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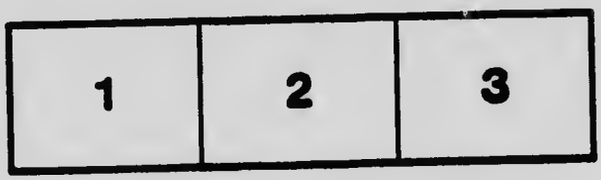

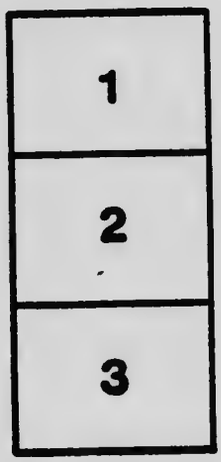

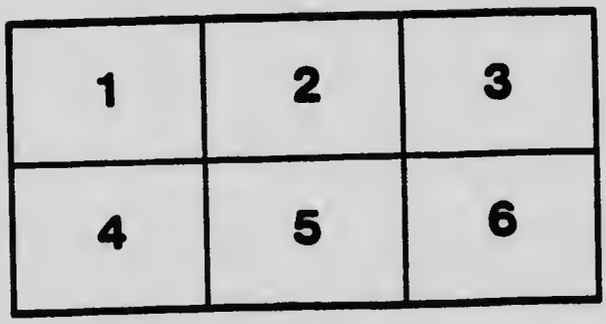

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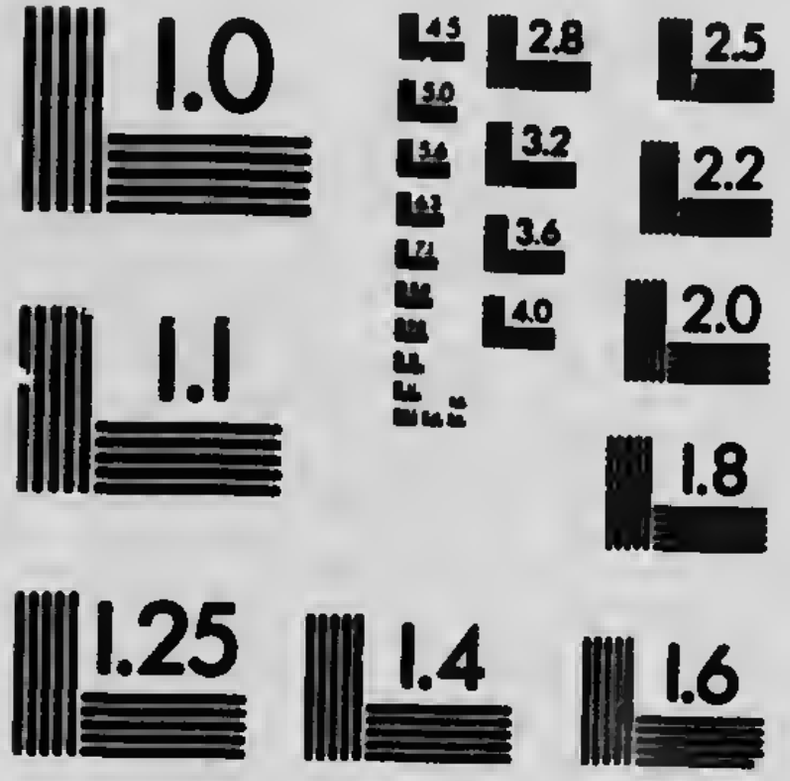

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GEOLOGICAL SURVEY OF CANADA
ROBERT BELL, I.S.O., M.D., D.Sc., (CANTAB.) LL.D., F.R.S., ACTING DIRECTOR.

REPORT

ON THE

PEEL RIVER AND TRIBUTARIES

YUKON AND MACKENZIE

BY

C. CAMSELL

OTTAWA
PRINTED BY S. E. DAWSON, PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1906

No. 951

ROBERT BELL, ESQ.,

Acting Director, Geological Survey of Canada.

DEAR SIR,—Herewith I beg to hand you my report and map of the Peel river and some of its tributaries. The report is accompanied by a few illustrations showing the physical aspect of the region traversed.

I remain, sir,

Your obedient servant,

C. CAMSELL.

OTTAWA, March, 1906.

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THE PEEL RIVER AND TRIBUTARIES

INTRODUCTION.

The field work assigned to me for the season of 1905 embraced a geologic and topographic reconnaissance of the Peel river in the extreme northwestern portion of the Dominion. Owing to the shortness of the season in that part, and the difficulty and length of time required to get in and out of the region, an early start from Ottawa was very necessary. In accordance, therefore, with instructions received from Dr. Bell, I left Ottawa about the middle of March for Winnipeg. Here some supplies were purchased and shipped by the Hudson's Bay Company to meet me at Fort McPherson in August, and later I proceeded to Dawson, where I arrived on the 1st of April.

At Dawson the interval between the closing of winter travel and the opening of navigation on the streams was consumed in the testing and correction of instruments, and in visiting and examining the placer mines of the Klondike creeks; and during this period we were much indebted to Mr. J. B. Tyrrell for his kindness and hospitality in allowing us the use of his house. To Major Z. T. Wood also, Commandant of the North-west Mounted Police in the Yukon, are my thanks due for his kindly assistance in the selection of canoemen and the loan of a canoe.

On May 22, the party, consisting of six men and three canoes, left Dawson by the ss. *Prospector* for Frazer falls on the Stewart river. Four days were consumed in reaching this point. Another delay, occasioned by an early rise of water in the Stewart river, prevented us from moving until June 5. When we began our journey at this date, it was only with the greatest difficulty and some danger that any progress could be made. With the water fifteen or twenty feet higher than its normal stage the velocity of the current is greatly increased, quantities of driftwood are being carried down stream, and in many places the banks are completely submerged. Under these conditions we were eight days in getting as far as Lansing river, a distance of eighty miles.

Above this river the water was at a much better stage and the travelling was easier, until we came within twenty-five miles of the mouth of Braine creek. In this portion of the Beaver river, a northern tributary of the Stewart, the stream is split up into several channels and is filled with gravel bars, while the grade is greatly increased, so that considerable difficulties were again encountered in making progress. At the

mouth of Braine creek the actual survey commenced, though a track survey had been carried up from Williams's cabin at the cañon seven miles below, to connect with Mr. Keele's survey of the lower part of the Beaver river.

ROUTES SELECTED.

It was my original intention on leaving Ottawa to follow identically the same route across the mountains which was taken by the prospectors in 1899, but I was dissuaded from this on reaching Dawson by many of those who came through the Bonnet Plume pass. These men stated that on account of the difficulties of this particular route, any other would be preferable. I could not learn that any one, at any time, whether white man or Indian, had ever taken a canoe across into the Peel River watershed by any other route than the Bonnet Plume pass. But I did learn that the Indians had come across from the Wind river to the Beaver river through a pass that was said to be very much lower than the Bonnet Plume. It was finally decided if possible to find this winter route and follow it.

On our way up to the Stewart river, we met Mr. Braine of Lansing creek, and from him we obtained the necessary information as to how to find the pass to the Wind river, for he himself had been through a part of it the winter before. It is sufficient to say here that the Braine pass through the mountains, though an easy winter route, is not a feasible one for canoes. Though we went through at a time when the water in Braine creek was probably at its best stage, yet we had to portage almost the entire load for fifteen and a half miles, and the canoes themselves for three and a half miles.

A micrometer and compass survey was carried from the mouth of Braine creek through Braine pass, and down Nash creek to the Wind river, a distance of thirty miles.

From the mouth of Nash creek to the Peel river the course of the stream is almost true north, so that to save time a careful track survey, checked by frequent observations for latitude, was all that was made. The distance is approximately 100 miles.

We reached the Peel river on the 13th of July, and from this point a micrometer survey was recommenced and carried down the stream to a point 98 miles below Fort McPherson, where the western branch of the river first joins Mackenzie waters, and from this point back to Fort McPherson by the central branch of the Peel river. The survey of this portion was completed on the 11th of August, and on the 15th the return journey to Dawson was begun.

Returning, the route followed was that by the Rat river through McDougal pass and into the Bell and Porcupine rivers, the same as had been taken by Mr. W. Ogilvie in 1887. A small portion of new work

was here done in surveying the central and largest outlet of the Rat river, the south branch, which was done by Mr. Ogilvie, being impassible excepting in the spring. The Rat river empties by three branches into Peel River waters, but the northern branch is an inconsiderable stream and only navigable in high water, so that no attempt was made to survey it. In the ascent of Rat river, we were particularly fortunate in having a great deal of rain and snow, which, though making the travelling very disagreeable, raised the level of the water sufficiently in the stream to allow of comparatively easy canoeing. The same conditions allowed us to get our canoes within six hundred yards of navigable waters on the other side of the divide, so that a portage of that length was all that was necessary. Had we been a week or two earlier, or a few days later, we would probably have been compelled to make a portage of three or four miles in length.

The Porcupine river was followed down to its junction with the Yukon at Fort Yukon, where we arrived on September 8, the actual travelling time from Fort Macpherson to Fort Yukon being twenty days. A track survey was carried all the way from Fort McPherson to the boundary line of Alaska just below Rampart House, where it was closed.

After a delay of five days at Fort Yukon, we caught one of the Northern Commercial Company's fast steamers plying between Dawson and St. Michaels, and arrived in Dawson on the 17th of September.

PREVIOUS EXPLORATIONS.

The first mention we have of the Peel river is by Sir John Franklin in his second voyage to the Arctic sea 1825-1828. On returning from this expedition, and while ascending the Mackenzie river a short distance above its mouth, he was led into the stream which he at first mistook for a branch of the Mackenzie. He ascended it for some considerable distance under this impression before he found out that it was an entirely different stream. He called it the Peel river in honour of Sir Robert Peel, and the favourable account he gave of the stream, and more particularly of its fur-bearing animals, attracted the attention of the Hudson's Bay Company and shortly after induced them to send an exploration party under Mr. Bell to make an examination of the river preparatory to establishing a trading post on it.

In the summer of 1839, Mr. Bell explored the river to the head of the Snake River branch, thinking this was the main stream, and the following year Fort McPherson was established at the head of the delta. During the winter of 1840-1841 Mr. A.K. Isbister, also an officer in the employ of the Hudson's Bay Company, made a survey and

sketch from his own and Mr. Bell's observations of the stream. This he published, along with an account of the topography and geology of the region, in Volume XV, 1845, of the Royal Geographical Journal.

In the summer of 1893, the late Count V.E. de Sainville, who was then living at Fort McPherson, with one canoe and two Indians made a very good survey and map of the stream as far as the mouth of the Wind river. As a rule the natives in going up to the Wind river, leave their canoes about 75 miles above the Fort and walk straight across country to the mouth of Wind river, thus avoiding the swift water in the river and cutting off the big bend that it makes. Count de Sainville, however, followed the course of the stream the whole way up to the Bonnet Plume river, the journey occupying two weeks. At the mouth of this stream, he left his canoe and walked up the river bank about twenty-five miles, from which point he cut across to the Wind river. This he followed down to its junction with the Peel river and back again to his canoe. On his map he gives his distances, elevations, and latitudes. He also mentions the occurrence of hot springs at the mouth of the Bonnet Plume river, at which ducks and geese were said to remain all winter. He notes also the existence, between the Bonnet Plume and the Wind rivers, of lignite beds which were burning at the time, and according to Indian report had been for years before. These beds are still burning.

EARLY PROSPECTORS.

For three or four years after the placer diggings were first discovered on the Klondike river, prospectors crowded into Dawson by every possible route, and some of those who went by the Mackenzie river found their way across the mountains by the Peel River route which led them through the Bonnet Plume pass into the waters of the Stewart river. In the fall of 1898 about 90 persons who followed this route found themselves compelled to winter on the Peel river. Most of them managed to get as far up as the mouth of the Wind river, where they built their cabins and spent the winter. A cluster of deserted cabins, which stand a few miles up the Wind river from its mouth, was called by them Wind city. During the winter they hauled their outfits and supplies to the head of the Wind river and through the Bonnet Plume pass, and thence down the Hell or Rackla river to a point about twelve miles from the Beaver river, which they called Spring camp. Here on the opening of navigation, they built boats or rafts and proceeded down the Stewart river to Dawson. A few of them remained on the north side of the divide until the rivers opened up, and then took their canoes across the pass and floated down the Rackla river. Mr. Patterson of Dawson was one of the latter, and from him I got a great deal of information relative to the Bonnet

Plume pass and the head of the Wind river. The pass he reports to be wide and flat, with an almost imperceptible slope to the waters of the Wind on the one side and those of the Stewart on the other. In fact one of the streams at the summit could, with very little trouble, be diverted so that it would flow to either side. He himself simply dragged his canoe through the marsh on the summit, and never had to carry it at all. He estimated the summit of the pass to be 3,500 feet above sea level.

About five years ago a couple of prospectors crossed the Peel-Yukon divide at the head of the Twelve-mile or Chandindu river, and descended the whole length of the Peel river to Fort McPherson on a raft, being the first white men to make the trip, but as these men were lost, and strange to say, thought themselves on the Stewart they made no sketch of the river, and only discovered their whereabouts when they landed at Fort McPherson.

In December, 1902, a small patrol of North-west Mounted Police left Dawson with dog teams, and crossing over the divide at the head of the Twelve-mile river, got into Peel River waters at the Blackstone river. They crossed to the Hart river and from thence to the Little Wind river and decended that to the Big Wind. From here they followed our own route to Fort McPherson, except that they cut across the big bend in the Peel from the Bonnet Plume river to Trail creek.

DETAILED DESCRIPTION OF ROUTES.

DESCRIPTION OF BRAINE CREEK.

Braine creek is a typical mountain stream, never in any part navigable for canoes. Rising in two small mountain glaciers on the flanks of one of the highest peaks in the region, it flows first in an easterly direction for two and a half miles, when it is joined by a branch of almost equal volume from the west. The combined streams then turn sharply to the southwest and, cutting almost directly across the strike of the rocks, join the Beaver river about fourteen miles below.

The stream occupies in its lower portion a broad U-shaped valley, sometimes a mile in width, with the bordering mountains rising to a height of 3,000 feet on either side. In the upper portion this width sometimes contracts to a quarter of a mile and its character is more V-shaped. The grade is always exceedingly steep, and the volume of water is never very great; wherever it is confined to a single channel, the latter is sufficient to float a lightly-laden canoe, but as the tendency of the water is to spread out into several different channels, the opportunities for real canoeing are rare.

Two cañons occur between the mouth and the forks of the stream. The lower one, at a distance of two miles from the Beaver river, is deep, narrow, and about two-thirds of a mile in length, around which a portage of half a mile has to be made. The stream here contracts to a width of twenty feet, and the walls are 150 feet high and almost vertical. The cañon lies at the entrance of the creek to the valley of the Beaver river, and is cut in a bed of dark, massive limestone which strikes at right angles to the course of the stream, or parallel to the Beaver river. It is the result of former glacial conditions, and has been formed since the ice retreated from the valley of the Beaver river. Evidences of a terminal moraine occur at the cañon, and the valley of Braine creek approaches a hanging valley in character.

The second cañon lies four and a half miles above the first This is caused by an eruptive mass of diabase, which cuts across and obstructs the valley of the creek. Its length is about 300 yards and the drop in it about twenty-five feet.

Immediately above each of these cañons the bed of the stream expands to a width of two-thirds of a mile, and occupies a greater part of the valley. These expansions in the beginning of July were still almost entirely filled with sheets of ice, varying in thickness up to ten feet, and through these the water has cut narrow winding channels. As the course of the stream is continually shifting, the water melts and wears away the ice at the base of the ice sheet, until it overhangs to such an extent that it is not able to support its own weight, and it falls with a splash. The result is that the course of the stream is diverted to the opposite side, where the same action is repeated.

Wherever the ice has melted away from the surface of the gravel, it has left on the pebbles a white deposit of carbonate, originally derived from the limestone bed over which the stream flows. This was first carried in solution in the water, then precipitated by freezing, and finally left as a residue on the melting of the ice. These large ice sheets, which cover several acres and are sometimes a mile in length, are formed in the winter time by the constant overflowing of the water. A great many of the small tributaries of Braine creek are fed from springs in the limestone, and these probably maintain a continuous outflow throughout the year, so that even in the coldest weather there must be a certain quantity of water flowing down the creek, thus accounting for the formation of the ice sheets. These latter attain a considerable thickness, but whether the accumulation of ice during the winter is balanced by a proportionate thawing during the summer was not determined; it is, however, probable that, except for a few isolated and shaded patches, the thawing action of the summer predominates, and all or most of the ice disappears.

The valley, where occupied by these glaciers, is bordered on either side by benches of clay and gravel. A bench of this character extends from the lower cañon right up to the second cañon, a distance of four and a half miles. It appears to be almost, if not absolutely level. At the lower cañon the top of the bench is 200 feet above the bed of the stream, and gradually approaching nearer to the level of the water as it ascends the valley, it disappears entirely at the second cañon. If this bench is actually level, it makes the grade of this part of the stream about fifty feet to the mile, inclusive of the two cañons.

At the second cañon there is an abrupt rise in the floor of the valley, caused by the aforementioned dike of diabase. This rise is slightly increased by a heavy deposit on the dike of glacial detritus irregularly distributed, which is apparently another terminal moraine similar to that at the lower cañon. A faint outline of another bench, similar to the well-defined one below, can be traced on the sides of the valley above the second cañon.

Above the second cañon, as below, expansions of the stream are occupied by sheets of ice; but the valley soon contracts to a width of a quarter of a mile, in which the water is necessarily more confined, allowing no room for the accumulation of ice. Here, rising abruptly from the water's edge, are steep talus slopes, on some of which banks of snow lie quite close to the stream.

Two miles below the forks of the creek, to which point the canoes were dragged, the character of the valley suddenly changes. The stream is here confined to one channel, the grade is not so steep, while the valley, widening to half a mile, is occupied by several small, marshy ponds. This portion is entirely devoid of any timber. Along the edge of the stream and ponds is a light growth of alders and willows, which is shortly replaced on the sides of the valley by bare rocky slopes of limestone talus. Only at the forks again does any spruce occur.

At the forks of Braine creek the valley divides, forming two passes, each of which brings one in a few miles into Peel River waters. One pass runs off to the northwest, and the other to the east. Camp was pitched here for a few days while the two passes were thoroughly explored, and the easier one selected for the portage. Though the eastern pass is 200 feet lower than the northwestern, the latter was the one chosen, because it brought us into a much larger and more navigable stream than the other. The eastern pass is the more direct route to the Wind river, and is the one that travellers would be more likely to take in the winter time.

The summit of the eastern pass is 150 feet above the level of the forks of Braine creek. The valley is very wide and open. A scrubby

growth of willows and alders fills the bottom of the valley, and the sides are fringed with a scattered growth of black spruce which extends a very short distance up the slopes of the bordering mountains. The tops of the mountains are usually about 2,700 feet above the bottom of the valley and consist of massive limestones, interbanded with layers of black slate and shaly limestone. The divide lies about two miles from the forks of Braine creek. Here a small creek heads, and after flowing for two miles through the broad flat valley, passing in its course through three or four small marshy lakes, joins a larger stream coming from the south; the combined streams then flowing in an easterly direction, enter the valley of the Wind river about five miles below. This stream, however, does not, on entering the Wind River valley, unite immediately with the Wind river; but, running parallel with it and in the same wide valley for several miles, connects at almost the same point as Nash creek. In fact, some of the water of Nash creek flows into this creek before its junction with the Wind river. This stream, however, did not appear to be navigable for canoes, and for that reason the eastern pass was not selected.'

The floor of the valley is covered with a thick deposit of glacial detritus irregularly distributed throughout its length and breadth. This is either piled up in scattered mounds, or else depressions have been left which are now filled with water. Numerous alluvial fans formed from the wash of the higher slopes project out from the base of the hills on either side.

In the northwestern pass the summit is 350 feet above the forks of Braine creek, and 400 feet above Nash creek, and is situated about half-way between the two points. The distance which the canoes had to be carried was three and a half miles. This pass is a part of the same structural valley that the eastern pass occupies, and a straight line drawn at right angles to the course of the Braine valley below the forks would cut both passes. Like the eastern pass, the northwestern is wide and open, and by following caribou trails through the low scrub the necessity of cutting a trail across was avoided until we got on to the lower flats of Nash creek, where a heavy growth of spruce and poplar was encountered.

On the lower part of Braine creek a few indications of the former presence of travellers or hunters were noted, but, towards the head, none at all. In the wooded flats of Nash creek I noticed several rotting tree stumps that had been cut probably forty or fifty years ago; but nowhere were there any recent signs of human presence.

Braine Creek, Beaver River.

TOPOGRAPHY AND GEOLOGY OF BRAINE CREEK.

Topographically the country between the Beaver river and Wind river is one of rather rugged relief. This is the back-bone of the great Rocky Mountain system, which here trends northwest and southeast, swinging slightly from its almost north and south trend farther south. This particular section is called the Ogilvie range. Few prominent peaks occur, and from the tops of any of them a general accordance of level can be noticed. The summit of Braine pass is estimated at about 3,400 feet, and the elevation of the highest peaks in the neighbourhood at 6,800. The general level of the whole range is somewhat lower than that farther south, though considerably higher than the elevation of the range to the west of Fort McPherson. The total discordance of vertical relief is about 3,000 feet. Few peaks exceed this.

The great wide valleys are longitudinal valleys coinciding with the strike of the rocks, and these are joined by narrower and shorter transverse valleys. The Beaver river occupies one of the former, as also the upper parts of Nash creek and the Wind river. These are roughly parallel to each other, though the lower part of the Wind River valley lies at a sharp angle to them.

The region during the glacial period was not covered by a large continental ice sheet, but the valleys alone were filled to a depth of 1,000 to 1,500 feet with valley glaciers, which apparently moved along the present grade of the stream. Evidence of glaciation can be traced to a height of about 4,500 feet above sea level, so that about 2,000 to 2,500 feet of the highest peaks protruded through the ice. The limit of glaciation corresponds fairly closely to the tree line, and is well shown by the rounded and graded appearance of the slopes and shoulders, above which the outline is more rugged and broken.

In the gradual retreat of the glacier up the valley of Braine creek, it evidently halted at each of the cañons a sufficiently long time to allow of the formation of extensive terminal moraines. On the disappearance of these glaciers, the valleys, both of Braine and Nash creeks, were filled to a depth of from fifty to a hundred and fifty feet with a heavy deposit of boulders, gravel and clay, the ground moraine of the valley glaciers, which was later subjected to deep dissection by the present streams, resulting in the region taking on its present topographic form.

At present only a few small cirque glaciers exist, and these only on the northern flanks of the mountains, where they are protected from exposure to the rays of the sun. The small glaciers in the bed of Braine creek have been already referred to. None of these were seen on Nash creek, though several of them occur in the valley of the Wind river.

A section across the summit from the Beaver river to the Wind shows a series of closely folded and sometimes faulted limestones and slates with some quartzites and conglomerate. Cutting these are some diabase dikes and intrusive rocks. The succession in descending order is somewhat as follows :—Massive dove coloured limestone becoming shaly at the base; bands of black slate; massive granular limestone containing fossils; ferruginous slates weathering red, and black weathering conglomerate at the base. Remnants of a coarsely crystalline quartzite at the top of the series sometimes form the peaks of the higher mountains. These strike as a rule from west to northwest, and dip at various angles forming a succession of synclines and anticlines. Many of the streams have cut out their valleys in the anticlines with the result that the sides of these valleys often present precipitous slopes and cliffs to the streams.

The great valley at the head of Braine creek, which forms the pass across to the Wind river, is apparently a great line of weakness, which has resulted in an overthrust fault, thus bringing up the underlying ferruginous slates to the surface. Along this line of weakness the slate has been much folded and contorted, and the limestone shows evidence of metamorphism in being converted into a white marble, which cleaves easily into the large rhombs of calcite. Another fault also occurs a few miles above the mouth of Braine creek, but its character is indefinite, and, unlike the other, is not marked by any great valley, though the metamorphic action resultant on the fault is plainly noticeable.

As we approach the Wind river, the upper limestones are replaced by the ferruginous slates, being brought up to form the summits of the mountains by a wide anticline. These dip down again to form the wide structural valley of the Wind river. The appearance of the ferruginous slates is a noticeable feature in the topography of the region, for the slopes take on a dull reddish colour due to the oxidation of the iron in the slates.

With the exception of some limonite in the rocks at the pass, no indications of economic minerals occur. While a few small colours of gold were obtained on the Beaver, these disappear entirely on Braine and Nash creeks.

NASH CREEK.

Some fossil corals and brachiopods collected from the limestone at the summit and lower down Braine creek have been identified by Dr. Whiteaves as Devonian forms.

Nash creek is considerably larger and longer than Braine creek. From the top of a mountain, 2,700 feet above the stream, a good view of the valley was obtained; it has a length of about 25 miles, and rises in a large lake two or three miles long. The general direction of this valley is almost true east and west in its lower part, bending slightly

to the north above the portage. Its valley is wide and U-shaped and increases in width near the head of the creek, where several lakes occur besides the large one in which the stream rises. From the north end of the portage trail to the junction with the Wind river is a distance of twelve miles. It enters the Wind valley, however, at nine miles from the portage and flows in it for three miles before joining its waters with those of the Wind river. One mile above the portage the stream forks, the smaller branch also rising in a lake about five miles beyond. The two branches each occupy, for several miles, a part of the same wide valley, and are only separated from each other by a long, narrow, isolated ridge 1,500 feet above the stream at its highest point. The upper part of the Nash valley lies parallel with the Beaver valley and, like the latter, coincides with the strike of the rocks. A straight line drawn through the upper part of the Nash valley and continued southeast would run directly through the two passes at the head of Braine creek, so that Braine pass is practically the continuation of the Nash valley, while the Nash valley below this is tributary to it. The grade of Nash creek is very steep, and though only one short cañon occurs, the rest of the stream is exceedingly swift, shallow and full of gravel bars. It is often bordered by cut banks of consolidated clay and gravel of glacial origin, which have a height of 100 feet and more. In two or three places great snowslides had occurred, and in one of these the water had cut a narrow channel between walls of snow twenty-five feet high.

Though on the northern slope of the divide, the water of Nash creek is about four degrees warmer than that of Braine creek, due, no doubt, to the large lakes in which Nash creek rises. The vegetation too is slightly different in character. Balsam poplar grows in abundance on the flats of Nash creek, while none was seen on Braine creek. Arctic poppies in great profusion were seen on the northern slope of the divide.

THE WIND RIVER.

On information obtained from some of the prospectors who crossed by the Bonnet Plume pass in 1899, I estimated that we reached the Wind river at a point about twenty-five miles below that pass. According to estimates made with a cyclometer in winter time by these prospectors, the distance from Peel river to the Bonnet Plume pass is 132 miles. My own estimate of the distance from Nash creek to the Peel river is about 100 miles.

The Wind river is so called by the Indians of that region because of the furious gales that are constantly blowing down its valley.

The valley occupied by the Wind river is broad and U-shaped, timbered in some parts by spruce and poplar, but totally bare in others. In this the Wind river flows in a broad, shallow bed sometimes half

a mile wide. Where confined to one channel the breadth of the stream, before its junction with Nash creek, is 100 feet, and its water is beautifully clear and blue.

Looking up the Wind river from the mouth of Nash creek, the valley appears to widen slightly and become shallower, and the bordering mountains have more gentle slopes and are relatively lower. It appears to be well timbered and the occasional gleam of sheets of ice can be seen in it.

Directly opposite the mouth of Nash creek a broad tributary joins the Wind river from the east. This appears to take its rise in a large basin-shaped hollow at the foot of some high, jagged snow-capped mountains, which rise to a height of over 3,500 feet above the river.

From Nash creek to where the Wind river breaks abruptly through the mountains is a distance of forty miles, and for this distance the course of the river is almost true north. The stream occupies a synclinal valley 3,000 feet deep, over which the water spreads in numerous channels mostly too shallow to float a canoe.

In several expansions of the river bed large sheets of ice were still remaining at the beginning of July, similar to those occurring on Braine creek. These, however, would all disappear long before the end of the summer.

Where confined to one channel, the water is deep, and runs at a rate of from four to eight miles an hour. The timber here consists almost entirely of a small and stunted variety of spruce, which fringes the valley at the base of the slope, and extends a few hundred feet up them. Cut banks of stratified sands and gravels are common, and alluvial fans occur at the entrance of nearly all the small tributaries.

The only stream of any importance entering the Wind river in its mountain section is the Bear river. This enters from the east at a point about twenty-five miles below Nash creek. It debouches into the Wind by several channels which spread over a delta plain three-quarters of a mile wide, so that it is difficult to estimate its volume. It is not easily navigable for canoes, though according to Indian report, it is occasionally used by the natives as a route to and from the Bonnet Plume river, with which it is connected by a number of small lakes and portages. Indian report is also responsible for a story of the existence of an active volcano in the mountains towards the head of Bear river; but judging by the nature of the rocks this is highly improbable.

On leaving the mountains the river emerges at once on to a rolling country of foothills, afterwards changing to a perfectly level wooded plateau which extends northward practically to the delta of the

Mackenzie river. To the right the mountains extend away far to the east, presenting a rather abrupt face to the lower country, and unbroken by any great valleys except that of the Bonnet Plume river. Westward they stretch away to the Little Wind river, beyond which they swing round to the north, and cross the Peel river near the mouth of the Hart river, thus forming a great semi-circular basin enclosing the lower parts of the Wind and Bonnet Plume rivers, and in which a few isolated outliers of the mountains break the monotonous level of the region, and rise to a height of about 2,000 feet.

The plateau itself is well wooded with small spruce and tamarack, and dotted here and there with numerous lakes. The surface is covered with a deep growth of sphagnum, making it a huge muskeg typical of the Mackenzie valley.

As it leaves the mountains the bed of the stream quickly expands to a width of almost a mile, and for three miles the water spreads all over this in numerous shallow channels. Large sheets of ice were yet remaining on the bars, and on these several caribou were seen.

Beyond this expansion the stream becomes more confined, and flows between steep banks 150 feet in height, composed of horizontal or gently inclined sandstone beds, until it is joined by the Little Wind river at a distance of eighteen miles below. Two miles above the Little Wind river the valley gradually contracts and approaches more to the nature of a cañon, the stream is swifter and bordered by high cliffs of limestone. The Illtyd range of mountains, the highest point of which rises 2,600 above the river, here crosses the river diagonally striking a few degrees west of north.

The Little Wind river was not explored, though from the tops of two of the hills of the Illtyd range its course was sketched in for a distance of twenty miles. It joins the Wind river from the west, emptying a volume of water about two-thirds as large as the main stream. Its water is much dirtier, and the temperature one degree lower (49°). It emerges from the mountains twenty miles above its mouth, and flows with a swift current in a wide valley cut into the rolling plateau. The banks are from fifty to a hundred feet high, and the stream is divided by gravel bars into several channels. It forks just at the edge of the mountains, and it was down the west branch that the North-west Mounted Police patrol travelled in January, 1902, on their way to Fort McPherson.

Shortly below its junction with the Little Wind river the bed of the main stream again expands, and down to within a mile of its junction with the Peel river it keeps an average width of half a mile. This, however, is taken up largely with willow islands and gravel bars, through which the stream has cut numerous small channels.

The valley here is incised to a depth of sixty feet in the plateau, and the bed-rock is only rarely exposed where the water cuts into the banks of the valley. The adjoining country is thickly wooded with spruce and tamarack and some birch, and the prevailing feature is the typical northern muskeg.

HUNGRY CREEK.

The only stream of any consequence entering below the Little Wind river is Hungry creek. This enters from the west at a point twenty-five miles above the Peel river. It debouches by several channels over a flood plain a quarter of a mile wide. Its bed is filled with gravel bars, and its banks are low and composed of clay and gravel. It rises in a large lake about fifteen miles up, and flows from this with an easy grade through the low rolling country. Its water has a brownish colour suggesting its origin in muskeg lakes.

During the autumn and winter of 1898 Hungry creek was explored and prospected by some prospectors on their way to the Klondike. They are said to have found hot mineral springs on one of the small tributaries which join it from the south. They also report the finding of colours of coarse gold on the stream. Sufficient time, however, was not allowed for us to verify either of these reports.

Mount Deception, 1,400 hundred feet in height, stands in the angle between Hungry creek and the Wind river.

Below Hungry creek, the Wind river flows with a slightly accelerated current in the same wide valley. To the east is a level wooded country, probably muskeg, with numerous small lakes on its surface; while to the west is a rolling country which gradually becomes more mountainous farther westward.

As it approaches the Peel river, the valley of the Wind becomes narrower, and the stream is more often confined to one channel. Cut banks appear on either side. These at first consist essentially of clay and gravel, but underlying them farther on are beds of lignite associated with clay and soft sandstone.

Within two miles of the Peel river the valley takes on a cañon-like appearance, bounded on either side by steep walls of sandstone or shales a hundred feet high, and the water rushes between these at a greatly increased speed, so that when it joins the Peel in the cañon, it cuts almost directly across that stream to the opposite wall of rock.

TOPOGRAPHY AND GEOLOGY OF THE MOUNTAIN SECTION OF WIND RIVER.

The topography of the mountain section of the Wind river is very similar to that already given for the section at the summit. The vertical relief at the mouth of Nash creek averages about 3,000 feet, but this gradually decreases to 2,000 at the northern border of the mountains.

The general outline of the mountains varies, depending on the character and structure of the rock formations. In the upper part of the Wind river, where the rock formations are principally limestone, the summits are broader and more rounded, and the slopes more gentle and subdued. Near the mouth of the Bear river, where sandstone and quartzites replace the limestone, many high jagged peaks occur, and steep cliffs and precipices border the stream on either side. Extensive slopes of heavy talus and many alluvial fans characterize the region in the vicinity of Bear river. North of this again is a limestone area, which continues to the edge of the mountains, and the character of the topography reverts to the same conditions that hold in the other limestone area.

Though marked cliffs and precipices do occur, the side slopes of the valley can generally be ascended without difficulty. They are wooded only for about two hundred feet above the stream, where steeper slopes of barren rocks and talus begin.

Though the summits of the range show a gradual decrease in elevation from Nash creek, northward, of about a thousand feet, yet at a certain point they break off very abruptly without any foothills, and dip suddenly down to the broad Peel plateau. This scarp-like appearance is only shown from the mouth of the Wind river eastward or on the northern face of the range; but west of the Wind river, where the range swings around in a curve to the north, it loses this feature entirely and, instead of breaking off abruptly, is flanked by rounded foothills, which slope gently down to the plateau below.

All data collected with regard to the glaciation of the mountain section of the Wind river point to the conclusion, that the region was not completely covered by a great ice sheet during the glacial period; but that the valleys alone were occupied by glaciers.

The valley of the Wind river was occupied by a large glacier, which filled it to a depth of a thousand feet or more. This had the effect of giving to the valley its present U-shape and of filling the bottom of the valley with a heavy deposit of glacial gravel and clay. Into this deposit the present stream has cut its bed to a depth of fifty feet, leaving only a narrow bench at the base of either slope to mark the level of the old valley.

That the movement of this valley glacier was northward—or down the present grade of the stream—is shown by the drift, which could only have been derived from the rocks to the south.

Existing glaciers were seen only on the flanks of the high mountains directly opposite the mouth of Nash creek. That mountain glaciers have existed along other parts of the Wind River valley, however, is proved by the presence of several basin-shaped cirques, particularly on the western side of the valley. Several hanging valleys also occur, in which the streams occupying them plunge quickly from their own valleys into the valley of the Wind river some hundreds of feet below.

Five miles below Nash creek stratified sands and gravels are exposed in the cut banks on both sides of the stream. These are probably a lake deposit formed by the damming of the stream below. Most of this sedimentary deposit has been eroded away by the later action of the stream, but one or two remnants still stand in the centre of the valley, rising to a height of 150 feet. These are composed of a very fine dark-coloured sand, with less gravel and clay. Other smaller rounded knobs of glacial material occupy the valley below.

The section from Nash creek to the edge of the mountains along the Wind river gives the following succession of rocks from the base upwards:—ferruginous slates and argillites; limestones often weathering red from the oxidation of iron; sandstones with some limestones, which alter to quartzites and crystalline limestones; dark reddish conglomerate.

At the mouth of Nash creek the valley is incised in a series of closely folded black slates, with which occur only remnants of the overlying limestones, lying in steeply inclined synclines. These strike east and west almost directly across the valley of the river and are inclined at high angles, or are vertical. Some of the slates cleave readily along the laminae into broad thin plates, others are more massive. Where they stand vertically they form exceedingly steep slopes flanked at the base by much sharp and broken talus, making it difficult to ascend.

Northward, the limestone, by replacing and overlapping the slates, gradually occupies larger areas, and the underlying slates only appear when brought up by an anticline.

Fifteen miles below Nash creek, at our camp of July 8, a coarse-grained, white sandstone first appears capping the limestone and slates. The limestone is here reduced a few feet in thickness and appears to rest unconformably on the slates. The sandstone lies horizontally, or dips at a low angle to the north. It forms some of the higher peaks in this neighbourhood, and shows the characteristic weathering of this kind of rock in being eroded into all sorts of fantas-

tic shapes. Sharp pinnacles and columns of rock are noticeable features wherever this sandstone occurs. Some of these peaks rise to a height of 4,000 feet above the river.

In places the sandstone is metamorphosed to a white and coarsely crystalline calcareous quartzite, which forms steep cliffs and precipices, particularly opposite the mouth of Bear river. But beyond this again, where the dips are more gentle and the metamorphic action less, the slopes are easier and usually covered with much talus. Alluvial fans are common along the sandstone area.

From Bear river to the edge of the mountains only sandstones and limestones appear in a succession of gentle anticlines and synclines, and overlying these on the edge of the slope is a small remnant of the dark reddish conglomerate.

Fossils are rare in the rocks of the Wind river.

Few indications of economic minerals occur in the rocks of the Wind river, and with the possible exception of iron ore, it is hardly probable that any will ever be found. Quantities of float of a banded, jaspery iron ore were found at the mouth of the Bear river, and I am informed by Mr. C. M. Merritt, of Vancouver, who was up the Bear river in the winter of 1898 and 1899, that the float ore becomes more common higher up the stream, and on the portage to the Bonnet Plume river forms a large proportion of the drift.

The ore is hematite, which weathers to a bright red, and is associated with red jasper. The same float also occurs in great quantities on the Bonnet Plume river and also on the Snake.

Near the northern border of the mountains the variation of the compass is about eight degrees (8°) greater than anywhere else, and it is very probable that the local attraction is due to a body of iron ore in the neighbourhood.

Only very fine colours of gold were found in the gravels of this part of the Wind river.

TOPOGRAPHY AND GEOLOGY OF THE PLATEAU SECTION OF WIND RIVER.

Immediately on emerging from the mountains, the Wind river enters the broad Peel plateau. This is a wide, level, or gently undulating table-land, standing here at an elevation of about 1,700 feet above sea level. Its southern boundary is the range of hills which stretches away eastward in almost a straight line towards the Mackenzie river at the Sans Sault rapid. On the west it impinges against the base of the same range, which swings northward from the Little Wind and continues in that direction to the Arctic ocean. In the great bay,

formed by this curve in the mountain range, the level of the plateau is broken by several short ranges of mountains, which are really the foothills of the main range.

These foothill ranges are usually low rounded hills seldom rising more than 2,000 feet above the plateau, and more often less than 1,000. Their origin is due to the same orographic movements in the earth's crust which resulted in the upheaval of the Ogilvie range of mountains. The majority of them are anticlinal in structure; but several are due to faulting on a large scale. Mount Deslaurier, nearly opposite the mouth of Hungry creek, is a good illustration of a mountain formed by a normal fault. This is a west facing fault scarp, which rises abruptly to a height of eight hundred and fifty feet, and then slopes back gently to the east at a very low angle. Before erosion of its summit by glacial action the throw of this fault must have been about 1,200 feet. Several others of the same character occur in the area covered by the foothills.

The foothills area extends northward some distance beyond the Peel river, and its eastern border touches the Snake river. Almost in the centre of this is a large basin, covering over five hundred square miles, occupied by almost undisturbed Tertiary rocks. This basin is almost completely enclosed by the encircling foothills, and lies between the Wind and Bonnet Plume rivers, extending southward from the Peel river some fifty miles. Its surface, which is very little above the bed of the Peel river, is perfectly level and dotted with numerous muskeg lakes. The Peel river skirts along the northern edge of the basin, entering it by a cañon and leaving it by a deep narrow gorge.

East of the Snake river the plateau, which is there 800 feet above the river, continues unbroken towards the Mackenzie river. No hills appear to obstruct the view eastward and the plateau stretches away to the horizon with a perfectly level and unbroken sky-line. It is everywhere covered with moss and wooded with small spruce and tamarack, and holds a few muskeg lakes. To the north it follows the base of the range of mountains, and slopes imperceptibly in this direction to the Mackenzie delta. It gradually narrows in width northward, as the Mackenzie river approaches the mountains, until it is forced to disappear altogether a few miles north of the Rat river where the stream skirts the base of the hills.

Evidences of glaciation on the Peel plateau are rather meagre, and though these show that the plateau was actually covered by a large ice sheet during the glacial period, yet no direct evidence, such as could be deduced from striae, as to the direction of the flow of the ice was obtainable. All the mountains occupying the region between the Wind and Snake rivers have been smoothed and rounded off up to a

height of 1,800 feet above the streams. They have the appearance of being in a state of mature dissection, cut by numerous small creeks and having many basin shaped hollows, which are frequently filled with water.

Few of the peaks of the foothills exceed 2,200 feet in height, and those with a greater elevation are widely different in their contour from those with a lower altitude. The highest peak of the Illtyde range, which lies east of the mouth of Little Wind river, has an elevation of 2,600 feet above the stream. Its summit is sharp and its highest slopes steep and covered with talus, showing no indication of ever having undergone glacial erosion, and bearing a sharp contrast to the outline of the hills seven or eight hundred feet below.

Rounded pebbles and drift of foreign material were found on the slopes of Illtyd range up to a height of 1,700 feet above the Wind river, and beyond that the surface was covered with broken and angular fragments of the country rock. The range to the east of the Snake river, whose highest points are only about 2,000 feet above the river, has apparently been completely submerged. No sharp peaks appear and water-worn pebbles were found up to a height of 1,600 feet. These consist of limestone, quartzite, granite and some conglomerate, most of which appears to have been derived from the main range to the south.

Some sections, which have been exposed in the valley of the Wind river, show boulder clay and gravel overlying the harder rocks, but as a rule the glacial drift is very thin or is seen only in patches. Eastward to the Snake river it becomes much thicker, but thins again northward to the Mackenzie delta.

The timber on this plateau consists almost entirely of spruce. Birch and tamarack which are totally absent in the mountain section, appear for the first time on the plateau near the mouth of the Little Wind river.

Banksian pine was never seen anywhere, and poplar of two varieties, only on the islands and lower flats of the river.

The height of the timber line on the hills near the Little Wind river is 1,400 feet above the bottom of the valley, or about 3,000 feet above sea level. Relative to the bottom of the valley, the timber line is at about the same elevation down to Fort McPherson; but its absolute elevation gradually decreases northward.

The geology of the foothills section of the plateau region is in marked contrast to that of the mountain section. Three miles from the base of the main range, cliffs 150 feet high, composed of slightly inclined sandstone, appear on the banks of the stream. These cliffs show the following succession from the base upwards:—A fine con-

glomerate, holding fragments of fossil wood and iron stone nodules, merging into a soft grey sandstone; the latter becomes more feldspathic towards the top, and altering to an arkose. On the top of all is a deposit of boulder clay. This rests on the Palæozoic limestone which forms the country rock of the Illtyd range. The contact between the sandstones and limestones was not seen, but they appear to be conformable, or nearly so. From their lithological resemblance to Cretaceous rocks in other parts of the North-west, the sandstones have been tentatively referred to the same age. No fossils, except the fragments of wood, were found in them.

These sandstones form cliffs on either side of the river down to a point within two miles of the Little Wind river, where they are replaced by the massive grey limestone of the Illtyd range, which here crosses the river diagonally. They have been gently folded into a series of low anticlines and synclines, which strike north parallel to the bordering mountain range, and have no doubt been affected by the orographic movements, which raised them above the floor of the plateau. They almost completely surround the Illtyd range and separate it from the main range to the south.

THE ILLTYD RANGE.

The Illtyd range is anticlinal in structure. It strikes north and slightly west of north, and is parallel to a similar range on the east side of the Bonnet Plume river. It is composed of massive, grey dolomitic limestones, and where it crosses the Wind river, these become slightly crystalline. For two miles the Wind river flows in a gorge-like valley bordered by cliffs of these limestones, and shortly below the mouth of the Little Wind river, it breaks through the range, and enters again the level plateau country. On its northern side the Illtyd range has a very gentle slope, and the limestones dip at a very low angle beneath the overlying Cretaceous sandstones. The highest point of the range is about 4,200 feet above the sea.

Below the Little Wind river, the Wind river widens considerably. It is filled with gravel bars and the valley is shallow. Near Mount Deslaurier it cuts into the eastern bank, exposing a section of soft grey sandstone, 100 feet thick, overlaid by some clay.

Mount Deslaurier itself is a west-facing fault scarp, rising abruptly from the water's edge to a height of 850 feet, and sloping gently away on the opposite side. It strikes parallel to the course of the stream, which it follows for four or five miles. It is composed of about four hundred feet of dark reddish conglomerate, containing angular and water-worn fragments of limestone, quartzite and other rocks; below this is a brecciated limestone, which, near the contact, also carries some

foreign fragments. At the water's edge is some sandstone. The latter was probably at first also included in the fault, but later erosive action has worn it all away, leaving now only the conglomerate on the surface.

In the angle between Hungry creek and the Wind river stands Mount Deception, an outlier of the main range to the south. This is a steep anticlinal hill, rising to a height of fourteen hundred feet above the river. It strikes northwest and dips at a very high angle. It is composed of a massive crystalline limestone, which varies in colour from pure white through a mottled, to a dirty gray, with earthy and black streaks.

Below Mount Deception the river enters a low level country underlaid by almost undisturbed Tertiary rocks. The stream occupies a shallow valley bounded by sloping wooded banks so that the contact between the rocks of the Tertiary basin and the older rocks was not seen, except at the mouth of the Wind river.

COAL.

About twelve miles below Mount Deception, however, cut banks sixty feet in height appear on either side. These at first consist entirely of boulder clay overlaid by gravels, but, farther down, a section of the Tertiary rocks is exposed. This shows six feet of lignite, associated with beds of clay and sandstone, overlaid by glacial drift.

The lignite is still in a primary stage of development, and shows the twigs and leaves of which it is composed, and even some blebs of resin. This seam of lignite is again exposed two miles below, overlaid by six feet of rusty gravels, and resting on a bed of clay. At the base of all is a soft and very fine-grained sandstone, which is also very porous. The lignite when dry burns fairly readily, giving off the odour of burning resin and leaving a great deal of ash. Another section of Tertiary rocks about four miles above the Peel river, and on the right hand side, where the stream cuts directly into the beds, shows the following succession of rocks:—

Gravel and boulder clay	40 feet
Unconformity.	
Sandstone with 8 seams of lignite from ½ to four inches thick	50 "
Unconformity.	
Rusty black slates	5 "
Water's edge	95 feet

One mile above the Peel river, the contact between the Tertiary rocks and the underlying slates is well shown in a steep cut bank on

the east side of the river. The section shows the great structural break and the lapse of time that must have occurred between the deposition of the two series of rocks.

The following section was measured :—

Glacial drift	40 feet
Unconformity.	
Sandstone with beds of reddened shales	30 "
Unconformity.	
Vertical black slates	20 "
River bed	90 feet

The reddened shales in the section probably correspond to the lignite beds of the section higher up, and indicate the previous combustion of the lignite. The slates stand in a vertical attitude, while the Tertiary beds, resting unconformably on the upturned and truncated edges of the slates, dip at a low angle to the east. The tilted surface of the Tertiary beds had been previously bevelled before the deposition of the glacial material, showing considerable lapse of time between the two periods. The Tertiary rocks are again exposed on the Peel river for a distance of about four miles and will be referred to later.

For the last mile the Wind river flows through a cañon 100 feet deep cut in upturned black slates and shales.

A small creek, which enters the Wind river a mile and a half from the mouth, cuts a deep and narrow gorge through heavy beds of black argillite. The creek has a beautiful waterfall with a sheer drop of fifty feet. The argillites are here seen to dip at a very low angle to the southwest, while at the contact with the Tertiary beds about a mile away they are almost vertical. The texture of these argillites is exceedingly fine-grained, and the largest particles in the rock are crystals of pyrite, which mineral also occurs in vuggs and well defined veins. These rocks are also exposed on the Peel river for several miles above the north of the Wind river, and in them the upper cañon of the Peel is cut.

On the bars of the Wind river, two miles above the mouth of the Little Wind river, a great deal of float lignite coal occurs. This is probably derived from the Cretaceous rocks, through which the river flows for some miles above this. The lignite in the Tertiary rocks at the mouth of the Wind river has already been mentioned.

GOLD.

Some coarse colours of gold were panned out from a shovelful of dirt scraped from the rim rock at the mouth of Little Wind river.

Coarse gold is also supposed to have been found in the gravels of Hungry creek by the prospectors in 1898, but sufficient time was not taken by us to verify this report. Very little indication, however, of placer gold was found on the bars within five miles of its mouth. As the stream rises in a large lake twelve or fifteen miles up, and flows through a low muskeg country to join the Wind river, it appears to be rather an unpromising place for the occurrence of gold, but some of its tributaries which flow through a more hilly country might carry the precious metal.

By far the largest percentage of the drift of the Wind river consists of limestones and quartzite pebbles derived from the rocks through which the stream flows, and the proportion of quartz is very small indeed. The natural inference one draws from this is, that the Wind river does not flow through a markedly mineralized belt of rocks.

THE PEEL RIVER.

The Wind river enters the Peel river one mile above the lower end of the upper cañon, or two hundred and one miles above Fort McPherson. A micrometer and compass survey was carried from here down the stream, and through the Western channel to where this joins the Mackenzie river, a distance of three hundred and five miles.

Above the mouth of the Wind river the Peel river was not explored for more than six miles, and that by walking along the shore. Few explorers or prospectors have ever been through the upper cañon, which extends from the mouth of the Wind river up to the Aberdeen falls, an estimated distance of about 30 miles. Some of the prospectors in 1898 ascended the stream as far as the falls during the winter, and a year or two later two others descended the stream from its head in rafts, having crossed over the divide from the Twelve-mile river. The cañon appears to be easily navigable for canoes, and no serious obstruction occurs as far as Aberdeen falls, around which a portage is necessary.

The upper cañon is one hundred to a hundred and fifty feet deep, with almost vertical walls of rock. Its average width is about five hundred feet, and the stream flows at a rate of from four to seven miles an hour. When the water is low, it would be comparatively easy to ascend; but, as the water marks show, it is twenty-five feet higher in flood, and would then be impassible.

On the 14th of July, with the Peel river at a medium stage of water, and the Wind river slightly higher, comparative estimates were made of the discharges of the two streams. An estimate was made of the Peel river above the mouth of the Wind, by taking cross-

sections of the bed and measuring the average velocity for a certain distance. No suitable place for taking the discharge occurs on the Wind river, so the volume and velocity of the united streams was ascertained below the junction. The results show the Peel river to have a discharge almost three times as great as that of the Wind. The actual figures obtained were :—15,136 cubic feet per second for the Peel river alone; and 20,538 cubic feet per second for the united streams. This allows the Wind river a discharge of 5,402 cubic feet per second. These figures are valuable merely as showing the comparative discharges of the two streams, and not for their absolute volume, for the volumes vary enormously at different seasons of the year.

The upper cañon of the Peel river ends one mile below the mouth of the Wind river, and from this point down to the next cañon, a distance of fifteen miles, the river bed has an average width of nearly a mile, most of which, however, is occupied by gravel bars and willow and poplar islands. For this distance the river flows through the low level Tertiary basin before mentioned. The banks of the valley are about a hundred feet deep. On the south side is a level wooded plain, stretching onward to the mountains ; while on the north is a great curve in the mountains, the two ends of which touch and cross the river at the upper and lower cañons.

Eight miles below the upper cañon, Mountain creek enters from the north, flowing through the great bay formed by the curve in the mountains. It is this stream that the Indians follow in making the cut-off across the great bend in the Peel to avoid the lower cañon and swift water ; and it was this route that the North-west Mounted Police patrol followed in making their winter journey from Dawson to Fort McPherson. The north end of this trail joins the river at the mouth of Trail creek 120 miles below.

Directly opposite the mouth of Mountain creek are the burning lignite beds noted by Count de Sainville on his map in 1893. It is impossible to say how long these beds have been burning, but for nearly a mile along the bank the lignite has been burnt away, and has so undermined the overlying glacial drift as to cause large landslides. One had only recently occurred in July, and thrown down a great mound of material half way across the stream, so as to divert the water to the other shore. In other parts exposures of reddened clays and shales indicate places from which the lignite has been consumed away.

It seems altogether likely that the burning away of the numerous lignite beds in this section, and the consequent sliding down and washing away of the overlying material, is accountable in some measure for the great width of the valley, which is wider here than in

Lower Canon, Peel River.

any part of its course below. The main stream follows pretty closely the cut banks on the south side of the valley, where the lignite beds are exposed and burning, and wherever landslides occur the slidden material is very soon dissolved or carried away by the water.

BONNET PLUME RIVER.

The Bonnet Plume river joins the Peel from the south, twelve miles below the Wind river. It enters the Peel by a number of channels, forming a delta some three miles wide. As a result of this, it is practically impossible to estimate its discharge, but it is probably larger than the Wind river. It occupies a broad, shallow valley, filled with gravel bars and cut into numerous channels, very similar to that of the lower part of the Wind river. It is said to rise in a large lake in the mountains, and its course is roughly parallel to that of the Wind river. It emerges from the mountains some sixty miles above its junction with the Peel, and flows for that distance through a flat wooded plain, unbroken by any mountains or hills, and underlain probably to some extent at least by Tertiary rocks. As a result its water is very muddy, and it discolours the Peel for some distance below. It was ascended by Count de Sainville for a distance of about twenty miles, but apart from the natives of the country, no other man has ever been far up it.

A sheet of ice occupies a large area at the mouth of Bonnet Plume river and hot springs are said to exist near here. The ice sheet is probably due to the constant flooding and freezing during the winter of the water from these hot springs. A diligent search for the hot springs on the east side of the river led to no discovery, but I afterwards learned that they were situated in the angle on the west side of the stream.

Below the Bonnet Plume river the valley gradually contracts in width, and from a distance appears to close altogether, until the entrance to the lower cañon is reached. Here the stream has cut a deep and narrow defile through the low range of hills which borders the low Tertiary basin on the east side. The banks of the valley quickly rise from a height of a hundred feet to five hundred feet, and from this point down to within thirty miles of Fort McPherson, a distance of 158 miles, the river flows through the high Peel plateau, cutting a deeper and deeper valley northward, until the banks attain a maximum height of 1,000 feet.

This lower cañon is about two miles long Its average width is 500 feet, bordered by almost vertical walls of thick bedded black slates. At ordinary stages of water it is not at all dangerous to navigation. Except at the entrance to the cañon, where a little rough-

water and heavy swells occur, the stream though swift is perfectly smooth. The level of floods in the cañon is marked by piles of drift-wood, stranded in bays and sheltered spots, and lies thirty feet above the ordinary level of the water.

About half way through the cañon on the right hand bank a lop-st :k stands to mark the position of two whirlpools, one on either side of the river, which are said to be exceedingly dangerous when the water is high. On the 15th July these whirlpools were only slowly revolving currents and hardly noticeable.

Below the cañon the valley again widens to form a large basin four miles long and a mile and a quarter wide ; then gradually contracting again, it turns sharply to the south, and follows a winding course easterly to the Snake river. From the cañon to the Snake river is a distance of about thirty-eight miles, and in this section the stream has a velocity often of eight miles an hour, and seldom less than six. Swinging from one side of the deep valley to the other, it cuts deeply into the soft shales and sandstone rocks, forming steep cut banks, which are constantly dropping fragments of rock into the rushing st·eam below. These cut banks alternate with points of gravel and oculders, which are sometimes clothed with a forest growth of spruce, poplar and willows.

The plateau to the south is broken by some low ranges of north and south hills, while to the north it is perfectly level, and carries on its surface several muskeg lakes. It is everywhere forested and covered with moss, which is always frozen a few inches below the surface. A few small patches have been burnt, but on account of the wet or frozen condition of the mossy surface these burnt areas never extend inland far from the river bank.

·een the Bonnet Plume and the Snake rivers only a few small enter the Peel, drawing their water from the lakes on the surface of the plateau.

SNAKE RIVER.

The Snake river, which is also called the Good Hope river, enters the Peel in the corner of the large elbow that the latter makes. It was originally supposed to be the larger of the two streams, and because its valley is a continuation in almost a straight line of the Peel valley below, it was taken to be the main stream. An estimate of its discharge, however, proves the Peel to be almost four times as large. The figures obtained for the discharge of the Snake river were 6,960 cubic feet per second, a considerably greater volume than the Wind river, and probably also than the Bonnet Plume. The river is supposed to have been explored by Mr. Bell of the Hudson's Bay Com-

pany in 1839, and he speaks of the Snake river as the main stream; but his sketch and description of the lower part of the Peel are so inaccurate, that it is difficult to say how much faith to put in his account of the Snake river. At its junction with the Peel, the Snake river, on July 21, had a width of 350 feet, with a maximum depth of nine feet. The water is a dirty gray colour, flowing at the rate of four miles an hour, and it occupies a valley seven hundred feet deep and about half a mile wide.

The Snake river was explored for a distance of twenty-five miles, and except that there was a slightly accelerated current and many islands, the general character of the stream was unchanged. From one of the neighbouring hills its course through the plateau could be traced for about fifty miles above the Peel, flowing in a northwesterly direction from near the eastern border of the Ogilvie range of mountains. The valley has a cañon-like appearance, bounded by steep banks of fossiliferous soft gray and reddish sandstones, which lie horizontally or are only slightly inclined.

The angle between the Snake river and the upper part of the Peel is occupied by a wide timbered flat. On this spruce trees, tall and straight, with a diameter of 24 inches were common. Birch is also fairly abundant, but few specimens attain a greater diameter than six inches. The other trees are tamarack and balsam poplar with alders and willows.

PEEL RIVER (Continued).

On mingling its waters with those of the Snake river, the Peel river turns off sharply at a right angle to its former course, and down to Fort McPherson trends a few degrees west of north. From the Snake river to the Fort is a distance of 147 miles, and in this section there is little variation in the general character of the valley. The valley itself has an average width of one mile, the greater part of which is usually taken up with gravel bars or wooded flats, and it is bounded by banks of clay, sandstone or shale, which vary in height from 600 to 1,000 feet. The average velocity of the current gradually decreases, and though it frequently attains a speed of eight it often drops to about two miles per hour.

For thirty-five miles below Snake river it has an absolutely straight course of almost true north, when it bends gradually towards the west, and flows in a general northwesterly direction as far as Satah river, being joined on the way by George creek from the east, and Cariboo and Trail creeks from the west.

George creek is an insignificant stream only about forty feet wide and a few inches deep, having a brownish water probably drawn from muskeg lakes to the east.

For some miles above George river the Peel river flows close against the eastern side of the valley, forming steep cut banks of cla and sandstone 700 feet in height. These, when composed of clay shale, form great landslides, or where of firmer rock are constantl dropping blocks and fragments into the stream below.

Directly opposite our camp of July 22, or about three miles abov George river, is what Mr. Isbister in his report called the "Alum Hill." Some epsomite is here deposited as a thin coating on the clay wherever a little water oozes out from the bank. A little of this white deposit of salt is seen all along the river banks from the Snake river down to George creek; but it occurs in greater quantity at the "Alum Hill". Some moose and caribou evidently frequent the place for the sake of licking the salt. The plateau behind the "Alum Hill", is much broken and dissected by valleys and deep sink holes.

Cariboo creek enters the Peel river from the west twenty miles below George creek. It occupies a valley almost half a mile wide, and out of all proportion to the amount of water flowing in it. It debouches by several channels into the Peel river, none of which, however, are more than six inches deep. The course of the stream could be traced southward for eight or ten miles in almost a straight line.

Fom Cariboo creek to Trail creek is twenty-two miles by river. The current here becomes noticeably slacker, and there are fewer islands and gravel bars, the stream usually flowing in only one channel instead of three or four as above. The banks of the valley become slightly lower, being about six hundred feet on the east side and eight hundred feet on the west, and at the same time the slopes are more gentle and more frequently wooded. The plateau slopes easily away to the northeast, while it gradually rises to the west. A stream of unknown name, about a hundred feet in width, enters from the east about nine miles above Trail creek.

Trail creek itself is about the same width, (100 feet), flowing in a deep and wide valley from the southwest. It is this stream that the Indians ascend in making their traverse across country to the mouth of the Bonnet Plume river. At this point the swift water in the Peel river begins, in going up stream, and they leave their canoes here and walk across country. Trail creek itself is not navigable.

SATAH RIVER.

Twenty miles below Trail creek Satah river enters from the east. The stream here has an average velocity of two or three miles an hour, and consequent on this growing slackness, gravel beaches are being

replaced by others of sand and clay. Deposits of silt and mud have accumulated in places, and these are occasionally cut into by the stream, exposing sections containing roots, stumps of trees and other material imbedded in frozen muck. Beds of peat too are common.

Four miles above Satah river a small stream enters from the west and directly opposite are the first recent signs of human occupation that we have seen since leaving Beaver river. These are fish stages, and low huts built of bark, logs and clay, looking very much like so many dog kennels.

At Satah river the Peel emerges from the high plateau, and enters what is probably the coastal plains of the Mackenzie river. The transition from the one to the other is very abrupt, and the escarpment of the plateau is about 600 feet high. The northern face of this escarpment, where the Peel river cuts through it, forms a semi-circle which is about ten miles across the base, and the stream after issuing from it skirts along the base of the western arm of the arc. This side of the escarpment has a maximum elevation of one thousand feet above the river, while on the east side this level decreases gradually, until about ten miles away it is only four hundred feet. Enclosed in this arc is a level lake country, underlaid by soft sandstones, and dotted everywhere with lakes of all sizes up to five miles in length. Satah river, which is a sluggish stream about 120 feet wide, drains this lake country, entering the Peel as it emerges from the plate 1.

Directly west of Satah river, and at a distance of about twenty-five miles is a range of high snow-covered peaks which McConnell calls the main range of the Rockie[illegible] gradually decrease in height to the south, becoming the low [illegible] range that crosses the Peel at the upper cañon. The plateau [illegible]ends up to the base of this range, the evenness of its surface being broken by several low north and south ridges lying parallel with the range of mountains.

Below Satah river the stream makes a wide bend to the west, to avoid which a short cut across country is made in the winter time. From here to Fort McPherson is fifty-three miles, during which distance the stream flows with an even current of about two miles an hour between low banks of clay. Bluffs of sandstone occur here and there. Few islands interrupt the course of the stream, and the average width is about six hundred yards. The stream skirts along the eastern face of the plateau escarpment, sometimes cutting through the projecting points or outliers of it, until as we approach the Fort, it gradually leaves it altogether never to touch it again.

Five streams join the Peel in this section, two from the east and three from the west; the largest of these, which is also the largest

tributary below the Snake river, enters from the west twenty-seven miles above the Fort, and is called by the Indians Road river. This stream, rising in the mountains to the west, is very swift, cutting a deep valley in the high plateau. It has a width at its mouth of about 100 yards.

From Road river down to Fort McPherson several encampments of Loucheux Indians were passed, the first seen since leaving Lansing creek. These spend the summer along this part of the river in fishing and drying the white fish they catch for their winter's use.

FORT McPHERSON.

Fort McPherson, which stands on the east bank of the river, is the most northern trading post of the Hudson's Bay Company. It consists of the Company's buildings and some houses belonging to the Church of England Mission. These latter are now being occupied by a small detachment of North-west Mounted Police, consisting of half a dozen men under Inspector Howard. There is also another fur trader who has lately started in business.

A careful estimate of the discharge of the Peel river was made at Fort McPherson on the 31st of July, when the level of the water was about a medium stage. Though the water mark of the spring freshet is thirty feet above the level in July, the Peel river keeps at a fairly uniform level all summer, and scarcely falls more than three or four feet below the level when the discharge was taken. The figures obtained for the discharge were 49, 206 cubic feet per second. The average velocity is about two miles an hour, and the greatest depth fifteen feet.

Fort McPherson stands on a bank seventy-five feet above the water, and this is the last high land on the river banks. Below this is the flood plain of the great Mackenzie delta, in which all, or nearly all, of the land is submerged in the spring floods. The southern edge of this delta is a line drawn from the Fort to Point Separation, and marked by several low ridges similar to the one on which the Fort stands. From Point Separation the trend of the higher land is northward, skirting along the east side of the eastern channel of the Mackenzie, and culminating in a low range of hills called the Reindeer hills beyond Campbell river. West of the Peel river the margin of the delta is the eastern face of the high escarpment mentioned before, which trends slightly west of north from Fort McPherson, crossing the Rat river below the mouth of Long-Stick creek, and gradually approaching the range of mountains west of it, until it merges with this range and disappears at the base of Mount Goodenough. The boundary of the delta north of this is then the base of the mountain range.

Below Fort McPherson the Peel river flows in a straight line northward for twelve miles. It then divides the eastern channel which is a travelled route and has been surveyed by Messrs. McConnell and Ogilvie joins the Mackenzie river by two mouths another twelve miles beyond.

The western channel, which locally goes by the name of the Huskie river, follows along the western edge of the delta and only joins the Mackenzie waters ninety miles below. There are two large channels of the Peel river between the extreme eastern and western ones, and several smaller ones, all of which would have taken more time than was at our disposal to survey, so that a survey was only carried down the Huskie river and up one of the middle channels.

HUSKIE RIVER.

The Huskie river or western branch of the Peel, has a variable width of from 75 to 200 yards, due to the fact that it is constantly sending off and receiving tributaries from either side. Its current is about one mile per hour, and it is bordered by banks twenty-five feet in height composed of alluvial clays and sands. It is exceedingly crooked, meandering in an exasperating manner over the level floor of the delta. The banks are wooded with willow and alders, with some spruce, which latter gradually decreases in quantity northward until 125 miles below McPherson it disappears altogether.

The south branch of the Rat river, which Ogilvie mapped in 1887, flows into the Huskie river thirteen miles below Fort McPherson and it was this stream which all the prospectors followed in 1898 on their way across to the Porcupine river.

The central branch of the Rat river joins the Huskie river twenty-one miles below the south branch, and a smaller branch comes in four miles below this. A survey of this central branch was made to connect with Ogilvie's of the south branch, but the northern branch was not explored.

Sixty-three miles below Fort McPherson, the Huskie river approaches within two miles of the base of the Rocky mountains, and here an Indian hunting trail leads into the mountains. An excursion was made to the summit of Mount Goodenough (3,000'), from which a good view of the delta was obtained. Under good conditions one is able to see the Arctic ocean from here, but, owing to the hazy condition of the atmosphere, this was impossible at that time. Through the delta several channels of the Peel and Mackenzie can be seen meandering in a very crooked manner; but the most striking feature is the countless number of lakes, large and small, that cover the surface of the delta everywhere. The whole delta is flooded with water in the spring

time, and these lakes are probably then filled, while small strea drain them during the rest of the season.

The delta is heavily wooded with spruce as far north as latitude 6 30′, where it gradually dies out, and only willows and alders remai These extend northward nearly to the sea, where the recently forme land is utterly devoid of any vegetation whatever. As the new lan of recent years is formed and extends seaward, the land formed i earlier years is covered with a growth of young willows, while th older land still is marked by a forest growth of larger willows an alders as well as spruce, so that the age of the land can be reckone by the age and character of the forest growth on it.

TOPOGRAPHY OF THE PEEL RIVER DISTRICT.

The topography of the country through which the Peel river flows is simple, and has been occasionally referred to in previous portions of this report. Above the lower cañon and as far up probably as Aberdeen falls, it occupies a wide basin almost completely surrounded by low ranges of hills. Inclosed in this basin are a number of round topped hills or groups of hills, whose origin is due either to faulted blocks or uplifted anticlines. Along the eastern edge of the basin, and occupying a shallow depression in it, is a large area underlaid by Tertiary rocks. These must have been deposited in an inland sea whose boundaries were the encircling hills, and whose outlet was probably by the lower cañon of the Peel river.

Leaving the Tertiary basin the Peel cuts a deep and narrow gorge through the hills bounding the basin on the east, and enters again the plateau region. Through this it flows for 130 miles, cutting a deep valley sometimes a thousand feet deep into the clays, shales and sandstones. Looking over the plateau from any one of the bordering hills, it appears to be perfectly flat, and shows an unbroken sky-line that is uniformly level; but in reality it is made up of several long and gentle undulations, which are perceptible only by careful measurements of the height of the banks of the valley. These undulations have a general north and south trend, lying parallel to the range of mountains against which the plateau abuts to the west. The plateau has a long gentle slope to the northeast towards the valley of the Mackenzie river, while to the north it appears to break off sharply, forming a steep escarpment overlooking the coastal plain. The Peel river breaks through the escarpment at Satah river and enters the coastal plain, though it follows closely the base of the escarpment for several miles below.

Below Fort McPherson is the delta of the Mackenzie river, through which branches of both the Peel and Mackenzie rivers ramify in all

directions. The delta covers an area of about 100 miles from north to south, with a width of from twenty-five miles across the south end to sixty or seventy miles across the north. Overlooking the delta from the west side is the northen extremity of the Rocky Mountain system, which extends down to the Arctic coast. Although interrupted in its course northward from the United States boundary line by several deep valleys and streams, and called by different names in different parts of the country, the continuity of this range is practically unbroken, and these mountains west of the delta are really the northern extension of the same range which crosses our southern boundary line. At the delta they rise abruptly to a height of 2,000 feet, and in many parts of the eastern face are inaccessible. Their summits here have the appearance of mature dissection in being well rounded and graded. The highest points are little more than 3,000 feet in height, and this elevation gradually decreases towards the north.

GLACIATION IN THE PEEL RIVER DISTRICT.

Reference has already been made to the glaciation in the section of the Peel River watershed enclosed by the foothill ranges. On the plateau to the north and west of this, that is, below the lower cañon of the river, apart from the fact that there has been glaciation to a certain point northward, very little information to supplement McConnell's deductions as to the glaciation on the lower part of the Mackenzie valley was obtained.

Heavy deposits of boulder clay occur in what are probably preglacial depressions near the mouth of Snake river. One section exposed shows 150 feet of dark boulder clay containing boulders of limestone, quartzite, conglomerate and sandstone, all of which were undoubtedly derived from the ranges to the south and southwest. Below Snake river boulder clay lies on the underlying rocks only here and there in patches, and always very thin, scarcely ever exceeding ten feet in thickness. Sections of the Peel valley often show beds of peat occupying the surface, and lying directly on the Cretaceous sandstones without any intervening glacial drift. Other sections show five or six feet of rusty gravel separating the peat from the sandstone.

On the slopes of the high plateau west of Satah river are numerous landslides exposing a dark clay which carries rolled gravel and boulders. This slope is also broken by two benches, one at a level of 50 feet above the river, and the other at 500 feet. On each of these is the same dark clay holding rounded pebbles. On the top of the plateau, which is entirely devoid of timber for some distance inland, a white clay appears lying in round open spaces three or four

feet in diameter and fringed with moss or grass. Scattered over th
open clay spots are quantities of small pebbles. I have noted
same occurrences on the barren lands, and they have also been m
tioned by other explorers in the same region.

In the mountains near the mouth of the Snake river, rolled pebb
were found at a height of 1,600 feet above the level of the stream; b
on Mount Goodenough, west of the Mackenzie delta, water-wo
pebbles and boulders of gneiss were found on the summit, which
3,000 feet high. The summit of this mountain is thickly strewn wit
pebbles, and on its south side at a level of 2,400 feet there is a ver
heavy deposit, resembling a terrace, of gravel and boulder, both o
limestone and gneiss. This rests directly on the broken quartzit
flags which constitute the country rock.

Evidence of a small mountain glacier on the east face of Mount
Goodenough was seen in a deposit of block boulder clay; no existing
glaciers, however, were seen in that region. The slopes and summits
of the range are well rounded and have the appearance of mature
erosion, though parts of it overlooking the delta break off sharply and
present steep and inaccessible cliffs to the eastward.

The few facts observed point to a northerly movement of the ice,
for the boulders in the clay of Snake river were evidently drawn
from the mountain ranges to the south and southwest. According
to McConnell's theory, the ice from the Archæan gathering ground to
the east of the Mackenzie river poured westward through the gaps
in the mountain on the east side of the river, until it reached the
main axial range, and was then deflected to the northeast down the
valley of the Mackenzie to the sea. From the mountains to the
west only large valley glaciers, from 1,500 to 1,800 feet in depth,
issued from the valleys, and spread over the surface of the plateau
moving slowly northward and perhaps slightly eastward, until they met
and merged with a northwestward moving sheet of ice from the
Archæan highlands to the east. The valley glaciers, after leaving
the mountains and spreading over the adjoining country, probably
covered and rounded off the tops of nearly all the mountains in the
foothills belt, leaving only a few nunataks here and there with an
elevation sufficient to protrude through the ice sheet.

On account of the softness of the rocks, and the universal covering
of moss, glacial striæ are never seen on the plateau itself. On the south
side of Mount Goodenough, at an elevation of 1,500 feet, grooves and
scourings which may be due to glacial action were noticed on a saddle-
backed ridge. These have a bearing of N. 20. W., but whether caused
by a small mountain glacier, or by the ice sheet which filled the
Mackenzie valley, it is difficult to say. The weight of evidence appears
to be in favour of the former cause.

Between the base of Mount Goodenough and the Huskie river, and at a distance of about a mile from the river, remnants of an old beach occur. This appears as an abrupt rise of twenty feet above the floor of the delta plain, or forty-five feet above the level of the water, and probably marks a former shore line of the Arctic sea.

GEOLOGY OF THE PEEL RIVER.

The upper cañon of the Peel river is cut in a series of tilted black slates, often dipping up stream. The strata of which it is composed, are alternately thick and thin bedded containing concretionary nodules with crystals and veinlets of pyrite and some bituminous matter disseminated through the rocks. This formation extends for a distance of three-quarters of a mile below the mouth of the Wind river, where it is replaced and overlaid by Tertiary clays and sandstones. The contact is not so well shown on the Peel river as it is on the Wind, though the unconformity between the two is plainly evident. These slates out-crop again fifteen miles below in the lower cañon of the Peel river, so that they border the Tertiary rocks both to the east and to the west. A small outcrop of bituminous limestone, overlaid by the red clay and sandstone of the Tertiary, is exposed one mile below the cañon on the south bank of the river.

When cut through by the Peel river, the Tertiary basin is thirteen miles in width. The rocks of this basin consist of thick beds of soft sandstone, with some thin seams of lignite, overlaid by more sandstone containing pebbles, with clay and some very thick beds of lignite. The whole series has been gently folded into a number of anticlines and synclines. One lignite bed near the top of the series is thirty feet in thickness and fairly persistent, appearing in two exposures four miles apart with a shallow syncline between. This bed rises in an anticline, the top of which has been truncated by later erosion, and beyond, it dips again and disappears beneath the bed of the Bonnet Plume river. Where it appears in the anticline it has been ignited by some cause or other and is now burning. It has been burnt for some distance along the bank of the river, and even across to the east side of the Bonnet Plume river, and has so undermined the overlying glacial drift as to cause extensive landslides. The large seam of lignite contains a fair quality of brown coal, which when dry burns readily, leaving a great deal of ash. The upper layers are separated by thin seams of clay, but the lower part is very pure. The heat of the burning lignite has baked the layers of clay to a bright brick red, which softens and dissolves in the water. Some of it turns a pure white or pinkish colour and is very hard.

Underneath the thirty foot lignite seam, and separated from it by a thick bed of sandstone, is another seam eight feet in thick-

ness. The whole is covered by about forty feet of gravel and glac drift.

At the entrance to the lower cañon the Tertiary rocks are replac by the same series of slates as appear in the upper cañon. This cañ is about two miles long. The slates here stand in a more vertic attitude than in the upper cañon, and strike about northwes They have been very much crushed and crumpled and many faul appear, while the rock itself has been greatly sheared and brecciated The lime in the rocks has crystallized out into calcite, and now appear as thin veins ramifying all through the series. The texture of th rock is exceedingly fine-grained, so that its component crystals cannot be distinguished even with a magnifying glass. It contains a large percentage of iron in the form of pyrite, and also some bituminous matter. The series have a banded appearance due to the weathering of some beds white and others black.

Half-way through the cañon a crystalline limestone, which apparently forms the base of the series, has been brought up to the surface in a steep anticline, and forms a narrow band thirty feet in width. The same limestone is again exposed at the lower end of the cañon, where the overlying slates have been thrown upwards at an angle of 45° and eroded away. They appear again north of the limestone, but dipping at a lower angle and showing less the effects of metamorphism. There is probably a fault here, otherwise it would appear as if the limestone overlaid the slates. A short distance below the cañon, the slates are replaced by shales, which dip at a lower and lower angle to the south, until two miles below, they are entirely disturbed and lie horizontally.

Though a diligent search for fossils was made in both cañons, none were found, either in the slates or the limestone, and these rocks are placed in the Devonian merely from their lithological resemblance to rocks on the Mackenzie river which have been referred to that period.

The slates of the lower cañon occupy a belt some two miles wide and were noted on the hills two miles south of the cañon. The same formation is probably continuous through the range of hills, which stretches northward for many miles from the cañon.

From the lower cañon to the Snake river, the river cuts a deep valley 500 to 700 feet in soft shales and sandstone of Cretaceous age. A section of the bank five miles below the cañon shows about 200 feet of yellow and red shales, which towards the base are interbedded with layers of sandstone, resting on massive sandstone fifty feet in thickness. Underneath is about 150 feet of rusty, pyritous shales, very fissile. Overlying all is the glacial drift with a depth of about forty feet. Farther down the stream the banks consist principally of sandstone, with thin beds of shale interposed between sandstone beds.

Structure of Rocks, Lower Cañon, Peel River.

In parts the sandstone contains concretions, many of which are ten feet in diameter.

Apparently the river in this portion cuts through a low anticline, for in the upper part the dips are all up stream and westerly, while near Snake river the dips are in the opposite direction. Towards the centre of this anticline the strata show a good deal of evidence of pressure. A few minor folds occur, and there are several faults. These latter are usually thrust faults, due to contraction and pressure rather than tension.

The Snake river has a deep and narrow valley cut into soft, grey, argillaceous sandstones, which lie horizontally or dip at a low angle to the east. The sandstone is massive, but the beds are separated from each other by thin seams of a harder red weathering sandstone which contains many fossils of Ammonites.

Two miles above the mouth of the river a small creek enters from the west. This has cut a deep cañon in the soft sandstone, affording a good section. One-third of a mile up the creek are some mineral springs, the water of which gives off a strong odour of sulphuretted hydrogen, while the logs and boulders in the stream are coated with the white substance which is usually found with all sulphurous springs.

South of the mouth of Snake river is a range of hills, whose highest points are about 2,000 feet above the river. This range is built up of hard grey sandstone very similar to the sandstone of the Snake River valley, only a little more indurated and approaching to a quartzite.

The fossils collected in the sandstone of the Snake river have been referred by Dr. Whiteaves to the Cretaceous period. (See page 49.)

Below Snake river the Peel river bends sharply to the north, and down the Satah river, in its course through the plateau, flows parallel with the strike of the gentle undulations in the plateau. In consequence there is little variation in the character of the rocks. Argillaceous sandstones, with interstratified beds of clay in the upper part of the river, merge gradually into sections in which the clay occupies a large portion or changes to shale. In parts the sandstone contains large concretions. In others it exhibits that peculiar structure due to pressure known as "cone-in-cone." Some of these pressure figures have a diameter of fifteen inches, and are either cone-shaped or bottle-shaped. On breaking them open the centre is seen to contain crystals of pyrite and marcasite. The surface of the cone peels off in layers like the layers of an onion, and the different layers are longitudinally striated and slickensided. The structure is supposed to be due to pressure upon concretions in the course of formation.

The clay beds gradually increase in thickness northward, until they predominate over the sandstones, when, they too, become shaly. As already mentioned, these beds at the Snake river are coated with a white crust of epsomite and above the mouth of the George river this coating becomes more pronounced.

Six miles above Cariboo creek is a small exposure of reddened clay shale, which, however, does not appear to be continuous, and immediately below this some lignite float was found on a bar, though the bed from which it was derived was not noticed.

Soft shales, often pyritous, occupy a larger section of the banks below Trail creek, and are associated with a sandstone which carries many fragments of Ammonites. The strata are entirely undisturbed, and the water frequently cuts steep banks which are 600 feet in height. Landslides have frequently broken the banks of the valley into a succession of irregular steps, giving the appearance often assumed in banks formed of the Pierre shales.

On leaving the plateau region at Satah river, the river enters a low lying level country, underlaid by soft sandstones and some conglomerate. Ten miles below Satah river cliffs of this sandstone one hundred feet in height appear on the east bank of the stream, and opposite our camp of July 26, the following section was measured:—

	Feet.
Soil and peat	20
Rusty consolidated gravels	5
Soft grey sandstone, massive	50
Fossiliferous green sandstone	20
Soft grey sandstone with concretions, also fossiliferous	25
	120

The rusty gravels of this section rest uncomfortably on the soft grey sandstone beneath. Three miles below, the gravels disappear, and the peat rests on the sandstone. The green sandstone consists of some layers which are made up entirely of fossils of a variety of *Tellinidae*, and are the same as appear in the sandstone of Rat river below the mouth of Long-Stick river.

Opposite the mouth of Road river a fine-grained conglomerate underlies the sandstone. The conglomerate is made up of a large percentage of sandstone blocks with smaller waterworn pebbles and some lignite fragments in a matrix of white siliceous sand. At the top it passes gradually into sandstone.

A pillar of rock, called by the natives "Shiltee," eleven miles above Fort McPherson consists of coarse siliceous sandstone which weathers

to a rusty brown and breaks down into a coarse sand. It is twenty feet in height, standing on a hill 300 feet above the river. An interesting Loucheux legend is connected with the history of this pillar. There were originally three pillars, standing as a warning to the Indians as a result of the disobedience of three giants who were turned to stone. Two of these pillars have fallen through the action of atmospheric agencies, and serve to illustrate the rapidity with which such changes take place in a country where there are such extremes of temperature.

As far as Fort McPherson a few isolated hills appear on either side of the bank, exposing the same sandstone as appears at "Shiltee," but at theFort this changes to a soft, dark and rusty shale Tha sandstone is apparently the same as occurs in the Lower Ramparts of the Mackenzie river, and by the description the conglomerate of the Ramparts is also identical with that of the Peel river.

The bluff on which the Fort stands, like many others in that section, is quite isolated and completely surrounded by the alluvial deposits of the delta formation.

Below Fort McPherson only alluvial sands and clays are exposed in the river banks, which are now scarcely twenty feet in height. Cut banks are very common, and these show the sands and clays overlaid by muck and vegetable matter, all of which is frozen. Cracks and fissures in this have become filled with ice, and wherever the sun's rays beat on them for a while the whole is constantly thawing and breaking down. As the upper layers of this alluvial deposit contain many roots and trunks of trees which serve to bind them together, they do not fall until the underlying beds have been washed away,or until they overhang far enough to be unable to support their own weight. These alluvial deposits are being built up year by year, at the time when the streams are in flood, and inundate the whole delta, and they deposit their load of sediment on the submerged surface. The small streams too, flowing in from the mountains to the west, carry down and deposit annually, a great deal of sediment on the borders of the delta.

MOUNT GOODENOUGH.

An excursion was made into the mountains to the west of the delta, and up to the summit of Mount Goodenough. Afterwards in ascending the Rat river, a section of the mountains through McDougal pass was also obtained.

The base of Mount Goodenough lies two miles back from the river. Its eastern face is exceedingly steep, so that a long detour up one of the creeks is necessary to make the ascent from the south side. The mountain range here is made up of horizontal or only

slightly folded strata, and characterized by flat or gently rounded tops. Mount Goodenough is 3,000 feet in height; but some elevations to the west of it may slightly exceed this. To the north and northwest there is a gradual decrease in elevation, until the range dips down to the Arctic ocean west of the mouth of the Mackenzie.

The geology of the range is not complicated. At the base is a thick series of black shales, which towards the top contain beds of very hard clay ironstone. These weather red, and the outcrop can be traced by its colour for miles along the eastern face of the mountains. These red beds contain remains of Ammonites, while the underlying and enclosing black shales are also fossiliferous. The shales are gradually replaced upwards by argillaceous sandstones, and these again by siliceous sandstones. These latter become metamorphosed to quartzites and constitute the upper members of the series.

Though the mountains rise abruptly from the floor of the delta, the strata have only a very low dip to the east. Farther to the west they have been more closely folded and frequently faulted. These strata are persistent up the Rat river and across to the Bell river, and have been folded into a series of anticlines and synclines, the whole section being an anticlinorium.

ECONOMIC GEOLOGY.

The rocks of the Peel river below the Wind river are not likely ever to be productive in minerals of economic interest other than coal and lignite.

In panning for gold on a bar on the Peel river above the mouth of the Wind half a dozen fine colours were obtained, showing that this stream contains more of that metal than the Wind river. Gold is reported to have been found by the Indians in the gravels of the Bonnet Plume river, and some specimens were exhibited; time, however, did not permit us to substantiate this report. This stream certainly carries a great deal of magnetic sand in its gravels, and for that reason it goes by the name of the Black Sand river among the Indians. A report is current that a certain prospector picked up a pebble of quartz, which showed some free gold, on a bar in the Peel river about thirty miles below the mouth of the Snake river; but if this is true, the specimen must have been carried there from beyond any part of the river that we were on, and was certainly not derived from any rocks near there.

Iron ore occurs merely as float in the wash of both the Bonnet Plume and Snake rivers. The ore is magnetite and hematite associated with red jasper. The float is widely spread over a great part of the Peel River basin. Mr. Keele found it in large blocks on the

Rackla river on the Yukon side of the divide, and it occurs in the wash of Bear river, so that a very extensive deposit of the ore must be situated in the mountain range towards the heads of these streams.

Mineral springs, containing sulphur, occur on a small tributary of the Snake river two miles above the Peel, and small quantities of this mineral are deposited on the boulders in the bed of the stream.

Seams of lignite occupy extensive areas in the rocks of the Tertiary basin at the Bonnet Plume river. The largest seam noted was thirty feet in thickness, another was eight feet, and several varied from two inches to ten. The lignite is not of very good quality, and has been burnt in many places by the fires which have been in existence for many years. Lignite also occurs a few miles above the mouth of Cariboo river, and also in the cañon of the Rat river above the mouth of Barrier river. Many sections of the Peel plateau below Snake river show beds of peat resting on the clay or sandstone, sometimes as much as twelve feet in thickness.

A fissure vein of bituminous coal three feet wide occurs on the right bank of the Peel river ten miles below the lower cañon. It cuts directly across the beds of sandstone and shale, standing vertically and striking 295°. It is very light and soft, burning readily with a red flame, and leaving very little ash. Its origin is probably the bitumen that occurs in the shales and some of the associated sandstones across which it cuts.

The slates and associated limestone occuring in the upper and lower cañons of the Peel river are more or less petroliferous, and afford indications of the presence of oil. Tar oozes out from these rocks in several places, and at the mouth of the Wind river the slates have been reddened, probably by the combustion of the oil which they contain.

GAME AND FISH.

Moose, though found over the whole region explored as far as the delta of the Mackenzie river, are never as abundant as they are on the Yukon side of the divide, and on the Peel river itself are rather scarce.

Caribou are plentiful everywhere in the vicinity of the mountain ranges, some even being found on the plateau.

Bears, both black and grizzly, are plentiful near the summit of the divide, and numbers of them were seen all the way down the Peel river, and particularly on the Mackenzie delta and in the mountains to the west of it.

Numbers of white mountain sheep were seen on both Braine and Nash Creeks. In the mountain section of the Wind river several of them were encountered on the banks of the stream, as well as the slopes of the valley. A small band was seen on Mount Goodenough west of the Mackenzie delta, and they are said to be abundant in the mountain range to the west of this; so that the range of this animal covers the whole district explored.

Grayling in the mountain sections, and white-fish, inconnu and pike in the lower parts of the district are the common fish of the country explored.

The Peel River district is inhabited by the Loucheux tribe of Indians, who trade with the Hudson's Bay Company at Fort McPherson. These obtain their living entirely by fishing in the summer, and trapping and hunting caribou in the winter. They make no attempt to build houses, and the cultivation of the ground is impossible, as the surface only thaws out during the summer for a few inches.

NOTES ON FOSSILS BY DR. WHITEAVES.

A. Apparently of Devonian age.

Favosites.—Fragment of a massive corallum in which Mr. Lambe thinks he can detect septal squamulae. No. 1, Braine creek.

Productella.—Gibbons ventral valves of a small species of productella, with coarse simple or bifurcating radiating ribs.

No. 2. Summit of Braine pass; and Braine pass Nos. 3, 4, 5, 7 and 8.

Atrypa reticularis.—Braine pass, number not stated. Impressions or natural moulds of the exterior of portions of two specimens of a brachiopod that may be A. reticularis, are labelled Braine pass No. 6.

B. Cretaceous species.

Imperfect specimen of the shell of a strongly convex and very inequilateral lamellibranchiate bivalve, rather like *Panopoea* or *Pleuromya* in shape, but with the valves apparently closed, not gaping, behind. Peel river No. 21.

Thracia.—Three small and imperfect specimens that seem to be referable to this genus.

Tellina (?) A few tolerably good specimens of a compressed subovate bivalve shell, with very thin test, which may be referable to the *Tellinidae*, or possibly to the *Veneridae*. But none of these specimens show the hinge dentition or muscular impressions.

Inoceramus.—The specimen labelled No. 10, though imperfect is large, but the other specimens are mere fragments. Snake river Nos. 9, 10, 11 and 12.

Ammonite No. 1.—Large crushed fragments of a smooth species with a narrow venter and umbilicus. Apparently a *Desmoceras* and possibly most nearly related to smooth variety of *D. affine* from the Peace and Loon rivers. Peel river No. 22.

Ammonite No, 2.—Cfr. *Desmoceras Liardense*, W., from the Liard river, which was first described by Dr. Whiteaves as *Placenticeras (Perezianum ?* var.) *Liardense*, in contr. to Canad. Palaeont., vol. 1, p. 158, pl. XXI fig : 1, but which has since been doubtfully referred to the genus *Desmoceras*.

A worn fragment of a cast of less than half a volution. Venter and umbilicus both apparently narrow ; radiating ribs low, broad and bifurcating or trifurcating. Peel river No. 16.

A small and very badly preserved specimen perhaps of the same species as the preceding, is labelled Peel river No. 17.

Ammonite No. 3. Fragment consisting of a rough cast of the interior of one of the septal chambers. Quite indeterminable even generically, but evidently different from No. 1 and 2. Peel river Nos. 18.

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854. Asbestus.
857. Infusorial Earth.
858. Manganese.
859. Salt.
860. Zinc.
869. Mica.
872. Molybdenum and Tungsten.
877. Graphite.
880. Peat.
881. Phosphates.
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913. Mineral Pigments.

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968. Report to accompany map of the Moose Mountain area, Alta., by D. D. Cairnes.
961. Reprint of No. 873.
962. " No. 672.

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Rossland district, B.C. (full report), by R. W. Brock.
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Report on Cornwall sheet, by R. W. Ells.
Reports on Country between Lake Superior and Albany river, by W. J. Wilson and W. H. Collins.

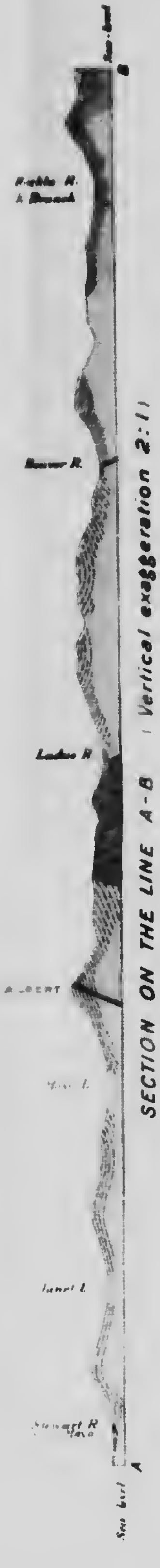
Index to Colours and Signs

Devonian

Upper Palaeozoic

Creeks producing gold

...ical Survey of Canada



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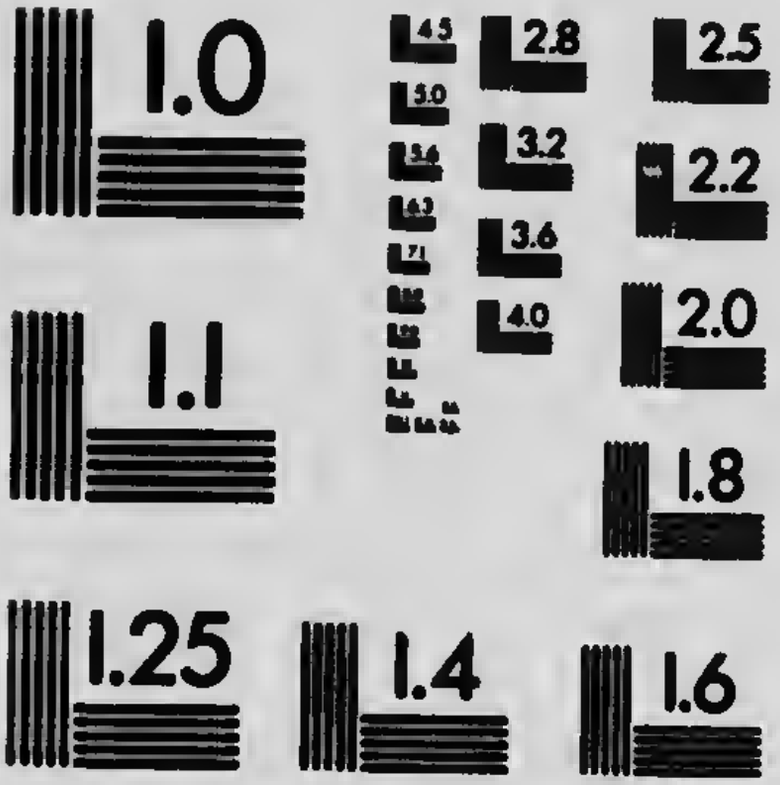

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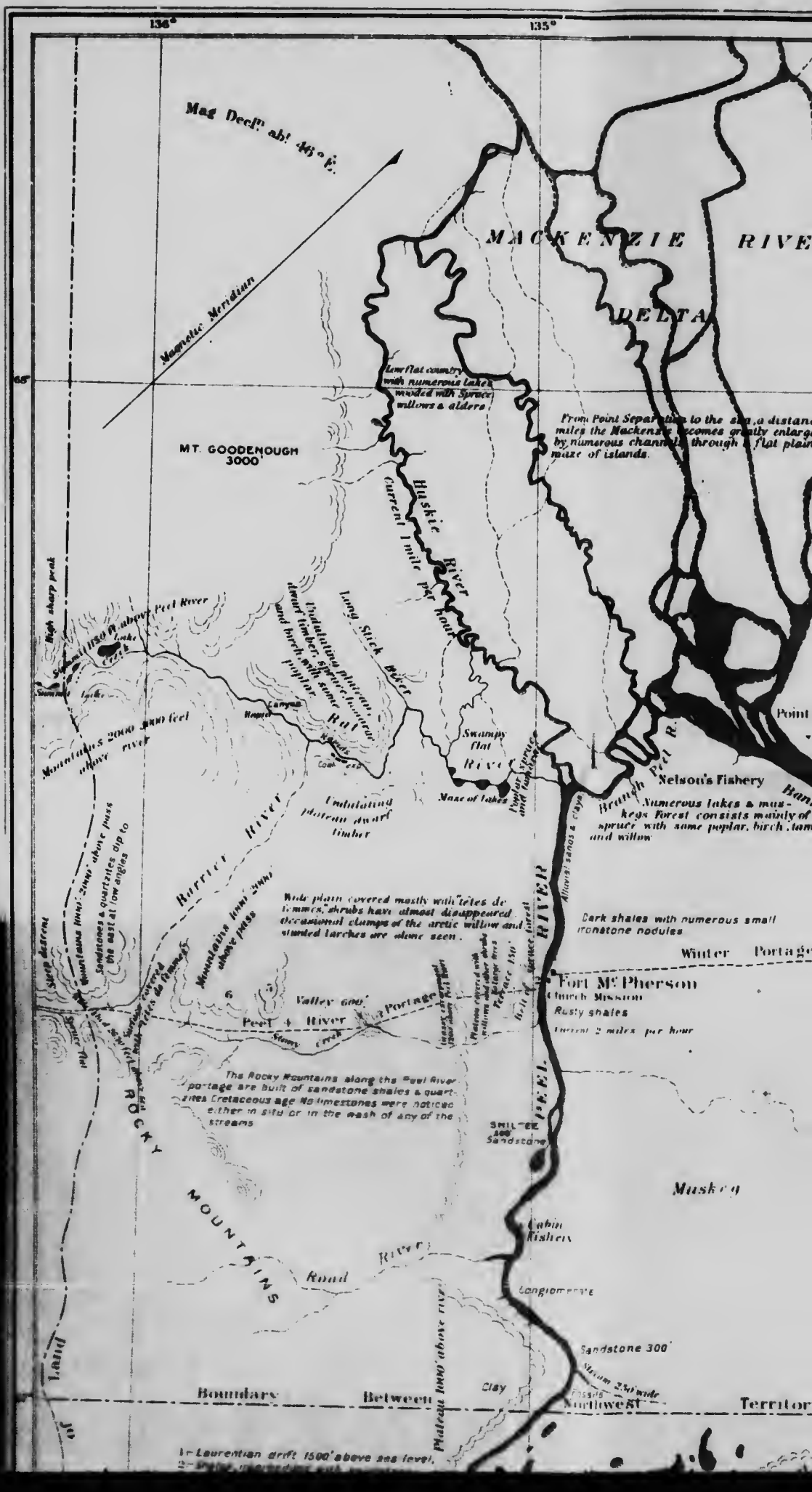
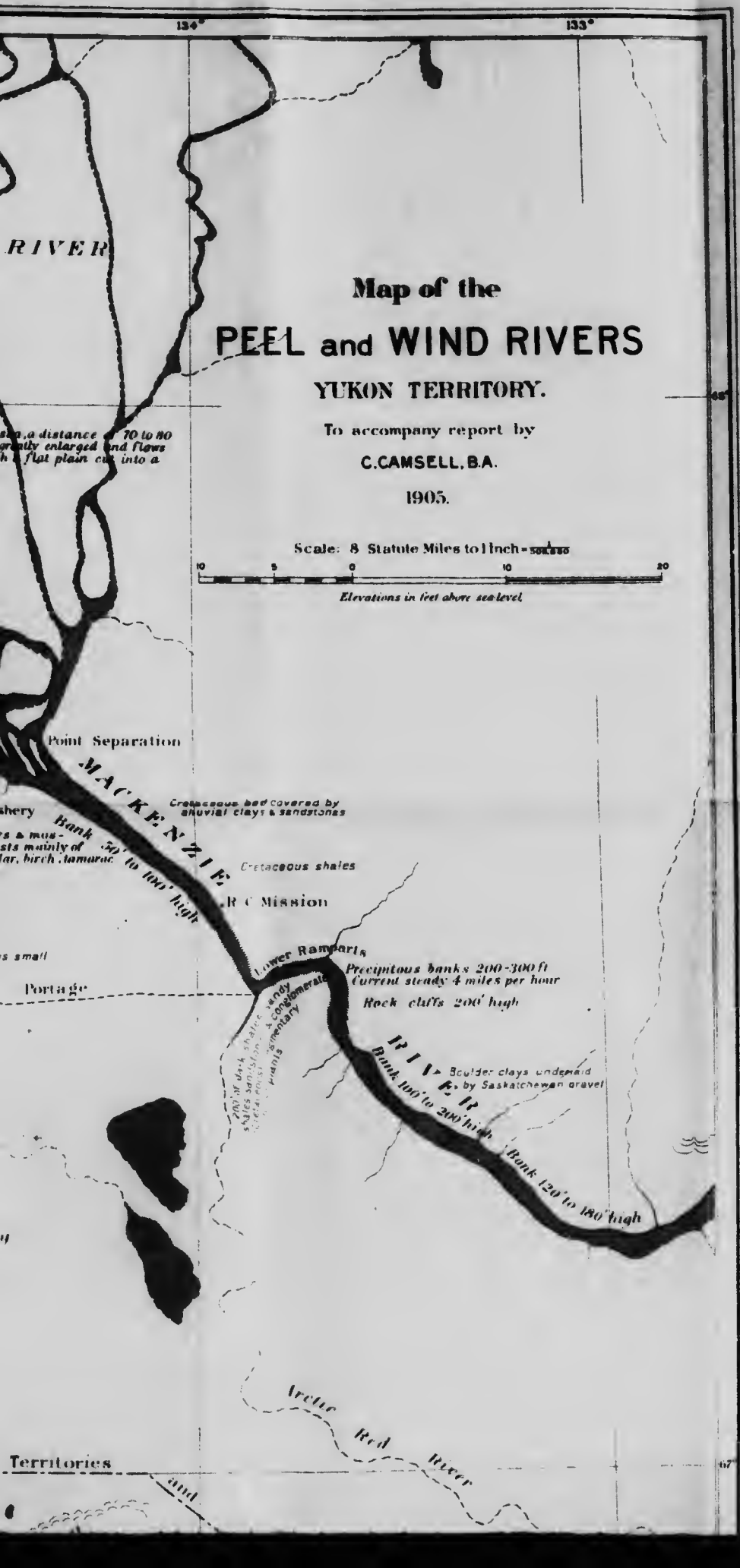
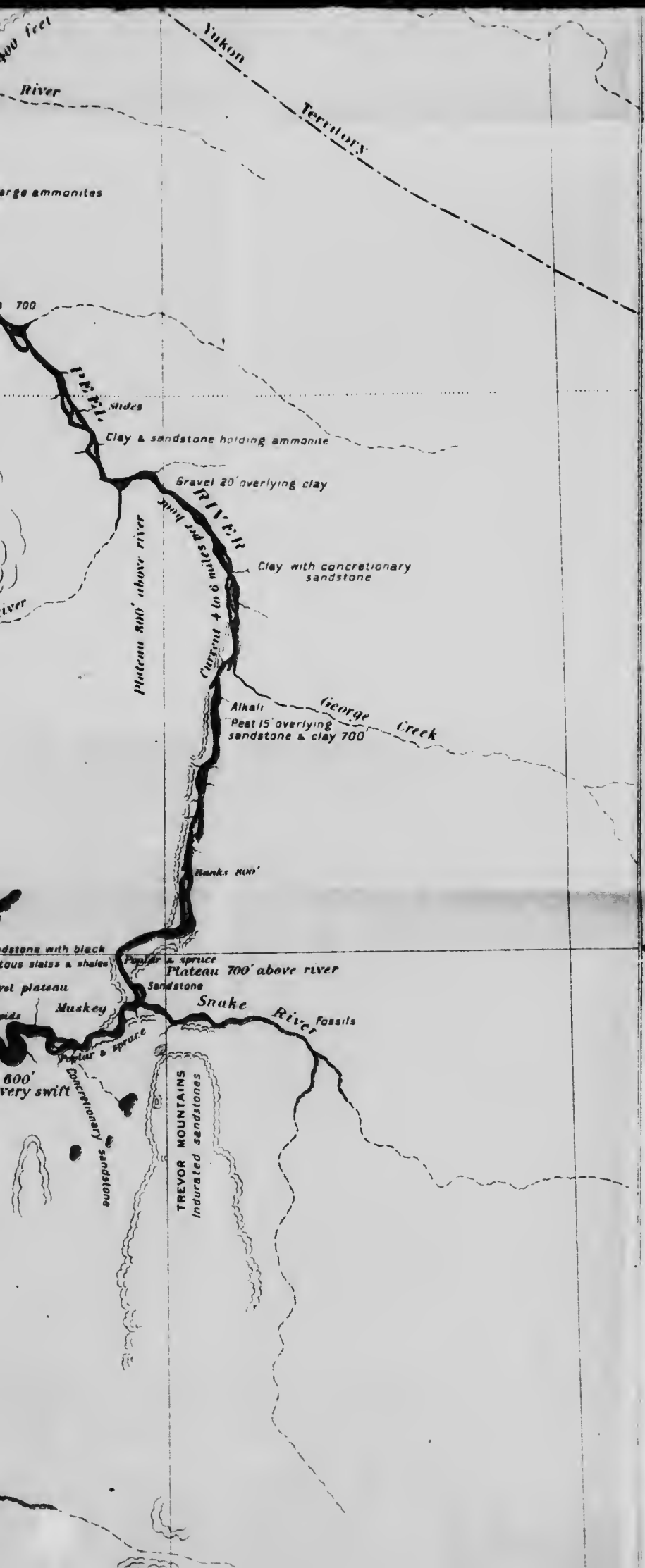
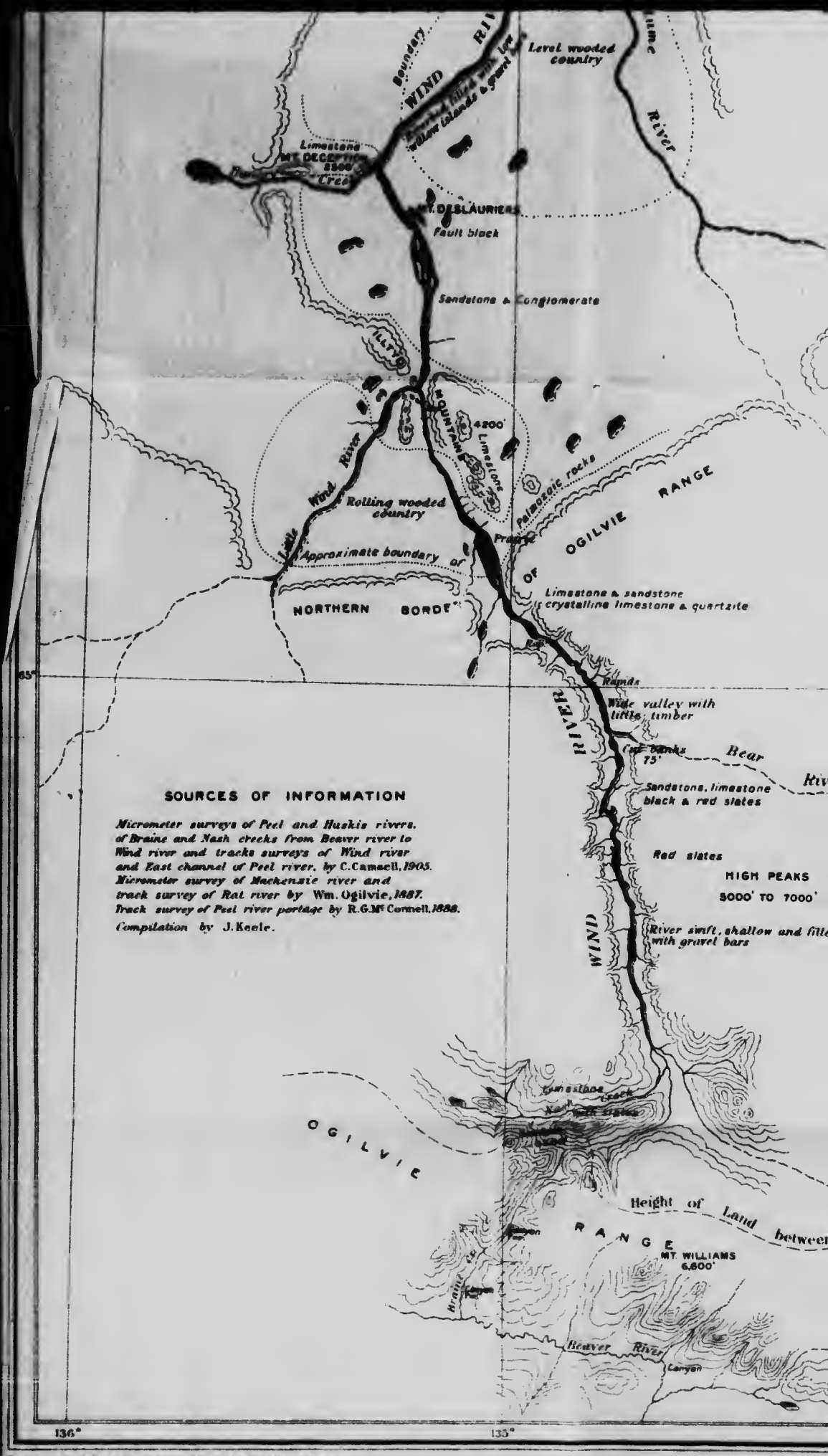



134°
133°
RIVER
Map of the
PEEL and WIND RIVERS
YUKON TERRITORY.
To accompany report by
C. CAMSELL, B.A.
1905.
Scale: 8 Statute Miles to 1 Inch = 506,880
10 5 0 10 20
Elevations in feet above sea-level
Point Separation
MACKENZIE
Cretaceous bed covered by alluvial clays & sandstones
Cretaceous shales
R C Mission
Lower Ramparts
Precipitous banks 200-300 ft
Current steady 4 miles per hour
Rock cliffs 200' high
Portage
Boulder clays underlaid by Saskatchewan gravel
Bank 100' to 200' high
Bank 120' to 180' high
Territories
Arctic Red River


3.- Shales interbedded with sandstones holding carbonized fragments of woods & leaves
5.- Greyish sandstones and quartzites nearly horizontal
6.- Quartzite series dipping to the east at angles of 30° to 70°
Sand & clay banks 30'
Salteh River
400 feet
Escarpment
Clay & soft black shales
Sandstones with large ammon
Soft shales 700
Arctic Circle
Trail
River
RANGE OF HILLS
Caribou
River
Winter Trail
HILLS
ROUNDED
Mountain Creek
Sandstone with b
& pyritous slates &
Level plateau
Rapids
Coal
Canyon
Banks 600'
current very swift
Fault blocks
PEEL RIVER
Canyon
Basin
Black pyritous slates & argillites
ROUNDED HILLS
Lignite
Boundary of Tertiary
Lignite burning Tertiary clays, sandstones & lignite, Springs
Black Slates
Horn
Level wooded country
WIND RIVER
Plume
River
Limestone
MT. DECEPTION
2500'
Creek
MT. DESLAURIERS
Fault block

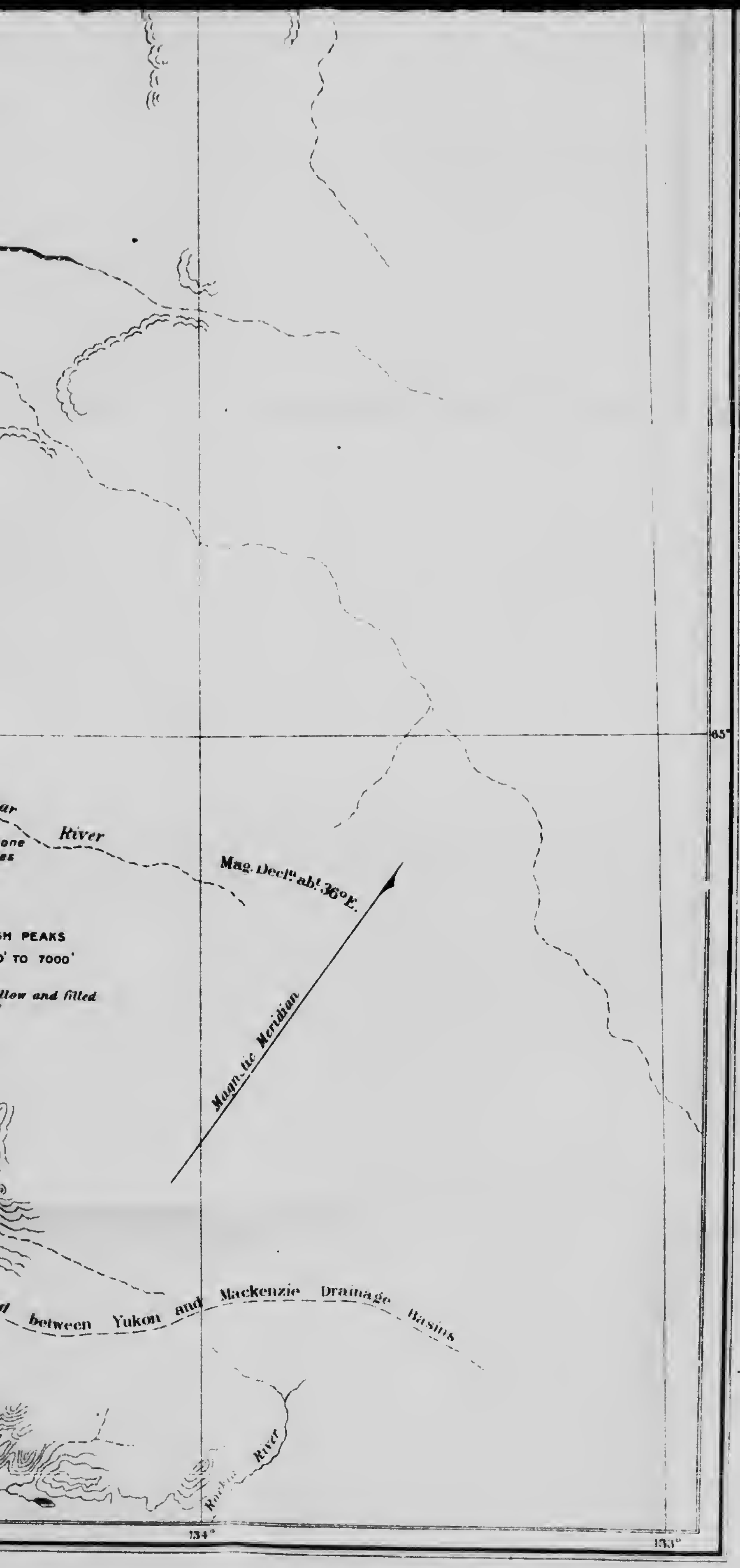

River
Yukon
Territory
erge ammonites
700
Slides
Clay & sandstone holding ammonite
Gravel 20' overlying clay
Clay with concretionary sandstone
Alkali
Peat 15' overlying sandstone & clay 700
George
Creek
Banks 800'
Plateau 800' above river
Current 4 to 6 miles per hour
edstone with black
tous slates & shales
Poplar & spruce
Plateau 700' above river
Sandstone
Muskey
Snake
River
Fossils
Poplar & spruce
600'
very swift
Concretionary sandstone
TREVOR MOUNTAINS
Indurated sandstones



SOURCES OF INFORMATION

Micrometer surveys of Peel and Huskie rivers, of Braine and Nash creeks from Beaver river to Wind river and tracks surveys of Wind river and East channel of Peel river, by C. Camsell, 1905.
Micrometer survey of Mackenzie river and track survey of Rat river by Wm. Ogilvie, 1887.
Track survey of Peel river portage by R.G.McConnell, 1888.
Compilation by J. Keele.

C.O. Sénécal, B.A. Sc., *Geographer and Chief Draughtsman*
P. Frèreault, *Draughtsman*



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