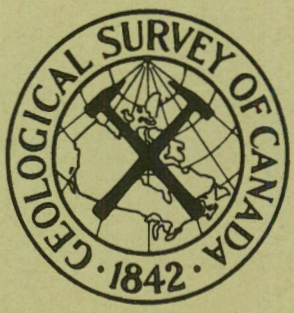

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PAPER 68-15

CARBONIFEROUS AND PERMIAN STRATIGRAPHY OF NORTHEASTERN BRITISH COLUMBIA

(Report, 3 figures)

E. W. Bamber, G. C. Taylor, R. M. Procter

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E. W. Bamber, G. C. Taylor, R. M. Procter

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ABSTRACT

Upper Paleozoic rocks beneath the plains and in the outcrop belt of northeastern British Columbia are divisible into five gross lithologic units. In order of decreasing age these are: (1) shales of the Besa River and Banff Formations; (2) carbonate rocks of the Prophet, Pekisko, Shunda and Debolt Foundations; (3) sandstones and shales of the Stoddart and Mattson Formations; (4) strata composed predominantly of siltstone of the Kindle and lower Belloy Formations; (5) chert of the Fantasque and upper Belloy Formations.

In the western part of the area, the Besa River shale ranges in age from Middle Devonian to Late Mississippian. The eastern carbonate units, of Mississippian age (Pekisko, Shunda, Debolt, and Prophet Formations), pass westward into shales of the Besa River Formation. The Stoddart Formation of Late Mississippian and Pennsylvanian ages, is the fine-grained equivalent of the Mattson sandstone. Both formations change laterally westward into Besa River shale.

Permian rocks (Kindle and Belloy Formations) are separated from Mississippian and Pennsylvanian rocks (Stoddart, Prophet, and Debolt) by an unconformity. A second unconformity separates the Fantasque Formation from the Kindle Formation.

CARBONIFEROUS AND PERMIAN STRATIGRAPHY OF NORTHEASTERN BRITISH COLUMBIA

INTRODUCTION

A belt of Carboniferous and Permian rocks extends from southern District of Mackenzie through northeastern British Columbia into western Alberta. The stratigraphic succession has been established in southern District of Mackenzie from studies of the surface exposures and, in the Peace River area, from surface and subsurface studies. Significant facies changes that occur between the two areas have obscured the relationships between these two stratigraphic successions. This paper presents the results of a study of the intervening area in northeastern British Columbia.

Previous Work

Williams (1944)[1] was the first to publish on the upper Paleozoic succession along the Alaska Highway in British Columbia. The same year, Kindle (1944) reported on the occurrences to the north on Liard and Beaver Rivers. Laudon and Chronic (1947, 1949) re-studied the succession reported by Williams and named the Kindle Formation. Sutherland (1958), who was the first to report on the stratigraphy away from the main travel routes, named the Prophet Formation. Kidd (1962, 1963) established the Besa River Formation, which is partly of Mississippian age, and Pelzer (1966) related this unit to the subsurface geology farther east. Taylor, from detailed mapping of the MacDonald Creek map-area (1963) recognized the presence of a Mississippian (Prophet Formation) and a Permian chert unit and suggested part of the present stratigraphic interpretation. Harker (1961) named the Fantasque Formation from adjacent southeastern Yukon. Pelletier (1959) and Hughes (1963) have published short references to the stratigraphy within northeastern British Columbia. Patton (1958), Douglas and Norris (1959), and Harker (1961, 1963) have reported in detail on upper Paleozoic rocks to the north of the report area. Rutgers (1958), Halbertsma (1959), Hovdebo (1962), Irish (1963), and MacGugan (1967) have described the succession south of the present map-area. The data in the present paper has been previously summarized (Bamber, et al., 1967).

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[1] Names and dates in parentheses refer to publications listed in the references.

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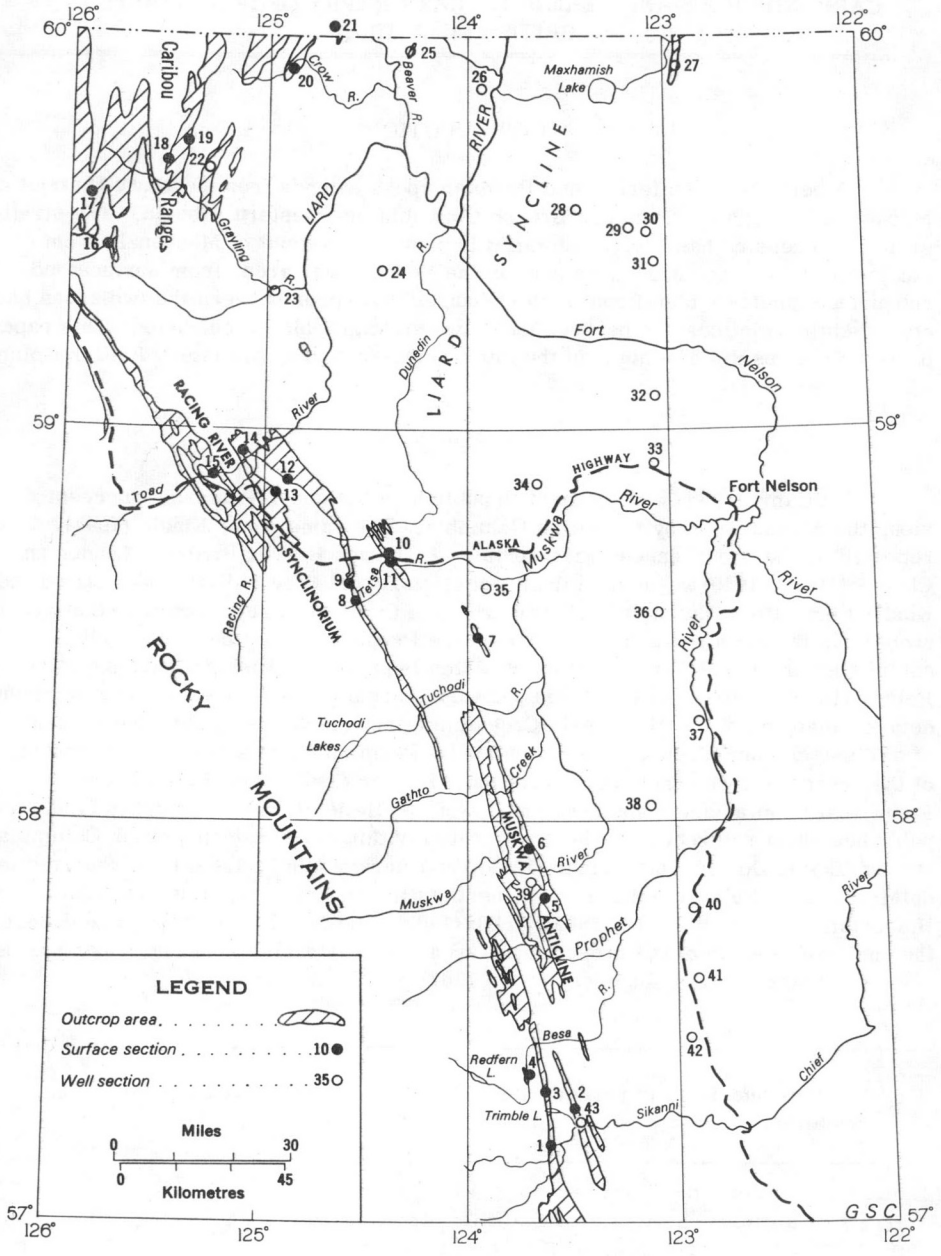

Figure 1. Distribution of Carboniferous and Permian rocks, and locations of sections

Present Work and Acknowledgments

During the summers of 1963, 1964, and 1965 the Carboniferous and Permian rocks of northeastern British Columbia were studied in conjunction with Operation Liard (NTS maps 94 G, J, K, N, and O, and parts of 95C), a helicopter supported, reconnaissance mapping project (Taylor, 1965) of the Geological Survey of Canada (Fig. 1). Taylor was responsible for the mapping and Bamber studied surface exposures in the foothills belt between latitudes 57 and 60 degrees north. Procter studied the succession in the subsurface of the adjacent plains and related it to the surface exposures. All fossil identifications were made by Bamber, except where otherwise acknowledged. Able assistance was given in the field by D. Mayes and A. Kuhme in 1963; D. Hetherington, R. Armstrong, D. MacDougal, and M. Wooding in 1964; and B. Reive, L. Grainger, and R. Craig in 1965.

STRATIGRAPHY

In northeastern British Columbia rocks of late Paleozoic age are exposed in a long, narrow, sinuous belt subparallel with the front of the Rocky Mountains south of Liard River, and extending north along both flanks of the Caribou Range (Fig. 1). East of the exposure belt, numerous wells have penetrated the succession. An unconformity separates Mississippian rocks from overlying Permian beds and another unconformity exists within the Permian sequence. Lower and Middle Pennsylvanian rocks are locally present beneath the pre-Permian unconformity. There is a major east-west facies change from carbonate to shale in Mississippian strata of the area. Different aspects of this change are expressed both in the subsurface and in the belt of exposures. The latter provides an oblique cross-section through the stratigraphic interval involved.

Besa River Formation

The Besa River Formation was defined by Kidd (1962, p. 97) as: ".... the thick, black shale sequence which is present in the northeastern British Columbia foothills and mountains, lying between Mississippian cherty limestone and Middle Devonian carbonates." The type section (locality 6) [1] is located 4 miles north of Muskwa River. North and west of the type area there is a lateral facies change from the cherty limestone of the Prophet Formation into dark grey shale which is here included in the Besa River Formation.

The Besa River Formation is exposed in a narrow band at the western edge of the foothills in the core of the Muskwa River anticline (type section), in several thrust-plates within the mountains near Wokkpash Lake, in the Racing River synclinorium, and in a broad area surrounding Caribou Range north of Liard River.

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[1] Locality numbers refer to numbered sections and wells shown in figure 1 and listed in Tables I and II.

Table of Formations

Period	Formation (Surface)	Formation (Subsurface)	Lithology	Thickness (feet)
Permian	Fantasque	Belloy	Light to dark grey spicular chert, glauconitic in part, minor dark grey shale and siliceous mudstone	0 - 200+
	?	?		
	Unconformity			
	?	?		
	Kindle	Belloy	Interbedded dark grey siltstone, shale, calcareous sandstone, siliceous mudstone and chert; minor limestone	0 - 600+
Unconformity				
Pennsylvanian?	Stoddart (Mattson)		Grey sandstone, thick-bedded; minor intercalated beds of grey-green shale and silty dolomite; dark grey-green shale at base	0 - 2,000+
Mississippian	Prophet	Debolt Shunda Pekisko	Light grey, crinoidal limestone, dolomite, and chert; minor amounts of grey shale and siltstone	0 - 1,800+
? Upper Devonian	Besa River	Banff Exshaw	Dark grey shale, calcareous and siliceous; minor amounts of calcareous siltstone and silty dolomite	800 - 3,000

The thickness of the formation in outcrop decreases from more than 2,200 feet at the type section[1], where the lower contact is not exposed, to between 1,000 feet and 1,300 feet to the northwest where older and younger beds are included.

At its type section the Besa River Formation consists mainly of medium to dark grey, calcareous shale with thin beds of argillaceous, silty limestone. A unit in the lower part of this section, consisting of dark grey to black, siliceous shale and mudstone, has been correlated with the Exshaw Formation by Pelzer (1965, fig. 16, p. 34; 1966, p. 302). In nearly all other stratigraphic sections in the western part of the area, the formation consists predominantly of siliceous, partly pyritic shale and mudstone with some siliceous nodules. However, at Mount Dopp (locality 4), the most southerly of the western sections, much of the shale is calcareous or dolomitic, and includes beds of calcareous siltstone, as well as argillaceous, silty dolomite.

The Besa River Formation extends eastward under the plains to about longitude 123° 30' W. and is present in only the most westerly wells south of latitude 59° N. It is overlain in the SOBC HB Trimble c-98-L, HB Pan Am Muskwa a-6-G, Pacific-SR-Del Rio Kledo c-14-G, and Pan Am Sheep Creek #1 wells (localities 43, 39, 34, and 35) by Mississippian carbonate rocks. Here it is composed of the characteristic dark grey to black shale and silty shale, interbedded with medium grey, calcareous shale and argillaceous limestone typical of the Banff Formation to the east. In this area, the black shale of the Exshaw Formation is easily recognized on Gamma Ray logs by its relatively high radioactivity. In wells farther west, where the Exshaw Formation is less radioactive, it is indistinguishable from the Besa River Formation. Combined evidence from surface and subsurface observations shows that the facies change from lower Mississippian units of the plains to the Besa River shales takes place along a line which trends almost north. The lower contact of the Besa River Formation becomes progressively older and the upper contact becomes younger from east to west. This diachronism is caused by a lateral change from carbonate in the east to shale and mudstone in the west in units of Devonian and Mississippian age. The Besa River Formation is underlain by the Dunedin Formation[2] over much of the Operation Liard area. The contact between the two units is sharp, but conformable, and its stratigraphic position is approximately constant in the area between Mount Dopp (locality 4), in the south, and Caribou Range, in the north. In Caribou Range the Dunedin Formation and the upper Stone Formation[2] pass northward into shale of the lower part of the Besa River Formation. Ten miles north of Mount Dopp (locality 4), a limestone bank at the top of the Dunedin Formation passes northward into the lower part of the Besa River Formation. The upper contact of the Besa

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[1] Kidd apparently included Member A of the Prophet Formation within the type Besa River Formation.

[2] Dunedin and Stone are new formational names that have been proposed by Taylor and MacKenzie in "Devonian Stratigraphy of Northeast British Columbia", Geol. Surv. Can. Bull. in press.

River Formation, in the core of the Muskwa anticline, is gradational with the overlying Prophet Formation and is probably Early Mississippian in age. To the northwest, however, in the Racing River synclinorium, the Besa River Formation includes beds correlative with the Prophet Formation, and is overlain by the Permian Kindle Formation. Despite its westward increase in stratigraphic range, the Besa River Formation decreases in thickness from more than 2,200 feet in its type section, to between 1,000 and 1,300 feet to the northwest. The facies change between the Prophet Formation and the Besa River Formation is discussed on page 7.

Fossils are rare in the Besa River Formation. Upper Devonian conodonts, ostracods, foraminifers, brachiopods, and cricoconarids (tentaculitids) occur in the lower part of the unit at several localities. Middle Devonian fossils have not been found in the formation, but are present in transitional beds of the uppermost Dunedin Formation (Taylor and MacKenzie, in press). The youngest fossils found in the Besa River Formation are Chesterian representatives of the ammonoid genus Goniatites from Smith River bridge on the Alaska Highway immediately west of the report-area GSC loc. 51525 (Hughes, 1963, p. 5). The stratigraphic position of these fossils within the formation is not known. To the east the Early Mississippian (Kinderhookian) brachiopod "Platyrachella" rutherfordi (Warren) occurs approximately 800 feet below the top of the type section (locality 6) (Kidd, 1963, p. 372). In addition, spiriferid and productoid brachiopods of late Kinderhookian to Osagean age were collected approximately 500 feet below the top of this section (GSC loc. 66700).

Prophet Formation

The Prophet Formation is a sequence of limestone, chert and dolomite of Mississippian age, named and subdivided from base to top into Members A, B, and C by Sutherland (1958, pp. 25-27). The formation is exposed as two, discontinuous, northwest-trending belts within the foothills between Halfway and Dunedin Rivers. The type section is located on Bat Creek (Locality 5), 6 miles south of Muskwa River.

The maximum thickness recorded within the area is 1,380 feet, north of Halfway River (Sutherland, 1958, p. 23). The thickness decreases in a westerly and northwesterly direction to 11 feet at a point 3 miles north of the Alaska Highway near the headwaters of Dunedin River.

The Prophet Formation can be recognized in two foothills wells; SOBC HB Trimble c-98-L, and Pan Am Sheep Cr. #1 (localities 43 and 35). In wells farther east, the equivalent stratigraphic interval is assigned to the Pekisko, Shunda and Debolt Formations. The Pekisko and Shunda Formations of the adjacent plains consist of fossiliferous, argillaceous limestone, calcareous shale, and calcarenite. From east to west, the Pekisko and Shunda Formations change facies into Besa River shale through a transitional zone represented by Member A of the Prophet Formation. The Debolt Formation (Macauley, 1958) consists of a thick sequence of bioclastic limestones with interbedded marine shales. It is divided into two members, which are equivalent to Members B and C, respectively, of the Prophet Formation. Chert is a relatively minor constituent of the lower member of the Debolt Formation in

eastern wells, but becomes progressively more abundant westward, and is dominant in Member B of the type Prophet Formation. A continuation of this facies change is expressed in outcrop by the change from carbonate rocks and chert of the Prophet Formation in the east, to laterally equivalent shale and mudstone of the Besa River Formation in the west. In eastern exposures, including the type section, Member A of the Prophet Formation consists of about 500 feet of banded, orange-brown and dark grey, slightly recessive siltstone, mudstone, chert, and silty limestone. Member A is transitional downward into the Besa River Formation, but has a sharp upper contact. Member B consists of 500 to 600 feet of chert, limestone, and dolomite in irregular lenses and beds. Sixty to seventy per cent of the member is chert. This member forms the resistant, dark grey, banded cliffs that characterize the Prophet Formation in outcrop. Member C consists of 150 to 200 feet of limestone and chert. It is similar in lithology to Member B, but generally contains more limestone than chert and is slightly recessive.

To the west, the Prophet Formation becomes thinner and shows an increase in chert content. North of the west end of Trimble Lake (locality 3), the lithology of Member A is distinguished from that to the east by a predominance of siliceous mudstone and a lack of silty limestone. Member B, which is reduced in thickness to 425 feet, consists of 85 to 90 per cent chert with some limestone and dolomite lenses, and contains several shale and siltstone beds. Shale and siltstone also occur in Member C, which is 175 feet thick and weathers to a greyish brown colour.

The thickness of the Prophet Formation continues to decrease in a westerly direction. This change in thickness is accompanied by a marked increase in shale content. At the western edge of the foothills the formation is reduced to thin ribs of chert containing rare, thin, lenses of limestone and dolomite. On Mount Dopp (locality 4), near Redfern Lake, several of these ribs are interbedded with shale and siliceous mudstone typical of the Besa River Formation. To the northwest, in the western foothills between South Tetsa River (locality 8) and Dunedin River headwaters only one chert rib remains. On Water Ouzel Creek (locality 9) the formation contains thin shale beds and is 93 feet thick, but becomes thinner northward toward the Alaska Highway. Three miles north of the highway, the formation crops out on a small tributary of Dunedin River, and consists of 11 feet of chert without shale beds. This thin chert of the western Prophet Formation could be confused with the Permian Fantasque chert, but the latter lacks the carbonate lenses which characterize the Prophet Formation.

No fossils have been found in the thin, western chert facies of the Prophet Formation. On Water Ouzel Creek, Goniatites crenistria Phillips was collected from shale 78 feet above the top of the Prophet Formation (GSC loc. 66648; identified by W.W. Nassichuk, Geol. Surv. Can.). This species is early Chesterian in age, and the shale is therefore slightly younger than the uppermost Prophet Formation of the type section, which is middle to late Meramecian in age. This fact, combined with the westward thinning of the Prophet Formation and the increase of shale and mudstone in its lower part, suggests that the western Prophet Formation (chert) is correlative with only the upper part of the type Prophet Formation, and that the Besa River - Prophet contact rises stratigraphically to the west. That is,

there is a lateral facies change from the chert and carbonate rocks of the Prophet Formation to the shale and mudstone of the Besa River Formation, beginning with Member A in the east, and progressing upward through the Prophet Formation toward the west. This progressive westward development of the Besa River Formation at the expense of the Prophet Formation is well shown in the intermediate section north of Trimble Lake (locality 3), where Member A consists mainly siliceous mudstone, and Member B contains shale beds and is relatively thin.

The east-west relationships between the Prophet and Besa River Formations, as described above, are consistent from Halfway River north to Dunedin River. In the southwest District of Mackenzie, Harker (1963, p. 5) and Pelzer (1966, p. 316, Fig. 16) report similar relationships between the Flett and Etanda Formations, which occupy stratigraphic positions similar to those of the Prophet and Besa River Formations.

Fossils collected from Member A and the lower part of Member B are of little use for age determination. The lower age limit of this interval is locally determined by the occurrence of late Kinderhookian to Osagean brachiopods in the underlying Besa River Formation at its type section (locality 6), 500 feet below the base of Member B (GSC loc. 66700). The upper age limit is established by the presence of Meramecian brachiopods and corals in the upper part of Member B. Numerous corals occur in Member C, including such characterisitic middle to late Meramecian species as Ekvasophyllum inclinatum Parks (GSC loc. 66691), Lithostrotion Siphonodendron) whitneyi of Meek (GSC loc. 66579). Lithostrotionella shimeri (crickmay) GSC locs. 66582, 66583), and Lithostrotionella mclareni (Sutherland) (GSC loc. 66582). This fauna is widespread, and its presence indicates correlation of Member C with: the middle Mount Head Formation (Loomis and lower Marston Members) of southern Alberta (Macqueen, 1965); the upper member of the Debolt Formation in the subsurface of northeastern British Columbia (GSC locs. 43497, 55780, and others); and the upper part of the Flett Formation, District of Mackenzie (GSC loc. 68829).

Stoddart Formation (Mattson)

The Stoddart Formation was named by Rutgers (1958) for the sandstone, shale and limestone succession between the Debolt Formation and the Permian beds in Pacific Fort St. John No. 23 gas well. The formation was raised to group status by Halbertsma (1959), who divided it into the Golata, Kiskatinaw, and Taylor Flat Formations, in ascending order. In the foothills between Halfway River and Peace River, Irish (1963) recognized the Golata Formation and used the name Kiskatinaw-Taylor Flat Formation for the undivided sandstone, shale, limestone, and siltstone sequence between the Golata and Fantasque Formation. For the purpose of this paper the Stoddart is treated as a single unit with formational status. The subdivisions used by Irish are recognizable in a narrow belt from the east end of Trimble Lake to the confluence of Keily Creek and Besa River, where there is a lower shale unit (Golata Formation), approximately 240 feet thick, overlain by 330 feet of sandstone, shale, and minor amounts of limestone (Kiskatinaw-Taylor Flat

Formation). The lithology of the Stoddart Formation throughout the remainder of the area is transitional with that of either the upper part of the Besa River Formation to the west, or the Mattson Formation to the north.

The Stoddart Formation is absent from the easternmost Paleozoic outcrops south of Chlotopecta Creek (locality 7). In these outcrops and in most of the subsurface to the east, the Prophet Formation or its equivalent, the Debolt Formation, is directly overlain by either Permian or Triassic rocks. However, the Stoddart Formation is preserved in a south-plunging structural depression along the western margin of the plains (localities 40, 41, and 42 and Table II). The Stoddart is present north of the Alaska Highway in the subsurface beneath the Liard syncline. There, the sequence has a strong similarity to the Mattson succession of the Northwest Territories.

At the western edge of the foothills, at Water Ouzel Creek (locality 9), the Prophet Formation is overlain by a shale unit of Chesterian age, approximately 150 feet thick, which is equivalent in age to the Golata Formation. This shale is overlain by a sequence of sandstone, shale, limestone and siltstone, approximately 550 feet thick. The upper 162 feet of this succession is relatively resistant and is assigned to the Permian Kindle Formation. The lower beds, and the underlying shale, are tentatively assigned to the Stoddart Formation.

A stratigraphic succession similar to that on Water Ouzel Creek is present to the northwest, between Dunedin and Toad Rivers. There, however, the Prophet Formation is not developed, and rocks equivalent to the Golata Formation are included in the upper Besa River Formation. Between the Besa River Formation and the overlying Permian rocks are 578 feet of unfossiliferous sandstone and shale. The stratigraphic assignment of these rocks is in doubt. They are lithologically similar to the Mattson Formation to the north and change westward into the Besa River shale, which is directly overlain by the Kindle Formation in the Racing River synclinorium and in the area between Liard River and Caribou Range. On the east flank of Caribou Range, the upper one-half of the Besa River Formation contains numerous thin, lenticular sandstone beds. These are probably tongues of the Mattson Formation which is well developed in La Biche Range northwest of Caribou Range.

Sub-Permian Unconformity

Rocks of Permian age rest disconformably on the Prophet Formation (middle to late Meramecian) on Chlotopecta Creek near the eastern edge of the foothills. The western extent of this disconformity cannot be accurately determined because of uncertainty regarding the stratigraphic relationships of beds beneath those of known Permian age. Laudon and Chronic (1949, pp. 193, 210) report an unconformity beneath the Permian Kindle Formation at its type section in the Racing River synclinorium. In the adjacent plains most of the Stoddart Formation and much of the Debolt Formation was removed during pre-Permian erosion. Thus, Permian rocks overlie formations as old as late Meramecian (Debolt Formation, Macauley et al., 1964), and as young as Atokan (Stoddart Group, Halbertsma, and Staplin, 1960, p. 364).

Kindle Formation

The name Kindle Formation was proposed by Laudon and Chronic (1949) for a unit consisting of siltstone, shale, siliceous limestone, and chert, exposed along the Alaska Highway between mile 381 and mile 430. The type section is located south of the Alaska Highway at mile 428, and the formation was originally defined to include all strata between the Besa River Formation and the overlying Triassic rocks. In Tetsa River Valley, near mile 381.5, the Triassic succession is underlain by 127 feet of bedded chert, beneath which there are 226 feet of sandstone, shale, limestone, and siltstone. Sutherland (1950) restricted the Kindle Formation at this locality to the lower unit and excluded the upper chert unit. This chert unit is assigned by the writers to the Fantasque Formation.

The Kindle Formation is well developed in the Racing River synclinorium and in a broad area surrounding the south end of Caribou Range (Fig. 1). Its thickness increases from approximately 291 feet at the type section (Laudon and Chronic, 1949, p. 193), to 673 feet between Liard River and Caribou Range (locality 17).

Three lithologic units are recognizable within the Kindle Formation. The lower unit consists of 130 to 200 feet of dark grey-weathering siltstone with thin shale beds and some lenticular beds of calcareous siltstone. In the lower part of this unit, the siltstone and shale are interbedded in approximately equal proportions. In the area between Liard River and Caribou Range, the lower unit is 400 to 500 feet thick and also contains beds of calcareous sandstone and sandy limestone. The sandstone beds are more numerous in the upper part of the unit. The middle unit is 75 to 100 feet thick, and has a banded appearance which results from an alternation of dark grey-weathering, argillaceous siltstone, and orange-weathering calcareous and dolomitic siltstone. The siltstone is pyritic in part. Lenses of silty limestone occur in some stratigraphic sections. This middle unit occurs between 135 feet and 223 feet in the type section, is recognizable as far north as the Caribou Range, and is present on the east flank of the Dunedin anticline. The upper unit consists of dark grey-weathering siliceous mudstones, shales, and some chert. This unit forms the upper, siliceous, dark grey-weathering part of the type section and is between 120 and 150 feet thick throughout the northern half of the area.

A sequence of siltstone, sandstone, shale and limestone, which is an eastern facies of the lower and middle units of the Kindle Formation, is widespread in the foothills between Toad and Halfway Rivers. This sequence is approximately 300 to 400 feet thick in the western foothills north of Tuchodi River, but is only 33 feet thick on Chlotopecta Creek (locality 7), near the eastern edge of the foothills. Permian siltstone of unknown thickness is present near Mount Stearns, just north of Halfway River. In the easternmost Paleozoic outcrops between Gathto Creek and Halfway River, Permian rocks are absent. There, Triassic rocks lie directly on Mississippian rocks of the Prophet Formation.

In the foothills north of Tuchodi River (Fig. 1) the Permian sequence beneath the Fantasque Formation contains beds of sandstone and siltstone with some intraformational conglomerate. Much of the sequence is very calcareous, and some coarse-grained, fragmental limestone is present. The presence of these relatively coarse-grained rock types and the abundance of calcareous material distinguish the eastern facies of the Kindle Formation.

Laudon and Chronic (1949, pp. 193, 210, Text Figure 9a) report an unconformity at the base of the Kindle Formation at its type section. The nature of the contact elsewhere in the Racing River synclinorium has not been established because of poor exposure. At the type section, the Kindle Formation is overlain by Triassic rocks (Laudon and Chronic, ibid., p. 210).

The Kindle Formation is Permian in age. The middle unit and upper part of the lower unit contain a few horn corals and a sparse brachiopod fauna. This fauna includes Choristites sp. (GSC loc. 68835) and an unidentified ?chonetid brachiopod (GSC locs. 66569, 68763, 68770, 68835), associated with Permian representatives of the genera Pterospirifer, Waagenoconcha, Spiriferella, and Neospirifer (GSC loc. 60853 to 60880, and numerous others).

The lower and middle units of the Kindle Formation are tentatively correlated with the upper part of the Mattson Formation in southern La Biche Range. There, the uppermost Mattson Formation contains the Permian brachiopods Pterospirifer sp., Waagenoconcha sp., and ?Muirwoodia sp., (GSC locs. 68830 and 68831). The sandstone beds within the lower unit of the Kindle Formation between Liard River and Caribou Range appear to be tongues of the upper Mattson Formation. The relationship between the upper unit of the Kindle Formation and the Fantasque Formation to the east has not been definitely established (see p. 13).

The Kindle Formation is thought to be equivalent to the lower part of the Belloy Formation (Halbertsma, 1959) of the adjacent plains and with Permian beds in the foothills between Halfway and Peace Rivers, which were included by Irish (1963) in the uppermost Stoddart Group (also, see Hovdebo 1962), and by McGugan (1967) in the Mount Greene beds.

Sub-Fantasque Unconformity

The Permian Fantasque Formation lies disconformably on older Permian rocks in the foothills between Dunedin and Halfway Rivers. The disconformable contact is marked by an abrupt change in lithology and commonly shows relief of 6 inches or more. In some stratigraphic sections between Chlotopecta Creek (locality 7) and Dunedin River the chert of the Fantasque Formation is underlain by a thin, irregular bed of shale containing numerous nodules and ?pebbles of phosphatic material. Erosion of the Kindle Formation is shown by the reduction of its thickness from more than 318 feet on the Tetsa River (Locality 11) to 33 feet on Chlotopecta Creek (locality 7). The contact between possible equivalents of the Fantasque Formation (see p. 13) and the middle unit of the Kindle Formation in the

Racing River synclinorium to the west, shows no relief, and the presence of a disconformity in this region has not been established. The time interval represented by the pre-Fantasque disconformity has not been determined because of insufficient faunal control in adjacent beds.

Fantasque Formation

The Fantasque Formation was named by Harker (1961, p. 8) for the "bedded cherts that occur above the Mattson formation" in Yukon Territory and southwestern District of Mackenzie. However, an outcrop previously described by Kindle (1944, p. 5), on the Beaver River, Yukon Territory, was chosen for the type section, and the sandstone overlying the chert unit at this locality was included in the Fantasque Formation by Harker (ibid.). Kindle (ibid., pp. 5, 6) reported a Permian fauna from this section, "collected from loose blocks of the calcareous sandstone at the west end of the chert bluffs, 540 feet above the river".

The type section was remeasured in 1965 by Bamber. The chert is 131 feet thick and occurs as irregular beds which are 2 to 5 feet thick. It varies in colour from light grey to medium brownish grey with some dark grey beds, and contains numerous sponge spicules, which are the dominant constituent of some beds. Fine grains of glauconite are scattered throughout the unit. In the lower 22 feet of the section the chert beds are separated by very thin partings or thin beds of dark grey siliceous shale. The base of the formation is not exposed. The chert is overlain by poorly exposed, greenish grey, slightly calcareous, fine-grained sandstone which is cross-laminated and shows numerous sole-markings. No fossils were found in this sandstone, but numerous fossils were collected from calcareous sandstone and limestone which crops out, stratigraphically below the chert, on the north side of Beaver River a short distance upstream from the type section (GSC locs. 68830, 68831). These fossils are very similar to the talus fossils collected by Kindle (1944, pp. 5, 6) which were assumed to have come from the sandstone above the chert. Furthermore, the lithology of the matrix surrounding the fossils in Kindle's collection is different from that of the upper sandstone, but is identical to that of the underlying fossiliferous sandstone found upstream. This suggests that the fossiliferous talus blocks reported by Kindle may have originated from outcrops stratigraphically below, rather than above, the chert. Also, the lithology of the beds overlying the chert resembles that of the sandstone found in the Lower Triassic Grayling Formation to the south. The authors, therefore, restrict the term Fantasque Formation to the chert unit only, and exclude the overlying, undated sandstone.

The Fantasque chert is present in the Operation Liard area from the south end of La Biche Range to Halfway River. The thickness of the formation decreases from about 150 feet in the north (locality 20, 21) to 43 feet in the south (locality 3), near Trimble Lake.

In southern La Biche Range, and in the eastern and central foothills between Toad and Halfway Rivers, the Fantasque Formation is composed of irregularly bedded, medium to dark grey chert, which is pyritic in part and contains abundant sponge spicules. North of Tuchodi River the chert beds in the lower 10 to 15 feet of the unit are separated by laminae and thin beds of dark grey shale, as in the lower 22 feet of the type section. The formation changes character towards the west. At the western edge of the foothills, near South Tetsa River, there are laminae and beds of shale throughout the formation, and the chert is interbedded with siliceous mudstone and siltstone. The chert unit is absent from the Racing River synclinorium and the flanks of Caribou Range. However, the upper, dark grey unit (see p. 11) of the Kindle Formation in these areas may be a western facies of the Fantasque Formation. Both units are siliceous, are of comparable thickness, and both cap the Paleozoic succession.

The Fantasque Formation is Permian in age. It contains few fossils other than sponge spicules. Poorly preserved productoid brachiopods and ?Helicoprion sp. have been collected from 81 feet below the top of the formation on Dunedin River (GSC locality 66707).

The Fantasque Formation has been recognized in the Halfway map-area by Irish (1963, pp. 385-386). Norris (1965, p. 13) used the name Fantasque Formation as far south as the Crowsnest Pass area in southern Alberta and British Columbia. The name Ranger Canyon Formation was applied to the same unit by McGugan and Rapson (1963, pp. 57-60; 1967, pp. 84-86), who reported Helicoprion sp. from a bed containing phosphatic pebbles at the base of the formation at Sundance Canyon near Banff (see also Warren, 1956, p. 248). This bed is similar to that found at the base of the Fantasque Formation south of Tetsa River (see page 11). The chert of the upper Belloy Formation (Halbertsma, 1959, pp. 116 to 118) in the plains is probably equivalent to the Fantasque Formation.

SUMMARY

The stratigraphic relationships presented in this paper are summarized as follows:

1) The Besa River Formation is a unit with diachronous upper and lower contacts. The diachronism is caused by a lateral change from carbonates in the east to shales and mudstones in the west, in units of Devonian and Mississippian ages (Fig. 2).

2) The Prophet, Flett, and Debolt Formations are laterally equivalent carbonate units. The Prophet Formation changes facies westward into shales of the Besa River Formation (Fig. 2).

3) The Stoddart Formation changes northward into the Mattson Formation (fig. 3). The upper part of the Besa River Formation in the Racing River synclinorium and on the flanks of the Caribou Range contains fine-grained equivalents of the Stoddart and Mattson Formations (Fig. 2).

4) The Kindle Formation, in its eastern facies, is unconformably overlain by the Fantasque Formation. The Kindle Formation, in its western facies, includes an upper member which may be the lateral equivalent of the Fantasque Formation (Fig. 2).

5) Two unconformities are present. Lower Permian rocks (Kindle and Belloy Formations) rest unconformably on rocks ranging in age from Meramecian (Prophet and Debolt Formations) to Atokan (Stoddart Formation). The second unconformity is within the Permian and separates the Fantasque Formation from the underlying Kindle Formation.

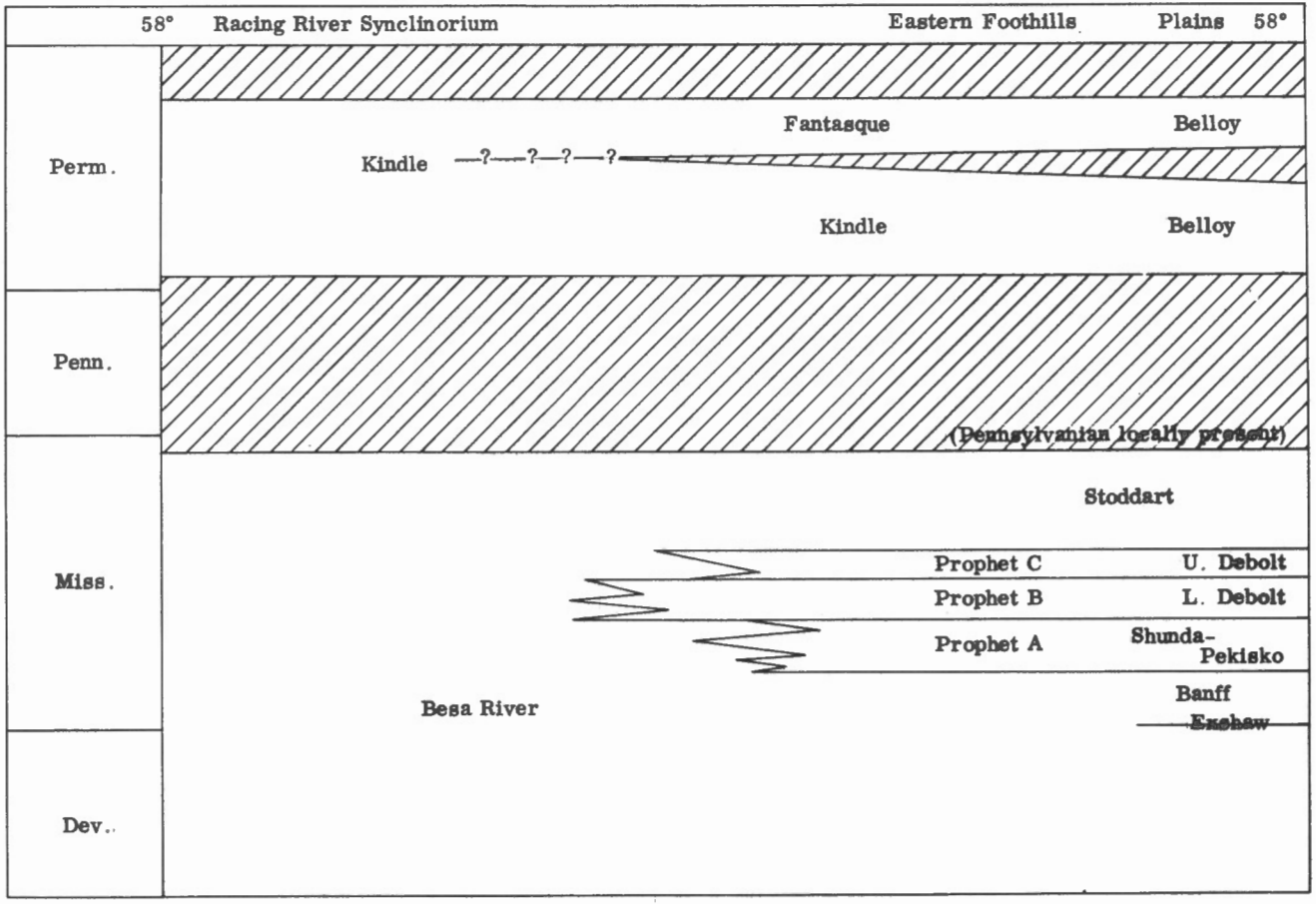

Figure 2. Diagrammatic east-west cross-section along 58 degrees north latitude

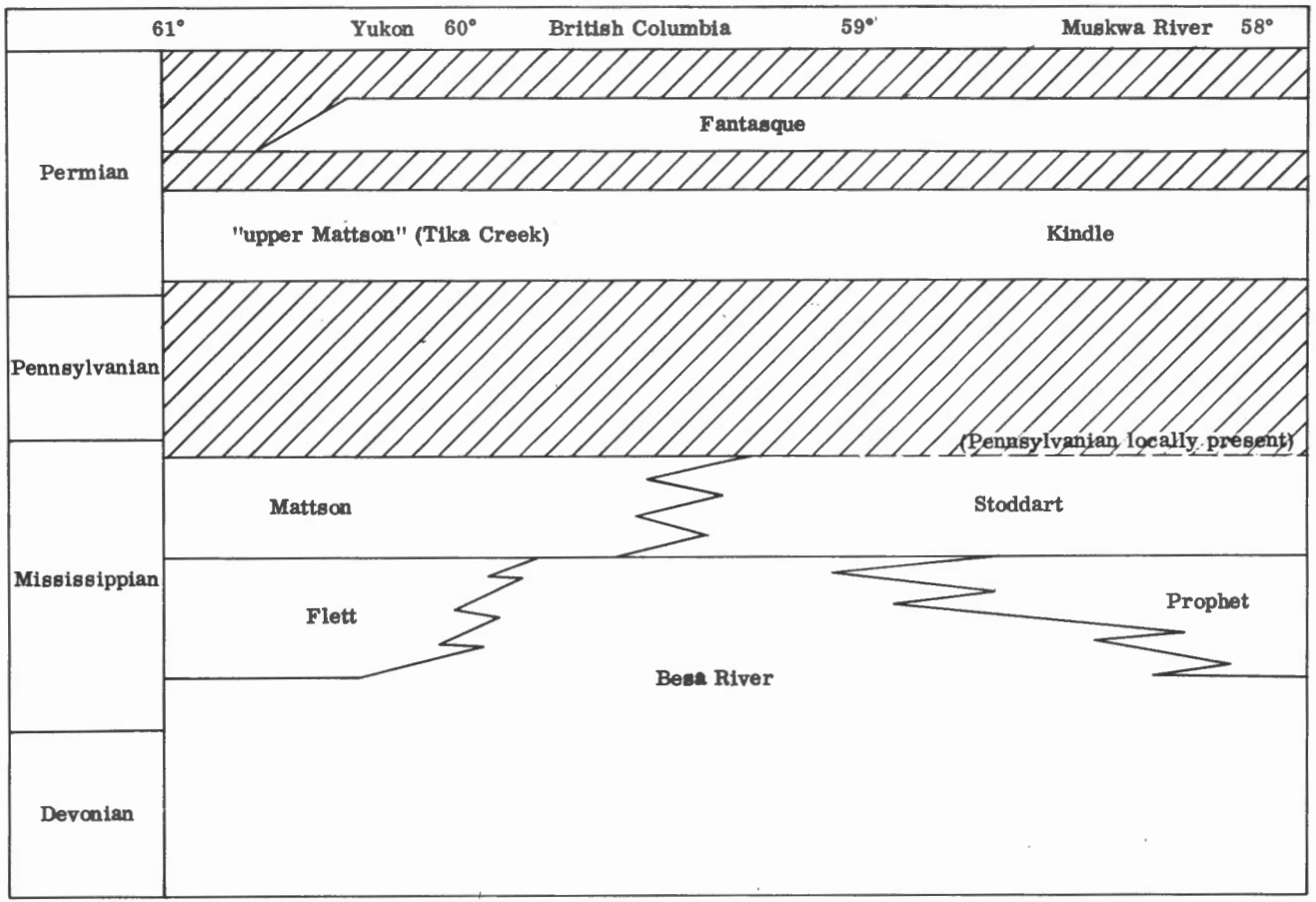

Figure 3. Diagrammatic north-south cross-section at 124 degrees west longitude

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Tables I and II

TABLE I - Surface Stratigraphic Sections

No.	Name	Location	Besa River Formation	Prophet Formation	Stoddart-Mattson Formation	Kindle Formation	Fantasque Formation
1	Trimble Lake South	57°11'N/123°37'W	180*	1,010 ø			
2	Trimble Lake East	57°11'N/123°31'W		1,005* ø			
3	Trimble Lake North	57°19'N/123°38'W		867*	570	absent?	43 ø
4	Mount Dopp	57°21'N/123°43'W	1,758*	564	47 ø		
5	Bat Creek	57°47'N/123°37'W	present	1,373 ø			
6	Muskwa River	57°57'N/123°43'W	2,200*	present			
7	Chlotopecta Creek	58°28'N/123°58'W		551*	absent	33	73
8	South Tetsa River	58°31'N/124°31'W	965	63	673	166	46 ø
9	Water Ouzel Creek	58°34'N/124°34'W	present	93	535	162	156
10	Mile 381 Alaska Highway	58°40'N/124°23'W				226*	127
11	Tetsa River	58°39'N/124°22'W				318*	58 ø
12	East Stone Range	58°52'N/124°53'W	1,316	absent	732	172	115 ø
13	MacDonald Creek	58°50'N/124°57'W	1,138	absent		670 ø	
14	Toad River Hotsprings	58°56'N/125°07'W	1,250?	absent	absent	745 ø	

15	Toad River Lodge	58°53'N/125°15'W	present	absent	absent	566	
16	Liard River Chutes	59°28'N/125°48'W				408* ø	
17	Deer River	59°36'N/125°56'W				673* ø	
18	Caribou Range	59°41'N/125°30'W	1,478	absent	100 (est.) ø		
19	Scatter River	59°44'N/125°25'W			present	290	
20	Crow River	59°54'N/124°54'W			present	225	40 ø
21	Beaver River (Mt. Merrill)	60°02'N/124°42'W			present		131*

* Bottom not seen

ø Top removed

TABLE II - Subsurface Stratigraphic Sections

No.	Name	Location	Besa River Banff	Prophet Debolt Shunda-Pekisko	Mattson Stoddart	Kindle	Fantasque Belloy
22	Shell E. Graying d-95-F	94-N-11/d-95-F	2,700 BR	absent	564	730 ø	absent
23	Toad R. Joint Venture No. 1	94-N- 7/c-10-E	2,060	absent	1,690	250?	absent
24	IOE Dunedin d-75-E	94-N- 8/d-75-E	594*BR	absent	1,735	86 ø	absent
25	Pan Am A-1 Beaver R. b-63-K	94-N-16/b-63-K	7,373 BR	absent	absent	absent	623 F
26	Imp. - Pan. Am. La Biche b-55-E	94-O-13/b-55-E	397*BR	absent	2,154	absent	618 F
27	Tex. NFA Maxhamish Lk. c-15-L	94-O-15/c-15-L	2,745	3,215 ø	absent	absent	absent
28	IOE - Pan. Am. Viscount a-77-D	94-O-11/a-77-D	760*	1,196	1,458	absent	178 F
29	Imp. Pan. Am. Tattoo a-26-B	94-O-11/a-26-B		700*	1,240	absent ?	340
30	B.C.O.L. Bekami Lk. No. 1	94-O-11/d- 9-A	750	1,740	290?	absent	absent
31	BA - Pan Am. Klenteh c-15-I	94-O- 6/c-15-I	1,350	1,278 ø	absent	absent	absent
32	Gulf States Poplar Hills No. 1	94-O- 3/b-97-A	1,285	1,143 ø	absent	absent	absent
33	Gulf States Evie Lk. No. 1	94-J-14/b-90-G	1,250	1,260 ø	absent	absent	absent
34	Pac-SR-Del-Rio Kledo c-14-G	94-J-13/c-14-G	1,401 BR	1,561	absent	absent	15 F
35	Pan. Am. Sheep Creek No. 1	94-J-12/d-95-D	1,750*BR	945 øP	absent	absent	130

36	Pure-Pac. Cheves c-5-A	94-J-11/c- 5-A	1,263	1,074 ø	absent	absent	20
37	Phillips Tenaka No. 1	94-J- 2/b-91-L	1,148	1,150 ø	absent	absent	25
38	CDR-Pac-Sinc Prophet d-21-B	94-J- 3/d-21-B	1,180	1,370	52	absent	25
39	HB-Pan. Am. Muskwa a-6-G	94-G-13/a- 6-G	2,000 ø BR	absent	absent	absent	absent
X40	Phillips Minaker a-25-H	94-G-15/a-25-H	1,055	1,780	170	absent	25
41	Sinc-Can. Atlantic B3-1	94-G-10/a-23-E	868	1,389	325	absent	35
42	Pac-HB Pocketknife c-37-L	94-G- 7/c-37-L	1,315	1,864	963	absent	20 F
X43	SOBC-HB Trimble c-98-L	94-G- 3/c-98-L	4,260	1,230 ø	absent	absent	absent

X Thickness probably in error because of structural complication.

* Bottom not seen.

ø Top removed.

BR Besa River.

P Prophet.

F Fantasque.