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COPTON CREEK MAP-AREA, ALBERTA

(REPORT AND MAP)

By

E. J. W. Irish

OTTAWA

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(Summary Account)

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Illustration

COPTON CREEK MAP-AREA, ALBERTA

INTRODUCTION

Location

Copton Creek map-area, with an area of 176 square miles, is situated near the eastern edge of the Foothills belt of west-central Alberta, between latitudes 54°00' and 54° 15' north and longitudes 119° 15' and 119° 30' west. It is bounded approximately on the north by Kakwa River, part of which stream flows within the northern boundary of the area, and on the south by Sheep Creek, which flows northeasterly just south of the southern boundary.

Accessibility

The map-area is not easily accessible, but can be reached by pack-trail either from the towns of Grande Prairie and Beaverlodge, which are situated north of Wapiti River on the Northern Alberta railway, or from the village of Entrance located to the southeast on the main transcontinental line of the Canadian National Railways 190 miles west of Edmonton.

In 1947, a road, 72 miles long, was completed from Entrance northwest along the route of the old Forestry pack-trail known as the Lower trail, to the site of the Muskeg No. 1 oil well in sec. 24, tp. 57, rge. 6, W. 6th mer. This well was abandoned in 1948, but the road, now maintained under difficulty by the Alberta Forest Branch, is passable for motor vehicles in dry weather. Copton Creek map-area is, therefore, more easily reached from Entrance by the use of this road than from the north because of the shorter distance over which equipment and supplies must be transported by pack-horse.

Entrance has a good store, post office, and telegraph service, and may be reached either by railway or by a branch road that connects with the Edmonton-Jasper highway 2 miles to the south.

To reach Copton Creek map-area from the end of the road at the site of the Muskeg No. 1 well, the Lower trail is followed westward up Muskeg River for about 6 miles to its junction with the Grande Prairie trail. The latter route is then followed down the northeast side of Muskeg River to its confluence with Smoky River at Daniels Flats, where the Smoky must be crossed. From the north side of the crossing the Grande Prairie trail follows down Smoky River, crosses Sheep Creek near its mouth, and then extends northwestward, crossing the northeast corner of the map-area just before reaching Kakwa River.

The southern part of Copton Creek map-area can be reached by following a trail up the northwest side of Smoky River to Gustavs Flats from where another trail extends northwest across the divide to Sheep Creek.

Few trails exist within the map-area itself, and horses are the only means of transportation for both men and supplies. A pack-trail follows Copton Creek easterly midway of the area and thence north close to the eastern border to connect with the Grande Prairie trail. Several old Indian trails were widened and cleared and some new trails were cut to facilitate travel.

Smoky River is difficult and dangerous to cross. The river is swift and can be forded only where and when it is shallow and at places where horses can obtain good footing. Like all glacier-fed streams, the water is so charged with silt that the bottom is seldom visible. In addition, the position of the sand and gravel bars changes from year to year. It is advisable, therefore, for travellers who wish to cross, and who are not familiar with the crossings, to obtain help from the Indians of the district.

At Daniels Flats, just below the mouth of Muskeg River, the Smoky can be forded satisfactorily when the water is low, but at times of high water or flood horses must swim, and supplies and

equipment must be transported from one side to the other by means of a raft or boat. During the field seasons of 1950 and 1951 Smoky River was never low enough for the ford to be used.

Previous Work

The writer is not aware of any published geological information on Copton Creek map-area. The reconnaissance work of J. MacVicar published in 1917, 1920, and 1924 did not extend north of Sheep Creek, and the results of more recent work done by field parties representing various oil companies is not available.

Acknowledgments

The present report is based on field work begun during the summer of 1950 and completed during the summer of 1951. In 1950 the writer was ably assisted in the field by L. E. Marjanen, G. K. Williams, and G. A. Lachance, and in 1951 by R. G. Maw.

He is indebted for many courtesies to members of the Alberta Forest Branch; to Messrs. R. Neighbor, S. H. Clark, and G. W. Munro of Entrance; and to Daniel Wanyandie at Smoky River.

Fossils collected were identified by F. H. McLearn and J. A. Jeletzky of the Geological Survey of Canada.

Physical Features

Copton Creek map-area lies within the eastern part of the Foothills belt of west-central Alberta, and is characterized generally by northwesterly trending ridges and valleys that parallel the structural trend. The highest altitudes are in the southwestern third of the area where most of the ridges rise above timber-line, which is approximately 6,000 feet above sea-level. It is in this region, also, that the northwesterly alinement of ridges and valleys is most pronounced. The general elevation of the ridges and their tendency to northwesterly

elongation decrease progressively toward the northeast, and north of Copton Creek the northwesterly trend gives way to gently rounded or flat-topped, poorly defined ridges separated by wide, swampy valleys. Thus, the elevation of the land, the structural deformation, and the regularity of the ridges and valleys all increase from northeast to southwest.

The highest summit, just south of the headwaters of Caw Creek, the most easterly fork of Copton Creek, rises to about 7,100 feet above sea-level, and the lowest point, on Copton Creek in the extreme north-eastern corner of the area, is just under 3,500 feet. The region has, therefore, a maximum relief of about 3,600 feet.

Most of Copton Creek map-area has been burned over by forest fires at various times in the past, so that most of the country below timber-line is now covered with a tangled mass of logs and either brush or second-growth jack pine. Small patches of virgin forest composed mainly of spruce trees remain in some creek valleys. Grass covers the ridges above timber-line where the rock slopes are not too precipitous.

Nickerson Creek, in the southeast part of the area, is the only one flowing southward into Sheep Creek. All other creeks are tributary to Copton Creek, which flows northward and empties into Kakwa River.

Copton Creek and its tributaries drain about two-thirds of the map-area. The stream is between 30 and 50 feet wide and normally between 2 and 3 feet deep, and throughout its course in the map-area flows in a broad, flat valley with steep sides. The floor of the valley consists of a series of flats underlain by stream gravels and at one time covered by a dense forest of spruce. Forest fires have burned over most of these flats so that they are now covered by a luxuriant growth of grass. Bordering Copton Creek and rising above the flats are low terraces in various stages of preservation. These are generally forested with second-growth jack pine.

Four tributary streams enter Copton Creek from the south. La Force Creek and Beaverdam Creek flow northerly and unite just before reaching the main stream where it turns to flow north. Grizzly Creek enters Copton Creek east of the centre of the map-area, and Caw Creek, which heads between high ridges in the southwestern part of the area, flows west and northwest to join Copton Creek just west of the map-area.

Adelade Creek, the only large northern tributary, flows southeasterly and enters Copton Creek just east of the centre of the map-area.

Wanyandie Creek, draining a large part of the northern third of the map-area, is not tributary to Copton Creek, but flows generally northeast and enters Kakwa River at the northern border of the area. Nickerson Creek drains a small region in the southwest corner of the map-area and is tributary to Sheep Creek.

Caw Creek and Nickerson Creek are carved in resistant sandstones and conglomerates, and flow in narrow, steepsided to canyon-like valleys. In contrast with them, La Force, Beaverdam, Grizzly, and Adelade Creeks all occupy wide, swampy, steep-sided valleys, probably due to the fact that the underlying strata are mainly gently dipping or flat-lying shales capped by harder strata above the present level of the stream (See accompanying geological map).

Wanyandie Creek also has a wide valley, but gently sloping rather than steep sides. It is entrenched in gently dipping, relatively soft sandstones and shales.

Glaciation

There are no cirques in Copton Creek map-area, and the numerous small creeks show no effects of ice erosion. However, all ridges exhibit a smoothed and rounded appearance, which is probably due to ice abrasion. Also, large quartzite erratics occur on the

higher ridges at elevations up to 7,000 feet and, as some of these blocks weigh many hundreds of pounds, they could have been transported to their present position and elevation only by moving ice.

Near the mouth of Copton Creek and along the banks of Kakwa River are exposures of boulder till and, along the larger stream valleys, terraces composed of poorly stratified sands and gravels that probably represent reworked morainal material. These valleys must have been filled with ice at one time, but they do not show features such as truncated spurs or hanging valleys, which are the typical result of active valley glaciers.

The evidence suggests, therefore, that the entire map-area was covered by a slowly moving ice-sheet but that there was comparatively little valley erosion.

GENERAL GEOLOGY

General Statement

Copton Creek map-area is underlain by a succession of marine and non-marine sedimentary strata ranging in age from Lower Cretaceous to, probably, Paleocene. The strata have been folded along northwesterly trending axes and displaced by strike thrust faults that parallel the axes of the folds. As a result, the formations are, in general, exposed as long, relatively narrow, northwesterly trending bands.

The older formations, comprising mainly Lower Cretaceous strata, are exposed in the southwestern two-thirds of the area, and are faulted and complexly folded. The northeastern third is underlain by Upper Cretaceous and, probably, some Paleocene strata.

Bedrock is best exposed in the stream valleys, especially where canyons have developed, but good exposures are also found on some of the higher ridges. Outcrops are scarce in the large area underlain by Upper Cretaceous strata north of Copton Creek, owing to

the gentle inclination of the beds and the resulting low, forest-covered hills and extensive muskegs. The best exposures occur in the creek valleys on both sides of the high ridges in the southwest part of the map-area.

Outcrops are sufficient in most places to permit reasonably accurate location of geological boundaries, but in parts of the area formational contacts have been inferred from relatively few outcrop data.

The rock formations have been traced by field mapping from other areas to the southeast, and most of them are the approximate counterparts of formations that were first studied and named in southwestern Alberta, 200 to 300 miles away. However, the stratigraphic succession in Copton Creek map-area shows analogies to that of the Peace River district, where the sequence is somewhat different and where a different formational nomenclature has been adopted.

Table of Formations

Period or epoch	Formation or group, and approximate thickness in feet	Subdivision and approximate thickness in feet	Lithology
Paleocene?			Sandstone, shale, conglomerate, coal (non-marine)
	Brazeau ± 6,000		Sandstone, shale, conglomerate, coal (non-marine)
		Solomon member 60-80	Sandstone (marine)

Upper Cretaceous	Wapiabi 1,000±	Baculites ovatus zone	Shale, sandy shale (marine)
		Scaphites ventricosus zone	
	Bighorn 600 ±		Quartzitic sandstone, shale, sandy shale (marine and non-marine)
	Blackstone 1,800±	Prionotropus zone	Shale and minor siltstone (marine)
	Dunvegan 400 +		Sandstone, siltstone, silty shale (marine and non-marine)
Lower Cretaceous	'Fort St. John' 400-500		Shale and silty shale (marine)
	Blairmore group: Luscar 2,000 ±		Sandstone, shale, conglomerate, coal (non-marine)
	Blairmore group: Cadomin 30-80		Conglomerate
	Nikanassin 600 +		Quartzitic sandstone and shale (marine and non-marine)

Lower Cretaceous

Nikanassin Formation

Nikanassin strata are the oldest exposed in Copton Creek map-area and are confined to the high ridges of an upwarped area extending northwesterly from the southeast corner. This upwarp is in the nature of a broad, complex, anticlinal fold on which are superimposed numerous en échelon minor crenulations. Subsequent erosion has exposed Nikanassin rocks as long, irregular, and usually narrow bands, the largest near the western boundary of the area.

Exposures are, in general, poor, and in most places only the uppermost part of the formation outcrops. This is particularly true of exposures along the south-flowing branches of Caw Creek, where there is considerable rock outcrop, but because the beds are involved in numerous small folds only a few tens of feet of the upper part of the formation can be seen. The best exposure of Nikanassin strata occurs on the upper part of Beaverdam Creek where the stream has cut a canyon through an anticlinal fold. This section comprises about 600 feet of strata above the Cadomin formation, but is not continuously exposed.

The observed Nikanassin rocks consist of hard, grey to dark grey, quartzitic, grey to buff weathering sandstones; brownish, buff weathering, silty sandstones; grey, silty shale; and black, carbonaceous shale. The sandstones are all fine to medium grained, and individual beds range in thickness from 6 inches to 3 feet. Ripple-marks are common in these beds, and poorly preserved, carbonized plant remains occur in some. No fossils other than plants were seen.

Cadomin Formation

The Cadomin formation lies, apparently conformably, above the Nikanassin. In Copton Creek map-area it is confined to the same areas as the older formation, and occurs as long, narrow, sinuous bands outlining these areas. The formation is distinctive, usually forms conspicuous outcrops, and is an excellent horizon marker. For these reasons it is mapped separately rather than as a part of the Blairmore group.

At most places where the formation occurs in Copton Creek map-area it can be divided roughly into three parts. The lower part consists of about 30 to 50 feet of massive conglomerate. Above this are from 20 to 40 feet of grey sandstone and siltstone in beds from 6 inches to 2 feet thick and, at the top, 20 to 30 feet of conglomerate, with intercalated sandstone lenses and beds. However, at some places in the map-area only the lower band appears to be represented.

The two conglomerate bands are identical in composition, and consist of closely packed pebbles of black, grey, green, and reddish chert and pink and white quartzite in a matrix of orthoquartzite. The lower conglomerate is, in nearly all places, coarser than the upper, with pebbles that range from ½ inch to 4 inches in diameter; pebbles in the upper band range from ¼ inch to a maximum of 2 inches. The rock is extremely hard, and fractures across the pebbles rather than around them.

Luscar Formation

The Luscar formation overlies the Cadomin conformably. Its beds occupy a belt about 4 miles wide on the same complex anticline that exposes the Nikanassin and Cadomin strata. Smaller areas of Luscar occur as windows on Copton, Grizzly, and Beaverdam Creeks.

No complete section of the formation could be measured, but large exposures occur on the south- and southwest-flowing tributaries of Nickerson Creek, on many of the northeast- and southwest-flowing tributaries of Caw Creek, and on the numerous small branches of both Grizzly and Beaverdam Creeks. The upper part of the formation probably includes strata equivalent in age to the Mountain Park formation of areas south of Athabasca River.

The Luscar formation consists of non-marine and brackish-water fine conglomerate; coarse-, medium-, and fine-grained, grey, greenish grey, and brownish sandstone; grey and black silty shale; coal seams from 6 inches to 23 feet thick; and thin, yellow weathering ironstone bands, which are usually associated with shale. The sandstones weather to shades of grey or buff. The strata show lateral variations in lithology within relatively short distances, but all sections are composed of similar types of rocks.

The upper 200 to 300 feet of the Luscar contain a larger proportion of thick, massive beds than elsewhere in the formation, and are

probably in part or entirely equivalent to the Mountain Park formation of areas farther southeast.

.....The following partial section was measured on the second southwest-flowing tributary of Caw Creek north of the south border of the map-area:

	Thickness Feet
Overlying beds: 'Fort St. John' shale	
Conglomerate, fine, cherty, rusty weathering	0.3
Sandstone, hard, medium-grained, dark brownish grey	13.0
Sandstone, hard, fine- to medium-grained, grey to dark grey; some silty sandstone	13.3
Sandstone, hard, fine-grained, grey, finely banded	1.5
Shale, dark grey; interbedded with grey sandstone in beds up to 6 inches thick	9.5
Sandstone hard, fine-grained, greenish grey	4.0
Sandstone, medium-grained, brownish; interbedded with dark grey shale	34.2
Sandstone, hard, fine- to medium-grained, grey-brown, finely banded	32.3
Sandstone, fine-grained, grey; contains poorly preserved plant remains	1.0
Sandstone, medium- to coarse-grained, grey; contains lenses of fine chert-conglomerate up to 3 inches thick	10.0
Shale, dark grey	2.0
Sandstone, hard, fine-grained, brownish grey, buff weathering; some of it is finely banded	16.0
Shale, dark grey, silty	5.0
Shale, silty; contains poorly preserved plant material	3.7
Sandstone, fine-grained, brown-grey buff weathering; has a muddy appearance	42.7
Sandstone, fine-grained, brown, buff weathering, slightly calcareous	33.0
Sandstone, coarse-grained, grey, calcareous; contains scattered pebbles and dark grey shale fragments; some carbonate stringers	10.0

	Thickness Feet
Sandstone, medium- to coarse-grained, grey, slightly calcareous, rusty weathering	19.0
Conglomerate, fine; and sandstone, very coarse, grey, cherty, rusty weathering	3.0
Shale, grey, silty; interbedded with fine-grained, brownish sandstone; much carbonized plant material	56.0
Sandstone, hard, fine-grained, buff-grey, buff weathering; carbonized plant remains	3.0
Covered	50.0
Shale, grey	10.0
Shale, grey; minor thin beds of soft, grey sandstone	14.0
Sandstone, hard, fine- to medium-grained, grey, buff weathering; in beds from 1 foot to 3 feet thick	30.0
Sandstone, fine-grained, grey, soft, concretionary	7.0
Shale, grey and dark grey; minor interbedded thin, grey, sandstone bands	41.0
Sandstone, fine-grained, grey, crossbedded	5.3
Shale, grey	6.0
Sandstone, hard, fine-grained, dark grey, yellowish weathering	2.0
Shale and sandy shale, grey	24.0
Sandstone, fine- to medium-grained, grey; beds up to 2 feet thick; minor grey shale partings	29.5
Conglomerate and coarse, grey sandstone	3.0
Sandstone, medium- to coarse-grained, grey	31.5
Sandstone, very coarse, grey	2.0
Shale, grey; interbedded with 2- to 6-inch beds of black, carbonaceous shale	21.0
Shale and sandy shale, grey; contains yellow weathering ironstone bands about 2 inches thick.	37.4
Sandstone, fine-grained, grey weathering; weathers platy	21.0
Shale, dark grey	8.3

	Thickness Feet
Sandstone, fine- to medium-grained, brownish grey, brown weathering; thin bedded, with carbonaceous shale partings	31.0
Shale, grey; contains concretionary sandstone bands up to 4 inches thick	13.5
Coal, sheared and weathered	3.5
Shale, grey; with interbedded sandstone	37.0
Sandstone, hard, medium-grained, grey; in beds up to 4 feet thick; some shaly sandstone; contains plant remains	56.6
Sandstone, soft, fine-grained, brown, buff weathering, finely banded; contains some plant remains	65.0
Sandstone, fine-grained, brown, brownish weathering	25.0
Covered (this interval contains a coal seam 13 feet thick)	50.0
Sandstone, fine-grained, brown, buff weathering	7.0
Total thickness	944.3

Underlying beds: covered

The following partial section was measured on the third tributary from the west border of the map-area flowing northeasterly into Caw Creek.

	Thickness Feet
Overlying beds: covered	
Sandstone, medium-grained, grey, buff weathering	20.0
Sandstone, fine-grained, grey, buff weathering; weathers platy and contains plant remains	4.0
Shale, grey; interbedded black, carbonaceous shale and thin coal stringers	2.5
Coal, sheared and weathered; apparently no shale partings	15.9
Sandstone, fine-grained, grey; interbedded with grey shale; plant remains in shale and sandstone; large wood fragments in sandstone	5.3

	Thickness Feet
Sandstone, fine- to medium-grained, grey, brown weathering; some plant remains	6.1
Shale, dark grey to black, carbonaceous	5.0
Sandstone, fine- to medium-grained, grey, brown weathering	17.2
Shale, grey; some black carbonaceous shale	3.0
Coal, broken and weathered	2.1
Shale, grey	0.7
Coal, weathered	1.0
Covered	184.6
Total thickness	267.4

Underlying beds: Cadomin formation

No complete section is exposed within the map-area, so that the total thickness of the formation could not be measured. It was estimated graphically on the structure-sections to be about 2,200 feet, but the true thickness may be more or less than this figure because of numerous minor folds and faults.

'Fort St. John' Group

Lying conformably above the Luscar formation is from 400 to 500 feet of marine shale. This shale occurs in two northwesterly trending belts on either side of, and roughly parallel with, the complex anticlinal structure that has exposed Nikanassin and Luscar rocks. The more southerly belt, in the southwest corner of the map-area, exposes narrow bands and tongues of 'Fort St. John' strata due to the erosion of numerous small folds. On the northeast side of the complex anticline the 'Fort St. John' shale is exposed in two, long, narrow, northwest-trending bands on either limb of a narrow, synclinal structure. One of these bands extends across the map-area, but the other, though it reaches the eastern border, is faulted out midway of the area.

To the northeast of this syncline is another, broad anticline, the crest of which is rather flat, though exhibiting many small folds. 'Fort St. John' shale is exposed as irregular rings, bands, and patches where Copton, Grizzly, Beaverdam, and La Force Creeks have cut through this structure. Many exposures of the upper part of the formation occur in the valleys of these creeks, but no complete section was obtained.

The strata consist mainly of dark grey to black, silty shale, but a zone containing sandstone bands lies about 40 feet above the base.

No fossils except fish scales were found in the 'Fort St. John' shale, but its stratigraphic position below the Dunvegan formation indicates that it is equivalent in age to a part of the Fort St. John group of Peace River district and is, therefore, of Lower Cretaceous age. A thickness of between 400 and 500 feet has been estimated for the formation in this map-area.

Upper Cretaceous

General Statement

Following the procedure adopted for adjacent map-areas, the writer has, in this report, continued to use the southern nomenclature, so far as possible, rather than that of Peace River district for the Upper Cretaceous formations. The reasons for this procedure have been given fully by Lang (6)[1] and Irish (5).

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[1]Numbers in parentheses are those of references at the end of this report.

Dunvegan Formation

The Dunvegan formation overlies conformably, and has a similar distribution to, the 'Fort St. John' shales.

In the southwest corner of the map-area it occurs as long, narrow bands, usually within or on the flanks of synclines, and outcrops

much better than the underlying shale. Northeast of the high anticlinal area that exposes Nikanassin strata, the Dunvegan underlies a long strip within the narrow syncline, and on the broad, flat-topped anticline northeast of the syncline, the strata occupy large areas on the tops of the ridges. The beds usually dip gently either to the northeast or southwest.

The Dunvegan formation consists of hard, fine- to medium-grained, grey sandstone and dark grey to black, silty shale. About 30 feet of hard, grey, quartzitic sandstone occurs at the base of the formation wherever the lower contact is exposed. Crossbedding and carbonized wood fragments are common in some of these sandstone beds.

Numerous exposures occur in the map-area, but no complete section could be measured. The thickness of the Dunvegan, as measured from the structure-sections, is not less than 400 feet.

The following fossils were collected from the Dunvegan formation:

Catalogue No. 19171

Twenty feet above the base of the formation where the Dunvegan-'Fort St. John' contact crosses Nickerson Creek:

Brachydontes multilinigera
Ostrea sp.
Yoldia ? sp.
Unio (Elliptio) cf. sulfuriensis

Catalogue No. 19172

On small tributary of Nickerson Creek, near south border of map-area:

Corbula cf. nematophora Meek

Catalogue No. 19173

In small area of Dunvegan in southwest corner of map-area:

Brachydontes multilinigera Meek
Ostrea sp.
Corbula pyriformis var. dunveganensis?
Corbula sp.
Inoceramus ?

Catalogue No. 19174

On the ridge just east of Copton Creek near centre of map-area; from the lower 100 feet of the formation:

Inoceramus dunveganensis
Brachydontes multilinigera Meek
Ostrea sp.

Catalogue No. 19175

On ridge 2 miles up the northeast-flowing tributary entering Copton Creek just east of the centre of the map-area; from the lower 200 feet of the formation:

Inoceramus ? (Perma ?) sp.

The fossils Brachydontes multilinigera, Unio (Elliptio) cf. sulfuriensis, Corbula pyriformis var. dunveganensis, and Inoceramus dunveganensis are typical of the Dunvegan formation of basal Upper Cretaceous age.

Blackstone Formation

The Blackstone formation overlies the Dunvegan strata conformably. It is confined, except for two small areas, about midway of the map-area. One long band is exposed along the axis of a narrow anticline extending northwest from the east border to a point near the centre of the map-area. A larger area, probably underlain by Blackstone strata, occurs near the west border in the northern part of the map-area. The strata there are mainly on the crest and northeast limb of the broad anticlinal structure previously referred to, and the area of Blackstone increases northwestward due to the plunge of the structure in that direction. Some large areas of exposures occur, but no fossils were obtained, and the shales have been designated as Blackstone on their stratigraphic position only. The position of the Blackstone-Dunvegan contact has, in places, been assumed.

Black shale occurs in a small area on top of the ridge between Grizzly and Beaverdam Creeks. It overlies the Dunvegan formation and

has, therefore, been mapped as Blackstone. The only other exposures are within a syncline in the southwest corner of the map-area.

The Blackstone formation consists almost entirely of black, fissile to thin-bedded, somewhat silty, marine shale, with numerous interbedded, hard, grey, yellow weathering, concretionary ironstone beds. A sandy zone, about 15 feet thick, occurs at the top, and a few intercalated, thin, grey sandstone beds throughout the formation.

Bighorn Formation

The Bighorn formation overlies Blackstone strata conformably. In Copton Creek map-area, its exposures are confined mainly to narrow, northwesterly trending bands extending from a point halfway up the eastern border of the map-area to near the northwest corner. For most of their outcrop area the Bighorn beds occur as two bands, one on either limb of an anticline, but toward the western border the two bands join, due to the northwest plunge of the structure.

Another small area underlain by Bighorn strata occurs in the valley of Copton Creek at a point just beyond where the stream turns to flow north; the beds are exposed where the creek has cut across a broad anticlinal structure.

Bighorn strata consist of hard, slabby, grey, quartzitic sandstone; softer, grey-brown, silty sandstone; grey, silty shale; dark grey to black, silty shale; and minor amounts of conglomerate. The pebbles of the conglomerate are of grey and black chert, and white quartzite; they are generally about pea-size, but may be much smaller.

In Copton Creek map-area, as in the area to the east, the Bighorn comprises three lithologic units, an upper and lower sandstone band separated by nearly 200 feet of black marine shale. Exposures of both sandstone bands are fairly good where small streams on the north side of Copton Creek have cut through the formation, but

no complete sections are exposed. Only a few very small outcrops of the middle shale member were seen. Measurements on three of the south-flowing creeks gave a total thickness of about 600 feet, and this is in agreement with more accurate measurements made a few miles to the southeast.

Fossils collected from the Bighorn formation include the following:

Catalogue No. 20105

Collected from the upper sandstone band on a point near the Copton Creek trail where Copton Creek changes course from east to north:

Arctica sp. indet.
Cardium (s. lato) sp. indet.
Nucula (s. lato) sp. indet.
Pelecypod, genus and species indet.
Gastropod, genus and species indet.

Catalogue No. 20106

Collected from the middle or shale member of the formation near the mouth of Beaverdam Creek:

Scaphites vermiformis Meek and Hayden (s. lato)
Inoceramus sp. indet. (cf. erectus Meek)
Inoceramus sp. indet. (? ex gr. fragilis Hall and Meek)
Inoceramus sp. indet.

Catalogue No. 20107

Collected on the northeast side of Oldburn Creek:

Inoceramus ex gr. lamarki Park (s. lato)

According to Dr. Jeletzky this may be a new variety or even a new species.

The fossils listed above are typical of the Bighorn formation.

Wapiabi Formation

The Wapiabi formation overlies the Bighorn conformably. It occupies two northwesterly trending bands midway of the map-area

on either flank of a narrow syncline. Wapiabi beds are also exposed in a smaller area beyond where Copton Creek turns to flow north and cuts through a broad, open anticline.

The formation consists chiefly of thin-bedded to fissile, dark grey to black shale and silty shale, with some interbedded, thin, concretionary, calcareous, buff weathering bands. In other map-areas, a 200-foot sandy zone occurs at the top, but is not exposed in Copton Creek map-area.

Many small outcrops of these shales occur both in the banks of Copton Creek itself and in most of the small, southwest-flowing tributaries, but no large sections are exposed. The approximate thickness, as estimated from the structure-sections, is between 900 and 1,000 feet. This is comparable with a measured thickness in Daniels Flats map-area to the southeast.

Fossils collected from the Wapiabi formation in Copton Creek area include the following:

Catalogue No. 20103

From the lower 20 feet of the formation on the small creek flowing easterly into Copton Creek, where Copton Creek turns to flow north:

Scaphites ventricosus Meek and Hayden (s. lato)
Inoceramus ex gr. fragilis Hall and Meek
Inoceramus sp. indet. A
Inoceramus sp. indet. B
Pelecypod, genus and species indet.

Catalogue No. 20104

Collected from the Wapiabi formation on first creek entering Adelade Creek from the north:

Panopea cf. gurgitis (Brogniart)

Catalogue No. 20110

Collected from the talus below a Wapiabi-Brazeau contact at the head of the fourth creek flowing south into Copton Creek. This

creek is about 2 miles west of the point where Copton Creek turns to flow north:

> Placenticeras sp. indet. (allied to P. meeki Bohm or P. planum Hyatt, but "seemingly different from any North American species hitherto described and figured".

The above fossil is thought to be of Montana age, and probably came from the lowermost part of the Solomon member of the succeeding Brazeau formation.

Brazeau Formation

The Brazeau formation, of late Upper Cretaceous age, overlies the Wapiabi conformably, and underlies the northeastern third of the map-area.

Solomon Member. This member, forming the lower 60 to 80 feet of the Brazeau formation, is a useful horizon marker, and has been mapped separately. It forms a thin, northwesterly trending band roughly separating the highly disturbed strata of the southwestern two-thirds of the map-area from the gently dipping beds to the northeast. Outcrops are numerous along the southeastern part of this band, but exposures become less frequent toward the northwest.

The Solomon member consists of a distinctive, hard, grey to greenish grey, buff weathering, slabby sandstone. Marine fossils have been found in it in nearby areas, and it is possible that the ammonite "Placenticeras sp. indet." listed with the Wapiabi fossils is from the base of the Solomon. This fossil was collected from talus at the base of a cliff in which occurs the Wapiabi-Solomon contact, and the sandstone in which the form is embedded resembles Solomon more than Wapiabi beds.

Main Part of the Brazeau Formation. Strata lying immediately above the Solomon member consist of dark greenish grey, medium-grained, soft sandstone, with interbedded grey, silty shale, and resemble beds occupying a similar position in other areas. They are generally softer and more shaly than overlying beds.

The remainder of the formation consists of roughly 6,000 feet of thick-bedded sandstone, conglomerate, shale, and coal. The sandstone is generally medium to coarse grained, grey and brownish grey, grey to buff weathering, and is commonly crossbedded. The conglomerate consists mainly of pebbles from $\frac{1}{2}$ to 1 inch in diameter composed of white quartzite and grey and black chert. In most places the rocks show gradations from conglomerate to sandstone containing scattered pebbles. In areas to the southeast there is a considerable thickness of massive conglomerate and pebbly sandstone, but in Copton Creek map-area the amount of conglomerate appears to be greatly reduced. The shales are dark grey and greenish grey, and are commonly silty.

Outcrops of the Brazeau beds are widely scattered and poorly exposed. The best exposures are of the lower beds and occur along the scarp on the north side of Copton Creek. Higher strata outcrop at intervals on the ridges and in the creek valleys to the northeast.

Paleocene (?)

Strata in the northeast corner of the map-area may be of Paleocene age. The beds are similar to, and conformable with, strata that are known to be part of the Brazeau formation, but it is probable that some are of post-Upper Cretaceous age. They consist of sandstone, shale, and conglomerate resembling those of the Brazeau formation, but are, on the whole, more thickly bedded, softer, and fresher in appearance. No fossils were found in them, and the lithological differences between these strata and those of the Brazeau formation are not sufficient to permit the drawing of a geological boundary.

Pleistocene and Recent

Till and fluvioglacial gravel mantle areas in the northeastern part of the map-area, and numerous exposures occur along the valley of Kakwa River and along the lower part of the valley of Copton Creek. Along the east-west course of Copton Creek, partly preserved terraces composed mainly of poorly to well stratified gravel and sand occur near the mouths of Adelade, Grizzly, and Beaverdam Creeks. This material is probably, in part at least, reworked outwash gravel and morainal material. In the southwest part of the map-area, small exposures of poorly stratified gravel occur in some of the larger creek valleys. Most of this material is coarse, but there are also deposits of finer gravel and sand.

STRUCTURAL GEOLOGY

General

The dominant structural features of the southwestern two-thirds of the map-area are northwesterly trending complex folds and strike thrust faults. With few exceptions, anticlines form the ridges and synclines the valleys, the anticlines being narrower and more compressed than the synclines. The folds are irregular, complex, and lie en échelon.

In the northeastern third of the area there appear to be no major folds or faults, and the underlying strata have very gentle dips, mainly to the northeast.

Faults

Several strike thrust faults have been recognized in Copton Creek map-area. Two of these are long and indicate considerable displacement. The most northeasterly fault lies predominantly within the Brazeau formation. Evidence for it is meagre and suggestive only, and for this reason the fault has been mapped as assumed. It

could not be traced far either to the northwest or southeast because of lack of exposures. In the valley of Copton Creek, both Wapiabi and Bighorn strata are exposed, and are mapped as cut off by the fault on the northeast; they were probably thrust onto the Brazeau from the southwest.

A second, and important, fault enters the map-area from the southeast about midway of the east border. It extends northwesterly entirely across the area, roughly parallel with, and on the southwest side of, the narrow anticline in which Bighorn strata are exposed. The strata have been overthrust from the southwest, and the fault has been mapped to the southeast as far as Pierre Greys Lakes map-area where it is known as the Muskeg fault (5). The displacement on this fault apparently decreases gradually to the northwest, for in this direction progressively younger strata are thrust over the Wapiabi formation.

About 3 miles south of the Muskeg fault, another thrust from the southwest is confined almost entirely to Luscar strata. This fault extends northwest from the eastern border to about midway of the map-area. It has been mapped to the southeast across Daniels Flats and into the Grande Cache map-area.

Near the southeast corner of Copton Creek map-area, two, long, northwesterly trending faults occur in Lower Cretaceous strata. About half-way across the area they merge, and the single break continues to and beyond the western border. These faults from the southwest have thrust Nikanassin strata over beds of the Luscar formation.

In addition to the above, numerous, small, local thrust faults were noted in the field, and a few of these have been mapped. Most of them are small thrusts that could not be traced more than a few tens of feet. Also, it is extremely probable that the map-area

includes many small faults that have not been recognized because of lack of exposures.

Folds

No folds of any consequence occur in the northeastern third of Copton Creek map-area. The strata there have, in general, gentle dips to the northeast. The formations in the southwestern two-thirds of the area are, however, intensely crumpled, and are involved mainly in four structural units--two anticlinal and two synclinal (See accompanying map and structure-sections). The anticlinal areas are broad, upwarped areas trending northwesterly, on which are superimposed numerous small en échélon folds. These two major structures are separated by relatively narrow downfolds, which are essentially complex synclines.

The broader of the two synclines occurs in the southwestern corner of the map-area and exposes 'Fort St. John' shales and Dunvegan strata. The major structure is complicated by numerous small folds, the partial erosion of which has resulted in the outcrop of formations as long, narrow bands and tongues.

Adjacent to, and northeast of, the syncline is a high, broad anticlinal area that trends northwest and has a width of between 4 and 5 miles. The structure is complicated by many smaller folds, and involves strata of the Lower Cretaceous Nikanassin, Cadomin, and Luscar formations. Erosion of the many small anticlines has exposed Nikanassin beds in irregular bands and tongues.

Bounding this wide, complex anticline on the northeast is another downfold or syncline. This structure, about 2 miles wide, crosses most of the map-area, and, where rock exposures are numerous, is known to be complicated by many small folds. Near the eastern border of the map-area, it is shown as a simple syncline only, because lack of rock outcrops there prevent an accurate interpretation of its complex nature. Strata comprising the syncline belong to the Lower

Cretaceous 'Fort St. John' and the Upper Cretaceous Dunvegan formations.

Northeast of this syncline is another broad anticlinal area. This structure has an approximate width of between 4 and 5 miles, is not as high as the similar structure farther southwest, and plunges northwest. It has rather steeply dipping limbs, with a broad, relatively flat top crenulated into numerous minor folds, most of which are more open than those of the anticline to the southwest. Most of the southeastern end of this structure is composed of Luscar and 'Fort St. John' strata, but toward the northwest these are capped by progressively larger areas of the Dunvegan formation, which, in turn, is overlain by Blackstone beds at the northwestern end of the anticline within the map-area. Where Copton, Grizzly, and Beaverdam Creeks have cut through the structure, Luscar and 'Fort St. John' strata are exposed as windows in the valleys.

The formations of this complex anticlinal structure have been thrust to the northeast onto an anticline that exposes Blackstone, Bighorn, and Wapiabi formations. This fold is narrow, compressed, and nearly symmetrical. It is continuous from just south of Smoky River to the western border of the map-area. For most of this distance only the northeastern limb is well exposed, but outcrops of the southwest limb occur at some places. The structure appears to be losing its identity near the west border of the area.

Northeast of this anticline is another syncline and anticline, both very gentle, open folds composed mainly of Brazeau beds. However, in the valley of Copton Creek, erosion has exposed strata of the underlying Wapiabi and Bighorn formations.

ECONOMIC GEOLOGY

Coal

In Copton Creek map-area, most of the observed coal seams occur in Luscar strata, but one seam was noted in the Brazeau formation. This seam is 2 feet thick, and occurs in carbonaceous shale in the north bank of Daniels Creek about 2 miles above its mouth. It is possible that other seams are present but not exposed, as scarcity of outcrops is typical of the areas underlain by these younger strata.

Coal seams up to 23 feet thick occur in the Luscar formation. About ¾ mile up from the mouth of the second southwest-flowing tributary of Nickerson Creek a seam is exposed at the crest of an anticlinal fold. It lies about 1,000 feet stratigraphically below the top of the Luscar formation and is 12 feet thick. The coal is banded, breaks into large blocks, and is, apparently, quite resistant to weathering. No clay partings were visible.

On the third, northerly flowing tributary of Caw Creek from the west border of the map-area, three coal seams are exposed. The following section was measured:

	Thickness Feet
Overlying beds: covered	
Sandstone, medium-grained, grey, buff weathering	20.0
Sandstone, fine-grained, grey, buff weathering; weathers platy and contains plant remains	4.0
Shale, grey; interbedded black, carbonaceous shale and thin coal stringers	2.5
Coal, sheared and weathered; apparently no shale partings	15.9
Sandstone, fine-grained, grey; interbedded with grey shale; plant remains in shale and sandstone; large wood fragments in sandstone	5.3

	Thickness Feet
Sandstone, fine- to medium-grained, grey, brown weathering; some plant remains	6.1
Shale, dark grey to black, carbonaceous	5.0
Sandstone, fine- to medium-grained, grey, brown weathering	17.2
Shale, grey; some black carbonaceous shale	3.0
Coal, broken and weathered	2.1
Shale, grey	0.7
Coal, weathered	1.0
Sandstone, fine-grained, grey-brown, buff weathering	5.0
Underlying beds: covered	

The 15.9-foot seam is 225 feet above the base of the formation.

At least three seams are exposed on a small creek forming part of the headwaters of Caw Creek. The following section was measured on a south-flowing creek at an approximate elevation of 6,500 feet.

	Thickness Feet
Overlying beds: covered	
Sandstone, grey, buff weathering, fine-grained ..	20.0
Coal	12.0
Sandstone, grey, buff weathering; contains ironstone concretions	2.0
Shale, grey	5.0
Coal	5.4
Shale, grey; numerous grey sandstone bands up to 1 foot thick	20.0
Sandstone, grey-brown, buff weathering	100.00
Coal	23.0
Sandstone, grey, fine-grained; contains plant remains	4.0
Underlying beds: covered	

These three seams are exposed above timber-line, and are considerably weathered, but no significant partings could be found. Their thickness may be somewhat exaggerated at this locality, which is close to the crest of an anticlinal fold. The 23-foot seam lies about 1,000 feet above the base of the Luscar formation.

About $\frac{3}{4}$ mile east of these seams are three other showings of considerably weathered coal. These may represent the same seams as above, but on the opposite limb of the fold.

Just east of the most easterly, south-flowing branch of Caw Creek are two small coal outcrops, probably representing the one seam on both limbs of a small syncline, and at the head of the same creek, near the divide, is another poor exposure, representing at least 4 feet of coal. About $2\frac{1}{2}$ miles east of this showing a poorly exposed seam occurs at the head of a northeasterly flowing tributary of Beaverdam Creek. One foot of coal outcrops here on two forks of the creek at an elevation of just under 5,900 feet.

Oil and Gas

Several oil companies have made geological investigations of parts of the map-area in recent years, but no wells have been drilled for oil or gas. Most of Copton Creek map-area is highly folded and faulted so that surface structures do not appear promising, but the subsurface possibilities have yet to be tested.

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