these rocks bevel the underlying Permian limestone with a slight angular unconformity.

Jurassic

A band of thinly bedded black shale and quartzite of probable Jurassic age extends across the project area resting unconformably on rocks ranging from Precambrian to Triassic.

Cretaceous

Distinctive dark grey quartzite, tentatively dated as early Cretaceous, overlies distinctive Jurassic (?) rocks. The former are in turn overlain by shale and siltstone of unknown age.

Numerous diorite to gabbro sills, now extensively altered, intruded the Mesozoic sediments, and possibly some of the older rocks, before the major deformation.

Rocks of the area are believed to have undergone major deformation at this time. It is believed to have been much stronger in the south, where it is characterized by ubiquitous complex folding, than in the north, where areas of relatively open folding separate locally complex areas.

The deformation was closely followed in the southern part by intrusion of scattered granitic stocks of probable Cretaceous age. These stocks are clearly crosscutting with related deformation and metamorphism confined to their immediate vicinity.

In the northwestern corner of the project area, a thick sequence of clastic terrestrial sediments was deposited about the time that folding and intrusion occurred elsewhere.

Tertiary and Quaternary

Tertiary time is represented by local valley accumulations of coarse terrestrial sediments. Some movement along major faults such as Tintina Trench postdates these sediments but movement probably started much earlier. Minor extrusions of andesite and basalt also occurred at this time and small sills and dykes of quartz porphyry were probably intruded although some may be related to the earlier granitic rocks. Most of the region northwest of Tintina Trench was glaciated during Pleistocene times although a few areas appear to have been sheltered.

Southwest of Tintina Trench

Much of the area is underlain by metamorphic rocks varying from greenschist to feldspar-bearing gneiss. Some of these rocks are known to be of Paleozoic age and there is no evidence either of an earlier period of metamorphism predating them or of a crystalline basement. The metamorphic rocks have been intruded by Mesozoic granitic rocks which may also have produced some granitic gneiss through metamorphism of the enclosing rocks. A few, small, scattered, alpine-type, ultrabasic intrusions are strung out through a belt parallel to Tintina Trench and as much as 12 miles southwest of this feature.

Following the intrusion of the granitic rocks, extrusive with associated terrestrial sedimentary rocks were deposited in small areas. Both have subsequently been either folded or tilted, but this clearly after the main deformation of the area. Still later, planation, tilting, and deep weathering occurred. No glaciation took place.

Correlation across Tintina Trench

No direct correlation can be suggested between rock units mapped on opposite sides of Tintina Trench in the project area although individual hand specimens may seem identical. The metamorphic rocks appear closest in original composition to some of the quartz-rich sediments east of the trench, and lateral movement appears to have adjoined rocks of different metamorphic rank (Roddick, 1967).

Chapter VI

ECONOMIC GEOLOGY

There has been substantial production of placer gold from the map-area, including the northern tip of the Klondike-Sixtymile and Haggart Creek – Dublin Gulch goldfields. A large asbestos deposit at Clinton Creek is currently being brought into production. Elsewhere many mineral showings are known but none has produced more than a few tons of hand-sorted material.

Placer Deposits

The northern tip of the Klondike goldfields and most of the Sixtymile goldfield lie within Dawson map-area, and there has been limited placer production from Haggart Creek and Dublin Gulch in Nash Creek map-area.

Klondike Goldfield

References. McConnell (1902a, pp. 16–42; 1905b*, 1907*); Green (1965, 1966).

The first significant production was in 1886 when considerable gold was recovered from bars in the Stewart and Yukon Rivers. Increased prospecting resulted, and the deposits of upper Fortymile River were discovered in 1886 and the Sixtymile goldfields in 1893. The town of Forty Mile (Fig. 1), located at the mouth of Fortymile River, dating from about 1886, served as the supply point for both goldfields. The discovery of gold on Rabbit Creek, later renamed Bonanza Creek, on 17 August 1896, sparked the Klondike gold rush of 1897 and 1898. The town of Dawson at the mouth of Klondike River served as the supply point for the rush. Initially, the individual claims were hand worked by underground methods or open-cutting. Subsequently, large blocks of claims were acquired by the Guggenheim interests and worked by hydraulic methods and dredging. Water was brought to bench operations in White Channel gravels at a head of about 500 feet by an ingenious ditch and flume line, about 70 miles long, leading from the Tombstone and Little Twelve Mile Rivers to the north of the goldfield. The line crossed the valley of Klondike River near Bear Creek by an inverted steel siphon not removed until 1967. In 1909, hydraulic operations using water from the ditch line were under way and a total of ten dredges were operating, seven of them electrically driven by power from the Little Twelvemile plant (*in* Bostock, 1957, p. 318). The Twelvemile ditch was used until 1933 and the last dredges ceased operations in late 1966. Most of the Klondike River valley between Hunker Creek and Dawson and parts of Bonanza and Hunker Creek within Dawson map-area have been dredged. In addition to company operations, a number of individual operators have been active within Dawson map-area. These include a hydraulic operation on Cripple Hill (Green, 1966, pp. 92, 93), another on

*Earlier reports on the Yukon Territory that are reprinted in Memoir 284 (Bostock, 1957) are indicated in the text with an asterisk.

Discovery Hill (op. cit., pp. 97, 98), and a bench operation near Germaine Creek (Green, 1965, pp. 64, 65).

Sixtymile Goldfield

References. McConnell (1905a, pp. 33A–37A*); Cockfield (1921); Bostock (1936b, p. 1; 1937, p. 1; 1939, pp. 3, 4; 1941, pp. 3, 4); Skinner (1961, p. 13); Dept. Mines Tech. Surv. (1964); Green and Godwin (1964, pp. 69–71); Green (1965, pp. 66, 67; 1966, pp. 105–108).

The Sixtymile goldfield is located near the Alaska Boundary, about 40 miles west of Dawson, and is reached by a rough road, 10 miles long, that leaves the main Sixtymile road near Mile 49. Miller and Glacier Creeks, the most important creeks of the goldfield, head near the International Boundary and flow southeast to join Sixty Mile River about 3 miles apart. Main placer areas include the two creeks, the part of Big Gold Creek between the mouth of Glacier Creek and Sixtymile River, and the valley of Sixtymile River between the two creeks. There has also been minor production from other creeks in the area. The goldfield was discovered in 1892 by miners crossing the divide from the Fortymile goldfields in Alaska. In addition to hand mining, two dredges have operated in the area: the first built by North American Trading and Transportation Company worked on Miller Creek in 1915 and 1916 (Cockfield, 1921, p. 37) and was later refitted by Holbrook Dredging Company and operated in the valley of Sixty Mile River between 1929 and 1941; the second, built by Yukon Explorations, Ltd., worked Big Gold Creek, downstream from the mouth of Glacier Creek, and the valley of Sixty Mile River between 1947 and 1959. Since the late 1940s a number of companies and individuals have operated bulldozer-sluicing plants. The goldfield is still producing, although on a much reduced scale since 1961.

Bedrock in much of the goldfield is quartzite, schist, and minor gneiss of unknown age. Volcanic rocks of Tertiary age are present on the lower parts of Miller and Glacier Creeks and presumably in the covered areas of the Sixtymile River valley. The gravels are reported (Cockfield, 1921, p. 38) to be of local origin and include flattened discs of phyllitic material and boulders of quartzite and the younger volcanic rocks. The ground is frozen and black muck is generally present.

Recorded production for the goldfield from discovery to 1965 is about 213,600 ounces of fine gold including 123,000 ounces up to 1917 (Cockfield, 1921, p. 37), about 12,700 for the Holbrook Dredging Company for 1934, 1935, 1939, and 1940 (Bostock, 1936b, p. 1; 1940, p. 3), 72,984 ounces for Yukon Explorations, Ltd., 1948 to 1961 inclusive (Dept. Mines Tech. Surv., 1964), 4,630 ounces for other operators between 1948 and 1962 (op. cit.), and about 290 ounces for later operations (Green and Godwin, 1964, pp. 69–71; Green, 1965, pp. 66, 67). Total production for the goldfield is probably only slightly larger than recorded production.

Miller Creek is about 5 miles long, with Discovery Claim about 3 miles from the mouth on a small right-limit tributary, Discovery Pup. The bottom of the main creek is narrow, and when visited in 1917 by Cockfield (1921, p. 42) it had already been worked twice in some cases and the lower 3 miles had been dredged by the North American Trading and Transportation Company. Important bench deposits occur along the left rim of the creek and these have been worked or prospected for about 3 miles along it. Water for these operations was brought by ditch from upper Miller Creek, and from as far as Pat Murphy Creek, a tributary of Sixty Mile River about 5½ miles southwest. On the lower part of the creek, about 29 to 30 Below, the old channel was deeply buried and was mined through shafts as much as 110 feet deep (Bostock, 1939, 1941).

Glacier Creek is about 7 miles long with Discovery Claim located near the end of the old wagon road, about 3 miles from the mouth. When visited by McConnell (1905a, p. 34) in

1901, the creek bottom had been worked from about 28 Above down almost to the mouth, a distance of about 5 miles. Later, considerable work was done along the benches of the creek, mainly on the left limit (Cockfield, 1921, pp. 43, 44). Yukon Placer Mining Company operated a bulldozer–sluicing plant on the creek from 1950 to 1961 and mined the ground between 30 Below Discovery to 40 Above.

Big Gold Creek meanders in a wide valley from the mouth of Little Gold Creek to the Sixty Mile River, a distance of about 2 miles, and the Sixty Mile River itself flows through a similar, though wider valley between Miller Creek and Big Gold Creek. Much of this ground has been worked by the two dredges operated in the area. The dredge operated by Holbrook Dredging Company worked the ground in the valley of Sixty Mile River from near the mouth of Miller Creek to about 1½ miles downstream, and Yukon Explorations, Ltd. dredged much of the remaining ground in Sixty Mile Valley and the valley of Big Gold Creek to near the mouth of Glacier Creek.

Little Gold Creek flows more or less parallel to Glacier Creek and at the closest point is about one-half mile north of it. Values on the creek were low and it was generally considered too poor to work in the early days (Cockfield, 1921, p. 45). However, in more recent years bulldozer mining was done on about 1½ miles of the creek commencing about 1½ miles upstream from the mouth.

Bedrock Creek, south of Dawson map-area, rises in Alaska and flows southeast parallel to Miller Creek to join Sixty Mile River about 2½ miles upstream from the latter. Cockfield (1921, pp. 45, 46) reported that in 1917 some prospecting but very little mining had been done on the creek. Since then some bulldozer mining, ending in 1960, has been done (Skinner, 1961, p. 13).

Fortymile Goldfield

The Fortymile goldfield was discovered in 1886 but most of the goldfield was subsequently found to lie in Alaska. The town of Forty Mile served as a supply point for the Alaskan operations for many years. The only operations within Yukon include mining on Moose Creek, south of Fortymile River, near the Boundary, and attempts, apparently unsuccessful, to dredge the lower part of Fortymile River (Bostock, 1938, p. 2).

Mayo Area: Haggart Creek and Dublin Gulch

References. Keele (1906a, pp. 18A–42A*); Cairnes (1916, pp. 19–22*; 1917, pp. 14, 15*); Cockfield (1919a, pp. 10B–12B*); Bostock (1939, p. 8; 1941, pp. 14, 15); Little (1959, pp. 21–29); Skinner (1961, p. 15; 1962, pp. 16–18); Green and Godwin (1963, pp. 57–60; 1964, pp. 74–77); Green (1965, pp. 70–73; 1966, pp. 110–113).

The productive part of Haggart Creek and its tributary, Dublin Gulch, are about 30 miles north of Mayo, Yukon. Haggart Creek flows into South McQuesten River and lies within the Stewart River drainage basin. The placer workings of Haggart Creek and Dublin Gulch are accessible by a secondary road that leaves the Mayo–Elsa road near Mile 268. Road distance to the farthest workings on Dublin Gulch is about 26 miles.

Coarse gold was found on Haggart Creek in 1895 (Keele, 1906a, p. 19A), and the creek is known to have been prospected in 1896 by Thomas Nelson (Cairnes, 1916, p. 20), after whom the creek was originally named. In 1898 Thomas Haggart, Thomas Nelson, Peter Haggart, and Warren Hiatt started from Dawson for the creek but en route separated into two parties. Peter Haggart and Warren Hiatt reached their destination first, staked Discovery, and renamed the creek after Peter Haggart. Mining has been carried on intermittently since on both Haggart Creek and Dublin Gulch. When visited by Cairnes (1916, pp. 19–22) in 1915, about 14 men were mining on Haggart Creek between Discovery and 20 Below, the upper end of Discovery claim being near the mouth of Dublin Gulch. Mining being done at that time included three summer opencut operations using self-dumping scrapers or cars, one hydraulic operation on the right rim of the creek, and two winter underground operations on the right-limit bench. At the same time three men were working Dublin Gulch; one, John Suttles, having mined near the mouth of the Gulch since 1898. His operation consisted mainly of hydraulicking the stream gravels. Cairnes (1916, p. 22) estimated the gold production of Haggart Creek to 1915 at $47,000 (about 2,550 crude ounces at the price given). Later Cairnes (1917, pp. 14, 15) quoted an estimate for Suttles' Dublin Gulch operation to 1916, including the production of the Cantin Brothers, who acquired it that year, of $51,000 to $56,000, roughly 3,000 crude ounces at the price given (Cairnes, 1916, p. 22). From 1916 to 1918 there was considerable interest in the placers of Dublin Gulch as a source of scheelite (Cockfield, 1919a, pp. 10B–12B), and some shipments were made during this period.

Following this period, activity on both Haggart Creek and Dublin Gulch is believed to have been limited to a few small operations until revived about 1937 by E. Barker on Haggart Creek and F. Taylor on Dublin Gulch.

Haggart Creek Mining Company, managed by Barker, held 22 claims on Haggart Creek and mined them from 1937 to 1945, using a modified bulldozer–sluicing plant and dragline operation. During this period, they produced about 10,000 ounces of crude gold (Skinner, 1962, p. 18). Later the creek was mined from 1953 to 1957 by Waddco Placers Ltd., who recovered about 12,620 ounces of crude gold (Skinner, 1962, p. 18) and from 1961 to 1964 by Spruce Creek Placers, Limited, who recovered about 3,136 ounces of crude gold. Both operators used bulldozer–sluicing plants. Fred Taylor has mined on Dublin Gulch since 1937, with the exception of 1943 to 1952 inclusive. Hand methods of ground sluicing and a gasoline hoist to remove the large boulders were used until 1946, and a bulldozer–sluicing plant subsequently. Taylor's production has been about 8,815 ounces of crude gold and 7 tons of tungsten concentrates. In addition, there were smaller placer operations on both Haggart Creek and Dublin Gulch during this period.

A minimum estimate of production up to and including 1965 is 29,756 crude ounces (about 890 fine) for Haggart Creek and 13,703 crude ounces (about 860 fine) for Dublin Gulch. For Haggart Creek, this includes 2,550 ounces to 1915; 10,000 ounces by Haggart Creek Mining Company, 1937–1945; 12,620 ounces by Waddco Placers Ltd., 1953–1957; 3,992 ounces by Spruce Creek Placers, Limited, 1961–1965; and 596 ounces from small operations by both Barker and Malicky. For Dublin Gulch, this includes 3,000 to 1916, 8,815 ounces by Taylor, 1937–1965, 1,065 ounces by Greig, 1955–1960, and 823 ounces by Smashnuk, 1960–1962.

Some scheelite concentrates have been shipped from Dublin Gulch, principally by Taylor, and the bulk of the Yukon production of 32,169 pounds of tungsten (WO_3) undoubtedly came from there. This was shipped in 1918, 1941 to 1944, and intermittently since 1951.

Both Dublin Gulch and the placer-bearing part of Haggart Creek are believed to have been filled by ice in the Pleistocene. Erratics of dense hematite and jasper in the gravels indicate that at least some foreign material has been added from the ice sheet. In the vicinity, ice is believed to have moved in a west to southwest direction with the main flow along the valleys of East McQuesten River and Lynx Creek. The valleys of Haggart Creek above Lynx Creek, essentially at right angles to the flow, and Dublin Gulch, protected by Potato Hills, escaped heavy scouring and modification.

Lode Deposits

Silver, Lead, and Zinc

A number of vein deposits containing values in silver, lead, zinc, and in some cases antimony, occur in rocks mapped as the Keno Hill Quartzite (unit 18), the Lower Schist division (unit 17), and unit 3. Other deposits occur near the contact of rocks of unit 2 with overlying massive carbonate rocks of unit 8 in the Nash Creek area, and one other is west of Tintina Trench in metamorphic rocks of unit C. None of the deposits are now economic although small shipments have been made from several in the past.

Rocks of the Keno Hill Quartzite (unit 18) and to a lesser extent the Lower Schist division (unit 17) are the host for the high grade silver–lead deposits of the Keno and Galena Hills area, a few miles south of Nash Creek map-area. Hence rocks assigned to these two units would appear worthy of careful prospecting within the present area.

(1)[1] *Stand-to Property* (Foley Silver Mines Ltd. (64°02′N, 135°10′W))

References. Cockfield (1922, p. 1–6*); Findlay (1967, pp. 25, 26).

The main showing is at an elevation of 4,750 feet on the north face of Stand-to Hill in Nash Creek map-area, and early work is described by Cockfield. Since then the showing has been staked many times but little more than representation work was done until the most recent work, begun in 1966 (Findlay, op. cit.). For this an 8-mile tote road was built to the property from the McQuesten – Hanson Lakes road.

The original showing was visited by the author in 1957, at which time the property was not being worked. The showing is in rocks of the Lower Schist division (unit 17) near their contact with Keno Hill Quartzite (unit 18). A fault, trending N 25° E and dipping steeply to the northwest brings greenstone (unit 20) in contact with dark grey graphitic phyllite and thinly bedded quartzite. An adit driven about 6 feet below the top of the greenstone body exposed a sheared zone about 4 feet wide. The adit, which appears to be about 30 feet long, had caved some 15 feet from the portal and was ice filled beyond. Specimens from the dump show limonite, formed as an alteration of siderite, containing nodules of galena to 3 inches in diameter and a little chalcopyrite. No sphalerite was observed. A picked specimen consisting mainly of galena assayed the following:

Gold (oz./ton)	Silver (oz./ton)	Lead (%)	Zinc (%)	Copper (%)	Antimony (%)	Cadmium (%)
0.005	71.78	83.4	0.10	0.32	0.39	0.04*

NOTE: Assay by Mines Branch, Department of Energy, Mines and Resources.
*Spectrographic determination.

The silver–lead ratios are similar to those obtained by Cockfield (1922, p. 4A) in assays of samples taken across the face and back of the adit.

In 1966 bulldozer trenching resulted in a new discovery just above Homestead Creek, about 300 feet east and 200 feet north of the old adit. Findlay (op. cit.) writes as follows:

> . . . The new discovery was visited in late August, 1966, and at that time consisted of a partly-stripped vein break cutting massive greenstone (20) intercalated with fine-bedded quartzite and quartz-mica schist [Lower Schist division, 17 of this report]. The break is up to 12 feet wide and is bounded by two strong, sub-parallel shears trending about N 15° W and dipping vertically or steeply east. Between the shear zones is highly fractured, locally gougy, reddish brown limonite-stained material carrying sub-parallel lenses and veins of

[1]Number that is used to indicate the property on the accompanying geological maps.

quartz-siderite with disseminated to massive galena, sphalerite, and minor chalcopyrite. Because of the great deal of disturbed rubble left by the bulldozer, the actual extent of mineralization was difficult to assess, but individual veins appeared to contain pods of massive ore up to 2 to 2½ feet in width. A chip sample across 12 feet near the up-slope (south) end of the zone assayed: 0.005 ounces per ton gold, 3.52 ounces per ton silver, 5.2 per cent lead, 1.0 per cent zinc, and 0.07 per cent copper. A grab sample from a massive lens assayed: 0.005 ounces per ton gold, 61.5 ounces per ton silver, 77.3 per cent lead, trace zinc, and 0.06 per cent copper.

The company reports (The Northern Miner, 26 October 1967, p. 6) that during 1967 two adits were driven on the showing and two new veins exposed by bulldozer stripping.

(2) *Rambler Hill Property* (64°04½'N, 135°16'W)

References. Cockfield (1919a, pp. 1–15*; 1922, pp. 1–6*).

This property lies southwest of the summit of Rambler Hill in Nash Creek map-area, at an elevation of 4,850 feet. A good trail leads from the end of the road at Hanson Lakes to upper Cache Creek. From a ruined cabin there a poor trail follows the hillside to the property. The showing has been staked a number of times in recent years and a limited amount of bulldozer stripping was done in 1961.

The showing lies on a north-trending lineament that can be traced for about three miles on air photographs. The country rock in the vicinity of the showing consists of grey phyllite, probably of the Lower Schist division (unit 17) and associated greenstone (unit 20).

When visited by the writer in 1957, very little work appeared to have been done since Cockfield's (1922, pp. 4A, 5A) description which follows:

> At the time of the writer's visit (July, 1921) the shaft was full of water and the upper workings could not be examined. The data obtained from a previous examination (Cockfield, 1919, pp. 6B-7B) are given here for purposes of reference. The vein-filling consists of limonite, galena, pyrite, quartz, cerussite, anglesite (?) malachite, and chalcopyrite. Limonite makes up by far the greater mass of the deposit. Included in it are small nodules of galena, coated with oxidation products. Near the surface and extending downward for 37 feet are large masses of galena. Farther down, these disappear, leaving only the small nodules.
>
> Galena appears in three open-cuts along the vein between the shaft and the adit. In the adit the vein is 3 to 4 feet wide. The strike and dip are both variable. The vein-filling consists of iron oxide and carbonate, manganite, and galena with lead carbonate and a little chalcopyrite. The galena occurs in small bands in the vein, and the chalcopyrite as small specks in the galena.

A picked specimen from the dump containing galena was assayed. This and assays of similar material given by Cockfield are as follows:

	Gold (oz./ton)	Silver (oz./ton)	Lead (%)	Zinc (%)	Copper (%)
Specimen GC7-62*	0.01	49.53	80.0	0.10	0.40
No. 1†	Nil	36.80	54.91		
No. 2†	Nil	36.00	52.60		

*Assay by Mines Branch, Department of Energy, Mines and Resources.
†Cockfield (1922).

(3) *Paul Group (Mount Cameron) Property* (64°05'N, 135°00½'W)

References. Cockfield (1920b, p. 5*; 1922, pp. 1–6*).

The Paul Group, described as the Mount Cameron property by Cockfield (1922), is held by Falconbridge Nickel Mines, Limited. The group is on the plateau north of Mount Cameron in Nash Creek map-area. No work other than a claim survey appears to have been done on the property in recent years.

The mineralization occurs along a strong fault trending N 27° E that displaces the east side of a limestone band about 400 feet to the north. The limestone, which occurs in unit 3, has an apparent surface width of 800 feet. The fault has been traced 950 feet in a series of trenches, and two adits, now caved, have been driven on it. An iron-cemented conglomerate, similar to those observed elsewhere in the area, occurs in a small creek on trend with the line of trenches and some 250 feet beyond the last trench.

The vein material exposed on the dump and in the trenches consists of siderite, now altered to limonite and hydrous manganese oxides, quartz crystals, galena, sphalerite, and chalcopyrite. Galena occurs in thin streaks following fractures, and the sphalerite and chalcopyrite commonly occur in the siderite as small blebs up to ½ inch in size. The heaviest mineralization, mainly siderite replacing limestone, appears to be confined to about 400 feet along the fault where both walls are in limestone. Scattered ore minerals were noted along the entire length of the fault workings. The width of the mineralized body is not obvious from the present exposures but Cockfield (1922, p. 6A) reports it to be 50 feet.

Assays of a picked sample from the dump and of a similar specimen taken by Cockfield (1922, p. 6A) are as follows:

	Gold (oz./ton)	Silver (oz./ton)	Lead (%)	Zinc (%)	Copper (%)	Antimony (%)
GC7-78*	0.005	40.48	40.9	10.75	0.28	0.09
Cockfield†	Nil	76.00	56.83			

*Assay by Mines Branch, Department of Energy, Mines and Resources.
†1922.

(4) *Kathleen Lakes Property* (64°17'N, 134°12'W)

The showing occurs at an elevation of about 4,200 feet and is about 2½ miles northeast of Kathleen Lakes.

G. Dickson, of Whitehorse, Yukon, holds claims covering the main showing, discovered by Dickson in 1954 and explored by Prospectors Airways Company, Limited in 1955. Only a limited amount of work has been done since then.

The showing is in orange weathering dolomite of unit 2 immediately beneath the unconformity with overlying lower Paleozoic limestone (unit 8). The attitude of the underlying rocks (unit 2) could not be determined but dips of the overlying carbonates (unit 8) range from gentle to nearly vertical, suggesting that folding, and possibly faulting, may have occurred. A rusty weathering manganese-stained zone, trending northeast and about 700 feet long, contains sphalerite, secondary zinc minerals (?), siderite, and minor galena. Veinlets of coarse calcite cut the zone. A sample of oxidized material assayed 49.1 ounces of silver per ton, trace lead, and 41.4 per cent zinc (assay by G. Spalding, Whitehorse).

The deposit appears to occur in the same stratigraphic position as and to be very similar to the Silver Hill showings described below.

(5) *Silver Hill Showings* (64°29'N, 135°16'W)

Reference. Cockfield (1925, pp. 1–18*).

The showings occur on Silver Hill, a small northeast-trending ridge subsidiary to Carpenter Ridge. Falconbridge Nickel Mines, Limited holds 15 leased claims in the area, which may be reached by a winter bulldozer road that follows Beaver River and Carpenter Creek from near the McKay Hill showings. Hart Lake, Elliott Lake, and the lake at the head of Carpenter Creek are all suitable for use by float-equipped aircraft.

The Silver Hill showings were found in 1923 and resulted in a midwinter staking rush to the area. Cockfield visited it the following summer. Little work appears to have been done since.

The showings are in dolomitic siltstones of map-unit 2 which contain some greenstone bodies (unit 20a). The deposits (Cockfield, 1925, pp. 11A, 12A) occur along short, transverse fissures and consist of galena with subordinate sphalerite, and a little pyrite in a gangue of calcite and siderite. Prospect pits or trenches comprise the workings. A number of veins are described (op. cit.) some of which are 6 feet wide and composed essentially of massive galena. Two assays are given: one across a width of 6 feet returned 9.00 ounces of silver per ton and 69.38 per cent lead, and the other taken across what is believed to be a tabular body 26 feet thick returned 4.5 ounces of silver per ton and 65.46 per cent lead.

Both assays show an extremely low silver to lead ratio and the deposits appear to be of limited economic interest unless a relatively large potential tonnage can be developed. Cockfield's description (op. cit.) suggests that the showings lie close to the unconformity between orange dolomite of unit 2 and the overlying Paleozoic carbonate (unit 8) and thus are similar to the Kathleen Lakes showing.

(6) *Grey Copper Hill Showing* (64°26'N, 135°16'W)

Reference. Cockfield (1925, pp. 1–18*).

The discovery of rich tetrahedrite float on the ridge in the autumn of 1923 caused a rush to the area the following winter. When visited by Cockfield (op. cit.) the summer after, only one vein was observed in place. This vein, estimated as 24 to 30 inches wide, contained siderite, tetrahedrite, and pyrite, with some quartz, azurite, and malachite. A sample of the 16 inches of the vein exposed assayed 52.0 ounces of silver per ton. The presence of tetrahedrite-bearing float, some of it carrying up to 1,100 ounces of silver per ton, suggests another vein or veins (op. cit.).

(7) *McKay and Horseshoe Hill Showings* (64°21'N, 135°23'W)

References. Cockfield (1924, pp. 22A–28A; 1925, pp. 1–18*).

Falconbridge Nickel Mines, Limited holds seven leased claims in the area. The property may be reached by an old bulldozer road from near Elsa that follows the west side of the valley of South McQuesten River, crosses a low divide northwest of the foot of McQuesten Lake to East McQuesten River, and follows the latter and Beaver River to the property.

The deposits were discovered in the summer of 1922 and were prospected for several years. The showings on McKay Hill were drilled in 1929 by The Consolidated Mining and Smelting Company of Canada Limited. Results were disappointing as it was found that the deposits did not extend to a reasonable depth, and the options held by the company were abandoned (Cockfield, 1930, p. 12A). Between August and November, 1948, East Bay Gold

Limited mined about 158 tons from the No. 6 vein that had been drilled previously. The shipment, hauled to Elsa by tractor train the following winter, assayed 11.4 ounces of silver per ton and 74.1 per cent lead. Mr. A. C. Lee, the engineer in charge, reports (*pers. com.*) that as the pits were deepened the lead content of the vein decreased rapidly and disappeared within a few feet.

Cockfield (1924, p. 23A) describes the sedimentary rocks on the showing as "... chiefly black slates, banded red and green slates, quartzite, conglomerate and limestone." (unit 3 of this report). "The igneous rocks of the district comprise both intrusive and extrusive types, both of which may be classed under the field name of greenstone." (units 4 and 20a? of this report).

Cockfield (1925, p. 13A) reports that the mineral deposits occur in and at the borders of small masses of largely amygdaloidal andesites and andesitic breccias in which calcite fills the amygdules and replaces the original constituents of the rocks. Trenching at the time of Cockfield's visit had exposed a number of veins, and the presence of others was suggested by float. Mineralization consisted of quartz with galena, tetrahedrite, and sphalerite. The veins trend about northeast. The main showing exposed a mass of galena 12½ feet wide which decreases to 4 feet in a cut 30 feet to the northeast and which is lacking in a cut 50 feet farther northeast. A sample cut across the full width of 12½ feet assayed 3.25 ounces of silver per ton and 56.45 per cent lead. The silver to lead ratios of most of the other samples of galena-rich mineralization taken by Cockfield are somewhat higher but none exceed one ounce of silver per one per cent lead. The silver values contained in tetrahedrite also appear to be low: one picked sample (No. 4, Cockfield, 1924, p. 26A), 4 to 6 inches across, that was rich in tetrahedrite assayed 38.00 ounces of silver per ton, 4.58 per cent lead, and 8.84 per cent copper; another sample of picked tetrahedrite (No. 20, op. cit.) from talus assayed 62.10 ounces of silver per ton, 9.27 per cent lead, and 15.04 per cent copper. Vein float also occurs on Horseshoe Hill nearby but the silver to lead ratios of three assays (Nos. 1 to 3, op. cit., p. 27A) are even lower than those of McKay Hill.

Peso and Rex Properties (about 64°00½'N, 135°58'W)

References. MacLean (1914, pp. 153–157); Skinner (1961, pp. 32, 33; 1962, pp. 31–34); Green and Godwin (1963, pp. 12–15; 1964, pp. 15, 16); Green (1965, pp. 20–22).

The Peso No. 1 showing has been explored intermittently since early in the century (Independence property of MacLean, 1914, pp. 153–157) whereas other veins on the property including the Rex are later discoveries. From 1961 to 1964 inclusive Peso Silver Mines Limited explored the properties but there has been no work done since although many of the claims are still held. When active the properties were reached by a road about 5 miles long, that followed the valley of Secret Creek and left the Haggart Creek road about 26 miles from its junction with the Mayo–Elsa road. Much of the road was in the creek bottom and consequently has washed out. Both the showings and the camp are located on the upland surface at elevations of 3,500 to 4,300 feet.

The showings consist of silver- lead- and antimony-bearing veins in phyllite and quartzite of unit 3. Work done includes underground exploration on the Peso No. 1 and Rex veins, bulldozer stripping of the Peso Nos. 1 to 6 veins, some surface diamond drilling, and geochemical and geophysical surveys.

(8) Peso Property

An irregular vein system comprising the Nos. 1, 2, and 3 veins has been partly exposed by surface stripping over a total distance of about 14,000 feet. The system probably consists of discontinuous *en echelon* veins rather than a single vein, and here and there subparallel veins occur as much as 20 feet from what appears to be the main system. The over-all trend of the system is about N 70° E with steep northerly dips. Numerous small offsets resulting from minor slips and cross-faults probably occur. In addition to the main vein system, two veins (No. 4 and No. 6) lie about 2,000 feet and another (No. 5) about 4,000 feet to the north.

Country rock in the vicinity of the showings consists principally of impure micaceous quartzite with lesser amounts of phyllite and schist all assigned to unit 3. Small sills of quartz porphyry and granite porphyry (unit 25) and possibly granodiorite (unit 21) are also present.

Exploration of the veins by bulldozer stripping is difficult as near-surface parts are highly oxidized and few sulphide minerals remain. Scorodite, a distinctive green, secondary, arsenic-bearing mineral, is frequently present. The ground is frozen and cuts made during the summer months must be examined soon after exposure as they rapidly become a morass of thawed rock fragments.

The underground workings on the Peso No. 1 vein are on the 3,350-foot level, about 110 to 160 feet below the surface exposure. The adit is about 361 feet long, at about 110 degrees azimuth, and intersects the vein between 302 and 326 feet from the portal. Drifting was extended about 70 feet southwest and 520 feet northeast subparallel to the vein fault. Short crosscuts were made through the vein fault for sampling.

Rocks exposed underground are very contorted. Quartzites are strongly lineated and in many places are isoclinally folded, with limbs parallel to the dominant foliation or bedding (?). Phyllitic rocks locally have strong wrinkle lineations. Slip surfaces, subparallel to the foliation of the rock and smeared with a paste of either chloritic or graphitic material, are common. Faults are abundant and several that are post-mineralization appear to displace the vein for short distances. The mineral zone, in general, follows a zone consisting of several breaks that trend about N 45° E and dip 65° NW; narrow intervening sections strike about N 80° E and dip 45° N.

The degree of alteration is variable, ranging from unaltered sulphides to completely oxidized material. Minerals observed underground include: leek-green scorodite; earthy, yellow to brown bindheimite; earthy, brown goethite; metallic, white arsenopyrite; brassy cubes of pyrite; metallic, black, needle-like masses of jamesonite; light brown siderite; metallic, black argentian tetrahedrite (freibergite); brownish jarosite (?); blue-green chalcanthite crystals from copper-bearing groundwater, on the walls of the adit.

The assays and descriptions of the following three samples give an idea of the mineralization in the No. 1 vein.

Sample No. *	Gold (oz./ton)	Silver (oz./ton)	Lead (%)	Zinc (%)	Copper (%)	Antimony (%)	Bismuth (%)	Cadmium (%)	Arsenic (%)
1	0.01	9.489	1.54	0.28	1.34	0.50	0.12	n.d.	3.37
2	0.04	36.083	6.90	0.02	0.040	4.91	0.01	0.05	4.90
3	0.01	3.30	0.82	0.05	0.20	0.59	0.05	n.d.	2.16

*Assays by Mines Branch, Department of Energy, Mines and Resources.

Sample Number 1: from the intersection of the vein and adit; sample width 15 feet. Specimens from this locality are predominantly siderite, but some quartz is also present. Jamesonite is readily identified by its soft, needle-like character. Arsenopyrite and freibergite are disseminated throughout the specimens. Vugs are common and frequently lined with small, dark brown stained siderite. Buff, clay-like minerals are concentrated in some of the vuggy parts of the specimens.

Sample Number 2: from a short crosscut about 60 feet northeast of the adit; sample width 15 feet. Specimens are predominantly brown, green, and grey clay-like minerals. The green mineral is wholly composed of minute crystals of scorodite; the brown mineral is probably goethite; the grey material is graphitic. Jarosite is possibly responsible for some of the silver content.

Sample Number 3: from a short crosscut about 180 feet northeast of the adit; sample width 9 feet. Specimens vary but are generally either white vein quartz with pyrite stringers along small fractures, or silicified quartzite in which pyrite, jamesonite, and white quartz fill the fractures.

(9) *Rex Property*

The property, located about 2½ miles east-southeast of the Peso No. 1, and at an altitude of about 3,850 feet, was explored by bulldozer trenching, geophysical work, diamond drilling, and a short shaft during the 1962 and 1963 field seasons and by extensive underground work in 1964.

The country rock is buff weathering, grey phyllitic quartzite and dark grey to grey-green phyllite of probable Precambrian age (unit 3). The rocks are strongly foliated parallel to the bedding and show evidence of considerable shearing, although they are less deformed than rocks of similar lithology on the main Peso showing nearby. The Rex vein trends about N 70° E and dips between 50° and 55° N. In the underground workings the vein appeared to have a strong, well-defined footwall shear, but subsidiary subparallel breaks occur in the hanging-wall. The adit, at an elevation of 3,550 feet and about 300 feet below the surface outcrop, intersected the Rex vein about 900 feet from the portal. The vein was explored for about 750 feet to the west and for 600 feet to the east. The total underground program involved about 3,500 feet of crosscutting, drifting, and raising, and 31 diamond-drill holes with a total length of about 3,500 feet. As many as 60 men were employed during the peak period and a small crew continued work until late October, 1964.

When visited in mid-June 1964, the footwall shear was exposed in the main drive about 400 feet west of the intersection of the main crosscut. Here, the footwall rocks consisted of interbedded grey quartzite, with beds 2 to 3 inches thick, separated by bands of dark grey phyllite, 1 inch to 2 inches thick. The main shear was marked by a band of rubbery gouge about one-half inch thick; the footwall rocks for about 4 feet below showed minor subparallel shears and some evidence of deformation. The zone itself consisted of a breccia of fragments of quartzite and phyllite mineralized with dark brown siderite, pyrite, and jamesonite. Hanging-wall rocks were not exposed in the face, but nearby they consist of light grey phyllitic quartzite. A grab sample from the face, composed mainly of siderite darkened by fine needles of arsenopyrite (?) plus minor tetrahedrite and fine pyrite, assayed 0.04 ounces of gold and 224.0 ounces of silver per ton, 8.9 per cent lead, 0.2 per cent zinc, and 6.86 per cent antimony (assay by G. Spalding, Whitehorse, Y. T.).

At the same date the intersection between a shear about 50 feet in the hanging-wall from the main footwall shear and a shear trending about N 40° E was exposed in the 74 raise, about 270 feet west of the main crosscut. The face, about 70 feet above the level, showed the following from footwall to hanging-wall: chloritic phyllite containing some pyrite, a ½-inch zone of black rubbery gouge in part with a pyrite-coated surface, 6 feet of breccia composed of fragments of chloritic phyllite and phyllitic quartzite cemented with siderite, minor bull quartz and sulphide minerals, and a hanging-wall of chloritic phyllite. The gouge appeared to be blackened by a high content of fine sulphide minerals, chiefly pyrite. Late in the season the 74 raise was extended to within 20 feet of the mineralized zone on surface which assayed (Peso Silver Mines Limited, Ann. Rept., 1963, p. 7) 0.01 ounce of gold and 44.0 ounces of silver per ton, 7.79 per cent lead, and 4.35 per cent antimony, over a length of 250 feet and an average width of 5.2 feet. When the writer visited the property early in October 1964, the face of the raise, about 300 feet above the level, showed from footwall to hanging-wall the following: dark grey phyllite, a zone about 50 inches thick, the lower third of which contained siderite with some sulphide minerals and the remainder an altered breccia streaked with limonite and containing minor sulphides, and a hanging-wall of grey phyllite.

In general, the shear in the footwall of the Rex vein appears to be much more continuous, contains more gouge, and shows more evidence of deformation along it than the subsidiary breaks in the hanging-wall. Some of the larger of these breaks appear to turn into and join the main zone. Erratic mineralization occurs along the breaks, particularly at junctions between two that are subparallel. Minerals identified in the veins are siderite,[1] quartz, jamesonite,[1] boulangerite,[1] galena, tetrahedrite,[1] pyrite, arsenopyrite,[1] and sphalerite. The siderite varies from light amber to an adamantine grey; the darker colour is produced by fine needles of arsenopyrite,[1] and possible other minerals, within the siderite crystals. Jamesonite occurs as dense matted areas of fine crystals and probably as fine hair-like crystals, although one specimen of the latter was found to be boulangerite.[1] Tetrahedrite occurs as irregular grains to about 5 mm in diameter in the silver-rich parts of the vein. Fine grains of pyrite are common throughout much of the vein. Tiny crystals of arsenopyrite[1] were identified in a jamesonite lens and are probably common to most of the high-jamesonite portions. Minor amounts of lustrous dark brown sphalerite are present.

Bindheimite,[1] a hydrous antimonate of lead, is widespread in the surface cuts on the Rex vein. Very small amounts of a medium to dark green, nickel-bearing mica were found both in the underground workings and the diamond drilling.

(*10*) *McQuesten Pass Showing* (64°07′N, 135°32′W)

The showing was discovered in 1951 by L. Brown and J. Alverson. Workings consist of a shaft, about 30 feet deep, and a number of open-cuts. The showing is in gritty quartzite of unit 3, and a few pieces of quartz porphyry (unit 25) were noted in the broken material. The mineralization occurs along a north-trending fault and consists of galena with quartz, siderite, and secondary minerals. Broken schist fragments are common within the mineralized portion. A picked specimen, rich in galena, assayed trace gold, 3.34 ounces of silver per ton, 56.3 per cent lead, and 14.1 per cent zinc (assay by G. Spalding, Whitehorse).

(*11*) *Spotted Fawn Property* (64°22½′N, 135°32′W)

Reference. Cockfield (1919, pp. 15B–17B*).

The showings are exposed in the canyon of Spotted Fawn Gulch, a tributary of Little Twelve Mile River. They are about 30 miles northeast of Dawson and are best reached by helicopter as there are no lakes suitable for float-equipped aircraft in the area and all the former roads and trails are in disrepair. Intermittent work, including driving a short adit on the main showing, has been done since it was described by Cockfield (op. cit.), the most recent being an examination of the property by The Yukon Consolidated Gold Corporation Limited in 1962. The latter company holds two Crown-granted claims in the area and staked an additional eleven at the time of the examination.

[1]Identified by the X-ray Diffraction Laboratory, Geological Survey of Canada.

The main showing consists of two veins confined to a greenstone sill (unit 20) exposed in the canyon. Cockfield (op. cit.) reports that the maximum thickness of one vein is 16 inches and the other 10 but that both pinch rapidly in either direction, thinning to less than an inch in a distance of 25 feet.

> The vein filling is coarsely crystalline galena with pyrite and calcite, with included angular fragments of the greenstone. These are frequently partly replaced by galena. Both walls of the veins are sharply defined, very little of the ore mineral extending beyond the wall. Small specks of galena do, however, occur in the wall rock, but they are exceedingly rare. . .
>
> Four samples were taken . . . No. 50 is intended to represent the average of the larger vein at this locality; No. 51, the intersection of the two veins; No. 52 a sample cut at intervals along the smaller vein at the same place; and No. 53, a cut taken across the two veins, including the wall rock lying in between, to give an idea of the content per ton of material mined. . .

No.	Gold (oz./ton)	Silver (oz./ton)	Lead (%)
50	Nil	73.60	50.11
51	Nil	105.00	63.36
52	Nil	30.08	20.64
53	Nil	29.96	18.62

The general area is believed to be worthy of careful prospecting. The original showing, although small, has an encouraging silver to lead ratio and the area is underlain by quartzite (unit 18) similar to the country rock of the rich deposits of Keno and Galena Hill, south of Nash Creek map-area.

About 5 miles northeast (64°25′N, 138°34′W) Gray (1968, p. 166) reports galena on the surfaces of rock fragments of syenite.

(*12*) *Blackstone Showing* (64°59′N, 138°18′W)

P. Sevensma (*pers. com.*) reports low grade lead–zinc mineralization in a dolomite breccia.

(*13*) *Silver City Property* (64°18½′N, 139°52′W)

References. Cockfield (1928, pp. 8A–10A*); Green and Godwin (1963, p. 20; 1964, pp. 18, 19); Green (1965, pp. 23–25; 1966, pp. 23, 24).

Silver City Mines Ltd. holds claims covering this showing, which is on the north bank of the Yukon River about 2½ miles downstream from the mouth of Fifteenmile River. The property, and similar showings about 6 and 11 miles downstream, have been explored intermittently since about 1900. The only known production is about five tons collected from float along the river bank at the present showing (Cockfield, 1928, p. 9A). In this vicinity the bank rises steeply and float has been found as much as 300 feet above river level. Much sloughing has occurred and there is little rock in place on the slope. The most recent work on the property was begun in the late 1950s and has continued intermittently since. Workings consist of exploratory tunnels, the latest about 425 feet above the river level, a limited amount of diamond drilling, and a large hydraulic cut, all in search of a sulphide-bearing vein that

J. Risco is reported to have intersected in 1929. Up to 1965 only minor amounts of mineralized rock had been located in place.

Country rock appears to consist of crumpled quartz–chlorite and quartz–sericite schist, greenstone (in part altered), and minor limestone higher on the slope. Float on the beach occurs in a quartz–carbonate rock, composed of sugary white dolomite, buff iron-bearing dolomite, quartz, and a green nickel-bearing mineral, that contains small amounts of sulphide minerals, principally galena and tetrahedrite. The rock is believed to have formed through the alteration of rock of basic to ultrabasic composition, and various stages of this alteration were observed both in surface exposures and drill core. It is not known whether the silver-bearing minerals occur as veins, pods, or simply disseminations within the quartz–carbonate rock.

(*14*) *Fortymile Showing* (64°25½'N, 140°33'W)

Reference. McConnell (1890, p. 140D).

McConnell reports the presence of a lode of argentiferous galena crossing Fortymile River a short distance above its mouth. A sample assayed 38.64 ounces of silver per ton.

Copper

A number of copper showings occur in Precambrian rocks of the three map-areas. Typically, these appear to consist of veins to a few feet thick containing relatively massive chalcopyrite. Several have been staked and explored but none has proved of economic interest.

(*15*) *McCluskey* (*Caley-Ahern*) *Showing* (64°46'N, 134°38'W)

The showing is believed to have been first staked by J. McCluskey in 1935 and it has been restaked intermittently since. It may be reached by a winter road extending north from Elsa along the valley of Wind River. About 4 miles north of the showing (64°49½'N, 134°39'W) a small lake known locally as Angel Lake has been used by float-equipped aircraft although only very small loads can be taken.

The showing was not visited but is reported to consist of scattered veins and float of siderite with some chalcopyrite found in a northeast-trending zone about 100 feet wide and 2,000 feet long. A sample taken from a siderite vein assayed 3.49 per cent copper over a width of 10 feet (B. W. Hester, *pers. com.*).

A shear zone containing a lenticular quartz vein and located about 2½ miles southwest across Wind River may be a continuation of the above showing. The vein is reported (A. E. Aho, *pers. com.*) to contain considerable chalcopyrite in one area along with minor amounts of bornite, pyrite, arsenopyrite, and siderite.

Other Minor Showings, Nash Creek Map-area

64°24'N, 134°42'W. A small amount of malachite was observed coating fractures in much altered argillite (unit 1) or greenstone (unit 20a).

64°39½'N, 135°00'W. Hematite and magnetite occur in a narrow shear in rocks of unit 1, and nearby a small pod of quartz contains some bornite and secondary copper minerals. Hematite-bearing rocks and minor malachite-stained float were observed about 3½ miles east.

About 65°00'N, 134°00'W. Much copper staining is reported on cliffs of carbonate rock (unit 1a) northeast of Bonnet Plume River.

64°45′N, 134°15′W and 64°48′N, 134°15′W. Gray (1968, p. 166) reports that chalcopyrite, azurite, and malachite were observed in surficial debris below outcrops of dolomite and slate at these locations.

(*16*) *Worm Lake Showing* (64°30½′N, 136°15½′W)

Boulders of massive chalcopyrite were found in the valley of the creek by the late Bobby Austin in the late 1950s. Country rock exposed in the creek valley consists of unmineralized, orange weathering dolomite of unit 2. The showing was optioned to Conwest Exploration Company Limited, which carried out limited geophysical surveying in the 1960 field season. Some diamond drilling was done during the 1966 field season but the source of the float was not located.

(*17*) *Rae and McKamey Showings* (64°40½′N, 136°58′W and 64°40½′N, 136°55½′W, respectively)

Copper showings were discovered in this area in the 1920s by a group of trappers, including Frank Rae and Fred Hoffman, who operated extensive traplines in the Hart River drainage until about 1949. The showings were not visited and the following information is taken from a report prepared for Asbestos Corporation (Explorations) Limited, which optioned and examined the property during the 1956 field season.

The showings are located in small draws on opposite sides of the west fork of a large creek tributary to Hart River, known locally as Rae Creek. Marc Lake (64°46′N, 136° 37′W), about 11 miles northeast, is the nearest lake usable by float-equipped aircraft although owing to its small size only partial loads can be taken.

The Rae showing occurs in a calcite-bearing vein about 6 feet wide that lies along a strong fault cutting argillaceous rocks of unit 1 and a greenstone sill (unit 20a). The best mineralization observed was near the contact of the two rock types where a 4-foot section of the vein containing chalcopyrite and some bornite is reported to have assayed 17 per cent copper. The vein was traced about 600 feet to the south in the argillaceous rocks by five trenches but only minor amounts of copper minerals were present.

The McKamey showing, across the main valley and about one mile east, also lies along a north-trending fault cutting rocks of units 1 and 20a. The main showing consists of a lens of chalcopyrite with associated calcite gangue lying in the faulted zone between argillaceous rocks (unit 1) and greenstone (unit 20a). Trenching indicated that the mineralized zone was about 3½ feet maximum thickness and of limited extent. Elsewhere on the claim groups, a number of smaller veins and lenses containing chalcopyrite were found during the exploration work.

These showings are currently held as the Zebra Group together with the Marc Group (64°38′N, 136°49′W), about 5 miles southeast, where a showing with values in copper, silver, lead, and zinc has recently been discovered (E. P. Callison, *pers. com.*, 1968).

Gold

(*18*) *Dublin Gulch Properties* (about 64°02½′N, 135°47′W to 64°01½′N, 135°49′W)

References. Keele (1906a, pp. 38, 39*); MacLean (1914, pp. 127–158); Cairnes (1916, pp. 29–34*); Cockfield (1919a, pp. 7–15*); Boyle (1965, pp. 82–84).

Quartz veins carrying arsenopyrite, pyrite, and gold occur near the head and on the south side of the valley of Dublin Gulch. The showings, including the Carscallen (Shamrock), the Olive, the Stewart-Catto, Blue Lead, and Eagle Groups, were explored intermittently until about 1918 but the known veins are narrow and values low. Nothing has been done on the properties in recent years.

Tungsten

(19) Dublin Gulch Showings (64°02′N, 135°50′W)

References. Little (1959, pp. 33–36); Boyle (1965, pp. 85, 86).

Scheelite has been recovered from the placer concentrates of Dublin Gulch, and the bulk of the Yukon production of 32,169 pounds of tungsten (WO_3) undoubtedly came from this source. During both World Wars considerable efforts were made to find lode deposits in the area; a summary is given by Bostock (*in* Little, 1959, op. cit.). In this work, small amounts of scheelite were found in place in quartz veins cutting both granitic and metamorphic rocks, in a pegmatite vein cutting granitic rocks, and in skarn beds formed from the alteration of limy rocks of unit 3. All the deposits described are small.

Tin

(20) Dublin Gulch Showing (64°02′N, 135°50′W)

References. Thompson (1945); Boyle (1965, pp. 84, 85).

Boyle describes the deposit as follows:

> Two cassiterite-tourmaline veins occur near the top of the hill overlooking Haggart Creek and Dublin Gulch. According to Bostock (pers. com.) these veins were found by E. R. Sheppard and H. Ray in August 1943 by painstaking panning of samples of soil. Consolidated Mining and Smelting Company, Limited, investigated the veins in 1945 by trenching and driving a crosscut below the surface outcrops, but the work failed to find orebodies large enough to mine and the prospect was abandoned. No work has been done on the veins since 1945. Thompson (1945) has published an early description of the prospect.
>
> The veins are extremely irregular and are more in the nature of impregnations in intensely shattered and brecciated fault zones. One of the mineralized shattered zones trends N 45° W, and the other, judging from pits that cross it, trends N 20° E. The dip of the mineralized zones is unknown, but appears to be steep. The width of the zones is uncertain but seems to vary from 1 foot to 25 feet. The wall-rocks are quartzites, phyllites, graphitic schist, and quartz-mica schist.[1]
>
> The mineralized zones consist of highly brecciated rock impregnated with microscopic green tourmaline, quartz, microcrystalline cassiterite, and chlorite. Small crystals and masses of pyrite are common in the primary mineralized material, and locally some chalcopyrite is present. The near-surface parts of the mineralized zones are oxidized and are composed of disintegrated breccia fragments containing tourmaline and cassiterite, powdery greenish brown soil composed of limonite, tourmaline, and cassiterite, and cellular fragments of rock containing quartz, limonite, altered pyrite, cassiterite, and tourmaline.
>
> According to Thompson a channel sample across one of the zones contained 1.53 per cent Sn. Two other channel samples taken by Bostock, across 30 inches, assayed 1.53 and 0.83 per cent Sn, a trace of gold, and 0.04 ounce of silver a ton for both samples. Bostock (pers. com.) states that the average of the samples assayed by the Consolidated Mining and Smelting Company was less than 0.3 per cent Sn.

[1]All assigned to unit 3 of this report.

Antimony

(*21*) *Antimony Mountain Showing* (64°16′N, 138°13′W)

A stibnite-bearing dyke of vein in this area has been staked and investigated a number of times in recent years, most recently in 1966. The showing was not visited and the following information was obtained from W. N. Plumb (*pers. com.*). The showing, exposed on a steep ridge at an elevation of about 5,800 feet, consists of an aplite or rhyolite dyke cutting syenitic rocks (unit 21b) and containing some quartz and stibnite. The stibnite occurs in single crystals, aggregates, and pods, the latter as much as 10 inches thick, and is erratically distributed within the dyke. The dyke strikes about N 45° E and dips from 70° SE to vertical. It is exposed intermittently on a steep slope northeast of the showing and can be seen to cross another ridge about 1,000 feet beyond.

P. Sevensma reports (*pers. com.*) that small quartz veins with same chalcopyrite cut rocks of unit 3 about 1½ miles west.

Iron

(*22*) *Pacific Giant Steel Ores Ltd.* (64°50′N, 134°17′W)

Reference. Green (1966, pp. 21–23).

Pacific Giant Steel Ores Ltd. owns 16 claims covering an iron showing staked by A. Jellinek and P. Runer in 1962. Representation work and some geophysical prospecting have been done. The showing is on a small knoll on the north side of Bear River valley at an elevation of about 3,500 feet. Transportation is normally by helicopter as Gillespie Lake, about 10 miles southeast, is the nearest lake suitable for float-equipped aircraft. The Wind River winter road, between Elsa and Crest Exploration Limited's Snake River iron property, passes within 12 miles northwest of the showing. A brief visit was made to the property in July 1965.

The deposit occurs near the point of a thin wedge of bright orange weathering silty dolomite of Precambrian age (unit 2) that is enclosed by underlying dark argillite and argillaceous quartzite (unit 1).

In the author's opinion, rocks in the wedge, striking about east and dipping steeply north, overlie those of unit 1 conformably to the south and are in fault contact along the northern edge, the wedge widening in the cirque to the east.

On the top of the knoll, a small outcrop contains hematite with lenses of pale pink chert (up to several millimetres in greatest dimension), interbedded with brown weathering, grey-green dolomite and dark green argillite. A draw trending southwest, approximately at right angles to the strike, exposes brown weathering rock, principally dolomite but containing some hematite, pink chert, and traces of chalcopyrite for about 500 feet across the strike. Down the slope on the north side of the knoll is a face principally of pink chert conglomerate with some dark green argillaceous rocks and some hematite in the matrix. The amount of hematite increases towards the base of the knoll. About 1,000 feet west of the top of the knoll a paced section included about 450 feet of iron-rich rock, with fine specular hematite as the major constituent, and farther south, beyond a 200-foot covered interval, about 100 feet of hematite-rich pink chert conglomerate and shale. Continuing west, the deposit passes beneath the cover of the valley floor although the company reports that specular hematite was found in test pits sunk in the area after the author's visit. Little more can be learned about the deposit without drilling.

The hematite in the showing is in the form of dense fine-grained specularite. The orange weathering, grey-green, silty dolomite of unit 2 consists principally of ferroan-dolomite (N_0 about 1.690) and minor quartz.

Small showings of both hematite and chalcopyrite have been reported elsewhere in the area, commonly in Precambrian rocks (units 1 and 2 near the unconformity with the overlying Paleozoic carbonate of unit 8). Hematite showings of this type, located along the east side of Wind River valley, about 11 miles west of the present property, sparked a small staking rush in 1958.

Deposits of this type have a markedly different geologic setting and are distinct from the sedimentary iron ores of the Crest deposit, about 45 miles northeast.

(*23*) *Shell Creek Property* (about 64°34′N, 140°20′W)

The showing, discovered by H. and W. Krause in 1956, was explored by Asbestos Corporation (Explorations) Limited in 1957. The property, located near the head of Shell Creek, is reached by a rough trail, about 8 miles long, following the creek from Yukon River.

The showings contain magnetite and minor hematite in iron-formation that has been traced about five miles northeast from the fork near the head of Shell Creek and about one mile downstream on the east side of the creek. The iron-formation contains fine-grained magnetite and some hematite interbedded with fine-grained buff to lavender quartzite and grey to dark green phyllite. These rocks are interbedded with phyllite, grit, and limestone, all assigned to unit 3. During the exploration program six trenches spaced over about 4 miles were cut in the iron-formation, and in some, magnetite-bearing bands as much as 40 feet wide and containing up to 30 per cent iron were exposed.

The outcrop pattern of the iron-formation is controlled by chevron folds trending northwest parallel to Tintina Trench and sloping gently southeastward. The main northwest-trending band appears to represent the limb of an anticlinal structure, and the complex outcrop pattern on the east side of Shell Creek the trace of the iron-formation around a group of troughs and noses of closely spaced chevron folds. A thin band of schist and phyllite with some magnetite, parallel to the main band and about one mile southwest, may represent the opposite limb of the anticlinal structure.

Industrial Mineral Deposits

Asbestos

Numerous bodies of ultramafic rock (unit E) have been mapped in Dawson map-area, southwest of Tintina Trench, and many more are probably present. Some of the latter should be apparent on aeromagnetic maps of the area currently being compiled and published by the Geological Survey of Canada. Many of the ultramafic bodies contain traces of asbestos fibre, but only one, the Clinton Creek property, is now being brought into production. The area seems worthy of much additional prospecting for other deposits.

(*24*) *Clinton Creek Property* (64°27′N, 140°42′W)

References. Green and Godwin (1964, pp. 19–21); Green (1965, pp. 25–27; 1966, pp. 25–27); Christian (1966).

Cassiar Asbestos Corporation Limited holds 179 claims covering the property, which was first staked by G. Walters in 1957. The company explored the property in 1957 and 1958 and from 1963 on. Early in 1965 they announced that it would be brought into production and since then construction and additional exploration have been under way.

The property is reached by a road about 26 miles long that leaves the Sixtymile road near Mile 37 and follows the ridge line west of Mickey Creek to the valley of Fortymile River, and then the valley of Clinton Creek. A bridge has been completed across Fortymile River, but on the crossing of Yukon River at Dawson present plans are to use a ferry service in summer, an ice bridge in winter, and an aerial cable system during freeze-up and breakup. During earlier exploration of the property a tote road following the same general route was used but several soft spots and difficulties with the ford on Fortymile River limited its usefulness during the summer season, at which time the camp was serviced by aircraft operating from an airstrip about two miles north of it.

The deposit is located on Porcupine Hill, on the south side of Clinton Creek, about 5 miles from the mouth. From the crushers at the pit the ore will be moved by tramline to the mill located on Trace Hill, about one mile north on the opposite side of Clinton Creek. The townsite, planned for a population of 600 to 700, is to be located about five miles away in the valley of Fortymile River upstream from the mouth of Clinton Creek.

Exploration work done on the property includes surface trenching and about 5,300 feet of underground work during 1957 and 1958; and from 1963 to 1965 magnetometer surveys, surface mapping, and about 30,000 feet of diamond drilling.

At the end of 1965 proven ore reserves were 14,545,775 tons valued at $14.12 per ton with a waste to ore ratio of 3.3 to 1, and indicated ore an additional 9,529,614 tons valued at $12.40 per ton with a waste to ore ratio of 6.5 to 1. Most of the production will be of Group 4 asbestos fibre, used mainly in cement products. Initial production is planned at a rate of 40,000 tons of fibre per year, rising to 80,000 tons by 1970.

The Clinton Creek property is on one of a number of small bodies of ultramafic rock that occur in metamorphic rocks of the area. Enclosing metamorphic rocks observed on the property include shiny black phyllite, platy black limestone, grey argillite, and brown weathering, micaceous, gritty quartzite. The body containing the showing is probably little more than a mile in maximum dimension. The orebody itself has now been traced for about 3,000 feet; the average horizontal width is about 300 feet and the depth up to 800 feet beneath the surface. Typically, the serpentine is lustrous, green to grey-green, with numerous polished slip surfaces. Nearly all of the asbestos occurs as cross-fibre veins, generally one quarter inch or less wide. Carbonates, present as thin vein and coating fracture faces, include calcite and dolomite. Part of the body has been altered to a buff-brown weathering quartz–carbonate rock composed of iron-bearing magnesite[1] (refractive index N_0 about 1.700), quartz, and lesser amounts of white dolomite and magnetite. In some specimens of this rock the outline of replaced asbestos fibre is still visible.

(25) *Foxy Group* (*Asbestos Corporation* (*Explorations*) *Limited*) (64°29′N, 140°43′W)

Reference. Green (1965, p. 27).

Asbestos Corporation (Explorations) Limited holds the Foxy 7 and 9 to 12 group of mineral claims located about 3 miles north of the Clinton Creek asbestos property and adjacent to the landing strip for the latter. In June 1964 two diamond-drill holes with a combined length of 990 feet were drilled on Foxy 11 claim. Both holes cut serpentinized ultramafic rocks containing traces of asbestos.

[1]Identified by the X-ray Diffraction Laboratory, Geological Survey of Canada.

(26) Caley Property, Cassiar Creek (64°18'N, 140°12'W)

Reference. Green (1965, pp. 27, 28).

Canadian Johns-Manville Company, Limited optioned the Caley property from F. Caley and associates of Dawson, Yukon, in September 1963. It consists of 51 claims, located on the west side of Cassiar Creek about 2 miles from the mouth and is reached by an access road, about 9 miles long, that leaves the Sixtymile road near Mile 29.

The property, originally staked in 1956, was optioned to Conwest Exploration Company Limited. In September 1957 it was transferred to Cassiar Asbestos Corporation Limited, which in 1959 carried out extensive surface stripping, drove two northwest-trending adits totalling 1,180 feet, and shipped a 3½-ton sample to Cassiar, British Columbia, for mill tests. The company dropped their option in 1963, at which time Canadian Johns-Manville Company, Limited optioned the property. During the 1964 field season, the latter company employed a crew of up to 10 men in a program of geological and geophysical work and diamond drilling of 12 holes with a total length of 2,000 feet. The writer visited the property in mid-July, 1964.

The main ultramafic body is partly exposed in a bluff on an otherwise timbered slope on the west side of Cassiar Creek valley. Numerous bulldozer cuts have been made across the body, and the surface expression of the ultramafic and associated quartz–carbonate rock appears to be about 1,500 feet along and 3,000 feet up the slope. Southwestward the ultramafic body is bounded by graphitic quartz–mica and chlorite schists, but to the northeast outcrop is lacking. Magnetometer work suggests that the ultramafic body terminates abruptly to the west, and the company geologist has interpreted this as a thrust zone. Results from the drilling suggest that the ultramafic body is a thin zone, 200 feet or less, forming a veneer on the hillside and underlain by a distinctive cataclastic talc schist that is in turn underlain by minor basalt and normal schist.

Typical serpentine is a medium to dark green rock, chiefly antigorite, cut by light green bands of cross-fibre asbestos, generally one quarter inch or less wide. Shiny slickensided surfaces are common. Much of the ultramafic body has been replaced by rusty weathering, light grey-brown quartz–carbonate. In some specimens the outline of replaced asbestos fibre is still visible. The carbonate, of the magnesite group,[1] contains considerable iron, and spectrographic analyses of quartz–carbonate rock made for the company indicate a calcium content between 2 and 7 per cent and a magnesium content of 10 to 14 per cent. The N_0 index of refraction for the mineral is about 1.700.

In addition to work on the Caley property, the company did some work on a small ultramafic body overlooking Yukon River about seven miles to the east and about one mile east of Woodchopper Creek.

Coal Deposits

Following discovery of the Klondike goldfields large amounts of fuel were needed in the area for heating, for use in the steam plants to thaw frozen ground during underground mining, and for boats operating on Yukon River. Wood soon became scarce in the immediate area and attempts were made to utilize the lignite deposits (included in unit 23) of Tintina Trench. Considerable work, including the construction of two short railways, was undertaken in these attempts but all were unsuccessful and wood continued to be the only important fuel utilized. In 1938 a second attempt, also unsuccessful, was made to reopen the Rock (Coal) Creek Mine near Dawson. At present, all the underground workings have sloughed or filled with ice and only shells of a few surface buildings remain.

[1]Identified by the X-ray Diffraction Laboratory, Geological Survey of Canada.

Most of the seams explored were thin and much folded and faulted such that there is little prospect of mining them as large-scale open-cast operations. Thus it is unlikely that the deposits will ever again be considered of economic interest.

(27) *Cliff Creek Mine* (64°33′N, 140°28′W)

References. McConnell (1903, pp. 46–48*; 1906, pp. 41, 42*).

The Cliff Creek Mine, developed by the North American Trading and Transportation Company about 1900, was located on Cliff Creek, about one and three quarter miles from the mouth. Cliff Creek is about fifty-five miles downstream from Dawson on Yukon River. When visited by McConnell (1903) in 1900 underground workings consisted of two drifts on opposite sides of the creek that followed the coal-bearing zone for a total distance of about 2,800 feet. The lignite zone, consisting of alternating beds of lignite, clay, and carbonaceous shale, measured more than 40 feet in thickness with the seams themselves between a few inches and 5 feet. A railroad had been built to the river and considerable tonnage is reported (op. cit.) to have been shipped to Dawson or used by river steamers. The mine had ceased operation by 1903 (McConnell, 1906).

(28) *Coal Creek Mine* (64°27½′N, 140°07½′W)

Reference. McConnell (1906, pp. 41, 42*).

The Coal Creek Mine is located on Coal Creek about 11¾ miles from Yukon River and the mouth of that creek, which is about six miles downstream from Fortymile and fifty miles downstream from Dawson. An ambitious scheme centred about the mine involved the building of a railroad to Yukon River, construction of bunkers on the river, installation of a coal-fired thermal-electric plant at the mine, and the construction of a power line to Dawson, a distance of about 39 miles. Initial development of the mine appears to have commenced about 1903 (McConnell, op. cit.), by the Coal Creek Coal Mining Company (Limited), and in 1906 the operation was purchased by the Sourdough Coal Company.[1] The thermal-electric plant and power line to Dawson were begun during the following few years. It is not known whether this project was actually completed and supplied power to Dawson. If so, it probably operated only briefly as sources of hydroelectric power were already developed on Little Twelve Mile River and, a few years later, on Klondike River. It is interesting to note that in addition to supplying electricity for power and light the company was contemplating the introduction in Dawson of a system of heating by electricity as a substitute for fuel.[1] At present, all the underground workings have caved in and all that remains at the mine are a few buildings and the foundations of the thermal plant. The scar of the power line to Dawson is still visible as is the railroad grade, and although the rails have been removed some of the equipment remains and is gradually disappearing in second growth at the Yukon River end. Total production figures are lacking but the company is reported to have shipped 2,000 tons of coal to Dawson in 1906.[1]

McConnell (pp. 41, 42) reports as follows:

> The seam worked, varies in thickness from 4 to 11 feet, and is overlaid by 3 inches of clay, followed by 12 feet of moderately hard sandstone. The floor consists of 6 feet of clay, resting on 16 feet of sandstone, below which is a band of black shale. The seam dips to the south-east at an angle of 45 degrees for a distance of 210 feet from the surface, and then bends round and dips to the southwest. The principal working consists of an incline 490 feet in length.

The 1907 pamphlet (op. cit.) mentions three seams of 8, 12, and 20 feet.

[1]From "The Yukon Territory its history and resources", a pamphlet published by the Canadian Government Printing Bureau, Ottawa, in 1907.

(29) *Rock (Coal) Creek Mine* (64°08′N, 138°56′W)

References. McConnell (1903, pp. 44–48; Bostock, 1938, pp. 13–16).

The Rock (Coal) Creek Mine is located on Coal Creek, a tributary of Rock Creek, about 8 miles upstream from the mouth of Rock Creek, which joins Klondike River about 10 miles east of Dawson. The Alaska Exploration Company was mining the property when McConnell (op. cit.) visited it in 1900. At this time workings consisted of an incline about 400 feet long, descending at an angle of 25 degrees southeast for the first 200 feet, beyond which the angle gradually decreased to about 4 degrees. The mine is reported (Bostock, 1938, p. 14) to have operated for a few years at that time.

The mine was reopened for about a year in 1936, at which time Bostock (1938, p. 14) reported that the following section was exposed about 350 feet from the head of the incline:

Top...........Patches of coal in shale
White clay seam

Top seam......3 ± feet coal
2 to 3 feet grey shale.

Bottom seam...3+ feet of coal, lower limit not exposed in face.
Floor of crosscut grey shale a few feet back from the face.

Bostock (pp. 15, 16) gives six analyses of the coal, all of which show little variation. Two are as follows:

Laboratory No.		18,597		18,598	
Condition of sample		As received	Dry basis	As received	Dry basis
Proximate analysis:					
Moisture	%	30.5	—	33.6	—
Ash	%	12.5	17.9	10.2	15.4
Volatile matter	%	26.0	37.4	25.8	38.8
Fixed carbon (by difference)	%	31.0	44.7	30.4	45.8
Ultimate analysis:					
Carbon	%	—	—	41.9	63.1
Hydrogen	%	—	—	7.1	5.0
Ash	%	—	—	10.2	15.4
Sulphur	%	—	—	0.5	0.8
Nitrogen	%	—	—	1.4	2.1
Oxygen (by difference)	%	—	—	38.9	13.6
Calorific value:					
Determined in B.T.U. per lb., gross				7,220	10,880
Coking properties		Both non-coking			
Softening temperature of ash		2,025°F		2,010°F	

18,597—top seam; west entry; face; 360.
18,598—bottom seam; west entry; face; 360.
Analyses by the Fuel Testing Laboratories of the Bureau of Mines.

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