GEOLOGICAL SURVEY OF CANADA
G. M. DAWSON, C.M.G., LL.D., F.R.S., DIRECTOR

REPORT

ON THE

GEOLOGY AND NATURAL RESOURCES OF THE COUNTRY

TRAVERSED BY THE

YELLOW HEAD PASS ROUTE

FROM

EDMONTON TO TÊTE JAUNE CACHE

COMPRISING PORTIONS OF

ALBERTA AND BRITISH COLUMBIA

BY

JAMES McEVOY, B.A.Sc.

OTTAWA
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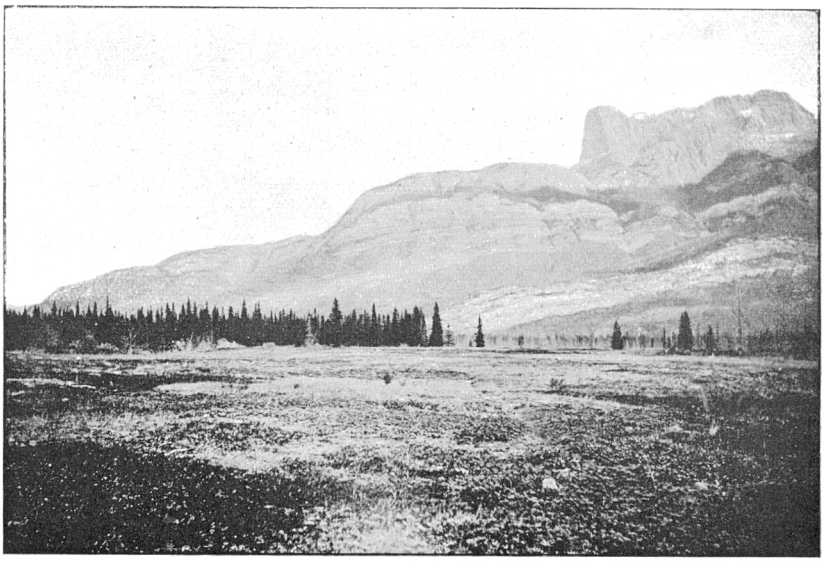
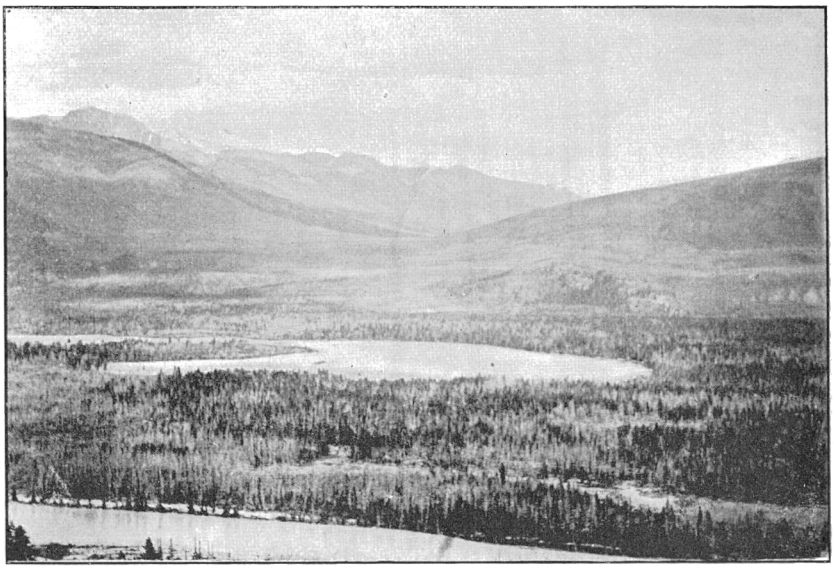


ROCHE MIETTE, OPPOSITE JASPER HOUSE, ATHABASCA RIVER.



MALIGNE RIVER VALLEY, OPPOSITE HENRY HOUSE, ATHABASCA RIVER.

To George M. Dawson, C.M.G., LL.D., F.R.S.,
Director, Geological Survey of Canada.

Sir,—I have the honour to submit herewith a report, with accompanying map, of the country traversed by the Yellow Head Pass route from Edmonton to Tête Jaune Cache, embracing portions of the district of Alberta and the province of British Columbia. It is the result of one season's exploration.

I have the honour to be, Sir,
Your obedient servant,

JAMES McEVOY.

Geological Survey Office,
Ottawa, May, 1899.

NOTE.—*The bearings throughout this report are given with reference to the true meridian.*

REPORT

ON THE

GEOLOGY AND NATURAL RESOURCES OF THE COUNTRY

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INTRODUCTORY.

The exploration described in the following report extended from Edmonton westward through the Yellow Head Pass in the Rocky Mountains, down the Fraser River to Tête Jaune Cache, and thence to the head-waters of Canoe River, a tributary of the Columbia. The accompanying map embraces the whole of the area traversed and extends in latitude from 52° 36′ to 53° 45′ N. and in longitude from 113° 20′ to 119° 35′ W. Extent of country traversed.

During the winter of 1859, Dr. (now Sir James) Hector, in connection with the Palliser expedition, travelled westward from Edmonton to the Athabasca River and ascended that stream some distance above Henry House. The results of this expedition are given in Captain Palliser's report and maps. Previous explorations.

In 1863, Milton and Cheadle, starting from the same place, followed practically the same route, but continued westward through the Yellow Head Pass and descended the North Thompson River to Kamloops, B.C. Their description of the journey, in 'The North-west Passage by Land,' graphically sets forth the difficulties to be met with and these are as numerous to-day as they were at that time.

Explorations carried out for the Dominion Government, with a view to the discovery of a suitable route for the Canadian Pacific Railway through this pass, were commenced in 1871, and a final location line, showing no higher grade than one per cent, was completed in 1876.

In 1871, Dr. A. R. C. Selwyn, then Director of the Geological Survey, made a journey from Kamloops to Tête Jaune Cache and ascended the Fraser River some distance above Moose Lake. An itinerary of this expedition is given in the Report of Progress for 1871-72.

Notwithstanding these explorations, little was known about the country except the location of the line and the sketching of the streams in the immediate vicinity thereof. It is intended in this report to give some further information about the route and also on the Information given in this report.

form and geological structure of the neighbouring mountains. On account of the small scale on which it is necessary to publish the map, (eight miles to an inch) the contour lines had to be limited to one for every thousand feet vertical interval.

Surveys.

Paced surveys were made and connected with the railway location line wherever it was possible, and traverses have elsewhere been checked by observations for latitude with a sextant. Topographical sketches, made with compass and hand-level were taken from mountain tops, forming a rough triangulation. These, supplemented by barometrical readings were employed to determine the mountain features.

In the following descriptive part of the report, portions of the already-published Summary Report of this exploration are embodied.

Topography and Route Traversed.

The district traversed may be divided into two parts:—From Edmonton to Brulé Lake on the Athabasca River, a gently rolling wooded plain. From Brulé Lake westward, a high rugged mountainous country traversed by low valleys.

Edmonton to Lake St. Anne.

A good wagon-road runs from Edmonton via St. Albert to Lake St. Anne, and in the autumn of 1898 it was cut out as far as Pierre Grey's at the head of Island Lake, a distance of sixty-eight miles. The prairie condition that exists around Edmonton gradually disappears toward the west, and before Lake St. Anne is reached the country is, to a great extent, covered with a thick growth of poplar and cottonwood. Farming settlements are numerous the greater part of the way, but near the lake there is little ground cultivated, although what there is produces good crops.

Lake St. Anne.

Lake St. Anne is a shallow body of water the surface of which is very little below the level of the surrounding country. It is about four miles wide and six miles long to the Narrows, beyond which it is reported to widen out to a still larger body. From the old beach-lines around the lake it is evident that its waters are subsiding. Father Veqreville pointed out the place where the water stood twenty years ago. It is twelve to fifteen feet above the present high-water mark.

Island Lake.

Westward from Lake St. Anne, the road reaches Island Lake, a narrow sheet of water ten miles in length, and follows near the northern shore to Pierre Grey's at its head. This lake is the source of the Sturgeon River that flows into Lake St. Anne, and thence via St. Albert into the North Saskatchewan River. A slight depression leads from Island Lake across the watershed of the Saskatchewan and Athabasca rivers, and at a distance of six miles the Pembin

River is reached by a rather precipitous descent of 250 feet. The last settlements on the road are between Pierre Grey's and Pembina with one exception that will be mentioned further on.

Pembina River.

The Pembina is about eighty yards wide, and for the greater part of the year is quite shallow and easily fordable. In the early spring, and in time of heavy rains, horses are compelled to swim in crossing. The valley of the Pembina is worn down to a depth of 250 to 300 feet, an amount of erosion far greater than should be expected from the volume of water at the present time. From what was seen later in the season, near the source of this stream at the edge of the mountains, it seems possible that some of the adjacent mountain streams, at present flowing into the McLeod and Brazeau rivers, at one time found their way into the Pembina.

Lobstick River and Lake.

Beyond the Pembina, the route ascends quickly to the level of the surrounding country which, away from the immediate vicinity of the streams, is quite flat, and continues westward crossing the Lobstick River at a point distant ten miles from the Pembina crossing. Lobstick River is locally known as Buffalo-dung River, but the name Lobstick, here given the preference, is that used on Palliser's map and on the railway exploration plans. The Lobstick at the crossing is 290 feet above the Pembina. It is here a slow, winding stream occupying a narrow valley not more than fifty feet in depth. Below this, it makes its rapid descent to the Pembina through a narrow deepening gorge, and joins the latter stream three miles above the crossing. A narrow strip along the northern bank of the Lobstick is open and grassy, but immediately behind is an extensive peaty swamp covered with Labrador tea, small brush and occasional stunted black spruce trees.

Continuing westward, the route traverses a gradually rising country that slopes very gently northward toward the Lobstick, crossing several small tributaries of that stream. Burnt and green woods of cottonwood and spruce alternate along the way and no outlook can be obtained. Nothing relieves the monotony of the route except the recurring changes from muskeg to bog-holes with intervening stretches of deep sticky white mud. Fallen timber is plentiful throughout. The principal tributaries of the Lobstick crossed are: Two Creeks, Partridge Creek, Coldwater Creek and Little Lobstick River. These are all small streams and make little impression on the even surface of the country. Three miles beyond the Little Lobstick the main Lobstick River is again crossed. It is here a small stream flowing from the south and its source is probably not more than ten miles distant.

Lobstick River to Carrot Creek.

Leaving Lobstick River, the route crosses a very bad muskeg half a mile wide and shortly afterwards ascends to higher open rolling hills

from which the first glimpse of the mountains is obtained. The snowy summits seen to the south-west are over seventy miles distant. On the west side of these hills Carrot Creek flows northward into the McLeod River and its western tributary, Medicine Creek is followed by the trail. Five miles up, at the second crossing of the stream a good camping place is known as Government Cache.

Wolf Creek.

It is nine miles from this place to Wolf Creek, a stream twenty-five feet wide and a foot deep at this season (the middle of June). It flows due north at the crossing but its general course is north-westward to the McLeod River.

Moose Creek.

Moose Creek, another parallel tributary of the McLeod, about one-half the size of the last, is eight miles distant. Between these two streams the same partly burnt country with sticky clay soil, is relieved by several miles of narrow sand ridges. There appears to be a number of these ridges running parallel to each other in a direction N. 65° W., with intervening narrow strips of peaty swamp.

McLeod River at crossing of old railway location.

Two miles and a half beyond Moose Creek the McLeod River is reached. It is 110 yards wide and at the time of our visit not more than two feet deep at the ford. Although the volume of water is far greater than that of the Pembina, its valley is comparatively small, being only ninety to a hundred feet below the level of the country. The partly open grassy country on the north bank of the McLeod is followed by the trail seven miles to the Big Eddy. A sharp bend of the river at this place, where it is folded back upon itself, is noted for its good fishing. A species of brook trout called "Bull Trout," (*Salvelinus malma* according to Prof. Macoun) is found there in abundance.

From Big Eddy to White Mud Creek.

From the Big Eddy the river takes a semicircular bend to the south, while the trail, ascending a tributary named Sun-dance Creek, joins the river again near White Mud Creek, eleven miles distant. At White Mud Creek there are half a dozen small log cabins used occasionally by half-breeds and Indians as winter quarters. The railway location line follows the southern bank of McLeod River to the Big Eddy and crossing there it ascends Sun-dance Creek for eight miles. Thence it continues westward to the Athabasca River without again touching the McLeod.

Prairie flats along McLeod River.

The trail again follows the north bank of the McLeod from White Mud Creek, for a further distance of thirteen and a half miles, to a place formerly known as Plum Pudding Cache, now called the 'Leavings.' This is an excellent camping ground with a wide prairie flat of rich grass, but it is no great exception to the general rule, as good

pasturage is to be found at short intervals along the whole route. The conditions in the immediate vicinity of streams are best suited to the growth of grass, as the better drainage in those places permits the escape of the excess of surface water, which, in flatter parts is retained by the impervious clay soil.

Course of the river.

From the 'Leavings' the McLeod turns southward toward the mountains, forming by its windings, when plotted on the map, the profile of a human face looking westward. On this profile the 'Leavings' would represent a point at the top of the forehead, and the bottom of the chin would be distant twenty-five miles in a straight line to the south. A large fork, half the size of the main stream, comes in at the point of the upper lip. A reference to the map will show the application of the above comparison.

Trail from McLeod River to Athabasca River.

The route continues westward from the 'Leavings' across the watershed between the McLeod and Athabasca rivers. It is formed by a slightly rolling ridge, decreasing in elevation toward the north. It is deeply drift-covered, and, where crossed, rises gently to a height of 940 feet above the McLeod or 1,340 feet above the Athabasca. The elevation of this summit above sea-level is 4,640 feet, or 917 feet higher than the summit of the Yellow Head Pass. A few miles to the north, where the railway line was finally located, the ridge is crossed at a much lower elevation. In a straight line, the distance between these rivers is under ten miles. The trail, however, turning south-westward along the western slope of the ridge, reaches the Athabasca at the mouth of Sandstone Creek, a point twenty miles distant from the 'Leavings' of the McLeod.

All this country has been overrun by fire and much valuable timber has been destroyed. It is now a wilderness of bare trunks. On the western slope of the watershed some very bad muskegs have to be crossed. Here, as well as generally elsewhere along the route, the trail follows pretty closely the one made during the railway exploration, but windfalls are numerous, and long detours are necessary. The corduroy laid down at that time across the muskegs, is now in such a bad state of preservation as to be dangerous for animals, and it is preferable to trust to the natural surface of the muskeg on either side.

Climate of country along eastern edge of mountains.

The climate of the country traversed between the Pembina and Athabasca rivers may be said to be a wet one, but as the bottom of the Athabasca valley is approached, evidences of a change become apparent, such as, smaller and more scattered timber, steeper slopes on side-hills and cut-banks of streams and a marked indication of drier conditions in the vegetation. This change is more noticeable farther up

the valley, and is most pronounced from Jasper House to Henry House. The change is evidently due to the greater effect of the Chinook winds in the proximity of the mountains, and is here so marked because of the lowness of the valley, which is only about 3,000 feet above sea-level. This permits a great descent of the air coming across the mountains, and the result is correspondingly great dryness and warmth.

Sixty miles to the south-east, at the edge of the mountains on the Brazeau River, where there is a similar abrupt descent but not to such a great depth, as the elevation of the plateau country outside the mountains is over 5,000 feet, the effect of these winds, while still appreciable, is not by any means so pronounced.

Views of Rocky Mountains.

Several points on the route across the McLeod-Athabasca watershed afford good views of the mountains, which have a very barren appearance. Bare limestone cliffs and steep rocky slopes meet the eye. For the most part these are without any covering of trees. Although trees are frequently found at an altitude of 6,000 feet above sea-level in sheltered valleys, the steeper slopes, and those exposed to the full force of the winter winds do not support a growth of trees above 5,000 feet and often not even to that altitude.

Athabasca River from Sandstone Creek to foot-hills.

Ascending the Athabasca from Sandstone Creek, it is four miles to Ne-kas-pi-kwat (corrupted into Cache Pecotte) near Hardisty Creek, where a branch route crossing the river turns northward to Smoky River. The valley of the Athabasca is wide and flat, with an abundance of grass and having in parts a light growth of scattered pines and some heavier spruce woods. The slope of the south-west side is so gentle that at a distance of a mile back the elevation is not more than a hundred feet above the river. The same characteristics continue up to Prairie Creek, a distance of six miles farther. Here the river bends slightly more to the west for a distance of eight and a half miles, where it issues from Brûlé Lake. This lake is an enlargement of the river seven miles long and half a mile to a mile in width, lying north-and-south. The trail does not follow this detour of the river and lake but instead ascends Prairie Creek for nine miles, then turns more toward the west across Drystone Creek to Fiddle Creek which flows into the Athabasca at the head of Brûlé Lake.

Brûlé Lake.

Up to the mouth of Prairie Creek there is no approach to a mountainous condition, the hills in the vicinity of the river nowhere rising more than four or five hundred feet above it, but as that stream is ascended the ridges that run at right angles to its course become more elevated, although still rounded in outline. Between

the upper part of Prairie Creek and Drystone Creek, Folding Mountain, the first foot-hill of the Rocky Mountains, rises up. From Fiddle Creek upward, high rugged mountains stand up boldly on each side with vertical cliffs and steep rocky slopes, leaving a flat-bottomed valley, one to two miles wide, through which the Athabasca River winds it way, seldom in one united stream, but lost in a network of sloughs. The trend of the mountain ranges is S. 60° E. to S. 70° E. following the strike of the rocks, and the confluent streams having the same direction are generally arranged in opposite pairs, each pair occupying one continuous valley crossing the main valley at right angles. A good example of this is Rocky and Stony rivers that join the Athabasca near the site of Jasper House at the foot of Jasper Lake.

In the mountains.

The Athabasca is sometimes crossed about three miles below the mouth of Rocky River. In very low water it can be forded at that point. There is a trail on each side of the river from there to Henry House. In order to continue up the east side of the river it is necessary to ascend the mountain side 1100 feet to get around a smooth rocky point that comes down to the water's edge. The descent of the slope on the other side is very precipitous to the bank of Rocky River. Where Rocky River was crossed near the mouth it was divided into ten separate channels and was barely fordable (July 2).

Trail on east side of river.

Just below the mouth of Rocky River, on the opposite side of the Athabasca, is the site of Jasper House. The original buildings have long since been destroyed by fire, but a log cabin of more recent date still stands to mark the spot. Jasper Lake, which begins just above Rocky River, is a similar body of water to Brûlé Lake, five miles long and a mile in width. The long narrow sandy ridge that forms the eastern shore, cuts off from the main body of the lake a smaller sheet of water, between it and the base of the hills, called Fish Lakes. The sandy ridge is from a hundred yards to a quarter of a mile wide. Its present form is due to the agency of the wind drifting up the fine silty sand from the beach and dropping it on the top of the ridge. On the wider part of the ridge some hollows contain shallow ponds. About three miles up the lake the ridge is cut by a stream carrying the waters of Fish Lakes into Jasper Lake.

Site of Jasper House.

Jasper Lake.

The drifting action of the wind may be noted along the river for some miles above the lake forming very narrow ridges five to ten feet high along the banks and affording dry ground for the passage of a trail. On the east shore of Brûlé Lake similar action appears to be going on.

Drift action of wind.

The direction of the Athabasca valley from the outlet of Brûlé Lake to a point a few miles above Jasper Lake, a distance of twenty-three miles in a straight line, is S. 30° W. It then changes to S. 15° E. to Henry House a further distance in a straight line of nine miles. Snaring River coming in from the west, is the only important tributary on this last course. Henry House, or Athabasca Dépôt as it was called during the railway exploration, was situated on the west bank of the Athabasca half a mile above the mouth of Maligne River. Nothing is to be seen there at present except the ruins of its chimneys.

Site of Henry House.

Maligne River.

The Maligne River, flowing into the Athabasca from a direction S. 65° E., is a swift stream, unfordable except at a very low stage of water, and possesses no extraordinary features for the first mile and a half above its mouth. Then begins a narrow winding gorge from fifty to a hundred feet deep and fifteen to twenty feet wide. The rock walls at the top of the chasm have partly closed over since it was cut out and in places are almost touching, boulders lodged in the crevice apparently preventing them from closing altogether. On reaching the level of the valley above the gorge, 350 feet above the Athabasca, it is seen that the volume of water is only about one-eighth of that of the stream below. The remainder evidently flows through an underground channel the outlet of which can not be clearly distinguished. It appears to issue from several passages. Medicine Lake, drained by this stream, is eleven miles distant, and it is reported that the greater part of the water flows all the way by an underground passage, only the excess of water in flood-time and that of the small tributary streams being on the surface.

Underground channels.

Farming land near Henry House.

Two miles and a quarter below Maligne River, on the west side of the Athabasca, a piece of land has been taken up by Mr. Swift, who has demonstrated that the country is capable of producing wheat, potatoes, and various kinds of vegetables. On September 2 he had harvested a crop of two kinds of wheat and his potatoes were of good size and quality. A great part of the Athabasca valley would make good farming land, the higher ground, however, would require irrigation. Grasshoppers are in some seasons numerous enough to be troublesome.

Miette River.

Miette River, which comes from the Yellow Head Pass, joins the Athabasca five miles above the Maligne. Its course is almost due east. On the south side, mountains up to 8,000 feet above sea-level, rise with uniformly steep slopes from the river, broken into by two valleys carrying rapid tributary streams into the Miette. To the north, after the first rather abrupt rocky rise of 600 to 700 feet, there is only

a slight increase in elevation for three or four miles, leaving a long strip of flat country dotted with ponds and swamps, the eastern end of which has been called Caledonia valley. The timber on this side has been practically all destroyed by fire but on the south side considerable areas of green woods still remain. The trail ascending the Miette runs along the rocky ridges near the stream and through windfalls of small pine for a few miles, then descending to the river-flat it crosses the stream four times in a distance of three miles, in order to avoid steep rocky banks. The first crossing is too deep to ford except at low stages of the water. The fourth crossing is eight miles in a straight line from the Athabasca. Just below it two large tributaries fall into the Miette, one from each side.

Trail up the Miette.

A mile above this, the river-bottom widens and the stream takes a winding course through marshes and meadows, half a mile to a mile wide. Fourteen miles in a straight line from the Athabasca, Derr Creek the largest tributary of the Miette flows in through three separate mouths. The valley is here wider than elsewhere and the dry open tract of grassy land between the branching mouths of Derr Creek is known as Dominion prairie. For two miles farther the valley continues wide and flat, a soft marsh occupying the whole width, forcing the traveller to climb along the timber-strewn hillside and across angular rock-talus at the foot of cliffs. Beyond this the stream again takes a steeper grade and three miles from Dominion prairie it is crossed for the last time. The Miette is here scarcely one-third the size that it is near its mouth.

Upper part of Miette.

At the place where this last crossing is effected the channel is blocked by log-jams, and the stream is divided into several branches running among the trees. When the last of these branches is crossed it is suddenly realized that the summit of the Yellow Head Pass has been reached, as at high stages some of the Miette water empties by this branch into the waters of the Fraser River. The altitude of the pass is 3,723 feet above sea-level, according to the railway survey. It is distant seventeen miles from, and 400 feet above, the Athabasca River. The pass, and valley for some distance on each side of it, are covered with heavy spruce timber that has escaped fire so far.

Summit of Yellow Head Pass.

From the summit, the route follows the flat bottom of the valley inclining gently downward in a south-westerly direction to Yellow Head (or Cow-dung) Lake, distant two miles and a half from, and a hundred feet below, the pass.

Yellow Head Lake extends four miles south-westerly and has an average width of half a mile, with two narrows near the lower end.

Yellow Head Lake.

The route proceeds along the north-west shore, passing through a thick windfall of heavy spruce timber on the way. The principal feeder of the lake is a stream from the south-east coming in a third of the way down the lake. This stream has two branches, one on each side of a conical mountain 9,000 feet high standing three and a half miles back from the lake. For a long distance on each side of the pass, the bold cliffs of Yellow Head Mountain are prominently in view. It stands guard over the pass which bends southward around its base. From the summit of this mountain a good view is obtained up the Fraser River and it is seen to take its rise, as its muddy waters indicate, in glaciers on high mountains, some twenty miles to the south. Fifteen miles to the south-east, the black ragged peaks of Mt. Geikie, 11,000 feet high, are strikingly noticeable, while to the north castellated summits over 10,000 feet in elevation cut off a more distant view.

Mountain peaks.

Yellow Head Lake to Moose Lake.

A small stream a mile in length carries the water of Yellow Head Lake into the Fraser River, which is here a large rapid muddy stream, unfordable at this season. The trail leads down the wide and partly open valley of the Fraser which trends N. 60° W. from this point. The river hugging the base of the steep mountain sides to the south, leaves a gently-rising slope on the north, half a mile or more in width. A few miles down, the timber becomes larger and thicker and at a distance of twelve miles from the pass the first of the freshly burnt country begins. Black, burnt forest continues almost without interruption to Tête Jaune Cache, the greater part of it having been set on fire early this season (1898).

Fourteen miles from the pass, a large stream called Grant Brook flows in from the north. It is about fifty feet wide and very swift. Three miles below this Moose River comes in also from the north. This is a rapid stream 150 feet wide, but is easily fordable except at high water. The head of Moose Lake is situated two and a quarter miles below the crossing of Moose River.

Streams flowing from Selwyn Range.

The distance between this part of the Fraser and Canoe River is only eighteen miles south-westerly in a straight line. The intervening range of mountains, to which the name of Selwyn Range is given, delivers most of its waters into the Canoe and McLennan rivers to the south-east, leaving a precipitous descent on the other side from the watershed to the Fraser River. This slope to the Fraser yields numerous short streams none of which appear to be more than seven or eight miles in length. One stream that joins the Fraser between the mouths of Grant Brook and Moose River, affords a picturesque glimpse of a waterfall, a short distance from its mouth. Along the valley of this

stream and the opposite one flowing into Canoe River, named Price Creek, the Indians are reported to have travelled with horses, for a short cut from Canoe River to the Yellow Head Pass. A stream falling into Moose Lake near its head, with its opposite stream Avalanche Creek, makes another gap in this range, which although lower than the one just mentioned, has an elevation of over 6,000 feet above the sea.

Moose Lake.

Moose Lake that receives and sends the Fraser waters, without any change of direction, is seven and a half miles long and a mile wide near its head, narrowing gradually toward the outlet. The mountains to the south of the lake rise abruptly from the water's edge, while on the north a stony slope of moderate inclination runs back for a considerable distance, increasing to a mile or more at the western end, before the steeper rocky slopes of the Rainbow Mountains begin. No streams of any importance come in from the north, as Moose River, bending westward, drains the Rainbow Mountains from behind. Viewed from a distance these mountains have a gorgeous appearance of red and yellow and hence the name given.

Fraser River below Moose Lake.

Issuing from Moose Lake the Fraser moves slowly along in a wide stream for two or three miles, then it narrows and, taking a steeper grade, hurries rapidly downward. Two and a half miles below the lake, the old railway location line crosses from the north to the south side of the river. Some distance further on, the valley becomes more confined, as the mountains on the north side now close in upon the river, similarly to those on the south; and, at a distance of eight miles in a straight line from the lake, the trail is forced to seek a passage by a narrow foothold scooped out of the face of crumbling rock overhanging the river. Beyond this the valley opens out to a wide basin-like flat. In this flat and fourteen miles below the lake the first of two large northern tributaries, a mile and a half apart, joins the Fraser.

Grand Fork.

This stream, known as the Grand Fork, is 100 feet wide with moderate current and appears to be always easily fordable. There is said to be a lake on this stream about six miles up, and to it may be due the regularity of flow and the absence of any appearance of freshets. The westerly tributary called Swift-current River is an erratic turbulent stream fed by glaciers. It may sometimes be forded without difficulty in the morning and the same evening be utterly impassable.

Robson Peak.

Looking up Grand Fork is the most imposing view met with on the whole route. Great mountains are on every hand, but over all stands Robson Peak, 'a giant amongst giants and immeasurably supreme.' This, as well as the following, is from the description

of the mountain by Milton and Cheadle.* 'When we first caught sight of it, a shroud of mist partially enveloped the summit, but this presently rolled away, and we saw its upper portion dimmed by a necklace of feathery clouds, beyond which its pointed apex of ice, glittering in the morning sun, shot up far into the blue heaven above.' The top of the mountain is usually completely hidden and rarely indeed is it seen entirely free from clouds. The actual height of the peak is 13,700 feet, or 10,750 feet above the valley. The face of the mountain is strongly marked by horizontal lines, due to the unequal weathering of the rocks, and has the appearance of a perpendicular wall. From the summit to the base on the Grand Fork, a height of over 10,500 feet, the slope is over 60° to the horizontal.

Height of the mountain.

Although Robson Peak has been long known, its height had never been determined, nor was it supposed to be particularly notable in that respect, but now since the height of Mts. Brown, Hooker and Murchison have been proved to be greatly exaggerated, it has the distinction of being the highest known peak in the Canadian Rockies.

It is interesting to note that in a paper read before the Royal Society of Canada by Dr. G. M. Dawson the following paragraph occurs :—

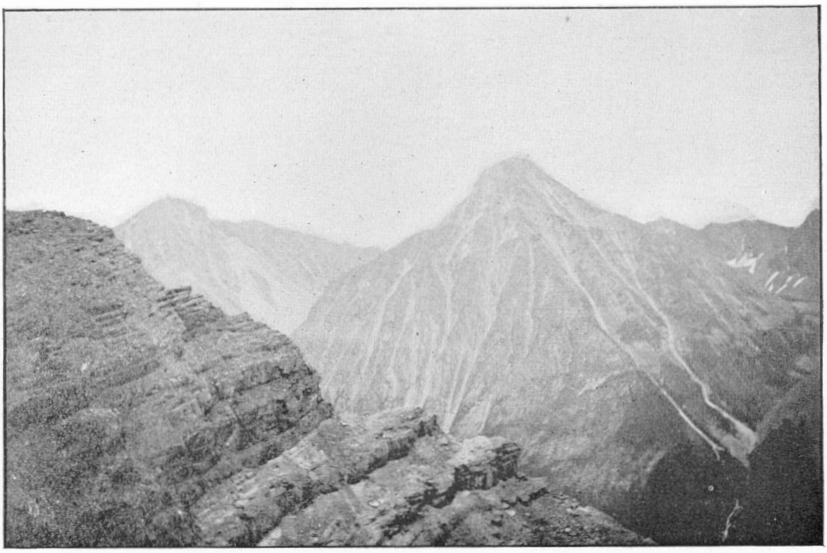
'The Kamloops Indians affirm that the very highest mountain they know is on the north side of the valley at Tête Jaune Cache, about ten miles from the valley. This is named Yuh-hai-has-kun, from the appearance of a spiral road running up it.' The mountain referred to is undoubtedly Robson Peak, as it is only fifteen miles north from the valley at Tête Jaune Cache. The 'spiral road' is probably an Indian's imperfect description of the horizontal lines on the face of the mountain. As far as can be learned no one, either Indian or white, has ever succeeded in reaching the summit.

Fraser River from Grand Fork to Tête Jaune Cache.

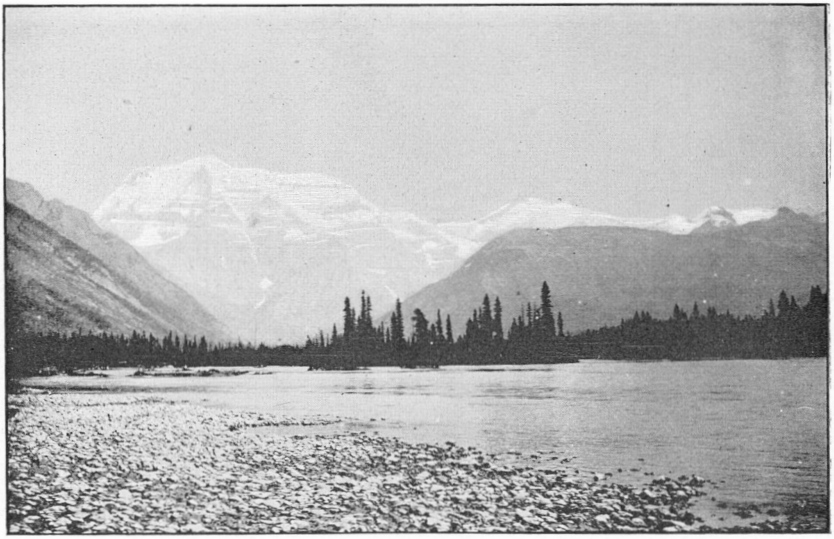
A little above the junction with the Grand Fork, the Fraser changes its course of N. 60° W., which it holds all the way from where it is first reached opposite Yellow Head Lake, to one of S. 40° W., for six miles, and then to due west for a further distance of five miles, to Tête Jaune Cache. The valley gradually narrows again during the first of these two courses, and on the last stretch the river is confined between high gravel banks, and toward the cache by low rocky bluffs.

At Tête Jaune Cache, the Fraser emerges into the great valley that runs from the 49th parallel to this point and continues beyond in the same general direction of N. 40° W. A good statement of the

* The North-West Passage by Land, pp. 252-253.



MOUNTAINS NORTH OF MOOSE LAKE, UPPER FRASER RIVER.



ROBSON PEAK, GRAND FORK, FRASER RIVER.

information to date concerning this valley is given by Mr. McConnell in the Annual Report for 1894, vol. VII. (N.S.) p. 18c, where it is described as 'one of the most important topographical features of British Columbia.' It preserves its main characteristics so well throughout, regardless of what stream occupies any particular part of its length, that here there is a striking resemblance to the part of it seen at Donald on the Canadian Pacific Railway. This portion of the valley has never been described before, but the description of Mr. McConnell, although given with particular reference to other parts of its length, is equally applicable here. The only alteration to be made is that the height of the Columbia-Fraser watershed should be 2,563 feet instead of 2,900. No rock-cutting is going on at the present time, but, as elsewhere in such cases, narrow secondary valleys are being cut out in the stratified gravels and sands.

McLenna River.

The Fraser now bends to the north-west along this valley, receiving a tributary, the McLennan River, from the south-east. The McLennan takes its rise in a shallow lake in the middle of the valley called Cranberry Lake, fourteen miles from the Fraser, but receives most of its waters from the adjacent mountains. It is about a mile from the eastern end of Cranberry Lake to the Canoe River, that comes in from the south-west and flows down the main valley, in the opposite direction to the Fraser, to join the Columbia River at Boat Encamp ment. The portion of the valley between the Fraser and Canoe rivers is much wider than its continuation in either direction, having an average width of four miles. It is very level from side to side and a cross-section would show only a gentle depression toward the centre The slightly more elevated strips of ground near the sides, are for the most part dry and sandy, covered with an open growth of small black pines, while the richer soil of the middle part shows much open grassy land, with some good spruce timber near the McLennan River.

Climate of valley.

The climate of the valley is drier than that of the upper part of the Fraser, as there is little rainfall during at least two months in the hottest part of the summer, but in the richer and lower lands there is sufficient moisture to produce good crops without irrigation. It is safe to say that at least a fourth of the area of the valley would make rich farming land.

The two principal tributaries of the McLennan River, fall into the valley a short distance below Cranberry Lake, the north-eastern branch, Swift Creek, being somewhat smaller than the westerly one, called Mica Creek, which takes its rise in the high glacier-clad mountains on the south-west side of the valley. On the north-east side, the mountains

Glaciers in Selwyn Range.

of Selwyn Range, rising to 8,000 and 9,000 feet above sea-level, have numerous small glaciers, and the streams are, however, all more or less laden with fine silt and mud. On the opposite side these conditions exist on a far greater scale and snow-clad and glacier-laden mountains rise higher and higher, far as the eye can reach in a south-westerly direction. Erosion is going on very rapidly. Every stream is choked with mud and detached fragments of rock are heard at short intervals crashing down the slopes. The height of several summits in these mountains was ascertained to be nearly 11,000 feet, and some of the more distant peaks appear to go beyond that figure.

Height of timber line.

The height of the limit of the growth of timber is, on the average, somewhat under 6,000 feet above sea-level. It varies a great deal, however, according to the exposed or sheltered nature of the place. In inner sheltered valleys the limit reaches an altitude of 6,500 feet and over, while the unprotected parts receiving the full force of the cold winter winds rarely have any timber above 5,500 feet and frequently not over 5,000 feet.

Cranberry Lake to Camp and Canoe rivers.

Canoe River is crossed near where it bends to the south-west, opposite the eastern end of Cranberry Lake. The water-level at the crossing is 135 feet below the level of Cranberry Lake and sixty feet higher than the Fraser River at the Cache. Cranberry Lake has an elevation of 2,563 feet above sea-level. Twelve miles distant, in a direction a little south of west Canoe River takes its rise issuing from beneath two great glaciers. Receiving several tributaries from similar sources, it is joined by Camp River two and a half miles above the crossing. Camp River comes from a low pass to the south-east, heading near Albreda Lake, the source of a tributary of the North Thompson River. The main branch of the North Thompson takes a circuitous course around and beyond the head of Canoe River just outside the south-west corner of the map. The passes leading from Canoe River to the North Thompson are occupied by large glaciers, and, owing to the extremely rugged character of the mountains, are difficult to cross. As a natural consequence of the glacier origin of Canoe River its volume changes rapidly with the temperature and amount of sunshine. During the hottest parts of the summer it is generally unfordable, but a few cloudy days so reduces the water that a passage is easily effected. At the date of our visit, in the latter part of August, it was necessary to swim the horses. Camp River, and Canoe River below the crossing, flow in opposite but parallel directions, five to six miles apart, and are separated by a high mountain ridge. The first summit on this separating ridge, called

Mount Thompson, has an altitude of 8,790 feet above sea. Viewed from Camp River this mountain presents a smooth and rounded appearance, but the opposite side is broken off suddenly by a sheer precipice of 1,500 feet with a glacier at its foot. Mount Thompson.

In order to continue the description somewhat in the order in which the explorations were carried out, it is necessary to break the thread of the narrative here, and return to the Athabasca River.

Route from Jasper Lake up Jack Creek to valley of Rocky River.

A route running S. 56° E., with the trend of the mountains, leaves the Athabasca at Jack Creek just above Jasper Lake. It was used by the Indians many years ago, when travelling between Rocky Mountain House and Jasper House. Besides affording the most direct course, it lead them through what was, at that time at least, a good hunting country. Ascending Jack Creek which is only six miles in length, the route follows the stony bed of the stream the greater part of the way. It then crosses a divide 5,600 feet above sea and further on crosses two more similar divides of 6,300 and 5,870 feet, with tributaries of Rocky River flowing northward between them. Descending from the third summit the trail reaches the outlet of a lake a mile long, which also drains northward into Rocky River. A branch route runs southward up the small stream falling into the head of this lake and through a gap leading to Medicine Lake six miles distant. The first lake mentioned is eighteen miles in a straight line from Jasper Lake. From this lake, the trail for three miles descends the stream draining it, and then turning more toward the east for a further distance of three miles, reaches Rocky River at a point distant nineteen miles from its mouth. For the latter part of this distance the trail is badly obstructed by fallen trees. Practically all the timber throughout the valley of Rocky River has been destroyed by fire, the fallen trunks now blocking and hiding the trail, which of late years has been little travelled. Crossing Rocky River the trail follows up the north bank of the stream which flows along a gravel-bottom for a distance of thirteen miles with moderate current and low banks. It is then confined between the rocky walls of a cañon a mile in length, having a fall at the upper end. The difference in level of the waters above and below the cañon is 200 feet. Four miles further up the river forks, the southern branch comes in with an elbow-like bend and its upper course is parallel to the main stream. This branch carries the greater part of the water. Valley of Rocky River.

Around the forks the valley is wider and flatter than any other part along the river. The altitude is 5,280 feet above sea. Following up Its upper part.

the stony bed of the other branch, for a distance of five miles the course is S. 80° E., then bending to S. 50° E. for a further distance of eight and a half miles, to the source of the stream in a small lake. Green timber begins shortly above the forks. It is small, however, owing to the altitude, and dies out altogether some distance below the lake.

Besides the fork mentioned there are numerous other tributaries, but none of them have any very great length, or important valleys. At the date of our visit in September their beds were for the most part dry. The whole course of Rocky River is remarkably straight, in fact it does not deviate anywhere more than a mile and a quarter from a straight line drawn from the mouth to the source. The mountains on each side of the valley, although broken into by the small lateral valleys, and varying somewhat in detail, present on the whole such a similarity of bare rocky slopes and cliffs, rising sharply at a uniform distance from the valley, that it is difficult to distinguish one part from another.

Southesk Cairn.

For some distance a conical hill is noticeable, standing directly in front, with a gap on each side between it and the bordering mountain ranges. On a near approach it is found to be a mile beyond the lake at the source of the river. This hill was named Southesk Cairn by the Earl of Southesk in 1863. The pass on the north side of it having an elevation of 7,500 feet above sea, is the lowest point on the divide between Rocky River and a branch of the Brazeau River flowing in the opposite direction.

Head-waters of Brazeau River.

The valley of the Brazeau on the other side of the summit descends rapidly, but without any cañon. The stream runs S. 60° E. for a distance of six miles, collecting the waters of several streams from the south, then turning to S. 80° E. and receiving the addition of a large branch from the south side, in a further distance of six miles it emerges from the mountains into a plateau country of between 5,000 and 6,000 feet elevation. Three miles to the east, the main branch of the Brazeau, which heads with the Athabasca near Brazeau Lake, also comes out of the mountains.

This plateau is a rich grass country, partly open, the remainder being only lightly covered with pine and spruce. It is slightly undulating, with a general slope to the north-east. The mountains rise abruptly out of this in a straight line of bare rock-cliffs, like a bold shore to a sea of green. There are no foot-hills along this part of the range, a fact accounted for by the nature of the uplift of the mountains which will be discussed in the latter part of this report.

Following a general course of N. 20° W., and gradually inclining away from the edge of the mountains the next stream of importance is nine miles distant. It is a branch of the north fork of the Brazeau. Its channel is narrow and straight with steep gravel banks 100 feet high. Two more branches of the north fork are crossed, distant three, and five and a half miles, respectively, from the first. The Forks of the Brazeau is thirty miles due east of the crossing of this last stream. The three branches of the north fork are about equal in size, being at this season (the end of September) about a foot deep and forty feet wide, but the first shows evidence of greater freshets in flood-time. Beyond the last branch the normal conditions, which usually obtain along the edge of the mountains, begin again in a long range of foot-hills having an elevation of about 7,000 feet, and running N. 60° W. with the trend of the mountains. The last branch drains the valley between this range and the mountains proper, and heads in the neighbourhood of the head of McLeod River.

Head-waters of Pembina River

Seven miles beyond this, in the same direction, a shallow stream twenty feet wide, was reached. This was followed down six miles in a north-easterly direction and proved to be the head-waters of the Pembina River. It barely enters the foot-hills, and cannot be considered a mountain stream. Between the last branch of the Brazeau and this stream, there is a low range of burnt hills, 500 to 600 feet high, but there is a low gap between the streams just outside the long foot-hill before mentioned. Owing to the amount of erosion in the Pembina valley lower down, it seems probable that at one time some of the streams, at present draining into the Brazeau, found their way through this gap into the Pembina.

All the plateau country traversed, that drains into the Brazeau, is fairly dry and open, but, on approaching the Pembina, as the distance from the mountains has been greatly increased, the direct action of the Chinook winds is not much felt, and the effect of a greater amount of moisture is seen in the numerous swamps and muskegs. An old Indian trail runs from where the south fork of the Brazeau was left, to the last branch of the north fork, and there is divided, one branch going up that stream, and another down. The route followed from there to the Pembina, without a trail, would scarcely be practicable in any but a very dry season.

It is three miles in a north-westerly direction from where the Pembina was left, to the head of a stream flowing into the McLeod River. The watershed is formed by low hills with extensive muskegs between. The stream just mentioned was followed with a course of

Head-waters of McLeod River.

N. 40° W. for a distance of six miles, when it is diverted from the direct course to McLeod River by intervening hills, and makes a right-angled bend by turning to S. 50° W. From this bend, it is six miles to the McLeod, across hills rising about 400 feet above the McLeod. Referring to the outline formed by the McLeod River as resembling a human face, the place now reached would correspond to the top of the throat. From this point to the "Leavings," the McLeod flows on a bed of gravel and stones, with uniformly rather steep grade, but without rapids or falls. The channel is nowhere worn down to bed-rock. Frequently the river is seen running against the foot of rock banks, but it does not appear to have in any place reached the bottom of the old channel, or to be making much progress in that direction. At the place where the McLeod was first crossed below the Big Eddy, it runs on solid bed-rock.

Geology.

The rocks met with in the district covered by this report are referable to the following formations :—

Tertiary—Paskapoo beds } Laramie.
Cretaceous— { Edmonton beds } Laramie.
Cretaceous— { Pierre and Fox Hill.
Devono-Carboniferous.
Cambrian— { Castle Mt. group.
Cambrian— { Bow River series.
Archæan—Shuswap Series.

General Description.

Rocks near Edmonton.

The rocks near Edmonton belong to the Edmonton beds of the Laramie, and are well described by Mr. Tyrrell in the Annual Report for 1886, vol. II. (N.S.) p. 107E *et seq.* They consist of black and white clay, clay-shale, coarse-grained gray sandstones, clayey sandstones, sandy shale and seams of lignitic coal. These rocks extend up the North Saskatchewan River forty miles above Edmonton, to Goose Encampment, where the top of the series is marked by two seams of lignitic coal ten feet each in thickness, separated by fourteen inches of dark clay-shale.

Drift deposits of country near Lake St. Anne.

The road from Edmonton via Lake St. Anne traverses a deeply drift-covered country, and no exposure of any formation older than glacial is to be seen. There is a great thickness of boulder-clay, nearly all the pebbles and boulders contained being gray quartzite derived from the Rocky Mountains. Boulders of Laurentian granite are numerous,

however, especially on the surface, and around Lake St. Anne boulders of yellowish-gray limestone holding Devonian fossils, and some of purplish-red quartzites or grit, are evidently derived from the Devonian area to the north and north-east.

At the crossing of the Pembina River the following section was seen :— Sections of rocks at crossing of Pembina River.

	Feet.	Inches.
Soft yellowish-gray sandstone with irregular seams of coal	12	0
Gray sandstone	1	0
Yellowish and brownish shale	9	0
Carbonaceous shale	1	0
Clay	0	6
Lignitic coal	6	0+
	29	6

These beds have a low south-westerly dip up stream. Half a mile above the crossing a seam of coal 13 feet 10 inches thick is exposed at the water's edge, overlain by four feet of impure coal. Above this is a tumbled and disturbed mass of carbonaceous shale and white clay, the result of the burning of a coal seam that lay above the one just mentioned. The clay is partly burned to a pale terra cotta. No trace of this upper seam can be seen at the present time. The fire which destroyed it burned for a number of years. The disturbance following the fire has made it difficult to trace the beds between the first section and the last, but judging by the attitude of the beds at the crossing they ought to underlie the large coal-seam of the second section. A little higher up the river on the north-west side the following section was measured :—

	Feet.	Inches.
Silty gravel	2	0
White boulder-clay	10	0
Covered	5	0
Carbonaceous shale	2	0
Lignitic coal	1	0
Clay	0	3
Lignitic coal	0	4
Impure coal	1	0
Carbonaceous shale	0	10
Lignitic coal	13	0
Covered	5	0
	40	5

In the thirteen-foot seam of coal in this section there are four small clay partings, amounting in all to nine inches. This seam is the same as that seen on the opposite side. Coal seam.

The west bank of the river at the crossing shows, at the water's edge, the same seam of coal that was seen on the east side, and is then

covered for a height of seventy feet, above which is seen fifty feet or more of thick beds of yellowish-gray sandstones. These sandstones considered alone would be assigned without much doubt to the Paskapoo beds, and when the previous sections underlying them are taken into account, the evidence seems conclusive that here is the junction between the Paskapoo and the Edmonton beds, the coal seams being on the same horizon as those at Goose Encampment.

Rocks of Lobstick River exposed in tributary.

Four miles west of the Pembina crossing, in the bed of the first small tributary of the Lobstick River, loose large slabs of yellowish sandstone are abundant, indicating the near presence of Paskapoo beds in place. Beyond this nothing is seen but the surface deposit of yellowish-white sticky clay, until two miles east of Coldwater Creek, where the northern end of a terrace-like ridge is crossed. The soil on this ridge is coarse brownish-yellow sand and seems to be locally derived from the Paskapoo sandstones that appear to underlie the greater part of the country between the Pembina and McLeod rivers.

Esker between Wolf and Moose rivers.

White clay continues to a point midway between Wolf and Moose creeks, called the Sand Hills, where a long esker commences. It is fifteen to thirty yards wide and five to fifteen feet high running N. 65° W. in a remarkably straight course, for a mile and a half, then turning to nearly due west and sending off two branches in a direction of N. 60° W. There appears to be several adjacent ridges running parallel to these branches separated only by narrow strips of muck swamp. These ridges are composed of very fine sand without any pebbles.

Limits of eastern drift.

The eastern drift extends to within two miles of the Sand Hills, or about a mile west of Wolf Creek, up to which point boulders of pink-coloured Laurentian granite are sparingly found. Beyond this point toward the west no drift was seen, except that derived from the Rocky Mountains. The boulders in this western drift are almost entirely composed of gray quartzite many of them rusty-weathering, with a few fragments of quartz-conglomerate. On a nearer approach to the mountains boulders of limestone, which apparently are not able to stand the wear and tear of long travel, begin to form an appreciable proportion of the drift.

Half a mile below the crossing of McLeod River the following section was seen :—

Section of Edmonton beds.

	Feet.	Inches.
Yellowish silty sand	3	0
Coarse yellowish-gray sandstone	50	0
Gray friable clay-shale	2	0
Carbonaceous shale	0	6
Lignite	0	6
Soft gray sandstone, some clayey bands, false-bedded	30	0
	86	0

The gray friable clay-shale contains petrified wood and fossil plants The beds are horizontal. There is nothing to be seen that would clearly show what is the age of these beds, but on account of their geographical position and the presence of soft clayey sandstones, they are doubtfully assigned to the Edmonton beds of the Laramie.

Beds near Big Eddy.

A mile above the Big Eddy on the McLeod, there is an exposure of fifteen feet of gray sandstone with nodular structure, overlain by eight feet of soft yellow and gray shales with irregular seams of lignite, the whole capped by thirty feet of yellowish boulder-clay holding small quartzite pebbles. At the upper crossing of Sun-dance Creek, five miles north-east of White Mud, ten feet of yellowish sandstones are exposed. They weather easily and show unequal hardening similar to those above the Big Eddy.

Section near the "Leavings" on McLeod River.

Six miles above the "Leavings" of the McLeod, an exposure on the east side of the river was seen from the opposite bank, and estimated as follows :—

	Feet.
Yellowish and gray sandstones with harder layers and nodules..	20
Gray shale....	5
Gray sandstone....	8
Yellowish-gray clay-shale....	6
Yellowish-gray sandstone, nodular....	10
Gray clayey sandstone with thin carbonaceous seams at top.....	7
	56

Surface deposits on McLeod-Athabasca watershed.

The watershed between the McLeod and Athabasca rivers is deeply covered with yellowish silty boulder-clay, having only a few small pebbles of quartzite. On the surface there are numerous large boulders of blue and gray limestone and some very large ones of quartz-conglomerate with pink coloured quartz pebbles. The latter are derived from the Cambrian rocks of the mountains, and although the nearest locality where they are found in place is fifty miles distant, the boulders are generally not much worn. Two and a half miles west of the "Leavings" a very distinct moraine occurs, running S. 5° E. and S. 50° W., in an angular form. It is composed of light-gray and rusty quartzite and quartz conglomerate, all from the mountains. Beyond the summit of the watershed a small stream has cut a channel eighty feet deep in the boulder-clay without reaching the solid rock.

Terraces in valley of Athabasca River.

Four miles from the Athabasca River and 650 feet above it, the surface soil becomes gravelly, indicating the presence of a body of water at some time, and across the river a long distinct terrace is visible with an elevation of 200 feet or more above this place or 4 000 feet above sea. Several lower terraces can be seen, the most extensive being 300

feet above the Athabasca. The receding waters must have remained for a long time stationary at that level, as the terrace is over a mile wide in places, and can be seen distinctly for a long distance up and down the valley.

Section on Sandstone Creek.

On Sandstone Creek, two and a half miles from the mouth, there is an exposure of hard rather coarse-grained sandstone, and near the mouth of that stream the following section was examined :—

	Feet.	Inches.
Silty soil (variable)	2	0
Boulder-clay, small pebbles	50	0
Irregular thickness of coarse yellow sand	4	0
Boulder-clay, quartzite-pebbles	20	0
Covered	8	0
Light-coloured sandstone with calcite in joints, one clayey band	6	0
Covered	10	0
Dark-gray shale	3	0
Yellowish-gray sandy shale	2	0
Sandstone	2	0
Gray shale	0	6
Gray sandstone	0	6
Carbonaceous shale	2	0
Dark-gray thin-bedded sandy shale	4	0
Covered	30	0
Gray clayey sandstone (fossils)	3	0
Yellowish-gray sandy shale, jointed	4	0
Soft gray sandstone	1	0
Sandy shale	1	6
Rather dark clay-shale	3	0
Soft shaly sandstone	4	0
Yellowish and bluish shale with irregular sandstone	5	0
Dark clay-shale	6	0
Bluish-gray clay-shale and irregular clayey sandstone	20	0
Gray sandstone false-bedded (part covered)	80	0
Bluish-gray clay-shale	4	0
Soft yellowish sandstone	4	0
	279	6

This section was not all seen in the one place, but it is believed to fairly represent the sequence of beds. Among the fossils obtained from the bed of clayey sandstone were the following :—

Physa Copei
Patula sp.
Zonites or *Conulus*
Fossil plant apparently *Taxites.*

Mr. Whiteaves who examined these, as well as the other fossils collected during the season, finds that they correspond with those found elsewhere in the lower division of the Laramie. This division of the

Laramie, called the Edmonton beds, is placed in Mr. Tyrrell's report, at the top of the Cretaceous.

Rocks of Prairie Creek.

Beyond Sandstone Creek no exposures are seen until Prairie Creek is reached, except the cut-banks of coarse gravel at streams. On the banks of that stream what looks at first sight to be a coarse pebble beach, is found to be a conglomerate composed of round quartzite pebbles, from one to three inches in diameter. The softer matrix of green sandstone having weathered away leaves nothing showing on the surface but the pebbles. To the north of this conglomerate, in a cañon half a mile in length, a section is exposed showing greenish sandstones and black shales dipping at angles of from 60° to 90°, and striking N. 65° W. At the southern end of the section the following beds are seen :—

	Feet.	Inches.
Stratified gravel and sand	4	0
Thin gray sandstones	4	0
Yellowish-gray shale, nodular, with irregular beds of greenish sandstone and two very small irregular seams of lignite	10	0
Lignite	0	4
Carbonaceous shale	2	0
Covered	3	0
Greenish sandstone	2	0
Slaty, jointed, friable shale	1	0+
	26	4

South of this section, beds of greenish sandstone and black shale alternate, the former increasing in proportion for a quarter of a mile when the rocks are almost all sandstone. Farther on the shales increase for 100 yards, but again the sandstone preponderates to the end of the exposure. The sharp folding which probably causes a repetition of some of these beds, gives the first evidence of the disturbance accompanying the uplift of the mountains.

In ascending Prairie Creek several exposures of alternating beds of greenish sandstone and conglomerate were seen, in descending order. The pebbles in the conglomerate are almost exclusively quartzite, a few only of slate were observed. The strike of these rocks is N. 65° W. the same as the last and the dip northward. In one place a dip of 60° was observed, but elsewhere it is from 20° to 30°. Beds of shale may occur here also, as the interval between exposures is considerable, and the erosion, which has been very great, would remove a greater proportion of such soft beds. Near where the route leaves Prairie Creek, the latter comes out of the hills from a lateral valley, and this may be termed the 'gap' of the stream. Opposite the gap there are no exposures, but on the hills to the north of it the same rocks are seen

dipping northward at low angles. All these rocks on Prairie Creek correspond to the Pierre shales and Fox Hill sandstones of the Cretaceous. The junction betwen them and the Edmonton beds seen at Sandstone Creek is covered. It is probably only a short distance below the mouth of Prairie Creek.

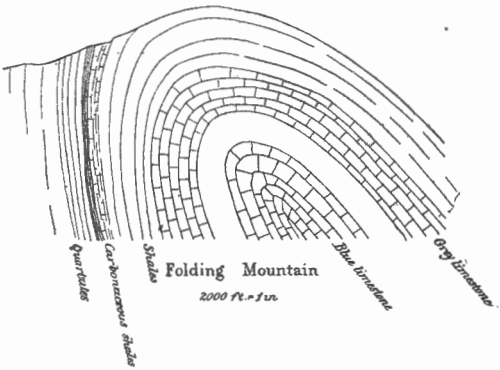
Rocks of Folding Mountain.

South of Prairie Creek, Folding Mountain, the first foot-hill of the Rockies rises, bringing up limestones, and siliceous shales and quartzites, in a sharply folded slightly overturned anticline. The following section was seen in descending order :—

	Feet.
Gray quartzites	200
Black carbonaceous shale	60
Dark flaggy limestone	100
Yellowish fine-grained siliceous shales with calcareous shales and some calcareous sandstone	500
Fine-grained gray and yellowish limestone highly siliceous, with a few bands of dark quartzite	500
Covered	300
Fine-grained blue limestone	500+
	2160

Among the fossils obtained from these limestones are a *Syringopora* like *S. perelegans*, and another like *S. nobilis*, simple corals, brachiopods and crinoid stems. According to these the rocks could be placed in the Devonian or possibly the Carboniferous, but as Carboniferous rocks are known to have been laid down in these mountains, by the fossils collected later on, it would be necessary to assume an overthrust, far greater than there is any appearance of, in order to bring up the Devonian rocks without showing the overlying Carboniferous beds. The following figure shows the attitude of the beds in the section just given.

Fig. 1.



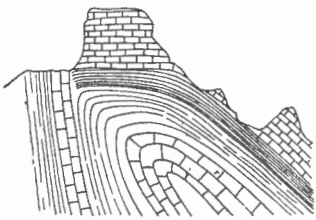
On the opposite side of the Athabasca, west of Brûlé Lake, in Bullrush Mountain, similar rocks have been folded in the same way, but a thrust from the south causing two lines of fracture, has as a result given a more complicated appearance. The strike of the rocks on both sides of the river is N. 65° W. The next mountain between Drystone Creek and Fiddle Creek shows a great thickness of limestone, with a fault running with the strike of the rocks, a little to the north of the summit. The plane of faulting dips to the south at a high angle. Shales appear to occupy the western flank, and some miles back from the river, along this mountain, numerous folded outliers of these rocks are seen among the limestones. Rocks of Bullrush Mountain.

Roche Miette, a notable landmark that is prominently in view for a long distance, stands on the east side of the Athabasca a few miles below Jasper Lake. It is the abrupt termination of a range of mountains over 8,000 feet above sea. Viewed from directly in front its upper portion has a roughly cubical form with an almost vertical face of 2,000 feet. The rocks seen in this mountain are given in the following section :— Rocks of Roche Miette.

Compact fine-grained blue and gray limestone	2000
Black shales with round nodules of iron-pyrites	400
Hard sandy shales	100
Brownish and reddish sandy shales say	300
Blue limestone with irregular cherty bands	500+
	3300

Figure (2) shows the arrangement of these beds.

Fig. 2.



Roche Miette

From the lower part of the upper limestone in this section the following fossils were collected :—

Atrypa reticularis.
Dyphyllum sp.
Cyrtina sp.
Spirifer (or *Spiriferina*) sp.
Cast of elongated spiral gasteropod.

Devonian fossils.

The age of the rocks in the above section is, according to these fossils, Devonian. All of the beds appear to be of a lower horizon than those seen in Folding Mountain. The black shales with nodules of iron-pyrites, disappear with a high dip to the south, but come to view again in a small exposure two and a half miles below the mouth of Rocky River. They are seen also on Stony River on the opposite side of the Athabasca in a series of small sharp folds.

Breaks in section.

Above Rocky River, large gaps occur in the section, caused by the deep lateral valleys, and as these valleys are generally arranged in opposite pairs, the exposures on one side do not supplement those found on the other. These breaks, and the similarity of beds of different horizons, renders it difficult to form an accurate idea of the thickness of rocks occupying this part of the valley. There appears to be a great thickness of alternating bands of blue-gray limestone and brown rather crystalline dolomites. The limestones are fine grained, and have numerous cherty bands, mostly white and irregular, but some bands of yellow chert reach a thickness of ten feet. Among the fossils contained in the limestones are the following :—

Athyris Angelica var. *occidentalis.*
Leptœna rhomboidalis.
Orthis, sp.
Aviculopecten, sp.
Pentremites, sp.
Streptelasma rectum ? Hall.
Spirifer, sp.

These are classed as probably Devonian. The dolomites are unfossiliferous. They weather out on the vertical faces to an uneven pitted surface.

Section from Snaring River to Henry House.

From a point two miles north of Snaring River, there is a section in ascending order to Henry House, with possibly a fault at Snaring River. The rocks in this section appear to overlie the last ones mentioned. At the base, comes a series of limestones, including thick beds of fine-grained bluish, light-gray cream-weathering, whitish crystalline with cherty layers, dark flaggy, white and brownish dolomitic varieties in ascending order with a total thickness of at least 5,000 feet. These are all on the north side of Snaring River, and, according to some fossils obtained, are probably Devonian. South of that stream is 800 feet of thin-bedded quartzite, yellowish-weathering dolomitic quartzite, siliceous shales and beds of gray limestone. Above these at Swift's, three miles below Henry House, is a cliff of dark-brown crystalline dolomite of medium texture. The thickness of the dolomite is about 700 feet.

Above the dolomite on the hills west of Swift's, blue and gray fine-grained limestone appears to have a thickness of 700 feet or over. The limestone was not seen continuously and possibly other beds are included here. About 500 feet above the highest part of the limestone is seen an exposure of black shales and flaggy cream-weathering limestone, from which the following fossils were obtained :—

Reticularia setigera ?
Productus, (very finely ribbed).
Spirifer, sp.
Dielasma, (cf. *D. Formosa*, Hall).

These are definitely classed as Carboniferous. Three-quarters of a mile above Henry House, the blue limestones underlying the fossiliferous beds described above, which are exposed near the river, are cut off by a fault, and no trace of any Carboniferous or Devonian rocks is found west of this point. The sudden disappearance of these beds is exactly similar to that of the Banff limestone, described by Mr. McConnell on the 51st parallel.* In both cases it 'seems to have been entirely swept away by the tremendous denudation to which the whole chain, but especially the western part, has been subjected.' Great fault.

The rock brought into contact with the limestones by the above-mentioned fault, is a hard conglomerate with pebbles seldom exceeding half an inch in diameter, and frequently so small that the rock might be called a grit. The pebbles are well rounded and consist of pinkish, milky, and semi-transparent quartz with similar pieces of greenish felspathic and chloritic rock and a little white felspar. There is a slight development of fine pale mica or talc. The rock is so typical of the Bow River conglomerates that the description of these given by Dr. Dawson in the Annual Report for 1885, vol. I. (N.S.) p. 159B, would be equally applicable in this place. Associated with these and underlying them, on the Miette River, are fine-grained conglomerates which have been squeezed out to a schist with a great development of pale mica. They weather easily, scaling off in layers along the plane of schistosity. Interbedded with these are gray and greenish-gray slates, with an abundance of small scales of mica and distinct slaty cleavage. The Miette River follows approximately the summit of a broken anticlinal fold in these rocks. These rocks have been highly altered and are now filled with a reticulation of small quartz veins, and some larger veins of two feet or more in width. For the greater part these are white and barren, but in places the cavities in the weathered surfaces show that they contain a good deal of iron-pyrites. Some claims have Bow River series. Quartz veins.

* Annual Report, Geol. Surv. Can., vol. II. (N.S.)1886, p. 19 D.

been staked out and a certain amount of work has been done. Assays of eight dollars to the ton are reported. Higher up the Miette, above Dominion prairie, 'colours' of gold can be obtained in the gravels. Its origin is probably in these rocks. Underlying the rocks just described is a great thickness of argillites, varying in colour from dark-gray to black, associated with some dark thin-bedded calcareous sandstones. The latter are considerably altered, and show an abundance of mica scales throughout. They were not, however, observed to cleave in any direction but parallel to the bedding. These rocks are also referable to the Bow River series, and correspond closely with the lower part of it. They also resemble the rock of the Nisconlith series of the southern part of British Columbia, which are of the same age.

Gold in gravels.

Rocks of Castle Mountain group in upper part of Yellow Head Mountain.

Above the highest part of the Bow River conglomerates seen in Yellow Head Mountain, no exposures were seen for a height of 1,400 feet. There is then exposed 200 feet of flat lying beds of rusty-weathering light-gray crystalline dolomite, overlain by 1,400 feet of light-gray crystalline dolomite, overlain again by 1,400 feet of gray quartzites to the top of the mountain. Both the dolomites and quartzites occur in thick beds, and the latter is of very fine texture. These beds may belong to the horizon of the Castle Mountain group of Mr. McConnell's section, or possibly to the upper part of the Bow River series. They are, however, always distinctly separable from the other rocks of the last-named series. The mountains on the south side of the pass show the same arrangement of rocks, the rusty band of dolomites toward the base being capped by the darker quartzites.

Between Grant Brook and Moose River.

The Fraser River appears to run the greater part of the way to Tête Jaune Cache on rocks of the same horizon as the Bow River series, and to have cut its valley along an anticlinal fold of these rocks. The south side of the valley was not examined owing to the unfordable character of the river, but the rocks appear to have a low dip toward the south. On the north side exposures near the bottom of the valley are very rare. A mountain on the north side between Grant Brook and Moose River, gave no exposures for the first 2,000 feet above the river, then gray quartzites were exposed dipping N. 25° E. at an angle of 70°. They are in beds two to three feet thick, with slaty partings, and continued for a thickness of 2,000 feet. Then comes a thickness of 1,200 feet of limestones and slates. The limestones include thin-bedded dark-blue, pinkish crystalline, and cream-coloured crystalline varieties. Above these is 1,200 feet of gray quartzites, with slaty partings very like the first ones seen. Overlying the quartzites is 3,000 feet of limestones and yellow schists. The

limestones are mostly flaggy, dark-blue and yellowish-weathering, and alternate with banded gray and yellowish sericitic schist. The rocks of this section correspond well with those of the Castle Mountain group. The quartzites at the bottom, which are undoubtedly the same horizon as those seen in Yellow Head Mountain, appear here to belong to the upper, rather than the middle, division of the Cambrian.

Rocks on Grant Brook.

An exposure near the mouth of Grant Brook shows disturbed and crumbling, greenish chloritic schists, striking N. 75° W. with the dip of schistosity toward the south, varying from 30° to 90°, and the dip of bedding, as seen in one place, 30° to the north. The schist weathers easily to a greenish clay, and is in places coated with ferric hydrate. Several quartz veins were seen up to a foot in thickness, showing slight signs of iron and containing some pearl spar. One of the specimens showed a coating of alunogen. The isolated nature of the exposure leaves uncertainty as to the age of the beds.

Rocks near Moose River.

Near the crossing of Moose River, bluish-gray and white, rather crystalline limestones are exposed, and a few miles below this, massive beds of gray quartzites are followed by squeezed talcose schist and hard, banded, yellowish and gray, thin-bedded schists, which are exposed near the head of Moose Lake. The strike of all these exposures is N. 65° W. and the dip varies from vertical to 70° to the north.

Rocks of Rainbow Mountains.

A mile and a half below the outlet of Moose Lake, the slope of Rainbow Mountains, although not affording a continuous section, shows near the bottom a considerable thickness of black and gray argillites, followed by gray quartzite and smooth greenish slate, and beyond this, after a wide break in the section, a thickness of at least 500 feet of quartzite, followed by 1,200 feet of black argillite, to the summit. The quartzites are coarser grained than any previously met with, and contain sufficient iron to weather out to brilliant red colours. Quartz veins are numerous in the argillites at both the top and bottom of the mountain. To the north of the summit, across a valley, thick beds of dark-coloured rock are seen, overlain by dark and yellow banded rocks looking like those seen on the mountain between Grant Brook and Moose River. The appearance of these rocks beyond the summit, makes it seem probable that those seen on the slope of the mountain, are of middle Cambrian age, the coarser quartzites perhaps representing the conglomerates seen elsewhere in that series.

Between Moose Lake and the Grand Fork of the Fraser River, several exposures were seen of black argillites and light-gray schists containing crystals of iron-pyrites. In the cañon north of the Grand Fork

these are interbedded with dark flaggy limestone. The strike continues about the same, N. 65° W., with a dip of 50° to 70° to the north.

Character of rocks between Grand Fork and Swift Current River.

The mountain between Grand Fork and Swift current River is composed of greenish and gray schists, with fine-grained schistose conglomerate near the bottom, the latter in beds six feet thick. Toward the summit there are black argillites in great thickness, with thick beds of gray talcose schist, dark flaggy limestone and slightly schistose conglomerate. Specimen No. 86 from the top of this mountain was taken from a part of the conglomerate where the pebbles are smaller than usual. A slide cut from this specimen has been examined by Dr. Barlow who gives the following description of it:—

Description by Dr. Barlow.

'Under the microscope the rock is seen to be a rather typical arkose or quartzite-grit. It is composed of comparatively large individuals of rounded or sub-angular grains, chiefly of quartz, with a much smaller proportional amount of orthoclase and plagioclase. These are embedded in a ground-mass much smaller relatively in quantity, made up of smaller fragments of these minerals together with a large amount of pale-yellowish sericite in minute irregular scales, most of which, at least, has resulted from the decomposition of both the orthoclase and plagioclase. Irregular patches of hydrous iron-oxide, which have evidently been derived from the decomposition of some ferruginous carbonate, are rather abundant. Occasional fragments and crystals of zircon were also noted. The quartz is of the usual granitic varieties, with dust-like and other inclusions. Some of the quartz shows undulous extinction very beautifully, as a result of pressure. Both plagioclase and orthoclase show considerable alteration to sericite.' The base of Robson Peak is probably composed of rocks similar to those last described, while the upper portion appears to consist of banded black and yellowish limestone and yellow schists, resembling those seen between Grant Brook and Moose River. The strongly marked horizontal lines on the face of the mountain are due to the unequal weathering of these rocks. If the fine-grained quartzites continue this far westward, they should appear between these two series.

Strike of rocks below Moose Lake.

As far down as the Grand Fork, the Fraser follows the strike of the rocks along an anticlinal fold, the rocks on the south side dipping away from the valley at low angles while the dips on the north are much steeper in the opposite direction. On the south-western stretch of the river from Grand Fork to within four miles of Tête Jaune Cache, it cuts across the strike almost at right angles, exposing a great thickness of highly altered schistose rocks that appear in all cases to have

been originally arkose. The lowest rocks in the series are seen about Swift-current River. Below that point there is an anticline followed by an ascending series for four miles, and then a synclinal fold bringing up the beds again, so that those seen at Tête Jaune Cache are not very far above the horizon of the beds at Swift-current River.

Description of rocks from near Tête Jaune Cache.

Specimen No. 90, from a point two miles above the Cache, and No. 91 from the south bank of the Fraser at the Cache, have been examined by Dr. Barlow, who gives the following description of them :—

'No. 90 is an arkose, which has been subjected to pronounced dynamic action. The larger quartz and felspar individuals may still be detected, but a marked foliation or schistosity has been induced in the rock as a result of pressure, the cleavage-planes being coated with silvery scales of hydrous muscovite or sericite. It has undergone advanced recrystallization, so as to mask its original character, and under the microscope presents a mass of interlocking grains of quartz orthoclase and plagioclase in which may still be detected the remains of larger individuals of the same minerals. Biotite is quite abundant and in a lesser amount sericite. Zircon is also present. The rock has been subjected to such a degree of pressure that the larger individuals are often broken up into a fine mosaic of interlocking grains. Some have not yielded completely, but are very badly shattered, while the individuals, which are as yet unbroken, show very pronounced strain shadows.

'No. 91 is very like No. 90, and has also been subjected to pronounced pressure with recrystallization. It contains a considerable amount of hydrous iron-oxide running with the foliation, which seems also to have been derived from the decomposition of some iron-bearing carbonate. Its clastic structure is masked somewhat by the recrystallization, but taken in conjunction with the preceding specimen its clastic character seems undoubted. Sericite is not so abundant. Occasional crystalline fragments of brown strongly pleochroic tourmaline was noticed as also fragments of apatite.'

Cleavage cutting across bedding.

Contrary to the changing dips of bedding, the dip of schistosity in these beds is constantly to the south at angles of 50° to 70°. Near Tête Jaune Cache, where some minor folds in the rocks were seen, the planes of cleavage cut across the curved lines of bedding like the vertical lines in the sign used to designate dollars ($).

These rocks are of Cambrian age, and probably belong to the same horizon as the Bow River series.

Rocks of mountains on east side of valley of McLennan River.

Eight miles south-east from the Cache, the mountains on the north-east side of the valley show at the bottom 4,000 feet or more of hard schistose conglomerate with pebbles of semi-transparent bluish quartz and milky-white felspar, dipping N. 25° E., at an angle of 30°. Above these is a thickness of 2,500 feet consisting of, banded gray and yellowish sericitic schist with patches of a black iron-mica probably biotite, and some crystals of iron-pyrites, a coarser grained sericite schist (Specimen No. 97) including beds of thinly-laminated broadly-cleavable sericite-schist and dark flaggy limestone.

Specimen No. 97 is described by Dr. Barlow as follows :—

'No. 97, a sericitic schist. It is a quartz-felspathic sandstone which has been altered as a result of pressure and recrystallization. It is now an interlocking aggregate of quartz, orthoclase and plagioclase, in somewhat uniform grains whose longer axes correspond with the marked foliation of the rock. Sericite and chlorite are likewise present in considerable amount in small irregular scales, running with the foliation. A ferruginous carbonate, most of which is decomposed to hydrous iron-oxide, is also abundant. Tourmaline in brown strongly pleochroic fragments is also rather plentiful, while some individuals of zircon were noted.'

Quartz veins.

These rocks occupy the upper portion of the first mountain in the form of a low syncline. They are all highly altered, the planes of schistosity running N. 65° W. and dipping toward the south at a high angle. A series of secondary cleavage or jointage planes run N. 25° E. vertical. Quartz veins are very numerous in these rocks, fifteen were counted in less than a mile. They vary from one to five feet in thickness and run with the secondary cleavage. All of them show more or less decomposed iron. Assays of some specimens did not show any mineral of value.

Another system of quartz veins is developed parallel to the principal cleavage-planes. None of these were seen of a greater thickness than one foot, and they do not seem to have the same persistence as the larger veins. Specimens were collected showing a small percentage of galena which proved to be argentiferous.

Argentiferous galena.

Just beyond the summit of the first mountain, and three and a half miles north-east from the main valley, there is an anticlinal fold of highly quartzose schists. These are only exposed for a short distance when their dip carries them out of sight, but they reappear two miles farther to the north-east, on the summit of the next ridge. On this ridge the quartzose schist gradually merges into hard conglomerate

holding pebbles of quartz and felspar and some larger fragments of black argillite. A specimen (No. 101) of the finer-grained portion of this rock was examined by Dr. Barlow, who gives the following description of it :—

'No. 101 is a light-gray sandstone, very similar to No. 86 (p. 34D) only less massive, while it contains abundantly disseminated small crystalline fragments of a ferruginous carbonate. Under the microscope its clastic structure is undoubted. It is composed of comparatively large individuals of quartz, orthoclase, plagioclase and microcline in a cement made up of the same minerals in a finer state of division, together with a considerable amount of minute irregular scales of sericite. The ferruginous carbonate mentioned above, shows characteristic high relief and brilliant polarization, and marked pleochroism almost colourless to pale-brownish, this property being most pronounced in the darker coloured individuals. Incipient alteration to yellowish iron-oxide may be noticed. It occurs in irregular crystalline aggregates with rhombohedral cleavage, occasional scales of biotite were noticed, as also some rather large crystals of zircon.'

The quartzose schist before mentioned as associated with this rock contains some crystals of iron-pyrites and pale-red garnet. The intervening low synclinal trough between the two ridges is occupied by rocks similar to those near the top of the first mountain. They have been here even more altered than in the first place, and consist chiefly of shiny lead-gray wrinkled sericite-schist and fifty feet of cream-coloured crystalline limestone.

Rocks of mountains east of Cranberry Lake.

The mountains east of Cranberry Lake show the same general sequence of beds as the first mountain. At the bottom there are yellowish-weathering coarse glittering schists with some large pebbles of quartz. These are evidently highly altered squeezed conglomerates. Dr. Barlow makes the following statement about a specimen collected here :—

'No. 100 is a rusty-weathering quartz-felspathic schist. It has undergone much deformation as a result of pressure, and its original grains have been greatly rolled out and granulated. The clastic nature of the rock is quite apparent despite the metamorphism. Sericite is present, though not very abundant, and is confined chiefly to the planes of cleavage as it has resulted from the shearing of the felspar. Iron-oxide is abundant, and has resulted from the decomposition of an iron-bearing carbonate. The rock is composed chiefly of quartz with a smaller amount of orthoclase and plagioclase.'

Above these beds are gray talcose schists wrinkled and squeezed, with a great thickness of gray and black argillite also wrinkled, and talcose between the layers. The top of the mountain is composed of hard gray schist, highly micaceous. In all these rocks above the altered conglomerates there are veins of quartz, slightly rusty. An adjacent mountain to the south-east, near the top is composed of black argillites, lead-gray sericite-schist and dark flaggy limestone. The argillites are rusty and micaceous. Several veins of rusty quartz were noted.

Traces of gold

Colours of gold can be found in most of the streams on the north-east side of the valley, and it is also reported that gold can be found in tributaries of the Fraser River.

Horizon of rocks of western slope of Selwyn Range.

The rocks just described on the north-east side of the valley between Tête Jaune Cache and Canoe River, are undoubtedly of Cambrian age. The squeezed conglomerate of the lower part of the series may be without much hesitation assigned to the horizon of the Bow River series, while the overlying schists and argillites probably belong to the same series but may include, toward the top, beds of the upper division of the Cambrian or Castle Mountain group.

Throughout the district so far described, the rocks are all stratified and no granite or other plutonic rocks were seen. It is safe to say that none such exist anywhere in the vicinity of the route traversed. Neither were any rocks of Archæan age met with, although gneiss was reported by Sir James Hector to occur on the Athabasca near the mouth of the Miette River. The fine-grained schistose conglomerate existing there, was probably mistaken for gneiss in the hurried examination made while travelling in the winter.

Archæan rocks of Mica Mountain.

On the south-west side of the valley, opposite Tête Jaune Cache, on Mica Mountain a great series of mica-schists are found dipping S. 45° W. at angles of 30° to 50°. This series includes dark glittering mica-schist, easily weathering, thinly foliated garnetiferous mica-schist, with a high percentage of mica and garnet, hard garnetiferous mica-schist in massive beds, bands of dark fine-grained micaceous rock apparently of eruptive origin, and layers of fine-grained gneiss which in some instances at least, is certainly intrusive. The whole series while differing somewhat from the Shuswap series of the southern interior of British Columbia, shows the main characteristics of that series and may be classed as such. The age of this series as given by Dr. Dawson is Archæan. The wide valley intervening between these rocks and those of Cambrian age opposite, is covered by superficial deposits and hides the line of contact. It would be necessary to

assume a great fault along this valley to explain the altitude of the rocks of the Shuswap series, if the apparent dip of these rocks were the real dip of the original bedding, but such is not the case. The rocks are extremely foliated and all trace of the original bedding is destroyed. This foliation is roughly parallel to that seen in the Cambrian rocks across the valley where the original bedding could still be distinguished. As it was there entirely independent of the dip of the bedding, it cannot here be taken to have any significance in the determination of the thickness of the formation.

Correlated with Shuswap series.

Pegmatite veins are of frequent occurrence in the garnetiferous mica-schists, some of them having a thickness of over fifty feet.

Constituents of veins at Bonanza mica mine.

The ordinary constituents of these are, quartz, triclinic felspar and muscovite. In addition to these they sometimes contain tourmaline, garnet, cyanite, beryl and apatite. Dr. Hoffmann has kindly examined many of the mineral specimens collected, and has determined these. On one of these veins, seven miles south of Tête Jaune Cache, the Bonanza mica mine is located. It is 5,300 feet above the level of the Fraser River. Where an opening has been made, the veins is about fifteen feet wide dipping S. 45° W. $<$ 40°, with the schists. Its continuation to the north-west is covered with talus from the mountain, while on the south-east side of the opening, the original rounded top of the vein is covered by the schists. The quartz, felspar and muscovite are separated into large masses. The crystals of muscovite, which are frequently eighteen inches long and eleven inches wide, are found in greatest abundance near the hanging wall. It is evident, not only from the fact that the great denudation to which these mountains have been subjected has only in recent times exposed the top of the deposit, but also from the amount of segregation, that the mass has been cooled at a great depth, and very slowly. Beryl is found in this vein. The mica is a transparent muscovite with a very slight greenish cast, and of excellent quality. While little work has been done with a view to proving the extent of the deposit, it may reasonably be expected, from what actually appears, that a large quantity of mica can be obtained here, and the probabilities of further important developments appear to be very favourable. Thirty feet below the Bonanza vein, is another vein of pegmatite, forty feet thick. A few miles to the south-east across an intervening ridge, another claim has been located by some Edmonton miners, but no work was in progress and the place was not visited.

Ten miles in a straight line to the south-east, the mountains near the head waters of Canoe River, are composed of the same rocks as

Mica Mountain, the garnetiferous mica-schist being here also the predominating rock. Pegmatite veins also occur and several mica claims have been staked out. On one of these some work is reported to have been done, exposing a deposit of marketable mica.

Rocks of Mount Thompson.

Mount Thompson between Camp River and Canoe River is also composed of rocks of the Shuswap series. They differ somewhat from those previously described by having a greater proportion of gray gneissic layers and highly quartzose glittering mica-schist. The gneissic layers in general follow the foliation of the schists, but are occasionally seen to break through them. They appear to have been originally intrusive granitoid rocks. There is no indication of gold in the rocks on this south-western side of the main valley.

The continuation of the valley to the north-west and south-east, seems to coincide with the dividing line between the Archæan and Cambrian rocks.

Devonian rocks of Rocky River.

Returning to Jack Creek on the Athabasca River, to keep the same order of precedence as in the descriptive part of the report, the exploration via Rocky River will be taken up. The route followed was almost directly along the strike of the rocks, and hence the observations made did not add much to the information already obtained about the rocks, except in regard to their geographical extent. The rocks along the whole route from the Athabasca to the Gap of the Brazeau, appear to be of Devonian age. They consist of brown dolomite and fine-grained gray limestone, with some thin beds of gray and brownish sandstone and shale. On the lower part of Rocky River the rocks have sharp folds and steep dips, but at the summit of the pass to Brazeau River they are only gently inclined to the south-west. This attitude is maintained to the edge of the mountains, in direct contrast to what was seen at the edge of the mountains on the Athabasca. On the Brazeau the transition from the mountains to the level plains is abrupt. No folding or crushing is to be seen, but a straight uplift without contortion of the beds and apparently without overthrust, for although the talus from the limestones hides the line of contact with the Cretaceous rocks of the level country beyond, these rocks are both found in place in the bed of the stream in positions which seem to preclude the possibility of a lateral movement of any extent.

Uplift of mountains without overthrust near source of Brazeau River.

Cretaceous rocks of Brazeau Hills.

The Cretaceous rocks referred to are greenish-gray sandstones, in beds three feet thick, with thin layers of conglomerate composed of small round pebbles. They dip to the north at a low angle, showing very little signs of disturbance. These rocks are identical with those

found on Prairie Creek, and appear to occupy, without any disturbance, the level country between the base of the mountains and the Brazeau Hills. The Brazeau Hills have an elevation of 6,500 or perhaps 7,000 feet above sea, and run parallel to the edge of the mountains, at a distance of ten or fifteen miles therefrom. The Brazeau River escapes through these by a very narrow deep cañon.

Northward from the Gap of that branch of the Brazeau just described, the same rocks appear to continue for some distance, though only one exposure of a finer-grained variety of sandstone was seen. Thirteen miles distant in a straight line, on a stream flowing north-eastward to the north branch of the Brazeau, there is an exposure of 150 feet of beds consisting of carbonaceous shale and yellowish sandstone with numerous small seams of coal, one of which has a thickness of three feet. The dip of these beds is N. 45° E. < 60° and a mile beyond the last branch of the Brazeau, greenish sandstones were found dipping S. 60° W. < 60°, thus showing that only for a short distance along the edge of the mountains the rocks escaped the usual lateral pressure accompanying the uplift.

Cretaceous rocks of head-waters of Pembina River.

The first rocks met with on the Pembina River were dull olive-green sandstones and shales striking N. 65° W., vertical. Farther down the river the rock consists entirely of soft gray shales, containing rounded and lenticular nodules of gray ironstone, sometimes cherty. As the river is descended the dips become undulating and less, until, at a distance of nine miles from where the river was first reached, the beds are almost horizontal. These rocks, as well as the shales and sandstones near the last branch of the Brazeau, closely correspond with the Pierre division of the Cretaceous.

Edmonton beds exposed along the McLeod River.

Along the McLeod River, from where it was reached to the 'Leavings,' numerous separate exposures were seen showing chiefly irregular coarse yellowish sandstone and clayey false-bedded sandstone. Interbedded with these are carbonaceous shales, and one seam of coal a foot thick was seen. Other seams were reported to occur on the river. Some prospecting has been done on the McLeod, in which a certain quantity of gold was obtained. It is found chiefly in a small seam in the river-gravels, principally composed of dark material derived from the shales. No fossils were found in these rocks to determine their age, but stratigraphically they appear to belong to the Edmonton beds or lower division of the Laramie.

Superficial Deposits and Glaciation in the Mountainous Region.

Evidence of former glacier in valley of Athabasca River.

The valley of the Athabasca has contained a large glacier flowing northward down the stream. No striæ were observed, as the limestones are not suitable to their preservation, but the rounded appearance on the southern side of projecting rocks shows the action of the ice and the direction of its flow. Boulder-clay is to be seen in many of the lateral valleys It is chiefly composed of local material, but also contains boulders that have travelled at least thirty miles. The boulders seldom exceed six inches in diameter, and are generally without any appearance of stratification.

Post-glacial lakes in valley.

After the disappearance of the glacier, the valley appears to have been occupied by a body of water standing at a level of 550 to 600 feet above the level of Jasper Lake. A long distinct terrace on the west side of Jasper Lake marks this level. It is composed chiefly of gray silt with a varying proportion of sand, and in some parts a few pebbles of quartzite and limestone. The fine silty sand along the shore of the lake and the banks of the river is probably derived from the washing down of this terrace.

Terraces near Henry House.

Above Henry House on the west side of the river, a well marked terrace 600 feet above the river, is composed of white calcareous silt containing pebbles of quartzite firmly cemented together. In one place the front of the terrace weathers out into conical pillars. These are without the usual large boulder forming caps, as none of the pebbles are of more than six inches in diameter. Terraces on the opposite side of the river are noticeable at about the same level. Along the upper part of the Fraser River valley a white silt terrace is seen in several places, and is best defined for some distance above Moose Lake. Its elevation is 3900 feet above sea, which is about the same as terraces just mentioned on the Athabasca.

Former lake in Yellow Head Pass.

Along the Miette valley and the Yellow Head Pass between this place and the Athabasca River, there are some signs of a terrace at about the same level, but not very distinct. This terrace as well as the typical white silt dies out near Moose River. It would appear that part of the Athabasca valley and this upper portion of the Fraser valley were occupied by one continuous body of water, in which the white mud derived from glaciers was deposited. A possible explanation of the termination of the white silt, is that the glacier coming in by the valley of Moose River, completely blocked the Fraser valley, holding back the waters for a long period of time. Along the remainder of the Fraser River to Tête Jaune Cache, while silty material is to

be seen locally, as well as clay, but the greater part of the superficial deposit is coarse stony gravel. In the valley between Tête Jaune Cache and Canoe River, on the north-east side near the base of the mountains, there are rolling ridges of fine sand for a distance of four or five miles from the Cache. The sand is washed very clean and will scarcely support any vegetable growth. That it contains a certain amount of iron is noticeable where recent fires have given it a bright red colour. A few miles further on, the cut-bank of a stream shows this sand to be well stratified. This valley has also been occupied by a body of water, and terraces were noted in two places having an elevation of 1,000 feet above the Fraser River at the Cache, or 3,400 feet above sea-level. The most extensive and best marked terrace in the valley is that on the south-west side of Canoe River opposite the crossing. Its elevation is 2,950 feet above sea.

Glacial striæ

No glacial striæ were seen on any of the higher mountains, and from their sharply angular appearance it does not seem probable that they were ever overflowed by ice. A mountain 8,000 feet high, situated eight miles, S. 60° E. from Tête Jaune Cache, showed signs of heavy glaciation, the striæ running S. 25° W. Robson Peak, lying in the direction from which this ice came, has probably been a gathering ground discharging south-west into the great valley. Mt. Thompson having an elevation of 8,790 feet has the general smooth aspect of a glaciated summit, but no striæ, nor travelled boulders could be found.

Trees.

The distribution of the principal trees is given in the following short notes :—Black and white spruce (*Picea nigra* and *P. alba*), poplar and cottonwood (*Populus tremuloides* and *P. balsamifera*) are found generally throughout the whole country traversed. Larch (*Larix Americana*) extends as far westward as the McLeod River and ascends that stream forty miles above the 'Leavings.' It was not seen on the Athabasca or westward. Black pine (*Pinus Murrayana*) first seen thirty miles west of Edmonton, continues throughout. Douglas fir (*Pseudotsuga Douglasii*) commences three miles below Jasper house and continues westward. The eastern 'balsam' (*Abies balsamea*) was first seen on the Athabasca River, while *A. subalpina* was found generally throughout the mountains. White pine (*P. monticola*) was seen at Moose Lake on the Fraser River. White-stemmed pine (*P. albicaulis*) was on most of the high mountains. Cedar (*Thuya gigantea*) and Hemlock (*Tsuga Mertensiana*) came in a few miles below Moose Lake and continue westward. Yew (*Taxus brevifolia*) is found on wet mountain sides, on the Fraser and Canoe rivers. Engelmann's spruce (*Picea Engelmanii*) was found generally through-

out the mountains, and another form seen is probably that noted by Prof. Macoun, as intermediate between this and the white spruce. Lyall's larch (*Larix Lyallii*) does not occur in the mountains in this district. Canoe-birch (*Betula papyrifera*) was first seen on the Athabasca River and continues westward.

Game

The occurrence of game in the district is summarized in the following notes :—Elk, sparingly found in the foot-hills of the mountains. Moose and deer, throughout, rather scarce. Caribou, in the mountains, scarce. Mountain sheep, scarce in the first ranges of the mountains. They do not appear to go more than thirty or forty miles into the mountains and seem to confine themselves to the limestone ranges. Mountain goats, plentiful, especially far into the mountains. They prefer higher and more rugged mountains than the sheep. Grizzly and black bears plentiful, the former in the mountains, the latter throughout. Grouse fairly abundant. Fur-bearing animals are to be found, but are not very plentiful now on account of the burning of the forests.